APRIL · 1953

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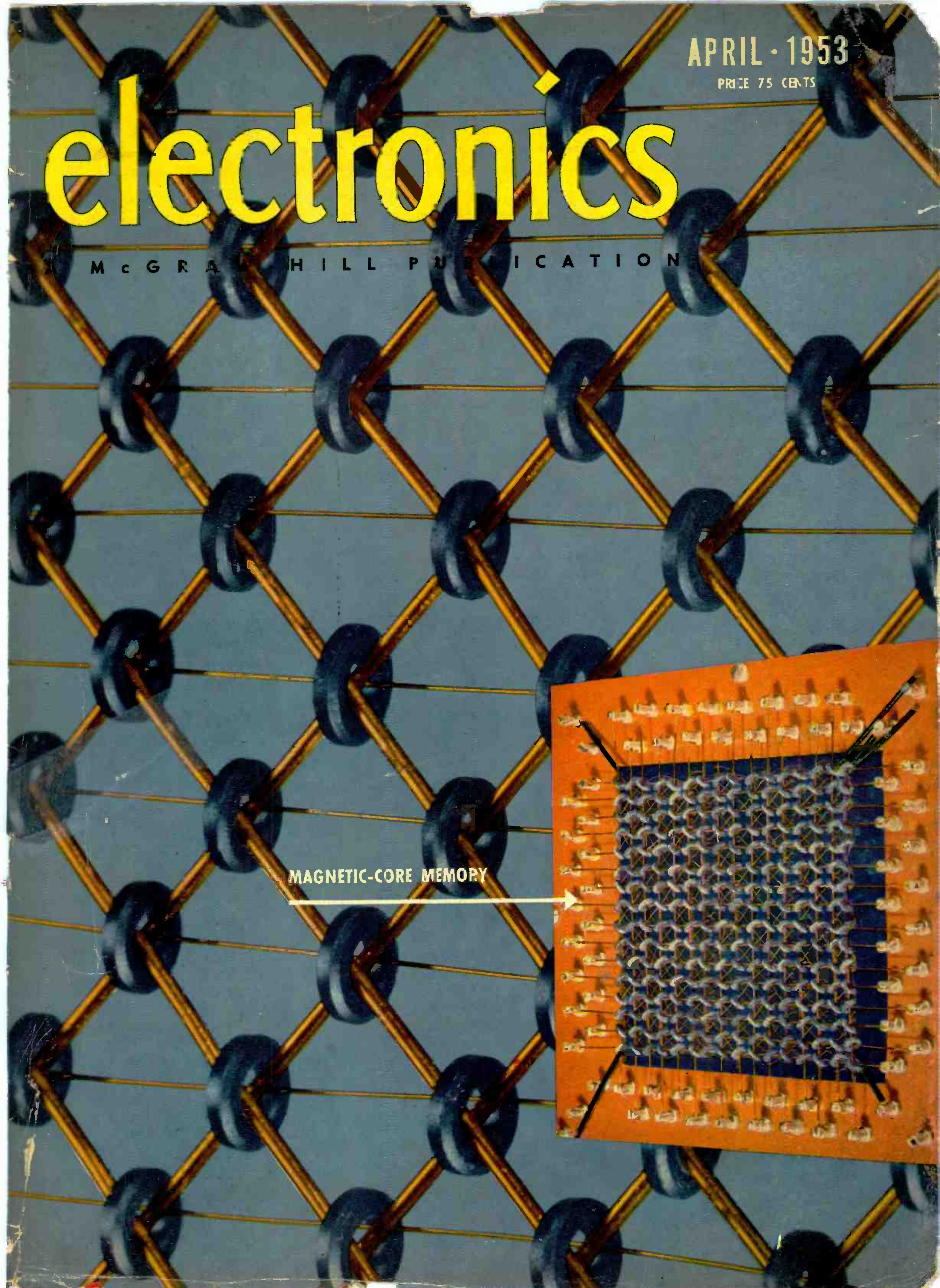

electronics

APRIL • 1953

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MAGNETIC-CORE ME ORY—New coincident-current memory, developed in Digital Computer Laboratory at MIT, uses 256 Ferramic toro s made by General Ceramics & Steatite Corp. For details, see p 146 .... COVER

April, 1953 ELECTRONICS Vol. 26, No. 4

Member ABC and ABP

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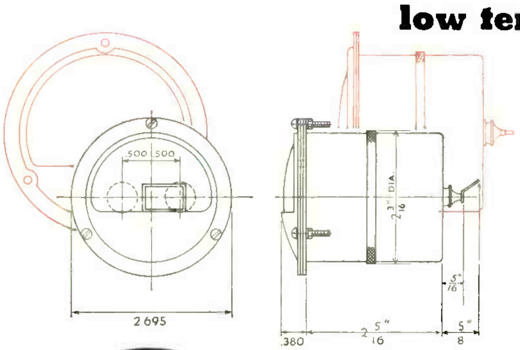

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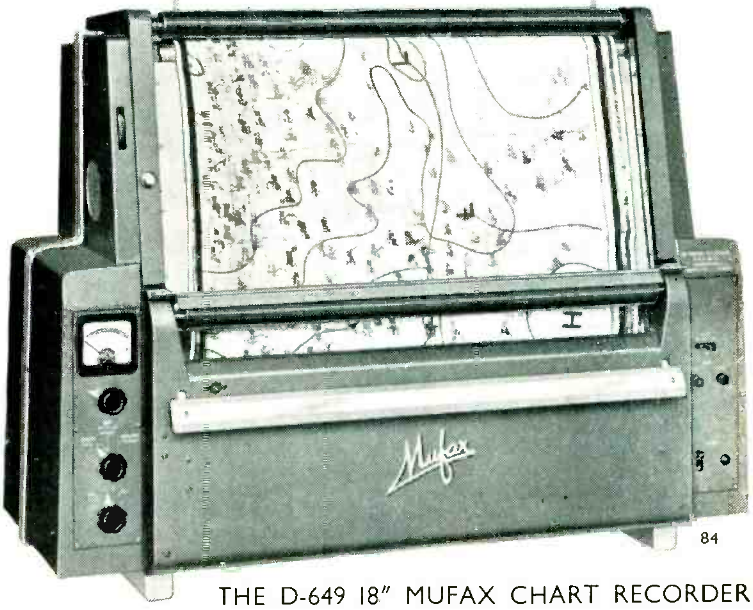

THE D-649 18″ MUFAX CHART RECORDER

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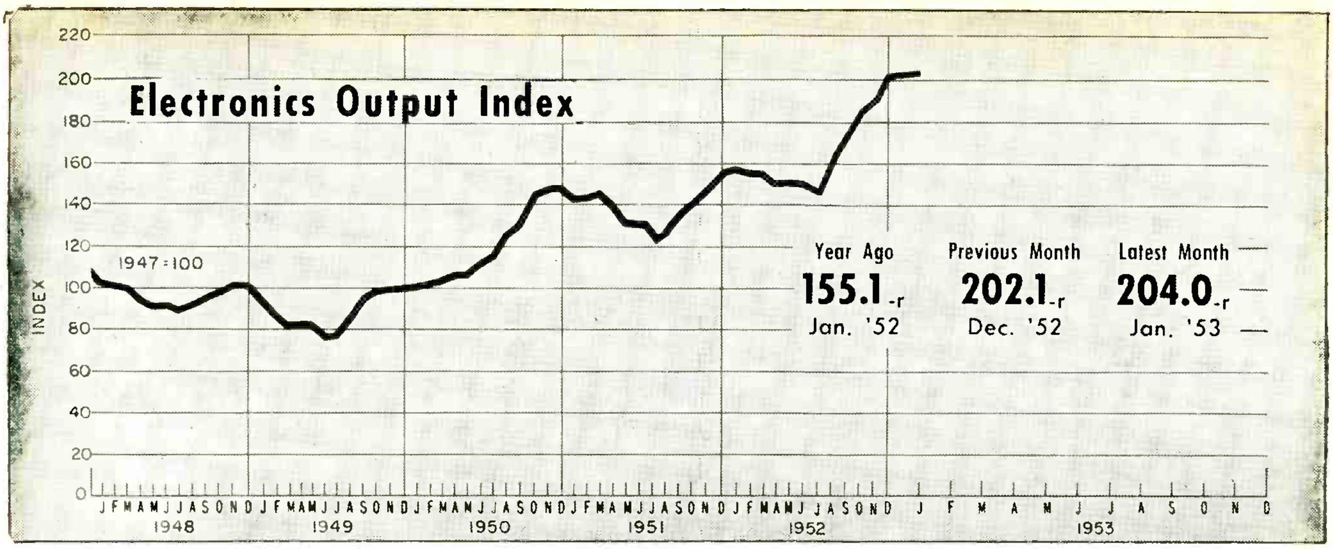


FIGURES OF THE MONTH

RECEIVER PRODUCTION

(Source: RTMA)	Year Ago Jan. '52	Previous Month Dec. '52	Latest Month Jan. '53
Television sets	404,932	921,086	719,234
Home sets	288,724	452,556	361,921
Clock Radios	80,151	271,507	189,592
Portable sets	68,433	194,837	93,962
Auto sets	195,147	406,258	447,667

RECEIVER SALES

(Source: RTMA)		Dec. '52	Jan. '53
Television sets, units	————	1,049,770	640,073
Radio sets (except auto)	————	1,514,688	414,726

RECEIVING TUBE SALES

(Source: RTMA)	Jan. '52	Dec. '52	Jan. '53
Receiv. tubes, total units	26,736,695	43,220,393	37,343,081
Receiving tubes, new sets	15,763,221	31,061,892	25,409,671
Rec. tubes, replacement	6,338,157	8,771,035	9,167,440
Receiving tubes, gov't.	3,209,025	1,745,491	1,576,298
Receiving tubes, export	1,426,292	1,641,975	1,189,672
Picture tubes, to mfrs.	340,192	852,501	825,209

SEMICONDUCTOR SALES

(Source: RTMA)		Dec. '52	Jan. '53
Germanium Diodes	————	1,568,334	1,470,472

BROADCAST STATIONS

(Source: FCC)	Feb. '52	Jan. '53	Feb. '53
TV Stations on Air	108	137	147
TV Stns CPs—not on air	0	177	221
TV Stns—Applications	506	791	815
AM Stations on Air	2,336	2,399	2,409
AM Stns CPs—not on air	74	130	131
AM Stns—Applications	313	246	252
FM Stations on Air	636	612	611
FM Stns CPs—not on air	14	15	20
FM Stns—Applications	8	12	8

COMMUNICATION AUTHORIZATIONS

(Source: FCC)	Jan. '52	Dec. '52	Jan. '53
Aeronautical	31,076	34,600	35,323
Marine	34,310	38,422	38,631
Police, fire, etc.	10,292	12,098	12,234
Industrial	11,859	15,653	15,761
Land Transportation	4,700	5,536	5,531
Amateur	103,570	117,800	117,106
Citizens Radio	792	1,858	1,892
Disaster	26	87	90
Experimental	425	500	507
Common carrier	877	1,023	1,037

TV AUDIENCE

(Source: NBC Research Dept.)	Year Ago Feb. '52	Previous Month Jan. '53	Latest Month Feb. '53
Sets in Use—total	16,129,300	21,234,100	21,907,100
Sets in Use—Netw'k conn.	15,262,600	21,136,900	21,817,200
Sets in Use—New York	2,840,000	3,290,000	3,350,000
Sets in Use—Los Angeles	1,100,000	1,375,000	1,395,000
Sets in Use—Chicago	1,093,000	1,360,000	1,410,000

NETWORK BILLINGS

(Source: Pub. Info. Bureau)	Jan. '52	Dec. '52	Jan. '53
AM/FM—ABC	$3,301,479	$2,856,714	$2,669,327
AM/FM—CBS	$5,161,397	$5,717,800	$5,157,346
AM/FM—MBS	$1,699,282	$1,980,316	$1,786,134
AM/FM—NBC	$4,357,353	$4,370,265	$4,260,555
TV—ABC	$2,020,461	$1,331,588	$1,604,892
TV—CBS	$5,074,643	$7,088,506	$7,321,386
TV—DuMont	$717,148	$1,211,316	$1,000,074
TV—NBC	$7,259,307	$7,830,806	$7,521,553

EMPLOYMENT AND PAYROLLS

(Source: Bur. Labor Statistics)	Dec. '51	Nov. '52	Dec. '52
Prod. workers, electronic	272,100	321,500-r	331,200-p
Av. wkly. earnings, elect.	$65.08	$68.30-r	$69.29-p
Av. wkly. earnings, radio	$60.61	$63.39-r	$63.79-p
Av. weekly hours, elect.	42.4	41.8	42.2-p
Av. weekly hours, radio	41.6	41.0	41.1-p

STOCK PRICE AVERAGES

(Source: Standard and Poor's)	Feb. '52	Jan. '53	Feb. '53
Radio—TV & Electronics	276.2	321.4	304.5
Radio Broadcasters	268.8	300.4	285.1

Quarterly Figures

INDUSTRIAL EQUIPMENT ORDERS

(Source: NEMA)	Year Ago 3rd '51	Previous Quarter 2nd '52	Latest Quarter 3rd '52
Dielectric Heating	$210,000	$510,000	$320,000
Induction Heating	$4,060,000	$2,410,000	$1,760,000
Welding Control	$1,280,000	$1,480,000	$1,810,000
Other Electronic Control	$720,000	$1,020,000	$920,000

INDUSTRIAL TUBE SALES

(Source: NEMA)	3rd '51	2nd '52	3rd '52
Vacuum (non-receiving)	$8,420,000	$12,110,000	$10,580,000
Gas or vapor	$2,620,000	$3,150,000	$2,950,000
Phototubes	$270,000	$480,000	$570,000
Magnetrons and velocity modulation tubes	$3,740,000	$9,830,000	$8,500,000

p—provisional; r—revised; e—estimated

INDUSTRY REPORT

Congress Starts Probe Of Color TV

Senator cries 'holdup', industry says 'not true', as investigation starts

CHARGING that "powerful interests have used every legal maneuver and technical roadblock" to delay the development of color tv until the monochrome market has been exhausted, Senator Johnson of Colorado has asked for a full Congressional investigation.

Senator Tobey, chairman of the Senate Committee on Interstate and Foreign Commerce, has promised a thorough probing.

(The House Commerce Committee under its chairman Rep. Wolverton, R., N. J., began its own tv color hearings March 24.)

▶ **First Step**—In a letter to W. R. G. Baker, chairman of the National Television Systems Committee, Tobey says, in part, "As a preliminary step before embarking on a full study of this problem, the following information is requested:

(a) Does any member of your group plan to manufacture any receiver sets capable of receiving the color signals under the Commission's present standards? If not, why not?

(b) Does any member of your group propose to manufacture receivers capable of receiving color signals under any other standards? For example, under the signals specifically approved by NTSC. If so, when do they expect to start production? If not, why not?

(c) Do you know if anyone is going to request the Commission to adopt new standards for color broadcasts? If so, when and who?"

▶ **Industry's Answer**—In reply to Tobey's request, Baker lists experimental compatible NTSC receiver availability reported at a January, 1953 meeting of his Committee and announces he is sending Tobey complete minutes of NTSC meetings. Baker then says that "Our Committee has concerned itself solely with a significant and highly challenging technical problem: how best to achieve the optimum in terms of a color television system. The only persons on the Committee and associated with its work are scientists and engineers of special technical qualifications. This has been the only limiting factor with respect to participation, since any interested scientist or engineer has been welcome. The Committee has not concerned itself with any phase of production equipment, nor with considerations involving the proprietary interests of members or companies in the industry."

▶ **Prime Objective**—Baker further states that "a primary objective of this Committee was to attempt to create a practical color transmission which would utilize as a foundation the existing monochrome transmission standards. . . Then this important improvement in this service can be realized without reducing the value of a single one of the millions of television receivers owned by the American public."

Reviewing the tv background, Baker says the NTSC monochrome standards established in 1941, adopted by the FCC, have proved to be "soundly engineered" and he intimates that the government freeze on color set construction has been mostly responsible for slowing up market development. A compatible color system is now practicable, Baker feels, and "the completion of extensive field tests scheduled to begin within the next month, should permit a definitive judgment."

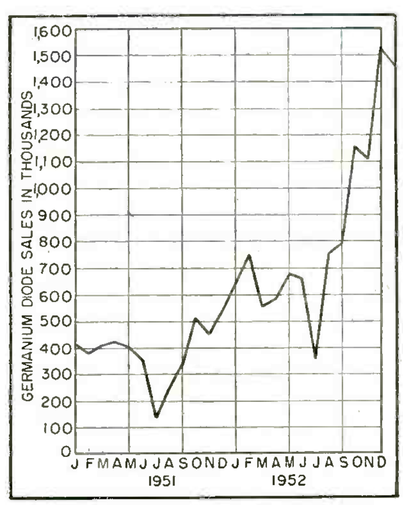
▶ **RCA**—David Sarnoff announced, in the midst of all this, that RCA has spent \$20 million for research and development of color television, \$5 million of it in 1952 and that "these large expenditures are continuing during the present year."

Germanium Diode Sales To Double Again

UHF-TV mixers and video detectors will account for half of expected 20 million in 1953

GERMANIUM diode sales doubled in 1952, and present indications are that they will double again in 1953.

RTMA statistics show that sales in 1952 totaled 9.5 million, as compared to 4.5 million in 1951 and



about 3.7 million in 1950. Sales in 1953 are expected to approach 20 million, with half of this figure being divided between uhf-tv mixers (5 million) and video detectors (5 million) in vhf and vhf-uhf combination sets.

Most impressive jump in sales came in latter part of 1952 when uhf tv became a reality and manufacturers rushed to meet demands of new areas. As shown in accompanying plot of sales by months, figures rose from 350,000 in July to over 1.5 million in December.

▶ **New Service**—Beginning in this issue, monthly germanium diode sales will be reported in the *Figures of the Month* department of ELECTRONICS appearing on page 4. These statistics show combined sales figures for General Electric, Raytheon, Sylvania and Hytron.

Setmakers Watchful As UHF Gains

Sales battle shapes up over r-f tuning methods; consumer reaction awaited

WITH 15 stations on the air and a score or more rapidly approaching completion, uhf television has receiver manufacturers watchful. Biggest question mark is front-end design.

Sets currently available generally feature either of two r-f tuning methods: One uses uhf-converter strips with from 13 to 16 positions. (An 82-channel detent-type tuner was recently announced.) The other method requires a separate tuner or converter that tunes continuously through all 70 uhf channels.

▶ **Enter the Viewer**—Big question is whether the average consumer will readily shell out the extra dollars that all-channel uhf reception might cost.

Manufacturers are divided in their answer. Some have come out four square for strip tuning. Others, particularly those whose vhf sets do not use turret tuners, offer continuous tuning. Still others are riding both ends of the goat and supply both. For the most part, a wait-and-see attitude pervades the industry. Even the staunchest partisans are not producing sets in overwhelming quantity.

▶ **A Look at the Field**—Twenty-four receiver manufacturers were asked about their plans: 11 said they were making uhf sets, 5 said sets would soon be forthcoming, 6 gave no information and 2 disclaimed interest in uhf.

All 24 had something to say about converting their late-model sets already in the field for uhf. Three offered conversion only by adding a continuous tuner, 15 said strips would be available and six offered both.

Of the new sets discussed, six models are continuously tuned, two are strip tuned and three come both ways. Only five set manufacturers responding announced a line of external uhf/vhf converters; two firms said that external converters were under development.

Business Machine Firms Active

Top manufacturers prepare to hasten computers' move from laboratory to office

BUILDING electronic brains for business is the most recent goal of the nation's leading business-machine firms.

Electronic computing techniques, developed during the latter part of World War II, were first applied largely to warlike chores like compiling ballistics tables and meteorological data. The big brains were built chiefly for government labs and universities. Electronic computing captured the popular imagination and names like SEAC, ENIAC, UNIVAC and even MANIAC began to enrich the language.

▶ **Out of the Lab**—After the war, several small firms, long on hair but short on capital, attempted to exploit the new devices commercially. Their machines were still, however, intended for use in laboratories. But, the big brains' aptitude for solving other problems was not lost to canny business-machine company executives. They foresaw use of electronic business machines to keep ledger accounts, make up payrolls, keep running sales records, compute and mail bills and premiums, control industrial production and maintain perpetual inventories.

▶ **Engineers Wanted**—You don't throw an electronic computer together solely by the model-shop pilot-plant approach; high-powered research is prerequisite. Competent engineers are rare birds, however, and how to acquire red-hot electronic research staffs plagued the business-machine people not a little.

Following P. T. Barnums' advice, "If you can't beat them, make 'em part of your act," business-machine firms with sales and application experience and smaller firms with technical know-how began to make sweet music together.

▶ **Many Mergers**—Remington Rand recently acquired Engineering Research Associates of St. Paul, Minn. and Arlington, Va., a well-seasoned electronics firm whose stock in trade heretofore has been custom-building super-secret computing equipment for government labs. ERA joins Eckert-Mauchly, makers of UNIVAC, as a division of Remington Rand.

Underwood has taken over the Electronic Computer Corp. of New York; National Cash Register has teamed up with Computer Research Corp. of Hawthorne, Calif., and Physical Research Co. has said "I do" to Marchand Calculating Machine.

Burroughs Adding Machine is in the electronics business via both their rapidly-expanding Philadelphia research lab and their Brooklyn subsidiary, Control Instrument

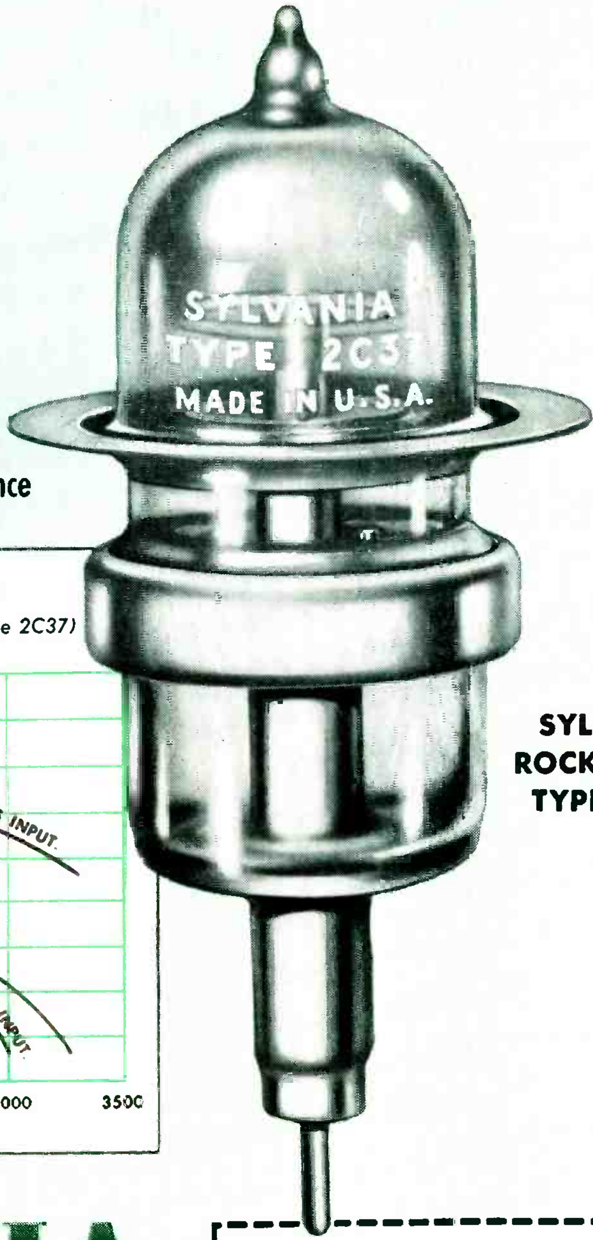
(Continued on page 8)

Here's how to get

GOOD USABLE POWER AT UHF

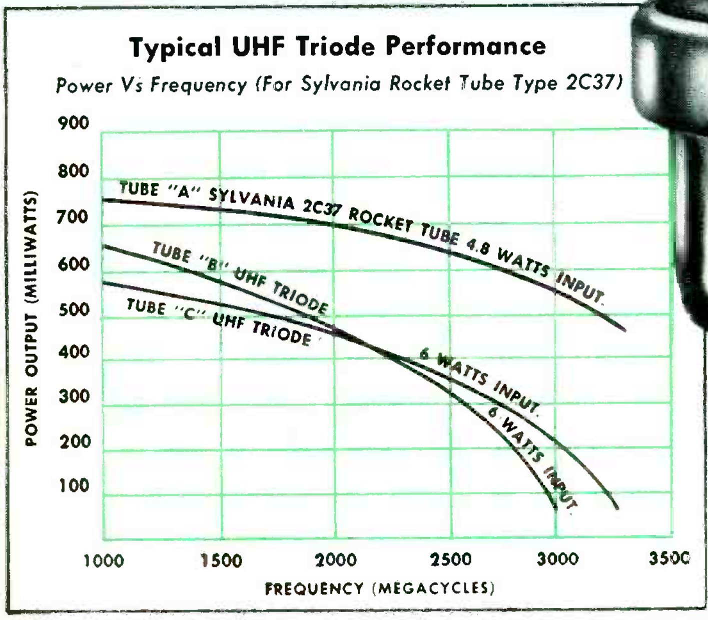
Sylvania Rocket Tube Type 2C37 supplies 450 Mw at 3300 Mc.

Because of their high power throughout the UHF spectrum, Sylvania rocket tubes are especially recommended for service as pulsed oscillators, cw oscillators, rf amplifiers and frequency multipliers . . . this is one more reason why it will pay you to specify SYLVANIA.



SYLVANIA ROCKET TUBE TYPE 2C37

Compare Sylvania Rocket Tube's Performance



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Co. Friden has bought the rights to the Benson-Lehner Computyper and is planning to market a low-cost printing calculator. Victor Adding Machine is energetically casting about for electronics engineers.

▶ **Self-Made Staffs**—In the electronic computer business since 1944, IBM will soon supplant their SSEC in the big-brain bracket with their new model 701. Production is scheduled to be one a month. The 604 printing calculator will remain IBM's entry in the medium price range.

Monroe has been building up its staff since the last war and recently launched the MONROBOT, a medium-priced business-type calculator. No mass production plans have been announced.

New Process Cuts Cost of Germanium

Rare transistor material is extracted from waste coal-gas liquid at half of present costs

ADDITION of processing facilities to the Omori plant of Tokyo Gas Co. will make possible the production of 100 grams of pure germanium a day from waste liquid, at about half the cost of present U.S. production methods. This and other Japanese pilot-plant installations now under way are expected to produce over 200 pounds of the precious metal this year. Present world output is only about 3 tons a year.

▶ **Process Details**—Black sediments are filtered out of the waste liquid, heated and burned with tar to get a reddish powder. Chloric acid is added and the powder is distilled to get germanium tetrachloride vapor at 85 deg C. Running this through water gives white germanium oxide which, when mixed with hydrogen gas at 900 deg C, gives 99.99 percent pure germanium.

The rare metal gallium, also essential to the electronics industry, can be obtained by extracting gallium tetrachloride from the sediments of germanium tetrachloride vapor with a solvent and electrolizing the extract.

Patents on the process have been applied for in 12 countries, including U.S., by inventor Masaru Inagaki, who is an engineer with the Coal Research Institute in Tokyo. The new process eliminates the problems of removing impurities such as arsenic and antimony, encountered in the present method which uses coal soot or coal ash.

BUILT-IN radar and target computer provide . . .

New Eye and Brain for AA Guns

BIGGEST peacetime military contract ever received by Sperry Gyroscope is for 'Skysweeper', the Army's largest-caliber automatic antiaircraft gun with radar, target computer and weapon on a single mount.

The weapon spots and tracks an enemy plane flying at near-sonic speed, aims and fires at a rate of 45 rounds per minute. It finds and tracks at 15 miles and provides effective shoot-down range of 4 miles.

▶ **Dollars per Gun**—Cost of the fire-control system is about 75-percent of the gun unit which costs \$240,000. Spares, tools and test equipment cost \$60,000, and the prime mover, a cargo tractor, \$85,000, to a total of \$385,000.

A complete Skysweeper has 317 electron tubes, 12,000 parts and 4,500 items in tools, test equipment and spare parts. A total of 18 harnesses connect the chassis. One of these contains 600 wires and three have 400.

Feasibility of an automatic on-mount radar fire control combined with a rapid fire antiaircraft gun was studied by Army Ordnance and Sperry in 1943.

Development work on the gun during the next few years resulted in the first complete experimental weapon being delivered to Ordnance in 1948.

This and the second system delivered one month later were given extensive evaluation tests at Aberdeen Proving Ground, Md. and Fort Bliss, Texas.

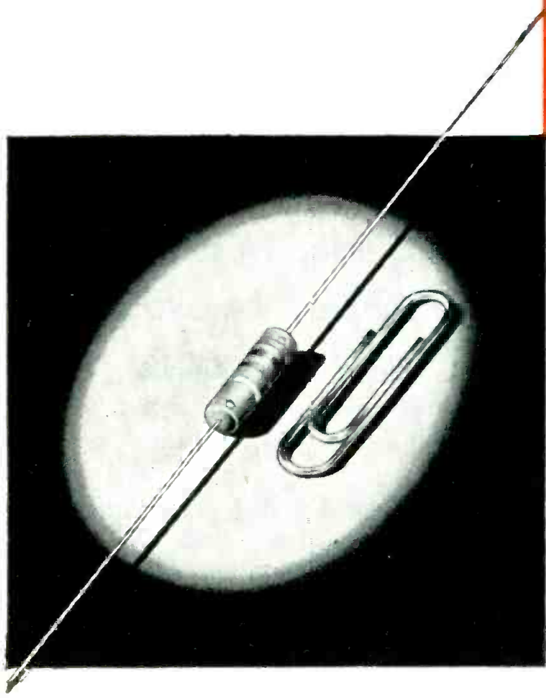
▶ **Speed Up**—A closely coordinated package subcontracting plan was

(Continued on page 10)

PROKAR® miniature molded CAPACITORS

...now all rated for operation at

125°C



NEW processing developments now make it possible for every Prokar miniature molded capacitor to be used at temperatures up to 125°C without voltage derating!

An exclusive Sprague solid dielectric and a mineral-filled phenolic jacket assure stable performance from −55°C to +125°C.

Ten mold sizes—ranging upwards from the .175" dia. x 5/8" long unit pictured actual size at left—give you maximum space economy in miniaturized equipments. Originally developed for military uses, the moderate prices of these miniature capacitors make them well worth your investigation also for use in dependable commercial electronic equipment. Write today for Engineering Bulletin 205F to the Sprague Electric Company, 35 Marshall St., North Adams, Massachusetts.

SPRAGUE WORLD'S LARGEST CAPACITOR MANUFACTURER

EXPORT FOR THE AMERICAS: SPRAGUE ELECTRIC INTERNATIONAL LTD., NORTH ADAMS, MASS. CABLE: SPREXINT

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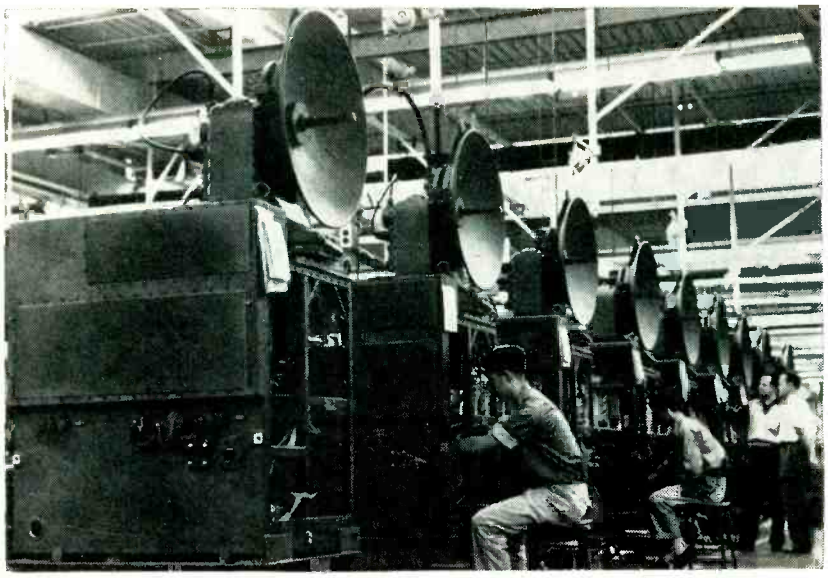


Production lineup of radar trackers for the Skysweeper

evolved, whereby other manufacturers could produce complete subassemblies of the system. This spreading of the work reduced lead time by one year and utilized surplus capacity of other manufacturing facilities.

Army Ordnance awarded Sperry a multi-million dollar contract to produce the fire-control systems at a high rate in December 1949. By February 1950, more than 20 subcontractors had started work on package units, while numerous parts designs were released to hundreds of small businesses.

A second-source prime contract was awarded to AC Spark Plug Division of General Motors, for additional production of Skysweeper fire control systems. Under an assistance agreement, Sperry provided AC Spark Plug with technical aid.

Radio-TV Industry Holds Price Line

Full price decontrol has not yet brought general price increases on parts or receivers

MANY industry observers thought that radio-tv parts and receiver manufacturers would take quick advantage of the recent decontrol of prices in the industry to up profits via price hikes. But so far, the industry in general has pretty well held price lines.

▶ **Parts Manufacturers**—Component makers themselves were of the opinion that most parts companies would raise prices as much as 10 percent as soon as the lid came off and that in a short time the industry as a whole would climb to a higher price structure. No such concerted movement has yet taken place. As a result of rising copper costs some parts manufacturers have upped prices on yokes, transformers and hookup wire but the number of companies doing so is still small.

Parts makers and buyers generally laud an announcement by Motorola. Even before full decontrol had taken place, Paul V. Galvin, president of the company, announced a 2-point policy: "(1) No increases will be allowed on any of our radio and television prices this year. Our basic policy will be to lower prices, if possible. (2) Because of the criticalness of our own cost-price relationship, all requests for price increases from our suppliers during the next few months will be examined by a committee of top management, including myself. This committee intends to follow the materials market in detail and to know whether companies among our suppliers look upon their relationship with Motorola with the long view in mind or only for the immediate gain."

▶ **Set Manufacturers**—Before the first of the decontrol actions had been taken, the beginning of an upward trend in tv receiver prices had begun. Admiral had raised prices on 8 tv models from $10 to $60 each. Emerson followed with an increase in list prices on 4 tv models of from $20 to $30 due to increased cost of cabinets and components. CBS-Columbia also raised prices on some models. However, none of these increases were made as a result of decontrol.

Guided-Missile Plans Make Progress Slowly

Three-billion dollars buys much research but little production

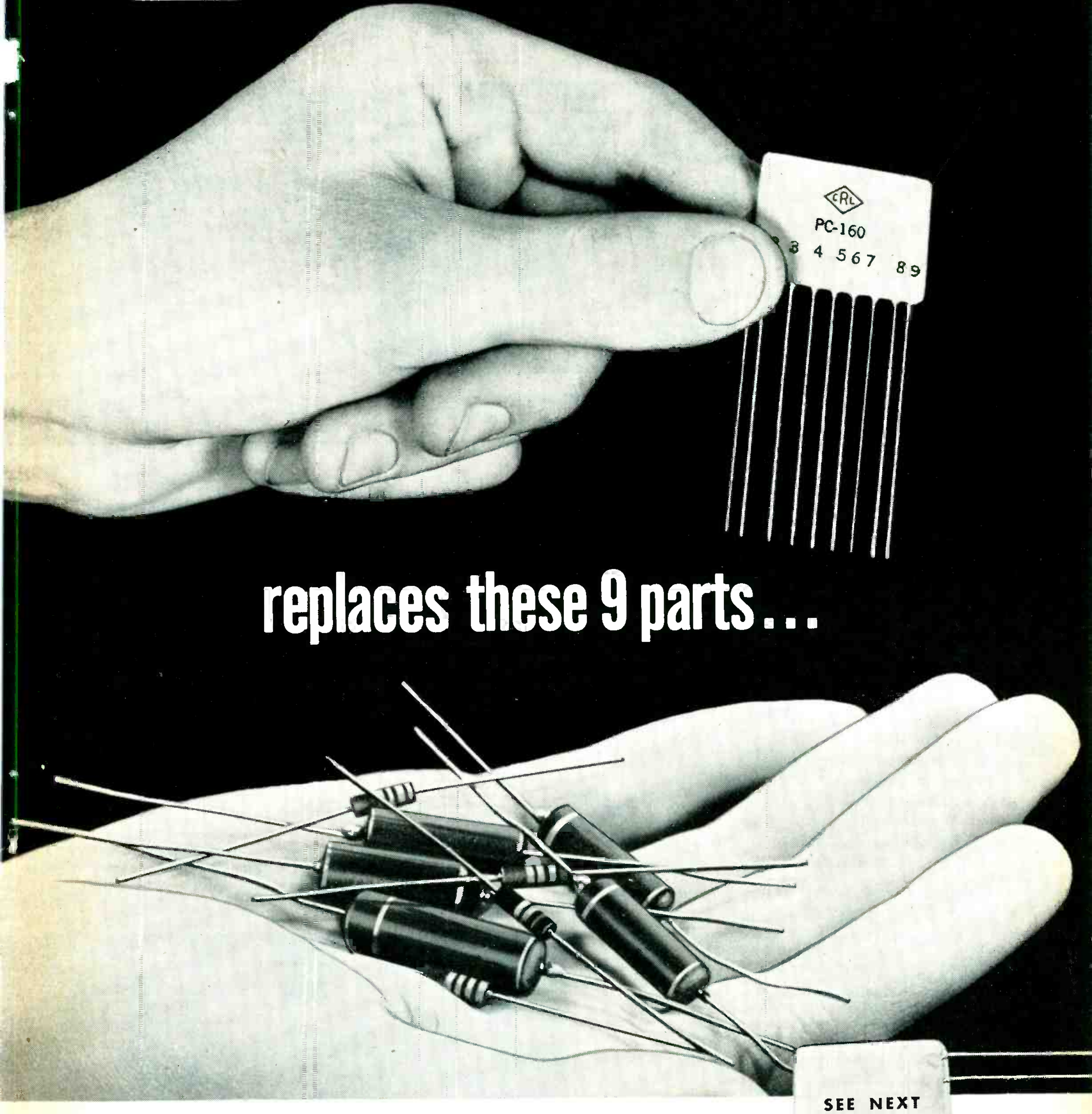
WHEN a rocket blasts off, it rises slowly in a cloud of dust and flame. Then it hovers precariously and for a sickening, dizzy second seems about to topple over. However, it begins to rise, gather speed and disappear from view, only to reappear seconds later as a wispy, silver trail spiraling in the stratosphere.

The entire guided-missile program seems to be at the second crucial point.

▶ **Cost**—Since June 1950, the guided-missile program has cost about 4 billion. The level of spending is rising steadily. The Air Force will spend $300 million this year as against $130 million in 1952 and $150 million in 1951. The

(Continued on page 14)

This *New* Centralab Printed Electronic Circuit

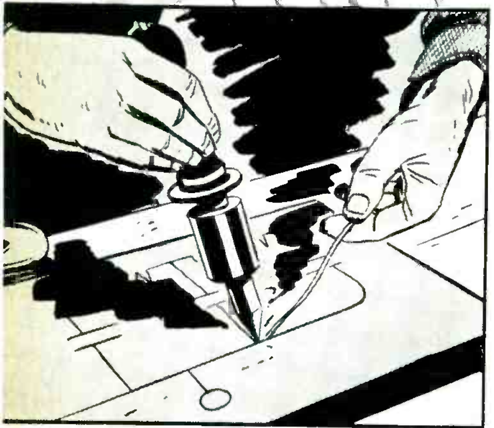


replaces these 9 parts...

but that's not all!

SEE NEXT TWO PAGES FOR COMPLETE DETAILS

Centralab Printed Electronic step up production,



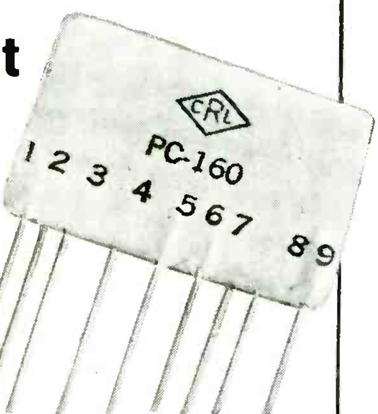
1 25% to 80% fewer soldered connections — speeds assembly

2 Fewer pieces to buy or inventory — saves money, saves time

3 Fewer connections minimize wiring errors — speeds production

Another Centralab *first!*

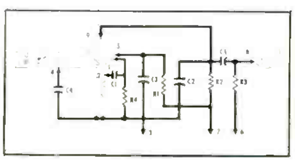
New Pendet



— a complete pentode detector and audio coupler circuit that replaces 9 parts . . . eliminates 9 soldered connections

Talk about compactness — this new Pendet has it! You get 4 resistors and 5 capacitors screened and fired to a *single* Ceramic-X plate. It replaces 9 conventional components. Only 9 connections are required instead of the usual 18.

Think what this terrific PEC "package" can do in simplifying installation and cutting manufacturing costs of ac, dc and portable receivers. Get complete information on this new PC-160 Pendet NOW. Check No. 42-149 in coupon.



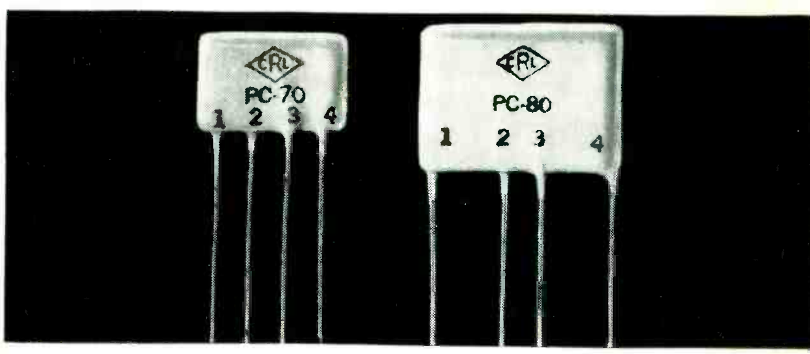
Pendet couples the combination detector and first audio pentode tube to the audio output tube. Plate is only 1-5/16" x 7/8" x 11/64" thick. Leads are 2-1/2" long. Capacitors are 450 vdcw, 800 vdc test. Resistors are 1/5 watt.

For scores of electronic applications — Centralab PECs give you 6 tremendous SAVINGS

Any way you look at them, Centralab Printed Electronic Circuits mean more money in your pockets. No other modern electronic development offers you *six* such tremendous time and cost-saving advantages for low-power applications.

Pioneered and completely developed by Centralab, these resistor-capacitor combinations in complete or partial circuits are extremely economical to use. Many times, the *first cost of PEC's* is less than the components they replace.

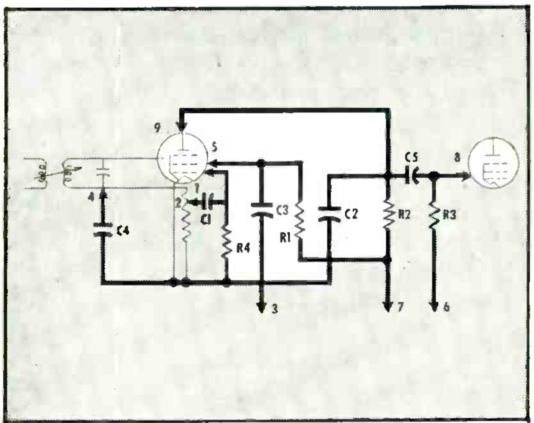
As for versatility—there are more than 30 standard



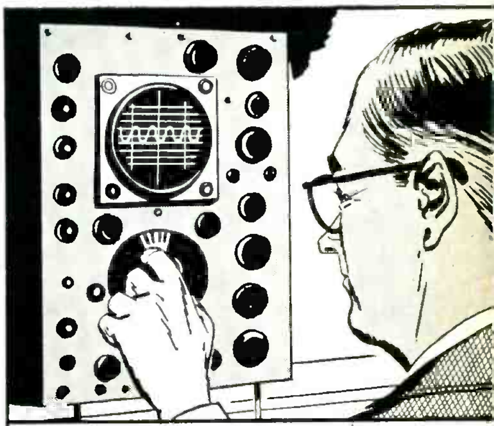
CENTRALAB TRIODE COUPLATES replace 5 components normally used in audio circuits. Triode Couplates are complete assemblies of 3 capacitors and 2 resistors bonded to a dielectric ceramic plate. Available in a variety of resistor and capacitor values. Technical Bulletin 42-127.

Circuits simplify design, improve performance

4 Lower installation cost — compared with separate components



5 Less weight, less space — "opens-up" tight chassis



6 Improved circuit stability due to uniformity of PEC plates

circuits already tooled for you. Those illustrated here can only suggest the wide range of sizes and capacities available.

If you have a special circuit problem, we'll even design custom plates at nominal cost where volume warrants. *No wonder 25,000,000 PECs are in use today!* No wonder scores of manufacturers say it's *good business* to specify and use Centralab Printed Electronic Circuits. Send coupon for full details.

Centralab

A DIVISION OF GLOBE-UNION INC. • Milwaukee 1, Wisconsin
In Canada, 635 Queen Street, East, Toronto, Ontario

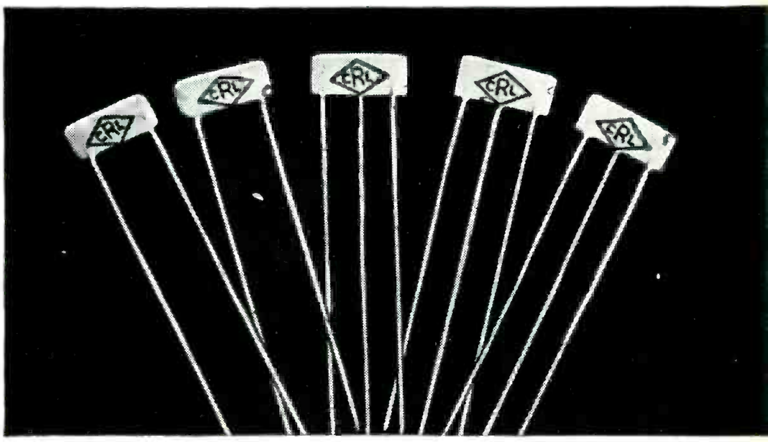
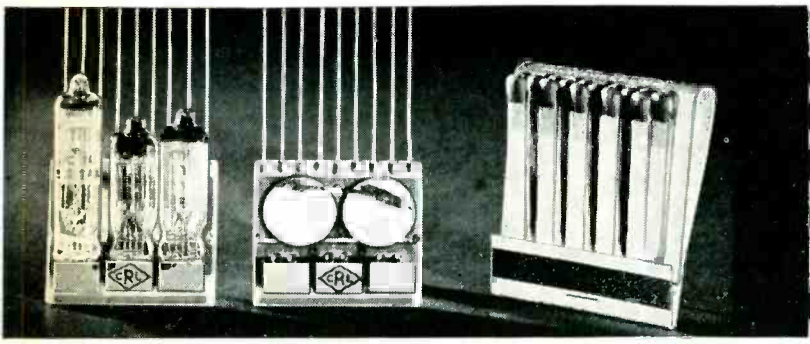


PLATE CAPACITORS AND RESISTOR-CAPACITORS. Excellent for miniature use. Actual size photograph. Because of extremely small size, they readily fit all types of miniature and portable electronic equipment — overcome crowded conditions in TV, AM, FM and record player chassis. Technical Bulletin 42-132.



AMPEC — A full 3-stage speech amplifier. Provides highly efficient performance. Size 1¼" x 1⅛" x ⅜" over tube sockets! Used in hearing aids, mike preamps and other applications where small size and outstanding performance count. Technical Bulletin 42-117.

CENTRALAB, A Division of Globe-Union Inc.
914-D East Keefe Avenue, Milwaukee 1, Wisconsin

I'd like to know more about Centralab Printed Electronic Circuits. Please send the bulletins as checked below:

☐ 42-117 ☐ 42-132 ☐ 42-127 ☐ 42-149

☐ PEC Guide No. 2 (A complete and comprehensive reference on PEC's).

Name..

Company..

Title..

Address..

City........................Zone..........State........................

Navy will shell out about $242 million. About half the money will go for electronic equipment for missile guidance and control. Other expenditures, not included in the guided-missile figures, will be made for vital ground equipment such as radar.

▶ **What Did It Buy?**—The money has been spread thinly. Research projects have ranged from developing new rocket fuels to compiling exhaustive meteorological statistics. Engineering staffs have had to be hired and trained. Aircraft manufacturers like Hughes and Martin found themselves in the electronics business while firms like Sperry and Raytheon have had to tackle problems of airframe design.

A list of companies in the field reads like a Who's Who of Industry and includes such firms as: Aerojet, Bell Aircraft, Bell Telephone Labs, Boeing, Consolidated Vultee, Douglas, Fairchild, General Electric, Northrup, Reaction Motors, Ryan Aeronautical and Western Electric.

Much of the money has gone for real estate. The armed services are operating 51 major facilities connected with the guided missile program.

▶ **Progress**—Two new Army missiles near the production stage are the Corporal E and the Niki. The Corporal E is a long-range missile for use against ground targets that the Army hopes will take over some of the chores heretofore done by big guns.

Already in use training Army GM battalions is the Niki, supersonic ground-to-air missile that the Army hopes will supply the antidote to swift high-flying bombers.

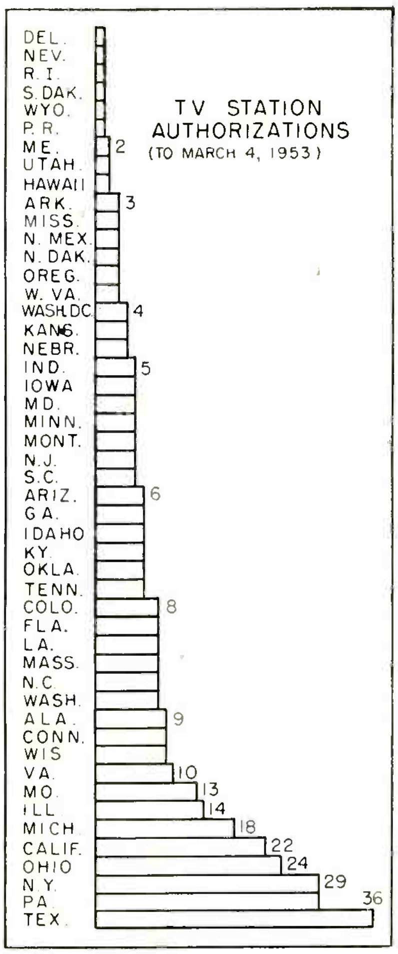
The Corporal E will be produced by the Firestone Tire and Rubber Co. The Niki is a joint development of Douglas and Western Electric.

The Navy will soon get its guided missiles ships, the Boston and the Canberra. Four other ships are already listed as part of the program. These include the battleship Mississippi, the seaplane tender Norton Sound and the submarines Cusk and Carbonero.

▶ **Components**—Battling the twin enemies of missile electronics, heat and size, engineers have worked up a host of new components. These include carbon and boron-carbon film resistors, tantalum-foil and barium-titanate capacitors, tiny magnetic amplifiers and silicon transistors.

The ceramic vacuum tube may provide an answer to operation of tubes at high ambient temperatures. New tubes, using ceramics bases instead of glass are said to operate at several hundred degrees centigrade.

TV Station Status



Total of 385 television station authorizations granted by the FCC to March 1953 show Texas, New York and Pennsylvania in the lead. Only two states (New Hampshire and Vermont) and two territories (Alaska and the Virgin Islands) do not yet have tv authorizations

Railroad Telephones Employ Transistors

WIDESPREAD use of transistors in the railroad field may result from an improved telephone subset developed by Baltimore and Ohio engineers. Used on heavily-loaded train-dispatching circuits, the device employs a single *pnp* junction transistor connected in a base-input amplifier circuit.

▶ **Power**—Direct-current supply is no problem since, in railroad practice, a local 4½-volt battery is normally used to power the telephone's carbon microphone. The subset provides 20 db gain, which exceeds that normally obtained from a telephone repeater on a dispatching line.

Fifteen transistor-amplifier subsets are in use in the B&O's fireline plant.

'Time Compressor' Does An Hour In 45 Minutes

Invention speeds up words or music without changing tone or ease of understanding

INVENTED by Grant Fairbanks, W. L. Everitt and R. P. Jaeger at the University of Illinois, an interesting new machine trades time against frequency, eliminates 'temporal redundancies' and proves that the ear is quicker than the tongue.

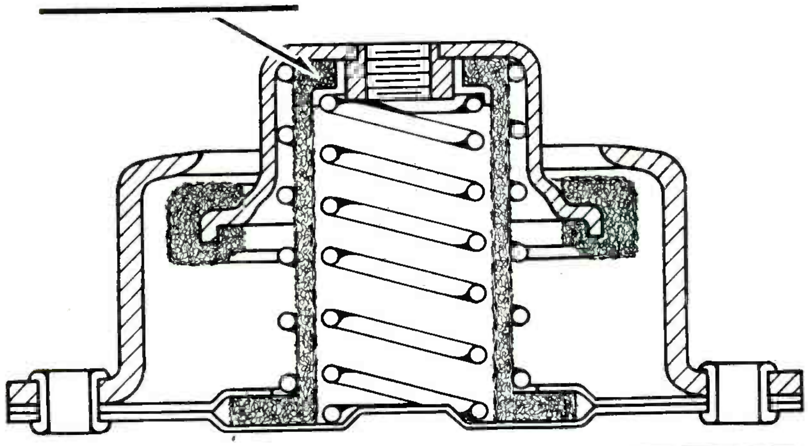
Speech and music compressions up to 10 percent go unnoticed by listeners, and more than 50 percent of the time can be thrown away without destroying understandability. This allows programs, for example, to be fitted exactly to allotted time.

▶ **How?**—Heart of the device is a revolving drum carrying four magnetic-tape pickup heads. An endless loop of tape passes around the drum and over erasing and record-

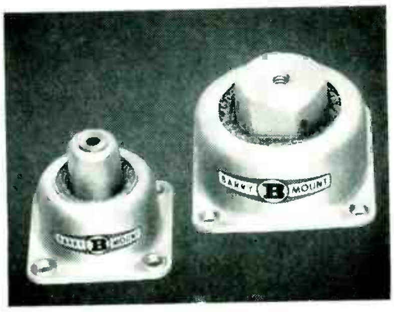
(Continued on page 16)

SHOCK AND VIBRATION NEWS

HERE'S THE SECRET



. . . of a NEW wire-mesh isolator that won't change on the job!



The new Type 7630 and Type 7640 ALL-METL Barrymounts have been specifically designed to eliminate loss of efficiency due to damper packing. Previous wire-mesh unit vibration isolators exhibited a definite loss of damping efficiency after a period in actual service, because the wire-mesh damper tended to pack. These new unit Barrymounts have eliminated this difficulty, because load-bearing spring returns damper to normal position on every cycle.

- Very light weight — helps you reduce the weight of mounted equipment.
- Hex top — simplifies your installation problems.
- High isolation efficiency — meets latest government specifications (JAN-C-172A, etc.) — gives your equipment maximum protection.
- Ruggedized — to meet the shock-test requirements of military specifications.
- Operates over a wide range of temperatures — ideal for guided-missile or jet installations.

Compare these unit isolators with any others — by making your own tests, or on the basis of full details contained in Barry Product Bulletin 531. Your free copy will be mailed on request.

Free samples for your prototypes are available through your nearest Barry representative.

THE BARRY CORP.

707 PLEASANT ST., WATERTOWN 72, MASSACHUSETTS

SALES REPRESENTATIVES IN

Atlanta Baltimore Chicago Cleveland Dallas Dayton Detroit Los Angeles Minneapolis New York Philadelphia Phoenix Rochester St. Louis San Francisco Seattle Toronto Washington

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ing heads. The speed of drum and tape can be adjusted independently to vary the amount of time compression.

Based on physical sound research, the electro-mechanical tape scanner samples the recording so as to eliminate redundant parts of the sound, without altering the original pitch, allowing the recording to be tailored to a desired length. Used on popular recordings, the device plays songs compressed 30 percent, which some listeners insist sound better than the original.

▶ **It Stretches, Too**—Time can be expanded by maintaining sounds longer than originally recorded. Also, by holding time constant, the frequencies can be compressed to a narrow band, so that more signals can be sent on a wire or radio channel. At the receiving end, the sound can be reshaped to its original pitch.

Flying Lab Services Radar Sights

Jet fighters are readied for action at front-line airfields by electronic test trailer

COMBAT ZONE maintenance and repair of complicated radar-controlled gun sights is routine work for the flying repair shop shown in the photograph. The seven-ton van and its crew of specialists can be loaded aboard a plane in 30 minutes and flown to advanced airfields for service jobs that once required shipment of equipment back to the United States.

This new approach to servicing will permit a saving of about $18,000 for every hundred items repaired. It also reduces the total number of gun sights needed by the Air Force.

▶ **The Works**—The van carries a complete line of electronic test equipment including provisions for accurate calibration work. Also included are all necessary tools, spare parts, modification kits, work benches, cabinets, and complete air conditioning and power plants.

The first fully-equipped van was outfitted and ready to go just 30 days after the empty van was acquired. Parts were flown from all parts of the country to the assembly point at Gentile Air Force Depot at Dayton, Ohio.

Radar gun sights are repaired in field by flying electronics laboratory shown being loaded into C-124 Globemaster for transport to Korea.

Broadcasters' Remote Operations On-Off

Engineer unions file objections to relaxation of rules on operator requirements

WITH TV OPERATIONS requiring skilled technicians, and facing decreasing a-m broadcast income, station owners, through NARTB, petitioned FCC for help. They requested relaxation of operator requirements and permission for remote control of certain a-m, as well as f-m stations (ELECTRONICS, p 8, July 1952).

Effective March 6, 1953, FCC ordered into force its proposal of last June. Under these revised rules persons holding restricted radio-telephone operator permits or higher are permitted to stand required regular transmitter watches at a-m and f-m broadcast stations employing nondirectional antennas and operating with 10 kw or less power. Remote control of such stations is also permitted.

▶ **The Switcheroo**—As of mid-January there were 17 f-m stations using remote control under special grants, 5 more with permits and a couple of a-m stations with permits but not yet remotely operated. More broadcasters were undoubtedly planning to get going under the blanket rule revision. One day before the effective date, FCC gave notice it was staying the revision.

Reason for the delay was a request by the International Brotherhood of Electrical Workers, asserting it was about to file a petition for reconsideration. It is expected that the union will base its objection on grounds of national security, having contended before that unskilled operators may be unable to shift transmitter frequencies properly for implementation of the 'Conelrad' plan.

▶ **Other Beefs**—Last-minute action by FCC may have resulted partly from other pressures. The National Association of Broadcast Engineers and Technicians, too, has addressed

(Continued on page 18)

Memo to T-V Station Chief Engineers

SAT., FEB. 1

JAN. 11, 195

T·V monitor for the VHF and UHF bands

Channels **2** *to* **83**

This instrument — the first UHF Monitor — is another example of the pioneering in engineering, design and workmanship which has characterized G-R monitoring equipment since the beginning of broadcasting.

FEATURES

★ *Continuous indication of percentage modulation and frequency deviation of aural and visual transmitters — large illuminated meter scales permit reading at a glance*

★ *High Stability*
Visual Monitor — ±500 cycles
Aural Monitor — ±1000 cycles
On all VHF channels, the above accuracy is guaranteed for at least thirty days — at the lower UHF frequencies (channel 14), the period is over sixteen days — on channel 83, the period is ten days or more

★ *High-fidelity audio output for distortion and noise-level measurements, and for audio monitoring — residual noise level is down 65 db or better for 25 kc deviation*

★ *Overmodulation alarm for aural transmitter — lamp flashes when modulation exceeds predetermined level set by dial*

★ *Sensitivity for both Aural and Visual inputs*
High Impedance Input (VHF) — 1 volt or better
Low Impedance (UHF) — 500 mw or less

★ *Excellent signal-to-noise ratio through channel 83*

★ *Separate heater inputs allow direct connection of crystal oven to station standby power*

★ *Pilot lamp indicates adequate r-f input level*

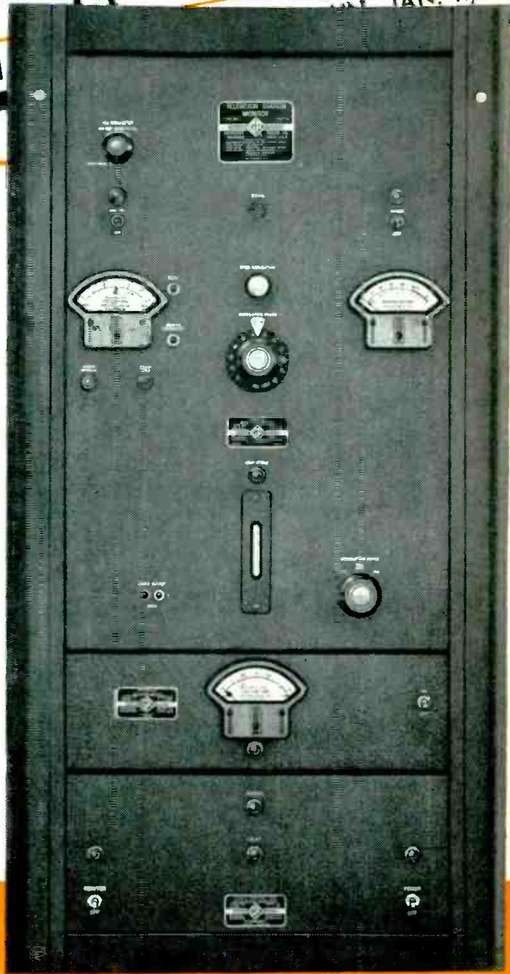
★ *Terminals are provided for connecting remote center-frequency and modulation meters and overmodulation indicators*

★ *Counter-type discriminator linear to better than 0.1% for ±100 kc range, permitting accurate distortion measurements and center-frequency indications reliable even with heavy modulation*

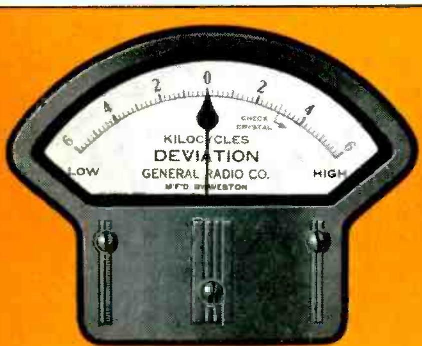
★ *New cabinet arranged for maximum heat dissipation and easy installation or removal for servicing*

The G-R Type 1183-T T-V Monitor meets all requirements of the FCC, including those established for offset operation. It not only provides complete monitoring facilities for VHF and UHF stations in accordance with FCC specifications, it assures the quality of everyday transmissions as well. Monitoring of distortion, noise, modulation level, and video and audio carrier frequencies, with the aid of this instrument, results in the rapid detection of substandard operation.

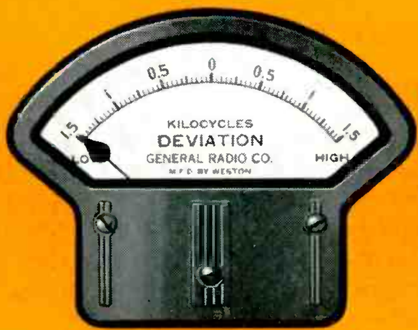
Conveniences for operating personnel are a major feature. The relatively high stability of the VHF Monitor makes frequency checks necessary only *once a month*. Stability, accuracy, ease of maintenance and operation, dependability and long life are optimum. The G-R trademark guarantees trouble free operation with a minimum of maintenance.



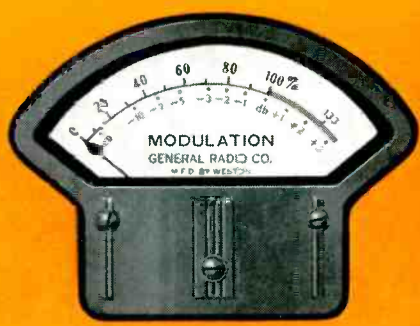
Type 1183-T T-V Station Monitor from $2830.00 to $2905.00 depending on frequency bands



Large-scale illuminated meter continuously indicates frequency deviation of aural transmitter in terms of highly stable crystal oscillator. Zero correction for crystal oscillator easily accessible from panel, to compensate for long-time drift.



Visual transmitter frequency deviation is continuously indicated by this large scale meter, in terms of the same master crystal



Modulation in both percentage and db is indicated continuously on this meter. Panel switch selects either peak, or indicates both peaks simultaneously. Meter ballistics meet FCC requirements.

GENERAL RADIO Company

275 Massachusetts Avenue, Cambridge 39, Massachusetts, U. S. A.
90 West St. NEW YORK 6 920 S. Michigan Ave. CHICAGO 5 1000 N. Seward St. LOS ANGELES 38

Admittance Meters ☆ Coaxial Elements ☆ Decade Capacitors ☆ Decade Inductors ☆ Decade Resistors ☆ Distortion Meters ☆ Frequency Meters ☆ Frequency Standards ☆ Geiger Counters ☆ Impedance Bridges ☆ Modulation Meters ☆ Oscillators ☆ Variacs ☆ Light Meters ☆ Megohmmeters ☆ Motor Controls ☆ Noise Meters ☆ Null Detectors ☆ Precision Capacitors ☆ Pulse Generators ☆ Signal Generators ☆ Vibration Meters ☆ Stroboscopes ☆ Wave Filters ☆ U-H-F Measuring Equipment ☆ V-T Voltmeters ☆ Wave Analyzers ☆ Polariscopes a strong protest, to Senator Charles W. Tobey, chairman of the potent Senate Interstate Commerce Committee.

Strong pitch by the unions may be the fact that FCC held no oral hearing to discuss the problem. Government action was based upon a consideration of 2,000 written comments from individuals (most of them operators), unions and trade schools as well as station managers, networks and associations of broadcasters.

Radio Controlled Light May Save Half Million

AWAITING FCC APPROVAL is a plan for turning New York City's street lights on or off at will by means of a coded signal superimposed upon the program from the city's municipally owned broadcast station WNYC.

Developed by Broadway Maintenance Corp., the control unit comprises a radio receiver complete with a short whip antenna. This receiver, the size of a soup can, is fastened directly above the lighting fixture. From the electronic circuit imbedded within, four wires lead from the base of the can. Two wires are attached to the lighting power line. The other two are connected in series with the lamp bulb.

▶ **Remote Control**—Each tiny receiver is designed to actuate the light switch when it receives a coded break in the carrier signal from station WNYC. In addition, the power of the broadcast station would be increased momentarily during this coded period. A listener would presumably be unable to detect this very momentary signal but, since a-m stations are not licensed for such purposes, a special grant is necessary from Federal Communications Commission.

▶ **The Dollar Angle**—At present, some street lighting is controlled by so-called astronomical time clocks that automatically take into account the changing seasons. It has been estimated that eventual replacement of 180,000 of these clocks and elimination of their attendant maintenance could save New York City $500,000 a year.

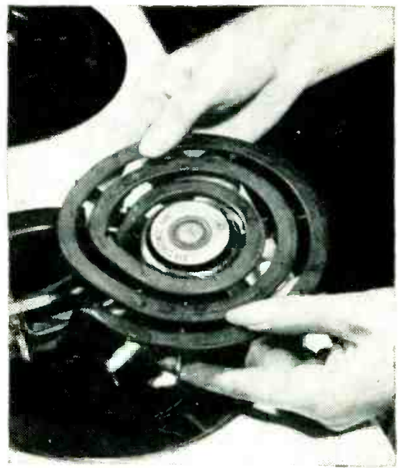
▶ **How Soon?**—Those familiar with the workings of FCC predict that New York City will not get a quick decision. Still pending is Chicago's petition for radio control of 3,000 traffic signals, although use of a broadcast transmitter is not contemplated there. Greeley, Colorado, is currently operating a similar network under a developmental grant, but uses a frequency 500 times higher than that proposed for New York.

Technician installs radio control unit atop street light. Instant blackout of New York City will be possible by signal from station WNYC

Electronic Eye Invades Kitchen

SURFACE heating unit of one model Westinghouse electric range cooks food without burning, even if all water is boiled away. Secret is the 'Electronic Eye' shown in illustration, a thermistor which senses excessive temperature and unbalances a bridge circuit feeding an amplifier and relay in the power line.

Front of range has dial marked in three cooking zones and additional intermediate points. Boiling of potatoes calls for setting at low boil for 25 minutes. Even if the cook neglects them for 50 minutes or longer there is no danger of food scorching because of the controlled surface unit, which was ten years in development.



Thermistor at center of range surface-heater coil senses pot heat

Financial Roundup

YEAR-END profit reports, stock filings and registrations and security transactions were made on the financial front of the electronic industry during the past month:

Net profits for 1952 of 5 important companies were up compared to 1951 profits:

Company	Net Profits 1952	Net Profits 1951
Garrett*	$1,382,000	$1,137,000
GE	151,719,905	138,116,527
Philco	11,491,207	12,168,046
RCA	32,325,399	31,192,732
Stewart-Warner	4,234,000	4,105,000
Westinghouse	68,581,000	64,578,000

* Six months report

▶ **Stocks Filed**—Audio and Video Products filed with SEC covering 138,000 shares of common stock (par 1 cent) to be offered at market (about 35 cents a share) for the account of certain selling stockholders.

Radar-Electronics filed with SEC covering 5,996,000 shares of common stock (par 1 cent) to be offered at 5 cents per share. Proceeds are to be used for working capital.

Western Electric filed with SEC covering 2,007 shares of common stock (no par) at $40 per share on the basis of one new share for each 10 shares held. Proceeds will be

(Continued on page 20)

Actual Size

NEW

5 KW at 900 MC GL-6182

- "Custom-tailored" for military communications and medium-power TV transmitters!
- Compact. Only 8 5/16" high!
- One tube handles all military and TV frequencies, 200 to 900 mc.
- Tetrode design assures low drive requirement.
- Modern ceramic construction and ring-seal design.
- Quickly installed or removed. Spring-finger electrical contacts; convenient, firm-grip handle. Tube weighs only 2 pounds!

U-H-F DESIGNERS: this 5-kw tetrode is the power tube you've been waiting for! Provides ample r-f for your new medium-power transmitter, efficiently, with economy—takes up minimum space, is lightweight and easy to plug in. A tube that maintenance-conscious operators will welcome! . . . Military communications and radar—industrial dielectric heating—u-h-f TV—these are leading applications. Get ratings and the full tube story in special G-E Bulletin ETD-726. Write *Tube Department, General Electric Company, Schenectady 5, N. Y.*

1878 75 195[?] YEARS OF ELECTRICAL PROGRESS
Diamond Anniversary

GENERAL ELECTRIC

163-1A4

used for expansion and general corporate purposes.

▶ **Registrations**—Cinerama registered with SEC covering $2 million of 4 percent convertible debentures due 1958 to be offered as a speculation at 100 percent of their principal amount. Proceeds to be used for assembly and supply of equipment for use in producing and exhibiting Cinerama productions.

P. R. Mallory registered with SEC covering 150,000 shares of cumulative convertible preferred stock, $50 par. Proceeds to be used for general funds and general corporate purposes.

Westinghouse registered with SEC covering (1) 200,000 shares of common stock, $12.50 par, to be offered under employee Stock Plan; (2) 598,735 shares of common stock, $12.50 par to be offered under Restricted Stock Option Plan to executive employees.

▶ **Other Actions**—Avco sold all holdings of New York Shipbuilding Corp. It marks the final step in the transition of the organization from a holding company into a integrated manufacturing corporation.

Cornell-Dubilier increased its authorized common shares from 0.5 million to 1 million shares to have them available for further acquisitions and possible stock dividends.

Color Selector for Paint Reduces Obsolesence

AUTOMATIC color "carousel" developed by Standard-Toch Chemicals takes less than 90 seconds to squirt a desired color paste into an open can containing only the vehicle. A selective mechanical and electronic control system measures out the kind and amount necessary to attain the shade previously chosen from a code-numbered color chip.

The can is magnetically held against the dispenser and the size of the can is automatically indicated by a vertical row of snap switches.

Carousel contains basic colors that are mixed according to the setting of controls. Using this electronic device, the merchant can avoid large inventories of seldom-used colors

Color controls and operating pushbuttons are easily manipulated by salespeople. The control box is located to the right of the color-tank turntable. If the receiving can is jostled out of position, all power in the color selector is immediately shut off.

Educational TV Goes Grass-Roots

June deadline for reserved channels will produce many applicants below state level

MINIMUM COSTS of plant at $300,000 and yearly operations at $200,000 (Joint Committee on Educational Television figures) make the average taxpayer snort at the idea of educational tv. But educators never seem to tire of patient explanations that school video isn't merely a matter of multiplying the little red schoolhouse by the number of receiving antennas. They speak persuasively of "increased productivity" in education and try to show that in a complex world, education must, of necessity, become more complex and efficient.

▶ **Kick in the Teeth**—Because television finances are big business, it was natural that New York State's Board of Regents should obtain construction permits for seven stations, plan for three more and then go to the legislature for money to build them.

A special commission appointed by Gov. Dewey voted 10-to-5 to turn down the plan. Nothing daunted, smaller groups in New York City and Rochester are working locally to obtain educational stations for their cities. In this regard, they are like other groups in other parts of the country operating below the state level.

Outstanding as a pattern of local activity is that of Detroit. Here, seventeen educational and cultural institutions in three counties are working out plans for a joint educational-tv venture. Emphasis, so far, has been upon studio locations (three scattered throughout the city) and programming. Application for a transmitter construction permit will come later.

▶ **Coming Deadline**—FCC will hold reserved channels until June 2. After this date, the earmarked bands may be thrown open for commercial use. By mid-March only 20 applications had been filed for the 242 educational channels. Of these, 14 construction permits have been granted (including those requested by the New York

(Continued on page 22)

Where

are Adlake Mercury Relays particularly fitted to function?

Type 1101 ADLAKE Time Delay Relay Contact normally closed for A.C. energization.

In any installation that requires both sensitivity and lasting dependability . . . from traffic control systems to long range navigation equipment . . . ADLAKE Mercury Relays will give superior service!

Here are just a few of ADLAKE'S many applications:

- Radio transmission
- Standard telephone circuits
- Precision control instruments
- X-ray control
- Air-conditioning and refrigeration controls
- Voltage regulators
- Incubators
- Production time controls
- Animated displays
- Duplicator controls
- Communication equipment
- Remote controls
- Alarms

The same engineering skill... the same high quality control standards . . . that have insured dependability in these installations are available for your relay problems. If you don't find the relay you need in the ADLAKE catalog, it will be custom-built for you. Write for full information today—The Adams & Westlake Company, 1171 N. Michigan, Elkhart, Indiana. In Canada write: Powerlite Devices, Limited, of Toronto.

EVERY ADLAKE RELAY GIVES YOU THESE PLUS FEATURES:

HERMETICALLY SEALED—dust, dirt, moisture, oxidation and temperature changes can't interfere with operation.

SILENT AND CHATTERLESS • REQUIRES NO MAINTENANCE.

ABSOLUTELY SAFE • MERCURY-TO-MERCURY CONTACT—prevents burning, pitting and sticking.

—And every ADLAKE is tested—and guaranteed—to meet specifications!

Adlake
96th year
of serving the transportation and building industries

THE Adams & Westlake COMPANY

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Manufacturers of ADLAKE Hermetically Sealed Mercury Relays

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State Regents). In addition, educational institutions have filed for 8 non-reserved (commercial) frequencies and 4 CP's have been awarded.

Along with Detroit, some 20 or 30 more schools and colleges are expected to make application before deadline.

British TV Sales Spurred by Coronation

TV set production rises to new high despite tax as 1952 radio sales show sharp drop-off

EXPECTED purchase-tax reduction has caused some British subjects to postpone buying new tv sets—but not many. Last year's U. K. tv production topped 800,000, an increase of more than 90,000 over 1951. Radio sales dropped 44 percent in the same two-year period.

Pre-coronation sales are expected to set new high for tv purchases regardless of tax. Retailers with large inventories are anxiously awaiting Parliament committee report that will clarify position of traders holding unsold goods on which customs and excise duties have already been paid at higher rates.

FCC Cracks Down On Diathermy

BY LOWERING THE BOOM on interference-radiating medical diathermy equipment, Federal Communications Commission may create a market for new machines that conform to modern specifications. Chief objection to older equipment is that it has no control of frequency and sends out strong signals that wander among television, aircraft and other bands as the patient moves during treatment.

▶ **Crackdown**—Last June, FCC realized that a hardship would be worked on doctors and hospitals if new rules were clamped down too hard too fast. It agreed to consider individual requests for continued temporary use of old equipment until it became possible to obtain better machines.

But reports of interference keep coming in. With few exceptions the troubles are traced to equipment manufactured prior to July 1947. Information available to the Commission indicates that type-approved, nonradiating machines are now available for early delivery. Accordingly, says FCC, there is no present intention to hold off full enforcement of modern standards beyond June 30, 1953.

Electronic Fuel Gage Extends Flight Range

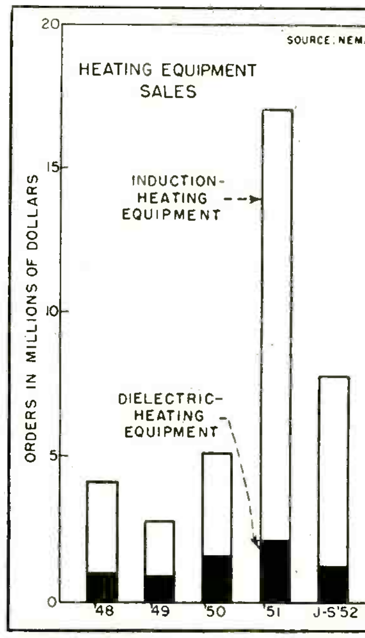
OPERATING RANGE or load carried by planes on long flights can be increased by the use of a new electronic system for accurately measuring the weight of fuel being consumed. The increase is gained by a reduction in the fuel-supply safety factor required in flight calculations.

In the usual method of measurement, by a flowmeter indicating consumption in gallons per hour, variations in fuel volume caused by temperature and altitude changes make a large safety factor necessary. The new system uses a weight-measuring device to continuously measure the density of the fuel and correct the output of the flowmeter for any variations. Consumption is indicated in pounds per hour with an accuracy of 1 per cent.

▶ **Other Applications**—The measuring system, made by Gavco Division of General Aviation Corp., can also be applied to guided missile research, where the density and flowmeter outputs can be used for frequency modulation in a telemetering system.

For industrial use, particularly in the chemical industry, the weight-corrected output on the flowmeter can be used to control the flow of liquid ingredients.

Heating Equipment Orders Rising



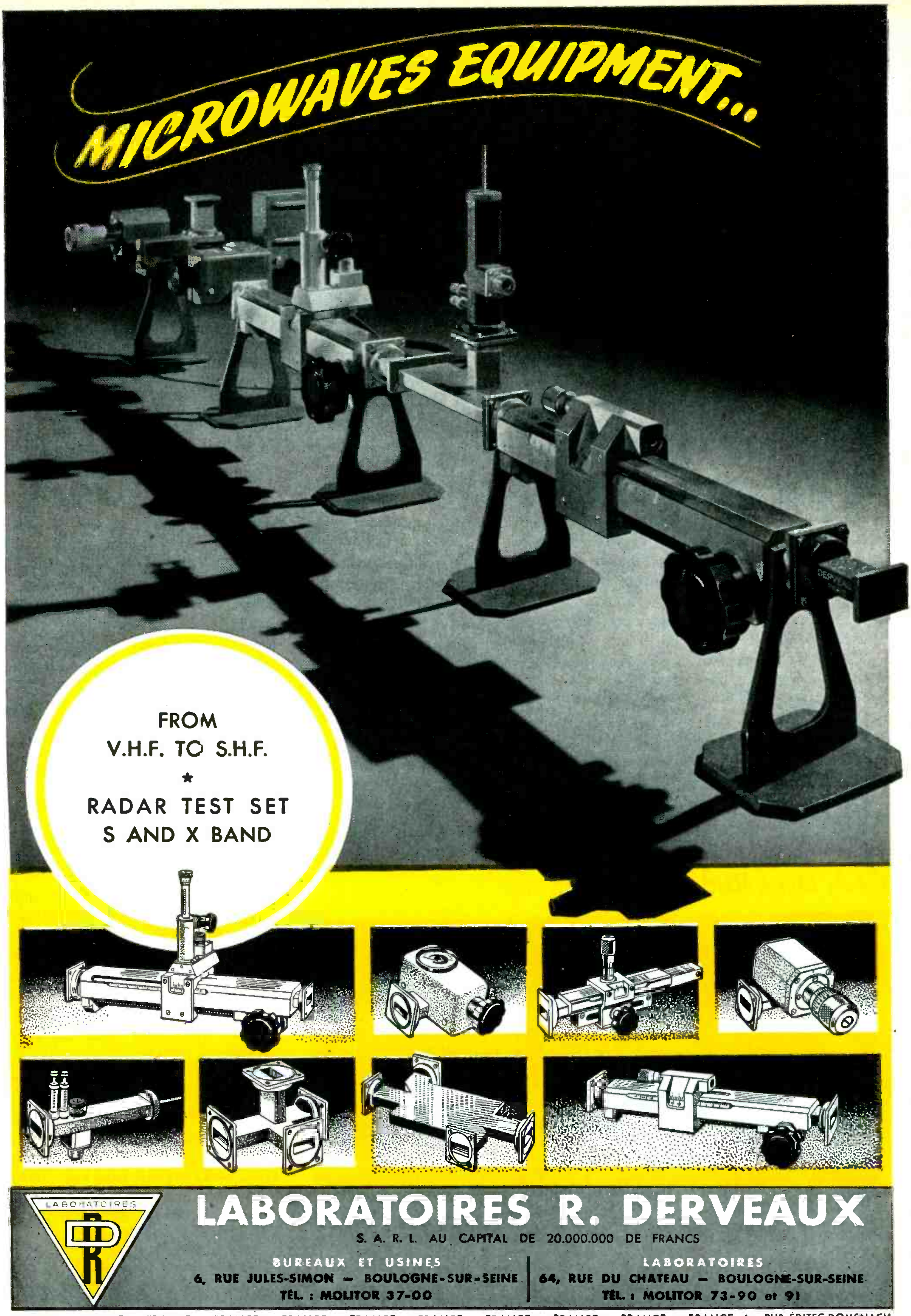
Total induction and dielectric heating equipment orders for 1952 were lower than the 1951 high of $17 million but the trend for the industry is moving upward, as shown in the chart. Rotating induction equipment still constitutes the bulk of the business but the proportion of both radio-frequency induction and dielectric equipment is increasing

Resistor Industry Helps Its Own

SMOKE had hardly cleared away from the $300,000 fire at Shallcross Manufacturing's plant in Collingdale, Pa. before competing resistor manufacturers were offering a helping hand. Several nearby companies, such as International Resistance and Mepco, offered use of their facilities and even supplied needed materials. Vendors wasted no time in replacing damaged supplies and equipment and customers cooperated in readjusting delivery schedules.

In expressing the company's appreciation for these neighborly actions, president John Shallcross said: "It makes me proud to be associated with an industry where folks are willing to go so far out of their way to help a fellow mem-

(Continued on page 24)



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ber of the trade over a rough spot."

The fire occurred on Sunday, March 8. Less than a week later the company had resumed resistor production on a limited scale and expected to be back in full operation in the factory within a month to six weeks from the date of the fire.

U. S. Electronics Firms Enter Japan

INDICATION of activity of U.S. manufacturers in Japan's electronic industry is given in the recently released official Japanese record of foreign entry into the industry of the country since 1950.

A total of 6 U. S. companies have entered into Japanese electronic manufacturing through a total of 13 technical assistance contracts with Japanese companies. The six firms and the number of contracts each have is as follows: Bendix Aviation, 1 contract; Hogen Laboratories and Faximile, 1 contract; International Standard Electric, 2 contracts; RCA, 5 contracts; Sperry, 2 contracts and Westinghouse, 2 contracts.

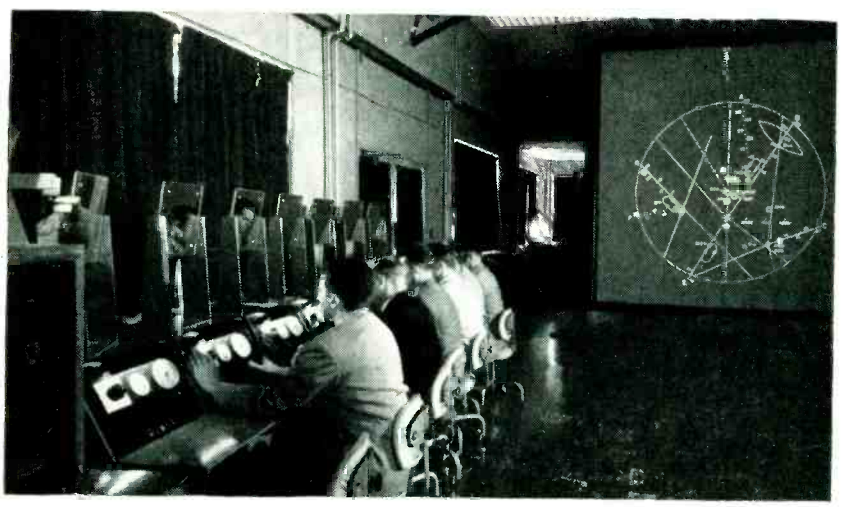
Three U.S. manufacturers acquired stocks in Japanese electronic companies. Westinghouse acquired a 4-percent interest in the Mitsubishi Electric Co.; International Standard Electric acquired a 6-percent interest in Sumitomo Electric Ind., Ltd. and Sperry acquired a 25-percent interest in Tokyo Keiki Seizosho., Ltd.

▶ **Contracts**—The number of technical assistance contracts for electronics entered into by U. S. firms has grown steadily since 1950. In that year only one such contract was signed but in 1951 5 were set and last year 8 agreements were made.

The type of equipment on which technical assistance was given by U. S. companies broke down as follows: 4 contracts were for electron tube manufacture, and transistors; 4 were for radar and marine electronic equipment; 3 for radio and communications equipment; 1 for tv receivers and 1 contract for facsimile equipment.

The Siemens und Halske A. G. company from Germany was the only other outside firm to enter Japanese electronics since 1950, according to the report.

CAA Uses Radar Simulator



Pilots seated at a multiple console fly in accordance with traffic controller's telephoned instructions from desk at center rear. White dots on chart at right represent the craft. Simulated radar presentation on common screen is electronically controlled and viewed in mirrors above each position

Transparent Airframes May Baffle Radar

AT THE RECENT annual session of the Society of Plastics Industry in New York, Wm. E. Braham of Zenith Plastic announced it is possible to produce complete airframes made of a plastic that is not only strong, easily molded and temperature stable, but is also nearly electronically transparent.

Carrying this development into the aircraft power plant, Braham said it might also be possible to produce engines which use plastic for all but the hot working surfaces—turbine blades, combustion chambers, and so on.

▶ **Small Target**—The problem for some electronics men is to figure out radar's potential limits. How much can transmitter power be increased to compensate for reduced target size? What is the smallest target an ideal radar can recognize? How well could an enemy missile whose only electronically reflecting surfaces were the bomb warheads be spotted high in the sky?

Canadian TV Expansion Sought

PRIVATE BROADCASTERS in Canada (as contrasted with government-controlled Canadian Broadcasting Corporation) have complained long and loud about their lot in Canadian radio. Now that many of them are losing listeners to the television programs from south of the border, they have set up a clamor for their own television stations.

But CBC was anxious to get its own television network going before allowing competition from private initiative. So far, it is transmitting programs from Montreal and Toronto, plans an Ottawa outlet for May. It has also blueprinted stations for Vancouver, Winnipeg and Halifax.

▶ **What's Left**—Canada's equivalent of FCC is the Department of

(Continued on page 26)

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Transport, but broadcasters must have their applications approved by CBC in addition. For the present, at least, CBC will accept tv applications only for cities in which it has no stations planned.

First applications with a ghost of a chance are: Hamilton, London, Sudbury and Windsor, Ont.; Quebec City, Que.; Saint John, New Brunswick; and Sydney, Nova Scotia.

MEETINGS

APRIL 8-10: AMA Spring Manufacturing Conference, Hotel Statler, New York, N. Y.

APRIL 11: New England Radio Engineering Meeting (NEREM) of IRE, University of Connecticut, Storrs, Conn.

APRIL 18: Seventh Annual Spring Technical Conference, Cincinnati IRE, Cincinnati, Ohio.

APRIL 20-MAY 2: IATA Technical Conference, Caribe Hilton Hotel. San Juan, Puerto Rico.

APRIL 21: Symposium on Ceramic-To-Metal Seals sponsored by the Panel on Electron Tubes of the Research and Research and Development Board, Rutgers University School of Ceramics, New Brunswick. N. J.

APRIL 23-24: International Symposium on Non-Linear Circuit Anlaysis sponsored by Brooklyn Polytechnic Institute, IRE, Office of Naval Research, Air Research and Signal Corps. Engineering Societies Bldg. Auditorium, New York, N. Y.

APRIL 23, 30, MAY 7, 14: Lecture Series on the general theory of semiconductors by H. K. Henisch of the University of Reading, England, Brooklyn Polytechnic Institute, Brooklyn, N. Y.

APRIL 27-30: Spring Meeting of USA National Committee of URSI-IRE professional Group on Antennas and Propagation, National Bureau Of Standards, Washington, D. C.

APRIL 27-MAY 8: British Industries Fair, Birmingham & London, England.

APRIL 28-MAY 1: Seventh Annual NARTB Broadcast Engineering Conference, Burdette Hall, Philharmonic Auditorium, Los Angeles.

APRIL 29-MAY 1: 1953 IRE-AIEE Electronic Components Symposium, Shakespeare Club, Pasadena, Calif.

MAY 11-13: IRE National Conference on Airborne Electronics, Dayton, Ohio.

MAY 18-21: 1953 Electronic Parts Show, Conrad Hilton Hotel, Chicago, Ill.

MAY 18-23: Third International Congress On Electroheat, Paris, France.

MAY 24-29: NAED, 45th Annual Convention, Conrad Hilton Hotel. Chicago, Ill.

MAY 24-28: Scientific Apparatus Makers Association Annual Meeting. The Greenbrier, White Sulphur Springs, W. Va.

JUNE 9-11: International Aviation Trade Show, Hotel Statler, New York, N. Y.

JUNE 15-19: Exposition of Basic Materials for Industry, Grand Central Palace, New York, N. Y.

JUNE 16-24: International Electro-acoustics Congress, The Netherlands.

JUNE 20-OCT. 11: German Communication and Transport Exhibition, Munich, Germany.

AUG. 19-21: IRE Western Electronic Show & Convention, Municipal Auditorium, San Francisco, Calif.

AUG. 29-SEPT. 6: West German Radio and Television Exhibition, Duesseldorf, Germany.

SEPT. 1-3: International Sight and Sound Exposition, Palmer House, Chicago, Ill.

SEPT. 21-25: Eighth National Instrument Exhibit, Sherman Hotel, Chicago, Ill.

Next Year's IRE Show Location?

WHEN the Government Tax Bureau announced it was taking over Grand Central Palace in 1954, IRE made arrangements to hold next year's show in the Kingsbridge Armory in the Bronx (New York City). Then the newspapers announced that the Tax Bureau had changed its mind and now considers the Palace 'not desirable'.

▶ **Who Says?**—Tracking the story to the General Service Administration, the agency that hires office space for all Uncle Sam's agencies, ELECTRONICS learned from Walter T. Downey, Regional Director, that the policy reversal was not yet official. Yes, the Treasury Department had changed its mind, but they are still awaiting permission from Washington to stop Palace negotiations.

Meanwhile, IRE says "No comment".

Business Briefs

▶ **Bathtubs** and home telephones are outnumbered by tv sets in Chicago, according to Admiral Corp. There are 1,360,000 tv sets in use while bathtubs number 1,260,000 and home telephones 1,320,000.

▶ **Costing** more than $600,000, New York Fire Department's new two-way f-m communications system uses 8 adjacent radio channels. Over 500 pieces of fire apparatus are now equipped; there are 10 marine installations and a batch of walkie-talkies. Motorola's share of the contract came to $586,000.

▶ **India** plans to spend $2.1 million on an expanded network of radio transmitters including three high-power shortwave transmitters, seven high-power medium-wave, five medium-power medium-wave and five low-power medium-wave transmitters.

▶ **Nuisance Tax** of $2.50 yearly on Canadian broadcast receivers has been abolished. Henceforth government-controlled Canadian Broadcasting Corp. operations will be supported by 15-percent excise tax on radio and tv sets, tubes and components. Yield of $12 million yearly is expected.

▶ **Ship-to-shore** tv trials in England resulted in clear tv reception from a point 16 miles distant and 100 feet under the sea. Experimental Pye transmitter used had an output of 250 watts.

▶ **Experimental** radar station will be constructed at Rensselaer Polytechnic Institute in Troy, N. Y. Three airborne units may be in operation by June for the study of the effects of weather conditions on range and clarity of image.

VARIAN X-BAND RADAR KLYSTRONS

Now in full production...

guaranteed specifications — quantity prices — assured delivery

V-260

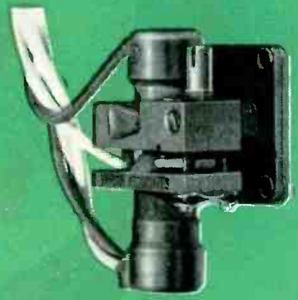
Rugged local oscillator for mobile radar. Highly non-microphonic. Shaft tuner; no chatter or backlash; excellent for motor-tuned systems. Reflex, 8.5-10.0 kmc, replacing Varian V-50.

V-280

For radar, beacon or low-power transmitter operation under severe mechanical punishment. Lock-nut tuner holds the tube on frequency even under shocks of several hundred g. Reflex, 8.5-10.0 kmc, replacing Varian V-51.

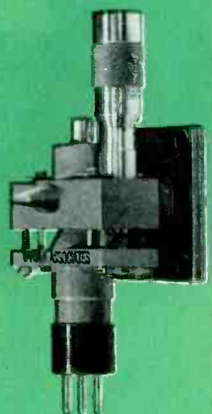
V-270
V-290

For high altitude or high humidity applications. Silicone-rubber-potted base and reflector connections instead of conventional base and reflector cap. Electrically identical with V-260 and V-280.



X-13

Reflex tube for test and measurement work at x-band. Integral tuner covers the full frequency range, 8.2-12.4 kmc. Typical power output is 150 mw over the band, 500 mw at center frequency.



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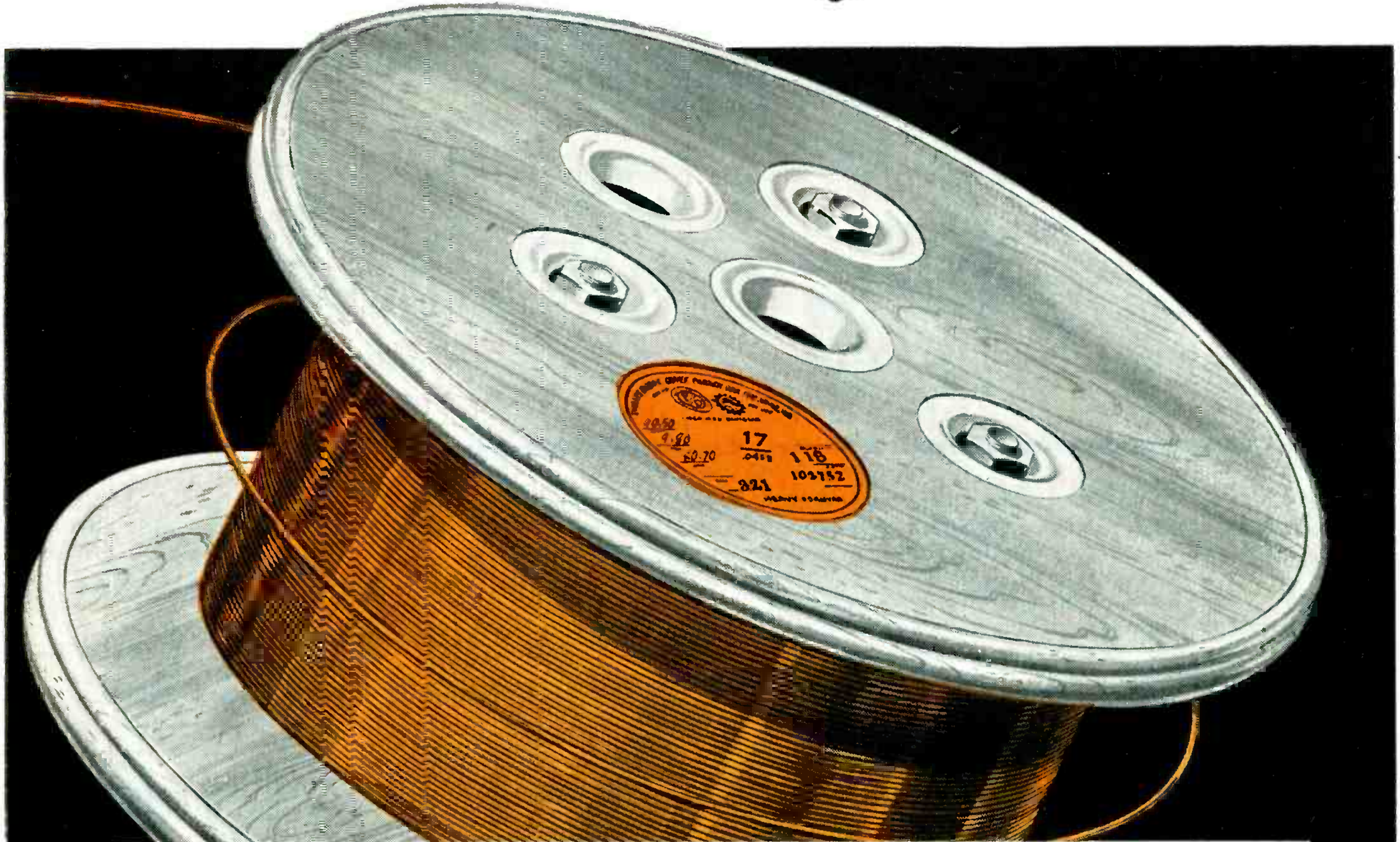
FORMVAR has become
FILM WIRE QUALITY!



PHELPS DODGE, recognizing the advantages of round Formvar magnet wire, became the leader in replacing enamel, fabric and paper-covered wires. Today, round Formvar is used extensively in motors, transformers and coils, with resultant overall cost reductions and quality improvements in the insulation system.

Where greater spacing or additional safety factors are indicated, fabrics such as cotton or paper can be added. For higher temperature operation Phelps Dodge Formvar, with a wrap of fiberglass, has been widely used.

For some applications a thin sheath of Nylon has been applied over the Formvar and identified as Phelps Dodge Nyform magnet wire.

★ ★ ★

Any time magnet wire is your problem, consult Phelps Dodge for the quickest, easiest answer!

to make the best!"

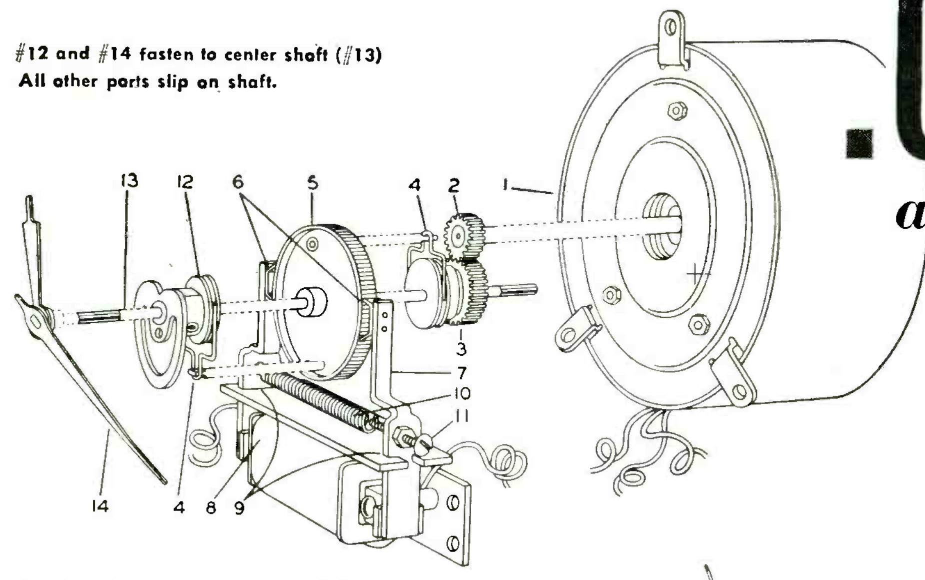
PHELPS DODGE COPPER PRODUCTS CORPORATION — MINE TO MARKET — REG. U. S. PAT. OFF.

INCA MANUFACTURING DIVISION

FORT WAYNE, INDIANA

Facts behind the S-1 TIMER'S extraordinary .005 SEC. *accuracy...*

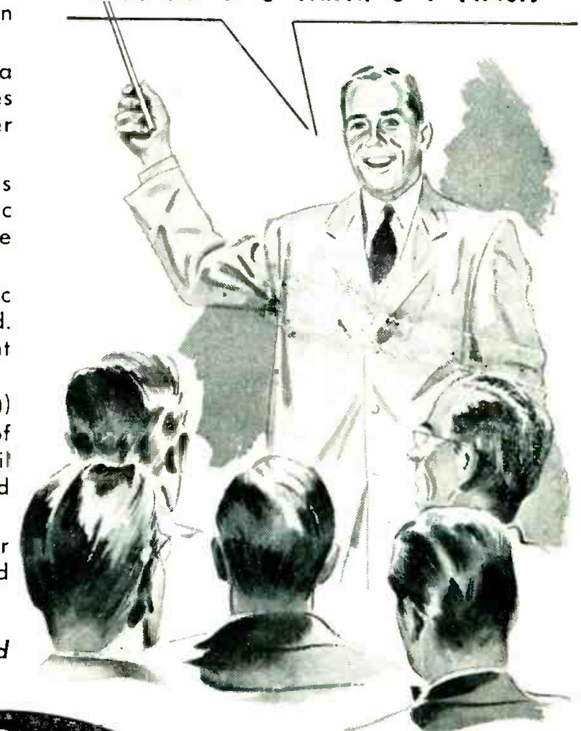
#12 and #14 fasten to center shaft (#13)
All other parts slip on shaft.



Formula S-1: **Expensive high torque, ball bearing motor, low inertia of moving parts, high proportion of precision and ground parts, no thrust bearings as found in ordinary clutches.**

- High torque (2 inch-ounce at 100 RPM) industrial grade motor (#1) with no internal gear train so small changes in load due to binds or hand acceleration cause no phase shift between rotor and rotating field ... runs continuously to eliminate starting error.
- Precision cut gears (#2, #3). Any eccentricity or inaccuracies in gearing reflect directly in timer reading.
- Slip clutch composed of hardened steel spring (#4) riding a V-grooved graphited (for long wear) collet, applies .6 inch-ounces of torque to aluminum (for low inertia) control disc (#5) with over 314 tiny teeth in its periphery.
- To hold control disc (#5) at rest, 2 hardened steel brake shoes (#6), ground to square knife edges, grip periphery of control disc in 4 places . . . control disc position to under ½ of a degree (1/720 second).
- Electro magnet (#8) pulls brake shoes away from control disc through armatures (#7). Air gaps kept to minimum for speed. Precision made fulcrums prevent stickiness or unequal movement of armatures.
- Adjusting screw (#11) adjusts tension of armature spring (#10) so that time between energizing magnet coil and starting of control disc is same as time between de-energizing magnet coil and stopping of control disc. This compensates for starting and stopping errors.
- Second friction clutch (#2) transfers control disc motion to center staff (#13); allows hands to be reset when control disc is held stationary.

"Gentlemen . . . Let me give you the formula for our astounding <u>final</u> accuracy of .005 sec. obtained with our D-C clutch S-1 Timer."



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SINCE 1884 **STANDARD**

The STANDARD ELECTRIC TIME COMPANY

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PRECISION TIMERS • CHRONO-TACHOMETERS • LABORATORY PANELS • PIPELINE NETWORK ANALYZERS

GERMANIUM DIODE INTERCHANGEABILITY CHART

TYPE & MFR.	G.E. REPLACEMENT	MINIMUM FORWARD CUR. @ +1V. (MA)	PEAK INVERSE VOLTAGE (VOLTS)	CONT. REVERSE VOLTAGE (VOLTS)	MAXIMUM REVERSE CUR. (μa) @ −50V.	MAXIMUM REVERSE CUR. (μa) OTHER	REMARKS
1N34 (S,K)		5.0	75	60	800	50 @ −10V.	
	1N48	4.0	85	70	833		
1N34A (S)		5.0	75	60	500	30 @ −10V.	
	1N52	4.0	85	70	150		
1N35 (S,K)		7.5	75	50		10 @ −10V.	Matched pairs;
	G8A	4.0	85	70	150		See Note 1
1N38 (S,K)		3.0	120	100		6 @ −3V.	
						625 @ −100V.	
	1N70	3.0	125	100	300	25 @ −10V.	
1N38A (S)		4.0	120	100		5 @ −3V.	
						500 @ −100V.	
	1N63	4.0	125	100	50		
1N39 (S,K)		1.5	225	200		200 @ −100V.	
						800 @ −200V.	
	1N75	2.5	125	100	50		
1N40 (S)		12.75 @ +1.5V.	75	25		40 @ −10V.	Quad; See Note 2
	1N73	15.0 @ +1.7V.	75			50 @ −10V.	Quad; See Note 3
1N41 (S)	None						
1N42 (S)		12.75 @ +1.5V.	120	50		6 @ −3V.	Quad; See Note 2
						625 @ −100V.	
	1N73	15.0 @ +1.7V.	75			50 @ −10V.	Quad; See Note 3
1N43 (WE)		5.0	60		850	20 @ −5V.	
	1N69	5.0	75	60	850	50 @ −10V.	
1N44 (WE)		3.0	115		1000		
	1N70	3.0	125	100	300	25 @ −10V.	
1N45 (WE)		3.0	75		410		
	1N65	2.5	85	70	250		
1N46 (WE)		3.0	60		1500		
	1N48	4.0	85	70	833		
1N47 (WE)		3.0	115		410	4 @ −3V.	
	1N70	3.0	125	100	300	25 @ −10V.	
1N48 (GE)		4.0	85	70	833		
1N51 (GE)		2.5	50	40	1667		
1N52 (GE)		4.0	85		150		
1N54 (S,K)		5.0	75			10 @ −10V.	
	1N69	5.0	75		850	50 @ −10V.	
1N54A (S)		5.0	75	50	100	7 @ −10V.	
	1N52	4.0	85	70	150		
1N55 (S,K)		3.0	170	150		300 @ −100V.	
						800 @ −150V.	
	1N75	2.5	125	100	50		
1N55A (S)		4.0	170	150		500 @ −150V.	
	1N63	4.0	125	100	50		
1N56 (S,K)		15.0	50	40		300 @ −30V.	
	1N69	5.0	75	60	850	50 @ −10V.	
1N56A (S)		15.0	50	40		300 @ −30V.	
	1N69	5.0	75	60	850	50 @ −10V.	
1N57 (S,K)		4.0	90	80		500 @ −75V.	
	1N52	4.0	85	70	150		
1N58 (S,K)		4.0	120	100		800 @ −100V.	
	1N63	4.0	125	100	50		
1N58A (S)		4.0	120	100		600 @ −100V.	
	1N63	4.0	125	100	50		
1N60 (S,K)			30	25			See Note 4
	1N64	.05 @ +0.25V.	20			25 @ −1.3V.	See Note 5
1N61 (K)		5.0	140	130		300 @ −100V.	
						700 @ −125V.	
	1N63	4.0	125	100	50		
1N63 (GE)		4.0	125	100	50		
1N64 (GE)		.05 @ +0.25V.	20			25 @ −1.3V.	See Note 5

TYPE & MFR.	G.E. REPLACEMENT	MINIMUM FORWARD CUR. @ +1V. (MA)	PEAK INVERSE VOLTAGE (VOLTS)	CONT. REVERSE VOLTAGE (VOLTS)	MAXIMUM REVERSE CUR. (μa) @ −50V.	MAXIMUM REVERSE CUR. (μa) OTHER	REMARKS
1N65 (GE)		2.5	85	70	250		
1N66 (R)		5.0	70	60	800	50 @ −10V.	
	1N48	4.0	85	70	833		
1N67 (R)		4.0	100	80	50	5 @ −5V.	
	1N63	4.0	125	100	50		
1N68 (R)		3.0	120	100		625 @ −100V.	
	1N75	2.3	125	100	50		
1N69 (GE)		5.0	75	60	850	50 @ −10V.	
1N70 (GE)		3.0	125	100	300	25 @ −10V.	
1N71 (S)	None						Quad
1N72 (GE)		0.8 @ +.5V.	5			800 @ −.5V.	See Note 6
1N73 (GE)		15.0 @ +1.7V.	75			50 @ −10V.	Quad; See Note 3
1N74 (GE)		15.0 @ +1.8V.	75			50 @ −10V.	Quad; See Note 3
1N75 (GE)		2.5	125	100	50		
CK705 (R)							Same as 1N66
CK706 (R)			50	40		200 @ −10V.	See Note 7
	1N64	.05 @ +0.25V.	20			25 @ −1.3V.	See Note 5
CK707 (R)		3.5	100	80	100	8 @ −3V.	
	1N52	4.0	85	70	150		
CK708 (R)							Same as 1N68
CK709 (R)				60			Quad; See Note 8
	1N73	15.0 @ +1.7V.	75			50 @ −10V.	Quad; See Note 3
CK710 (R)		3 @ +0.5V.	10	5		200 @ −.6V.	See Note 9
	G7A						See Note 6
CK711 (R)				80	30		Quad; See Note 10
	1N73	15 @ +1.7V.	75			50 @ −10V.	Quad; See Note 3
CK712 (R)		2.0	225	200		800 @ −200V.	
	1N75	2.5	125	100	50		
CK713 (R)		21 @ +2.0V.	75	75		250 @ −40V.	
	1N52	4.0	85	70	150		
1N81 (GE)		3.0	50	40		10 @ −10V.	
1N82							UHF Mixer
	G7A	0.8 @ +.5V.				800 @ −.5	See Note 6
CK715 (R)							Frequency Mult.
	G7E	0.8 @ +.5V.	5			800 @ −.5	Frequency Mult.
1N91 (GE)		1000	100				Diffused Junction Rectifiers
1N92 (GE)		1000	200				
1N93 (GE)		1000	300				
1N94 (GE)		1000	400				
G11 (GE)							Transistor
G11A (GE)							Transistor

NOTE 1: Forward resistances matched within 10% at +1V.
NOTE 2: Four diodes in tube shell with forward resistances balanced within +2.5% at +1.5V. Forward resistances of each pair matched within 3 ohms.
NOTE 3: Four diodes in hermetically sealed tube shell. Forward resistances matched within 6.7 ohms for 1N73 and 13.4 ohms for 1N74 at 15 Ma. Forward resistances of each pair matched within 2 ohms for 1N73 and 6.7 ohms for 1N74 at 15 Ma.
NOTE 4: Tested with 1.8V. RMS input at 40 Mc, 70% modulated at 400 cycles. Minimum output is 1.8V. peak-to-peak across 4700 ohms shunted by 5 MMF.
NOTE 5: Tested with 0.1V. RMS, 44 Mc input to last I.F. grid. Minimum output is 100 μa through 3600 ohms shunted by 5 MMFD.
NOTE 6: Maximum conversion loss is 10db measured at 900 Mc with 0.7 Mw L.O. level and d-c forward bias from a 0.25V., 250 ohm source.
NOTE 7: Tested with 0.1V. RMS, 50 Mc input to last I.F. grid. Minimum output is 330 μa through 5100 ohms shunted by 5 MMFD.
NOTE 8: Four diodes in tube shell with forward resistances matched within 2.5%. At −10V. diodes are matched 2.5% or all have a resistance greater than 1.0 meg ohm.
NOTE 9: Typical noise temperature ratio of 2.
NOTE 10: Four diodes in tube shell. Each pair of diodes is shunted by 10,000 ohms center-tapped and the center tap of resistor and diodes connected by a microammeter. With 0 to +3V. dc applied unbalance current limit is 5 MA.

• *For a free file card copy of this data write: General Electric Co., Section 443, Electronics Park, Syracuse, N. Y.*

GENERAL ELECTRIC

Want more information? Use post card on last page.

It's VERSATILITY that sells SANBORN in the field of Industrial Recording

As indicated by references at the right, you may have a choice of five different instruments (A) for quick and convenient standard rack mounting in the system at A_1, PLUS a choice of up to four of any of the three different type amplifiers (B) or any combination of these amplifiers

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SANBORN
FOUR-CHANNEL
OSCILLOGRAPH
RECORDING
SYSTEM
(MODEL 67)

A

DC PREAMPLIFIER

AC PREAMPLIFIER

DC CONVERTER—for low level DC recording such as thermocouple output.

TRIPLEXER—when coupled to a DC amplifier permits the recording of three events in one channel.

THRESHOLD MONITOR provides means for the control of voltage levels or rate of change.

B

DC (General Purpose) AMPLIFIER

STRAIN GAGE (Carrier) AMPLIFIER

SERVO MONITOR AMPLIFIER—a phase discriminating AC amplifier used in servo design and testing.

As shown in the diagram, removing or interchanging any of the amplifiers or other instruments is simply a matter of sliding the unit in or out of the mounting rack where contact is made automatically by plug-in connectors. Screws at the four corners of the panel hold the instrument in place.

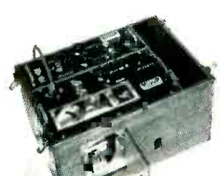
Other features of this system which add to Sanborn VERSATILITY are the choice of eight paper speeds—50, 25, 10, 5, 2.5, 1.0, 0.5 and 0.25 mm/sec, and the use of either 4-, 2-, or 1-channel recording paper.

And, of course there are these popular Sanborn advantages: a high torque movement (200,000 dyne cms per cm deflection), direct *inkless* recording in *true rectangular coordinates*, and provision for code and time markings.

Sanborn Recording Systems may be used to record any one or more of a wide variety of phenomena whose characteristics range from static to 100 cycles per second. If your recording problem is not one which can be solved by standard Sanborn equipment, our engineers will be glad to suggest ways in which modifications of it may suit your requirements.

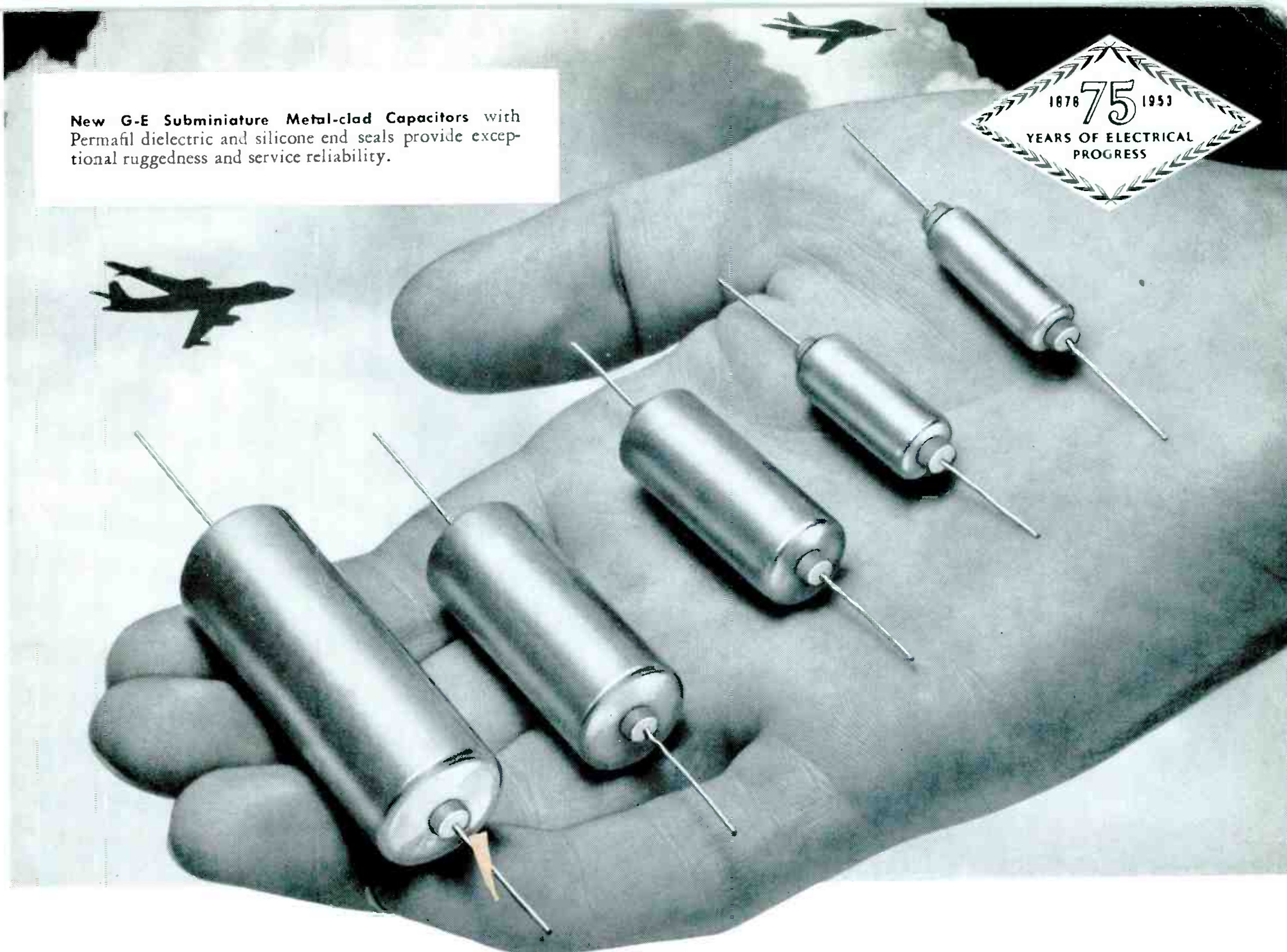
A complete catalog of Sanborn Industrial Recording Equipment will be sent gladly on your request.

SANBORN 1-, AND 2-CHANNEL RECORDING SYSTEMS



One channel Model 128/141 above and two-channel Model 60 at right both incorporate Sanborn recording advantages which include interchangeability of amplifiers and (with Model 60) preamplifiers.

SANBORN COMPANY
CAMBRIDGE 39, MASS.



G.E. ANNOUNCES a new line of subminiature metal-clad capacitors

with silicone end seals and a solid dielectric for operation from —55 C to +125 C without derating

This new line of General Electric subminiature metal-clad capacitors offers the designer and user of electronic equipment the utmost reliability under the severe operating conditions required of military equipment. G-E metal-clad capacitors are rugged units that provide the essential advantages of small size, no liquid leakage, and high insulation resistance. They also will withstand extreme temperature and humidity conditions.

While these capacitors have been designed for application in the temperature range from −55 C to +125 C *without derating*, they can, with proper derating, be operated up to +150 C.

G-E subminiature metal-clad capacitors offer two important, exclusive features that insure outstanding performance:

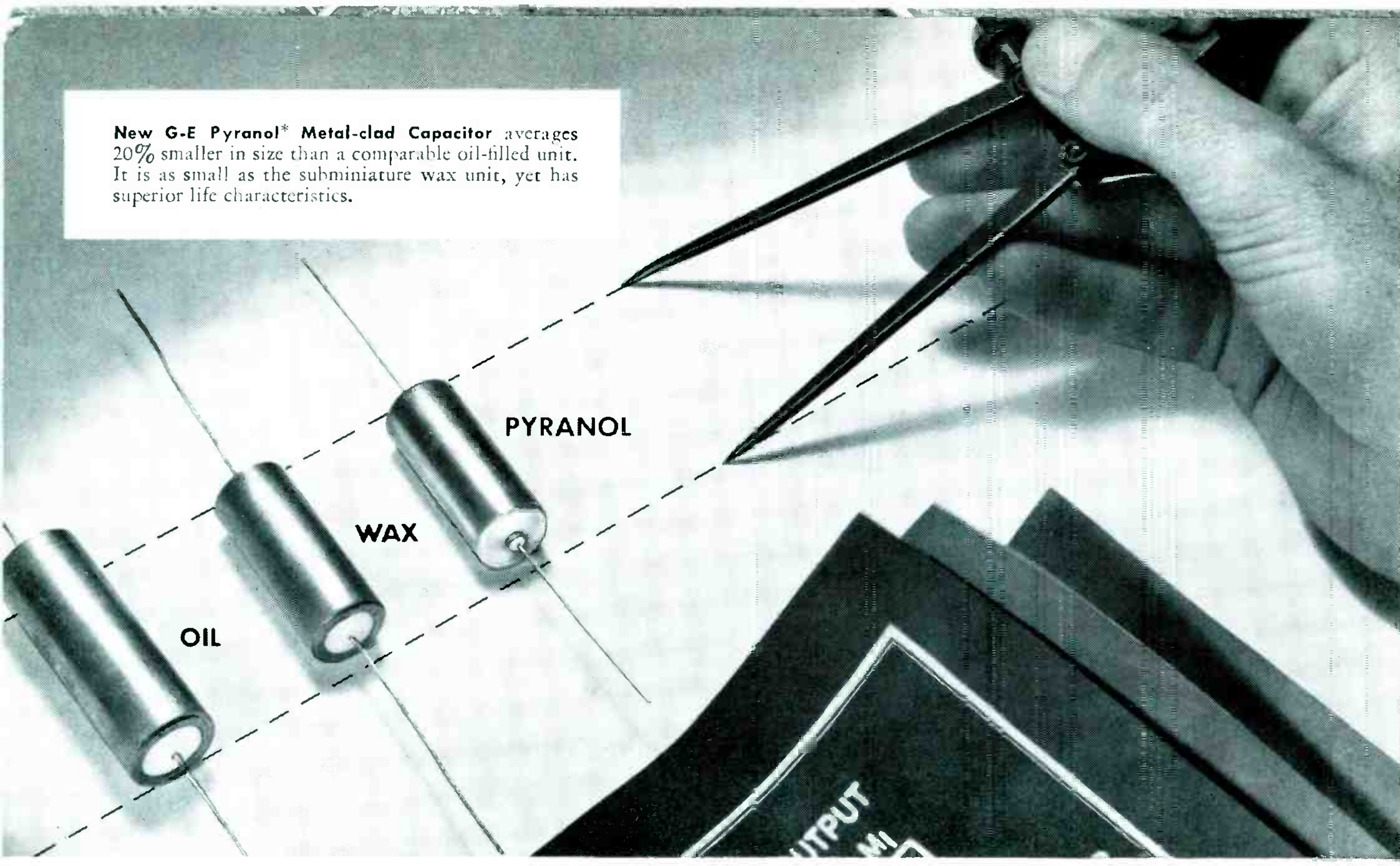
- **Solid dielectric**—G.E.'s Permafil—to provide excellent electrical characteristics and to eliminate the possibility of leakage.
- **Silicone end seal** for high shock resistance—both thermal and physical.

G-E subminiature metal-clad capacitors meet all requirements of JAN-C-25 and the proposed MIL-C-25. They can be supplied in both tab and exposed foil designs depending upon your application requirements.

Need Wax Replacement? If you are caught in the squeeze because of the recent elimination of characteristic J (wax) from the proposed MIL-C-25 specifications, you need not go to a larger capacitor (or continue to use an unacceptable product). See back page of this advertisement for information about a new line of G-E liquid-filled metal-clad capacitors. They're as small as the wax units, yet have superior life characteristics which make them a "natural" for military equipment.

GENERAL ELECTRIC

See next page for informative data on these new G-E capacitors



ANNOUNCING also . . . a new line of G-E Pyranol liquid-filled metal-clad capacitors

subminiature in size—inexpensive—for operation to +85 C

This new line of G-E subminiature metal-clad capacitors with Pyranol dielectric equals its 125 C Permafil cousin for reliability and ruggedness. It is designed for operation from −55 C to +85 C *without derating*.

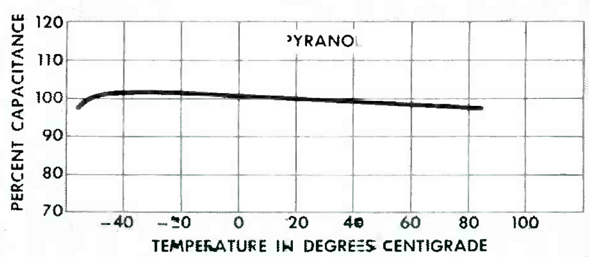
Pyranol, long noted for its high dielectric strength and exceptional stability, has been used in G-E capacitors for more than 20 years with excellent success. Now recently improved, Pyranol makes possible a small-size capacitor with extremely good life characteristics.

This G-E metal-clad line also incorporates the silicone end seal for maximum resistance to shocks—both thermal and physical—and thus permits soldering right up to the bushing without danger of damaging the seal.

G-E Pyranol metal-clad capacitors can be supplied in either tab or exposed foil designs in ratings from .001 to 1.0 muf in voltages of 100, 200, 400, and 600 volts d-c working.

Delivery of G-E Subminiature Capacitors. While many sizes and voltage ratings of both the 125 C Permafil and the 85 C Pyranol metal-clad capacitors are available for immediate shipment, not all muf and voltage ratings are in stock. However, the full line of each type of G-E metal-clad capacitor will be in "stock shipment" shortly. If your requirements demand the highest performance standards for subminiature capacitors, check with your nearest G-E Apparatus Sales Office for exact delivery information. Or write to Section 442-4, General Electric Company, Schenectady 5, New York.

*Reg. trademark of General Electric Company



Capacitance vs. Temperature is shown by this typical curve. G-E Pyranol subminiature metal-clad capacitors have only a small capacitance change through the entire range from −55 C to +85 C.

You can put your confidence in—

GENERAL ELECTRIC

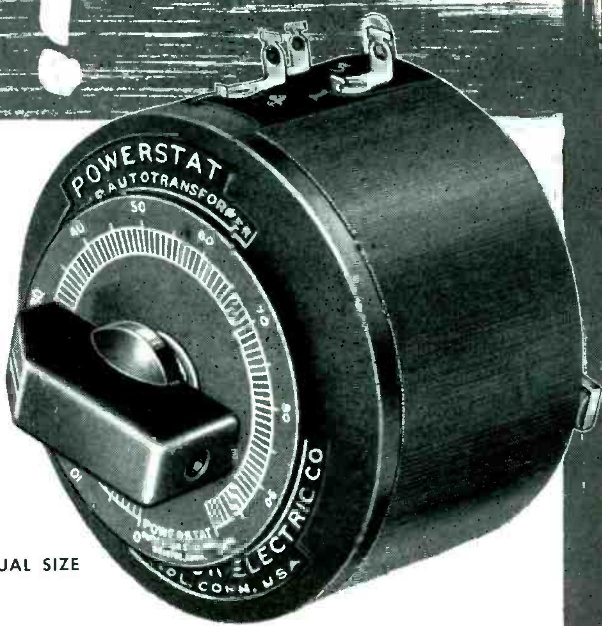
For a remarkable demonstration of the ruggedness and reliability of these new G-E capacitors, visit the General Electric Booth at the 1953 Institute of Radio Engineers Show in New York City.

Compare!

POWERSTAT

Variable Transformer

TYPE 10



ACTUAL SIZE

. . . with a rheostat or other resistance type controls. You will find POWERSTAT type 10 the ideal source of variable a-c voltage control of 50-100-150 watt loads.

POWERSTAT type **10** is rated:

INPUT: 120 Volts, 60 Cycles, 1 Phase

OUTPUT: 0-120 Volts, 0-132 Volts, 1.25 Amperes, 150/165 Volt-Amperes

POWERSTAT type **10** weighs only **1 POUND, 13 OUNCES.**

- **EFFICIENCY** of type 10 is high . . . does not control by dissipating power in the wasteful form of heat as does a resistance type control.
- **SPACE REQUIREMENT** of type 10 is only 2¹⁄₁₆ by 3⅛ inches. Not only is it compact but since it does not produce heat there is no ventilation problem.
- **CONSTRUCTION** of type 10 is rugged for long life and dependable service.
- **ADAPTABILITY** of type 10 to any load within its rating is possible without tailoring as is necessary with a resistance type control.
- **RATING** of type 10 is conservative with the rated output current available at any brush setting.
- **MOUNTING** of type 10 is simple by means of a single hole in the panel. It is locked in position by a keying arrangement.
- **OPERATION** of type 10 is smooth, stepless and silent.
- **PRICE** of type 10 is low . . . comparable to any other type of a-c voltage control apparatus of equal capacity and characteristics.

A comparison of POWERSTAT type 10 with a rheostat or other resistance type controls reveals that it is the logical answer to any variable a-c voltage control problem involving loads up to 150 watts.

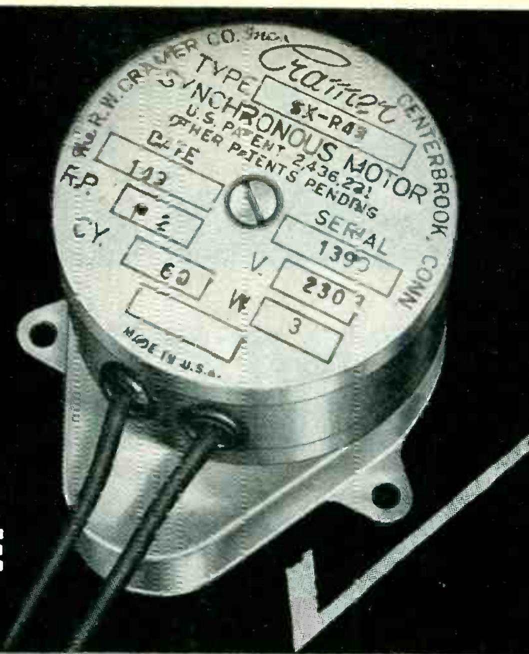
POWERSTAT type 10 is a small, compact autotransformer of toroidal core design with a movable brush-tap. Rotation of the tap delivers any output voltage from zero to, or above, line voltage. It is tapped to allow compensation for a 10 per cent drop in line voltage.

Additional information on POWERSTAT type 10 is available by writing **204 Mae Avenue, Bristol, Conn.**

THE SUPERIOR ELECTRIC CO.
BRISTOL, CONNECTICUT

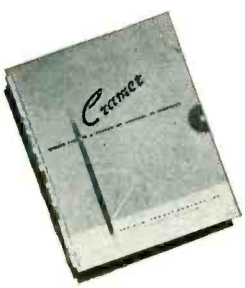
Cramer
TIMING DEVICES

SYNCHRONOUS TIMING MOTOR



GIVES YOU UP TO 5 TIMES THE TORQUE

This "mighty midget" SX motor provides the power for a wide variety of timing devices, recording instruments, signal systems, traffic controls, and other similar control devices that require dependable performance at constant speed. Available in many output speeds ranging from one revolution per second to one revolution per day, the SX *provides up to five times the power of most hysteresis clock motors of equivalent size.*



Write for Cramer Timing Device Catalog or specify Bulletin No. 10A for complete information on the Model SX Motor.

Check THESE OUTSTANDING FEATURES

- **30-Inch Ounces Torque at 1 R.P.M.** . . . extra margin of power for adverse operating conditions.
- **Instantaneous Response** . . . to synchronous speed within 2 cycles of applied voltage; dead stop within 1 cycle.
- **Runs Only at Synchronous Speed** . . . no slip or sub-synchronous speed possible.
- **Runs Equally Well in Any Position.**
- **Controlled Rotation** . . . clockwise or counterclockwise, as desired.
- **Dual Rotation** . . . oscillating motion also possible on motors 4 R.P.M. or faster by limiting travel of output member with positive stops.
- **Replaceable Coils** . . . simplify servicing or changing voltages in the field.
- **One or Two-Way Friction** . . . permits output shaft to be turned manually, independent of gear train and motor.

S P E C I A L I S T S   I N   T I M E   C O N T R O L

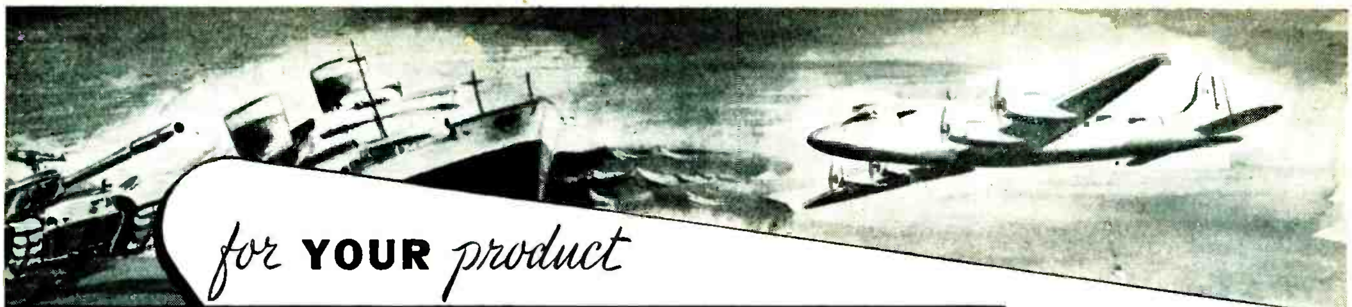
Interval Timers · Time Delay Relays · Time Totalizers · Cycle Timers · Running Time Meters · Pulse Timers · Hermetically Sealed Military Timers · Synchronous Timing Motors

the R. W. CRAMER COMPANY, INC.

BOX 3, CENTERBROOK, CONNECTICUT

7CR53

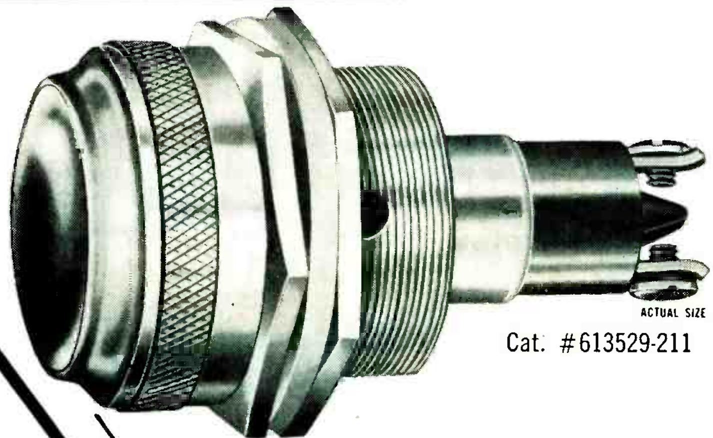
Want more information? Use post card on last page.



for **YOUR** *product*

WHICH PILOT LIGHT DO YOU NEED?

DIALCO



Cat. #613529-211

THE BIG ONE

This Pilot Light Assembly was first made to accommodate the *S-11 lamp* and was intended for use in the cabs of great diesel locomotives.

This BIG one

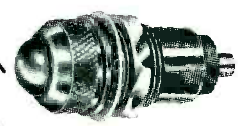
or

this LITTLE one

Dialco HAS THE COMPLETE LINE OF INDICATOR and PANEL LIGHTS

THE LITTLE ONE

The miniaturization program on defense products required the development of this *sub-miniature* light. It is used on communication equipment and aircraft. Midget flanged base bulbs to fit are rated 1.3, 6, 12, and 28 volts.



Cat. #8-1930-621

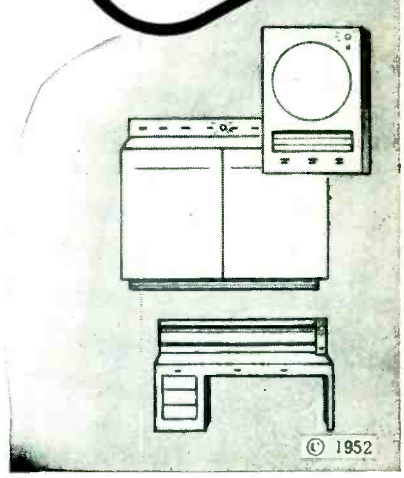
Samples to suit your own special conditions and requirements will be sent promptly and *without cost*. Just outline your needs. Let our engineering department assist in selecting the *right lamp* and the *best pilot light* for YOU.

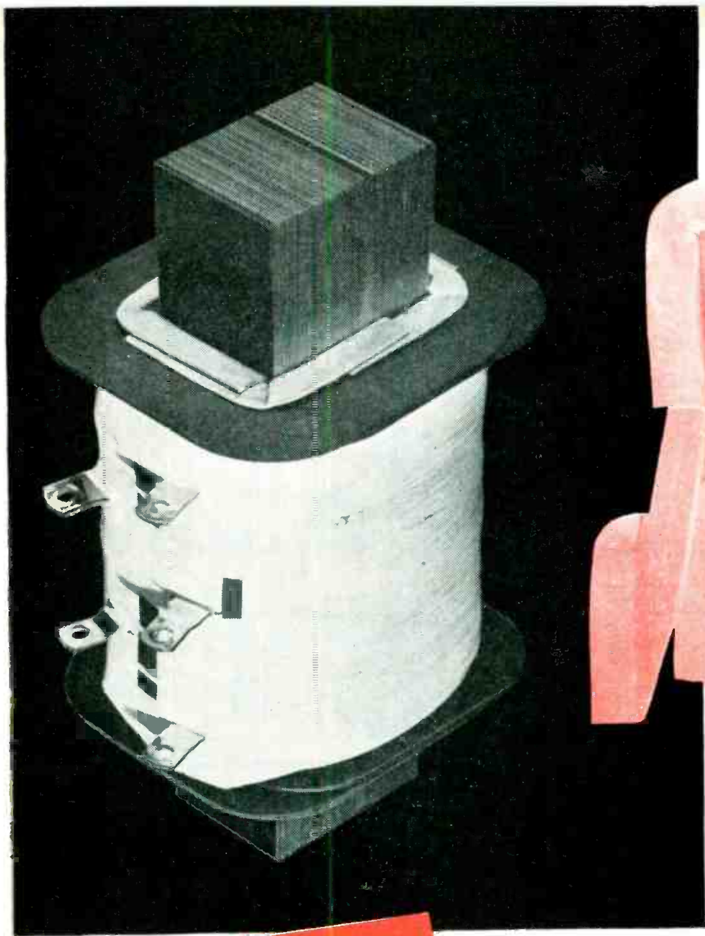
Write for the Dialco HANDBOOK of PILOT LIGHTS

Foremost Manufacturer of Pilot Lights

DIALIGHT CORPORATION

60 STEWART AVE., BROOKLYN 37, N. Y. HYACINTH 7-7600





Formed pieces of tough, National Vulcanized Fibre, with exceptionally high dielectric strength, are used to make this universal coil form. It is expandable to conform to cores of various sizes.

NATIONAL VULCANIZED FIBRE

contributes to an improved product—in universal coil forms for Cutler-Hammer, Inc.

This practical use of National Vulcanized Fibre by Cutler-Hammer, Inc. in their wire spools is typical of the countless contributions National Vulcanized Fibre—*the material of a million uses*—makes to business and industry.

In the electrical field National Vulcanized Fibre has been the standard insulation for years. It has high dielectric strength and, when subjected to hot electrical arcing, it evolves neutral gas which extinguishes arc without "tracking." Many electric appliances find National Vulcanized Fibre to be the one best material for one or more of their parts.

National Vulcanized Fibre applications, both mechanical and electrical, are varied and extensive. In mechanical applications it is desirable because it possesses exceptional tensile and crushing strength, toughness, density and resistance to wear—coupled with ease of fabrication. It actually improves with age; for many mechanical purposes it is better, more durable than metal.

Available in various grades and colors; and in sheets, rods, tubes and special shapes. Write for detailed literature and engineering service information—

NATIONAL VULCANIZED FIBRE CO.

Wilmington Delaware

Offices in Principal Cities

Since 1873

National Laminated Plastics nationally known—nationally accepted

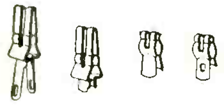
PHENOLITE Laminated PLASTIC

NATIONAL VULCANIZED FIBRE

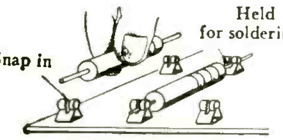
Here is Plug-in Unit Construction

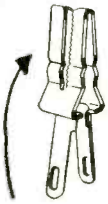
Everything you need to mount, house, fasten, connect, monitor your equipment.

1st START WITH ALDEN MINIATURE TERMINALS

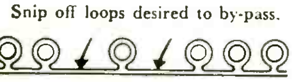


Here's a beautiful new little Terminal that really puts soldering on a production basis; taking a minimum of space and material. Ratchet holds leads firmly for soldering, no wrap-around or pliering necessary. Unique punch press configuration gives rapid heat transfer, taking less time and solder. Designed for Govt. Miniaturization contracts. Staked in Alden Prepunched Terminal Cards, allow patterns for any circuit.





Snip off loops desired to by-pass.



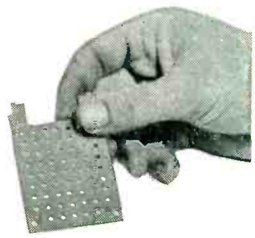
JUMPER STRIP

Stake under Terminals for common circuits. Loops match prepunched holes in Terminal Cards. Snip off loops desired to by-pass.

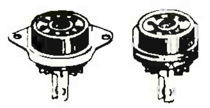
FOR YOUR SMALLER UNITS .

2nd Take Pre-punched Terminal Mounting Card ready-cut to size you require. Stake in Alden Miniature Terminals to mount your circuitry.

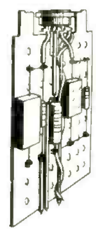
Prepunched Terminal Mounting Cards come in all sizes needed for Packages: miniature 7-pin and 9-pin units, or 11-pin and 20-pin plug-in units. Card is natural phenolic 1/16" thick prepunched on 1/4" centers with .101" holes for taking the Miniature Terminals.



3rd Attach Miniature Terminals, Alden Card-mounting Tube Sockets and Mounting Brackets, which mount in the prepunched holes.



Alden Card - mounting Tube Sockets for miniature 7, miniature 9 and octal tubes, are complete with studs and eyelets for easy mounting on Prepunched Cards.

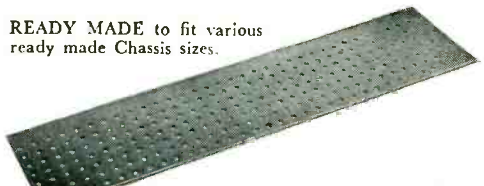


Mounting Brackets stake to the Prepunched Card, mount Card to Package Base and Lid.

FOR YOUR LARGER UNITS .

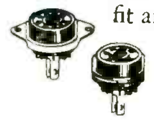
2nd Lay out circuitry with Prepunched Terminal Mounting Card in lengths up to 3'.

READY MADE to fit various ready made Chassis sizes.

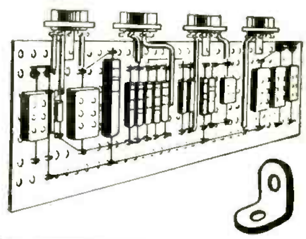


Organize circuitry in compact vertical planes. Use both sides of Prepunched Card to stake in Alden Miniature Terminals to your circuitry layout. Vertical position gives ready accessibility; there is no "underneath" in Alden design.

3rd Attach Miniature Terminals, Card-mounting Tube Sockets and Mounting Brackets, which fit any of the prepunched holes.



Alden Card-mounting Tube Sockets, ready-made in variety of sizes, complete with studs and eyelets for easy mounting on Prepunched Cards.



TO OBTAIN COMPLETE DETAILS .

Tiny Sensing Elements specifically designed to spot trouble instantly in any unit.

Here are tiny components to isolate trouble instantly by providing visual tell-tales for each unit.

"PAN-i-LITE" MIN. INDICATOR LIGHT

So compact you can use it in places never before possible. Glows like a red-hot poker. Push-mounts in .348" drill hole. Bulbs replace from front. Tiny spares are unbreakable, easily kept available, taped in recess of equipment. Alden #86L, ruby, sapphire, pearl, emerald.

MINIATURE TEST POINT JACK

Here are tiny insulated Test Point Jacks that make possible checking critical plate or circuit voltages from the front of your equipment panel—without pulling out equipment or digging into the chassis. Takes a minimum of space, has low capacitance to ground, long life beryllium copper contacts. Available in black, red, blue, green, tan and brown phenolic conforming to MIL-P 14B- CGF; also nylon in black, red, orange, blue, yellow, white, green. Alden #110BCS.

ALDEN "FUSE-LITE"

Fuse Blows — Lite Glows.

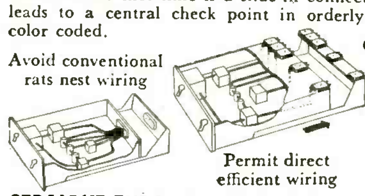
Signals immediately blown fuse. Lite visible from any angle. To replace fuse simply unscrew the 1-pc. Lite-lens unit. Mounts easily by standard production techniques, in absolute minimum of space. 110V Alden #440-4FH. 28V #440-6FH.

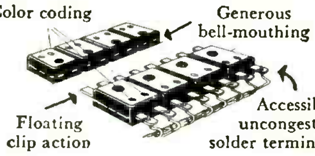
Free Samples Sent Upon Request

Get one point of check of all incoming and outgoing leads thru ALDEN BACK CONNECTORS

SINGLE CHECK POINT

Here for the first time is a slide-in connector that brings all incoming and outgoing leads to a central check point in orderly rows, every lead equally accessible and color coded.





STRAIGHT-THROUGH CIRCUITRY

Wiring is kept in orderly planes, avoiding rat's nest of conventional back plate wiring. Connections between Terminal Mounting Cards are through Back Connectors so that all circuitry is controlled at this central point. Incompatible voltages safely isolated and separated.

EASY INSERTION AND REMOVAL

Mating tolerances permit easy insertion and removal without demanding critical alignment tolerances. Assure proper contact, with safety shielding of dangerous voltages. Leads can be attached above, below or out of the back for most direct and efficient interconnects.

Ready-made Alden Back Connectors meet all conceivable needs, for slide-in chassis replaceable in 30 seconds with spare.

NA-ALD **ALDEN PRODUCTS COMPANY**

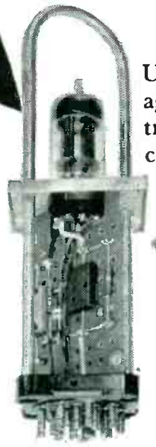
READY-MADE for your Electronic Equipment

All designed — all tooled — production immediately available — no procurement problems. *Apply ALDEN Standards wholly or in part.*

ALDEN PLUG-IN PACKAGES

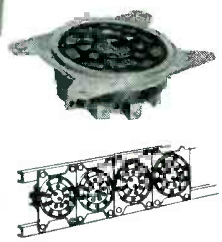
4th After mounting your circuits on Terminal Cards, use Alden Standard Plug-in Bases, Housings, Bails for packaging.

Min. 7 & 9-pin BASES available, also 11-pin & 20-pin, BAILS & HOUSINGS or LIDS to match.



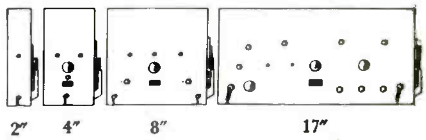
ALDEN PLUG-IN PACKAGES

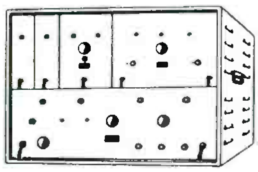
Using standard Alden Plug-in Packaging Components you can mount a tremendous variety of circuits on chassis or in racks.



Alden "20" Rack Mounting Socket with extended ears that mount side by side and in multiple rows on U-Channels that accommodate 50 Alden "20" Plug-in Units illustrated, in 10½ x 19" rack mounting panel.

HOUSE PLUG-IN UNITS IN ALDEN BASIC UNI-RACKS

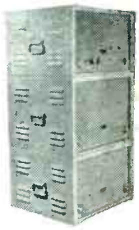




FOUR SIZES OF CHASSIS MOUNT IN ANY COMBINATION IN ALDEN UNI-RACKS

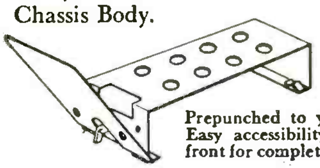
STACKED

Mounting all equipment in Alden Uni-Racks provides a uniform system easy to handle and ship. Can be installed and interconnected as fast as unloaded.



ALDEN BASIC CHASSIS

4th Fit Prepunched Cards carrying completed circuitry into Standard Alden Basic Chassis Body.



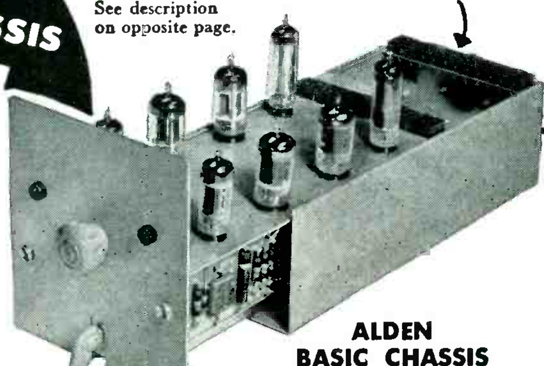
Prepunched to your specs. Easy accessibility at sides, front for completing wiring.

SERV-A-UNIT LOCK

pulls in or ejects chassis.

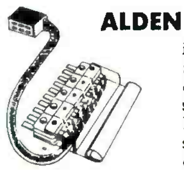
SLIDE-IN BACK CONNECTORS

See description on opposite page.



ALDEN BASIC CHASSIS

with spares provides 30-second servicing for your unitized circuitry.



ALDEN UNIT CABLE

interconnects between Uni-racks or other major circuitry divisions. Quick, sure, coded means of isolating and restoring (with spare) inter-division circuits.

SEND FOR FREE "ALDEN HANDBOOK"

Your design and production men have always wanted these advantages:

1. Experimental circuitry can be set up with production components, cutting down debugging time.
2. Allows technicians, rather than engineer, to debug, by taking out unit.
3. Given the circuitry, nothing further to design—make up from standard Alden components.
4. Optimum circuit layout using standard terminal card.
5. Absolute minimum requirements of labor, materials, space.
6. The various sub-assemblies can be built concurrently on separate assembly lines.
7. No tooling costs—no delays—no procurement headaches.
8. Fewer prints—smaller parts inventory.
9. Can subcontract assemblies.

Your customers and sales force will welcome these advantages:

The big objection to electronic equipment—from the user's point of view—is that if it goes out of order he feels helpless. But you have a perfect answer when your equipment is made to Alden Standards of Plug-in Unit Construction because they assure DEPENDABLE OPERATION, as follows—

30-SECOND REPLACEMENT OF INOPERATIVE UNITS by plugging in available coded spares.

TROUBLE INSTANTLY INDICATED AND LOCATED by monitoring elements assigned to each functional unit.

TECHNICAL PERSONNEL NOT REQUIRED to maintain in operation, due to obvious color coding and fool-proof non-interchangeability of mating components.

TOOLESS MAINTENANCE made possible by patented Alden fasteners and plug-in locking and ejecting devices.

AIRMAIL SERVICE—
Compact functional units practical to send airmail to factory for needed overhaul.

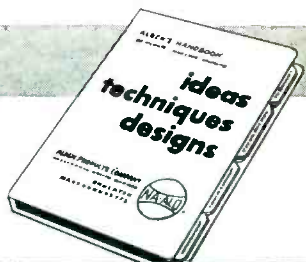
UNI-RACK FIELD HANDLING UNIT—groups functional units into stacking cabinets not exceeding one- or two-man handling capacity—go easily through windows, doors.

CONNECT AS FAST AS UNLOADED, by coded non-interchangeable unit cables plugged in between Uni-racks.

SEND FOR FREE 226-PAGE HANDBOOK

This 226-page Handbook describes fully the Alden System of Plug-in Unit Construction and the hundreds of components ready-made and completely tooled to meet your every requirement. It's a gold-mine for those designing electronic control equipment that is practical in manufacture; dependable in operation.

REQUEST YOUR COPY TODAY — SENT FREE!



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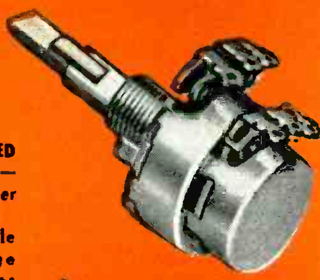
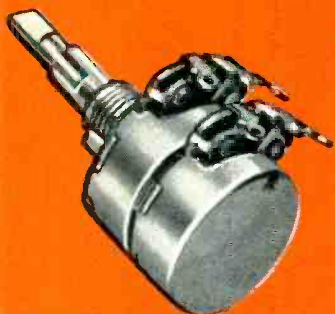
***Exceptionally* good delivery cycle on civilian orders due to tremendous mass production facilities.**

TYPE C45-70

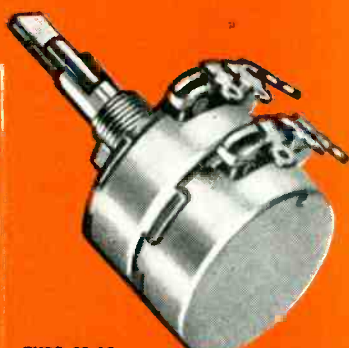


NEW HIGH QUALITY MINIATURIZED "DIME-SIZE" CIVILIAN CONTROL—*Performance Fully Equals Larger Types.*

TYPE 70, 3/4" diameter variable composition resistor. Wattage rating: .3 watt for resistances through 10,000 ohms, .2 watt with 350 volts maximum across end terminals for resistances over 10,000 ohms. Also available in concentric shaft tandem construction C45-70 as shown above.

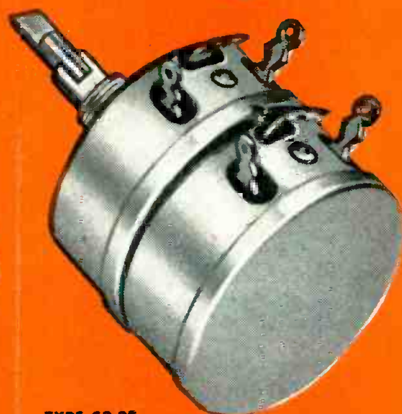


TYPE C2-45



TYPE C2-35

TYPE C2-252

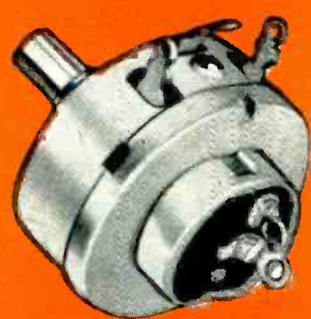


TYPE C2-25

TYPE GC-45, 15/16" diameter variable composition resistor. Wattage rating: 1/2 watt for resistances through 10,000 ohms, 1/3 watt for resistances over 10,000 ohms through 100,000 ohms, 1/4 watt with 500 volts maximum across end terminals for resistances over 100,000 ohms. Available with or without illustrated attached switch and in concentric shaft tandem construction C2-45 as shown above.

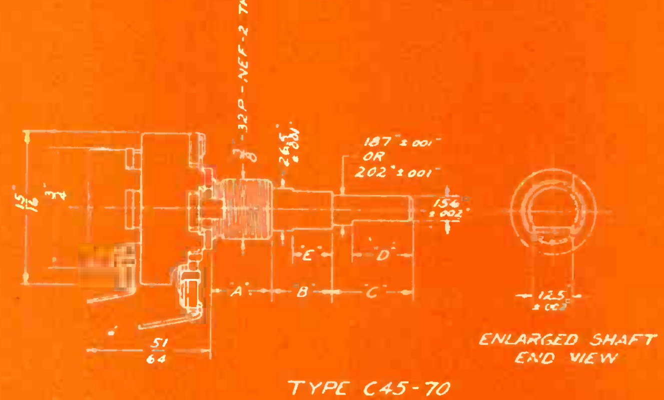
TYPE GC-35, 1 1/8" diameter variable composition resistor. Wattage rating: 3/4 watt for resistances through 10,000 ohms, 2/3 watt for resistances over 10,000 ohms through 25,000 ohms, 1/2 watt with 500 volts maximum across end terminals for resistances over 25,000 ohms. Available with or without illustrated attached switch and in concentric shaft tandem construction C2-35 as shown above.

TYPE GC-252, 2 watt, 1 17/64" diameter variable wirewound resistor. Available with or without illustrated attached switch and in concentric shaft tandem construction C2-252 as shown above.



TYPE GC-25, 4 watt, 1 17/32" diameter variable wirewound resistor. Available with or without illustrated attached switch and in concentric shaft tandem construction C2-25 as shown above.

Typical concentric shaft tandem with panel and rear sections operating separately from concentric shafts (TYPE C45-70 ILLUSTRATED). Similar construction available for all military resistors.



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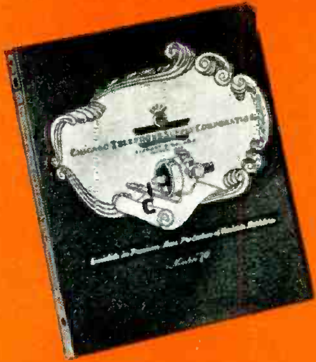
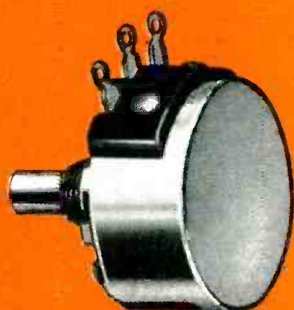


NEW 38-PAGE ILLUSTRATED CATALOG—
Describes Electrical and Mechanical characteristics, Special Features and Constructions of a complete line of variable resistors for military and civilian use. Includes dimensional drawings of each resistor. *Write today for your copy.*

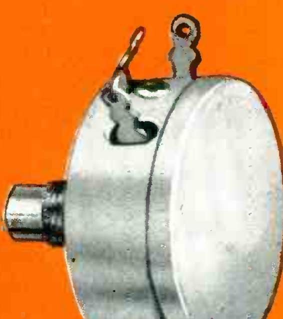
TYPE 45, (JAN-R-94, Type RV2)
1/4 watt, 15/16" diameter variable composition resistor. Also available with other special military features not covered by JAN-R-94 including concentric shaft tandem construction. Attached switch can be supplied.

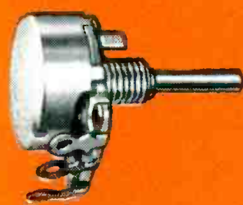
TYPE 35, (JAN-R-94, Type RV3)
1/2 watt, 1 1/8" diameter variable composition resistor. Also available with other special military features not covered by JAN-R-94 including concentric shaft tandem construction. Attached switch can be supplied.

TYPE 252, (JAN-R-19, Type RA20)
2 watt, 1 17/64" diameter variable wirewound resistor. Also available with other special military features not covered by JAN-R-19 including concentric shaft tandem construction. Attached switch can be supplied.

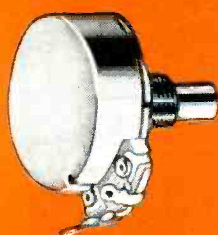


TYPE 25, (JAN-R-19, Type RA30)
(May also be used as Type RA25)
4 watt, 1 17/32" diameter variable wirewound resistor. Also available with other special military features not covered by JAN-R-19 including concentric shaft tandem construction. Attached switch can be supplied.

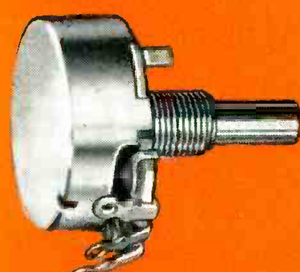




TYPE 65, (Miniaturized)
1/2 watt 70°C, 3/4" diameter miniaturized variable composition resistor.



TYPE 90
1 watt 70°C, 15/16" diameter variable composition resistor. Attached switch can be supplied. Also available in concentric shaft tandem construction.



TYPE 95, (JAN-R-94, Type RV4)
2 watt 70°C, 1 1/8" diameter variable composition resistor. Also available with other special military features not covered by JAN-R-94 including concentric shaft tandem construction. Attached switch can be supplied.

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Specially designed for military communications equipment subject to extreme temperature and humidity ranges. −55°C to +150°C...aridity to saturation.

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MEPCO'S NEW SEALED Precision Resistors STOP Humidity Failures

Over 2 years of laboratory development and testing were required to achieve a sealed resistor design up to Mepco's standard of quality. No sacrifice of our standard time-proven features have been made in order to perfect this sealed resistor.

SPECIFICATIONS: Meets all requirements of MIL-R-93A and JAN-R-93.

SEALING: Completely encapsulated and bonded.

OPERATING TEMPERATURE: −65°C. to +125°C.

WINDINGS: Reversed and balanced PI-windings for low inductance with use of only the finest "certified" resistance alloys.

EXCLUSIVE INTERNAL FEATURES: Internal section's cross-over wire insulated from winding by 2000 v. insulation (patented). Special metal molded connecting feature, which bonds end of winding and terminal in a non-corrosive and mechanically secure manner — no solder or flux used.

TERMINALS: Rigid hot solder coated brass terminals for easier and more secure soldering.

TYPE	NOMINAL WATTAGE RATING	RESISTANCE MIN.	RESISTANCE MAX.	NO. SECTIONS	SUPERSEDES JAN-R-93 TYPE
RB15 (M15)	.25 .50	0.1 ohm 0.1 ohm	.185 meg. .6 meg.	2	RB10
RB16 (M16)	.35 1.00	0.1 ohm 0.1 ohm	.3 meg. 1.5 meg.	2	RB11
RB17 (M17)	.50 1.00	0.1 ohm 0.1 ohm	.3 meg. 2.0 meg.	4	RB12
RB18 (M18)	.50 1.00	0.1 ohm 0.1 ohm	.75 meg. 4.0 meg.	4	RB13
RB19 (M19)	1.00 2.00	0.1 ohm 0.1 ohm	4.0 meg. 15.0 meg.	8	RB14
RB52 (M52)	.25 .50	0.1 ohm 0.1 ohm	.1 meg. .5 meg.	2	RB51

MIL - R - 93A
WATTAGE & RESISTANCE TOLERANCE

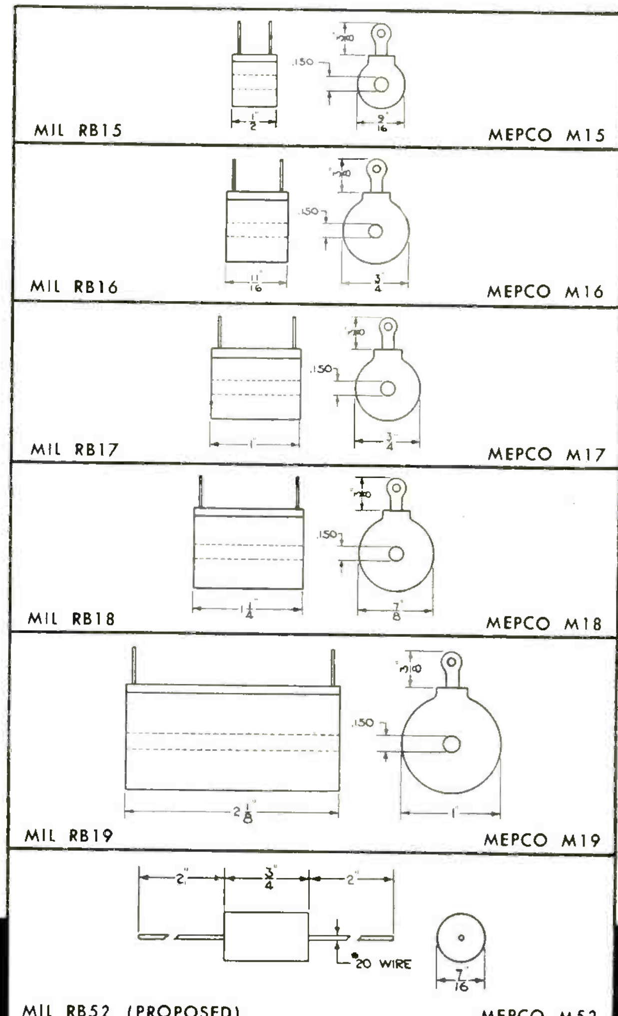
TOLERANCE SYMBOL	RESISTANCE TOLERANCE	PERCENT OF NOMINAL WATTAGE
B	0.10 %	50 %
C	0.25 %	50 %
D	0.50 %	75 %
F	1.00 %	100 %

MIL - R - 93A
TEMPERATURE COEFFICIENT
(REFERRED TO 25°C)

SYMBOL	EXPRESSED IN PERCENT PER DEGREE C. NEGATIVE, MAX.	POSITIVE, MAX.
E	0.0022	0.0022
J	0.0040	0.0155
K	0.0050	0.0255

SPECIAL REQUIREMENTS

Variations of the above ratings, tolerances, temperature coefficient, etc. can be supplied to special order.



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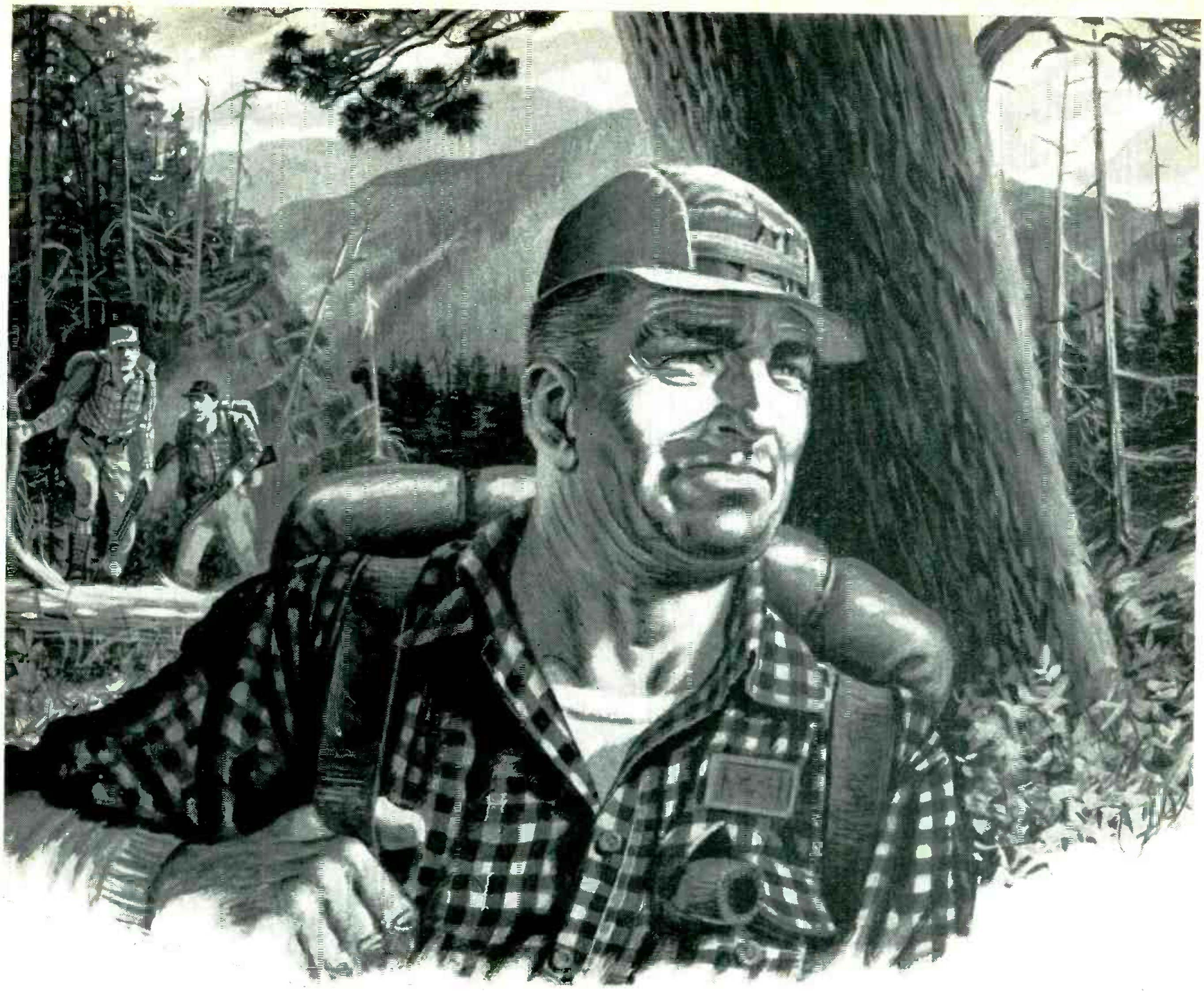

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LOW-CURRENT

SORENSEN'S EXPANDED LINE OF B-SUPPLYS NOW INCLUDES THIS NEW MULTI-RANGE DUAL SUPPLY.

Many users of Sorensen Nobatrons* and AC Regulators are unaware that the standard Sorensen line includes a wide range of "B-Nobatrons" — high voltage, low-current DC sources.

Are you familiar with the number of units in the line? Two of them — models 360BB and 520BB — are low-cost units for those not requiring outputs adjustable down to zero, but which can be paralleled for higher current requirements. The other models are highly flexible, all-purpose laboratory instruments. All of them provide voltage and current well in excess of the specifications given below (these "plus values" are shown graphically in the new Sorensen DC catalog).

You owe it to yourself to get acquainted with these Sorensen B-NOBATRONS. You'll find they are reasonably priced — surprisingly so — yet in all ways live up to the Sorensen reputation for sound engineering, quality construction, dependable operation. Write for information.

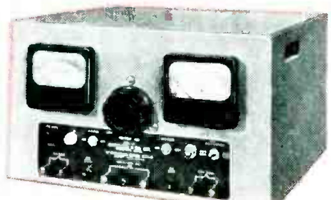
*Reg. U.S. Pat. Off. by Sorensen & Co., Inc.

MODEL 350-B SPECIFICATIONS

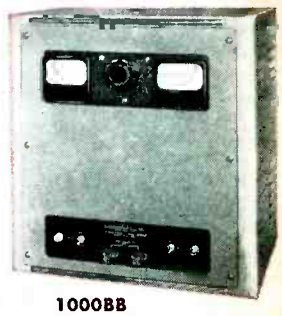
INPUT	105 - 125 VAC, 50 - 60 ~, 1Ø.
OUTPUT	1. 175-350 VDC @ 0-60 Ma simultaneously from two independently adjustable outlets. 2. 175-350 VDC @ 0-120 Ma from one outlet. 3. 0-175 VDC @ 0-60 Ma from one outlet. 4. 6.3 VAC @ 3.5 amps., C.T., unregulated.
OUTPUT REGULATION	±1.0%
RIPPLE	10 mv
SIZE	13" x 7½" x 8"

520BB

560BB



500BB



1000BB

325BB

360BB

MODEL NO.	325BB	360BB	520BB	560BB	500BB	1000BB
Output voltage	0-325	175-360	200-500	0-500	0-500	200-1000
Output current	0-125 Ma	0-120 Ma	0-200 Ma	0-200 Ma	0-300 Ma	0-500 Ma
Output voltage, bias	0-150	....	....	0-150	0-150	....
Output current, bias	0-5 Ma	....	....	0-5 Ma	0-5 Ma	....
Ripple	10 mv	10 mv	10 mv	10 mv	10 mv	20 mv
Low AC voltage (center tapped, unregulated)	6.3 at 10 amp.	6.3 at 10 amp.	6.3 at 10 amp.	6.3 at 10 amp.	6.3 at 10 amp.	....

Regulation accuracy: ±0.5% (±1% in 360BB and 520BB)
Input: 105-125 volts AC, 50-60 cycles, single phase.
Models 325BB, 560BB, 500BB and 1000BB are metered.
Units are normally self-contained. All can be provided with a front panel for rack mounting.

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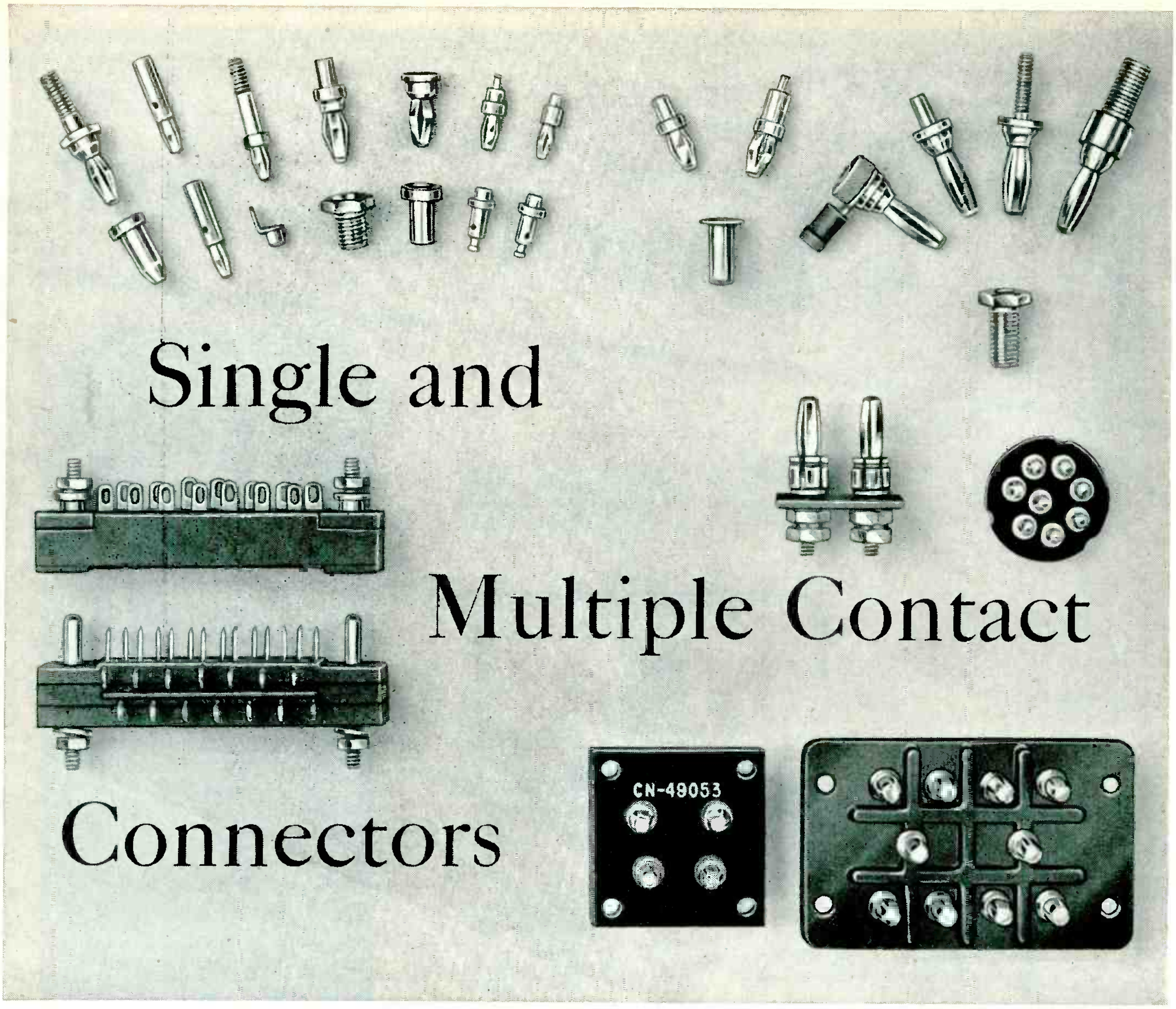

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Molded assemblies are available in standard 12 and 14 pin connectors. Banana plugs and jacks can readily be made in assemblies for specific application.

Ucinite banana pins have one-piece beryllium copper springs to insure proper alignment and firm contact under the most adverse conditions. Mounting ends can be made up in practically unlimited variety for staked or threaded mounting. Springs and mating jacks are available in several sizes.

Ucinite engineers are ready to design and manufacture single and multiple contact connectors to solve your special problems.

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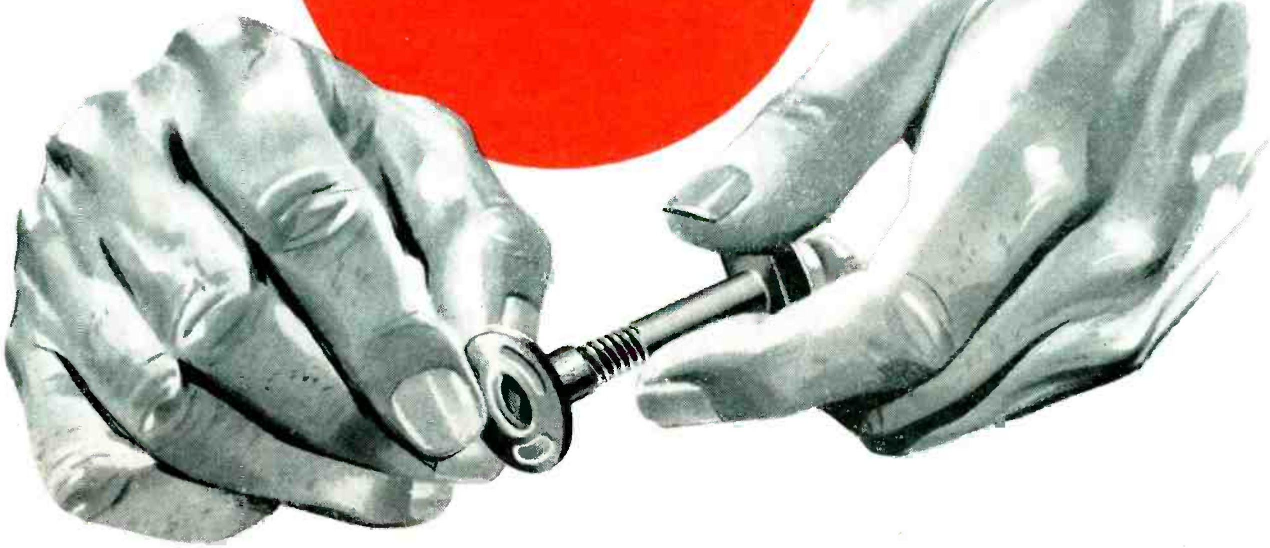

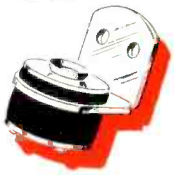

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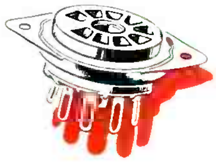
United-Carr's engineering department is constantly at work, improving current DOT fasteners and designing entirely new fasteners to meet the changing needs of industry.



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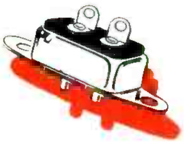
The fasteners and assemblies illustrated here are typical of thousands of special devices designed and manufactured by United-Carr and its subsidiaries.

We urge you to call in your nearest United-Carr field engineer before *your new designs crystallize. It is at this all-important planning stage that you can make most effective use of our special services.*



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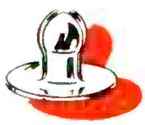

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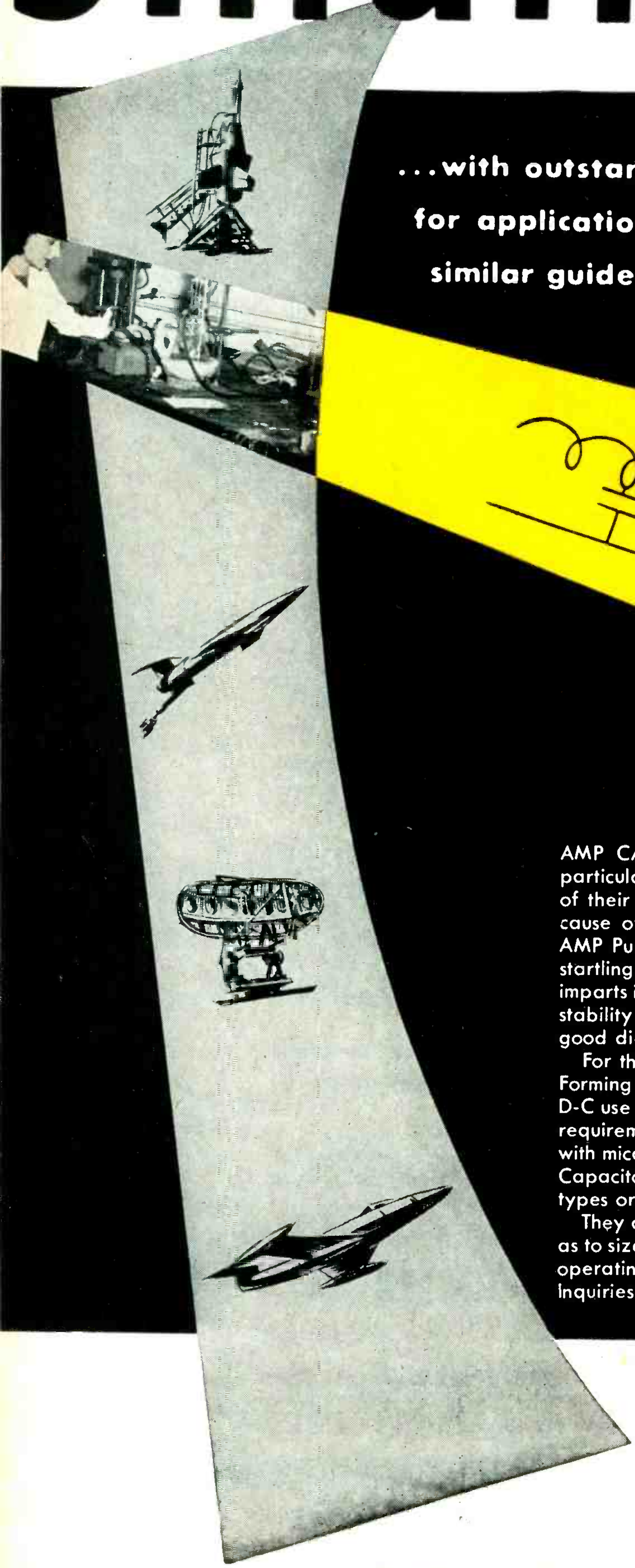
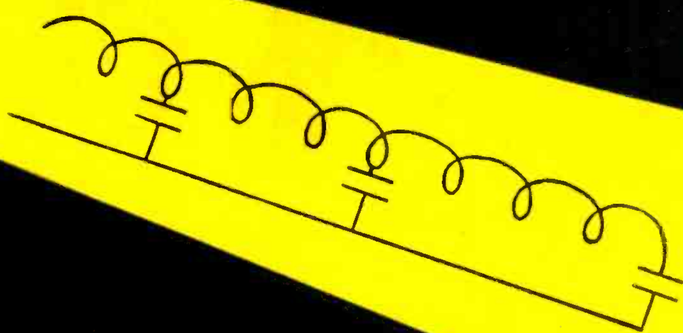


...with outstanding STABILITY and RELIABILITY for application in radar, missile control, and similar guided systems!



AMP CAPITRON* Capacitors and Pulse Forming Networks are particularly suited for radar and guided systems not only because of their remarkable size and weight characteristics, but also because of their outstanding stability and reliability in operation. AMP Pulse Forming Networks are fabricated with AMPLIFILM,* a startling new synthetic dielectric, chemically similar to mica, which imparts its unique combination of extremely high dielectric strength, stability over wide temperature ranges, low power factor, and good dielectric constant to these products.

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There's no substitute for proven performance—and for more than 15 years Owens-Corning Fiberglas materials have been helping to make good electrical equipment perform even better. Five such materials are shown below and on the facing page. All are proven . . . all are universally available . . . most are priced no higher than ordinary organic products. . .

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**Fiberglas is the trade mark (Reg. U. S. Pat. Off.) of Owens-Corning Fiberglas Corporation for a variety of products made of or with fibers of glass.*

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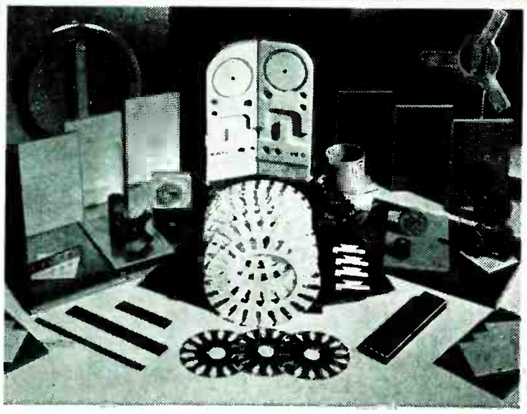

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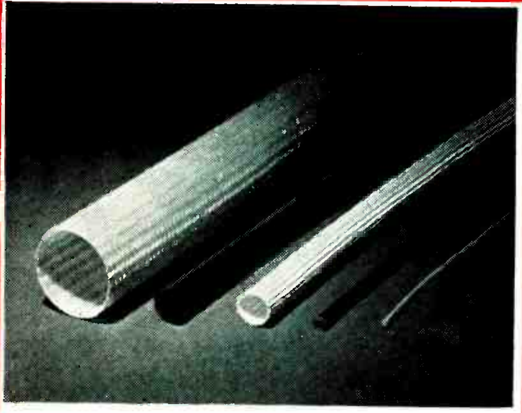
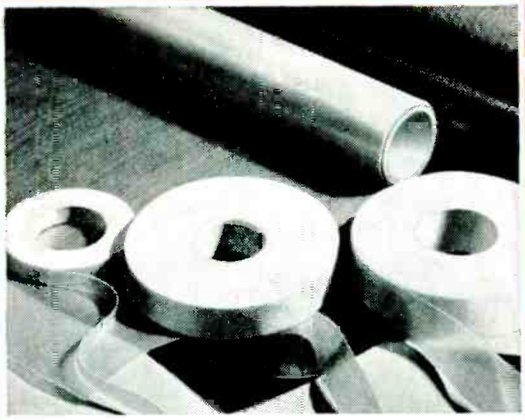
Fiberglas yarns absorb energy without permanent set—give Fiberglas glass-base laminates maximum impact resistance. Retain their shape—can't shrink or swell—and punch clean, handle well. Available impregnated with phenolic, polyester, melamine, silicone resins.



sleeving and tubing

Sleeving and tubing made with Fiberglas yarns offer unsurpassed strength, flexibility and resistance to moisture, oils, most acids. Won't burn during soldering work and is easier to slip over conductors because it is round and smooth inside.



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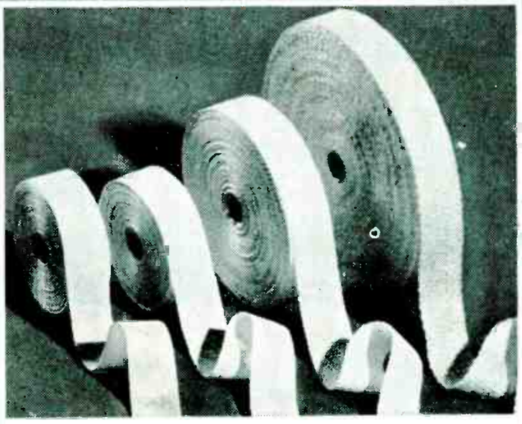
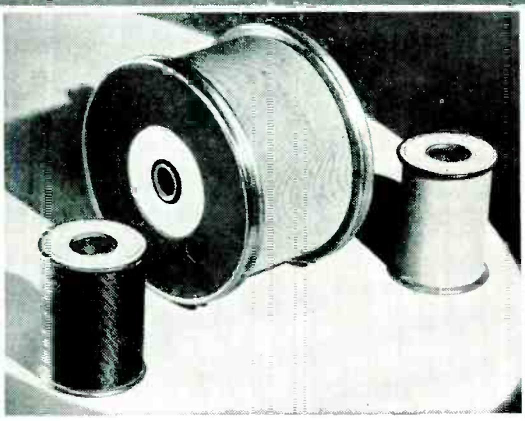
Glass can't burn; cloths woven of Fiberglas yarns thus offer unparalleled fire safety. Permit operation of equipment at higher ambient temperatures for longer time with fewer breakdowns. Dissipate heat faster, too—provide greater overload insurance.



electrical tapes

Exceptional tensile strength and smaller diameter of Fiberglas yarns means thinner, stronger tapes—less bulky wrappings, savings in space. Fewer equipment breakdowns, too, because Fiberglas yarns cannot stretch or shrink . . . won't burn . . . and are resistant to moisture and most acids.



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Fiberglas yarns used in magnet wire are thinner than organic textiles, yet withstand higher temperatures. Makes possible the design of smaller, lighter, higher-rated equipment—with corresponding savings in metals and other expensive materials.

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VOLTAGE REGULATED POWER SUPPLIES

For Industrial and Research Use

by KEPCO

Kepco Voltage Regulated Power Supplies are conservatively rated. The regulation specified for each unit is available under all line and load conditions within the range of the instrument.

Write for complete specifications.

VOLTS	CURRENT	REGU-LATION	RIPPLE	6.3 V.† AC. CT.	MODEL
0-1500	0-200 Ma.	0.5%	20 Mv.		1520
0-1200	0-20 Ma.	0.1%	10 Mv.	10 Amp.	1220
0-1000	0-500 Ma.	0.5%	20 Mv.		1350
200-1000	0-500 Ma.	0.5%	20 Mv.		1250
0-1000	0-50 Ma.	0.1%	10 Mv.	10 Amp.	1020
0-600	0-3 Amp.	0.5%	10 Mv.		780
0-600	0-2.25 Amp.	0.5%	10 Mv.		770
0-600	0-1.5 Amp.	0.5%	10 Mv.		760
0-600	0-750 Ma.	0.5%	10 Mv.		750
0-600 0-150 Bias	0-300 Ma. 0-5 Ma.	0.5% *	5 Mv. 5 Mv.	10 Amp.	615
0-600	0-300 Ma.	0.5%	5 Mv.	10 Amp.	500R
#1 0-600 #2 0-600	0-200 Ma. 0-200 Ma.	0.5% 0.5%	5 Mv. 5 Mv.	10 Amp. 10 Amp.	800
0-600 0-150 Bias	0-200 Ma. 0-5 Ma.	0.5% *	5 Mv. 5 Mv.	10 Amp.	815
#1 200-500 #2 200-500	0-200 Ma. 0-200 Ma.	0.5% 0.5%	5 Mv. 5 Mv.	6 Amp. 6 Amp.	510
200-500	0-200 Ma.	0.5%	5 Mv.	6 Amp.	245
0-400 0-150	0-150 Ma. 0-5 Ma.	0.5% *	5 Mv. 5 Mv.	10 Amp.	400
100-400	0-150 Ma.	0.5%	5 Mv.	10 Amp.	141
100-400	0-150 Ma.	0.01%	1 Mv.	10 Amp.	2000
0-350	0-3 Amp.	0.5%	10 Mv.		730
0-350	0-2.25 Amp.	0.5%	10 Mv.		720
0-350	0-1.5 Amp.	0.5%	10 Mv.		710
0-350	0-750 Ma.	0.5%	10 Mv.		700
100-325 0-150 Bias	0-150 Ma. 0-5 Ma.	0.5% *	5 Mv. 5 Mv.	10 Amp.	131
0-300 0-150 Bias	0-150 Ma. 0-5 Ma.	0.5% *	5 Mv. 5 Mv.	5 Amp.	315
0-150	0-50 Ma.	0.5%	5 Mv.		150
3-30	0-30 Amp.	0.5%	0.1%		3030
1-13	0-10 Amp.	0.5%	10 Mv.		3200
0.3-3	0-100 Ma.	5 Mv.	1 Mv.		3100

DC POWER SUPPLY SPECIFICATIONS

REGULATION:

As shown in table for both line fluctuations from 105-125 volts and load variation from minimum to maximum current.

*Regulation Bias Supplies: 10 millivolts for line 105-125 volts. ½% for load at 150 volts.

†All AC Voltages are unregulated.

All units are metered except Models 131, 315 and 3100.

All units are designed for relay rack mounting or bench use.

WORKMANSHIP

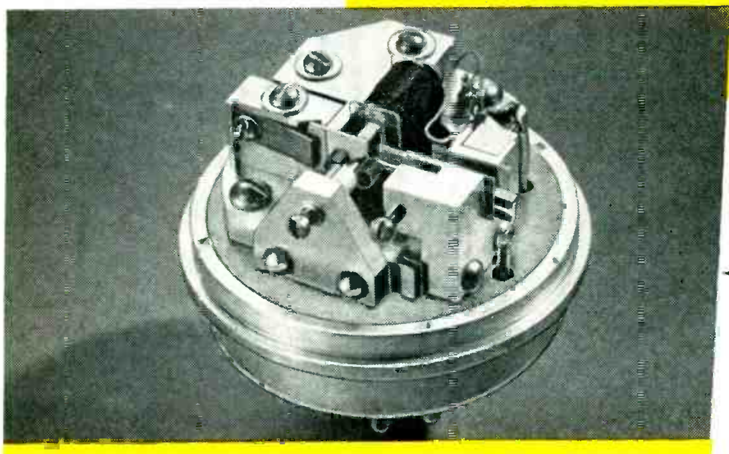
Workmanship is of a quality with the highest existing production standards and best instrument electronic practices consistent with the intended use of the item as a continuous duty voltage regulated power supply. Oil filled paper condensers and resistor-board construction are included in the design.

MANUFACTURERS OF ELECTRONIC EQUIPMENT • RESEARCH • DEVELOPMENT

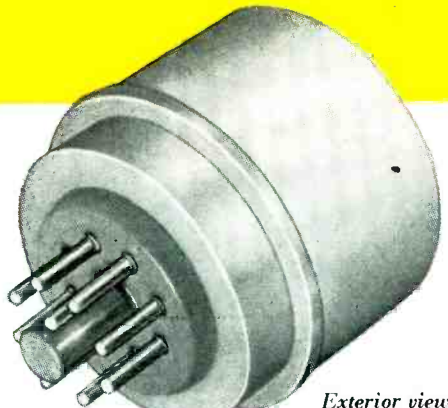
KEPCO LABORATORIES

131-38 SANFORD AVENUE • FLUSHING 55, NEW YORK

No ordinary relay...This! New CLARE Type T High Frequency Impulse Relay will follow 2500 cycles per second with life measured in billions of operations!



View of Clare Type T High Frequency Impulse Relay with dust cover removed



Exterior view of relay ready for mounting

specifications ....

MECHANICAL

SIZE:	1-15/16 in. diameter x 2-3/16 in. overall.
WEIGHT:	5 ounces.
MOUNTING:	Equipped with mica-filled bakelite plug, to fit a standard 8-pin octal socket.
COVER:	Removable dust-tight cover.
CONTACTS:	
Type:	Form A (s.p.s.t., normally open)
Material:	Platinum-iridium
Gap:	0.0005 inch
Pressure:	30 grams, min. (Coil energized with 50 ampere-turns)
COIL:	
Type:	Single winding, bobbin-wound
Wire:	Heavy formex

ELECTRICAL

COIL DISSIPATION:	0.5 watt (estimated max.)
CONTACT RATING:	0.05 amp., max. 50 volts ac, non-inductive. (estimated)
CONTACT BOUNCE:	None
OPERATION:	
Pull-in	15 ampere-turns
Drop-out	12 ampere-turns
Pull-in time	120 microseconds
Drop-out time	100 microseconds

RATE: Will follow 2500 cycles per second; aperiodic to 1000 cycles per second.

LIFE EXPECTANCY: 5 x 10^9 operations with zero contact current.

DIELECTRIC STRENGTH: 500 volts, rms.

TYPICAL APPLICATIONS

Coil inductance	0.3 hy (contacts open)
Coil inductance	0.35 hy (contacts closed)
Coil resistance	135 ohms
Pull-in current	10 to 12 ma.
Drop-out current	8 to 10 ma.
Normal coil current	40 ma.
Contact current	0.075 ma.

LIFE EXPECTANCY: Following a 1 x 10^6 operation run-in period, a life of 5 x 10^9 operations with a .075 ma. contact load over a 6-month period without readjustment.

Originally designed for use in an analog computer, the new CLARE Type T High Frequency Impulse Relay is now available for other applications which require a highly sensitive relay completely free from contact bounce and capable of a prodigious number of operations at extremely high speeds.

Its pull-in time of 120 microseconds and drop-out time of 100 microseconds enable this relay to follow up to 2500 cycles per second; aperiodic to 1000 cycles per second.

In a typical application, it has a life expectancy, following a run-in period of 1 x 10^6 operations, of 5 x 10^9 operations with a 0.75 ma contact load over a 6-month period without readjustment.

To achieve its high-speed, no-bounce, and other unusual characteristics, this relay is built to extremely close tolerances, with a high degree of precision, under conditions of utmost cleanliness. This necessitated the development of techniques never before employed in the manufacture of relays.

Even before this first public announcement of the availability of this truly remarkable relay, its fame has spread. Already dozens of inquiries and sample orders have been received from laboratories and development organizations which had learned of its existence through the manufacturer who first applied it in a well-known computer. It may provide the answer to one of your problems.

For full information on this new relay or for consultation on any relay problem, we invite you to contact your nearest CLARE sales engineer or write to C. P. Clare & Co., 4719 West Sunnyside Avenue, Chicago 30, Illinois. In Canada: Canadian Line Materials Ltd., Toronto 13, Ontario. Cable address: CLARELAY.

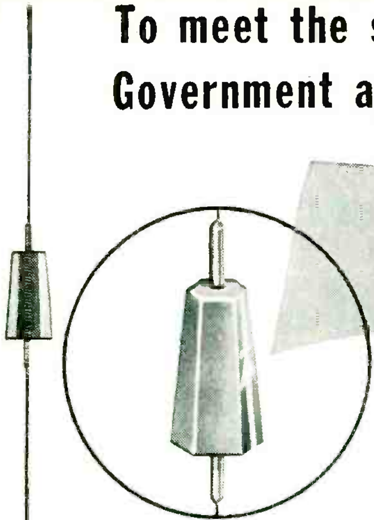
WRITE FOR BULLETIN 117

CLARE RELAYS

FIRST *IN THE INDUSTRIAL FIELD*

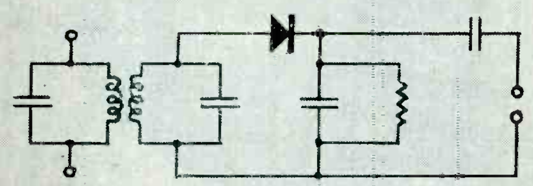
To meet the strictest requirements of both Government and Industry, specify

JAN TYPE RR Germanium Diodes



Precision made, easy to handle, easy to assemble — the tapered shape shows polarity at a glance! Make **Radio Receptor** Germanium Diodes your first choice in the large variety of electronic circuits where JAN types are a must.

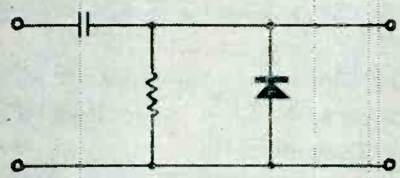
1N69
1N70
1N81



DETECTOR CIRCUIT

TYPICAL USES

COMPUTOR CIRCUITS	MODULATORS
CLAMPING CIRCUITS	NOISE ELIMINATORS
RF DETECTORS	CLIPPERS
CONTROL CIRCUITS	LEVEL SETTERS
DISCRIMINATORS	RESTORER CIRCUITS

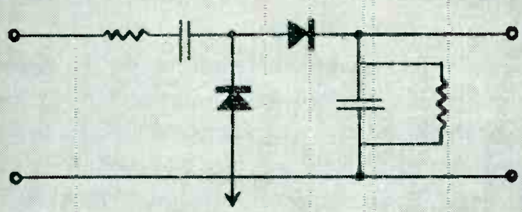


CLAMPING CIRCUIT

JAN TYPES · *ALL VALUES MEASURED AT 25°C.*

CODE NO.	Min. Forward Current at 1 Volt (MA)	Max. Reverse Current (Micro-Amperes)	*Average Rectified Current (MA Max.)	†Minimum Reverse Volts	Max. Cont. Reverse Operating Volts
1N69	5.0	50 @—10V 850 @—50V	40	75	60
Rectification efficiency: 35% minimum in 100 MC test circuit.					
1N70	3.0	25 @—10V 300 @—50V	30	125	100
1N81	3.0	10 @—10V	30	50	40

*Average half wave rectified current at 60 CPS and 25°C. Consult us for ratings at other conditions.
†For zero dynamic resistance.



COUNTING RATE CIRCUIT

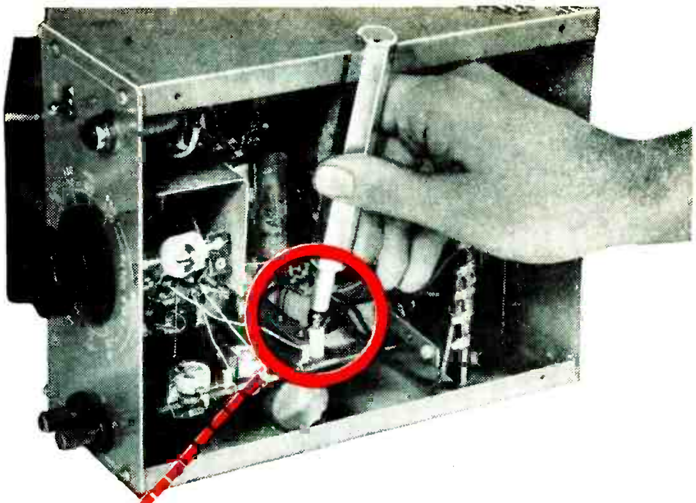
Radio Receptor Germanium Diodes may hold the answer to many of your problems. Our engineers will be glad to study your requirements and submit their recommendations. Many other types, both standard and special, are available . . . Write us!

Seletron and Germanium Division

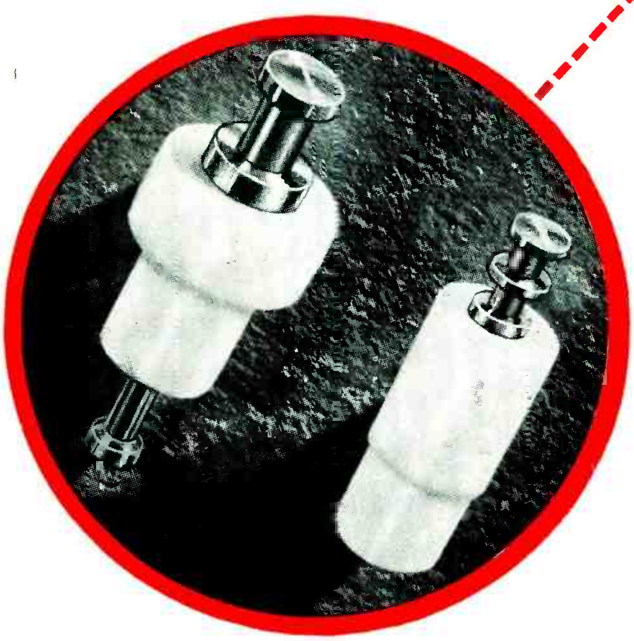
RADIO RECEPTOR COMPANY, INC.

RR ***Since 1922 in Radio and Electronics*** RR

SALES DEPT: 251 West 19th Street, New York 11, N. Y. • FACTORY: 84 North 9th Street, Brooklyn 11, N. Y.



Du Pont "TEFLON" provides high-temperature insulation



Terminals made by
Sealectra Corp.,
New Rochelle, N. Y.

Dielectric properties remain constant over wide temperature range

Standoff and feed-thru insulator terminals often fail in service due to high-temperature breakdown. Cracking frequently occurs during degreasing operations. And breakage may occur during manufacture. Today's equipment and operating conditions require terminals that eliminate these failures and provide improved, lasting performance.

In designing such improved terminals, Sealectro Corporation sought an insulating material that had good dielectric properties, resistance to high operating temperatures and chemical attack, and the toughness and resiliency to eliminate breakage and cracking. And it had to provide for simple, positive installations.

They chose Du Pont "Teflon"* tetrafluoroethylene resin. "Teflon" is an excellent insulator. Its dielectric constant (2.0) and loss factor (0.0005) are unaffected in temperatures from −80°F. to 400°F. Du Pont "Teflon" is inert to all chemicals except molten alkali metals and fluorine. It is tough, durable . . . will not crack or arc. And the one-piece terminals assure simple, tight, lasting installations.

Du Pont "Teflon" serves many uses in electrical equipment—coaxial spacers, insulation for wire, cables and motor windings, and other parts where high temperatures, service, dielectric strength and durability are required. Perhaps it can help you improve or develop a product. For full information, write E. I. du Pont de Nemours & Co. (Inc.), Polychemicals Department, Room 224T, Du Pont Bldg., Wilmington 98, Delaware.

*REG. U.S. PAT. OFF.

DU PONT
REG. U. S. PAT. OFF.
BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY

Polychemicals
DEPARTMENT
PLASTICS • CHEMICALS

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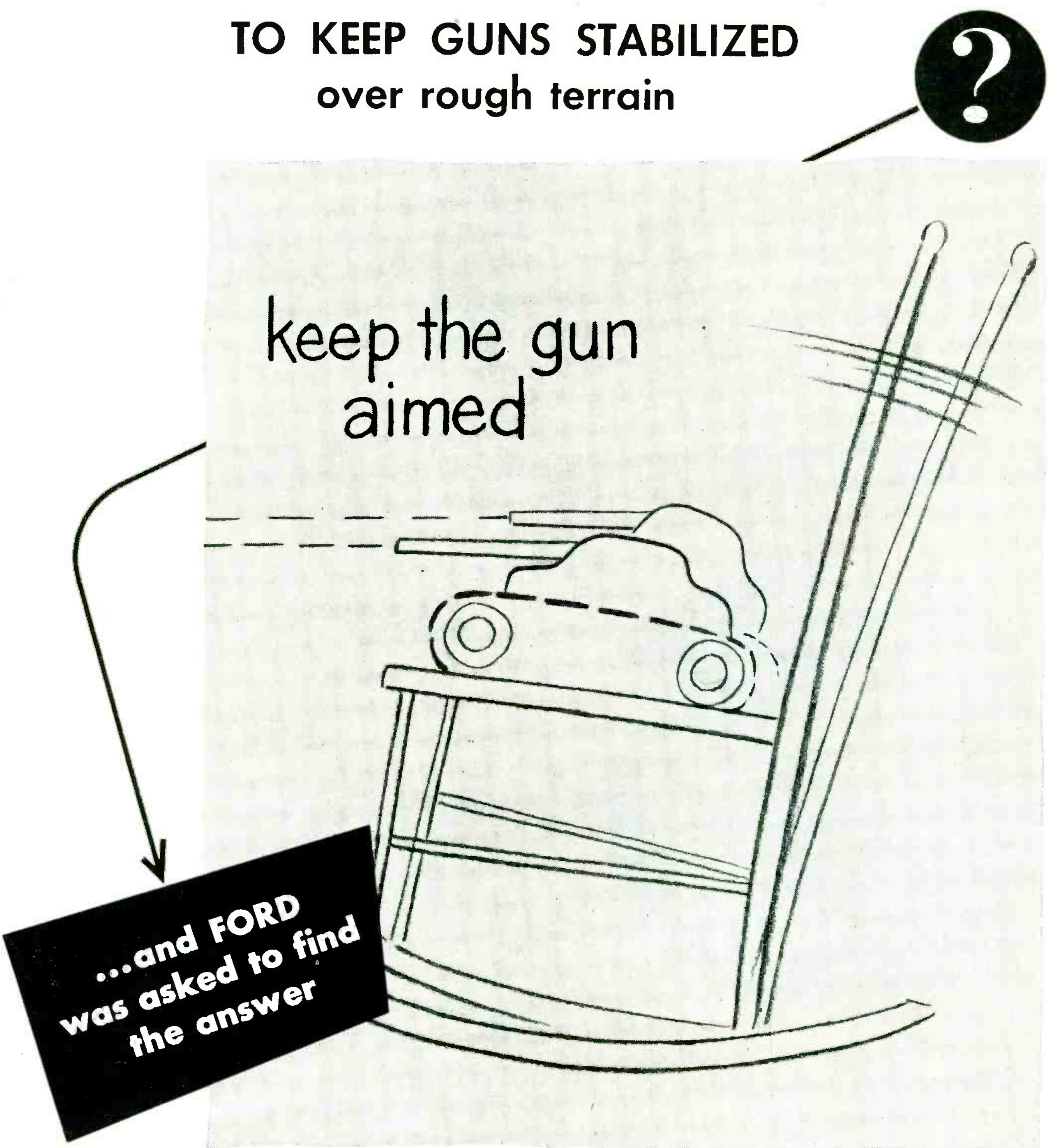
TO KEEP GUNS STABILIZED
over rough terrain



Over open area a tank pitches and heaves like a rocking chair . . . but regardless of the bumps . . . ditches . . . hills . . . the guns keep pointing at the target while the tank is moving. Ford Instrument Company played a vital role in designing and manufacturing a stabilizer unit for the tank's gun fire control system.

This is typical of the problems that Ford has solved since 1915. For from the vast engineering and production facilities of the Ford Instrument Company, come the mechanical, hydraulic electro-mechanical, magnetic and electronic instruments that bring us our "tomorrow" today. Control problems of both Industry and the Military are Ford specialties.

7

You can see why a job with Ford Instrument Company offers a challenge to young engineers. If you qualify, there may be a spot for you in automatic control development at Ford. Write for brochure about products or job opportunities. State your preference.

FORD

FORD INSTRUMENT COMPANY
DIVISION OF THE SPERRY CORPORATION
31-10 Thomson Avenue, Long Island City 1, N. Y.

A NEW IRVINGTON CLASS "B" INSULATION...

IRV-O-BESTOS®

By bonding a range of thicknesses of Quinterra asbestos to various thicknesses of Mylar—a tough, strong polyester film with the highest dielectric strength known—Irvington now brings you a line of Class "B" insulation that balances cost and properties to meet your needs. The Mylar gives IRV-O-BESTOS its high tensile, tear and dielectric strength. The Quinterra makes for ease of gripping—gives added heat stability and added thickness at moderate cost.

Since Quinterra is available in thicknesses from .003″ to .015″, and Mylar from .0005″ to .007″, a very large number of combinations are available—in duplex constructions or in triplex, with either the Quinterra or the Mylar on the outside. Whether your requirements are for high dielectric strength, or for added thickness at low cost, IRV-O-BESTOS will fill your needs.

Look to IRVINGTON for Insulation Leadership

- INSULATING VARNISHES
- VARNISHED CAMBRIC
- VARNISHED PAPER
- VARNISHED FIBERGLAS
- INSULATING TUBING
- CLASS "H" INSULATION

Mail the coupon for technical data and samples of this outstanding new Class "B" insulation.

*Johns-Manville Corp. trademark **du Pont trademark

Send this convenient coupon now

Irvington

VARNISH & INSULATOR COMPANY

10 Argyle Terrace, Irvington 11, New Jersey

Plants: Irvington, N. J.; Monrovia, Calif.; Hamilton, Ontario, Canada

Irvington Varnish & Insulator Company
11 Argyle Terrace, Irvington 11, N. J.

Gentlemen:
Please send me technical data sheet and samples of your new IRV-O-BESTOS Class "B" insulation.

Name............................Title............
Company............................
Street............................
City..................Zone..........State............

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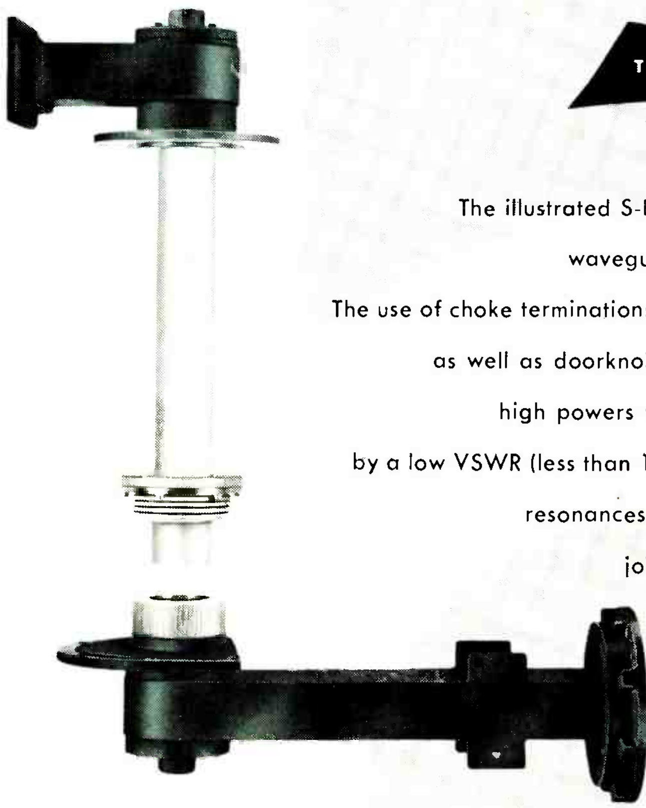
BOGART

MANUFACTURING CORPORATION

Producers of Microwave Equipment Since 1942



TRAIN ROTATING JOINT

The illustrated S-Band Rotary Joint is a waveguide to coaxial to waveguide structure employing doorknob transitions. The use of choke terminations for the inner conductor of the coaxial section, as well as doorknob transitions, ensures satisfactory operation at high powers without breakdown. This joint is characterized by a low VSWR (less than 1.04 over a 2% bandwidth) and freedom from resonances throughout its rotation of 360°. Similar rotary joints for elevation and cross-level purposes are available in various sizes of waveguide.

Inquiries are cordially invited
write to DEPT. R1

BOGART manufacturing corporation
315 SIEGEL STREET BROOKLYN 6, NEW YORK

SERVING THE ELECTRONIC INDUSTRY

DESIGN • DEVELOPMENT • PRODUCTION

Bradley Rectifiers are doing many different types of jobs

HERE IS A PARTIAL CHECKLIST OF HOW THEY ARE HELPING TO IMPROVE CIRCUIT PERFORMANCE

- ☐ MAGNETIC AMPLIFIERS
- ☐ MODULATORS
- ☐ CURRENT LIMITERS
- ☐ INSTRUMENT PROTECTION
- ☐ TEMPERATURE COMPENSATORS
- ☐ VOLTAGE REGULATORS
- ☐ D. C. VALVES
- ☐ BIAS SUPPLIES
- ☐ BATTERY CHARGERS
- ☐ ARC SUPPRESSORS

CHECK THIS LIST to see if you might be overlooking a simplified way to solve a circuit problem or better circuit operation. New developments have widened rectifier application. Bradley engineers can help you realize these new possibilities for your product.

In either conventional or special applications, Bradley rectifiers offer maximum stability and long life under usual or unusual temperature conditions. Laboratory conditions of manufacture, engineer inspection, and our exclusive vacuum process assure top quality, prompt delivery and lowest unit cost.

Write or call us for further information.

COPPER OXIDE MODULATOR

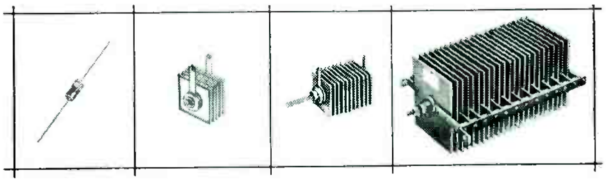
Bradley copper oxide modulator for this very low voltage threshhold application features low noise level, good temperature characteristics, and long-term stability. No moving parts to get out of order as in mechanical modulator; much longer life than vacuum tube.

SELENIUM AND COPPER OXIDE RECTIFIERS | VACUUM PROCESSED for PERFORMANCE AS RATED

SELF-GENERATING PHOTOELECTRIC CELLS

Bradley
LABORATORIES, INC.

The complete selenium rectifier line — from microamperes to thousands of amperes



BRADLEY LABORATORIES, INC., 168 Columbus Avenue, New Haven 11, Conn.

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UG-569/U

UG-572/U

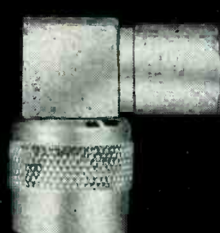
UG-643/U

UG-571/U

UG-573/U

UG-564/U

UG-565/U



UG-567/U

C CONNECTORS

by KINGS

C Series Connectors are a greatly improved mechanical and electrical type of co-axial connector. They are constant impedance and are designed for use with 50 ohm, middle size RF cables.

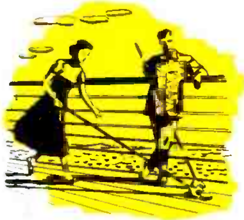
The C Series like every co-axial connector made by Kings is the result of constant research and development. Engineering ingenuity and precision manufacture have put "Connectors by Kings" in the front-line of communications equipment for industry and the armed services.

If you have a connector problem consult Kings. You'll be glad you called on Kings first.

KINGS Electronics CO., INC.

40 MARBLEDALE ROAD, TUCKAHOE, N. Y.

Have you heard *the latest*... IN BACKGROUND MUSIC?



An atmosphere to relax and enjoy — or the stimulation to work, to think, to play or buy — these are the benefits of background music. And background music is now practical *anywhere*, even beyond the reach of present wired services.

With the announcement of the new AMPEX 450, magnetic tape, musical wonder of a coming era, has become the ideal medium for background music. Hourly cost drops to a new low; quality rises to an all-time high. A wide variety of music for every purpose is now available on pre-recorded tape (see your Ampex distributor). Tape recordings eliminate needle scratch and their fidelity is permanent. They last for any conceivable number of plays.

On the AMPEX 450, up to eight hours of unrepeated music is available from one 14-inch reel of tape, and fully automatic repetition is available. The troubles and complexities of record changers are eliminated. And the AMPEX requires no standby attention from an operator.

AMPEX background music has a place in your business.

For further information, write to Dept. E

AMPEX

MAGNETIC RECORDERS

THE NEW AMPEX 450

- 8 hours of uninterrupted music (rest periods as desired)
- Usable on land, sea or air
- No standby operator required
- Lowest cost per hour

AMPEX ELECTRIC CORPORATION
934 CHARTER STREET • REDWOOD CITY, CALIF.

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keeping communications ON THE BEAM

JK PRODUCTS

the JK FD-12

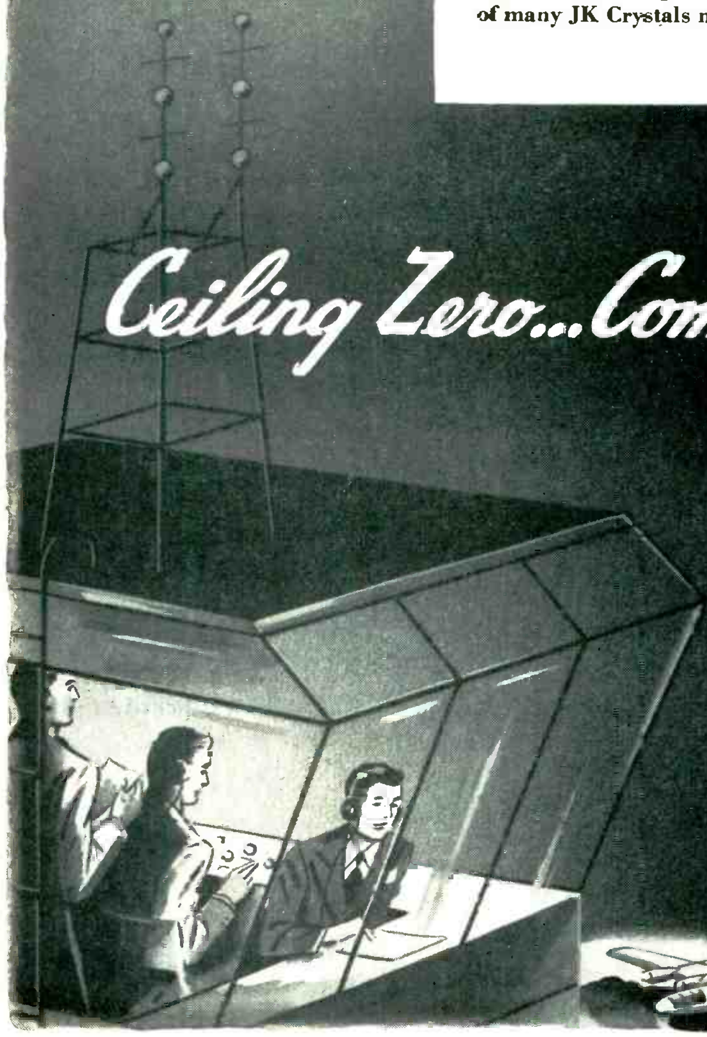
FREQUENCY AND MONITOR MODULATION

Monitors any four frequencies anywhere between 25 mc and 175 mc, checking both frequency deviation and amount of modulation. Keeps the "Beam" on allocation: guarantees more solid coverage, too!

JK STABILIZED H-17 CRYSTAL

CRYSTALS FOR THE CRITICAL

The JK H-17 Crystal meets rigid airline requirements for compactness, light weight, rugged dependability. A Military type, it is hermetically sealed—dust and moisture proof—plated, quartz plate is shock mounted. One of many JK Crystals made to serve every need.



Ceiling Zero... Communications 100%

"Pea soup" over the field . . . and still the giants of air travel come in "on the beam". When visibility is poor, commercial pilots must rely on radio-radar equipment to bring their ship in safely. JK Crystals play an important role in this every day drama of keeping airlines communications "on the beam" in the air and on the ground.

THE JAMES KNIGHTS COMPANY
SANDWICH ILLINOIS

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DESIGN and PRODUCTION NEWS

FOR ELECTRICAL AND ELECTRONIC ENGINEERS

Published by TECHNICAL SERVICE, Chemical Manufacturing Division, The M. W. KELLOGG Company APRIL 1953

Miniature Tube Socket Eliminates Ambient Temperature Interference

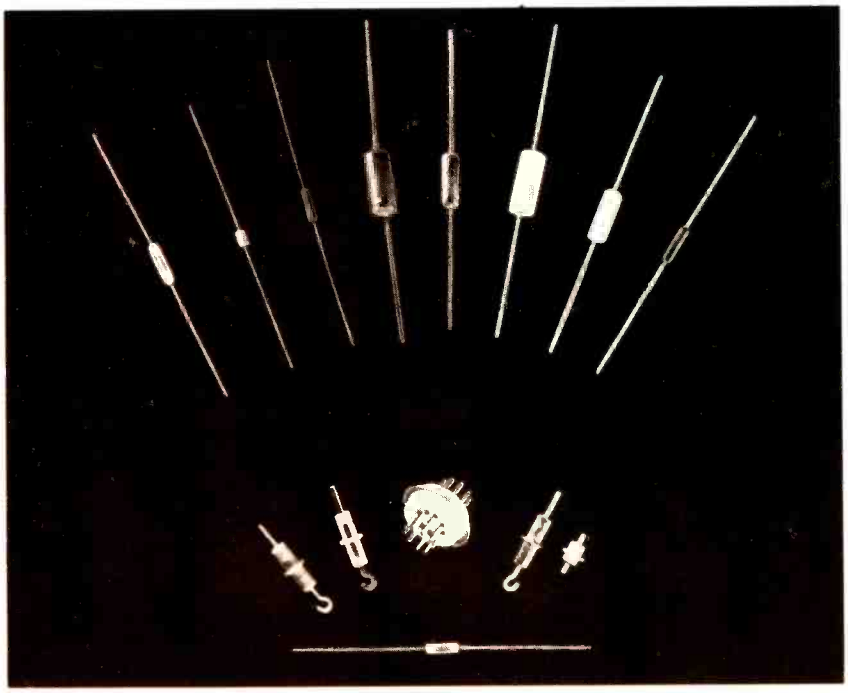
This new socket, overcomes two important obstacles to dependable tube performance—interference from high and low ambient temperatures, and erratic output at high frequencies due to insulation leaks—through the use of Kel-F trifluorochloroethylene polymers as the insulation. The precision molded insulation resists buckling, cracking or chipping due to sudden rises in temperature. The unique properties of the plastic allows the injection molded part to remain tough but resilient at temperatures of from below zero to well above 300° F. The high dielectric strength and low dissipation factor of Kel-F assures consistent, reproducible output even at high frequencies.

United States Gasket Company of Camden, N. J., produces this injection molded tube socket for a major electronic component manufacturer. Designating it as the "Chemelec"** series socket, U.S. Gasket is currently producing 7- and 9-pin types for a variety of military and industrial applications.

The resistance of Kel-F to embrittlement under constant vibration, or mechanical failure due to physical abuse, make it particularly suited to military uses. Its broad range of application also includes installations where high humidity is encountered—the zero water absorption, non-wetting characteristics of Kel-F allow it to maintain a high level of dielectricity through elimination of surface leakage due to moisture or fungus films. Additional flexibility in specifying this tube socket is possible because Kel-F is also resistant to attack or degradation by chemicals, oils and most organic solvents.

*** Trade mark of the United States Gasket Co.*

Refer to Report E-107

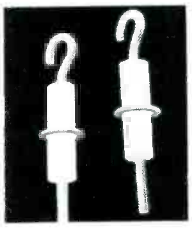


Terminals with KEL-F* Plastic Insulation Feature 10^6 Megohm Insulation Resistance...and Minus 94° F. to 390° F. Range!

With true hermetic seal characteristics these terminals will bear rough production handling and still pass a 7 pound terminal pull test and a 10 inch ounce torque test on the central conductor. Combine this with the high insulation resistance, broad temperature utility and mechanical strength of Kel-F in the body, and you have a solder-seal type terminal that stands out among all others.

Manufactured by the International Resistance Company of Philadelphia, Pa., this "Type HS-1" terminal (pictured at right) achieves its high rating through the use of insulation injection molded of Kel-F and a special process developed by this company to obtain a plastic-to-metal bond of remarkable strength. Employing highly dielectric and inert Kel-F polymers as the insulation in this terminal, International has overcome limitations associated with similar type terminals: low corona breakdown voltage, electrolysis under high DC voltage, failure under thermal shock.

The molded Kel-F is inert to acids, alkalis, oils, vapors and most organic solvents—thereby extending its usefulness to many processes and industries. Consistent, dependable, performance is assured in humid installations — insulation molded of Kel-F has zero water absorption, sheds water, precludes formation of fungus.



International Resistance Company molds and extrudes Kel-F polymer in many forms to serve many phases of the electrical and electronic industry. The main illustration includes several of the current applications, as well as others in the testing stage, among them press-fit insulated terminals . . . resistors with bodies molded of Kel-F . . . similar items in which the Kel-F is loaded with mica and silica . . . miniature insulated feed-through terminals . . . injection molded multiple header for hermetic seal use . . . selenium rectifier employing parts of Kel-F. Work is also continuing on development of unusual types of electrical materials which take advantage of the unique electrical and physical properties of Kel-F alone, or in combination with other materials.

Refer to Report E-104

(SEE REVERSE SIDE)

* *Registered trademark for The M. W. Kellogg Company's trifluorochloroethylene polymers*

KEL-F

FLUORO CHLORO CARBON PLASTIC

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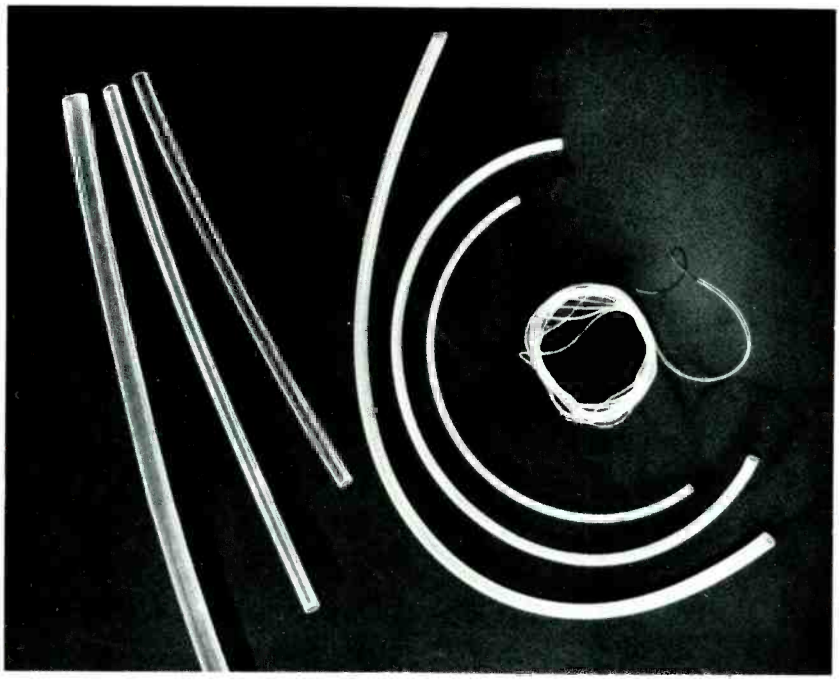

"Spaghetti", Flexible in Sub-sub-zero Temp., Protects Against Oils, Chemicals and Moisture!

This smooth extruded "spaghetti" sleeving for aircraft wiring made of Kel-F* polymer, is in a class by itself. Not only does it have a high dielectric strength of from 2500 to 5000 volts per mil, and excellent arc resistance, but it will stay pliable and resist cracking and splitting even after prolonged use at temperatures from minus 90° to 300° F. The unique physical and chemical properties of this fluoro-chloro-carbon plastic permits the lightweight but tough sleeving to remain unaffected under constant exposure to chemicals, oils, or aircraft fuels. Having a zero water absorption rating, it will shed water and prevent accumulations of troublesome fungus.

Significant advantages are gained in using this sleeving to protect aircraft wiring. The high heat resistance of Kel-F and its non-flammability make it particularly valuable in enclosed or tight installations—also lighter sleeving can be used while still maintaining superior protection. The overall result is a significant reduction in the weight and bulk of an assembly.

Preliminary investigations also show that sleeving, made from unplasticized grades of Kel-F polymers withstands nuclear radiations without significant effects on its electrical or mechanical properties.

Resistoflex Corporation of Belleville, N. J., manufactures several grades of "spaghetti" and rigid sleeving, made from Kel-F polymers, under the name Fluoroflex "C"**. Flexible spaghetti, ranging in size from #22 wire up to 3/4" I.D. is extruded in continuous lengths from Kel-F polymer. Larger sizes, up to 1 1/4" I.D., are available in 12' lengths.

The activities of this company in applying Kel-F to corrosion, temperature and electrical problems are widespread. It has developed extruded (reinforced steel braid) aircraft hose for handling corrosive oxidants, sheets for gaskets and pump diaphragms, precision machined fittings and instrument parts of Kel-F to close tolerances.

** Trade mark of Resistoflex Corporation

Refer to Report E-105

New Technical Bulletin on Properties Issued...

Kel-F Technical Bulletin #1-12-49, has just been revised and reissued as #1-3-53. The new edition of the bulletin contains expanded data on physical properties including a table of Chemical Resistance to more than 100 specific chemical substances... two new tables on Permeability ... also new data on Light Transmission in both the visible and ultra-violet spectrums.

If you have not received your copy, just drop a card or note to Technical Service.

Molders of the Month

Leading molders and extruders specialize in fabrication of materials and parts made of Kel-F ... each month this column will spotlight several of these companies with their principal services and products.

American Phenolic Corporation
Chicago, Ill.
Kel-F Coated Wire, Cable, Injection Molding

Crane Equipment & Supply Company, Inc.
Waterbury, Conn.
Kel-F Dispersion Coatings

Flek Corporation
Los Angeles, Cal.
Injection, Compression and Extrusion Molding
Electronic Sealing of Film
Dispersion Coating

Insulating Fabricators of New England, Inc.
Watertown, Mass.
Fabrication of Parts From Sheet, Rod, Tubing
Machining, Engraving, Stamping, Punching, Polishing of Parts

Linear, Incorporated
Philadelphia, Pa.
Compression Molding
"O" Rings, "U" and "V" Packings, Gaskets, etc.

The Polymer Corporation of Pennsylvania
Reading, Pa.
Extruded Tape, Strip
Molded Rods, Beading
Extruded Rods

For complete information regarding any item mentioned in DESIGN AND PRODUCTION NEWS, ask for detailed APPLICATION REPORTS, write

Technical Service
CHEMICAL MANFACTURING DIVISION
THE M. W. KELLOGG COMPANY
P.O. Box 469, Jersey City 3, N. J.
or offices in New York, Chicago, Los Angeles.

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* Registered trademark for The M. W. Kellogg Company's trifluorochloroethylene polymers

A Great First in Automatic Controls

- **Zero Maintenance**
- **No warm-up time**
- **Absolute reliability**
- **Fast response**
- **Miniaturized and Hermetically Sealed.**

Illustrated at the left is the 434-B Servo Amplifier, designed to drive the MK14, MK7 and MK8 BuOrd Servo Motors from synchro data. No power supply or stabilization tachometers are required. There are only six connections to the unit: 2 inputs, 2 outputs, and 2 for 117 volts, 400 cps.

TRANSISTOR - MAGNETIC

SERVO AMPLIFIERS

With the transitor as a preamplifier, there results a combination with the power output capacity of the magnetic amplifier and the sensitivity and speed of response of the transistor. Hermetic sealing is feasible because of the practically unlimited life and the low internal temperature rise. This radically new amplifier, developed and manufactured by the Industrial Control Company, will revolutionize the application of automatic control systems and servomechanisms in . . .

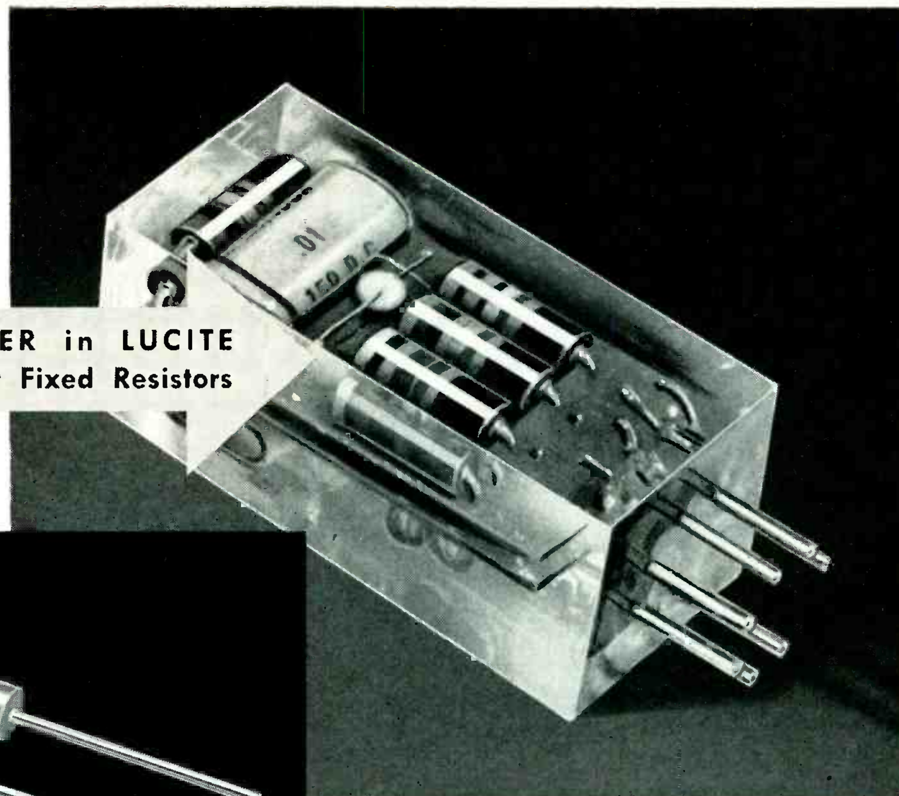
- *Industrial Controls*
- *Military Equipment*
- *Atomic Energy Installations.*

The Engineering Staff of the Industrial Control Company is continually engaged in long range development, designed to bring to our customers a variety of new techniques and equipments in this field.

INDUSTRIAL CONTROL COMPANY

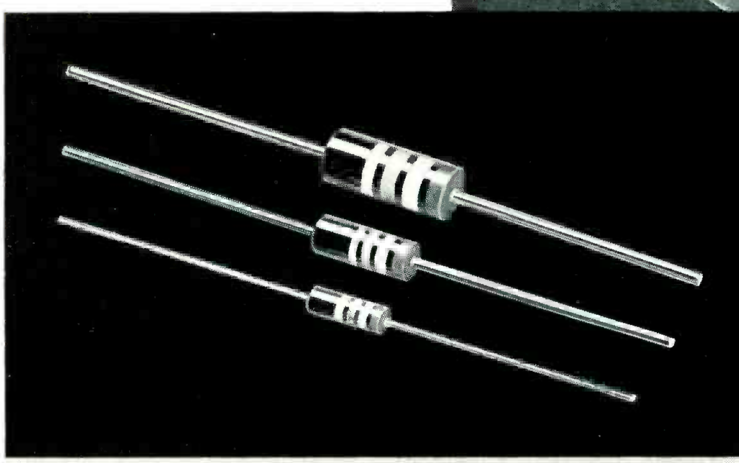
Wyandanch Long Island, New York

PHONE: MIDLAND 3-7548



TRANSISTOR AMPLIFIER in LUCITE equipped with Bradleyunit Fixed Resistors

Courtesy of Bell Telephone Laboratories, Inc.



Bradleyunit Fixed Resistors—½, 1, and 2 watt units

BUILD SUPERIOR PERFORMANCE

INTO YOUR ELECTRONIC EQUIPMENT WITH ALLEN-BRADLEY QUALITY COMPONENTS

If you want to be sure of getting consistently fine and dependable performance from your electronic circuits over a long period of time, just follow the example of leading laboratories... and use Allen-Bradley solid molded resistors.

Bradleyunit resistors have permanent characteristics, because they are rated to operate continuously at 70C ambient temperature . . . not 40C.

Bradleyunits withstand extremes of temperature, pressure, and humidity without deterioration. They are solid-molded with high mechanical strength.

The A-B honeycomb carton prevents tangling of leads and saves time in production. Leads are differentially tempered to prevent sharp bends near the resistor body.

Let us send you an A-B resistor chart.

Allen-Bradley Co., 110 W. Greenfield Ave., Milwaukee 4, Wis.

CERAMIC CAPACITORS
from 0.00047 to 0.01 mf

After long research Allen-Bradley has developed a high quality line of ceramic capacitors. Every step, from making the ceramic discs to the final impregnation and testing of the finished capacitor, is done in the Allen-Bradley plant.

A-B capacitors are approved by the largest manufacturers and research laboratories. Samples for testing furnished on request.

A·B Quality

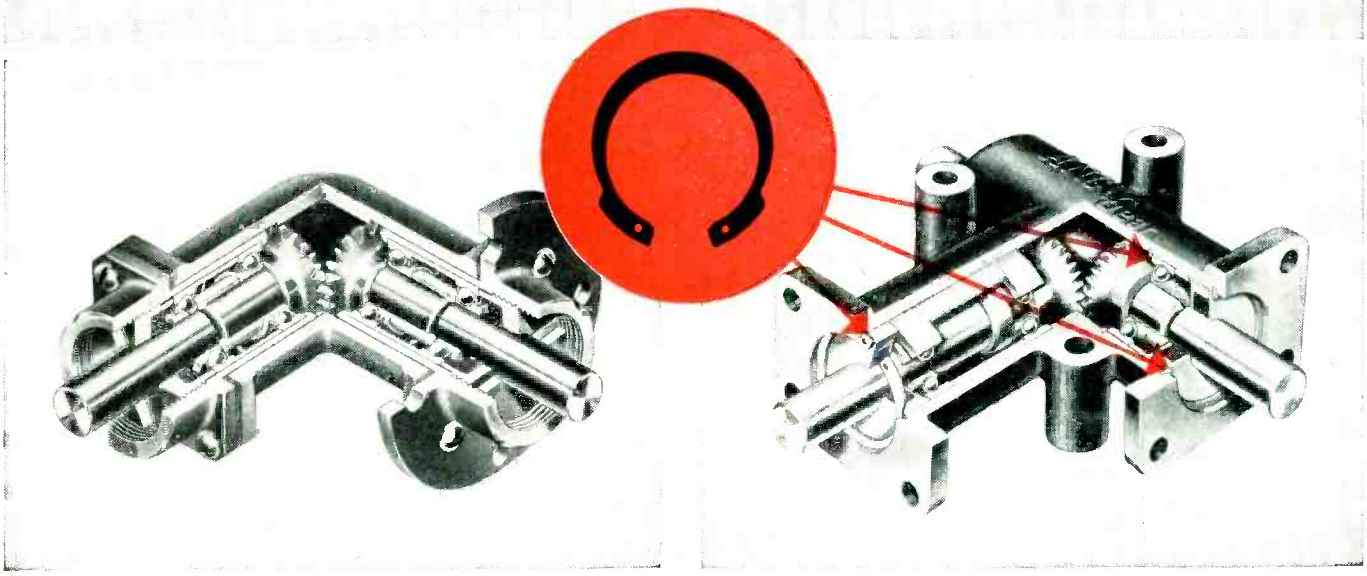
ALLEN-BRADLEY

RESISTORS & CAPACITORS

Sold exclusively to manufacturers of radio and electronic equipment

QUALITY

3 Waldes Truarc Rings Replace 19 Parts ...Save $6.75 Per Unit...Cut Weight by Nearly 16%



OLD WAY 2 Threaded nuts locked bearings in place. 8 screws and washers positioned bearing and shaft assemblies. This fastening method required expensive tapping and threading. Assembly was slow and costly.

TRUARC WAY Two Truarc inverted rings (Series 5008) provide uniform shoulder to lock bearings in place, position bearing and shaft assemblies. Additional Truarc Ring (Series 5100) locates ball bearing ...eliminates 1 sleeve type spacer.

Airborne Accessories Corporation, Hillside, New Jersey, uses Waldes Truarc Retaining Rings to take *all* thrust load from right angle bevel gears in their ANGLgear*. Truarc Rings make ANGLgear* more compact—save approximately ¼" at each end of housing. By providing a choice of 3 mounting possibilities — instead of 1 — Truarc Rings make ANGLgear* adaptable to many different assemblies. New design increases load capacity . . . eliminates machining of threads.

Redesign with Truarc Rings and you, too, will cut costs. Wherever you use machined shoulders, bolts, snap rings, cotter pins, there's a Waldes Truarc Retaining Ring designed to do a better job of holding parts together.

Waldes Truarc Rings are precision-engineered . . . quick and easy to assemble and disassemble. Always circular to give a never-failing grip. They can be used over and over again.

Find out what Truarc Rings can do for you. Send your blueprints to Waldes Truarc engineers for individual attention, without obligation.

Trade Mark of Airborne Accessories Corp.

SEND FOR NEW CATALOG

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REG. U. S. PAT. OFF.
RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

WALDES TRUARC RETAINING RINGS AND PLIERS ARE PROTECTED BY ONE OR MORE OF THE FOLLOWING U. S. PATENTS: 2,382,947; 2,382,948; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,509,081 AND OTHER PATENTS PENDING.

Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N. Y.

Please send me the new Waldes Truarc Retaining Ring catalog.

E-045

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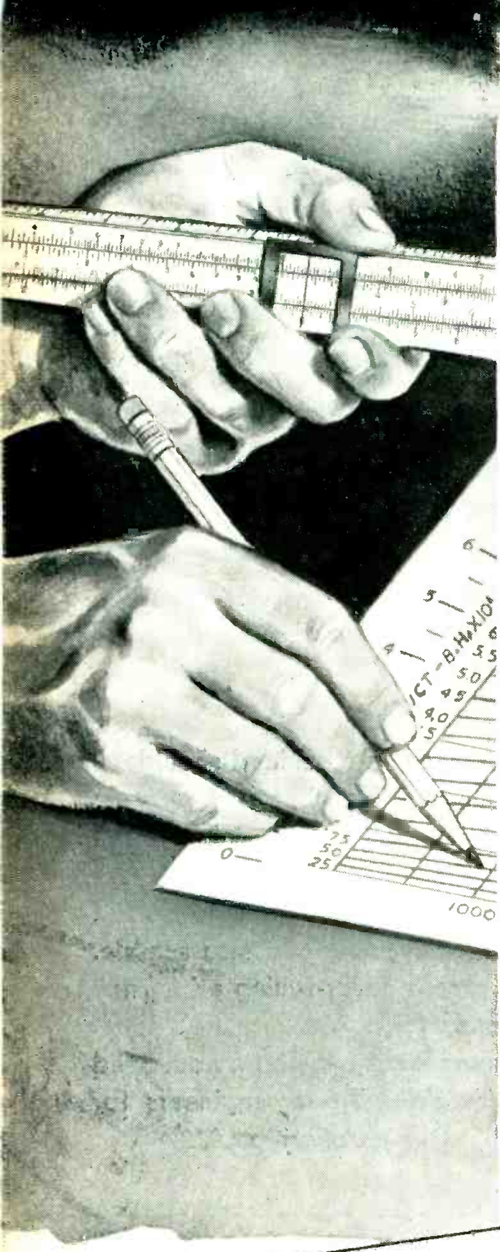
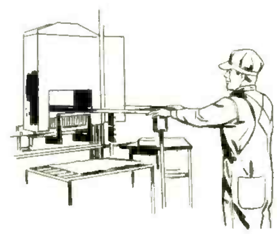
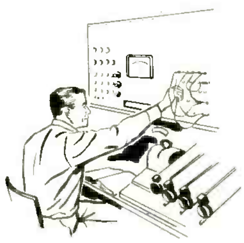


Permanent magnets last forever . . . a reliable source of permanent potential energy. Indiana Permanent Magnets supply a constant, uniform magnetic field, indefinitely.

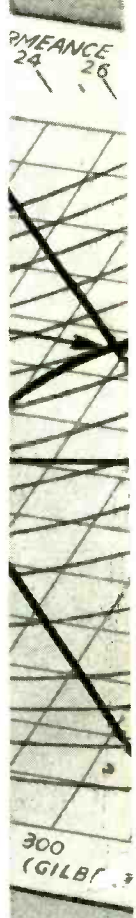
Research Leadership — Constant research at INDIANA has produced new and better permanent magnets. In countless different products, this versatile "packaged energy" improves performance, permits new uses or applications, saves space and money. INDIANA engineers, backed by years of experience gained in the development of over 30,000 magnet applications, are exceptionally well qualified to help you. They will properly design the magnet and select the best permanent magnet material for your product.



Quality in Mass-produced Magnets— Look to INDIANA for quality permanent magnets—for unsurpassed skill in manufacture—for cost-cutting engineering aid. Rigid supervision in every step of production is your guarantee of magnets with precise electrical characteristics and exact physical dimensions.



To meet your mass production needs, INDIANA gives you the advantages of the largest facilities in the world for the manufacture of permanent magnets and complete permanent magnet subassemblies. Futhermore, INDIANA makes no end products, has no subsidiaries; therefore, you can discuss your confidential problems freely with us. Take advantage of this wealth of extensive experience; "know-how"; top engineering; and prompt, reliable delivery of magnets on a regular production schedule. To help you in your design and production problems, consult The Indiana Steel Products Company, today.



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INDIANA—World's largest exclusive producer of permanent magnets—CAST: Alnico, Indalloy, Cunico, Cobalt. SINTERED: Alnico, Indalloy, Vectolite. DUCTILE: Cunico, Cunife, Silmanal. FORMED: Chrome, Cobalt, Tungsten.

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SALES OFFICES FROM COAST TO COAST—BOSTON • CHICAGO • CLEVELAND

Molded Tube Sockets
for High Production Applications
Direct Ground to Chassis
Recent addition to METHODE line of TUBE SOCKET ACCESSORIES is this new "Twist-On" type of tube shield and base, mounted in combination with molded sockets, as illustrated. Projecting lugs on shields provide direct ground to chassis under screw pressure and a reliable shock and vibration proof mount.
Other METHODE PRODUCTS include:
• Laminated wafer tube sockets
• Military tube and crystal sockets
• Panel Connectors
• Printed circuit sockets
• Tube shields
METHODE Manufacturing Corp.
2021 West Churchill Street • Chicago 47, Illinois
Geared to produce Plastic and Metal Electronic Components
Top and Sub-mount Octal Sockets, G. P. or Mica Phenolic, 1 5/16" or 1 1/2" mounting centers.
"J Lock" Type Miniature and Noval Socket and Shield Base Combination, G. P., Mica Phenolic or Ceramic Insulators.
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"Snap-in" Type Miniature and Noval Sockets and Shield Base Combination, G. P. or Mica Phenolic.
Miniature "Crimp-in" Sockets, G. P. Phenolic, with and without center shield.
SubminiatureTube Sockets, 4, 5, 6, 7 and 8 pin sizes, Mica Phenolic.
Actual Sizes
We invite your inquiries

NEW *hp* AUDIO

New! Completely redesigned!
Highest quality throughout
Lighter weight, smaller size
New wider frequency range
Time-tested RC circuits
No zero set. High stability
Constant output, low distortion

New convenience for laboratory, field or production measurements in sub-audio, audio, telephony, carrier current, super-sonic, telemetering and rf applications.

COMPACT, EASY TO USE BASIC INSTRUMENTS FOR LABORATORY OR PRODUCTION TESTS

Hewlett-Packard RC oscillators have long been basic tools for making electrical and electronic measurements of precise accuracy. Now these world-famous test instruments are redesigned to give you the most compact, dependable, accurate and easy-to-use commercial oscillators available.

New *-hp-* 200 series oscillators have highest stability and precisely accurate, easily resettable tuning circuits. Low impedance operating levels together with superior insulation guarantee peak performance throughout years of trouble-free service. New models have wider frequency range. Operation is simplified—just three front panel controls. Size is different, too—the instruments are more compact, lighter in weight and enclosed in an easy-to-handle aluminum case with carrying strap. Minimum bench space is required. (Rack mounting available on request.)

Complete Coverage! HEWLETT-PACKARD

OSCILLATORS

The total coverage of just two of the new *-hp-* oscillators is materially greater than that offered by four previous *-hp-* instruments. For example, new Model 200AB, for general audio tests, offers a wider frequency range of 20 cps to 40 kc and a full watt output. New *-hp-* 200CD, for wide-range measurements at lower power, provides constant voltage output from 5 cps to 600 kc.

In addition to these new instruments, *-hp-* continues to offer Model 200H for carrier current work up to 600 kc, and Model 202D for low frequency and vibration studies down to 2 cps. These instruments retain their time-tested design.

Components, insulation and other electrical and mechanical features are of the highest possible quality. The instruments are carefully adjusted and calibrated to meet exact frequency and performance specifications. An output amplifier provides complete isolation of the load, and changes in the output load cannot change the performance of the oscillator. Frequency stability is better than ±2% including warmup, and hum voltage is less than 0.1% of rated output.

-hp- 202A Low Frequency Function Generator

This instrument is a compact, convenient and versatile source of transient-free test voltages between 1,000 and 0.01 cps. It provides virtually distortion-free signals for vibration studies, servo application, medical and geophysical work and other subsonic and audio problems. The equipment generates 3 wave forms—sine, square and triangular. Output is 30 volts peak-to-peak for all wave forms. The output system is fully floating with respect to ground and may be used balanced or single-ended. The instrument will deliver 10 volts RMS to a 2,500 ohm load; internal impedance, however, is only 40 ohms. There are no coupling capacitors in the output system, and a high degree of dc balance is achieved by a special circuit. Price, $450.

BRIEF SPECIFICATIONS—200 SERIES OSCILLATORS

-hp- MODEL	FREQUENCY RANGE	BANDS	FREQUENCY RESPONSE	POWER OUTPUT	LOAD IMPEDANCE	DISTORTION	POWER CONSUMPTION	PRINCIPAL APPLICATIONS	PRICE
200AB	20 cps to 40 kc	4 ranges	± 1 db Ref. 1 kc	1 watt or 24.5 v	600 ohms	1%	60 watts	Audio Tests	$120.00
200CD	5 cps to 600 kc	5 ranges	± 1 db Ref. 1 kc	160 mw — 600 ohms or 20 volts open circuit*		1%	75 watts	Audio, Ultrasonic, tests	$150.00
200H	60 cps to 600 kc	4 decades	± 1 db Ref. 1 kc	10 mw or 1 v	100 ohms	1%, 100-100,000 cps 3%, 60-600,000 cps	115 watts	Carrier Current & Telephone Tests	$350.00
202D	2 cps to 70 kc	5 ranges	± 1 db Ref. 1 kc	100 mw or 10 v	1,000 ohms	1%	80 watts	Low Frequency Measurement	$275.00
200I	6 cps to 6 kc	6 ranges	± 1 db Ref. 400 cps	100 mw or 10 v	1,000 ohms	1% 10-6,000 cps	115 watts	Interpolation and Frequency Measurement	$225.00

(*Internal impedance 600 ohms.) Data subject to change without notice. Prices f.o.b. factory.

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hp INSTRUMENTS – Complete Coverage!

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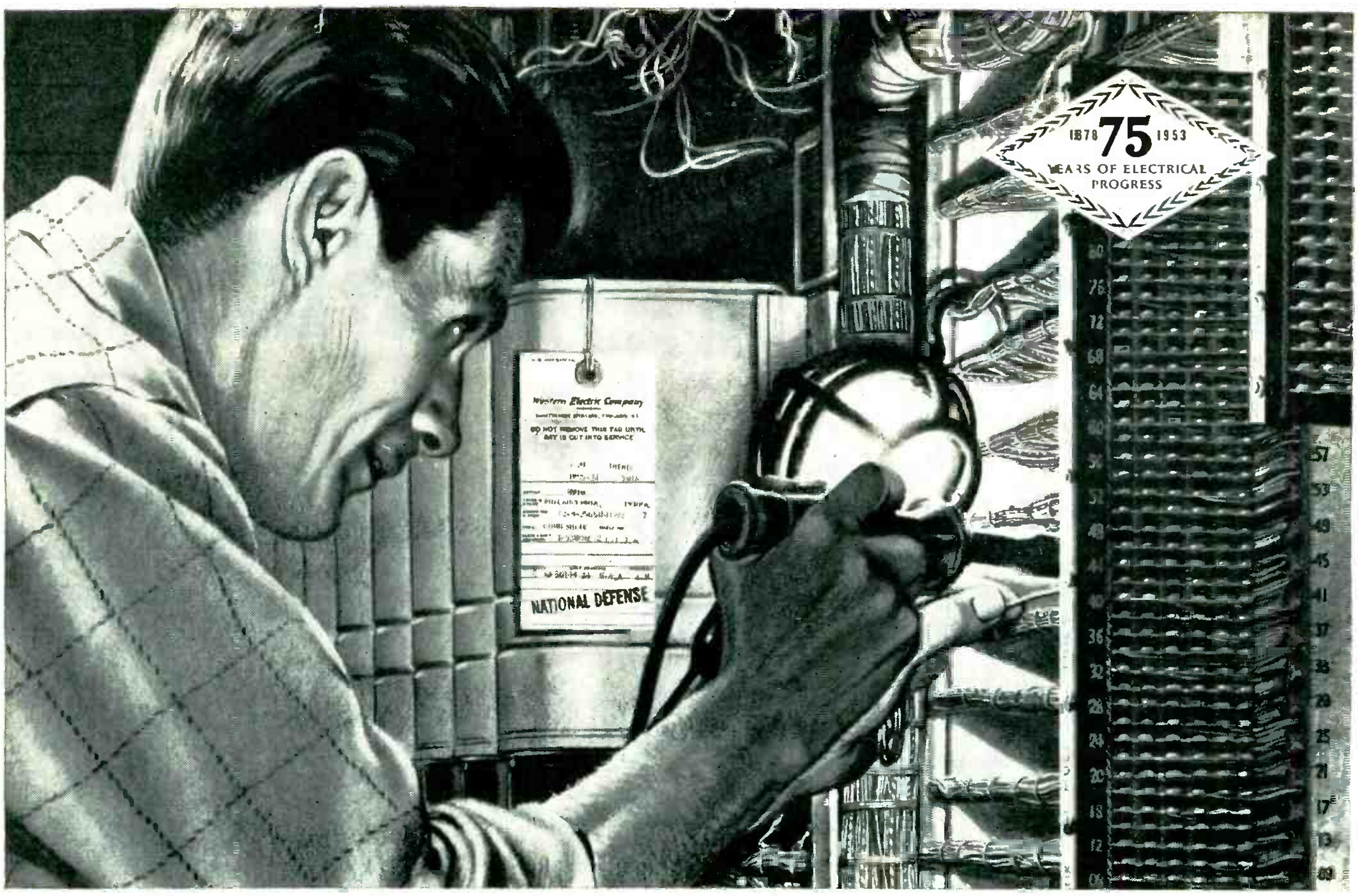


Western Electric installer in an aircraft plant connecting telephone equipment with a G-E soldering iron.

Western Electric Uses G-E Soldering Irons to Speed Vital Telephone Installations

For efficient soldering of millions of connections during the installation of telephone equipment, Western Electric uses G-E industrial soldering irons. Repeat orders testify to this company's satisfaction with G-E irons.

No matter what *your* soldering operation—intermittent or high-speed repetitive work—General Electric has the iron to meet your particular requirements. You'll find that G-E irons, equipped with the famous long-life Calrod* heating element, give you lower maintenance costs. You can choose durable, interchangeable calorized copper tips or, for even longer maintenance-free tip life, sturdy Ironclad copper tips. Ratings range from 25 to 1250 watts, tip sizes from ⅛-inch to two inches.

Give G-E industrial soldering irons a chance to prove their lower over-all costs to you. Buy a few through your nearest G-E Sales Office or Apparatus Distributor, and keep cost comparison records on their performance. You will see for yourself that these irons will save you money. General Electric Company, Schenectady 5, N. Y.

*Reg. Trade-mark of General Electric Company

720-101

You can put your confidence in—

GENERAL ELECTRIC

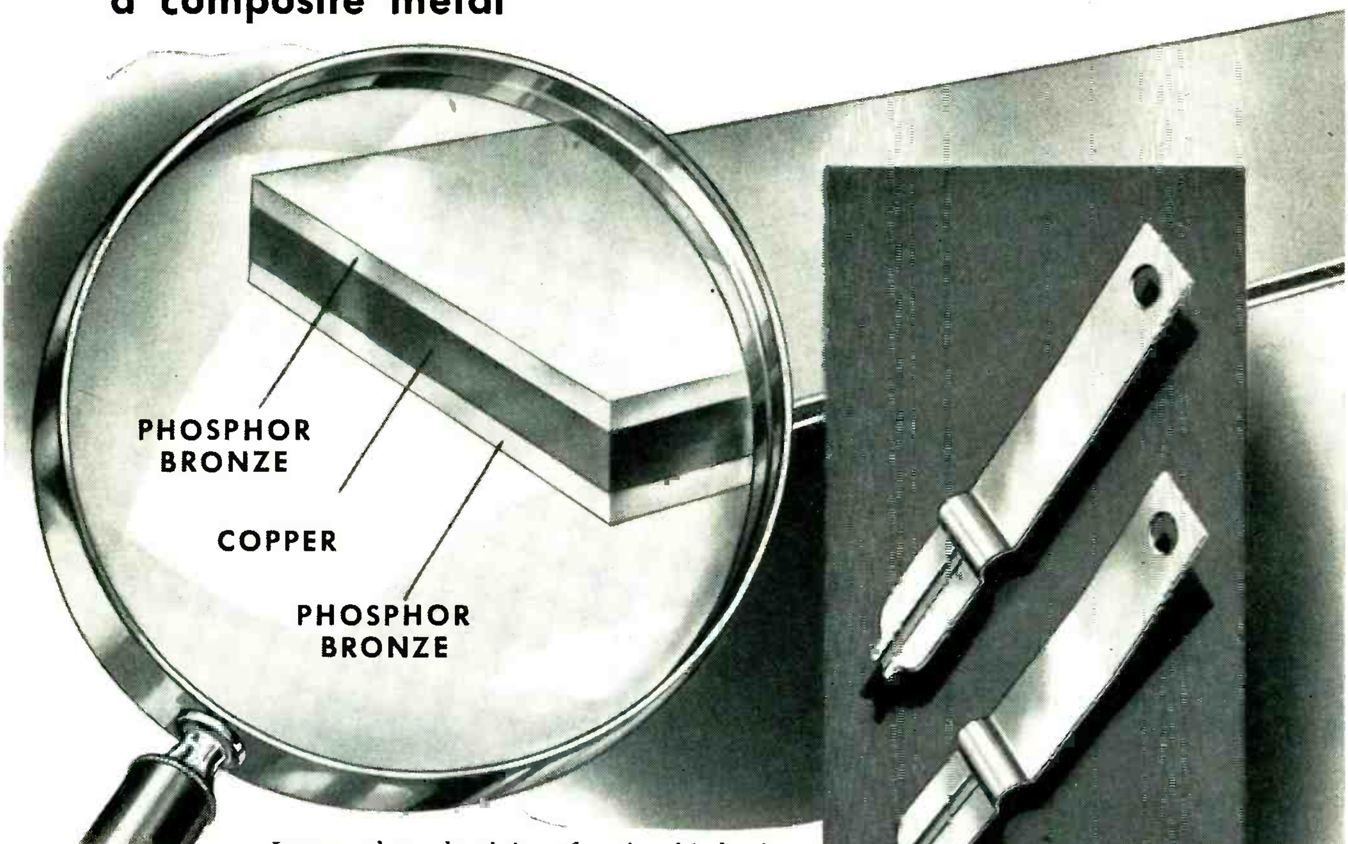
You can often replace heavy irons with this 120-volt, 60-watt lightweight iron for communications soldering.

PROBLEM:

Obtain higher electrical conductivity without increasing the cross-sectional area of spring blades

SOLUTION:

General Plate provided the solution with BRONCO . . . a composite metal



Increased conductivity of spring blades in a time switch was recently required by a manufacturer of demand meters. Operating requisites were high conductivity, excellent spring properties and small cross-sectional area.

General Plate provided the solution with BRONCO, phosphor bronze double-clad on copper. The phosphor bronze makes an excellent spring member; the copper gives increased conductivity. BRONCO 25/50/25 provides an electrical conductivity of 55% compared with solid copper.

BRONCO permits miniaturization. It permits you to make smaller units because you can reduce spring size without sacrificing conductivity.

No matter what your problem, it will pay you to consult with General Plate. Their vast experience in bonding any combination of malleable metals can overcome your problems . . . often reduce costs.

General Plate products include . . . precious metals clad to base metals, base metals clad to base metals, thin-gauge rolling, composite contacts, buttons and rivets, *Truflex*® thermostat metals, *Alcuplate*®, platinum fabrication and refining, #720 manganese age-hardenable alloy. Write for complete information and Catalog PR700 today.

You can profit by using General Plate Composite Metals!

METALS & CONTROLS CORPORATION
GENERAL PLATE DIVISION
34 FOREST STREET, ATTLEBORO, MASS.


No tapping!
THEY CUT THEIR OWN THREADS!
SHAKEPROOF® THREAD-CUTTING SCREWS
Save time ... Save tools ... Give you a tighter, stronger fastening!
The shank slot does it! Type 1 is designed for the harder metals. Type 23 with a wider slot works well in die castings. Type 25 with a spaced thread is ideal for plastics.
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SHAKEPROOF
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DIVISION OF ILLINOIS TOOL WORKS
St. Charles Road, Elgin, Illinois • Offices in principal cities
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America's Great Resources Plus A Free Economy Made This Business Possible!
FREE...TESTING SAMPLE KIT
... contains SHAKEPROOF Thread-Cutting Screws in a variety of sizes and head styles. Try them on your product now ... ask for Kit No. 22 for metals or Kit No. 10 for die castings or plastics.
Shakeproof

Everyone Can Count on VEEDER-ROOT

REPORTER AT LARGE . . . that's what you might call this new Veeder-Root Reset Magnetic Counter . . . adaptable to remote counting from machines or processes to central boards or instrument-clusters, wherever you want to put them. NOW . . . what can your imagination do with these few facts? For the *full facts*, write:

VEEDER-ROOT INCORPORATED

"The Name That Counts"

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Montreal 2, Canada • Dundee, Scotland
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"Counts Everything on Earth"

4 FINE RHEOSTATS

Announcing 3 new sizes now in production

We have added to our new H-50 rheostat, announced a few months ago—the new H-75, H-100 and H-150 models. These higher wattage rheostats incorporate all the new improved features that have made the H-50 so successful.

- **Unequalled perfection in brush control, which automatically adjusts tension to complete, continuous contact.**
- **Positive, smoothly-controlled spring action which eliminates all strains tending to bind shaft in the bushing.**
- **Greater flexibility—no risk of backlash.**

All models are of course completely bonded with our new high-temperature-enamel;—thermo-shock-proof; more resistant to heat; increased safety factor; higher terminal strength.

And all are designed to comply with current standards of:

(a) Military Specifications JAN-R-22.
(b) Underwriters' Laboratories.
(c) R.T.M.A.
(d) N.E.M.A.

Send today for our new bulletin, containing additional information.

H-150
150 watts

H-100
100 watts

H-75
75 watts

H-50
50 watts

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Rheostats and Resistors

Subsidiary of

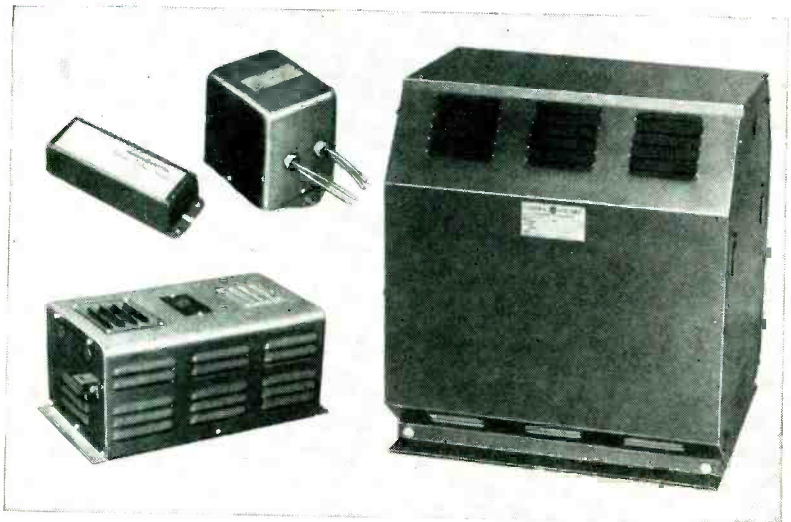
THE NATIONAL LOCK WASHER COMPANY

Established 1886 — Newark 5, N. J., U. S. A.

The mark of quality for more than a quarter of a century

DESIGNER'S

New line of G-E voltage stabilizers features flexibility



G-E STABILIZER LINE has output ratings from 15- to 5000-va.

Now, to help you iron out voltage ups and downs, General Electric offers a new line of standard automatic voltage stabilizers that offers greater design flexibility at no extra cost. These compact, lightweight units can be a key feature in your design of sensitive electronic equipment where precision performance depends on accurate voltage stabilization.

Output ratings of 1000, 2000, 3000 and 5000 volt-amperes are available, with 115 and 230 volts on both input and output, to give you a wide variety of operating combinations. Fluctuations between 95 and 130, or 190 and 260 volts are corrected to a stable 115 or 230 volts within ±1 per cent — in less than two cycles. Single-core construction completely isolates input circuit from output circuit. For more information see Bulletin GEA-5754.

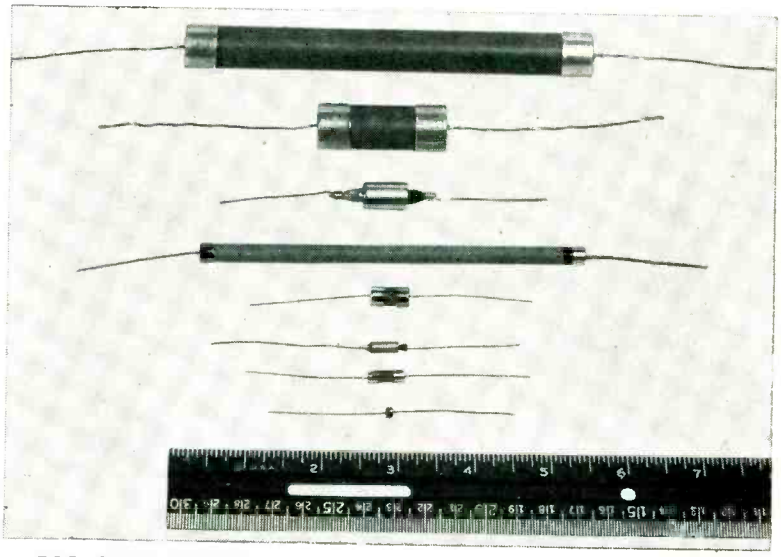
Miniature selenium rectifiers resist severe operating conditions

Two types of totally enclosed casings are available: Textolite* tubes for normal operating conditions; hermetically sealed, metal-clad casings to meet severe government specifications.

These small-size selenium cell assemblies have long life, high reverse resistance, good regulation and low heat rise. Their ambient temperature range is broad—from −55C to +100C. Lead mounting is standard, but they may also be bracket-mounted.

This new G-E line of rectifiers may be used for blocking, electronic computer, signal, magnetic amplifier, communication or control circuits; for operating small relays, solenoids, precipitators. Cell sizes range from 3/32 in. to 15/32 in. diameter, d-c current ratings 0.050 milliamperes to 25 milliamperes. For further information, write for Bulletin GEA-5935.

*Reg. Trade-mark of General Electric Co.



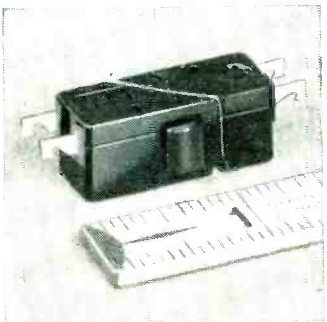
FOR COMPACTNESS, washers between cells have been eliminated

You can put your confidence in—

GENERAL ELECTRIC

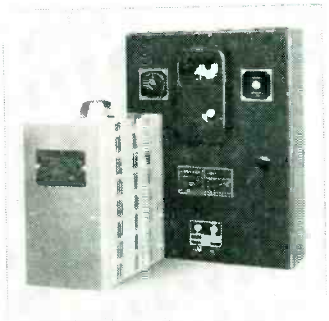
DIGEST

TIMELY HIGHLIGHTS ON G-E COMPONENTS



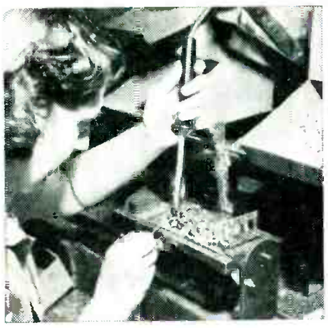
Switchettes are versatile, have high current rating

A wide range of design problems can be solved by G-E general-purpose switchettes. They are corrosion-proof, vibration-resistant, small, lightweight. Efficient at sea level or at 50,000 feet, in ambient temperatures from 200F to −70F. Ratings up to 230 volts, 25 amp. a-c; 250 volts, 25 amp. d-c. See Bulletin GEC-796.



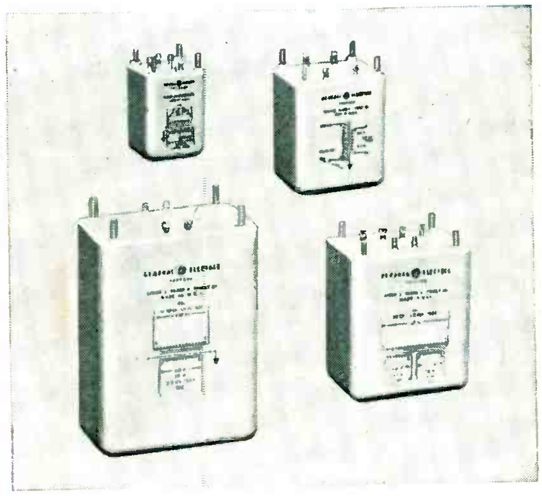
Inductrols—for automatic or manual voltage regulation

Compact design of G-E inductrols lets you fit them into any location. They offer micrometer-fine control, autotransformer efficiency. Hand-operated and automatically operated models are available for indoor service 600 v and below on circuits 3 to 520 kva. Bulletin GEC-795 covers single-phase inductrols; GEA-5824, 3-phase models.



New iron weighs only 8½ oz.

The new 120-v, 60-w G-E lightweight iron is designed for high-speed, production-line soldering on electronic, instrument, and communications equipment. Thin, 5/16-inch diameter shank gets the ¼-inch tip into places a regular iron can't reach. Balanced design allows the soldering of more joints per minute. Long-lasting Iron-clad tip needs no filing or dressing. See Bulletin GED-1583.



COMPLETE LINE includes 11 sizes

G-E cast-permafil* transformers designed to meet MIL-T-27 specs

The small, light design of General Electric's new line of cast-permafil transformers makes possible greater flexibility in many electronic designs. Sealing these solventless-resin-type transformers for life has eliminated the need for metal enclosures and fungus-proof coatings. Construction is simple—terminals are anchored directly in the tough, solid, shatter-resistant permafil mixture to cut size and weight by 20 per cent. Machined and punched parts have been kept at a minimum for lower cost.

Cast-permafil transformers have an expected life of 1000 hours or more at 130 C ultimate. The complete line of 11 sizes is available in various terminal arrangements, and is designed to meet MIL-T-27 (Grade 1) performance requirements. For more information, write General Electric Co., Sect. 667-25, Schenectady 5, N. Y.

EQUIPMENT FOR ELECTRONICS MANUFACTURERS

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- Meters, Instruments
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- Capacitors
- Transformers
- Pulse-forming networks
- Delay lines
- Reactors
- Thyrite*
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- Inductrols
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- Fractional-hp motors
- Rectifiers
- Timers
- Indicating lights
- Control switches
- Generators
- Selsyns
- Relays
- Amplidynes
- Amplistats
- Terminal boards
- Push buttons
- Photovoltaic cells
- Glass bushings

Development and Production Equipment

- Soldering irons
- Resistance-welding control
- Current-limited high-potential tester
- Insulation testers
- Vacuum-tube voltmeter
- Photoelectric recorders
- Demagnetizers

Reg. Trade-mark of General Electric Co.

General Electric Company, Section A667-25
Schenectady 5, New York

1878 75 1953 YEARS OF ELECTRICAL PROGRESS

Please send me the following bulletins:
√ for reference
X for immediate project

- ☐ GEA-5824 Three-phase Inductrols
- ☐ GEA-5935 Miniature Rectifiers
- ☐ GEC-795 Single-phase Inductrols
- ☐ GEC-796 Switchettes
- ☐ GEA-5754 Voltage Stabilizers
- ☐ GED-1583 Soldering Iron

Name ____________

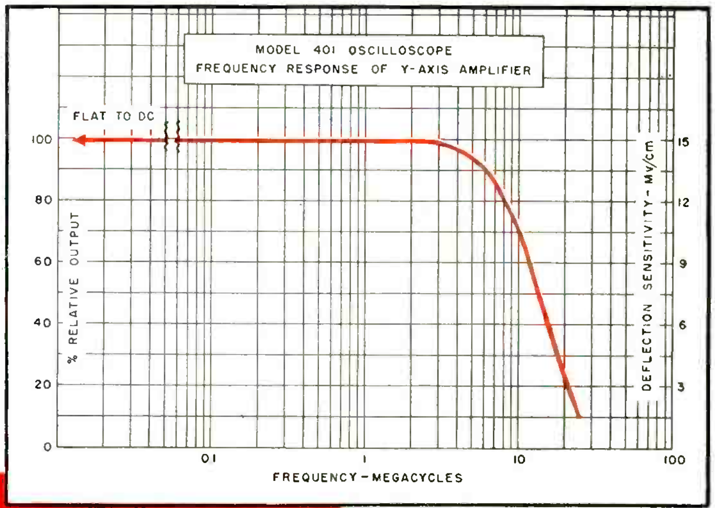
Company ____________

City ____________ State ________

Want more information? Use post card on last page.

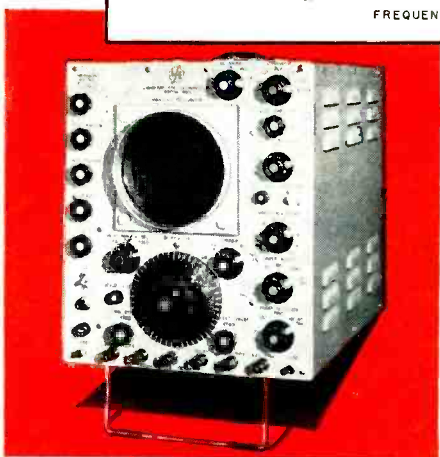
ONLY THE LFE 401 OSCILLOSCOPE

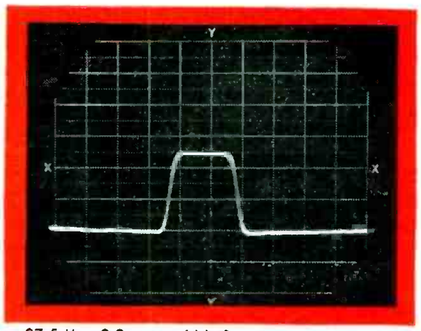
Offers all these Important Features



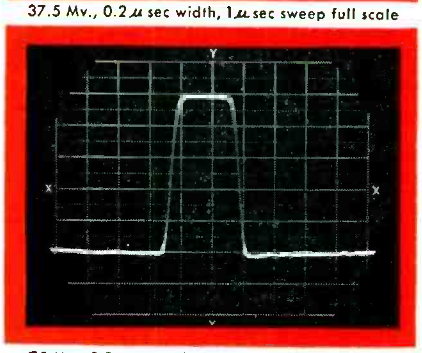
HIGH SENSITIVITY AND WIDE FREQUENCY RESPONSE OF Y-AXIS AMPLIFIER

The vertical amplifier of the 401 has been designed to provide uniform response and high sensitivity *from D-C*. The accompanying amplifier response curve shows the output down 3 db. at 10 Mc. and 12 db. at 20 Mc. Alignment of the amplifier is for best transient response, resulting in no overshoot for pulses of short duration and fast rise time. Coupled with this wide band characteristic is a high deflection sensitivity of 15 Mv./cm. peak to peak at *both D-C* and A-C.





37.5 Mv., 0.2 μ sec width, 1 μ sec sweep full scale



75 Mv., 0.2 μ sec width, 1 μ sec sweep full scale

LINEARITY OF VERTICAL DEFLECTION The vertical amplifier provides up to 2.5 inches positive or negative uni-polar deflection without serious compression; at 3 inches, the compression is approximately 15%. The accompanying photographs illustrate transient response and linearity of deflection.

SWEEP DELAY The accurately calibrated delay of the 401 provides means for measuring pulse widths, time intervals between pulses, accurately calibrating sweeps and other useful applications wherein accurate time measurements are required.

The absolute value of delay is accurate to within 1% of the full scale calibration. The incremental accuracy is good to within 0.1% of full scale calibration.

SPECIFICATIONS

Y-Axis

Deflection Sens. — 15 Mv./cm. p-p
Frequency Response — DC to 10 Mc
Transient Response — Rise Time (10%-90%) 0.035 μ sec
Signal Delay — 0.25 μ sec
Input line terminations — 52, 72 or 93 ohms, or no termination
Input Imp. — Direct — 1 megohm, 30 μ μ f
Probe — 10 megohms, 10 μ μ f

X-Axis

Sweep Range — 0.01 sec/cm to 0.1 μ sec/cm
Delay Sweep Range — 5-5000 μ sec in three adjustable ranges.
Triggers — Internal or External, + and −, trigger generator, or 60 cycles, undelayed or delayed triggers may be used.
Built-in trigger generator with repetition rate from 500-5000 cps.

General

Low Capacity probe
Functionally colored control knobs
Folding stand for better viewing
Adjustable scale lighting
Facilities for mounting cameras

PRICE: $895.00

Additional Features:

TRIGGER GENERATOR with variable repetition rate from 500 to 5000 cps.

POSITIVE & NEGATIVE UNDELAYED TRIGGERS and a **POSITIVE DELAYED TRIGGER** are externally available.

An **INPUT TERMINATION SWITCH** for terminating transmission lines at the oscilloscope.

A **FOLDING STAND** for convenient viewing.

FUNCTIONALLY COLORED KNOBS for easier location of controls.

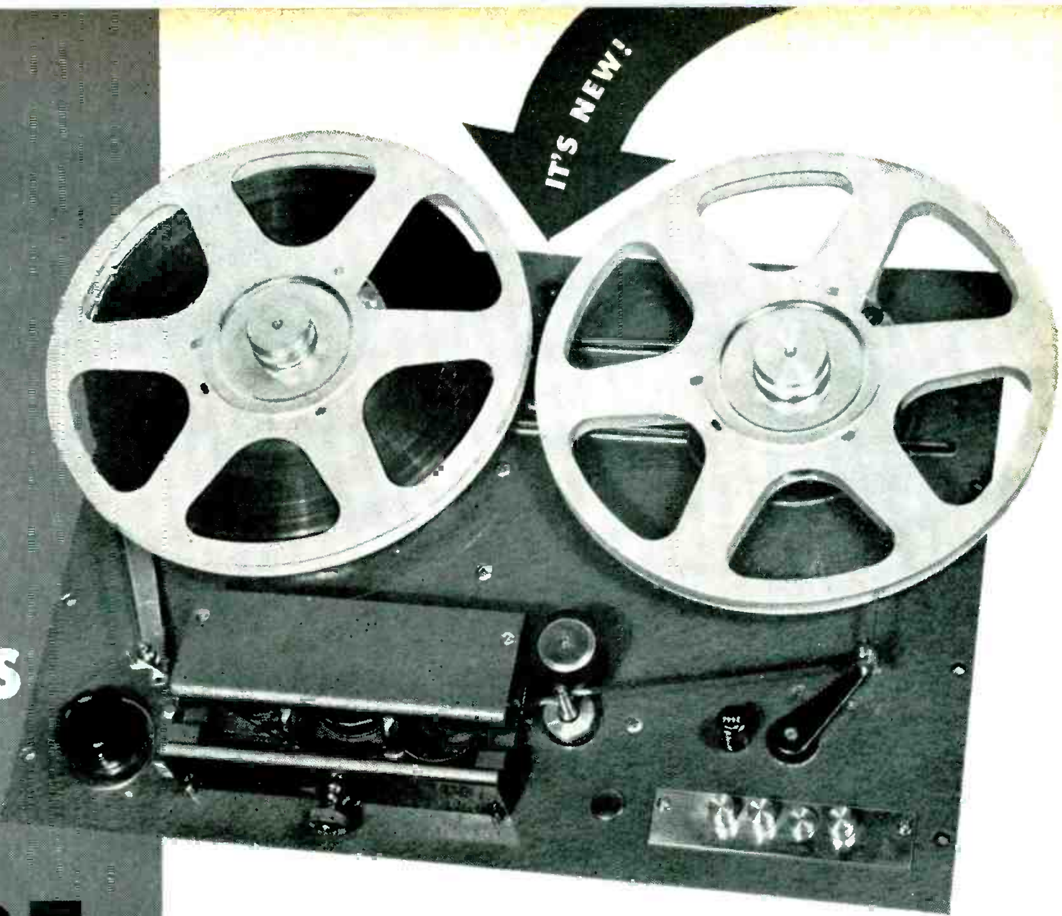
Designed and built *for* electronic engineers, the 401, with its high gain and wide band characteristics, and its versatility, satisfies the ever-increasing requirements of the rapidly growing electronics industry for the ideal medium priced oscilloscope.

Write for Complete Information

L/E

LABORATORY for ELECTRONICS, INC.
75 PITTS STREET • BOSTON 14, MASS.

PRECISION ELECTRONIC EQUIPMENT • OSCILLOSCOPES • MAGNETOMETERS • COMPUTERS • MICROWAVE OSCILLATORS • MERCURY DELAY LINES



puts other tape recorders in the SHADE ... the PRESTO RC-11

PRESTO introduces a precision-engineered tape recorder with a radical new type of construction!

Featuring a self-contained capstan drive unit, the PRESTO RC-11 provides durability, flexibility and rapid maintenance heretofore unheard of in tape equipment. Motor, fly wheel, capstan shaft, pressure pulley and solenoid are all pre-mounted on a cast aluminum sub-assembly . . . a complete working unit quickly removable for service or replacement.

A heavy, ribbed, cast aluminum panel designed for rack or case mounting supports all other components. Overall durable construction gives additional reinforcement and protection during shipping and adds years to the life of the machine.

In terms of performance and operational ease, the RC-11 also steps out front. This new recorder, with complete push button operation, automatic microswitch in case of tape breakage and a reel capacity of 10½ inches, is an engineer's delight.

The combination of advanced design and engineering in the RC-11 puts ordinary tape recorders in the shade . . . makes this instrument an *investment*, not an expenditure. Ask your PRESTO distributor for full information on this important development in tape recorder design . . . the *all new* RC-11.

The "unitized" construction of the Presto RC-11

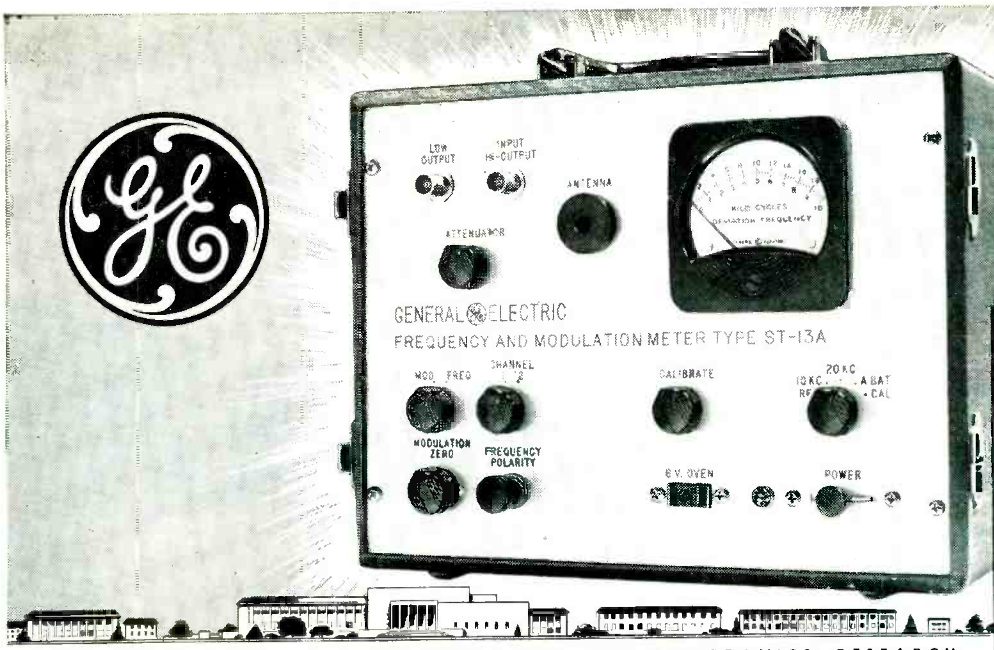
. . . allows a complete flexibility in the manufacture of various types of instruments. By the simple rearrangement of components the RC-11 becomes a high fidelity recorder, a dual track, bi-directional recorder or reproducer or a long-playing reproducer with automatic tape reversal.

PRESTO RECORDING CORPORATION
PARAMUS, NEW JERSEY

Export Division: 25 Warren Street, New York 7, N. Y.
Canadian Division: Walter P. Downs, Ltd., Dominion Square Bldg., Montreal

WORLD'S LARGEST MANUFACTURER OF PRECISION RECORDING EQUIPMENT AND DISCS

DP-DT and TP-DT types with spring return
Small, 3-position slide type
4P-DT with spring return
4-position SP
Money-Saver Switches that Boost Product Efficiency
The right type—at the right price—
FOR INSTRUMENTS, RADIOS, APPLIANCES, TOYS, SMALL MOTORS and dozens of other uses.
SP-ST; SP-DT; DP-DT and DP-ST slide types
3-position DP
SP-DT with spring return
Push type, momentary contact
4P-DT with or without indent action
Triple-pole, double-pole type
DP-DT plunger switch with latch
4-gang SP-DT or 4-gang SP-ST
SP-DT spring return plunger switch
Tops FOR FRACTIONAL H.P. MOTORS
3-ampere types—SP-ST or SP-DT
Write for Stackpole Catalog RC8
Electronic Components Division
Stackpole Carbon Company, St. Marys, Pa.
STACKPOLE
FIXED AND VARIABLE RESISTORS • SPECIAL RESISTORS • CERAMAG® (ferrite) CORES • IRON CORES • CHOKE FORMS • GA "GIMMICK" CAPACITORS, etc.



ELECTRONICS PARK — G-E HEADQUARTERS FOR ELECTRONICS RESEARCH

Accessories include: External antenna mount (above), adaptor cable, and crystal ovens.

New! G-E FREQUENCY AND MODULATION METER

Measures both carrier frequency displacement and square wave modulation with direct reading on 2-range 3½" meter

Here is a quality FM Communications instrument with features that are *unmatched in the industry!* The ST-13A is engineered to give you hairline accuracy . . . lowest possible cost . . . plus full provision with oven accessories for future split-channel adjustments. This unit meets today's demand for accuracy and economy and provides for tomorrow's more stringent needs. Two RF outputs for receiver testing and alignment. New case design is durable and good looking.

SPECIFICATIONS—MODEL ST-13A

FREQUENCY RANGES
One or two specified frequencies in the following ranges:
25 MC to 50 MC, 72 MC to 76 MC, 148 MC to 174 MC
Quartz crystal operating range: 4 MC to 6 MC

REFERENCE OSCILLATOR ACCURACY
.001% from 32°F to 122°F
Greater accuracy will be obtained over a more limited temperature range.
External connection, internal wiring and a socket are provided for 6 V oven operation where wider temperature range with greater accuracy is available.

MODULATION ACCURACY
± (5% + 200 cycles)
On sinusoidal or square wave modulation (complete limiting).

METER RANGES
0 to 10 KC and 0 to 20 KC. These scales are calibrated in terms of carrier frequency displacement from the internal reference oscillator and deviation due to square wave modulation. Sinusoidal modulation is 1.57 times this value. A conversion curve appears in the cover.

INPUTS
Eighteen-inch collapsible whip antenna.
Fifty-ohm BNC connector. This input can handle only limited power as it is followed by a molded carbon potentiometer attenuator.

OUTPUTS
Low RF output—adjustable around 1 microvolt.
High RF output—adjustable from about 100 to several thousand microvolts, depending on frequency.
Both outputs come out on 50-ohm BNC connectors.

POWER—INTERNAL BATTERIES
2—45 volt batteries; 2—1.5 volt flash light cells; 2—1.5 volt pen light cells.

TUBE COMPLEMENT
2—1L4, 2—1U4

G-E OSCILLOSCOPE—MODEL ST-2A

Here's the ideal scope for shop and general laboratory use. Size and weight have been held to a minimum yet you are assured of quality G-E construction and materials. Features high sensitivity . . . exceptional stability. Special features include a DC vertical amplifier to adapt the equipment to a wide range of applications. Deflection pattern expands to several times tube diameter.

1878 75 1953
YEARS OF ELECTRICAL PROGRESS

General Electric Company, Section 443
Electronics Park, Syracuse, N. Y.
Please send me a copy of the following bulletins:
☐ ST-13A (ECL-15) ☐ ST-2A (ECL-9)
NAME..........
COMPANY..........
ADDRESS..........
CITY.......... STATE..........

GENERAL ELECTRIC

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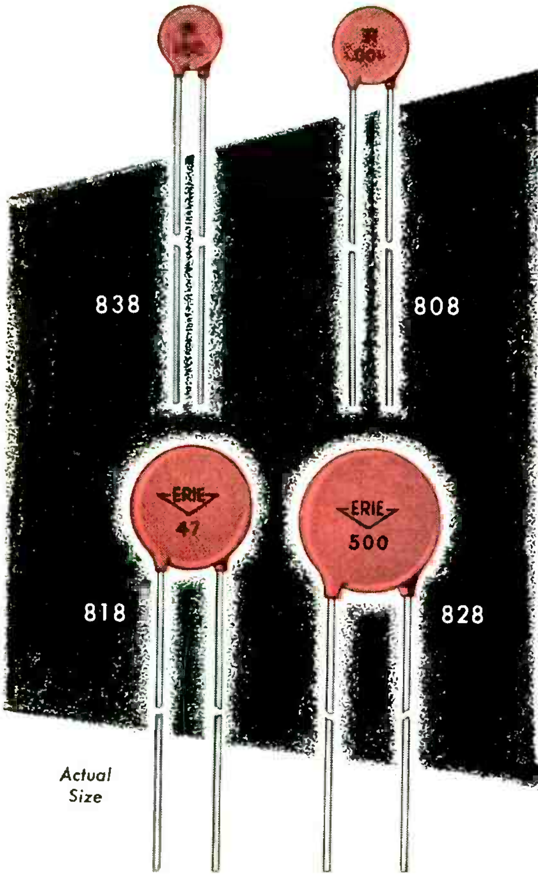
ERIE

HIGH VOLTAGE DISC CERAMICONS®



SPECIFICATIONS

Capacitance . . . Within stated tolerance at 1 KC, 1 to 5 volts RMS, and 25°C.

Standard Capacitance Tolerances . . . ±5%, ±10%, ±20%, guaranteed minimum value. (±5%, and in some cases ±10%, not available on Hi-K items.)

Standard Voltage Ratings, D. C. Working . . . 1000, 1500, 2000, 3000, 5000, 6000.

Dielectric Strength Test . . . Two times rated working voltage, with megohm series resistance.

Life Test . . . 1.5 times rated working voltage at 85°C. for 1000 hours.

Insulation Resistance . . . 10,000 megohms minimum.

Temperature Characteristic and Power Factor . . . One of four, depending on capacitance value and rating.

Characteristic	*Maximum Power Factor*	
P100 thru N1400	0.1%	Exact conformance per Erie GP1 Ceramicons, Bulletin 312.
Hi-K—12A	2%	Exact conformance per Erie Disc Ceramicons, Bulletin 438.
Hi-K—35	2%	
Hi-K—70	2%	

ERIE Disc Ceramicons have proven to be an ideal adaptation for high voltage application. Inherent construction simplicity means greatest economy yet for comparable voltage and capacitance values.

They are amazingly easy to install in small spaces . . . they simplify soldering and wiring operations, and speed up the assembly line. Erie Disc Ceramicons consist of round flat dielectrics with fired on silver plates and leads of No. 22 tinned copper wire firmly soldered to silver electrodes.

The Ceramicons are phenolic dipped and vacuum wax impregnated for moisture seal. They are identified by the Erie trademark and are marked with nominal capacitance and rated voltage.

Rated D.C. Voltage	Capacitance Range, MMF
1000	6 —10,000
1500	5 — 6,400
2000	3.5— 5,100
3000	6 — 3,250
5000	6 — 520
6000	5 — 340

Write for Bulletin 440. Erie Standard 500 volt By-pass and Coupling Disc Ceramicons are described in Bulletin 438. For Temperature Compensating Disc Ceramicons see Erie Bulletin 439.

ERIE components are stocked by leading electronic distributors everywhere.

ERIE TRADE MARK RESISTOR CORP.

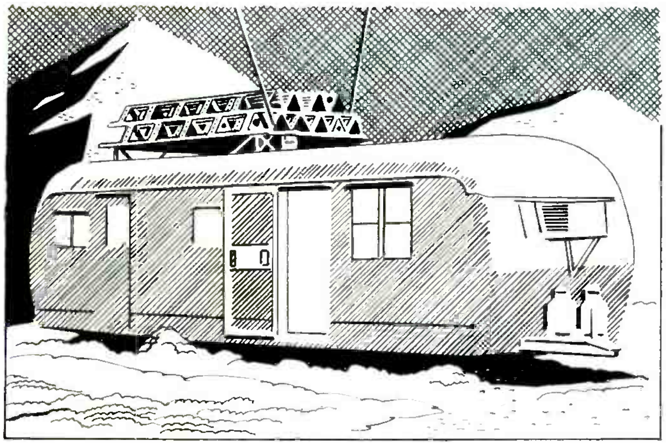
ERIE RESISTOR CORPORATION . . . ELECTRONICS DIVISION

Main Offices: **ERIE, PA.**

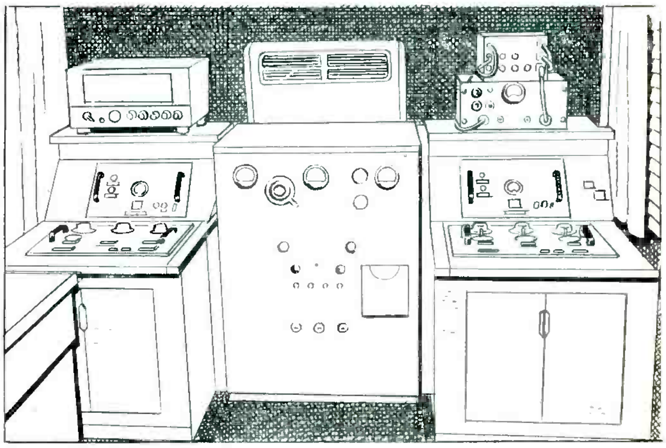
Sales Offices: Cliffside, N. J. • Philadelphia, Pa. • Buffalo, N. Y. • Chicago, Ill. Detroit, Mich. • Cincinnati, Ohio • Los Angeles, Calif.

Factories: **ERIE, PA. • LONDON, ENGLAND • TORONTO, CANADA**

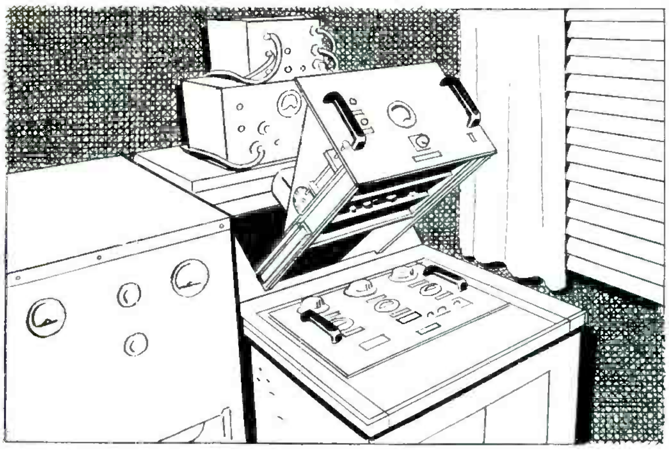
Case History: Hastings needed accessibility



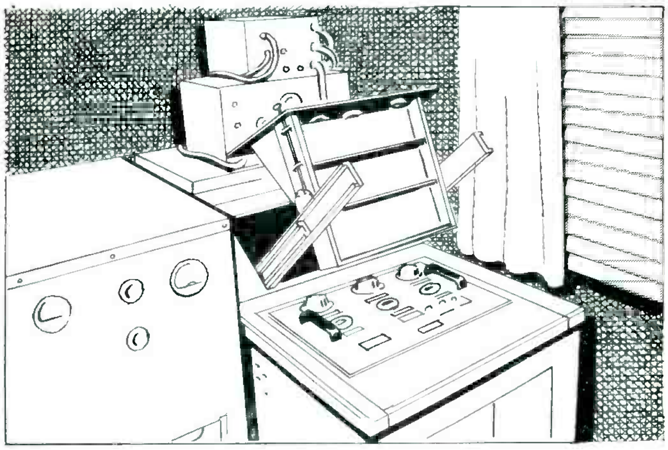
1 ***Mobile relay stations*** are a part of this nation's defense network. Hastings Instrument Co., Inc., manufactures much of the equipment installed in these rugged trailers.



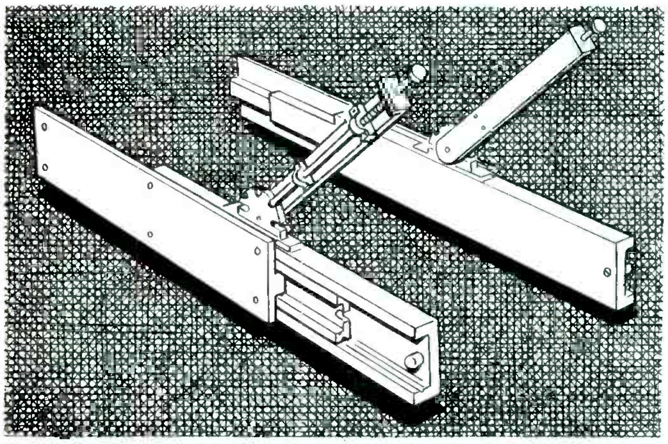
2 ***A lot of equipment*** has to go into a very small space. Yet the very nature of the problem requires that the operating components be *accessible* for maintenance and servicing.



3 ***Grant Industrial Slides*** were used. With them, units may be withdrawn and locked in a fully extended position in a matter of *seconds*, with no more effort than opening a filing cabinet.



4 ***A full 90° tilt*** brings the wiring under the chassis into full view for repair. Unit locks at this and other angles, and may continue to operate in any of these positions.



5 ***Grant No. 363 Slide*** is just one of an unlimited variety available. Load requirements from 25 to 500 lbs. Locking in closed, open or pivoted positions, angles up to 180°.

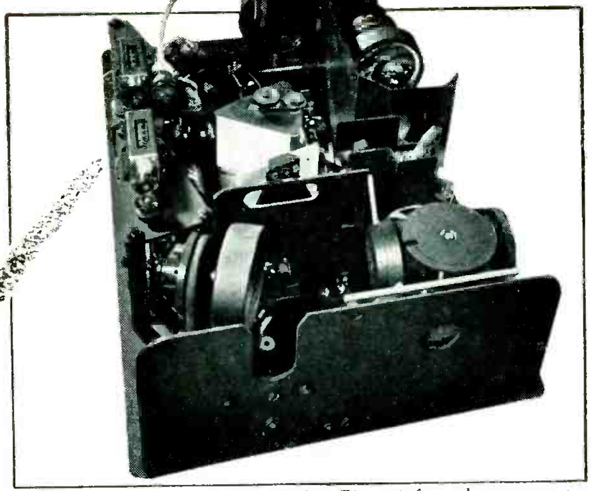
Grant Industrial Slides provide *built-in* accessibility, without effort, without costly loss of operating time. Bring your equipment *mechanically* up to your high electronics standards. Whatever the problem, call upon Grant, the foremost name in sliding devices.

grant industrial slides

a product of the engineering design department of
Grant Pulley and Hardware Company
31-75 Whitestone Parkway, Flushing, New York.
Write for information . . . consult on any problem

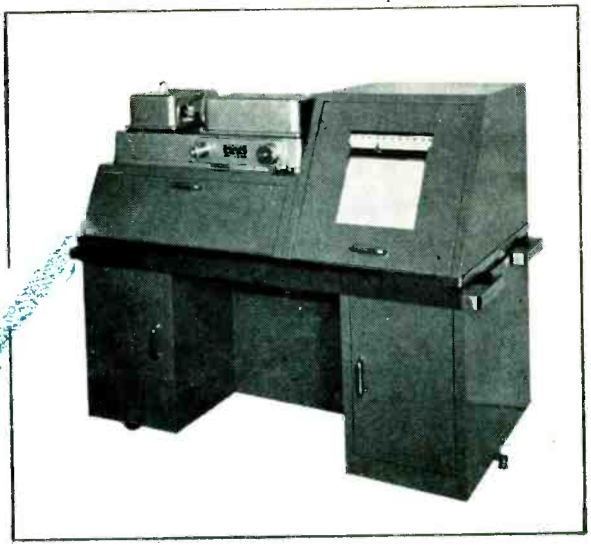

LAPP GAS-FILLED CONDENSERS
For duty at high voltage and high current, Lapp Gas-filled Condensers offer the advantages of extreme compactness . . . low loss . . . high safety factors . . . puncture-proof design . . . constant capacitance under temperature variation . . . grounded tuning shaft . . . complete reliability—electrically and mechanically. Models for capacitances up to 60,000 mmf; current ratings to 525 amps at 1 mc; voltages to 100 kv peak.
Write for description and specifications. Radio Specialties Division, Lapp Insulator Co., Inc., Le Roy, N. Y.
LAPP
Lapp

this is your product



Above: Perkin-Elmer infrared spectrometer —in its Karp-built cabinet, below.

but



this is your "trademark"

Your customers see the *outside* of your product a lot more than they see its inner mechanisms. Does it have the appearance of a precision instrument? Does it look the part?

In other words, do you get the same perfection in your cabinets that your engineers build *inside?* Smooth flawless welded seams? Perfectly fitted doors and panels...exactly the finish you specify...and, above all, absolute uniformity between all cabinets?

Karp customers do—and they know that this painstaking sheet metal fabrication doesn't mean high prices.

They know that our vast assortment of available dies eliminates the need for much costly tooling. They know that our plant—the length of three city blocks—with its modern facilities, offers custom production at prices that are surprisingly low.

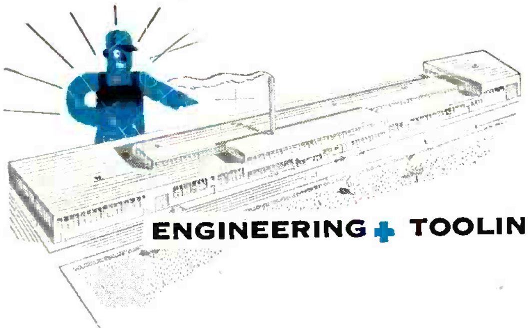
You'll find, as others have, that we can produce to exacting tolerances precisely the type of cabinet you require.

In large quantity or small. Steel or aluminum. Any type of welding. Painstaking hand finishing. Prompt shipment.

Visit our plant and see these things for yourself if you wish. We welcome your visit. Write for our bulletin.

KARP METAL PRODUCTS CO., INC.
215 63rd ST., BROOKLYN 20, N. Y.

MOST COMPLETE FACILITIES FOR LARGE AND SMALL RUNS OF
ENGINEERED SHEET METAL FABRICATION



ENGINEERING + TOOLING + PRODUCTION + FINISHING = KARP

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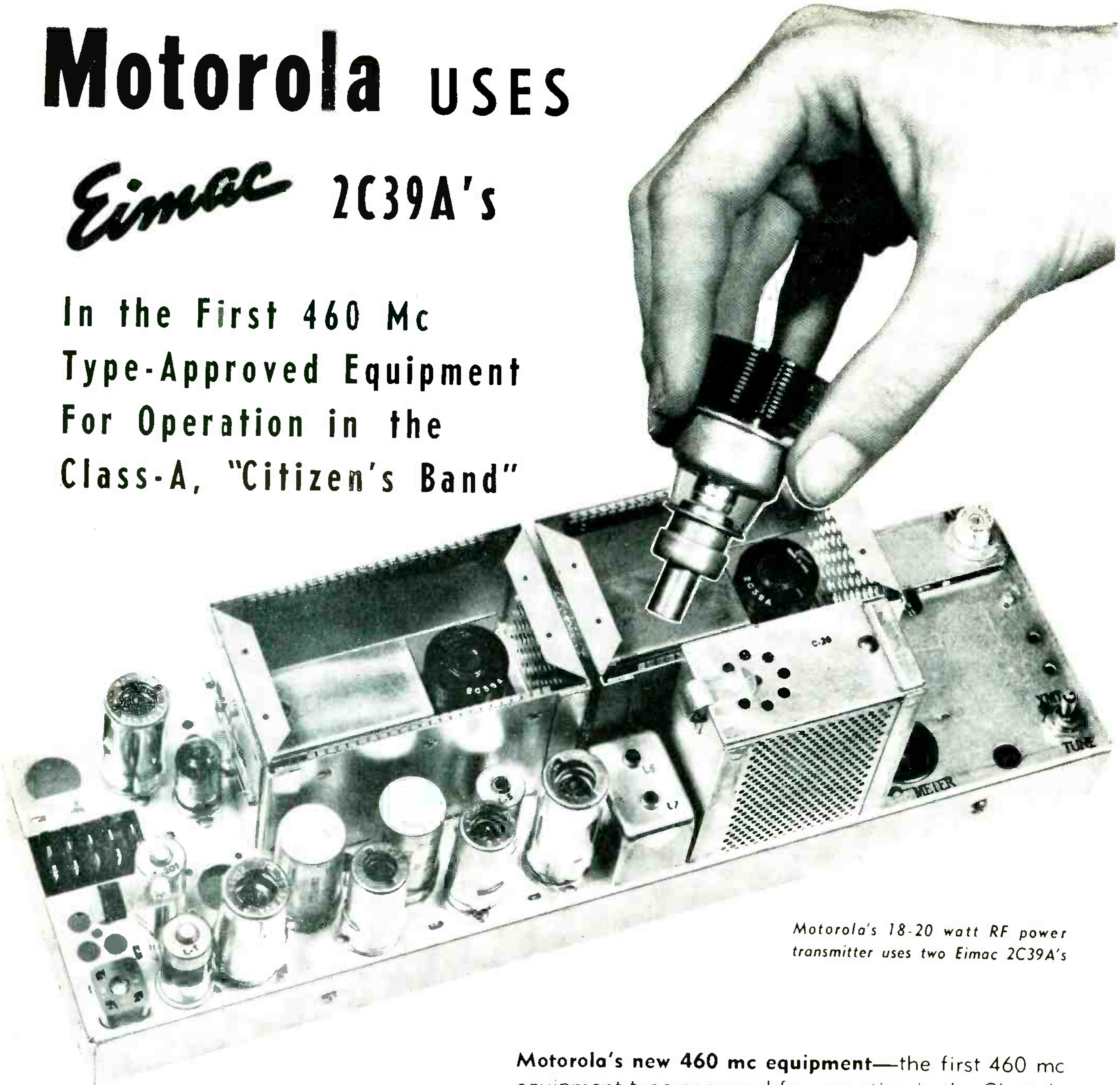
Motorola USES Eimac 2C39A's

In the First 460 Mc Type-Approved Equipment For Operation in the Class-A, "Citizen's Band"



Motorola's 18-20 watt RF power transmitter uses two Eimac 2C39A's

Motorola's new 460 mc equipment—the first 460 mc equipment type-approved for operation in the Class-A, "Citizen's Band" employs Eimac 2C39A's as tripler-drivers and power amplifiers in its mobile and base station transmitters. In the Eimac 2C39A, Motorola utilizes a highly efficient, domestically available tube that has been JAN accepted and proved in rugged and exacting military service. Motorola, through the use of Eimac 2C39A's and other late electronic developments, makes available a UHF two-way radio system designed to meet the demands of individuals, industry and emergency services.

FOR INFORMATION ABOUT THE 2C39A WRITE EIMAC'S APPLICATION ENGINEERING DEPARTMENT

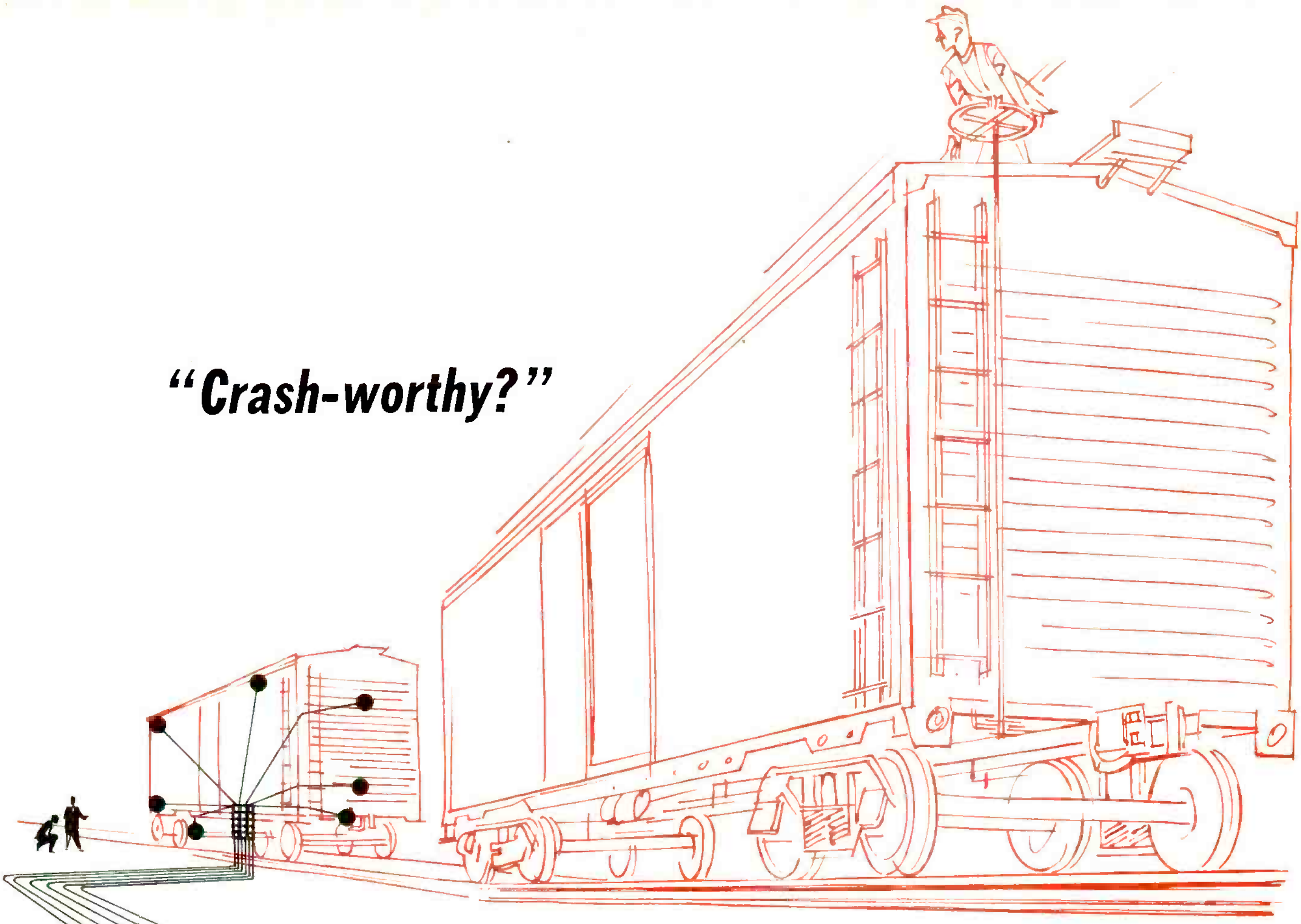
FOLLOW THE LEADERS TO

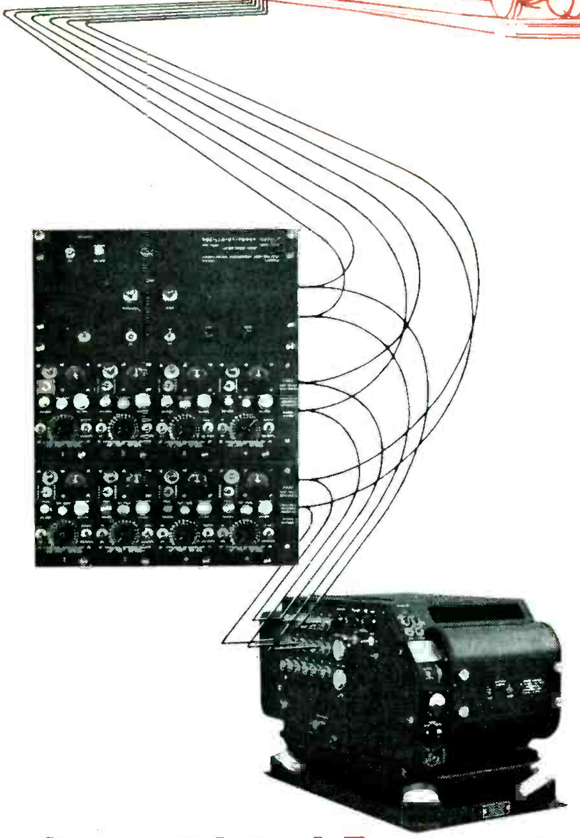
Eimac REG. U. S. PAT. OFF. TUBES

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA

Export Agents: Frazar & Hansen, 301 Clay St., San Francisco, California

"Crash-worthy?"





Pre-check with Consolidated Instrumentation

WHAT happens to structural members and car-body components when freight cars are subjected to the shock impacts and buffeting of hump-yard switching?

To determine stress distribution and to evaluate the effectiveness of shock protection devices, the Pullman-Standard Car Manufacturing Company selected a Consolidated 5-114 Recording Oscillograph, System D Amplifiers, and Bridge Balance as basic recording instruments.

Freight cars, loaded with sand and steel blocks at gross weights ranging from 46,400 pounds (empty) to 164,000 pounds (fully loaded) crashed together 185 times at speeds up to 10 miles per hour.

In this way the dynamics of simultaneous shocks, some as brief as one five-thousandth of a second, were permanently recorded in visual form. From such data will come design changes, giving protection against shock and vibration damage. Thus an improved product is achieved.

Consolidated Engineering
CORPORATION
300 North Sierra Madre Villa, Pasadena 15, California

Sales and Service through **CEC INSTRUMENTS, INC.,**
a subsidiary with offices in: Pasadena, New York, Chicago, Washington, D. C., Philadelphia, Dayton.

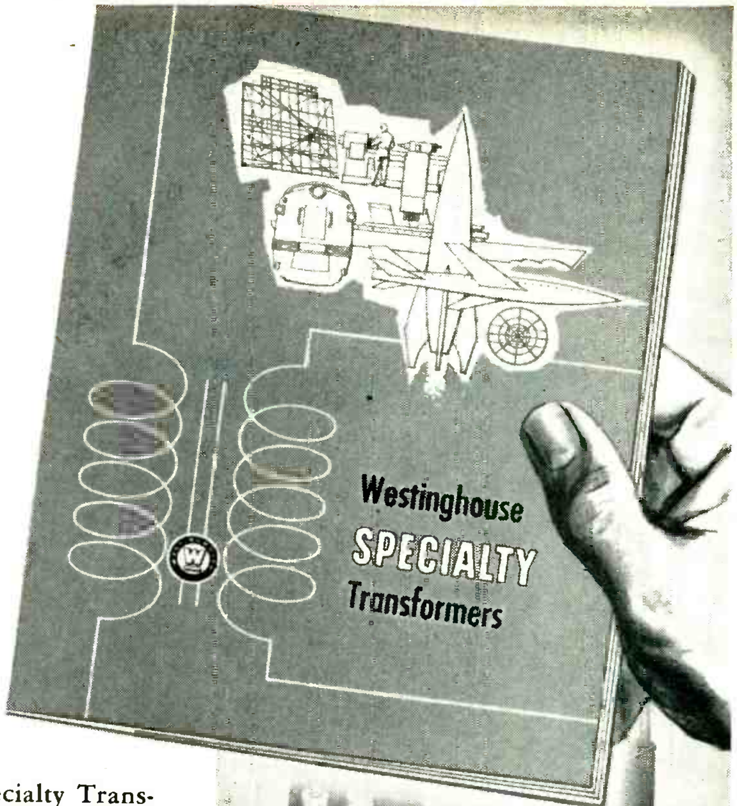
analytical instruments for science and industry

Dynamic Recording Systems

such as the one shown here are designed and manufactured by Consolidated. Variations in the arrangement of the equipment are infinite. Applications are widely varied throughout industry and the sciences. A typical recording system includes pickups, amplifiers or bridge balances, and a recording oscillograph. Write for Bulletin CEC 1500B-X7

Want more information? Use post card on last page.

FREE BOOK on specialty transformers



This fully illustrated book on Westinghouse Specialty Transformers contains full details on design, construction and operation of each type in entire line.

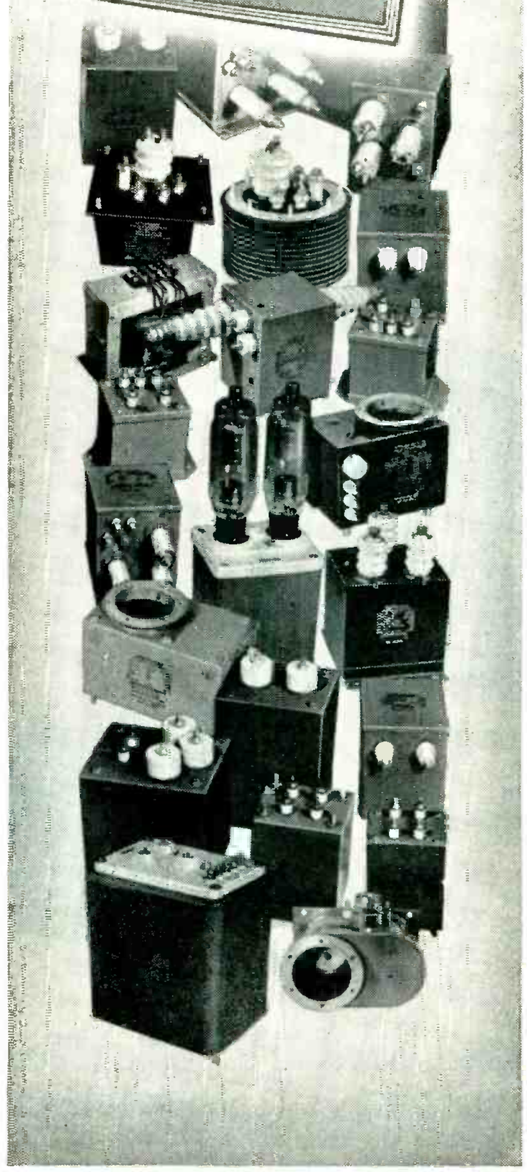
Find the answer to your problems in these types!

"Off-The-Shelf" Standard Models . . . includes electrical and electronic designs for both commercial and military applications.

"Built-To-Order" Special Designs . . . reviews wide range of custom-built types. Shows how Westinghouse adapts basic transformer components to meet your exact specifications economically.

SEND FOR YOUR COPY TODAY! Write on your letterhead for Booklet B-5806, or use coupon below. Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Penna.

J-70689-A



YOU CAN BE **SURE**...IF IT'S

Westinghouse

Westinghouse Electric Corporation
Application Data and Training Dept.
P. O. Box 868
Pittsburgh 30, Pennsylvania

Gentlemen:

Please send me Booklet B-5806,
Westinghouse Specialty Transformers

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FIRM________________________

STREET______________________

CITY_________ ZONE_____ STATE_______

SEALTRON'S NEW seal assemblies
END "SOLDERING-IN" TROUBLES

Now you can get rid of troublesome, costly seal-assembly operations. Sealtron will solder seals into your assemblies, will guarantee hermetic perfection. *Not* "standardized" designs, these assemblies are built to *your* specifications by our specialists — delivered to you on time, at low cost.

Take the seal assembly shown above, for example. We produced the mounting inserts and tuning device, installed them in our stamped lid, and soldered in the seals. Result? Reduced costs, elimination of soldering-in troubles for our customer — and a unit that's guaranteed free of hermetic "leaks."

Send for our new easy-to-use catalog-brochure today— and remember, Sealtron Protects Sensitive Parts.

Let our specialists take over your seal assembly problems. Write us today — you can depend on our prompt service.

Here's how you'll save:

- You use every seal you purchase.
- Eliminate throw-aways, "shrinkage" of seal supplies.
- No more losses due to oxidation of seals in storage.
- Stop costly salvaging of defective assemblies. Sealtron guarantees its work, will pressure-test assemblies, if requested.
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Selected stock. Always free from defects and surface blemishes.

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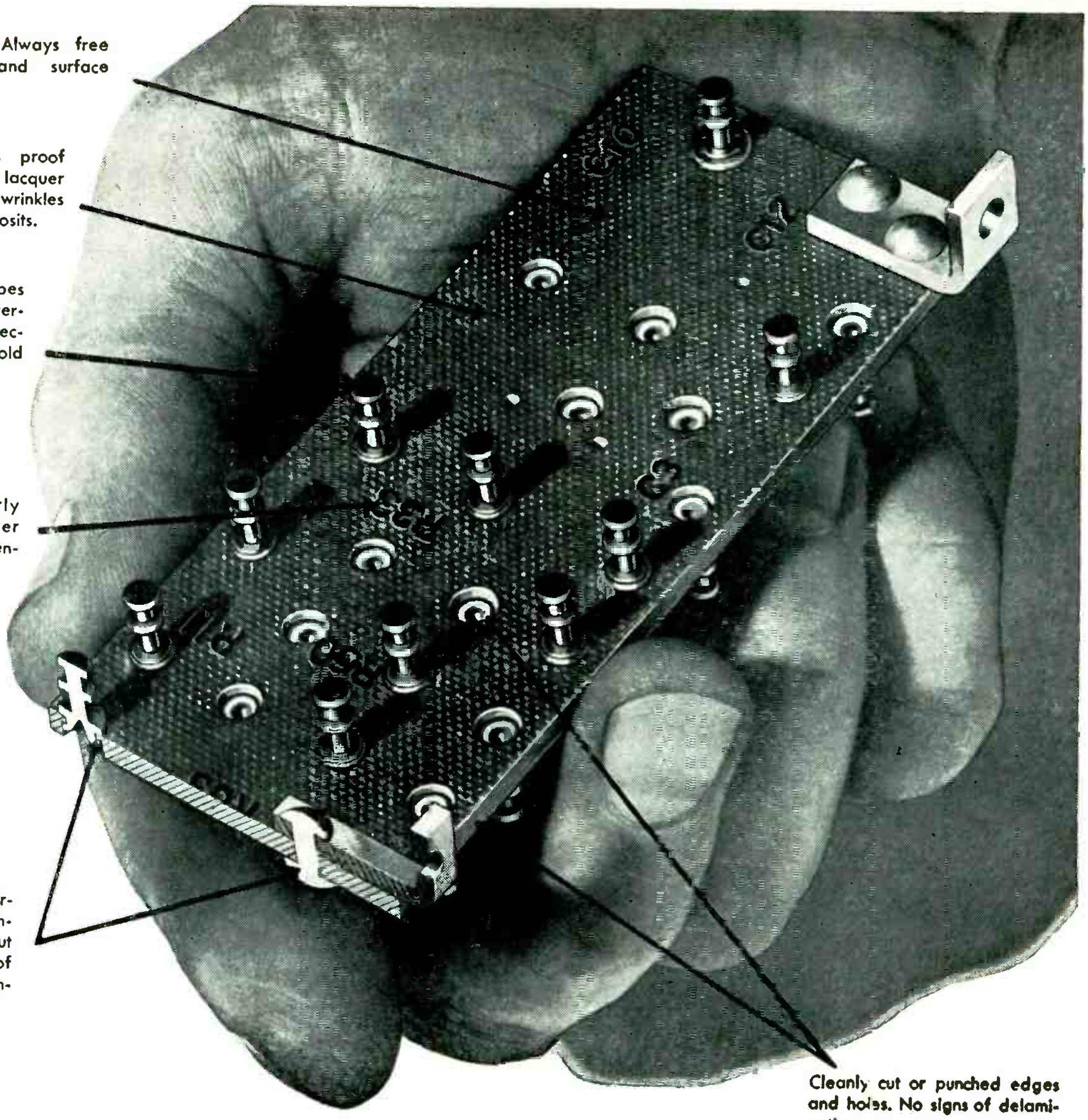

Cleanly cut or punched edges and holes. No signs of delamination.

Little details on terminal boards ...*make the big difference in quality*

C.T.C. is constantly supplying special terminal boards to the top names in electronics. These boards are built to strict government specifications, are fabricated of certified materials to fit the job. Among the specifications involved are: MIL-P-3115A, MIL-P-15037, MIL-P-15035, MIL-P-15047, MIL-P-997A.

Our Custom Engineering Service is well-equipped to fill these specifications for you. We are thoroughly familiar with the JAN and MIL-approved materials and finishes in accepted usage by government agencies and the armed forces. This, combined with assembly know-how developed over many years of supplying electronic components and equipment to the government, enables us to meet your needs for quality above and beyond the basic government standards.

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For complete information write: Cambridge Thermionic Corporation, 457 Concord Avenue, Cambridge 38, Mass. West Coast manufacturers, contact: E.V. Roberts, 5068 W. Wash. Blvd., Los Angeles, or 988 Market St., San Francisco, Cal.

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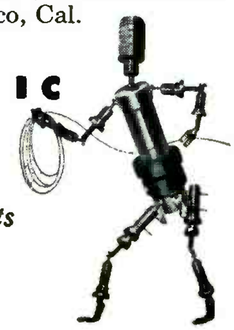

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PROSPERITY IN THE USA: How Deeply in Debt Are We?

How prosperous *are* the people of the United States? Previous messages in this special series have answered this question in part by recording the progress — relatively slow progress — we have made in increasing both the income and the wealth per person in the USA.

This fourth and concluding piece of the special series deals with the extent to which our prosperity should be discounted because it has been accompanied by an increasing volume of debt. Many correspondents have suggested to us that an individual or a nation can temporarily increase prosperity by borrowing, but in so doing lives on both borrowed goods and borrowed time. Our purpose here is solely to throw light on the question of whether or not we are now in that unenviable position.

On January 1, 1953, the total debt of the United States government and of its citizens was $627 billion, as shown in the table below. On its face, a debt of this magnitude, which represents about $3,900 of debt for each person, suggests that we are heavily debt-ridden.

TOTAL DEBT — PUBLIC AND PRIVATE

Federal government debt	$267	billion
State and local debt	30	"
Private debt		
Corporations	195	"
Individuals	135	"
	$627	billion

The burden of our debts, however, does not depend simply on their size. It depends in much more decisive degree on our capacity to carry the load successfully. This capacity, in turn, is partly a matter of attitude, and attitudes defy objective measurement. A community that gets very jittery about its debts has less capacity to carry its burden successfully than one that does not. But the accurate measurement of jitters, present or prospective, still remains to be mastered.

Capacity to Carry the Debt Load

Nonetheless, it is possible to throw some light on our capacity to carry the debt burden by studying key economic elements that can be measured with some degree of accuracy. The following paragraphs indicate how some of these key economic elements stand.

Compared with our national income, the total volume of our debts, public and private, is still well below the level of 1929, when it proved to be too big for the good of the country. Our total debt is now 113% greater than the national income whereas in 1929 it was 146% greater.

There are several other cheering facts about our debts. One is a sharp decline in interest rates which makes the cost of carrying our debts relatively much less than it was in 1929. It took 8% of our total national income to carry our debts in 1929; it takes only about 5% of the income today.

More Cheering Facts

We also have much more ready cash now than in 1929. Today individuals and corporations hold a total of $269 billion in cash or its equivalent which is almost twice as much as the portion of private short-term debt (about $140 billion) that is subject to sudden demand for payment.

Many students of the subject cite the relatively low cost of carrying our debts and the large volume of cash on hand, and reach the comfortable conclusion that our debt burden is nothing to worry about. In further support of this view they emphasize the fact that no important part of our debt is owed abroad. Hence, they reason there is not the danger, so conspicuous in Britain since the end of World War II, that our economy will be upset by the necessity of making heavy debt payments to other countries.

Some Dangers of Present Debt

However, the nature of our debts presents dangers that it would be foolish to ignore. This is true of both the debt of $267 billion owed by the federal government to its citizens and the $330 billion in private debts owed by some citizens and corporations to others.

Public debt can be a dangerous kind of debt because government has the power to print money or to create its equivalent by expanding bank credit. Of the $215 billion that the federal government borrowed during World War II, over $90 billion was borrowed from banks. This was the largest single contributor to the inflation of prices that since the war has robbed the dollar of about half of its purchasing power, and thereby robbed the buyers of government bonds of about half the purchasing power these bonds were supposed to represent.

If, as is quite possible, a new emergency should again require the federal government to borrow heavily while its debt remains so high, it is doubtful that the public would be avid to buy its bonds. Hence, the government might again be forced to resort to the inflationary process of relying on bank credit.

Private debts can be dangerous if the people take on new debts more rapidly than is justified by the growth of business or by their ability to repay. Last year bank loans were increased by the imposing sum of about $6½ billion, which represents an increase of about 11% in total loans outstanding. This is almost twice as much as the increase in the volume of business over the same period. Installment credit for consumers increased by $3 billion last year, again an increase in debt about twice as great as the increase in business volume in the fields where the credit was used. It is also the fastest rate of such growth in our history.

Constructive Use of Credit

So long as the expansion of credit does no more than keep pace with expansion in the volume of business, the expansion is constructive. Also, when credit is expanded to acquire resources and equipment that will enlarge the volume of business a little later, that use is clearly constructive. But when private credit expansion begins to run ahead of business growth, it is time for us to be heads up. Such credit expansion courts price inflation. It also creates a forced draft under business so that, if credit is cut off, there may be a painful drop.

To give a summary answer to the question: *Is the level of debt in the United States a danger to our prosperity?* — the answer seems to be, "Not at the moment." We owe nothing abroad. The interest burden on present debt is relatively small, and we appear to have the resources to handle the short-term debt. Yet both the total amount of debt and the recent rapid increase in total private debt, especially the latter, are enough to signal for caution. We need restraint on the part of business and consumers to avoid expanding private borrowing at an excessive rate. The federal debt needs to be reduced and put in more manageable form. If these things are done, we can proceed to build a sound prosperity.

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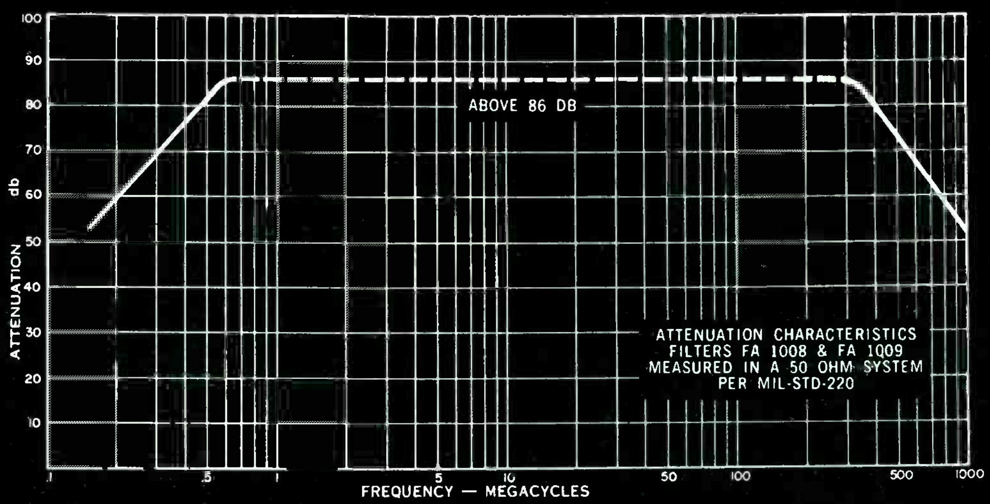

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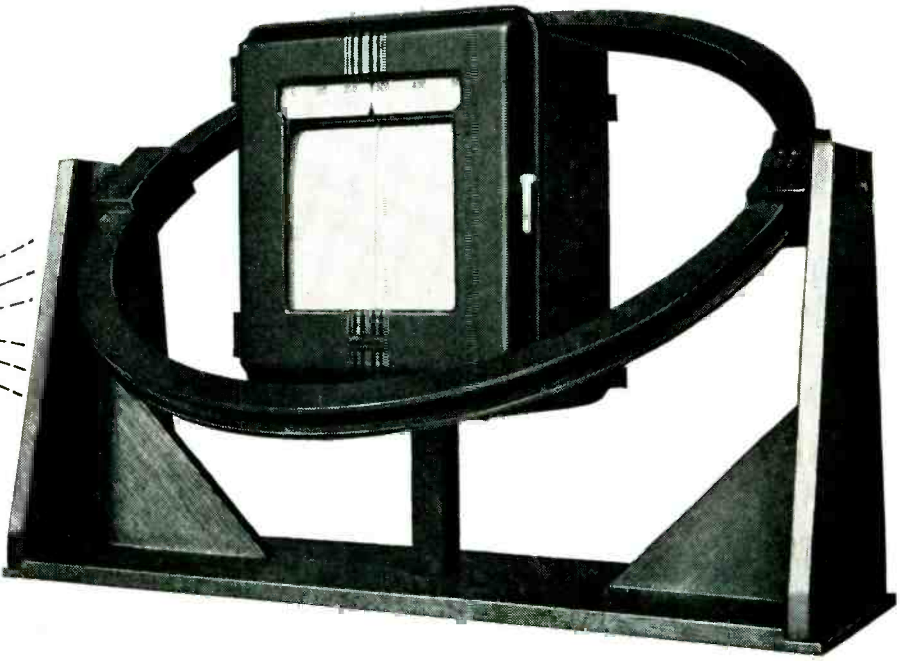

● Built into every Speedomax recorder and controller is a high degree of indifference to stray electrical fields. And this is one of its most useful characteristics in almost any job. It means that you can install a Speedomax near a big motor, power line or X-Ray machine—any electrical equipment in fact—and you'll probably see no effect at all from surrounding electronic noise and "junk".

The reason for this indifference to stray fields goes back through the adjustment, building and design of the instrument, to its basic engineering. Speedomax has an *electronically-clean measuring circuit*, as well as clean signal and amplifier circuits.

This clean design includes a bifilar-effect slidewire, to eliminate any objectionable inductance at that point. It includes our "no-moving parts" trolley contact on the slidewire, which eliminates pigtails and their variable inductances. It includes use of a Mumetal slidewire shield where desirable, instead of less expensive but lower-permeability aluminum. And it includes a lot of just downright meticulous detailing, such as carefully engineered wiring and input filtering, plus ingenious shielding where required.

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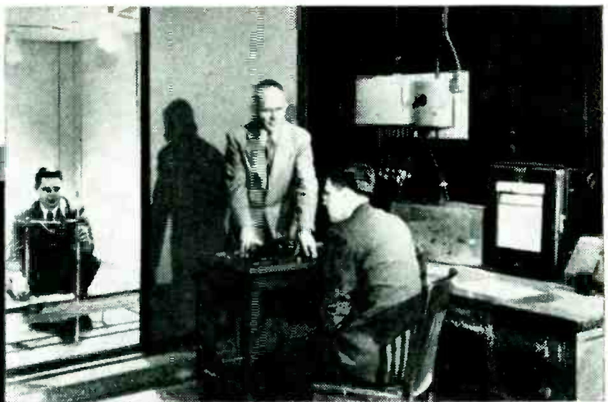
Our Catalog ND46(1) and Technical Publication ND46(1) tell the story. Write our nearest office or 4979 Stenton Avenue, Philadelphia 44, Pa.

Scientists find that Speedomax instrument operation is not affected by the stray fields created by motors, electric heaters, x-ray equipment and other laboratory gear.



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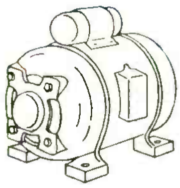

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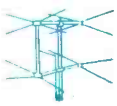

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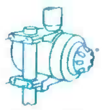
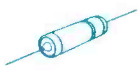
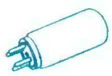


ROTATORS



CAPACITORS



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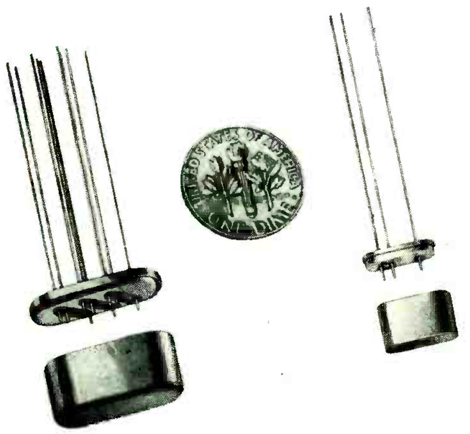

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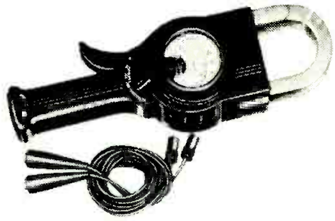

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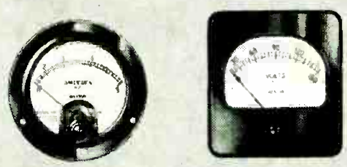

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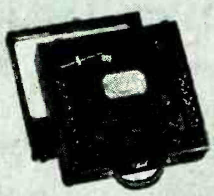

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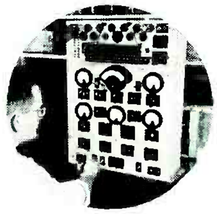

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Tests tubes under exact operating potentials. Accurately determines true mutual conductance of all tubes, in accordance with manufacturers' rated operating conditions, or under special operating conditions.

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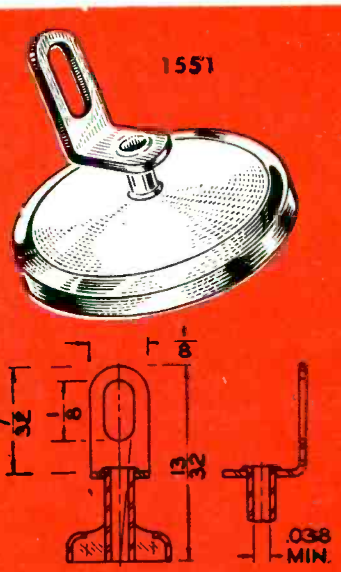

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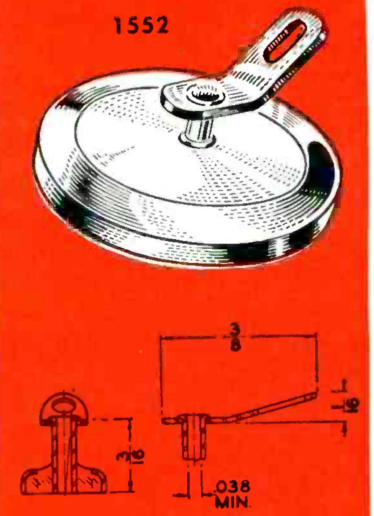

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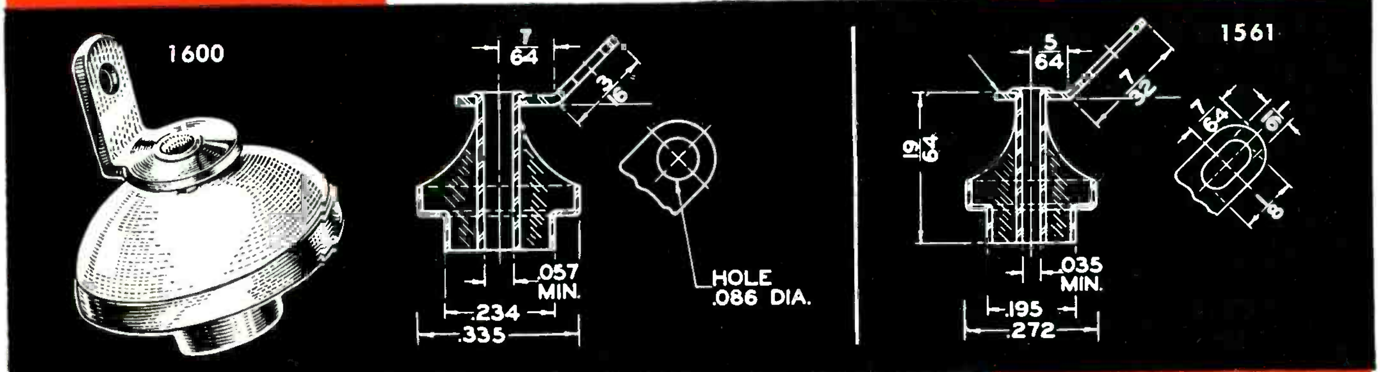

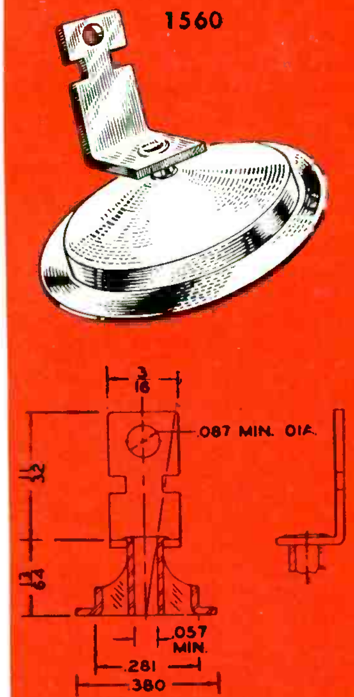

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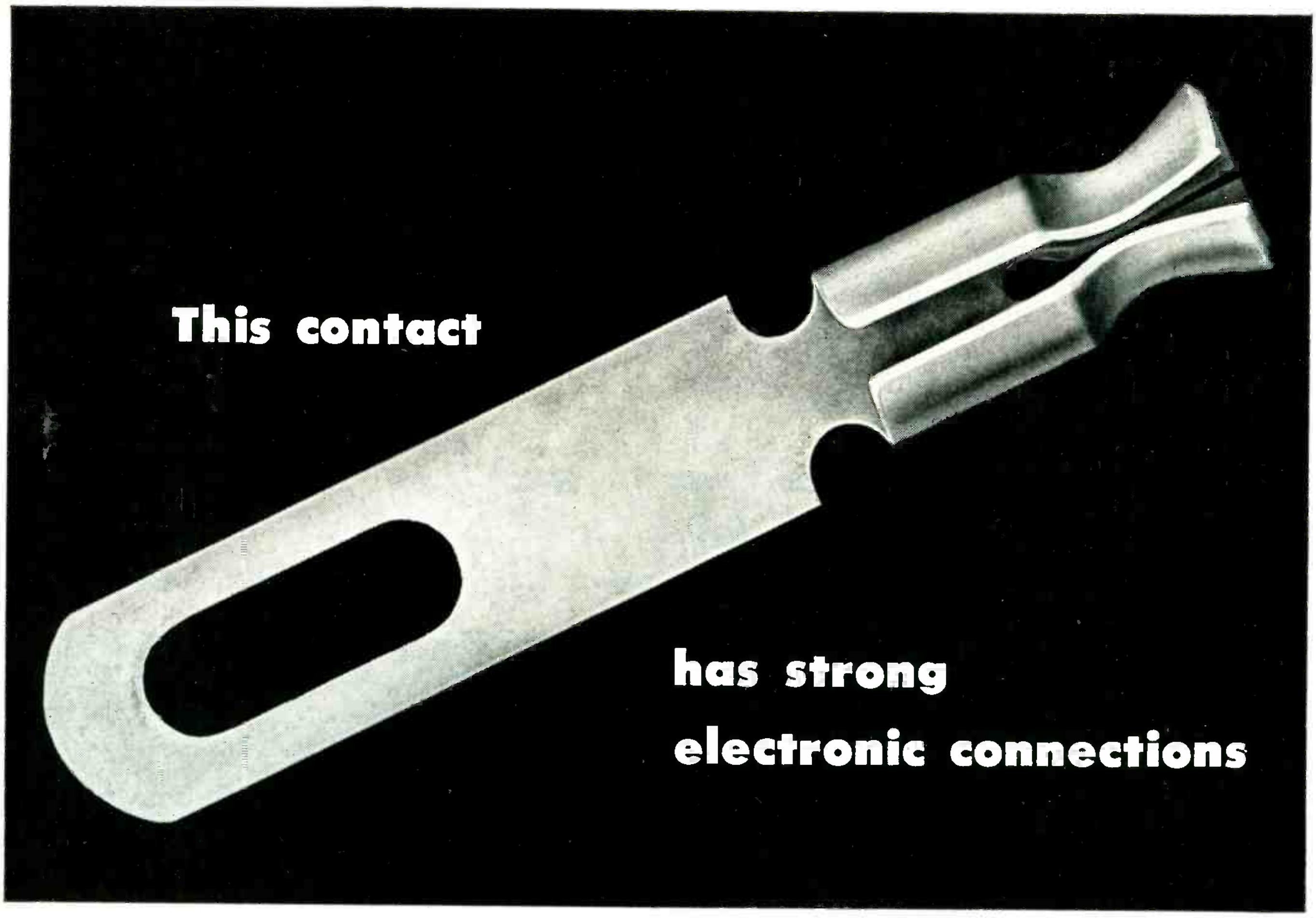

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The men who design our military equipment are well aware of the old saying "For want of a nail, the shoe was lost"... and consequently the battle. The specifications, the load and test requirements, are exacting. Contacts must excel in spring properties, in resistance to both corrosion and relaxation, in electrical conductivity. They must not be subject to vibrational fatigue and must withstand wide variations in temperature. There is one metal which possesses all these essential characteristics to a high degree— Berylco beryllium copper.

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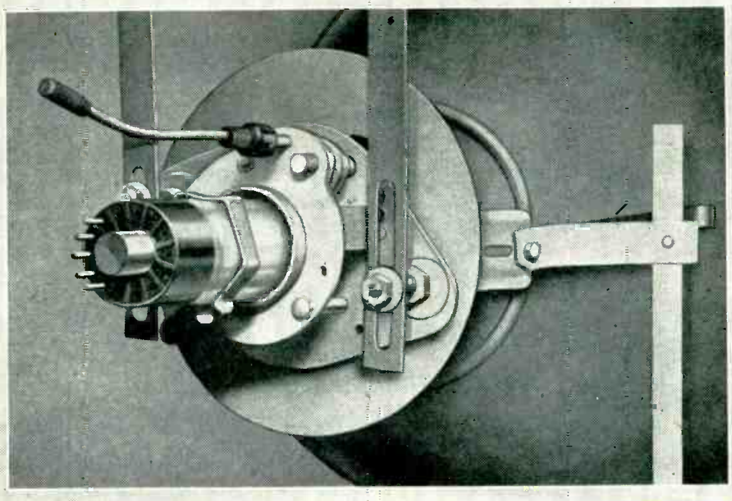
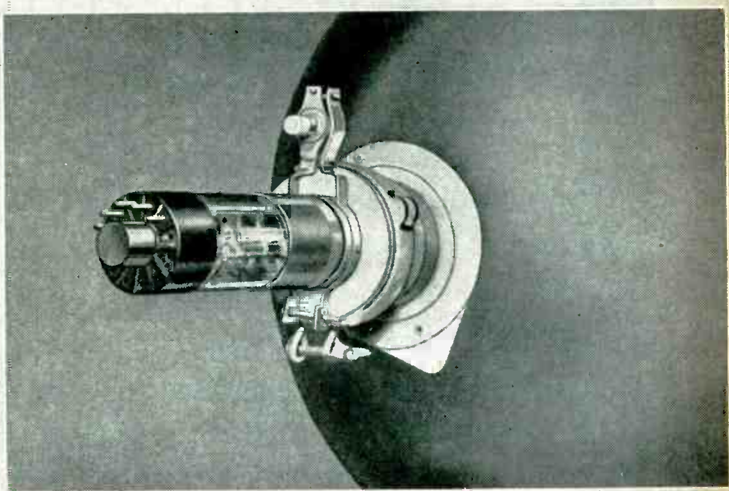
COMPARE (left) the bulky parts needed for a standard tube with (right) the clean simplicity of an *i-m-f* tube ready to install!



The external ion-trap magnet on this standard tube, is an extra cost item for the TV manufacturer and requires special adjustment. The focus coil and complicated mounting also mean extra cost. They take up space, add weight, consume assembly and adjustment time. Get rid of all three parts with G. E.'s new *i-m-f* tube!

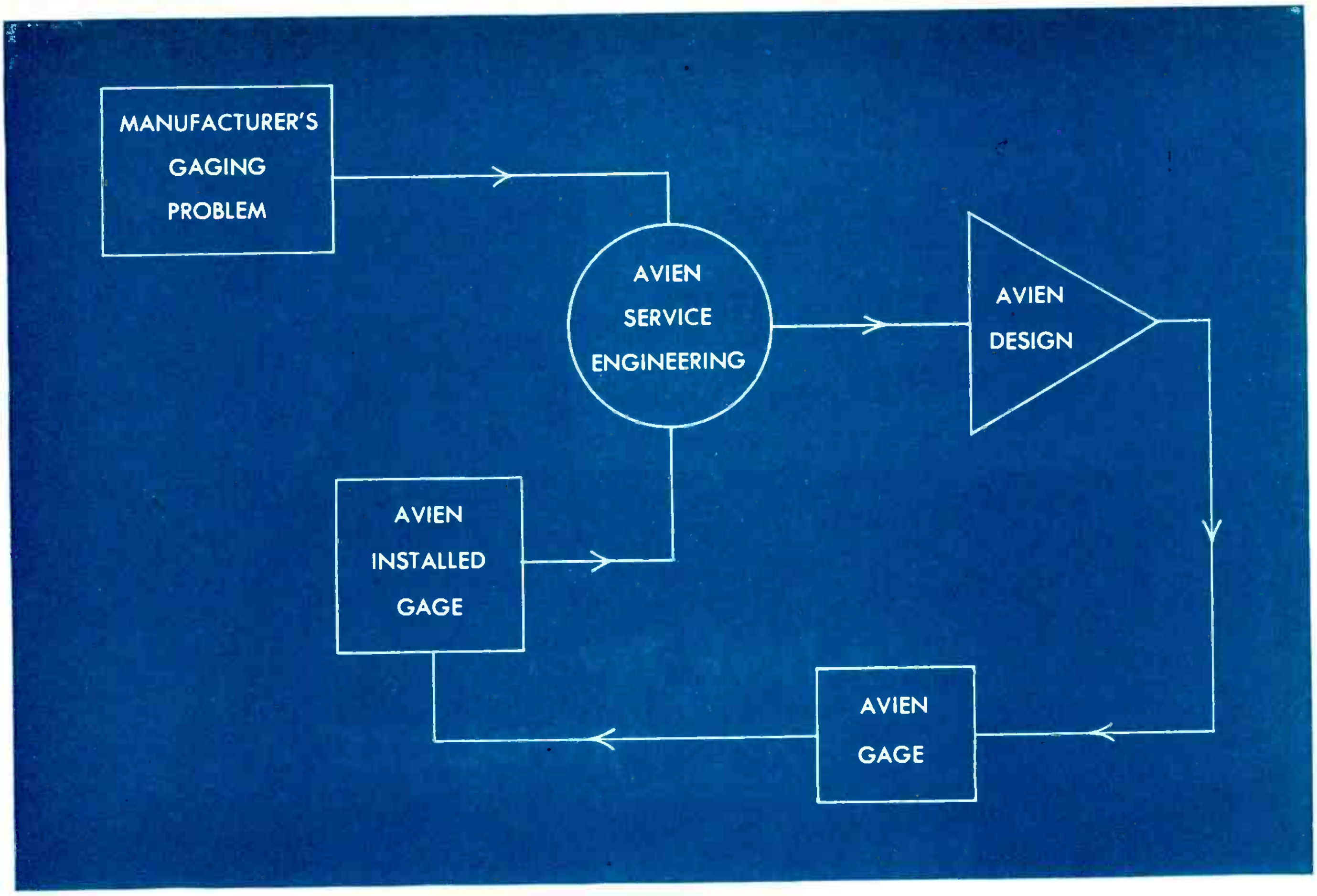


Now, no hard-to-adjust external ion-trap magnet! No focus coil, or external focus magnet, with cumbersome bracket! Instead, an *i-m-f* tube calls for just two parts when installed, both of them compact: (1) a close-fitting steel shunt band that is easily slipped on and (2) a small centering device to position the picture.

On this 75th anniversary year, General Electric takes pride in announcing its *i-m-f* picture tube as the latest in a long series of significant G-E "firsts". To the many advantages given by internal, factory-adjusted ion-trap and focus magnets, can be added radically improved design in important tube details. One example of this is the new, precision-made metal "lens" that greatly narrows the electron beam, assuring clean, sharp picture definition over the entire TV screen area. Now 90°-sweep tubes can have good detail across the whole face! You can expect production soon in 21" size. Other *i-m-f* types will be added rapidly. Television manufacturers and television designers will be sent full information on request. *Tube Department, General Electric Company, Schenectady 5, New York.*

GENERAL ELECTRIC

162-1A2



Are you using this "Servo" principle?

This Avien "feedback" system has important advantages for plane-makers and engineers.

Avien was among the first to use the servo principle in the design of aircraft gages.

But there's another servo principle that Avien offers to every aircraft manufacturer.

It's a "feedback" system that has provided a lot of effective answers to aviation's most complex problems.

This scheme is basically simple. Once handed the problem, Avien tailor-makes gages for the aircraft. Avien engineers follow through all the way, from drawing board inspiration to instrument panel installation.

But after installation is completed, Avien's job continues. Avien field engineers constantly check and test the gages *in service*—and feed back information to design headquarters.

This "closed-loop" operation has aided Avien in the perfection of some remarkable products.

We've designed Cylinder Head Temperature Indicators and Jet Tailpipe Thermometers that use the servo principle. Result: longer scale gages, unaffected by lead characteristics.

We've designed a Jet Engine Thrustmeter that computes gross thrust from measurement of tailpipe pressures and ambient pressures.

We've made over fifty fuel gages that measure fuel quantity by weight, eliminating moving parts in the fuel tank.

Every month, Avien produces over 10,000 major instrument components for the aviation industry.

Right now, we have two goals.

First, we're going to keep on solving the toughest instrumentation problems in the industry. If you think you've got them, call us.

Second, we're going to keep on adding the best engineers in the business. If you think you're one of them, send your detailed resume to Department E.

Avien

AVIATION ENGINEERING CORPORATION

34-56 58th STREET, WOODSIDE, L. I., NEW YORK

WHEN THEY DESIGN
WHEN THEY SPECIFY
WHEN THEY BUY . . .

they look for
PRODUCTS
FIRST in the
GUIDE

Engineers, designers, specifiers, purchasing agents — everyone who has anything to do with the design or use of electronic gear, components or allied products have, for years, learned to use the ELECTRONICS BUYERS' GUIDE for essential product data and sources. The reason? Because they have found it thoroughly up-to-date, the most accurate and the only complete source available. Tailored as it is to the critical needs of the electronic industry, it is the only book upon which the industry's technicians rely.

electronics BUYERS' GUIDE

PUBLISHED MID-JUNE 1953

FOR THE REASONS WHY IT'S THE ADVERTISER'S BEST BUY

THE **3** ESSENTIALS THAT MAKE THE

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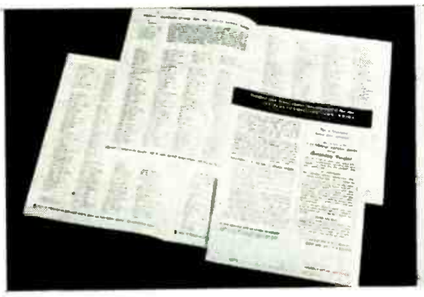
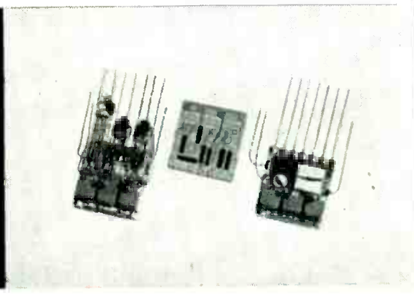
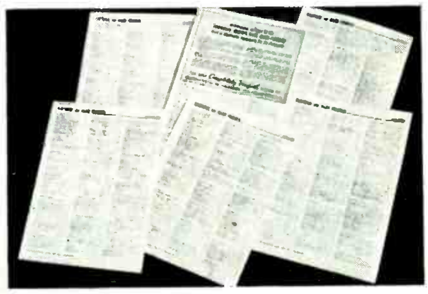
The **ONE** *reliable source of product information*



1. ACCURACY



2. NEW PRODUCTS



3. COMPLETENESS

1. ACCURACY . . .

The year-'round staff of the ELECTRONICS BUYERS' GUIDE has had years of experience in compiling and verifying products. Fully aware of the rapid changes that are taking place in the electronic field, the staff starts from scratch each year. Questionnaires are sent to every manufacturer. When they are returned, they are checked — and double checked. Nothing is taken for granted in relation to products, terminologies and new classifications. A manufacturer's product will not be included in the "GUIDE" until evidence is supplied that they are manufactured and available. It is this careful research in which no detail is overlooked, that provides users with a GUIDE that is the only accurate and reliable product source available in the electronic field.

2. NEW PRODUCTS . . .

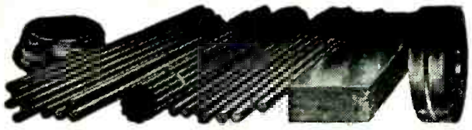
Electronics is a fast moving science-industry. The experiments of yesterday become the realities of today. Thus it becomes vitally important that all new products are included to keep listings . . . not only up-to-date, but up-to-the-minute. A continuing search is made of *all* sources for new products and new terminologies. This search is a year 'round job. Every possible method is employed, including direct contact with industry through our sales and field representatives. The result of this painstaking search makes the "GUIDE" the only book that provides complete up-to-the-minute information.

3. COMPLETENESS . . .

By completeness is meant that *ALL* essential product information is provided. This includes: Complete listing of all manufacturers and their products — not just a token listing. Correctness and completeness of addresses. Sufficient cross indexing to locate any product regardless of terminology. And, most important, the format of the "GUIDE" provides, in *one* complete listing, a simple method of locating products. In addition to these important details, the "GUIDE" has trade name and distributor listings. These are the factors of completeness — these are the essential things that have made the "GUIDE" the "breadboard blue book" for every technician or purchaser in the field.

These 3 essential features of the Electronic Buyers' Guide serve the industry in the exacting manner that it requires. It is these three essentials that have earned for the "Guide" its wide reputation, its increased usage, its universal acceptance. They are the reasons why . . .

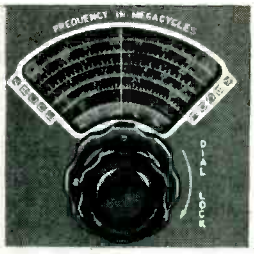
THE "GUIDE" IS THE ADVERTISERS BEST BUY!



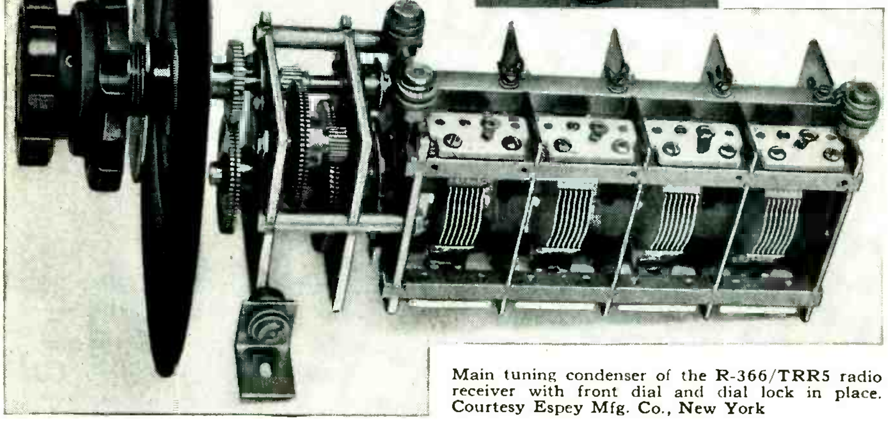
BRIDGEPORT BRASS COMPANY

COPPER ALLOY BULLETIN

Bridgeport Brass Co. MILLS IN BRIDGEPORT, CONN. AND INDIANAPOLIS, IND.—IN CANADA: NORANDA COPPER AND BRASS LIMITED, MONTREAL



Main tuning dial showing location of the dial lock assembly. Courtesy Espey Mfg. Co., New York



Main tuning condenser of the R-366/TRR5 radio receiver with front dial and dial lock in place. Courtesy Espey Mfg. Co., New York

Precision Tuning Accomplished by Using Bronze and Brass Parts

An important feature which receives careful consideration when designing a communications receiver is the mechanical tuning system. A military receiver must be able to accurately separate and hold the signal it is receiving even under adverse conditions when the receiver may be constantly jolted or vibrated.

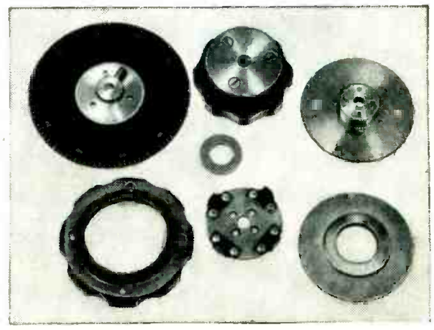
Mechanical Bandspread

The R-366/TRR5 radio receiver specially designed for the United States Marine Corps as a communications and morale receiver is equipped with a geared tuning drive and special dial locking device. By using a series of accurately machined brass gears (alloy 63, 66% copper, 1.1% lead, remainder zinc), a reduction ratio of 10:1 is obtained, assuring smooth tuning and easy separation of signals. Spring loading the split gear sections eliminates back lash when tuning. The gear mechanism also drives the main tuning condenser shaft (free-machining brass rod) which in turn rotates the four gang set of rotor plates. An automatic stop at each end of the dial travel protects the condenser plates from damage. These plates are blanked from high brass (approx. 66% copper, balance zinc) annealed and then silver-plated to increase resistance to corrosion.

Dial Lock Assembly

When the desired station is located, the condenser can be held in place with a special dial lock.

Many different types of dial locks have been designed but most all have one fault in common. As they are tightened, they exert pressure against one side of the dial or knob, causing a slight movement and consequent detuning of the receiver.



Dial Lock disassembled to show bronze and brass parts. Courtesy Espey Mfg. Co., New York

The illustrated dial lock prevents this movement by simultaneously exerting pressure on four sides of the tuning knob. When the dial lock knob is rotated, four heat treated beryllium copper springs mounted on a brass plate tighten against the edges of a braking plate fastened to the main tuning knob.

The disassembled illustration of the dial lock shows the various brass and bronze parts used in the assembly. All high brass parts are nickel plated to increase resistance to corrosion. The dial lock knob is a machined bronze casting. The beryllium copper springs insure high resistance to fatigue and a strong grip to prevent slipping.

Bridgeport Service

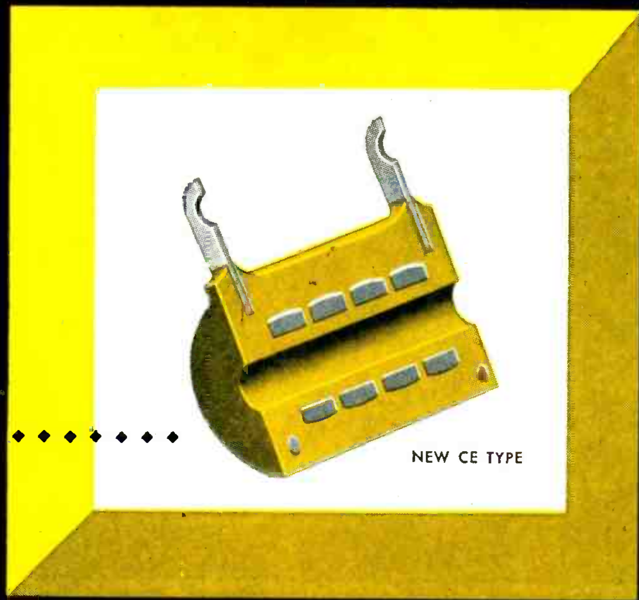
The use of the correct alloy and temper is most important in precision fabrication. For help on your metal problems, contact the nearest Bridgeport office. (9420)

Want more information? Use post card on last page.

Want more information? Use post card on last page.

16 years of experience

...and know-how goes into your purchase of a Cinema resistor..........



Accurate wire wound resistors in the new Cinema CE type are hermetically sealed to surpass the requirements of MIL R-93A. Investigate the use of the new CE resistor in your applications. Contact your local Cinema Engineering Company factory representative, or write direct today for literature.

IN NEW YORK
Audio & Video Products Corp.
730 Fifth Ave. • Plaza 7-3091

EXPORT AGENTS
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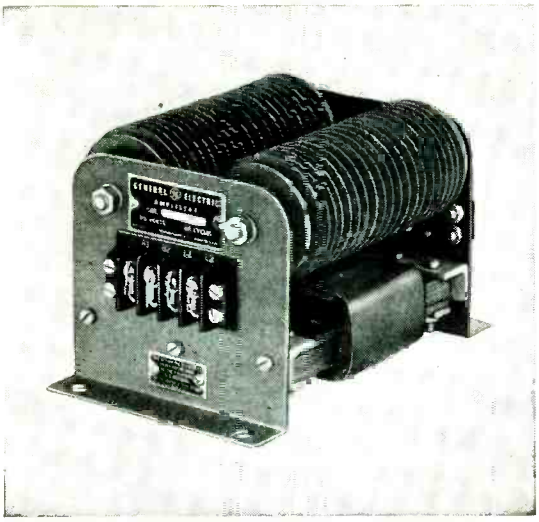
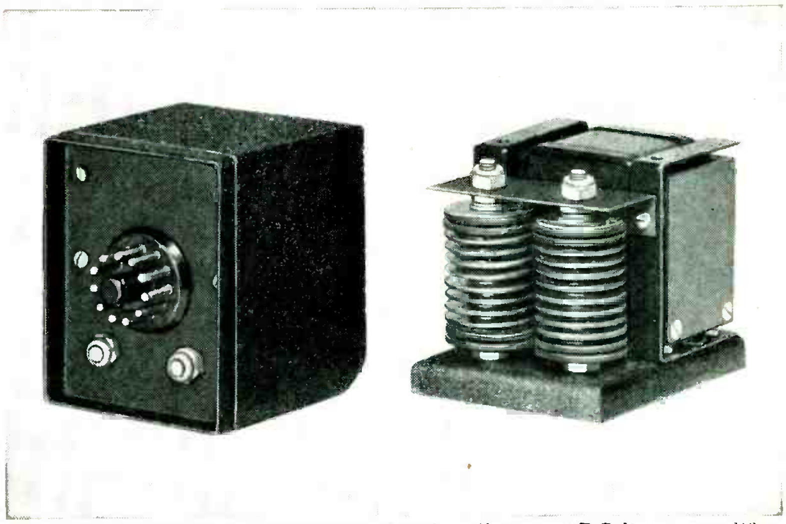
301 Clay Street
San Francisco, Calif., U.S.A.

CINEMA ENGINEERING CO.
1510 W. VERDUGO AVE., BURBANK, CALIF.



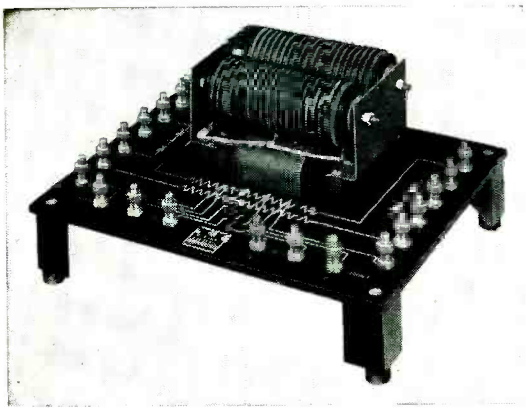
40-VOLT-AMPERE INDUSTRIAL AMPLISTAT operates directly from 115-volt, 60-cycle power supply.



400-CYCLE PLUG-IN AMPLISTAT is a push-pull output DC linear amplifier with three separate input windings. Tube-type base simplifies mounting.

New line of G-E Amplistats now available for high-gain DC amplification circuits

ONE-VOLT-AMPERE AMPLISTAT is compact (two-inch cube), mounts in standard octal socket for convenient connection and easy circuit testing.



EDUCATIONAL-LABORATORY AMPLISTAT (10-volt-amperes) has multiple input for flexibility. Diagram molded into panel allows easy demonstration.

The Amplistats (self-saturating magnetic amplifiers) illustrated here are typical of the units General Electric is now producing. Ten ratings have been designed to extend application to a wide variety of circuits. There are two models in the 1-volt-ampere range, one model in the 40-volt-ampere range, and two models for use with 400-cycle input current.

An Educational-Laboratory unit (40-volt-ampere) and a 400-cycle hermetically sealed unit are also available. New ratings of 25-volt-amperes, 125-volt-amperes, and 600-volt-amperes will go into production in the near future.

General Electric's expanded line of Amplistats offers you many advantages in the design of control and instrumentation systems which require high-gain DC amplification of small signal sources. Combining amplifying and rectifying elements in a packaged unit, G-E Amplistats give you instant starting, low power consumption, long life, electrical signal isolation, and rugged durability where moderate shock or vibration might occur. They are simple and convenient to mount, and are often lighter in weight than other types of amplifiers.

G-E engineers are ready to assist you in developing complete amplification systems around these units or in designing units for specific applications. Mail coupon below for more information on G.E.'s new Amplistat line. *General Electric Co., Schenectady 5, N. Y.*

General Electric Company
Section 411-110
Schenectady 5, N. Y.

Please send without charge bulletin GEA-5950 on G.E.'s new Amplistat line.

☐ For immediate project. ☐ For reference only.

NAME .... TITLE ....

COMPANY ....

ADDRESS .... CITY .... STATE ....

GENERAL ELECTRIC

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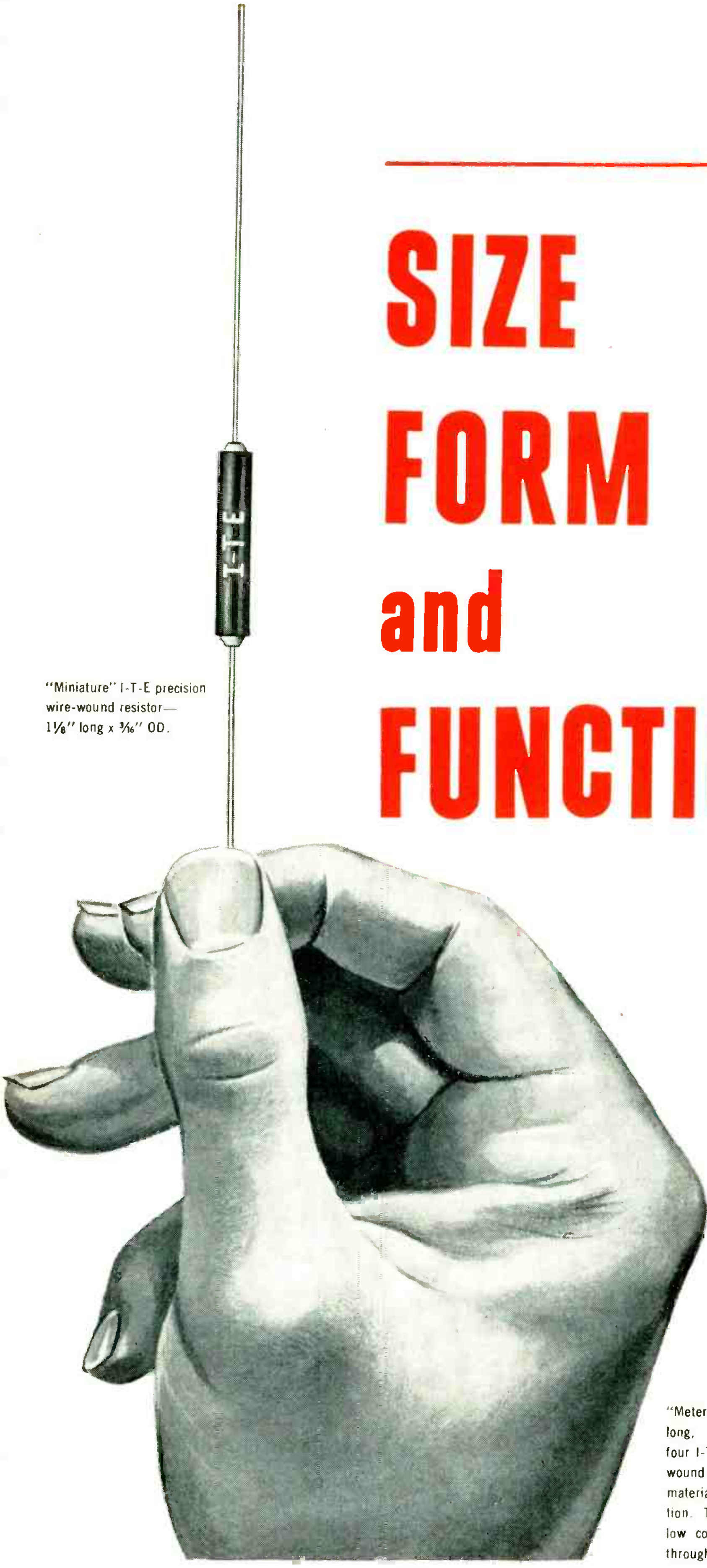
SIZE FORM and FUNCTION



"Miniature" I-T-E precision wire-wound resistor—1⅛" long x 3/16" OD.

"Meter multiplier" — 9 25/32" long, ferrule type—houses four I-T-E precision resistors wound on bobbins of the same material as the encapsulation. This assures uniform low coefficient of expansion throughout the resistor resulting in a true hermetic seal.

Want more information? Use post card on last page.

How Carboloy permanent magnets

Products work better, weigh less, cost less to build

Throw away that electro-magnetic source of energy! Replace it with a Carboloy permanent magnet!

Hundreds of manufacturers in the field of communications equipment have taken this sound advice . . . and make better performing products for less money as a result

Here's why: A Carboloy permanent magnet is a simple package of stored energy that will *never fail*. When it replaces a wound coil in a circuit, it is usually a smaller assembly, with current losses eliminated. For unlike a coil, a magnet generates no current-wasting heat; its field strength always remains steady.

Fabrication costs go down because the magnet eliminates the coil, wires and operating parts. Even in small sizes, it is powerful. That means product design is simplified . . . size and weight substantially reduced. A Carboloy permanent magnet costs nothing to operate, never needs maintenance. Result? More savings, more product dependability.

Why not call a Carboloy magnet engineer soon? Find out just where and how a magnet assembly can help you . . . and get an expert, helpful assist in magnet design and application.

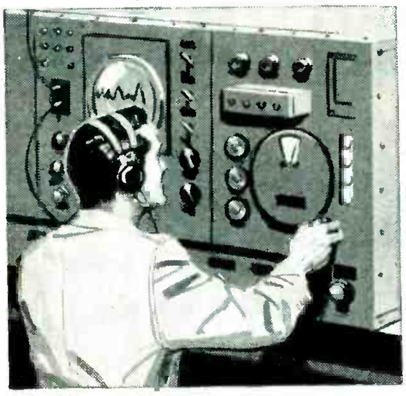
High-quality, low cost Carboloy Permanent magnets are available in all sizes, all shapes — cast or sintered to your specifications. Mail coupon for free Magnet Design Manual and Standard Stock Catalog.

HEARING AIDS — Here is an outstanding advance in hearing aids—a new *all-transistor, all-magnetic "Radioear"* developed by E. A. Myers & Sons, Inc., Pittsburgh. Carboloy permanent magnets are used in the magnetic receiver and magnetic microphone—both newly designed, high-efficiency, high-output units made especially for use in the all-transistor "Radioear."

Magnets have eliminated hearing aid failure caused by severe conditions of heat and humidity encountered in use, and make it possible to match the impedance of the transistor amplifier without the use of an input transformer as required for crystal-type microphones.

improve communication devices

WALKIE-TALKIES—Size and weight are highly vital here. Carboloy permanent magnets in these speakers help to reduce both considerably.

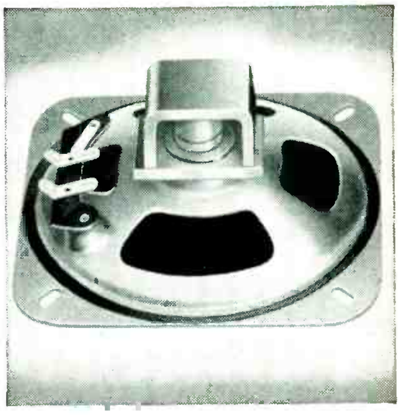


TRANSMITTER RECEIVERS—Huge communication links like these rely on Carboloy permanent magnets for trouble-free performance.

FIELD TELEPHONES—In receivers, Carboloy magnets help step up clarity, cut down size and weight, and reduce power requirements.

16 OUTSTANDING ADVANTAGES OF CARBOLOY PERMANENT MAGNETS

- Cool — generate no heat
- Require no electrical energy
- Cost nothing to operate
- Eliminate coils, windings, wiring, etc.
- Need no maintenance—no coils to burn out, no slip rings to clean or replace, etc.
- Simplify mechanical assemblies — exert strong tractive force for holding, lifting and separating devices that eliminates component parts, makes product design and fabrication simple
- Save space — great magnetic strength in small sizes
- Powerful — and power is constant
- Combine electrical and mechanical features — transform electrical energy into mechanical motion; mechanical motion into electrical energy
- No power failures
- Resist moisture — no coils to collect dampness
- Give uninterrupted operation
- Create savings — often eliminate costly, power-supplying parts
- Simple — no operating parts
- Reduce weight, product size
- Supply a permanent source of energy



RADIO, TV SPEAKERS—In these speakers, current passes through the voice coil which is the magnetic field set up by the Carboloy permanent magnets. The uniformity and strength of the magnets help produce truer tone.

CARBOLOY

DEPARTMENT OF GENERAL ELECTRIC COMPANY

11139 E. 8 Mile Street, Detroit 32, Michigan

Plants at Detroit, Michigan; Edmore, Michigan; and Schenectady, New York

"Carboloy" is the registered trademark of the Carboloy Department of General Electric Company

FREE CATALOG AND MANUAL

Carboloy Department of General Electric Company
11139 E. 8 Mile Street, Detroit 32, Michigan

Send me, at no cost or obligation, copies of Permanent Magnet Design Manual PM-101 and Standard Stock Catalog PM-100.

NAME__________ POSITION__________

COMPANY__________

ADDRESS__________

CITY__________ ZONE____ STATE______

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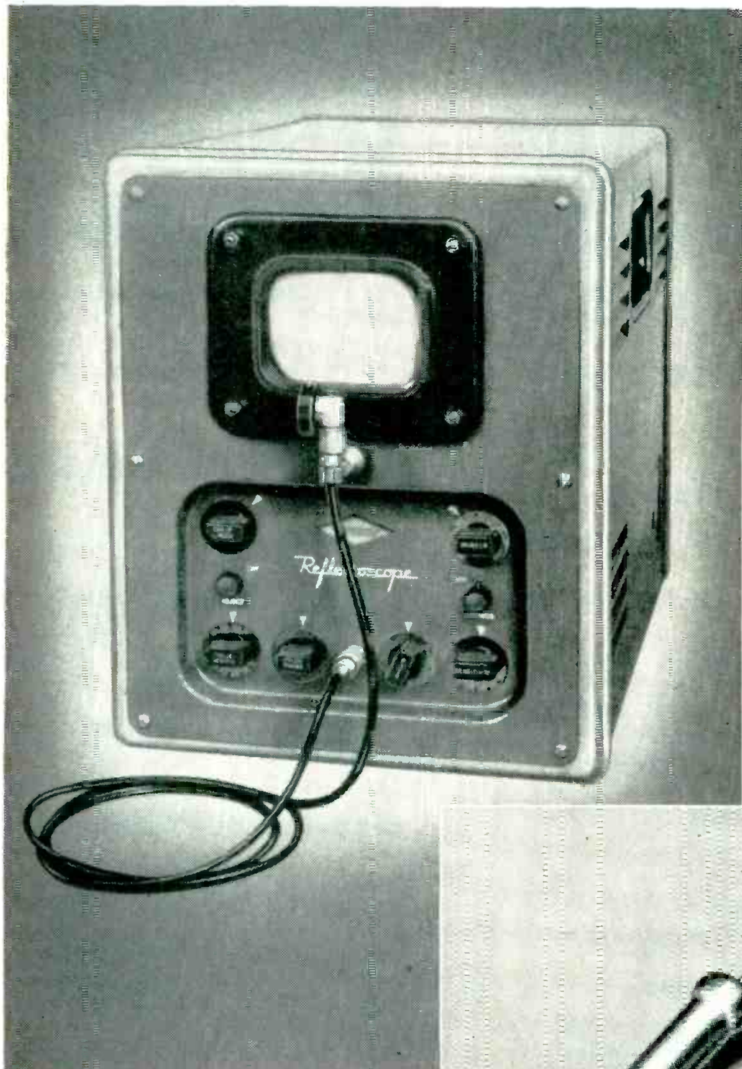
Flaw finder switches to

AXIOHM RESISTORS

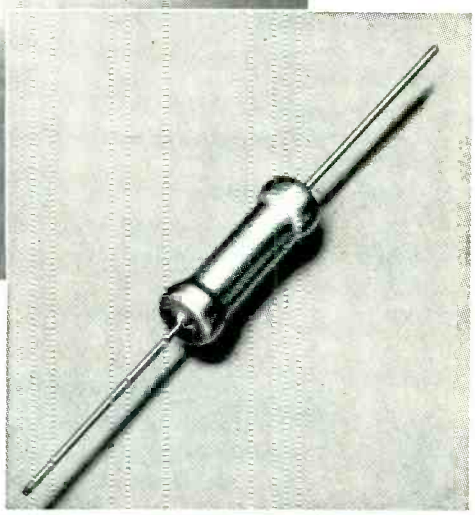


Sperry Reflectoscope, made by Sperry Products, Inc., Danbury, Conn.

The Sperry ultrasonic Reflectoscope, a compact, portable unit designed for on-the-job inspection, "listens" for defects through as much as thirty solid feet of aluminum and even greater thicknesses in steel and other materials.

Many of the circuits in this highly sensitive electronic instrument now include Ward Leonard Axiohm Resistors. Sperry's design engineers gave three reasons for specifying this ruggedly built, self-mounting, miniature resistor.

- **stronger anchorage of the axial lead**
- **smaller size**
- **full watt rating at high resistance values**



AXIOHM RESISTORS of the vitreous enamel wire-wound power type are designed for use by the electronic and allied industries. These newly developed miniature resistors are self-supporting by their own wire leads which are hot tin-dipped for ease of soldering. They are available in conservatively rated 5 and 10 watt sizes. Write for Axiohm resistor bulletin.

WARD LEONARD

WARD LEONARD ELECTRIC COMPANY

MOUNT VERNON, NEW YORK

Result-Engineered Controls Since 1892

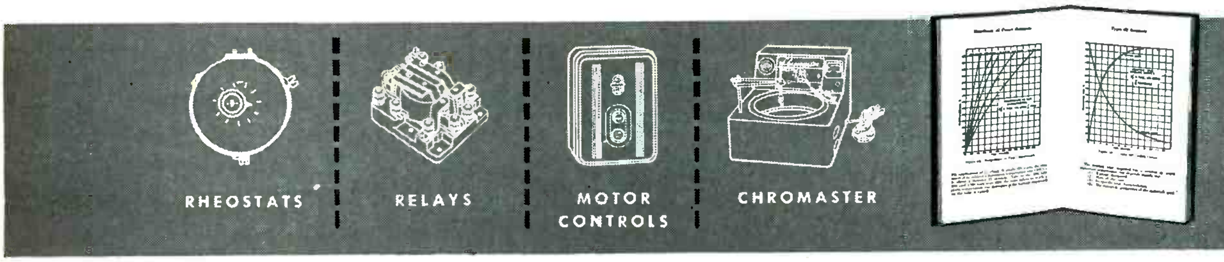
WARD LEONARD makes 19 distinct inspections and tests on every Vitrohm resistor

Measurement of outer diameter and concentricity of ceramic cores are but two of the 19 checks made on every Axiohm resistor.

In the Axiohm, as in every stock and made-to-order resistor, Ward Leonard gives this same careful attention to the details that result in long-life service even under the most adverse conditions.

Every resistor component is matched with respect to thermal expansion. Ward Leonard resistor cores, Vitrohm enamel, terminals, junctions, even resistance wire, are result-engineered for accuracy and uniformity.

Whether your product is a delicate electronic device like the Reflectoscope or a heavy-duty industrial machine, you need an electrical control you can count on. Ward Leonard has the productive facilities and the technical know-how to meet your every resistor need. Let Ward Leonard's engineering department help you select the right one. Ward Leonard Electric Company, 31 South Street, Mt. Vernon, New York.

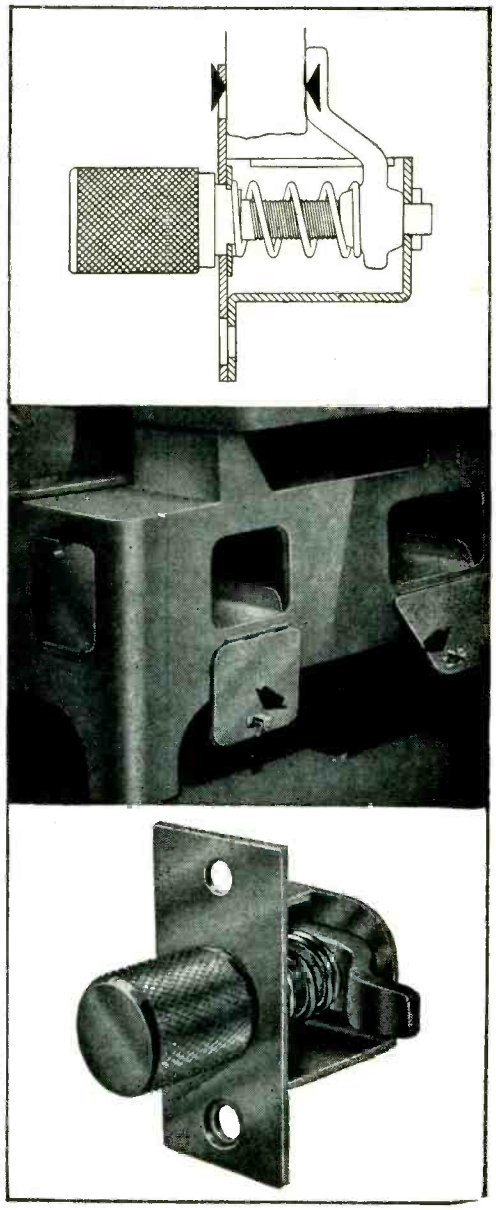


Ward Leonard's complete engineering textbook, "Handbook of Power Resistors," $3. per copy.

Want more information? Use post card on last page.

variable distance
variable pressure

by merely turning the knob



for a tight fit

regardless of irregularities

Manufacturers are assured of tightly-closed doors and panels, with gaskets tightly compressed, by using Southco Adjustable Pawl Fasteners. Variations in thickness at point of fastener contact, whether in heavy castings or light metal frames, do not affect either the fit or the simple fastener installation procedure.

Adjustment is made automatically every time the knob of a Southco Fastener is turned. Only one size is stocked for use on various panel thicknesses, but every fastener fits.

For complete data on Southco Adjustable Pawl Fasteners, write to Southco Div., South Chester Corp., 1417 Finance Bldg., Phila. 2, Pa.

Important for military contractors! Prompt deliveries now possible.

SOUTHCO®

FASTENERS

PAWL • SCREW AND SPRING • DRIVE RIVETS • ANCHOR NUTS • ENGINEERED SPECIALTIES

OFFICES IN PRINCIPAL CITIES

WHEREVER TWO OR MORE PARTS ARE FASTENED TOGETHER; STANDARD AND SPECIAL DESIGNS FOR IMPROVED PERFORMANCE AND LOWER PRODUCTION COSTS

TRULY independent screwdriver Vernier Phasing

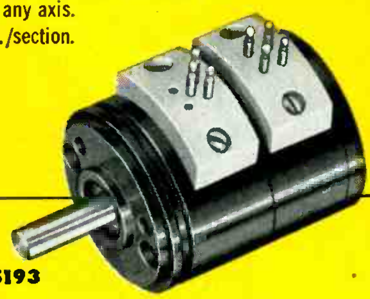
MODEL 85194

Self-locking screwdriver-actuated phasing adjustment. Each section easily adjusted to maximum resolution (one wire) in $\pm 11°$ range. 2½" diameter; ¼" shaft; 2,000 to 300,000 ohms per section; 4 watts @ 25° C; 1 to 6 sections; body length 4.8" max.

SPECIFICATIONS

RESISTANCE: 2,000 to 300,000 ohms/section ($\pm$5%).
LINEARITY: $\pm$ 0.3% of total resistance.
POWER RATING: 4 watts per section at +25°C ambient.
ELECTRICAL CONTACT ANGLE: 356° standard. (Any winding angle up to 360° on order).
MECHANICAL SHAFT ROTATION: 360° continuous.
TORQUE: Starting torque for 6-section unit: 1.2 oz.-in.
TEMPERATURE RATING: Operating range from −55°C to +71°C ambient.
ACCELERATION: Will function during acceleration of 50G, applied along any axis.
WEIGHT: 4 oz./section.

the Giannini *Gangpots* multiple potentiometers



MODEL 85193

Compact-rugged-accurate. A smaller version of the GANGPOT without the phasing feature. Diameter 1⅛"; ¼" shaft; aluminum housing; 500 to 70,000 ohms per section; 1 to 6 sections; body length 3.5" max.; dual mounting; linear or non-linear windings up to 360° available.

SPECIFICATIONS

RESISTANCE: 500 to 70,000 ohms/section ($\pm$5%).
LINEARITY: $\pm$0.5% of total resistance.
POWER RATING: 2 watts per section at +25°C ambient.
ELECTRICAL CONTACT ANGLE: 354° standard (Any winding up to 360° on order), with the brush non-shorting.
MECHANICAL SHAFT ROTATION: 360° continuous.
TORQUE: Starting: less than 0.6 oz.-in. for a 6-section unit.
TEMPERATURE RATING: Operating range from −54°C to +71°C ambient.
ACCELERATION: Will function during acceleration of 50G, applied along any axis.
WEIGHT: 1 oz. per section.

For modifications of standard specifications, please forward requirements.

Specifically designed and built to performance standards far beyond present concepts of potentiometer design, GANGPOT Instrument-Quality potentiometers are ready to solve multiple potentiometer problems. Rugged, aluminum-housed units with low torque, high performance, and long-life accuracy, GANGPOTS are presented in two sizes to fill all requirements. GANGPOT EXTRAS include solid, stainless steel shafts, toroidally wound coils for up to 360° windings, shielded ball bearings, syncro or screw type mounting, and adaptability to non-linear functional windings. Built without any bulky external bolts, clamps or rings, the GANGPOTS lend themselves to an unsurpassed versatility of design applications.

For catalog and engineering data on these and other fine instruments write:

Giannini INSTRUMENT QUALITY POTENTIOMETERS

G. M. GIANNINI & CO. INC., PASADENA 1, CALIFORNIA—EAST ORANGE, NEW JERSEY

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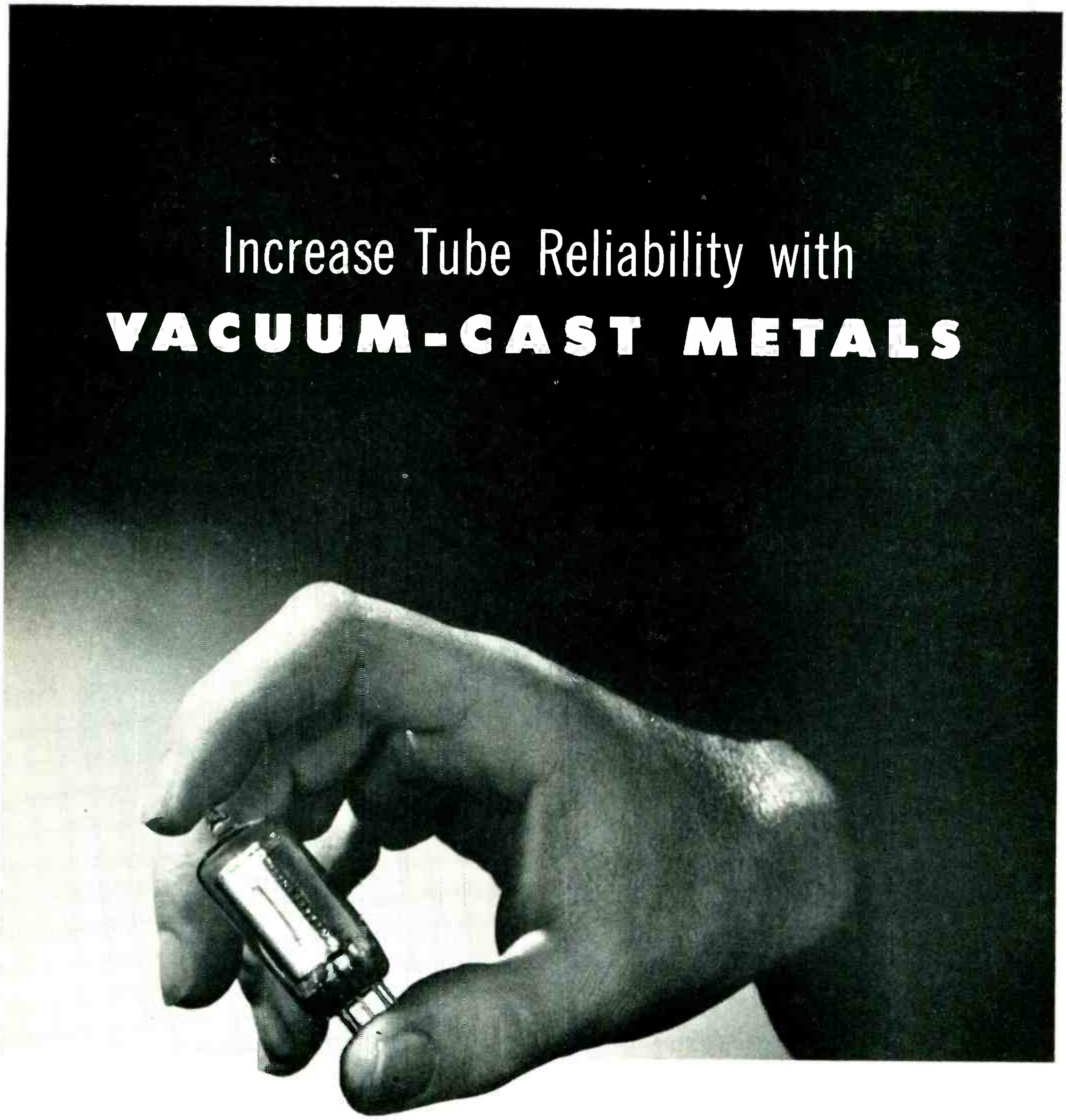

Vacuum-melting removes gases and oxide inclusions from metals . . . makes them less porous, so they won't absorb or emit gases.

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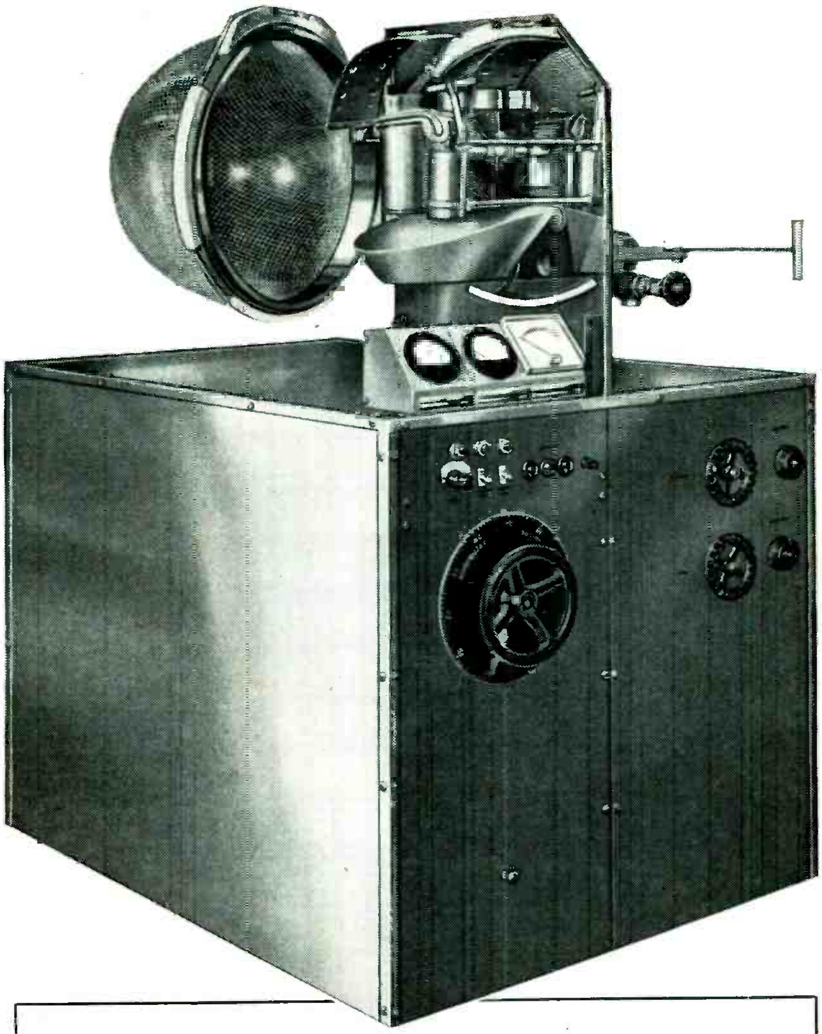

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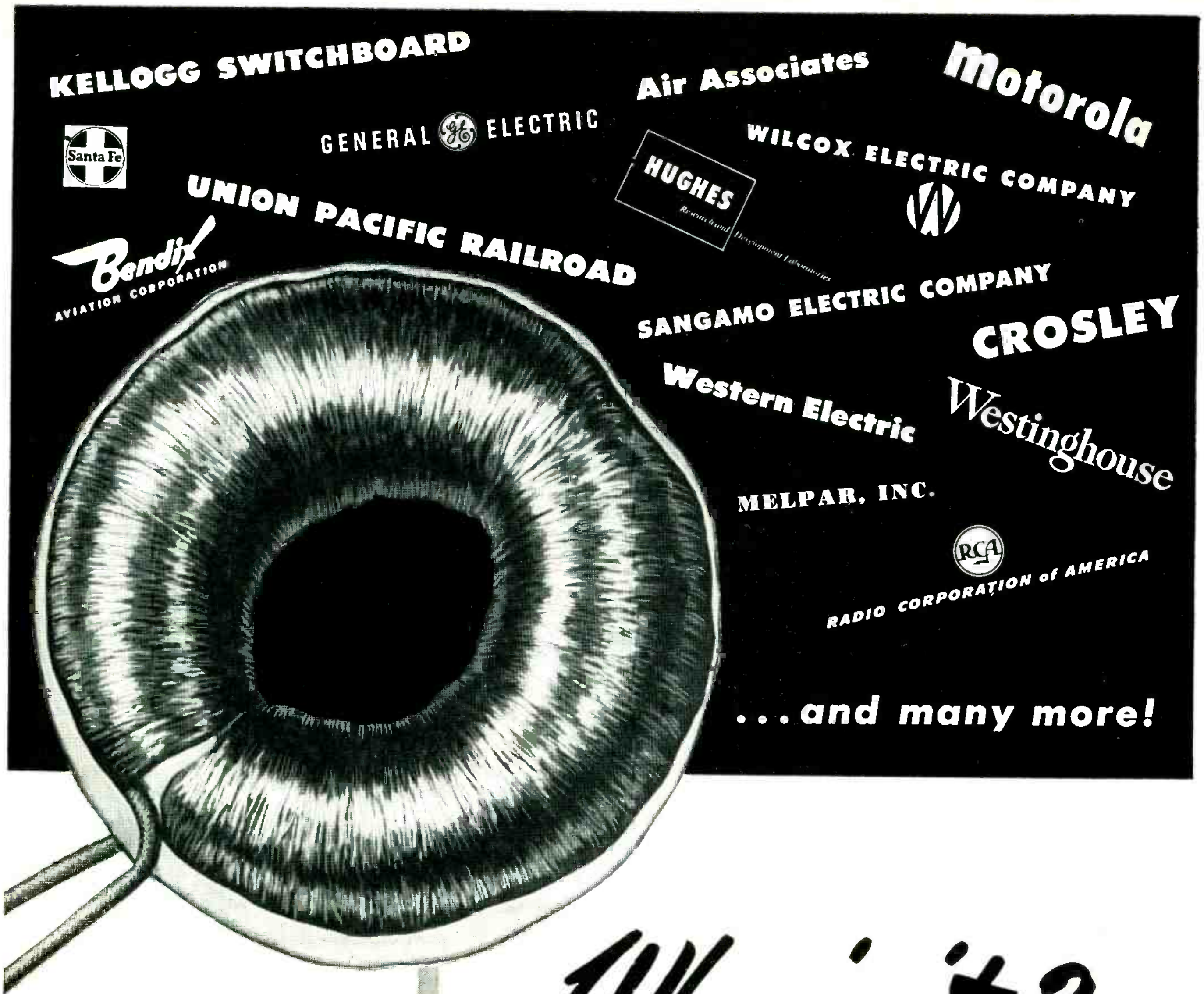

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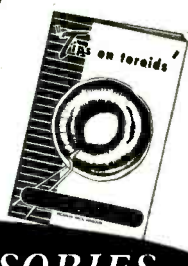

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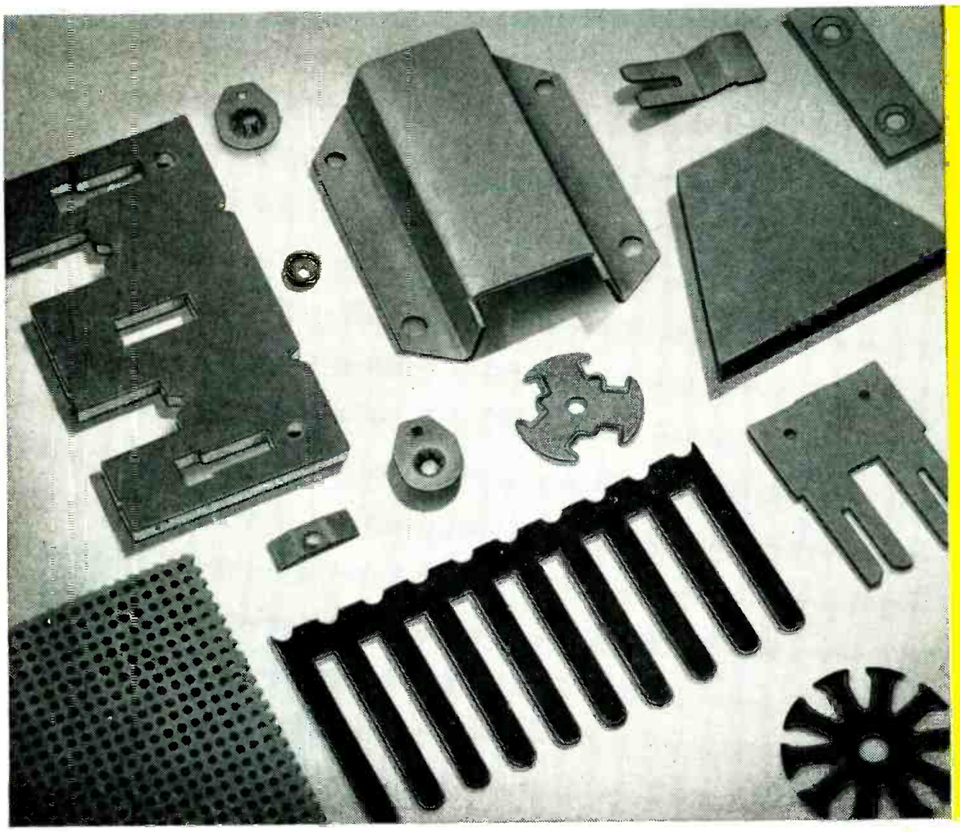

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CROSS TALK

▶ **TRIO** . . . Long-range prospects for electronics are excellent. We are living in an age of almost unlimited power (atomic energy), and unlimited speed (jets). To utilize these two things we need unlimited control, and control is where electronics shines.

▶ **SPACE** . . . There are two schools of thought among reputable scientists relative to space travel. One believes that man will contrive practical space stations, eventually reaching distant celestial bodies, and the other does not.

One thing, at least, is certain. If and when man does leave his natural habitat the vehicle he uses will depend heavily upon the science of electronics for navigation, communication and many other things not yet fully visible. Man may, in effect, ride electronics to the moon.

▶ **TIMETABLE** . . . Several experimental television receivers of different makes have just been tested on NTSC color signals at a Long Island laboratory. The results were good.

Early in April these same receivers, augmented by several more obtained from still other manufacturers, are scheduled to be put through their paces in Syracuse. Then they will be tried out again, in Philadelphia.

The timetable is subject to change without notice but it does seem that the system could be ready for demonstration before the FCC this summer, and perhaps as early as June.

▶ **WORKMANSHIP** . . . Modern design plus mass production can provide low-cost electronic equipment capable of giving good service. Much still depends, however, upon personal care during assembly and, particularly, the conscience of inspectors at the end of the line.

Somehow, we've gotten the impression that an unusual number of casually-put-together items are currently being sold. Two ceramic trimmer capacitors were picked up at retail; one entirely lacked threads for the adjustment screw. Of three simultaneously purchased toggle switches one was defective. Two trips were necessary to buy one good transformer. A microphone fresh from the shipping carton proved intermittent due to soldering flux under riveted lugs.

Maybe we're just unlucky. Or maybe pride in good workmanship has momentarily declined to a point where not even the fanciest test procedures can catch all the bugs.

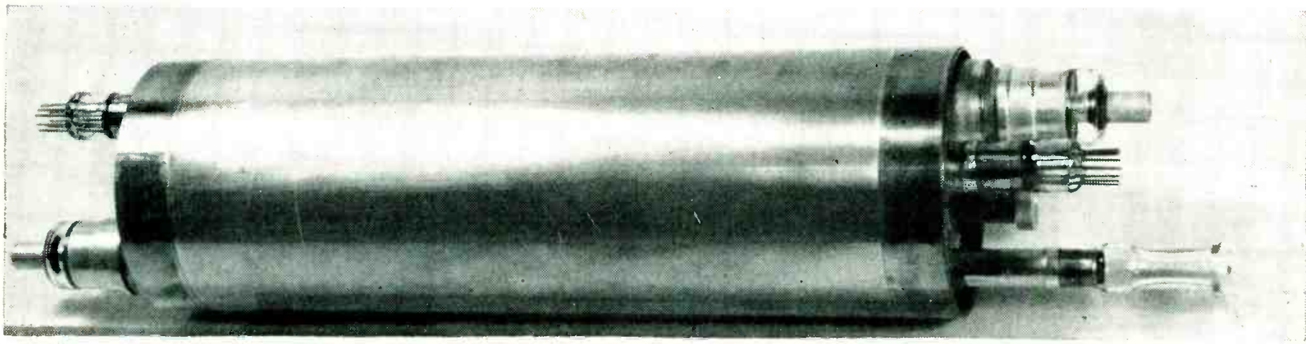
▶ **DETROIT** . . . Car manufacturers tell us it is only a question of time when most American automobiles will be equipped with 12-volt electrical systems; increasing load is almost more than 6-volt batteries of reasonable size can stand despite numerous improvements.

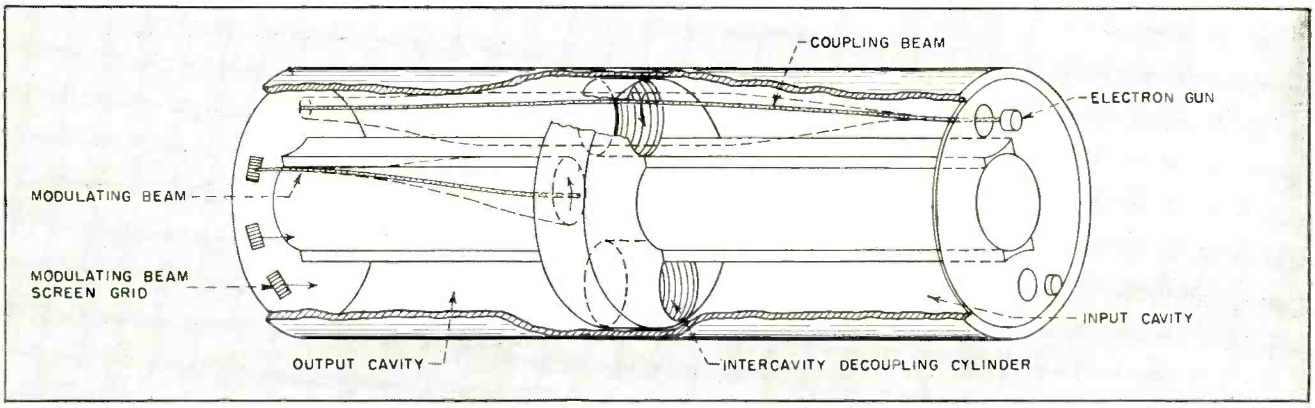
It may take several years, but the market for 12-volt mobile electronic equipment and accessories is destined for expansion. Use of raised voltage and lowered amperage has many virtues. Smaller, lighter high-voltage power supplies handle a given load faster and easier, are much less critical with respect to input-circuit wire size. There could be some new troubles with regulation, but car makers say that they are aware of this and are working on it.

▶ **SHOPTALK** . . . Since 1944, all ELECTRONICS' feature articles have been published on sequential full pages. There is no "turnover", no "continued" line, no interleaved extraneous material to complicate reference to illustrations.

We wonder how many of our readers realize that this policy, which involves considerable editing trouble and substantial cost, is by no means common in commercial publications.

▶ **CONSERVATION** . . . It is said that one manufacturer of envelopes for television picture tubes has contributed substantially to the defense program by taking the lead out of its glass.





Electron coupler is 18 in. long by 5½ in. in diameter. Details shown in cutaway include the two coupling-beam electron guns and three of the five modulating beams. Coupling loops are not shown

Spiral-Beam Tube

Multibeam electron coupler may be useful in ultrahigh-frequency television transmitters. Tube has excellent linearity, 5-mc bandwidth and 50-percent transfer efficiency. Five parasitic electron beams in output circuit control power transfer to load

By C. L. CUCCIA

Radio Corporation of America
RCA Laboratories Division
Princeton, N. J.

DESIGNED to operate at the 1-kw level in the 800-mc range, the multibeam electron coupler is an improved spiral-beam modulation tube suitable for use in uhf television. When placed between generator and load, the electron coupler presents a constant impedance while permitting control of power to the load. The tube uses coaxial-line cavities and has five modulating electron beams in the output circuit. It possesses excellent linearity characteristics, a bandwidth in excess of 5 mc and a 50-percent transfer efficiency.

Use of auxiliary electron beams in the output cavity of the tube provides a modulation method whereby a 50-volt modulator grid swing can control power output over a range of 98 percent of maximum. This is seen as a great improvement over the performance of single-beam electron couplers[1,2]. A single-beam tube operated at 775 mc with a beam current of 50 milliamperes and an input-cavity po-

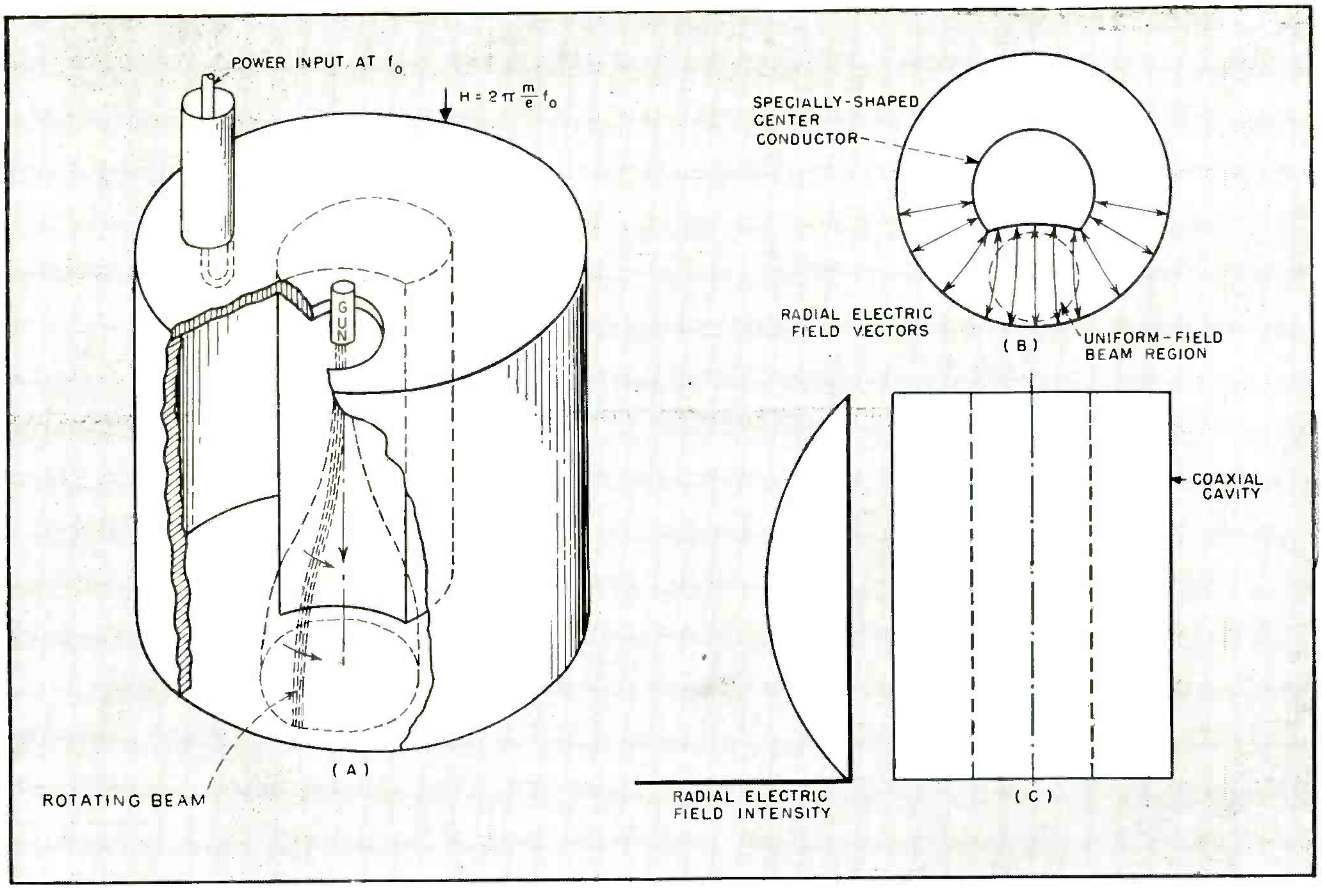


FIG. 1—Rotating coupling beam in coaxial cavity has milk-bottle shape (A). Transverse electric field is uniform in beam region due to specially-shaped center conductor (B) and varies sinusoidally along axis of cavity

Modulates 1 KW at UHF

tential of 650 volts, using transit-time control, required a voltage swing of nearly 1,000 volts to achieve the same depth of modulation.

In the multibeam electron coupler, the auxiliary beams work both to absorb power and to create a mismatch between the tube and its output load, thereby making the amount of power transferred to the load a function of the auxiliary beam current.

Coaxial Cavity

Auxiliary-beam modulation is capable of producing high-level amplitude modulation. This can be accomplished in the tube to be described only by auxiliary-beam currents of from one-half to one ampere. To accommodate these currents, it is convenient to utilize resonant coaxial cavities. The use of coaxial cavities in an electron coupler also yields advantages in header construction and suitability for use with electromagnets.

Consider the case of an electron beam sent through a coaxial cavity whose center conductor (Fig. 1B) is shaped to produce a transverse, alternating, electric field of suitable rectilinearity in the path of the electron beam. Such a cavity is illustrated in Fig. 1A. In this cavity the transverse electric field varies sinusoidally along the path of the electron beam.

Let a magnetic field be placed parallel to the path of the electron beam and let the operating frequency be adjusted to the cyclotron frequency

$$f_o = 2.794H \times 10^6 \quad (1)$$

where H is magnetic field intensity in gausses and f_o is frequency in cycles per second.

If the length of the cavity is $L/2$, then the deflection, X, of the directrix beam at some distance l through the cavity is

$$X = \frac{2.36}{\pi} \frac{E}{V_b^{1/2} f_o} \frac{L}{2} \left(1 - \cos 2\pi \frac{l}{L}\right) \times 10^6 \quad (2)$$

where E is the peak value of the transverse electric field in volts per centimeter, V_b is the beam voltage in volts, f_c is frequency in cycles and l and L are in centimeters.

Coupling-Beam Shape

Because the cyclotron frequency is used as the operating frequency, the electrons all have the same azimuthal angle at any instant, thereby causing the electrons to form a directrix beam. However, unlike the cone-directrix beam formed in vane-cavity electron couplers, the directrix beam in a coaxial cavity will have a milk-bottle shape as shown in Fig. 1A. This shape is described mathematically by Eq. 2.

The reason for the milk-bottle shape is readily understood. As the electrons enter the coaxial cavity, the transverse field intensity is initially zero. As the electrons pass through the cavity, encountering the sinusoidally varying field, the greatest contribution to the spiral radii is obtained near the center of the cavity where the peak transverse electric field is maximum. This causes the rapid increase in X in this region as illustrated in Fig. 1C.

Power into a rotating directrix beam in a coaxial cavity of length $L/2$ is expressible in either of two forms[1]

$$P = \frac{1}{8\pi} \frac{I_o}{V_b} E^2 \left(\frac{L}{2}\right)^2 \qquad (3A)$$

$$P = 1.768 \times 10^{-2} \times f_c^2 \times I_o \times X^2 \qquad (3B)$$

where I_o is the beam current in amperes and V_b is the d-c beam voltage. Equation 3 shows that if peak alternating electric field strengths are equal, the power absorbed by a directrix beam in a coaxial cavity is $2/\pi$ times that absorbed in a cavity with an axially uniform field. The resistance in ohms presented by such a beam in a coaxial cavity is

$$R = d_1^2 E_1^2 / 2P = 16\pi\ V_o/I_o\ (d_1/L)^2 \qquad (4)$$

where d_1 is separation between pole faces in centimeters.

Once the power given by Eq. 3 has been absorbed by the rotating beam, it can be utilized for electron coupling. Were the cavity to be closed as shown in Fig. 1A, this power would be dissipated at the end of the cavity in the form of heat. However, if the rotating beam is passed into a second cavity, the rotational energy contained in the beam can be used to excite the second cavity.

This principle is used in the spiral-beam tube. Two coaxial cavities, each with a suitably shaped center conductor, are placed end to end. Two round apertures are installed between the cavities to allow two electron beams to enter and pass through the second or output cavity after traversing the input cavity.

Secondary-Cavity Modulation

As the electrons pass through the intercavity space after emerging from the input cavity, no energy is imparted to or extracted from them since no transverse electric fields are present. Each electron pursues a helical path through the intercavity space at a transit velocity prescribed by the beam potential. Therefore, the electrons enter the output cavity with the same spiral radius with which they emerged from the input cavity.

As the rotating electron beam passes through the output cavity, a current[1] is induced in the load of the output system because the electrons represent an oscillating space charge with periodicity, f_c, between the pole faces. The product of this induced current and the load resistance will yield the r-f voltage across the pole faces.

If the load, R_o, exists across the output cavity boundaries, it can be shown that all of the rotational power in the beam can be extracted when

$$R_o = 16\pi\ V_b/I_o\ (d_o/L_o)^2 \qquad (5)$$

I_o is the optimum value of coupling-beam current that will accomplish the matching suitable for complete transfer of input power to the output load; V_b is the beam voltage in the output cavity and d_o and $L_o/2$ are respectively the pole-face width and length in the output cavity. For this particular value of coupling beam load and current, the beam-configuration in the output cavity will be an exact image of the beam-configuration in the input cavity, that is, the milk-bottle directrix having maximum radius at the entrance to the cavity and zero radius at the exit or collector.

When an auxiliary beam of magnitude I_M is injected only through the output cavity, the beam will present the resistance

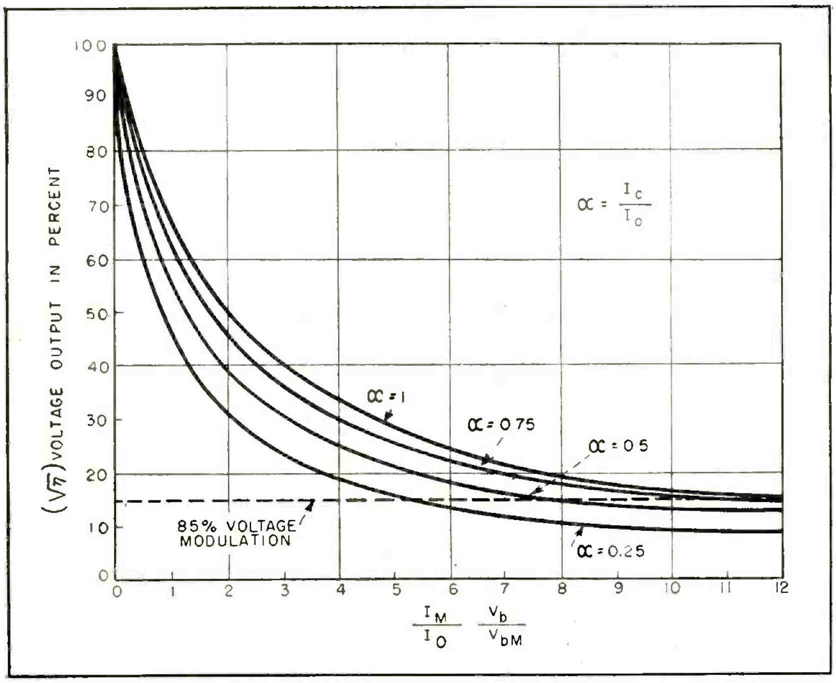


FIG. 2—Voltage output is function of optimum coupling-beam current, modulating beam current and operating parameters of tube

$$R_M = 16\pi\ V_{bM}/I_M\ (d_o/L_o)^2 \qquad (6)$$

where V_{bM} is the difference in potential between the output cavity and the auxiliary-beam cathode. Resistance R_M will be in shunt with load resistance R_o forming a combined load R_C where

$$R_C = R_M R_o / R_M + R_o \qquad (7)$$

Consider now the power transfer efficiency, η, where

$$\eta = \frac{\text{r-f power into } R_c}{\text{r-f power into input cavity}} \times 100$$

If the coupling beam is matched to the output cavity when the auxiliary-beam current is zero,[1]

$$\eta = 4\gamma/(1+\gamma)^2 \times 100 \qquad (8)$$

where

$$\gamma = R_C/R_o \qquad (9)$$

Mismatch

As the auxiliary beam current is turned on and increased in value from zero, the output cavity experiences a mismatch between the coupling beam and the combined load presented by the combination of the output load and the shunting resistance due to the auxiliary beam. This mismatch results in a decrease in transfer efficiency. The power goes to three sinks[1]—output load, auxiliary beam and collector, rather than to the output load alone. To illustrate load mismatch and output cavity-auxiliary beam modulation, consider the following cases that follow from Eq. 8:

Case A—When the auxiliary beam is off, $R_M = \infty$, $\eta = 100$ percent.

Case B—When the auxiliary beam is turned on such that $R_M = R_o$, the transfer efficiency is reduced to 88 percent leaving 44 percent of the power available to the output load.

Twelve percent goes to the collector and 44 percent to the auxiliary beam.

Case C—When the auxiliary beam is adjusted such that $R_M = 1/10\ R_o$, transfer efficiency is 30 percent. Seventy percent of the total power goes to the collector; 27.28 percent goes to the auxiliary beam and only 2.72 percent reaches the output load. This corresponds to 97.18 percent power modulation and demonstrates the capabilities of the output cavity-auxiliary beam modulation method.

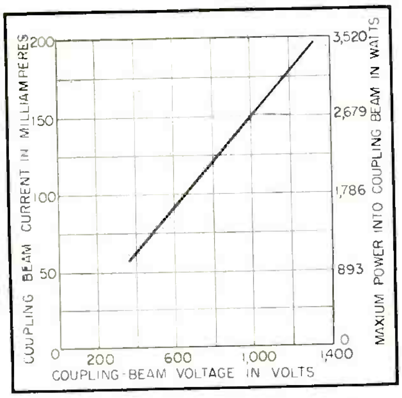


FIG. 3—Input cavity presents match to 50-ohm line over wide range of coupling-beam current and voltage

The preceding discussion presupposes the coupling-beam current at optimum value, I_o, which is related to the load R_o, by Eq. 5. However, it is expedient to increase the depth of modulation for certain ranges of performance by operating with a coupling-beam current differing in value from I_o. This is illustrated in the general case when some arbitrary value of coupling-beam current, I_c, is related to the optimum coupling-beam current by

$$I_c/I_o = \alpha \qquad (10)$$

Using Eq. 5 and 6 the ratio R_o/R_M can be expressed in terms of the optimum coupling-beam current and the auxiliary-beam current as

$$R_o/R_M = I_M/I_o \cdot V_b/V_{bM} \qquad (11)$$

It follows[1] that the relationship between percent voltage output $\sqrt{\eta}$, α, I_M and I_o is that shown in Fig. 2. The ratio V_b/V_{bM} will be a constant depending upon the operating parameters of the tube.

Depth of Modulation

Modern practice in commercial transmission requires a depth of voltage-modulation of 85 percent, which corresponds to 97.75 percent power modulation. With a source of auxiliary-beam current capable of yielding twelve times the magnitude of the optimum coupling-beam current, this depth of modulation can be achieved for $\alpha = 1$. However, as seen from Fig. 2, if values of α down to 0.5 are chosen, it is possible to achieve this depth of modulation with less auxiliary-beam current without too great a sacrifice of power-transfer efficiency at the peak power. However, the auxiliary-beam voltage must be sufficient to yield the required modulating current.

Mechanical Design

The developmental multibeam electron coupler operates at 800 mc. It is a seven electron-beam tube using output cavity-auxiliary beam modulation and coaxial cavity construction.

Two of the seven beams are coupling beams passing the entire length of the tube. Each coupling-beam gun is capable of 200 milliamperes, produces a cylindrical beam ⅜ in. in diameter and traverses an electric field region having boundaries 1½ in. apart. The power-handling capabilities of such a tube at 800 mc using all 400 milliamperes of coupling-beam current, with a practical grazing limit set at 1.25 centimeters, may be calculated using Eq. 3

$$P = 1.768 \times 10^{-2} \times 800^2 \times 0.400 \times 1.25^2 = 7{,}072 \text{ watts} \qquad (12)$$

Actually, considerations arising from the method of modulation place severe restrictions on this magnitude.

Auxiliary-Beam Guns

Five electron-beam guns are installed in such a way that the electrons from these guns traverse only the output cavity. Each gun is a screen-grid-beam type similar in cathode and grid construction to the design used in the 6L6. Each output-cavity gun yields a rectangular beam, $\frac{5}{32} \times \frac{7}{32}$ in., capable of producing, at several hundred volts effective plate potential, a beam current of 120 ma at zero grid bias. Beam current can be reduced to zero by approximately minus 50 volts on the control grid. All five auxiliary beam guns acting simultaneously are capable of yielding up to 650 ma.

The multibeam electron coupler based on the coaxial design is pictured in the photograph. The tube is cylindrical, using header construction which leaves the sides of the tube free of protuberances. Design is such that the tube is suitable for use with solenoidal magnets and water-cool-

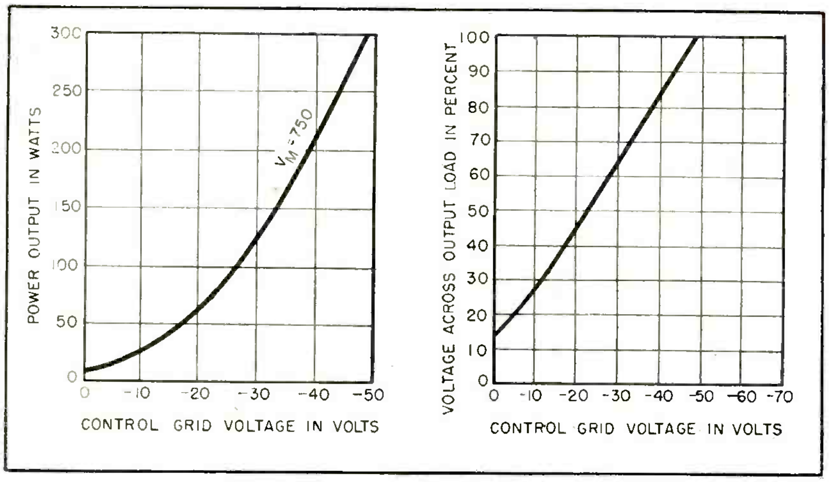


FIG. 4—Power and voltage outputs versus control-grid voltage for peak power output of 300 watts, corresponding to 750 volts beam voltage

ing rings. Only the output cavity is tuned, the input cavity frequency being fixed at 800 mc. The tube is approximately 18 in. long and 5½ in. in diameter. The main body of the tube is copper, with monel end rings atomic-hydrogen welded to monel rings on the headers.

Experimental Performance

The input cavity should present a matched or mismatched load to the driving magnetron depending upon what operating point is desired. It is important that this match or mismatch be constant. The match will be a function of four system parameters provided that the frequency involved is the cyclotron frequency. These parameters are:

(1) The coefficient of coupling of the coupling loop and the associated parameters that transform the impedance of the beam in the beam space to that of the termination of the transmission line to the electron coupler.

(2) The coupling-beam current.

(3) The coupling-beam voltage in the input cavity.

(4) The peak-power input, which should be substantially under the value that would cause electrons to graze on the pole faces and be lost to the output cavity.

By making suitable choices of parameters, the input-cavity system presented a match to the driving transmission line during operation over the ranges of coupling-beam currents and voltages described in Fig. 3. Match was obtained over a wide range of usable current values up to 200 milliamperes at 1,250 volts. Included in Fig. 3 are calculated values of maximum power that can be handled by the coupling beam having the values of I_o and V_b prescribed by the experimentally observed curve.

The transfer efficiency of the multibeam electron coupler was found to be about 50 percent, as contrasted with the transfer efficiency of 70 percent obtained with the single-beam electron coupler[2]. This decrease in transfer efficiency is attributable to the length of the beam path and to the lack of exact parallelity of magnetic field lines over the entire beam path as a result of the use of solenoidal magnets rather than an electromagnet.

Input

The tube was operated with a top power input of one kilowatt. Up to 650 milliamperes was available from the five auxiliary beam guns with $V_{bM} = 750$ volts and a grid swing of $0 < e_g < -50$ was required to swing the auxiliary beam current from maximum to zero. In a typical d-c operating run, the multibeam electron coupler was first adjusted to $I_o = 165$ milliamperes and $V_b = 1{,}150$ volts, corresponding to a maximum power of 3,410 watts, achieving thereby a match for the 50-ohm line (Fig. 3). Since this would have required a total auxiliary beam current of almost two amperes for 85 percent depth of voltage modulation it was found expedient to mismatch the coupling beam and the output load.

The coupling-beam current was reduced to 60 milliamperes, corresponding to a maximum power into the beam of

$$P = 1.768 \times 10^{-2} \times 800^2 \times 0.060 \times 1.25^2 = 1{,}062 \text{ watts} \quad (13)$$

The parameters yielding the depth of modulation are

$$\alpha = \frac{60}{165} = 0.364 \quad (14)$$

$$V_b / V_{bM} = 1{,}150/750 = 1.532 \quad (15)$$

$$I_M / I_o = 650/165 = 3.94 \quad (16)$$

$$I_M / I_o = V_b / V_{bM} = 1.532 \times 3.94 = 6.04 \quad (17)$$

These values substituted into the curves of Fig. 2 give 15.5 percent. In the actual experimental test, this depth of voltage modulation was almost exactly corroborated.

Output

The actual power output and voltage runs for a peak output of 300 watts are shown in Fig. 4. This power corresponds to a beam voltage of 750 volts. It is evident from Fig. 4B that the linearity of the output voltage as a function of modulating-grid voltage is excellent.

The bandwidth of the modulation system was examined by impressing on the control grids of the auxiliary-beam guns a signal of known amplitude whose frequency was continuously variable from 100 kc to 5 mc. The output of a diode detector inserted into the transmission line at the output load was detected and viewed on an oscilloscope. The response of the system was found to be substantially independent of frequency up to and beyond 5 mc. This result was independent of the depth of modulation of the auxiliary-beam modulation system.

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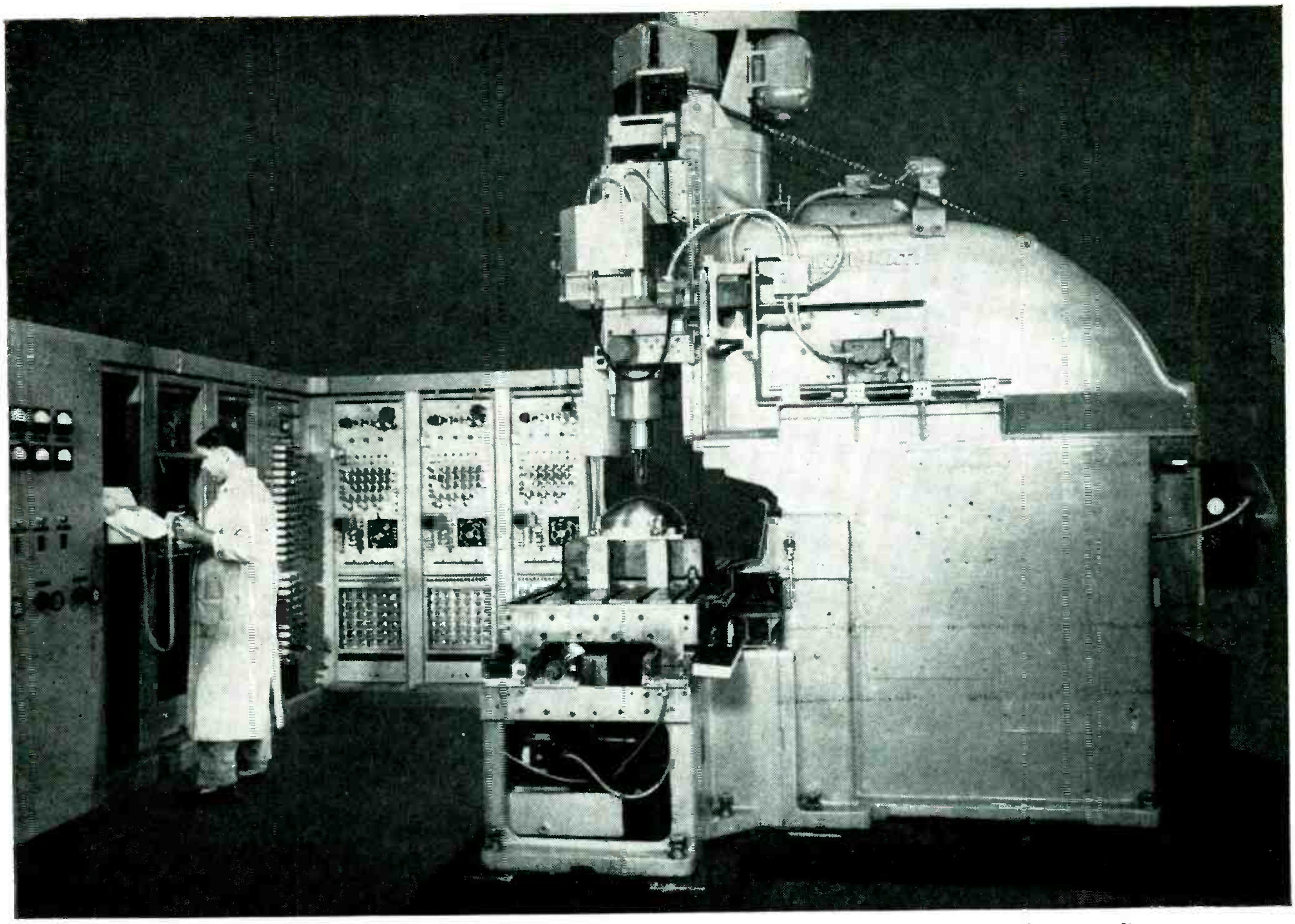

Cincinnati Hydro-Tel, automatic 28-inch vertical milling machine, is controlled by 250-tube electronic director

Punched Tape Guides Milling Machine Cutters

Modern information handling and feedback control techniques may eliminate costly and time-consuming setup procedures in metal-trades industry. Automatic vertical milling machine cuts out each piece in response to instructions punched in paper tape

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In certain metal-trades industries, notably aircraft manufacturing, automatic production of machined parts may be relatively costly and inefficient. Many different parts are required and production runs are characteristically short. A skilled machinist is needed to set up the machine each time a new part is manufactured. Often expensive jigs and fixtures and specially-designed cutting tools are required for a particular part.

Numerical control can eliminate these costly change-overs by providing prearranged machine setups that can be changed much as a phonograph record is changed. Machining information is reduced to a series of numerical specifications appropriate to the machine tool. Milling machine work is described as a series of cuts in Cartesian coordinates; lathe work is specified in cylindrical coordinates. The numerical specifications are then tabulated and transferred to some permanent information-storage medium such as punched cards, punched tape or magnetic tape. A machine tool equipped to read and act upon the stored information may then machine the piece. All that is required for a different part is a new tape.

Control System

Operation of the numerically-controlled milling machine shown in the photograph may be explained with the aid of the functional block diagram in Fig. 1. The data input system reads the punched paper tape containing the machining information and arranges the information appropriately in storage. The input system consists of a tape reader, stepping-switch data distributors, a set of relay storage registers, and appropriate control systems.

The data-interpreting system interpolates between the points on the work that are specified explicitly on the tape. It comprises a pulse generator and an electronic pulse distributor.

The decoding servomechanisms convert the numerical information to an equivalent analog form, while the power servomechanisms control the motions of the machine tool itself.

There are three power servomechanisms to control the motions of the head, table and cross slide. The power servomechanism controlling the table is shown schematically in Fig. 2. The system consists of a hydraulic rotary transmission driving a lead screw and controlled by synchro signals. Identical units drive the head and cross slide. The power servomechanisms are designed for high stiffness of output and as low a bandwidth as possible to prevent chattering under machining loads. Approximately $\frac{3}{4}$ horsepower is required.

Interpolation

Choice of an interpolation function determines in great measure the cost, complexity and convenience of the machine. The simpler the machine's interpolation function, the more input data is required for any job. In the extreme case, if the machine has no systematic interpolation function, data must be provided for every point on the finished work. For a machine capable of handling workpieces 60 inches long and 30 inches wide, some form of interpolation appeared to be highly desirable. While curvilinear interpolation might have allowed a great saving on input data, it could be built into the machine only at the cost of highly complex special circuitry. A linear interpolation function was adopted as a compromise.

Operation of the interpolator in response to each command on the tape results in a constant feed rate at the milling machine in each machine axis. The vector summation of the three constant feed rates causes the tool to move over the work in a straight line. To achieve this result, the interpolator transmits to each axis a counted number of pulses at a repetition rate proportional to the desired feed rate. Each pulse indicates that the machine should move 0.0005 inch. The number of pulses thereby controls the distance through which the machine should move, while the repetition rate controls the feed rate.

The interpolator also synchronizes the three pulse trains so that the three machine axes start and stop together. Thus the output of the interpolator is a series of sets of three pulse trains, each set directing the machine tool along some straight line in space. The number of pulses in each train and the time interval during which each set of trains should run are determined by the information in storage.

Digital-to-Analog Converter

Since the power servomechanisms use a synchro data system, the converter must be capable of driving a synchro; it must have an output in the form of a shaft rotation. The interpolator produces a series of pulses each representing a unit of desired motion. The converter must accept as its input a pulse train on either of two lines. Since the machine tool must always be accurately located in space and the pulses form the only converter input, the converter itself must maintain an accurate count of the total number of pulses received and insure that its output shaft position, except for transient disturbances, always indicates the correct total number, regardless of how long the run is.

A schematic block diagram of the digital-to-analog converter is shown

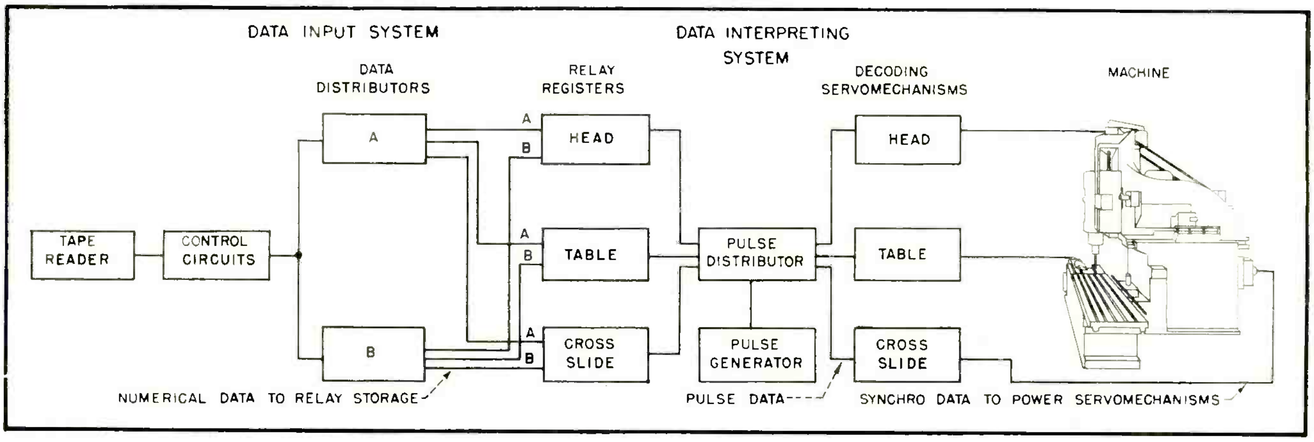

FIG. 1—Tape reader and digital-to-analog converter supply synchro data to power servomechanisms. Orthogonal motions of table, head and cross slide can produce any desired cut

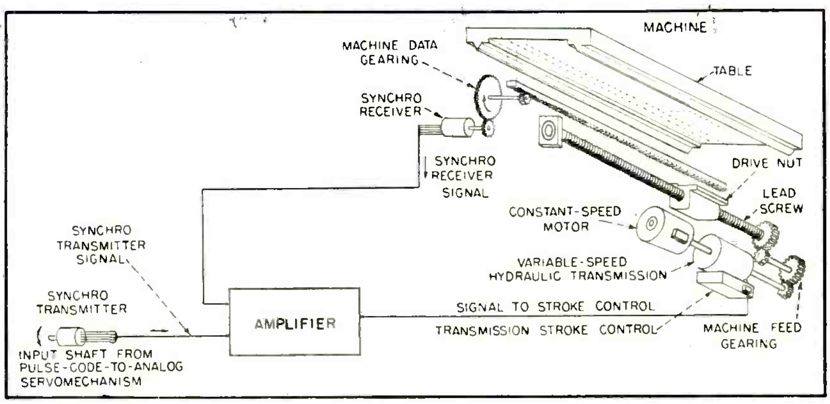

FIG. 2—Power servomechanism controlling table motion consists of synchrocontrolled hydraulic rotary transmission driving lead screw. Identical units control head and cross slide

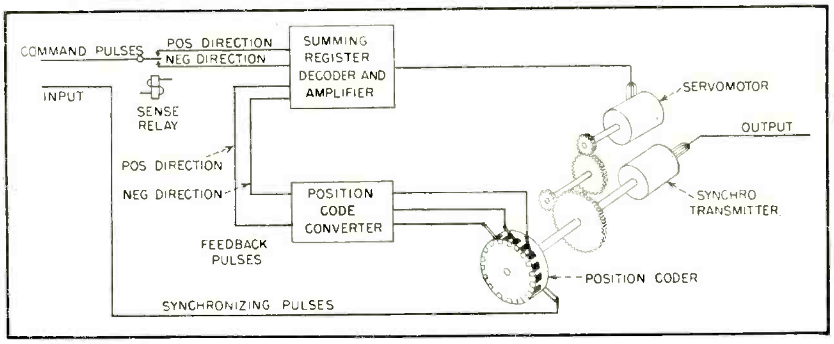

FIG. 3—Digital-to-analog converter changes input pulse data to equivalent shaft rotation. Commutator-type coder wheel generates feedback pulses for checking

in Fig. 3. It contains an instrument servomechanism whose output shaft, driven conventionally by a 60-cycle, two-phase induction motor, carries a commutator-type coder wheel upon which three brushes ride. These brushes allow an electronic unit with which they are associated to generate and transmit a pulse whenever the wheel rotates through an angle of one degree. The pulse is transmitted on one line whenever the rotation is clockwise and on another whenever the rotation is counterclockwise. Exactly 360 pulses are generated for every complete revolution of the wheel. Thus the total rotation of the wheel is always given by the total number of pulses. The system is designed so that these feedback pulses are never coincident with possible output pulses from the interpolator. Hence it is possible to feed both sets of pulses into a reversible counter that will then maintain a running count of the total number of interpolator pulses, less the total number of feedback pulses. This count, which measures the degree to which the converter output differs from its total input, is used to generate the error voltage for the servomechanism. The polarities and connections are such that the servomechanism always tries to rotate the coder wheel in whichever direction will bring the error count to zero.

Use of this type of servomechanism for numerical-to-analog conversion provides several features of importance. In the first place, it permits the actual direct decoding of a numerical signal into an analog signal to take place in the error channel of a servomechanism where the magnitude of the signal is always a small fraction of the total signal handled by the servomechanism. In the second place, inaccuracies in this conversion affect only the gain, not the positional accuracy of the servomechanism. Lastly, the dynamic characteristics of a servomechanism may easily be adjusted to provide whatever smoothing or filtering may be required in the interpolator output.

Operation

A summary of the components of the entire machine indicates the nature of the input information required for the operation of the machine. Each of the three motions of the machine is driven by an independent hydraulic power servomechanism in response to rotations of a control synchro. Any machine motion in space may be achieved by simultaneously rotating a combination of the three control synchros. Each of the three synchros is rotated by a decoding servomechanism in response to a pulse train from the interpolator. The desired combination of three rotations is achieved by separately controlling the pulse repetition rate of each pulse train so that the desired total number of pulses is transmitted to each axis in the specified time interval. Eight different time intervals from 2 seconds to 4¼ minutes are available. Thus, during each time interval the machine's cutting tool moves in some straight line with respect to the work. The interpolator receives from the data system numbers spefying the time interval and the three distances, which are, therefore, merely the three orthogonal components of the straight line along which the tool is to pass. These numbers come from the tape.

To prepare the tape, the programmer need merely describe numerically the desired tool path over the work in a series of straight-line increments, and punch the three components of each straight line in order on the tape. Preliminary operation on actual machined pieces indicates that in some cases the production of a single piece by numerical control shows savings when compared to previous toolroom methods. In almost all of the cases studied to date, the cost of tape preparation is recovered after fewer than five pieces have been run.

Acknowledgment

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TRANSISTORS: Theory and Application

Energy Levels in

Part II

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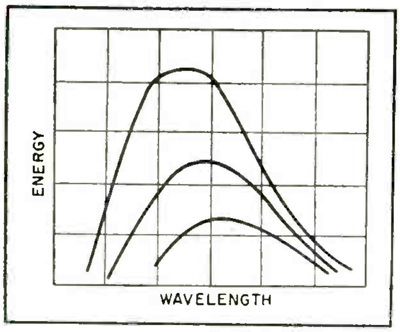

FIG. 1—Black-body radiation curves, showing variation of energy with wavelength. Energy increases with absolute temperature, and the peaks shift toward the shorter wavelengths

IN THE FIRST article of this series an approximate explanation of transistor action was given. This introductory treatment of transistor theory demonstrated that the field of transistors is intimately connected with the study of solid materials in general, and with semiconductors in particular. The principles governing the behavior of solid materials are collectively referred to as solid-state theory.

Semiconductors

Like any other specialized branch of the sciences, the field of semiconductors uses its own terms and definitions. This nomenclature cannot be explained in all cases by using the concepts normally encountered in electronics. New and very general concepts which describe the basic behavior of matter and energy must be introduced to aid in explaining clearly the terms commonly used in semiconductor and transistor work.

As an illustration, in the study of transistors it is difficult to avoid the use of such terms as *energy levels*, *forbidden bands* and *quantum states*. The explanation of these terms may be more readily understood if the reader is first introduced to the fundamental principles of quantum mechanics.

Black Bodies

Consider an air-tight box whose inside walls are lined with a thick layer of felt. Over the felt has been deposited a heavy, uniform layer of lampblack to provide a smooth, flat inside surface. Such an enclosure absorbs all the frequencies in the light or visible range and reflects none and is called a black body. It is significant in the field of physics because of all the absorbers known, a black body is the most perfect.

If energy in the form of radiation (heat or light) were introduced into this box through a tiny hole in one end, it would bounce back and forth from wall to wall ultimately being almost totally absorbed. The energy would merely raise the temperature of the black body. It can be shown that this simple structure is an ideal absorber and an ideal radiator.

Physicists have found that the behavior of the black body can be described in relatively simple mathematical terms.

By means of bolometers, physicists are able to measure minute amounts of heat or radiant energy. With single-color or single-frequency filters it is possible with the aid of the bolometer to determine the amount of energy contained in each frequency component of the radiation being studied.

The black body is the most perfect radiator known. Of all possible radiators, not only will the black body give off the maximum amount of radiant energy, but that radiant energy will contain the widest range of frequencies. A bolometer inserted in a tiny hole in the black body, for a given temperature of the black body, will show a variation or distribution of the energy with frequency as shown in Fig. 1.

Much can be said about these curves but it is actually not important for future applications in the study of transistors. The reader need merely note that these curves are obtained by a straightforward process from a simple and fundamental experiment.

The bolometer is capable of measuring temperature very accurately. The experiment described above can be made under careful control and with almost no special equipment. The distribution of black-body radiation was known to physicists as far back as the 1890's. The data was so accurate and fundamental that it was felt that if the physicists could explain the curves obtained, whatever theory of matter was proposed as a basis for the explanation stood an excellent chance of being the ultimately correct theory of the structure of matter.

Some of the outstanding physicists who lived about the year 1900 tried their hand at proposing a theory of matter on the basis of which an equation could be obtained involving the energies, the wavelength and the temperature which when plotted would give a curve

Transistor Electronics

Fundamental principles of quantum mechanics, as they apply to transistors, are described in easy-to-read language for electronics engineers and technicians with limited backgrounds in physics. Pertinent theories of Planck and Einstein are discussed

that would fit Fig. 1. These efforts were to no avail.

Planck's Theory

One of the physicists interested in this mathematical and physical problem was an obscure professor of thermodynamics named Max Planck. He came to the conclusion that one or more of the fundamental assumptions being made by these eminent physicists must be inadequate or entirely incorrect. Planck asked himself what assumption must be made, regardless of whether it was reasonable or not, in order that the theory of matter based on this assumption would lead to a mathematical expression to fit the curve.

Generally speaking, this kind of thinking is both unscientific and unwise. It is called an ad hoc theory, that is, it is a theory compounded to fit a specific set of facts and these facts only. While an ad hoc theory usually fits the facts, it is frowned upon by the scientific world. In nearly all such cases, it is not long before additional data are uncovered which the ad hoc theory, made to fit only a specific set of facts, fails to explain. For this reason, the physicists of the day paid little attention to Planck's hypothesis.

Planck found that he could write a mathematical expression to fit the curve of black-body radiation if he assumed that the moelcules of the material of which the black body was made, namely the molecules of the lampblack, would oscillate or vibrate under the action of the heat energy supplied. Each molecule thus became a generator of high-frequency energy or an oscillator.

Thus far his assumption was not different from that made by the other physicists. But Planck broke sharply from the assumptions made by the others when he said that these microscopic oscillators can generate energy only in integral multiples of a unit amount of energy which we shall call simply E (the least amount of energy that any oscillator could have would be E ergs or joules or any other unit of energy). Oscillators may generate $2E$, $3E$, $10E$, $72E$, and so on, but never, say, $2.5312E$ ergs or units of energy, or $3.5E$ units, or $7.7E$ units. In short, the basic unit of energy E can be multiplied by an integer, or a whole number only. When describing the energy of any other oscillator, all intermediate values of energy were arbitrarily omitted from further consideration in Planck's theory. This hypothesis received little immediate attention.

Photoelectricity

When light strikes certain surfaces, such as zinc, electrons are knocked out from the metal surface. If a metal plate is then placed near the metal surface in a vacuum and made positive with respect to the zinc plate, electrons will flow to the positive plate and an electric current can be detected. Phototubes are made that employ this principle.

It might seem perfectly reasonable that if the intensity of the light shining on the zinc plate is increased, the energy with which the light strikes the zinc atoms would be increased and the electrons knocked out from the zinc plate would have greater energy. This is entirely wrong.

The intensity of the light has no effect on the energy of electrons knocked out—it determines only the number of the electrons liberated from the zinc plate. To get higher-energy electrons out, the frequency of the light must be increased.

The fact that the higher energy electrons are freed by the higher frequencies of light was well known

TRANSISTOR QUANTUM MECHANICS

An acquaintance with quantum mechanics is prerequisite to thorough understanding of transistor electronics.

In this article the concepts of energy levels, energy bands, forbidden bands and quanta in general are discussed in basic language designed to be understood by electronics engineers and technicians whose knowledge of solid-state physical principles has been neglected because of long association with tube technology.

These principles, along with those of hole formation and transistor action presented in the first article of this series, are presented as groundwork for the more advanced theory and practical applications of transistors to be covered in subsequent article.

around 1905. As in the case of black-body radiation, physicists were unable to establish the mathematical relationship between energy and frequency. When quite a young man, Einstein tried to find this mathematical relationship. He found that if he applied Planck's idea about the energy imparted to the zinc plate by the light occurring only in integral multiples of a fixed unit of energy E, there was a possibility that he could supply a suitable equation. Planck, for this basic unit of energy, had written simply E is proportional to f, the frequency, or E = constant $\times f$.

This constant, which is now known as Planck's constant, is given by 6.6×10^{-27} erg sec, and is usually designated by the letter h. So the equation that Planck wrote for this basic unit of energy is

$$E = hf \qquad (1)$$

The unit of Planck's constant is erg seconds and that of f is cycles per second. In physics "cycle" is not a bona-fide unit and the units of frequency will usually be found to be given by "per second" or time^{-1}. Dimensionally

$$\begin{array}{ccc} h & f & = E \\ \text{erg secs} & \times \dfrac{1}{\text{secs}} & = \text{ergs} \end{array}$$

Starting with Planck's assumption and applying it to the photoelectric effect described above, Einstein wrote an equation which stated that the kinetic energy of an electron emitted from the photosensitive surface, $\frac{1}{2}\, mv^2$, is this Planck energy hf minus a constant w_o which depends on the nature of the photosensitive metal and is called a work function. Thus Einstein wrote

$$\tfrac{1}{2}\, mv^2 - hf - w_o \qquad (2)$$

This equation has been experimentally established as correct and accurate and provides a quantitative formula to explain adequately the photoelectric effect. However, a single application like this one does not prove a theory and the physicists of the time were not greatly impressed by an isolated success of so radical a theory.

Application of Theory

The reader is probably acquainted with the dispersion of light by a glass prism. White light

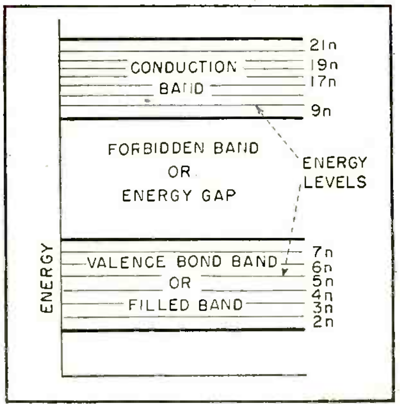

FIG. 2—Energy of a quantized particle, such as an electron. Only the ordinate is to scale. Figure shows how energy, according to quantum mechanics, can change in discrete amounts only, and often in large jumps

focused as a beam on a prism is broken up into its component colors or frequencies, violet, indigo, blue, green, yellow, orange and red.

Consider two vertical carbon electrodes with the lower one scooped out to form a hollow in the top of it where it faces the upper one. Pour a small quantity of fine chips of some element like copper or aluminum into this hollow. Near the space between the two carbon electrodes place a suitable prism. When an electric arc is struck between the carbon electrodes, the characteristics of the arc are affected by the element placed in the hollow. The element vaporized by the heat of the arc radiates a large number of frequencies and these are dispersed or separated by the prism. Focusing the radiation on a suitable photographic plate constitutes an exposure. When the plate is developed, regularly spaced lines are observed on the negative.

This negative is called a spectrogram. The lines in the spectrogram are unique for each element and correspond to the frequencies into which the radiation is dispersed by the prism. For a long time scientists tried to understand why the frequencies were related in specific ways and to predict new lines in certain elements. As they did not understand the fundamental laws which produced the spectrograms, they were mostly content to derive empirical laws on the basis of which they could account for the observed lines. They could not derive these formulas from considerations of the structure of matter.

A number of series, or groups of lines, were known for the element hydrogen. From chemical findings it was known that hydrogen had only one electron associated with its nucleus. To explain the observed series, a physicist named Bohr tried to apply the Planck concepts about the energy occurring in discrete jumps to the orbit of the hydrogen electron. Not only did Bohr's theory fit the observed facts about the hydrogen atom and electron, but also he was able to propose a simple formula which explained the frequencies of the lines in the hydrogen and helium atom spectrograms.

His formula went further—it predicted where to look for new lines beyond the range of equipment then available. When improved apparatus had been developed the lines were found as Bohr had predicted. Thus, by application of Planck's rather radical innovation, Bohr was able to provide a satisfactory formula for the frequencies of the lines in the hydrogen series. Previous attempts to provide a formula based on classical concepts had failed.

Energy Levels

To the physicist, mechanics means the body of laws, all the mathematics and formulas, all the theorems and axioms, in short, all the rules that govern the description and explanation of a given science.

Quantum mechanics is the body of rules and laws and mathematics which determines our description of the phenomena of nature in terms of quanta, or discrete amounts of something, such as energy or momentum. The ideas about the laws of nature as conceived prior to the advent of the quantum hypothesis are known as classical mechanics.

Consider a molecule d inches above the ground. The reader can imagine an experiment in which he raises the molecule an infinitesimally small amount, Δd. Potential energy may be defined as the weight of a body times the distance through which it is raised. If the change in height of the molecule is given by

Δd, the change in its potential energy is given by $W\Delta d$. If we can make Δd extremely small, we can also make $W\Delta d$ quite small and thus change the energy by as small an amount as we please. But Planck's hypothesis says we cannot do this—the least amount by which energy may be changed is given by $E = hf$, where h is Planck's constant, and f is a frequency associated with the molecule.

The concept of energy varying in jumps or quanta does not appeal to the common sense as much as energy varying smoothly or having a continuous distribution. As we will see later many of our ideas on logic are rudely disturbed by the mandates of quantum mechanics. The success of quantum mechanics lies in its ability to explain experimental data and to indicate new avenues of experimental investigations.

The discreteness in the distribution of energy of electrons when within the field of influence of the nucleus makes it necessary to consider energy levels. An energy level means a specific value of energy which is some whole number multiplied by hf. By speaking of an energy level, we imply that the adjacent energy value is another level not less than hf units of energy above or below the first.

Energy Bands

For many reasons energy levels frequently occur in groups, and such a series of energy levels is called an energy band. There are some series of energy levels that are never observed experimentally. In other words, electrons have never been found that have energy levels in these series.

Such groups of energy levels are called forbidden bands or energy gaps. The concept of energy bands and forbidden energy levels is of particular importance in the study of semiconductors and transistor theory.

Previous Article

Part I—Introduction to Transistor Action, p 98, March 1953

The abscissa on Fig. 2 has no scale; a vertical series of points would do just as well. The ordinate is energy in suitable units. At the top of Fig. 2 is shown a series of energy levels marked with possible, though not necessarily realizable, energy values, and this set of energy levels constitutes a band. It is called conduction band to indicate that in our discussion of germanium, electrons with energy levels that fall within this band are the ones that are taking part in the conduction process or are carriers of electric current.

Below this conduction band other energy levels are theoretically possible. In the case of germanium, at room temperature electrons which have energy values that fall in this range are never observed. These energy levels that are not observed experimentally constitute a forbidden band or energy gap.

An electron volt is a unit of energy used by physicists in the quantitative description of electrical phenomena. It is the energy acquired by an electron in falling through a potential difference of one volt. In terms of this measure of energy, the energy gap or forbidden band width for the semiconductor germanium is about 0.7 electron volt (ev), and for silicon, another semiconductor used in transistors, it is about 1.1 ev.

Below the forbidden band shown in Fig. 2 is a series of possible energy levels which collectively form a band called a valence-bond band. For the present it is sufficient to say that these electrons are bound or fixed in their energy levels. These electrons cannot readily change their energy level or wander about under the influence of electric fields. Within the valence-bond band a single electron may be found at each of the possible energy levels. As the electrons cannot readily change their energy level, the entire band ordinarily remains filled and therefore is called a filled band.

For an insulator such as diamond the energy gap is 7.0 ev (compare Ge 0.7 ev, Si 1.1 ev). For a conductor, the conduction and valence bonds overlap and an energy gap does not exist. It is thus seen that the energy gap may be used to classify insulators, semiconductors, and conductors.

It is important to observe that the levels in the valence-bond band are below the levels in the conduction band. If sufficient energy is imparted to electrons in the valence-bond band, they may acquire sufficient energy to jump across the energy gap. In verification of the quantum hypothesis, the electrons never land within the forbidden band. They will either acquire enough energy to suddenly appear at levels in the conduction band or they will stay in the valence-bond band.

Quantum State

The reader is now familiar with the fact that electrons may have different energy levels. This difference, as well as other differences between electrons, may be completely described by a set of numbers peculiar to quantum mechanics called the quantum numbers. These quantum numbers which completely specify the condition or state of an electron define its quantum state. It is sufficient to remember that surface states and quantum states of particles such as electrons or atoms may be described by these quantum numbers.

Summary

The following points should be retained from this article.

(1) An electron, when in the sphere of influence of the nucleus, has certain possible, discrete values of energy, or energy levels, which are integer multiples of hf. No intermediate values of energy are permitted.

(2) Groups or ensembles of energy levels are called bands.

(3) For a semiconductor, there is a conduction band, a forbidden band or energy gap, and a valence-bond band.

(4) One electron can be distinguished from another by specification of its quantum state.

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X-Ray Absorption Gage

Detects and records voids as small as 10^{-4} cubic inches in artillery projectile filling. System is insensitive to x-ray voltage fluctuations, reduces limiting noise from multiplier phototubes by novel negative feedback arrangement

By GEORGE M. ETTINGER

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SUPERSEDING the slower x-ray photography method of detecting voids in artillery shell fillers, the instrument described here meets the problem of adequate signal-to-noise ratio without bandwidth reduction. Noise is caused by statistical fluctuation of phototube sensitivity and by x-ray fluctuation due to line voltage variation.

General Description

A photoelectronic method is employed where x-rays, after passing through the part under test, strike a pair of potassium iodide scintillation crystals which emit visible light approximately proportional to x-ray intensity. The light from the crystals is brought to the cathodes of secondary emission phototubes whose output is amplified and applied to a d-c meter and a chart recorder.

In common with recent industrial x-ray systems[1], the generator employed is of the self-rectifying type and produces short pulses of x-rays at 60 cps repetition rate. It is therefore possible to employ a-c couplings in the various amplifiers, so drifts due to phototube and amplifier warm-up and aging are very much reduced.

To eliminate variations due to line voltage changes, the whole system is operated as a self-balancing bridge where output is substantially independent of excitation voltage and varies only when unbalance between the bridge elements is present (Fig. 1).

When equal x-ray absorption takes place along the paths from the x-ray generator to the two scintillation crystals, the outputs from the two preamplifiers (60 cps repetition rate pulses) will be equal, and no voltage is induced in the secondary of the differential transformer shown. If the thickness of material facing one scintillation counter is reduced due to a void, the output of that preamplifier will become greater than that of the other preamplifier; therefore a difference signal appears across the transformer secondary, providing

From a paper presented at Eighth National Electronics Conference Chicago, Ill.

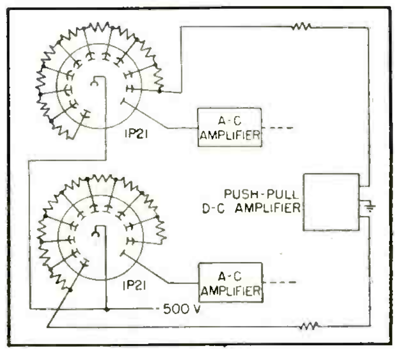


FIG. 2—Dynode feedback reduces unbalance between the two phototubes by varying their dynode potentials

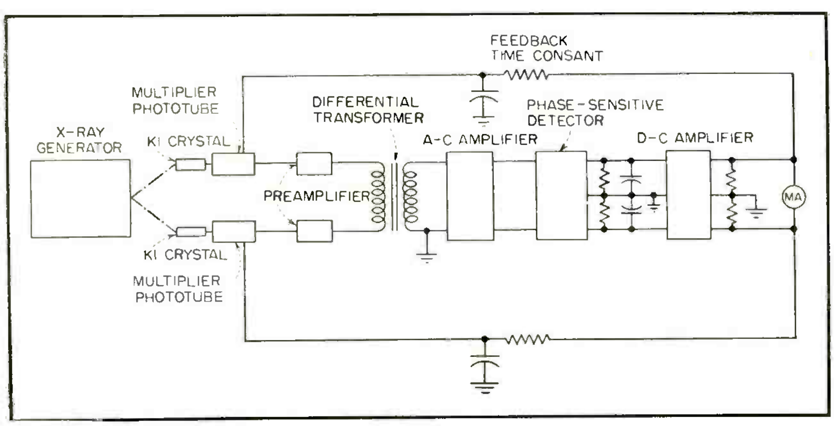
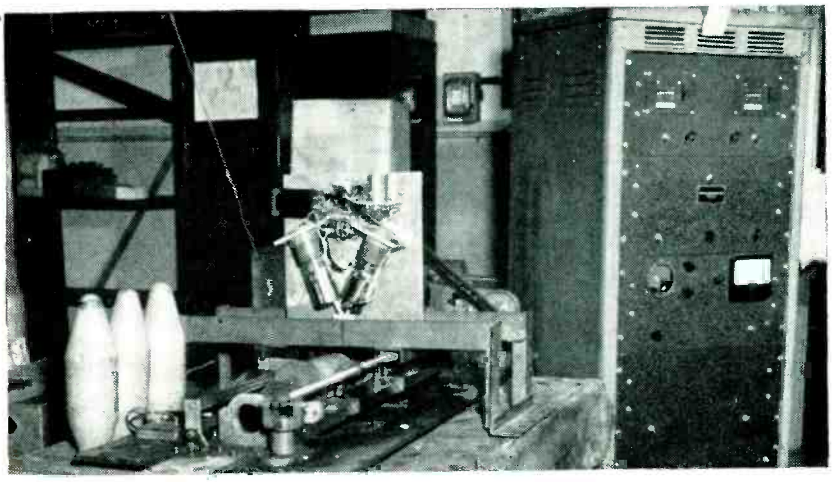


FIG. 1—Block diagram shows self-balancing bridge arrangement of differential x-ray gauge whose output is independent of line voltage variations

Checks Artillery Shells



Artillery projectiles are tested by x-ray gauge to detect filler irregularities and voids inside shell

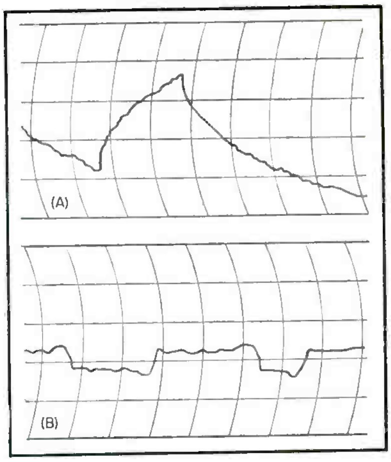


FIG. 3—Pulses with regeneration (A) and negative feedback (B)

input to a vacuum-tube amplifier which drives a phase-sensitive detector whose output polarity changes if the unbalance between the two x-ray absorption paths reverses. The signal is further amplified in a push-pull stage and fed back to the dynodes of the photomultipliers so as to reduce the unbalance between the two signals, by varying the dynode potentials of the two phototubes (Fig. 2).

The cathode voltage is constant and the potential of the positive end of the bleeder chain is changed as required to vary photomultiplier gain. The total accelerating voltage, distributed over nine or ten stages, is therefore controlled. Since the photomultiplier is essentially a constant current device, with anode current almost independent of anode-to-last-dynode voltage, this arrangement is satisfactory for accelerating voltage changes of the order of 100 volts.

The dynode feedback system gives self-balancing bridge operation where the input to the metering and recording instruments is the voltage necessary to restore balance. In addition, the feedback system reduces those components of the phototube noise which are of a modulation nature (shot effect) since an increase of emission from one multiplier phototube causes reduced accelerating voltage to be applied to that tube, as well as increased voltage to the other tube. These tend to reduce the effects of changes of phototube characteristics. The system may be analyzed by the well-known techniques of envelope feedback, and stability conditions determined. Figure 3 shows pulses due to a small change of x-ray absorption in one channel, when the system is connected for positive feedback or regeneration (Fig. 3A) and for negative feedback or self-balancing action (Fig. 3B).

Mechanical Considerations

Projectiles of 3.5-inch diameter, having a ⅛-inch steel casing, were to be inspected for the presence of cavities in their filling. To scan the complete volume, it was found desirable to employ a helical scanning method, with two fixed scintillation crystals a small distance apart (Fig. 4). A scanning pitch of 3/16-inch was chosen, and the speed of rotation adjusted so that faults 3/16-inch apart would produce signal pulses separated by 0.2 second, which could be handled by an electronic system having a bandwidth greater than 5 cycles per second. Where signal-to-noise ratio is not so important, as when inspecting a component for larger faults, the mechanical scanning speed may be increased and the amplifier bandwidth extended by switching capacitors out of the low-pass filter structures.

The end view of Fig. 4 shows a

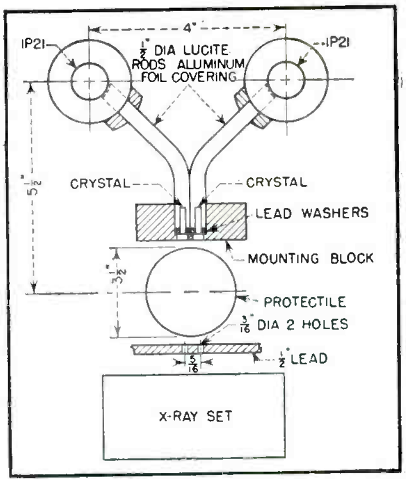


FIG. 4—Details of balanced x-ray detector system with two scintillation crystals fixed a small distance apart to allow scanning complete volume

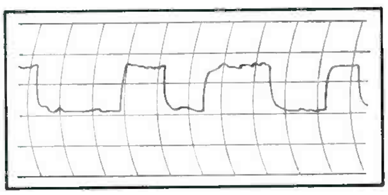


FIG. 5—Output of absorption gauge for 0.002-inch change in 0.5-inch steel equivalent, obtained with 180-kvp x-rays, 4-ma beam current

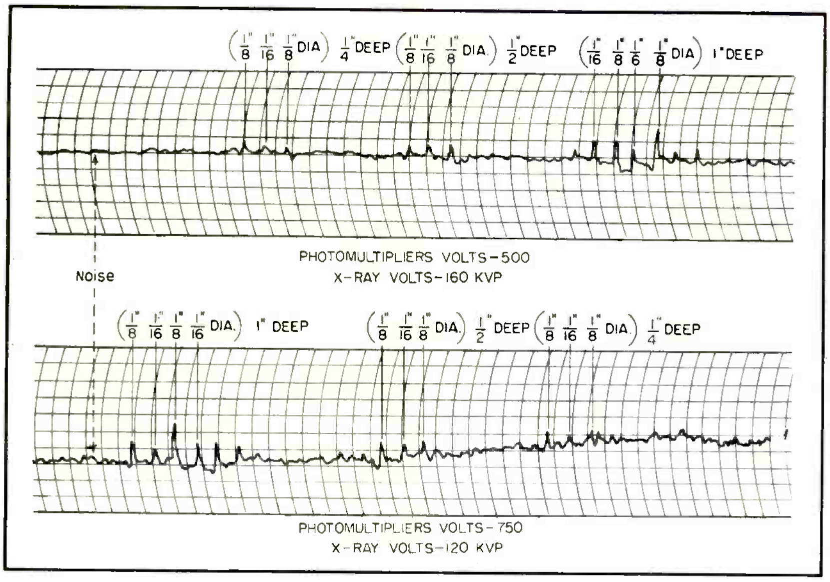


FIG. 6—Typical projectile test record with pulses corresponding to varied depths in filler. Reducing phototube voltage improves signal-to-noise ratio

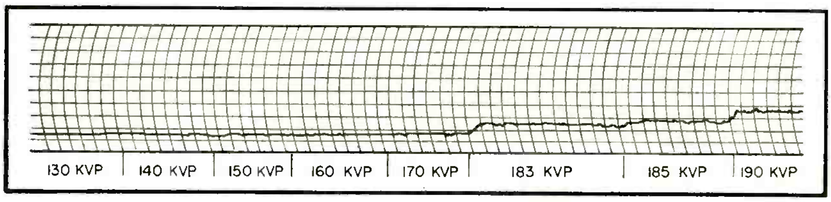


FIG. 7—Effect of x-ray voltage variation on gage output with projectile in position and stationary shows voltage change from 120 to 170 kvp produced output change no greater than change in steel thickness of 0.005 in 0.025 inch

projectile, an x-ray generator, and two multiplier phototubes. Type 5819 tubes are preferred to the type 1P21 in this application, because of their higher sensitivity and their flat window. To keep the two potassium iodide crystals in close proximity and yet allow for the diameter of the phototubes, curved light guides of clear Lucite were employed. The crystals were cemented to one end of the guides whose other ends were cemented to the phototube windows.

One of the x-ray beams passes through the center of the projectile; the other beam is some distance off center. This arrangement is necessary to avoid a blind spot which exists with symmetrical beams where a small cylindrical volume around the center line is never inspected.

The x-ray beams were each $\frac{3}{16}$-inch diameter; the potassium iodide crystals themselves were only $\frac{1}{8}$-inch square, so that further collimation between the projectile and the crystals was unnecessary.

Figure 5 shows the system output, as displayed on a chart recorder, when a steel shim 0.002 inch thick was placed between the projectile and one of the scintillation crystals. The projectile, at an x-ray voltage of 160 peak kilovolts, had an x-ray absorption equal to approximately 0.5 inch of steel. The signal-to-noise ratio under these conditions is approximately six to one, indicating unity signal-to-noise ratio would be obtained for a thickness change of less than 0.0005 inch in 0.5 inch of steel. This signal-to-noise ratio can be controlled by variation of amplifier bandwidth; the bandwidth of 5 cycles per second is adequate in this application.

Typical Results

A typical record obtained when testing a projectile is shown in Fig. 6. The pulses correspond to artificial defects in the filling, $\frac{1}{8}$ and $\frac{1}{4}$-inch diameter, and one inch, $\frac{1}{2}$ inch and $\frac{1}{4}$ inch deep. Signal-to-noise ratio of three to one is maintained for the smallest void, whose volume is approximately 0.0008 cubic inch.

Figure 6 also shows the improvement of signal-to-noise ratio obtained by reducing photomultiplier voltage from 750 volts to 500 volts. The increase of amplifier gain or x-ray voltage necessary to compensate for the relatively low phototube sensitivity at these accelerating voltages can be achieved easily. In the present case, the x-ray voltage was increased from 120 peak kilovolts to 160 peak kilovolts.

The effect of x-ray voltage variations is shown in Fig. 7. A change of voltage from 120 to 170 peak kilovolts, at constant beam current, produced a change of output no greater than that due to a steel thickness change of 0.005 inch in 0.25 inch.

Circuit Details

Figure 8 shows the preamplifier and photomultiplier circuits employed in each pickup head. The amplifiers employ miniature pentodes, type 6AK5, operated in a starved pentode circuit.[2]

Figure 9 is the circuit of the differential amplifier and phase-sensitive detector. Signals from the two preamplifiers are fed by a pair of cathode followers to the differential transformer, wound on a Permalloy toroidal core. The cathode resistances are taken to a negative supply of 150 volts, to ensure that no overloading takes place in the system before the difference-taking process is carried out in the transformer.

The phase-sensitive detector, deriving its input from a 6SK7 pentode, consists of a 6SN7 double triode whose plates are connected to a center-tapped 60-cps trans-

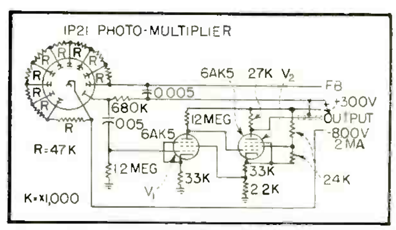


FIG. 8—Preamplifier and phototube circuits used in each pickup head. Miniature 6AK5 tubes operate in starved pentode circuit

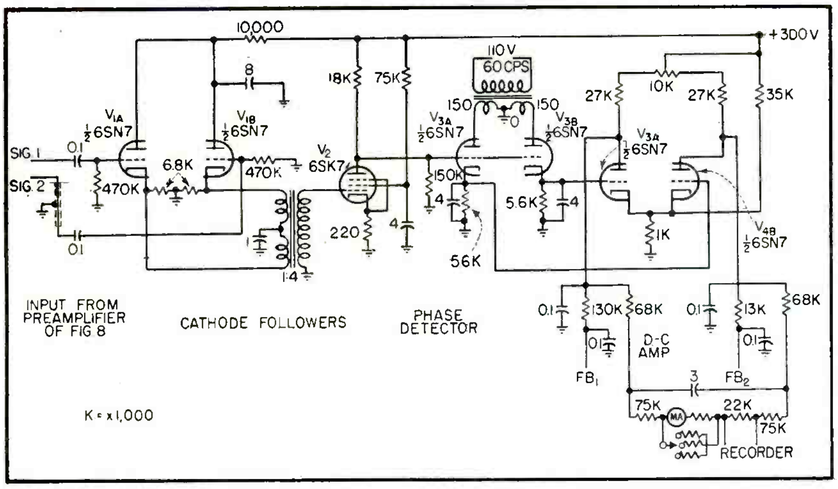


FIG. 9—Differential amplifier and phase sensitive detector circuits. Signals from preamplifiers feed differential transformer with toroidal core

former. Push-pull rectified output is obtained from the two cathodes. The last voltage amplifier stage is again a 6SN7 double triode, and provides signal for a push-pull power amplifier to feed a chart recorder, a center-zero milliammeter for direct indication, and phototube dynode feedback.

Phototube Performance

In the balanced x-ray detecting system, signal-to-noise ratio is largely determined by phototube noise. To be considered are thermionic emission from the photocathode and secondary emitter surfaces, and shot effect, which produces a noise modulation of the carrier and cannot be removed by means of tuned circuits.

To study these effects, the electrical output from several types of multiplier phototubes was displayed on a recording spectrum analyzer, to yield the spectra reproduced in Fig. 10. These were taken with the phototube excited by short light pulses at 1,400 cps repetition rate. The noise level is small while there is no signal; however the noise level is only a few decibels below signal level when signal is present, showing the noise is of a modulation nature. Analysis[3] shows that phototube voltage signal-to-noise ratio due to shot effect alone is approximately proportional to the square root of the signal applitude.

The records of Fig. 10 indicate the desirability of reducing dynode voltage to obtain high signal-to-noise ratio. The noise is concentrated in a band extending approximately 30 cycles per second on either side of the modulation frequency, so signal-to-noise ratio will be approximately inversely proportional to bandwidth for pass bands less than about 15 cps wide.

Further tests have indicated the desirability of reducing the voltage between photocathode and first dynode, as well as the voltage between last dynode and anode, to a lower value than the accelerating voltages between the secondary emission dynodes. In recent published work[4,5] on scintillation counters, it has been suggested that signal-to-noise ratio can be improved by operating with very large potential differences between photocathode and first dynode. Measurements made on a number of 5819 and 1P21 tubes, however, have indicated that better signal-to-noise ratio may be obtained with low cathode-first dynode voltage (Fig. 10). These measurements were made with a bandwidth of only a few hundred cycles per second so that the shift of the maximum of the phototube noise power spectrum due to change of cathode-first dynode voltage had little effect.

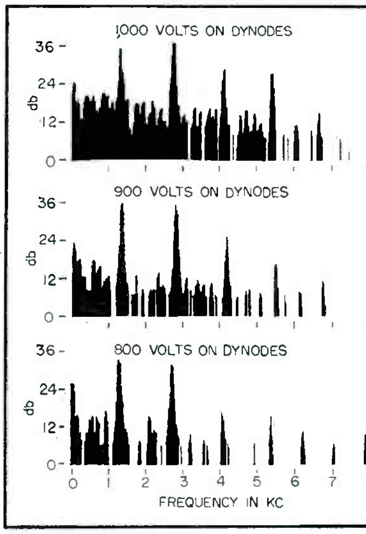


FIG. 10—Output spectra of 1P21 tube at various accelerating voltages indicate better signal-to-noise ratio at lower dynode voltages

Some improvement was obtained by using the 10-stage 5819 tube rather than the 9-stage 1P21. Signal-to-noise ratio for a 5311 (British) photomultiplier tube was higher than for the other tubes. Most of the noise in the 5311 tubes was due to thermionic or field emission, rather than due to shot effect.

This instrument may be employed quite generally in thickness gaging as well as in fault detection. For thickness gaging, one of the crystals is irradiated by x-rays passing through a reference piece of the same material as the part or parts to be tested; a discrimination of 0.0005 inch of steel in 0.25 inch, or one part in 500 thickness change, can be obtained. For the detection of small faults or irregularities a method where the part under inspection acts as its own reference piece is preferred, as in the present application where two identical pickup heads are employed.

Acknowledgments

Thanks are due to F. Fua, Standard Electronics Research Corp. for much helpful advice and criticism. Facilities for the multiplier phototube investigation were provided by Paul Onkley, Department of Electrical Engineering, Columbia University. This work was done under contract DA 30-069-ORD-116, Ordnance Department, Department of the Army.

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Ferrites Speed

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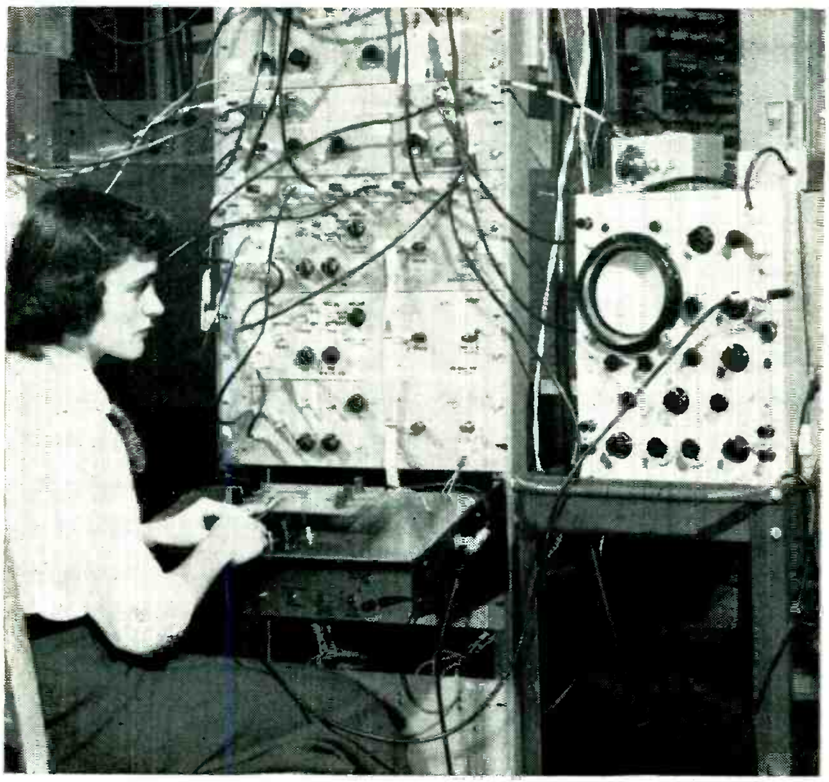
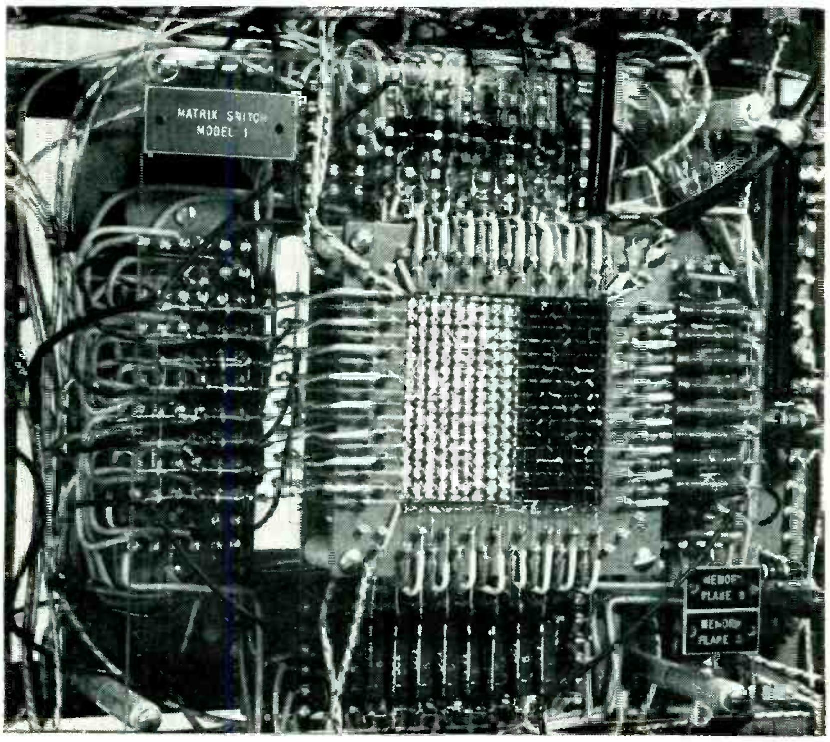


Test equipment for examining pulse characteristics of individual toroids under typical circuit conditions



An experimental coincident-current memory containing two 16-by-16 arrays. This unit is driven by a magnetic matrix switch

RELIABILITY is the paramount factor in the design of large systems such as electronic digital computers. Present operating machines are so large that the limit imposed by the frequency of failures prohibits further expansion. Pulse circuits in these machines have been pushed to the upper limit of operating speed. Yet the need for larger-capacity higher-speed systems is urgent.

A new material for increasing reliability is a ferrite (ferromagnetic ceramic) having a nearly rectangular hysteresis loop. The most important application for this material is a high-speed arbitrary-access memory in which tiny ferrite toroids are used to store binary information. Many other pulse-circuit applications are significant, some depending on the hysteresis of the material for memory and others using its non-linear characteristic for switching applications.

Coincident-Current Memory

Magnetic drum and acoustic delay line storage units are inherently serial devices and use time as one selection coordinate, resulting in a great loss in computing speed or flexibility. The electrostatic storage tube, now the most widely used high-speed arbitrary-access memory, is a complex device requiring considerable maintenance and lacking satisfactory reliability for many applications. The coincident-current memory, using ferrite toroids for storage of binary information, is an inexpensive, simple, high-speed, arbitrary-access memory

Digital Computers

Memory units and matrix switches using new square-loop ferrite material increase speed and reliability of digital computers. Storage units with arbitrary-access and read-out time of five microseconds or less makes stored information rapidly available without scanning time required by other systems

which promises to provide the degree of stability and reliability required.

Operation

A flux-current (Φ-I) characteristic of a ferrite toroid is shown in Fig. 1A. The positive and negative remanent magnetizations are defined as the one and zero states respectively. In the 4-by-4 memory array illustrated in Fig. 2, information is read out of the array by applying coincident current pulses of amplitude $-I_m/2$ to one vertical and one horizontal element, causing a large change in the flux of the selected core if it holds a one and a very small change if it holds a zero.

A flux change in any core in the array will induce a voltage on the output winding which threads every core. Voltages obtained by reading a one or a zero from a single core are shown in Fig. 1B. Since reading out always leaves the selected core in the zero state, rewriting is necessary if information is to be retained. This is accomplished by applying coincident-current pulses, of amplitude $+I_m/2$, to one horizontal and one vertical element. Writing new information is accomplished during a normal read-rewrite cycle by disregarding the old information read out and writing the new information by the same mechanism used for rewrite.

A possible arrangement for a parallel computer memory is shown in Fig. 2B. An array is placed in each column and only one x-coordinate switch and one y-coordinate switch are used to provide the coincident-current pulses for the entire memory. If n is the number of x or

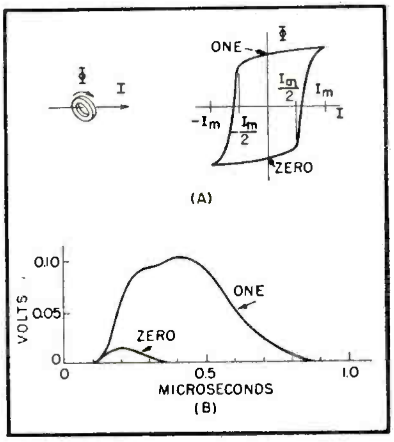


FIG. 1—Characteristic curve (A) of ferrite toroid. Voltages produced (B) by a one or zero stored in a toroid

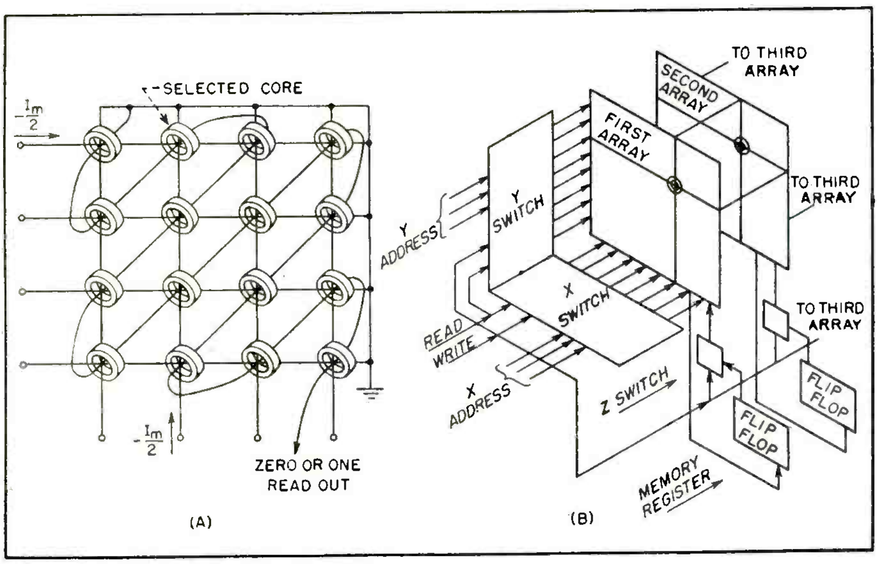


FIG. 2—A 4-by-4 memory array (A) with current pulses $-I_m/2$ reading out the selected core. Arrangement in (B) permits selecting from a number of arrays

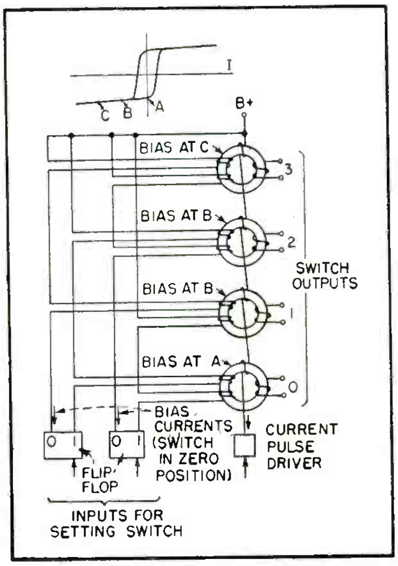
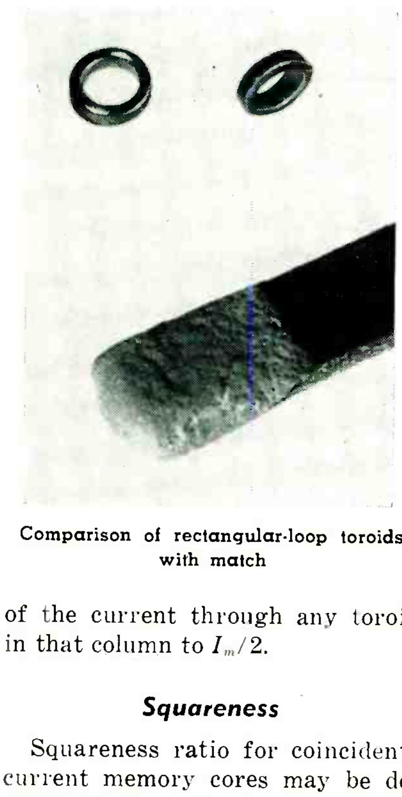


FIG. 3—A four-position magnetic matrix switch using ferrite toroids

y elements, each switch can be set by a binary number containing $\log_2{}^n$ digits, and n^2 binary digits are stored in each column of the memory. When the two switches are pulsed for read, the information is read out of the selected x-y location in all columns simultaneously into the memory register.

For rewrite, the switches write into the same x-y location in all columns. However, in each column in which the memory-register flip-flop holds a zero, a coincident current pulse of amplitude $+I_m/2$ is applied to every toroid in the array. The z-coordinate switch provides this inhibiting current pulse for each column in which a zero is to be written, to limit the magnitude



Comparison of rectangular-loop toroids with match

of the current through any toroid in that column to $I_m/2$.

Squareness

Squareness ratio for coincident-current memory cores may be determined from the hysteresis loop

$$R_s = \frac{\Phi\left(-\frac{I_m}{2}\right)}{\Phi\,(I_m)}$$

Note that R_s is a function of I_m. Any given ferrite toroid, however, will have a single maximum R_s which occurs at the optimum value of I_m.

Magnetic-Matrix Switch

A 2^n-position matrix switch employing 2^n non-linear magnetic cores is very similar to the familiar diode-matrix switch. An n-digit binary number sets the flip-flops which bias the cores so that all but one are biased into the saturation region. This selected core is then the only one which is switched when the current pulse from the driver is applied.

A driving pulse of opposite polarity must be applied to reset the switch before it is again ready for operation. Two 16-position switches have been used to drive a 16-by-16 coincident-current memory array during the last year at MIT. These switches employ the same rectangular-hysteresis-loop material as that used for the memory array.

Slightly different characteristics are desired for switch cores, however. Instead of a high squareness ratio as defined for the coincident-current memory, a high ratio of remanent magnetization to saturation magnetization is desired together with a low coercivity.

Other Applications

Ferrite toroids possessing rectangular hysteresis loops may be used for high-speed storage of binary information in other ways than the coincident-current memory. If the total number of digits to be stored is small, so that direct selection is practical, a single-coordinate selection scheme may be used. In this case, the current pulses used for reading and writing may vary between rather wide limits provided they exceed a certain miniumum amplitude.

Where time selection may be used, rectangular loop ferrites may be employed in a static-magnetic delay line of the type developed by the Computation Laboratory of Harvard University.

Magnetic cores possessing non-linear characteristics can be used for other switching or logical operations besides the magnetic-matrix switch, particularly for operations similar to those performed by crystal-diode and or gates

Testing

A high squareness ratio is a necessary but not sufficient condition for a satisfactory toroid. To properly evaluate ferrite toroids for the memory application, a pulse test has been designed which subjects a single toroid to the conditions that might be encountered in an operatin array. Actually, two tests are performed, one to determine the smallest possible voltage from a selected toroid holding a one and another to determine the largest possible voltage from a selected toroid holding a zero.

Figure 4 shows a pulse pattern which writes a one into a toroid, followed by a number of half-selecting read pulses which disturb the one and tend to decrease its magnitude, as shown on the hysteresis loop. The disturbed one is finally read out by a full-amplitude read pulse. In the case of a satisfactory toroid, the voltage from the disturbed one is not a function of the number of half-selecting pulses, provided that the number of half-selecting pulses is greater than some small number, usually two or three.

A test which determines the largest zero is shown in Fig. 5. In this case, the zero is disturbed by a number of half-selecting write pulses. A large ratio of disturbed-one voltage to disturbed-zero voltage is necessary for a satisfactory toroid. This ratio may be calculated on a peak-amplitude basis or on the basis of instantaneous voltages sampled at the time that the ratio is a maximum.

To prevent the voltage from half-selected toroids in a large array from adding so that the total voltage from all half-selected toroids might swamp the voltage from the selected toroid, the output winding is arranged so that the polarity of the voltage induced on it will alternate with each toroid along any element of the array. This, incidentally, means that the voltage from the selected toroid may be positive or negative.

The total voltage observed on the output winding is

$$V_T = \pm\,[\,V_s - 2V_{hs} + (n-2)\,V_\delta] + V_l$$

where V_s is the magnitude of the voltage from the selected toroid, V_{hs} is the magnitude of the voltage from a half-selected toroid, V_δ is the uncancelled voltage from a pair of half-selected toroids of opposite polarity, and V_l is the voltage induced in the output winding due to leakage flux or flux not con-

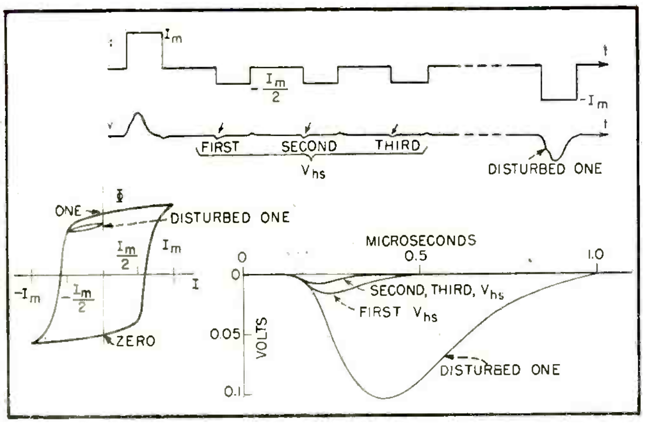


FIG. 4—Results of a pulse test used to determine smallest possible voltage from a toroid holding a one

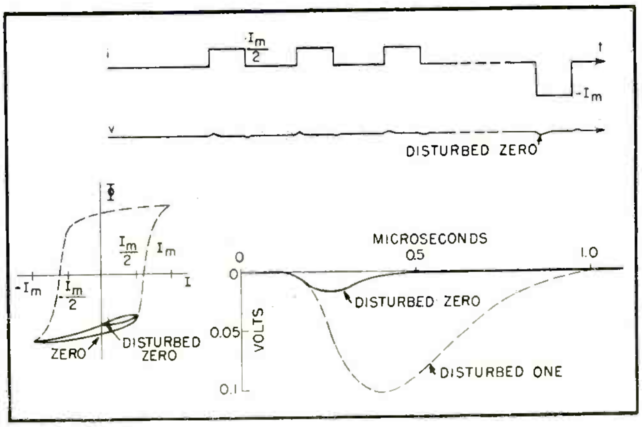


FIG. 5—Results of pulse test used to determine largest possible voltage from a toroid holding a zero

fined to the toroids.

The voltage V_δ may be positive or negative; in the ideal case it would be zero. Since it appears in the expression for the total voltage with a coefficient $(n - 2)$ it establishes an upper limit on the size of the array. Perhaps the most important factor behind V_δ is the uniformity of the magnetic characteristics of the toroids. The requirement for small V_δ makes a high degree of uniformity essential. Another contribution to V_δ may come because V_{hs} will be different for a given toroid depending on whether it contains a one, a zero, a once-disturbed one, a twice-disturbed one and so on. However, although the difference between the voltage from a half-selected undisturbed one and a half-selected undisturbed zero may be significant the number of such pairs is limited to two. The large number of V_δ's will be from half-selected cores containing disturbed ones or disturbed zeros, where the difference will be much less.

Ferrite Characteristics

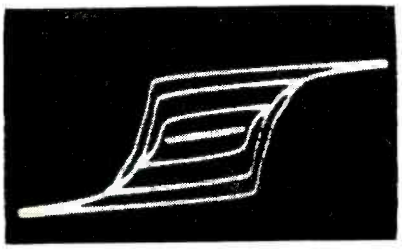
The rectangular-loop ferrite now used at MIT was developed by the General Ceramics and Steatite Corporation from a magnesium ferrite. The saturation flux density of this body, MF-1118, is approximately 2,000 gausses and the coercivity is 1.5 oersteds. A family of hysteresis loops is shown in the photograph, and other characteristics are listed in Table I.

The toroids for coincident-current-memory application have an outside diameter of 0.090 inch. The small size is necessary to reduce the power requirements for driving the arrays. The I_m for this toroid is 1.0 ampere and the maximum squareness ratio is 0.7. The disturbed one voltage has a peak amplitude of 0.1 volt and a duration of 1 microsecond. The ratio of disturbed one to disturbed zero is 10 on a peak-amplitude basis and greater than 200 on the basis of sampled instantaneous voltages.

The process by which a rectangular hysteresis loop is obtained in a polycrystalline ferrite is not understood, nor are the factors which determine the switching time or waveshape of the output voltage. Rec-

Table I—Properties of the Rectangular-Loop Body MF-1118

μ_o	40
μ_{max}	515 at 1,040 gausses
B_s	1,780 gausses at 25 oersteds
B_r	1,590 gausses
B_r/B_s	0.9 approx.
H_c	1.5 oersteds
Volume Resistivity	2×10^7 ohm-cm
Curie Temperature	300 deg C



Family of hysteresis loops for General Ceramics MF-1118 ferrite

For some polycrystalline ferrites with large magnetostrictive coefficients, notably nickel-zinc ferrite, rectangular hysteresis loops have been obtained by compressing a toroid by means of a clamp around the outside diameter. In this case, the stresses set up an easy direction of magnetization which accounts for the rectangularity of the hysteresis loop. Residual mechanical strains in MF-1118 may be responsible for its rectangularity.

The same rectangularity and performance has been observed in toroids ranging in diameter from 0.060 inch to 2 inches.

Recent experiments to reduce the coercivity of the body MF-1118 have produced rectangular-loop bodies with coercivities as low as 0.5 oersted. However, this switching time increases from 1 microsecond to approximately 5 microseconds.

The high degree of uniformity required for the coincident-current-memory application necessitates careful control in the production process. The uniformity of the toroids produced must be considered an integral factor in the evaluation and development of satisfactory toroids.

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Video Inset System

Television camera scanning foreground subject against plain background is used to switch a second camera, focused on inexpensive background. Resulting composite is economical, particularly for trick effects. Circuits are given both for the novel keying separator and commercially available effects amplifier

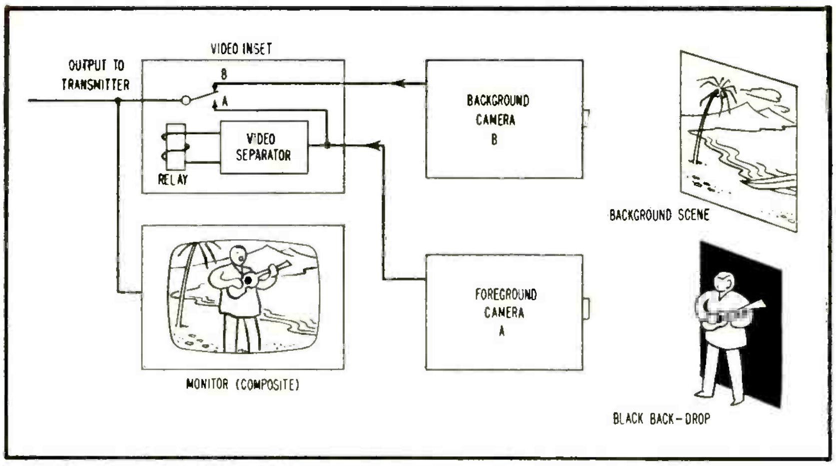

FIG. 1—Elements of the video inset system show a simplified camera relay

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TELEVISION broadcasters are beginning to make increased use of a technique whereby the scene from one camera may be used as a background into which the picture from another may be inset as a foreground. Background scenery is automatically cut out over the area silhouetted by the foreground subject to avoid the double exposure effect of ordinary superimpositions. Highlights do not bleed through the foreground, and the composite picture may be in true or fantastic perspective as desired.

The so-called matte process employed in the film industry achieves these results through meticulous photography together with special processing and combining. In television, the video inset system combines the scenes by instantaneous and automatic camera switching. Many novel effects are practical in both media and in motion pictures, production costs are sometimes drastically reduced by miniaturization of large background sets. This same cost saving may be feasible for television in the near future.

The video inset system permits using any properly synchronized camera as a source of background scenery or action. The camera may be located in the studio originating the foreground picture or in a different one. The background may be derived from a small flip card, a transparency, a motion picture film or a live action scene in the same or a different studio.

Basically, the present system is merely a method of switching from the background camera to the foreground camera whenever the latter scans anything other than black. Essential elements, functions and results are shown in Fig. 1. Here, the foreground camera pictures only a man, strumming a ukelele; the background camera pictures a tropical scene, while the composite as viewed on the monitor, shows the man still strumming, but now standing in front of the tropical scene.

First known experimental development in the use of electronic backgrounds was conducted several years prior to the war by NBC. Fundamental ideas were proved successful, although difficulty was encountered in properly switching cameras. By 1940 various patents had been issued on the basic system[1, 2, 3], one of which included both a foreground-background combination and a middleground as well. Experimentation was resumed at NBC in 1948, with materially improved results. A method of pulse shortening, applied to electronic background systems, has been described in the literature.[4]

During the past year it is understood that at least three broadcasters have tested and used electronic systems similar to the present video inset, with varying degrees of success. All known sys-

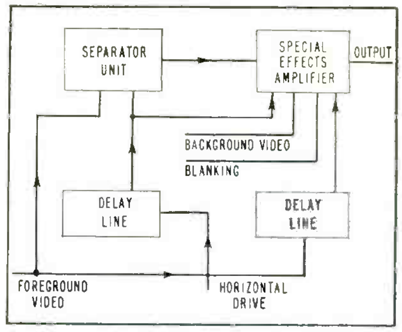

FIG. 2—Special interconnections, including delay cables, are used to insure proper register of composite video signal

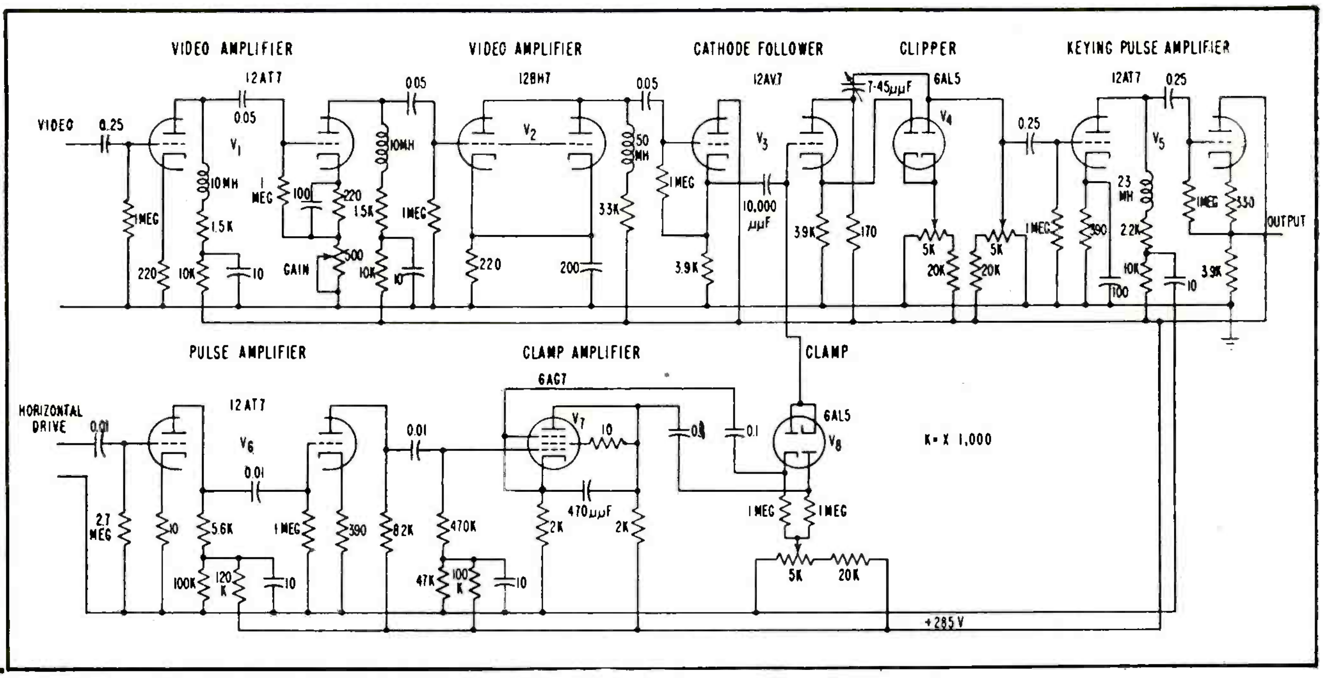

FIG. 3—Circuit diagram of the NBC keying separator amplifier

tems are subject to certain inherent limitations and are capable of proper performance only under carefully controlled conditions.

The apparatus required, in addition to the usual camera equipment, consists basically of a double-throw selector switch that can be actuated as a function of foreground picture content. While foreground camera A scans the black back-drop, the switch conducts video from the background camera B. Then, as the foreground scanning leaves the black area, the switch throws so that camera A becomes active, replacing the background camera signals. Reverse action occurs as scanning returns to the black area. Practically, the selection could not conceivably be accomplished by the mechanical switch indicated in Fig. 1.

Actually, switching must occur in considerably less than 1 microsecond and can best be achieved at the required rate electronically. Actuation as a function of foreground camera video output requires reshaping this camera's video output. Signals corresponding to shades other than black operate the switch or gate to the foreground camera signals whereas on blacks it reverts to the background.

A block diagram of the video inset equipment, including the necessary video delays and interunit connections, is shown in Fig. 2. This comprises two major components: the keying separator, which develops keying pulses from the foreground camera output; and special effects amplifier type TA-15A, which further shapes and amplifies the keying pulses and also switches cameras as a function of these pulses.

Keyer Equipment

The first component is essentially a clipper capable of making square-topped pulses from any and all video signals that depart from black level. Camera equipment contains some irregularity in the black level base line, caused by miscellaneous noise voltage, burns, improper shading, and redistribution effects.

The clipping level is therefore adjusted to avoid these spurious voltages by operating somewhat above theoretical black level.

A complete schematic of the separator unit is shown in Fig. 3. Video signals are first amplified and then clamped to preserve a constant black level. All stages are shunt peaked for minimum delay time and optimum transient characteristics. Frequency response is flat to 7 mc and no compression is evident with as much as 45 volts peak-to-peak at the clamped grid. The clamping diodes are each driven by horizontal pulses, amplified to approximately 80 volts. The clamped stage, a cathode follower, feeds two series-connected biased diodes that function as clippers.

Capacitance neutralization from the cathode-follower plate provides cancellation of the capacitance coupled video components, which would otherwise pass through in an unclipped state. Both white and black portions of the signals are eliminated by the diodes, leaving approximately a 2 percent segment. This is normally derived from the near-black portion of the video wave. The segment can be clipped from any desired portion of the amplitude range, by adjustment of a black level control potentiometer in the clamp diode circuit. Clipper output is amplified and then fed from a cathode follower as the keying signal, into the special effects amplifier.

Circuits of the separator unit are designed for stable operation since the separating process is inherently critical.

The high levels employed in clamping and clipping reduce variations that would be caused at lower levels by tube and temperature changes. The avoidance of video wave compression prior to clipping is essential, to accommodate axis shifts with typical television pictures. Otherwise, after

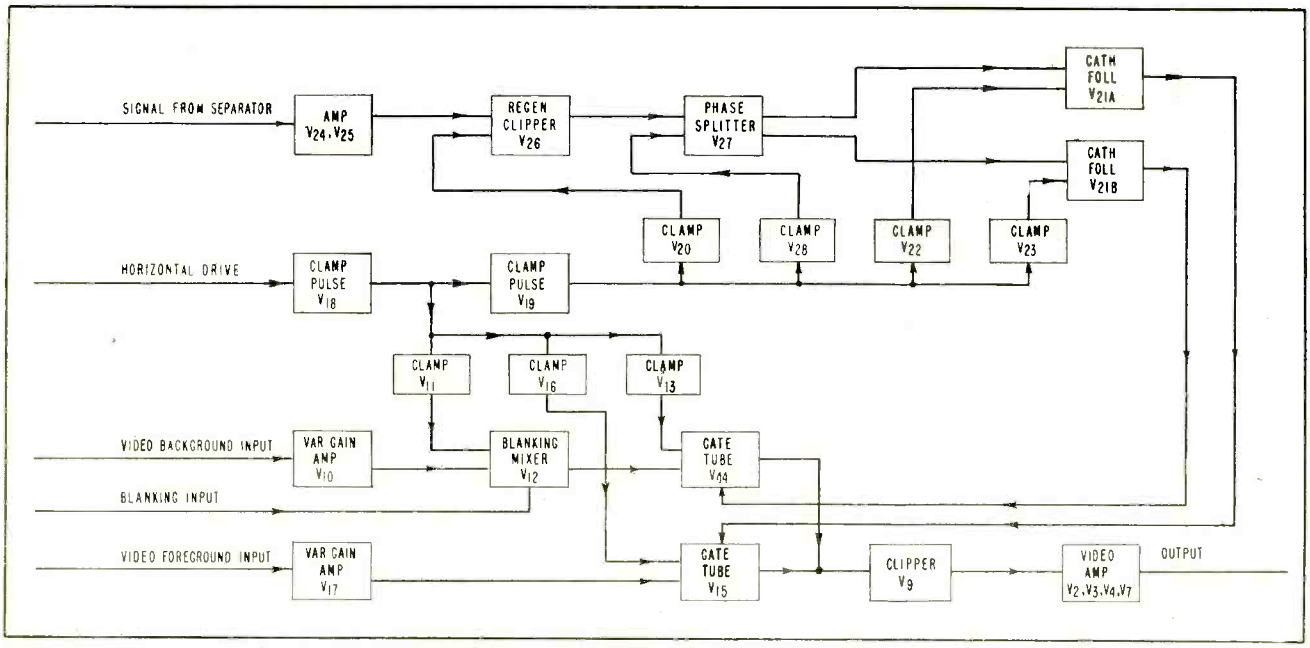

FIG. 4—Block diagram of the special effects amplifier showing tube designations is explained in text with reference to Fig. 5

initial adjustment, clipping would not fall within the same limits for all video signals. Total delay time in the video channel of the separator unit approximates 0.15 microsecond. A length of properly terminated coaxial cable delays clamp-driving pulses by at least an equal amount to permit clamping during blanking time.

A block diagram of the special effects amplifier is shown in Fig. 4, and a complete schematic is in Fig. 5. Tube numbers correspond in these diagrams, although certain portions unnecessary for an understanding of the operation are omitted from the block diagram. The signal from the separator unit consists essentially of flat topped pulses of white and black in accordance with the signals clipped from the foreground camera video information.

These pulses are amplified by tubes V_{24} and V_{25} and are then shaped in the regenerative clipper stage V_{26}, which removes any possible remaining noise or gray components. The signal then passes through the phase splitter V_{27} and the push-pull cathode follower stage V_{21} to key on and off the switch or gate tubes V_{14} and V_{15}.

The foreground video signal is applied to V_{17}, a gain-controlled amplifier and then to the clamped grid of gate tube V_{15}. The background video signal is amplified in a gain-controlled amplifier stage V_{10} and then is applied to the clamped blanking mixer stage V_{12}. Blanking pulses are added here to obtain setup and to facilitate switching of the video signals. The gate tube associated with this background channel is always keyed on during the blanking period as well as during the scanning of black areas of the foreground picture. Thus it is necessary to add blanking only in the background channel.

Video signals applied to the gate tubes are transmitted through them in accordance with the keying pulses impressed on their suppressor grids. If at the gate tubes the keying pulses are correctly timed to the foreground video signal, they cause background scene to be cut out over an area exactly matching the outline of the object to be introduced. Since the keying signal passes through a greater number of stages than the video and each introduces some delay, it is necessary to increase the video delay in order to attain correct timing at the gate tubes.

Four high-level and three low-level clamps are utilized in the special effects amplifier. It is the purpose of each of these to maintain a fixed black setting at the various grids, under conditions of changing duty cycle. The selected video from the gate tubes is clipped in V_9 to remove excessive blanking and is then amplified in V_7, V_2, V_3 and V_4.

Operation

At present, the system does not function properly if a foreground person has dead-black hair. In addition, some back-drop materials develop high light reflections along folds and so cause incorrect camera selection.

The system may be operated in reverse, employing a white back-drop or a back-lighted translucent screen. Difficulties are encountered here from white areas in the foreground, such as shirts, teeth and eye whites. Less critical keying can be obtained, however, provided the camera is irised down to the stop where the back-drop light level is just sufficient to operate the camera pickup tube over the knee of the saturation curve.

The video inset technique at the present state of the art is valuable in producing special novel effects, such as headless men, bodyless heads and feats of magic. When camera pickup tubes are produced that accommodate greater ranges of light levels, tremendous savings, through use of less large-scale scenery, may be possible.

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(2) Goldsmith, U. S. patent 2,172,936.
(3) Goldsmith, U. S. patent 2,193,869.
(4) Johnson, *Jour. SMPTE*, July 1950.

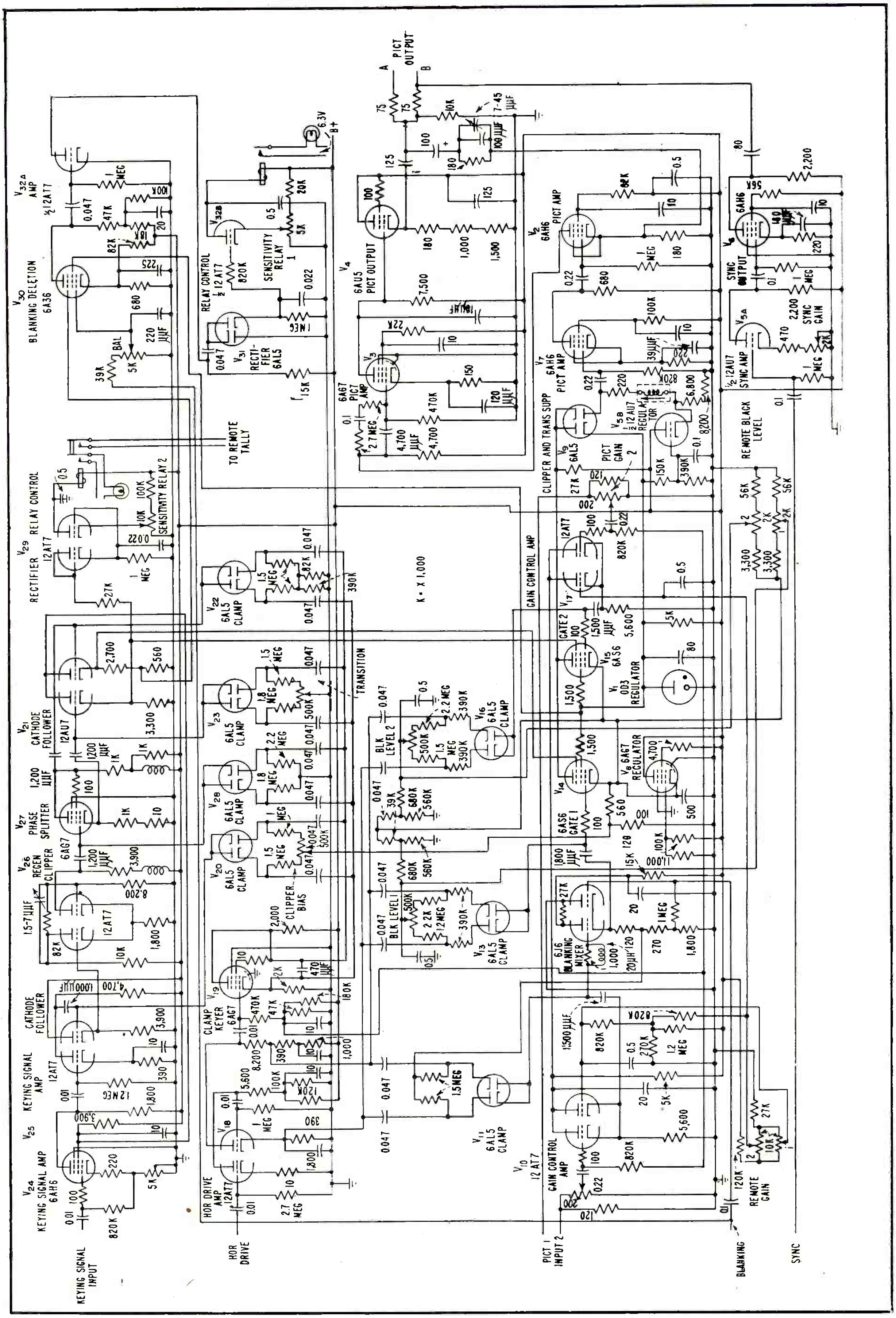


FIG. 5—Schematic diagram of the RCA type TA-15A special effects amplifier used as an integral part of the video inset system

Typical of all-transistor instruments is Meyers' "Radioear" using three pnp's

Transistorized Hearing Aids

Hard-of-hearing public expected to accept higher initial cost of junction transistor hearing aids to take advantage of operating economy. Manufacturers divide on question of all-transistor versus combination tube and transistor instruments

By JAMES D. FAHNESTOCK
Associate Editor, ELECTRONICS

FIRST LARGE-SCALE commercial application of transistors was announced by several hearing-aid manufacturers at the end of last year.

Immediately after the first announcements of hearing aids using transistors, it became apparent that there were two schools of thought as to the best way to employ transistors in hearing-aid instruments.

On one side, designers decided that the poor noise characteristics of even the junction transistors made them unsuitable for use in the low-level stages of high-gain units, since noise introduced in the first stages would be amplified by succeeding stages. To keep noise levels down, the designers chose to use subsubminiature vacuum tubes in preamplifier and driver stages and a transistor to replace the usual power-output tube.

On the other side, many manufacturers decided that the noise level of the all-transistor circuit was sufficiently low for most purposes. The impressive reduction in battery cost made possible by the elimination of the need for B voltage tipped the scale in favor of the transistors for all stages.

Combination Circuit

An example of a hearing aid using a combination of tubes and transistors (Sonotone "1010") is shown in block diagram form in Fig. 1. For the tubes, this instrument uses a 15-volt B battery with a life estimated at 2,000 hours at a drain of 60 microamperes. A 1.25-volt A battery powers the transistor and heats the tube filaments. Life of the A battery is 63 hours at an average current drain of 13 milliamperes.

In this unit a special transformer was required to match the high plate impedance of the driver tube to the low base-input impedance of the transistor. A primary impedance of over a half megohm is achieved by winding 10,000 turns of No. 48 wire (657 feet, at 1.3-thousandth-inch diameter) on a core built up of subminiature mu-metal laminations. Special techniques are, of course, required to form this winding without breaking the fine wire used. The 250-ohm secondary consists of 200 turns of No. 45 wire.

A tantalytic capacitor is used in the circuit of the brute-force filter in the constant-current source for the base circuit of the transistor.

Avaliable power output of this tube-transistor instrument is 1½ mw, which provides 124 db of sound pressure in the ear. The acoustic gain is 65 db, and residual noise level is at least 50 db below maximum output at full-gain setting.

The transistor used is an *npn* junction unit manufactured by Germanium Products Corp. of Jersey City, N. J.

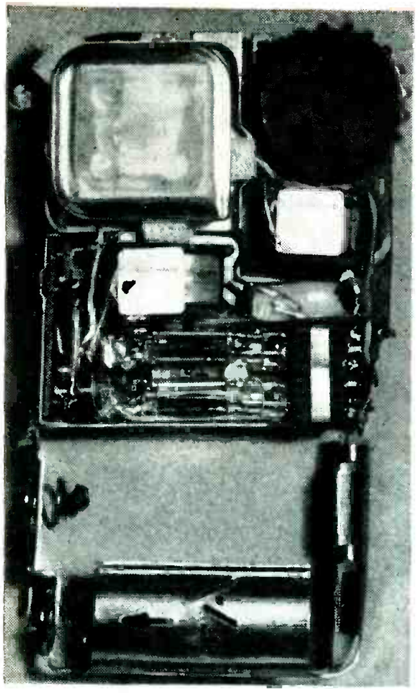
All-Transistor Units

The circuit diagram of one of the all-transistor hearing aids is shown in Fig. 2. This circuit

Table I—Battery Data for "Radioear" All Transistor Hearing Aid

Battery Type	Estimated Life in Hours	Estimated Battery Cost	Estimated Cost Per Hour
1—1RM-12 or equal..	2,000	$0.65	1/31 cent
1—1015E or equal....	500	0.15	1/33 cent
2—RM-1 or equal....	250	0.60	1/4 cent
3—RM-1 or equal....	150	0.90	2/3 cent

Typical Drains: 1.5 ma at 1.25 v; 3.5 ma at 2.5 v; 6 ma at 3.75 v



Sonotone "1010" uses two tubes and one npn junction transitor

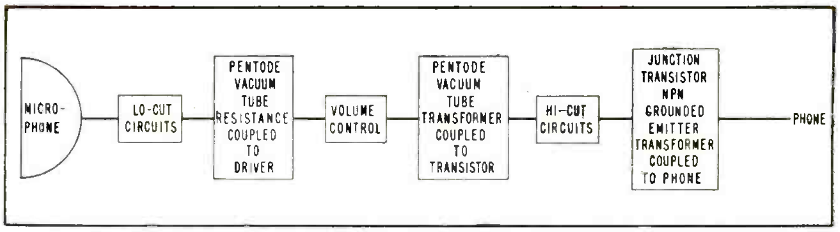


FIG. 1—Block diagram of tube-transistor hearing aid using two subminiature tubes and one npn junction transistor

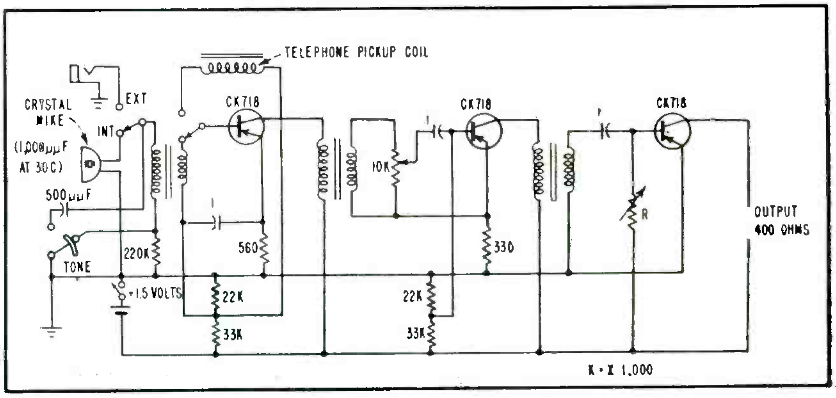


FIG. 2—Circuit diagram of Zenith hearing aid using transistors exclusively. Battery cost is 1/25 that of comparable all-tube instrument

(Zenith "Royal") operates on a single penlight battery with a drain of 4.5 ma, to give a battery life of 400 hours. Compensation for changes in transistor characteristics due to temperature variations is automatic. Sound-power output of the unit is 135 db with an overall gain of 62 db.

Transformer coupling is used in this circuit between three grounded-emitter transistor amplifier stages. Constant base current for the first two stages is provided by a divider arrangement across the single-cell battery supply; a large series resistance provides constant current for the output stage.

One type of all-transistor instrument (Edward A. Meyers' "Radioear") gives the user a choice of battery supplies. This unit can be powered by one, two or three 1.25-volt cells, as indicated in Table I. With three cells, saturation sound-pressure output available will run as high as 135 db or more (re 0.0002 d.s.c.) at 1,000 cps. With a highly-damped receiver and two cells (2.5 volts), the saturation output is slightly under 130 db. Electrical-power output is approximately 10 mw (with 3.75 volts) and total power gain is between 80 and 90 db.

A test on this all-transistor unit showed the distortion to be about 17 percent at saturation output and 4.4 percent with the output set at one decibel. Distortion decreases with output level.

Raytheon CK718 *pnp* junction units are used in both all-transistor circuits discussed.

Noise

The tube-transistor hearing aid has a residual noise level of at least 50 db below maximum output at full gain. The all-transistor units have a somewhat higher noise level at the output, but advocates of this type of circuit claim that noise is not a problem for persons with hearing deficiencies and that a noise level 40 to 50 db below signal level is negligible for all practical purposes. One manufacturer reports a lower noise level in an all-transistor unit (Gem Ear Phone Co. "V-70-T") than in vacuum-tube hearing aids.

Accessories

The usual variety of accessories are made available with transistorized hearing aids. No evidence of all-transistor hearing aids with automatic volume control has been reported. Several designers have provided sockets and switches for attachment of telephone pickup coils. By this means, the user is able to hear telephone conversations without the distortion introduced by the telephone ear piece and the hearing-aid microphone.

To date, only junction transistors have appeared in hearing aids, and grounded-emitter circuits are universally used. Packaging continues to show subminiaturization; thickness of the instruments varies between ⅝ inch and 1 inch, with heights from 2½ to 3 inches and widths of from 1½ to 2 inches.

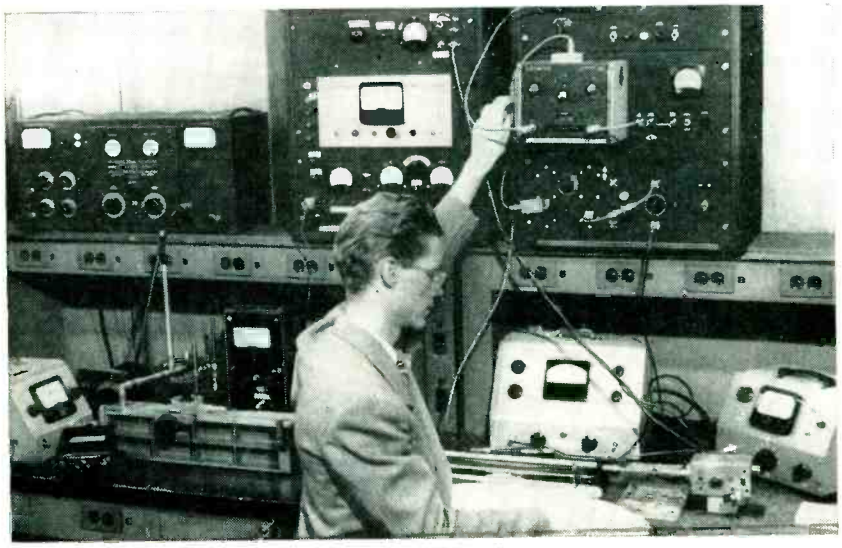
Low operating voltages permit use of smaller lower-voltage capacitors. Virtually no heat is generated by the transistor units.

Costwise, all-transistor hearing aids compare reasonably well with all-tube and tube-transistor instruments. Special circuits such as response-shaping networks and volume compression circuits are refinements found in the more expensive units.

One manufacturer gives battery-cost-reduction figure of 1/25 that for typical tube units. These remarkable savings have become strong inducements for users to pay the somewhat higher initial cost for transistorized units.

Testing UHF-TV

Characteristics of germanium mixer crystals for uhf television and other receivers can be measured with laboratory setup in five minutes using fuse bolometer and standard test equipment. Alternative production testing method for untrained personnel measures admittance at audio frequencies



Laboratory setup of equipment used to measure characteristics of 1N72 mixer crystals

CONVERSION LOSS L of a crystal mixer is the ratio of the available input signal power to the available output signal power[1]. It is a measure of the efficiency of conversion from r-f signal to i-f output.

Noise temperature t, also called output noise ratio, is the ratio of the available noise power output from the crystal mixer to that of a resistor. It differs from unity for semiconductor mixers because of noise generated by the biased crystal in excess of thermal or Johnson noise and is akin to the excess noise in a carbon microphone.

By including the effect of the i-f amplifier noise figure, $F_{i\text{-}f}$, a useful relationship can be drawn for determining the r-f noise figure $F_{r\text{-}f}$.

$$F_{r\text{-}f} = L(F_{i\text{-}f} + t\text{-}1)$$

The value of $F_{i\text{-}f}$ will generally be a function of the mixer's i-f admittance compared to the admittance for which the i-f amplifier noise figure is optimized.

Measurement Theory

To evaluate the effect of the mixer crystal upon overall noise figure, L and t must be known at the desired operating point. Noise temperature may be measured by determining the ratio of the noise output from an i-f amplifier whose input terminals are loaded by the mixer under test to the noise output when that amplifier is loaded by an ohmic resistor with the same value as the crystal resistance. This ratio is denoted as Y factor.

Mixer noise temperature can be determined from Y factor and the i-f noise figure of the amplifier when resistively loaded

$$t = F_{i\text{-}f}(Y\text{-}1) + 1$$

Conversion loss can be calculated from $F_{r\text{-}f}$, $F_{i\text{-}f}$ and t

$$L = F_{r\text{-}f}/(t\text{-}1 + F_{i\text{-}f})$$
$$= F_{r\text{-}f}/(Y)(F_{i\text{-}f})$$

If the i-f noise figure is measured with the amplifier terminated at the input by the mixer, a correlation check may be made against Y factor

$$F_{i\text{-}f\ mixer}/F_{i\text{-}f\ resistor} = Y$$

This measurement method assumes that the crystal has been biased at the desired operating point in local oscillator power injection and d-c bias, and that the mixer is terminated through lossless transformers by the desired impedances. The bias conditions will affect all the crystal parameters, including the crystal impedances.

The terminating impedances of the crystal mixer at input, image, local oscillator, local oscillator harmonic and output signal frequencies will have an effect on the measured effective conversion loss. These terminations at other than input and output signal frequencies are important because of undesired parasitic responses that occur in the mixing process.

The input signal will heterodyne with the local oscillator power to generate both sum and difference-frequency energy. The difference-frequency power is normally the desired i-f output signal. The energy at sum frequency can be partially recovered by a direct beat with the local oscillator second harmonic that is generated by the nonlinear crystal characteristic.

Image power is generated in the mixer by the beat between the input frequency and the local oscillator second harmonic, as well as by a beat between the output signal voltage and the local oscillator. It may be partially recovered by reflection back to the mixer and a beat with the local oscillator, or it may be absorbed by the source impedance

Mixer Crystals

By NICHOLAS DeWOLF
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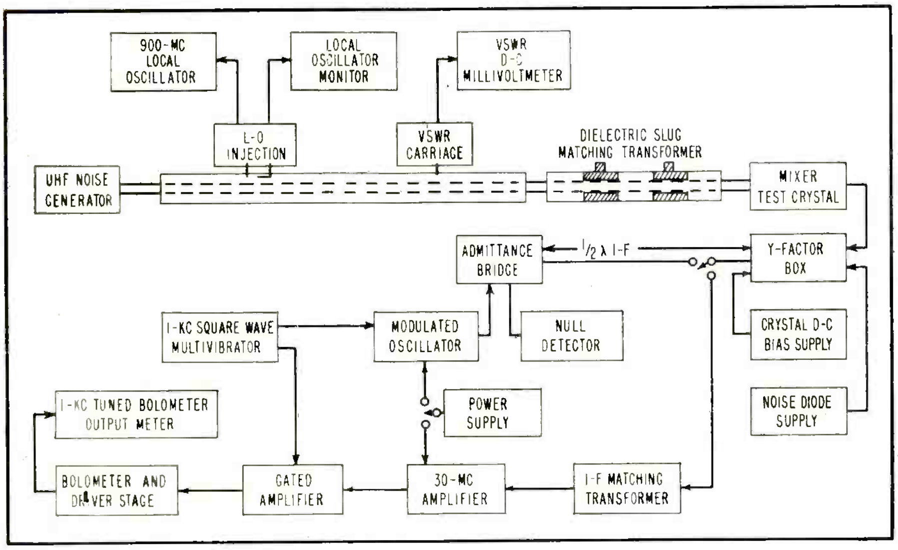


FIG. 1—Measuring equipment for uhf germanium mixer crystals is used in the laboratory to obtain parameters

that is driving the mixer.

Several special definitions for conversion loss have been derived[2]. To achieve a result typifying the average application and to simplify the measurement, the conversion loss that is commonly measured is L_o, the broad-band conversion loss. It is measured with the signal and image terminated in the same impedance, and the mixer matched to the local oscillator wave. The conversion loss in a given application may vary by 1.5 db above or below the broad-band loss, but L_o will equal the average result.

Measuring Equipment

A block diagram of the laboratory equipment for measuring mixer crystal parameters is shown in Fig. 1. It is essentially a uhf receiver, arranged for the measurement of F_{r-f}, F_{i-f}, Y, i-f mixer admittance and r-f mixer admittance. In addition, the biases on the crystal can be varied and monitored, and the r-f match may be adjusted. From this data, the conversion loss, noise temperature and crystal impedances may be measured as functions of the operating conditions.

The local oscillator frequency is 900 mc, selected to observe the crystal characteristics at the upper end of the uhf band, where variations in r-f reactance have a maximum effect. The intermediate frequency must be chosen as a compromise between F_{i-f} which increases and t which decreases with increasing frequency. A mean value of 30 mc was selected because the noise figure of crystal-mixer receivers optimizes, equipment is easily available at this frequency and noise temperature can be accurately measured.

The crystal under test is clipped into the mixer test board, which consists of a flat-strip transmission-line circuit[3] shown in Fig. 2 and the photograph. The mixer circuit is intended to tune out the capacitance of the average crystal, match its resistance to 50 ohms and prevent loss of either signal input to the crystal or output signal from the crystal.

In addition, second-harmonic energy generated by the crystal is reflected to the crystal by harmonic shorting terminations at either end. Two sheets of 1/16-in. Teflon-impregnated glass fiber board are sandwiched together about a 0.003-in. flat-strip photographically etched circuit, with copper sheeting on the top and bottom of the sandwich. A General Radio 874C connector is used at the r-f input, and advantage is taken of its tapered configuration to provide a smooth transition between the strip line and coaxial elements.

Insertion loss of this mixer circuit, measured by determination of the swr with the load terminals shorted and opened, is less than 0.05 db. When loaded with a passive resistor and matched to 50 ohms at the local-oscillator frequency, the swr at 30 mc either side of the local-oscillator frequency (signal and image frequencies) is 1.25. This will cause a mismatch error of less than 0.05 db.

The shorted tuning stub is cut to resonate the average crystal capacitance of 1.1 μμf and the quarter-wave transformer, adjusted by varying the width of the transmission line strip, is centered to match the mean 1N72 crystal resistance of 150 ohms to the line. Of all 1N72 crystals tested at the design bias conditions, 90 percent fall within a swr of 2.5 in the mixer. These bias conditions are set at 0.7 mw local-oscillator injection, and forward d-c bias from a 250-ohm 0.25-volt source.

Dielectric Slug Transformer

At other bias conditions and with other mixer crystal types, the mismatch may increase. The dielectric-slug matching transformer preceding the test mixer is used to match out these variations. It consists of a GR 874LB coaxial slotted line with ¼ wavelength polystyrene sections that can be moved along the line by polystyrene rods extending through the slot. This device, commonly called a slug tuner, requires a line 1¼ wavelengths long, and will match out any swr up to e^2, where e is the effective dielectric constant.

The position of the slugs determines the mixer impedance presented to the local oscillator wave when they are used to match the mixer to the line. At 900 mc the tuner used will match a swr of any phase and amplitude up to 5.2 and has a maximum insertion loss of less than 0.1 db for all settings.

The tuner and mixer are driven from the noise generator through a Hewlett-Packard 805A parallel-plate slotted line, used for measuring the swr of the mixer. The local oscillator power is injected into the line by a capacitive-tuned probe, illustrated in Fig. 3. The probe is driven from a uhf oscillator, isolated by a 10-db pad to prevent spurious responses. Power injected to the transmission line is 12 db down from the power available to the probe. At the local oscillator frequency, the probe introduces a swr of 1.15 on the line, causing a mismatch error of less than 0.05 db. The injection method has a bandwidth of 12 mc at 900 mc reducing the noise sidebands of the local oscillator at signal and image frequencies by approximately 15 db. This reduction assists in preventing the oscillator noise sidebands from increasing the effective noise temperature. The mismatch introduced on the line by the probe at the signal and image frequencies is less than 1.02.

An untuned detector probe is constructed near the main injection probe, and serves to monitor the local-oscillator injection power. It is located near the end of the injection probe, but well out of the fields in the main transmission line. Calibrated against the available power in the line, it has been found to have a frequency dependence over an 80-mc bandwidth of only 0.03 db per megacycle, with an almost linear decrease in sensitivity with frequency.

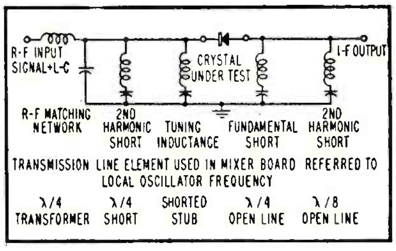


FIG. 2—Equivalent circuit of mixer test board

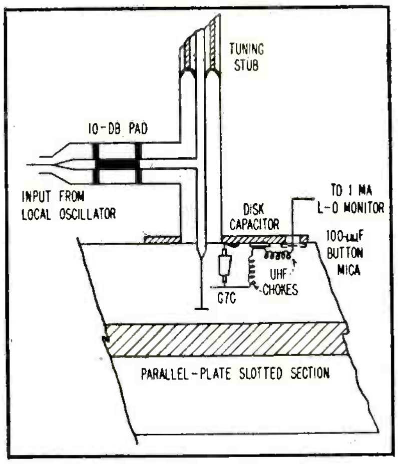
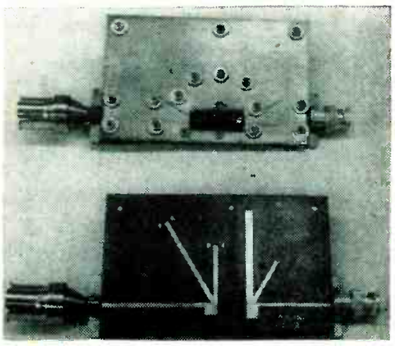


FIG. 3—Local oscillator injection and monitor probes



Etched transmission line circuit used for mixer crystal test

Noise Generator

The r-f noise figure of the mixer is measured with a Polytechnic Research and Delevopment type 904 uhf noise generator, to which an external precision meter has been added to improve the accuracy of the noise diode current measurement. A value of 3 db must be added to the measured noise figure to allow for the noise signal injected into the unwanted image channel. If a narrow-band tuned circuit were inserted in the line to reject the image power input this correction would not be necessary, but the conditions for broad-band loss measurement would be violated. The i-f noise output from the uhf noise generator is prevented from being injected into the mixer by the shorted tuning stub. An additional correction is necessary for the noise diode's transit time.

The Y-factor box, shown in Fig. 4 terminates the i-f amplifier input and provides an adjustable admittance that duplicates the mixer i-f admittance. It can be exchanged with the mixer for the measurement of Y factor. A temperature-limited noise diode is included for the measurement of i-f noise figure and is arranged so that noise figure can be measured with either the mixer or the duplicating admittance terminating the amplifier.

Because of the extreme sensitivity of the noise diode plate current to filament current changes and therefore to line-voltage change, a storage battery is used in the filament supply. In addition, the d-c bias on the mixer crystal is injected at the Y-factor box. Good filtering is necessary for all the supply voltages. The use of ceramic disk bypass capacitors soldered directly to the chassis is recommended. If the input and output leads to the bypass disk are soldered on opposite sides, the mutual coupling impedance between filter sections may be kept at a lower value than possible with button mica bypass capacitors.

To adjust the comparison admittance to the same value as the mixer i-f admittance at the noise diode an admittance bridge is provided. For convenience and accuracy the bridge is located at the end of a cable half the i-f wavelength as measured from the noise diode. The cable will present the same admittance to the bridge as its terminating impendance, and may be easily measured for electrical length by measuring its susceptance when terminated in an open circuit. The circuit capacitance is tuned out, and the bridge admittance reading used in the noise-figure calculation.

The admittance bridge, a Wayne Kerr B701, is driven by a buffered 1-kc square-wave modulated i-f electron-coupled oscillator. The amplitude of this signal at the mixer must be kept at a low level to prevent upsetting the nonlinear crystal impedance and may be checked by observing that it does not alter the d-c crystal bias. Since this level is generally below 25 millivolts, a sensitive null detector must be used. A single-stage broadband i-f amplifier, followed by a crystal detector and a high-gain audio amplifier tuned to 1 kc is used. This method permits fixed-tuned measurements for changes in the oscillator frequency as large as 4 mc.

Once the crystal mixer i-f admittance has been measured and a duplicate ohmic termination has been substituted, the *Y*-factor box output is switched from the admittance bridge to the i-f amplifier and the bridge oscillator is turned off to prevent spurious coupling of i-f power to the amplifier.

The i-f amplifier has a gain of 120 db and a bandwidth of one megacycle. The input is a Wallman[4] cascode circuit and in the complete circuit used has a noise figure of 1.8. It is preceded by an *L* matching section adjusted for the best noise figure when driven from the average mixer crystal, an impedance of approximately 250 ohms. The line from the amplifier to the switch is made identical in length to the line from the bridge to the switch. The impedance presented to the amplifer is then the same as the impedance presented to the bridge.

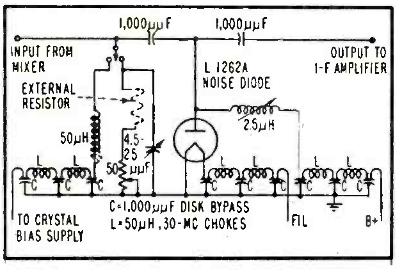


FIG. 4—Contents of Y-factor box used in noise temperature test

In measuring the relative noise output from the amplifier, it was desired to avoid the use of a diode video detector. A rectifier requires linearization for successful use in noise-figure measurements employing the noise diode method[7] and still has a limited range over which accurate measurements can be made.[6] The most satisfactory method for power measurements is the bolometric, or thermal measurement, and it yields results that are truly proportional to power output.

A biased Wollaston wire bolometer consisting of a 1/100 ampere Littelfuse is used and its resistance change caused by output power heating is measured. The incremental change in resistance is proportional to the input power, provided that the input power is a small fraction of the d-c biasing power. Another limitation on the amount of output power that can be linearly measured is imposed by the possibility of overload in the last i-f amplifier stage that drives the bolometer.

It is desirable for the noise peaks to be at least 15 db below the overload power output of the amplifier. An additional 15 db should be allowed for the ratio of peak-to-rms noise power. This generally limits the maximum usable output power to below 0.1 milliwatt, which makes stability in bolometer bridge measurements extremely difficult to maintain, particularly in light of the zero drift caused by thermal changes and variations in the bolometer bias.

Bolometer Driver

To avoid the instability of the bridge method the i-f amplifier stage preceding the bolometer driver stage is gated with a 1-kc square wave, as illustrated in Fig. 5. The control grid is driven to cutoff by a square wave derived from a multivibrator and buffer amplifier. The buffer is a triode stage with the plate load grounded, and a negative d-c supply. This references the square wave to ground, and flattens the top of the output pulse thereby improving the i-f output pulse shape.

The i-f pulses are injected to the bolometer fuse by the driver stage. The bolometer has a thermal time constant of approximately 1/3 millisecond, which allows it to vary in resistance at a 1-kc rate. The bolometer is biased by a direct current passing through a transformer coupled to a high-gain tuned Hewlett-Packard 415A swr indicator. The scale of the meter is calibrated in db based on a square-law detector and is therefore a direct measure of relative output noise power. This method is usable at an input level of 2 microwatts, but is normally used at a level of 50 microwatts and gives a more stable noise output reading than any other method observed.

It is possible, when familiar with the equipment, to make a complete crystal measurement in five minutes, including adjustment of the d-c and local-oscillator bias, a measurement of the mixer r-f and i-f impedance and a calculation of the broadband conversion loss and the noise temperature. Rapid and simple measurements are necessary because a number of operating conditions must be investigated to determine optimum biases and the distribution of parameters of a representative group of crystals. In addition, the results can be transposed to a given uhf converter design, enabling calculation of its noise figure.

Production Testing

In production testing 1N72 uhf-tv mixer crystals, the laboratory method outlined is too complex for rapid testing.

Variation in noise temperature is relatively unimportant in uhf-tv mixers because the high intermediate frequencies and the high i-f noise figure make the contribution of excess noise temperature negligible for normal crystals, particularly if biased by a well-filtered local oscillator.

Variation in i-f mixer admittance will affect the i-f noise figure and the bandwidth of the input circuits. It is desirable then, to measure this admittance and reject those units that seriously deviate from the mean value. This measurement may be accomplished at audio frequencies, for the i-f impedance is

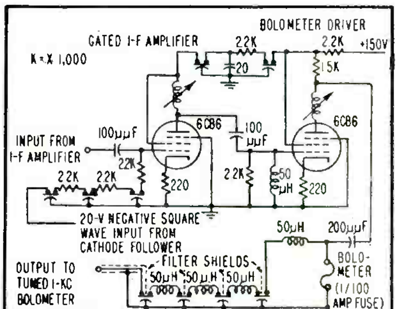


FIG. 5—Measurement of relative output noise power is obtained with this circuit

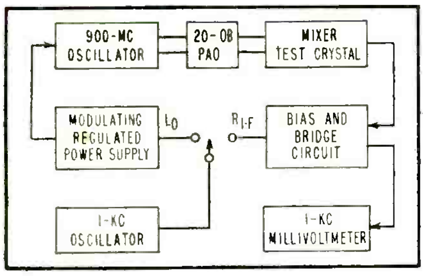


FIG. 6—Production test equipment arrangement

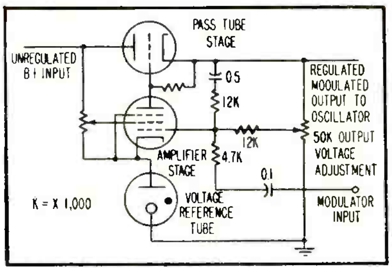


FIG. 7—Small-percentage modulation circuit

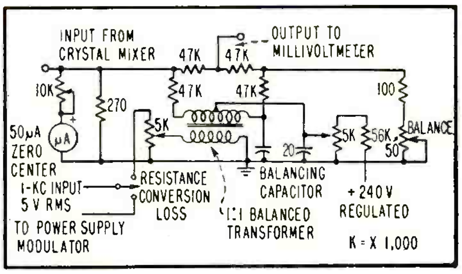


FIG. 8—Production testing uses resistance bridge and bias supply

relatively independent of frequency.

The uhf noise figure of a receiver employing a given mixer crystal depends directly on the conversion loss of the crystal.

The conversion loss may be conveniently measured for production testing by the amplitude modulation method used in the production testing of microwave silicon crystals. A block diagram of the method used is shown in Fig. 6.

The crystal under test is mounted in the printed-circuit test mixer illustrated and a 900-mc signal is injected from a source that is matched to the mean crystal impedance. This signal is at local oscillator level, P_o, and is modulated by a 1-kc sine wave to a modulation depth m below 5 percent. The mixer output is terminated in a 1-kc load R_e that is matched to the mean i-f crystal resistance of 250 ohms, and the audio output voltage e_o is measured by a millivoltmeter. The conversion loss is then determined by

$$L_o = m^2 P_o R_1 / e_o^2$$

This measurement is based on the loss in converting the available sideband input power $m^2 P_o$ to output audio power, the sidebands of the modulated input representing signal power that heterodynes with the carrier or local oscillator power to produce a 1-kc i-f output.

The measurement will be in error by any mismatch at r-f or i-f, but this will tend to reject those crystals that are not typical in impedances. A 2-to-1 mismatch will cause a 0.5-db error and occurs in less than 10 percent of the crystals used.

Modulator

It was desired to modulate the oscillator from a low source impedance and a regulated supply. The circuit used, shown in Fig. 7, consists of a commercially designed regulated power supply with a means for modulating the grid of the amplifier stage without upsetting the normal a-c or d-c feedback. Feedback is sufficient to make the gain essentially independent of tube variations, and lowers the output impedance. The supply used had an a-c gain of 2, an a-c and d-c impedance of less than 10 ohms and a maximum modulation capability of 20 percent.

The modulation depth is fixed by a careful measurement of the oscillator output power versus input supply voltage characteristic, and a calculation of the modulating voltage required.

The crystal mixer 1-kc resistance is measured with the bridge and bias circuit illustrated in Fig. 8. It is desirable to have the bridge output read equally for values of mixer resistance above or below the design value of 250 ohms by the same ratio. This is accomplished if the mixer is shunted by the design value and balances against a resistor of half the design value. In addition, the desired d-c bias source impedance is equal to the design value, and this same value is the desired terminating impedance for the conversion-loss measurement.

All these conditions are satisfied by the circuit illustrated, which is also designed to permit grounding of both the mixer and the millivoltmeter. In addition, only the 1-kc input needs switching in changing from the conversion loss to the resistance measurement.

The voltage output from the mixer when L_o is measured and the voltage level at the mixer when the

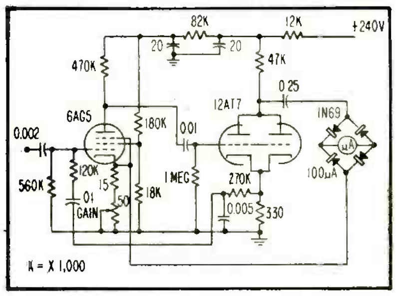


FIG. 9—One kilocycle millivoltmeter for production testing

i-f resistance is measured must both be kept at a low level.

The millivoltmeter used shown in Fig. 9 is a two-stage amplifier and bridge rectifier with sufficient degeneration effectively to stabilize the instrument from the effect of tube variations. The gain is controlled by adjustment of the feedback to take advantage of the maximum usable degeneration. Additional low-frequency negative feedback is supplied to reduce the sensitivity to hum voltage input without impairing the 1-kc characteristics. This circuit is normally adjusted to 4 millivolts full scale.

The production test equipment has proven extremely stable and will maintain its calibration within 0.1 db for a day's operation.

The author wishes to acknowledge the suggestions and assistance of C. J. Goodman and E. J. Jarrold in the measuring equipment.

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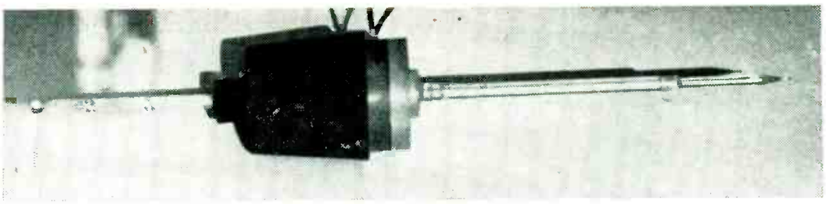


Immersion thermocouple comprises cold junction thermometer, cold-water chamber and hollow needle point containing hot junction, left to right

R-F Irradiation of Seeds

Dry seeds of carrots, onions and celery irradiated for short periods at 44.5 mc show higher percentage of germination than those untreated. Theory, optimum exposure and equipment for controlled experiments are described with a view towards possible conveyor-belt method of mass irradiation

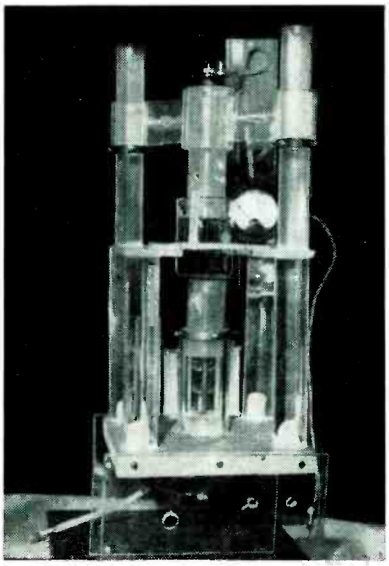
IMPERFECT GERMINATION is a problem for farmer and horticulturist. Various procedures for increasing percentage germination of seeds have been developed. Some of these use hot-bath or radiant heating techniques. Seeds have also been irradiated with selected radio frequencies for internal heating.

Preliminary experiments with a resonant-line, push-pull oscillator using two type 5-250A tetrodes feeding r-f power to a Pyrex beaker containing carrot, onion and celery seeds indicated that the rate of germination is a function of power input, d-c voltage gradient across the seed mass, frequency, time of exposure and state of the seed.

The period of exposure had to be limited to a few seconds. Experiments with the apparatus described below showed that the maximum germination rate was obtained when 103 cc of seed in a 17 × 88-mm Petri dish were irradiated from 10 to 11 seconds; 37.5 cal of r-f energy were introduced per cc of seed at a rate of 14 w per cc across an rms r-f gradient of 340 to 360 v per cm.[1]

These parameters produced external post-irradiation temperatures of between 42 and 50 deg C in various seeds. Higher temperatures were detrimental or even lethal. They may have caused internal temperatures of more than 70 deg C, which can inhibit biochemical systems. The distribution of some sugars in irradiated seeds exhibited a complete reversal from the controls. About 11 to 14 cal per cc were required to double the sugars subject to invertase action at the expense of a proportionate decrease of keto-sugars.

The r-f oscillator used for seed irradiations utilizes a grid-controlled type 3X2500A3 medium-μ triode at 44.5 mc. The seeds can be considered as aggregates of colloids of high viscosity with low r-f skin effects. Therefore, the r-f current passing through the seed is largely composed of the two vectors: $I_c = 2\pi f C_o K E$ and $I_r = I_c \tan \delta \approx I_c \cos \theta$.



Preliminary experiments were carried on with oscillator using two 5-250A tetrodes

R-F Currents

The in-phase current I_r is a function of the bulk capacitive leakage resistances, such as occur in vacuolar fluids with high K values. The reactive current I_c is a function of capacitances across membranes of living cells and between woody cells and large macromolecular complexes of proteins, fats and carbohydrates.

A mass of seeds is a uniform population of units of equal electrical characteristics arranged at random in the electrical field. The potential across this mass is a function of the interelectrode potential, dielectric constant, integrated ellipticity of all seeds and orientation of these ellipsoids in the r-f field. Thus, as shown in Fig. 1, a carrot seed parallel to the field will absorb more energy than one normal to it[2].

An evaluation of r-f effects on seed germination required quanti-

* Work done while author was a member of Department of Botany, University of California, Berkeley, Calif.

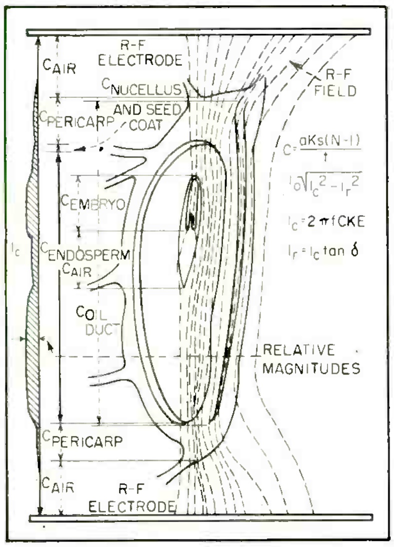


FIG. 1—Course of r-f lines of force longitudinally through a carrot seed

tative methods of administering prescribed dosages of high-frequency radiation. Prerequisites were: a stable frequency, a simple and quick-acting timing control, and sufficient power. The main circuit diagram indicates the cavity oscillator built around the Eimac 3X2500A3 triode operated at maximum anode potential of 6,000 v.

The grid is keyed through a bank of VR150's so that the blocking bias of −750 v can be reduced to −150 v for periods from 0.4 to 60 sec. Plate potential can be controlled manually or by a timer.

The oscillator is used in a single-ended circuit with a high ratio of tank to tube capacitance, which is important for biological work[3-6]. The cavity, a modification of designs[7,8], is shown in greater detail in Fig. 2.

A thin copper cylinder 19¼ in. high and 31 in. in diameter serves as the anode tank circuit. Its frequency is determined by a vertically sliding tuning cylinder and disk in electrical contact with the grid tank cylinder. The tube anode cylinder is set flush with the cover of the cavity and forms a plate-blocking capacitance of 0.01 μf. The grid ring of the tube is fitted into a copper ring flared out to serve as one side of the 5,800-μμf grid-leak capacitance.

The ungrounded side of the filament supply enters the cavity through a winged copper tube that serves as a cathode-voltage shield and as the cathode r-f coupling. The filament socket is air cooled with a supply pressure of 13 lb per sq in. Load coupling is at the edge of the plate-tuning disk opposite a slot in the cavity wall. The adjustable h-v electrode is supported by two inverted Pyrex U's.

Interelectrode potential and r-f power absorption in the sample were determined indirectly by calculation from the d-c plate and grid potentials[8]. It was assumed that the angle 2θ of the r-f current conduction in each cycle remains constant at any d-c plate potential higher than cutoff. This angle was calculated from the d-c plate and grid potentials. Then the rms voltage during the conduction period of each cycle can be found. This rms value was selected in preference to the rms value of the total cycle because the conducting fraction of each cycle determines the power input into the load.

Then the conducting negative

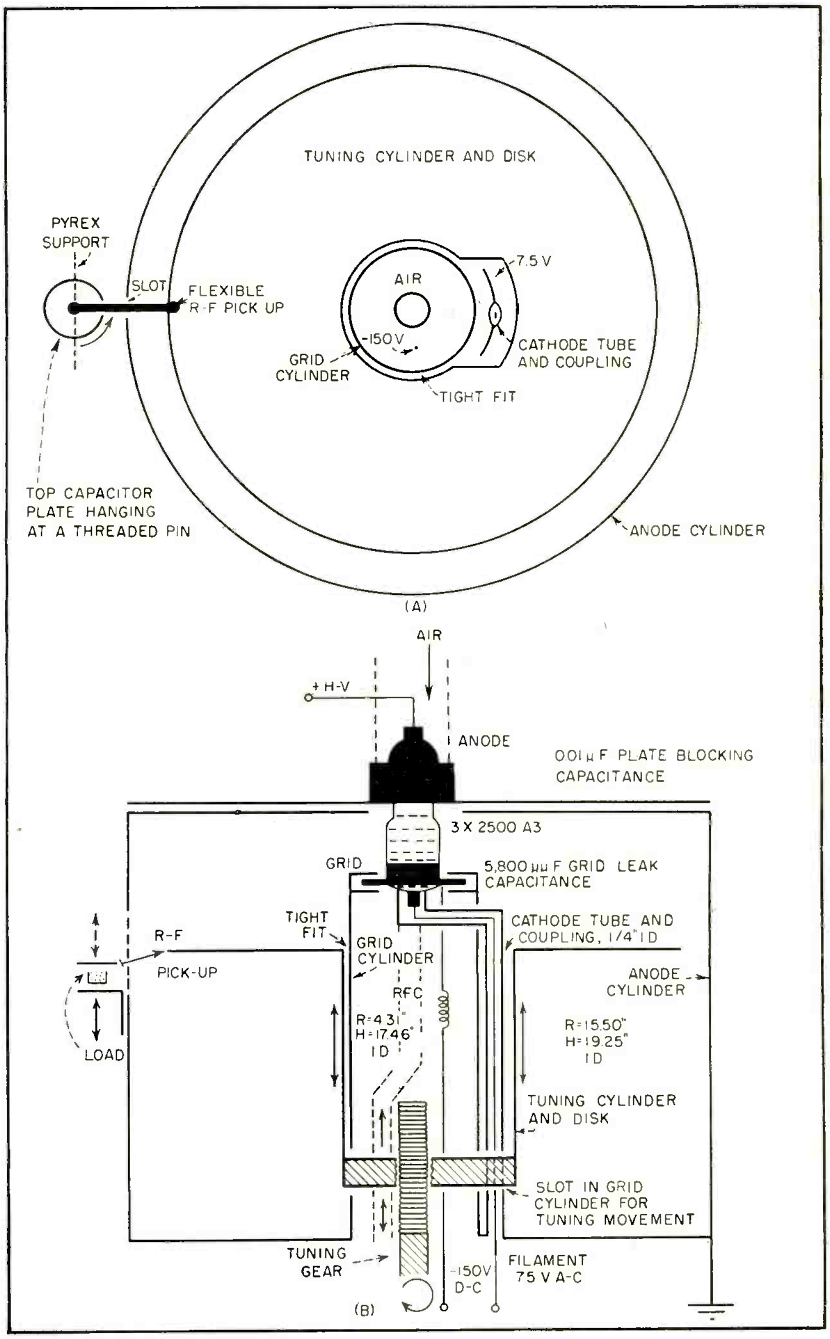


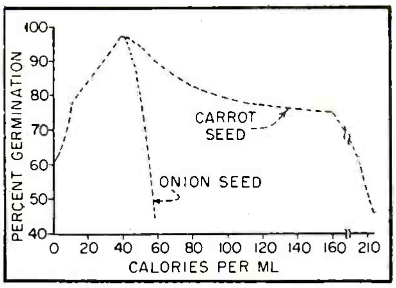
FIG. 2—Cross section of cavity oscillator (A) tuning cylinder at level of upper loading plate and (B) vertical section details

r-f swing has a potential $E = E_b - E_o(41.28/\theta)\ \sin(0.0345\ \theta)$, where E_o = r-f volts, E_b = d-c plate volts, E = rms volts across the electrodes, and $\theta = \frac{1}{2}$ angle of current flow. The power input into the sample $P_g = 5.58 \times 10^{-7} f(E_s/d_s)^2 K_s \cos\phi\ (1/s)$, or $P_{ml} = 16.417\ P_g s$; and the energy input $W = P\ (t/4.183)$, where P_g and P_{ml} = r-f power in watts per gram or watts per cc of load, E_s = rms potential across the sample, d_s = 0.9 cm of sample thickness, K_s = dielectric constant 3.20 of sample, $\cos\theta$ = load power factor of 0.090, s = relative density of sample, and f = frequency.

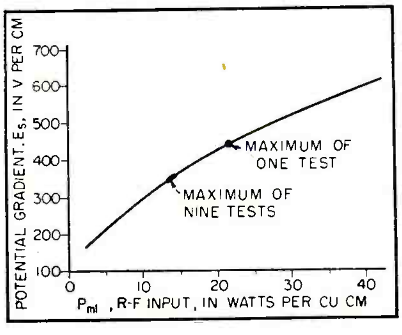
Seed temperatures were determined at the exact instant of the end of irradiation by an immersion thermocouple built into a number 26 hypodermic needle by John E. Gullberg of the University of California.

These experiments help to explain inconsistent results of earlier investigators who used frequencies anywhere between 20 and 225 mc[1, 10]. This range covers energy absorption bands of those macromolecules most common in seeds, as proteins and saccharide polymers. Whenever the period of exposure was less than 15 seconds some increase of the rate of germination occurred, especially when the external seed temperature did not rise more than 30 deg C and not above 60 deg C. Prerequisites for this were anode potentials of more than one kilovolt and consequent high r-f potentials across the load.

Most earlier experiments failed because requisite equipment was unavailable. Further work may concentrate on reducing the exposure period even more and on finding means to increase the rms r-f potential gradient across the seed mass without arcing. For this purpose centimeter waves may be of value. Then the energy input could be raised. There is still the question whether the enhancement of germination rates is part of a universal phenomenon applicable also to other well known biological r-f stimulations particularly in r-f therapy. It would also be interesting to know if the biological reaction results solely from the dielectric heating effect or also from some undefined molecular resonance.



Seed germination as a function of energy input for carrot and onion seeds



Variation of r-f power with potential gradient across the sample

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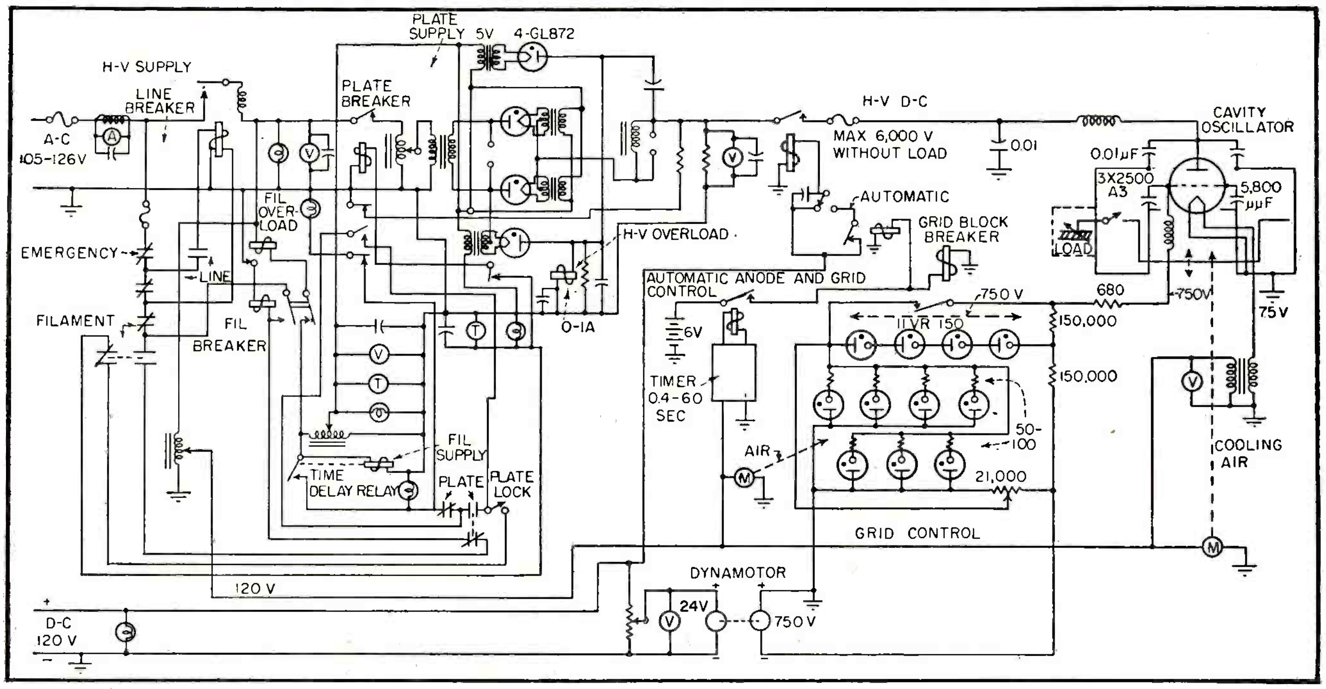

Circuit diagram of the radiation equipment includes timer for accurate dosage and safety controls for nontechnical personnel

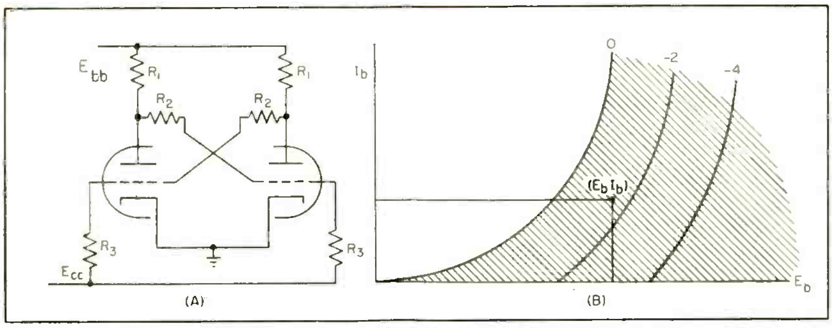

FIG. 2—Rudimentary circuit for steady-state design (A) and tube characteristic (B) showing operating point

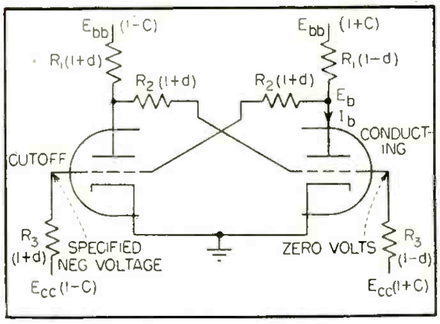

FIG. 3—Circuit showing conditions under which d-c stability is most difficult

How To Design

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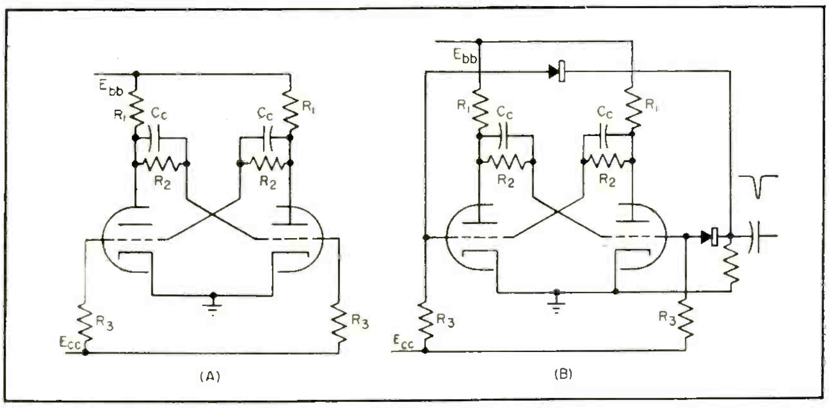

FIG. 1—Basic bistable multivibrator circuit (A) is modified for switching (B) by adding triggering network

BISTABLE multivibrators, such as the one shown in Fig. 1A, can remain quiescent indefinitely with either tube conducting and its opposite cutoff. This characteristic gives the circuit widespread usefulness in digital computers, counters and other pulse circuits.

If the basic circuit is modified as shown in Fig. 1B by addition of a triggering network, it may be switched from one stable state to the other. The transition between stable states is not treated in detail here, but certain factors that are related to the dynamic behavior of a complete circuit, such as minimum time between successive triggers, plate and grid waveforms and coupling capacitors, will be examined later.

* Now with The W. L. Maxson Corp., New York, N. Y.

The rudimentary circuit shown in Fig. 2A may be designed to insure stability of the stable states under adverse combinations of resistor deviations, supply voltage regulation and vacuum-tube emission deterioration. Since the circuit is symmetrical, it demands nominal symmetry of resistance values for proper operation. The design procedure described yields nominal values of resistance having a specified percentage tolerance, in conjunction with supply voltages E_{bb}, E_{cc} having specified regulation.

D-C Stability

The circuit of Fig. 1A will have two stable states if the conducting tube causes the voltage on the opposite grid to fall to cutoff or below, and if the cutoff tube causes the voltage on the opposite grid to rise to some point above cutoff. These two conditions are the basis of the design equations, with the second condition modified to read "the cutoff tube causes the voltage on the opposite grid to rise to zero." Zero is a more-or-less arbitrarily chosen point which, for all tubes, will insure conduction. It should be noted that although the coupling capacitors are essential for triggering the circuit they have no bearing on the d-c stability.

For a given tube, given resistors R_1, R_2, R_3 and given supply voltages E_{bb} and E_{cc}, plate voltages, grid voltages and all currents can be determined. If allowable resistance variation is specified as x percent and the supply variation as y percent, the conditions for d-c stability can be imposed in the form of two equations. One states that under the most adverse combinations of resistance and supply voltages the high grid is at cathode potential, which is assumed to be zero. The other states that under the opposite extremes the low grid is not above cutoff. Since the two conditions prevail in a common circuit, a third

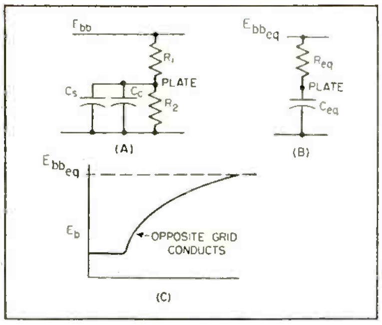

FIG. 4—Effect of coupling capacitor on switch-over

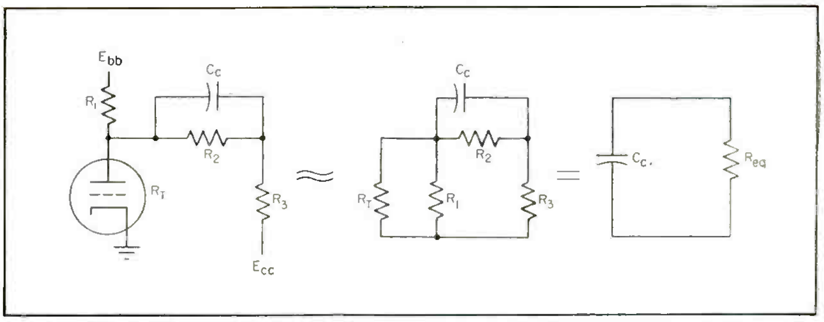

FIG. 5—Equivalent circuit showing the effect that the coupling capacitor has on the triggering rate

Bistable Multivibrators

Arrangement of flip-flop circuits for reliable operation despite adverse combinations of resistor deviations, supply voltage regulation and loss of tube emission. Guides are given for selecting the proper coupling capacitor and triggering network

independent equation can be written. There are then three equations with five unknowns (the two supply voltages and the three resistors), and it should be possible to solve for R_1, R_2 and R_3 in terms of E_{bb} and E_{cc}.

An arbitrary point E_b, I_b in the shaded region of the plate characteristics, Fig. 2B, is selected. This point is associated with the extreme values of voltage and resistance indicated in Fig. 3. Under those conditions, an equation is written stating that the grid voltage of the on tube is zero

$$\frac{[E_{bb}(1-c) - E_{cc}(1+c)]\,[R_3(1-d)]}{R_1(1+d) + R_2(1+d) + R_3(1-d)} + E_{cc}(1+c) = 0 \qquad (1)$$

Another equation states that the assumed E_b keeps the opposite grid at a specified negative voltage, E_g equal to or slightly beyond cutoff

$$\frac{[E_b - E_{cc}(1-c)]\,[R_3(1+d)]}{R_2(1-d) + R_3(1+d)} + E_{cc}(1-c) = E_g \qquad (2)$$

A third equation can be written that states that the current through R_1 is equal to the assumed plate current I_b plus the current through resistor R_2

$$\frac{E_{bb}(1+c) - E_b}{R_1(1-d)} = I_b + \frac{E_b - E_g}{R_2(1-d)} \qquad (3)$$

These equations can be solved for nominal resistances R_1, R_2 and R_3. Results are expressed in terms of E_{bb}, E_{cc} the arbitrary values E_b and I_b, the specified negative grid voltage E_g, the resistor tolerance d, and the voltage tolerance c

$$R_1 = \frac{1}{(1-d)\,I_b}\left[(1+c)\,E_{bb} - E_g + \left(\frac{1-d}{1+d}\right)^2\left(\frac{1-c}{1+c}\right)\frac{E_{bb}\,E_g}{E_{cc}} - \left(\frac{1-d}{1+d}\right)^2\frac{(1-c)^2}{(1+c)}\,E_{bb}\right] \qquad (4)$$

$$R_2 = \frac{E_b - E_g}{(1-d)\,I_b}\,\frac{\left[(1+c)\,E_{bb} - E_g + \left(\frac{1-d}{1+d}\right)^2\left(\frac{1-c}{1+c}\right)\frac{E_{bb}\,E_g}{E_{cc}} - \left(\frac{1-d}{1+d}\right)^2\frac{(1-c)^2}{(1+c)}\,E_{bb}\right]}{\left[E_g - E_b - \left(\frac{1-d}{1+d}\right)^2\left(\frac{1-c}{1+c}\right)\frac{E_{bb}\,E_g}{E_{cc}} + \left(\frac{1-d}{1+d}\right)^2\frac{(1-c)^2}{(1+c)}\,E_{bb}\right]} \qquad (5)$$

$$R_3 = \left[\frac{E_g - (1-c)\,E_{cc}}{(1+d)\,I_b}\right]$$

$$\frac{\left[(1+c)\,E_{bb} - E_g + \left(\frac{1-d}{1+d}\right)^2\left(\frac{1-c}{1+c}\right)\frac{E_{bb}\,E_g}{E_{cc}} - \left(\frac{1-d}{1+d}\right)^2\frac{(1-c)^2}{(1+c)}\,E_{bb}\right]}{\left[E_g - E_b - \left(\frac{1-d}{1+d}\right)^2\left(\frac{1-c}{1+c}\right)\frac{E_{bb}\,E_g}{E_{cc}} + \left(\frac{1-d}{1+d}\right)^2\frac{(1-c)^2}{(1+c)}\,E_{bb}\right]} \qquad (6)$$

In order that positive values of resistance for R_1, R_2 and R_3 are insured, E_{bb} must be greater than a certain lower limit, and E_{cc} must be algebraically less than a certain upper limit. These restrictions on E_{bb} and E_{cc} may be written

$$E_{bb} > \frac{E_b - E_g}{\left(\frac{1-d}{1+d}\right)^2\frac{(1-c)^2}{(1+c)}} \qquad (7)$$

$$E_{cc} < \frac{\left(\frac{1-d}{1+d}\right)^2\left(\frac{1-c}{1+c}\right)E_{bb}\,E_g}{E_g - E_b + \left(\frac{1-d}{1+d}\right)^2\frac{(1-c)^2}{(1+c)}\,E_{bb}} \qquad (8)$$

Three equations are thus derived which, when used to select values for R_1, R_2 and R_3, will insure that the circuit of Fig. 3 is bistable even under the extreme deviations of the resistances and voltages from their nominal values, and even when the tube emission becomes so low that the arbitrarily selected point E_b, I_b corresponds to zero bias. By choosing the point E_b, I_b deeper in the shaded portion of Fig. 2A, that is, by lowering the ratio of I_b to E_b, the design can be made even more conservative, insuring bistability for a long life. This, however, results in larger values for R_1, R_2 and R_3, since all resistors are inversely proportional to I_b, and therefore it results also in a lower permissable trigger rate.

The actual operating point of a nominal tube is not at E_b, I_b but at the intersection of its load line with the nominal zero-bias plate characteristic. Therefore, I_b in the actual circuit is always greater than the arbitrarily chosen value; thus, the point E_b, I_b should never be taken at or near the maximum allowable plate current.

Coupling Capacitor

The coupling capacitor allows switching between stable states. If it were not present, the reversing impulse would bring both halves to identical conducting states and the final state would be independent of the initial state. A practical way to obtain the proper size of this capacitor is the empirical approach guided by some basic facts.

In order to convey most efficiently the leading edge of the rising plate waveform to the grid of the cutoff tube, the coupling capacitor should be larger than the interelectrode capacitance between grid and cathode of the cutoff tube.

The rate-of-change of the rising plate waveform will affect the size of the coupling capacitor, since a slowly rising plate waveform, due either to high stray capacitance or slowly falling trigger, requires a higher coupling capacitance to pass the rising wavefront to the grid of the cutoff tube. The falling plate always drops faster than the ascending plate rises; therefore, it is only necessary to insure that the rising waveform be satisfactorily conveyed to the grid of the cutoff tube.

The first two criteria tend to increase the size of the coupling capacitor. However, although higher capacity increases the certainty of switch-over, it also increases the time required for the rising plate voltage to reach its quiescent value.

Figure 4A is an equivalent circuit of one half of Fig. 1A during the time that the opposite grid is conducting and R_2 and the coupling capacitor C_c are essentially clamped

DESIGN PROCEDURE

In the following expressions resistor tolerance is assumed to be $d = \pm 10$ percent and the voltage tolerance $c = \pm 5$ percent. With $d = \pm 10$ percent, this means that 5 percent resistors must be used in the circuit, and that the remaining percentage accounts for the necessity of choosing RMA values different from the calculated values.

STEP 1— Select point E_b, I_b somewhere below the zero-bias line, keeping in mind that small ratios of I_b to E_b will mean larger resistors (therefore slow triggering rates), and that plate dissipation must not be exceeded by the actual I_b, which will always be larger than the chosen value of I_b, except when tube emission deteriorates to the extent where E_b, I_b is actually the operating point.

STEP 2— If the tube being used is a pentode, for a given screen grid voltage obtain the cutoff bias E_g. This will be a negative number. If the tube being used is a triode, the cutoff bias varies with plate voltage, and may be approximated by $E_g \approx -KE_{bb}$. This equation may be plotted using published tube characteristics, and the constant K is obtained as the slope of the line.

STEP 3— The lower limit for E_{bb} can now be calculated. For a pentode, $E_{bb} > E_b - E_g/0.576$, and, for a triode, $E_{bb} > E_b/0.576 - K$.

STEP 4— Select a value for E_{bb} greater than the lower limit. The desired plate voltage swing will be a factor in determining this, for it is approximately equal to $E_{bb} - E_b$.

STEP 5— The upper limit for E_{cc} may be calculated. For a pentode

$$E_{cc} < \frac{0.605\,E_{bb}E_g}{E_g - E_b + 0.576\,E_{bb}}$$

and, for a triode

$$E_{cc} < -\frac{0.605\,KE_{bb}^2}{E_{bb}\,(0.576 - K) - E_b}$$

If the pentode equation is used, the magnitude of the boundary value always decreases for increasing E_{bb}, and, if the triode equation is used, the magnitude of the boundary value decreases with increasing E_{bb} until E_{bb} is twice the value of its lower limit. Then it increases with increasing E_{bb}.

STEP 6— Select a value for E_{cc} less than the upper boundary. Notice that the boundary is a negative number and that a value must be taken more negative.

STEP 7— Calculate the resistance R_1, R_2 and R_3 from Eq. 4, 5 and 6. They are, with $c = 0.05$ and $d = 0.1$ substituted

$$R_1 = \frac{1}{I_b}\left[0.527E_{bb} - 1.11E_g + 0.672\,\frac{E_{bb}E_g}{E_{cc}}\right]$$

$$R_2 = \frac{E_b - E_g}{I_b}\left[\frac{0.527E_{bb} - 1.11E_g + 0.672\,\frac{E_{bb}E_g}{E_{cc}}}{E_g - E_b - 0.606\,\frac{E_{bb}E_g}{E_{cc}} + 0.576\,E_{bb}}\right]$$

$$R_3 = \frac{|E_g - 0.95E_{cc}|}{I_b}\left[\frac{0.431E_{bb} - 0.91E_g + 0.552\,\frac{E_{bb}E_g}{E_{cc}}}{E_g - E_b - 0.606\,\frac{E_{bb}E_g}{E_{cc}} + 0.576E_{bb}}\right]$$

These equations may also be used in cases where triodes are employed, simply by substituting the equation $E_g = -KE_{bb}$. From these equations, it can be seen that R_1 is independent of E_b. However, R_2 and R_3 increase as E_b increases.

Pentode

Tube—6AN5 ($E_{g2} = 40$ volts)
c = ± 10 percent
d = ± 20 percent (This permits 10 percent resistors)

STEP 1— The point $E_b = 10$ volts, $I_b = 8$ ma was chosen. Since the point is below the knee of the zero-grid-bias characteristic, the plate voltage will be relatively insensitive to the plate load resistor.

STEP 2— $E_g = -15$ volts ($E_{g2} = 40$ volts)

STEP 3— $E_{bb} > 76.5$ volts (see Eq. 7)

STEP 4— E_{bb} was chosen to be 120 volts to give a plate swing of approximately $120 - 10 = 110$ volts.

STEP 5— $E_{cc} < -45.8$ volts (see Eq. 8)

STEP 6— E_{cc} was chosen to be -80 volts.

STEP 7— From Eq. 4, 5 and 6

$R_1 = 18{,}150$ ohms
$R_2 = 75{,}200$ ohms
$R_3 = 114{,}200$ ohms

The RMA standard values chosen were

$R_1 = 18{,}000$ ohms
$R_2 = 75{,}000$ ohms
$R_3 = 110{,}000$ ohms

The d-c measurements on this circuit were:

	Tube 1	Tube 2
High plate voltage	*96.5*	*97*
Low plate voltage	*8.6*	*8.3*
High grid voltage (tube removed)	*27.8*	*25*
Low grid voltage	*−28.6*	*−27.7*
Plate swing voltage	*87.9*	*87.8*

Triode

Tube—12AU7 (cutoff constant $K = 0.1$)
c = ± 5 percent
d = ± 10 percent (This permits 5 percent resistors)

STEP 1— From the limit inequality for E_{cc} given by Eq. 8, solve for E_b

$$E_b < \frac{0.605\,KE_{bb}^2}{E_{cc}} + E_{bb}\,(0.576 - K)$$

and by substituting for E_{bb} and E_{cc}

$$E_b < 53.2 \text{ volts.}$$

STEP 2— On the 12AU7 plate characteristic curves, choose a point such that $E_b < 53.2$ volts and which will lie below the zero bias line. The point chosen was $E_b = 40$ volts, $I_b = 2$ milliamperes.

STEP 3— Calculate the three resistors R_1, R_2 and R_3 from Eq. 4, 5 and 6

$R_1 = 58{,}000$ ohms
$R_2 = 241{,}000$ ohms
$R_3 = 202{,}500$ ohms

The RMA standard values chosen were

$R_1 = 56{,}000$ ohms
$R_2 = 240{,}000$ ohms
$R_3 = 200{,}000$ ohms

With these resistance values, the nominal value of the high grid voltage (with the tube out) was calculated to be

$$E_{g\,high} = \frac{R_3\,(E_{bb} - E_{cc})}{R_1 + R_2 + R_3} + E_{cc} = 15.6 \text{ volts.}$$

The low grid voltage, for nominal voltages and resistances and the tube operating point at $E_b = 40$ volts, was calculated to be, approximately

$$E_{g\,low} \approx \frac{R_3\,(E_b - E_{cc})}{R_2 + R_3} + E_{cc} = -22.7 \text{ volts}$$

For comparison, the measured values on this circuit were as follows:

	Tube 1	Tube 2
High plate voltage	*105*	*110*
Low plate voltage	*23.6*	*28*
High grid voltage (tube removed)	*16.5*	*16.2*
Low grid voltage	*−30*	*−28*
Plate voltage swing	*81.4*	*82*

In circuits of this type, it is often desirable to know how far off the nominal values the supply voltages can go and still have stable operation. Measurements with this 12AU7 triode flip-flop showed that the unclamped grid voltage (that is, the potential at the junction of R_2 and R_3 when the tube is removed) could be brought to zero by lowering the bias supply from −75 volts to −96 volts, a change of 28 percent, or by lowering the B+ supply from 150 volts to 125 volts, a change of 17 percent. Conversely, it was found that to turn on the cutoff tube the bias supply would have to rise to −36 volts, a change of 52 percent, or the B+ supply would have to rise to 190 volts, a change of 27 percent. These results indicate that the design is quite conservative, and stable operation would probably be obtained over wider variations of the supply voltages than those tolerances used in establishing the size of R_1, R_2 and R_3.

to ground. Capacitor C_s of Figure 4A is stray capacitance between plate and cathode. From Thevenin's theorem another equivalent circuit, Fig. 4B, can be derived, where

$$E_{bbeq} \approx \frac{R_2}{R_1 + R_2}\,E_{bb}$$

$$R_{eq} = \frac{R_1\,R_2}{R_1 + R_2}$$

$$C_{eq} = C_c + C_s$$

Thus, the rising plate waveform may be approximated by a rising exponential, Fig. 4C, representing the charging of the coupling and stray capacitances toward the quiescent value of the high plate voltage. The initial sharp rise of the curve is essentially the amplified version of the negative trigger signal on the grid. A break or discontinuity occurs when the opposite grid is driven to conduction, and the coupling capacitor is clamped to ground and effectively shunted across the plate-to-cathode capacitance.

Triggering Rate

Minimum time between reversals is affected by the size of the coupling capacitor by virtue of the fact that it is related to the time needed by the coupling capacitor connected to the high plate to discharge to its quiescent low voltage. During this transient, the discharge current passing through R_3 temporarily lowers the voltage on the cutoff grid beyond its steady-state bias. Consequently, if it is desired to reverse the circuit before it completely relaxes, a greater trigger amplitude is needed. To obtain the time constant of the discharge, the equivalent circuit of Fig. 5 is developed, from which it may be written

$$T = R_{eq}\, C_c$$

where T is the time constant, and

$$R_{eq} = \frac{R_2\left[R_3 + \dfrac{R_1 R_T}{R_1 + R_T}\right]}{R_2 + R_3 + \dfrac{R_1 R_T}{R_1 + R_T}}$$

As a check on the size of the coupling capacitors, connect a trigger circuit to the multivibrator grids. Connect all appendages to the circuit such as cathode-follower grids and resistance voltage dividers. Reduce the trigger amplitude until the multivibrator just fails to flip over. This can be verified by a scope probe on the low plate. If the coupling capacitor is large enough, the trigger amplitude at this critical point should not drive the grid much more than half-way toward cutoff. Should pulses larger than this be needed for triggering, reliable operation will be uncertain when using tubes with reduced G_m.

Trigger Networks

The trigger network connects to the rudimentary circuit in a symmetrical way and steers the trigger pulse to the proper tube to cause reversal. The trigger is either positive or negative. Positive pulses effect switching by turning on the off tube. Negative pulses turn off the on tube.

Generally, the negative pulse can be smaller than the positive pulse because the on tube amplifies the trigger pulse.

The circuit of Fig. 6A uses large-amplitude negative pulses or steps. If a negative trigger is applied to the capacitor, it will appear attenuated at both plates, but the attenuation is greater at the plate of the conducting tube. Therefore, only a small negative pip passes through the coupling network to the negative grid. The cutoff tube does not attenuate the signal as much and a large negative pulse is applied to the conducting grid. The coupling-circuit time constant is not critical since differentiation of a step wave occurs in the cross-coupling network.

Smaller Pulses

The circuit of Fig. 6B takes negative triggers or steps of smaller amplitude. The diodes steer the negative wave to the high plate and thence to the high grid; they also isolate the trigger source from the plate as soon as regeneration starts.

If the coupling circuit does not have a sufficiently small time constant compared to the turn-over time, the rising plate will be depressed slightly near the top of its excursion by the negative input waveform.

The input time constant should be small enough compared to the repetition period of the triggers to prevent biasing of the coupling diodes.

Since the high plate is somewhat below E_{bb}, the input wave must overcome the differences between the high plate voltage and E_{bb} before passing through the diode.

If thermionic diodes are used, the relation of R_1 *to* R_k is unimportant. But germanium diodes may have a back resistance, R_b, comparable to the plate resistor so that the effective plate resistor is R_1 in shunt with R_b and R_k in series.

The circuit of Fig. 6C takes directly on the grid negative pulses whose duration is short with respect to turnover time. This circuit requires the smallest-amplitude pulses.

If R_3 is not small compared to R_b of a germanium diode, the negative grid will be raised.

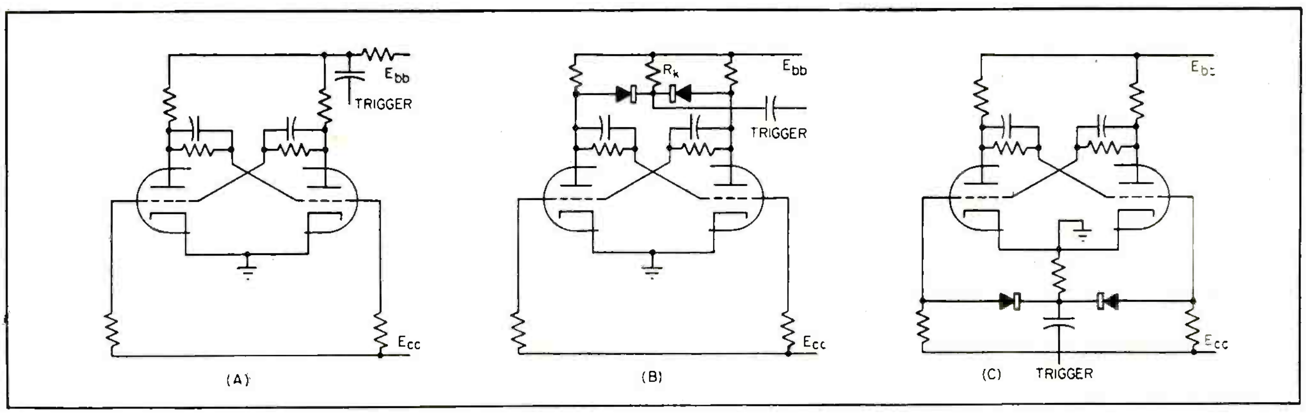

FIG. 6—Flip-flop with triggering network designed for large-amplitude negative pulses or steps (A); for smaller negative pulses (B); and for still smaller negative pulses of short duration (C)

Cathode-Interface Effects In TV Receiver Design

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Judicious choice of tube types by television receiver designers can forestall development of cathode interface resistance thereby extending useful life of tubes. Principles apply also to design of mobile radio equipment and electronic computers

SLEEPING SICKNESS, the popular term for cathode interface resistance, has long been a bugbear to computer engineers. This article analyzes its effects in typical television receiver applications.

Interface resistance acts circuitwise like an inadequately bypassed cathode resistor. It affects primarily high g_m tubes with small cathode areas. In television and i-f stages, interface resistance causes loss of gain; in video amplifiers it causes loss of low-frequency response as well. Interface resistance can also produce malfunctioning in multivibrators and blocking oscillators.

Interface impedance builds up to some degree in all cathodes but reaches rather high values in active cathodes. The resistance compound is barium-ortho-silicate, a semiconductor. The higher the percentage of silicon in the cathode, the greater will be the formation of interface resistance. Interface resistance

Table I—Simulated Typical Values of Cathode Interface Resistance Illustrate Effect on Television Receiver Tube Characteristics

TYPE	Cathode Area in Cm^2	Predicted Interface Resistance in Ohms			Loss of I_b in Percent			Loss of g_m in Percent (vlf)			Loss of g_m in Percent (h-f)		
		A	B	C	A	B	C	A	B	C	A	B	C
12AT7	0.270	93	279	465	20	40	50	40	70	75	15	30	40
6BK7A	0.335	75	225	375	40	55	65	50	75	85	25	50	55
6AF4	0.215	116	348	580	30	50	60	50	75	85	20	35	50
6AU6	0.740	33	100	165	15	30	50	25	50	80	10	25	30
6CB6	0.499	50	150	250	15	25	45	35	65	75	15	25	35
6BH6	0.443	56	168	280	25	50	60	40	65	75	20	40	45
6AH6	0.925	27	81	135	10	25	35	25	55	65	10	20	25
6SN7GT	0.745	33	99	165	5	15	25	10	25	35	5	10	20
12AU7	0.405	62	186	310	10	25	40	20	40	55	10	20	25

Column	Normalized Resistance in $Ohm\text{-}Cm^2$
A	25
B	75
C	125

Note—Regular bias by means of bypassed cathode resistor in every case except 6SN7GT and 12AU7 varies inversely with cathode area.

Operation with no space current develops higher interface resistance than if space current is drawn[1]. Higher-than-normal operating temperature accelerates formation of interface resistance. However, Fig. 1 shows that, consistent with the negative temperature characteristic of semiconductors, measured interface resistance varies inversely with cathode temperature[2].

A barrier capacitance is associated with interface resistance[8]. For our purposes, interface impedance will be treated as a parallel R-C circuit with time constant of 0.2 to 0.5 microsecond.

What It Does

Since operational effects are exactly the same as for an inadequately bypassed cathode resistor, low-frequency sine waves show the effect of added bias and cathode degeneration, while high-frequency sine waves exhibit only the effect of added bias. Waveforms with steep wavefronts have overshoots, a typical result of poor low-frequency response.

It is easy to reach the false conclusion that tube emission is the cause of low transconductance when interface resistance is the actual culprit. Assume we find a 6BK7A with g_m 30 percent low and emission is suspected. According to curve *C*, Fig. 2, 30-percent-low g_m indicates a possible interface resistance of 29 ohms. Referring to Fig. 1, if the heater voltage is lowered ½ volt or 8 percent, the interface resistance increases to 75 ohms and the apparent g_m is now 55 percent low. On the other hand, if heater voltage is increased to 6.8 volts, 8 percent high, the interface resistance will drop to 10 ohms and the apparent g_m becomes almost normal. With a transconductance variation of this sort with heater voltage, it is certainly easy to convict the tube of having low emission.

At high frequencies the interface resistance is bypassed and the loss in transconductance is not nearly as severe as Fig. 2 shows. Only d-c degeneration is present. Thus the loss of gain in the presence of interface is actually less than low-frequency transconductance measurements imply.

In the case of waveforms containing steep wavefronts there will be, in addition to the loss of gain, overshoots proportional to the amount the plate current has fallen off as the result of interface development. The percentage decrease in plate current as a function of R_k was also determined for the same tubes. The plate current drop, of course, is not as great as the transconductance drop.

For example, a 6BK7A with 50 ohms of interface resistance would show an overshoot of 25 percent if a square wave were applied to its grid, and the input signal appropriately increased to give the original output voltage.

Figure 3 shows the plate waveform of a 6AH6 having an interface impedance of 17 ohms and 0.02 microfarad when measured at 6.3 volts heater voltage. The three waveforms are for operation with heater voltages of 5.5, 6.3 and 7 volts and demonstrate the extreme sensitivity of interface resistance to cathode operating temperature.

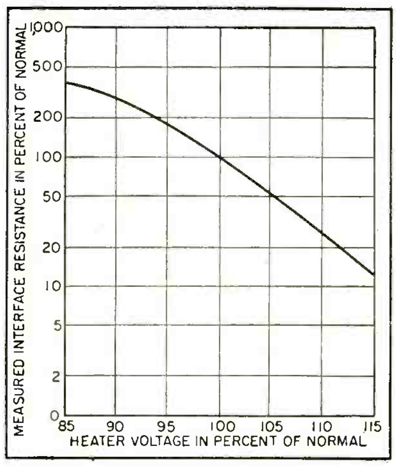

FIG. 1—Measured values of cathode interface resistance plotted as a function of heater voltage

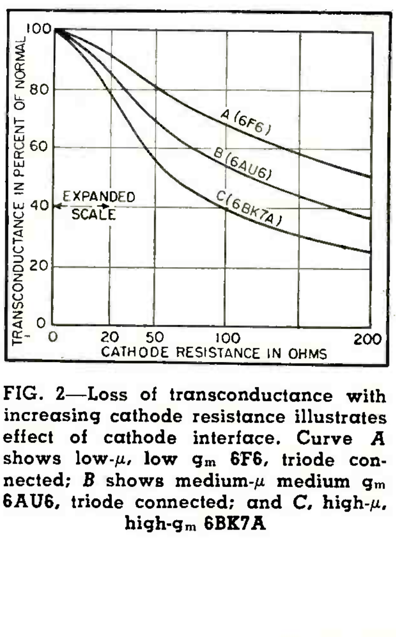

FIG. 2—Loss of transconductance with increasing cathode resistance illustrates effect of cathode interface. Curve *A* shows low-μ, low g_m 6F6, triode connected; *B* shows medium-μ medium g_m 6AU6, triode connected; and *C*, high-μ, high-g_m 6BK7A

Application

To obtain actual values of interface resistance, a group of 12SN7GT's, half of which had moderate silicon in the cathode sleeves and half of which had relatively high silicon in the cathode were run for 2,000 hours under various operating conditions, 2,000 hours being representative of a year's operating life for a television set. The results varied so widely that only broad average conclusions could be drawn. When operated at rated heater voltage and a range of space current of from one to ten milliamperes, both normal and active cathodes developed about the same interface resistance, its normalized value ranging from zero to over 100 ohm-cm². With high-heater-voltage operation, 12 percent high, normal cathodes had about the same range, but the active cathodes were substantially higher, averaging about 125 ohm-cm². There was some indication that interface resistance developed higher values in multivibrator operation.

Using values obtained in this life test we can consider what may happen if such interface resistance values develop in service. Table I shows several common television tubes with assumed normalized interface resistance values of 25, 75 and 125 ohm-cm². Tubes with small cathode areas and high g_m and/or high μ such as the 6AF4 and 6BK7A are particularly vulnerable to interface effects. In low-frequency circuits these tubes may lose 80 percent of their g_m. Even in the usual h-f or vhf applications, it is entirely possible in 2,000 hours to have the transconductance decreased almost 50 percent by interface effects.

Both the 6SN7GT and the 12AU7 have similar ratings and both have been used in the same type of service, but the 12AU7, because of its smaller cathode area, can develop almost twice as much interface

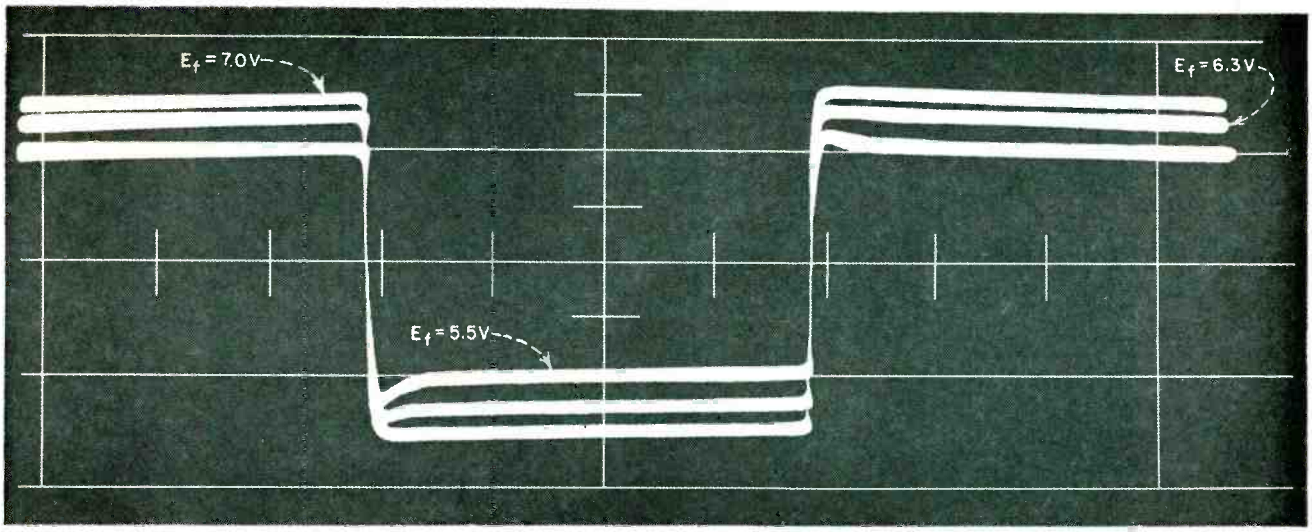

FIG. 3—Plate-voltage waveform for 6AH6 with 50-kc square-wave excitation. Overshoots due to cathode interface resistance are noted as heater voltage is reduced

resistance as the 6SN7GT in the same length of time. In i-f amplifiers also, the tubes with the larger cathodes are the best from a life standpoint.

In 2,000 hours, three 6AU6 i-f amplifiers would be down about 30 percent in gain if 25 ohm-cm² of interface resistance is present. On the other hand, 6BH6's with the same normalized interface would be down 50 percent. Power output tubes and deflection amplifiers generally have large cathodes and low μ, and ordinarily are little affected in usual service by interface resistance.

Video Amplifiers

In video amplifiers, the poor low-frequency response which is the result of interface predicts that black areas turning sharply to grey would have a white trailing edge, while white areas turning to grey would have a black edge. This can be demonstrated by the addition of external capacitance and resistance to simulate interface impedance. However, with typical television signals it was found necessary to use rather high impedance values before such edge effects occurred. Apparently, in the usual television system the high-frequency response is none too good and low values of interface impedance only add a form of high-frequency peaking.

However, with values of 200 ohms in a single-stage video amplifier pentode, it was possible to get edge effects. Also, overshoot on the leading edge of the blanking pulse caused sync to occur sometimes on the blanking rather than the synchronizing pulse, with the result that the picture moved to the left and showed a tendency to vertical instability. However, it is not likely that 200 ohms interface resistance can be developed in 2,000 hours in tubes of this description because of their large cathode areas.

Other Effects

In the usual ringing-coil horizontal multivibrator it was found that when a simulated impedance having a resistance of 300 ohms was used, it was no longer possible to hold sync by the usual front panel controls, and with 400 ohms it was impossible to hold sync with any control. The same 300-ohm figure gave similar results in the usual syncro-guide circuit. In neither case was it found that the time constant of the impedance was of any importance.

Values of 300 ohms are entirely possible in some tubes used in multivibrator and syncro-guide service, particularly if the set runs a great deal on high line voltage and is occasionally called upon to operate at low line. Vertical blocking oscillators were found to be quite unaffected by cathode impedance. For low values of simulated resistance the vertical size actually increased, and it was necessary to get up to values of 800 to 1,000 ohms before performance suffered.

Real difficulty with interface resistance is most likely to occur when the tubes operate at high heater voltage during most of their life but are called upon occasionally to operate at low voltage. The classic case of this is the automobile receiver where the source voltage with the generator charging may be 7 volts with perhaps 6.8 volts at the tube heaters. However, operation is also expected without the battery charging and with tube heaters working at 5.5 volts, where any interface resistance which may have been developed is increased about three times.

Fortunately, long tube life is not expected in auto sets; 500 hours at full 6.8-volt represents many thousand miles of normal use. However, there are other mobile applications such as police and taxicab sets where 2,000 hours can be run up in a short time.

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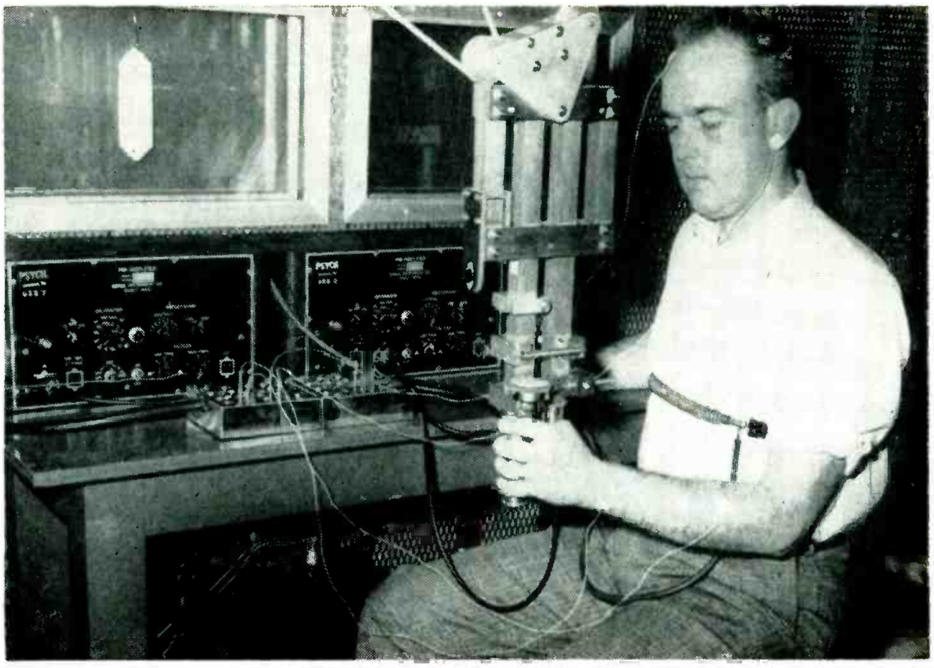

Electrodes take bioelectric potentials from arm muscle and frontal lobe of brain to measure strain and effort of subject exercising on isometric dynamometer

Bioelectric Integrator

Circuit quantifies bioelectric potential from muscles to measure strain and effort of human subjects performing various tasks. Data obtained may aid engineers in reducing operator fatigue and inefficiency through proper design of instrument controls

ELECTRONIC measuring instruments are widely used in experimental psychology. Work, fatigue, effort, sensory-motor control and even mental attitude can be better understood from measurement of bioelectric potentials taken from human subjects.

Importance of measuring strain and effort was suggested by an Air Force research assignment the goal of which was to design machines and instruments better adapted to the characteristics of human operators.

Although the Air Force project was restricted to measurement of speed and error when instrument controls were changed in various experimental ways, it was felt that measurement of strain and effort would be a valuable addition to speed and error data. A direct index of strain and effort can be obtained by recording the bioelectric effects of the muscles used.[3, 4]

Amplification

Electrical output of warm-blooded tissue taken from the surface of the skin varies, after conduction losses, from 10 to 500 microvolts depending upon the size of the pickup electrode. This output is a summation of the activity of millions of body cells acting generally in unsynchronized bursts of volley impulses. Frequency analysis show that frequencies from $\frac{1}{3}$ to 5,000 cps are involved.

Three similar instruments are commonly used for amplification of bioelectric potentials: the electrocardiograph for making tracings of heart action; the electroencephalograph for making tracings generally called brain waves; and the electromyograph for making tracings from the bioelectric output of muscles. A commercial instrument is now available that can be used for all three functions merely by adjusting calibrated filter networks to pass the characteristic dominant frequencies found in each.

Most commercial instruments have been built to yield paper tracings that discriminate severely against higher frequencies, and

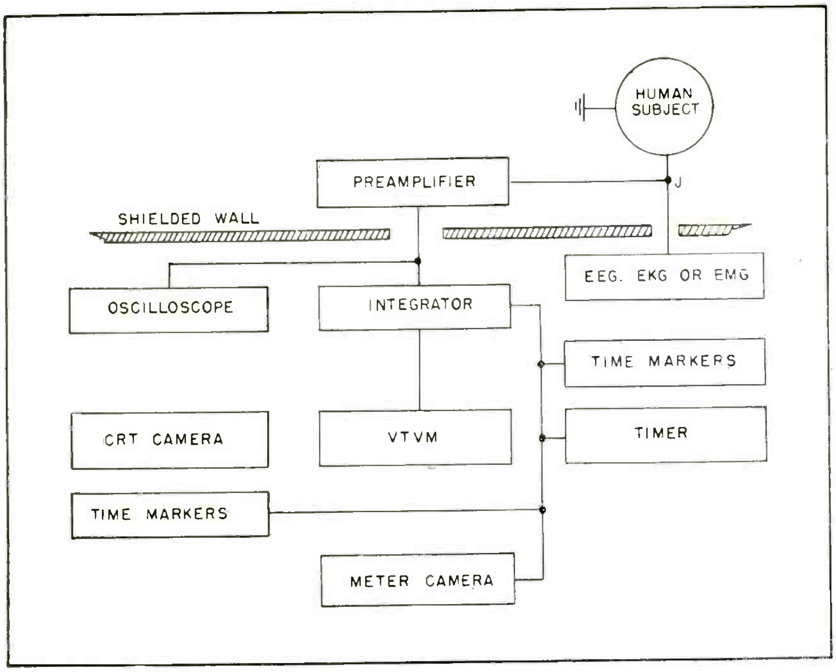

FIG. 1—Arrangement of instruments used to study human strain and effort by measuring bioelectric potentials

EASIER KNOB-TWISTING

Design of controls can be as important to the performance of electronic equipment as design of circuits.

Poorly designed controls create operator fatigue that can lead to inefficient operation and substandard performance of the man-machine team.

After World War II, the Air Force began to study radar operator's speed versus error with a view to improving the design of knobs used for linear scale settings.[1-2] The operator ranged on targets displayed on an A-scope simulator. His speed and errors were recorded and correlated with changes made in range-dial diameter, dial friction and ratio of range-step travel to dial rotation.

Results suggested that a direct measure of strain and effort would be a valuable addition to speed versus error data.

It now appears that both physical and mental strain and effort may be quantified. Such data may soon enable equipment designers to tailor instruments to fit best the characteristics of the average operator

Gages Strain and Effort

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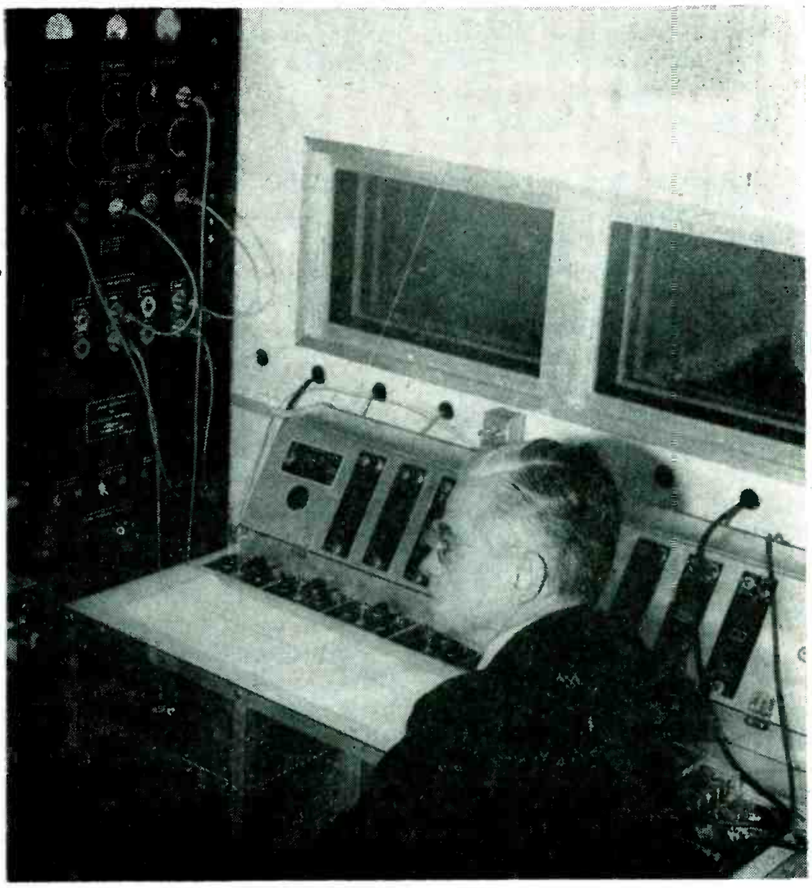
from such data only qualitative interpretations are generally possible. On the basis of such recordings the alpha and beta brain waves were discovered. However, custom-made assemblies have included cathode-ray tube photography and these have produced tracings of the higher frequencies complicated only by the problem of noise. Amplification to a million times is often needed.

Integration

Bioelectric output may be quantified by securing the integral of the complex potential waveform. Earlier instrumentation for summing the area under the amplified bioelectric output curve provided a



Bioelectric integrator outside shielded room quantifies potentials taken from subject. Electroencephalograph at right makes continuous paper tracing

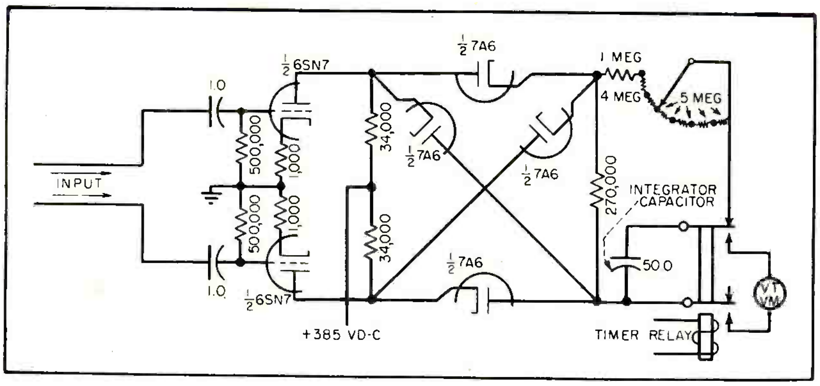


FIG. 2—Schematic shows one channel of four-channel bioelectric integrator. Additional R-C amplifier may be switched in when dealing with low potentials

series of $\frac{1}{10}$-second integrations registered on photographs of a crt face.

The instrument described is capable of summating a record three minutes or longer in duration or any fraction of this time. Output is measured directly by a vacuum-tube voltmeter.

To record accurately the smallest electrical effects from subjects in a completely resting state, the assembly is housed in a double-shielded laboratory.

Figure 1 is a block diagram of the instrumentation used with the bioelectric integrator. The eeg, ekg and emg are combined in a standard instrument for making tracings on paper.

The integrator is a four-channel system such that the output from four pairs of electrodes can be integrated simultaneously in four parallel channels. Push-pull amplification and integration are used.

The outer shield of the subject's room is of sheet steel; the inner shield is a copper net. Windows and lamp openings are covered with two layers of electrically conductive glass, continuous with the shielding. The shielding properties of this glass are such that a subject's electrode, held a foot away from a tungsten lamp will not gather appreciable radiation.

Operation

A given channel, beginning with the human subject, is divided at junction J, one line running by shielded cable through the wall to the eeg, ekg or emg, where paper tracings are made with a signal marker superimposed to show the exact time duration for which the integrator computes its answer. If an unusual curve should appear, the paper tracing can often show the reason for the unexpected answer.

The other branch from J goes to a battery-operated preamplifier equipped with filter controls that can provide either broad-band amplification or selective amplification of selected frequency components. The output goes then by shielded cable to the integrator and a double-gun crt whose face can be photographed on continuously moving film.

Timing

Intervals over which bioelectric potential is integrated are governed by a timer consisting of a synchronous motor geared to a cam and microswitch system. The relays in the integrator can be opened and closed for a large number of different time intervals selected by changing the gears and cams.

Marks are placed on both the paper tracing and the crt film to show the portion of the curve integrated. The timing control also controls a camera that photographs the vacuum-tube voltmeter dial to record on 16-mm microfilm the result of each integration.

For example, in present experiments, a subject lying flat on his back with no voluntary body movement begins his task of mental computation. A series of 9-second samples accurate to ± 0.002 second is taken during a three-minute period without the subject's knowledge. During a rest period of comparable time, the subject's basal electrical potential is taken for comparison.

Circuit Details

Amplified bioelectric potentials run through a full wave rectifier into the R-C integrator. The input from the bioelectric amplifiers is applied to R by closing the switch. The rate of charging of the capacitor is determined, for a given voltage, by the value of R and is relatively linear if the charge at C is held well below maximum value. Provision is made for increasing the value of R to allow integrations to be made over longer periods. The value of C must be large, 50.0 microfarads for this instrument.

The value of the capacitor charge is given by $Q = Cv$ where Q is in microcoulombs, C is in microfarads and V in microvolts. Since the capacitors in the integrator are fixed, charge can be measured with a vacuum-tube voltmeter. The capacitor plates are shorted after each integration.

Figure 2 shows one of the four integrator channels schematically. Input is from the preamplifier in the subject's room. While this diagram shows one stage of R-C amplification preceding the full-wave rectifier, provision is made for switching in an additional stage of amplification when dealing with unusually low bioelectric output.

Output switches are relay controlled by the synchronous timer. The step-resistance is varied by a dial calibrated in approximate time intervals during which integration is expected to be carried on. Charge on the capacitor is measured by a vtvm having an input resistance of approximately six megohms. Although the capacitor is an oil-filled, low-loss type, dielectric losses are such that the meter must be photographed within the first two seconds to avoid drift.

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UHF Grid-Dip Meter

Permits determining the approximate tuning of filters and amplifiers, frequency of spurious resonance, values of circuit components and approximate value of Q at frequencies between 390 and 1,000 megacycles

By A. E. HYLAS and W. V. TYMINSKI

A TUNABLE OSCILLATOR, coupled inductively or capacitively to circuits under test, comprises the usual grid-dip meter. Loose coupling between the meter and the circuits under test is desirable for accuracy, and implicit in the procedure is that the distance between them be a small fraction of a wavelength.

The conventional circuit used for this application is a modified Colpitts oscillator employing capacitance tuning between plate and grid. As operation at higher frequencies is attempted, the required external inductance becomes so small, both physically and electrically, that it is difficult to couple the oscillator to circuits under test.

The upper frequency limit of most commercial meters employing shunt capacitance tuning is approximately 400 mc. With the allocation of tv broadcasting service in the band between 470 and 890 mc, extension of the grid-dip meter technique to this region is found to be desirable.

Extension of this range requires operation of tubes above their self-resonant frequency. Another design consideration is that the coupling point remain at a fixed position as the frequency is varied, and also that this coupling point be readily available.

Figure 1 shows several possible schemes for tuning a uhf oscillator. The inductive tuning shown in Fig. 1B limits operation to frequencies below the self-resonant frequency of the oscillator.

Pettit[1] has shown that series capacitance tuning, as indicated in Fig. 1C, extends the range of oscillators above their self-resonant frequency. In this particular circuit, variation of the maximum-current position with frequency does not lend itself easily to grid-dip-meter applications. A re-arrangement of the series capacitance into a balanced circuit, as shown in Fig. 1D, provides a maximum current point, the location of which remains fixed with tuning. Figure 1E has similar characteristics and will be considered later. Both balanced circuits satisfy the essential requirements mentioned, operation of available oscillator tubes above their self-resonant frequency and a fixed coupling point with frequency.

Circuit Analysis

To determine the feasibility of balanced series tuning using reasonable values of capacitance, an analysis was made to determine the length and number of probes necessary to cover the range of approximately 400 to 1,000 mc. Figure 2 shows the equivalent circuit of an oscillator employing balanced series capacitance tuning. The tube is represented by a capacitance-loaded transmission line with bb' being the plate and grid terminals of the tube and the length of line between bb' and aa' is the necessary connection between the tube and the tuned circuit. The equivalent capacitance of the tube is C_o and the length of the external probe is l. A condition for resonance at aa' is

$$X_T + X_P = 0 \qquad (1)$$

By substituting the reactances as determined by transmission line

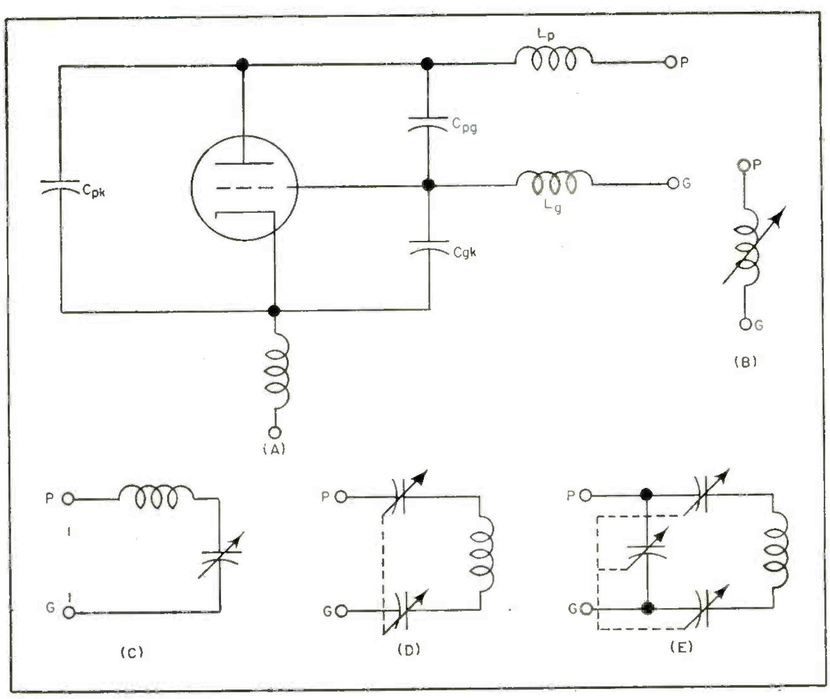


FIG. 1—Several methods of tuning a uhf oscillator

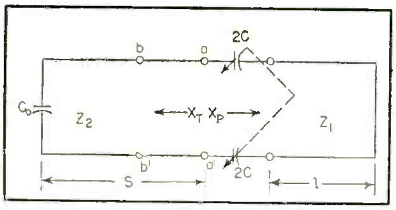


FIG. 2—Equivalent circuit for series capacitance tuning

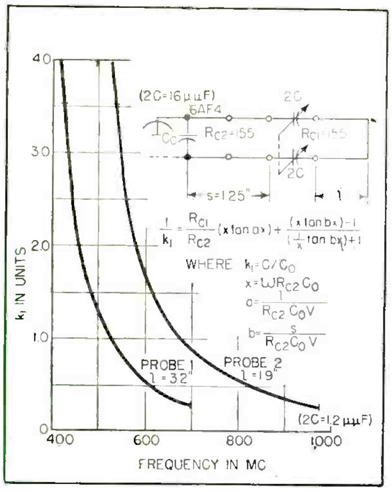
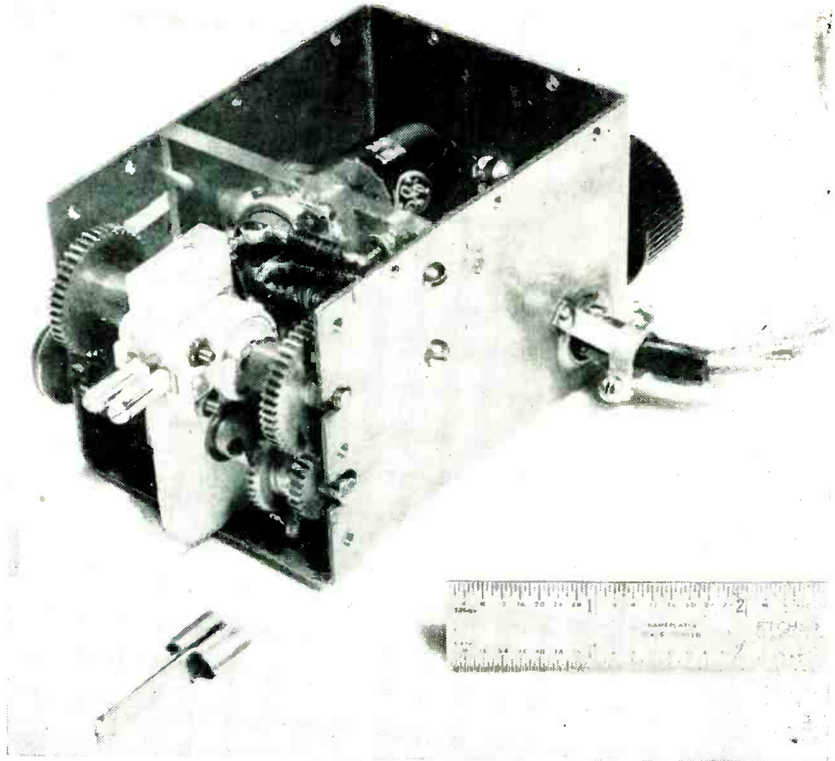


FIG. 3—Variation of k_1 with frequency for grid-dip meter using series tuning



Experimental model using ceramic capacitors covers the frequency range from 430 to 975 mc continuously

theory where

$$X_T = \frac{\frac{1}{j\omega C_0} + j\, Z_2 \tan \beta_2 S}{Z_2 + \frac{1}{\omega C_0} \tan \beta_2 S}$$

$$X_P = \frac{1}{j\omega C_0} + j\, Z_1 \tan \beta_1 l$$

and letting $C = k_1 C_0$, $\omega_0 = \frac{1}{Z_2 C_0}$, $x = \frac{\omega}{\omega_0}$,

$$\beta_1 l = ax = \left(\frac{\omega_0 l}{v_1}\right) x \text{ and } \beta_2 S = bx = \left(\frac{\omega_0 S}{v_2}\right) x.$$

Eq. 1 may be solved for the reciprocal of k_1

$$\frac{1}{k_1} = \left(\frac{Z_1}{Z_2}\right) x \tan ax + \frac{x \tan bx - 1}{\frac{1}{x} \tan bx + 1} \qquad (2)$$

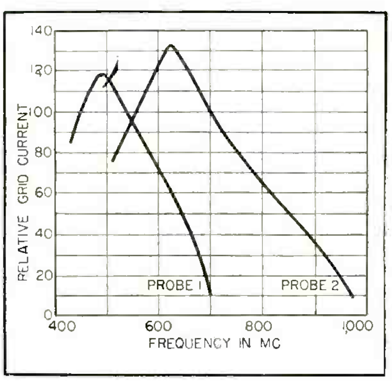


FIG. 4—Variation of grid current with frequency for developmental uhf grid-dip meter

When a particular tube is employed, the constants of Eq. 2 may be determined and a plot of $k_1 = f\ (x)$ may be plotted. For an oscillator employing balanced series tuning and a 6AF4, the constants are $C_o = 2.27$ μμf $f_o = \frac{\omega_o}{2\pi} = 452 \times 10^6$ cycles and $b = 0.296$.

By setting an upper frequency limit and a minimum capacitance, the probe length l can be determined. For a maximum frequency of 975 mc ($x = 2.16$) and a minimum capacitance of 1.2 μμf ($k_1 = 0.265$), a probe length l of 1.9 in. ($a = 0.462$) is obtained.

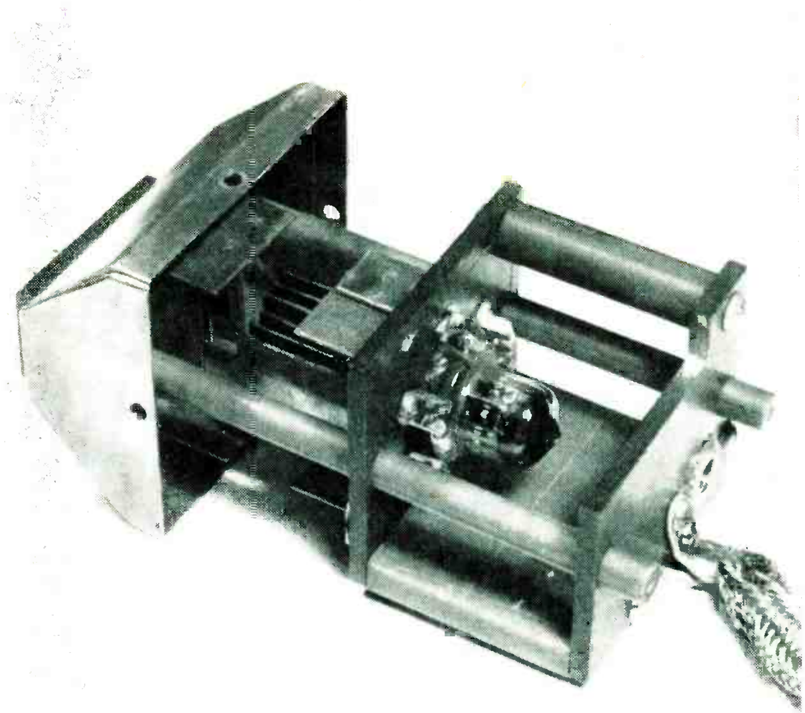
For an upper frequency limit of 700 mc ($x = 1.55$), a probe length of 3.2 in. is required. A plot of Eq. 3 showing the variation of k_1 with frequency for the two probes is shown in Fig. 3. As the tuning capacitance becomes very large, the frequency changes slowly. If the capacitance were infinite, probe 2 would tune to 465 mc and probe 1 to 372 mc.

Although a frequency range from approximately 390 to 1,000 mc would be preferred, several practical considerations dictated 425 and 975-mc limits for this particular arrangement. High-frequency operation was limited to 975 mc because previous experience with the 6AF4 showed that operation above this frequency is marginal if the maximum plate dissipation is not to be exceeded. The lower limit of 425 mc was used because the longer probes necessary for operation at lower frequencies were subject to multiple-mode operation.

An experimental model of a grid-dip meter employing balanced series capacitors and the probe lengths calculated is shown in one photograph. The two series capacitors are ceramic trimmers with a nominal range of 2 to 12 μμf and a measured variation of 1.2 to 16 μμf. The lead length of these capacitors was considered as part of the transmission line.

A plot of the variation of grid current with frequency for this arrangement is shown in Fig. 4. The 430 to 700-mc range for probe 1 and the 510 to 975-mc range for probe 2 are in close agreement with the calculated values. The variation of grid current is greater than would be desired, but is still within useful limits.

Since a special capacitor would



Final version uses 6F4. Tube and circuits are mounted on movable carriage

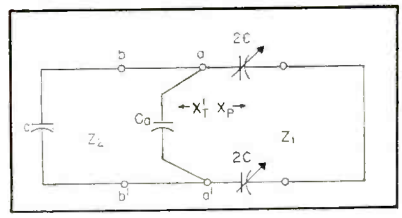


FIG. 5—Equivalent circuit for series-shunt capacitance tuning

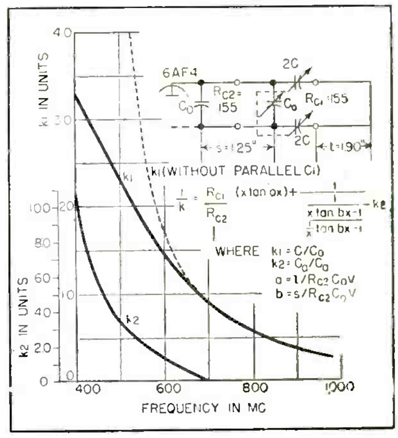


FIG. 6—Variations of k_1 with frequency for grid-dip meter using shunt and series tuning

have to be built for the grid-dip meter, an anlysis was made to determine the feasibility of using both shunt and series tuning to cover a wider range of frequencies with a single probe. The resonant condition for this circuit at aa' as shown in Fig. 5 is

$$X'_T + X_P = 0 \qquad (3)$$

where

$$X'_T = \frac{1}{\dfrac{1}{X_T} + \dfrac{1}{X_{ca}}}$$

and

$$X_{ca} = \frac{1}{j\,\omega\, C_a}$$

Using the same relationship as indicated for Eq. 1, Eq. 3 may be solved for the reciprocal of k_1 and

$$\frac{1}{k_1} = \left(\frac{Z_1}{Z_0}\right) x \tan ax + \frac{1}{\dfrac{\dfrac{1}{x}\tan bx + 1}{x \tan bx - 1} - k_2} \qquad (4)$$

where

$$k_2 = \frac{C_a}{C_0}$$

The variation of k_1 with frequency for series tuning ($k_2 = 0$), is shown as the dotted line in Fig. 6. The solid curve shows a desired variation of k_1 as a function of frequency and the curve in the lower left-hand corner indicates the necessary value of shunt capacitance in the form of k_2 versus frequency. In the shunt-series tuning illustrated, no parallel capacitance is added until a frequency of 700 mc is reached so as not to affect operation at the upper end of the band.

A simple air-dielectric shunt and series capacitor was built for the grid-dip meter shown in the second photograph. While this capacitor arrangement is simple to fabricate, it has the disadvantage that the effective transmission-line length is increased as the series capacitance decreases, thus reducing the probe length and frequency range. Series variation is from approximately ½ to 20 μμf, and the shunt variation from 0 – 2 μμf. This unit uses the 6F4 to provide more output power at the high end of the band, and the tube and its associated circuits are mounted on a movable carriage which may be translated in motion to vary the series capacitance.

The complete, enclosed unit can be used with commercial grid-dip-meter power supplies and extends grid-dip-meter techniques to over 1,000 mc. As in conventional grid-dip-meter technique, the stationary maximum current point of the probe should be coupled to maximum current points in circuits under test. For coupling into high-impedance points, voltage probes consisting of open lines may be used.

Coupling to cavities may present some difficulties if the maximum current point is not readily accessible. In measurements of this type, it is necessary to provide a hole at the maximum current point so that the probe can be coupled to the H field of the cavity. Here the small width of the probe is a definite advantage.

The meter described has been found useful in uhf development work and appears to provide a solution for the extension of the grid-dip-meter technique to over 1,000 mc. The assistance of Herbert Colomy in devising the mechanical arrangements and building the developmental models is gratefully acknowledged.

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Production-Line Gas Test for Picture Tubes

Electrical method of measuring gas ratio, proportional to degree of vacuum, permits testing for residual gas while finished tubes move past on conveyor line. Ionization-gage checks show that dividing gas ratio by 10 gives approximate gas pressure in microns

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As a check of quality, manufacturers of cathode-ray tubes use JAN specifications based on the gas ratio, designated as $(I_N - I_L)/I_P$, where I_P is grid No. 2 current in ma, I_N is gas current in μa and I_L is leakage current in μa. For I_P, $E_b = +25$v and $E_{c1} = 0$v; for I_N, $E_b = -25$v and $E_{c1} = 0$v; for I_L, $E_b = -25$v and $E_{c1} = -70$v. For all three, $E_{c2} = 250$v. I_N is read within 10 seconds of reversal of E_b.

A circuit typical of that used for measuring gas ratio is shown in Fig. 1. When operated to read ion current, this circuit resembles that of an ionization gage, with the picture tube replacing the gage tube. With this circuit more sensitive metering is required than is used in the ionization-gage circuit. The cathode current is in the order of 1 ma instead of 10 ma, and ion currents may be as low as 0.01 μa or less for a good tube instead of 0.1 μa. Leakages in the cathode-ray tube are even more critical than in the ionization gage and must be taken into consideration.

Using zero-bias emission, gas currents will vary according to gas pressure and beam current. By dividing the numerator of the gas ratio formula by the grid No. 2 current the resultant ratio is in microamperes of ion current to milliamperes of electron current. Since at pressures of less than one micron the ion current is proportional to the gas pressure and the number of ions formed by collisions is proportional to the electron beam current, the gas ratio is a constant regardless of the emission current ranges available in present-day cathode-ray picture tubes. This fact is brought out by the curves in Fig. 2. Tube *A* is an excellent tube with respect to gas content, having a gas ratio of 0.016. The maximum limit for an acceptable tube is in the order of 0.25. Tube *B* is not quite so good as *A* but is still satisfactory, with a gas ratio of 0.074. Tube *C*, however, has a gas ratio of about 2.2 and is well outside the satisfactory limit, even though the linearity still exists. This tube, while exhibiting poor gas-ratio readings, has within it a vacuum of about 0.2 micron. This indicates how important it is to maintain high vacua in picture tubes.

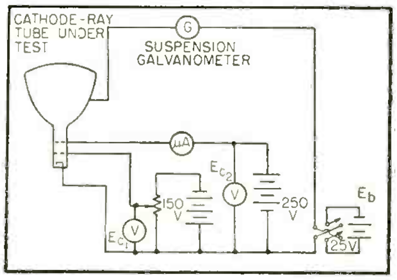


FIG. 1—Circuit used for laboratory version of gas ratio test unit

Method of installing ionization gage on picture tube for correlating gas ratio measurements with gas pressure in tube

To determine sources of gas molecules and ions. the tube may be checked for gas by means of an attached ionization gage before it is operated with a raster upon the screen, checked again with a pattern on the middle of the screen, then checked with the raster overscanning the screen so the electron beam is striking the walls of the glass bulb. The electron beam bombarding these various surfaces results

Gas-buggy test unit used at Electronics Park plant to check for gas in tube and leakage between elements, at rate of one tube per minute. Four tubes are connected at a time so that three are being preheated while the fourth is checked. Tubes are aged for several days in storage before this final checkup

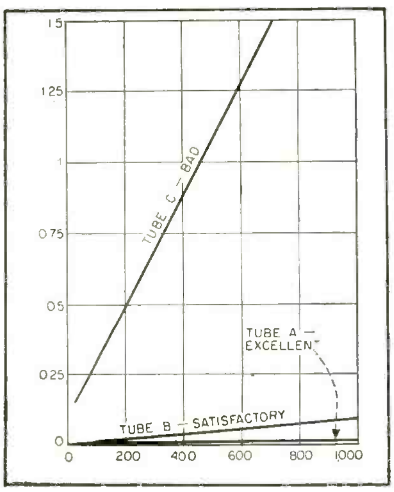


FIG. 2—Gas ratio for any given tube is a constant regardless of emission when gas current in μa is plotted vertically against cathode current in μa

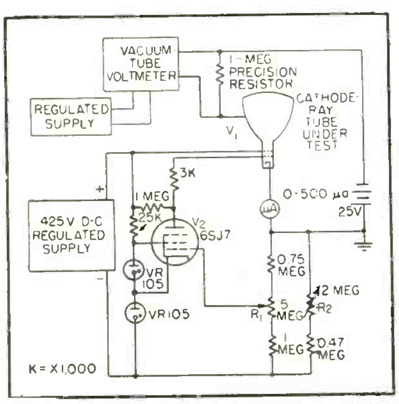


FIG. 3—Production-type gas ratio test

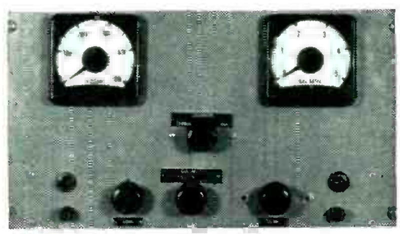
in gas and ion emission which affects tube operation adversely.

With this arrangement a number of gas-ratio readings were compared to those of the ionization gage. It was found that the gas pressure in microns was equal to the gas ratio divided by a factor of approximately 10. The significance of this comparison is clouded by the fact that there may be ions derived from sources other than residual gases when measuring gas ratio. Since any ions could be detrimental to the satisfactory performance of the tube, it appears that the gas-ratio method is a test indicative of tube quality.

Production Gas Testing

Figure 3 is a circuit diagram of a semiautomatic means of measuring gas ratio which is particularly applicable to production testing. Regulator tube V_2 controls the voltage on grid No. 1 of cathode-ray tube V_1. The regulator tube derives its signal from a voltage divider whose output is proportional to the cathode current of the picture tube under test. The level of this signal may be varied by R_1.

By proper adjustment of R_1 and R_2, the electron current in the ca-



Front panel of semiautomatic gas ratio indicator

thode-ray tube may be arbitrarily selected and other tubes of the same type will automatically be set at this value of current. If the tube to be tested delivers more than the pre-set amount of current, the control grid of V_2 becomes more positive, causing the plate voltage to decrease. This lowers the grid voltage on the cathode-ray tube and tends to reduce the electron current to the proper value.

Ions attracted to the negative second anode result in a current which develops a voltage across the 1-meg precision resistor and causes a deflection of the vacuum-tube voltmeter. The meter may be calibrated in terms of gas ratio where I_P is the figure for electron current as set up by R_1 and R_2. The vacuum-tube voltmeter circuit compensates for leakage currents.

Miniaturization of

Use of smaller window than usual in laminations reduces space and weight 30 percent and cuts power losses about 20 percent for same temperature rise. New calculation chart speeds design of optimum chokes using standard cores, and applies also to single-ended audio transformers

POWER SUPPLIES for airborne equipment frequently become excessively large and weighty when designed by standard methods. To maintain well-engineered designs and concurrently minimize weight and space, the problem of miniaturization of power supplies and their associated components has been investigated. To incorporate questions of weight into the design of power supplies, it was necessary to conduct a survey encompassing the functions of inductivity, resistance, size and temperature rise of filter chokes. The information presented herein is a preliminary synopsis of this miniaturization program.

Filter Choke Heating

The problem of miniaturizing any electronic equipment ultimately leads to an investigation of the equipment's heat dissipation. For filter chokes, this starts with the basic iron-core inductor formula

$$L = 1.256 \times 10^{-8} N^2 K \qquad (1)$$
$$K = a_i\mu/(l_i + l_a\mu)$$

where N is the number of turns, a_i is iron-core cross-section in sq cm, l_i is length of magnetic path in cm, l_i is length of airgap in cm and μ is initial relative permeability. One part of the formula is governed by the coil (N^2) and one depends on the shape of the iron core (K). However, the two terms are not independent. The number of turns N depends on the window space of the iron core, and K is a function of ampere-turns AT.

Assuming now a certain shape of iron core (standard lamination with square core), K becomes only a function of μ and l_a. As μ is a function of l_a and AT, K can be expressed in terms of l_a and AT; K goes through a maximum when l_a is varied and AT is kept constant. These maxima of optimum values of K are the only points which are of interest for further calculations, hence K_{opt} can be expressed in terms of AT only. At the same time, the optimum value of l_a has a direct relation to AT.

Consider now the power losses P_{cu} which determine the temperature rise of a certain size of choke.

$$P_{cu} = I^2R = I^2 N^2 l_{av}\zeta/\xi W \qquad (2)$$

where I is direct current, l_{av} is average length of one turn in cm, ζ is specific resistance in ohm-cm, W is window area of iron core in sq cm and ξ is filling factor (copper area ÷ window area).

Replacing N in Eq. 1 by its equivalent in Eq. 2 and rearranging to put all variable quantities to the left and the core constants to the right side gives

$$I^2L = 1.256 \times 10^{-8} \frac{P_{cu} W \xi}{l_{av}\zeta} K P_{cu} \qquad (3)$$

It has been shown earlier that K is a function of AT only. Equation 2, however, gives a direct relation between P_{cu} and $(IN)^2$ which allows the expression of K in terms of P_{cu}.

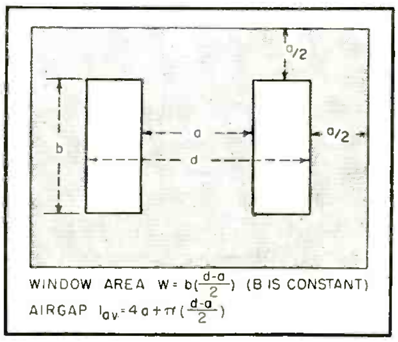


FIG. 1—Lamination shape and dimensions for standard square-stack core

The term on the left side has the dimension of an energy, hence the problem of filter chokes is a problem of storing energy. The amount of energy which can be stored depends mainly on the permissible losses P_{cu} and on some technological properties of the iron core (K) and the coil (ξ).

Miniaturization Procedures

Equation 3 represents the key to miniaturization. It is apparent that an increase of P_{cu}, although resulting in higher coil temperatures, is most beneficial. However, the problem arises whether to remove the additionally produced heat by means of forced cooling, or to run the coils at higher temperatures. The temperature limit is imposed today by the insulating material, which in the case of silicone compounds can resist temperatures up to 250°C. There is not much reason for trying to pass this limit because of a rapid drop in the permeability of the iron core above 300°C (Curie point 770°C) and an appreciable increase in the copper resistance. For iron alloys and ferrites, the Curie point is generally much lower and the situation is even worse.

Another angle of attack is the filling factor, which is as low as 15 percent in conservative coils. By using random-wound coils, it seems possible to obtain a filling factor close to 50 percent.

The factor K depends on the core material and on the shape of the core. Since most of the energy stored in a choke is located in the

Airborne Filter Chokes

airgap in the form of a magnetic field, the inductivity of the choke becomes higher as the saturation becomes greater and the cross-section of the airgap becomes larger.

The only function of the iron core is to provide the airgap with a maximum flux for a given number of ampere turns on the coil. This is done best with a core material which combines a high magnetic induction with a reasonable initial permeability (about 50 and over). Silicon steel is one of the best materials in this respect, hence the calculation chart refers to such cores.

Core Lamination Shape

The following comparison of different core shapes is done with the assumption that the coil diameter, which determines the permissible heat dissipation, is kept constant and the heat produced in the coil is taken as a parameter.

Substituting AT for IN in Eq. 2, then substituting for window area W and airgap l_{av} the expressions of Fig. 1 give an equation for AT as the first step in expressing I^2L as a function of a/d and the copper losses:

$$(AT)^2 = \frac{P_{cu}\,\xi\, b}{\zeta}\underbrace{\frac{(1 - a/d)}{(8-\pi)\,(a/d) + \pi}}_{A^2}$$

$$AT = \sqrt{\frac{P_{cu}\,\xi\, b}{\zeta}} \times A \qquad (4)$$

The calculation chart in this article gives the relation between AT and I^2L for one ratio of a/d, namely $a/d = 0.45$ for EI-21 cores. Comparing two arbitrarily chosen core shapes with the same magnetic path length, which is approximately the case for the choke under investigation, gives

$$I^2L = I_o^2L_o\,\frac{a^2}{a_o^2} \qquad (5)$$

With constant magnetic path length, the thickness of the airgap remains the same, and the energy content I^2L of the derived core represents again an optimum value.

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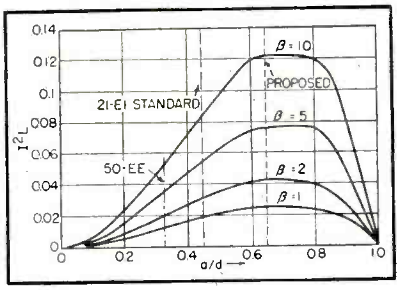

FIG. 2—Curves for silicon steel, showing that optimum core shape is obtained at a dimension ratio a/d of about 0.65

Equations 4 and 5 permit plotting $I^2L = f\ (a/d)$ as shown for silicone steel in Fig. 2.

The parameter β is proportional to P_{cu}. As will be seen later, $\beta = 1$ means a temperature rise of 24°C for average coil construction.

Figure 2 shows that an optimum core shape is reached at about $a/d = 0.65$; this value is not critical, and it does not depend on β, or in other words, on the power losses P_{cu}. The inductivity at $a = 0.65\ d$ is up to 50 percent higher than with the standard $a_o = 0.45\ d$. This means that for a given inductivity the size of the choke can be reduced by 33 percent.

Stack Thickness

An investigation made to find a favorable stack thickness showed that the ratio of I^2L to weight is practically independent of the stack thickness. This permits the selection of core dimensions to give square cores, which are most suitable from the point of view of winding technique.

Calculation Chart

The principles outlined have been used to develop the calculation chart in Fig. 3 for chokes with standard iron cores. Starting with the three fundamental quantities: inductivity L, direct current I and the permissible temperature rise Δt, the optimum size and airgap, the resistance R and all specifications of the coil are easily determined with this method.

The chart makes use of Eq. 3 which shows that maximum I^2L depends only on P_{cu} or, in other words, on the number of ampere-turns. This relation has been empirically evaluated for EI-21 standard core of 3.75-percent silicon steel, and the resulting curve has been expanded to include other core sizes in common use also.

As noted previously, there is for each core a direct relation between airgap and AT. It is therefore possible to plot a scale for the airgap along the curve $I\ \sqrt{L} = f\ (AT)$.

Introducing a temperature-rise factor, another group of curves (dotted lines) can be plotted which connect the points of equal temperature rise for different sizes of chokes. This factor is defined as

$$\beta = \frac{(AT)^2\, l_{av}}{OW \times 10^4} \qquad (6)$$

where O is the surface of the coil; β depends on the core size, but not on the type of winding used.

The actual hotpoint temperature rise Δt is found from

$$\Delta t = \beta\,\frac{\zeta}{\xi\alpha} \times 10^4 \qquad (7)$$

where α is the heat transfer coefficient in (W_{cm}^{-2}) (°C^{-1}) between the hotpoint and the surrounding medium. Heat measurements on random-wound coils with natural convection cooling lead to

$$\frac{\zeta}{\xi\alpha} \times 10^4 \cong 24^\circ\ \text{C}$$

The filling factor ξ is in average practice about 0.3 to 0.35, and α ranges from 2.4 to 2.1 × 10^{-3}. The first value is valid for small sizes, the second for large ones. The product $\xi\,\alpha$ stays fairly constant.

The calculation of the coil specifications is simplified by introducing two quantities, S and T, which are characteristic constants for each core dimension:

$$T = F\sqrt{\frac{4}{\pi}\,\xi\, W} \qquad (8)$$

$$S = l_{av}\,\zeta/\xi W \qquad (9)$$

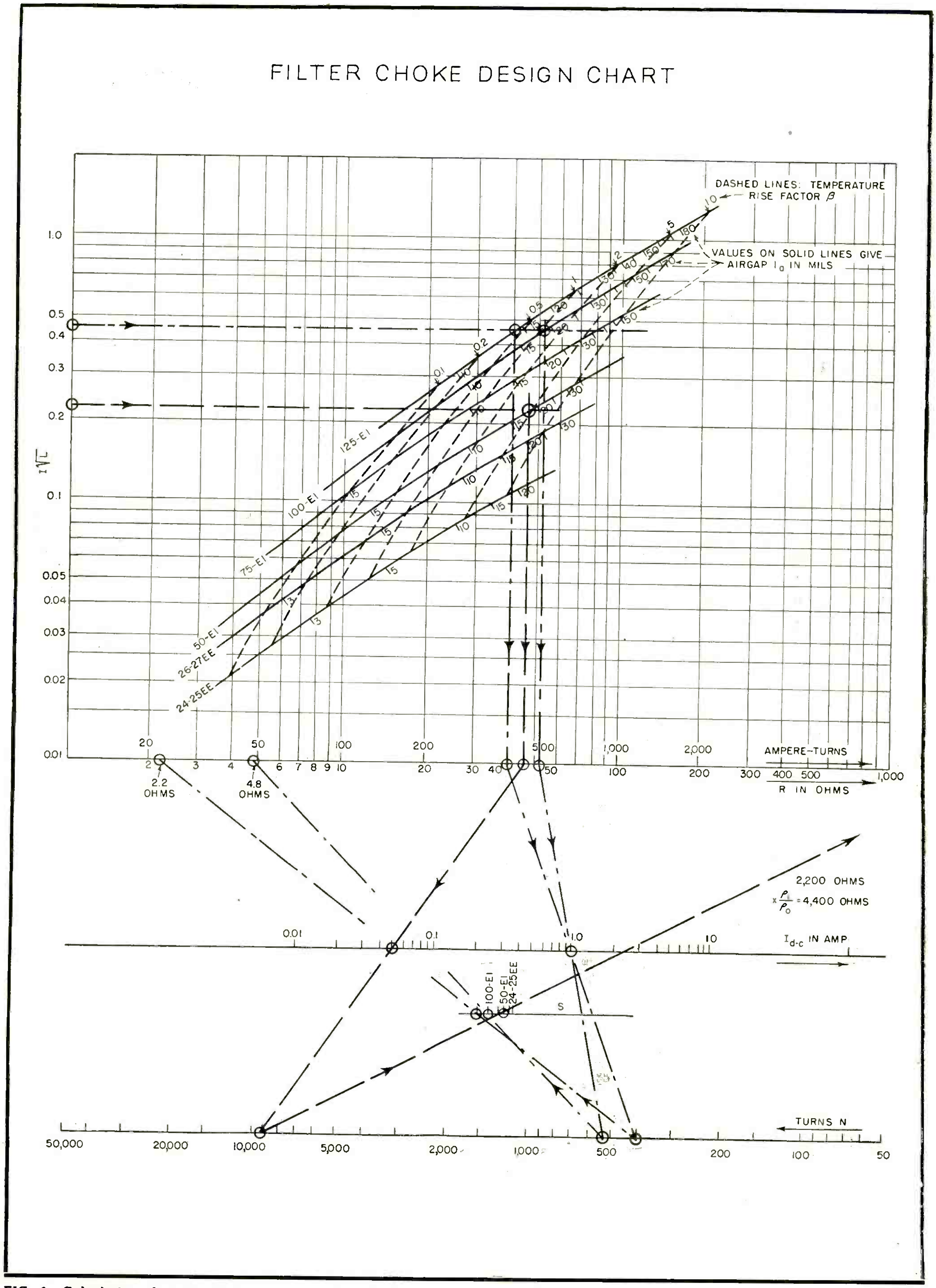

FIG. 3—Calculation chart for chokes using 7-mil laminations of 4-percent silicon steel with square stack. Dash-dotted lines show solution worked out for Example 1, and long dashed lines apply to Example 2

where F is the ratio of diameter ϕ for insulated wire to ϕ for bare wire.

Use of Calculation Chart

Step 1. To calculate size and coil data of a choke, assume first the permissible hotpoint temperature rise Δt by subtracting the ambient temperature from the maximum permissible temperature (90°C to 110°C for average construction). The temperature rise factor β is obtained from Eq. 7 as $\beta = \Delta t/(10^4\ \zeta/\alpha\ \xi)$, where $10^4\ \zeta/\alpha\ \xi \cong 24°C$ for average construction (random-wound heavy enameled wire).

Step 2. Find $I\sqrt{L}$, where I = direct current in amperes and L = wanted inductivity in henrys. Now find on Fig. 3 for a given $I\sqrt{L}$ and temperature rise factor β the core size and the required ampere-turns (AT) as well as the airgap dimensions.

Step 3. Determine the number of turns from $N = AT/I_{dc}$.

Step 4. Determine the approximate coil resistance from $R = SN^2$ where S is a constant depending on choke size, as follows:

Core	Value of S*
EE 24–25	0.33×10^{-4}
EE 26–27	0.31×10^{-4}
EI 21	0.27×10^{-4}
EI 75	0.23×10^{-4}
EI 100	0.17×10^{-4}
EI 125	0.14×10^{-4}

*Based on $S = 1.75 \times 10^{-6}$ ohm-cm

If necessary, choose a larger size of choke for lower resistance.

Step 5. Calculate wire diameter from $\phi = T/\sqrt{N}$, where ϕ is the diameter in mils with insulation and T is a core constant, as follows:

Core	Value of T
EE 24–25	256 mils
EE 26–27	300 mils
EI 21	366 mils
EI 75	472 mils
EI 100	626 mils
EI 125	780 mils

Choose the next smaller wire size from a standard wire chart (Table I).

Step 6. Calculate coil resistance from $R = Nl_{av}\ R_o/1{,}000$, where R_o = resistance of 1,000 feet of wire and l_{av} = average length of one turn in feet, as follows:

Core	Value of l_{av}
EE 24–25	0.148 ft
EE 26–27	0.19 ft
EI 21	0.25 ft
EI 75	0.35 ft
EI 100	0.47 ft
EI 125	0.58 ft

This calculation chart is suitable only for alternating currents I_{a-c} lower than 1 percent of the direct current I_{d-c}. For $I_{a-c}/I_{d-c} > 1$ percent, the resulting L is up to 100 percent higher and special charts are needed. The nomogram on the bottom of the chart serves to determine N and R. Run a straight-edge from AT through I_{d-c} to get N, then run the straight-edge from N through S to get R.

EE24-25, EI-21 and similar designations are standardized core shapes. A square stack is always considered.

Example 1: Ratings of a filament filter choke are 0.2 h, 1 amp., $R < 2.5$ ohms, ambient temperature 20°C, temperature rise <60°C. For this conservative design, use $10^4\ \zeta/\alpha\ \xi$ =24°C as given in Step 1 and calculate the maximum β as 60°C/24°C = 2.5. With $I\sqrt{L} = 1\sqrt{0.2} = 0.45$, the chart in Fig. 3 shows that core sizes 100-EI and 125-EI will give a lower temperature rise than 60°C (β <2.5).

Take first the smallest possible core and read along the dash-dotted line the following data for EI-100: $\beta = 1.2 \rightarrow \Delta t = 29°C$; airgap = 18 mils; ampere-turns = 520; turns N = 520; approximate resistance R = 4.8 ohms. The latter value exceeds the required 2.5-ohm limit, hence a larger core size must be tried. For EI-125, $\beta = 0.4 \rightarrow \Delta t = 10°C$; airgap = 14 mils; ampere-turns = 400; turns N = 400; approximate resistance R = 2.2 ohms.

According to Step 5, wire size $\phi = T/\sqrt{N} = 780/20 = 39$ mils. From a wire chart, No. 19 single Formvar wire has the next smaller diameter of 37.4 mils. For this wire, resistance $R = N\ l_{av}\ R_o/1{,}000 = 400 \times 0.58 \times 8.051/1{,}000 = 1.87$ ohm.

Example 2: Ratings of a high-voltage filter choke are 20 h, 50 ma, ambient temperature 100°C and maximum coil temperature 200°C. Calculate first the value of β. Considering that the specific resistance ζ at 200°C is just about twice the value for copper at room temperature, use 12°C for $10^4\ \zeta/\alpha\ \xi$. Then β = 100/12 =8.3. With $I\sqrt{L} = 0.05\sqrt{20} = 0.244$, the dashed line on the chart gives: Core size = EI-50 (EI-21 is equivalent); airgap l_a = 18 mils; ampere-turns = 460; turns N = 9,200 (for 50 ma); $R+$ = 2,200 ohms (for EI-50 core) but this value has to be doubled due to the elevated operating temperature, hence R = 4,400 ohms; wire size ϕ = 366/9,200 = 3.8 mils. Single Formvar wire No. 40 = 3.6 mils. Resistance at room temperature = 9,200 × 0.25 × 1,049/1,000 = 2,390 ohms. Resistance at 200°C = 2 × 2,390 = 4,780 ohms.

The author wishes to thank T. Field for reviewing the manuscript and W. Sutton for conducting the necessary measurements in the laboratory.

Table I. Wire Table for Choke Design

AWG B&S Gage	Diameter in Inches			Turns per Inch (Formvar)	Ohms per 1,000 ft
	Bare	Single Formvar	Double Formvar		
16	0.0508	0.0524	0.0538	17	4.016
17	0.0453	0.0469	0.0482	19	5.064
18	0.0403	0.0418	0.0431	21	6.385
19	0.0359	0.0374	0.0386	23	8.051
20	0.0320	0.0334	0.0346	26	10.15
21	0.0285	0.0299	0.0310	30	12.80
22	0.0253	0.0266	0.0277	33	16.14
23	0.0226	0.0239	0.0249	37	20.36
24	0.0201	0.0213	0.0223	42	25.67
25	0.0179	0.0190	0.0200	47	32.37
26	0.0159	0.0169	0.0179	52	40.81
27	0.0142	0.0152	0.0161	57	51.47
28	0.0126	0.0135	0.0145	64	64.90
29	0.0113	0.0122	0.0131	71	81.83
30	0.0100	0.0109	0.0116	80	103.2
31	0.0089	0.0097	0.0104	88	130.1
32	0.0080	0.0088	0.0094	98	164.1
33	0.0071	0.0079	0.0084	110	206.9
34	0.0063	0.0070	0.0075	124	260.9
35	0.0056	0.0062	0.0067	140	329.0
36	0.0050	0.0056	0.0060	155	414.8
37	0.0045	0.0050	0.0054	170	523.1
38	0.0040	0.0045	0.0048	193	659.6
39	0.0035	0.0040	0.0042	215	831.8
40	0.0031	0.0036	0.0038	239	1049.0

Nuclear Resonance

Qualitative and quantitative analysis of materials is provided by measuring effect on nuclei of unidirectional magnetic and r-f fields. Test specimen may be in any form, though liquid is most convenient. Continuous measurement is possible

PHYSICISTS of the leading research laboratories have been giving increased attention to nuclear resonance during the past few years.[1]

The art has now advanced to the point where it has been possible to construct engineering instruments having designs based on the new principles evolved. Such instruments are already in use by commercial companies and others engaged in chemical and nuclear research.

Nuclear Resonance

The nuclear resonance field being of comparatively recent origin, many engineers may not be familiar with the phenomenon involved. Nuclear resonance is in reality quite complex, particularly in view of the fact that the exact nature of the nucleus is even now not fully understood and much is still to be learned of its various properties. However, a general idea of the theory of operation may be obtained by taking a simplified viewpoint.

Considering particles at the atomic level, we find that they are composed of a central, relatively heavy, charged nucleus and a number of circulating or orbital electrons. As the nucleus rotates or spins, it creates a magnetic field which may be regarded as being similar to that of a small magnet. In other words, the nucleus has a magnetic moment.

If the nuclei are subjected to a strong external unidirectional magnetic field, for instance that produced between the pole faces of a large electromagnet, the magnetic moments of the nuclei will tend to line up with this field in the same way that a small magnet will orient itself in a strong magnetic field. If these nuclear particles are, in addition, then excited by a radio frequency field that may be created by r-f current in a coil—then, at a certain well-defined frequency, precession of the nuclei will occur. This precession may be compared to the precession of a gyroscope which will precess in a certain direction when an external force couple is applied. The external force couple, in the case of the nuclei, is the r-f field. When the frequency of the field is at nuclear resonance, that is, equal to the precession frequency, a large number of the nuclei will precess in phase. The rotating nuclear magnetic field so produced can then be detected by the voltage that it induces in a small coil placed with its axis perpendicular to the polarizing field.

Precession Frequency

From the foregoing discussion it may be appreciated that the frequency of precession, or the frequency of nuclear resonance will be related to the magnetic moment and spin of the nucleus and the constant magnetic field. Fortunately, the various elements and their isotopes have widely separated resonance frequencies. With a controllable electromagnet, covering a sufficiently wide field range, say 500 to 10,000 gausses, the nuclear precession frequencies may be concentrated in the 2 to 16 megacycle band and thus cover the majority of detectable isotopes.

There is a fundamental equation that relates precession frequency with the isotope and the strength of the polarizing field.

$$\omega = \gamma H$$

where $\omega = 2\pi f$; f is the precession frequency; γ is a constant which is related to the magnetic moment and spin of the isotope, or the gyromagnetic ratio; and H is the strength of the polarizing field.

If any two factors of this expression are know the third can be determined. With a known isotope and a measurable frequency, the field can be found. If the field and frequency are known, the isotope can be identified.

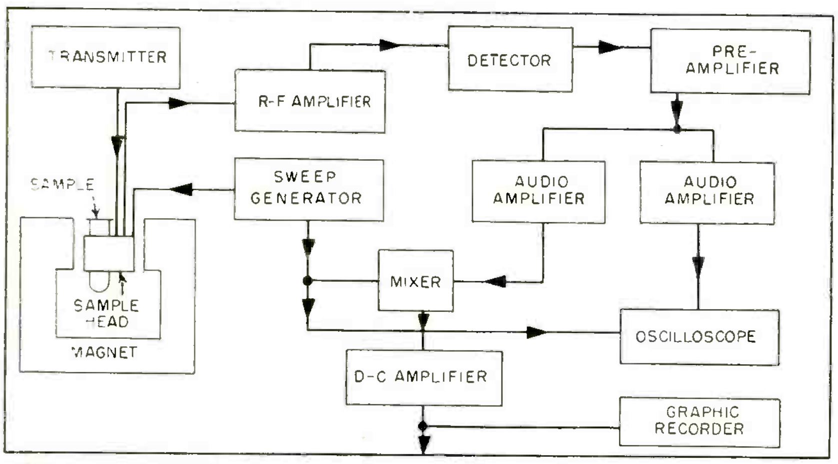

FIG. 1—Block diagram shows use of r-f transmitter, receiver and associated equipment

Spectrometer

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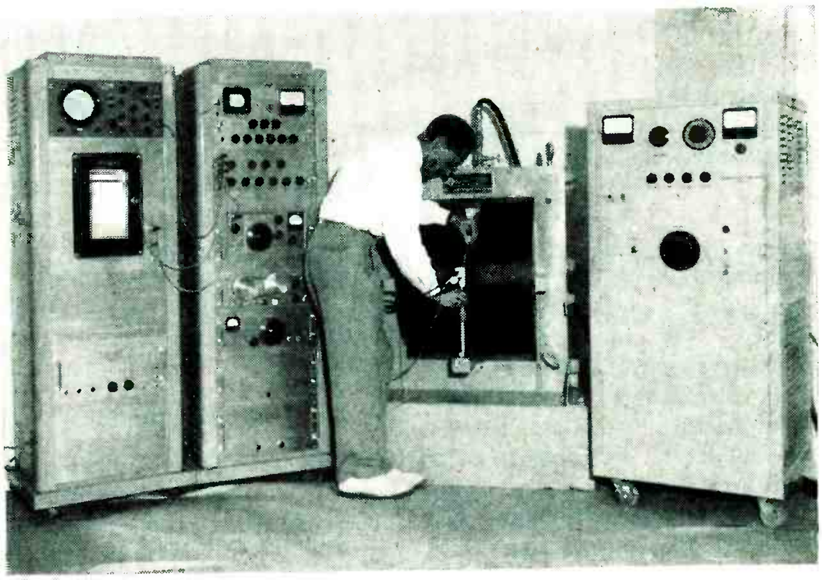

Sample of material being tested (usually liquid) is placed in test tube and inserted between jaws of large magnet where analysis process is accomplished

It should be mentioned that there are a few isotopes which do not respond to nuclear resonance techniques, because of the particle arrangement of their nuclei. However, most elements have at least one isotope which has spin and magnetic moment and is susceptible to nuclear resonance excitation. The manner in which the various fields are applied to obtain precession will be discussed later in the article.

Sensitivity

Presently constructed instruments can readily detect the deuterium which is present in natural water in an abundance of 0.02 percent in a one or two cubic centimeter sample of water. Sensitivity depends to a considerable extent on the volume of the test sample. A larger sample, other factors being equal, would give a greater signal, as there are more nuclei present. Possibly the only limitation to using really large test samples for greater signals would be in the construction of a sufficiently large magnet for the required polarization of the nuclei in the sample.

Another factor affecting sensitivity is the strength of the polarizing field. By using strong fields and a higher radio-frequency excitation, stronger signals may be picked up by the receiver coil. Large signals are readily obtained from protons and thus large clear signals may be observed when a natural water sample is used due to the high percentage of hydrogen present.

The special advantage of the nuclear resonance technique from a chemical point of view is that samples may under proper circumstances be in various chemical and physical forms and that an analysis can be made without changing in any form the properties of the sample. In particular, the method is well adapted to continuous flow observations of chemical processes.

Apparatus Used

With this brief discussion of the general principles of nuclear induction, we can proceed to the description of some of the apparatus that goes to make up a radio-frequency nuclear-resonance spectrometer. Such an instrument, for example, may be used to detect and measure the abundance of isotopes that are present in various substances. The instrument is particularly applicable to measurements and investigations of liquid samples.

The photograph shows a typical laboratory setup for making measurements on liquid samples. The electromagnet used for polarizing the nuclei is in the center of the picture. The sample in the test tube is about to be placed in the sample probe, which for convenience of insertion may be withdrawn from the magnetic pole pieces. During the measurement, the sample is slid to the center of the large circular pole faces.

The electromagnet is controlled by the unit to the right which has all the necessary control features required for producing the required strength of fields. It is necessary to hold the field to a very constant value during nuclear tests as the precession frequency is directly dependent on the value of the magnetic field. While the techniques of obtaining very constant radio frequencies are well established, techniques for establishing corresponding magnetic fields of the same order of stability have only recently been established. Highly regulated electronic stabilizers are used to provide the necessary stability of the electromagnetic field for making measurements to the desired accuracy.

Stabilization

Complete stabilization of the magnetic field to any desired degree can be achieved by use of special nuclear resonance methods; in particular, by the use of a nuclear resonance fluxmeter which will hold the magnetic field to the same tolerance as it is possible to hold a given radio frequency, where such an accuracy of field is required for a

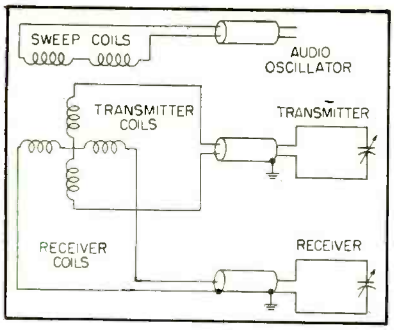

FIG. 2—Probe contains three sets of coils

particular measurement. Such an instrument is contained in the rack to the immediate left of the electromagnet. This rack also contains the necessary electronic equipment for the transmitters and receivers that go to form the completed nuclear induction instrument. The second rack contains the recording equipment on which the signal can be transcribed and oscilloscopes for visual observation. This particular set-up can be regarded as typical of the nuclear art at the present time.

The block diagram (Fig. 1) shows the units that make up the nuclear-resonance spectrometer. The sample, which is usually in liquid form and is contained in a test tube, is placed in a special probe which is inserted between the pole faces of the electromagnet.

Sample Probe

The sample probe, which if of very solid construction to ensure complete stability of the received signal, contains three sets of coils surrounding the sample, as shown in Fig. 2. The first set provides the r-f excitation field through the sample. The current for these coils is supplied from the transmitter contained in the rack through a coaxial cable. The second coil, placed at right angles to the transmitter coil, picks up the minute precession signals from the sample and transmits these signals, via coaxial cable, to a sensitive radio receiver, which is also contained in the rack.

The third set of coils is positioned in such a way that the electromagnetic polarizing field is amplitude modulated by an audio frequency. As the field is swept sinusoidally through the nuclear resonant frequency, the precession of the nuclei will be greater or less, depending on the magnitude of the sweep field. Thus an effectively amplitude-modulated r-f signal is picked up by the receiver coil.

After r-f amplification and detection, an audio signal is obtained that can be readily amplified and used for observation and recording. The type of signal observed may be very similar to the typical symmetrical resonance curve of a receiver as shown in Fig. 3. Other types of signals are obtained of various shapes, depending on the sample nuclei and the adjustment of the various controls. Their complexity will not be discussed in this article.

R-F Equipment

A 10-watt r-f transmitter is used, and since it is coupled directly to the receiver coil, complete blocking of the sensitive radio receiver would occur unless special precautions were taken in the probe. To prevent this, the cross-coil arrangement of transmitter and receiver coils is used. Special techniques have been developed in the building of sample probes for insuring that only an extremely small transmitter signal is picked up by the receiver coil even when a powerful transmitter is used. This insures that a large percentage of the signal at the receiver coil is the signal received from the precessing nuclei of the sample. A small signal from the transmitter is desirable at the receiver input terminals as the principle of reception is similar to that of the homodyne used in radio receivers.

The radio receiver should receive no signals whatever from the transmitter directly, so shielding of each is required to avoid direct pickup. The requirements for the r-f transmitter are rather stringent. It must be continuously tunable, stable, well-shielded, and have a variable output, as it is necessary in certain nuclear experiments to use very small r-f excitation fields. When searching for very weak nuclear signals, the transmitter in particular should be free from undesirable modulation components. Such expedients as running the heaters from a d-c source have been found desirable in transmitters used for nuclear resonance measurements.

The major requirement for the radio receiver used is extreme sensitivity. The receivers are possibly the most sensitive receivers that have been developed for any purpose. For this reason, it is only to be expected that the input circuits use the low signal-to-noise ratio devices outlined by Wallman and others. The theory of the signal-to-noise ratio of the nuclear resonance phenomenon is fairly well-established and experiments indicate that it agrees quite closely with practice.

Extreme sensitivity for a favorable signal-to-noise ratio may be obtained in the nuclear resonance field by continual reduction of bandwidth in a way that would not be possible with communication systems required for transmission of instantaneous complex intelligence. Generally speaking, the rate of obtaining data is not a major consideration in the design of a nuclear receiver. In extreme cases, several minutes may be taken to obtain data. This can lead to bandwidth reductions completely beyond the scope of the normal communication receiver design; bandwidths may be measured in seconds rather than in cycles. Therefore receivers with sensitivities of the order of a few hundredths of a microvolt are realizable, and such sensitivities are in demand for work of this type.

Techniques of direct receiver measurements of sensitivities of this order have not as yet been developed by radio engineers. Noise diodes cannot be used because the diode current required is often too small for satisfactory diode operation. Almost the only reliable checks are those obtained by nuclear sample, and it has been

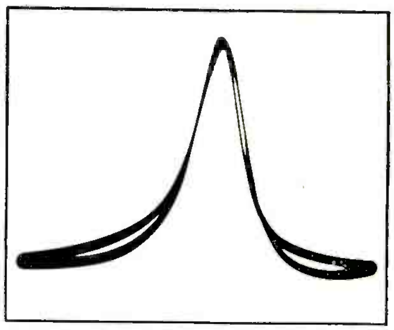

FIG. 3—Proton signal symmetrically formed

found in practice that a relatively good check of the operating sensitivity of the receiver by this method is one of the best methods of determining the absolute sensitivity of the receiver. It is particularly advantageous in this connection that the natural abundance of isotopes in certain substances appears to be remarkably uniform. The main disadvantage of testing the receiver in this way is that a fairly complex nuclear laboratory setup is required.

Band Reduction

Some of the means used to reduce bandwidth and to record and observe the nuclear signal may be of interest. The signal from the probe, which is in reality a vector addition of a small signal from the transmitter and the nuclear signal picked up from the sample, is amplified with a wide-band r-f amplifier and applied to a detector that extracts the audio signal produced by sweeping the static magnetic field. After further audio amplification, the nuclear signal may be readily observed on a conventional oscilloscope which obtains a sweep voltage from the same generator that supplies the sweep field to the sample. A somewhat different signal is obtained by using a linear sweep; the sine wave sweep gives a more coherent picture.

The signal observed on the oscilloscope would, of course, have a bandwidth which may be several hundred cycles, depending on the sweep frequency. Thus, an observed signal on the oscilloscope will be limited on a signal-to-noise basis in accordance with the bandwidth of the system used for observing the signal. A 60-cycle sweep, such as is commonly used, requires a system response of the order of 1 kc. In many cases, the corresponding sensitivity is inadequate. With the 60-cycle sweep full advantage is not taken in such a simple system of observation of the fact that it is permissible to run a test for several minutes in order to record a signal, and rapid observation is not necessarily required.

To take full advantage of a long recording time, the audio signal is fed to a mixer tube of the phase discriminator type which has its quadrature signal supplied from the sweep generator. By this means, it is possible to extract from the discriminator an extremely low frequency signal that corresponds to the oscilloscope signal, and to reduce its bandwidth to mere fractions of a cycle. Thus, good signal-to-noise ratios are obtained with extreme sensitivity. These signals may be observed either on a d-c meter or a graphic recorder that will draw out the signal on paper at any desired speed in accordance with the requirements of the particular nuclear test. The sensitivity obtained by this method may be some hundreds of times greater than that of direct observation on an oscilloscope.

The particular nature of the graphic recording process necessitates that some other parameter besides the sweep field be changed in order to record a signal of a time interval of the duration discussed. In the spectrometer shown in the photograph, two methods are made available. The radio frequency may be very slowly changed by means of an electric motor which can be seen just below one of the radio frequency units, or alternatively, a small potentiometer may be slowly rotated to change the field of the magnet. As the frequency is slowly swept through resonance, a curve of the familiar discriminator type will be obtained on the recorder. That is, the signal will slowly climb to a maximum, pass through the center zero and pass to an oppositely poled maximum (see Fig. 4). The amplitude of the signals obtained will be directly determined by the abundance of that particular isotope in the sample.

Frequencies

A brief discussion of the nuclear resonant frequencies of isotopes corresponding to a given magnetic field and the observed sensitivities should be of interest. The greatest sensitivity for nuclear resonance equipment of the type discussed is obtained with the hydrogen 1 isotope or proton. Thus natural water, H_2O, which has an abundance of this isotope will give a large clear nuclear resonance signal. Theoretical considerations indicate that with a magnetic field of 5,000 gausses and a system bandwidth of 1 cps, the signal-to-noise amplitude ratio should be approximately a million to one. Observed sensitivities correspond to theoretical values within a factor of 2 or 3. The signal-to-noise ratio is approximately proportional to both the square of the magnetic field and the volume of the sample; thus greater sensitivities are obtainable with higher frequencies and greater volumes, other factors remaining equal. With a 10,000-gauss polarizing field, the proton resonance is 42.5 mc; deuterium resonance, 6.52 mc and oxygen 17 resonance, 5.76 mc. The proton resonance may be observed at 4.25 mc with a corresponding reduction in the polarizing field, that is, a field of 1,000 gausses.

The above brief discussion gives some idea of current engineering practice concerning one particular form of nuclear resonance instrument and some of its uses. Many pieces of equipment are under development in the nuclear laboratories and more new and interesting arrangements are constantly being devised in this field. It is not possible to discuss all the applications of these instruments, electronically or otherwise. To those interested, it can only be suggested that the reference given below be reviewed and current work in the field be studied by reading the many articles now appearing in the physics and other journals.

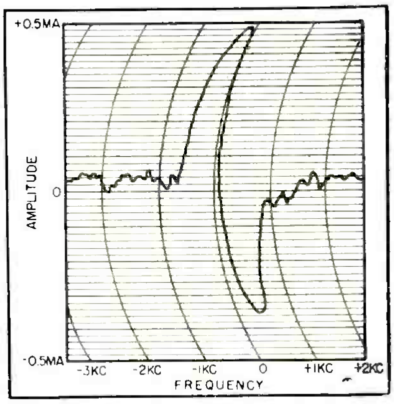

FIG. 4—Record of blip showing abundance of oxygen 17 in water. Nuclear resonance is at point where curve crosses centerline

REFERENCE

(1) F. Bloch, Nuclear Induction, *Phys. Rev.*, 70, Oct. 1946.

High-Impedance

By WILLIAM S. CARLEY and EDWARD F. SEYMOUR

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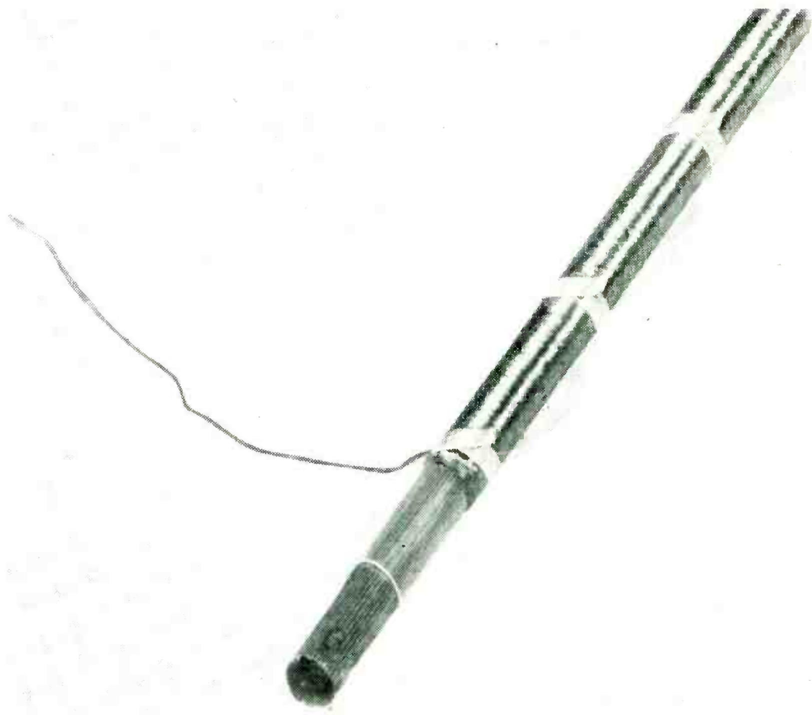


Enlarged view of end of wound delay line shows core details, dielectric and winding

INCREASING use is being made of distributed-constant electromagnetic delay lines as circuit elements in present-day electronic equipment. The characteristic impedance of these lines has been limited to values between 400 and 3,000 ohms.[1,2] Applications exist for lines with higher characteristic impedance. A brief discussion of the factors that determine the delay time and characteristic impedance will first be given, then ways of increasing the characteristic impedance will be discussed in detail.

The delay time, phase velocity, and characteristic impedance of a distributed-constant delay line can be derived from the simplified equivalent circuit of Fig. 1 where all losses have been neglected. These are

$$t_d = \sqrt{LC} \qquad (1)$$

$$\beta = \omega \sqrt{LC} \qquad (2)$$

$$Z_o = \sqrt{\frac{L}{C}} \qquad (3)$$

where L = inductance per unit length and C = capacitance per unit length. If R and G, the resistance and conductance per unit length, are present but $R << \omega L$ and $G << \omega C$ the following more general equations apply[3]

$$T_d = \sqrt{LC}\left[1 + \frac{1}{2}\left(\frac{R}{2\omega L} - \frac{G}{2\omega C}\right)^2\right] \qquad (4)$$

$$\beta = \omega\sqrt{LC}\left[1 + \frac{1}{2}\left(\frac{R}{2\omega L} - \frac{G}{2\omega C}\right)^2\right] \qquad (5)$$

$$Z_o = \sqrt{\frac{L}{C}}\left[1 + \frac{1}{2}\left(\frac{R^2}{4\omega^2L^2} + \frac{RG}{2\omega^2LC} - \frac{3G^2}{4\omega^2C^2}\right) + j\left(\frac{G}{2\omega C} - \frac{R}{2\omega L}\right)\right] \qquad (6)$$

It has been found that the attenuation of delay lines increases very rapidly with frequency above several megacycles.[4] The largest part of this increase was attributed to insulation loss. Experimental evidence in the form of lines wound with low-loss hand-coated wires substantiates this fact. At high frequencies R is proportional to $\sqrt{f}$. From reference 4 it is estimated that G is proportional to f^2 for Formex insulated wire.

It has been observed that the inductance of a delay line decreases at higher frequencies.[5,6,7] This is caused by phase shift per turn increasing so that although the turns are still magnetically linked as the frequency increases they add less and less to each other's magnetic field. A plot[7] of normalized inductance L/L_o and time delay T/T_o vs

$$\frac{dT_o}{l} f$$

appears in Fig. 2 where d = diameter of line, T_o = time delay for low frequencies, l = length of line and f = frequency.

The effect of turn-to-turn capacitance has been studied.[6,8] At low

* This article is based on a paper presented at the 1952 National Electronics Conference. The conference paper will appear in the *N.E.C. Proceedings*.

Artificial Delay Lines

Distributed-constant delay lines for short pulses may be designed with characteristic impedances as high as 10,000 ohms. Typical line is 10 in. long, 0.2 in. in diameter, weighs less than 10 grams and provides delay of 3.7 microseconds

frequencies the effect of this capacitance is negligible as the phase of the voltage in each turn of the coil is the same. As the frequency increases the phase of the voltage in each turn changes. Thus the effect of the turn-to-turn capacitance increases with frequency until the phase shift per turn equals 360 degrees. This turn-to-turn capacitance has the effect of increasing C to the value

$$C = \frac{C_o}{1 - \left(\frac{\omega}{\omega_o}\right)^2} \quad (7)$$

where ω is the angular frequency of the input signal

$$\omega_o^2 = \frac{1}{L'C'} \quad (7')$$

where $L' = L/N$ = effective inductance per turn, C' is the self capacitance between two adjacent complete turns and C_o is the capacitance per unit length from winding to core at low frequencies.

The inductance thus decreases with frequency and the capacitance increases with frequency. If the magnitude of these two effects were the same, delay time would be constant with respect to frequency. If $\frac{2\lambda}{d} > 13$ (λ = wavelength) a fair equalization of delay time could be obtained.[6] This would require

$$\frac{C'}{C} = \frac{25 d^2 N}{4(2\pi)^2} \quad (8)$$

but C' =

$$\frac{\pi d K_e}{3.6 \log_e \left\{ \frac{x+s}{x} + \sqrt{\left(\frac{x+s}{x}\right)^2 - 1} \right\}} \quad (9)$$

$$\doteq \frac{\pi d K_e}{3.6 \sqrt{2} \sqrt{\frac{s}{x}}} \; \mu\mu\text{f per turn}^{6}$$

where K_e = dielectric constant of wire insulation, x = diameter of wire, S = wire separation and d = diameter of coils.

Substituting $N = 1/x$ (for a close wound coil) and Eq. 9 in Eq. 8 we obtain

$$K_e^2 x^3 \doteq \frac{SC^2 d^2}{15} \quad (10)$$

where C is in micromicrofarads per axial centimeter.

The equalization of delay time by this procedure is done at the expense of decreasing characteristic impedance.

Another method of equalization of the delay time, likewise at the expense of characteristic impedance, is the use of patches.[4, 9] Patches are bridging capacitors over a number of turns, effectively increasing C as the frequency increases. Lumped-constant phase correcting networks have also been studied.[10]

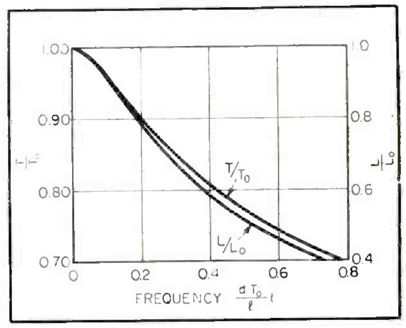


FIG. 2—Curves show effect on line inductance and delay

Equations 1 through 6 are derived on the assumption that the parameters R, L, G and C remain constant. Above a certain frequency we now see that R is proportional to $\sqrt{f}$, G is proportional to f^2, L decreases with increasing frequency and C increases with increasing frequency.

The resistance effect may be minimized by using small wire sizes

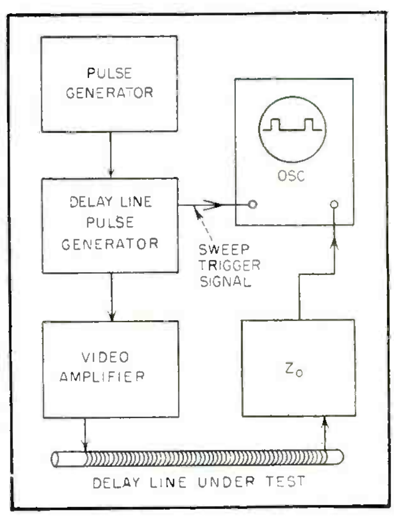


FIG. 3—Simplified block diagram of setup for testing distributed-constant lines

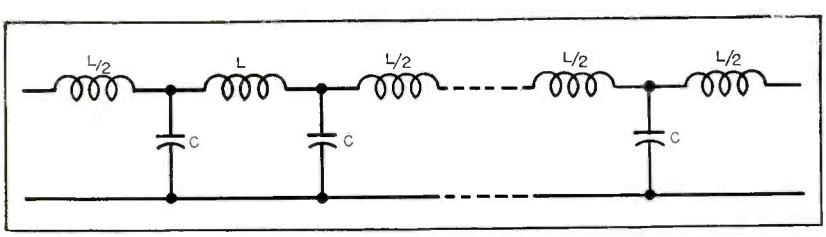


FIG. 1—Simplified equivalent circuit of a distributed-constant delay line of helix parameters

such as B & S gauge numbers 41, 44, 46 and 48. Little can be done about the conductance except to use low-loss insulation. Teflon-insulated magnet wire is now available which should have much lower insulation loss. The effects on both L and C may be reduced appreciably by winding the lines on a small diameter form such that the phase difference per turn is reduced. As shown by Eq. 3 one could increase the characteristic impedance by increasing L or decreasing C. If C were decreased, the time delay would decrease.

High-Z Lines

The purpose of the investigation, reported in this paper, was to produce lines having relatively large delays and high characteristic impedances. To achieve these goals both L and C were increased, but L was increased by a considerably larger factor than C.

To obtain as large a delay as possible it was decided to use the complete core as a ground. The capacitance per unit length can be varied by controlling the thickness and dielectric constant of the insulation material placed between the core and the winding. This large capacitance per unit length would necessitate a correspondingly large inductance per unit length to secure a high characteristic impedance.

The secret of success for the high characteristic impedance line is the method of obtaining the high inductance. First, a small wire size was chosen. As B & S gauge No. 48 copper magnet wire had a large attenuation and was too easily broken most of the work was done with No. 46 wire. With this wire a bank winding with approximately 3 layers was found necessary to obtain the necessary inductance.

The theoretical discussion of the compensation of a multilayer line will not be taken up at this time. The problem is quite complex with self capacitance from one turn to several neighboring turns and has not been completely solved. The discussion of the variation of time delay with frequency in the previous section is directly applicable only to single layer lines. A comparison of the calculations for single layer lines with the experimental results of multilayer lines appears later in this paper.

Line Construction

The lines were wound on $\frac{3}{16}$-inch diameter polystyrene cores 12 inches long. These cores were given several coats of silver conducting paint to form the ground strip. After an overnight drying period, the cores were axially slotted forming 36 thin strips, each strip being about 0.015 inch wide between 0.003-inch slots. A one-inch length of the core was left unslotted to facilitate the connection of the external ground lead.

The core was covered with a layer of insulating material to serve the dual purpose of insulating and controlling the winding-to-core capacitance. A 0.85 × 11.5 inch piece of Teflon tape 0.003 inch thick was wound around the core. This made 1.4 turns around the core. A number of small pieces of cellophane tape held the Teflon on the core until the line was wound. The tape was removed piece by piece as the line was wound.

The winding was done on a lathe. To provide uniform wire tension, both to secure a good winding and to prevent breakage, the wire feeding device shown in the photograph was used. The wire tension is adjustable over a range of about 10 to 70 grams and is continuously indicated by a pointer.

A wire guide attached to the longitudinal feed of the lathe was placed about $\frac{1}{16}$ inch from the core, which was chucked in the lathe. The longitudinal travel of the wire guide was 0.00066 inch per turn. As this distance is a fraction of the wire diameter, the result was a multiple layer coil approximately bank wound. The far end of the core was attached to a counter chucked in the tailstock. A steel drill rod was inserted through a hole in the core for rigidity. A 10-inch long winding was wound on the core. Lines have been wound with speeds varying from about 200 to 500 rpm.

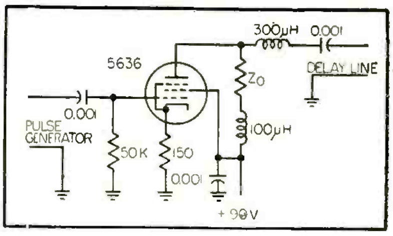


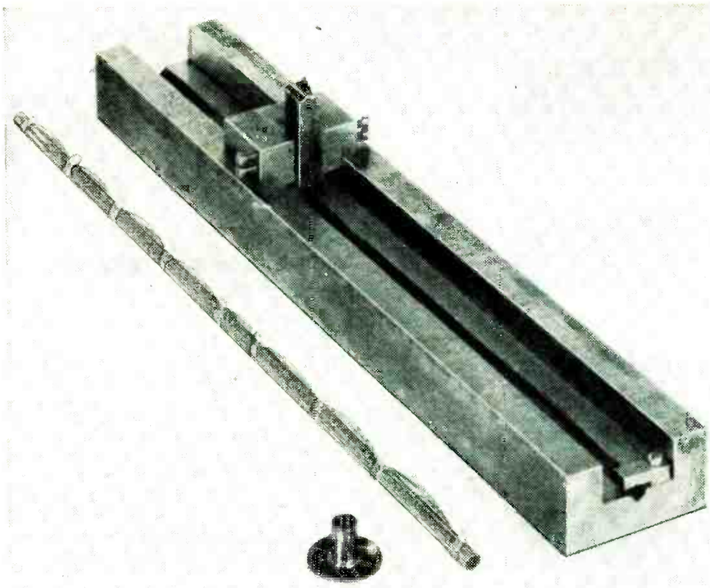
FIG. 4—Video amplifier circuit diagram

A piece of No. 26 wire was soldered to the ends of the winding and secured to the winding with polystyrene dope.

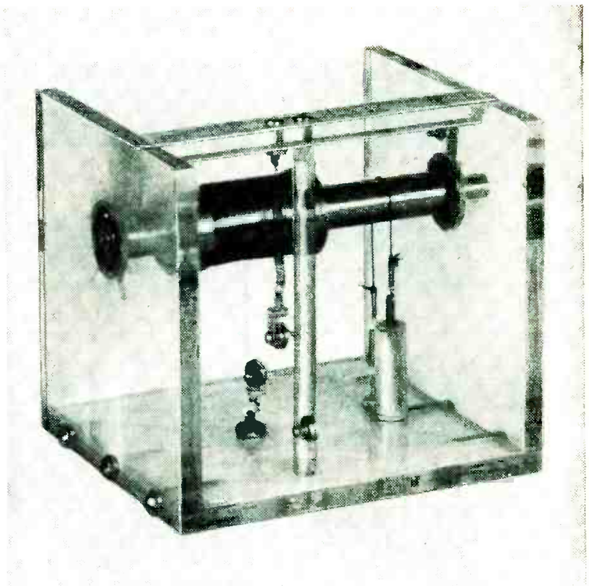
The method for determining the characteristic impedance of these delay lines is based upon the fact that no reflections occur in an ideal-

Table I—Summary of High-Impedance Distributed-Constant Delay Line Characteristics

	L (mh)	C ($\mu\mu$f)	Z_0 (ohms) meas (real part)	Z_0 (ohms) calc	t_d (μsec) meas	t_d (μsec) calc	rise times (μsec) t_{ri}	rise times (μsec) t_r	rise times (μsec) t_{r1}	attenuation (db/μsec delay)	winding length (inches)
No. 44 line	24.0	518	5,600	6,600	3.5	3.6	0.1	0.14	0.1	0.3	10
No. 46 line	22.1	652	5,600	5,830	3.75	3.8	0.1	0.15	0.12	0.4	10
No. 48 line	21.70	164	5,600	6,800	3.4	3.2	0.1	0.18	0.15	1.3	10
High Impedance	40.7	450	9,000	9,500	4.5	4.3	0.08	0.2	0.18	0.4	9.3
No. 44 line	40.7	450	10,000	9,500	4.5	4.3	0.08	0.24	0.22	0.2	9.3



Slotting device for preparing delay line cores. Indexing head is shown in foreground



Constant tension wire feeder permits use of wire as small as No. 48 in delay lines

ized delay line terminated in its characteristic impedance. The characteristic impedance of a line whose parameters are a function of frequency would most certainly be a function of frequency. The value of the characteristic impedance in a practical case involving complex waves must therefore be compromised for minimum reflections over the band of frequencies for which the line is designed to operate.

Measurements

In making measurements, the lines are terminated at the input as well as the output to minimize any possible secondary reflections at the input. A suitable means of determining the effective characteristic impedance when the line is used to delay rectangular pulses is to feed the pulse itself into the delay line and to adjust the terminating impedances for minimum reflections.

A block diagram illustrating the experimental method for determining the characteristic impedance of these delay lines and for recording the response of the delay lines to rectangular pulses appears in Fig. 3.

The oscilloscope sweep is triggered by the input pulse. A camera, mounted on the oscilloscope, records the input and output wave shapes of the delay line. The load impedance of the video amplifier was made equal to the characteristic impedance of the line. A diagram of the video amplifier appears in Fig. 4.

The pulse distortion and attenuation were also measured with the equipment connected as shown in Fig. 3, using the oscilloscope camera. The delay time as well as the rise and fall time was likewise measured on the oscilloscope. The delay time was defined as the time between the midpoint of the leading edge of the input and output wave forms. The rise and fall times were defined as the time duration between the 10 and 90-percent values of the pulse amplitude. The pulse duration was defined as the time between the 10-percent values. The attenuation was measured by comparing the amplitudes of the input and output pulses.

Results

The data on a particular line, typical of those wound follows:

Core diameter is 0.188 inch, with 36 slots.

Dielectric is Teflon 0.003 × 0.85 × 11.5 inches.

Length of winding is 10 inches with 1,520 turns per inch (0.00066 inch per turn) of No. 46 HF wire 0.0019 inch in diameter.

The electrical characteristics of the line measured at 1,000 cps were, R = 3,660 ohms, L = 22.1 mh, G = 0 and C = 652.1 μμf.

Impedance and time delay calculated from these measurements, are Z_o = 5,830 ohms and t_d = 3.8 microseconds. The experimental data obtained on this line were Z_o = 5,600 ohms resistance in series with a parallel network of a hundred-microhenry choke and a 2,200-ohm resistance (determined for minimum reflection with 0.3-microsecond pulse).

Time delay was 3.75 microseconds and t_{ri} = rise time of 1-μsec input pulse = 0.1 microsecond; t_r = rise time of 1-μsec output pulse = 0.14 microsecond as

$$t_r = \sqrt{t_{ri}^2 + t_{rl}^2} \qquad (11)$$

where t_{rl} = rise time output pulse if a perfect input pulse were applied to the line. Thus t_{rl} = 0.1 μ sec.

Photographs of the input and output waveforms appear in Fig. 5 for pulse durations of 0.30, 0.37, 0.62 and 1.0. Input and output waveforms superimposed to a larger scale are also included. The reflections appearing between the input and output pulses no doubt occur at points where the spill over from true bank winding was particu-

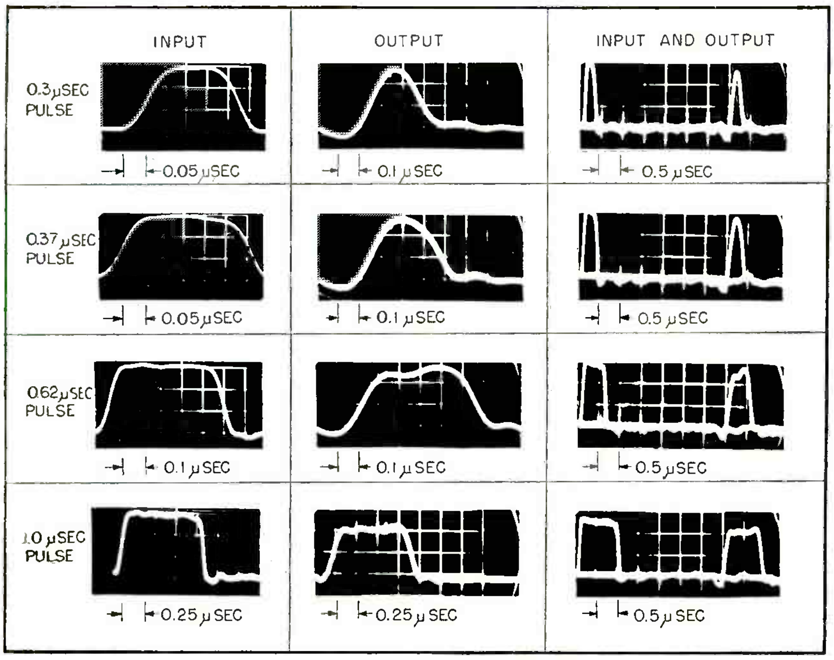


FIG. 5—Pulse response of 5,600-ohm line wound with No. 46 wire

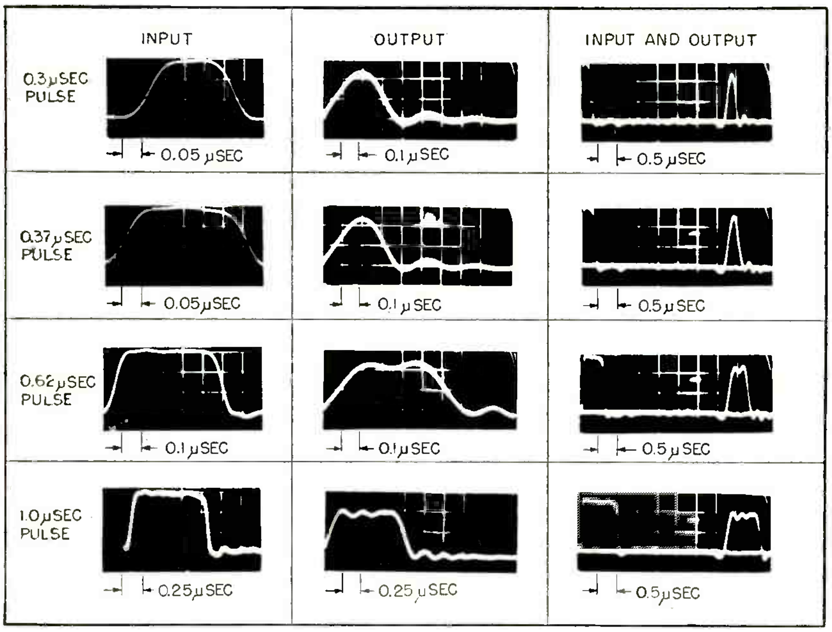


FIG. 6—Pulse response of 5,600-ohm line wound with No. 44 wire

larly bad. All photographs were taken with the same value of terminating impedance which was the value obtained as the best impedance match with a 0.3-μsec pulse applied. In the case of the longer pulse durations, slightly better waveforms can be secured by reterminating the line. An example will be shown later.

Substituting in Eq. 10, on the supposition that this equation holds for a bank winding, we find the winding-to-core capacitance should be 0.29 μμf per centimeter for proper equalization. This value was obtained using 3.6 for the dielectric constant of Formex and 0.0002 inch as the thickness of the dielectric. From the measurements, the capacitance to core was 25.7 μμf per centimeter. The effect of the stray capacitance is therefore much higher for the multilayer line. Equations are being derived which give very good agreement.

The value of ω_o may be calculated from Eq. 7'. If $L' = 1.46$ μh and $C' = 2.2$ μμf from Eq. 9, $\omega_o = 0.56 \times 10^9$. The resonant frequency thus is 89 mc.

Resonant Frequencies

Resonant frequencies of 124, 165, 215, 235, 332 and 375 mc were obtained experimentally. The 235-mc reading had a considerably higher Q than the others and was probably the resonant frequency of a single turn. The 124-mc frequency had a very low Q. No readings were observed from 60 to 124 mc.

The thickness of the dielectric used in calculating the resonant frequency was determined by measuring the overall diameter of the insulated wire with 1/10,000-inch micrometers. The wire was coated with X-Var which chemically attacks the Formex. After the wire was wiped clean the diameter was measured again. This method does not give extreme accuracy.

The resonant frequency of the inductance of one turn and the core capacitance of that turn is calculated to be 368 mc. This value checks the 375-mc value very closely. If one assumes that we have a fictitious single layer winding and each turn has an inductance 3 times that of the former single turn ($L' = 4.38$ μh). We have effectively lumped up the inductance of three layers into one.

If the equivalent single-layer winding outlined above is assumed, the resonant frequency of the inductance of one turn and the capacitance to core of one turn is 212 mc. This checks the 215 megacycle value very closely.

No explanation is apparent for the 124 and the 332 megacycle readings. The fact that there were two layers of insulation over 40 percent of the core and one layer over 60 percent of the core might account for some of these resonances.

Waveforms

Photographs of the waveforms of a line of similar dimensions except 1.5 layers of Teflon and wire size changed to No. 44 with 55 grams tension appear in Fig. 6. The winding was approximately 4 layers. The termination was the same

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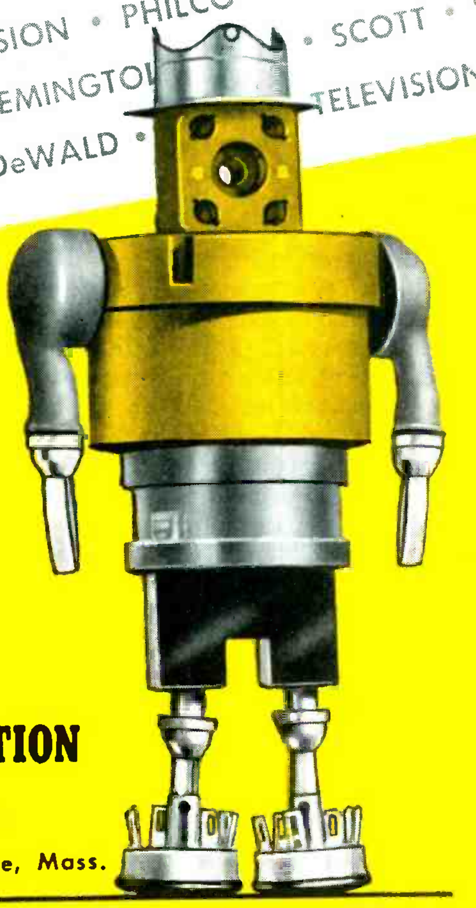

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except the series inductance was raised to 250 μh. A comparison of Fig. 5 and 6 shows the delay and attenuation to be slightly less for the No. 44 line although the phase distortion and small reflections along the line are slightly greater. This is probably due to the spill over being greater with the four layer winding.

A line was wound using 1.8 layers (1.1 inch wide strip) of Teflon and wire size changed to No. 48 with 20 grams weight tension with an average of 2.2 layers on this winding. The terminating impedance used was the same as in the previous case except the series inductance was changed to 200 μh. The line was terminated for minimum reflection using a 0.3-μsec pulse input. The waveforms of this line appear in Fig. 7. It will be noted that the attenuation has increased appreciably. There is more ringing on the top of this wave. The line was reterminated with a 1-μsec pulse applied. The terminating impedance turned out to be a 5,600-ohm resistor.

Lines with higher characteristic impedances than 5,600 ohms have been obtained using a ¼-inch diameter core and 2⅜ layers of Teflon tape. The characteristic impedance, when terminated with a 0.3-μsec pulse applied, was increased to 9,000 ohms in series with a 400-μh choke. The input impedance (shunt impedance in output of video amplifier) was 7,400 ohms in series with an inductance of 400 μh. Photographs of the waveforms of this line appear in Fig. 8.

This particular line had only 14,165 turns and the winding was 9.3 inches long. It had a time delay of 4.5 μsec, or a time delay of almost 0.5 μsec per inch. When the line was reterminated using a 1-μsec pulse, the terminating impedance turned out to be a 10,200-ohm resistor. The output impedance of the video amplifier was increased to 11,000 ohms. The waveforms of this termination also appear in Fig. 8. This line was wound with No. 44 wire.

The characteristics of these lines are compared in Table 1. The real part of the terminating impedance (the best value for 0.3-μsec pulses) is listed in all cases. In the case of the high characteristic impedance line, the characteristics for the best one-microsecond pulse termination also appear. The attenuations listed were measured values with a one-microsecond pulse applied to the line. From Fig. 5 and 6 it will be noted that the attenuation is greater for shorter pulse durations.

From the data presented, delay lines with impedances of 5,600 ohms and reasonable attenuations for pulse widths less than 1-μsec can be obtained. It appears likely that lower attenuations can be obtained if better winding techniques can be developed for the No. 44 gauge wire. The availability of Teflon-insulated magnet wire in small wire sizes should aid in the reduction of attenuation and improvement of phase response.

The authors are indebted to J. F. Peoples for his assistance and to M. F. Davis for his encouragement.

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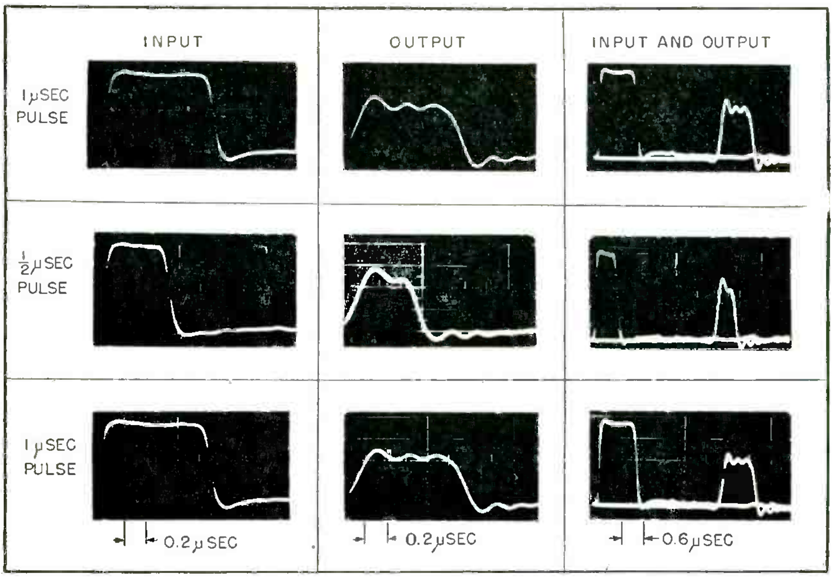


FIG. 7—Oscillograms show 5,600-ohm line wound with No. 48 wire terminated for a 0.3 μsec pulse (top and middle) and 1.0-μsec pulse (bottom)

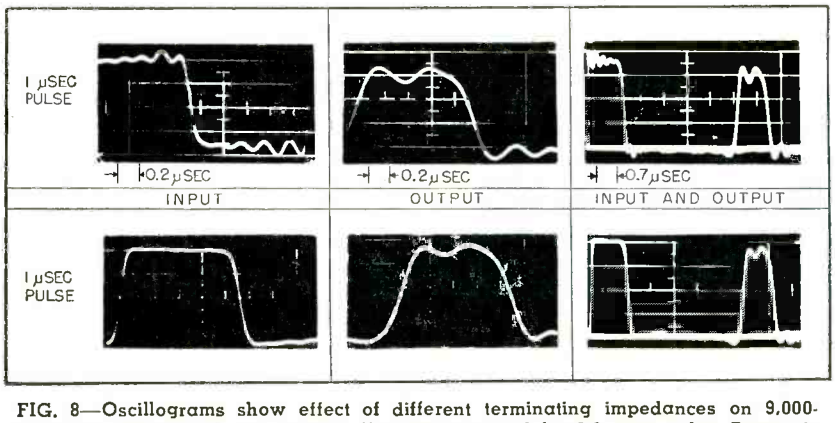
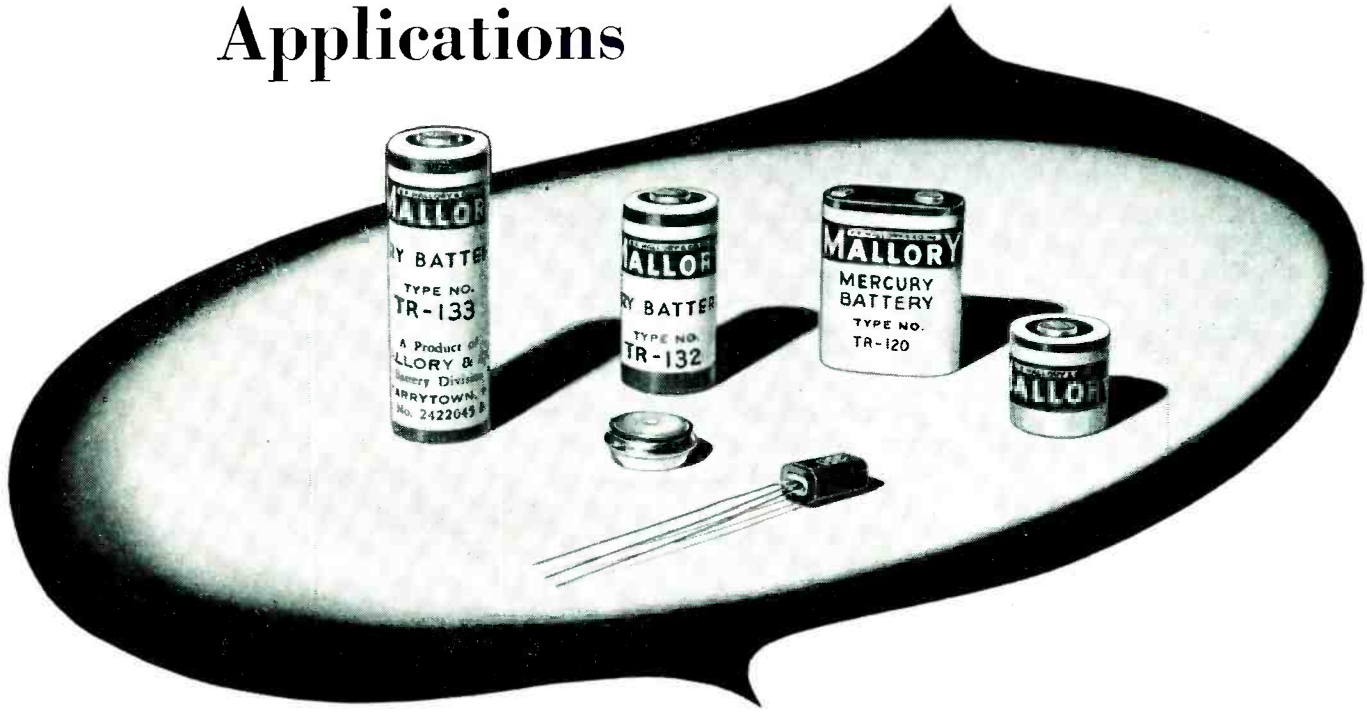


FIG. 8—Oscillograms show effect of different terminating impedances on 9,000-ohm line wound with No. 44 wire. Top is terminated for 0.3 μsec pulse. Bottom is terminated with 10,000-ohm resistor

For Transistor Applications



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OTHER DEPARTMENTS featured in this issue:

Demonstration Equipment for Electronic Courses

EVER INCREASING COMPLEXITY of military electronic equipment places a burden on military personnel charged with operating and maintaining the gear. With training time and personnel both at a premium, much of the work at the Navy's Special Devices Center, Sands Point, N. Y. concerns design of demonstration devices, technical training aids and full-scale working models of operational electronic equipment.

One piece of equipment used for classroom demonstration, has components mounted on boards that show the circuit schematically. One such board is shown in the photograph. Nine basic circuits are available. These circuits are: (1) simple a-c circuits that can be arranged to demonstrate series and parallel resonance, differentiation, integration, and phase shift; (2) diode characteristics and diode circuits such as shunt and series limiters; (3) triode characteristics; (4) full and half-wave rectifiers with various filter combinations; (5) cathode-coupled multivibrators both free-running and driven; (6) shock-excited oscillator; (7) hard-tube, nonrecurrent sweep generator; (8) blocking oscillator; and (9) cascade amplifiers with various coupling arrangements. The last board can also be used to show pentode and tetrode static characteristics.

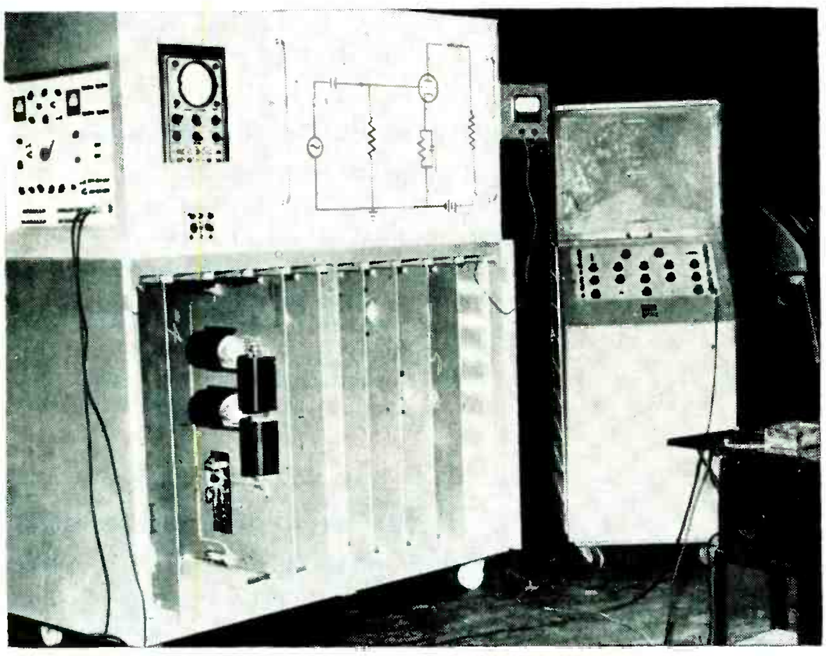

FIG. 1—Classroom demonstration board allows nine different circuits to be demonstrated to a large group. Projection oscilloscope at right makes it possible to show what is happening at various points in the circuit

Two variable B+ supplies deliver 0 to 350 volts to the circuits. A variable C-supply delivers −50 to +50 volts while the alternating filament voltage is adjustable from 0 to 13 volts.

Sine-wave, square-wave, positive or negative pulse and sawtooth inputs may be applied to the demonstration circuits. The sine wave can be varied in frequency from 20 cps to 150 kc; rms value is 10 volts. The square wave retains its shape up to 4,000 cps while the sawtooth seems linear to between 6,000 and 7,000 cps.

An electronic switch permits display of waveshapes at various points in the circuit both on the built-in oscilloscope and on the projection oscilloscope. A vacuum-tube voltmeter may be switched to show voltage and currents throughout the circuit under study. Meter readings can be projected on a screen by the projector shown in the photograph.

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VERNIER FREQUENCY DIAL: This dial is divided into approximately 100 equal scale divisions and is coupled to the main frequency dial by a 24:1 gear train. The approximate frequency change per vernier division is 35 kc.

FREQUENCY MODULATION (DEVIATION): The FM deviation is continuously variable from zero to 240 kc. The modulation meter is calibrated in three FM ranges (1) 0-24 kc., (2) 0-80 kc., and (3) 0-240 kc. deviation.

AMPLITUDE MODULATION: Utilizing the internal audio oscillator amplitude modulation may be obtained over the range of 0-50% with meter calibration points of 30% and 50%. By means of an external audio oscillator the RF carrier may be amplitude modulated to substantially 100%. A front panel jack is provided which permits direct connection of an external modulating voltage source to the final stage for pulse and square wave modulation. Under these conditions the rise time of the modulated carrier is less than 0.25 microseconds and the decay time less than 0.8 microseconds.

MODULATION CONTROLS: Separate potentiometers are provided for continuous control of FM and AM levels.

MODULATING OSCILLATOR: The internal AF oscillator may be switched to provide either frequency or amplitude modulation. It may also be switched off. Eight fixed frequencies between 50 cycles and 15 kilocycles are available, any one of which may be selected by a rotary type switch.

RF OUTPUT VOLTAGE: The RF output voltage is continuously variable over a range from 0.1 microvolt to 0.2 volts at the terminals of the output cable. The impedance of the RF output jack, looking into the instrument, is 53 ohms resistive.

DISTORTION: FM: The overall FM distortion at 75 kc. is less than 2% and at 240 kc. less than 10%.

AM: The distortion present at the RF output for 30% amplitude modulation is less than 3% and for 50% AM less than 6.5. At 100% the distortion is 12% to 15% depending upon the modulating frequency.

SPURIOUS RF OUTPUT: All spurious RF output voltages are at least 25 db. below the desired fundamental. Total RMS spurious FM from the 60 cycles power source is down more than 50 db., with 75 kc. deviation as a reference level.

EXTERNAL MODULATION REQUIREMENTS:

Frequency Modulation: The deviation sensitivity is 50 kc. per volt. For external FM the input impedance is 1500 ohms.

Amplitude Modulation: Approximately 45 volts are required for 50% modulation and 100 volts for 100% modulation. For external AM the input impedance is 7500 ohms.

Audio Voltage for External Use: There is available at the FM external oscillator binding posts about 5 volts a.c. maximum and at the AM external oscillator binding posts, 50 volts maximum.

DIMENSIONS AND WEIGHT: Outside cabinet dimensions: 17" high, 13½" wide, 11½" deep. Weight: 35 pounds.

Price: $980.00 F.O.B. Boonton, N. J.

BRC

BOONTON RADIO Corporation

BOONTON·N·J·U·S·A·

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oped at Sands Point is an ultrasonic radar simulator to aid crews of intercontinental bombers. To provide a radarscope view of the terrain an ultrasonic transmitter bounces 15-mc pulses on a bas-relief map immersed in water. The return signals are heterodyned up to 3 mc and used to feed a standard radar video device.

Sorting Eggs by Shell Color

BECAUSE New Englanders prefer brown eggs and denizens of New York, Philadelphia and Cleveland like them white, an electronic sorter has been designed to discriminate among six or more shades.

Two photocells make up two arms of a self-balancing bridge with span-adjusting resistors and a balancing rheostat forming the other two arms, as shown in Fig. 1. The amplifier detects any unbalance in the bridge and amplifies this voltage differential to drive a synchro motor until a new balance is obtained.

When differences of shell color cause a change in the ratio of the light received by the two photocells, the motor assumes a new position.

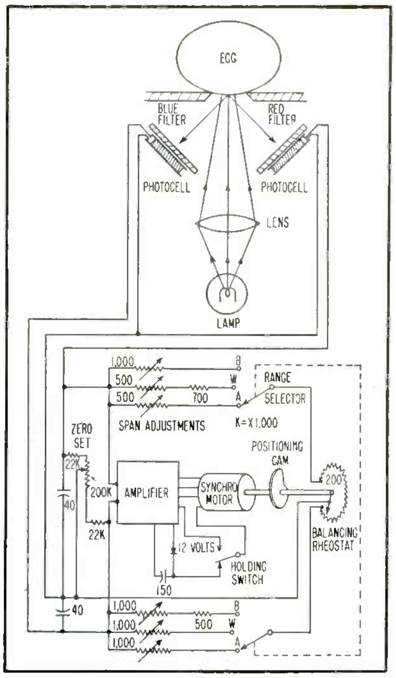


FIG. 1—Shell-color determinator utilizes light reflected from egg shell through red and blue filters to photocells

For this reason, the cam angle becomes an indication of color. Auxillary mechanical devices can be arranged to load the eggs into the machine and distribute them into proper bins. For example, the holding switch can be used to lock the motor in place while the color information is transferred to the loading mechanism.

In the *A* position, the range switch accommodates eggs of all colors. In the *B* and *W* positions, eggs from light to dark brown and those from white to light brown, respectively, are graded.

The circuit was developed by the U. S. Department of Agriculture at Beltsville, Md., but no complete machinery is available for purchase there.

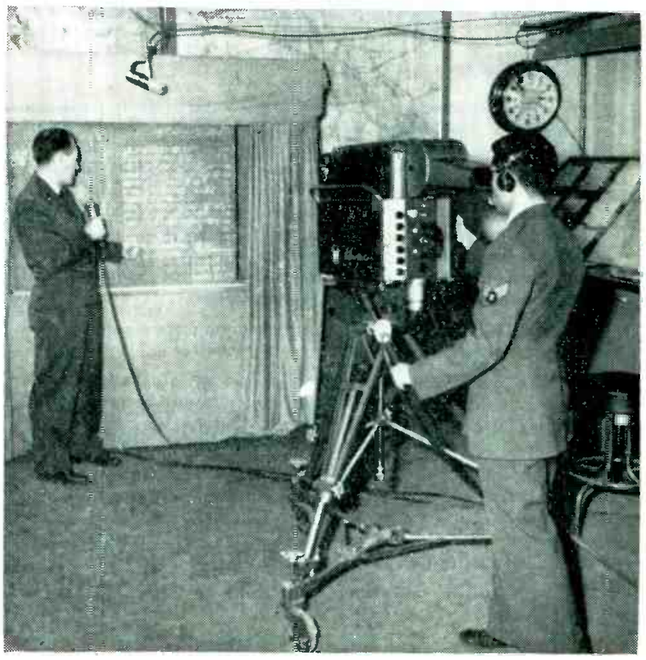
Magnesium Waveguide Characteristics

REPLACEMENT of conventional waveguides, particularly in aircraft, by those of lighter weight, may be possible according to the Air Force.

Magnesium waveguides can be produced in substantially all the sizes and shapes in which brass and aluminum guides are made. Their use makes possible a weight reduction of about 80 percent over brass waveguides. There is a 35-percent weight saving over those fabricated from aluminum. Development work now going on may effect a further

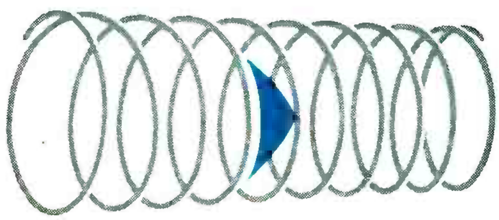
VIDEO WEATHER BRIEFING SPEEDS AIR FORCE

Jet pilots in alert hangar ready room receive hourly information from central point via closed-circuit television, saving half hour over old method. System can be expanded over wide area for other instructions



Air Force Video Production Squadron recently provided equipment for a 15-day test of visual briefing for pilots. Camera above is trained on map while forecaster explains meteorological developments

There's a 10-turn Helipot to meet *your* requirements



With the development of the original HELIPOT—the *first* multi-turn potentiometer—an entirely new principle of potentiometer design was introduced to the electronic industry. It made possible variable resistors combining high resolution and high precision in panel space no greater than that required for conventional single-turn potentiometers.

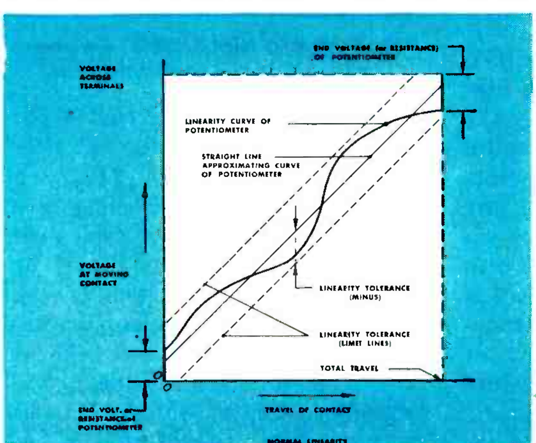
The Helipot Principle... *High resolution and precision settings require a long slide wire. But by coiling a resistance element into a helix, it is possible to gain desired resolution and precision without wasting panel space. This principle is applied in various Helipot models with slide wires ranging from 3 to 40 helical turns.*

Advantages are immediately apparent. In the case of the widely-used 10-turn Model A Helipot, for example, a 45" long slide wire—coiled into ten helical turns—is fitted into a case 1¾" in diameter, and 2" in length. Another advantage of the 10-turn pot is that, when equipped with a turns-indicating RA Precision DUODIAL, slider position can be read directly as a decimal, or percentage, of total coil length traversed.

10-TURN HELIPOT MODELS—CONDENSED SPECIFICATIONS

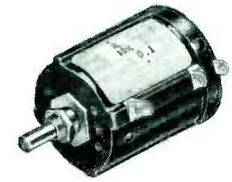
	Model A	Model AN	Model AJ
No. of turns	10	10	10
Resistance Range	10 ohms to 300,000 ohms	100 ohms to 250,000 ohms	100 ohms to 50,000 ohms
Resistance Tolerance: Standard	±5%	±5%	±5%
Best	±1%	±1%	±3%
*Linearity Tolerance: Standard	±0.5%	±0.5%	±0.5%
Best	±0.05% (1K ohms and above)	±0.025% (5K ohms and above)	±0.1% (above 5K ohms)
Power rating @ 40°C	5 watts	5 watts	2 watts
Mechanical Rotation	3600° +4° −0°	3600° +1° −0°	3600° +12° −0°
Electrical Rotation	3600° +4° −0°	3600° +1° −0°	3600° +12° −0°
Starting Torque	2 oz. in.	1.9±.3 oz. in.	.75 oz. in.
Running Torque	1.5 oz. in.	0.6±.3 oz. in.	.60 oz. in.
Net Weight	4 oz.	4 oz.	1 oz.

*i.e. INDEPENDENT LINEARITY. The above linearity tolerances are based on the following definition recently proposed to clarify and standardize nomenclature related to precision variable resistors. . . . "Independent linearity is the maximum deviation in percent of the total electrical output of the actual electrical output at any point from the best straight line drawn through the output versus rotation curve. (This line shall be measured through the extent of the effective electrical angle.) The slope and position of the straight line from which the linearity deviations are measured must be so adjusted as to minimize these deviations."



10-Turn Helipot Highlights

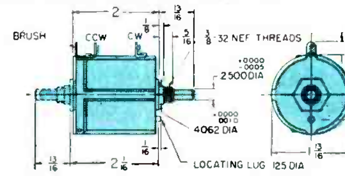
From the basic Helipot principle, model variations have been developed to meet new requirements:



Model A Helipot

the original 10-turn Helipot—provides a resolution from 12 to 14 times that of conventional single-turn potentiometers of same diameter (1¾"), linearities as close as ±0.05% in resistances as low as 1K ohms.

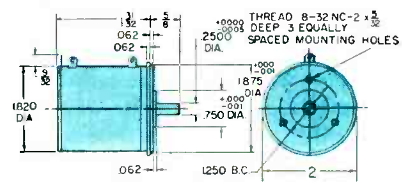
The same multi-turn principle is also available in 3 turn units (Model C), and larger-diameter units of 15 turns (Model B), 25 turns (Model D), and 40 turns (Model E)—a type for every application from 5 ohms to 1 megohm.



Model AN Helipot

an ultra-precision version of the basic 10-turn Helipot. Produced in volume to extremely close electrical and mechanical tolerances, this unit features precision ball bearings (Class 5), servo mounting lid, plus linearity tolerance as close as ±0.025% as low as 5K. A 3-turn unit (Model CN) is also available.

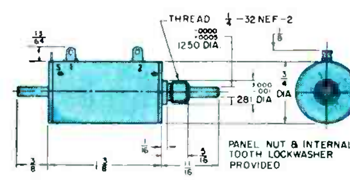
Models AN and CN are particularly recommended for precise servo-mechanism applications and represent the most advanced design and highest quality available today in the field of precision potentiometers.



Model AJ Helipot

a 10-turn *miniature* Helipot only ¾" in diameter, weighs 1 oz., has slide wire 18" long. Also available with servo mounting (Model AJS) and servo mounting with *ball* bearings (Model AJSP). Linearities as close as ±0.1% as low as 5K.

Designed for long life under severe operating conditions, the AJ Series is widely used where small size and weight are vital.



Design details on above units are subject to change without notice. Certified drawings available upon request.

Only Helipot is able to supply—in volume—multi-turn helical potentiometers *with special features to meet your particular needs* . . . Special Shafts, Extra Spot Welded Taps at any position, Ganged Assemblies (except AJ), Special Temperature Coefficients, etc. Send us your requirements!

For complete details contact your nearby Helipot representative. Or write direct.

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reduction to about 50 or 55 percent the weight of aluminum guides.

Attenuation in magnesium guides is about 20 percent higher than in brass, but this figure can be improved by silver plating. Although it is difficult to plate magnesium with a nobler metal, preplating techniques have made it possible to silver-plate sections two feet long.

Magnesium is silver white in color and has a specific gravity of 1.74. In its pure state it weighs 108.6 pounds per cubic foot. By alloying zinc, aluminum and magganese with magnesium, a combined strength-weight ratio is obtained that is the highest and lightest ratio available from any common metals.

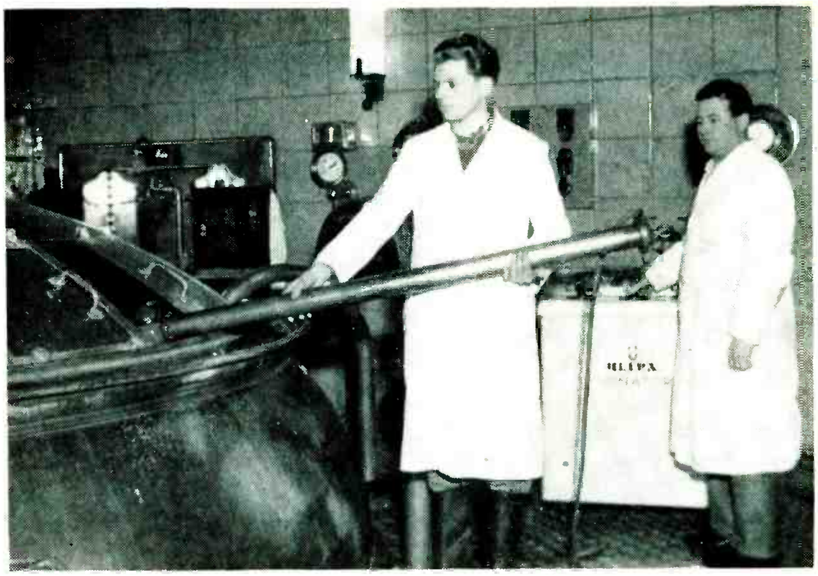
Dust and filings ignite easily and attachment of flanges by welding requires special techniques.

The full report, PB 107,675, may be obtained in photostat or microfilm from the Library of Congress.

German Brewers Use Ultrasonics

SAVINGS UP TO 40 PERCENT in hops is claimed by a 96-year-old brewery at Weissenthurm, near Koblenz, Germany, through the use of ultrasonic vibrations at one stage of their operations.

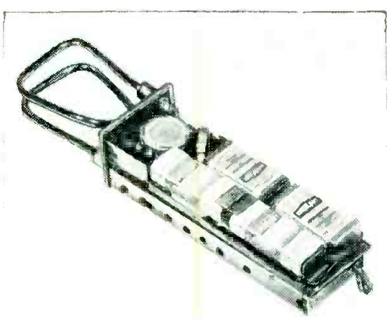
Water and malt are cooked at 75 C four to six hours. The mixture is drawn off, clarified and hops are added. The resultant mixture is boiled an additional two hours. During this time, the ultrasonic transducer is lowered into the vat and some 300 watts of 1-mc power applied. It is believed that the bitter substances from the hops are more effectively extracted by this means.



Brewer lowers copper-sheathed ultrasonic transducer into beer vat while assistant prepares to switch on 1-mc generator

The equipment is essentially a 1-mc crystal oscillator followed by a buffer and a final amplifier. The transducer employs six quartz-crystal capsules.

Hand Transmitter Eliminates Mike Cable



This 25-milliwatt f-m transmitter was designed by Motorola engineers to extend the range of the microphone used with a loudspeaker system in railroad yards. It operates in the 152-to-174 mc band, produces a 15-kc deviation and measures approximately 2 × 3 × 7 inches

PERTINENT PATENTS

AN UNUSUAL APPLICATION of electronic techniques is involved in patent 2,617,852 for an "Electrical Well Logging System" issued to H. C. Waters and assigned to Perforating Guns Atlas Corp., of Houston, Texas.

In the electrical logging of oil wells, resistivity values and the natural d-c potential of the earth formations in an oil borehole are made at various penetrations and between and across the varying formations traversed by the borehole.

This invention provides a method and apparatus as illustrated in Fig. 1, for obtaining and indicating the resistivity values and/or potential from a combination of three points or two different distances and any one point in the borehole. For example, electrical resistivity at two different distances of penetration may be measured and are transmitted to the surface in the form of slowly varying direct-current values simultaneously with natural d-c potential of the earth as it exists

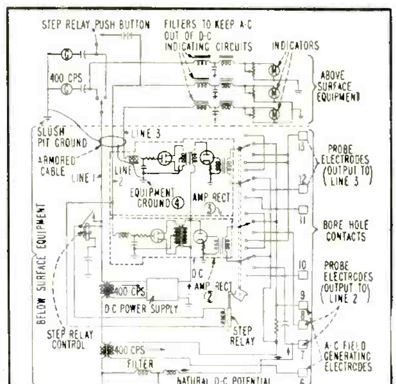


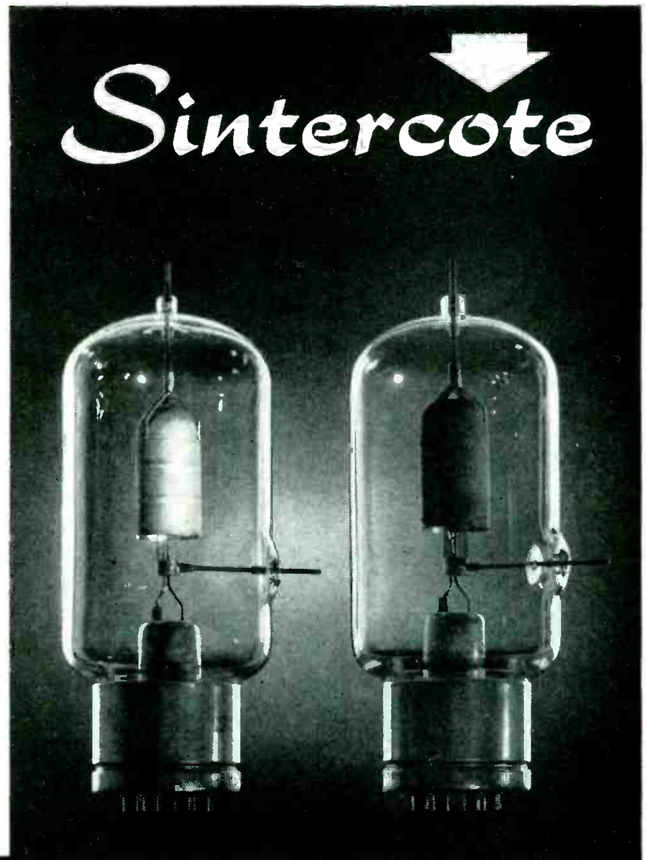
FIG. 1—Well-logging system uses combination of a-c and ground potential

between a moving electrode in the borehole and a fixed reference electrode at the surface.

Resistivity measurements are made by generating a 400-cycle field into the earth between a pair of terminals near the bottom of the borehole. Probe electrode pairs selectively pick up the a-c field at various levels in the borehole. Natural d-c potential is picked up at one probe terminal capacitively iso-

LOS GATOS

Sintercote



Los Gatos Type 254 Triode with tantalum anode. Plate dissipation is 75 watts.

Addition of Sintercote anode raises rating to 125 watts. Operating life more than doubles.

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ANOTHER PLUS for the traditional nine-plus lives of Los Gatos electron tubes. Development by Lewis and Kaufman engineers of the exclusive new Sintercote black-body anode surface gives you tubes with much more than twice their former service lives.

SINTERCOTE consists of finely-divided particles having a high spectral emissivity—several times that of a bright surface. Result: Increased plate dissipation. In addition, Sintercote is a strong getter which keeps Los Gatos tubes hard throughout their lives; protects cathodes against ion bombardment. Result: Increased life.

Get further details from your regional Los Gatos field-engineering representative, or write:

LEWIS and KAUFMAN, Ltd.

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LOS GATOS LONG LIFE

lated from the a-c line and filtered to remove the a-c component. The a-c picked up in the probe electrodes is amplified and rectified. The resultant d-c component is carried to the surface where galvanometers (possibly recording instruments) indicate the potentials derived. Probe terminals are selected by a step relay controlled from the surface by pushbuttons.

The potentials indicated on the galvanometers show the resistivity between points separated by some predetermined distance in the borehole contacted by the electrodes. Natural d-c potential on resistivity potential is carried to one of the galvanometers upon appropriate setting of selector switches.

No details are provided in the patent description as to what specific use is made of the information collected through the application of the equipment of this invention beyond that substantially disclosed above.

In patent 2,617,926 issued to the late Louis Cohen, entitled "Interference Reducing Radio Receiving System", many variations of a principle to be employed for radio interference reduction are shown applied to antenna coils of radio receivers.

The simplest embodiment of the invention is shown in Fig. 2A. An antenna coil is so constructed in conjunction with a metal plate that the metal plate is adjustable and may be brought closer to or further from the coil to vary its effective electrical length by varying the distributed capacitance. A second antenna coupled to the metal plate collects energy just as the regular antenna. The degree of transfer of the energy from the second antenna

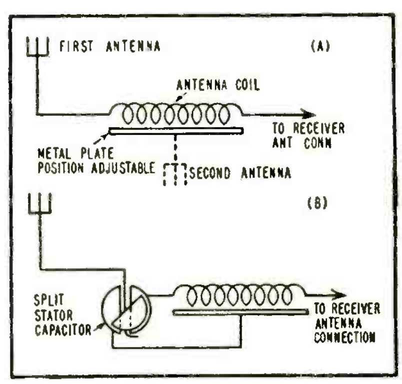


FIG. 2—Two methods of coupling opposing interference signals

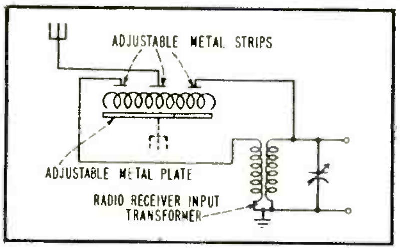


FIG. 3—Interference eliminator coupled to receiver input

is varied by the position of the metal plate with respect to the coil.

In Fig. 2B is shown how the technique of the invention is applied to employ only one antenna through the use of a split stator capacitor.

Figure 3 illustrates a further refinement of the technique of this invention with its connection to the radio receiver input transformer. Adjustable metal strips capacitively couple the interference reducing coil and plate arrangement to the antenna and the primary and secondary of the antenna input transformer of the radio receiver.

In accordance with this invention the inventor shows that the phase and amplitude relationships of an electrical disturbance which sets up oscillatory currents in a wave conductor and associated circuits may be represented by the formula.

$$I = E\,\psi\,(f)$$

where E is the applied voltage and $\psi\,(f)$ is a function of the frequency determined by the circuit parameters. If the energy is applied to the circuit components in such a relationship that a current $E_1\,\psi_1\,(f)$ is generated of equal amplitude and opposite polarity to a current $E_2\,\psi_2\,(f)$ produced by applying the disturbance to some point on the

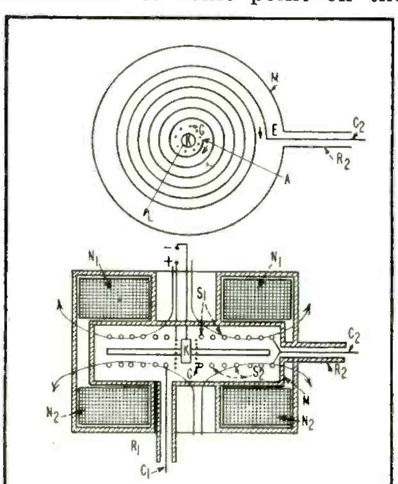


FIG. 4—Spiral traveling-wave tube elements

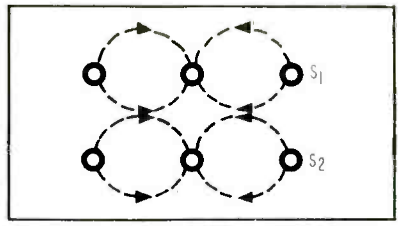


FIG. 5—Radial electric field between successive turns of same spiral

conductor, then the resultant transmission of the disturbance is zero

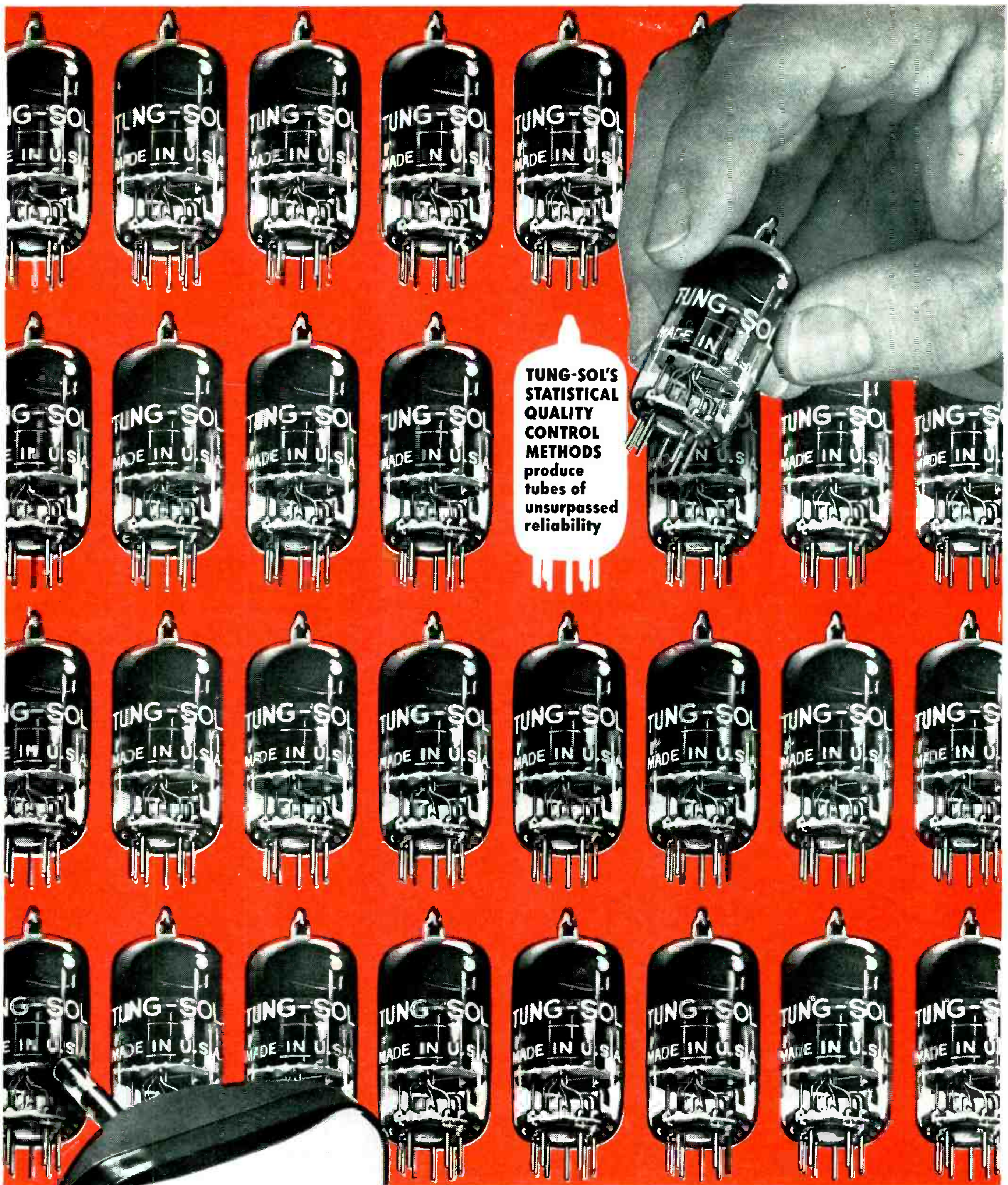
$$E_1 \psi_1 (f) - E_2 \psi_2 E (f) = 0$$

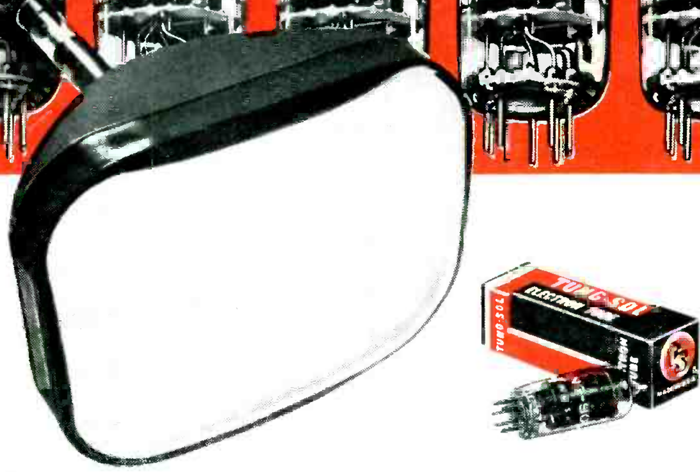
It is known that traveling-wave tubes as conventionally constructed are elongated structures in order to accommodate the various tube components incorporated within the traveling wave tube envelope. In patent 2,617,961 granted to Lothar Brueck of Paris and assigned to Compagnie General de T.S.F. of France, a structure for traveling-wave tubes is disclosed that proposes to reduce the length requirements thereof, among other advantages.

The Brueck invention is shown in Fig. 4, 5, and 6. Figure 4 shows plane spirals in elevation and plan views as employed in the traveling wave tube of this invention. Figure 5 indicates the radial electric field that exists between successive turns of the spiral. Figure 6 is a cutaway view of the structure of a traveling-wave tube incorporating the plane spiral of the invention in the form of a spiral waveguide.

The inventor claims that in conventional traveling-wave tubes, because of the small pitch of the helix along which the traveling wave is propagated, short-wave amplification cannot be obtained at will. When the diameter of the helix is smaller than a quarter wavelength the field within the helix becomes too weak, because the field lines produced along the axis of the helix by the various parts of one single turn are in opposition, and are partially destroyed.

In Fig. 4, the input channel may be a coaxial cable. The inner conductor C_1 may be one of the spirals (S_2). Outer conductor R_1 is connected to the envelope. The output channel is a second coaxial cable connected to the two spirals and the outer conductor R_2 is also connected





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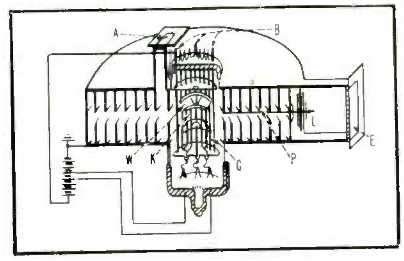

FIG. 6—Sector division by means of bars as explained in text

to the envelope. Field coils N_1 and N_2 are similar to loudspeaker field coils and provide a constant magnetic field. The lines of this field follow the radial direction. Its purpose is to trap electrons within the walls of the waveguide or turns of the spiral. The cathode is of the tube indicated at K; G is the control electrode.

In Fig. 6 the waveguide input is shown at A and the output at E; P represents the walls of the waveguide spiral that is split along the line L.

Microwave energy applied to the waveguide input travels through the split waveguide spiral while electron beams move radially through the split from the cathode that is axially disposed in the spiral. The envelope is maintained at a positive potential with respect to the cathode.

Bars at B are maintained at cathode potential so that radial electron beam sectors are generated for specific control of the beams. Variable potentials applied to the bars would, in effect, modulate the electron stream and, accordingly, the output of the traveling wave tube.

In the patent description, various techniques are disclosed by which the fields may be directed and concentrated within the waveguide spirals to effect differences in electron speed within the guide and the phase relationship of the waves propagated within the guide.

The inventor also claims that by connecting reactive coupling means in appropriate places in the circuit the traveling-wave tube can be made into an oscillator at very high frequencies.

Patent 2,600,961 on a very similar device that does not show waveguide structures was issued some five months earlier to one Diemer, and is assigned to Hartford Na-

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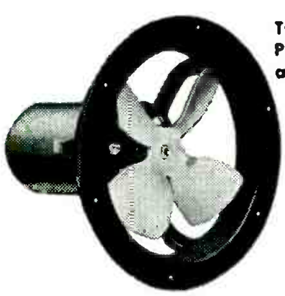
Throughout the free world's sky lanes, EAD electrical devices protect, control and actuate aircraft equipment on both commercial and military planes of many nations. Wherever the design requires small, lightweight, dependable rotating electrical units, the aviation industry has learned to rely on EAD for the answer.

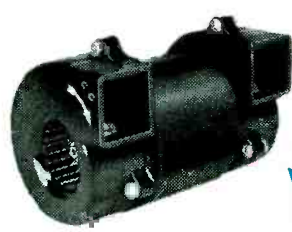
Type B302H-1C **VARIABLE FREQUENCY** Centrifugal Blower. 115 volts, 320/1000 cycle, 50 C.F.M. at 0" S.P., single phase.

Type J31E-23 **DUAL FREQUENCY** Capacitor Run Induction Motor. 115 volt, 50/60 cycle—360/1600 cycle, single phase.

Type N2B-2 **LOW HARMONIC** Alternator. Content less than 2% total distortion on each phase. 7 volt, 30 cycle, 2 phase.

Type F4H92H-1CC **400 CYCLE—RING MOUNTED** Propeller Fan. 115 volt, 400 cycle, 130 C.F.M. at .5" S.P., single phase.





Type B7P3K-3 **DOUBLE ENDED—VARIABLE FREQUENCY** Centrifugal Blower. 115 volt, 320/1000 cycle, 80 C.F.M. at 0" S.P., single phase.

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tional Bank and Trust Co. The bank is the American Trustee for the N. V. Philips Gloeilampenfabriken of Eindhoven, Netherlands.

The very simplicity of the arrangement of the circuit of the patent 2,617,927 issued to the late Louis Cohen of Bethesda, Md. for an "Interference Eliminating System" makes it particularly interesting. The circuit is shown in Fig. 7.

Two parallel open end antennas are coupled to an antenna input transformer of a radio receiver. Essentially, one is capacitively coupled and the other is inductively coupled to the receiver input amplifier stage. The former connects to the secondary and the latter connects to the primary.

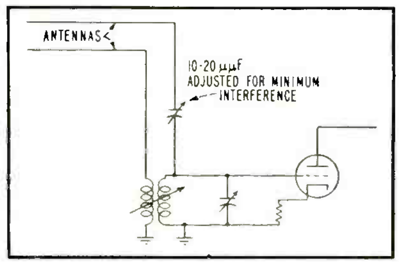


FIG. 7—Simple system claimed to eliminate static and interference

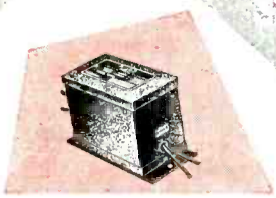
The inventor points out that every disturbance voltage is characterized by its own frequency, generally of a lower order than the desired frequency received by the radio receiver. When the system of the invention is properly adjusted for minimum interference, voltages of interfering energy are of the same character in both antennas and equal in magnitude but opposite in polarity, thus, balancing out. The desired signal voltages will not balance out. A lengthy mathematical justification is incorporated in the patent to which the reader is referred for further study.

Recent patent 2,617,854 issued to H. E. Van Valkenburg for an "Induced Voltage Flaw Detector", describes a technique for detecting flaws in the surface of magnetic metals. The patent is assigned to the General Electric Co.

The arrangement of apparatus is shown in Fig. 8. Horizontal sweep voltages are generated for a cathode-ray oscilloscope indicating sys-

WIDEST

range of voltage regulator ratings and types available from stock



STANDARD TYPE "CV" UNITS:
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Most voltage regulating requirements can be met from these "stock" voltage regulating transformers. Regulation is ±1% or less with a total primary voltage variation as great as 30%. This is the static-magnetic voltage regulator that has become the "Standard of the World."

STANDARD SPECIALIZED TYPES:
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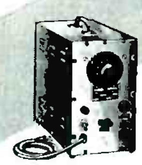
HARMONIC NEUTRALIZED
...less than 3% harmonic distortion . . . ±1% regulation.

PLATE AND FILAMENT
. . . ±3% regulation or less...single, compact voltage source.



VARIABLE AC VOLTAGE SUPPLY
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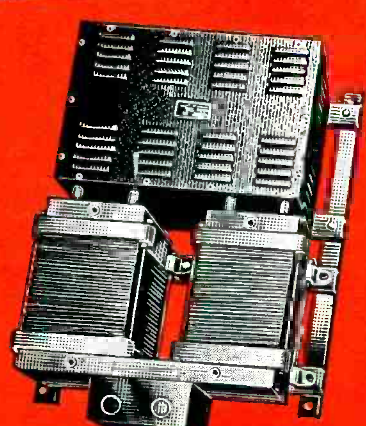

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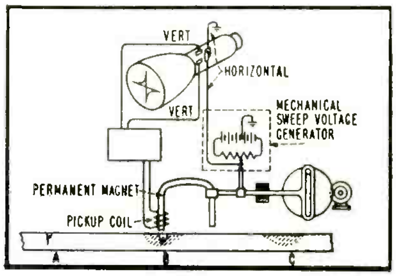


FIG. 8—Induced-voltage flaw detector

tem by the action of a motor-driven slider and crank-link mechanism driving a potentiometer back and forth across a source of voltage. A permanent horseshoe magnet coupled to the slider crank link is oscillated across the surface area of the magnetic material under examination. A pickup coil is wound about one leg of the magnet. The pickup coil is coupled to an amplifier. The amplifier output is applied to the vertical plates of the oscilloscope.

The system operates similarly to the sweep analysis of a radio or audio-frequency spectrum. Horizontal sweep voltages are synchronized with the scanning of the metal under analysis. During the sweep as the magnet oscillates over the surface of the metal, which is moved at a slow uniform rate beneath the magnet, any discontinuity in the granular structure of the metal or any mechanical flaws or cracks will result in a difference in the magnetic flux induced within the metal by the magnet. The flux changes induce a voltage in the pickup coil. The variable voltage resulting therefrom is amplified and displayed on the scope. Fig. 9A, 9B and 9C show, respectively, the waveform produced by a crack in a homogenous portion of the metal, a crack in a welded portion and an unbroken, welded portion of metal under test.

A variation of the system is shown in Fig. 10. Here, a high-

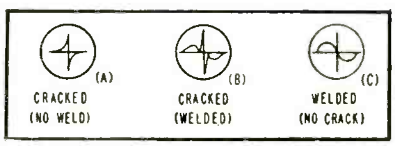
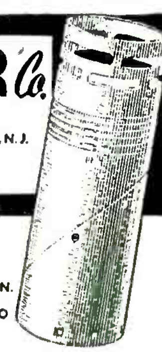


FIG. 9—Typical patterns for (A) cracked, (B) cracked and welded, (C) welded metal



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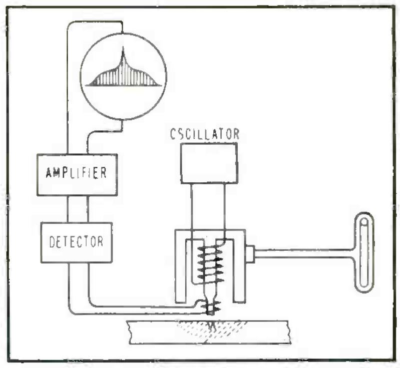

FIG. 10—Alternative technique using electronic sweep for flaw detection

frequency oscillator excites a winding about the center leg of a laminated E-shaped core and induces a voltage in a second winding. The latter winding is coupled to a detector and amplifier, the output of which in turn is applied to the vertical plates of the scope. Horizontal sweep is applied internally to the scope.

So long as the metal is moving beneath the laminated E-shaped induction coil, the coupling between the oscillator winding and the pickup winding is constant. Any variation in the metal structure owing to flaws in the granular structure, or cracks, will result in a difference in the coupling and a change in the amplitude of the resultant signal displayed on the scope.

An invention of Heinz E. Kallman of New York, N. Y., entitled "Electron Multiplying Device" was awarded patent 2,617,948. The inventor claims that the novel features of his invention are applicable to all types of electron multiplier devices whether photocathode or grid controlled.

It is well known that there is a residual current (termed by the inventor, standing current) in the conventional electron multplier. The amplification of the electron multiplier applies as well to the residual direct current as it does to the modulation component. Since some of the input signals to such a tube are relatively weak, the ratio of the signal level to the residual d-c remains in the output. This limits the usable magnification range of the electron-multiplier devices within which the residual current is manageable.

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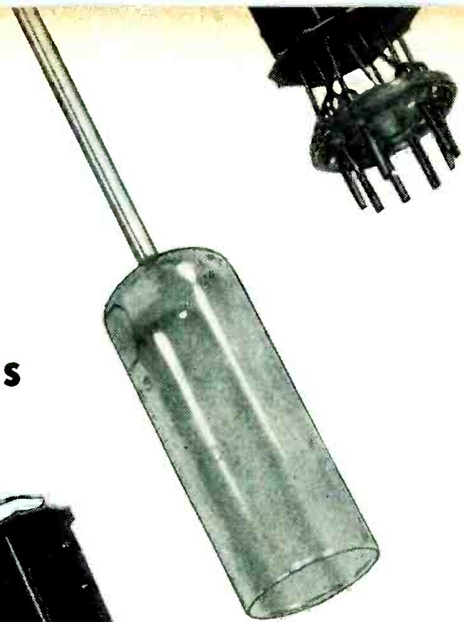

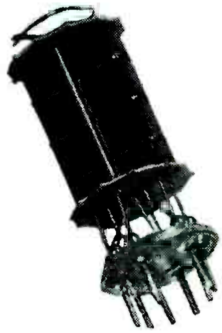

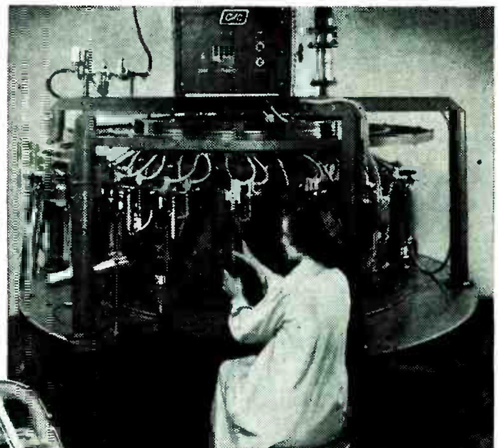

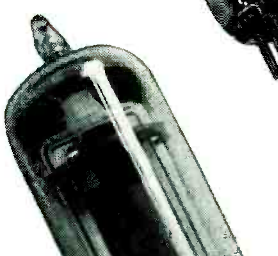

On a *continuous, non-indexing basis*, CVC's new rotary exhaust machine provides automatic base sealing, tube exhaust, and final tip-off at *rates 25 to 30% above normal*. And it produces a *pressure of 1 micron* or lower at each tube port as compared with the usual 10 to 100 microns.

Designed for miniature electronic tubes, this new machine can be converted for use on larger or smaller tubes if necessary. *An indexing feature is easily added* if required for such an operation as precise forming.

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A simpler version of the machine is now being employed to pump vacuum bottles and can be adapted to other continuous vacuum pumping and sealing tasks.

To find out more about how this new exhaust machine can speed tube production, reduce costs and improve tube quality, write to **Consolidated Vacuum Corporation, Rochester 3, N. Y.** (A subsidiary of Consolidated Engineering Corporation, Pasadena, Calif.) Sales offices: Menlo Park, Calif. • Chicago, Ill. • Camden, N. J. • New York, N. Y.

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much greater magnifications possible in a single-stage electron-multiplier circuit by constructing the multiplier to include an extra control grid, interposed either between a pair of dynodes in the electron stream, or between the final dynode and anode, and an external circuit for coupling a modulation component derived from an early dynode such as No. 1 in Fig. 11 to the control grid following a subsequent dynode closer to the anode.

By this technique, the originally low depth of modulation may be increased by amounts approaching 100 percent.

The technique may be termed remodulation of the electron multiplier and has been described in the literature: H. E. Kallman, Remodulation in Electron Multiplier Cascades, *Proc. IRE* P 282 Feb. 1953.

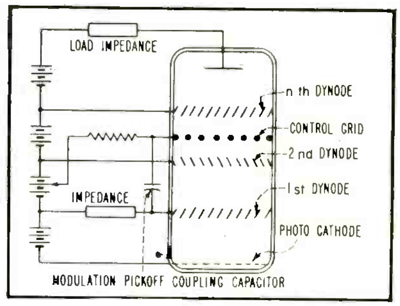

FIG. 11—Electron multiplying device applicable to television

An invention relating to a method for analyzing combustible gases has been awarded U.S. Patent 2,617,716. The inventor, Ralph E. Hartline, of Tulsa, Oklahoma, has assigned the patent to Stanolind Oil and Gas Co., of Tulsa.

In the previously used combustible gas analyzing systems one of the problems encountered has been zero drift of the indicating apparatus employed and also in local heating filamentary sampling chambers result in ambient temperature changes that upset the accuracy of such instruments.

Combustible gas analysis is accomplished by permitting a gas sample under analysis to pass through a chamber containing a filament that acts as a load across a source of a-c potential. The heating of this filament in the gas

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chamber causes resistance variation of the filament, a load variation and consequent current variation. The changes are impressed on a bridge circuit balanced against a voltage twice the frequency of the primary source of a-c potential. The variation of some parameter (in this case combustibility) of the gas sample is indicated by the rectified component of the harmonic output voltage.

The circuit of the combustible gas analyzer is shown in Fig. 12. An alternating voltage at frequency f is applied to the gas detector filament superimposed on a direct-current. The output of the gas detector is applied to a balanced modulator through C_1 and C_2 at a frequency f having a low-frequency

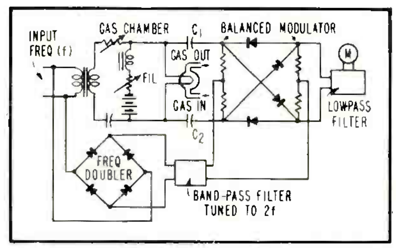


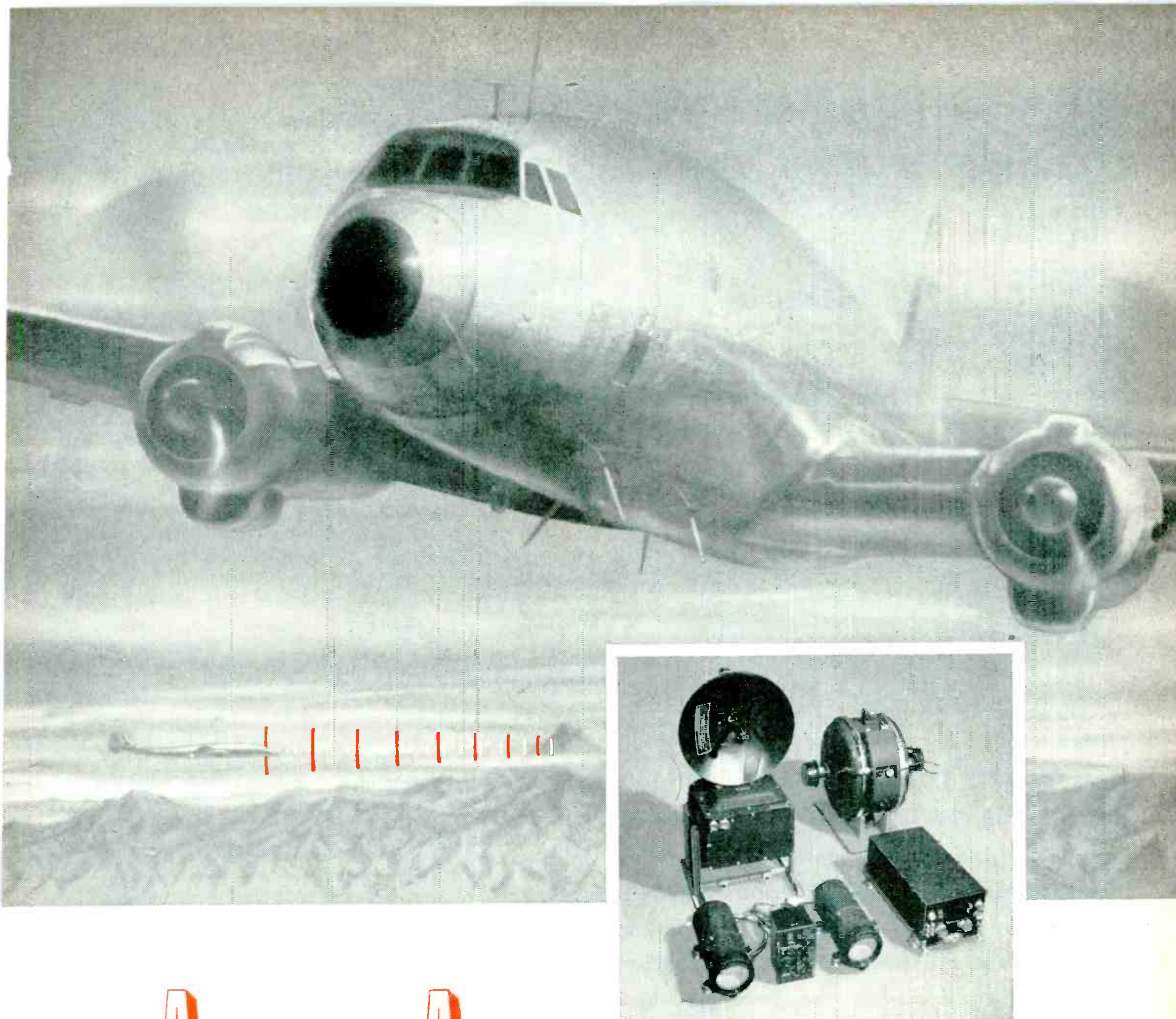
FIG. 12—Analyzer for combustible gases

modulation component determined by the variations in the filament resistance with combustion variations.

The d-c potential applied to the low-pass filter will vary as the amplitude of f applied to the balanced modulator. A voltage at a frequency $2f$ is also applied to the balanced modulator as a balanced bias voltage. A direct voltage will appear at the output of the balanced modulator proportional to the second harmonic voltage drop across the gas-chamber filament. The low-pass filter rejects all but the d-c component of the output of the balanced modulator and the output voltage is applied to an indicator such as a meter or oscilloscope.

The cyclic variation of the gas chamber filament brings it periodically through a range at a rate far in excess of any temperature variation and produces an output in the system with a negligible zero drift.

This invention is employed in



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geochemical analysis in oil wells. It is one of many examples of the increasing employment of the electron tube arts in the oil and other geophysical industries.

X-Ray Image Amplifier

FLUORESCENT SCREENS used by physicians in examining patients by x-ray have an efficiency of about 5 percent. To see the fluoroscopic image, the radiologist must dark-adapt his eyes for at least 20 minutes. A newly developed image amplifier reduces this time to about four minutes.

Increased brightness of the x-ray image has been attained by converting x-ray energy into light with a fluorescent screen and thence to electrons by means of an adjacent photoelectric surface. Electrons are accelerated by a high potential placed across the vacuum tube to give a brightness gain of 10 or more. Further gain is attained by electrostatic focusing of the electron stream to reduce the image to approximately a fifth its original size.

The reduced image, made up of high-speed electrons, impinges on a phosphor output layer that converts the electron stream back to a visible image, brightened 200 times. As a final step, the intensified image is magnified by means of an optical system without loss of brightness.

The intensification achieved by reducing the image size in the electron-optical system is possible because the brightness is increased in inverse proportion to the area. This results from all the electrons being utilized in forming the image. When the area is reduced, the total energy therefore remains constant. Thus the energy per unit area, which is

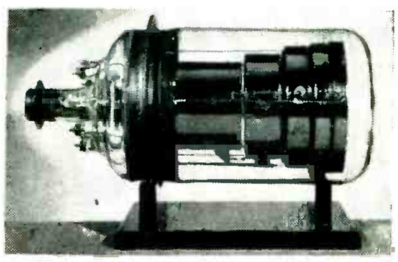

FIG. 1—Developmental model of the Westinghouse image amplifier tube

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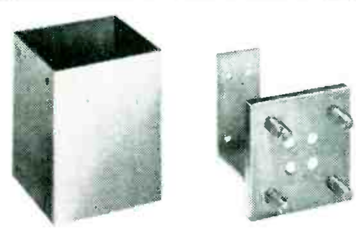

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proportional to brightness, must go up.

Limitations of the optical magnification that can be obtained without loss of brightness make it unprofitable to reduce the electron image to less than one fifth the size of the x-ray image. The reduced image seen through an ordinary optical magnifier appears normal size.

Radiation hazard to radiologist and patient is basically the same as with conventional fluoroscopy, but there are two ways in which significant reductions of the hazard are possible. First, the radiologist may reduce the intensity of the x-ray beam, for example to one fourth the usual amount. Under these conditions he will still have an image 50 times brighter than the conventional. Second, because he learns what he wants to know so much quicker, the examination time and hence the radiation exposure is greatly reduced.

In addition to shorter examinations, such techniques as stereofluoroscopy and even the televising of fluoroscopic images may become practical. These possibilities are in addition to the advantage that the physician is able to perceive objects presently indiscernible.

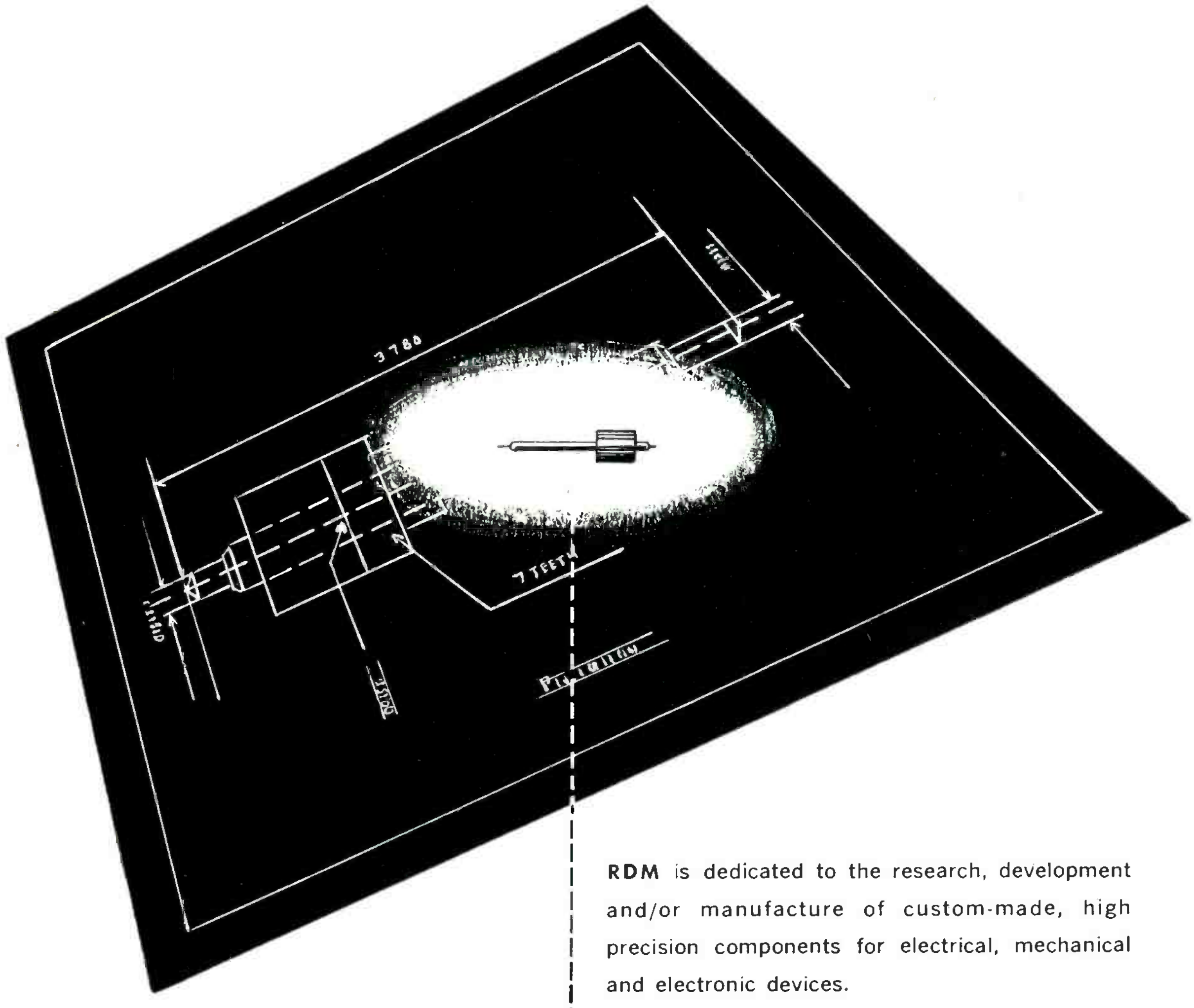
Replenisher for Hydrogen-Filled Tubes

By J. H. JUPE
Middlesex, England

A DEVICE for automatically replenishing hydrogen removed from tubes by clean-up consists of an evacuated nickel capsule that contains a small amount of zirconium hydride. When the capsule is heated to a temperature exceeding 400 deg C, hydrogen evolved from the hydride can diffuse through the walls. When cold, the nickel container prevents the return of the hydrogen to the hydride where it would be reabsorbed.

Automatic operation is obtained by attaching the capsule to the plate of a hydrogen-filled tube. As pressure within the tube falls owing to the clean-up process the voltage drop across it rises increasing the power dissipated at the plate. The increased dissipation raises the

miniaturization through critically precise components



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temperature of the plate and causes the capsule to operate. When sufficient hydrogen has been evolved to restore the correct pressure, plate heating is reduced and the evolution of hydrogen ceases.

Remote Control Caps TV Camera Lens

By C. J. AUDITORE
Facilities Engineer
WOR-TV
New York, N. Y.

IT IS SOMETIMES desired to operate a television camera in a fixed position, focused on a predetermined scene without the benefit of a camera operator in attendance. To avoid retention of a scene, called burning-in, the image orthicon camera tube should never be allowed to remain focused on a stationary bright scene for more than a few minutes at a time. Therefore, it is necessary effectively to cap the lens by some other than physical means.

An electronic lens capping method has been tested at WOR-TV and has proved to be satisfactory. To understand it, it is necessary to examine the operation of the image section of the tube.

The image section contains a semitransparent photocathode on the inside of the face plate, a grid to provide an electrostatic accelerating field, and a target that consists of a thin glass disk with a fine mesh screen very closely spaced to it on the photocathode side. Focusing is accomplished by means of a magnetic field produced by an external coil, and by varying the photocathode voltage.

Light from the scene being televised is picked up by an optical lens

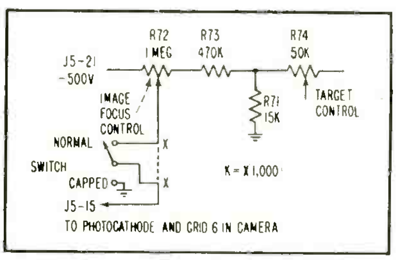
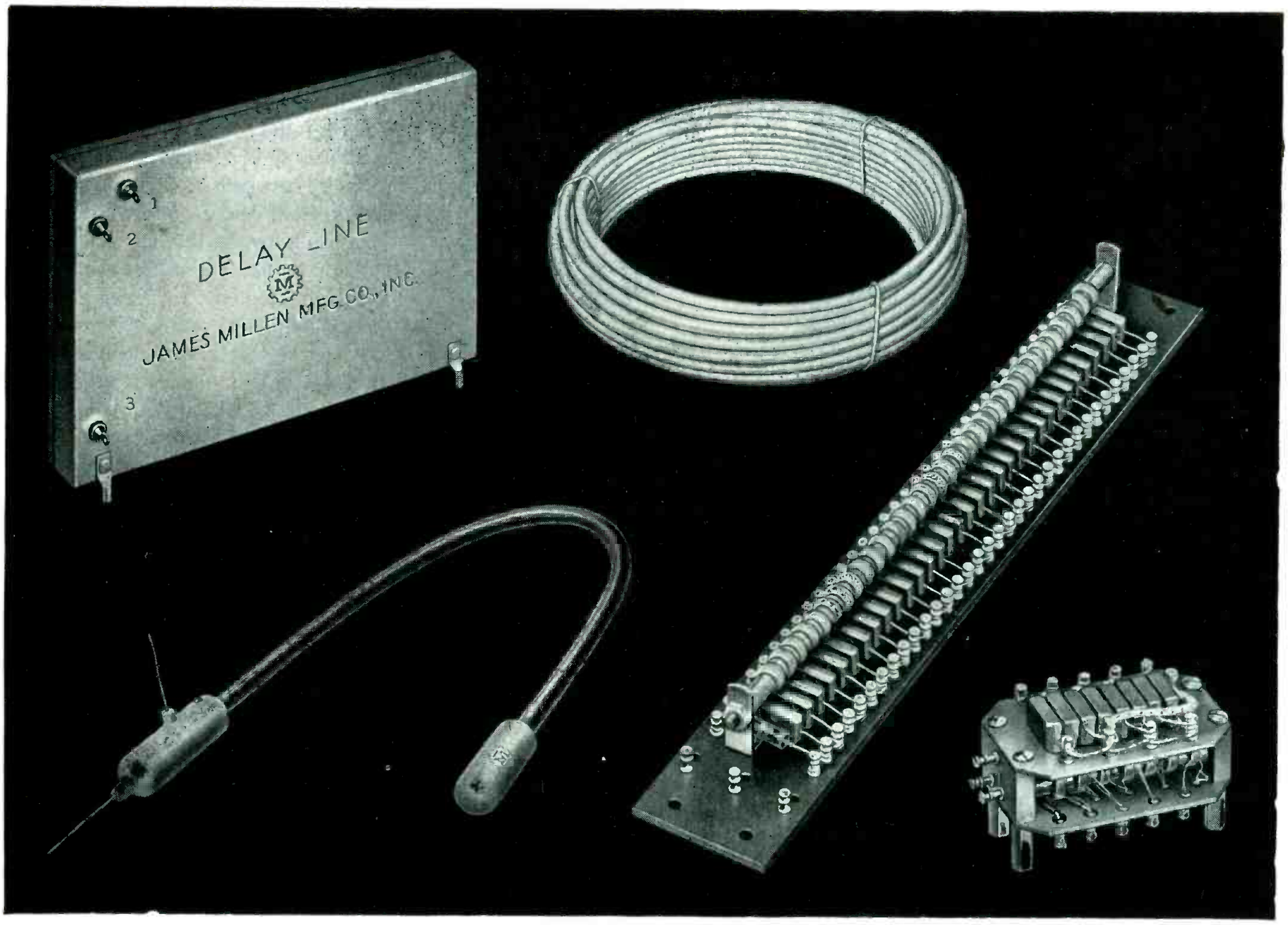


FIG. 1—Effective lens capping for a camera in the TK-10A chain is accomplished by insertion of a toggle switch as shown



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system and focused on the photocathode, which emits electrons from each illuminated area in proportion to the intensity of the light striking the area. This stream of photoelectrons is focused on the target by the magnetic and accelerating fields.

On striking the target, the photoelectrons cause secondary electrons to be emitted by the glass. The secondaries thus emitted are collected by the adjacent mesh screen. Emission of the secondaries leaves on the photocathode side of the glass a pattern of positive charges corresponding to the pattern of light from the scene being televised. Because of the thinness of the glass target the pattern will burn-in if it is stationary and prolonged in duration.

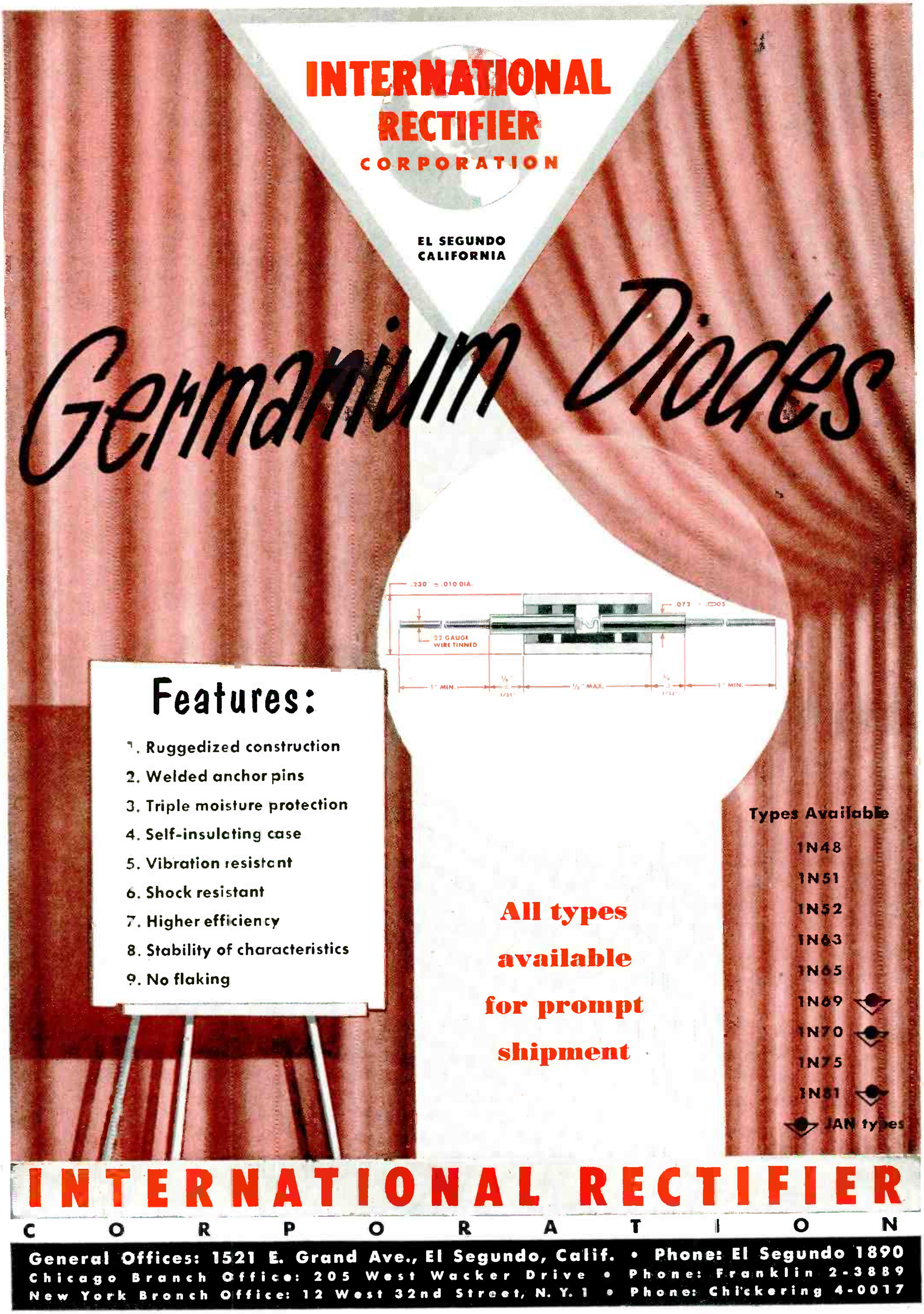
This pattern will be completely discharged by the scanning beam on the opposite side of the glass if the flow of photoelectrons from the photocathode is interrupted either by capping the lens or by removing the electrostatic accelerating potential between the photocathode and the target.

The photocathode is normally operated at approximately −425 volts while the target voltage is somewhere within the range of ±3 volts. The photoelectron stream can be cut off, therefore, simply by grounding the photocathode and its associated accelerating grid 6. This voltage is controlled by a potentiometer in the remotely located camera control unit of the RCA TK-10A camera chain. The addition of a toggle switch is all that is required effectively to cap the lens as shown in Fig. 1. It is necessary only to remove dashed wiring between points *X-X* and install a single-pole double-throw toggle switch.

Ultrasonic Method of Tire Inspection

ULTRASONIC EQUIPMENT can be used to detect internal flaws in tires, but because of the geometric shape of a tire, the tread pattern and the need for inspecting a relatively large area in a short time, special problems are introduced.

In the device described a circuit



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providing a frequency-modulated signal sweeping from 34 to 46 kc is used. To allow moving the tire while in contact with the microphone and transmitting unit a liquid bath is used as a sound transmitting agent. The tire is placed in the liquid bath and a transducer and a microphone are placed opposite each other in the liquid with the portion of the tire under examination between the two. Rotating the tire allows inspection of the entire surface.

Inspection in this manner will detect separations in the tire structure, internal breaks, and porosity or looseness around the cords. Cuts and external breaks will give an indication if there is a film or pocket of air trapped in or around the break. Most small clean cuts will give little or no indication. If, however, there is a rotted or separated area around the cut where the liquid does not penetrate the fault will be indicated.

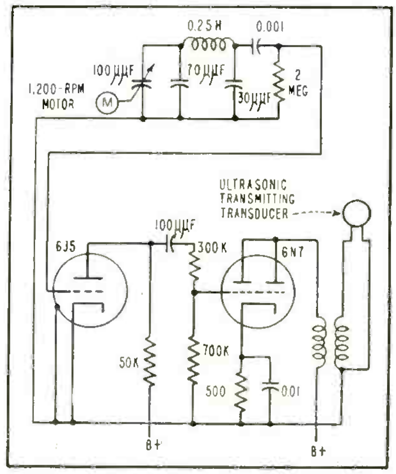
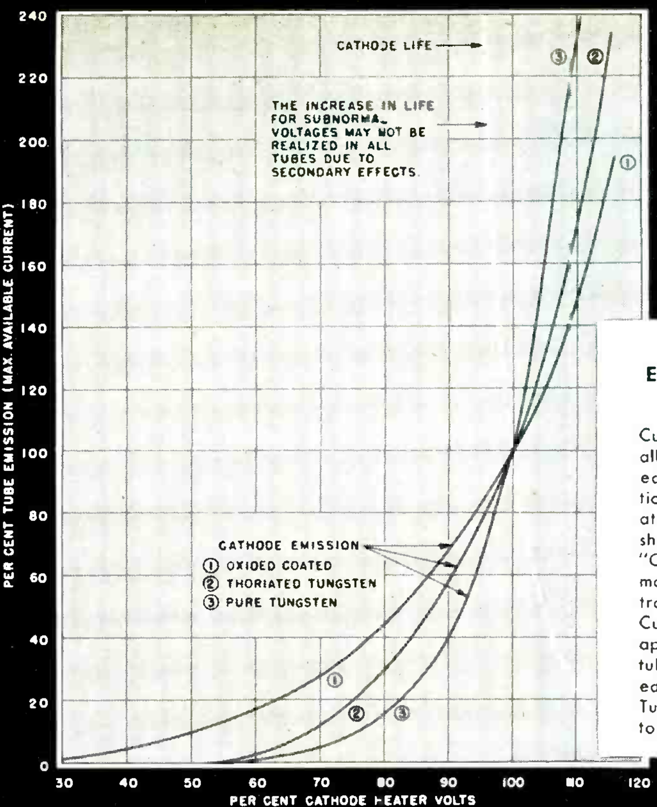
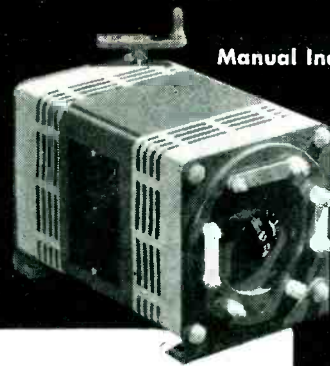


FIG. 1—Diagram of ultrasonic oscillator used in tire inspection unit

Electronic Equipment

The ultrasonic driver unit is shown in Fig. 1. A Colpitts oscillator circuit is used, the frequency of which is continuously varied by a motor-driven capacitor. The motor operates at 1,200 rpm sweeping the frequency range forty times a second. Trimmer capacitors are used to set the sweep range to the desired values. A 6N7 resistance-coupled amplifier provides about two watts of power to drive the crystal transmitter. The crystal is





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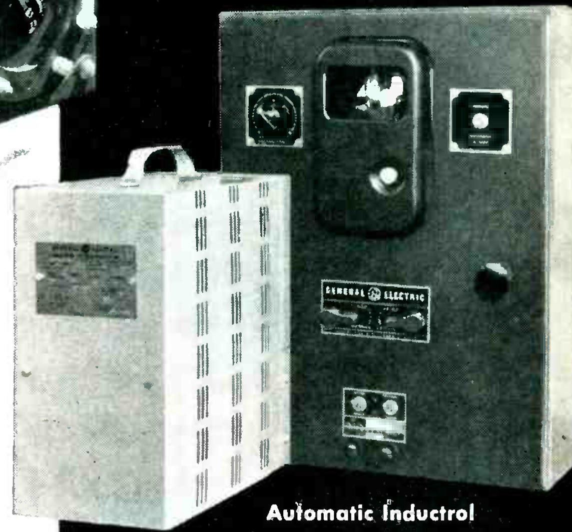

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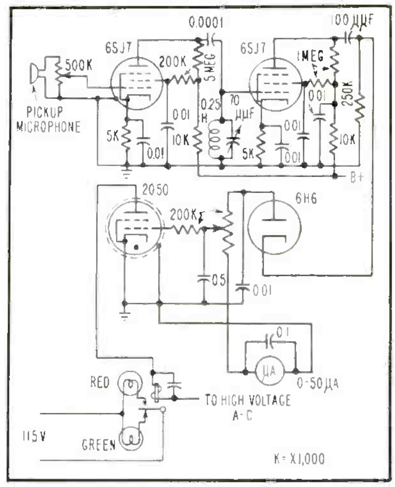

FIG. 2—Receiver circuit for ultrasonic tire inspector

surrounded by castor oil and enclosed in a waterproof rubber housing.

The microphone pickup (Fig. 2) is in contact with a thin metal diaphragm in the end of a watertight cylindrical metal container. To make the response of the microphone directional the metal container is surrounded by a metal wall with an air space between.

The amplifier contains two high-gain resistance-coupled stages, the output being rectified and observed on a microammeter. A portion of the rectified output voltage is filtered and applied to the grid of a thyratron as a negative bias. When the amplifier output drops below a predetermined value, the thyratron fires, actuating a relay that turns off a green pilot lamp and turns on a red one indicating a defect in the tire. Since the plate supply of the thyratron is from the high voltage a-c winding of the power transformer the tube will be extinguished as soon as the negative bias is resumed.

In use the input potentiometer is adjusted to give about 80-percent full-scale reading when a tire without defects is placed on the test stand. The bias of the thyratron is then adjusted so that it will be triggered when the reading drops to about 50 percent of full scale.

Gearing permits the transducer and microphone to be moved together across the tire from shoulder to shoulder. This movement together with rotation of the tire allows the inspection of any portion

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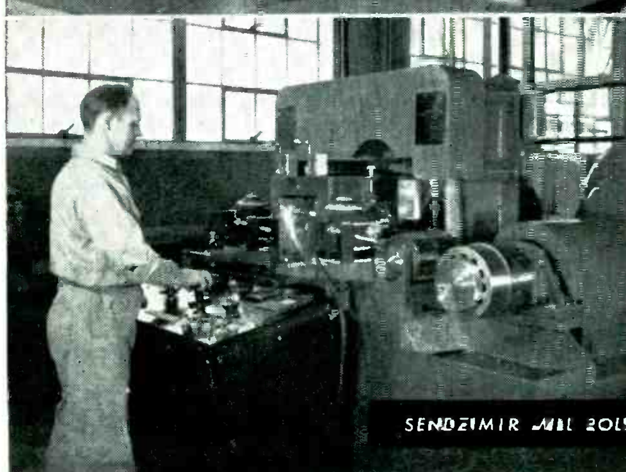

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Inspection of a bus tire takes from five to fifteen minutes depending on the tire quality and the thoroughness desired.

This article has been abstracted from a paper entitled "Ultrasonic Method of Tire Inspection" by W. E. Morris, R. B. Stambaugh and S. D. Gehman appearing in the Dec. 1952 issue of *Review of Scientific Instruments.*

A Recorder Bias and Audio Level Measuring Instrument

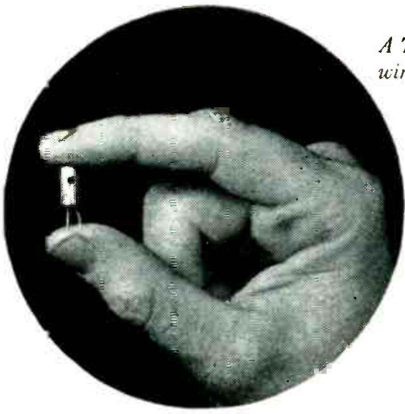
DOUGLAS E. TAYLOR
Asst. to Dir. Engineering
Dictaphone Corp.
Bridgeport, Conn.

THE CORRECT A-C BIAS and audio signal level at the recorder head are two important factors in obtaining the best possible results from a magnetic recording machine. These two values are combined in the voltage across the recording head. They can be separated by making the audio measurement with the high-frequency bias set at zero, or making the bias measurement with the audio signal set at zero.

However, it is almost always more convenient to make these measurements with both currents at normal operating levels. The circuit described here shows how this can be done with a single instrument using a dpdt switch and a combination of two inductances, two capacitors and some resistors. These are all contained in a small meter box as shown in the photograph.

This unit is normally connected to the recording machine panel by two well-insulated but unshielded cables. One end of each cable is plugged into the instrument box and the other ends are plugged into receptacles on the recording machine panel that are directly connected to the terminals of the recording head.

The a-f signal may extend over



*A **Transistor** of point-contact type. Two hair-thin wires control current flow in germanium metal.*

It's helping to win the Battle of the Watts

*Laboratories engineer examines **Transistor** oscillator. It is used in Englewood, New Jersey, where 10,000 subscribers can personally dial distant cities. **Transistors** generate the signals which carry the dialed numbers to other towns and cities. Other uses are in prospect.*

When you keep down the power needed to send voices by telephone you keep down the special equipment needed to supply that power. A great new power saver for telephony is the ***Transistor***, invented at Bell Telephone Laboratories, and now entering telephone service for the first time.

Tiny, simple and rugged, the ***Transistor*** can do many of the things the vacuum tube can do, but it is not a vacuum tube. It works on an entirely new principle and uses much less power than even the smallest tubes. This will mean smaller and cheaper power equipment, and the use of ***Transistors*** at many points in the telephone system where other equipment has not been able to do the job as economically.

It's another example of how Bell Telephone Laboratories makes basic discoveries, then applies them to improve telephone service while helping to keep its cost down.

TRANSISTOR FACTS

Created by Bell scientists. First announced in 1948.

Has no glass bulb, requires no filament current or warm-up period. Operates instantly when called upon. Uses no energy when idle.

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the range of 30 to 15,000 cycles, but for many purposes a much narrower band suffices. The bias frequency is four or more times the highest recorded frequency. For 5,000 cycles, the bias frequency would be 20,000 cps or more. This separation makes possible a simple filter circuit that will pass one frequency and reject the other to a degree sufficient for a practical measuring device.

In the particular application for which this instrument was designed the actual voltage readings were not important, so the resistors were chosen to give a midrange reading. The current from the recording head is first passed through a series resistor R_1, which should be high enough to make the current drawn by the instrument small compared to that of the recorder. The load resistors R_2, R_3 are given a value that provides the correct filter termination impedance. The bias voltage is usually higher than the signal voltage so an additional resistor R_4 is connected to the junction point of R_2-R_3, providing a meter deflection for bias that is similar to that for correct signal level.

The two filters L_1-C_1 and L_2-C_2 are series and parallel-resonant filters both tuned for the a-c bias frequency, in this case 20,000 cps for a recording range of 200 to 5,000 cps. When the dpdt toggle switch is in the bias position, the series-resonant filter is in series with the meter and presents a very low impedance to the bias current, allowing it to pass through to the meter. The parallel-tuned filter bridged across the meter presents a very low impedance to all frequencies except the bias frequency

Compact test meter for audio signal level and recorder bias. A 100 μa movement is used

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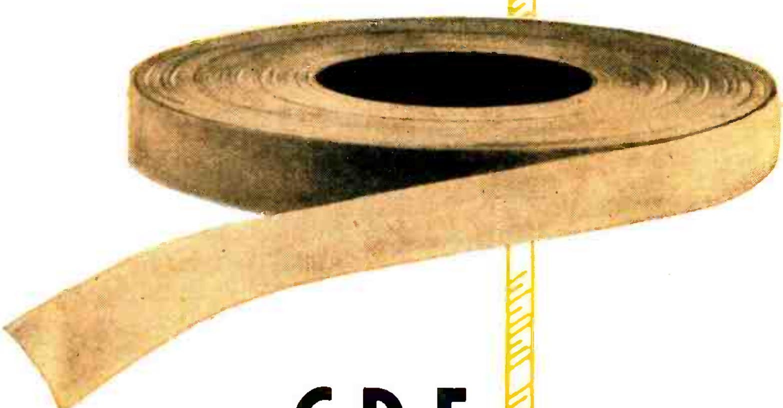

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FOR CHEMICAL AND MECHANICAL USES Remember, Teflon is non-adhesive and chemically inert. Bakers, food packagers, and pump manufacturers use it. For applications requiring extreme electrical insulation stability, high temperature or resistance to corrosion, C-D-F unsupported and fibre glass cloth supported products can do a job for you.

C-D-F's work with Teflon is really rolling! New applications are being developed daily in our laboratories by specialists who are devoting their entire time to improving and developing new Teflon products. Start talking Teflon with the man from C-D-F (sales offices in principal cities)—he's a good man to know!

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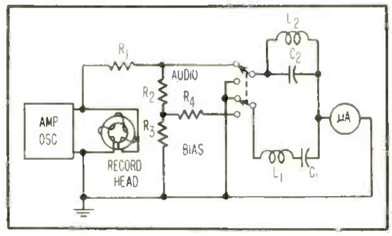

FIG. 1—Circuit of bias and audio level meter shown connected to the recorder head

allowing these frequencies to bypass the meter.

In the audio position, the parallel-tuned filter is in series with the meter presenting a maximum impedance to the bias frequency but allowing the lower audio frequencies to pass through. The series resonant filter now bridges the meter presenting a very low impedance to any residual bias current that may have passed through the parallel-resonant filter so that essentially only audio current is passing through the meter.

Figure 1 shows the meter and its filter circuit bridging the recorder. The voltage drop across a resistance of about 5 ohms in series with the recorder coil could be used as a source of potential but some amplification would then be necessary. The output from the amplifier would be fed to the filter network. This arrangement was not used in this case because portability was important. The amplifier and its battery power supply would have made the unit bulky and much heavier.

This circuit has worked satisfactorily in a multiple-channel recording system where signals from a variety of sources are all recorded simultaneously on a single tape. The measuring device provides a quick and accurate method of occasionally checking the various amplifier and bias oscillator control settings for optimum operating values.

Repairable Plug-in Circuit

By Robert H. Harwood
U. S. Navy Electronics Laboratory
San Diego, California

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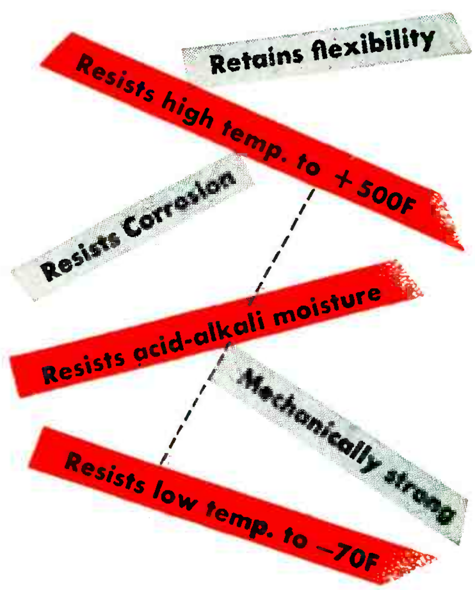

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FIG. 1—Navy Electronics Laboratory packaged replacement unit with section cut away to show placement of components

in one, two, three and four-tube sizes the units are all of the same width and height although length varies with the number of tubes. All circuit connections are brought out to an eleven-pin plug on the base of the unit. The plug is recessed to permit the body of the unit to come in contact with the mounting panel for maximum heat transfer.

The units shown in photographs are constructed on a fiber mounting board with holes punched and marked for all probable combinations of terminals required. The parts board slides into a pair of slots at the base of the package and another set in the cap. These slots provide a snug fit for the board, holding it firmly in place when the

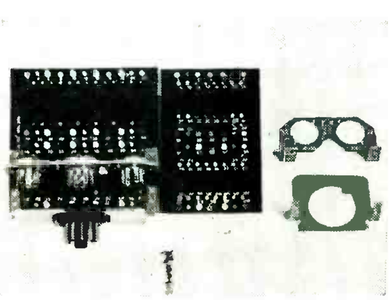


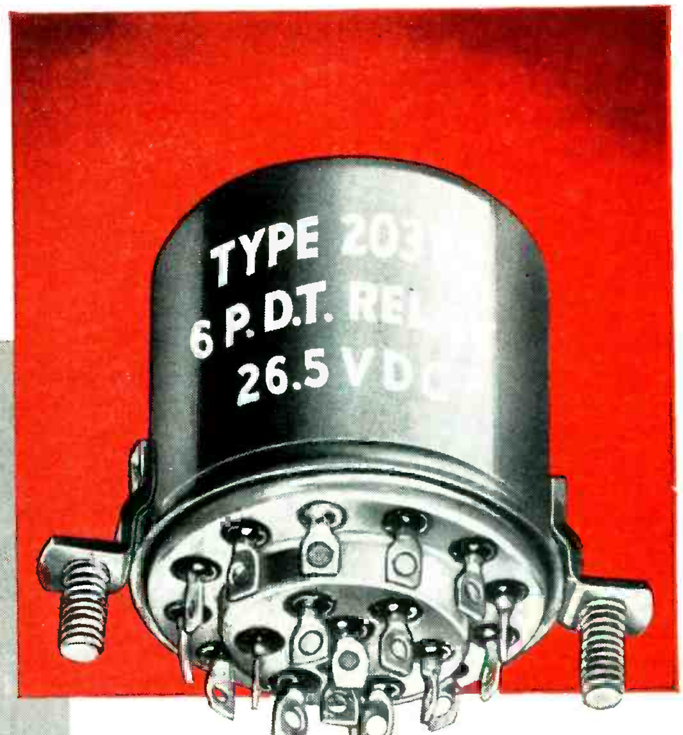
FIG. 2—Plug-in package unit removed from housing. Standardization of base plug wiring reduces possibility of damage by plugging in wrong type of unit

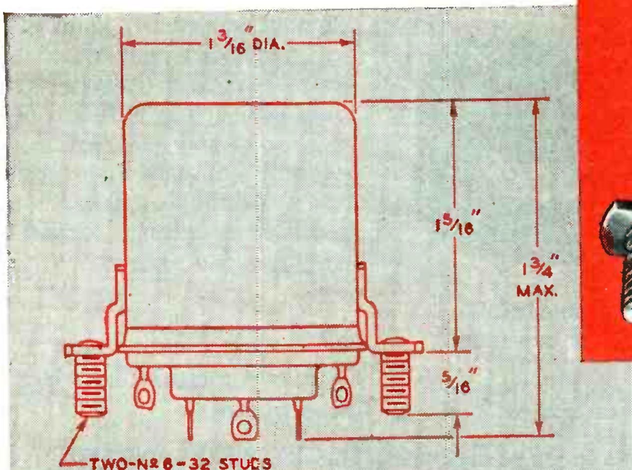
Miniaturized DC Relay

for military aircraft applications

IMPORTANT FEATURES

- **Designed to meet U. S. Air Force Relay Specification MIL-R-5757**
- **Palladium Contacts . . . Six-pole, double-throw design**
- **Moisture-free-gas-filled . . . Hermetically sealed**





ACTUAL SIZE

RCA-203W1 DC RELAY

. . . Specifically produced for military requirements by the Electronic Components activity of the RCA Tube Department.

Immediately available to prime suppliers and sub-contractors of military aircraft equipment, the new RCA-203W1 DC Relay is designed for general use throughout the electrical systems of military aircraft.

Built to operate under severe service conditions, and in any mounting position, the RCA-203W1 will provide longevity of service under extremes of temperature, humidity, shock, vibration and voltage variations. Because it is hermetically sealed in a steel envelope which is evacuated and filled with moisture-free gas, the coil and contacts are impervious to dust, moisture, and corrosion.

Its 6-pole, double-throw construction features palladium contacts rated to handle 2 amperes with a resistive load at 26.5 volts dc and 1 ampere with an inductive load at the same voltage. Contacts are arranged in a break-before-make sequence.

A technical bulletin covering ratings, dimensions, terminal connections, operating information, and descriptive data on shock, vibration, and life tests, is yours for the asking. Just write RCA, Commercial Engineering, Section 42DR, Harrison, N. J. . . . or contact the nearest RCA field office.

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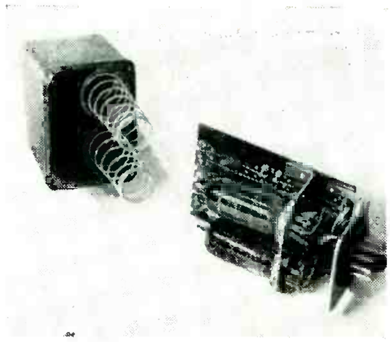

FIG. 3—Mounting board and tube chassis. Terminals are placed on board depending on type of circuit being wired

cap has been secured.

Tubes are mounted on chassis that are bolted to the mounting board. Tube wells in the aluminum housing are designed to fit any miniature tube as are the springs that hold the tube in place.

A gasket placed between the base and cap make the unit drip-proof when assembled. By using a special type of 11-pin socket and sealing the base and cap joint with waterproof cement the unit can be made waterproof and gasproof.

Circuits developed so far include a complete audio amplifier from preamplifier to power output, servo amplifiers and gating circuits.

Quartz Crystal Growing Technique

IN THE MANUFACTURING of quartz crystals the dissolving of quartz requires one temperature and its deposition requires a lower temperature. This fact led to the development of the two chamber vessels shown in Fig. 1, in which the two processes could be separated. Because of the elevated pressure required, the process employs a specially designed and fabricated autoclave of heavy alloy steel tubes capable of withstanding up to at least 6,000 psi at 400 deg C. The two chambers are joined near each end by small diameter tubes to provide a continuous circuit. The autoclave is mounted with the chambers substantially horizontal and is mechanically driven to rock at about three times per minute.

Each chamber is provided with

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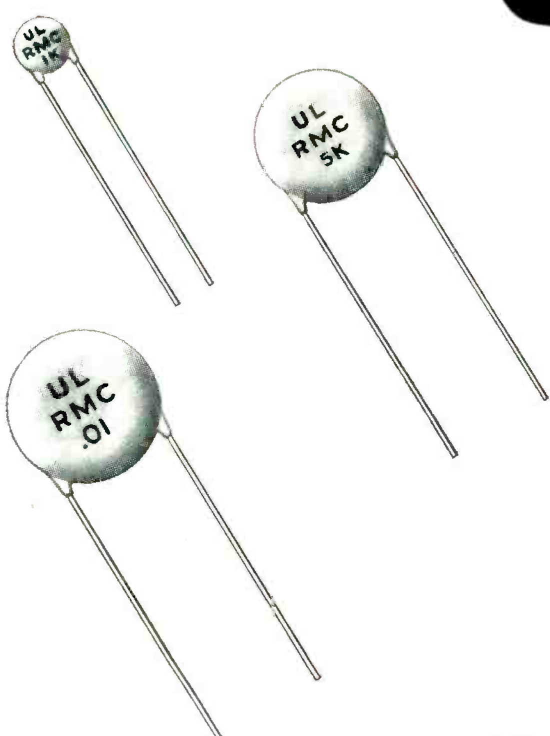

Underwriters' Laboratories specify that a ceramic capacitor used in AC line by-pass applications must withstand a 1500 volt AC 60 cycle one minute test.

RMC has developed Type UL DISCAPS for this or any application where a steady or intermittent higher voltage may occur. Capacities between .001 MFD and .02 MFD are now in production.

The use of Type UL Discaps will effect considerable cost savings over any other type of capacitor acceptable to the Underwriters' Laboratories.

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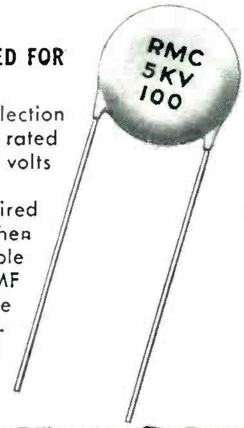
HIGH VOLTAGE DISCAPS DESIGNED FOR 90° DEFLECTION YOKES

Designed especially for 90° deflection yokes, these RMC DISCAPS are rated at 2000, 3000, 4000, and 5000 volts DC.

The voltage safety factor required in this application is insured when DISCAPS are used. Now available in any capacity between 15 MMF and 240 MMF, their smaller size and lower initial cost offer definite production ease and overall savings.



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its own heating devices and temperature control. Chunks of quartz are placed in the dissolving chamber and an array of quartz seed plates is supported in the other. The remainder of the autoclave space is filled to approximately 70 percent with sodium carbonate solution. The chambers are then sealed with high-pressure closures and the autoclave heated. The mean temperature is brought up to about 350 deg C, the dissolving chamber being maintained about 10 deg higher than the other during the operation.

The degree of filling and the temperature mentioned above re-

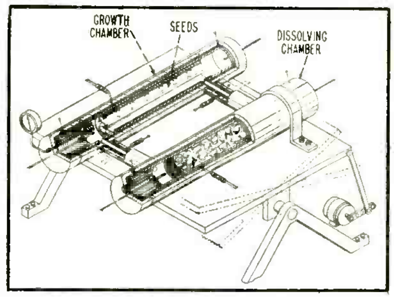

FIG. 1—Autoclave method of growing quartz crystals requires rocked chambers under heavy pressure

sult in the liquid phase expanding to fill the autoclave. The fact that circulation occurs under such conditions was shown by the actual transfer of quartz from the raw material to the seed plates, and has been demonstrated and studied in a small glass model. The solution in the dissolving chamber is at the higher temperature and less dense than the solution in a crystallizing chamber.

When the autoclave is tipped in one direction during the rocking cycle, the less dense solution rises and the heavy solution falls causing a flow of solution that reverses its direction when the autoclave tips in the opposite direction in the next half of the rocking cycle. The reciprocating flow of solution causes a slow, regular exchange of solutions between the two chambers, one at higher temperature and unsaturated with respect to silica, and the other cooler and super-

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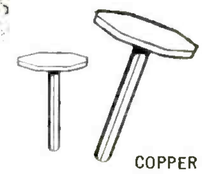

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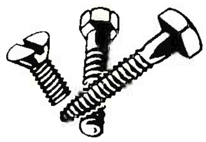

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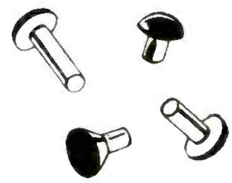

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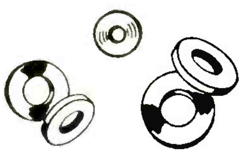

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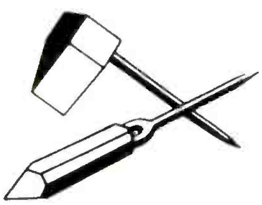

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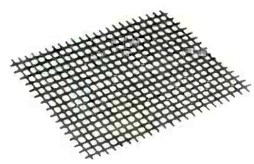

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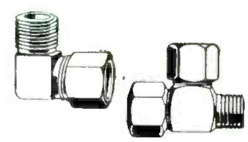

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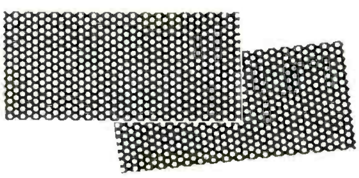

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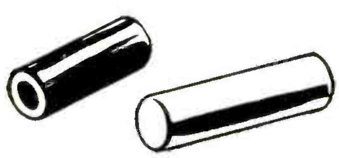

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saturated with respect to silica. The amount of flow is only estimated, and it is difficult to obtain actual measurement, yet practice has shown it to be large enough to transfer quartz satisfactorily.

A powerful tool for research on quartz has been the gamma radiation from Cobalt-60, which permits photographing the growing crystals within the high-pressure autoclave to observe the progress of their growth. The visible detail does not extend to quality of the deposited quartz, but the approximate dimensions and weights can be obtained readily from the gammagraph. An experiment using new conditions is now inspected as the run proceeds, and if the seeds were to show signs of thinning down or disappearing, conditions would be altered or the experiment terminated. Previously it was not known whether an experimental run would yield crystals until the run was ended and the autoclave opened.

Comparison of Quartz

Quartz crystals to be useful must have a high degree of freedom from defects, which includes and goes beyond the obvious virtue of clarity. A modern oscillator circuit cannot tolerate a quartz plate containing many or large inclusions. The oscillating plate depends on a uniform mechanical elasticity to give its vibration an accurate and constant period. It is obvious that it can be disturbed by flaws such as cracks and included bubbles or solid particles.

The oscillator plate receives its impulse to vibrate from the alternating electrical signal brought to the faces of the plate through the metal coatings applied thereto. Thus another purity of the crystal is required in addition to the absence of flaws visible under the microscope. The plate must consist of one crystal and not be twinned.

Quartz shows two types of interpenetration twinning—known as optical and electrical—and the presence of either on opposite sides of a boundary in a quartz plate means that the two portions will not move in unison and in the same direction in the electromechanical vibration process. Such a plate has

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in half a second!

the new ***ElectroniK*** *high speed recorder*

Electrical Characteristics

SENSITIVITY
0.14% of span or 4 microvolts, whichever is greater.

ACCURACY
± ¼% of scale span or 45 microvolts.

MINIMUM SPAN
1 millivolt.

PEN SPEED
½ second, full scale.

CHART SPEED
1, 2, 3, or 4 inches per second—or optionally, 2, 4, 6, or 8 inches per minute.

INPUT SIGNAL
any d-c millivoltage.

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To achieve high pen speed without overshoot, the instrument embodies an improved velocity damping circuit that brings the pen to a fast, smooth stop at its balance position. Chart speeds as fast as 4 inches per second spread out the vertical time base for maximum readability. Power reroll of paper is available at the high chart speeds.

Like all *ElectroniK* instruments, this model records any d-c millivoltage signal . . . operates with thermocouples, strain gauges, and a host of other transducers. It can be supplied for full scale spans as small as one millivolt.

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a reduced activity and is likely to be worthless as an oscillator.

This material has been abstracted from "The Properties of Synthetic Quartz Crystals and Their Growing Technique", by Dr. D. R. Hale, *Brush Strokes*, Dec. 1952.

Two Synchronized Clock Circuits

BY D. SACHS
Los Angeles, Calif.

USING AN OSCILLOSCOPE as a remote indicator for a master clock can be accomplished with the circuit shown in Fig. 1A. A 60-cycle voltage is applied through the tube and 90-deg phase shifting network to the plates of the c-r tube, producing a circular sweep.

At the master clock a 60-cycle synchronous motor drives a set of contacts mounted 90 deg apart. The contacts are arranged so that each time they pass one of the clock hands a circuit will be closed pulsing an r-f transmitter. The contact for the minute hand is outside the radius of the hour hand so that it will contact only the longer hand. The minute-hand contact also produces a larger pulse voltage making a larger trace on the oscilloscope screen.

An r-f amplifier and detector at the oscilloscope receives the pulses from the master station, and since the circular sweep of the c-r tube is in synchronism with the 60-cycle motor driving the contactors, traces will be produced on the screen at a position corresponding to the posi-

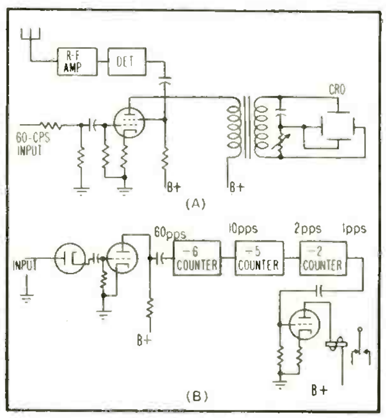

FIG. 1—Circuit for oscilloscope repeater clock (A) and circuit for synchronizing clock to line current (B)

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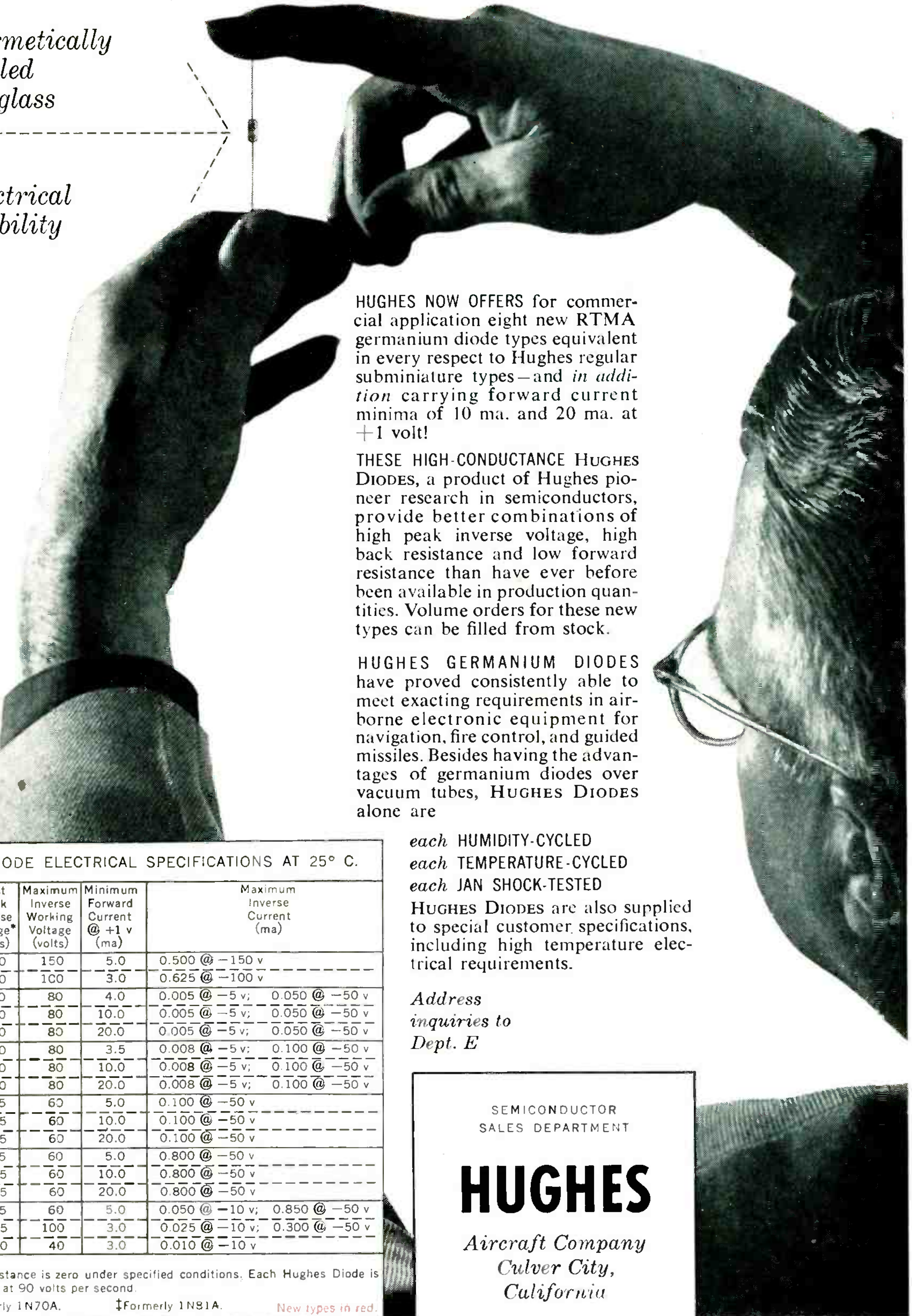

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	1N68A	130	100	3.0	0.625 @ −100 v
High Back Resistance	1N67A	100	80	4.0	0.005 @ −5 v; 0.050 @ −50 v
	1N99	100	80	10.0	0.005 @ −5 v; 0.050 @ −50 v
	1N100	100	80	20.0	0.005 @ −5 v; 0.050 @ −50 v
High Back Resistance	1N89	100	80	3.5	0.008 @ −5 v; 0.100 @ −50 v
	1N97	100	80	10.0	0.008 @ −5 v; 0.100 @ −50 v
	1N98	100	80	20.0	0.008 @ −5 v; 0.100 @ −50 v
High Back Resistance	1N116	75	60	5.0	0.100 @ −50 v
	1N117	75	60	10.0	0.100 @ −50 v
	1N118	75	60	20.0	0.100 @ −50 v
General Purpose	1N90	75	60	5.0	0.800 @ −50 v
	1N95	75	60	10.0	0.800 @ −50 v
	1N96	75	60	20.0	0.800 @ −50 v
JAN Types	1N126**	75	60	5.0	0.050 @ −10 v; 0.850 @ −50 v
	1N127†	125	100	3.0	0.025 @ −10 v; 0.300 @ −50 v
	1N128‡	50	40	3.0	0.010 @ −10 v

*That voltage at which dynamic resistance is zero under specified conditions. Each Hughes Diode is subjected to a voltage rising linearly at 90 volts per second.

**Formerly 1N69A. †Formerly 1N70A. ‡Formerly 1N81A. New types in red.

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tion of the hands on the master clock.

A clock circuit kept in synchronism by one second pulses from a 110-v 60-cycle line is illustrated in Fig. 1B. A clipper and differentiating circuit produces 60 sharp pulses per second. Three step-down counters of the diode-blocking-oscillator type reduce this to one pulse per second, which will energize the relay operating a clock mechanism at the rate of one pulse per second.

Grid Current Synchronization System

ADVANTAGES OF SIMPLICITY obtained by using a Miller transitron in a sweep circuit are often offset by limitations this circuit imposes on scan-to-flyback ratio and synchronization. The usual method used to overcome this effect is to inject a synchronizing signal on the suppressor of the tube. This method presents the problem of preventing the synchronizing signal from modulating the sweep velocity.

To eliminate these difficulties the circuit described here was developed. The transitron tube V_3 is used in a cathode-follower circuit with V_2 as the follower. In operation tube V_1 grid bias is adjusted to the point where it begins to conduct at the end of each sweep, reducing the gain of V_2. This in turn reduces the negative feedback due to C_a allowing the positive feedback between the screen and suppressor of V_3 to initiate the flyback. Thus, the grid potential of V_1 determines the sweep length and can be used as a control, eliminating the need for injecting a signal on the suppressor.

In the circuit shown, potentiometers R_1 and R_2 provide amplitude and synchronization control and R_3

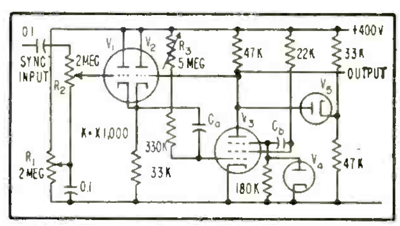

FIG. 1—The modified Miller transitron circuit


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controls the sweep velocity. Diode V_4 prevents the suppressor from becoming positive and V_5 prevents grid current in V_2.

Amplitude of the sweep is determined by V_6 and the amplitude control, and is independent of the sweep velocity.

This article has been abstracted from "The Miller Transitron" by O. C. Wells appearing in the September 1952 issue of *Electronic Engineer*.

Neon Lamp Flip-Flop and Binary Counter

By H. A. Vuylsteke
Technische Laboratoria
University of Ghent
Ghent, Belgium

NEON GLOW LAMPS in place of the usual triodes or thyratrons in flip-flop and binary counter circuits have many advantages including low current consumption, low cost and stable operation when bulbs having the same operating characteristics are used. The circuits described here use NE-2 lamps.

The basic circuit is shown in Fig. 1A. Two glowlamps are connected in series with a resistance R. The midpoint voltage $V/2$ is chosen between the firing and extinction voltage of the lamps being used.

A triggering pulse applied through capacitor C to the midpoint will cause one of the lamps to ignite;

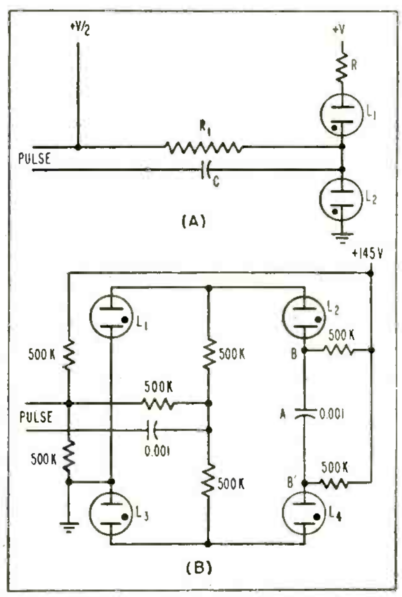
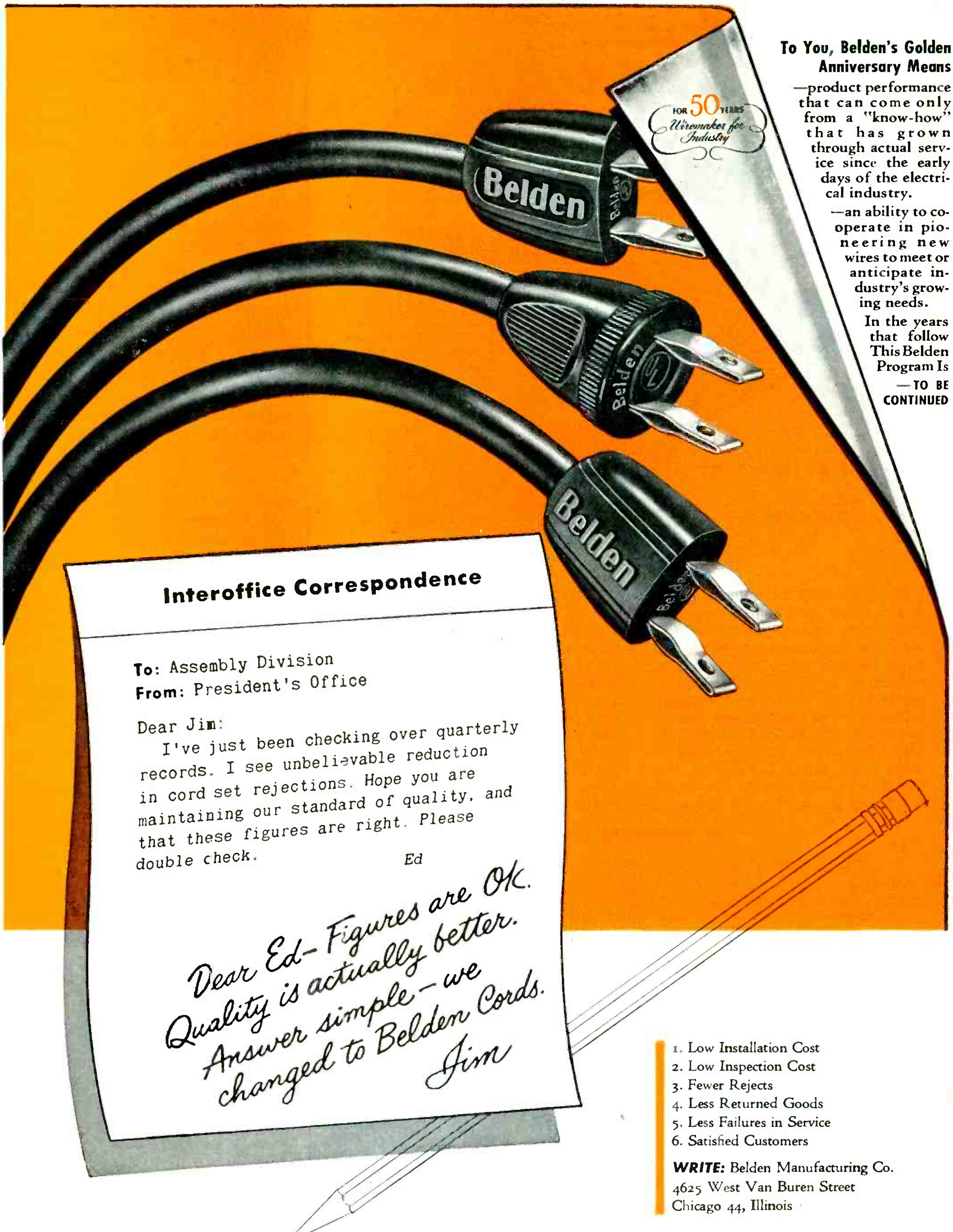


FIG. 1—Basic circuit (A) used in flip-flop and binary counter. Flip-flop (B) uses NE-2 neon lamps



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this ignition will increase the potential difference across the other lamp causing it to fire. A positive pulse will cause L_2 to fire first, followed immediately by L_1. A negative pulse will fire L_1 first.

The flip-flop circuit shown in Fig. 1B is made by doubling the original circuit and adding a commutation capacitor A. A trigger pulse of about 20 volts, either positive or negative, will cause the circuit to function. A positive pulse will trigger one of the two left-hand lamps L_1 or L_3. This will be followed immediately by ignition of the opposite right-hand lamp L_2 or L_4. Assuming L_1 to fire followed by L_2 the potential at point B will be lowered depending on the current drain, while the potential of point B' remains at full voltage.

A subsequent pulse, either positive or negative, will fire the other pair of glowlamps, L_3 and L_4. This will cause a voltage drop at point B', which will be applied through the commutation capacitor to point B lowering the voltage at B below the extinction voltage of lamps L_1 and L_2. These lamps will go to the nonconducting state and L_3 and L_4 will continue to glow. Each successive pulse will cause the alternate pair to glow.

This circuit can be used as a binary counter by repeating the same circuit n times for counting 2^n. The pulses can be applied to successive stages by connecting point B' to the input of the next flip-flop through a suitable capacitor and clipper to suppress the negative pulse.

Glow lamps used in these circuits have the added advantage of indicating the state of equilibrium without supplementary equipment. Due to their exceptionally small current drain they are well suited to portable use with batteries.

Tube Envelope Temperature

By WALTER R. JONES
*Panel on Electron Tubes
346 Broadway, 8th Floor
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OPERATING TEMPERATURE of tube envelopes becomes increasingly important as the size of electronic equipment is reduced. If the same

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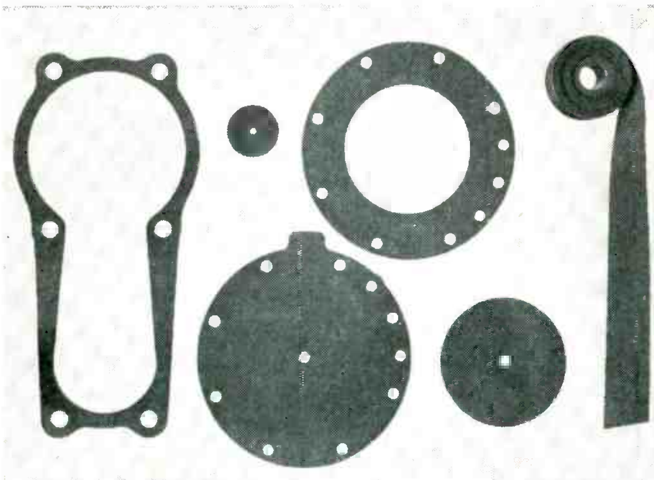

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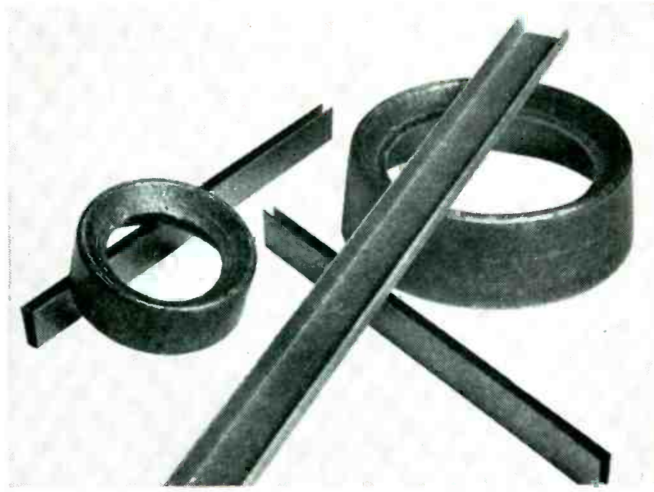

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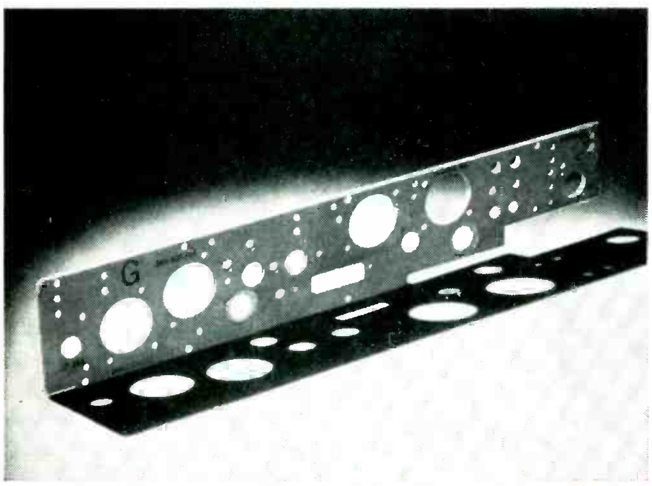

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amount of power is to be dissipated within two enclosures one of which is much smaller than the other, the temperature of the smaller enclosure will rise to much higher values than that of the larger. This fact is borne out in Table I, which indicates both areas and maximum dissipations for the bantam or T9 tube, the miniature or T5½ tube and subminiature or T3 tube. It will be noted that as the sizes decrease, the value of watts per square inch is increased and the maximum bulb temperature is increased correspondingly. The life of a vacuum tube is materially affected by the operating temperature of its bulb, as well as its other parts.

TABLE I—Bulb Temperature at Sea Level

	T9	T5½	T3
Bulb Area (Sq In.)	10.5	4.1	1.7
Max. Watts Dissipation	18.7	16.8	7.8
Watts per Square Inch	1.78	4.1	4.6
Max. Bulb Temp deg C Ambient 23C	160	255	280

There are some absolute limits on the permissible glass temperature, one being the softening point of the glass and another the point at which appreciable conductivity occurs—called electrolysis. Below these limits there is an indefinite region in which varying kinds and degrees of trouble are encountered, especially owing to evolution of gas from the bulb, itself the getter and other tube parts. The temperature of concern is that at the hottest spot on the envelope, which usually occurs midway between the top and bottom micas. The location can be readily found by the use of temperature sensitive lacquers marketed by Tempil Corporation, 11 West 25th Street, New York City.

During manufacture, while the vacuum tube is on the production pumping set-up, the envelope and the metal parts within the tube structure are heated to much higher temperatures than those to which they would normally be subjected during operation in order that all of the absorbed and adsorbed gases may be removed. If, however, during operation, the operating tem-

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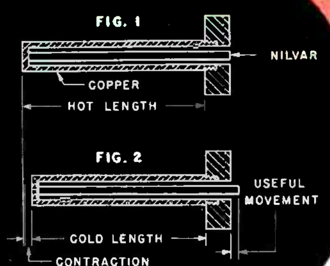

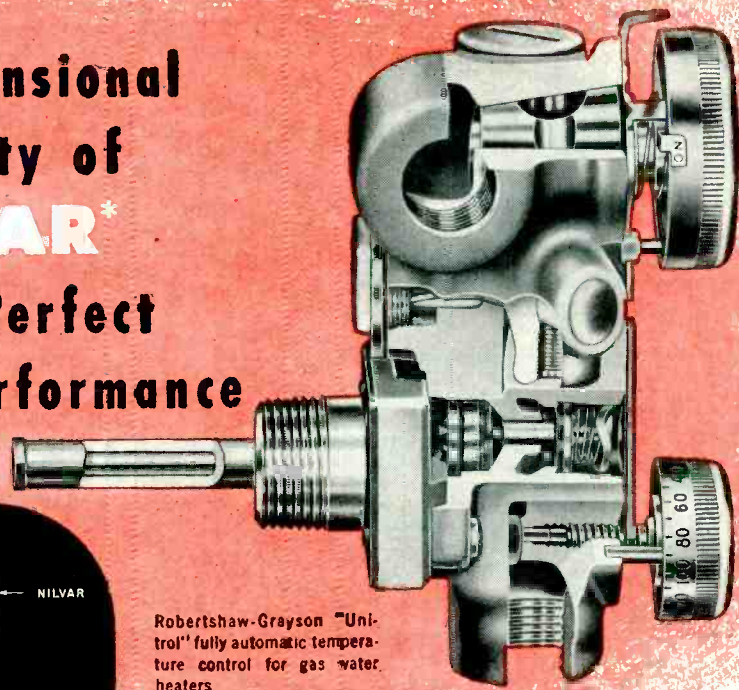

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perature of the envelope or the parts themselves exceeds the temperatures reached while the tubes were being pumped during production, it is likely that varying amounts of gases will adversely affect tube life.

Normally, the function of the getter that produces the silver-like deposit or the black deposit on some of the newer tubes is to provide a means for removing any gases that may subsequently be set free during the operation of the tube. There is a limited amount of gas that this getter material can safely pick up. Amounts beyond this will result in the tube's gas content being materially increased. In addition, if the glass bulb should be heated sufficiently the getter patch may be caused to migrate or leave the bulb.

TABLE II—Bulb Temperatures 23° C Ambient at Sea Level

		Percent Maximum Plate Dissipation				
Type	Bulb	20	40	60	80	100
12AU7	T6½	77C	100C	118C	133C	146C
6C4	T5½	64	82	98	113	125
6AH6	T5½	88	103	116	126	132
5U4G	ST16	105	116	127	138	149
5687	T6½	123	140	155	155	183

It may redeposit itself on some cooler part of the tube so that a considerable amount of gas trapped by the getter will now be released and may not recombine when the getter condenses on the cooler portions of the tube. In this instance, then, the gas content would also be materially increased. Should the getter condense on the mica supports of the tube there is a possibility that leakage between elements supported in the mica may be increased. This leakage may affect performance materially.

As seen from Table I, a tendency to decrease the size of electronic gear aggravates the bulb-temperature condition. Tube life, in general, can be extended by maintaining low temperatures for the glass envelope. This is especially important in high-power output tubes because of their higher plate and cathode dissipations. The tempera-

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CR-18	BH6A	0.8 - 15.0	—55° to +90°	± .005%
CR-19	BH6A	0.[illegible] - 10.0	—55° to +90°	± .005%
CR-23	BH6A	10.0 - 75.0	—55° to +90°	± .005%
CR-24	BH7A	15.0 - 50.0	—55° to +90°	± .005%
CR-27	BH6A	0.8 - 15.0	[illegible] to +80°	± .002%
CR-28	BH6A	0.[illegible] - 20.0	+70° to +80°	± .002%
CR-29	AR2[illegible]W	0.080 - 0.19999	+70° to +80°	± .00[illegible]%
CR-30	AR23W	0.080 - 0.19999	+70° to +80°	± .002%
CR-32	BH6A	10.0 - 75.0	+70° to +80°	± .002%
CR-33	BH6A	10.0 - 25.0	—55° to +90°	± .005%
CR-35	BH6A	0.800 - 20.0	+80° to +90°	± .002%
CR-36	BH6A	0.800 - 15.0	+80° to +90°	± .002%
CR-37	BH9A	0.090 - 0.250	—40° to +70°	± .02%
CR-42	BH9A	0.090 - 0.250	+70° to +80°	± .003%
CR-44	BH6A	15.0 - 20.0	+80° to +90°	± .002%
CR-45	BH6A	0.455	—40° to +70°	± .02%
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ture rise in the envelope may be limited by: reduction of total tube dissipation; provision for improved ventilation; maintenance of low ambient temperatures.

In general, the envelope temperature of small receiving-type power tubes should be kept below 175 deg centigrade for increased reliability. The chief effect of high temperature on vacuum tubes is not a sudden change in operating characteristics but a gradual deterioration of characteristics. Table II indicates the operating bulb temperatures for five types of tubes, having various sized envelopes for plate dissipations ranging from 20 percent up to maximum rated dissipations. This gives an idea of the extent to which it is possible to reduce bulb temperatures by decreasing the total tube plate dissipation.

TABLE III—Sea Level Bulb Temperatures vs Dissipations and Ambient Temperature Variations

Ambient	Watts per Sq In 1	2	3	4	5
	Bulb Temp deg C at Hottest Spot				
23C	100	170	230	280	310
160	220	260	300	340	370
250	310	350	390	420	450

The ultimate bulb temperature depends not only upon the dissipation within the tube itself but also upon the temperature of the surrounding air immediately adjacent to the tube envelope. Table III shows how these ambient temperatures affect the bulb temperature for various watts per square inch dissipation. From these data it is apparent that precautions must be taken to keep the ventilation around the tubes such that the temperature will be as low as possible.

The importance of bulb temperatures on tube life can be noted in recent information published by various tube manufacturers showing the life which may be expected for subminiature tubes. Most of these tubes are rated for maximum bulb temperatures of 200 deg with a few having a rating of 250 deg C. A reduction of bulb temperature on the order of 20 percent when

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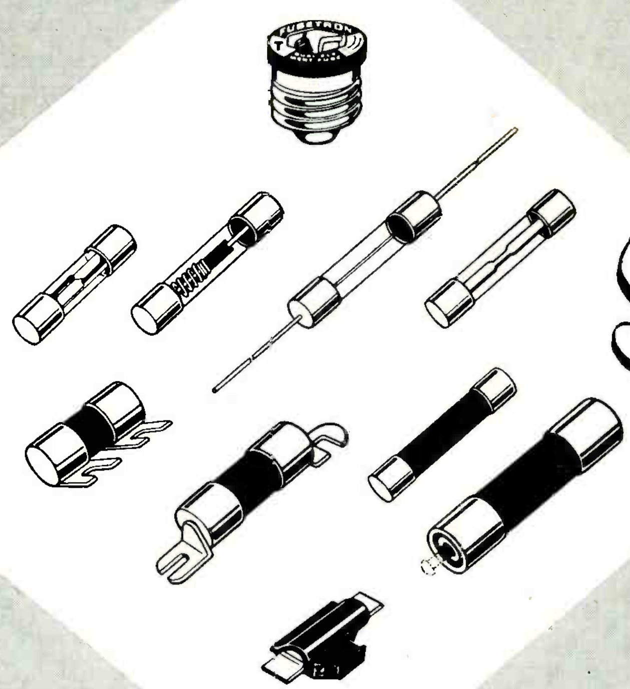

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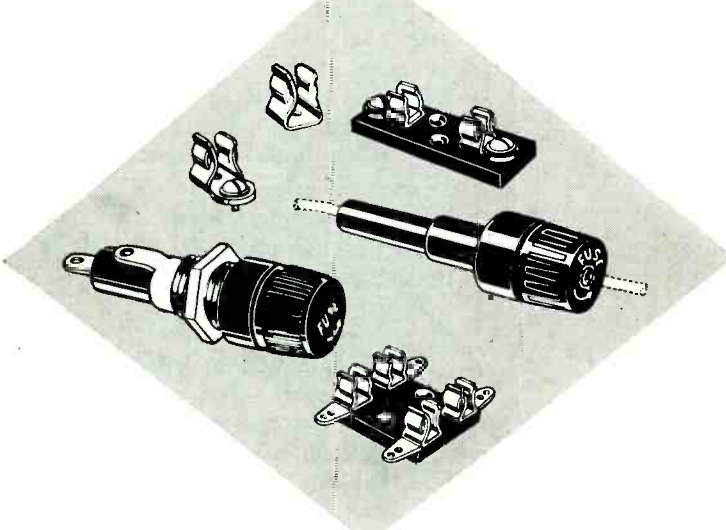

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operating in the region of 200 deg C bulb temperatures will result in a substantial increase in the life expectancy of the tubes. The cooling of the tube envelope is the most important consideration in mounting the tube.

A loose-fitting shield such as is commonly employed with miniature tubes may increase the temperature appreciably. The situation arises because the shield is not tight fitting but instead provides a blanket of hot air around the tube. Thus the shield does not provide a good thermal contact with bulb of the tube or to the chassis and cannot effectively cool the bulb.

If shields are employed, and they are tight fitting and can be fastened directly to the chassis, a considerable amount of heat can usually be removed in this manner. To obtain maximum heat radiation, the shield should not be plated and should not be polished.

So far, sea-level altitudes have been assumed. Many tubes operate at high altitudes some or all of the time. This environment aggravates the cooling problem still more since the density of the air decreases with altitude. The decreased effective cooling of a tube at higher altitudes requires that the total tube dissipation be derated in order not to exceed critical bulb temperatures. This derating depends upon the altitude and may amount to as much as 40 or 50 percent.

To obtain maximum reliability from vacuum tubes and equipment, it is important that pains be taken to keep the operating temperature of the bulb at its hottest spot within the limit specified by data sheets.

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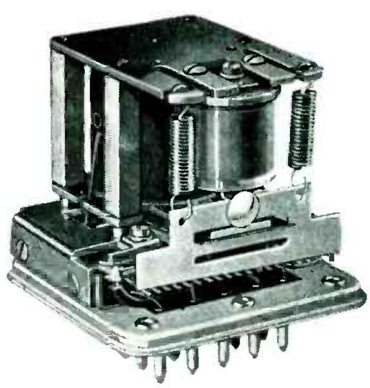

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Production Techniques

Edited by JOHN MARKUS

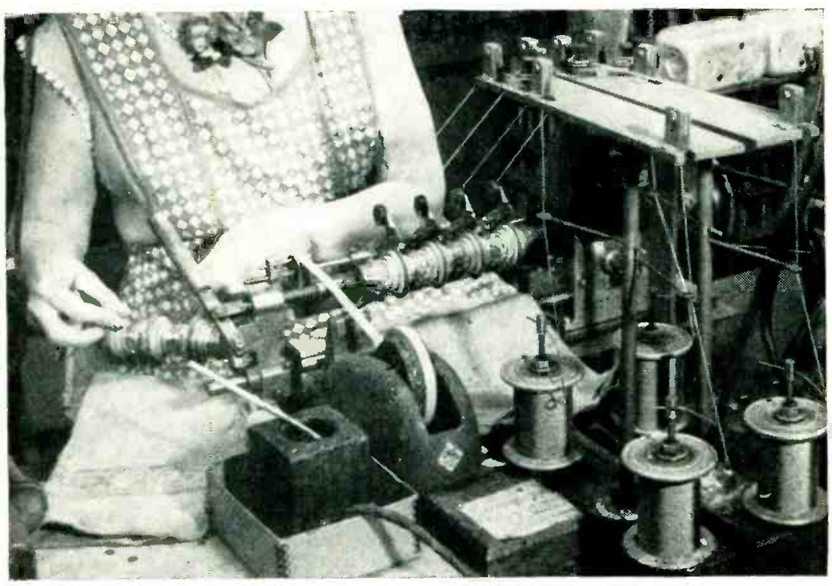
OTHER DEPARTMENTS featured in this issue:

Keyed Mandrels and Dereelers Speed Winding of Coils

HORIZONTAL flyback coils are wound four at a time by a single operator with practically no machine off-time for loading and unloading, through use of multiple mandrels designed especially for the purpose by Crosley Division of Avco Mfg. Corp. The operator disassembles a filled mandrel and reassembles it with empty coil forms during the winding cycle time.

Each flyback transformer has four coils, one of which is tapped, giving a total of nine leads. These must be brought out at identical positions on each unit, to insure positive identification during subsequent assembly operations. Keying of the coil forms and all parts of the mandrel achieves this by insuring that the mandrel can be assembled only one way. Appropriately spaced metal pins on keyed spacers are used between the coil forms; as each coil lead is brought out, it is wrapped around the correct pin. The lead is then anchored in position on the coil with a tab of paper, to insure correct positioning of leads after they have been

Construction of dereeler. Mounting bolt has drilled hole; dereeler bolt fits loosely in this and has two lock nuts at its bottom end so it can turn freely against slight spring friction without getting loose. Dereelers reduce wire tension and make it more constant, since heavy spool does not turn



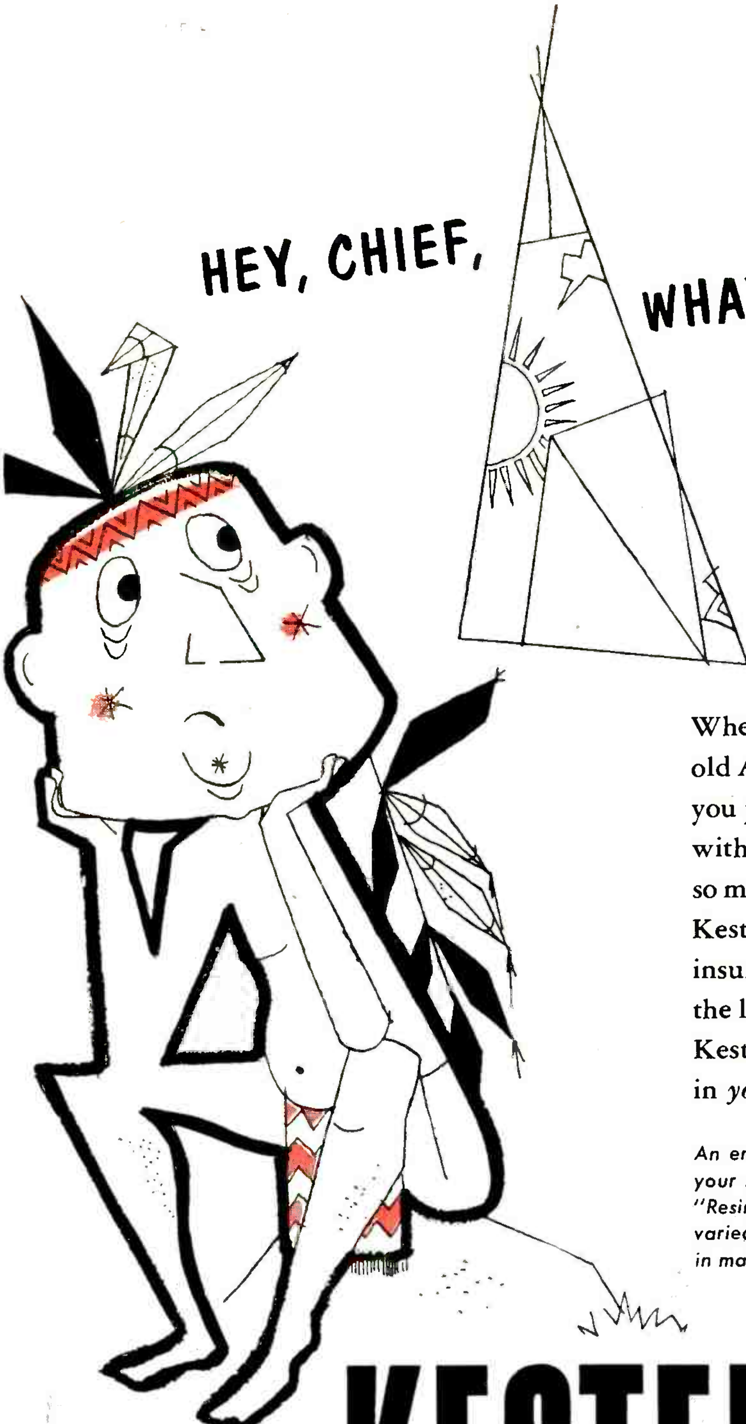
Winding flyback coils in multiples of four on keyed mandrel. Dereelers are on tops of wire spools at lower right. Tape for anchoring leads is in heavy dispenser, with end of tape anchored over tailstock so pieces can be cut easily with scissors that are always in operator's right hand. While winding is in progress, operator cuts the adhesive tape into strips and sticks them on her left hand, ready for instant use

unwound from the metal pegs during disassembly of the mandrel.

On this and other winding machines in Crosley's television receiver plant, simple dereelers are used to maintain essentially constant wire tension with stationary spools of wire. A free-spinning wire eyelet is mounted on top of each spool in such a way that it rotates at a speed directly related to that at which wire is being wound on the coils.

When a spool is empty, the mounting bolt of the dereeler is loosened with a wrench so that the entire assembly can be spun out with the fingers for changing

HEY, CHIEF, WHAT'S A WIGWAM WITHOUT WAMPUM?



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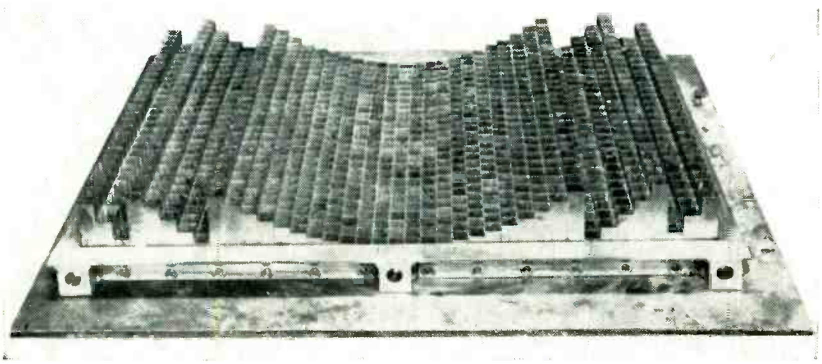
spools. The mounting bolt applies pressure to the spool when tightened.

A shaft for the spool is set into a steel strap that is part of the coil-winding machine. A small spring applies enough drag to the flying eyelet arm to prevent overshooting and backlash of fine wire when the machine is stopped.

Radar Antenna Lens Made From Square Tubing



Experimental radar lens made of square Monel tubing, as it appeared after furnace brazing and removal of solder

USE of thin-wall seamless square Monel tubing solved a fabricating problem in connection with the production of an experimental egg-crate radar screen lens for the U. S. Signal Corps. The requirement was a small compact parabolic antenna lens having 988 precisely dimensioned square tubular openings with comparatively thin walls. The overall size of the lens was 30 inches by 20 inches.

The standard method of making this type of lens, involving assembly of metal strips much in the fashion of the cardboard strips for egg crates and then soldering, was found to be unsatisfactory for this design. The chief problem was making openings which were absolutely square while maintaining thin walls and sharp corners.

The next technique tried by the contractor, I-T-E Circuit Breaker Co., Philadelphia, Pa., was assembling square brass tubing cut to exact length, then furnace-brazing in a jig. Although the softest available silver solder was used, the tubing failed to braze properly and serious cracks developed at the sharp corners.

Investigation then revealed that one grade of hard-drawn seamless Monel tubing made by Superior Tube Co. of Norristown, Pa., would provide the desired strength, corrosion resistance, electrical properties and ease of brazing. The pieces were ordered already cut to their exact lengths, then were flash nickel-plated, tin-plated, coated with soft silver solder, assembled in an adjustable jig and furnace-brazed.

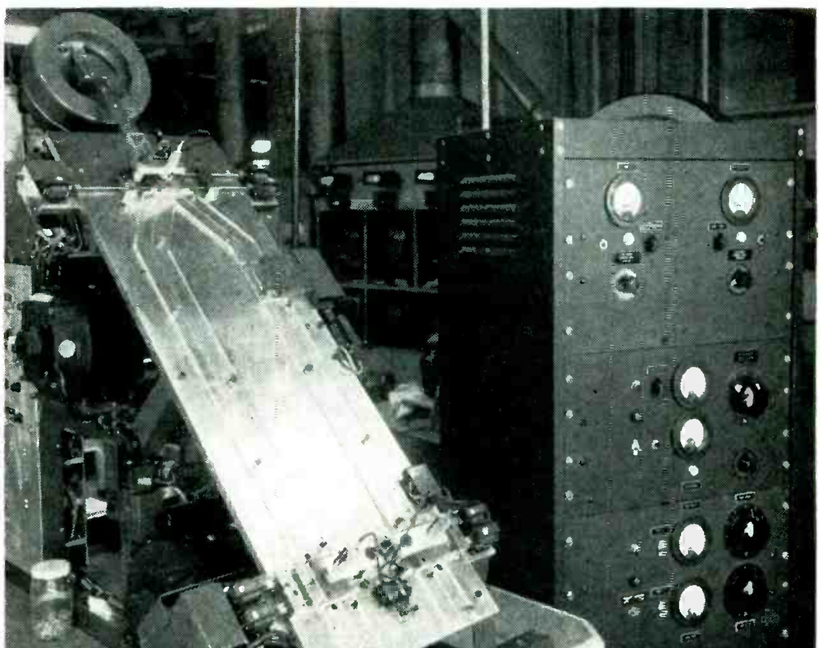
Production Testing of Rectifier Plates

By JACK BRADSHAW

Quality Control Engineer
Bradley Laboratories
New Haven, Conn.

HUMAN error in reading meters, formerly a bottleneck in testing daily production of copper-oxide and selenium rectifier plates, has been eliminated by the development of a new and entirely automatic tester that makes the required reverse leakage test on approximately 25,000 plates a day. Time required per test is only a fraction of that for the former manual operation.

Plates to be tested are loaded into the hopper at the top of the machine in batches of about 10,000, hence loading is required only two or three times a day. The machine then runs unattended, passing acceptable units down the slides to a waiting tote box and dropping rejects through the slide to a pan underneath. Fingers in the slowly-rotating motor-driven hopper push the plates one at a time out onto the start of the plastic chute, down which they slide by gravity to a solenoid-actuated gate. This opens



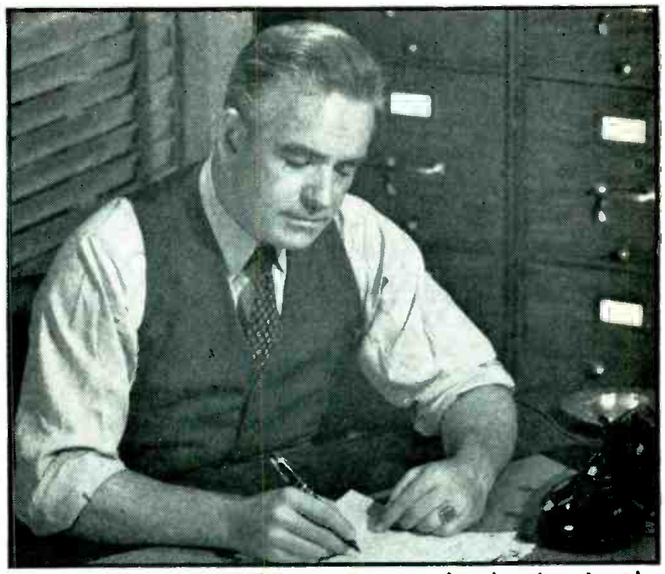
Automatic tester for tiny rectifier plates. Parts are loaded into circular rotating hopper at upper left, sorted according to polarity at V junction in chute, and tested for reverse leakage at bottom. Test rack is at right

ANOTHER PERFORMANCE REPORT FROM CONDENSER PRODUCTS COMPANY

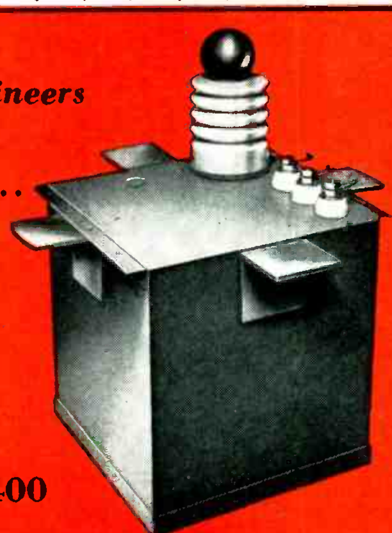
"We had a high voltage power supply problem . . .

"Our problem was to find a 30,000 volt power supply to be used as a source of voltage for kinescopes. It also had to be suitable for experimental work and in airborne equipment. The main considerations were small size and light weight, but also we needed a design that would conform to military specifications.

"We consulted 'CP' and told them what we needed . . ."



"CPs" engineers came up with this . . .



Type PS30-3C400

The "CP" Engineering Department designed a power supply with the following characteristics:

Input voltage: 115 V AC

Frequency: 320 to 1000 CPS

Output voltage: 0-30 KV continuously variable — .3 ma rated current.

Ripple voltage: Less than .1 peak-to-peak at maximum rated current of .3 ma

Temperature: To operate over a range of −10°C to +55°C and 95% relative humidity.

General: To operate effectively in any position.

Taking advantage of hermetic sealing and oil-filled construction in addition to new techniques and use of plastic film for high voltage capacitors, Condenser Products' Engineers developed type PS30-3C400 to comply with all requirements. Size of unit is 5½ x 5½ x 6¼". Total weight: 11 lbs.

"CP" is now filling orders for HiVolt Power Supplies

in the following ranges: 2,000 V, 5,000 V, 12,000 V, 15,000 V, 30,000 V, and 50,000 V, at frequencies of 60 cycles and 400 to 1,000 cycles. HiVolt Power Supplies are engineered for various applications. Because of their small size, light weight, flexibility, and ease of operation "CP" HiVolt Power Supplies are ideal for operation of display tubes, radiation counters, photoflash devices, dust and electrostatic precipitators, oscilloscopes, insulation testers, spectographic analyzers and other equipment.

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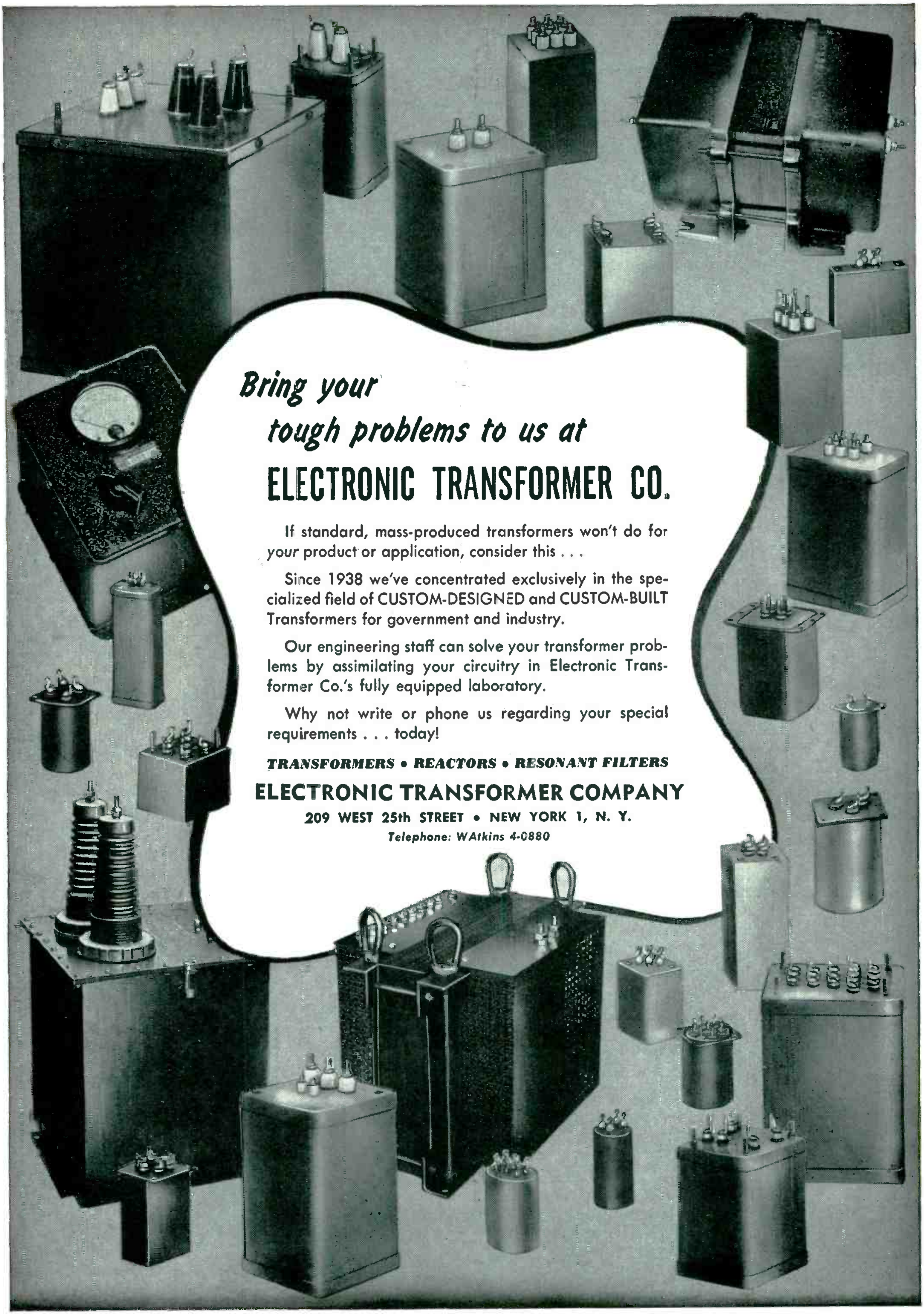
at regular intervals under control of a motor-driven sequence timer to let the plates through with adequate spacing so they do not pile up and touch each other at the test stations below. The tiny plates, only $\frac{3}{16}$ inch in diameter, ride flat down the chute.

As each plate emerges from the first gate in the chute, a contact arm is pressed down on it by a motor-driven linkage and the resistance of the plate is measured. Since forward and reverse resistance values vary greatly, the resistance reading serves to tell which side of the plate is up. An electrical circuit responds to this resistance and actuates either of two gate solenoids, one controlling the entrance to each of the two slides at the fork in the chute. Plates with positive side up go down the lefthand chute. All other plates go down the righthand chute to a gate and second polarity-checking station. This applies a d-c voltage across each plate and measures resulting current to verify that the plate is upside-down, then actuates a motor-driven linkage that inverts the plate and lets it go down the chute.

A second check is necessary because some correctly-positioned plates can get into this chute also; these are passed without being inverted.

Since plates are positive-side-up in both chutes when approaching the bottom, the test stations here are identical. Solenoid-operated gates again stop the plates and let them through at spaced intervals, and motor-operated linkages again push contacts against each plate in turn for the reverse-leakage test. A conventional multistage amplifier in the associated test rack amplifies this leakage current. If the resulting value is too high, one relay operates to actuate a rejecting mechanism that drops the plate through a hole in the slide into a scrap bin. If the leakage value is within tolerance, another relay operates to actuate the lowest solenoid-operated gate in that chute, allowing the plate to slide out into the tote box below the end of the chute.

The test rack contains controls and meters that permit setting up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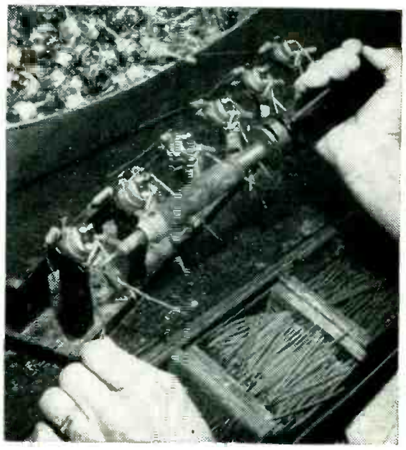
the tester for many different voltage ratings and permissible leakage values for plates. The meters also permit monitoring of tester operation at any time merely by pressing a button under each meter in turn. The machine was built to Bradley specifications by Talco Engineering Co., New Haven, Conn.

Holding Fixtures

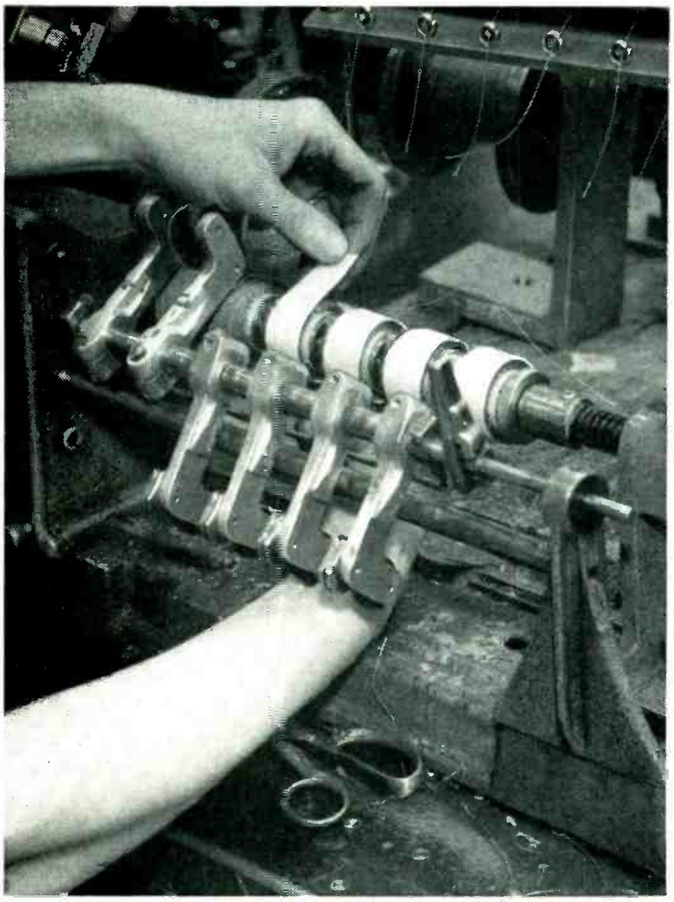


Six-unit holding fixture speeds subassembly work on television receiver controls by providing best work angle

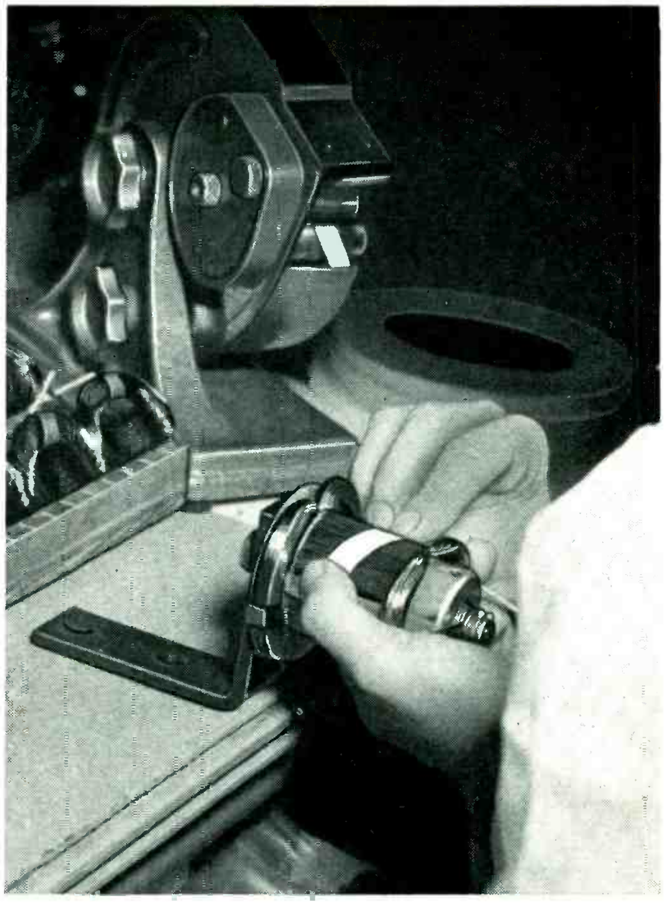
A SPECIAL Crosley-designed fixture holds six potentiometer units at the optimum angle for soldering leads and small components to their terminals at a subassembly position in the Cincinnati radio and television plant of this firm.

Each fixture has threaded jaws that fit over the soft brass threads of the control without damaging the threads. The threaded jaws

Method of opening threaded jaws of Crosley-designed fixture for loading and unloading



STRONG THERMOSETTING ADHESIVE, tough backing and thin caliper make "Scotch" Yellow Flat-back Paper Tape No. 39 ideal for outside wraps on primary windings.



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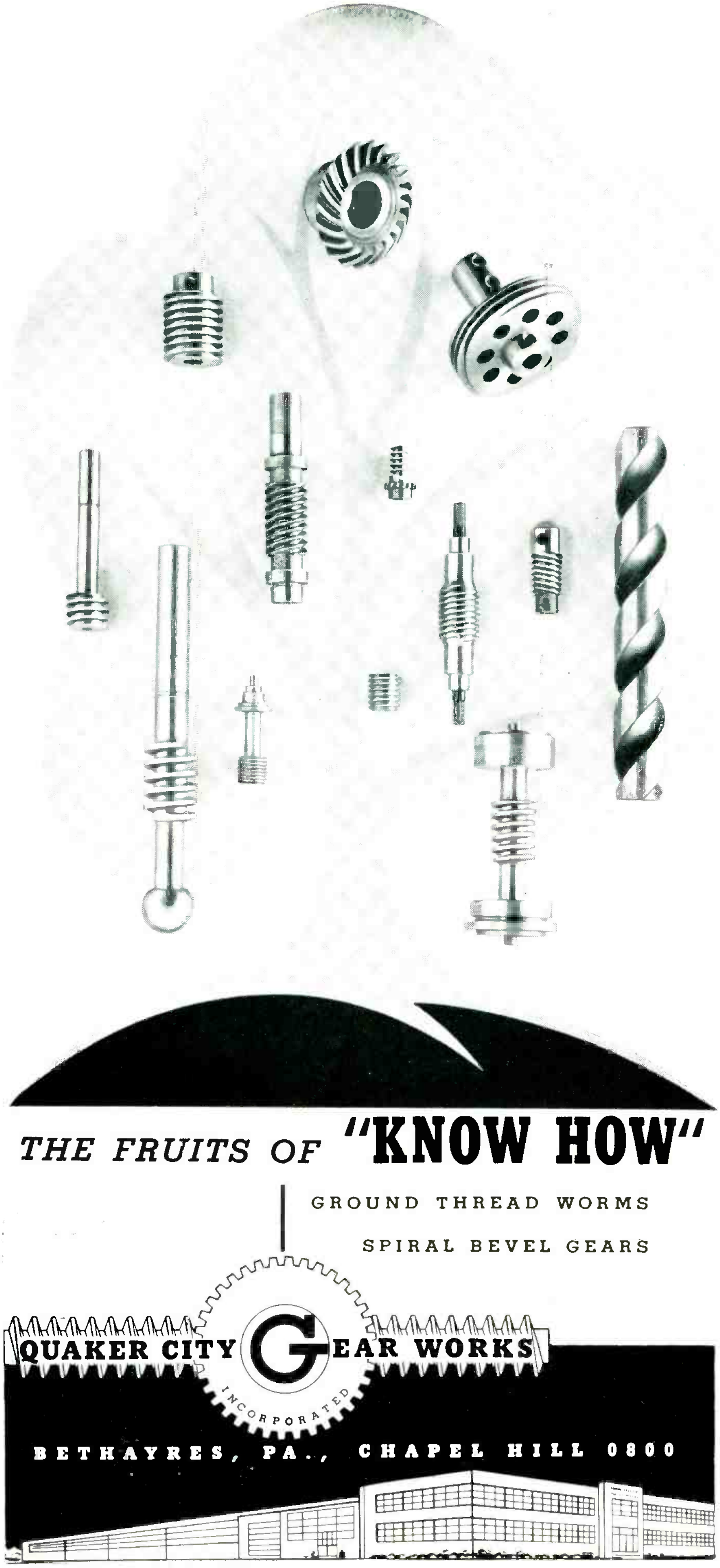

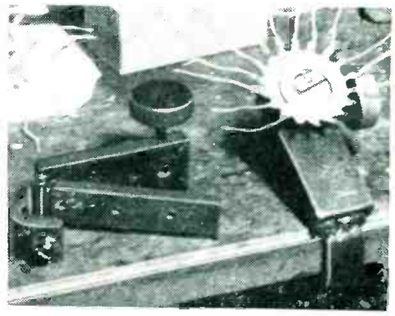

DuMont fixture for holding single control. Shaft rather than bushing is locked in position

also prevent pulling out the entire control accidentally when working with pliers on the joints. One jaw is rigidly mounted on the base plate of the fixture, and the other is on a spring-loaded arm. Pressing the back end of this arm separates the jaws for unloading and loading.

Another type of holding fixture for controls is used at subassembly positions in DuMont's television receiver plant in East Paterson, N. J. This is an individual fixture having a setscrew for fastening it to the front edge of the workbench. The hole in the fixture is a loose fit for the shaft of the control. A knurled knob is provided for locking the shaft in the fixture. The multicontact switch can be rotated as required for soldering work, but the switch has sufficient detent action so it cannot spin around during the work.

Twisting Filament Leads

THE PROBLEM of twisting together two four-foot lengths of insulated wire to serve as filament leads in a chassis was solved through use of

Method of using air gun to twist filament leads together after they have been cut and stripped on an Artos machine

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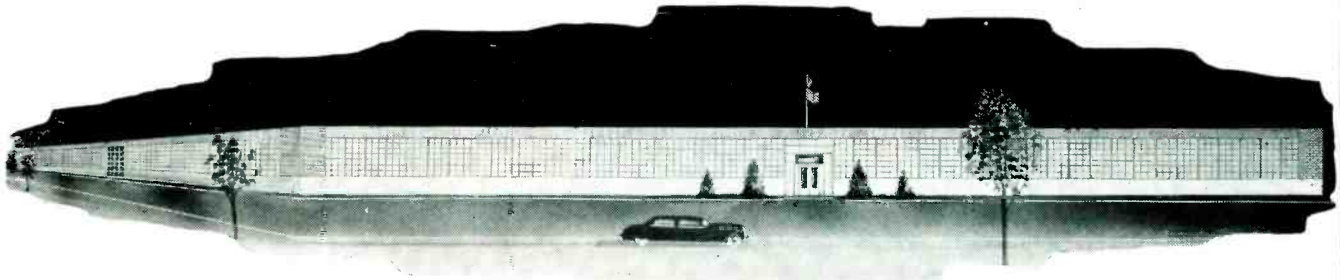

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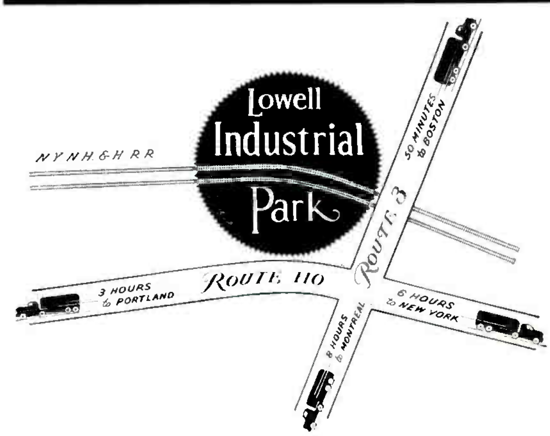
Long an industrial center, Lowell possesses well developed technical resources and a reservoir of skilled artisans whose deep attachment to the community makes them hard to lure elsewhere.



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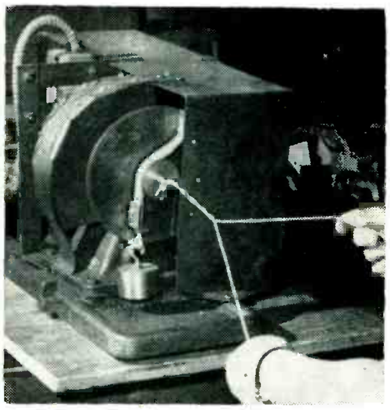
an air gun in Sylvania's Buffalo plant. The gun is clamped into a simple stand that is fastened to the workbench. A machined metal disc having two drilled holes is inserted in the chuck of the gun in place of the conventional screwdriver bit or nut-driving socket.

In using the setup, the operator pushes the ends of the wires into the diametrically opposite holes and bends the wires outward just enough so they stay in position. Now, while holding the wires near their other ends at an angle of about 30 degrees apart, she operates a foot valve to turn on the air gun. This twists the wires together uniformly at high speed.

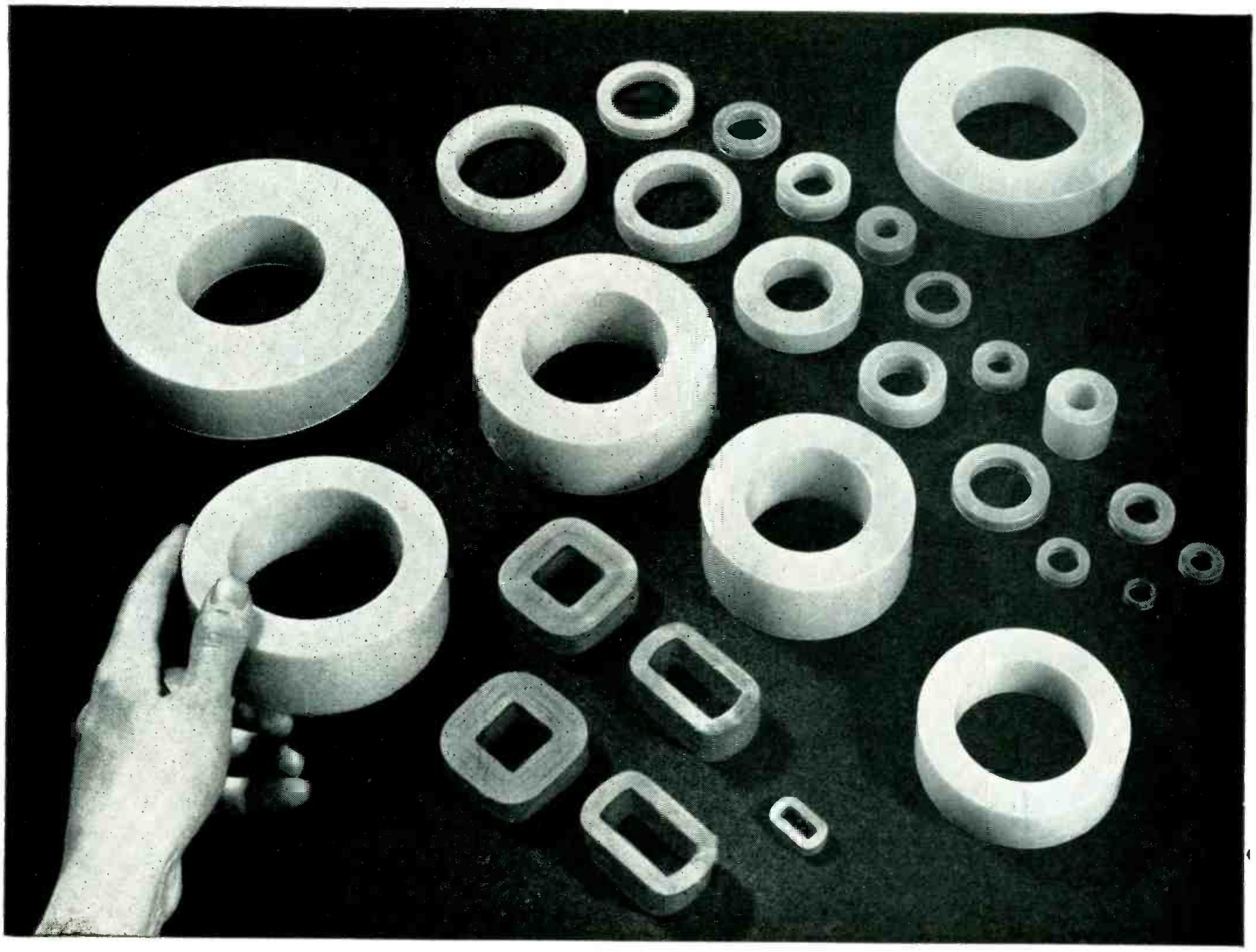


Method of using modified tapping machine for twisting leads together

Twisting of long leads after their ends had been soldered to the pins of a plug was solved at Olympic Radio & Television by modifying an old tapping machine. In place of the tapping chuck, a hook was mounted on the drive shaft. The hook passes through an extra pulley that is used with a leather strap and 1½-lb weight to obtain braking after declutching.

The operator places the plug end of a pair of wires in the hook, grasps the other ends of the wires and spreads them apart, then pulls to actuate the clutch and start the twisting. When the desired amount of twisting has been obtained, releasing the tension stops the twisting chuck, and a flip of the twisted wire unhooks the plug end.

The tapping machine used for the purpose employs a simple clutch;



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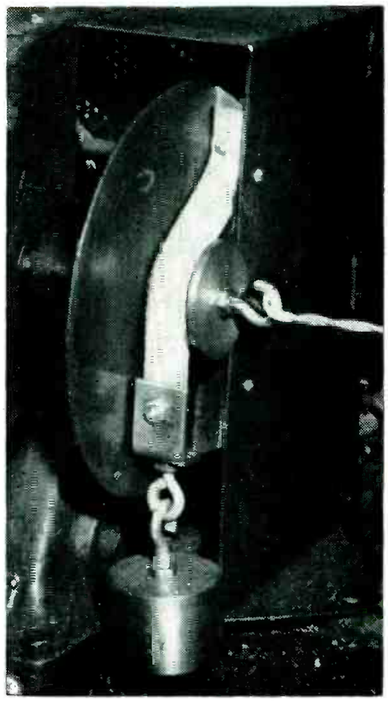


Method of mounting hook and braking pulley in place of tapping chuck

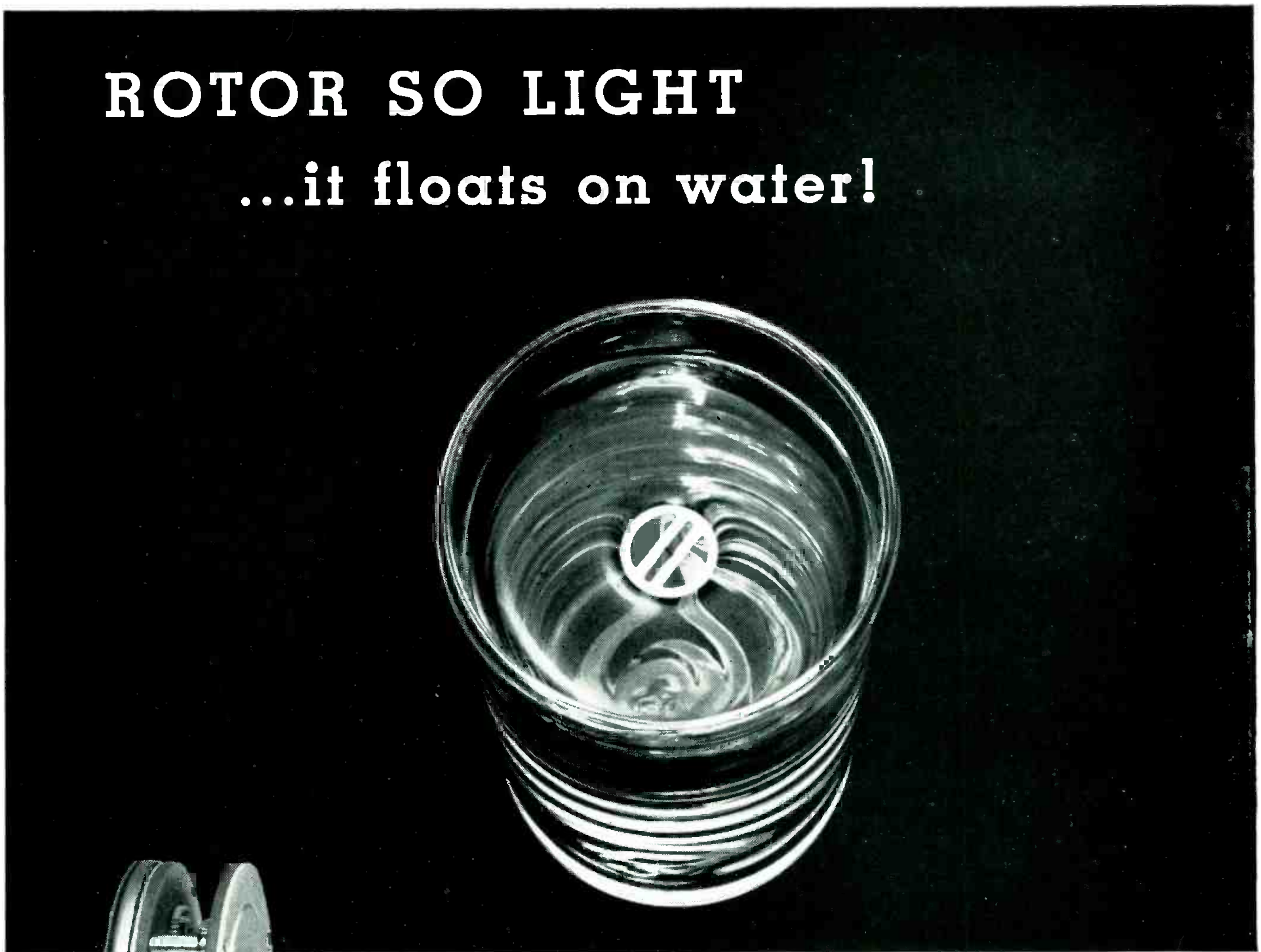
pulling on the twisting hook moves a steel disc against a motor-driven leather-faced wheel, giving speed reduction along with transmission of torque.

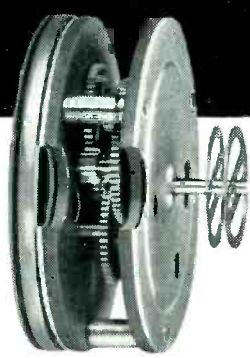
Trimming Metal Shells

A MACHINE for quickly trimming edges of shells after drawing or welding corners is used at Karp Metal Products Co., Brooklyn, N. Y.

The cutting arrangement consists of two motor-driven circular rotating heads. The one on the outside of the chassis has a knife edge,

Trimming excess metal from edge of formed shell for electronic equipment housing. Rollers on bottom of pressure arm permit sidewise movement while maintaining downward pressure





Rotor unit of H-3 motor
with cover removed

Telechron Synchronous Timing Motors

Hard, special-formula steel. Yet the rotor floats. It's so light, mere surface tension holds it up. Imagine what an advantage like this can mean to you when you specify Telechron Synchronous Timing Motors for your equipment.

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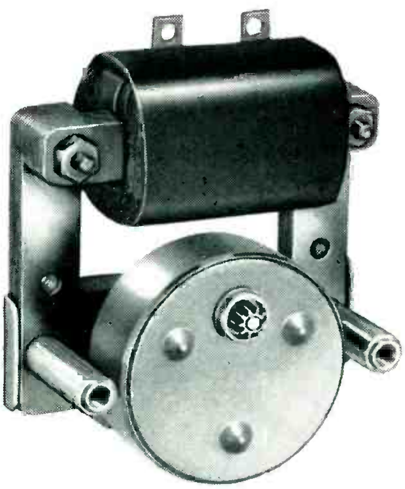
Write for complete catalog and information on our Application Engineering Service.
Telechron Department, General Electric Company, 44 Homer Ave., Ashland, Mass.



Model H-3—for radio timers,
process timers, and time switches

Telechron®

MARK OF TIMING LEADERSHIP

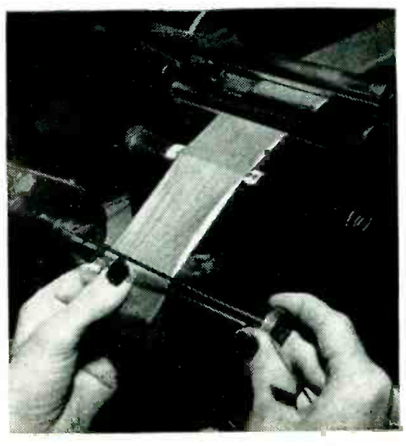
Want more information? Use post card on last page.

and the one on the inside has a mating groove to accept the knife. In use, the shell is placed over the grooved head. An air-operated plunger with freely-rotating pressure wheels is brought down on top of the shell to prevent it from riding up during the cutting operation. The rotating knife-edged cutting head is then brought against the outside of the shell. Excess metal is removed as the shell is moved between the wheels, to give a quick trimming job.

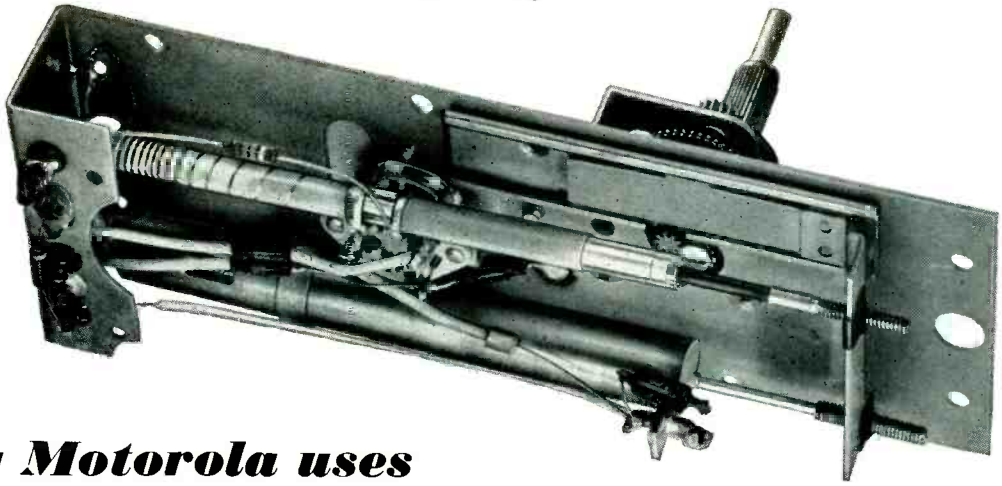
Capacitor Winding Techniques

ACCURATE winding of both conventional and metallized paper capacitors to pre-determined capacitance values is achieved in the North Bergen, N. J., plant of Pyramid Electric Co. through use of three different types of winding machines, each best suited for a particular type of production.

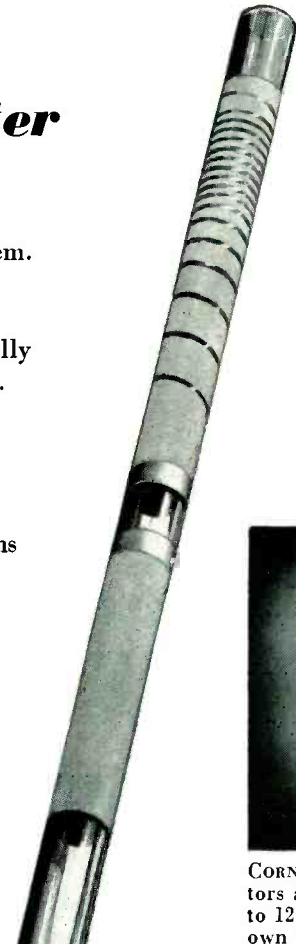
The simplest machine winds one capacitor at a time. The operator rotates the mandrel so its lengthwise groove is up, holds the strips of paper and foil over this groove, then inserts the arbor pin to lock the start of the winding onto the arbor. The pointed end of the arbor pin fits into a hole in an enlarged portion of the arbor near the headstock. The metal disc on the other end of the pin has a center hole to fit over the free end of the arbor. The pin is sufficiently springy and tight to stay in position when in-



Inserting arbor pin to lock start of winding on single-capacitor machine



Why Motorola uses Corning Metallized Glass Inductances in new UHF converter

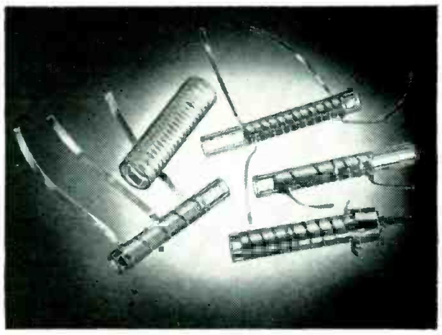


UHF converters present a tough design problem. Not only must they tune an unusually broad band, stability is extremely important.

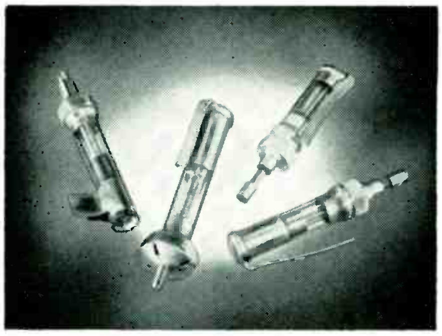
Motorola solved their problem with a specially designed CORNING metallized glass inductance. As can be seen from the illustration, the tuning elements are a combination of distributed capacitance and inductance. The variable pitch winding tailors the unit to the desired tracking curve. One end of the turns is broadened to provide termination surface. The accuracy and rigidity of the glass assure stable, noiseless tuning.

The exceptionally high electrical stability and low temperature coefficient of CORNING metallized glass inductances are a result of the integral contact of the fired-on metallizing with the dimensionally stable glass coil forms. Drift is negligible, even under unusually variable ambient temperatures. High Q is inherent.

CORNING metallized glass inductances may well be the answer to your problem. All it takes to find out is a letter to us. Our engineers are ready to go to work for you.



CORNING Metallized Glass Inductances can be designed to fit your requirements exactly. Uniform, variable or double pitch windings are as easily manufactured as are fixed tuned, permeability tuned or permeability tuned inductance-trimmer combinations. Once a design has been approved, it can be accurately duplicated on automatic machinery to very close tolerances and in any quantity.



CORNING Metallized Glass Trimmer Capacitors are available in standard types from .3 to 12 u.u.f. or can be designed to meet your own particular needs. They are simple to solder, rugged and easy to tune critically. Their superior electrical characteristics are similar to CORNING inductances.

Corning Glass Works

New Products Division • CORNING, N. Y.

Corning means research in Glass

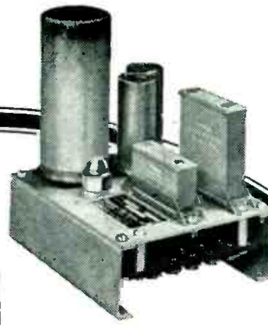
Corning Glass Works
Department NP • Corning, New York

Please send me literature on
☐ Metallized Glass Inductances, ☐ Metallized Glass Trimmer Capacitors.

Name .... Title ....

Company ....

City .... Zone .... State ....



TYPE 2003
Same as Type 2007 (at right) except Tube 12AT7 and 5 pigtail components are external.

TYPE 2007, BASIC UNIT
Contains shock-mounted fork, double triode and all circuitry. Output, 400 or 500 cycles. Accuracy ± 1 part in 50,000. Octal base container, 1½" x 4½". Weight, 10 oz. Power required, 75 to 200 V.-D.C. at 1 to 5 m.a. and 6.3 V. at 300 m.a. Designed for MIL equipment.

TYPE 2001-2, BASIC UNIT
Frequencies, 200 to 3000 cycles. Dividers and multipliers available for lower and higher frequencies. Output, 6 V.—JAN construction.

TYPE 2005, UTILITY
Provides 10 Watts at 110 V. Precision frequencies from 50 to 500 cycles. Input power, 50 to 500 cycles, 45 Watts.

TYPE 2121-A, LAB. STANDARD
Outputs, 60 cycles, 0-110 Volts, 10 watts; 120-240 cy. impulses. Input, 50-400 cycles, 45 Watts.

TYPE 2111A, POWER UNIT
50 Watt output. 0-110-220 V. at 60 cycles or any frequency 50 to 1000 cycles.

Precision FREQUENCIES

GUARANTEED ACCURACY
1 PART IN 100,000 (.001%)
except where otherwise noted

The basis of these frequency standards is an electronically actuated high-precision fork, temperature-compensated and hermetically sealed against barometric changes. The partial list of uses at the right not only suggests the broad range of applications but also proven dependability where there can be no compromise with accuracy. Please request details by Type No. Our engineers are available for advice or cooperation on related problems.

WIDELY USED IN SUCH FIELDS AS
Aviation, Navigation
Ordnance, Ballistics
High Speed Photography
Viscosity Measurement
Fluid Flow
Nuclear Physics, Telemetering
Chemical Reaction
Radiation Counting
Computers
Facsimile
Fire Control
School and Indl. Research Labs.
Accurate Speed Control

American Time Products, Inc.

580 Fifth Avenue ***New York 36, N. Y.***

OPERATING UNDER PATENTS OF WESTERN ELECTRIC COMPANY

Cutting foil and paper layers of finished capacitor with knife made from hack-saw blade

serted. All of the winding machines employ variations of this basic arbor pin design for anchoring the start of a winding.

A small piece of kraft paper is inserted between layers to protect against shorts at the start of the winding. Operation of a foot pedal now actuates a clutch to start the actual winding operation.

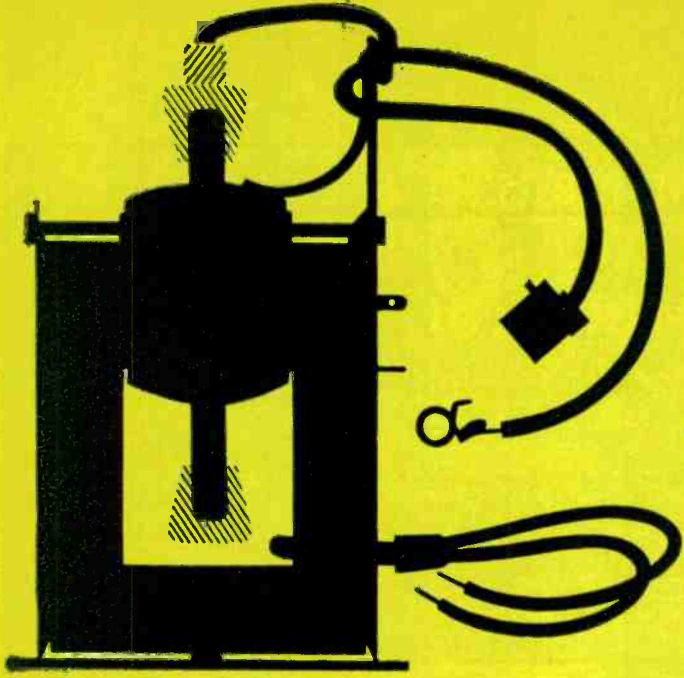
When the correct number of turns is indicated on an attached mechanical counter, the operator stops the machine and cuts the foil and paper layers with a sharp knife. A gummed tab is then applied to anchor the ends on the roll. These tabs are provided in various colors and have different colors of printed dots to serve as a coded indication of the type of impregnation to be given the capacitor.

Guide bars and rollers prevent the paper and foil strips from dropping back into the machine when a cut is made. One roller is free-floating and gravity-loaded to provide the necessary friction for this.

The cutoff knife was made from a hacksaw blade, ground, sharpened and honed to the razor edge required for cutting the thin paper and foil without tearing it. Tape is wound around one end of the blade to serve as a handle.

Dual Semiautomatic Machine

For higher production rates on small as well as large capacitors, another type of machine is used. This saves time by winding one section while the operator is gluing and unloading the other section. The operation can be described by starting at the instant when the



high voltage ARC INHIBITOR by Guthman

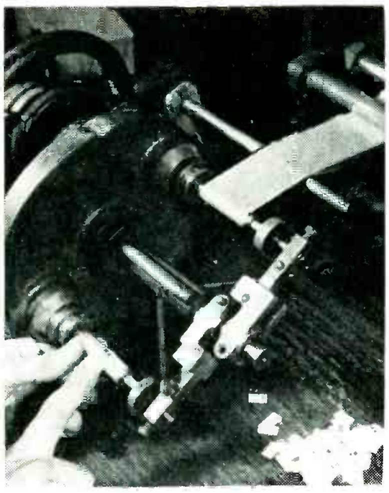
When TV manufacturers discovered that higher voltages of the new 27 and 21-inch television receivers rendered existing wax corona ring sweep transformers inadequate, they brought the problem to Guthman.

In a cooperative program with these TV engineers, a flyback transformer with a cast resin corona ring was developed—the perfect answer to this difficulty.

Your problems in the development of coils and transformers are welcome at *Edwin I. Guthman & Company, Inc.,* 15 South Throop St., Chicago 7, Telephone: CH 3-1600, also Attica, Indiana.

THEY HAD A PROBLEM...

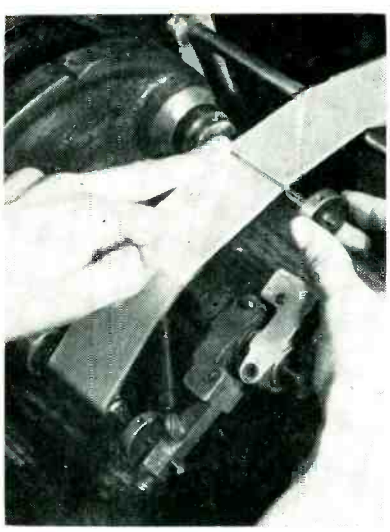
Burton browne advertising



Applying gummed label to finished capacitor unit on dual semi-automatic machine while second unit is being wound on arbor at rear

machine has just finished winding a capacitor and has stopped automatically. The operator at this time has finished applying the gummed locking label to the previously finished unit. She flips out of the way the hinged righthand support end for the arbor closest to her, pulls out the pin on this arbor, slips off the finished unit, then rotates the entire geared head of the winding machine half a turn so that the newly completed capacitor is now in front of her and the empty arbor is under the strips of paper and foil.

The arbor pin is now inserted in the empty arbor to lock the start



Inserting arbor pin to lock start of next winding after indexing head to bring newly-finished capacitor forward

HERE IT IS..! THE

MAGNETIC MODULATOR

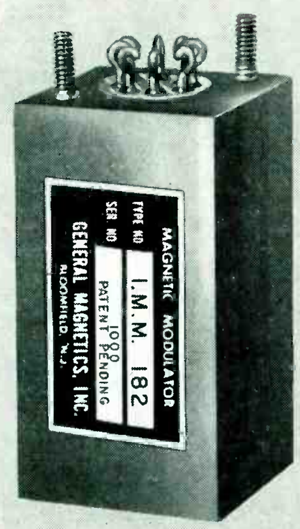
Now Available in 60 and 400 Cycle Designs

A CONVERTER WITH HIGH SHOCK AND VIBRATION RESISTANCE AND PRACTICALLY UNLIMITED LIFE
OPERATION IN AMBIENT TEMPERATURES FROM $-55^{\circ}C$ to $+200^{\circ}C$

LOW LEVEL DUAL POLARITY DC SIGNALS → CONVERTED TO → PHASE REVERSING SUPPRESSED CARRIER MODULATED ENVELOPE

INPUT INFORMATION

- PHOTO CELL
- THERMOCOUPLE
- STRAIN GAUGE
- MAGNETOMETER
- MICROSEN
- LOW LEVEL DC VOLTAGE



ACTUAL SIZE

OUTPUT INFORMATION

- SERVO AMPLIFIERS
- RECORDER
- MOTOR CONTROL
- SPEED CONTROL
- FLIGHT CONTROL
- FIRE CONTROL
- AUTO POSITIONING
- VOLTAGE, CURRENT, FREQUENCY CONTROL

The IMM 182 Magnetic Modulator is designed to convert low level dual polarity DC signals into 400 cycle signals of corresponding amplitude and phase sense.

400 CYCLE UNIT SPECIFICATIONS

Size—1-3/32 x 1-3/32 x 2-1/8 in.
Weight—4 oz.
Temp. rise—negligible
Life—unlimited
Input res.—2,000 ohms.
Output impedance—5,000 ohms.
Nominal input signal ± 40 microamps.
Nominal output volts—0.9 volts RMS @ 400 cycles
Output at null—10 mv. rms. max.
Output phase—0 or 180 ± 5 deg.
Harmonic Distortion—Less than 10%, above 0.1V output

The same precision engineering which has made our Magnetic Modulators outstanding in the field of electronics is applied in the production of our magnetic converters, computers, magnetic amplifiers, and thermocouple converters.

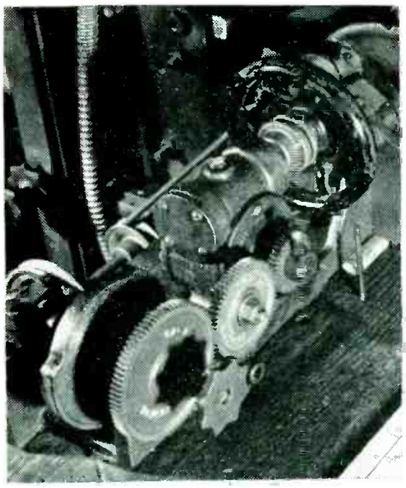
On request, we will be pleased to furnish complete details. Our Engineering Department will give prompt attention to your specific magnetic modulator and amplifier specifications.

We specialize in control systems and components for automatic flight, fire control, analog computers, guided missiles, nuclear applications, antennas and gun turrets, commercial power amplifiers, and control systems.

For further details write Dept. E.

GENERAL GM INC. MAGNETICS

135 Bloomfield Ave., Bloomfield, N. J.

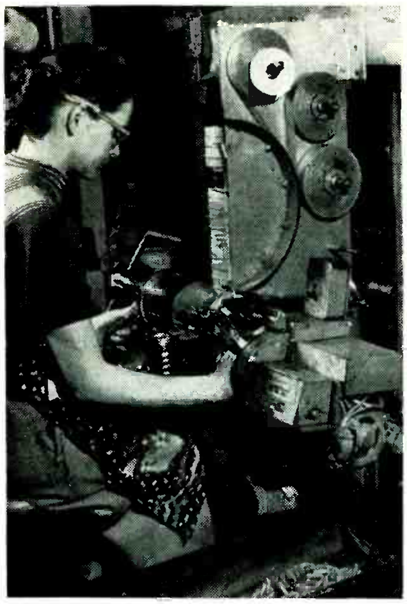


Headstock end of dual semi-automatic machine with protective housing removed to show cam and quick-change gears that shut off machine when correct number of turns is wound. Push rod under cam goes down through table to actuate motor clutch

of the next winding, and the right-hand arbor support is flipped back into position. The strips are cut between the arbors with a knife, about two inches of foil are pulled out from between the layers of paper at the start of the new winding to avoid direct shorts, and the operator then steps on a foot pedal to start the winding operation. She now returns to the other arbor, tears out a similar amount of foil from between each layer to avoid end-of-winding shorts, turns this arbor manually with her fingers to finish the winding, then applies the anchoring sticker to complete the cycle of operation.

The geared head is arranged so that only one arbor is driven at a time. Diametrically opposite notches on the head mate with a detent spring underneath to give precise positioning of the arbors.

The machine is automatically stopped, after winding the desired number of turns, by a cam-and-gear arrangement. The cam is driven by the powered arbor through a train of gears. When starting a new winding, the operator holds down the foot pedal long enough for the cam to rotate out of its depressed part and hold the clutch closed. The cam then holds the clutch open for a predetermined fraction of its revolution. As the end of the winding is reached, the roller on the clutch-locking lever



Tandem high-speed machine for winding paper capacitors two at a time. Operation is almost completely automatic

moves up into the recessed part of the cam, releasing the clutch and stopping the winding.

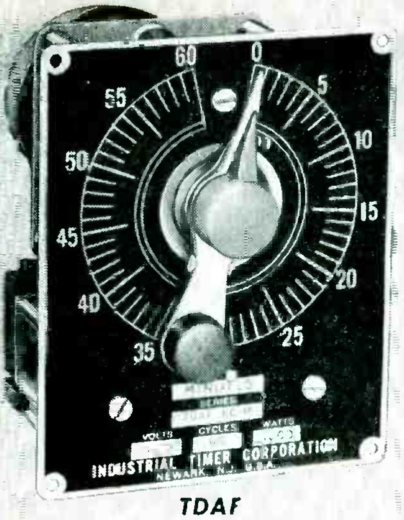
The number of turns is changed in two ways, by changing the easily removed gears and by adding or removing cam inserts. These inserts are fastened to the cam with machine screws.

Tandem Winding Machine

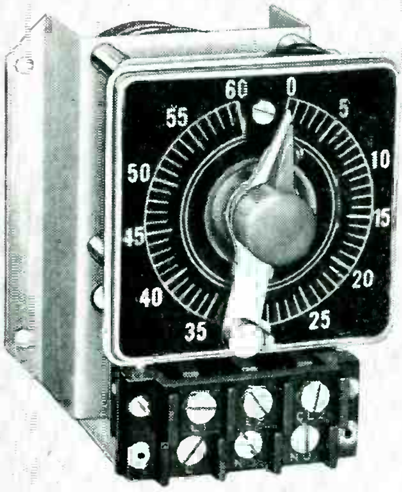
A still more automatic two-arbor machine winds two capacitors simultaneously on each arbor and automatically glues the ends of the finished units. Here, however, the arbor is split into two equal sections along a diameter and the paper and foil strips are locked between the two halves of the arbor to hold the start of each winding. An operating cycle is as follows, starting at the instant when winding has been completed:

(1) Index the machine by giving crank lever half a turn with left hand, to transpose position of arbors. The empty arbor head is now farthest away from the operator and ready for loading, with both halves of its arbor retracted to the left.

(2) Push in first half of empty arbor. This is mounted on a slide along with the pointed rod that later serves for flipping the cut ends onto glue pads. This first half



TDAF



TDAB

TDAB (in case)

TWO IMPROVED TYPES of Synchronous Motor Driven TIME DELAY TIMERS for Industrial Applications

Time Delay Timers are designed for application on circuit controls where a time delay is required between the closing of one circuit and the predetermined closing or opening of another.

Series TDAF and Series TDAB Time Delay Timers are built to stand abuse, and afford the dependable, consistent operation which modern industrial applications demand.

These timers are designed to handle time cycles up to 3 hours. They employ an external, magnetically-operated clutch that not only assures exceptional accuracy but permits *instantaneous,* automatic reset. Thus these timers are ideal for use where rapid recycling is necessary.

OUTSTANDING FEATURES

Automatic, Instant Reset—As soon as the clutch is disengaged, an internal spring brings the actuating arm back to its reset position in a fraction of a second.

Time Setting Adjustment—Adjustment is accomplished by simply moving the black-button pointer to the time cycle required. Quick, easy, accurate.

Dial—Dials of both series have large, easily read numerals.

SERIES TDAF TIMERS

for panel mounting. Terminal strip for electrical connections located at back. 115 volt and 220 volt, A.C.—25, 50, and 60 cycles. (For time ranges, see chart.)

SERIES TDAB TIMERS

for surface mounting. Terminal strip for electrical connections located at front, below dial. If required, can be supplied in steel housing, as illustrated—eight knockouts for easy hook-up. 115 volt and 220 volt, A.C.—25, 50 and 60 cycles. (For time ranges, see chart.)

TIME RANGES—Series TDAF and Series TDAB Timers

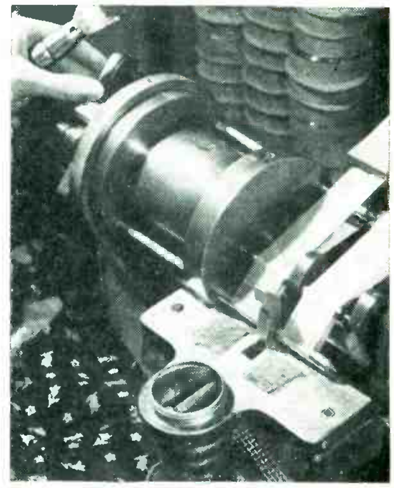
DIAL CALIBRATION	MAXIMUM TIME CYCLE
1/10 Second	5 Seconds
1/4 Second	15 Seconds
1/2 Second	30 Seconds
1 Second	60 Seconds
2 Seconds	3 Minutes
5 Seconds	5 Minutes
15 Seconds	15 Minutes
30 Seconds	30 Minutes
60 Seconds	60 Minutes
2 Minutes	3 Hours

For complete technical data request bulletin 39

MANUFACTURERS OF THESE AND OTHER TIMERS AND CONTROLS FOR INDUSTRY—Cam Timers • Manual Set Timers • Tandem Automatic Recycling Timers • Instantaneous Reset Timers • Running Time Meters

Timers that Control the Pulse Beat of Industry

INDUSTRIAL TIMER CORPORATION
115 EDISON PLACE, NEWARK 5, N. J.



Inserting first half of split arbor along with pointed rod by pushing slide with left hand, preparatory to anchoring start of next winding so that strips can be cut

of the split arbor goes under the strips as it passes through center and right-end bearing supports. The arbor thus has three points of support while winding its two units.

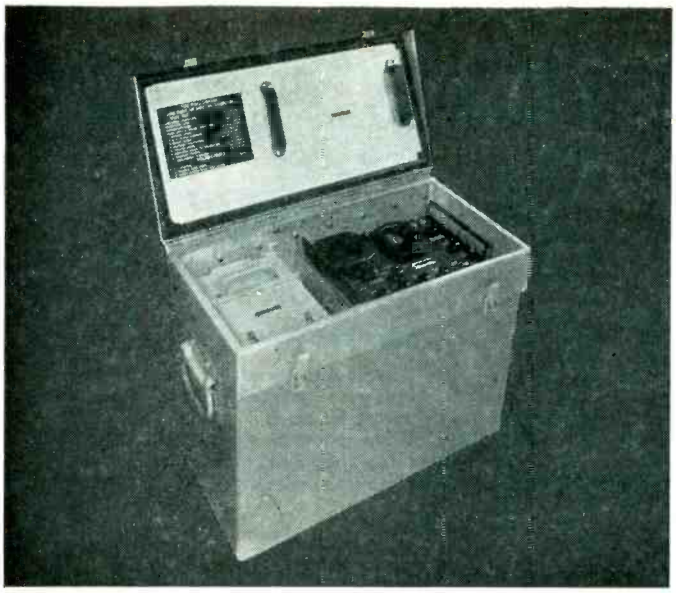
(3) With right hand, push guillotine-blade slide to left and depress slightly. This causes a compression bar, also on the slide, to push the strips of foil and paper against the flat surface of the arbor half that is in position.

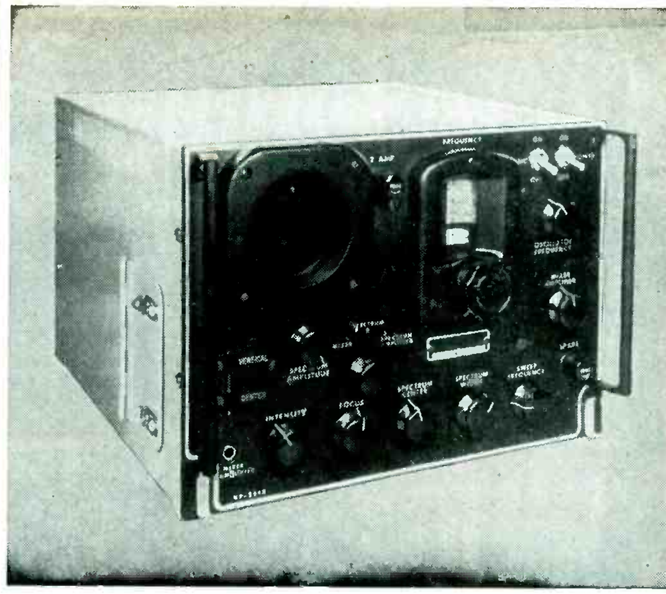
(4) Insert second half of arbor over top of strips, flat face down, by pushing it in with left hand. This locks the start of the next winding.

(5) Push guillotine blades all the way down to cut strips, then release and retract blades to right out of way. The cut ends of the finished units now flip over glue pads on the table in front of the machine.

(6) Press handle at right of machine to start winding operations. This drives both arbors, hence also

Method of depressing guillotine blades to cut strips of paper for both sections simultaneously





NE-11-20-S SPECTRUM ANALYZER

Description

The Spectrum Analyzer is test equipment designed primarily for use with aircraft radar and beacon equipment operating over a frequency range of 8470 to 9630 mc/s. Housed in a compact portable carrying case, the whole assembly weighs approximately 90 pounds.

In operation, the Spectrum Analyzer displays on an oscilloscope a pattern representative of the distribution of energy among the various frequencies in the output of a pulsed oscillator. This equipment is equal to our government models TS-148/UP.

Applications

This very sensitive micro-wave receiver will provide accurate measurement of the spectra of radio frequency oscillations in radar and beacon equipment. It will also measure, within its own range, frequencies of echo boxes, magnetrons, test sets, local oscillators and a variety of resonant cavities. It can also be used to check magnetron pulling and AFC circuits, and as a frequency-modulated oscillator to tune T/R Boxes and R/T Boxes in transmitter-converters.

The Analyzer is so sensitive that the magnetron signal can usually be picked up at some distance from the source, thus making the equipment easy to use in any convenient location.

Specifications

Power Supply .... 50-1200 Cps; 105-125 Volts; 125 Watts
Frequency-meter Range .... Calibrated directly from 8470 mc/s to 9630 mc/s
Sweep Frequencies .... Continuously Variable from 10 to 30 Cps
Attentuation (Spectrum Amplitude) .... Uncalibrated. Variable from 3 to 70 db.
Operating Temperature Range .... —40°C. to +55°C.
Frequency swing of analyzer r-f oscillator (sawtooth FM) .... 40 to 50 mc/s
Overall i-f bandwidth at half power points .... 50 kc/s
Sensitivity to CW — Spectrum Amplified Pos. — 80 db. below 1 watt for 1 inch of deflection on Oscilloscope Screen.
— Spectrum Position — 55 db. below 1 watt for 1 inch of deflection of Oscilloscope Screen.
Maximum dispersion of spectra .... 1.5 mc/s per inch
Maximum error .... ± 5 megacycles

We will gladly furnish all details regarding specifications, prices, and delivery.

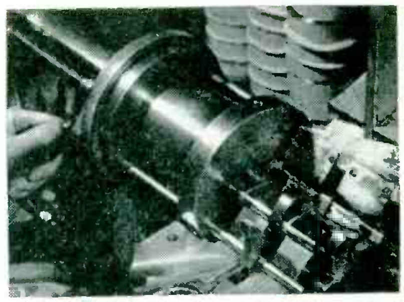
Write, wire or telephone for information.

NORTHEASTERN ENGINEERING INC.

Manchester, New Hampshire

Telephone 2-6485

Want more information? Use post card on last page.

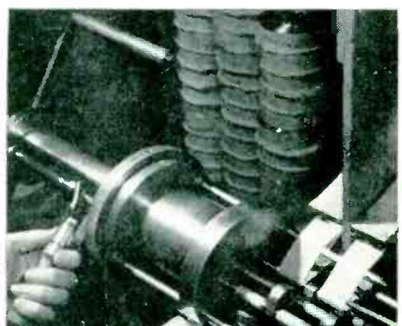


After cutting, ends of papers flip over glue-saturated felt pads on top of glue pump. In another fraction of a second, when machine starts, these strips will have been pulled over the pads to complete the winding of two capacitors

completes the winding of the finished unit; its loose ends are dragged over the glue pads as they are pulled in, and the loose ends are thus automatically glued at the instant that the rolling is completed. The arbor with the finished units continues spinning, as this does not interfere with unloading.

(7) Pull out one half of arbor for finished unit by slipping forked tool under sleeve on left end of this arbor half and pushing it to left.

(8) Strip second half of arbor by moving to left the cross bar on which are mounted the pointed paper-flipping rod and the free-turning half arbor. This releases the finished capacitor sections, allowing them to drop down the chute and into a tote tray. By now the winding on the other arbor has been completed and both arbors have been stopped by the predetermined electrical counter mounted on the right of the machine. This acts through solenoids and snap-action switches to stop the machine



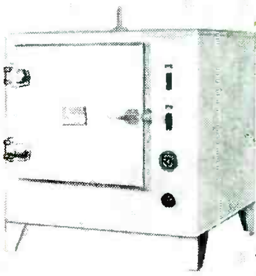
Left hand of operator is holding forked tool used to push out first half of split arbor preparatory to releasing finished units. Winding is already under way here on the next two units

GRAMER *Hermetically Sealed*

TRANSFORMERS

MEET MIL-T-27 GRADE 1 CLASS A SPECIFICATIONS WITH IN-PLANT TESTING FACILITIES

TEMPERATURE and IMMERSION CYCLING



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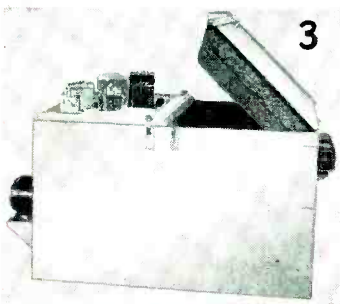


3

FIVE (5) CONTROLLED CYCLES OF 15 MINUTES EACH STEP

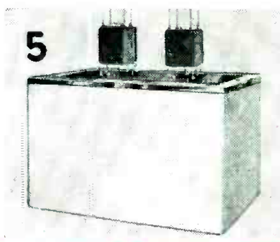
Step 1. Oven 185° F.

Step 2. Room Temperature

Step 3. Cold Chamber --67° F.

Step 4. Room Temperature

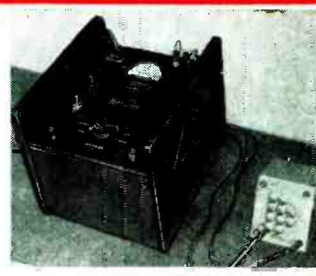
Step 5. Saturated Salt Bath Total Immersion



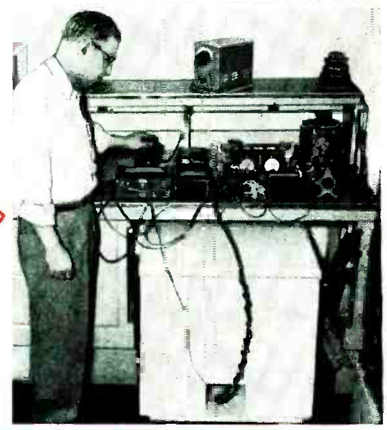
5

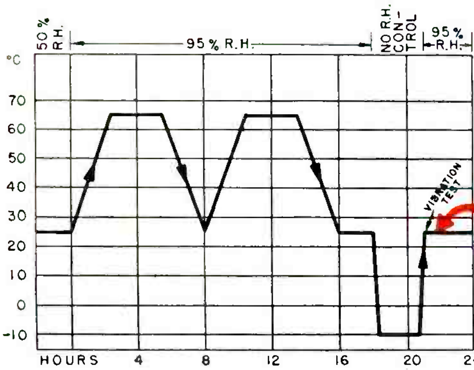
EXACT ELECTRICAL MEASUREMENTS

INSULATION RESISTANCE measured accurately to 2,000,000 Megohms



TEMPERATURE RISE TEST

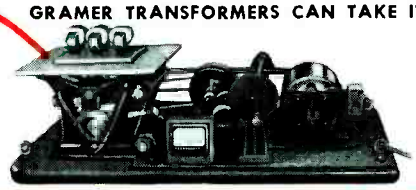




MOISTURE RESISTANCE

Transformers withstand 10 humidity cycles shown at left and are subjected to a 15 minute vibration test, 10 to 55 cycles per second. Some specifications require DC polarizing voltage applied from terminals to case during the entire time units are in humidity cabinet.

GRAMER TRANSFORMERS CAN TAKE IT!



VIBRATION MACHINE

HUMIDITY CABINET

GRAMER

We Invite You—Send Your Specifications c/o Dept. E.

TRANSFORMER CORPORATION

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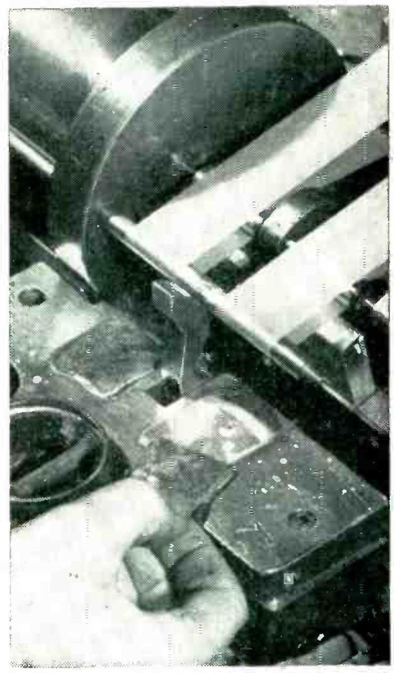


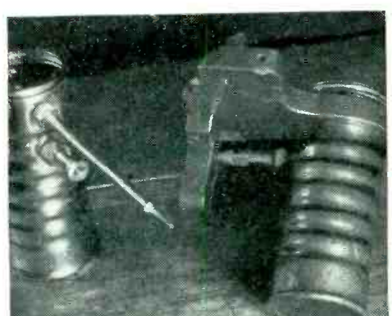
Closeup of glue pump, with pad removed to show hole through which glue is squirted up through pad each time round bar strikes lever, as shown here, during indexing of head

at the precise instant when the desired number of turns is achieved. One type of unit suitable for this purpose is the Microflex Counter made by Eagle Signal Corp., Moline, Ill.

(9) Index the head of the machine 180 degrees to start next cycle of operation.

Automatic Glue Pump

The pointed paper-flipping rods on the outer circumference of the indexing head serve the added purpose of actuating a pump lever that forces glue up into the felt pads each time the head is indexed. An ordinary automotive-type oiler serves as the pump. The long nozzle of the oiler is replaced with



Details of glue pump, along with standard oiler (at left) from which it is made

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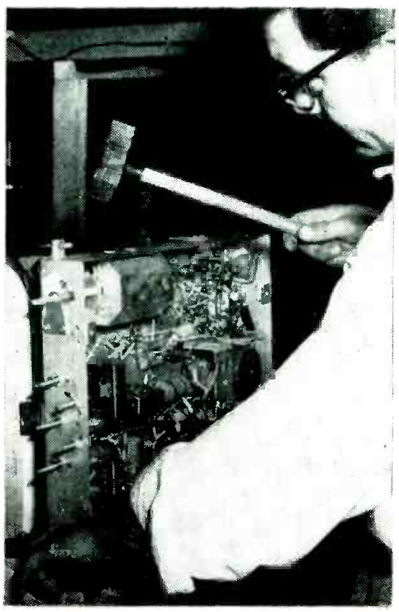
a casting that in effect provides a T-shaped nozzle for squirting two pads at once. The T-shaped channels in the brass casting were obtained by drilling through the casting from three directions mutually at right angles, then plugging the ends of the holes appropriately with Allen screws. A lever was then mounted on the casting in such a way that its lower end pushed in the pump-actuating piston each time the pointed rod passed over the upper end during the indexing operation.

A polyvinyl acetate glue is used. This remains sufficiently fluid for continuous use in the oiler even without a cover on the oiler, and provides adequate adherence for the kraft capacitor tissue.

Sponge Rubber Mallet

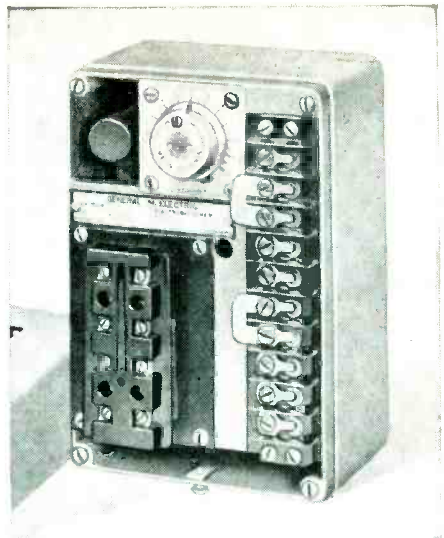
INTERMITTENT connections and microphonic tubes are safely detected without risk of damaging other parts by using a mallet made from three pieces of half-inch sponge rubber. Each piece is approximately 2 inches wide and 4 inches long. The pieces are fastened together with rubber cement, a hole is drilled through them and a wood handle made from dowel rod is glued into this hole.

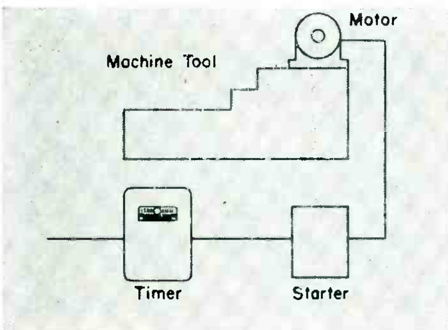
If handle and strips tend to



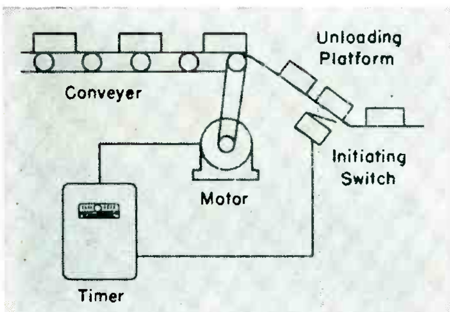
Method of using improvised rubber mallet to check for intermittents

G-E Electronic Timer Has High Repetitive Accuracy



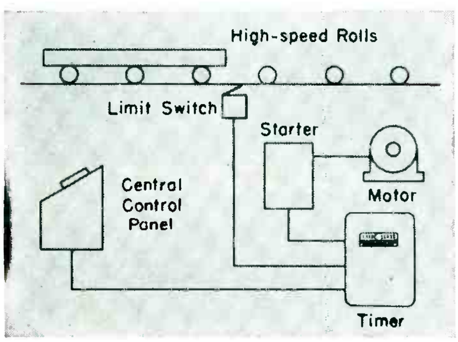


General Electric Electronic Timers assure precise timing of repetitive operations. One manufacturer reports the use of G-E timers on bearing grinding machines where they control cutting time and drift time. Here, G-E timers perform over 500 repetitive time cycles per hour. Where you require a uniform product turned out at high speed, put the accuracy of the General Electric Electronic Timer to work for you.



Controls F-hp Motor Directly

Here, a G-E Electronic Timer controls directly the small motor of a box conveyor. The timer tells the motor when enough boxes have been delivered to the gravity conveyor. A limit switch, actuated by the first box, tells the timer when to start. You can get a G-E Electronic Timer to start fractional-horsepower motors directly or handle motor starters up to NEMA Size 3.



Can Be Remotely Adjusted

Here a steel company, through a furnace control desk, controls the time cycle of high-speed rolls even though the timer is inaccessible. A limit switch actuated by the steel slab starts the electronic timer. Your G-E Electronic Timer can be located wherever necessary and remotely adjusted from a convenient location.

SPECIFICATIONS

EXCELLENT REPETITIVE ACCURACY
High-quality capacitors permit errors no greater than ±2% of dial setting, independent of normal temperature changes.

THREE TIME RANGES AVAILABLE
.06-1.2, .6-12, 6-120 seconds, each continuously adjustable through a 20:1 range.

TWO TYPES OF OPERATION
Can be set for immediate or delayed start.

HIGH CONTACT RATING
One million operations at full-load, up to ten million at less load. Handles motor starters to NEMA Size 3, starts f-hp motors directly.

REMOTE CONTROL
Timing potentiometer and dial assembly may be located where most convenient.

CONSTRUCTION
High quality components, conservatively rated for top performance and long life.

PHOTOELECTRIC RELAY CR7505-K100

One of a complete line of devices for all photoelectric applications. This model is inexpensive, has broad application. Bulletin GEA-3533D.

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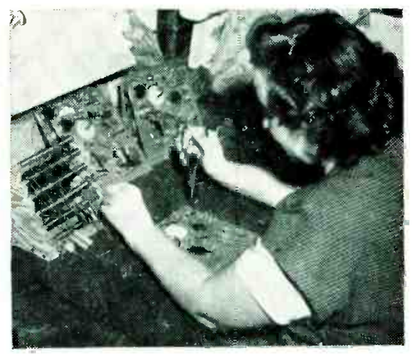
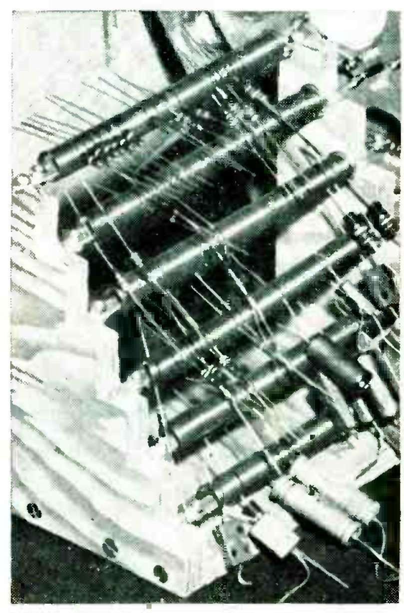
loosen after a period of continuous use, vinyl plastic adhesive tape is wrapped around as reinforcement. This improvised tool is used in the test section of Olympic's television plant in Long Island City.

Spring Rack Holds Parts

IN SMALL-QUANTITY subassembly work where one operator completes the entire job at DuMont, a simple coil spring rack is used to hold the parts needed for a run of perhaps three units. Before starting, the operator places on this rack the required number of each part, taking them from paper bags alongside her.

The rack consists of a plywood stand on which are mounted prestretched coil springs. Each spring is bolted to its own metal strip to





Stand made from springs, metal strips and plywood here holds parts needed for three terminal board subassemblies. Operator keeps original sample in front of her to serve as guide, supplementing prints mounted above sample

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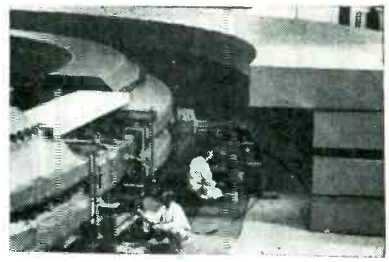
obtain uniform tension just sufficient to grip the leads that are inserted between turns. The strips rather than the springs are fastened to the plywood stand.

Making Concrete Dust-Free



Method of using coated concrete blocks at Brookhaven

To OBTAIN a dust-free atmosphere for the cosmotron at Brookhaven National Laboratory, a thin coating of Vibrin polyester resin was sprayed on each of the 10-ton concrete radiation shield blocks that are stacked four tiers high for more than 100 feet around the circumference of the equipment.

To prevent the blocks from causing dust when they are occasionally moved, a 1/32-inch coating of the resin was sprayed on with standard compressor equipment. This sealed the cement with a hard glass-like surface that resists flaking even under a weight of 40 tons. The material is quick-drying, permitting

Spraying concrete blocks for cosmotron with dust-preventing resin. Preliminary tests indicate the solution also has waterproofing value

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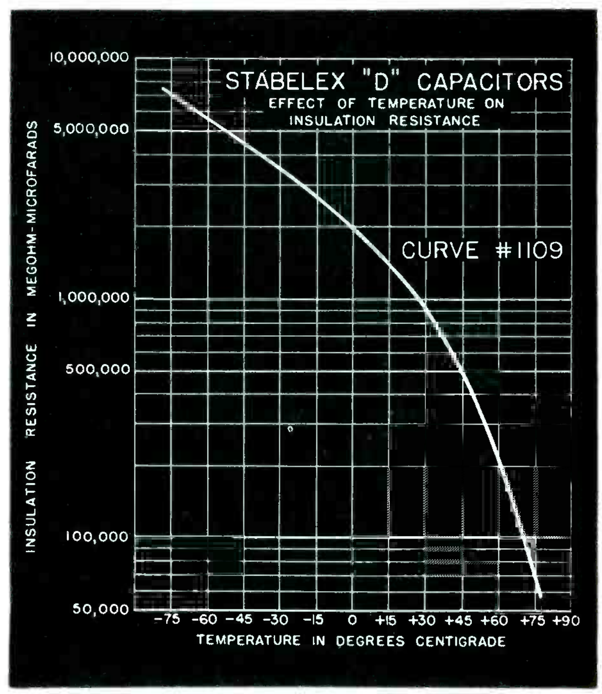

The unusually high insulation resistance at 20° C. in turn insures unusually high resistance at temperatures up to 75° C. The insulation resistance of these capacitors at 75° C. is approximately ten times that of commercial oil capacitors at 20° C. This is well illustrated in Curve #1109.

Performance curves illustrating various characteristics of the Stabelex "D" Capacitor will appear in this magazine each month.

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application of two coats within a few hours. Calcium carbonate was used to extend the resin, and a pigment was added to give the coated blocks an attractive gray color. Cost is competitive with paint.

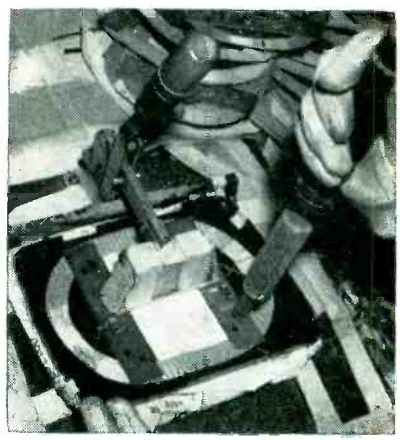
The Vibrin resin is a product of the Naugatuck Chemical Division, U. S. Rubber Co., Naugatuck, Conn.

Blower Speeds Cooling of Induction Soldering

A SMALL blower aimed directly at the work coil of an induction soldering setup for hermetic soldering cools the solder much faster after completion of the heating cycle, thereby boosting the production rate appreciably. On short heating cycles the blower does not affect the temperature of the work, nor does it affect the work coil because that is already water-cooled internally. A successful application of this technique at Utility Electronics used an induction heater made by Marion Instrument Co.

Soldering Iron Stakes Plastic Pegs

LOOP antennas are rapidly mounted on the back covers of portable radio receivers through use of a simple lever-operated holding jig and a modified soldering iron. The plastic cover, resting on a newspaper pad to protect it from scratches, is set in position under the holding jig. A



Flattening plastic peg by applying heat and pressure with electric soldering iron, while clamping jig holds antenna flat against inside of cover for three-way radio

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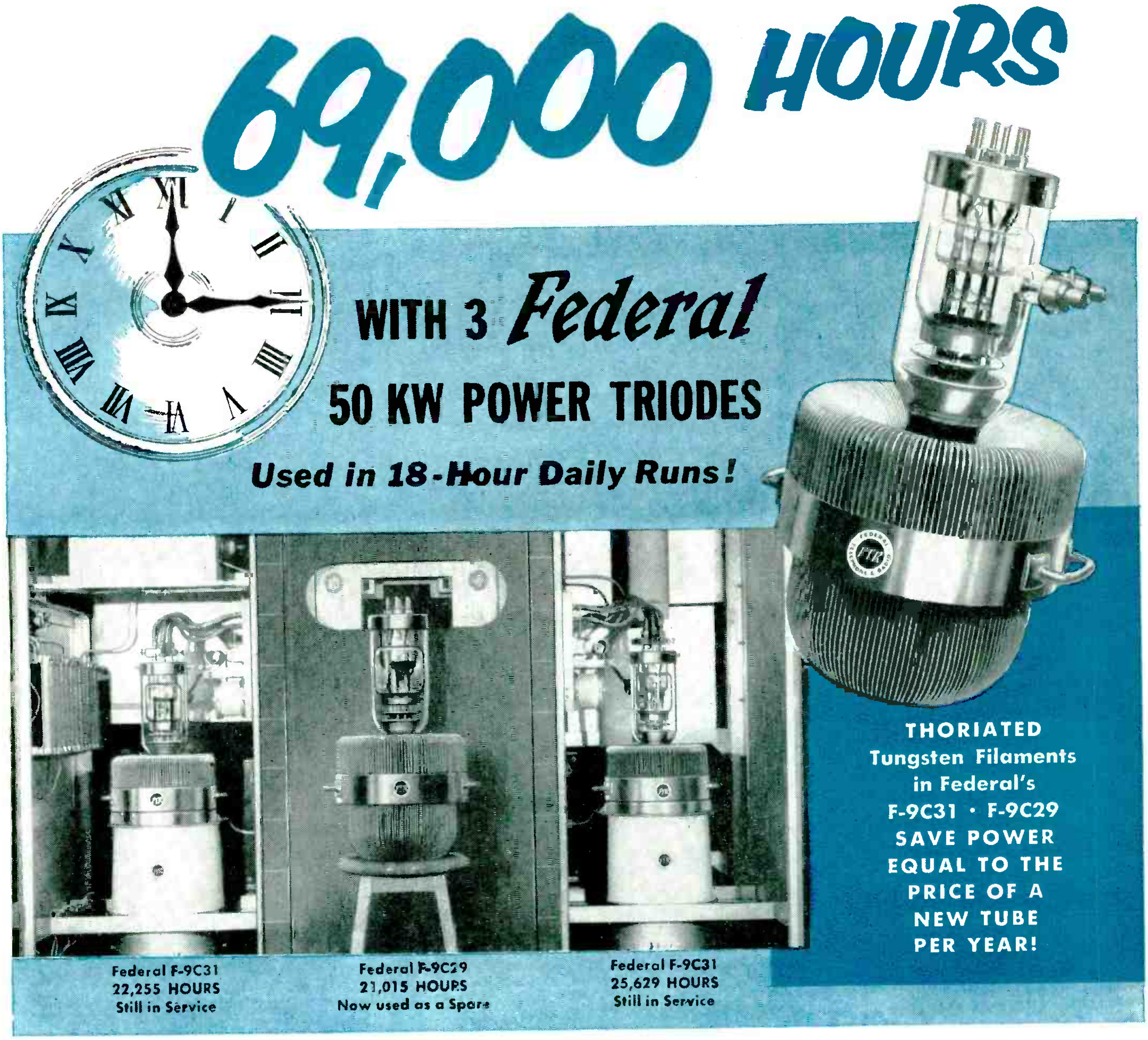

THIS is the life story of 3 of numerous Federal power triodes used by the Canadian Broadcasting Corporation at station CBX, Lacombe, Alberta: Since October, 1948, to recent date, these tubes have served for 69,000 hours. Both F-9C31's appear to have full emission and capability of many more hours. The F-9C29 – used in modulator unit – is on standby after 21,015 hours.

Behind the long performance of these 3 tubes is Federal's pioneering in the *multi-strand thoriated tungsten filament,* which permits hairpins to expand *individually* . . . eliminates stresses which might be conducive to filament warping.

Cathodes of this type provide lower operating temperatures . . . keep components cooler, more durable. Because *less* filament power is consumed, tube life is *longer* . . . operating costs are *lower*. The power saved per-tube-per-year equals the price of a *new* tube!

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loop antenna is now dropped over the pegs molded into the thermoplastic cover, and the handle of the jig is pulled forward. A combination of cam and lever action moves the pressure block down on the antenna and holds it there for the remainder of the operation. The operator now applies the flattened end of the soldering iron to each plastic peg in turn. This softens and flattens the peg, much as if peening a red-hot rivet.

A backward push on the lever handle releases pressure, so that the finished unit can be taken out to complete the work cycle. This procedure is used in Emerson's Jersey City plant.

Tweezer-Type Soldering Iron

IN SOLDERING deflection yoke leads to special terminal lugs that are to fit inside the female connector for the deflection yoke of Olympic's television receiver, surplus solder would prevent insertion of the lugs in the connector. To offset this, a Pres-To-Heat soldering tool made by Triton Manufacturing Co, East Haddam, Conn. is used to heat the joint. This is a resistance type tool operating from a step-down transformer. Pressing a button on the tool closes the tweezer-type jaws against opposite sides of the joint. Current flows through the joint, heating it in a few seconds. The operator then

Using soldering tweezers to get heat exactly where it is needed on a joint

applies a small amount of solder to complete the joint.

A simple wood fixture is used for this operation to permit handling seven leads at a time. The connecting lugs are pushed over headless nails driven into the wood, so that they are in the optimum position for attaching and soldering the wire.

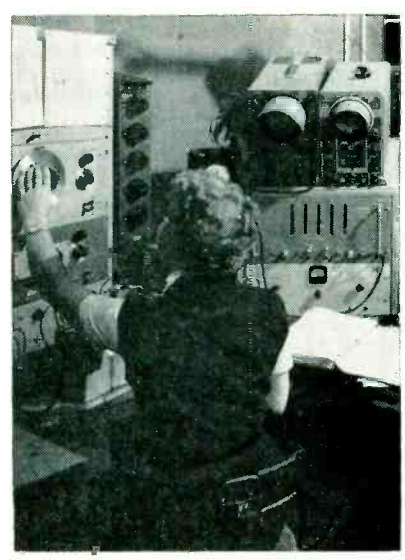
Production-Testing Filters

By Wallace Rianda

Applications Engineer
Berkeley Scientific Division of Beckman Instruments, Inc. Richmond, Calif.

New test methods employing Berkely digital-reading frequency meters are used at Lenkurt Electric Co. to provide frequency determinations to an accuracy of ±1 cycle. The training period for test operators is materially decreased, and frequency checking time is cut to 30 seconds as contrasted to several minutes for older methods.

A major problem encountered in the development of increased production of carrier telephone and telegraph equipment is that of adapting former laboratory test techniques to production line requirements. Typical is the precise determination of characteristics of filters and meshes, critical components in carrier equipment. Es-



Production setup for checking large quantities of filters at Lenkurt plant, using new equipment and technique for checking any test frequency up to 500 kc to accuracy of 1 cycle per second in measuring time of only 30 seconds

No. 108 machine makes coil winding more profitable

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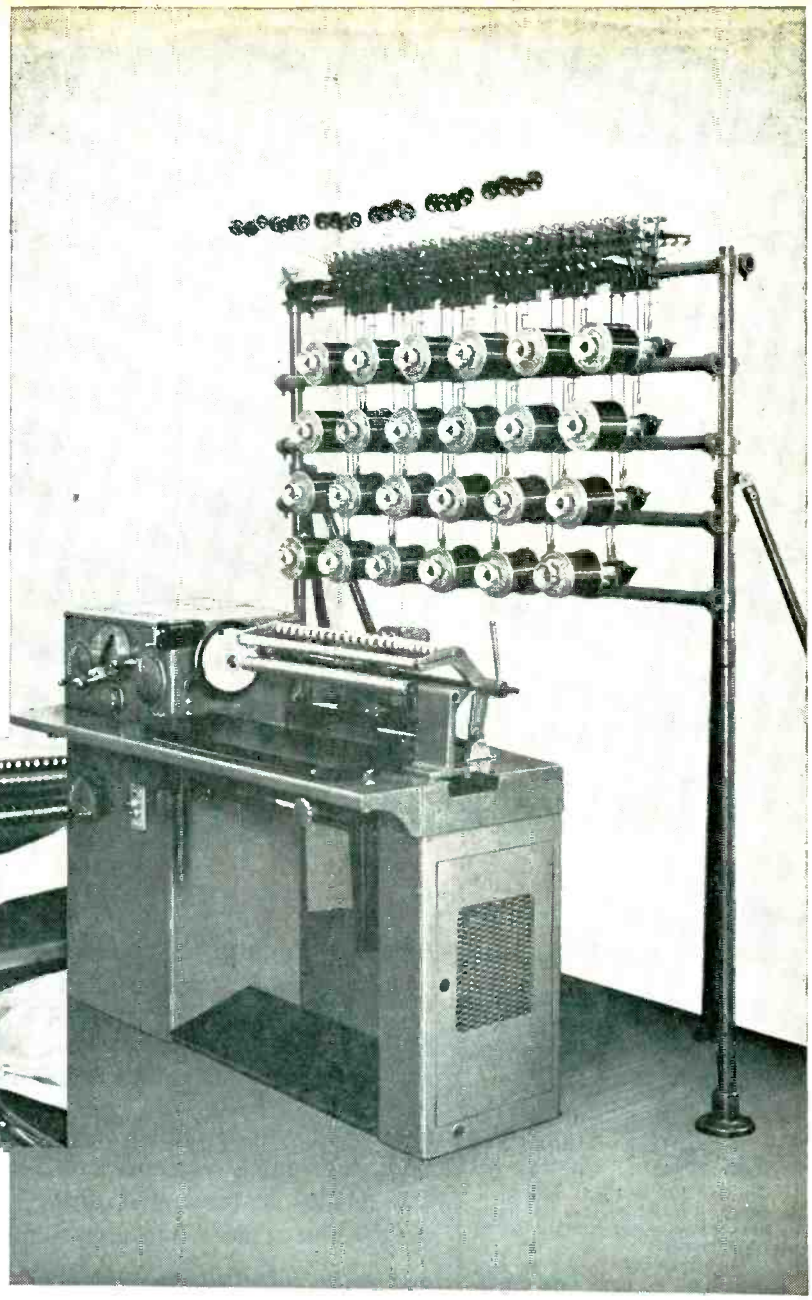

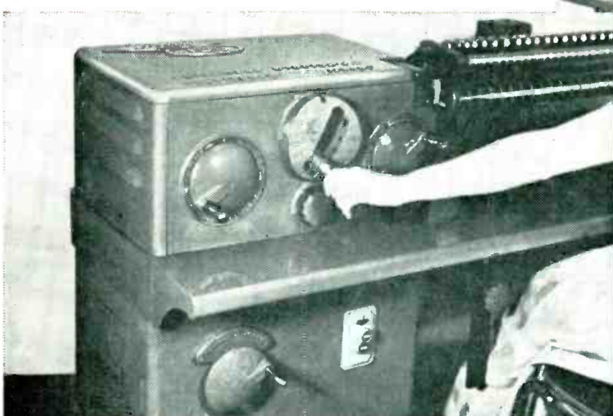

Leesona® No. 108 Coil Winder for high accuracy, top production and lowest costs in shops where change-overs are frequent. Takes long or short runs; easy to set up; no cams or gears to remove when making set-up changes; all controls are within easy reach of the operator even when seated.

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So simple, the operator can make set-up changes in a matter of minutes. So moderate in price you can easily replace older, less satisfactory equipment and soon see savings write off your investment.

This is the manual paper feed machine which won the "Electrical Manufacturing" magazine's design prize. Set-up time is reduced to a minimum by external controls and change-over from job to job is quick and easy. It winds wires from #20 to #44 (A.W.G). Coil lengths may be from 1/4" to 3 5/8", with outside diameters up to 5" round or square.

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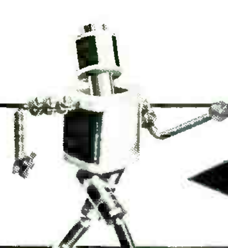

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sentially a matter of determining db versus frequency, the actual checking involves determination of frequency up to an accuracy of 1 cycle, precise measurement of the output voltage of an audio oscillator and of a filter, and determination of the effective a-c resistance of a mesh.

Old Method

The method previously used to determine frequency is shown in Fig. 1. The Lissajous pattern on the oscilloscope was used to determine the frequency of the interpolation oscillator against a multiple of one of the selectable basic standards. The output of the interpolation oscillator was then beat against a signal generator in a varistor-type modulator. The difference frequency was passed by the low-pass filter and applied to the amplifier. The frequency meter then read the difference frequency.

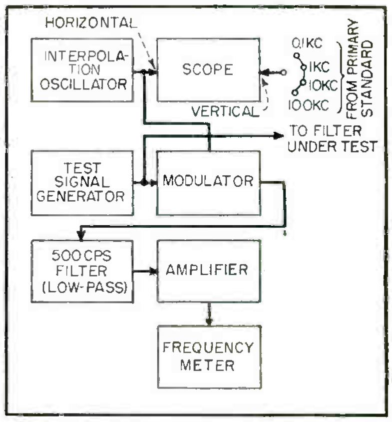
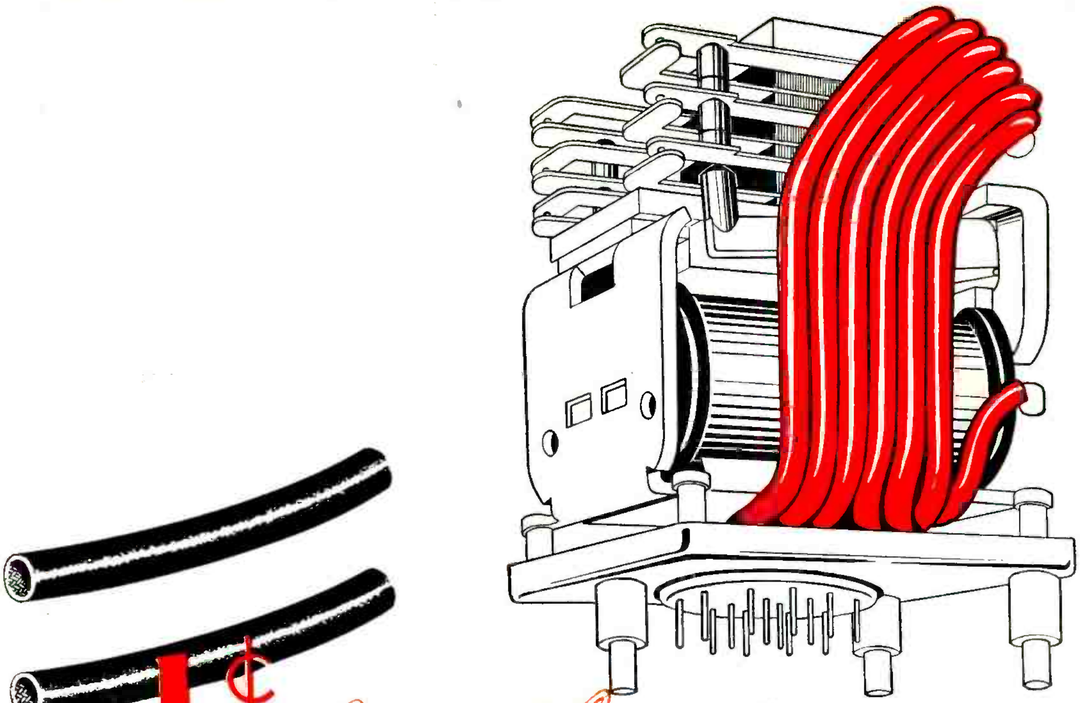


FIG. 1—Block diagram illustrating method formerly used for measuring frequency during testing of filters for carrier telephone and telegraph equipment

As an example of this operation, assume that the operator wished 3,535 cycles. The interpolation oscillator would then be adjusted until a 3.5 to 1 pattern was obtained on the oscilloscope using the 1-kc standard. The signal generator would then be adjusted until a frequency of 35 cycles was obtained on the frequency meter. One of the important limitations of this particular system was that the operator might not know if the actual frequency was 35 cycles above 3,500 cycles, or 35 cycles be-



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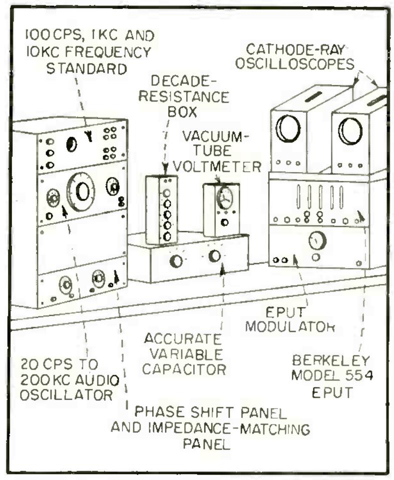

FIG. 2—Filter test station using new method

low 3,500 cycles. In other words, when the frequency meter read 35 cycles, the actual frequency could be either 3,535 or 3,465.

Other disadvantages of the old method included the time required (often several minutes for each check) and the necessity of using relatively skilled technicians at each test stand.

New Method

The method now used employs a direct-reading digital events-per-unit-time meter as the frequency-determining device. The setup of the typical present filter test station is shown in Fig. 2, and the block diagram is shown in Fig. 3. Components include a 20 to 200,000-cycle signal generator, a phase-shift panel, a resistance decade, a vacuum-tube voltmeter, a capacitance padder, an oscilloscope for measuring phase shift, an oscilloscope for monitoring the output of

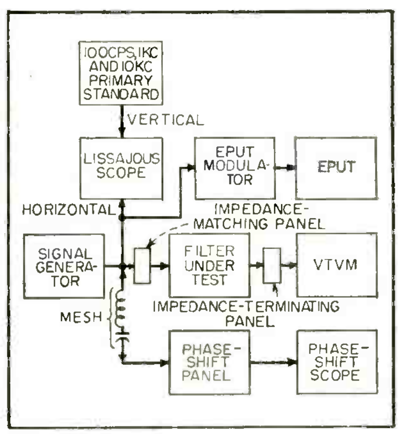

FIG. 3—Block diagram illustrating new method employing an Eput (events-per-unit-time) meter to indicate frequency

the oscillators, an events-per-unit-time meter and an events-per-unit-time meter modulator.

The signal generator employs an oscillator circuit which uses feedback with resultant high-frequency stability. The oscillator has three controls—a range selector switch for frequency, a calibrated frequency dial and an amplitude control dial. The frequency dial calibration is held to $\pm\frac{1}{4}$ or a dial division.

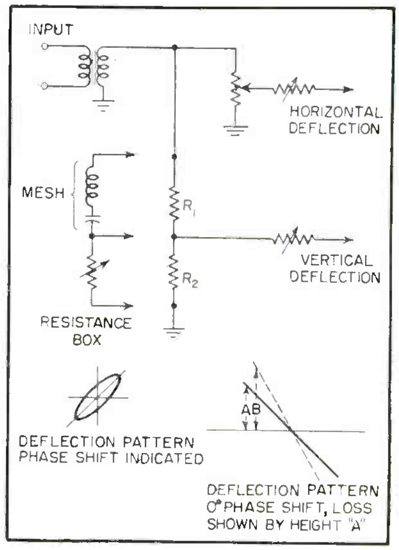

FIG. 4—Method of using resistance decade box to determine effective a-c resistance of a mesh

The phase-shift panel is used in conjunction with the phase-shift oscilloscope to determine the characteristics of meshes (portions of filters consisting of a single series inductance and capacitance). The input frequency is applied to the mesh which is connected to the phase-shift panel and then to the phase shift oscilloscope. The Lissajous pattern on the oscilloscope shows the phase shift of the mesh. Zero phase shift is obtained by padding the mesh capacitor with the precision capacitance padder.

The resistance decade box is used as in Fig. 4 to determine the effective a-c resistance of a mesh. The input is fed through a transformer and through divider networks to the horizontal and vertical deflection plates on the oscilloscope. Precision resistors R_1 and R_2 give a fixed distance A. After this distance is noted, the mesh is inserted

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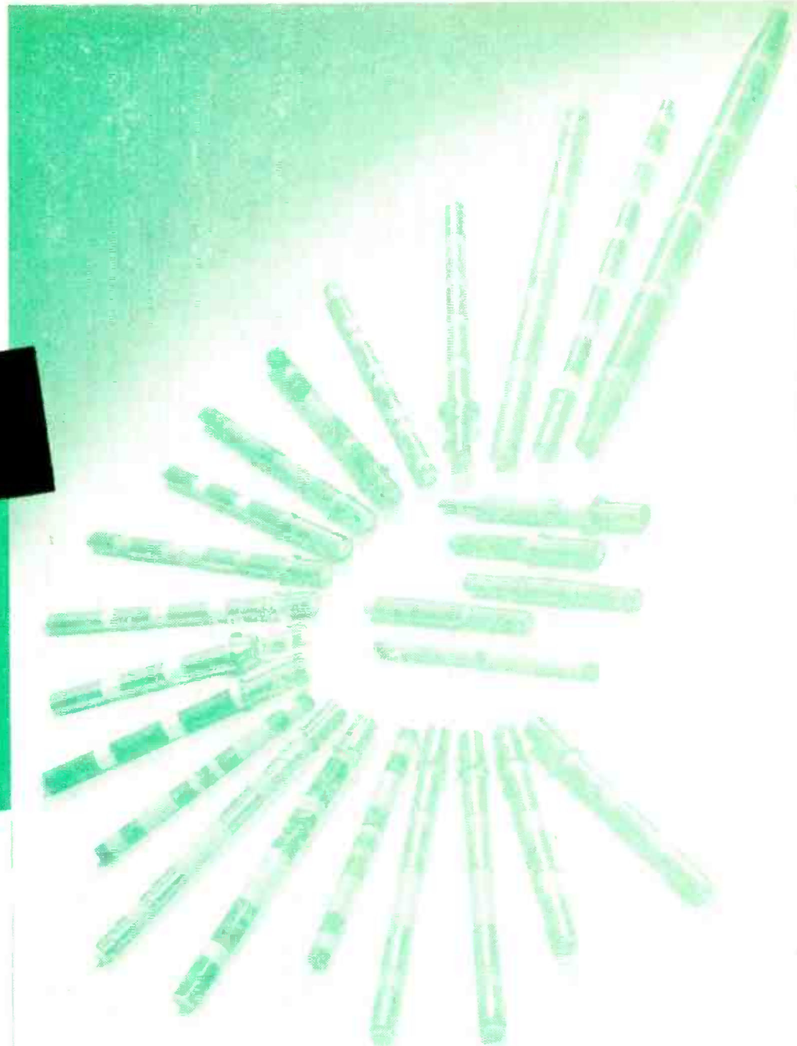

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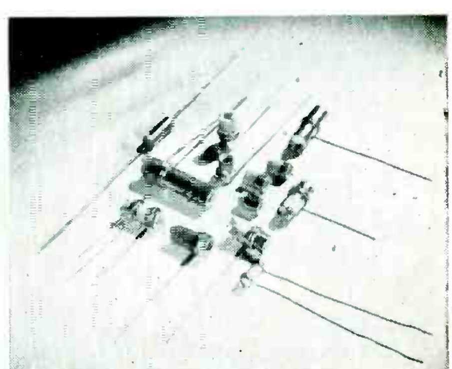

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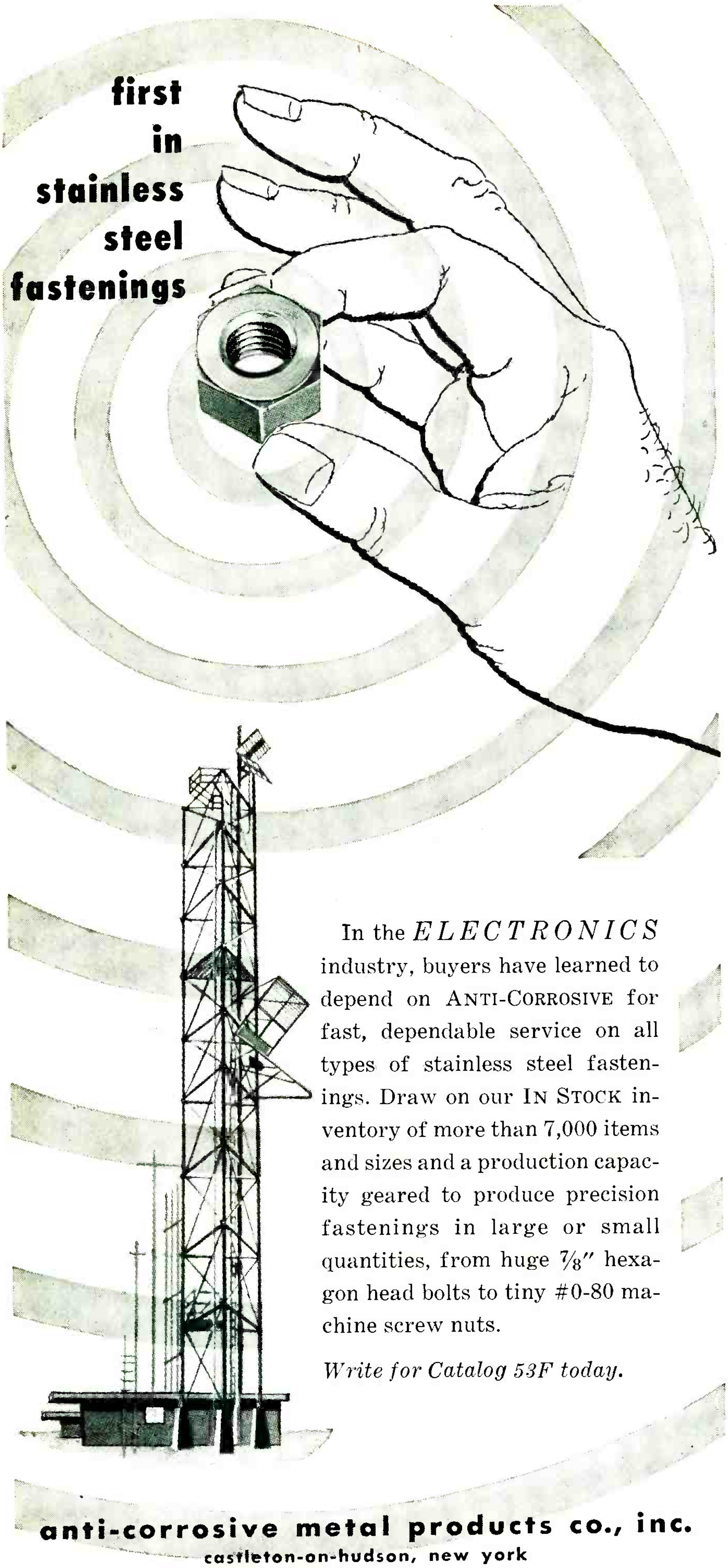

in place of R_1 and the decade box in place of R_2. The decade box is then varied until the distance A returns to its original condition. The effective a-c resistance of the mesh can be read off the decade box.

The vacuum-tube voltmeter is used to read the input and output voltages of the filter. Accuracy of this instrument is ±2 percent of full scale. In the testing of filters the frequency is varied until the desired db point is obtained. The Eput is then used to read the frequency accurately.

The capacitance padder is used in conjunction with the phase-shift panel to determine the characteristics of a particular mesh, or to determine the inductance of a coil.

The two oscilloscopes are used for measuring phase shift and observing the Lissajous pattern of the basic frequency standard and of the audio oscillator. The second oscilloscope is used primarily to adjust rapidly to a multiple of the standard. It is also used to check the drift of the audio oscillator during a test period.

The events-per-unit-time meter used is capable of measuring frequency in digital form from 20 cps to 100,000 cps.

Eput Modulator

The instrument shop at Lenkurt has designed and constructed a unit to extend the frequency response of the Eput meter from 100 kc to 500 kc. This unit is the Eput modulator, shown in block diagram form on Fig. 5. The unknown frequency and a 100 kc standard frequency from the Eput are connected to the two front-panel jacks. If the unknown

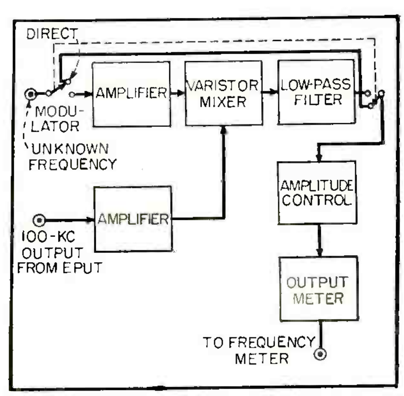

FIG. 5—Block diagram of Eput modulator

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frequency is between 100 kc and 500 kc, the selector is placed in the appropriate position. The unknown is then amplified and mixed in a varistor-type mixer, with the sum and difference frequencies being applied at the low-pass filter. The difference is then passed through the amplitude control to the output monitoring meter. This output is then applied directly to the input to the 100 kc frequency meter. When placed in the direct position, the frequency read on the Eput meter is the actual frequency. When placed in the modulator position, the frequency read on the Eput meter must be increased by a multiple of 100,000.

Assume that the operator wished to set an input frequency of 35,152 cps. Since the dial calibration on the signal generator is held to $\pm\frac{1}{4}$ of a dial division, the operator can rapidly swing the dial controlling the frequency up to 35 kc. By monitoring the Lissajous pattern on the oscilloscope, the operator can rapidly and momentarily set his oscillator to exactly 35 kc. He then makes the slight frequency adjustment on the oscillator while reading the frequency directly on the Eput. When the Eput meter reads 35,152 his test generator frequency is established for the test. During the test a glance at the scope shows, without waiting for the Eput to recycle, if his oscillator has drifted.

In frequency response tests of filters the operator runs his test oscillator out on each side of the mid-band point until the vacuum-tube voltmeter reads a predetermined attenuation ±0.2 db. He then reads the frequency of the signal generator required to obtain this attenuation. The tolerance specifications are tabulated in frequency versus 3-db, 20-db, 40-db points, etc.

Testing Employee Vision

INAUGURATION of a system of testing employee vision eliminated almost 75 percent of the defective units that formerly got past the inspection department at Motorola. Since most inspection work is done at a distance of about 13 inches, good short-range vision is highly essential.

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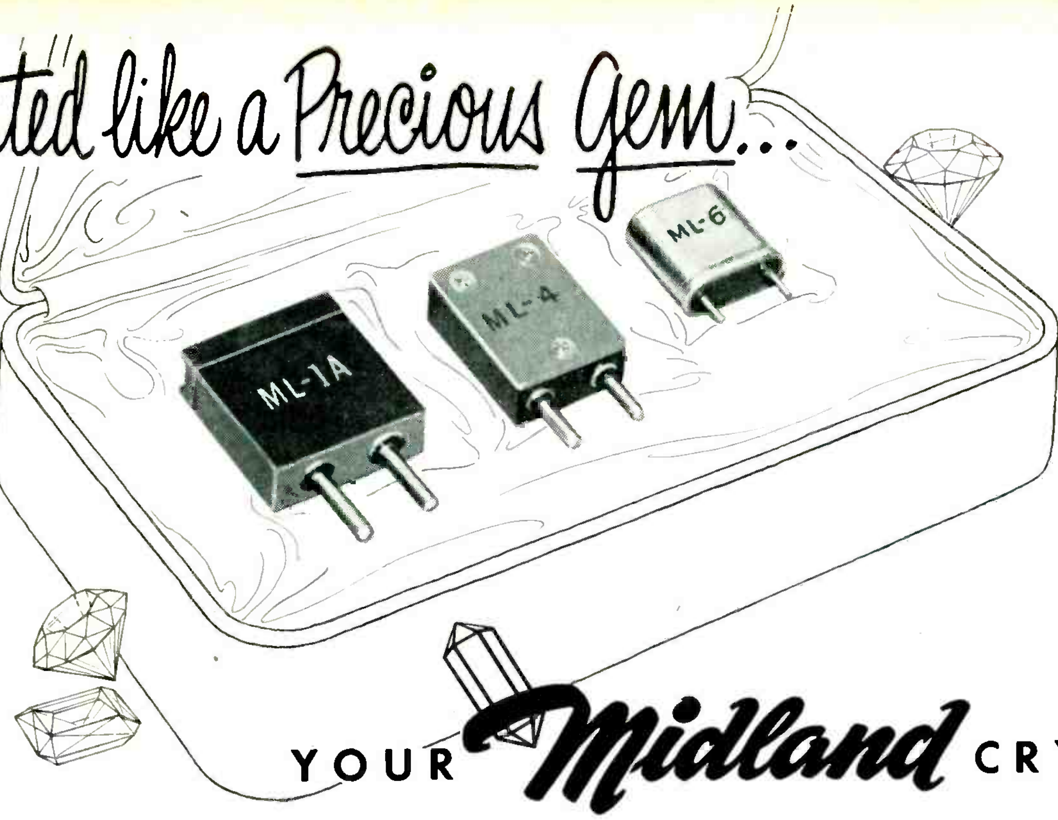

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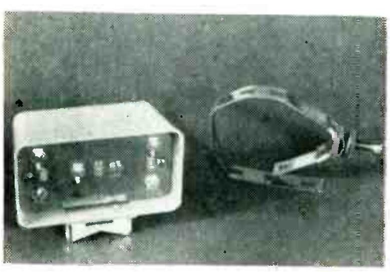
NEW PRODUCTS

Edited by WILLIAM P. O'BRIEN

Control, Testing and Measuring Equipment Described and Illustrated . . . Recent Tubes and Components Are Covered . . . Twenty-Three Trade Bulletins Reviewed

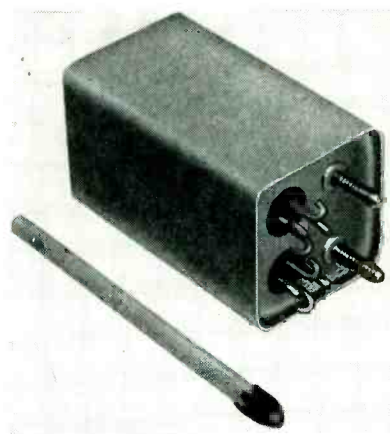
Clipper Diode and Rectifier Tube

AMPEREX ELECTRONICS CORP., 230 Duffy Ave., Hicksville, L. I., N. Y., announces the type 6269, a new, high-vacuum clipper diode and rectifier tube that is only 2 in. long (without leads) and ¾ in. in diameter. It is cooled by liquid-immersion (silicone oil). Although developed primarily for military radar applications, it shows possibilities for use in the high-voltage electronic field where space requirements are critical. Maximum peak voltage is 16 kv and peak current is 250 ma.



UHF-VHF Crossover Network

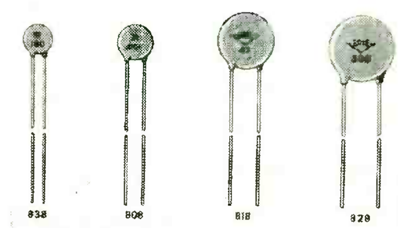
HUGH H. EBY, 4712 Stenton Ave., Philadelphia 44, Pa., has available a new crossover network that combines uhf and vhf into a single antenna system. Only one line to the receiver is required, without the use of switches. The crossover network is an electronic filter that employs a high and low-pass resonant circuit, designed to isolate the vhf antenna and to eliminate interference. It is installed easily on the mast or crossarm of the antenna by a clamp that is supplied. All elements and metal parts are corrosion resisting.



DPDT Relay

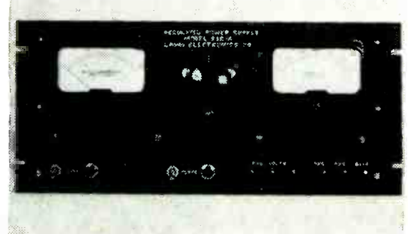
PHAOSTRON CO., 151 Pasadena Ave., South Pasadena, Calif., is now manufacturing a miniature, hermetically-sealed, dpdt relay, weighing only 3½ oz and designed to operate through a wide range of environment. Due to its perfectly counterbalanced features this relay will withstand high acceleration, vibration, shock and tumbling. It meets the shock requirements of MIL-E-5400 and will withstand continuous acceleration of 50 g without malfunctioning. Certain contact combinations can be furnished with a required coil power as low as 20 mw and any relay in this series can be obtained with a coil resistance as high as 15,000 ohms.

OTHER DEPARTMENTS featured in this issue:



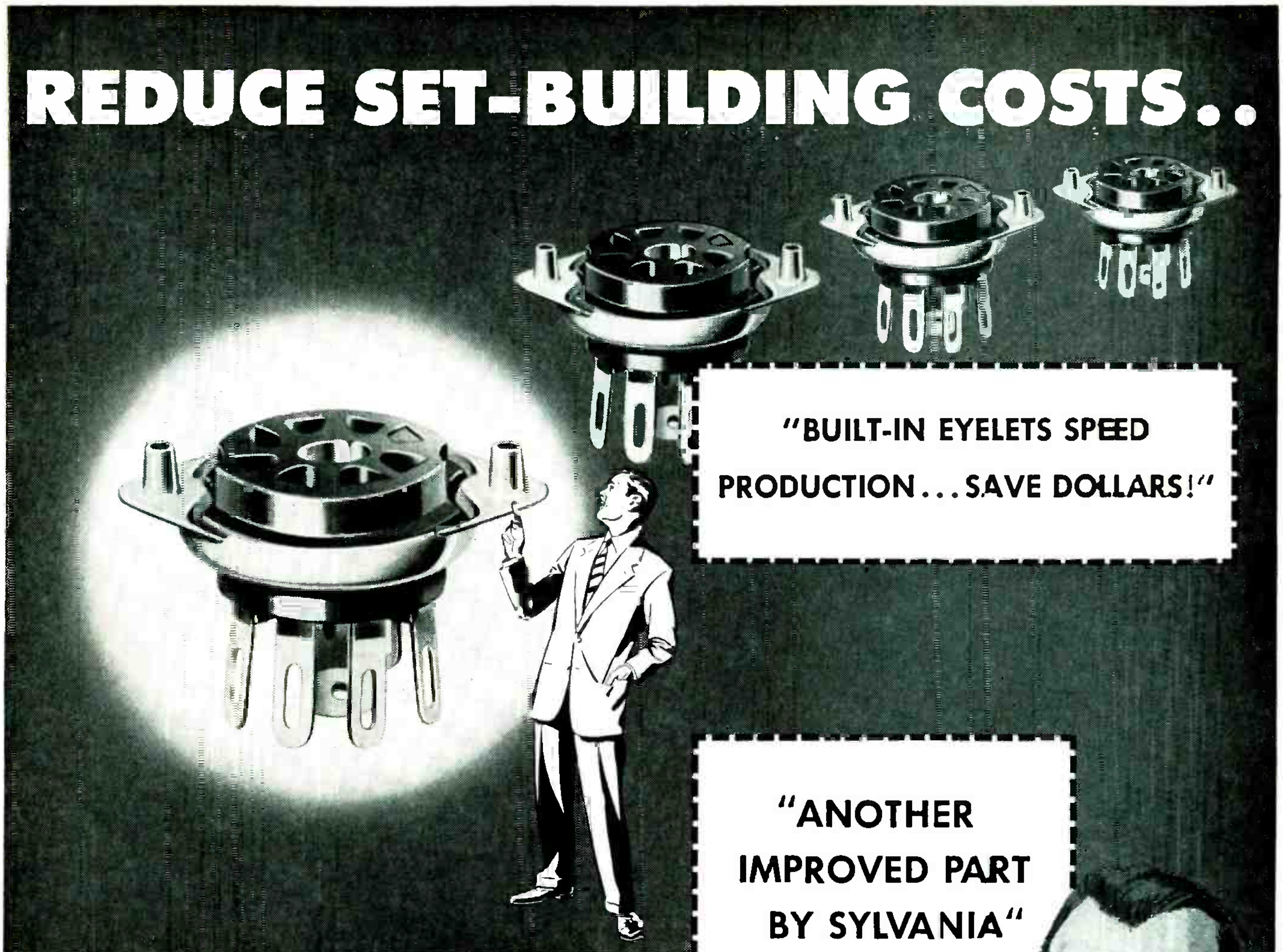
H-V Capacitors

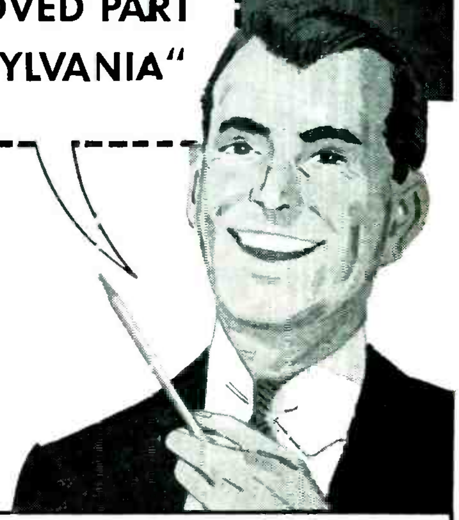
ERIE RESISTOR CORP., Erie, Pa., announces a line of high-voltage disk Ceramicon capacitors. Exhaustive tests for life and other qualities have been carried on over a period of years to establish required dielectric thicknesses for safe ratings. Standard sizes in the new line are ⅜ in., 19/32 in. and ¾ in. maximum diameter. They have phenolic dipped, vacuum-wax-impregnated case insulation. Leads are No. 22 tinned copper wire. Standard d-c working voltage ratings are 1,000, 1,500, 2,000, 3,000, 5,000 and 6,000, with a dielectric strength test of twice the rated working voltage.



Regulated Power Supply

LAWN ELECTRONICS CO., East Freehold Road, Freehold, N. J., is now





with this New Sylvania Integral Eyelet Socket

You'll speed up radio and television set assembly and pare down costs with this new Sylvania socket!

The eyelets are formed into the saddle and *actually function as rivets.* Just 2 simple operations and these sockets are firmly secured to the chassis. You save rivet costs, save time, and get a sturdy, durable, top-quality job.

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These new Sylvania sockets are now available with 7-pin, octal, or 9-pin bases. Insulators are either general-purpose or low-loss phenolic.

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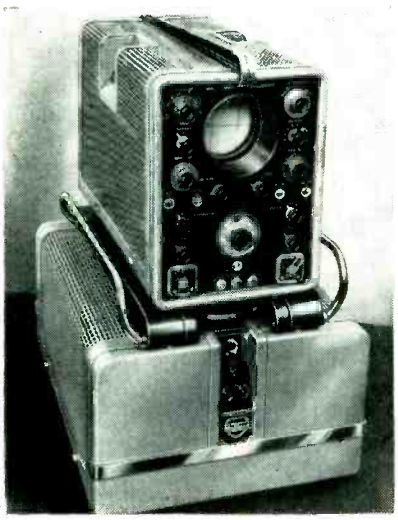
producing the model 603-A regulated d-c power supply. The unit features 0.1-percent regulation, less than 1-mv ripple, and less than 0.5-ohm output impedance. Output voltage is continuously variable from 0 to 600 v with either the positive or negative terminal grounded, and the unit will supply up to 300 ma at any voltage setting. The power supply also features a bias supply variable from 0 to −250 v stabilized to 0.1 v and a 6.3 v, 6 ampere center tapped filament supply. Dimensions of the unit are 19 in. wide × $8\frac{3}{4}$ in. high × $10\frac{1}{2}$ in. deep.

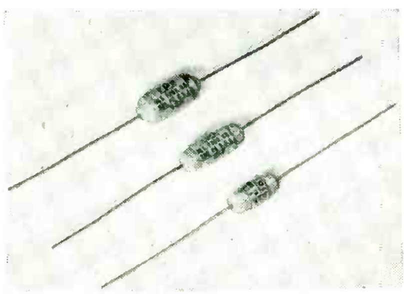


H-F Oscilloscope

INTERNATIONAL ELECTRONICS CORP., 137 Hudson St., New York 13, N. Y. The Mullard type E.7581 oscilloscope is intended to cover a wide field, particularly in connection with tv development, radar and nuclear research. The instrument is built around a c-r tube with a useful screen diameter of 13 cm, and a blue-white trace suitable for visual or photographic work. Final anode voltage of the tube is adequate for normal use with recurrent phenomena. The X and Y amplifiers are as far as possible identical, thus enabling quantitative measurements of phase relationships to be made. Each amplifier has a bandwidth extending from d-c to 15 mc. Provision is made for beam modulation with a special amplifier of 5-mc bandwidth and of sufficient sensitivity to give reasonable modulation from an r-f signal generator.

Multipurpose Signal Generator

HEWLETT-PACKARD CO., 395 Page Mill Road, Palo Alto, Calif. Receiver and amplifier gain, selectivity, sensitivity and image rejection are just a few of the uhf-tv measurements made quickly and easily with the model 612A master-oscillator power-amplifier generator. It offers continuous coverage between 450 and 1,200 mc. Frequency and output are directly set and read on large dials. No charts or interpolation are necessary. Maximum output is 0.5 v into 50 ohms throughout frequency range. The instrument offers broad band modulation up to 5 mc, and has low incidental f-m.

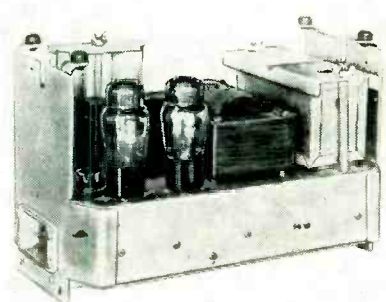


Wire-Wound Resistors

RESISTANCE PRODUCTS CO., 714 Race St., Harrisburg, Pa., has announced new midget precision wire-wound resistors. Their small size and light weight make them self-supporting. This is especially useful in aircraft applications. They are made in the following sizes: $\frac{1}{2}$ in. long × $\frac{9}{32}$ in. in diameter; $\frac{3}{4}$ in. long × $\frac{9}{32}$ in. in diameter; and $\frac{3}{4}$ in. long × $\frac{3}{8}$ in. in diameter. These type C resistors are completely insulated and enclosed in rugged plastic jacket. Steatite winding forms have high insulation with low coefficient of expansion. Windings are impregnated in special compound with protection against dust, salt spray, humidity and mechanical damage.

Air-Cooled Ignitron

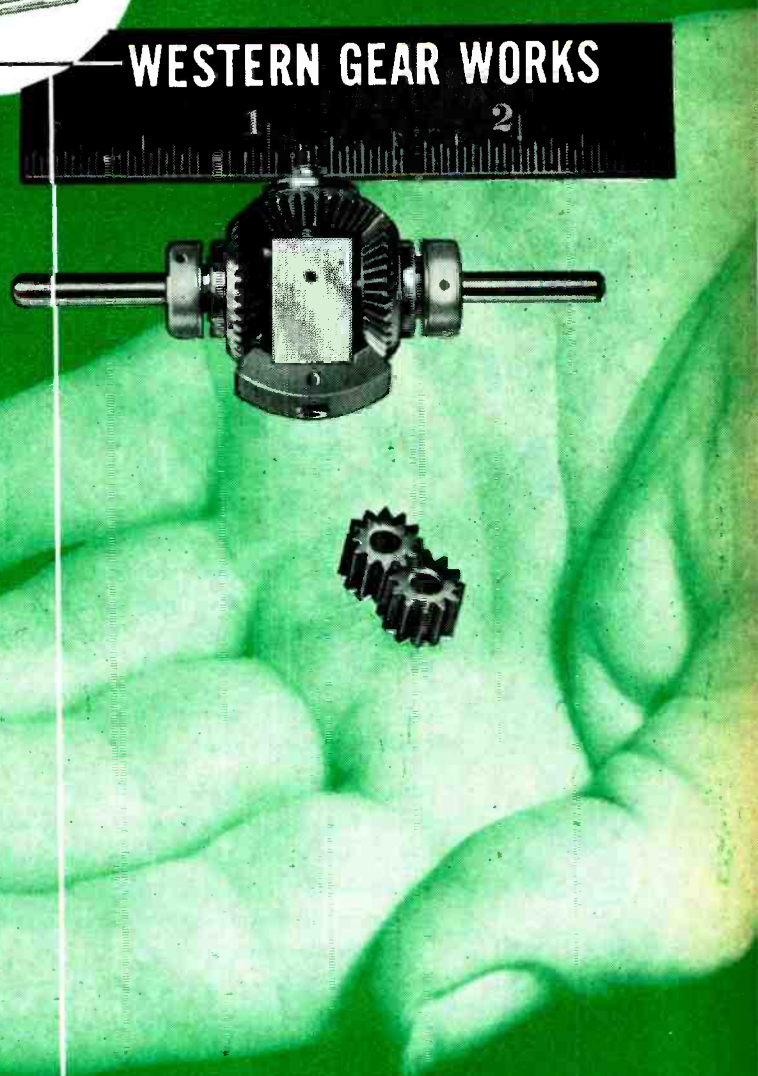
NATIONAL ELECTRONICS, INC., Geneva, Ill., has developed a 56-ampere ignitron that does not require water cooling and is electrically similar to the 5551 size B ignitron tube. The NL-1005 tube is designed for forced air cooling but may be used at reduced ratings with free ventilation. In the welding control application it is the approximate equivalent of a 300-ampere magnetic contactor. The tube is capable of controlling maximum rms demand current of 2,400 amperes at 250 v a-c or 1,200 amperes at 500 v a-c. Maximum average anode current rating is 56 amperes d-c.



D-C Train Power Supply

FEDERAL TELEPHONE AND RADIO CORP,. Clifton, N. J., has developed a 12-v d-c train power supply that eliminates the need for an a-c converter and incorporates a plug-in vibrator cartridge capable of operating both transmitter and receiver. Type M322-1 power supply

Electronic Gears and Gear Drives by — WESTERN GEAR WORKS



Do you have a problem involving the design of gears or gear drives for electronic application? For operation of servo-mechanisms, computors, adjustment of radar or other antenna systems, for auto-tune transmitters? Do you require "just ordinary" gearing or extremely accurate "precision class" gears?

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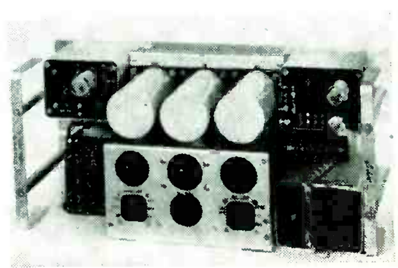
features simplicity of design. This results in improved system-wide performance, and enables substantial savings in initial installation costs and maintenance. The unit's circuit employs a heavy-duty railroad-type plug-in vibrator with full-wave tube rectifiers, weighs 35 lb and has a temperature range of -30 C to $+60$ C. Nominal input voltage is 12.6 v d-c, while the output voltage is rated at 300 v d-c at 110 ma for the receiver and 300 v d-c at 325 ma for the transmitter.

Tiny Mercury Batteries

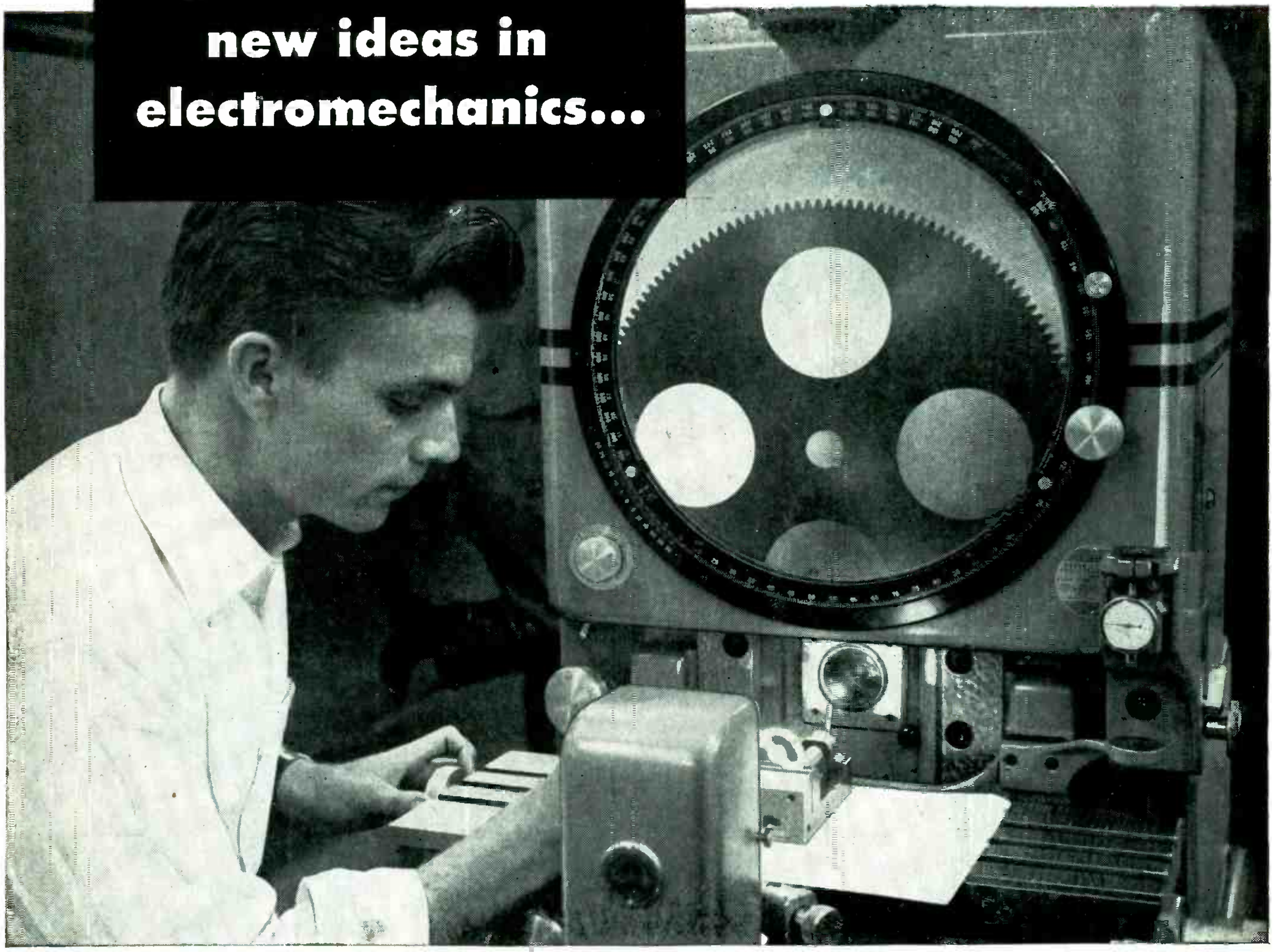
P. R. MALLORY & CO., INC., North Tarrytown, N. Y., has introduced a new line of low-voltage, tiny mercury batteries for junction-type transistor applications, in hearing aids and miniature radio receivers. These Energy Capsules and Power-Pak batteries are designed to meet the specific requirements and characteristics of transistor operations, such as increased energy per unit volume, long service life, constant discharge characteristics and long, corrosion-free shelf life. They maintain a substantially constant voltage and energy output level over wide temperature ranges at current drains from 10 μa to 10 ma.



Carrier Telegraph System

LENKURT ELECTRIC CO., INC., County Road, San Carlos, Calif. Either physical or carrier-derived

geared to new ideas in electromechanics...



AT NORTH AMERICAN AVIATION

One of the big reasons for the success of North American Aviation's Electromechanical Department is its painstaking attention to small details—like the millionth of an inch on a gear or the hairline accuracy of the tiny part shown on the contour projector. These small details are some of the factors contributing to the complex missile guidance and automatic control systems which are being designed and developed by this department for projects which stagger the imagination.

North American's fine reputation for pioneering in far-reaching technical fields is part of the answer to the question: "Why do so many talented engineers choose North American as a place to work?" Another is the extremely advanced equipment – much of it invented and built by North American itself—available to the engineers who work here.

In addition to North American's popularity as a place to work, there are always fine career openings for imaginative scientific minds. If you like theory, you will discover an exciting and secure future in the fields of operations analysis, advanced dynamics, kinematics, noise, error or information theory, systems engineering, statistical quality control or servo analysis.

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voice circuits can be economically divided into a number of telegraph channels with the type 24C amplitude-modulated carrier telegraph equipment. Up to 18 duplex telegraph channels can be derived from a single 4-wire circuit, or up to 9 duplex channels can be derived from a single 2-wire circuit with this equipment. The derived channels can be used for teleprinter service, remote control and other telegraphic indication. Frequency allocations and levels are compatible with other widely used carrier telegraph systems. The channel terminal panel includes transmitter, receiver and relays. Jacks and controls for adjusting bias and loop current are easily accessible on the front of the panel.

Small Pneumatic Transmitter

THE BRISTOL CO., Waterbury 20, Conn., has announced a miniature pneumatic transmitter for measuring and transmitting readings of temperature, pressure, vacuum, differential pressure and liquid level to recording, indicating, and controlling receivers, including miniature type receivers. Transmission is by means of air pressures of between 3 and 15 psi that have a direct relation to the measured quantity. The series 650 transmitter uses standard Bristol measuring elements and a simple transmitting mechanism with only one pivot and no flexures. It is sensitive to extremely small changes in the

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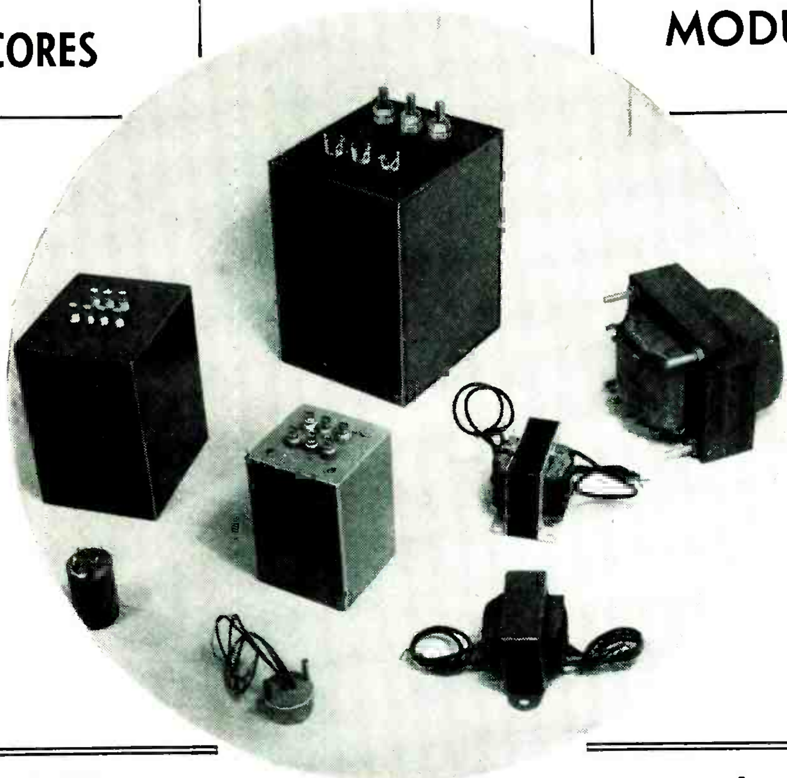

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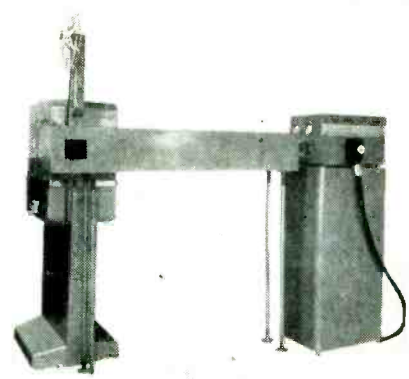
measured value, as little as 0.03 percent of range, including reversal. It weighs $7\frac{1}{2}$ lb, is weatherproof, can be installed in any location and will operate in any position.

Modulator

BRADLEY LABORATORIES, INC., New Haven, Conn. A copper-oxide rectifier with a low threshold voltage rating is being used as a modulator in an electronic unit used in aircraft. The hermetically sealed modulator is relatively unaffected by subzero temperatures, high altitudes or unequal atmospheric pressures. The modulator, approximately 1 in. $\times$ $1\frac{7}{8}$ in. $\times$ $\frac{3}{8}$ in., has no moving parts. Current and temperature characteristics are balanced to better than 1 percent. The modulator operates over a range of -65 to $+85$ C and at the audio frequencies.



Film Multiplexer and Shadow Box

FEDERAL TELECOMMUNICATION LABORATORIES, INC., Nutley, N. J., has developed a new film multiplexer and shadow box designed for use with image orthicon camera chains. The FTL-263A consists of a light-tight wooden shadow box

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TABLE OF MAGNETIC PROPERTIES OF FERRAMICS

PROPERTIES	UNITS	A-106	B-90	C-159	D-216	E-212	G-254	H-419	H-1102	I-141	J-472
Initial Perm. at 1 mc/sec	—	20	95	250	410	750	410	850	550	900	330
*Max. Perm.	—	130	183	1100	1030	1740	3300	4300	3800	3000	750
*Sat. Flux Density	Gauss	1500	1900	4200	3100	3600	3200	3400	2800	2000	2300
*Residual Mag.	Gauss	1000	830	2700	1320	1350	1050	1470	1500	700	1650
*Coercive force	Oersted	5.0	3.0	2.1	1.0	.65	.25	.18	.55	.30	.80
Temp. Coef. of initial perm.	%/°C	.15	.04	.40	.30	.25	1.3	.05	.80	.50	.22
Curie Point	/°C	300	260	330	165	160	160	150	125	70	185
Vol. Resistivity	ohm-cm.	[illegible]x10^7	2x10^5	2x10^6	3x10^7	4x10^5	1.5x10^8	1x10^4	2x10^4	2x10^5	5x10^7
Loss Factor: At 1 mcs/sec	—	.0005	.00016	.00007	.00005	.00008	.00008	.00030	.0004	.0002	[illegible]
At 5 mcs/sec	—	.0007	.0011	.0008	.0012	.002	.00075	.00155	.001	.005	.0004

*Measurements made on D.C. Ballistic Galvanometer with Hmax = 25 oersteds. Above data based on nominal values

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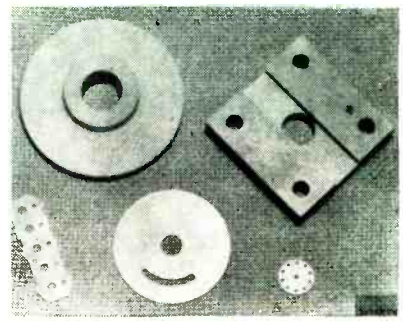
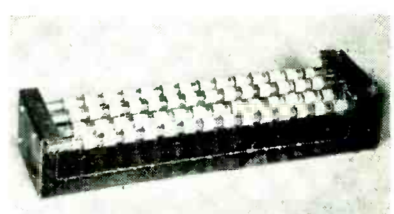
with apertures for accepting the outputs of two 16-mm projecters, an optical mirror multiplexer, a high-resolution screen, and an aperture for the camera that is focused on the screen. The mirrors are adjustable in three planes for best possible operation, and the entire unit is mounted on four adjustable metal legs to permit the unit to be properly leveled. An important advantage of the unit is the total overall length which allows placement of the shadow box through an opening in a wall so that either a standard film camera or a studio camera may be used.



Melamine Laminate

SYNTHANE CORP., Oaks, Pa., is producing a new glass-mat melamine laminate that combines high fire and arc resistance with good mechanical and chemical properties. Designated as G-8, the new laminate is available to suppliers of electrical and power equipment at a considerable saving under the cost of the continuous filament glass base materia (INEMA-grade G-5) whose electrical properties it matches. The new material is laminated in thicknesses from $\frac{1}{16}$ in. upward. Sheet sizes are standard 36 in. × 36 in.



Lumped Constant Delay Lines

THE MAY ENGINEERING CO., 6055 Lankershim Blvd., North Hollywood, Calif., offers low-cost laboratory-built lumped-constant delay

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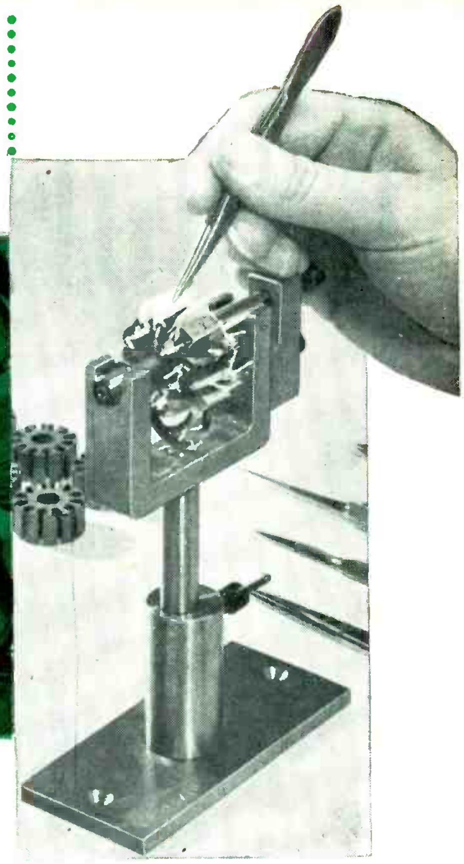

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Eclipse-Pioneer Division of Bendix Aviation, Teterboro, N. J., through development and manufacture of instruments and accessories, has been a major factor in the rapid expansion of the Aviation Industry. Although their production is now more than 5 times its pre-Korea level, this growth has been accomplished without sacrifice in the quality of its precision products.

To insulate stators of Autosyn Synchros, Eclipse-Pioneer specifies and uses Natvar varnished cambric because of its consistently good electrical and physical properties.

All Natvar flexible insulations are dependably uniform, no matter when or where purchased. They are immediately available either from your wholesaler's stock or direct from our own.

MIGHTY MITES! In spite of their size, Autosyn Synchros must operate with extreme reliability over a wide temperature range. Stators are being assembled in approximately 150 varieties at Eclipse-Pioneer, and strict adherence to engineering specifications is a must. They are insulated with strips of Natvar bias cut varnished cambric because of its uniformly high dielectric strength and flexibility.

Natvar

Natvar Products

- Varnished cambric—straight cut and bias
- Varnished cable tape
- Varnished canvas
- Varnished duck
- Varnished silk
- Varnished special rayon
- Varnished Fiberglas cloth
- Silicone coated Fiberglas
- Varnished papers
- Slot insulation
- Varnished tubing and sleeving
- Varnished identification markers
- Lacquered tubing and sleeving
- Extruded plastic tubing and tape
- Extruded plastic identification markers

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NATVAR CORPORATION

FORMERLY THE NATIONAL VARNISHED PRODUCTS CORPORATION

TELEPHONE RAHWAY 7-8800 CABLE ADDRESS NATVAR: RAHWAY, N. J.

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lines built to close tolerances in open frame construction. Circuit designers can test these lines in their experimental equipment and determine final specifications requirements before quantities of delay lines are ordered. Accessibility permits great flexibility in choice of delay by tapping the line. Illustrated is a typical line with 0.05-μsec rise time, 300 ohms characteristic impedance and 1.0-μsec delay. Individual sections are constructed to permit adjustment of the filter network parameter. Low attenuation, low rise time and other features are realizable in these delay lines.

Decade Amplifier

HERMON HOSMER SCOTT, INC., 385 Putnam Ave., Cambridge 39, Mass. The new type 140-A decade amplifier is a miniaturized laboratory voltage amplifier with 1-mc frequency response and stabilized voltage gains of 10 and 100. Typical applications are to extend sensitivities of oscilloscopes, vtvm's and other indicating or recording devices. A low-flux-density transformer permits the amplifier to be used without effect on nearby equipment operating at low signal levels. The amplifier is entirely resistance coupled, and no peaking coils or compensating networks are used that might cause undesirable transient effects. Frequency response is flat from 2 cps to 1 mc, ±0.1 db. Equivalent input noise is less than 8 μv in the X100 position. Maximum undistorted output voltage is 40 v. Maximum ouput current

is 1 ma. Input impedance is 1 megohm shunted by 10 μμf.

Electric Timer

VOCALINE CO., OF AMERICA, INC., Bristol Motor Division, 24 Coulter St., Old Saybrook, Conn., has developed a sturdy, reliable electric timer with an extra high rating (1,650 w) for use as an automatic time control attachment for electric heating pots, tumbling machines, air conditioning and humidifiers, or for controlling the break-in period for motors and electronic equipment. The unit called Two-Timer model 2T-20 can be preset to turn on or off a properly rated device plugged into it at any time up to 20 full hours (or fraction thereof) ahead. It is designed for use with 105–120 v, 50–60 cycle current, rated load 15 amperes at 110 v. Powered by the model 200 Bristol Circle B synchronous timing motor, the complete unit weighs 1 lb and measures 2 in. × 2 in. × 4 in.

Isotope Comparator

THE VICTOREEN INSTRUMENT CO., 5806 Hough Ave., Cleveland 3, Ohio. The isotope comparator is a high-efficiency radiation indicator designed primarily for medical radio-

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Klincher LOCKNUT

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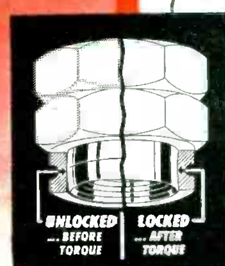
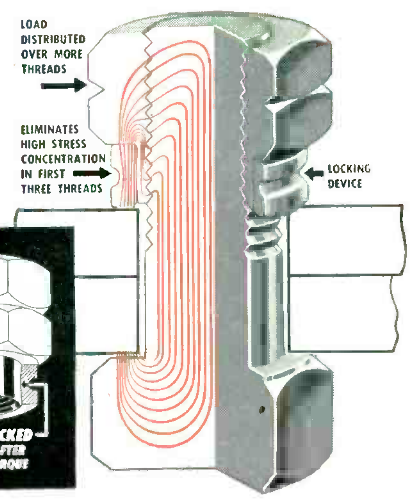
High Temperature
Fastening up to

1600°

. . . particularly where high frequency vibration, tensile strength and re-usability are factors!





Reasons are many why Klincher is getting first call on more and more of the really tough fastening jobs in the Electronics industry. For instance, on critically vital thermocouples Klincher Locknut permits use of desired torques without causing stud failure or unnecessary wear of stud threads.

In rectifiers, too; in chassis connections and terminal posts . . . wherever bolts studs or axle shafts must be preserved, Klincher Locknuts excel.

Inquiries invited regarding specialized locknut problems. Write for data and experimental samples, giving size and application.

KLINCHER ADVANTAGES:

Spin freely down to work. Stays positively locked.

After breakaway, nut spins off freely, ready for reuse, without impairment of locking efficiency.

Only one piece to stock and handle . . . saves time installing and removing.

Ideal for standard and power wrenches.

Manufactured in stainless steel and other materials.

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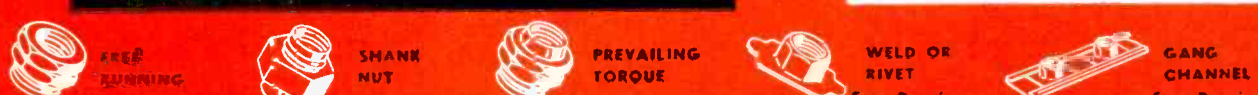
2153 HILLSIDE AVE. INDIANAPOLIS, INDIANA



National Fine and National Coarse Threads

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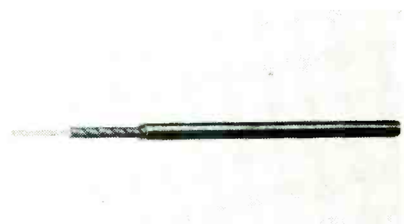
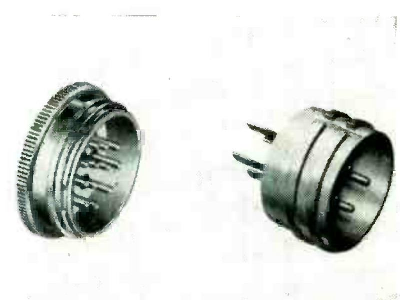
active tracer work and useful in other applications. Ten Geiger tubes banked in parallel on the rear panel give high counting efficiency over six ranges of sensitivity necessary for making many rapid comparisons of samples with a control standard, directly in percentage of the stronger source. The unit may be carried about the laboratory for quick surveys. A sliding shield is provided for beta discrimination.



Ignition Cable

General Electric Co., Bridgeport 2, Conn., has announced Bureau of Ordnance approval for its insulated, high-tension ignition cable under specification MIL-C-3162 as type 1 grade C, class 2. This cable, which is used for ignition systems of internal combustion engines in aircraft, automotive vehicles and marine service, has a temperature range of 250 to −65 F, and must remain flexible even under the severe cold conditions encountered by modern, high-altitude flying ships. The new cable has a stainless steel conductor with a synthetic rubber insulation. Over the insulation is a glass-reinforcing braid and an overall low-temperature sheath. The cable is available in 5-mm size.



Hermetically-Sealed Connectors

Cannon Electric Co., 3209 Humboldt St., Los Angeles 31, Calif., has added the KH and RKH connector

Not even 8,650 jarring blows a minute can shake the tenacious grip of an EVERLOCK washer in its role as a vital part of the Master Tamper. On *any* job its alternating chisel edges maintain a never-failing BITE into both the face of the work and the nut, under powerful spring tension. Now available in four standard types; or special—made to your precise specifications. When ordering screw-washer assemblies from screw manufacturers, always specify EVERLOCK washers for dependability and fast service.

DOUBLE CHISEL EDGES LOCK CONNECTIONS 2 WAYS

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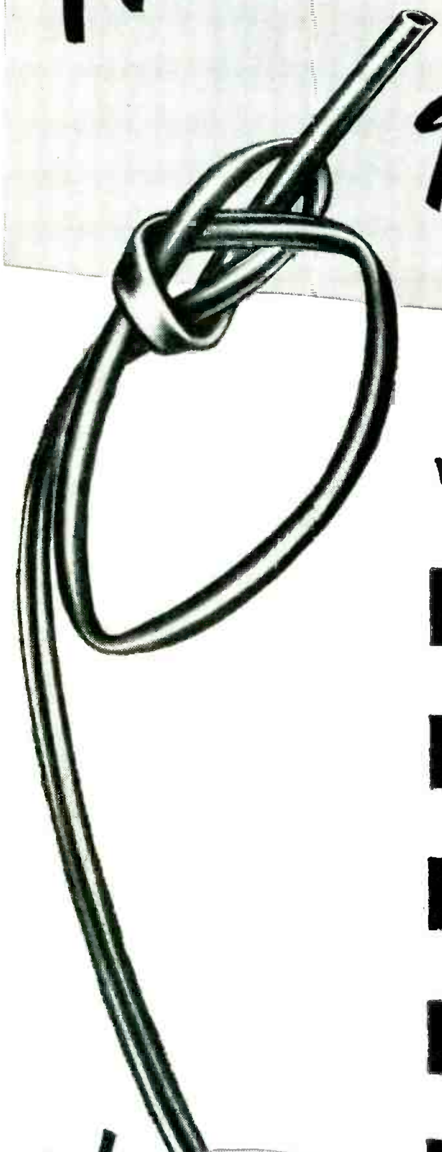
series to its hermetically-sealed lines. The new plugs and receptacles are made for relays, position indicators, direction finders, tachometers and the instrument industry in general. Chief feature of their steel shell is the heavy-duty special Acme thread. The KH receptacles mate with standard K plugs, and RKH plugs with standard RK receptacles. The hermetic seal is achieved by the special vitreous insulation around the steel contacts and fused to the shell. The KH connectors will withstand 200 to 900 psi, depending on size and contact complement. Temperature operating range varies from —320 F to +600 F., emergencies to 1,000 F if mating fitting and finish are expendable. All MIL-C-5015 vibration and thermal shock tests are met.

Comparison Bridge

GENERAL RADIO CO., 275 Massachusetts Ave., Cambridge 39, Mass. Accurate and simple production tests are possible on the new general-purpose type 1604-A comparison bridge. With a basic accuracy of 0.1 percent, the bridge can be used for direct comparison of resistors, capacitors and inductors over the wide impedance range of about 2 ohms to 20 megohms. Two impedance-deviation ranges, ±5 and ±20 percent, are provided. Dissipation-factor differences are also indicated. The bridge is completely self-contained with a cathode-ray visual detector and an oscillator operating at either 1 kc or 5 kc. Operation is from the a-c line. The point at which the bridge is grounded can be switched, so that measurements can be made with the

New ELECTRICAL TUBING gives *Better Performance* 5-WAYS



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VARGLAS Tubing is now impregnated with G. E. PERMAFIL

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1 BETTER DIELECTRIC RETENTION

. . . 7,000 volts — and keeps its high dielectric value under toughest service conditions.

2 BETTER FLEXIBILITY

. . . twist it — tie it — bend it — wrap it! No crack — no peel — no dielectric loss.

3 BETTER HEAT RESISTANCE

. . . withstands more than 2,000 hours at 105° to 110° C — 1,000 hours at 125° C — extensive periods even at 150° C.

4 AVAILABLE IN COILS

. . . so that you can cut the length you need — no more, no less, no waste. Standard colors — wide range of sizes — meets or exceeds all A.S.T.M. specifications.

5 CAN BE AFTER-TREATED

. . . in baking and varnishing operations. Reacts better than most oleoresinous materials and other synthetic coated tubings.

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Please send me full information as well as a free sample of your new Varglas Tubing impregnated with General Electric Permafil. I am particularly interested in samples suitable for ....

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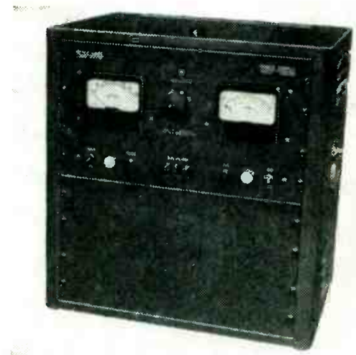
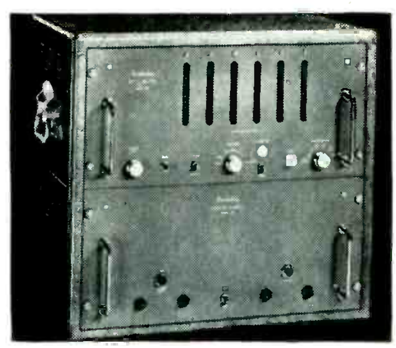


Voltage-Regulated Power Supply

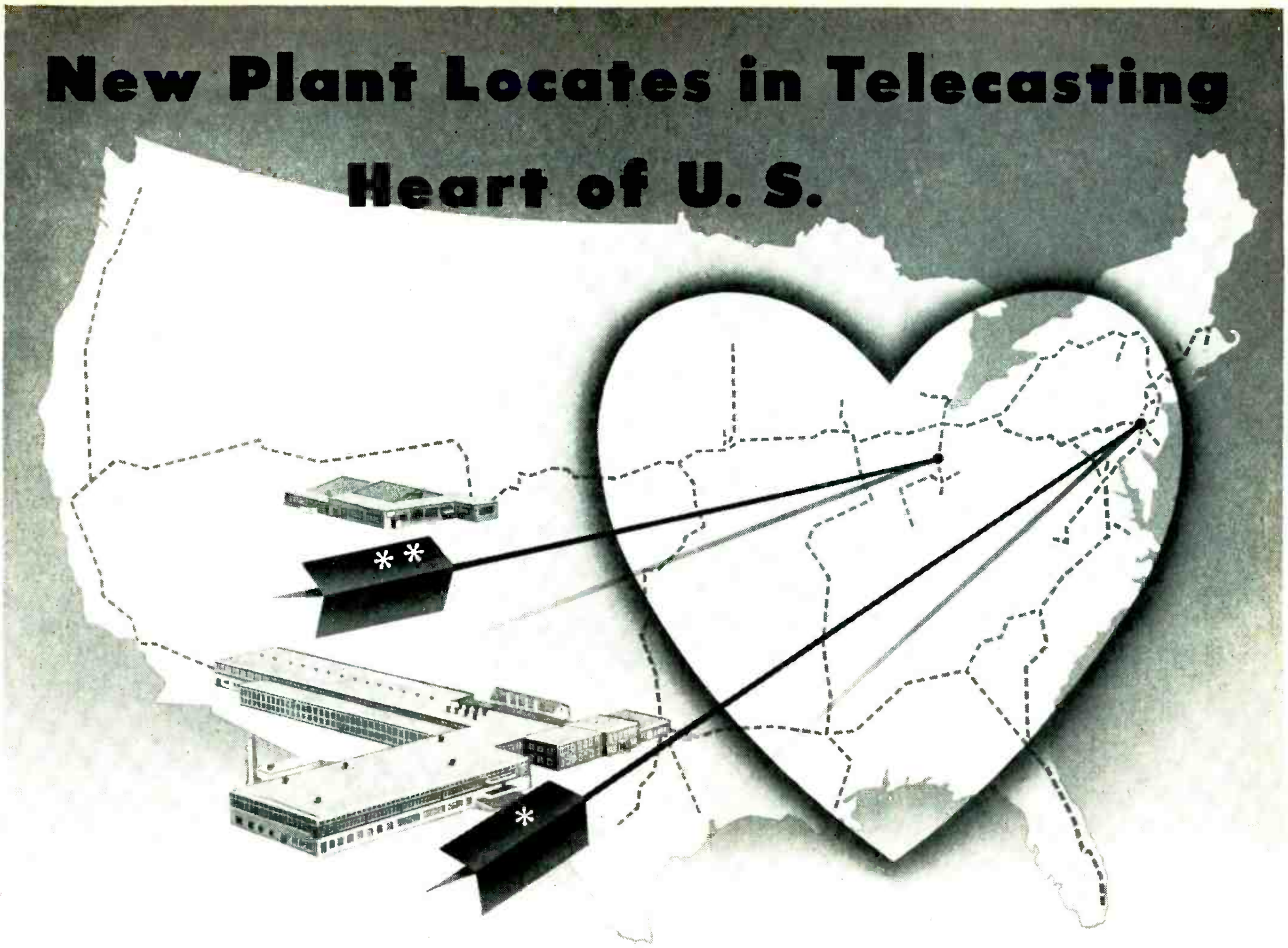
KEPCO LABORATORIES, INC., 131–38 Sanford Ave., Flushing 55, New York. Model 1520 features a regulated h-v d-c power supply with excellent regulation, low ripple content and low output impedance. The h-v supply is continuously variable from 0 to 1,500 v and delivers from 0 to 200 ma. In the 30 to 1,500-v range the output voltage variation is less than 0.5 percent for both line fluctuation from 105 to 125 v and load variation from minimum to maximum current. Ripple voltage is less than 30 mv peak to peak.



EPUT Meter

BERKELEY SCIENTIFIC DIVISION OF BECKMAN INSTRUMENTS, INC., 2200 Wright Ave., Richmond, Calif. Model 5558 events-per-unit-time meter is a high-speed electronic counter combined with an accurate time base to provide an instrument that will automatically count and display the number of events that occur during a precise time interval. The EPUT will count events occurring either regularly or with ran-

New Plant Locates in Telecasting Heart of U. S.



Things are humming in Wapakoneta, Ohio. There, about 10 miles west of the Dayton-Toledo coaxial cable is the new plant of Superior Tube Company. This plant complements the production capabilities of the Superior main plant, takes care of your ever-increasing demands for television and military purposes.

Superior nickel cathodes are made in a wide range of types, O.D.'s, wall thicknesses and lengths—with or without bead—and in active, normal and passive alloys, depending upon the application and the degree of emission required.

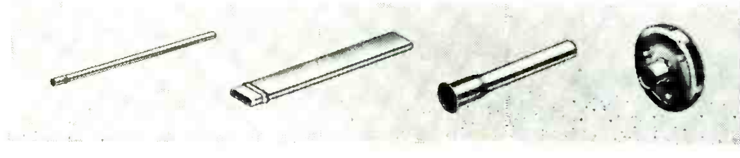
Superior produces both Seamless and Lockseam† nickel cathodes. For many electron tubes Lockseam—made by a patented process from strip stock—has an economic advantage. Superior Seamless shows great advantages in uniformity, close tolerances, and small O.D. for sub-miniature tubes.

Superior equipment is more than matched by the care taken in production. Each melt of alloys is laboratory-checked for emission and performance. Many extraordinary precautions are taken in manufacture to avoid contamination.

Before you order cathodes, first see what Superior engineering, quality, and delivery can do for you.

*Main Superior Tube plant at Norristown, Pa.
**NEW Superior Tube plant at Wapakoneta, Ohio

Many other types of nickel cathodes—made in Lockseam† from nickel strip, disc cathodes, and a wide variety of anodes, grid cups and other tubular fabricated parts are available from Superior. For information and Free Bulletin, address Superior Tube Company, Electronics Division, 2500 Germantown Avenue, Norristown, Pa.



Seamless Nickel Cathode Round, single bead, .045" O.D. x .002" Wall. 27 mm long.

Lockseam† Nickel Cathode Rectangle, single bead, .030" x .100" O.D. x .0021" Wall. 13 mm long.

Seamless Monel, Expanded and flanged. (Exp. to .165"/.168" I.D.—Fl. to .230") .139 O.D. x .005" Wall x 1.100" long.

Disc Cathode .121" O.D. .312" long.

Superior
THE BIG NAME IN SMALL TUBING

All analyses .010" to ⅝" O.D.

Certain analyses (.035" Max. wall) up to 1⅝" O.D.

†Manufactured under U.S. Patents

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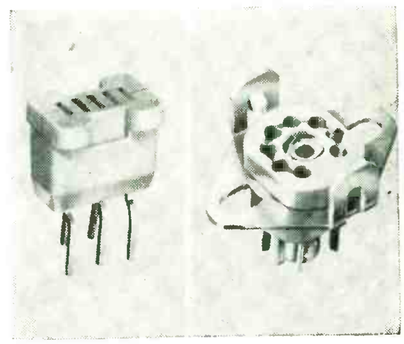
dom distribution at rates from 20 to 1,000,000 events per second with an accuracy of one count. The result is displayed on the illuminated number panels of 6 decimal counting units and read directly in digital form. Because of its direct readout feature with no lights to add or interpolate it is ideally suited for production line operation by relatively unskilled personnel.



Subminiature Tube Sockets

HUGH H. EBY, INC., 4722 Stenton Ave., Philadelphia 44, Pa. A new line of standard subminiature tube sockets is available in two styles. The rectangular socket is made in 5, 6, 7 and 8 pin with contacts in two lengths for conventional and printed circuit application. The round style is available with or without saddle. Both sockets are produced to recognized industry standards and dimensions. Contacts are beryllium copper silver plated, tin dipped, or gold flash over silver. Bodies are of low-loss mica-filled phenolic, and the saddle is nickel-plated brass.

TV Picture Tubes

THE RAULAND CORP., 4245 N. Knox, Chicago, Ill., has announced two new 21-in. rectangular tv picture tubes with spherical faceplates. The 21YP4 has electrostatic focus and magnetic deflection requiring a focusing voltage from —0.4 to —2.2 percent of the anode voltage. The 21ZP4A has magnetic focus and magnetic deflection. Both tubes have gray filter faceplates that improve picture contrast. Each type tube has external conductive coating that acts as filter capacitance. Each also uses the company's indicator ion

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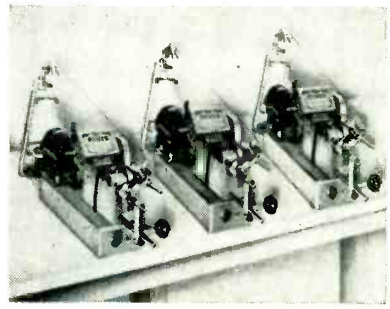
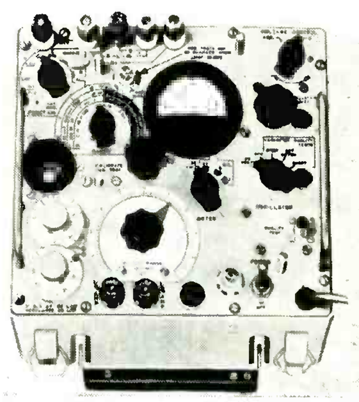
trap gun that provides outstanding picture quality with a minimum of installation servicing time.



Fine Wire Bobbin Winder

GEO. STEVENS MFG. CO., INC., Chicago 30, Ill., has announced the model 111-A miniaturized high-speed fine-wire bobbin winder. An automatic counter permits instant resetting of the winding cycle by merely touching a lever. Dimensions of the unit are 21¾ in. long × 8 in. wide × 12 in. high. Net weight is 42 lb. A slow-start feature avoids possibility of wire breakage. Top winding speed is 7,000 rpm. The model 111-A winds all types of random-wound bobbin coils, solenoids, repeater coils and precision, noninductive resistors.



Inductance Bridge

CLOUGH-BRENGLE CO., 6014 Broadway, Chicago 40, Ill. Model 712 capacitance - resistance - inductance bridge is used to measure the capacitance of paper, mica, electrolytic, ceramic and air capacitors; the stray capacitance of bushings, switches and wiring; the dissipation factor of capacitances; the leakage current of electrolytic capacitors; the resistance of composition and wire-wound resistors; the inductances of coils and transformers; the storage fac-

SMALL METAL STAMPINGS

PATTON-MacGUYER

For over 33 years P-M has been a dependable source for small metal stampings. An extensive modern plant, complete equipment, specialized engineering experience and toolmaking skill combine at P-M to produce stamped metal parts accurately, economically, promptly. Moderate die charges. Modern facilities for large volume production. Special stamping problems are gladly accepted; recommendations for the most efficient and economical solutions are made promptly. Send prints for your next stamping job to P-M.

TERMINALS FOR ELECTRIC WIRES

Being long experienced specialists in the terminal field, we have dies to produce over 400 different kinds of separate terminals, and every modern facility to meet your standard or special requirements. We also provide terminals in continuous form, supplied on reels, with machine for attaching and soldering tandem terminals to wires in one continuous operation. Send for folder.

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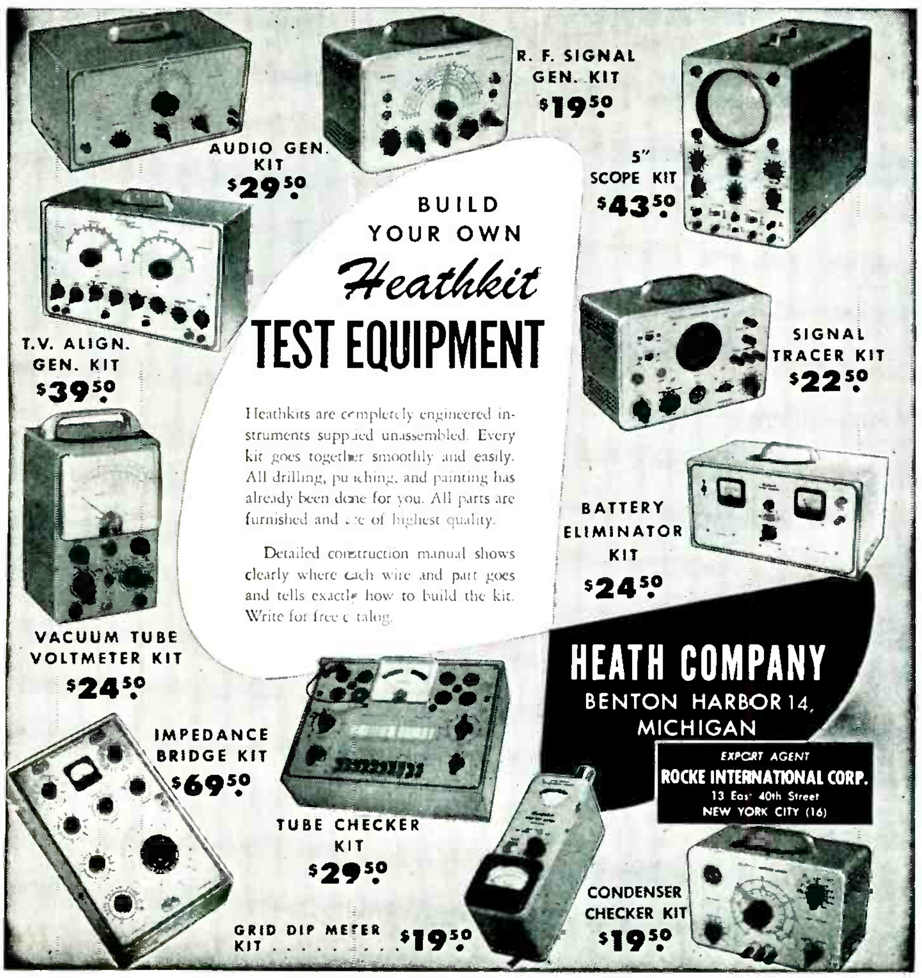

they can't shake loose...

HOLD THEM TIGHT with a

BIRTCHER CLAMP

There is a Birtcher Clamp . . . *or one can be designed* . . . for every tube you use or intend to use.

Regardless of the type tube or plug-in component your operation requires . . . and regardless of the vibration and impact to which it will be subjected . . . a Birtcher Tube Clamp will hold it securely and *rigidly* in place.

Catalog and samples sent by return mail.

The BIRTCHER CORPORATION
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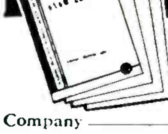

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Company ______________ E-4-3
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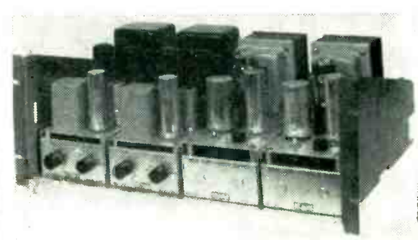
Address ______________
City ______________ State ______________

tor (Q) of inductances; the turns ratio of transformers; the insulation resistance of capacitors, bushings and barriers; and the quality of capacitors already wired into a circuit.

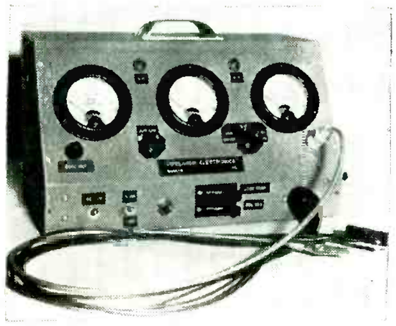
Dot Generator

RESEARCH ELECTRONICS, Roslyn, Pa. Model 102 pin-point dot generator is a new type burst pulse generator for laboratory or production testing. The 65-v, 0.05-μsec output pulse width is determined by a plug-in pulse transformer, and is controllable in burst duration from approximately 10 to 150 μsec at an adjustable 315,000-pps rate. This new tool is of special interest in the development and manufacture of tv receivers, deflection yokes, focus devices, ion traps and picture tubes.



Plug-In Audio Amplifiers

GATES RADIO CO., Quincy, Ill., has announced a new line of versatile plug-in audio amplifiers. An idea of the compactness of the plug-in units may be had from the fact that eight of the new preamplifier units occupy only 7 in. × 19 in. panel space. The same space will hold two program amplifier units and two regulated power-supply units. Other features of the new assemblies include self-aligning plugs and receptacles; simplified rear wiring, since cable harness clamps and troughs are all a part of the panel and shelf assembly; a new low in noise and distortion characteristics; better shielding; and greater flexibility.



CRT Test Set

RESEARCH ELECTRONICS, Roslyn, Pa., has perfected a portable crt test set for all tv picture tubes and magnetically deflected radar tubes, which measures all characteristics including emission, cutoff, gas ratio, heater-cathode leakage positive and negative, grid-cathode leakage, A_2 leakage and G_2 leakage. It features electronically controlled and regulated circuits of high accuracy and sensitivity, but is simple and rugged enough for warehouse and portable use. It operates from standard 115 v a-c lines.

Precision Phasemeter

DELTRON INC., P.O. Box 192, Glenside, Pa. Model 100A phasemeter is a 2-cycle to 200-kc unit designed for use in the audio, ultrasonic, servomechanism, industrial control and acoustical fields for determination of phase characteristics and time relationships. It is applicable to the power field and general laboratory use for power factor measurements and electronic component testing. Error is less than 4 deg from 20 cycles to 20 kc; increasing gradually to 8 deg above

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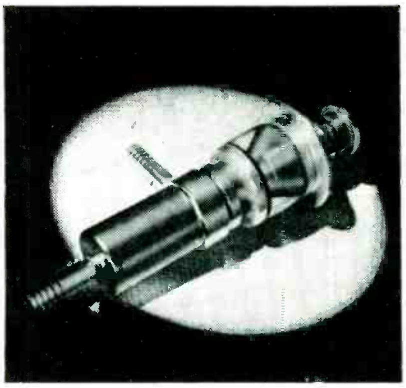
20 kc and below 20 cycles. Input impedance is approximately 20 megohms shunted by 10 μμf. Input voltage is 1 to 50 v sine wave; to 500 v with accessory input dividers.

Program Equalizer

CINEMA ENGINEERING CO., 1510 West Verdugo Ave., Burbank, Calif., has announced the type 4031-B program equalizer that has wide applications in the sound and electronic laboratories for research and control. The broadcasting, recording and motion picture industries are using it as a practical, high-quality program equalizer that provides corrections for frequency response in audio equipment, sound pickup and transmission lines. Easy operation of two control knobs allows wide range of over 395 available curve combinations. Controls provide for independent adjustment of the high and low frequencies in 2-db steps. Minimum input level is −70 dbm; maximum, +20 dbm.

D-C Power Supply

NEUTRONIC ASSOCIATES, 83-56 Victor Ave., Elmhurst 73, N. Y., announce the availability of model 33HRR, 1 to 30 kv, regulated, reversible, 5-ma rating, r-f d-c power supply. This equipment was developed to provide a tool for serious research beyond the usual current limitations of r-f h-v power supplies. Output is from below 1 kv to 30 kv at 5 ma in three ranges. Regulation is 0.1 percent at all voltages. Line voltage stabilization is 0.1 percent from 105 to 130 v a-c. Ripple voltage is less than 0.05 percent of d-c output voltage.



Coaxial Terminal Triode

MACHLETT LABORATORIES, INC., Springdale, Conn., announces the ML-6257, a water-cooled ring-seal triode incorporating an integral anode water jacket. Designed specifically for r-f heating application in the 2-to-3 kw range, but well adapted to a-m, f-m and tv transmission, the ML-6257 has plate input and dissipation ratings of 7 kw and 5 kw, respectively; stress-free thoriated tungsten filament operates at 12.6 v, 27 amperes. Maximum ratings apply to 110 mc. The tube is also available in a forced-air cooled model and in a version designed for use with the company's quick-change automatic seal water jacket.

Magnetic Recording Tape

MINNESOTA MINING AND MFG. CO., 900 Fauquier St., St. Paul, Minn., let WILLIAMS help you apply ferric oxides to the manufacture of your

ferrites

You'll be well repaid by getting the facts on a special group of Pure Ferric Oxides, developed by Williams especially for use in the manufacture of ferrites.

Williams Ferric Oxides analyze better than 99% Fe_2O_3. They contain a minimum of impurities. They are available in a broad range of particle sizes and shapes. Among them, we're certain you'll find one that's "just right" for your requirements. The proper application of Ferric Oxides to the manufacture of Ferrites is our specialty.

Tell us your requirements... we'll gladly send samples for test. Chances are good that our Ferric Oxide "Know How" can save you considerable time and money. Address Dept. 25, C. K. Williams & Co., Easton, Pa.

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P. S. We also produce IRN Magnetic Iron powders for the Electronic Core Industry, the Magnetic Tape Recording Industry and others. Write for complete technical information.

Model 100A Phasemeter

New

LOW COST—PRECISION Direct Reading PHASEMETER

- 0° to 180° lead or lag in 90° expanded scale ranges.
- 2 cycles to 200 kilocycles.
- Error less than 4° from 20 cycles to 20 kilocycles; above 20 kilocycles and below 20 cycles increasing gradually to 8°.
- Input impedance approximately 20 megohms shunted by 10 mmf.
- Input voltage 1 to 50 volts sine wave; to 500 volts with accessory input dividers.
- Invaluable in the ***audio, ultrasonic, servomechanism, industrial control*** and ***acoustical*** fields for determination of phase characteristics and time relationships.
- Applicable to the power field and general laboratory use for power factor measurements and electronic component testing.

Literature on request.

Price: $145.

DELTRON INC.
P.O. Box 192 Glenside, Pa.

TAKE NO CHANCES WITH VITAL EQUIPMENT... *Specify*

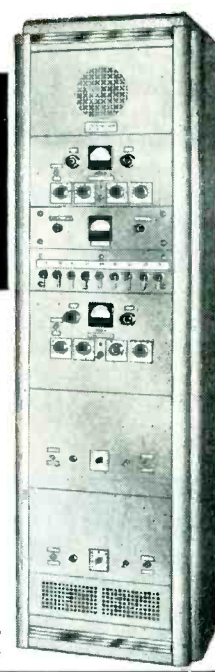
SERIES 6918 or 6924

RACKS by PAR-METAL

18½" or 24" DEEP, for 19" WIDE PANELS

- *Panel Spaces:* 61¼", 70", or 77" high.
- Finished in Prime Coat, Black Wrinkle, Grey Lacquer, Grey Wrinkle.
- Series 6918 or 6924 Racks may be used in *"rows"* or *"gangs,"* as corner trims are removable from *front* of cabinet.
- Standard shelves and roller trucks are manufactured by us for use with these Racks.

THESE RACKS ARE MODERATELY PRICED and AVAILABLE FOR SHIPMENT FROM STOCK



Our P-6924 Rack as used by Gai-Tronics, Inc., Reading, Pa.

Planning an electronic product? Consult Par-Metal for

RACKS • CABINETS
CHASSIS • PANELS

Remember, Par-Metal equipment is made by *electronic specialists*, not just a sheet metal shop.

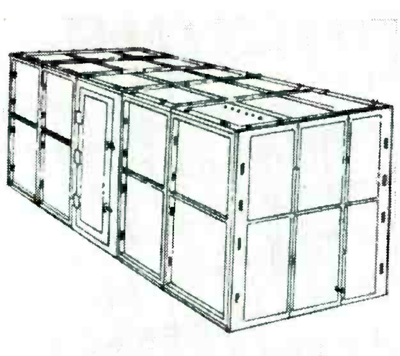
Made by Electronic Specialists!

PAR-METAL ELECTRONIC HOUSINGS

PAR-METAL
PRODUCTS CORPORATION
32-62 — 49th ST., LONG ISLAND CITY 3, N. Y.
Tel.: AStoria 8-8905
Export Dept.: Rocke International Corp.
13 East 40 Street, New York 16, N. Y.

WRITE FOR CATALOG!

has announced the Scotch No. 120 High Output magnetic recording tape that is designed especially for use in radio, tv and recording studios, in computer work and in other critical applications. With the new tape at least 8 db greater signal-to-noise ratio is obtainable on conventional professional magnetic recorders. In the pulse recording field it will enable manufacturers of electronic computing equipment to get improved pulse definition and to keep signals high enough above noise level for more accurate work. The new tape has a strong and flexible coating, dry lubricated by a special process to prevent squealing on critical machines. Output uniformity at 1 kc is guaranteed not to exceed $\pm\frac{1}{4}$ db within a reel and $\pm\frac{1}{2}$ db from reel to reel. The No. 120 tape is available in lengths of 2,400 ft on the NARTB reel or hub, and in 1,200 ft lengths on the 7-in. plastic reel with the $2\frac{3}{8}$-in. hub. All lengths are guaranteed splice-free.



Double-Shield Screen Room

ERIK A. LINDGREN & ASSOCIATES, 4515 North Ravenswood Ave., Chicago 40, Ill., is manufacturing a screen room that uses a double screen design in which the outer and inner screens are physically and electrically insulated from each other to assure minimum interference for testing and evaluating many types of electronic equipment. The lightweight prefabricated panels are 31 in. × 91 in., easily assembled to various dimensions, and the screening is heavy copper, securely attached to the panel frames. Construction is entirely portable, easily dismantled and moved to any desired location. Six power line entrances are provided as well as a special copper-covered power-line

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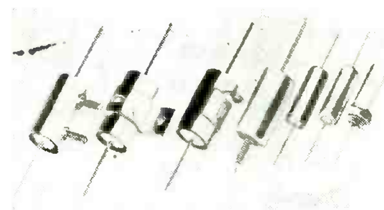
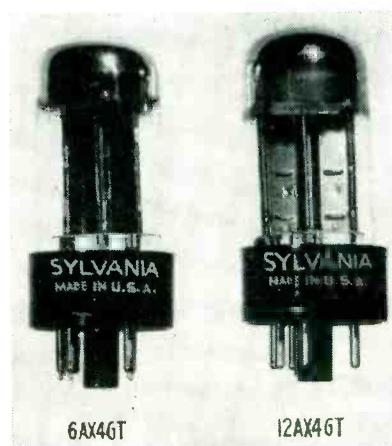
filter section on which entrance filters are mounted.



Metal-Cased Paper Capacitors

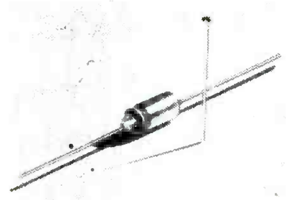
CORNELL-DUBILIER ELECTRIC CORP., South Plainfield, N. J., has expanded to twelve types the Demicon series of miniaturized, tubular metal-cased paper capacitors. The Demicons are hermetically sealed in metal cases, with glass-to-metal seal terminals, and are available in seven mounting and container styles. Impregnants, tolerances and internal constructions are provided to meet the most popular applications encountered in present-day engineering practice. All Demicons will comply with applicable parts of specifications JAN C-25 and Mil-C-25A.



Damping Diodes

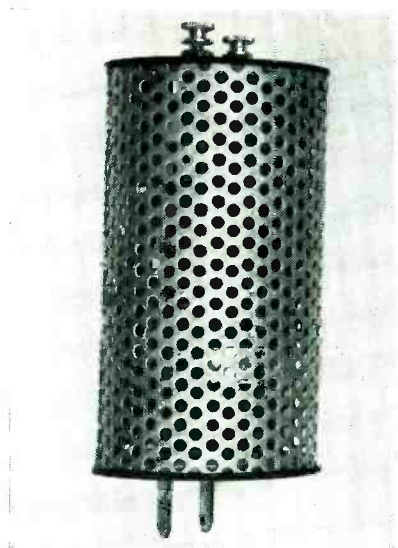
SYLVANIA ELECTRIC PRODUCTS INC., Emporium, Pa., has announced two new diodes for use in tv horizontal frequency damper circuits. Types 6AX4GT and 12AX4GT are half-wave, indirectly heated diodes contained in T-9 envelopes. They are designed to withstand the extremely high voltage pulses of line frequency between cathode and both heater and plate elements, normally encountered in direct drive circuits. The tubes are identical except for heater characteristics. The 6AX-

4GT requires 6.3 v at 1.2 amperes. The heater of the 12AX4GT requires 12.6 v at 600 ma.



Tiny Electrolytics

MICAMOLD RADIO CORP., 1087 Flushing Ave., Brooklyn 37, N. Y., is now producing the Microlytic capacitors in a range of sizes and ratings. The smallest unit is only 0.175 outside diameter and $\frac{11}{32}$ in. long. These tiny electrolytic capacitors were intended to serve in the circuits of such units as very small amplifiers, hearing aids and transistor devices. Maximum temperature rating is 65 C. Complete ratings and mechanical variations can be supplied to the customer's specification.



Power Supplies

JERSEY CITY TECHNICAL LABORATORY, 880 Bergen Ave., Jersey City 6, N. J., has added to its line two Mini-Pack power supplies. The Mini-Pack is a small selenium rectifier source of instant power. Model R gives 108 v regulated low-ripple d-c with an OB2 voltage-regulator tube. It will maintain constant voltage output with load variations up to 15 ma, or lightly loaded with input variations from 100 to 130 v a-c. Model P is a voltage doubler,

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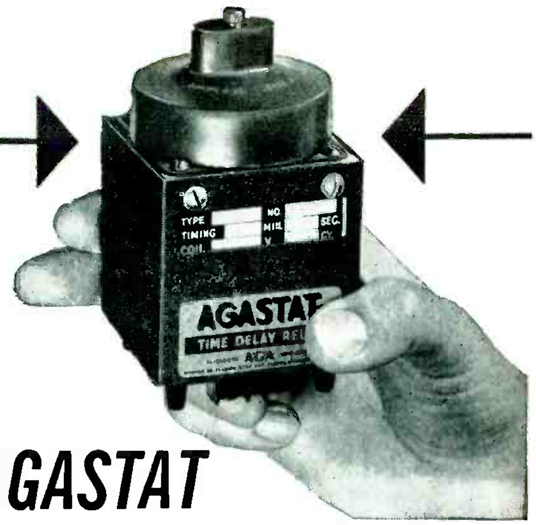

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solenoid actuated—pneumatically timed

Introduces time delays into a-c or d-c circuits. Easily adjusted to provide delays ranging from 0.1 second to five or more minutes.

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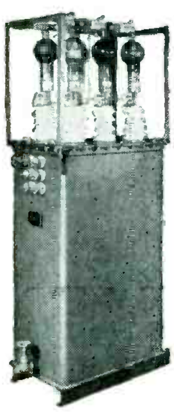

34 KW 17,000 V.D.C.

← NEW UNITIZED RECTIFIERS

For high voltage D.C. sources . . . lower initial cost . . . minimum upkeep . . . convenient —ready to connect to A.C. line and D.C. load . . . compact — requires minimum floor space.

Askarel Immersed Filter Reactor 50,000 Volt Test

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Your Special Metals Rolled to Thin Sizes & Close Tolerances

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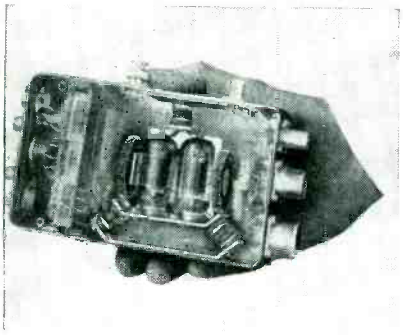
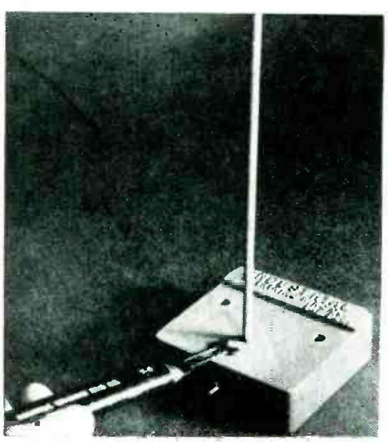
10 w power source of low-ripple d-c. The no-load voltage output is 330 v. At 50 ma, the maximum constant-duty current, the output is 200 v. For intermittent use, the current may go as high as 65 ma.



Amplifier Bridge

ROBINSON AVIATION, INC., Teterboro, N. J. In the new Simmonds amplifier bridge for the Pacitron fuel gage system, new standards of lightness and compactness have been achieved by a unique system of Met-L-Flex (all-metal) internal vibration and shock mounts. Need for external mounting is eliminated and the sensitive tubes are fully isolated from vibration and shock. The entire unit is so small it fits in the palm of one's hand and weighs only 1 lb 3 oz. An effective center of gravity type of mounting permits the unit to be mounted also in the inverted position.



Retaining Rings

INDUSTRIAL RETAINING RING CO., 8 West Sidney Ave., Mt. Vernon, N. Y. Open-type retaining rings measuring $\frac{1}{16}$ in. and applicable to a $\frac{3}{32}$-in. diameter shaft are being stacked for manufacturers. Stack-

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ing of the No. 1000-9 rings to fit shaft diameters of 0.094 in. marks the smallest size rings yet to be stacked in a wide range of sizes that includes open-type retaining rings measuring as much as 1½ in. and applicable to a 1-in. diameter shaft. With the company's modern dispensing method the rings are shipped stacked on metal rods that become part of an assembly that includes a specially designed cast-iron base and an application tool. The retaining rings are made from carbon spring steel and provide shoulders on grooved circular shafts. They replace many fastening devices that require costly machining and assembling. Radially applied, the rings are quickly and easily snapped into position. A brochure illustrating the ring stacks with the one-at-a-time dispensing and application feature is available.

Scintillation Count Rate Meter

NUCLEAR RESEARCH AND DEVELOPMENT, INC., 6425 Etzel Ave., St. Louis 14, Mo., has developed the CRM-500 scintillation count rate meter that may also be used for Geiger and proportional counting. It incorporates three basic features: (1) A fast pulse amplifier with a rise time of 0.25 μsec and a variable amplification up to 1,500. (2) A true electronic discriminator that accepts pulses from −100 to +50 v. (3) A well-regulated h-v supply that is variable from 500 to 1,800 v and is regulated to 0.005 percent per 1-v change in line voltage between 95 and 100 v. The count-rate circuit is normally supplied with counting rate multiples of 1,000, 5,000, 10,000, 20,000 and 50,000 counts per minute, but can also be supplied with scales up to 500,000 counts per minute. A switch on the front panel allows the selection of percent error over the range of 1, 2, 5, 10 and 20 percent.

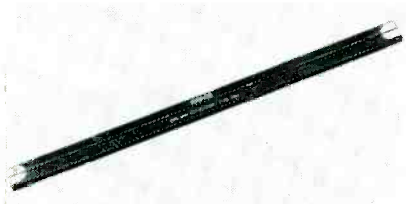
Rectangular CRT

WATERMAN PRODUCTS CO., INC., Philadelphia 25, Pa. Model 3XP Rayonic rectangular cathode-ray tube provides unusually brilliant and sharply defined trace and high deflection sensitivity at medium anode potentials. The tube provides a light output four times greater and a vertical sensitivity twice as great as comparable crt's operating at similar anode potentials. All this has been accomplished without sacrificing low interelectrode capacitances. These characteristics make it ideal for h-f video work as well as low repetitive operation. Because of its unique shape and size, the 3XP lends itself readily to multi-tube oscilloscopy. The tube is available in P1, P2, P7 and P11 phosphors.

Microwave Receivers

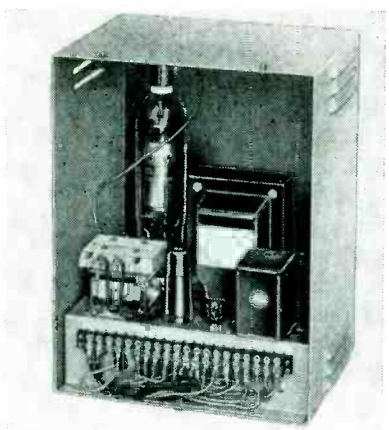
POLARAD ELECTRONICS CORP., 100 Metropolitan Ave., Brooklyn 11, N. Y., announces a series of four wideband microwave receivers covering the frequency range from 1,000 to 10,750 mc. These receivers include such desirable features as linear db indication, single dial tuning, low noise figure, a-m and f-m reception and afc. The video bandwidth is such that a 1-μsec undistorted pulse of 10 v will appear across an output impedance of 100 ohms. Model RL covers the frequency range from 1,000 to 2,100

mc; model RS, 2,000 to 4,500 mc; model RM, 4,400 to 8,400 mc; and model RX, 7,000 to 10,750 mc.



Potentiometer Element

MARKITE CORP., 155 Waverly Place, New York 14, N. Y., has available the type 2028 potentiometer element. This is a rectilinear model of 20,000 ohms resistance having an active length of 10 in. and a linearity of ± 1 percent. These elements are of particular interest in applications where the advantages of extreme wear resistance and substantially infinite resolution are important. They feature outstanding operational reliability when used in conjunction with the input-output tables of analog computers such as the 10-101A input-output table of the REAC computer.

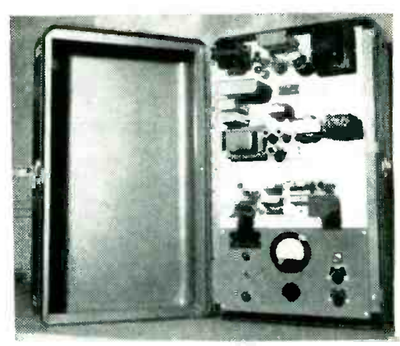


Variable Speed Drive

THE ARROW-HART & HEGEMAN ELECTRIC CO., 103 Hawthorn St., Hartford 6, Conn., has a new development in motor-control equipment, the electronic variable speed drive for fractional h-p motors. With the optional Dual Range feature, speeds from 100 to 3,500 rpm are available. The series motor used can be started, stopped or dynamically braked and can be rapidly accelerated to preset speeds. The series motor makes use of both the a-c and d-c output from a single thyratron tube. Inherent compensation is 10 percent of line voltage and 5 percent of speed, but full voltage compensation is also available as an extra feature.

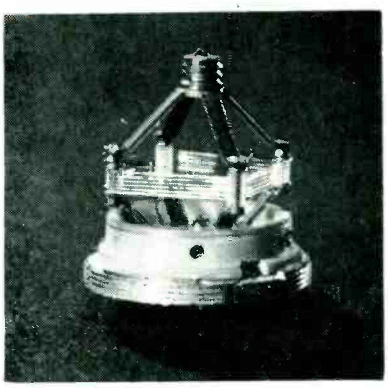
Laboratory Monitor

BERKELEY SCIENTIFIC Division of Beckman Instruments, Inc., 2200 Wright Ave., Richmond, Calif. Model 1800 laboratory monitor is a general-purpose count rate meter with provision for a visual and/or aural indication. A front panel control permits selection of five different meter ranges: 300, 1,000, 3,000, 10,000 and 30,000 counts per minute. Aural volume control is also provided. The instrument may be obtained with a G-M tube and probe. Accuracy is approximately ±5 percent. Dimensions are approximately 6½ in. × 6½ in. × 10¼ in. Net weight is approximately 8 lb.



Constant-Frequency Control

GENERAL ELECTRIC Co., Schenectady 5, N. Y., has announced a new constant-frequency control designed to hold alternator frequency within 0.001 percent on motor-generator sets supplying up to 10 kw of power. It is available in 50, 60 and 400 cps standard in single or three phase, and nonstandard frequencies are available on special order. Specific applications include the prevention of undesired hysteresis and eddy current effects in testing due to frequency variation; a standby source of emergency power for automatic and synchronous equipment; and as a plant frequency standard where one 60/400 cycle source supplies power to many parts of a plant and eliminates the need for a number of smaller sources. The electronic control consists basically of a tuning fork and a phase comparator enclosed in a case approximately 6 × 24 × 36 in.



Tiny Pressure Transducer

CONSOLIDATED ENGINEERING CORP., 300 N. Sierra Madre Villa, Pasadena 8, Calif. Pressure measurements ranging from theoretical investigations of aircraft turbulence-distribution patterns to practical surveys of hydraulic-system and pipeline pulsations are simplified by a miniature pressure transducer recently announced. The type 4-310 Star pickup measures only $\frac{1}{2}$ in. in diameter and less than $\frac{3}{4}$ in. in length, and weighs only 20 oz. Its flush diaphragm is designed for insertion directly into a process vessel or stream of either liquid or gas for test and monitoring purposes. The unit may be used with recorders for permanent test records or with visual indicators and meters for on-the-spot measurements. For detailed specifications, electrical characteristics and pres-

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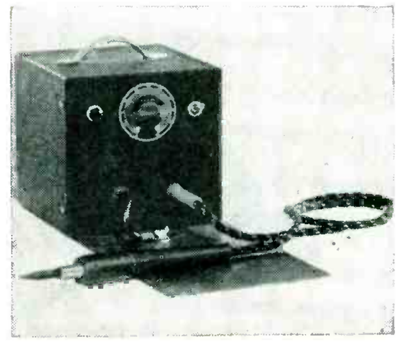
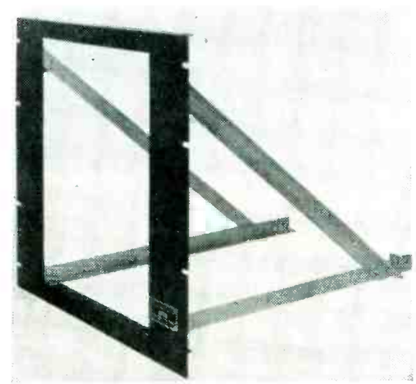
sure ranges available see bulletin CEC No. 1534.



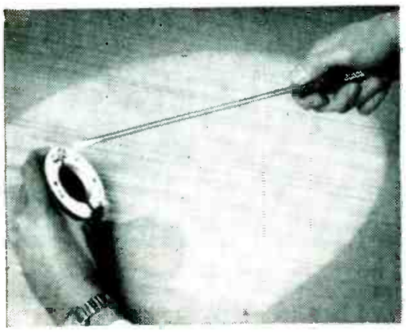
Soldering Unit

SUNRISE PRODUCTS CO., P. O. Box 173, Hawthorne, N. J. Model L-72 Glo-Point soldering unit features a metal ground plate on which jigs could be mounted in addition to the adjustable heat control that allows the electrodes to heat up instantly to 1,250 F. The unit is desirable for soldering capacitors, capacitor cans, lugs, terminal boards and electronic parts. A descriptive pamphlet is available on request.



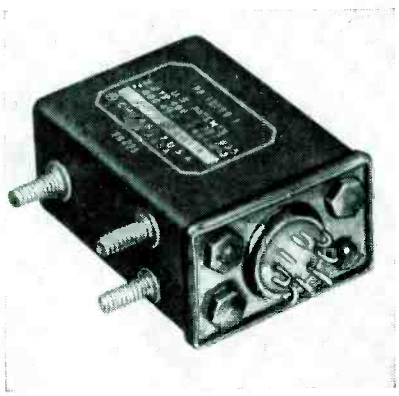
Rack Mounting Adapter

ALLEN B. DUMONT LABORATORIES, INC., 1500 Main Ave., Clifton, N. J. Type 2598 rack mounting adapter was designed for use with types 303, 303-A, 303-AH and 322 c-r oscillographs. The adapter was intended to provide a rigid mount for the instrument and to present a neat, yet completely accessible unit in standard 19-in. relay racks. It bolts to the rack frame and provides a sufficiently large front opening to permit all but the front panel of the c-r oscillograph to pass through. The adapter is shipped disassembled with simple instructions on its assembly and the insertion of the instrument.



Special-Purpose Screwdriver

XCELITE, INC., Orchard Park, N. Y., has introduced to the electronic industry a special-purpose screwdriver for adjusting focalizer coils. It has a 10-in. shank to reach into the tv chassis, and its $\frac{1}{4}$-in. blade is flared at the tip and tapered to fit snugly in the focus adjustment screw. Advantages of this tool are that it is nonmagnetic, fatigue-resistant and does not need frequent regrinding, as do fibre or plastic blades.



Miniature Relay

AUTOMATIC ELECTRIC SALES CORP., 1033 West Van Buren St., Chicago 7, Ill. Bantam-sized class S relays are now available in a new small hermetically-sealed enclosure. The entire unit measures $2\frac{1}{32} \times \frac{31}{32} \times 1\frac{1}{2}$ in. and weighs only $1\frac{7}{8}$ oz. Mounting studs may be arranged on base or narrow side of housing. This minature relay was designed for minimum inductance and maximum make-and-break speeds. It is tamper-proof and atmosphere-protected and meets or betters all provisions of MIL-R6106. It is recommended for applications wherever

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extremes of shock, temperature and vibration require exceptional performance.

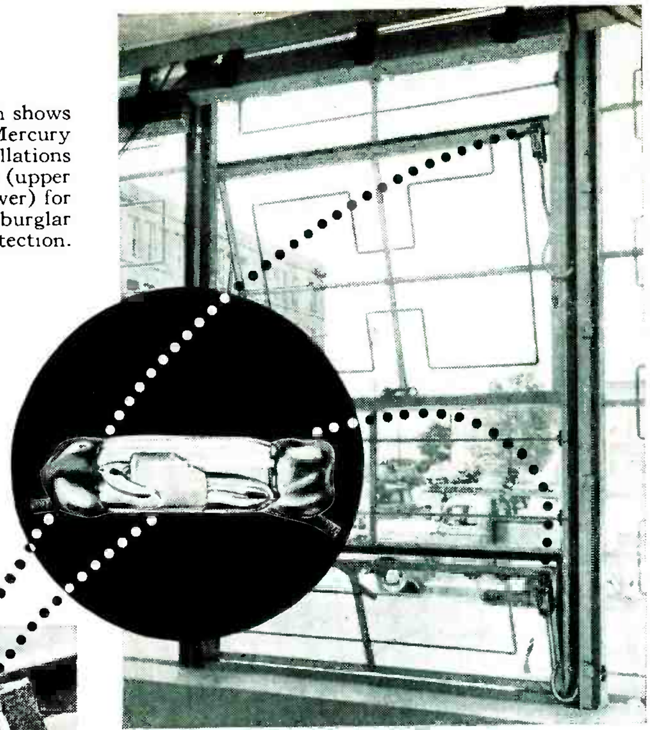
Magnetic Amplifiers

KEYSTONE PRODUCTS CO., 904 Twenty-Third St., Union City, N. J., announces a series of five packaged magnetic amplifiers. In place of the conventional output transformer and power amplifier tubes, the Moto-Mag KP10–400 utilizes a phase-sensitive vacuum tube, demodulator and magnetic amplifier output stage that eliminates the need for rectifiers and assures greater reliability. It operates from an input voltage of 115 v, 400 cycles single phase; output is 10 w reversible phase. The KP10-400 operates from −55 to +70 C with minimum variation. The unit measures 4 in. high, 3½ in. wide and 2½ in. deep.

Accelerometer

G. M. GIANNINI & CO., INC., 117 E. Colorado St., Pasadena 1, Calif., announces a new, long-life accelerometer designated as the 24132. Smallness and compactness are noteworthy features of this instrument that utilizes a potentiometer resistance and is hermetically sealed in an inert gas. It also features a low, natural frequency and a large output requiring no amplifying unit in most cases. The 24132 is obtainable in resistance ranges from 1,000 to 20,000 ohms and for any accelerometer measurement up to 30 g with special adaptations possible. The potentiometer element safely carries current up to 10 ma. Opti-

Illustration shows Honeywell Mercury Switch installations on two windows (upper and lower) for complete burglar alarm protection.



Close-up view of Honeywell Mercury Switch installed in mounting cover of ADT alarm switch.

ADT finds Honeywell Mercury Switch ideal alarm protection when applied to tilted windows

● Electric protection services of the American District Telegraph Company include the use of a Honeywell Mercury Switch as part of the burglar alarm protection applied to horizontally pivoted windows of the fenestra or projected type.

When the window is closed, the switch is in its normal or protected position. Opening of the window activates the mercury switch and causes the alarm to be transmitted to the ADT Central Station.

This use of the Honeywell Mercury Switches by ADT engineers is typical of the many uses for these versatile switches where tilt motion and low operating force are provided. Often the proper tilt motion can be developed and MICRO field engineers, experienced in switch application problems, are at your service to review your requirements as to mounting, actuating linkages, lead supports, terminal blocks and enclosures.

There are more than 125 designs of Honeywell Mercury Switches from which to select the exact characteristics your application may require. Write for a catalog or contact your nearest MICRO branch office for complete information and engineering assistance.

MICRO
MAKERS OF PRECISION SWITCHES
FREEPORT, ILLINOIS

A DIVISION OF
MINNEAPOLIS-HONEYWELL REGULATOR COMPANY

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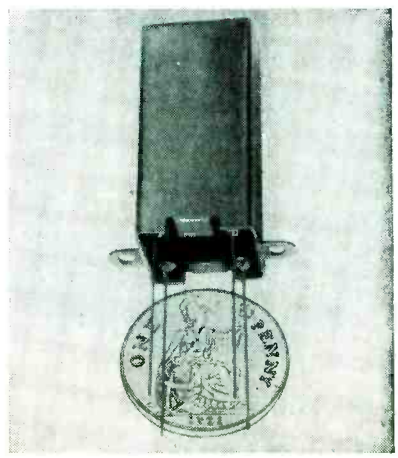
mum operation between −54 and +71 C is obtained. Damping is 0.5 ±0.075 of critical for a 7.5 g instrument as a typical case.

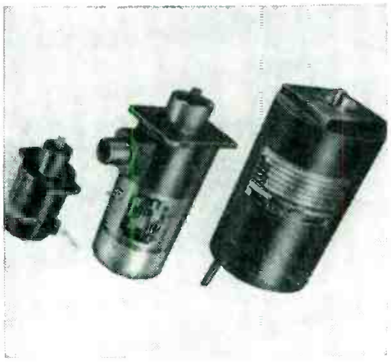
Heavy-Duty Line Switch

STACKPOLE CARBON CO., St. Marys, Pa. Designed primarily for handling high currents at low voltages as in auto radio, tv and similar uses, the type A-12 dpst line switch is rated 12 amperes at 12 v d-c. Only $\frac{7}{8}$ in. in diameter and $\frac{9}{32}$ in. deep exclusive of terminals, it is designed for attachment to types LR and LP and other standard volume controls. Terminals are hot tin dipped for easy soldering. They are doubly locked in position by means of both ears and rivets. Heavy wires can thus be attached to the terminals without danger of loosening them. The design of the switch avoids the possibility of solder and flux flowing to the contact and impairing performance.



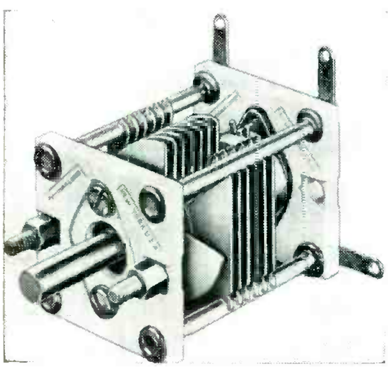
I-F Transformer

THE PLESSEY CO. LTD., Ilford, Essex, England. The new E/19 i-f transformer is an all-purpose unit developed to meet the requirements of modern miniature tubes and receivers. Permeability tuned in the normal manner, this transformer has a Q factor of 85 and an overall bandwidth for two stages of 7.7 kc at 6 db, and 15.4 kc at 20 db. An improved method of core positioning, which utilizes a new high viscosity, chemically stable, packing compound between core threads and bobbin, allows the core to be adjusted over a substantially wider temperature range than hitherto.



Special Purpose Motors

BILL JACK SCIENTIFIC INSTRUMENT Co., Solana Beach, Calif. This new series of special purpose d-c and a-c motors for velocity servo, position servo and actuator applications is based upon improved lamination design. The motors are available in ratings from 1/100 to 1 horsepower with clutch, brakes and control tachometer.



High-Speed Capacitor

HAMMARLUND MFG. CO., INC., 460 W. 34th St., New York 1, N. Y., has announced a butterfly-type variable capacitor capable of continuous operation at speeds as high as 3,200 rpm. The capacitor, designed for sweep circuits and other applications requiring alternating capacitance values, eliminates rotor contact springs and uses commercial ball bearings in addition to a novel alignment and end-thrust take-up device. Soldered brass rotor and stator assemblies, nickel or cadmium plated are used. Units are available with series effective capacitance values ranging from 5.4 to 17.0 $\mu\mu$f nominal. Air gap between

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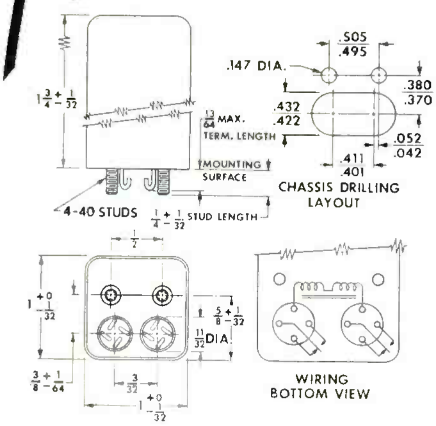
Phaostron SENSITIVE MINIATURE RELAYS

PERFECTLY COUNTER-BALANCED



Contact arrangements up to and including DP DT 3 Amp at 28 volts D.C., or 100 Milliamperes at 150 volts D.C. resistive load.

Hermetically Sealed.

Required coil power as low as 20 milliwatts.

Coil resistance up to 15,000 ohms.

Weight, maximum 3.5 oz.

DUE TO ITS PERFECTLY COUNTER-BALANCED FEATURES THIS RELAY WILL WITHSTAND HIGH ACCELERATION, VIBRATION, SHOCK AND TUMBLING

Mass Production Requirements Invited

Detailed information on request.

ENVIRONMENT FREE ELECTRICAL EQUIPMENT by Phaostron

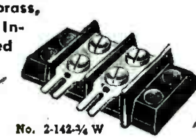
PHAOSTRON COMPANY • 151 PASADENA AVE. • SOUTH PASADENA, CALIF.

INCREASED INSULATION BETTER CONNECTIONS

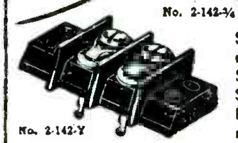
JONES BARRIER Terminal Strips

Leakage path is increased—direct shorts from frayed terminal wires prevented by bakelite barriers placed between terminals. Binder head screws and terminals brass, nickel plated. Insulation, molded bakelite.

No. 2-142



No. 2-142-¾ W



No. 2-142-Y

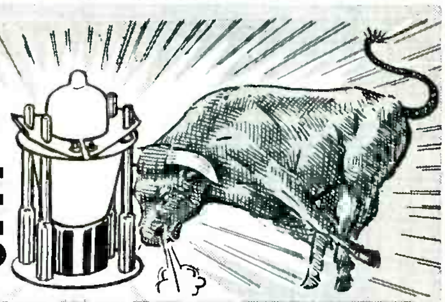
Shown: Screw Terminals — Screw and Solder Terminals — Screw Terminal above, Panel with Solder Terminal below. For every need.

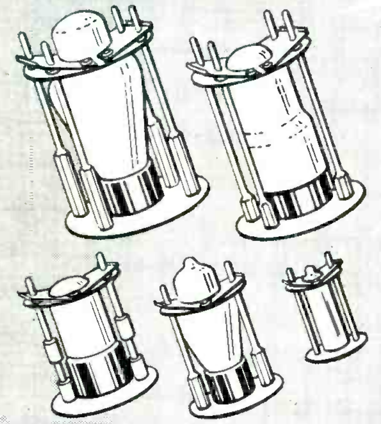
Six series meet every requirement: No. 140, 5-40 screws; No. 141, 6-32 screws; No. 142, 8-32 screws; No. 150, 10-32 screws; No. 151, 12-32 screws; No. 152, ¼-28 screws.

Catalog No. 18 lists complete line. Send for your copy.

HOWARD B. JONES DIVISION
CINCH MANUFACTURING CORPORATION
CHICAGO 24, ILLINOIS
SUBSIDIARY OF UNITED-CARR FASTENER CORP.

SHOCKPROOF VACUUM TUBE RETAINERS





These retainers are used to secure Vacuum Tubes and to resist side motion of Vacuum Tubes used in radio equipment which is subject to shock and vibrations. These retainers meet the requirement of all JAN specifications. The insulated portion is made of a melamine base Fibre Glass Phenol which provides 300 volts insulation to ground and withstands a temperature of 350 F. The insulated plate can readily be fastened or released by hand.

Available for envelope types T7, T8, MT8, T9, T12, ST12, T122DL, ST14, S14, ST16, T5½, T6½, MT-IC, ST19, T14, ST128CT-9.

Manufacturers of Electronic Components

JAMES IPPOLITO & CO., INC.
401 CONCORD AVENUE, BRONX 54, N. Y.

COMMUNICATIONS ENGINEERS

- **Design**
- **Project**

A limited number of experienced engineers required for responsible positions in engineering departments. Specific projects include commercial carrier and radio systems as well as military equipment.

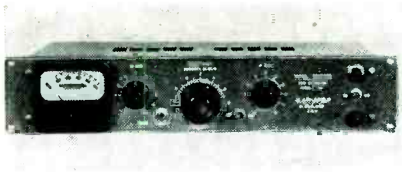
These are permanent positions with an expanding company offering good working conditions and liberal pension and insurance plans. Salaries are commensurate with training and experience.

Ideal location 20 miles south of San Francisco.

LENKURT ELECTRIC CO., Inc.
SAN CARLOS, CALIF.

Lenkurt

plates is 0.030 in. nominal. Outside dimensions of each silicone-treated steatite base is 1⅜ × 1⅜ in.



Selectivity Converter

J. L. A. McLaughlin, P. O. Box 529, La Jolla, Calif., announces the development of a continuously variable straight-sided selectivity converter. The type MCL-50 Signal-Splitter is designed to provide jam-free bandwidths for every c-w or speech receiving condition. Its continuously variable filters provide bandwidths from 0.4 kc to 6.0 kc with 60-db cutoffs of from 500 to 600 cps. It can be used with any standard a-m receiver and requires a rack-panel space of only 3½ in. It has self-contained power supply and audio amplifier with an output of 18 dbm across 600 ohms.

Picture Tube Brightener

C-B-C Electronics Co., Inc., 1310 Callowhill St., Philadelphia, Pa. The Picboost Pacemaker illustrated will restore brilliance to any size or type picture tube for periods up to several years. It can be installed within a few minutes, just by plugging in. No soldering is necessary, no 110-v a-c lines are used, and no adjustments are needed. Four models are available in this series. Models 1F and 2F restore new tube brightness to dim picture tubes in parallel and series circuits respec-

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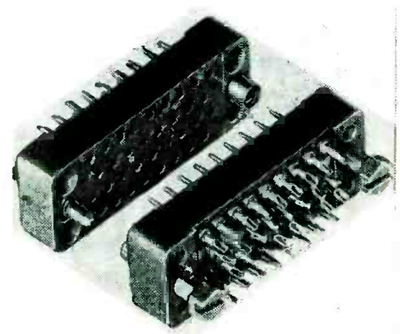
tively. Models 3F and 4F relieve heater to cathode shorts only, in parallel and series circuits respectively.

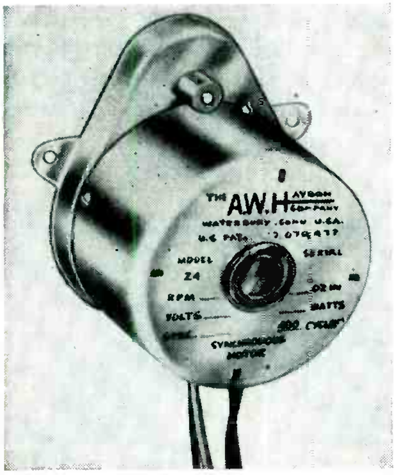


Connector Guide Pin and Socket

DEJUR-AMSCO CORP., 45-01 Northern Blvd., Long Island City, N. Y. The polarizing guide pin and guide socket can now be provided on the series 20 miniature rectangular connector from 7 to 104 contacts. This screw-lock type of guide pin provides positive means of locking the plug and receptacle against vibration or accidental disconnection. It also provides a mechanical means of disconnecting the plug from the receptacle without prying or forcing, thus preventing unnecessary damage and providing a very positive connection.

Single Ear-Phone Unit

THE CANADIAN BENAUDI CO. LTD., P. O. Box 1255 Ottawa, Ontario, Canada, has developed a new single earphone unit that offers important advantages in all cases where headsets are not required. It may instantaneously be placed about the ear where it hangs freely therefrom, its very light weight bringing no discomfort to the user. The unit's receiver is interchangeable and various impedances up to 15,000 ohms, frequency ranges and sensitivities can be provided as may be required. The sound is carried through a specially designed tube provided with a flexible mushroom-shaped tip that automatically closes the ear channel to any external noise and outside interference. Other advantages include abolition of the head band, only one hand being required to place the unit on the ear, ease of interchangeability of the unit between users and robustness against rough handling.

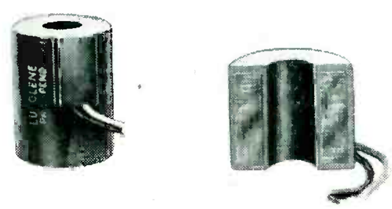


Timing Motor

A. W. HAYDON Co., Waterbury, Conn., has developed a practical 400-cycle synchronous a-c timing motor for use where light weight, accuracy and dependability are required. It was developed as a result of increased use of 400-cycle power in the expanding field of guided missiles, as well as the aircraft industry. The motor features almost instantaneous starting and stopping. Use of an spdt switch accomplishes effective reversing. One winding 90 deg out of phase assures rapid starting, smooth operating and absolute ease of reversal. The timing motor operates on 115 v ±10.0 percent with frequency of 400 cps ±20.0 percent. The torque is 0.025 oz-in. at 3,000 rpm starting and running. The motor operates with a power input of 6 w, including the phase shift network (4.5 w motor winding). It meets the temperature, altitude and vibration requirements of MIL-E-5272.

High-Temperature Insulation

SUN CHEMICAL CORP., Electro-Technical Products Div., Nutley 10, N. J., has announced two new products that meet all class H requirements and offer design economies at higher temperatures. The Sil-Thin-Glas 0.002 and 0.003 and Sil-Thin-Bestos 0.003 to 0.0035 possess exceptional dielectric and tensile strength. Their thinness, flexibility and light weight permit compact construction, and size and weight reduction of electronic and electrical equipment. Available in rolls, sheet or tape form, they are especially recommended for coil and relay insulation, layer and barrier insulation for transformers, and coil wrappings for fields and stators.



Molded Coil

DELUXE COILS, INC., First and Webster Sts., Wabash, Ind., has developed a molded waterproof type of electrical coil winding for intense moisture conditions, and explosion proof applications. The coils are enclosed in Luxolene Green molding resin which allows operating temperatures continuously of 90 to 250 F. The core tube is made of the same resin or exterior casting making the complete coating one homogeneous mass. Lead wires are of the 105C UL approved polyvinyl-chloride type and a bond is achieved between the resin and lead

Use WEST - CAP miniature CAPACITORS to meet exacting requirements

Hermetically sealed in metal case

Check these important features:

- Positive hermetic sealing
- Small physical size
- Tab or ext. foil construction
- Grounded or insulated sections
- Designed and built to meet most exacting requirements for:

1. Mechanical
2. Electrical
3. Temperature
4. Humidity

Send for complete catalog and specifications

SAN FERNANDO ELECTRIC MFG. CO.
Box 952
12900 Foothill Blvd., San Fernando, Calif.
Phone EMpire 1-8681
Offices: WASHINGTON, D.C., CHICAGO, DETROIT, N. Y.

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Our Coaxial Cable Connectors Meet All Government Specifications

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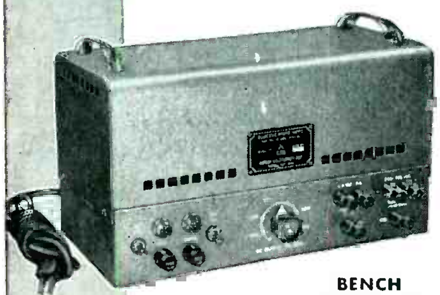

BENCH MODEL 25

• STABLE • DEPENDABLE • MODERATELY PRICED •

- **INPUT:** 105 to 125 VAC, 50-60 cy
- **OUTPUT #1:** 200 to 325 Volts DC at 100 ma regulated
- **OUTPUT #2:** 6.3 Volts AC CT at 3A unregulated
- **RIPPLE OUTPUT:** Less than 10 millivolts rms

WIDTH 14"
DEPTH 6"
HEIGHT 8"
WT: 17 LBS.

For complete information write for Bulletin E

LAMBDA ELECTRONICS CORPORATION
CORONA NEW YORK

MIL-B-233A
JOINT ARMY-NAVY SPECIFICATIONS

SPARE AND REPAIR

PARTS BOXES

Manufactured to meet material, workmanship and finish requirements of Army-Navy specifications.

Accessories: Internal framing, partitions, trays and wood chucks as required.

Complete Facilities under one roof for quality mass production, including Heliarc welding, baking and finishing. Whistler and Wiedermann equipment for short runs. Tool and die engineering and designing. Completely conveyerized finishing facilities. Large assortment of stock and special dies for radio and television and electronic field.

Write for Catalog and Price List.

ART–LLOYD
Metal Products Corp.

2973 Cropsey Ave., Brooklyn 14, N. Y. • CO 6-5100
PRECISION SHEET METAL PRODUCTS, MASS PRODUCTION SPECIALISTS.

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wire. Production shipments of coils are all tested in water for 24 hours. Each shipment is certified that after 24-hour immersion with 500 v d-c applied, the leakage resistance through water to ground has been found in excess of 200 megohms.

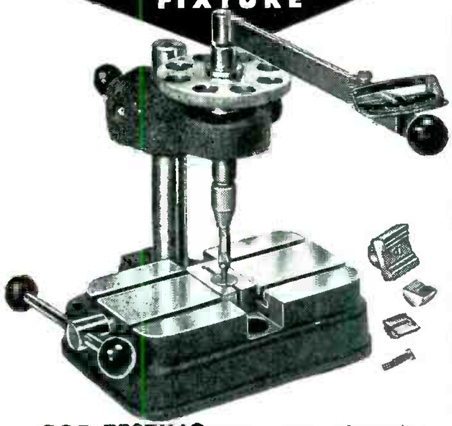
Relay Rack

INSULINE CORP. OF AMERICA, 36–02 35th Ave., Long Island City 1, N. Y., has brought out an open-face relay rack designed to take standard 19-in. panels. Sturdily made of 1/8-in. steel, it measures 38 1/4 in. high, 20 in. wide and 18 3/8 in. deep, weighs 39 lb and has 36 3/4 in. of vertical panel space. Catalog No. 3913 rack is intended for radio transmitters and transmitter-receiver combinations, p-a amplifiers and distribution systems, tape or wire recorders, laboratory or service shop test equipment, and similar electronic applications.

Voltage-Regulated Power Supplies

KEPCO LABORATORIES, 131-38 Sanford Ave., Flushing, N. Y. Model 750 voltage-regulated power supply features one regulated d-c voltage supply with excellent regulation, low ripple content and low output impedance. The h-v supply is continuously variable from 0 to 600 v and delivers from 0 to 750 ma. In the 30 to 600-v range the output voltage variation is less than 0.5 percent for both line fluctuations from 105 to 125 v and load variation from minimum to maximum current. The ripple voltage is less than 10 mv peak to peak. Cabinet height is 28 in., width, 21 1/2 in., and depth, 16 in. Also available are the

STURTEVANT TORQUE TESTING FIXTURE



FOR TESTING Screws, thread-cutting and thread-forming screws—all types of threaded fasteners; threaded parts and threaded connections.

FOR MANUFACTURERS
DESIGNERS
INSPECTORS
TOOL ENGINEERS
LABORATORIES and for
PRODUCT CONTROL
in assembly.

Capacities: (0-200 in. lbs.) or (0-150 ft. lbs.)

Write for Bulletin TTF

P.A. STURTEVANT CO.
ADDISON QUALITY ILLINOIS

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versatile
Multi-channel — telegraph A1 or telephone A3.

FROM GROUND TO AIR OR POINT TO POINT

STABLE

High stability (.003%) under normal operating conditions.

RUGGED

Components conservatively rated. Completely tropicalized.

Model 446 transmitter operates on 4 crystal-controlled frequencies (plus 2 closely spaced frequencies) in the band 2.5-24.0 Mcs (1.6-2.5 Mcs available). Operates on one frequency at a time; channeling time 2 seconds. Carrier power 350 watts, A1 or A3 AM. Stability .003% using CR-7 (or HC-6U) crystals. Operates in ambient 0° to +45° C using mercury rectifiers; -35° to +45° C using gas-filled rectifiers. Power supply. 200-250 volts. 50/60 cycles. single phase. Conservatively rated, sturdily constructed. Complete technical data on request.

Here's the ideal general-purpose high-frequency transmitter! Model 446 . . . 4-channel, 6-frequency, medium power, high stability. Suitable for point-to-point or ground-to-air communication. Can be remotely located from operating position. Co-axial fitting to accept frequency shift signals.

Consultants, designers and manufacturers of standard or special electronic, meteorological and communications equipment.

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3090 DOUGLAS ROAD MIAMI 33, FLA.
Reg. U.S. Pat. Off.

Roanwell

Style No. 2906

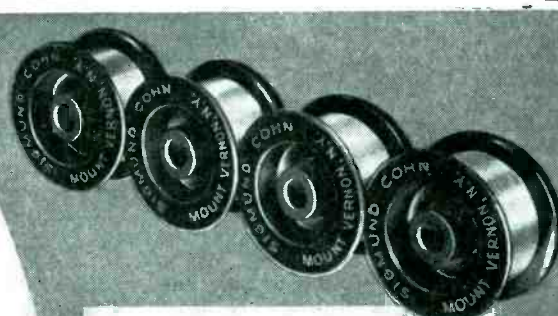
CLOTHES CLIP

Sturdily constructed for maximum life. Finished in semi-gloss black enamel. Ribbed, firm-gripping clamping pads made of hard neoprene. Mounting plate enables clip to be attached to hard surface, such as a switch case. Hard drawn steel spring wire insures optimum spring action.

WITH MOUNTING HOOK FOR USE ON CORDSETS . . . This model utilizes a steel mounting hook which can be hooked directly on a cordset molded for this purpose.

DATA SHEETS ON REQUEST.

ROANWELL CORPORATION
27 SIXTH AVENUE, BROOKLYN 17, NEW YORK



Fine WIRE For TRANSISTORS

In line with our specialization in wire for new applications, we produce wires of composition suitable for the manufacture of Transistors; including GALLIUM GOLD and ANTIMONY GOLD. These alloys have been made to fill a specific need arising from new developments in this field.

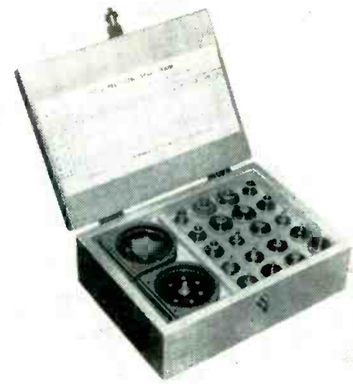
Other wires we make regularly for similar application are PHOSPHOR BRONZE, bare or electroplated, and PLATINUM Alloys produced to meet rigid specifications of tensile strength, size and straightness.

SINCE 1901

Write for Latest List of Products

SIGMUND COHN CORP. 121 So. Columbus Avenue • Mount Vernon, N.Y.

model 760, delivering 1.5 amperes; model 770, 2.25 amperes; and model 780, 3 amperes.



Gear Train Kit

BOWMAN INSTRUMENT CORP., Smith Municipal Airport, Fort Wayne, Ind., has added to its product line a new universal precision gear train kit. The new kit features standard ratios from 20 to 1 to 1,250 to 1, with special ratios up to 15,000 to 1 available where required. All ratios are obtained in the same basic gear housing simply by changing gear clusters according to instructions provided. The unit is designed for servo breadboarding and general laboratory use. Combination data are printed on the inside of the box cover for easy reference.

Flexible Coil Forms

PRECISION PAPER TUBE CO., 2035 W. Charleston St., Chicago 47, Ill., has announced the Flexiform coil forms with special flexible flanges that completely eliminate taping operations on motor-field coils. This is a highly important factor in speeding up assembly lines, especially where mass production techniques are desirable. Since automatic equipment is used in the

VULCAN
ELECTRIC HEATING UNITS

Ring Heaters

The same standard construction as Vulcan cartridge and strip heaters. Coil is of highest grade resistance wire and is supported in and insulated from sheath by refractories of proven quality.

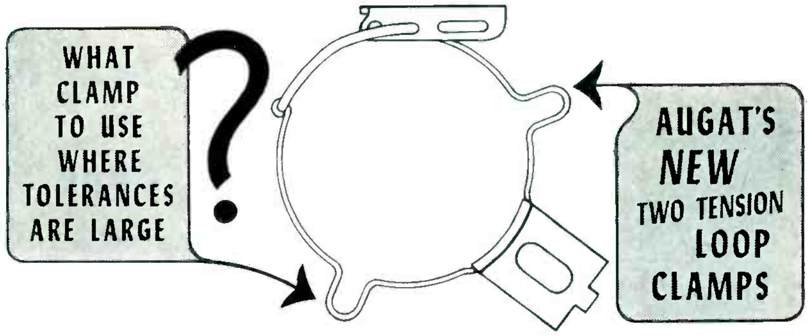
Easily installed by clamping against the surface of hot plates, pots, defrosters, vulcanizers, moulds, dies, water heaters, etc.

Rust-resisting sheath for temperatures to 750° F.

Stainless steel sheath for temperatures to 1200° F.

6 standard sizes. Special sizes available.

VULCAN
ELECTRIC COMPANY
DANVERS 10, MASS



Augat two-tension loop clamps are the long-sought answer for uses where socket tolerances vary up to .040. The bands of these sturdy clamps are made of Beryllium copper, heat treated to retain original tension and nickel plated to withstand a 96 hour salt spray test with no adverse effect.

The remaining parts of Augat's two-tension loop clamps are made of 18% nickel silver.

Write today for catalog and samples.

AUGAT BROS. INC.
31 PERRY AVENUE • ATTLEBORO, MASS.

Measurements Corporation
MODEL 58

UHF RADIO NOISE & FIELD STRENGTH METER

Frequency Range
15 Mc. to 150 Mc.

FREQUENCY ACCURACY: ±2%. Individually calibrated dial.

SENSITIVITY RANGE: 1 to 100,000 microvolts. Direct reading dial.

POWER SUPPLY: Built-in supply, 117 volts AC, 6 volts DC.

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PRIMARY BATTERIES
for your Specialized Needs

DRY TYPES

78 Standard Industrial, Laboratory and Government Types.

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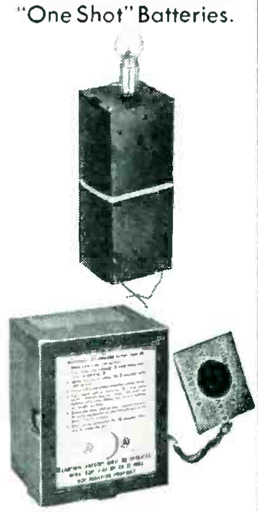
Our engineers will design and create to your requirements. Send us your specifications.

HI-DRIVE MINIATURE MOTOR

Precision-built, low-cost, battery-operated — available for delivery now.

RESERVE TYPES

Water activated "One Shot" Batteries.



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SPECIALTY BATTERY COMPANY
A Subsidiary of the RAY-O-VAC *Ray-O-Vac Company*
MADISON 10, WISCONSIN

making of Flexiform bobbins, they can be readily supplied in shapes and sizes as specified at an economical price. Flanges are flexible rope paper and are fastened to the core by an exclusive process that eliminates swaging. Dielectric kraft paper is used for the core.

Microwave Equipment

WESTINGHOUSE ELECTRIC CORP., P. O. Box 2099, Pittsburgh 30, Pa. A new 2,000-mc microwave system that utilizes microwave radio (type FR) and frequency-division multiplex equipment (type FJ) is available. The microwave carrier is divided into 30 voice channels or equivalent telegraphic functions (15 per voice channel) by the type FJ multiplexing equipment. The multiplexing equipment was designed specifically for use with the microwave equipment and provides maximum flexibility of arranging various combinations of services on the channels. The basic units of the type FR microwave radio equipment are the same for both terminal and repeater station assemblies. Either type of assembly requires a single fixed rack or cabinet, and each is readily changeable from one type of operation to the other to facilitate system expansion.

Insulated Test Clips

INDUSTRIAL DEVICES, INC., Edgewater, N. J. Model 1410A test clips feature a plastic insulation that covers the entire clip, including the nose, without the bulkiness of rubber boots or insulating tape. They can be used in pairs as a

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source of power for equipment under test without the danger of a short circuit due to the clips touching each other or other components. In use on test equipment leads, the clips may be changed from one connection to another without cutting off the power in the equipment. A highly-efficient nylon insulation conforms to the shape of the metal clips thus allowing the same degree of flexibility and easy handling as bare metal clips. A nylon sleeve is threaded to the clip for easy connection to leads. Terminals are provided for either a soldered or screw terminal connection. Strain relief is provided by means of usual wire clamps.

Literature

Product Catalog. Phalo Plastics Corp., 25 Foster St., Worcester 8, Mass., has available a 46-page booklet that features easy reference indexing of all the company's major product groups. It shows the company's important strides in the manufacture of insulated wire and cables and cord set assemblies for electronics, electrical manufacturing, radio, television, communications and industrial applications.

Photoelectric Densitometer. Photovolt Corp., 95 Madison Ave., New York 16, N. Y. Bulletin No. 800 announces the model 525 photoelectric densitometer for chromatography. The instrument described and illustrated is designed for the evaluation of filter paper strips and sheets as obtained by partition chromatography and paper electrophoresis. Included are a reference list and a page showing prices for the complete line.

Paste Solder. Fusion Engineering, 4504 Superior Ave., Cleveland 3, Ohio. Bulletin TE-400 describes Electro-Tin, a new material designed to cut out costs, save time and increase production wherever soldering and dip tinning are used. Electro-Tin finds wide application in all fields of assembly and wiring where soft solders are used. The material described is a combination

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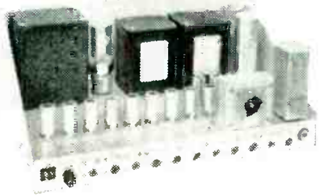

S178A

ANTENNA MULTICOUPLER

Operates 10 Receivers from One Antenna

- Antenna Impedance 50-1000 ohms
- Frequency Range 2-20 Mc
- Rack Mounting
- Used and Approved by many Government Agencies
- $308.00 FOB Washington, D. C.

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WESGO ALUMINA CERAMIC INSULATORS

- High purity . . . free of all impurities such as Iron, Titania, Alkali group elements.
- Made to various formulations with Alumina content from 94% to a pure sintered Alumina with 99.85% minimum Al_2O_3.
- Available in porosities ranging from 20% to an impervious, vacuum tight body.
- Formed to dimensional tolerances of plus or minus ½%, minimum of plus or minus .001″.
- Completely homogeneous structure.

Our Engineering Department will gladly answer all inquiries relative to your particular problems.

WESTERN GOLD & PLATINUM WORKS
Ceramic Division
589 BRYANT ST., SAN FRANCISCO, CALIF.

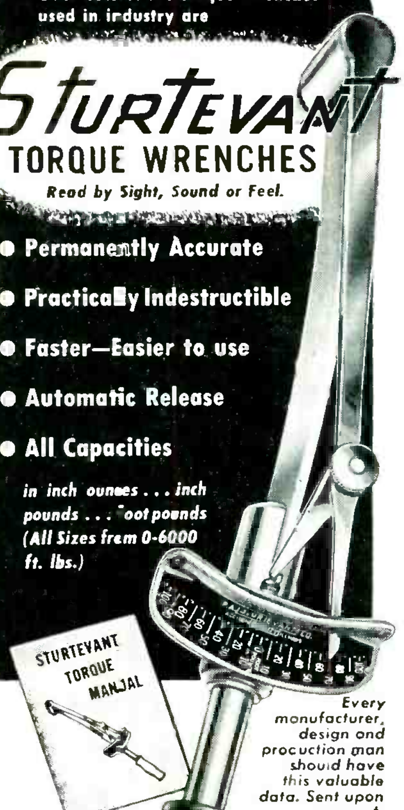
Over 85% of the torque wrenches used in industry are

Sturtevant TORQUE WRENCHES

Read by Sight, Sound or Feel.

- Permanently Accurate
- Practically Indestructible
- Faster—Easier to use
- Automatic Release
- All Capacities

in inch ounces . . . inch pounds . . . foot pounds (All Sizes from 0-6000 ft. lbs.)

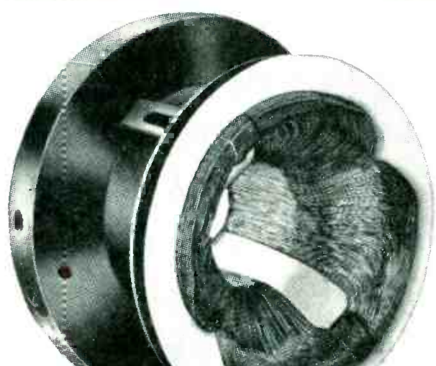


Every manufacturer, design and production man should have this valuable data. Sent upon request.

P.A. STURTEVANT CO.
ADDISON QUALITY ILLINOIS

DX Announces

a NEW 90° YOKE for 27″ TUBES



It's Engineered for TOP PERFORMANCE ... in Production NOW!

This new DX 90° Deflection Yoke has everything a television receiver manufacturer wants . . . a sharp full-screen focus, a minimum of pincushioning, the ultimate in compactness and a price that's downright attractive. Because this yoke has been brilliantly designed for mass production on DX's specialized equipment, it warrants immediate consideration in your 27″ receiver plans. Write us today.

DEFLECTION YOKES . . . TOROID COILS . . . CRYSTALS
I. F. TRANSFORMERS . . . R. F. COILS . . . DISCRIMINATORS
SPEAKERS . . . TV TUNERS . . . ION TRAPS . . . TRANSFORMERS

DX COMPONENTS "the heart of a good television receiver" TRADE MARK

DX RADIO PRODUCTS CO.
GENERAL OFFICES: 2300 W. ARMITAGE AVE., CHICAGO 47, ILL.

of newly developed organic, fast-acting fluxing agents in which is dispersed finely divided metal tinning agents. The combination of the two makes possible soldering under difficult conditions, using nonacid, neutral materials superior to ordinary rosin, and yet possessing characteristics of strongly active acid fluxes.

Potentiometers. Helipot Corp., South Pasadena, Calif. Bulletin No. 128 on the new AJ series potentiometers was recently issued. It contains general features of the AJ, AJS and AJSP models, as well as drawings, specifications and special features of all three models.

Demineralizer. Penfield Mfg. Co., Inc., 19 High School Ave., Meriden, Conn. The purity of the water used in compounding coating solutions and preparing tv tubes, infrared and fluorescent lamps often is a real problem to manufacturers of such products. The demineralizers described and illustrated in technical bulletin 023 offer a completely automatic method of producing the extremely high purity water required for both washing molded glass and preparing coating solutions—at a fraction of the cost of distilled water.

Magnetic Tape for Instrumentation. Audio & Video Products Corp., 730 Fifth Ave., New York, N. Y. A single-sheet bulletin announces the type 109 Scotch brand data recording tape developed by the Minnesota Mining and Mfg. Co., for data recording, telemetering, shock and vibration measurements, geophysical applications, computer work and industrial research. The tape described, factory tested and preselected for minimum count of nodule or surface imperfections, is shipped in hermetically-sealed containers and comes in $\frac{1}{4}$-in. $\frac{1}{2}$-in., $\frac{3}{4}$-in. and 1-in. widths up to 4,800 ft in length.

New Reproducer. Jensen Mfg. Co., 6601 Laramie, Chicago, Ill. Technical bulletin No. 4 describes four-channel high-fidelity system. It gives constructional information for the Transflex bass reflex trans-

mission line unit and associated 45-cycle crossover network for the frequency range adjacent to the lower limits of audibility. The unit described is a unique arrangement quite compact in terms of the wavelengths involved.

Coax Components and Test Equipment. Microlab, 301 S. Ridgewood Rd., South Orange, N. J. Catalog No. 4 gives an 8-page treatment of a line of coaxial components and test equipment. Included among the items illustrated and technically described are fixed pad attenuators, low-pass filters, coaxial terminations, power-line filters and frequency multipliers. A price list has been inserted.

Miniature Snap Switch. Tyniswitch Division, The Sessions Clock Co., Forestville, Conn. A 6-page bulletin on the construction and operational characteristics of Tyniswitch has just been published. A low-cost, high-rating miniature switch, the specifications and standard adaptations of Tyniswitch are fully described and detailed.

Screw Locking Insert. Brush Nail Expansion Bolt Co., Greenwich, Conn. A recent four-page folder describes and illustrates the knurled insert, a screw locking insert that is distinguished by a large band of diamond knurling on its grip area. Its three-stage principle of operation is shown. Recommended hole sizes and ordering information are included.

Silicone Rubber O-Rings. Bacon Industries, Inc., 192 Pleasant St., Watertown, Mass. Technical data sheet No. 103 provides detailed specifications of silicone rubber O-rings. A feature of the O-rings, as pointed out in the literature, is the special manufacturing method used which makes allowance for the shrinkage factor encountered with silicone rubber and therefore assures O-rings which have the exact dimensions specified. The full information contained in the data sheet on the dimensions of both regular and special sizes and a detailed table of tensile strength, hardness, compressibility and other features, provide the reader with a

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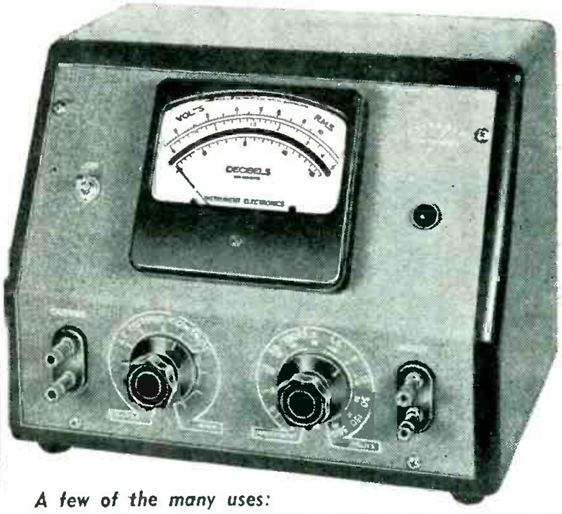
50 MICRO VOLTS TO 500 VOLTS

MODEL 47 VOLTMETER



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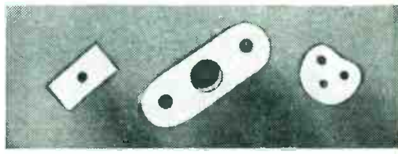

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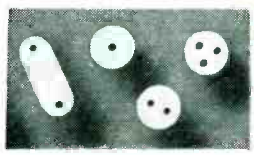

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The expanding Electronics Division of Westinghouse has a number of desirable sales and application engineering positions open for men well qualified in one or more of the above fields. These openings require technical graduates with good personalities and business sense, men who like to meet people and work with them on a broad range of equipment application problems rather than specializing in a narrow field of design. Previous technical sales experience is desirable but not necessary.

Permanent positions are available at Headquarters (Baltimore) as well as in various sales offices throughout the country. The latter positions generally require training at Headquarters for a period depending on previous experience.

All these positions offer top pay, commensurate with ability and experience, with excellent opportunity for advancement on merit. They carry the usual generous employe benefits offered by Westinghouse—low-cost group life and hospitalization insurance, an excellent retirement plan, graduate study opportunities and paid vacations. Re-location allowances will be made by the Company.

Send resume of qualifications to:

Manager, Industrial Relations, Dept. CK
Westinghouse Electric Corporation
109 West Lombard St.
Baltimore 1, Md.

Want more information? Use post card on last page.

convenient compilation of important data.

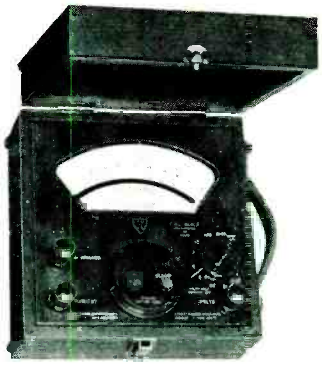
Transformer Engineering Bulletins. Sylvania Electric Products Inc., Ipswich, Mass. Bulletins T-101 and T-102 cover two different transformers. They deal with the MIL-T-27 specifications for electronic equipment transformers and the ruggedized miniature cast resin type. Included are classifications, requirements, ratings and applications. An extra sheet gives full technical data for the entire line.

Instrument Transformers. General Electric Co., Schenectady 5, N. Y. The 1953 edition of the company's instrument transformer buyer's guide contains basic, up-to-date information on the complete line. The fully illustrated, 102-page publication, GEA-4626F, contains ratings, ASA accuracy classifications, and prices of all GE indoor and outdoor potential and current transformers. Listings of ratio and phase-angle tests, together with tables covering the mechanical and thermal limits of current transformers, are included.

Power Pentode. Lewis and Kaufman, Ltd., 50 El Rancho Ave., Los Gatos, Calif. A new technical data sheet for Los Gatos brand 4E27A power pentode illustrates the tube, provides dimensions, general electrical characteristics, and constant current characteristics under two modes of operation: 500 screen volts, zero suppressor volts; and 500 screen volts, 60 suppressor volts. Maximum ratings and typical operation data are given for: class-C r-f power amplifier and oscillator (class-C telegraphy, f-m telephony), class-B a-f power amplifier and modulator and class-C r-f plate-modulated amplifier.

Transformer Laminations. Allegheny Ludlum Steel Corp., 2020 Oliver Building, Pittsburgh 22, Pa., is presenting a greatly expanded description of laminations in the fifth edition of its transformer lamination catalog. Included are technical information and full-size drawings of all the available standard shapes. Each lamination is provided with a

RAWSON METERS



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Resistance exceeds million megohms.
Can measure static electricity.

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Developed for use as potential dividers in high voltage electrostatic generators, S.S.White 80X Resistors have many characteristics—particularly negative temperature and voltage coefficients—which make them suitable for other high voltage applications.

They are constructed of a mixture of conducting material and binder made by a process which assures adequate mechanical strength and durability. This material is non-hygroscopic and, therefore, moisture - resistant. The resistors are also coated with General Electric Dri-film which further protects them against humidity and also stabilizes the resistors.

WRITE FOR BULLETIN 4906

It gives complete information on S.S.White resistors. A free copy and price list will be sent on request. Send for a copy.

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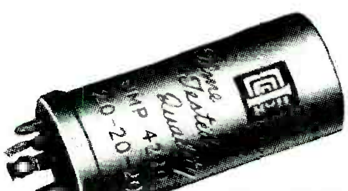

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Many, many notable advances in the art of capacitor design and manufacture have been made by the ILLINOIS CONDENSER COMPANY. As an example, ILLINOIS CONDENSER COMPANY has recently been awarded a patent on their unique and exclusive molded capacitor construction as featured in the UMP types.

For almost two decades, ILLINOIS CONDENSER COMPANY has been building quality capacitors and regular users include most all of the largest manufacturers of TV and radio sets. Their names literally compose the "blue book" of electronics.

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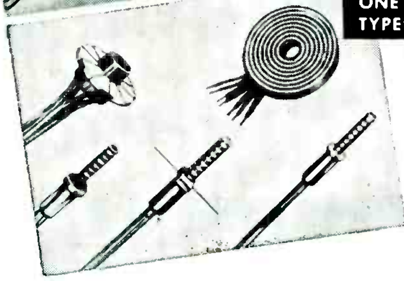
ALL TYPES OF CONSTRUCTION NOW AVAILABLE AT LOW COST

MOLDED OR FABRICATED TYPES FOR LOWEST POSSIBLE COST

Assemblies of these types can be supplied at low cost. Quality is the highest in the industry. Dimensional accuracy and other characteristics are excellent and these units are highly recommended for instruments such as synchros.



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INSTRUMENT CORP. OF AMERICA BLACKSBURG, VIRGINIA weight table to assist in ordering. The company's magnetic shield fabricating facilities are also described.

Coil Winding Machine. Universal Winding Co., P. O. Box 1605, Providence, R. I. A four-page bulletin covers the No. 108 quick-set-up coil winder for hand-feed paper-insulated coils in stick form. It contains a very well illustrated description of the unit, an outline of special design features, and complete technical specifications.

Audio-Radio-TV Equipment. David Bogen Co., Inc., 29 Ninth Ave., New York 14, N. Y. "Electronics for Audio-Radio-Television," a 24-page, illustrated, three-color booklet, reveals the design features, specifications and prices of the company's extensive line of amplifiers, p-a systems, tv boosters and allied equipment. Associated lines described in the new bulletin are transcription players, baffles, reproducers, high-fidelity amplifiers, tuners and speakers, trumpets, line-matching transformers, microphones and accessories.

TV Tube Complement List. Mullard Ltd., Century House, Shaftesbury Ave., London WC2, England, has available a wall chart giving the tube complements of all the company-equipped tv receivers marketed since 1950. Covering 24 different makes and nearly 150 different types of receivers, it serves as a much-needed guide to tv tube-stocking as well as being an invaluable reference for service engineers. The chart is printed on a single sheet and has been specially designed so that the receiver type and tube type numbers can be easily correlated. It is in three colors.

Thermocouple Gage Control Circuit. Scientific Specialties Corp., Snow and Union Sts., Brighton Station, Boston 35, Mass. Model V-32 thermocouple gage control circuit that is designed to operate with the RCA type 1946 thermocouple gage tube or equivalent, and measures pressures in the range 0.001 to 1 mm Hg is described and illustrated in a single-page bulletin. The unit discussed in the bulletin is op-

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(PREFERABLY COMPONENTS)

Presently covering both the radio-TV and military electronic industries in N. Y. C., Northern N. J. and Long Island.

RA-7248, Electronics
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standing wave indicator SW-12...

The SW-12 Standing Wave Indicator is designed to measure the standing wave ratio within a waveguide or coaxial system used to transmit pulses of R.F. power. It can also be used as a null detector in bridge measurements. SW-12 can be used with both square law crystal detector or bolometer probes. The meter is calibrated directly in VSWR.

INPUTS: Input 1—R.F. probe with crystal rectifier
Input 2—R.F. probe with bolometer

FREQUENCY RESPONSE: Flat within 3 db from 500 to 2000 cps. Can be used down to 200 cps.

SENSITIVITY: 400-500 cps — 20 microvolts full scale
500-2000 cps—15 microvolts full scale
2000-3500 cps—20 microvolts full scale

INPUT IMPEDANCE: 250 ohms nominal

OUTPUT METER CALIBRATION:
SWR scale from 1:1 to 4:1
Linear scale from 0 to 10

LINEARITY: 5% variation in linearity from 15% of full scale to full scale meter reading.

POWER REQUIREMENTS: 115 VAC single phase, 35 watts, 50—800 cps.

TUBE COMPLEMENT: 2—6SJ7 1—6H6
1—6V6GT 1—6X5GT

SPECIAL FEATURES: Shock resistant non-microphonic construction.

DIMENSIONS: Height 8⅞"
Width 8 11/16" Length 16 5/16"

WEIGHT: 20 lbs.

CASE: Cabinet with side handles.

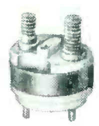
FINISH: Hammertone grey case and satin aluminum panel.

TRIAD TELEVISION CORPORATION
1001 FIRST AVENUE
ASBURY PARK, N. J.

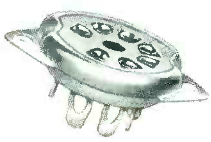
ELECTRICAL INSULATION THAT WILL TAKE 2000° F. FOR BRIEF PERIODS!

Aircraft fire detection apparatus needs that. Here is the Mycalex glass-bonded mica part that has it.

Mycalex 410 molded with steel ring inserts for thermocoupling device produced by Thomas A. Edison, Inc.



● For permanent endurance Mycalex can take 650°F. continuously without heat distortion or any other injury.



ACTUAL SIZE

Mycalex is superior for high voltage, high frequency components that must operate in small spaces.

For example, tube sockets like these — now used in over 60% of all television receiver tuners. — Manufactured and sold by Mycalex Tube Socket Corporation, Clifton, N. J.

If your insulation must take heat or get rid of heat, investigate Mycalex!

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MYCALEX
THE INSULATOR ®

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World's Largest Manufacturer of Glass-bonded Mica Products

Executive Offices: 30 Rockefeller Plaza, New York 20, N.Y.

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PIX WIRE FORMING SPECIALISTS

Precision Parts to meet your Production and Engineering needs. From .002" dia. to .125" dia. Radio tube parts—Stampings—Drawings Modern facilities, high-production equipment.

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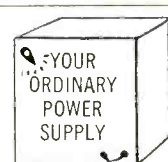

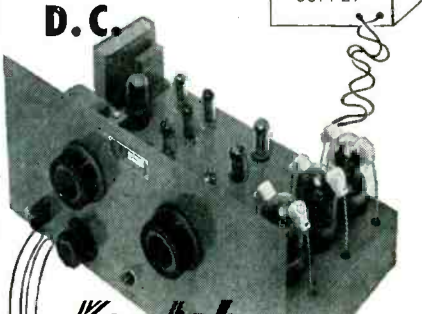

Kay-Lab

SUPER-REGULATOR

OUTPUT IMPEDANCE 0.005 OHMS
NOISE-RIPPLE UNDER 100 MICROVOLTS
STANDARD CELL STABILITY AVAILABLE

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KALBFELL LABORATORIES, INC.

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Advertising men agree—to do a complete advertising job you need the double effect of both Display Advertising and Direct Mail.

Display Advertising keeps your name before the public and builds prestige

Direct Mail supplements your Display Advertising. It pin-points your message right to the executive you want to reach —the person who buys or influences the purchases.

In view of present day difficulties in maintaining your own mailing lists, our efficient personalized service is particularly important in securing the comprehensive market coverage you need and want.

Ask for more detailed information today. You'll be surprised at the low overall cost and the tested effectiveness of these hand-picked selections.

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erated on 110 v, 60 cycle a-c and consumes approximately 10 w. Prices are included.

Miniature Clutch. High Precision Inc., 375 Morse St., Hamden, Conn., has prepared a folder suggesting possible uses and giving specifications for a line of miniature overrunning clutches, known as Miniclutch. Typical applications of the units described are recording instruments and business machines, motion-picture projectors, ratchet-feeds, servomechanisms and control devices such as are used in gun-pointing equipment.

Terminal Boards. Aircraft Radio Corp., Boonton, N. J. A new 4-page brochure deals with ceramic insulated terminal boards developed for use in airborne receivers and transmitters and in signal generators and other industrial electronics equipment where reliable, long operation under extremes in temperature and moisture is important. The boards described are fungus proof and arc resistant. Comprehensive diagrams and photographs of the boards are featured as well as illustrations of typical applications.

Transistor Test Equipment. Transistor Products, Inc., Snow and Union Sts., Brighton Station, Boston 35, Mass. A single-sheet bulletin illustrates and describes the model T-61, a device designed to test the small signal behavior of all point contact and junction transistors. The theory of operation outlined shows the emitter current, collector current, emitter voltage, collector voltage and characteristics measurement ranges. The unit's accuracy is described and price is included.

Regulated H-V Power Supply. Scientific Specialties Corp., Snow and Union Sts., Brighton Station, Boston 35, Mass. A single-page bulletin illustrates and describes the PS-22 electronically regulated supply that is designed for use with photomultiplier tubes, counters, and other devices requiring a closely regulated well stabilized voltage. Output, regulation, input power and mounting information are given. Prices are included.

PLANTS AND PEOPLE

Edited by WILLIAM G. ARNOLD

OTHER DEPARTMENTS
featured for this issue:

Expansion of RTMA Proposed At Board Meeting

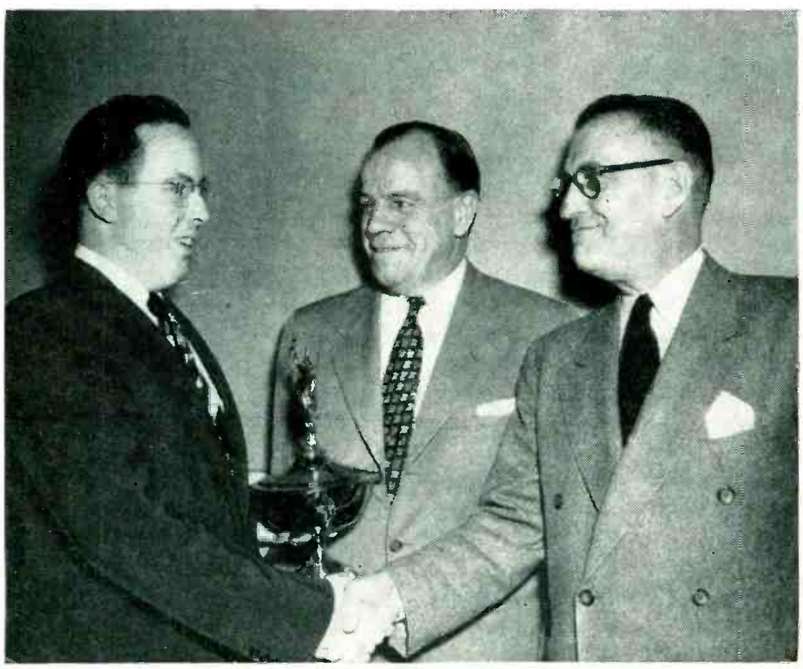
THE RTMA board of directors accepted in principle the recommendations of a special committee of the technical products division calling for expansion and reorganization of the Radio-Television Manufacturers Association to provide greater recognition for manufacturers in the advanced electronics field. The action climaxed a recent 3-day industry conference.

President A. D. Plamondon, Jr., referred to an expanded organization committee a report presented by director E. K. Forster and C. B. Thornton, of Hughes Aircraft Co.

The major recommendations of the committee were that RTMA change its name to the Electronics Manufacturers Association, or some similar name, a division for manufacturers of advanced electronics products be established within the association, and the engineering department be expanded and technical standards and contract specifications be developed for advanced electronics products in the military and commercial sales areas.

Mr. Thornton, in presenting the report prepared by Mr. Foster and himself, pointed out that the electronics industry has expanded greatly since World War II and that for the last three years the dollar volume of sales of electronics equipment to the Armed Services has exceeded that in the commercial equipment field, including radio and tv sets.

MULLICAN WINS EDISON RADIO AMATEUR AWARD



Don L. Mullican of Searcy, Ark., who helped rally emergency aid to tornado-stricken Arkansas in March of 1952, received congratulatory handshakes from W. R. G. Baker, GE vice-president, and J. Milton Lang, general manager of the GE tube department, after he received the Edison Radio Amateur Award for outstanding public service by a radio amateur during 1952. Don, a 20-year-old Bible student at Harding College in Searcy, stuck to his radio amateur rig almost without relief for more than five days to bring emergency help to Searcy and the nearby towns of Judsonia and Bald Knob

L. W. Teegarden

Teegarden Elected Executive Vice-President Of RCA

ELECTION of L. W. Teegarden as executive vice-president of the Radio Corporation of America was announced by Frank M. Folsom, president.

Mr. Teegarden, a pioneer merchandiser, has been active in the electronics industry for many years. Prior to assuming his new post, Mr. Teegarden was vice-president in charge of technical products of the RCA Victor division. In this position, he supervised the activities of both the engineering products department and of the tube department.

"Under Mr. Teegarden's leadership, the activities over which he has had responsibility have attained new high levels of success," said Mr. Folsom. "His election to the post of executive vice-president of RCA is fitting recognition of his administrative achievements over

Want more information? Use post card on last page.

the many years he has been with RCA."

Since joining RCA in 1930 as a district sales manager, Mr. Teegarden has held increasingly responsible positions on behalf of RCA Victor activities. In 1936, he became the first to serve as regional manager with responsibility for the merchandising of all RCA Victor products. His success in establishing this position led to the formation of a regional organization on a nation-wide basis.

Six years later Mr. Teegarden was named assistant general sales manager of all RCA Victor product activities. He was appointed general manager of the tube department in 1944, and a year later was named vice-president in charge of this department.

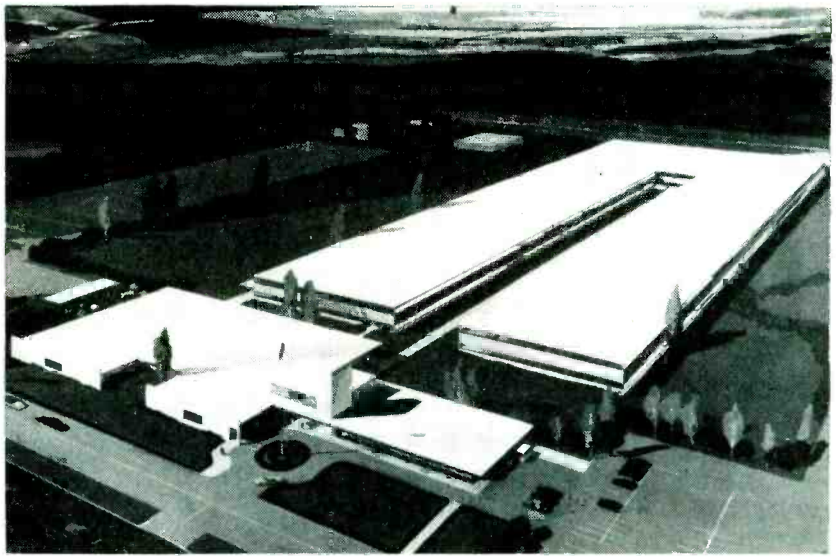
Under his direction, the tube department achieved mass production of television picture tubes for home receivers.

Mr. Teegarden's responsibilities were increased in 1949 to include supervision of RCA Victor's engineering products department, which has since established new sales records under his direction.

PACKARD-BELL BREAKS GROUND

Company executives at Packard-Bell ground-breaking ceremonies for the $750,000 addition to its tv and radio plant were, left to right: Robert S. Bell, executive vice-president; Herbert A. Bell, president and founder, and Joe M. Spain, vice-president. The new 95,000 sq ft building will contain two units: a division for milling and assembling tv cabinets, and an electronics section for government contracts

Beckman Begins Construction On $2 Million Plant



ARNOLD O. BECKMAN, president and founder of Beckman Instruments, Inc., officially broke ground recently for the new $2 million, 200,000 sq ft instrument factory and administrative offices to be erected on a 40-acre site in the La Habra-Fullerton area of California. First occupancy of the plant is scheduled for midsummer.

Westinghouse To Buy Philco's TV Station WPTZ

E. V. HUGGINS, president of Westinghouse Radio Stations, Inc., and James H. Carmine, executive vice-president of Philco Corp., announced jointly that Westinghouse had arranged to purchase tv station WPTZ in Philadelphia from Philco. Approval of the FCC is being sought. Acquisition of the station will involve approximately $8.5 million.

In commenting on the proposed transfer of ownership, Mr. Carmine said, "Sale of station WPTZ, at this time, will enable Philco to concentrate its activities in its principal fields of research, development and production of tv receiving sets, radios, and major appliances which are merchandised through its distributors and dealers, and the manufacture of electronic equipment for government and industry."

Mr. Higgins said, "This is another step toward completion of our plans to bring additional service to the millions of people living in areas served by Westinghouse."

After approval of the purchase by the FCC, WPTZ will become the second tv station to be operated by Westinghouse. The first is WBZ-TV in Boston.

Federal Elects Maginnis V-P And Chief Engineer

THE ELECTION of William P. Maginnis as vice-president and chief engineer of Federal Telephone and Radio Corp. was announced by Henry C. Roemer, president of Federal.

Mr. Maginnis, who will direct telephone, radio and vacuum tube engineering for Federal, joined the company in 1951. He was with RCA for 21 years and headed components engineering at the RCA Camden plant prior to joining Federal. Previous to his Camden assignment, Mr. Maginnis was chief engineer at the RCA manufacturing plant in Bloomington, Ind.

Graduating from the University of Pennsylvania in 1929, Mr. Maginnis started his career in com-

SUPER REGULATED VOLTAGE & CURRENT STANDARD

TYPE M–DC–2

For Accurate Calibration of D. C. Voltage and Current Instruments

THE SUPER REGULATED VOLTAGE & CURRENT STANDARD provides simple, accurate calibration of D. C. Voltmeters and Milliameters. It is an accurate voltage or current source for Analog Computer instrumentation. The instrument is a rugged, dependable secondary standard for general laboratory and production use, which replaces the Potentiometer and its accessories, i.e., Galvanometers, Standard Cells, Power Supplies, and Precision Resistors.

The instrument is a super regulated power supply with an internal reference standard cell, precision resistance decade and precision load. It is required wherever accurate D. C. current and voltage standards are maintained.

SPECIFICATIONS

OUTPUT:
0 to 109.99 Volts D. C.
(in 0.01 volt steps)
0 to 109.99 mA D. C.
(in 0.01 mA steps)

ACCURACY:
Voltage, 0.05% of indicated voltage.
Current, 0.05% of indicated current.

RIPPLE:
Less than 0.08 millivolts at full voltage output.

LOAD IMPEDANCE:
Full scale voltage,
Load may be as low as 1000 ohms.
Full scale current,
Load may be as high as 1000 ohms.

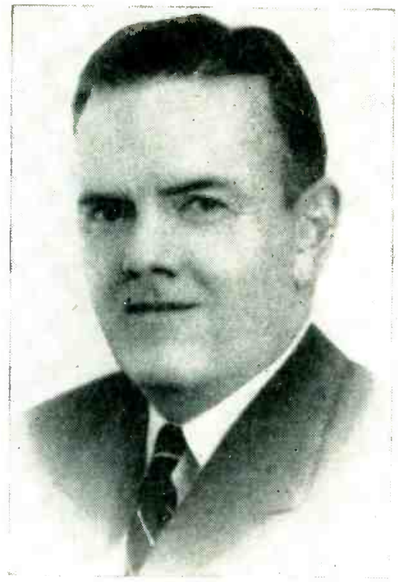
LOAD DEPENDENCE:
Within the range specified, the load dependence is included in the accuracy of the calibrator and automatically compensated for.

INPUT POWER:
105-125 Volts, 60 cycle, 150 Watts maximum.

MOUNTING:
Aluminum cabinet or relay rack.
Panel size, 19" x 8¾", depth 16".
Net weight 40 pounds.
Shipping weight 65 pounds.
(Data subject to change without notice.)

RADIATION, INC.

MELBOURNE, FLORIDA



William P. Maginnis

munications engineering at the Bell Telephone Laboratories, Inc., in New York. In 1930 he left Bell to begin his long association with RCA.

Clevite Acquires Transistor Products

CLEVITE CORP. announced recently that it is acquiring a majority stock interest in Transistor Products, Inc., of Boston, Mass.

Transistor Products, Inc. was formed in March, 1952 to engage in the development and manufacture of transistors and diodes. Roland B. Holt, formerly director of the Nuclear Research Laboratory of Harvard University, is president. The company has a license from Western Electric Co. and is producing transistors on a small scale.

Development work in the transistor field has been going on in the Clevite group for several months. Brush Electronics Co., a Clevite subsidiary, is also licensed by Western Electric. This development program will be consolidated with that of Transistor Products, Inc., it was stated.

CBS-Hytron Plans New TV Tube Plant

PLANS for the construction of an ultra-modern tv picture tube plant and warehouse in Kalamazoo, Mich., were announced by Bruce A. Coffin, PREMAX

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Ground Rods

Low cost drawn steel Ground Rods, heavily copper plated to insure perfect electrical contact—and pointed for easy driving. In 4,' 6' and 8' lengths, ⅜ to ⅝" diameter. Send for Bulletin and prices, and use Premax in your TV installations.

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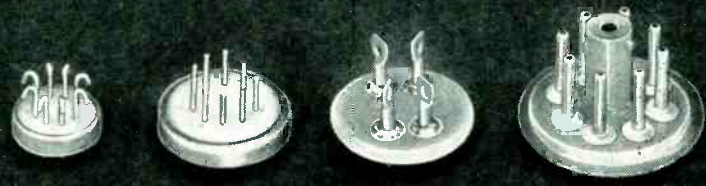

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PARTIAL CONTENTS: Fourier-transform method. Response of an ideal low-pass filter to a step voltage. Physical significance of response curves. Response to a pulse series. Determination of network response by Fourier transforms. Use of partial fractions in the solution of transform problems. Laplacian transform and inverse Laplacian of a step voltage. Typical network problems using L transforms. High-pass RC filter. Pulse transformers. Step-voltage build-up time response of a step-down transformer. Delay-time response. Special coaxial delay lines. Design of lumped lines. Supersonic delay lines. Shunt-peaking amplifier. Four-terminal coupling networks. Transmission-line amplifiers. Cathode follower. Limited circuits. Clipping circuits. Peak-riding clipper. Integrating circuits. Positive-bias restorer. Electron-coupled pulse oscillators. Relaxation oscillators. Multi-vibrators. Sweep circuits. Time calibration. Pulse-counting systems. Commutation. Modulation. Synchronization. Commercial pulse communication system. Introduction to radar systems. Timing unit. Radar receiver. Navar system. Lorain system. **Get this authoritative handbook today! Coupon below brings you "Pulse Techniques" on FREE trial for 10 days. Mail it NOW.**

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president of Hytron Radio and Electronics Co. The new manufacturing facilities form part of the company's expansion plans to answer the growing demands of the tv industry.

The new Kalamazoo plant is scheduled for occupancy in June 1954, when production will start. It is expected that the full operating rate of production will be reached by the fall of 1954. The 235,000 sq ft plant has been designed for production of the new large-screen tv picture tubes under the direction of Charles F. Stromeyer, CBS-Hytron's vice-president in charge of engineering and manufacturing. The manufacturing equipment will incorporate the latest automatic techniques in the manufacture of the large 21-inch to 30-inch picture tubes.

Raytheon Forms Special Products Division

THE FORMATION of a Special Products Division of the Raytheon Television and Radio Corp. was announced recently by H. C. Mattes, executive vice-president.

Raul H. Frye, formerly director of research and engineering for the company, was named general manager of the new division. His duties include complete supervision of all planning, research and production for the division, reporting to W. L.


Raul H. Frye

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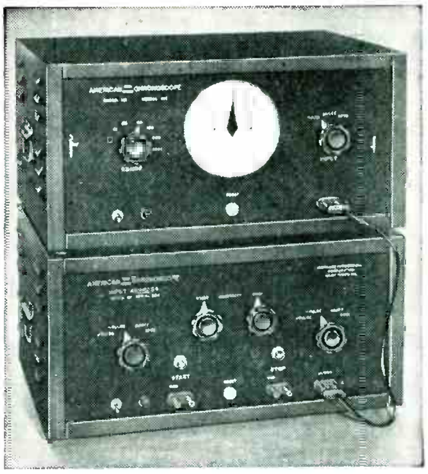

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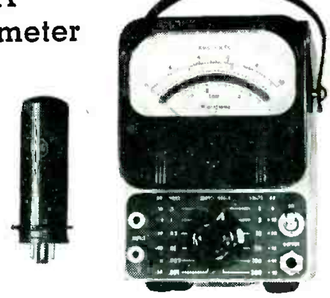

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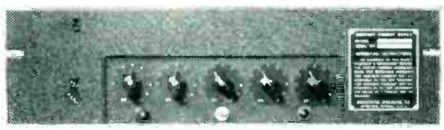

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Dunn, vice-president.

Shortly after his appointment, Frye named Robertson Gannaway, formerly chief technical engineer,

Robertson Gannaway

director of research and engineering for the Special Products Division.

Sylvania To Erect Lab Building

THE RADIO TUBE division of Sylvania Electric Products, Inc. today announced plans to construct a 120,000 sq ft facility in Williamsport, Pa., to house a group of divisional engineering laboratories.

The new laboratories, according to M. J. Burns, general manager of the radio tube division, will be devoted, among other things, to development work and pilot plant operation in radio receiving tubes for military uses; new product development work; fundamental chemical research; and application engineering, including a rating laboratory in which tubes will be evaluated for performance under abnormal conditions. Other research and developmental activities in various fields of electronics also will be undertaken at the new laboratories. Actual construction is not expected to begin until May or early June. The labs will be in full operation soon after the first of next year. Approximately 400 persons will be employed. Ralph P. Clausen, chief engineer of the radio tube division's general engineering department, will have executive direction of the operations of the new laboratories.

Bentley Named Chief Engineer At DuMont

ALFRED Y. BENTLEY has been named chief engineer of the receiver division of Allen B. DuMont Laboratories, Inc., it was announced yesterday by Irving Rosenberg, director of operations of DuMont's receiver and cathode-ray tube divisions.

Mr. Bentley had been chief engineer of the DuMont cathode-ray tube division since 1947. Prior to that time, he was assistant head of the cathode-ray tube engineering department, the position to which he was assigned when he joined the DuMont organization in December, 1945.

Mr. Bentley replaces Robert J. Cavanagh in his new post. Because of the pressure of DuMont's research and development activities, Mr. Cavanagh will return to his original engineering and research post with DuMont's research division.

Consolidated Engineering Makes New Moves

PLANS for the development of "Instrument Park," a landscaped and architecturally controlled industrial community with a "university campus atmosphere," were revealed by Philip S. Fogg, president of Consolidated Engineering Corp. The firm has filed an application with the Pasadena Planning Commission requesting a zone change to permit light manufacturing use of a 20-acre site north of the company's existing plant.

Mr. Fogg also announced the promotion of Hugh F. Colvin, 35-year-old engineer-executive, to the position of vice-president and treasurer of the company,

Election of Kneeland Nunan as executive vice-president and member of the board of directors of Consolidated Vacuum Corp. of Rochester, New York, newly acquired

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Kneeland Nunan

subsidiary of Consolidated, followed Mr. Colvin's promotion. Mr. Nunan, former vice-president in charge of sales, will replace Mr. Colvin at the Rochester operation.

Aerovox Plans West Coast Expansions

AEROVOX CORP. recently announced through its president, W. Myron Owen, the construction of a modern, completely-equipped 50,000 sq ft plant in South Monrovia, California for manufacturing most of the Aerovox line of capacitors. Appointment of George M. Ellis as chief application engineer for all Aerovox divisions in the west was also made known.

The new plant is being made available to west coast manufacturers and distributors as a source of electronic components. Thus, Aerovox becomes the first large eastern capacitor manufacturer to establish west coast manufacturing facilities. Construction of the new plant is expected to get under way very shortly and it is estimated that the facility will be in operation early this summer.

Mr. Ellis was formerly vice-president and chief engineer of Acme Electronics, Inc., a subsidiary of Aerovox Corp. In addition to his new duties, Ellis will continue as vice-president of Acme, according to Hugh P. Moore, president of the division.

Mr. Moore has appointed D. A.

Gehlke as Acme's new chief engineer to succeed Mr. Ellis. Mr. Gehlke formerly was associated with Bendix, Lear and Western Electric.

Bloser Named V-P Of Transicoil

DWIGHT W. BLOSER, formerly chief engineer of the Transicoil Corp, was named vice-president of the company, it was announced by William M. Henderson, president. Mr. Bloser's new position involves supervision of the design, engineering and production of control motors, gear trains, induction generators, servo amplifiers and synchros. Prior to joining the company in 1952, he was senior engineer of Kearfott's Motor and Synchro Lab, and served in an engineering capacity with Sperry Gyroscope, Signal Engineering & Mfg. Co., American District Telegraph Co., and the Bendix Aviation Corp. He is a 1933 graduate of Pennsylvania State College.

Dwight W. Bloser

FCC Appoints Miller

COMMISSIONER Robert T. Bartley announced appointment of Kenneth W. Miller to be his engineering assistant. A member of the FCC's engineering staff since 1940, Mr. Miller has recently been serving as assistant U. S. supervisor for CONELRAD in the office of the chief engineer.

Mr. Miller was an engineer in the

common carrier branch of the International Division in 1946, subsequently serving as a branch chief on tv broadcast engineering matters and with the office of the chief engineer on international broadcasting and special problems.

Stromberg-Carlson Appoints Engineers

MALCOLM P. HERRICK has been appointed chief engineer and Rudolph G. Miller assistant chief engineer of the Stromberg-Carlson Company's Radio-Television Division, according to C. J. Hunt, general manager of the division. John H. Craft, Jr. has been appointed national service manager of the division.

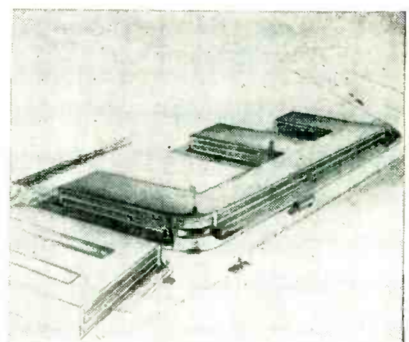
Mr. Herrick has been with Stromberg-Carlson as a staff engineer, engaged in radio and television design and production engineering, since his graduation in electrical engineering from the University of Maine in 1944.

Mr. Miller has been assistant chief engineer with both Colonial Radio and Detrola Corp. From 1945 until the present he has been chief mechanical engineer in Stromberg-Carlson's Radio-Television Division, a post he continues to hold.

Mr. Craft joined Stromberg-Carlson in 1946 as a staff engineer. He was transferred to the company's service department in 1949, to hold training clinics for tv service men throughout the U. S.

Little Plans Second Research Building

IMMEDIATELY adjacent to its recently constructed Mechanical-Division building, Arthur D. Little, Inc.



will build a 60,000 sq ft research laboratory, pictured above. Experimental work in chemistry, chemical engineering, physics, new products and production methods will probably be housed in the building by Jan. 1, 1954. Ground will be broken in April for the two-story E-shaped brick and stone structure, to be located near the Concord Turnpike in Cambridge, Mass. A large auditorium will be incorporated in the building and will be used for seminars and meetings.

Ashman Named President Of Air Associates

ELECTION of J. E. Ashman as president and director of Air Associates, Inc. was announced by the firm's board of directors. His duties include administration of the company's program of product diversification and broadening of markets.

Previously Mr. Ashman was executive vice-president of Rockwell Manufacturing Co., maker of Delta power tools, Nordstrom valves and other products. He also was formerly associated with U. S. Steel and Burroughs Adding Machine.

IRC Founder Is Honored

DR. HAROLD PENDER, educator, inventor and founder of the International Resistance Co., was admitted as Eminent Member into Eta Kappa Nu Association in recognition of his technical attainments and contributions to society through outstanding leadership in the profession of electrical engineering.

Huggins and Baudino Advance At Westinghouse

E. V. HUGGINS has been elected vice-president of corporate affairs for Westinghouse Electric Corp. by the board of directors. This is a newly created position with the company.

Mr. Huggins was also elected president of Westinghouse Radio Stations, Inc. At the same meeting, J. E. Baudino was elected executive vice-president in charge of all operations. Mr. Baudino was formerly general manager of all operations.

Since November of 1951 Mr. Hug-

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gins has been assistant secretary of the United States Air Force with general supervision over the Air Force's world-wide installations, its overseas and off-shore procurement program, and relationships with civil aviation. Mr. Huggins had resigned as executive vice-president of the Westinghouse Electric International Company to accept the Air Force assignment.

Mr. Baudino joined Westinghouse in 1927 after graduation from the University of Illinois. He has been associated with Westinghouse broadcast activities since that time, serving in engineering, business and management capacities in Pittsburgh, Boston, Philadelphia and Washington.

New Clare Relay Plant Completed

THE NEW relay manufacturing plant of C. P. Clare & Co., just completed on Chicago's northwest side,

covers 50,000 sq ft. As shown above, it is of one-story windowless design, with the exception of a large glass area for the reception room in the front of the building. Production facilities are being moved to the new plant as rapidly as possible.

Williford Elected President Of Link Aviation

E. ALLAN WILLIFORD has been elected president of Link Aviation, Inc. by the firm's board of directors. He succeeds Edwin A. Link, founder of the company, who continues as chairman of the board and director of research.

Mr. Williford has been vice-president and general manager of the Link firm since he joined the company in 1950. A graduate of the University of Illinois, Williford was previously associated with Union

Carbide and Carbon Co. for 24 years, during which he rose from salesman to general sales manager of the carbon products division of National Carbon Co.

In 1945 he became vice-president of General Analine and Film Corp. and general manager of its Ansco division in Binghamton, N. Y., resigning this position in 1949. Soon after he became associated with Link.

Kleinschmidt Honored

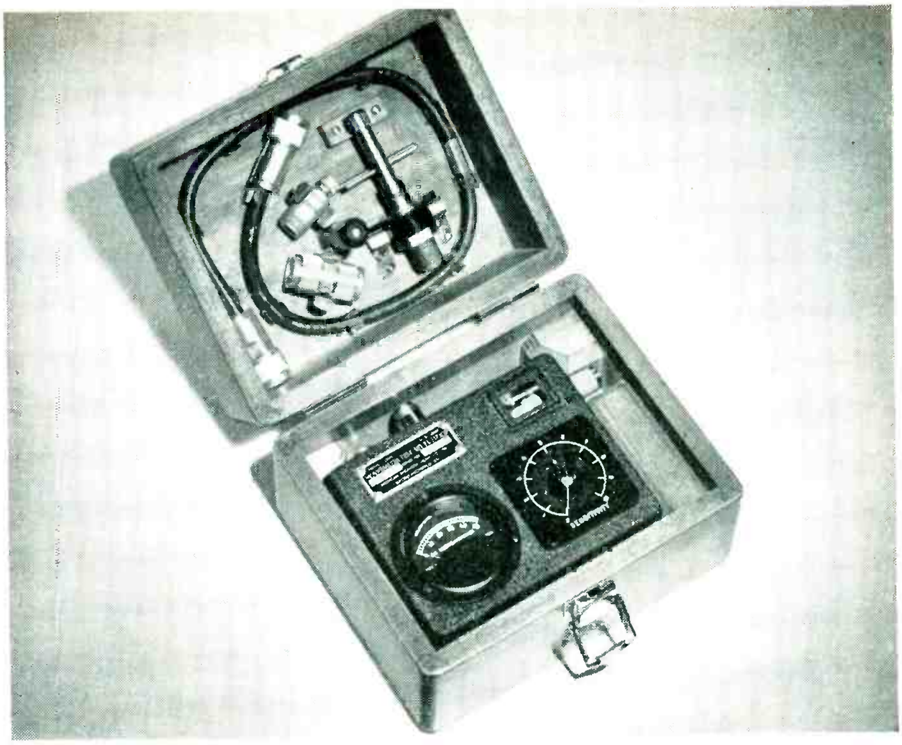
EDWARD E. KLEINSCHMIDT, founder and president of Kleinschmidt Laboratories and inventor of teletype and the new portable teletypewriter, was awarded a special citation by the Chicago chapter of the Armed Forces Communications Association, for "his distinguished contributions to the progress of civilian and military communications particularly in the field of printed, electrically transmitted messages."

Edward E. Kleinschmidt

Collins To Expand Dallas Plant

COLLINS RADIO CO. is adding 35,500 sq ft to its 50,000 sq ft building in Dallas, Texas, it was announced by James G. Flynn, Jr., general manager of the Texas division.

The firm began its operations in



Dallas about 1½ years ago with a 25,000 sq ft building, and a few months later moved into an additional plant. The new addition will bring total square footage in the area to 110,500 sq ft.

The new wing includes a 4,000 sq ft cafeteria for employees and 4,000 sq ft of additional office space, with the remaining area being used for manufacturing. The company expects to have more than 1,000 employees on the payroll by early spring.

General Porter Joins Ultrasonic Board

ELECTION of General William N. Porter as a director of Ultrasonic Corp. was announced by Harold W. Danser, Jr., president. General Porter is president of Chemical Construction Corp., a wholly owned

General William N. Porter

subsidiary of American Cyanamid Company which is engaged in engineering and construction of chemical and metallurgical processing plants throughout the world. A graduate of the U. S. Naval Academy in 1909, General Porter was chief of the Chemical Warfare Service from 1941 through 1945.

Bendix Names Walz

APPOINTMENT of Richard F. Walz, former sales engineer for Audio Products Corp., to Bendix Computer's administrative staff was announced by Palmer Nicholls, vice-president. He will serve as sales and engineering aide to Maurice W. Horrell, assistant general manager of the division.

Walz directed the initial installation of instrument landing equipment at Los Angeles International Airport in 1942 as project engineer for International Telephone Development Corp. In 1946 he was named chief radio engineer for Air-Associates, Inc., and in 1948 established the Walkirt Co. as co-owner. At Walkirt he developed the circuitry and packaging techniques for which the company is known. He sold his interest in 1950 and joined the staff of Audio Products.

GE Modernizes Plant

A $400,000 modernization program has been launched by the General Electric Co. at its Bleeker Street plant in New York City, according to an announcement by plant manager Frank Greene, Jr.

The program will involve the installation of machinery to be used in the manufacture of polystyrene cabinets for clock radios and table model radios.

About 8,000 sq ft of floor space will be added in the form of a mezzanine constructed in a two-story bay of the plant. This mezzanine will be used for storage of raw materials. Under it will be the moulding equipment. Machines have been ordered and production of cabinets is scheduled in about 9 months.

Krygier Advances At CBS

THE APPOINTMENT of George Krygier to the position of administrative engineer was announced by Leopold M. Kay, vice-president of engineering for CBS-Columbia.

Mr. Krygier joined CBS-Columbia in 1950, serving as liaison engineer with Underwriter's Laboratories. In his new position, Mr. Krygier will handle engineering administrative functions and coordinate the activities between the engineering department and other divisions of the company.

Tetrad And Triad Merge

ALL of the operations of Tetrad Co., Inc., specialists in the production of miniaturized electronic components, have been consolidated with the operations of Triad Transformer Manufacturing Co., according to an

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announcement by the latter company. No changes in personnel are contemplated.

Astron Expands Plant

ASTRON CORPORATION recently expanded their plant capacity and manufacturing facilities in East Newark, N. J. The additional space will enable Astron to more than double productive capacity on its line of quality dry electrolytic capacitors and greatly increase production on many other types of capacitors and filters for both military and commercial use.

Honeywell Named Chief Engineer of Servo-Tek

C. CLINTON HONEYWELL of Bergenfield, N. J. has been named chief engineer of Servo-Tek Products Company, according to an announcement by Floyd V. Wilkins, president of the firm.

Dalmo Victor Plans Plant Addition

CONSTRUCTION plans for a plant addition to house a military equipment test laboratory were announced by Dalmo Victor Company, San Carlos electronics firm.

Preliminary approval has been given by the San Carlos planning commission for the 75 by 100 ft one-story, tilt-up concrete structure to be erected alongside Dalmo Victor's main plant.

Tomlinson I. Moseley, president of the company, said the laboratory facilities are being provided by the U. S. Navy and will be used to test various equipment under operational conditions.

WESCON Appoints Four

FOUR project-committee chairmen for the 1953 WESCON (Western Electronic Show & Convention) have been announced by the board of directors.

Coming under the supervision of Walter Noller of Remler Co., the WESCON vice-president representing IRE, two of the appointments are: Bernard M. Oliver, papers committee; Wilson Pritchett, arrangements committee.

The other two appointments come under the supervision of Richard Huggins, Huggins Laboratories, the WESCON vice-president representing WCEMA. These are: Les Logan, hotels committee; David H. Ross, visitors' service committee.

Radio Club Re-elects Officers

OFFICERS of the Radio Club of America have been re-elected and will serve the club during 1953. They are: president, John H. Bose; vice-president, Ralph R. Batcher; treasurer, Joseph Stantley; corresponding secretary, Frank H. Shepard, Jr.; recording secretary, Frank A. Gunther. Elected to the board of directors were: Ernest V. Amy, Edwin H. Armstrong, George E. Burghard, Alan Hazeltine, Harry W. Houck, Jerry Minter and Harry Sadenwater.

Airborne Advances Lebenbaum

AIRBORNE INSTRUMENTS LABORATORY, INC., has announced the appointment of Matthew T. Lebenbaum as supervisor of a newly formed applied electronics section

Matthew T. Lebenbaum

in its research and engineering division. Mr. Lebenbaum was formerly an assistant supervising engineer in the radar section. Peter D. Strum has been appointed assistant supervising engineer of the new section.

From June, 1942 until he joined Airborne in 1945, Mr. Lebenbaum

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was a research associate with the Radio Research Laboratory at Harvard University.

LaPointe Plascomold Changes Its Name

THE company name of the LaPointe Plascomold Corp has been changed to La Pointe Electronics, Inc., it was announced by company president Jerome E. Respess, after authorization by the stockholders of the company at the annual meeting. The name change was desirable, according to Mr. Respess, because the major products of the company are in the electronics field.

Two top-level promotions were also recently made at LaPointe. William A. Damerel was appointed vice-president of LaPointe Electronics and Milby M. Hancock, formerly general manager, was elevated to the position of assistant to the president.

Tuerck Appointed Research Head of Patterson, Moos

WILLIAM TUERCK, JR. has been appointed director of electronic research of Patterson, Moos & Company, Inc., of New York, it was announced by E. M. Patterson, president of the research and development firm. In addition to his new position in charge of one of the six research laboratories of the company, Mr. Tuerck will continue as chief engineer of Magnex Corp., the production affiliate of Patterson, Moos.

Douglas Forms Microwave Co.

R. HARRY DOUGLAS announced the formation of the Douglas Microwave Co. Inc. of New York City, which he heads as president and chief engineer. Mr. Douglas has been in the microwave field since 1943 and was formerly president and chief engineer of the Kings Microwave Co., chief electronics engineer of Bernard Rice's Sons, and an engineer-officer of the Signal Corps Engineering Labs., Ft. Monmouth, N. J. Microwave and radar components and test equipment units are currently being manufactured to customer specifications as well as to company designs.

Gertsch Appoints Rorden

ROBERT J. RORDEN has been appointed chief engineer for Gertsch Products, Inc., Los Angeles, according to Len Cutler, vice-president and chief engineer. He had previously been with the Point Mugu government projects several years and more recently with Dalmo Victor Co.

Industrial Tubes Expands

INDUSTRIAL TUBES, INC. now occupies a new one-story modern factory building constructed especially for the production of industrial electronic tubes. The corporation, which was formed a year ago, now regularly manufactures industrial rectifier and thyratron tubes. According to John H. Hutchings, president, production has risen steadily during the past seven months and promises to double again by this summer.

OTHER NEWS

Raytheon Sizes Up Its Defense Orders

RESULTS of a recent survey by Raytheon Manufacturing Company indicate that "small business" is doing all right for itself in government defense orders.

E. F. Leathem, assistant to the president of Raytheon, states that small firms are getting 52 percent of all Raytheon orders, and 81 percent of those which these concerns can handle. Raytheon ranks 42nd among the 100 leading government prime contractors and placed orders totaling $57 million during the first three-quarters of 1952.

In a report submitted to the Air Force Small Business Subcontracting Program Committee, Mr. Leathem stated that "Raytheon's normal purchasing practices, which generally are followed by most large concerns, require that we place as many orders as possible with small business, not only because this procedure is in line with government requirements but also because we have found that it is good business to do so. Improved liaison, better quality and quantity control, closer personal attention to our requirements and competitive prices are among the advantages resulting."

Raytheon does business with almost 4,000 vendors, of which over 3,000 employ less than 500 people, Mr. Leathem stated. Of those orders given to big business, 76 percent of the purchases were for items which small business cannot manufacture. Small firms are not equipped to supply such items as glass bulbs for vacuum tubes, specially treated metal in the form of oxygen-free copper, vacuum-cast molybdenum, steel alloys, brass, tungsten and aluminum. These materials and others can be purchased only from big business.

CELEBRATE EDISON'S BIRTHDAY

The 106th birthday of Thomas Alva Edison was celebrated at the 36th annual luncheon of the Edison Pioneers. Pictured at the luncheon are Charles Edison, left, honorary president, and GE president Charles E. Wilson, new president of the Pioneers. The luncheon heard principal speaker James A. Farley discuss the topic "Thomas Edison, the man, the inventor and the philosopher"

Penn State Schedules Transistor Short Course

A TRANSISTOR short course, designed especially for practicing engineers in the industrial field and for engineering faculty members of colleges and universities, will be conducted by the department of electrical engineering and general extension services of Pennsylvania State College on June 8-19 at State College, Pa.

The course will be run on a lecture-discussion-laboratory basis. Lectures will be provided by such companies as Bell Labs, GE, IBM, Philco, RCA, Sylvania and by Wright Air Development Center and the university.

RCA To Develop New Airborne Radar

DEVELOPMENT of a new type of airborne weather-detection radar unit will be undertaken by RCA Victor in cooperation with United Air Lines, Inc.

This is the first program RCA has undertaken with the goal of providing commercial air lines with a radar system designed exclusively for weather-mapping use.

This radar unit will operate at new frequencies to "map" weather obstacles on a wide front. It is expected to provide pictures that will give a pilot information on the depth as well as the breath and height of storm fronts.

RCA expects to deliver experimental equipment early next summer so that tests can be conducted during the period of greatest storm activity.

Michigan Offers Courses In Automatic Control

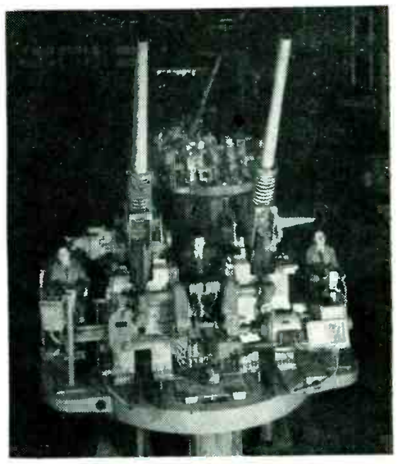
THE UNIVERSITY OF MICHIGAN College of Engineering has announced two intensive courses in automatic control. The first is scheduled for June 15 to 20 and the second for June 22 to 25, 1953. The courses are intended for engineers who want a basic understanding of the field but who cannot spare more than a few days for the purpose.

The purpose of the course is to make it easier to learn by a coherent presentation the fundamentals of modern automatic control and by providing a comprehensive set of notes to serve as a framework for further study.

Extensive use will be made of computing, instrumentation and servo laboratories on the campus. The rôle of analog computing methods will be emphasized.

Electronic Firepower

ONE of the largest World War II manufacturers of antiaircraft guns is again tooled up to mass-produce the more powerful electronically-controlled gun mounts needed by the U. S. Navy. First three-inch, twin-fifty gun mount, weighing 17 tons, to be produced by the Firestone Tire



& Rubber Company is pictured above as it is inspected by Harvey S. Firestone, Jr., (left) chairman of the company, J. E. Trainer (center), and Raymond C. Firestone (right), vice-presidents.

Equipped with automatic loading devices and intricate radar fire-control systems, the guns will hurl three-inch shells at low or high-flying aircraft. The value of the initial Navy contract with Firestone for these new gun mounts has been announced as $62 million.

Components Symposium Set

SIX general sessions have been scheduled for the 1953 Electronic Components Symposium to be held April 29 to May 1 at the Shakespear Club in Pasadena.

R. Simon Ramo, vice-president in charge of operations at Hughes Aircraft, will be chairman of the opening session. The subject to be covered will be "Critical Problems Being Faced by the Electronics Industry in Meeting Industrial and Military Demands".

The afternoon session of the opening day will be led by Dr. A. W. Rogers, chief of the components branch, Signal Corps Electronic

Laboratory. Six papers will be presented on subjects relating to the session topic "Environmental Packaging Problems".

"Electronic Tubes and Tube Reliability" will be the topic of the morning session of April 30.

Mr. M. Barry Carlton of the Research and Development Board will lead the afternoon session on "Reliability Problems".

Dr. Louis Kahn, director of research of the Aerovox Corp., will be chairman of the morning session May 1 which will cover "Resistors, Capacitors and Dielectrics".

The closing session will be led by Reuben Lee of Westinghouse Electric Corp. The subject will be "New Devices and Materials".

Dr. A. M. Zarem of the Stanford Research Institute is general chairman of the symposium.

Conference Examines The Engineer Shortage

THE TRAINING and use of skilled assistants is one way to beat the engineer shortage, according to engineering executives at the Fifth College-Industry Conference at Northwestern University.

Titus G. LeClair, manager of engineering for Commonwealth Edison and Public Service Company of Illinois, said that requiring an engineer to handle all the details of his job is "our greatest source of wasted engineering talent."

"The obvious answer to this problem is to relieve the engineer of his paper work and other non-technical activities by giving him the help of a technical assistant, draftsman, clerk or perhaps all three," LeClair said.

He told the engineers and educators that "the technical assistant might be a technical institute graduate or have one or two years of college. With this type of skilled assistant, the engineer is able to do the engineering without going on to do the "red tape."

"Not only can the engineers work more effectively," LeClair pointed out, "but they are better satisfied when they feel their technical skills are being usefully employed and that the opportunities for advancement are better."

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NEW BOOKS

UHF Practices and Principles

BY ALLAN LYTEL. *John F. Rider Publisher, Inc., New York*, 1952, 390 *pages*, \$6.60.

HERE is broad, fundamental background theory and practical data on transmitting and receiving equipment for the entire uhf range from 300 mc to 3,000 mc. This includes police, fire department, taxicab, truck and other mobile communication services, television and even radar. Although some mathematical equations are included, the book is not intended for reference use by design engineers; rather, it appears best suited for students in trade and vocational schools, as well as for television and radio servicemen who seek only a general knowledge of what is going on in this fast-opening new territory of the radio spectrum. End-of-chapter questions facilitate classroom and self study use.

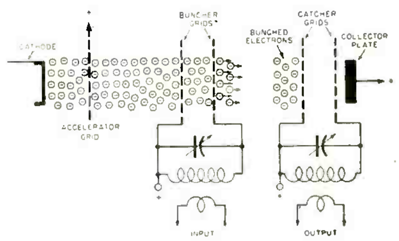

FIG. 7-36—Electrodes in a klystron tube (from Lytel—"UHF Practices and Principles")

Illustrations are particularly deserving of mention, being carefully selected to show technical details of equipment; there are very few front-panel-of-transmitter or rear-view-of-housing shots. Examples of some of these illustrations are shown here.

Chapter organization might be called conventionally tutorial. The first three chapters bring the reader up to date on theory by reviewing the history and use of the uhf spectrum, pointing out the differing behavior of components at these higher frequencies, and covering the differing propagation characteristics of electromagnetic radio waves. Five of the remaining chapters then take up new types of components—receiving antennas, trans-

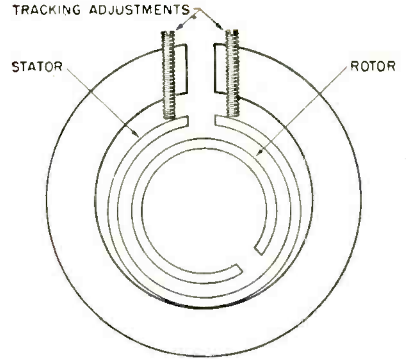

FIG. 8-14—Side view of cylindrical tuner (from Lytel—"UHF Practices and Principles")

mission lines and wave guides, new types of tuned circuits, oscillators and developmental tubes. One chapter deals with receivers and converters, another with transmitters, and the last with test equipment and techniques to round out the picture of uhf at work today.—J.M.

Electronic Engineering Principles

BY JOHN D. RYDER, *University of Illinois. Prentice-Hall, Inc., New York*, 1952, *second edition*, 505 *pages*, $9.00.

THE PRIME theme of this book is well stated in the preface to the first (1947) edition: "The author has been convinced for a considerable time that electronics has outgrown its position as a subordinate field of communications or radio engineering and should be treated independently as *electronic engineering*. So considered, it becomes applicable to all electrical engineering, involving as it does theories of conduction, simple atomic structure and generalized circuit analysis with linear and nonlinear elements. Thus, electronic engineering is fundamental to all power or radio applications of electron tubes, but is not necessarily a part of either field."

It is in such thought that the author, now head of the Department of Electrical Engineering at the University of Illinois, distilled the knowledge and varied experience gained over some fifteen years in both the teaching and the industrial practice of communication engineering and applied electronics to produce a book that was

subsequently adopted as a textbook in a preponderance of the leading departments of electrical engineering. In the reviewer's opinion, a yet more extended use will accrue to the second edition.

The essential structure and major content are epitomized in the fifteen chapter headings: 1. The Fundamental Particles of Electronics; 2. The Movement of Charged Particles in Fields; 3. The Cathode-Ray Tube; 4. Emission of Electrons; 5. Space Charge in Vacuum Tubes; 6. Vacuum Diode Rectifiers; 7. The Vacuum Triode; 8. Multi-Element Tubes; 9. Small-Signal Amplifiers; Feedback; 10. Large-Signal Amplifiers—Class A and B; 11. Gaseous Conduction; 12. Gas Diodes; 13. Gaseous Control Tubes and Circuits; 14. Photoelectric Cells; 15. Solid-State Electronics.

Comparison of the contents of the old and new editions indicates many improvements and additions. Thus, the context has been rendered easier to use: in the large, by an overall consideration and revision of content; in particular, by consolidation of the material on electron emission encompassed in Chapters 4, 11, and 15 of the first edition into Chapter 4 of the present edition. The treatment of the vacuum triode, of amplifiers and —in connection with the latter—of feed-back is extended in scope. The rapidly burgeoning use of transistors and the attendant need for an introduction to the basic theory underlying the functioning of solid-state electronic devices is recognized by inclusion of a new chapter thereon. The table of physical constants encompasses certain improved values effected since publication of the first edition. The number of student exercises and problems has been increased; new line drawings and cuts added; and the list of references at the end of each chapter enlarged to include particularly-apposite lately-published papers.

The physical qualities of the text maintain the publisher's usual standards of excellence. The binding is sturdy, attractive and such that the book lies open at any page; the typography enables easy reading under artificial light—no small boon to the student; the line drawings are uniform of weight and well-lettered; the illustrations of electronic apparatus and devices are excellently delineated; the numerous equations are well-set and amply displayed; and the boldface type distinguishing vector quantities is easily marked from the ordinary type used for scalar quantities. The general quality of presswork and proofreading is evidenced in the fact that in a careful reading of the text, with attention to factual detail, the reviewer noted only several trivial misprints in this first press run of the new second edition.

In recapitulation, the reviewer is of a mind that the author and his publishers have collaborated to produce a most excellent textbook, and one that well fulfills the author's proposed "fundamental and thorough treatment of basic electronics." In such thought, it is to be remarked that, as well as for formal classroom use in an organized electrical engineering curriculum, it is admirably suited to use by the practicing engineer who—possessing the indicated desirable prerequisites of a knowledge of the elements of "calculus and a-c circuit analysis"—seeks a text for initial self-study, or for revitalization of once-studied content, or merely as a general reference which will bring him abreast of the current status of electronic engineering.—THOMAS J. HIGGINS, *Professor of Electrical Engineering, University of Wisconsin.*

Theoretical Nuclear Physics

BY JOHN M. BLATT AND VICTOR F. WEISSKOPF. *John Wiley & Sons, Inc., New York*, 1952, 864 *pages*, $12.50.

HERE is a comprehensive, almost encyclopedic, yet extremely lucid and readable account of the theoretical concepts and methods underlying contemporary nuclear physics. Written by two outstanding nuclear physicists, the book should prove invaluable to graduate students and research workers in physics. To use this volume effectively, the reader must possess at least an introductory knowledge of quantum mechanics and the related mathematical disciplines.

While physicists will undoubtedly be delighted by the publication of this excellent textbook and general reference, electronic engineers will find the book of limited interest. Emphasis is placed upon the development of theoretical models and semi-empirical viewpoints and upon the interpretation of experimental material with the aid of these tools. The design of piles and other topics forming the subject of nuclear engineering are explicitly excluded from consideration, as are, for the most part, nuclear phenomena involving energies greater than 50 Mev.

Beginning with a review of the general properties of nuclei, the book goes on to develop the theory of nuclear forces. Scattering experiments involving protons and neutrons are discussed in the light of present ideas on the nature of the forces between them. This leads to the theory of the deuteron and to the study of three- and four-body problems. The systematics of stable nuclei are presented next, followed by a description of special models of the nucleus such as the liquid drop model.

The theory of nuclear reactions is then presented in an introductory manner. In the central chapter of the book, a vast amount of experimental information is interpreted in the light of the Breit-Wigner theory of nuclear resonance phenomena. The detailed analysis will probably overwhelm the student but should gratify the active research worker. The authors then treat the theory of nuclear reactions in a more formal manner and succeed in revealing the staggering complexity of the problem at hand.

To the subject the authors bring imagination and considerable expository ability. The use of waveguide and electric circuit analogies of nuclear reactions is particularly noteworthy. Unfortunately, the electronic engineer must run a strenuous gauntlet before he can appreciate these analogies in full.

The latter portion of the book deals with spontaneous decay of the nucleus, beta decay, radiative phenomena and nuclear shell structure. It is unfortunate that the authors have not included such topics as neutron diffraction by crystals and nuclear magnetic resonance phenomena, but even without them the book is quite lengthy.

As a comprehensive, authoritative, and highly readable introduction to theoretical nuclear physics, this volume is strongly recommended. — FRANK HERMAN, *Research Physicist, RCA Laboratories, Princeton, New Jersey.*

Fundamentals of Engineering Electronics

BY W. G. DOW, *University of Michigan. John Wiley & Sons, Inc., New York*, 1952, *second edition*, 627 *pages*, $8.50.

FIFTEEN years have elapsed since the appearance of Professor Dow's "Fundamentals Of Engineering Electronics." During this interim, not only did the text gain tremendous popularity since it encompassed physical phenomena with engineering understanding but, also, noteworthy advances were made in the rational comprehension of matter and the physics of electron tubes. Consequently, it was a natural step for the author to modernize his original text into a second edition and to expand his thoughts into two additional books to be published in the near future under the titles of "Fundamentals Of Physical Electronics" and "Microwave Electron Tubes."

The present version has retained its original usefulness as a treatise on engineering concepts. Each chapter is profusely documented. In all, there are over 340 periodical references with approximately 85 per cent dated between the years of 1937–1952. In addition, appropriate books have been separately listed. These references are tabulated under chapter numbers in a section of 24 pages entitled Bibliography, located adjacent to the Index.

Since the first few chapters of the original edition contained topics which were rather involved, the author has rearranged and diffused the subject matter into an orderly sequence which seems to be less formidable. However, a strong mathematical background is still needed to truly appreciate the

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wealth of details and interpretations which are clearly presented. It is definitely a text aimed toward either the senior year of undergraduate studies or the first year of graduate studies.

As explained in the Preface, the important changes include the use of the meter-kilogram-second system throughout. In the study of space-charge-control tubes, conformal analysis has been preserved and the equivalent grid sheet potential concepts have been added as well as analytical discussions on microphonics in filamentary-cathode triodes, the upper limit to transconductance per ampere, secondary emission in any tube, pentagrid tube principles, the dependence of interelectrode and input-output capacitances on tube geometry, and the uhf figure of merit.

An introduction is given to principles related to the design of microwave electron tubes with stress on the effects of electron transit time, input loading and input-to-output phase angles. The induced current concept is discussed as well as klystrons, magnetron oscillators and travelling-wave amplifiers.

The energy-level concepts in metals have been extended to cover semiconductors and to explain the basic behavior of semiconductor electron devices including transistors. The Fermi distribution function and the Fermi energy level are introduced and considered. The internal behavior of gaseous-conducting devices as influenced by mean free paths and drift velocities of electrons and ions has been elaborated upon. Paschen's Law and Townsend's Alpha are quantitatively treated. The Maxwell-Boltzmann velocity distribution equation is derived.

Principles of amplifier circuits have been extended to include Thevenin's and Norton's theorems, negative feedback, the cathode follower, class C operation and the grid separation amplifier circuit.

The main omissions relative to the first edition are radiation of electromagnetic waves, the mechanism of propagation, polarized light, light interference, reflection phenomena, design of power supply filters and inversion from direct to alternating current and associated circuits.—ANTHONY B. GIORDANO, *Polytechnic Institute Of Brooklyn.*

High-Energy Particles

BY BRUNO ROSSI. *Prentice-Hall Inc., New York,* 1952, 569 *pages,* $12.50.

PROF. Rossi has given us an outstanding book on the phenomenological aspects of the high-energy particle field. Although the book is written primarily for the specialist in high-energy particle research, it will be of interest to all serious students of nuclear or cosmic ray physics. In it the reader will find a discussion of the developments leading up to the identification of the high-energy particles known at present, together with a detailed account of many of the more important experiments of the last decade dealing with both cosmic ray and artificially generated high-energy particles.

One of the main purposes of the book is to develop the methods by which the experimentalist can interpret the result of observations in terms of particle type, mass, charge and energy. Theoretical derivations are given of all of the principal relationships required. These derivations are concisely presented, frequently using classical methods as a means of explaining the fundamental ideas back of the derivations. When this artifice is used, the corrections introduced by the more exact quantum mechanical treatment are pointed out and the exact formulas given. Where necessary, tables and graphs accompany the analytic relationships. Mathematics is used freely throughout the text, but is of such a form that it should present no serious obstacle to the reader.

The first portion of the book treats the general problems of the interaction between moving particles and electro-magnetic fields, electrons or matter. This section provides a general background of the absorption, ionization, scattering and energy conversion which occurs when particles pass through matter.

The second part of the book deals with experimental methods. A very thorough and informative discussion of ionization chambers, proportional counters and Geiger counters is to be found in this section. A very complete discussion is also given on the use of photographic emulsions for particle detection. Cloud chambers and scintillation counters are described in this section also, but given a rather cursory treatment. The electronic circuitry involved with this type of equipment is considered outside the scope of the book.

Following this general background material is a discussion of the elementary particles known to exist, including, in addition to the nuclear particles and the π and μ mesons, a section dealing with the V particles. This is followed by a detailed description of the phenomena associated with cosmic ray showers.

The next three chapters deal with the interaction of artificially generated particles and cosmic ray particles with matter. These chapters describe the many experiments which demonstrate the reactions occuring when high-energy particles encounter matter. Throughout these chapters, a very thorough quantitative account of the analyses of experimental results is given. This is one of the valuable features of the book inasmuch as it provides the experimentalist with a solid background and point of departure for further research in this field. These chapters are profusely illustrated with many plates showing different types of tracks in photographic emulsions. These plates are convincing evidence of the reality of the phenomena described in the accompanying text. The work is well documented by a seventeen-page bibliography.

The book is written in a clear, easily readable style. Its organization is logical and well thought out. The many illustrations and plates are excellently done and well printed. While a few typographical errors are to be found in the text, their number is probably below the average for a book of this type and they do not seriously intrude upon the reader.

In the preface to this book, the author states that the two objectives are: "First, to give a comprehensive account of our present knowledge concerning high energy phenomena - - - - ; second, to provide the active investigator with a report on current problems in high-energy physics and present him with a collection of formulas, tables and graphs useful to his work." In these aims, the author has been eminently successful and has created a book which may be destined to become a classic in the field.—G. A. MORTON, *RCA Laboratories, Princeton, New Jersey.*

THUMBNAIL REVIEWS

RADIO & TV HINTS. Edited by Martin Clifford. Gernsback Publications, Inc., New York, 1952, 112 pages, paper-covered, $1.00. A gimmick book for those who work in labs or shops, presenting practical short-cut techniques, circuit tricks, tools and salvage ideas useful in circuit development and actual production of electronic

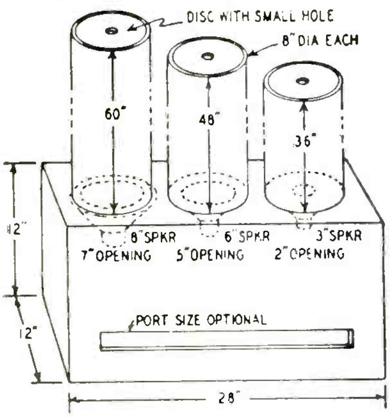

FIG. 518—Unusual three-speaker baffle (from Clifford—Radio & TV Hints)

equipment. Examples: Small steel springs are useful for making temporary connections between wires; placing a metal plate across the open bottom of an a-f chassis will often get rid of the last bit of hum; to remove solder quickly from components to be salvaged, heat the joint and then brush off the solder quickly with a cheap one-inch paint brush.

THERMIONIC VACUUM TUBES. By W. H. Aldous and Sir Edward Appleton. Methuen & Co. Ltd., London, and John Wiley & Sons, New York. 160 pages, $2.00, 1952. A completely revised and rewritten Sixth Edition of a popular member of the Methuen family of monographs on physical subjects. Material on traveling-wave tubes and similar subjects indicates its up-to-date character.

BACKTALK

Electronic Organs

WIDE interest in electronic organs has been exhibited by our readers. In the editorial offices of ELECTRONICS, we often receive letters from readers suggesting new and different ideas for generating tones for electronic musical instruments. Since it is, in general, contrary to our policy to publish proposals in the feature section, these ideas cannot be called to the readers' attention unless they are submitted as letters to appear in the *Backtalk* department of ELECTRONICS.

The following correspondence illustrates the chain of events that often follows the conception of an idea by a private individual. The first letter was written to a large manufacturer of electronic organs by J. B. Winther with the technical description of his idea for a new tone generating scheme. Following this description is a reply from the Patent Counsel of that company reprinted here for the benefit of those who may have conceived similar schemes, but who have not taken the time to call their ideas to the attention of a manufacturer as Mr. Winther has done.

DEAR SIRS:

I AM pleased that you are interested in appraising my scheme.

Actually the idea originated over 10 years ago, and I have waited to see it commercialized by someone. I felt that such an idea being basically simple would be apparent to anyone versed in electronics, and might appear on the market at any time.

After reading the article in the January 1951 issue of ELECTRONICS "Gas-Diode Electronic Organ" by R. M. Strassner, I felt convinced that if my method had ever been common knowledge, no one would go to the extent that the author did in designing an electronic organ.

My method achieves all the requirements which Strassner outlines as his objective. These I have outlined below:

"One of the greatest complaints against electronic instruments is that they are generally too perfect, and therefore unnatural.

"Too many controls confuse or discourage the performer." I believe this is true for the average musician seeking a low priced instrument.

"It was required to develop an organ-like electronic instrument that would retail for $800." Because of low labor costs, I believe my method could easily equal or possibly better this figure.

Following is a description of my scheme along with a diagram. I have not attempted to secure a patent on this method, but have chosen a less tedious, and not nearly so drawn out method, by providing a signed document establishing the date of conception. Although this method does not provide the legal protection of a patent, it does provide a lever for the original inventor, thus he may work with experts in the field to provide mutual benefit to all concerned.

After you review this material, I would appreciate your reaction, and if favorable, please advise what course you propose to follow. I have been in engineering development for many years and fully realize the time, money, and engineering know-how which must yet be put into this new idea to make it productive.

J. B. WINTHER
Kenosha, Wisconsin

Organ Description

FOR MANY YEARS electric keyboard instruments have been manufactured, their primary objective being to duplicate the results obtained with the mighty pipe organ. Various and ingenious methods have been devised, ranging from elaborate electronic circuits to modified reed organs in an effort to create an instrument which sounds just like a real pipe organ. The tone of a single organ pipe has been studied in great detail to obtain data on wave shape of fundamental, harmonics, percent of harmonic content and other characteristics. An electronic circuit is then developed which will duplicate these same tone patterns, or even attempt to improve on them.

The method outlined below seems to be the natural way to accomplish

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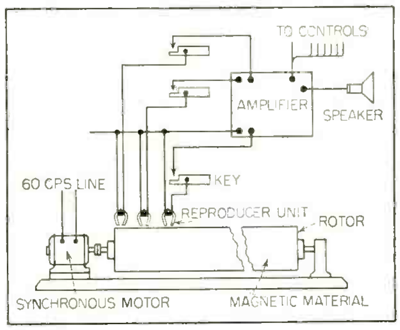
our objective. The sound emitted from an individual pipe of a pipe organ is recorded. The method of recording may be an adaptation of sound-on-film or wire recording. A suggested method is outlined below:

After each note is recorded (assume 61 in all) then there will be 61 separate individual patterns on record, each one ready to exactly imitate the original parent note. These 61 recordings or sound tracks are placed on a common conveyor, and set in motion. There will be 61 unit pick-ups involved, each ready to reproduce the recorded note, but not until the circuit is completed at the instrument keyboard by the selected key, during a rendition. Since any individual note is a continuous pattern of successive wave shapes, it is not necessary to extend the recording any longer than would be required to establish the wave pattern. This could be done in several cycles of the fundamental wave.



Suggested electronic organ scheme

In a practical way this could be accomplished by recording around the circumference of a cylinder. Thus, the note could be continuous by duplicating itself for each revolution. There are problems which could be overcome, for example, overlap at the start and finish of the recorded note as the second revolution was started. This might be overcome by using two reproducers on one sound track 180 degrees apart and using less than a full revolution of recording, thus there is always one reproducer unit active at any one time.

As pointed out in the drawing a drum of ferrous magnetic material (possibly even Alinico material) of the type used in the wire of wire recorders could be

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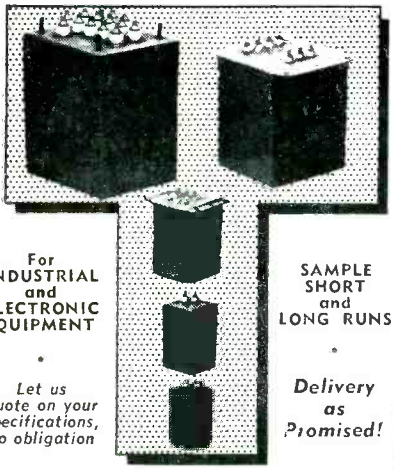

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formed into a seamless tube.

The 61 notes could probably be recorded in 61 pattern rings in about 24 inches of linear length of roll and probably a 1-ft diameter roll may be used. At 1,800 rpm it would be possible to record 60 complete cycles of a 1,800 cycle note or two complete cycles from a 60 cycle base note.

With the above arrangement it appears possible to build all the components into a small space. It seems that organ notes would be the most practical to reproduce as it appears to be a continuous note right from the start while a piano note would lack the hammer on-string effect. In fact, notes from a more expensive electronic organ could be reproduced this way by using the instrument for recording the parent note.

Also it would appear that a reedless piano accordian with this arrangement could produce unparalleled effects. An electromagnetic air-pressure sensing device in its bellows chamber could be used to modify the notes for expression in the music, to duplicate present playing techniques.

The method as illustrated does appear to have unusual possibilities. It has promise of opening a field of low-priced instruments.

Company Reply

DEAR MR. WINTHER:
WE THANK YOU very much for your letter and your very lucid explanation of your improved electrical musical instrument.

We have naturally given consideration to various types of signal generators involving recordings of sound produced by pipes and various other instruments. This has likewise been given consideration by a large number of other people as is evidenced by a number of patents which have issued disclosing various schemes for using recorded tones as a basis for the production of tones in an electrical musical instrument. For example, the following patents disclose rotating devices in which the sound is photographically recorded and picked up photoelectrically: 2,199,948, 2,223,489, 1,980,-

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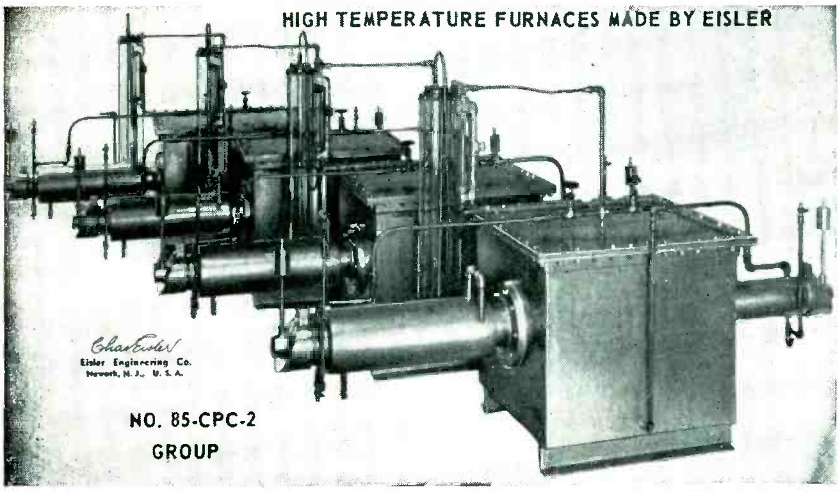

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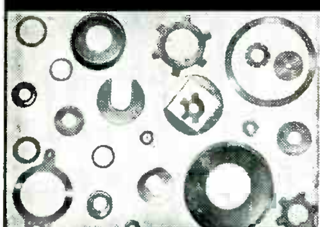

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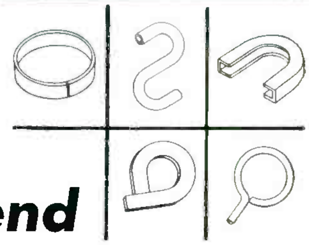

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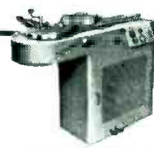

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You have apparently studied the problem sufficiently to realize one of the difficulties, namely, that of overlap. We question somewhat whether your proposal, by which this overlap problem could be overcome, would work out unless you could start and stop recording the wave at the exact instant that it "crossed the zero axis." Another difficulty to which you have apparently given much thought is that the organist likes to have available a large number of different tone qualities. In your proposed instrument this could, of course, be accomplished by having several of the drums you described, with their associated pickups, and to a limited extent might be accomplished by various filter meshes in the output system of the organ.

We wish to thank you for the clear manner in which you have presented your ideas but regret that in our opinion you have not made any novel suggestions. We are therefore not interested in pursuing the matter further.

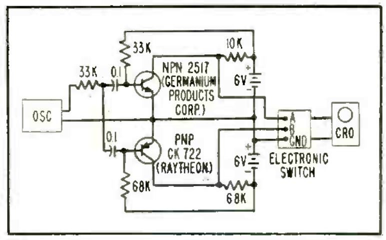
(Name of Patent Counsel and Company withheld by request.)

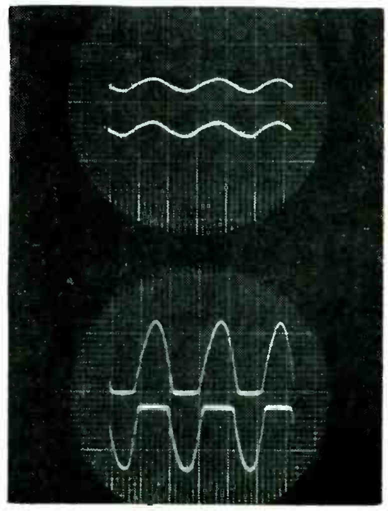
Complementary Symmetry

DEAR SIRS:

I HAVE read with much interest the article entitled "Experiments Illustrate Transistor Applications" in the March issue of ELECTRONICS. There is one point on which I should like to comment concerning the "complementary-symmetry" amplifier. Figure 1A of the article shows two grounded-emitter transistors, one an npn and the other a pnp, with a common base input terminal. A statement in the article referring to this arrangement says, "Due to the opposite

 Want more information? Use post card on last page.





Circuit (top) and output waveforms for pnp-npn transistor amplifier

signs of the transfer characteristics of these two types of transistors, the output signals will be 180 deg out of phase, one having been shifted 180 deg the other going straight through".

The writer wonders if it would not be better to call this action a "polarity discrimination" or a "phase splitting" rather than a "phase shifting". It would seem well worthwhile to provide as unambiguous an explanation as possible for transistor circuits.

To completely satisfy the writer's thoughts, the above circuit was constructed and tested as indicated. The oscillograms show the actual output voltage waveform for a small input signal and then for a large input signal.

The capacitors and biasing currents of the circuit could be removed with no loss, but an improvement in curcuit efficiency; they were included only to allow each transistor to amplify small signals linearly.

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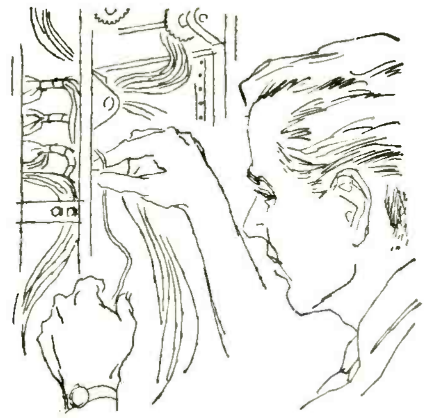

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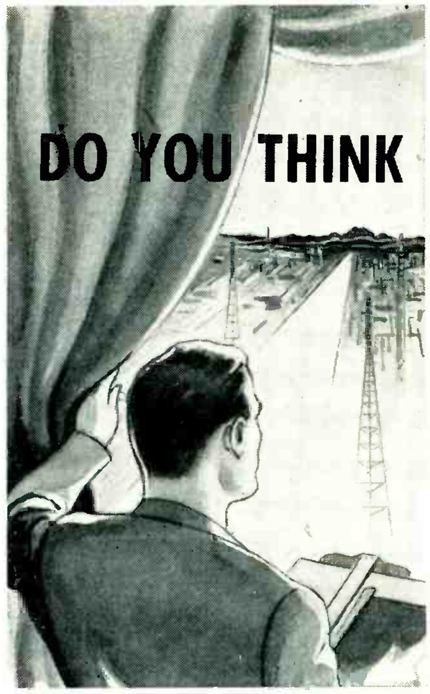

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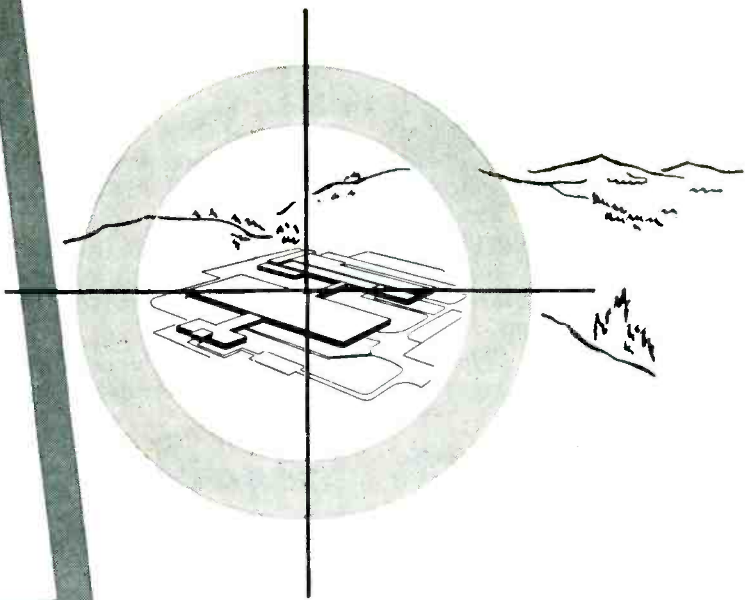

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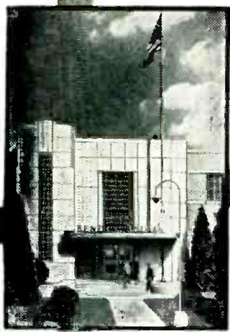

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A NEW Electronic Product!
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- **MECHANICAL ENG.**

Also We have many openings for men qualified by education or experience in all phases of electronics.

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With the Bendix York Division, you will benefit from high wages, paid vacations and holidays and ideal living conditions in a beautiful suburban area.

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Bendix
AVIATION CORPORATION
YORK DIVISION

Phone: York 5521 York, Penna.

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- ELECTRONIC COUNTERS
- AUTOMATIC CLERICAL SYSTEM
- DATA HANDLING EQUIPMENT
- DIGITAL COMPUTERS
- PRECISION TIMING INSTRUMENTS
- AUTOMATIC MACHINE CONTROL
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Excellent opportunity for a man with electronic background, mechanical aptitude, and IMAGINATION.

Well-established and expanding company.

Please send resume of education and experience to Sales Manager.

POTTER INSTRUMENT COMPANY
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Attractive opportunities offered to Engineers experienced in and qualified to design aircraft flush antennas and radomes.

Complete modern facilities for laboratory testing and evaluation available.

Salary dependent upon experience and ability.

Contact Mr. J. C. Buckwalter,
Chief Engineer

DOUGLAS

DOUGLAS AIRCRAFT COMPANY, Inc.
LONG BEACH, CALIFORNIA

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Recent graduates from engineering colleges in Aeronautical, Mechanical, or Electrical Engineering. After a training course at our factory we will locate men in Dallas, Texas, and Los Angeles, California. Prefer men 25 to 30 years of age.

If you are interested in making connections with a company which is geared to war or peace conditions and which has plans for a long-range program independent of Government defense appropriations, we can offer qualified men an excellent future.

P-6742, Electronics
330 W. 42 St., New York 36, N. Y.

TRANSFORMER ENGINEER

We can offer outstanding opportunity to a man with two or more years experience in transformer design and development. Position requires initiative and ingenuity. Excellent future.

B.S. in E.E. or equivalent required.

Free life-accident and health insurance. Paid holidays and vacation.
Replies kept confidential. Contact F. J. Kennedy—

PERMOFLUX CORPORATION
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MOTOROLA INC. NEEDS

ELECTRONIC ENGINEERS

Experienced engineers for television receiver and circuit design. Experienced men also needed in U.H.F. and V.H.F. tuner design.

MECHANICAL ENGINEERS

Experienced mechanical engineers with a degree in M.E. or equivalent. Must have at least five years of actual design experience on electro-mechanical products.

RADIO ENGINEERS

Experienced in the design of broadcast and shortwave receivers for export use.

ELECTRO-CHEMISTS

Experienced electro-chemists needed in our fast growing plated circuit division.

Salaries commensurate with ability and experience. Excellent opportunities for advancement. More than the usual employee benefits.

Your reply will be kept in strictest confidence. Include a summary of your education, background and experience when you write to:

PERSONNEL DEPARTMENT
CONSUMER PRODUCTS DIVISION
MOTOROLA INC.
4545 W. AUGUSTA BLVD.
CHICAGO 51, ILLINOIS

We desire personnel of the highest caliber—experienced in the field of airborne automatic electro-mechanical control equipment.

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MECHANICAL DESIGN
ELECTRONIC
SERVO

DESIGNERS-LAYOUT MEN

ELECTRONIC
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This work deals with the manufacture and development of highly complex equipment of the most advanced type in a new and expanding division of an established firm with 20 years of successful experience in the precision instrument field.

We cite a few of the good reasons why you might like to join our organization . . .

SALARY increases are based on merit and initiative—two weeks VACATION. HOSPITALIZATION BENEFITS. GM's own INSURANCE PLAN—POSITIONS ARE PERMANENT due to long range manufacturing and developing programs—EXPENSES incident to interviews and moving all absorbed by company—HOUSING and LIVING CONDITIONS among the best and finest of any along Lake Michigan.

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- Educational opportunities for advanced degrees available at U. of W., Marquette. Technical engineering offered at Milwaukee Vocational School.

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Excellent opportunities in the field of

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Senior and Junior Engineers

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Investigate the outstanding record of achievement and future plans of

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Alexandria, Virginia
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MELPAR INC.

ELECTRONIC ENGINEERS

EE or ME degree, minimum 3 years' experience in research and development work involving circuit development, servo-mechanisms, analogue computers or related equipment.

FIELD REPRESENTATIVES

A few openings for graduate engineers only with backgrounds similar to above. Continental U.S.A.

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A young company of young, successful men, firmly established as designers and manufacturers of electronic equipment . . . a medium-sized staff in which you receive individual recognition . . . a policy of promotion-from-within that helps qualified men move ahead swiftly . . . a modern laboratory located in a pleasant suburban community ideal for family living.

Expenses will be paid for qualified applicants who come for interviews. Please submit complete resume to: Mr. H. F. WARE

GENERAL PRECISION LABORATORY
INCORPORATED
A Subsidiary of GENERAL PRECISION EQUIPMENT CORPORATION
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This rapidly growing Organization in south central Wisconsin, approximately 100 miles from Chicago, has several openings for Junior and Senior Engineers in the U.H.F. and Microwave fields.

UNUSUAL SALARY OPPORTUNITIES

exist under ideal working conditions in large, well-equipped laboratories. Personnel benefits such as sickness, accident, and life insurance in addition to a very liberal pension system are offered.

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Real ability and originality can find new challenge and opportunity in Southern California with a leading west-coast electronic development and manufacturing organization.

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Experienced in design-development of electronic devices.

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To design electro-mechanical equipment items.

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Engineer standard and display types—V.H.F.—U.H.F. areas.

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Excellent conditions including regular advance review, health and disability insurance, 40 hour week, standard paid holidays and annual vacations. Relocation should not disturb urgent military projects.

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Well rated company also has government prime contracts.
Reasonable rental housing available.
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With experience in design and development of transformers for electronic applications, and capable of assuming the position as head of a design section on this type of equipment. All replies will be held confidential and should include details of education, experience and salary desired.

MOLONEY ELECTRIC COMPANY
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WILCOX ELECTRIC COMPANY, INC.
of
KANSAS CITY, MISSOURI
requires

ENGINEERS!

with Experience in

- HF and VHF systems
- Aeronautical Equipment
- Application of Advanced Circuit Technique
- Ability to combine associated engineering skills in electronic systems

also needed

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who can accept responsibility for successful completion of a system design

These positions are available in a company which supplies equipment to the major airways of the world.

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WILCOX ELECTRIC COMPANY, INC.
1400 Chestnut Street
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HOUSTON, TEXAS

Precision equipment manufacturer needs qualified experienced engineer for audio and sub-audio transformer design and development. Experience with high permeability alloys desirable. Knowledge of magnetic circuitry must be sufficient for development work on magnetic amplifiers. Salary commensurate with ability.

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Responsible positions in mechanical, electrical or electronic engineering, physics or engineering physics for advanced development and design of special equipment and instruments. Prefer men with minimum of two years' experience in experimental research design and development of equipment, instruments, intricate mechanisms, electronic apparatus, optical equipment, servomechanisms, control devices and allied subjects. Positions are of immediate and permanent importance to our operations. Southwestern location in medium sized community. Excellent employee benefits. Reply by letter giving age, experience and other qualifications. All applications carefully considered and kept strictly confidential.

Ind. Rel. Manager
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Desiring the challenge of interesting, diversified, important projects —
Wishing to work with congenial associates and modern equipment and facilities —
Seeking permanence of affiliation with a leading company and steady advancement —
Will find these in a career here at GENERAL MOTORS.

Positions now are open in ADVANCED DEVELOPMENT and PRODUCT DESIGN, INDUSTRIAL ENGINEERING, TEST and TEST EQUIPMENT DEVELOPMENT.

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MILITARY RADIO, RADAR AND ELECTRONIC EQUIPMENT
ELECTRONIC COMPONENTS
TRANSISTORS AND TRANSISTOR AND VACUUM TUBE APPLICATIONS
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ACOUSTICS—loud speakers, etc.

Inquiries invited from recent and prospective graduates as well as experienced men with bachelors or advanced degrees in physics, electrical or mechanical engineering, chemistry, metallurgy.
Salary increases based on merit and initiative.
Vacations with pay, complete insurance and retirement programs.
Location is in a low living cost center.
Relocation expenses paid for those hired.

All inquiries held in confidence and answered—WRITE or APPLY to

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GENERAL MOTORS CORPORATION
Kokomo, Indiana

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has openings for

ELECTRICAL ENGINEERS

With at least three years experience in design and development of MAGNETIC SERVO AMPLIFIERS.

A chance to grow with a young and progressive company. Salary and advancement commensurate with ability. State education, experience and salary requirements.

Address all inquiries to:

GENERAL MAGNETICS INC.
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WANTED

ENGINEER WITH EXPERIENCE IN VHF OR UHF

Interesting creative work with the most resourceful and progressive firm in the field of television equipment.

This position is permanent. It will offer every opportunity for unlimited advancement and for developing a successful career. The plant is now housed in a newly-acquired larger building, only 22 miles from downtown New York City. The surroundings and atmosphere are stimulating and congenial.

Attractive Salary
Write stating qualifications.

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526-536 NORTH AVENUE
WESTFIELD, NEW JERSEY

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Sperry

Wide range of experience including design of wide band receivers, radar display systems, analogue computers, servo systems & CR oscillographs . . . thorough knowledge of RF circuits, wave shaping, pulse forming, triggers & gates (microwave techniques unnecessary)

A FEW KEY POSITIONS . . .

Opening of our own manufacturing facilities creates permanent positions in research and development of vital, long-range products.

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. . . Gracious country living, free from big-city pressures, provides a relaxing atmosphere in which you can do your best work . . . yet within easy reach of the cultural advantages of New York City.
. . . Association with an established yet growing organization with few competitors in the field, where your merit and ability are given full consideration.
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DANBURY
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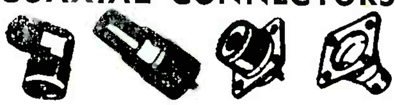
		1S5	.69	6AH6	1.29	6F6G	.87	6SQ7	.65	7Z4	.79	14E7	1.09	50Y6GT	.92	1B27	14.95
		1T4	.71	6AJ5	1.95	6F7	1.05	6SQ7GT	.65	10	.39	14F7	.89	53	.95	1B29	2.75
		1T5GT	.71	6AK5	.84	6F8G	.91	6SR7	.63	12A	.65	14H7	.89	55	.99	1B32	3.75
OOA	$1.50	1U4	.73	WE-6AK5	1.85	6G6G	.99	6SS7	.99	12A6	.64	14J7	.89	L55B	.32	1B35	11.00
O1A	.67	1U5	.77	6AK5W	2.95	6H6	.66	6ST7	1.05	12A6GT	.64	14N7	.89	56	.69	1B36	12.50
OZ4	.59	1V	.65	6AK6	.99	6H6GT	.66	6T7G	1.09	12A7	1.16	14R7	.89	57	.69	1B38	32.50
OZ4A	.63	1X2	.93	6AL5	.59	6J5	.59	6T8	.98	12A8GT	.77	14S7	.89	58	.69	1B40	4.95
1A3	.71	2A3	1.28	6AL5W	2.65	6J5G	.64	6U5	.98	12AH7GT	1.32	14W7	.89	59	1.24	1B41	47.50
1A5GT	.72	2A5	.79	6AQ5	.72	6J5GT	.55	6U7G	.65	12AL5	.79	14X7	.89	70L7GT	1.29	1B42	9.80
1A6	.72	2A7	.79	6AQ6	.79	6J6	.95	6V6	1.49	12AT6	.55	19	.89	71A	.79	1B54	32.50
1A7GT	.79	2B7	.79	6AR5	.79	6J7	.99	6V6G	.89	12AT7	.99	19T8	.99	75	.85	1H20	.88
1B3GT	.99	2E5	.94	6AS5	.99	6J7GT	.79	6V6GT	.67	12AU6	.71	22	1.16	76	.69	1P21	35.00
1B4P	.79	2X2	.50	6AS6	2.25	6J8G	1.28	6W4GT	.64	12AU7	.86	24A	.89	77	.69	1P23	4.10
1B5	.74	2X2A	1.85	6AS7G	4.25	6K5GT	.99	6W6GT	.88	12AV6	.54	25A6	1.16	78	.79	1P24	1.27
1C5GT	.85	3A4	.65	6AT6	.63	6K6GT	.65	6X4	.59	12AV7	.99	25L6GT	.69	79	.89	1S21	9.50
1C6	.69	3A5	.95	6AU5GT	1.21	6K7	.79	6X5GT	.59	12AW6	1.20	25Z5	.79	80	.59	1Z2	3.75
1C7G	.69	3A8GT	1.50	6AU6	.65	6K7G	.86	6Y6G	.89	12AX7	.99	26	.79	81	1.41	2A4G	1.22
1D5GP	.69	3B7	.57	6AV6	.55	6L5G	1.06	6ZY5G	.89	12BA6	.69	27	.69	82	1.19	2AP1	8.95
1D7G	.69	3C6	1.15	6B4G	1.25	6L6	1.87	7A4	.76	12BA7	.95	28D7	1.95	83	1.11	2AP5	8.95
1D8GT	.71	3D6	.57	6B5	1.20	6L6G	1.49	7A5	.79	12BD6	.99	30	.70	83V	1.25	2B4	2.10
1E5GP	.71	3LF4	.91	6B7	.95	6L6GA	1.39	7A6	.75	12BE6	.66	30 Spec	.45	84/6Z4	.75	2B22	2.20
1F4	.69	3Q4	.77	6B8	.75	6L7	.99	7A7	.76	12C8	.65	31	.59	85	.79	2C21	.65
1F5G	.69	3Q5GT	.83	6B8G	.75	6L7G	.85	7A8	.78	12F5GT	.79	32	.69	89Y	.55	2C22	.45
1F6	.71	3S4	.77	6BA6	.65	6N7	.99	7AD7	1.44	12H6	.69	32L7GT	.87	117N7GT	1.89	2C26	.39
1G4GT	.69	3V4	.79	6BA7	1.20	6N7GT	.89	7AH7	1.08	12J5GT	.55	33	.69	117P7GT	1.89	2C26A	.49
1G5G	.69	5AZ4	.54	6BC5	.88	6P5GT	.96	7B4	.79	12K8	.70	34	.69	117Z3	.65	2C33	4.95
1G6GT	.69	5R4GY	1.59	6BC7	1.10	6Q7	.89	7B5	.79	12Q7GT	.67	35/51	.59	117Z6GT	.97	2C34	.49
1H4G	.89	5T4	1.91	6BD5GT	1.60	6R7	.79	7B6	.79	12SA7GT	.69	35A5	.72	FM-1000	1.59	2C39	22.00
1H5GT	.69	5U4G	.59	6BD6	.85	6S4	.72	7B7	.79	12SF5	.79	35B5	.75	Transmitting and Special Purpose Tubes		2C40	12.00
1H6G	.75	5V4G	.98	6BE6	.65	6S7	1.06	7B8	.78	12SF5GT	.79	35L6GT	.67			2C42	23.75
1H6GT	.79	5W4	.82	6BF5	1.10	6S7G	.99	7C4	.45	12SF7	.85	35W4	.55			2C43	17.75
1J5G	.74	5X4G	.79	6BF6	.83	6SA7	.71	7C5	.79	12SG7	.85	35Y4	.72			2C44	1.20
1J6G	.69	5Y3GT	.47	6BG6G	1.89	6SA7GT	.67	7C7	.79	12SH7	.73	35Z4GT	.69			2C46	21.50
1L4	.69	5Y4G	.71	6BH6	.95	6SB7Y	1.05	7E5	.79	12SJ7	.71	35Z5GT	.55			2C51	5.75
1LA4	.87	5Z3	.87	6BJ6	.95	6SC7	.93	7E6	.58	12SJ7GT	.65	36	.64	OA2	.95	2D21	1.55
1LA6	.99	5Z4	1.40	6BK7	1.60	6SD7GT	.94	7E7	.83	12SK7	.69	37	.69	OA3	1.15	2E22	1.85
1LB4	1.01	6A6	.82	6BL7GT	1.45	6SF5	.83	7F7	.99	12SL7GT	.93	38	.69	OA4G	1.25	2E24	4.10
1LC5	.81	6A7	1.05	6BN6	1.59	6SF5GT	.80	7F8	1.35	12SN7GT	.89	39/44	.59	OB2	1.10	2E26	2.85
1LC6	.93	6A8	.95	6BQ6GT	1.26	6SF7	.75	7G7	.89	12SQ7GT	.68	41	.71	OB3	1.19	2J21A	8.75
1LD5	.93	6AB4	.83	6C4	.55	6SG7	.75	7H7	.79	12SR7	.79	42	.79	OC3	1.10	2J22	8.95
1LE3	.93	6AB7	.98	6C5	.70	6SH7	.75	7J7	1.10	12SR7GT	.89	43	.79	OD3	.95	2J26	24.75
1LH4	.82	6AC5GT	1.19	6CB6	.79	6SH7GT	.75	7K7	1.10	12X3	.89	45	.79	1B21A	2.65	2J27	22.95
1LN5	.74	6AC7	.85	6C6	.73	6SJ7	.71	7L7	.97	12Z3	.89	45Z5GT	.89	1B22	2.50	2J31	27.00
1N5GT	.83	6AC7W	3.25	6C8G	.96	6SJ7GT	.69	7N7	.97	14A4	.97	46	.81	1B23	9.60	2J32	36.50
1N6G	.75	6AD6G	.98	6CD6G	2.21	6SJ7Y	.85	7Q7	.79	14A7	.74	47	.99	1B24		2J33	39.50
1P5GT	.69	6AD7G	1.29	6D6	.88	6SK7	.72	7R7	.94	14B6	.74	50	1.09	West	12.95	2J34	27.00
1Q5GT	.99	6AE6G	.89	6D8G	.83	6SK7GT	.72	7S7	1.11	14B8	.89	50A5	.89	1B24		2J37	13.70
1R4	.69	6AF6G	.89	6E5	1.10	6SL7GT	.81	7V7	1.11	14C5	1.10	50B5	.69	SYLV	18.95	2J38	17.50
1R5	.79	6AG5	.79	6F5GT	.83	6SN7GT	.73	7W7	1.11	14C7	.93	50C5	.69	1B24A	39.50	2J39	36.50

COAXIAL CONNECTORS



83-1AC	$ .42	83-1RTY	$ .65	83-22R	$ .68
83-1AP	.30	83-1SP	.45	83-22SP	.80
83-1F	1.10	83-1SPN	.50	83-22T	1.95
83-1H	.12	83-1T	1.30	83-168	.12
83-1HP	.22	83-2AP	1.95	83-185	.12
83-1J	.73	83-22AP	1.40	83-765	.24
83-1R	.40	83-22F	2.10	83-776	.65
		83-22J	1.40		

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UG-7/AP	$6.30	UG-22C/U	$1.20	UG-37/U	$17.50	UG-102/U	$.80	UG-176/U	$.12	UG-255/U	$1.95
UG-12/U	.95	UG-23/U	1.20	UG-57B/U	1.70	UG-103/U	.68	UG-177/U	.24	UG-260/U	.85
UG-15/U	1.25	UG-23B/U	1.50	UG-58/U	.70	UG-104/U	1.40	UG-185/U	.95	UG-261/U	1.10
UG-18/U	1.25	UG-23C/U	1.10	UG-58A/U	.90	UG-106/U	.15	UG-191/AP	.80	UG-262/U	1.10
UG-18B/U	1.05	UG-24/U	1.30	UG-59A/U	2.15	UG-108/U	2.60	MX-195/U	.75	UG-273/U	1.45
UG-19/U	1.60	UG-25/U	1.35	UG-83/U	1.75	UG-109/U	2.60	UG-197/U	2.80	UG-274/U	2.30
UG-20B/U	1.60	UG-27/U	1.25	UG-85/U	1.60	UG-146/U	1.95	UG-201/U	1.95	UG-275/U	5.50
UG-21/U	.85	UG-27A/U	2.25	UG-86/U	2.25	CW-159/U	.60	UG-203/U	.65	UG-276/U	2.75
UG-21A/U	1.50	UG-28A/U	2.95	UG-87/U	1.40	UG-166/U	32.50	UG-206/U	1.45	UG-290/U	.90
UG-21B/U	1.00	UG-29/U	.95	UG-88/U	.90	UG-167/U	3.75	UG-224/U	1.15	UG-291/U	.95
UG-21C/U	1.05	UG-30/U	2.35	UG-89/U	1.10	UG-171/U	2.25	UG-236/U	3.85	UG-306/U	2.65
UG-22/U	1.30	UG-34/U	9.75	UG-90/U	1.15	UG-173/U	.35	UG-245/U	2.25	UG-414/U	1.95
UG-22B/U	1.20	UG-36/U	12.50	UG-98/U	1.85	UG-175/U	.12	UG-254/U	2.75	UG-625/U	1.00

QUOTATIONS UPON REQUEST ON ANY CONNECTORS NOT LISTED HERE

M-358	MC-277	PL-259A	PL-325				
M-359	MC-320	PL-274	SO-239	93-C	49120	D-163950	ES-685696-5
M-359A	PL-258	PL-284	SO-264	93-M	49121A	D-166132	ES-689172-1
M-360	PL-259	PL-293	TM-201				

COAXIAL CABLE

Type	Price Per M Ft.	Type	Price Per M Ft.	Type	Price Per M Ft.	Type	Price Per M Ft.
RG-5/U	$140.00	RG-13/U	$216.00	RG-26/U	$475.00	RG-50/U	$325.00
RG-6/U	180.00	RG-17/U	650.00	RG-29/U	50.00	RG-58/U	60.00
RG-7/U	85.00	RG-18/U	900.00	RG-34/U	300.00	RG-58A/U	70.00
RG-8/U	100.00	RG-19/U	1250.00	RG-35/U	900.00	RG-59/U	60.00
RG-9/U	250.00	RG-20/U	1450.00	RG-54A/U	97.00	RG-62U	75.00
RG-9A/U	275.00	RG-21/U	220.00	RG-55/U	110.00	RG-77/U	100.00
RG-10/U	240.00	RG-22/U	150.00				
RG-11/U	100.00	RG-22A/U	285.00				
RG-12/U	240.00	RG-24/U	675.00				

ADD 25% TO PRICES SHOWN FOR QUANTITIES UNDER 500 FT.

OIL FILLED CONDENSERS

MFD	VDC	Price	MFD	VDC	Price	MFD	VDC	Price	MFD	VDC	Price
2	400	$ .55	1-1-1	1200	$1.85	1	6000	$9.95	.001	50KV	$24.50
5-5	400	1.65	.1	1500	.69	.1	7000 R'd	1.79	.025	50KV	42.50
1	600	.55	3	1500	2.50	.1-.1	7000	5.95	.2	50KV	85.00
2	600	.69	4	1500	2.95	.1	7500	2.85	.25	50KV	95.00
2-2	600 R'd	1.65	.1-.5	2000	.95	.5	7500	7.95	7.5	220VAC	1.95
3	600	.95	.25	2000	1.50	.075-.075	8KV	6.50	1-3	330VAC	1.95
4	600	1.65	.3	2000	1.30	1	10KV	29.50	12.75	330VAC	4.10
4	600 R'd	1.65	1	2000	1.95	.1	12KV	8.95	15	330VAC	4.50
5	600	1.75	3	2000	3.75	1	15KV	45.00	5	440VAC	3.10
6	600	1.85	12	2000	8.95	.045	16KV	4.70	2.9	660VAC	3.50
8	600 R'd	1.85	1	2500	2.75	.05	16KV	4.95	7	660VAC	4.25
8-8	600	1.95	1-1	2500	3.85	.25	20KV	19.95	8	660VAC	4.50
4-4-4	600	2.50	32	2500	15.80	1	20KV	54.00			
4 x 3	600	2.50	.5	3000	2.40						
10	600	3.25	1	3000	3.40						
50	600	7.95	.03	4000	1.25						
1	1000	.65	3 x .2	4000	2.95						
2	1000	.90	2	4000	6.95						
2	1000 R'd	.95	.2	5000	2.50						
3.5-.5	1000	1.85	1	5000	4.88						
4	1000	1.95	2	5000	18.50						
6	1000	2.50	5	5000	29.50						
8	1000	3.25	.015-.03	6000	1.65						
1	1200	.85									

OILMITES

MFD	VDC	TYPE	Price
.02	600	OM-6002	$ .45
.05	600	OM-6005	.48
.1	600	OM-610	.51
.25	600	OM-625	.55
.5	600	OM-650	.60
1.0	600	OM-601	.85

PULSE TRANSFORMERS

UTAH 9262 9278 9280

G.E. K541318
G.E. 68G-627
G.E. 68G828
G.E. 68G929G1
G.E. 80G13
G.E. K-2468B
G.E. K-2469A
G.E. K-2744B
AN/APN-9 (901756-501)
AN/APN-9 (901756-502)
AN/APN-9 (352-7250)
AN/APN-9 (352-7251)
Westinghouse 132-AW
Westinghouse 139DW2F
Westinghouse 166AW2F
Westinghouse 176AW2F

UTAH 9318 9340 9350

Westinghouse 187AW2F
Westinghouse 232-AW2
Westinghouse 232-RW-2
AN/APN-4 Block Osc.
Philco 352-7149
Philco 352-7150
Philco 352-7071
Philco 352-7178
Raytheon UX-7350
Raytheon UX-10066
W.E. D-161310
W.E. D-163247
W.E. D-163325
W.E. D-164661
W.E. KS-9563

SPRAGUE PULSE NETWORKS

7.5 E3-1-200-67P, 7.5 KV. "E" Circuit 1 Microsec. 200 PPS 67 ohms imped., 3 sections $4.30
7.5 E3-3-200-67P, 7.5 KV. "E" Circuit 3 Microsec. 200 PPS, 67 ohms imped., 3 sections $6.75
7.5 E4-16-60-67P, 7.5 KV. "E" Circuit 4 sections, 16 microsec, 60 PPS, 67 ohms imped $8.25
10-E4-85-750-50P, 10 KV. "E" circuit. .85 microsec. 750 PPS, 50 ohms imped., 4 sections .. $26.25
10-E4-2.2-375-50P, 10 KV. "E" circuit. 2.2 microsec. 375 PPS, 50 ohms imped., 4 sections .. $26.25
15 E4-91-400-50P, 15 KV. "E" Circuit .91 microsec. 400 PPS, 50 ohms imped., 4 sections ... $37.50
15-A-1-400-50P, 15 KV. "A" Circuit, 1 microsec. 400 PPS, 50 ohms imped $32.50

FILAMENT TRANSFORMERS

INPUT—115 V., 50/60 CYCLES

UTC	5 V. @ 1A.-Herm. Sealed	$1.20
GE	5 V.ct. @ 8A. and 5 V. @ 8A Insul. 750 V.-Encl. Case	3.85
UTC	6.3 V. @ .6A-Herm. Sealed	1.45
—	6.3 V. @ 1A.-Open frame	.89
GE	6.3 V. @ 20A.-Encl. Case	4.25
GE	6.3V. @ 1.2A; 6.3V. @ 0.6A; 5V. @ 2A.-Open Frame	1.60
Raytheon	6.3V.CT. @ 3A.; 6.3V. @ .5A Insul. 1780 V. RMS-Herm Sealed	2.30

INPUT—208/230 V., 50/60 CYCLES

GE	2.5 V.CT. @ 10A., Insul.-5KV Encl. Case	2.10
GE	5V. CT. @ 7.5A; Insul.-1.5 KV Open Frame	3.45
GE	5 V. CT. @ 7.5A; Insul.-7KV Open Frame	5.25
GE	5V.CT. @ 7.5A., Insul.-10 KV Encl. Frame	6.25
GE	INPUT 190.5V., 50/60 CYCLES; Sec.-4.3V. to 25.98V. by 6 taps Open Frame	7.95
GE	INPUT 220V 60 CYCLES; Sec.-5V.CT., @ 7.5A., Insul.-5KV-Open Frame	4.60

CM TEST EQUIPMENT

3CM Pickup Horn Antenna AT-48/UP	$9.98
10CM Signal Generator—I-138A	$185.00
10CM Freq. Meter CW60ABM	$97.50
"K" Band RF Head—RT-99/APS-32; incl. 3J31 Magnetron, 2K33A Klystron, etc	$650.00

SPARE PARTS FOR ARMY AND NAVY RADIO, RADAR & SONAR EQUIPMENT

AN/APS-2	AN/APN	AN/ARC-3	QCB
AN/APS-3	AN/APN-9	SF	QCJ
AN/APS-4	AN/ARC-1	SL	QCL
AN/APS-15	AN/ARC-3	SO	WEA
etc.	etc.	etc.	etc.

QUOTATIONS UPON REQUEST

LECTRONIC RESEARCH LABORATORIES

715-19 ARCH ST. PHILA. 6, PA.

Telephones - MARKET 7-6771-2-3

SPECIALS

STANDARD BRANDS ONLY

WRITE FOR OUR FREE BULLETIN

2J40	34.50
2J48	49.50
2J49	65.00
2J50	39.50
2J54	67.50
2J56	148.50
2J61	45.25
2J66	165.00
2K23	37.50
2K25	28.50
2K26	105.00
2K28	29.50
2K29	27.50
2K33	265.00
2K33A	280.00
2K39	135.00
2K45	129.50
2K55	135.00
3AP1	8.95
3AP4	10.25
3B22/ EL-1C	2.60
3B23	4.75
3B24	5.20
3B24W	7.50
3B25	4.50
3B26	3.75
3B27	4.20
3B28	7.75
3BP1	5.75
3C23	9.65
3C24	1.85
3C27	6.95
3C31/ EL-C1B	3.95
3C37	32.50
3C45	12.95
3CP1	2.25
3D21	2.98
3DP1	4.85
3DP1A	6.75
3E29	13.75
3EP1	4.75
3FP7	2.90
3FP7A	6.95
3GP1	3.95
3HP7	3.95
3J31	115.00
4-125A	29.50
4A1	1.18

4AP10	4.40
4B22/ EL5B	8.95
4B24	5.75
4B25/ EL-6CF	8.95
4C35	27.00
4E27	21.50
4J36	150.00
4J38	120.00
4J52	275.00
5AP1	5.95
5AP4	4.75
EL-C5B	3.95
5BP1	5.50
5BP4	5.50
5C22	47.75
5CP1	4.50
5CP7	9.50
5D21	19.50
5FP7	1.95
5HP1	5.50
5HP4	5.75
5J29	18.50
5JP1	26.50
5JP2	26.50
5JP4	26.50
5LP1	21.75
5LP5	19.75
5MP1	10.50
6-8B	.85
C6A	6.75
6AN5	3.30
6AR6	3.25
6C21	27.50
6C24	52.50
6F4	5.95
C6J	9.95
6J4	6.85
7-7-11	1.19
7BP1	8.65
7BP7	6.50
7BP12	14.95
7BP14	14.95
7CP1	14.95
9GP7	11.75
9LP7	4.50
10BP4	17.95
10FP4	22.50
10T1	.88

10Y	.39
12DP7	14.50
12GP7	18.50
12HP7	14.75
13-4	.80
15E	1.95
15R	.65
FG-17/ 5557	4.95
REL-21	1.95
24G	1.85
HK-24	4.95
RK-25	3.82
FG32/ 5558	6.75
FG33	17.50
RK34	.49
35T	4.95
35T ion gauge	5.95
35TG	4.95
REL36	.45
T-40	3.75
FG-41	122.50
RK-47	4.92
EF-50	.79
VT-52	.35
53A	5.60
RK59	2.44
VT-62 Br.	1.15
RK-63	22.50
FG-67	14.80
VT-67	.48
RK-69	2.25
72	1.32
73	1.32
RK-75	3.50
75T	5.80
VR-75	1.15
VR-78	.64
FG-81A	3.95
VR-90	1.19
91	14.80
FG-95/ 5560	25.00
VT-98 (Br.)	19.50
C100A	2.30
C100E	2.30
100R	2.90

100TH	9.95
WE-101F	3.62
WE-102F	2.85
FG-104/ 5561	24.60
FG-105	19.50
VR-105	1.10
WE-113A	1.32
HY-114B	.75
WE-117A	.95
F-123A	7.75
WE-124A	3.80
F-127A	22.50
VT-127A	3.60
AB-150	12.50
VR-150	.95
FG-166	48.50
FG-172	29.50
FG-178	14.50
FG-190	12.15
HF-200	16.50
L-200B	65.00
203A	7.40
203B	6.33
204A	47.50
CE-206	3.15
211	.95
WE-211D	12.50
WE-211E	12.50
212E	42.50
WE-215A	.24
217C	8.95
221A	1.95
227A/5C27	4.60
WE-231D	2.25
232CH	240.00
RX-233A	4.95
FG-235A/ 5552	94.50
WE-244A	5.20
WE-245A	2.35
WE-249B	3.50
WE-249C	3.50
250TH	22.50
250TL	22.50
WE-252A	5.65
WE-254A	5.90
WE-257A	3.77
FG-271/ 5551	62.50

WE-274A	5.50
274B	2.85
WE-275A	6.95
WE-283A	4.25
WE-285A	5.57
WE-286A	7.90
WE-294A	5.75
304TH	8.75
304TL	8.75
307A	4.25
WE-309A	6.45
WE-310A	6.25
WE-313C	4.15
316A	.89
327A	4.25
WE-331A	9.75
WE-343A	185.00
WE-346A	2.75
WE-350A	6.95
350B	4.95
WE-356B	5.45
361A	4.75
368A	6.95
371A	.95
371B	.95
388A	2.95
393A	8.60
394A	4.50
WE-399A	4.70
GL-415/ 5550	39.50
417A	16.95
434A	24.50
446	1.75
446A	1.95
446B	2.95
450TH	42.50
450TL	42.50
451	1.39
471A	2.65
503AX	1.25
506AX	1.25
507AX	1.47
527	17.50
530	17.20
531	7.50
532A	3.75
WL-533	19.50
559	2.20

561	3.50
KU610	12.50
HY615	.49
KU-623	39.50
KU-628	22.50
KU-634	39.50
WL-652/ 5551	62.50
WL-654/ 659	82.00
WL-670A	8.70
WL-672	22.00
WL-681/ 5550	39.50
700A	24.50
700B	24.50
700C	24.50
700D	24.50
701A	6.95
702A	2.95
702B	4.25
703A	5.95
704A	.95
705A	2.25
706AY	45.00
706BY	45.00
706CY	45.00
706FY	45.00
706GY	45.00
707A	7.95
707B	14.90
708A	4.75
709A	3.85
710A	1.70
713A	1.45
714AY	10.75
715A	6.25
715B	8.95
715C	19.50
717A	1.47
718AY	45.00
718BY	45.00
720DY	95.00
721A	3.95
722A	2.95
723A	9.95
723A/B	18.50
724A	3.22
724B	3.22
725A	8.95

726A	14.50
726B	45.00
726C	65.00
730A	25.00
731A	2.45
788Y	1.40
800	1.75
801A	.45
803	4.95
805	4.50
806	24.50
807	1.65
808	2.65
809	2.95
810	10.95
811	3.60
813	10.50
814	3.95
815	2.95
816	1.45
826	1.25
828	11.25
829	9.95
829A	11.95
829B	12.95
830B	2.95
832	7.95
832A	9.95
833A	39.50
836	4.10
837	1.45
838	3.75
841	.49
843	.59
845	5.75
845W	6.75
849	29.50
851	67.00
852	19.50
860	4.95
861	22.50
864	.35
865	1.28
866A	1.48
866JR/ 2B26	1.25
872A	3.95
874	1.15
876	1.60
878	1.85

884	1.75
885	1.75
886	2.60
902P1	9.95
905	3.50
918	1.65
919	1.95
923	1.35
927	1.85
931A	5.00
954	.39
955	.55
956	.49
957	.49
958A	.69
959	2.25
991	.45
1003	.90
CK-1005	.69
CK-1006	3.30
E-1148	.35
1201	.79
1203	.45
1291	.57
1294	.69
1299	.57
1602	2.25
1613	.89
1614	2.00
1616	1.07
1619	.39
1620	6.25
1622	2.25
1624	1.90
1625	.39
1626	.30
1629	.30
1630	.95
1631	1.38
1632	.75
1636	3.10
1638	.70
1642	.65
1644	.95
1645	1.95
1655	1.90
1665	1.80
1904	14.80
1960	.70
2050	1.70

2051	1.10
5611	115.00
5651	2.75
5654	2.90
5691	8.55
5692	8.55
5693	6.95
UX-6653	.65
7193	.45
8011	.87
8012	2.60
8013	2.75
8013A	4.90
8016	1.05
8020	1.25
8025	6.95
9001	1.50
9002	.95
9003	1.50
9004	.45
9005	1.95
9006	.35
189048	3.79
189049	3.79
199698	2.69

Crystal Diodes

1N21	1.19
1N21A	1.69
1N21B	3.00
1N22	1.25
1N23	1.95
1N23A	2.75
1N23B	3.45
1N27	1.79
1N31	7.90
1N34	.66
1N34A	.90
1N38	1.50
1N39	6.10
1N40	8.50
1N41	9.85
1N42	18.00
1N43	1.40
1N45	.94
1N52	1.05
1N55	3.05
1N60	.55

IMMEDIATE

DELIVERY FROM STOCK

GENERAL ELECTRIC	ARMA
CONTROL INSTRUMENT	BENDIX
FORD INSTRUMENT	KETAY
HENSCHEL	DIEHL

SYNCHROS

ARMY ORDNANCE—NAVY ORDNANCE—COMMERCIAL

AY-101D	5D	6DG	X	2JD5E1	C-78248
1CT	5DG	6G	2J1F1	C-44968-6	C-78249
1DG	5F	7DG	2J1G1	C-56701	C-78254
1F	5G	7G	2J1H1	C-56776-1	C-78410
1G	5N	A	2J1M1	C-69405-2	C-78411
1HG	5SF	B	2J5A2	C-69406	C-78414
1SF	5SG	M	2J5D1	C-69406-1	C-78415
5B	6CT	N	2J5HA1	C-77610	C-78670
5CT			2JD5A2		C-79331

SYNCHRO CAPACITORS SYNCHRO BLOWN FUSE INDICATORS
SYNCHRO OVERLOAD INDICATORS

TYPE "J" POTENTIOMETERS $1.25 ea.

Resis.	Shaft	Resis.	Shaft	Resis.	Shaft
60	SS	5K	1/4"	50K	3/8"
60	9/16"	5K	3/8"	50K	1/2"
100	SS	5K	1/2"	100K	SS
200	SS	10K	SS	150K	1/2"
250	1/8"	10K	3/8"	200K	3/8"
500	SS	10K	1/2"	250K	SS
500	5/16"	15K	SS	250K	3/4"
500	1/2"	15K	1/2"	250K	3/8"
500	5/8"	20K	SS	500K	SS
650	1/2"	25K	SS	500K	1/4"
1K	SS	25K	1/4"	500K	7/16"
2K	3/8"	30K	1 1/8"	1 Meg	SS
2500	SS	40K	SS	2.5 Meg	SS
4K	SS	50K	SS	5 Meg	SS
5K	SS	50K	1/4"		

DUAL "J" POTS—$2.95 ea.

50 SS	330 SS	2500 SS	2.5 meg SS
100 SS	500 SS	10K SS	5 meg SS
250 SS	1K SS	1 meg SS	1K/25K ⅜"

TRIPLE "JJJ" POTS—$3.95 ea.

100K/100K/100K ⅜"   20K/150K/15K ⅜"

ANTENNAS

AN-74BX .... $ 3.75
AT-38/ARN-PT (70 to 400 MC) 13.70
AT-49/ARN-4 (300 to 3300MC) 13.70
AN-65A/AP/O(SCR-521) 1.50
AN-66A/AP/O(SCR-521) 1.75
AIA 3CM conical scan 125.00
ASB Yagi—5 element 450 to 560MC 9.00
ASB Yagi—Double stacked 6 element 14.70
ASA Yagi—Double stacked 370 to 430MC 29.40

TACHOMETER GENERATOR

Elinco type PM-1-M—2.0 VDC output per 100 RPM Brand New .... $27.50 ea.

AIRBORNE TV EQUIPT.—mfd. by RCA

Conversion Unit—CRV-59AAE—Complete with Lens and Iconoscope; Transmitter—CRV-52ACB complete; Dynamotor—28VDC 25 Amp. Excellent for Instruction or Demonstration Purposes.

2 ϕ LOW INERTIA SERVO MOTORS

Diehl FPE-25-11—75V 60 cy. .11 Amp 4 Watts. Each $34.50
KOLLSMAN—45 Volt 60 cycle 4 watts 1500 RPM—new $22.50
PIONEER—10047-2-A 26 volt 400 cycle with 40:1 reduction gear $14.50
PIONEER—CK 13 115 volt 400 cycle—includes damping signal generator (autosyn) $47.50

RELAYS

Sigma type 4AH—2000 Ω 4 ma DC coil—SPOT contacts—hermetically sealed 5 pin plug-in base $3.30
Stevens Arnold type 171 Millisec relay—900 ohm coil SPST NO contacts $5.50
Cutler Hammer and Square D type B-7A contactor—24 VDC coil—SPST NO 200 Amp contacts ..$4.75
Price Bros. type 161-M—220 VAC contactor—SPST NO double bk 30A contacts $3.25
G.E, CR5181-1A6—115 V 60 cy. AC contactor—4PST 30 Amp contacts plus two auxiliary SPDT contacts $14.50
RBM—115 V 60 cy. AC coil—DPDT 3 amp Contacts $3.20
Sigma type 5F—Coil 3500 ohms—pulls in @ 2.5MA out @ .5 MA—copper slug for slight time delay. Contacts—SPDT 2 Amp $3.95
Sigma type 5RLP—Dual coil 60 ohms each, pulls in @ 12MA out @ 10MA. Contacts—SPDT 2 Amp $3.75
Leach type 1521—Coil 115 VAC 60 cy—Contacts SPST NO Double Break 15 Amp.—Mycalex Insul. $3.25
Cramer Model 1C2H—110V 60 cy. motor. Interval timer—two SPST 15A contacts (on 1 hr. off 1 hr.) can be adjusted $2.95
Westen Model 813-MR-5—Instrument type—Coil 1000 ohm 350 micro amp—contacts SPDT 35 ma. .$16.50

TRANSFORMER

Westinghouse—Hipersil—Pri—115V 60 cy.—¾ KVA —Sec #1—240V @ 1.56A.; Sec #2—240V @ 1.56 A $18.75
G.E.—Hi Voltage—Pri—115V 60 cy.—Sec. 6250 V @ 80 MA.—12.5KV Insulation $18.50
Bendix Buck Boost—Input—100V to 130V in 5V steps. 60 cy. Output 115V 25 Amp $16.85
Constant Volt. Transformer—Sola 30807—Input 95-125 VAC 60 cy. Output 115 VAC 250 VA....$49.00

GENERATORS AND INVERTERS

Eclipse-Pioneer type 716-3A (Navy Model NEA-3A) Output-AC 115V 10.4A 800 to 1400cy. 1ϕ; DC 30 Volts 60 Amps. Brand new $38.50
Eclipse-Pioneer type 1235-AA. Output-30 Volts DC 15 Amps. Brand New—Original Packing..$15.50
PE-109 Inverter—13.5 VDC to 115 VAC 400 cy 175 VA 1ϕ (new) $79.50
PE-218 Inverters 28 VDC to 115 VAC 400 cy 1500 VA. (New) $49.50
Pioneer Type 800-1B Inverter—28VDC to 120V 800 cy 7 amp AC (used) $22.65
G. E. Inverter—28 VDC to 120 VAC 800 cy 750 VA 1ϕ $39.50
ATR Inverter 6VDC to 110 VAC 60 cy 75W..$22.95
PU-7/AP Inverter—28 VDC to 115 VAC 400 cy 2500 VA (used) $75.00
Eclipse-Pioneer type 12121-1A Inverter—Voltage and frequency regulated—24VDC 18 Amp input—AC output 115V 3ϕ 400 cy 250 VA 0.7 PF—(New) $225.00
Eclipse-Pioneer type 12116 Inverter—28 VDC to 115 VAC 400 cy 1 ϕ 50 VA .... ea. $79.50
Eclipse-Pioneer type 12117 Inverter—28 VDC to 26 VAC 400 cy 1 ϕ 6 VA .... ea. $33.50
Leland 10563 Inverter—28 VDC to 115 VAC 400 cy. 3 ϕ 115 VA .... ea. $75.00

VARIABLE TRANSFORMERS

Amertran—Type RH—Input 115V 400 cycles. Output —75-120V 6 Amp .... $6.95 ea.
Amertran—29144—Input 115V 60 cy 1 ϕ. Output—103-126V 2.17 Amp .... $8.25 ea.
Powerstat-Superior 1226—Input 115/230 VAC 50/60 cy.—Output 0-270V 9 Amp 2.4 KVA....$37.00 ea.

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.09 MFD 1500 VDC G1 .... ea. $9.25
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.004 MFD 6000 VDC G1 .... ea. 18.10
.00015 MFD 20000 VDC G3 .... ea. 24.50

Terms 20% cash with order, balance C. O. D. unless rated. All prices net F. O. B. our warehouse, Phila., Penna., subject to change without notice.

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NEW YORK'S RADIO TUBE EXCHANGE

TYPE	PRICE	TYPE	PRICE	TYPE	PRICE	TYPE	PRICE	TYPE	PRICE	TYPE	PRICE	TYPE	PRICE
OA2	$1.40	2J21A	17.95	4E27	17.50	RK-73	1.95	450TH	45.00	806	27.50	955	.55
OA3	1.10	2J22	17.95	4J25	199.00	100TH	9.95	450TL	45.00	807	1.69	956	.69
OB2	1.35	2J26	27.75	4J26	199.00	FG95	24.95	464A	9.95	808	3.50	957	.29
OC3	1.25	2J27	29.95	4J27	199.00	FG105	19.00	471A	2.75	810	11.00	958A	.69
OD3	1.25	2J31	29.95	4J31	199.00	203A	8.95	527	15.00	811A	3.95	991	.65
C1B	3.95	2J32	69.95	4J32	199.00	211	.95	WL530	3.50	813	9.95	F1148	.35
1B21A	2.75	2J36	105.00	4J33	199.00	217C	18.00	WL531	22.50	814	3.95	1280	1.25
1B22	3.95	2J38	17.95	4J37	199.00	242C	10.00	WL533	17.50	815	3.50	1611	1.95
1B23	9.95	2J39	12.50	4J38	89.00	244A	12.95	700A/D	25.00	816	1.45	1613	1.38
1B24	17.95	2J40	35.00	4J39	199.00	249C	4.95	701A	7.50	829	12.95	1616	2.95
1B26	2.95	2J42	200.00	4J41	199.00	250TH	22.50	703A	6.95	829A	13.95	1619	.89
1B27	13.50	2J49	109.00	C5B	3.95	250TL	19.95	705A	3.95	829B	15.95	1622	2.75
1B32	4.10	2J50	195.00	5BP1	6.95	274A	3.00	707A	17.95	830B	2.50	1624	2.00
1B38	33.00	2J61	45.00	5BP4	6.95	204B	3.00	707B		832	7.95	1625	.45
1B42	19.95	2J62	45.00	5CP1	6.95	304TH	10.00	714AY	17.95	832A	9.95	1851	1.85
1B51	9.95	2K25	29.50	5D21	21.00	304TL	10.00	715A	7.95	833A	49.95	2050	1.85
1B56	49.95	2K28	37.50	5JP1	27.50	307A	4.95	715B	12.00	834	7.95	2051	1.80
1B60	69.95	2K29	37.50	5JP2	19.50	310A	5.95	715C	25.00	836	4.95	8012	4.25
1N21	1.35	2K41	150.00	5JP4	27.50	311A	6.95	717A	1.95	837	2.95	8013	2.95
1N21A	1.75	2K45	149.50	WE6AK5	2.50	312A	3.95	718AY/EY	48.50	838	6.95	8013A	5.95
1N21B	4.25	2V3G	2.10	C6A	12.50	323A	15.00	719A	29.50	845	5.59	8019	1.75
1N22	1.75	3BP1	7.50	C6J	10.95	327A	3.95	721A	3.95	849	52.50	8020	3.50
1N23	2.00	3B24	5.50	7BP7	7.95	328A	6.95	722A	3.95	851	80.50	8025	6.95
1N23A	2.75	3B24W	7.50	7DP4	10.00	350A	6.95	723A/B	24.95	860	4.95	PD8365	89.00
1N23B	4.25	EL3C	5.95	12AP4	55.00	350B	5.95	724A	4.95	861	29.50	9001	1.75
1N34A	.96	3C22	120.00	15E	1.95	357A	20.00	724B	6.95	866A	1.79	9002	.95
1N43	2.50	3C24	1.95	15R	.95	368AS	6.95	725A	9.95	869B	57.50	9003	1.75
2B22	1.95	3C31	3.95	NE16	.66	371B	2.95	726A	24.00	869BX	35.00	9004	1.75
2B26	3.75	3DP1A	10.95	FG17	6.95	385A	4.95	726B	56.00	872A	3.95	9005	1.90
2C34	.35	3DP182	12.00	KY21A	8.75	388A	2.95	726C	69.00	878	1.95	9006	.35
2C40	10.00	3E29	15.50	FG33	12.95	394A	7.95	728AY	27.00	884	1.95		
2C43	20.00	3GP1	5.50	35T	4.95	MX408U	.75	730A	24.00	885	1.75		
2C44	.90	4A21	2.75	45 Special	.35	417A	17.95	801A	1.00	889R	199.50		
2D21	1.75	4B26	6.95	RK39	2.95	434A	19.95	802	4.25	914	75.00		
2E22	2.75	4C27	25.00	HF50	1.75	446A	1.95	803	7.95	931A	5.00		
2E30	2.75	4C28	35.00	VT52	.25	446B	5.40	805	5.95	954	.35		

Minimum Order

$25.00

MICROWAVE TEST EQUIPMENT
TS148/UP
SPECTRUM ANALYZER

Field type X Band Spectrum Analyzer, Band 8430-9580 Megacycles.

Will check Frequency and Operation of various X Band equipment such as Radar Magnetrons, Klystrons, TR Boxes. It will also measure pulse width, c-w spectrum width and Q or resonant cavities. Will also check frequency of signal generators in the X band. Can also be used as frequency modulated Signal Generator etc. Available new complete with all accessories, in carrying case.

Also available of new production TS239A Synchroscope.

Other test equipment, used checked out, surplus.

TSK1/SE K Band Spectrum Analyzer
TS3A/AP Frequency and power meter S Band
RF4A/AP Phantom Target S Band
TS10/APN Altimeter Test Set
TS12/AP VSWR Test Set for X Band
TS13/AP X Band Signal Generator
TS14/AP Signal Generator
TS15/AP Flux Meter
TS16/AP Altimeter Test Set
TS19/APQ 5 Calibrator
TS33/AP X Band Power and Frequency Meter
TS/34AP Western El Synchroscope
TS34A/AP Western El. Synchroscope

T35/AP X Band Signal Generator
TS36/AP X Band Power Meter
TS47/APR 40-400 MC Signal Generator
TS69/AP Frequency Meter 400-1000 MC
TS100 Scope
TS102A/AP Range Calibrator
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TS125/AP X Band Power Meter
TS126/AP Synchroscope
TS147 X Band Signal Generator
TS251 Range Calibrator APN9
TS270 S Band Echo Box

TS174/AP Signal Generator
TS175 Signal Generator
TS226 Power Meter
TS239A Synchroscope

SURPLUS EQUIPMENT

APA10 Oscilloscope and panoramic receiver
APA38 Panoramic Receiver
APS 3 and APS 4 Radar
APR5A Microwave Receiver
APT2 Radar Jamming Transmitter
APT5 Radar Jamming Transmitter

MINIMUM ORDER 25 Dollars

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Cables: TELSERSUP

SPECIAL

Wide Band S Band Signal Generator 2700/3400MC using 2K41 or PD 8365 Klystron, Internal Cavity Attenuator, Precision individually calibrated Frequency measuring Cavity. CW or Pulse Modulated, externally or internally.

Large quantities of quartz crystals mounted and unmounted.
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Large quantity of Polystyrene beaded coaxial Cable.

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PHONE WORTH 4-8262

MOTOR GENERATORS

2.5 KVA Diehl Elec. Co. 120DC to 120AC, 60 cy., 1 Ph. Complete with Magnetic Controller, 2 Field Rheos and full set spare parts including spare armatures for generator and motor. New $295.00

2 KVA O'Keefe and Merritt. 115DC to 120AC, 50 cy., 1 Ph. Export Crated. New $149.50

MOTOR GENERATOR, TYPE CGU-2 Unit of U. S. Navy TCK-7 Transmitter Motor: 2 H.P. 230V. D.C., 10 amps. Generator: 1800V. D.C., 0.4 A. 500V. D.C., 0.35A. 115V. D.C., 1.5A. 12 V. D.C., 2A. 3480 R.P.M. Self excited. Brand new including spare armature. $169.50

ALLIS-CHALMERS 230DC to 115AC, 60 cy., 1 Ph., 1.25 KVA $225.00

INVERTERS

Onan M-G.-215H. Navy type PU/13. Input 115/230, 60 cy., 1 Ph. Output: 115, 480 cy., 1 Ph., 1.2Kw and 26V DC at 4 amps. New $295.00

Onan M-G.-0-75. Navy type PU/11 Input: 115/230, 60 cy., 1 Ph. Output: 115, 480 cy., 1 Ph., 5.3 amps. and 26 VDC @ 3.8 Amps. New $225.00

Leland Elec. Co. PE206A. Input: 28DC at 38 Amps. Output: 80V, 800 cy. 1 Ph., 485VA. New $22.50

G.E. J8169172. Input: 28DC. Output: 115, 400 cy., 1 Ph., 1.5KVA. New $32.50

G.E. 5AS131551IA. Model 218J. Input: 28DC. Output: 115, 400 cy., 1 Ph., 1.5 KVA. Regulated. New $89.50

Holtzer-Cabot M.G. 164. Input: 440, 3 Ph., 60 cy., Output: 70V, 146 cy. 3 Ph., 0.140KVA. New $67.50

Elcor. 74DC to 110AC, 60 cy., 1 Ph. at 2.4 Amps. New $39.50

DYNAMOTORS

Navy type CAJO-211444. Input: 105 to 130DC. Output: either 26DC at 20 amps. or 13DC at 40 amps. Radio filtered and complete with line switch. New $89.50

Type PE94CM. For SCR-522. Brand new in overseas cases. Has wide band, input and output filters $19.50

AMPLIDYNES

G.E. 5AM21JJ7. Input: 27VDC. Output: 60VDC. 150 Watts. 4600 RPM. Type MG-27-B. New $34.50

Edison 5AM31NJ18A. Input: 27VDC, 44 Amps. 8300RPM. Output: 60VDC at 8.9 Amps. 530 Watts. New $12.50

G.E. 5AM31NJ9A. 530 Watts. 7500 RPM Input: 27VDC, Output: 60VDC. Weight 34½ lbs. $29.50

SMALL D.C. MOTORS

G.E. 5BA50LJ2A. Armature 27VDC at 8.3 Amps. Field 60VDC at 2.3A RPM 4000. H.P. 0.5 New $27.50

Oster E-7-5. 27.5DC. 1/20HP, 3600RPM. Shunt Wound. New $6.50

Dumore Co. type ELBG. 24VDC, 40-1 gear ratio. For type B-4 Intervalometer. New $6.75

G.E. 5BBY47AB12. ¼ H.P. Perm. Mag. —1 amp. 250V. 1725 RPM. New .. $22.50

400 CY. BLOWERS

Westinghouse. Type FL. 115V. 400 cy., 6,700 RPM. Airflow 17C.F.M. New. $6.75

SYNCHROS

Ford Inst. Co. Synchro Differential Generator. Mod. 3 Type 5SDG. 90/90V. 400 cy., Ord. Dr. 173020. New .. $22.50

Armor. Synchro Differential Generator, Type 6DG. New $60.00

Hobart Mfg. Co. Synchro Differential Synchro Type XIX 115V. 60 cy. New. $9.50

SOUND POWERED CHEST SETS

U. S. Instrument Co. No. A-260 Combination headset and chest microphone. Brand new, including 20 ft. of rubber covered cable $17.50 each

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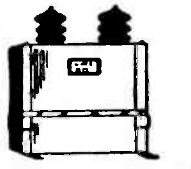
Cathode Ray Shields for 3" tube .. $2.75
Shock Mounts Lord #20 .... $.40
Shock Mounts U. S. Rubber #5150C $.30
Commando Pole Jacks (Cook Elec. Co.) $1.00
Switchboard Lamp Receptacles & Jewels $.40
Dial Drive Assembly for Bendix, MN-28-Y $2.75
Instruction Manual for SCR 193A, B, C, D, E $2.00
Solenoid Cannon 24 V.D.C.—New. $1.45
Attenuators Tech-Lab 500/500 type 700 $2.00

MULTI-CONDUCTOR CABLE

CO-215. Stock 3E2215. Bulk 9 conductor No. 20 A.W.G. Stranded tinned copper plastic insulated, color coded, tinned copper braided shield. Flamenol jacketed. Made by G.E. Available 1000, 1500, 2000 ft. reels. Price .... $15 ft.



HIGH VOLT OIL CAPS

Mfd.	Volts D.C.	Price
.001	50,000	$37.50
.01	5,000	2.95
.02	8,000	9.50
.025	50,000	45.00
.025/.025	50,000	59.50
.1	500	.95
.1	3,000	2.95
.135	7,500	6.95
.2	50,000	67.50
.25	15,000	19.50
.25	20,000	26.50
.25	50,000	72.50
1.	7,500	12.50
1.	15,000	49.50
2.	5,500	12.50
2.	6,000	14.50

Standard Brands

RADAR SETS

MODEL SQ. Portable radar set, 10CM. Operates on 90-130 volt, 60 cy., 1 Ph. "A", "B", and "PPI" presentation. Complete with tech manual and full set of operating spare parts.

MODEL SG-1. Consists of complete equipment including Radar Transmitter-Receiver CRP-43AAK-3, Range and Train Indicator CRP-55ABC-3, Control Amplifier CRP-50AAT-1, Motor Dynamo-Amplifier (Amplidyne) CG-21AAY and Antenna Assembly CRP-66ABJ-1.

MODEL ASG-1 Radar unit consisting of transmitter and converter assembly CPR-43ABC. Antenna Assembly CRP-ACZ, Mounting Base CPR-10ABE, etc.

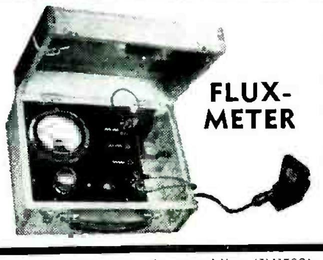
Spare Parts available for Model SQ and SG-1 Radar.

MICA CAPACITORS

Style	MFD.	DCWV	Price
A	.00003	2000	$.75
A	.00005	3000	.75
A	.00009	3000	.75
A	.0001	4500	1.65
C	.0002	1000	.60
A	.0003	2500	.75
B	.00035	2500	.60
A	.0004	2500	.60
B	.0004	3000	.75
A	.00056	5000	3.50
A	.0007	3000	.75
A	.00075	2500	1.75
A	.00075	5000	3.50
A	.0015	5000	3.50
A	.001	4500	1.75
A	.003	3000	1.75
C	.005	2500	1.75
A	.006	2500	1.75
A	.12	500	1.95

MISC. RADAR EQUIPMENT

Modulator Units for SO-11 (CUZ-50AGD)
Pulse Timer units for SD-5
Transmitter-Receiver units SO-13
Spare Parts for SG-1
Spare Parts for SQ
Marker Oscillator Crystals in holders 98.35KC
Bearing Control Units CRP-23AEK
Synchro Amplifiers—Bendix
90° Waveguide Bends 10CM Bronze
Signal Monitors CRP-60AAN
Repeater Amplifiers CBM-50AFO
Oscillator Tube Cavities for SO-1, 13 etc., RF303.
10CM Horns, 1½" x 3" waveguide, standard contact, flange input, circularly polarized horn output
Duplex Tees #2Z3005-17
Auxiliary Rectifier CABM-20237 (SO-2 Radar)
SO-1 (66AGE) Antenna R.F. Nozzle Assemblies (RF502)
SO-1 (66AGE) Antenna Reflector Assemblies (RF503)
SO-1 (66AGE) Antenna Reflector Assemblies (RF503)
SO-1 (6AGE) Antenna Waveguide Resonance Chamber Assemblies (RF515)
SO-1 RF Coupling Waveguide to Transmitter (Z304)
SO-1 RF System and duplexing cavity (RF301 with V309)



Used to calibrate field strength of magnets from 500 to 4000 gauss and indicate polarity. Probe has gap of 1¼". Beautifully built in hardwood case with hinged cover.

FLUX-METER

Instructions for operation on under side of cover. Size 12¾ x 9 x 6 in. Ideal for lab and school use. New. An exceptional value at **$29.50**

SYNCHRO CAPACITORS

.6-.6-.6 mfd Mark 12, Mod. 2, type 1C $1.75
10-10-10 mfd Mark 1, Mod. 2, type 3C $5.65

G. E. BATTERY CHARGER
Charges 54 cell battery at from 1 to 10 ampere rate

Input 115V., 60 cy. 1 Phase.

The model 6RC89F16 Copper Oxide battery charger consists of a transformer, a secondary reactor, a copper oxide rectifying element, a ventilating fan, control circuits and auxiliary equipment necessary for proper operations. Transformer tapped for various supply voltage. Eight secondary taps for adjusting changing rate. Built into metal cabinet. Metered. Complete with spare fan and fuses. New in original packing cases. Shipping weight approx. 305 lbs.

Price $255.00

PANORAMIC ADAPTER MODEL AN/APA-10

Provides 4 Types of Presentation: (1) Panoramic (2) Aural (3) Oscillographic (4) Oscilloscopic

Designed for use with receiving equipment AN/ARR-7, AN/ARR-5, AN/APR-4, SCR-587 or any receiver with I.F. of 455 kc. 5.2mc or 30mc. With 21 tubes including 3" scope tube. Converted for operation on 115 V. 60 cycle source.

Price $245.00
Gov't Cost $1800.00.
AN/APA-10 80 Page Tech Manual $2.75

SCR-522 EQUIPMENT

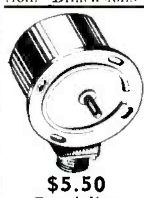
Complete BC-624C receivers and BC-625AM Transmitters including mounting racks, plugs, connectors, P.E. 94CM dynamotor. Brand new equipment with instruction manuals.

REPAIR PARTS FOR BC-348 RECEIVERS (H, K, L, R, Only)

Also BC 224 Models F. K., Coils for ant., r.f., det., osc., I.F., c.w. osc., xtal filters, 4 gang cond., front panels, dial assemblies, vol. conts., etc. Write for complete list and free diagram.

RADAR REPEATER ADAPTERS
NAVY TYPE CBM-50AFO

A repeater unit for video signals and trigger pulses designed to work in conjunction with standard Navy radar equipments wherein provision is made for operation of remote P.P.I. sets. This adapter provides four video and trigger pulse lines for operating one or more remote P.P.I. installations. The equipment contains its own D.C., power supply 115 Volts, 60 cycles A.C. from ships' power supply line is required for operation. Dimensions are 31½ x 21 x 15 in.



LINEAR SAWTOOTH POTENTIOMETER
No. KS 15138

$5.50 Brand New

Has continuous resistance winding to which 24 volts D.C. is fed to two fixed taps 180° apart. Two rotating brushes 180° apart take off linear sawtooth wave voltage at output. Size approximately 3¾" dia. x 3" deep x 4¾" long. Enclosed in die cast alum. frame with AN connector socket.

TEST EQUIPMENT

TS-16 APN Test Set
TS-47/APR Test Osc. 40-500MC.
TS-127/U Freq. Meter 375-725MC.
TS-487/U Peak to Peak VTVM
BC-221 Freq. Meter
BC-423-B Radio Modulator (Tweeter)
BC-1203-B Pulse Modulator
I-222A Signal Generator
APR-1 Receiving Sets
APR-1 and APR-4 Tuning Units
APR-5A Receivers 1000—6000MC
Telrad 18A Frequency Standards

60 CYCLE TRANSFORMERS

G. E. Step-Down. 6KVA. Pri: 230/460. Sec: 115/125. 60 cy. Size: 20" x 11" x 9½". Weight 225 lbs. Navy grey finish, integral junction box and mounting brackets $125.00

Plate Trans. Raytheon U-5815. Pri: 440/220, 60 cy. 3 phase. Sec: each phase 1310V @ 0.67A test 6000V $110.00

Plate Trans. Pri: 115V., 60 cy., 1 Ph. Sec: 1470V C.T. @ 1.2A tested at 5500V. RMS. Raytheon. Size 12¼ x 10 x 10 in. Shipping wt: 150 lbs. New. Price $27.50

HIGH POT TRANSFORMER

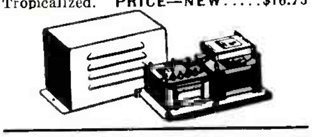
Westinghouse. Pri: 115, 60 cy. Sec: 15,000V C.T., @ .060A, C.T. ungrounded. Excellent for high-potting tests. Size OA 12H x 8½W x 9¼D. Weight 67 lbs. Fully enclosed steel case. Price .. $39.50

PULSE TRANSFORMERS

KS-9563 Supplies 3500V peak from 807 tube $3.95
KS-161310—50kc to 4MC $3.95
High Reactance Trans. G. E. Type Y-3502A—60 cy. Voltage 1120-135, Ind. H.V. winding 135 hy. Output: Peak 22.8KV. Cat. 8318065G1 .... $39.50

RAYTHEON VOLTAGE REGULATORS

Adj. input taps 95-130V., 60 cy. 1 Ph. Output: 115V. 60 Watts. ½ of 1% Reg. Wt. 20 lbs. 6¼" H x 8¾" L x 4⅝" W. Overload protected. Sturdily constructed. Tropicalized. PRICE—NEW $16.75



400 CYCLE TRANSFORMERS

Auto. .945S-520P KVA. 460/345/200/115. Weight 22 lbs. G. E. Cat. 80G184 .... $4.50

Fil. IN: 0/75/80/85/105/115/125. Out: 5V3A/5V3A/5V3A/5V6A/6.3V0.5A No. 7249010 .... $1.95

Plate. KS9560 800 cy. Pri: 115V. Sec: 1350-0-1350 at .057A Elecstat shld. Wt. 2.3 lbs. $2.95

Plate & Fil. KS9555, Pri: 115V. Sec: 930-0-930 and three 6.3V windings $3.95

Fil. KS9553. Pri: 115V. Sec: 8.2V1.25A /6.35V1.5A Elecstat Shld. Wt. 0.5 lbs. $2.95

Plate & Fil. Pri: 0/80/115V. Sec: #1=1200V DC @ 1.5MA. Sec. #2=400V DC @ 130MA. Fil Secs: 6.4V4.3A/6.35V.8A (Ins. 1500V) 5V2A/5V2A. $4.95

Plate. Thordarson T46889 500 cy. Pri: 105/120. Sec: 2800-0-2800. 7KV Ins. 1.5KVA. $29.50

Misc. types: G.E. #68G665X, #68G666X, #68G667, #68G668X, #80G200, #80G199 .... $2.00

REACTORS

KS9589 Retard. 4HY @ 100MA .. $1.00
#2C2270/R2 For Keyer Unit BC409 $3.75
Multi-Choke 3 hy @, .275A 70 ohms, 17 hy. @ .125A 200 ohms, 17 hy. @ .125A 200 ohms 7¼ x 6⅝ x 3¾ $6.95

HIGH QUALITY CRYSTAL UNITS

Western Electric — type CR-1A/AR in holders. ½" pin spacing. Ideal for net frequency operation. Available in quantities. 5910-6350-6370-6470-6510-6610-6670-6690-7270-7350-7380-7390-7480-7580-9720. All fundamentals in KC. Good multipliers to higher frequencies. $1.25 each

RADAR ANTENNAS

Type SO-1 (10CM) assembly with reflector, waveguide nozzle, drive motor, etc.

Type SO-3 (3 CM.) Surface Search type with reflector, drive motor, etc., but less plumbing. New in original cases

Type SO-13. (10CM.) Complete assembly with 24" dish, dipole, drive motor, gearing, etc.

1 K.W. MODULATION TRANSFORMER

R.C.A. Broadcast Type. Primary 15,000 ohms. Secondary 5,030 ohms 0.86 KVA audio. Designed for 833 class B modulation to two 833's in final amplifier. Size 11¼ x 9½ x 13. Weight 143 lbs. Type 900777-502. Price, new $97.50

IN21B XTAL DIODE

Sylvania 1N21B. Individually boxed and packed in leaded foil $3.00

TERMS: Rated Concerns Net 30, FOB Bronxville, New York. All Merchandise Guaranteed. Prices Subject to Change

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INC.
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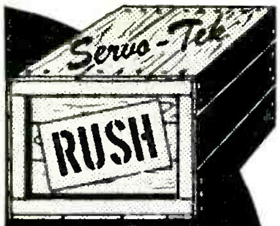
PHONE: BRONXVILLE 2-0044



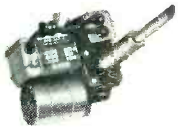
AVAILABLE FOR IMMEDIATE DELIVERY

SYNCHROS
D-C MOTORS
A-C MOTORS
INVERTERS
SERVO MOTORS
ACTUATORS
GEAR MOTORS
GENERATORS

Guaranteed to Meet Original Manufacturers Specifications

● **SELF-EXCITED 400 CYCLE GENERATOR** — G-E #5ASB31JJ3. Output 115 volts 400 cycle, @ 7.2 amp. Designed for pulley drive @ 8000 rpm. 6" long x 6" diam. Only small qty. available. SA-292 .... ea. $129.50

● **REVERSIBLE DUAL SPEED D-C MOTOR** — John Oster Type, DESTU-2-IR Western Electric #KS-15170-LOI. 26 volts @ 1.3/2.3 amps. 4500/10,000 rpm. @ 2 oz.-in. torque. 4" long x 2¼" diam. 3/16" shaft extends ⅜". Weighs 2 lb. SA-228 .... $8.75



● **AIRESEARCH LINEAR ACTUATORS** —4 types available; AR-42, AR-46, AR-4017, and AR-63. 115 volts, 400 cycle single phase. Compression and tension 25-50 lb. static 200 lbs. Approx. 4" travel. Wt. 1.5 lb. #SA-326.......... $19.50

● **TEMPERATURE INDICATOR** — Edison #P109-C127A. FSSC #88-I-2815. Minus 10 plus 120 deg. C. 24-28 volts d-c. Wheatstane-bridge type of instrument. Used with resistive type sensitive element. Weighs 1 lb. SA-410 .... $3.75

● **PIONEER 12120-4-A INVERTER** — Input 115 volts d-c @ 1.0 amp. Output 115 volts 400 cycle single phase @ .45 amp. Shown with magnetic amplifier. SA-406 .... $89.50

● **AIRCRAFT GENERATOR** — Eclipse #716-3A, Navy #NEA-3. Dual output, 115 volts @ 10.4 amps., 800 cycles and 30 volts d-c @ 60 amps. Driving speed 2400 rpm. Weighs 44 lbs. SA-306 .... $29.50

● **G-E AMPLIDYNES**

SA-111	5AM31NJ18A	$ 49.50
SA-147	5AM45DB15	139.50
SA-257	5AM73AB95	169.50
SA-197	5AM73AB58	169.50
SA-196	5AM31NJ9A	49.50

● **AMPLIDYNE MOTORS**

27 volts d-c field, 60 volts d-c armature.

SA-345	5BA50LJ22	$29.50
SA-318	5BA50LJ67	49.50
SA-270	5BA50LJ66	49.50
SA-173	5BA50LJ2A	49.50
SA-298c	5BA25DJ300	49.50
SA-298d	5BA55JJ3	49.50
SA-394	5BA50LJ29	49.50
SA-395	5BA50LJ1	49.50
SA-396	5BA50GJ1	49.50
SA-298c	5BA55EJ8	49.50

● **NAVY SYNCHRO CAPACITORS** — Delta connected. Sections matched to 1%. Improves accuracy of synchro systems when used with each control transformer and differential.

SA-127 Type 1C 1.8 mfd. ea.	$2.75
SA-155 Type 3C 30 mfd. ea.	6.75
SA-205 Type 6C 60 mfd. ea.	9.75
SA-346 G-E #25F679-9 mfd. ea.	4.75

● **A-C AIRCRAFT MOTOR** — G-E #5K31GJ11. 200 volts 3 phase 400 cycle @ 20 amps. 9800 rpm. @ 40 ounce feet. (Approx. ¾ hp.) Thermal protected. 9" x 5½" diam. Weighs 17 lbs. SA-402 .... $85.

● **BALL BEARING D-C MOTOR** — Manuf. Russell Electric. -Navy #211-221. 24 volts d-c @ 8.8 amps. 3/16 hp. @ 3550 rpm. 40 deg. C. temp. rise, continuous duty. Compound wound, 8" long x 5" diam. ½" shaft extends 1½". Ball bearing construction. Weighs 21 lbs. SA-397 .... $9.75

● **DUAL D-C OUTPUT GENERATORS** — Manuf. Fractional Motors & Russell Electric, Navy #211219. Input 3/16 hp. @ 3450 rpm. Output #1, 240 volts @ .1 amp. Ouptut #2, 12.5 volts @ 4.0 amps. Ball bearing construction. 9" long x 5" diam. ½" shaft extends 1½". Weighs 21 lbs. SA-398 .... $9.75

● **D-C GENERATOR** — Manuf. Russell Electric. Navy #211220 — Input 3/16 hp. @ 3450 rpm. Output 86 watts @ 430 volts. Ball bearing construction. 9" long x 5" diam. ½" shaft extends 1½". Weighs 21 lbs. SA-399 .... $9.75

● **REMOTE POSITION TRANSMITTER** — GE 8TJ9. 360 degrees (Continuously rotatable) patentiometer Taps @ 120 deg. Two contacts 180 deg. apart. 24 volts d-c. Weighs 4 oz. SA-13 .. $3.75

● **AIRCRAFT A-C ROTARY ACTUATOR** — Ritter #D-2163. 208 volts, 3 phase, 400 cycle. Gear ratio 5580: 1. 1 rpm. output @ 500 in-lb torque. Thermo-protected. Built-in potentiometer follow-up and limit switches. Used on Northrop Flying Wing. 11" long x 4½" diam. ½" shaft extends 2". Weighs 10 lbs. SA-400 .... $49.50

● **400 CYCLE BRAKE MOTOR** — AiResearch #27770. 115 volts single phase. .03 hp. @ 6500 rpm. 4.6 oz-in torque. Used with 2.5 mfd. capacitor. 2¾" long x 1⅝" diam. 3/16" shaft extends ¾". Weighs 1 lb. SA-392a $8.75

● **AIRESEARCH #277B0** — Similar to SA-392a above except .025 hp. and shaft detail. SA-392b $8.75

● **AIRESEARCH #27652** — Similar to SA-392a except it does not have brake and 5500 rpm. speed. SA-392c $8.75

● **AIRCRAFT A-C ROTARY ACTUATOR** — Ritter #D2162. 208 volts 3 phase 400 cycle. 1280 watts. With potentiometer follow-up. 600: 1 gear reduction. 20 rpm. output @ 1800 in-lb. torque. Used on Northrop Flying Wing. SA-404 $165.

● **AIRCRAFT A-C ROTARY ACTUATOR** — AiResearch #291-80. 200 volts 3 phase 400 cycle. 10,000 in-lb. torque, with clutch overload rated @ 11, 250 in-lb. Static 27,000 in-lb. Output speed 7 rpm. Thermal protected motor rated @ 2 hp. Weighs 22 lbs. SA-509 .... $165

● **MURRAY 2 KVA ALTERNATOR** — 115 volts 400 cycle, self-excited single phase generator. 3450 rpm. Mounted on base ready for a motor of your choice. Only 3 available. $275

Prices F.O.B. Hawthorne

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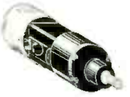
ALNICO FIELD MOTORS



(Approx. size overall . . . 3¾" x 1¼" diameter) **Delco-Type** 5069230: 27.5 volts; DC; 145RPM **$19.95 ea.**

DELCO TYPE #5069600: 27.5 volts DC; 250 RPM **$19.95**

PM Motor, Delco Type #5069370: 27.5 volt; DC Alnico Field; 10,000 r.p.m.; dimensions 1" x 1" x 2" long; shaft extension ½", diameter 0.125" **$12.50**

PM Motor, Diehl Mfg. SS FD6-21: 27.5 volt; DC Alnico Field; 10.000 r.p.m.; dimensions 1" x 1" x 2" long; shaft extension ½", diameter 0.125" **$12.50**

AC CONTROL MOTOR

Diehl Mfg. Co., FPE-25-7, 20 Volts, 2 ph 1600 RPM. .85 amps **$15.00**

A. C. SYNCHRONOUS MOTOR Type RBC 2505; Volts 115; Cycles 60; RPM 60; Mfg. HOLTZER CABOT ELECT. Approx. size: 2⅝" x 2⅝" x 2⅝" .... **$15.00 ea.**

400 CYCLE MOTORS

PIONEER: TYPE CK5 2 Phase; 400 cycles **$35.00 ea.**

EASTERN AIR DEVICES TYPE J49A: 115 V; 0.1A; 7000 r.p.m. Single phase 400 cycle .... **$17.50 ea.**

AIRESEARCH: 115V; 40 CPS; Single phase 6500 RPM; 1.4 amp; Torque 4.6 in. oz.; HP .03 .... **$10.00 ea.**

EASTERN AIR DEVICES TYPE JM6B: 200 VAC; 1 amp; 3 phase; 400 cycles, 6000 RPM .... **$12.50 ea.**

EASTERN AIR DEVICES, TYPE J31B: 115 V, 400-1200 Cycle. Single Phase **$12.50 ea.**

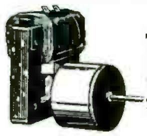
AIRESEARCH: AC Induction, 200 V; 3 Phase, 400 Cycle, 2 H.P.; 11,000 RPM; 8 amps .... **$79.50 ea.**

AIRESEARCH: AC Induction, 200 V; 3 Phase, 400 Cycle, .12 H.P., 6500 RPM; 1.5 amps **$25.00**

Electric Motor: PNT—1400—A1—IA Serial No. 207, 208 V., 400 cycles, 3 phase Kearfott Co., Inc. .... **$17.50 ea.**

SERVO MOTOR 10047-2-A; 2 Phase; 400 Cycle. with 40-1 Reduction Gear

$17.50 ea.



TELECHRON SYNCHRONOUS TIMING MOTORS: 110 VAC; 6 cycle: 2 RPM and 4 RPM; approx. 2¼" square overall .... $2.95 ea.
In lots of 10 or more $2.50 ea.

SMALL DC MOTORS

DELCO #5068750: constant speed; 27 VDC; 160 RPM; built-in reduction gears and governor .... **$17.50 ea.**

J. OSTER: series reversible motor; 1/50th H.P.; 10,000 RPM; 27½ VDC; 2 amps;

SPERRY #806069; approx. size 1⅝" x 3½" **$7.50 ea.**

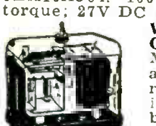
(Approx. size....4" long x 1¼" dial.)

General Electric Type 5AB10AJ37; 27 volts, DC; .5 amps. 8 oz. inches torque; 250 RPM, shunt wound; 4 leads; reversible **$15.00 ea.**

General Electric. Mod. 5BA10FJ33; 12 oz. inches torque, 12 V DC, 56 RPM, 1.02 amp. **$15.00 ea.**

General Electric-Type 5BA10AJ52C; 27 volts, DC; .5 amps, 8 oz. inches torque; 145 RPM; shunt wound; 4 leads; reversible **$15.00 ea.**

GENERAL ELECTRIC DC MOTOR Mod. 5BA10AJ64. 160 r.m.p.; 65 amp; 12 oz.-in. torque; 27V DC .... **$19.95 ea.**



WESTINGHOUSE OVER-CURRENT RELAY: Type MN, adjustable from .04-.16 amp. (1210991). External reset push button. Enclosed in glass case . . . hand calibrated. NEW LOW PRICE. **14.95**

BLOWER

Eastern Air Devices, Type J31B; 115 volt; 400-1200 cycle; single phase; variable frequency; continuous duty; L & R #2 blower; approx. 22 cu. ft./min. **$15.00**

BLOWER ASSEMBLY

115 Volt, 400 Cycle, Westinghouse Type FL, 17CFM, complete with capacitor. **New** .... **$12.50 ea.**

SENSITIVE ALTIMETERS

Pioneer Sensitive altimeters. 0-35,000 ft. range . . . calibrated in 100's of feet. Barometric setting adjustment. No hook-up required...**$12.95 ea.**

INVERTERS

10563 LELAND ELECTRIC

Output: 115 VAC; 400 cycle; 3-phase; 115 VA; 75 PF. **Input:** 28.5 VDC; 12 amp .... **$80.00 ea.**

PE 218 LELAND ELECTRIC

Output: 115 VAC; Single Phase; PF 90; 380/500 cycle 1500 VA. **Input:** 25-28 VDC; 92 amps; 8000 RPM; Exc. Volts 27.5. **BRAND NEW** .... **$39.95 ea.**

MG 153 HOLTZER-CABOT

Input: 24 V, DC. 52 amps; **Output:** 115 volts—400 cycles, 3-phase, 750 VA. and 26 Volt—400 cycle, 250 VA. Voltage and frequency regulated .... **$95.00 ea.**

PIONEER 12130-3-B

Output: 125.5 VAC; 1.15 amps, 400 cycle single phase, 141 VA. **Input:** 20-30 VDC, 18-12 amps. Voltage and frequency regulated .... **$89.50 ea.**

12116-2-A PIONEER

Output: 115 VAC; 400 cyc; single phase; 45 amp. **Input:** 24 VDC 5 amp.... **$90.00 ea.**

10285 LELAND ELECTRIC

Output: 115 Volts AC. 750 V.A., 3 phase, 400 cycle, .90 PF, and 26 volts, 50 amps, single phase, 400 cycle, .40 PF. **Input:** 27.5 VDC, 60 amps. cont. duty, 6000 RPM. Voltage and Frequency regulated... **$195.00**

10486 LELAND ELECTRIC

Output: 115 VAC; 400 Cycle; 3-phase; 175 VA; .80 PF. **Input:** 27.5 DC; 12.5 amp; Cont. Duty .... **$90.00 ea.**

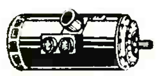
12121-1A PIONEER

Output: 115 VAC; 3-phase; 400 cycle; 250 VA; 0.7 PF. **Input:** 24 VDC; 18 amp. Voltage and freq. regulated **$125.00**

94-32270-A LELAND ELECTRIC

Output: 115 Volts; 190 VA; Single Phase; 400 Cycle; .90 PF. and 26 Volts; 60 VA; 400 Cycle; .40 PF. **Input:** 27.5 Volts DC; 18 amps; cont. duty, voltage and freq. regulated **$95.00**

115 VOLT GENERATORS



Brand new Eclipse generators: 115 VAC; 9.4 amp; 1000 watts; single phase; 800 cycles, 2400-4200 rpm. DC output is 30 volts at 25 amp. Unit has spline drive shaft and is self-excited **$29.95**

5 RPM GEAR HEAD MOTOR

Mfg. RAE., Type 7519; 115 volts AC, DC; Fractional HP, overall dimension 5¼" **$12.95** each. Lots of 10. **$11.95 ea.**

TRANSFORMERS

SOLA
One KVA, 210-270 Volts, 240 Sec., 3-Phase
#30663 .... $175.00

FILAMENT, Gen. Elec. #7455321: Primary 110/125 Volts, Secondary 11 Volts 65 Amps, 975 KVA. Shipping wt. approx. 60 pounds. **$24.95**

FILAMENT, AMERTRAN #29048: Primary 115 Volts, 50/60 cycle. Secondary 5 volts, 190 amp. Shipping weight approx. 75 lbs. **$36.50**

VARIABLE, AMERTRAN #29114: 250 VA, 103-126 commutator range, fixed windings, 115 volts, max. 2.17 amps.......... **$19.95**

Immediate Delivery
ALL EQUIPMENT FULLY GUARANTEED
All prices net FOB Pasadena, Calif.

PIONEER GYRO FLUX GATE AMPLIFIER

Type 12076-1-A, complete with tubes **$27.50 ea.**

TACHOMETER INDICATOR G. E. GENERATORS SINGLE

Sensitive Type, Kollsman Mark V; Range 0-3500 RPM in 3½ revolutions of the indicating pointer. **$9.95 ea.**

Tachometer Indicator and Generator (above) .... **Both $33.50**

TACHOMETER GENERATOR (MARK V) **$25.50 ea.**

G. E. GENERATORS

General Electric Type 5ASB-31JJ3; 400 cycles out at 115 volts; 7.2 amps; 8,000 rpm.; size 6" long x 6" dia. **$99.50 ea.**

SINE-COSINE GENERATORS

(Resolvers)

Diehl Type FJE43-9 (Single Phase Rotor). Two stator windings 90° apart, provides two outputs equal to the sine and cosine of the angular rotor displacement. Input voltage 115 volts, 400 cycle .... **$30.00 ea.**

Diehl Type FPE-43-1 same as FJE-43-9 except it supplies maximum stator voltage of 220 volts with 115 volts applied to rotor .... **$25.00 ea.**

Arma Resolver Type 213014; equal in size to size 5 synchro; 55-60 cycle; single phase primary, 2 phase secondary......... **$79.50**

GENERATORS

Eclipse-Pioneer; 716-3A (Navy Model NEA-3A) OUTPUT: 115 VAC; 10.4 amps; 800 cycle; single phase; 28.6 VDC; 60 amps @ 2400 rpm; spline drive; self exciting; wt. 60#.
BRAND NEW in original box.... **$39.95 ea.**

SYNCHRONOUS SELSYNS

110 volt, 60 cycle, brass cased, approx. 4" dia. x 6" long. Mfg. by Diehl and Bendix.

Quantities Available.
REPEATERS .... **$20.00 ea.**
TRANSMITTERS .... **$20.00 ea.**

SYNCHROS

IF Special Repeater (115V-400 Cycle) **$15.00 ea.**

2JIF 3 Generator (115-400 cyc.)... **$10.00 ea.**

5CT Control Transformer; 90-50 Volt; 60 Cyc. .... **$50.00 ea.**

5F Motor (115/90 volt—60 cyc.)..**$60.00 ea.**

5G Generator (115/90 volt—60 cyc.) **$50.00 ea.**

5/DG Differential Generator (90/90 volts —400 cyc.) .... **$30.00 ea.**

TRANSMITTER, BENDIX C-78248; 115 Volt, 60 Cycle .... **$25.00 ea.**

Differential—C-78249; 115 Volt; 60 Cycle **$5.00**

REPEATER, BENDIX C-78410; 115 Volt, 60 Cycle .... **$37.50 ea.**

REPEATER, AC synchronous 115 V., 60 cycle, C-78863 .... **$15.00 ea.**

7G Synchro Generator (115/90 volt; 60 cycle) **$75.00**

6G Synchro Generator (115/90 volt; 60 cycle) **$60.00**

6DG Synchro Differential Generator (90/90 volt; 60 cycle) **$60.00**

2JF51 Selsyn Control Transformer: 105-55 Volts; 60 Cycle.................. **$50.00**

2JD5J2 Selsyn Motor: 115-90 Volts; 60 cycle **$50.00**

5JD5HA1 Selsyn Generator: 115-105 Volts; 60 cycle **$50.00**

2JIF1 GENERATOR: 115—57.5 Volt; 400 cycle .... **$12.50 ea.**

2JIH1 DIFFERENTIAL GENERATOR: 57.5 —57.5 Volt; 400 cycle.......... **$12.50 ea.**

2JIG1 CONTROL TRANSFORMER: 57.5—57.5 Volt; 400 cycle.............. **$7.50 ea.**

PIONEER AUTOSYNS

AY-1.......26 Volt—400 Cycle....... **$6.95**
AY-5.......26 Volt—400 Cycle....... **$7.95**
AY27D **$12.50**
AY6—26 Volt—400 cyc........... **$4.95 ea.**
AY30D—26 Volt—400 cyc........ **$25.00 ea.**
AY14D **$10.00**
AY34 .... **$20.00**
AY20—26 Volt—400 cyc......... **$12.50 ea.**

PIONEER TORQUE UNITS

TYPE 12604-3-A: Contain CK5 Motor coupled to output shaft through 125:1 gear reduction train. Output shaft coupled to autosyn. follow-up (AY43). Ratio of output shaft to follow-up Autosyn is 15:1. **$70.00 ea.**

TYPE 12602-1-A: Same as 12606-1-A except it has a 30:1 ratio between output shaft and follow-up Autosyn.......... **$70.00 ea.**

TYPE 12602-1-A: Same as 12606-1A except it has base mounting type cover for motor and gear train........... **$70.00 ea.**

MICROPOSITIONER

Barber Colman AYLZ 2133-I Polarized D.C. Relay: Double Coil Differential sensitive, Alnico P. M. Polarized field. 24V contacts; .5 amps; 28 V. Used for remote positioning, synchronizing, control, etc....... **$12.50 ea.**

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2C4197C/F2	Filter	UTC-52804
2C4512/66	Trans.	Hamm. Super Pro
2C4528.3/44.1	Trans.	BC-779B and 1004C
2C4528/12	Filter	Hamm Super Pro
2C6191A/3	Trans.	BC-191A and 3
2C6191/K1	Choke	BC-AA-191
2C6191/T3	Trans.	BC-AA-191
2C6191F/T2	Trans.	BC-375, BC-191
2C6230/123	Trans.	BC-AE-230 and BC-AG-230
2C6230.3/124	Trans.	BC-AH-230, BC-AL-430
2C6307AK1	Choke	AFC-1, BC-307A, and B
2C6386A/T14	Trans.	BC-446-A and C
2C6494A/C6	Cond.	
2C6494A/C11	Choke	BC-604A
2C6494A/R4	Relay	BC-604A-B-C-D
2C6530-653A/C10	Choke	BC-653A
2C6530-653A/T5	Trans.	BC-653A
2Z9613.304	Trans.	BC-1296A
2Z303-3	Adapter	AN/FMQ-1
2Z3020-6	Recept.	
2Z3265-66	Trans.	SCR-508-528
2Z3400-108	Bag	U/W MP-48
2Z5731-337	Imp. KD	UW/SCR-508-528
2Z6721-487	FT-487 Mtg.	U/W SCR-511
2Z7267-25	Type J.A.B. Pot	APS-13
2Z7585-18	Relay	33A and 34A Xmitter
2Z7617A	Relay	PE-55
2Z7636-16	Relay	RA-10DA and DB
2Z8673-42	Socket	MS5/AA
2Z9010A	Strap	BC-148, GN-35 CS-38
2Z9476	Strip	SCR-609A and 610A
2Z9601.44	Transf.	BC-401B
2Z9601.51	Trans.	AN-MD-1FRC
2Z9608.36	Trans.	RA-61-A
2Z9611.11	Transf.	P/O Projector PH-398
2Z9611.39	Trans.	RC-150 and 151
2Z9611.65	Trans.	PE-138A of SCR-527A
2Z9611.115	Trans.	RCA #ET-8010E
2Z9611.209	Transf.	TCS-5-8-9 and 10
2Z9611.289	Trans.	SCR-584-B
2Z9611.307	Trans.	T-50/CPN-8 of AN/CPN-8
2Z9612.10	Trans.	P/O Projector PH-398
2Z9612.52	Trans.	BC-1160A (RC-150B, C, D)
2Z9612.98	Trans.	AN/FRC-1
2Z9612-105	Transf.	TCS-5-8-9-11
2Z9612.111	Transf.	Xmitter, TZO
2Z9613.14	Trans.	SCR-296A
2ZK9613.30	Trans.	BC-800-A, SCR-729A
2Z9613.67	Transf.	Xmitter, BC-642
2Z9613.128	Trans.	SCR-588B
2Z9613.276	Trans.	Scope, BC-1060-A
2Z9614-34	Trans.	RT-5/APS-4, AN/APS-4
2Z9614-87	Trans.	AN/APS-13
2Z9614-94	Trans.	Scope 1D-75, CPS-1
2Z91615.1	Trans.	P/O Projector PH-398
2ZK9617-22	Trans.	SCR. 518A
2Z9618-9	Trans.	T-28/APT-1, AN/APT-1
2Z9618-42	Trans.	A/N-MD-30/APT-4
2Z9618-54	Transf.	TS-121/CPN-8
2Z9619-42	Trans.	R-36/TPS-2
2Z9619-43	Transf.	AN/TPS-2
2Z9619-63	Trans.	R59/TPS-3, AN-TPS-3
2Z9619-99	Trans.	AM-61/APG
2Z9619.116	Trans.	AN Rec R-58/ARQ-8
2Z9621-43	Trans.	BC-922
2Z9621-112	Trans.	SCR-268A and SCR-296A
2Z9625-1	Trans.	PE-104A, SCR-234A
2Z9625-8	Trans.	PA-5-A Public Address
2Z9625-29	Trans.	TS-25-3
2Z9625-35	Trans.	Switchboard 102-B
2Z9626	Trans.	SCR-629 A and C
2Z9627-35	Trans.	Rec. Coder, R-56/CPN-8
2Z9628-2	Trans.	E 2-Unitron Rect.
2Z9628-5	Trans.	PE-157 A and B of SCR-511
2Z9631.7	Trans.	PO/AN/TTO-1
2Z9631.94	Transf.	T-14/TRC-1
2Z9631.187	Trans.	Projector PH-405
2Z9632	Trans.	BC-329G and RM-60-G
2Z9632.8	Trans.	BC-654 of SCR-284A
2Z9632.14	Trans.	SCR-511A
2Z9632.39	Trans.	SCR-517A
2Z9632.125	Trans.	PA-6A Public Address
2Z9632.159	Trans.	P/o BC500B
2Z9632.170	Trans.	Xmitter and Rec., BC-659A
2Z9632.171	Trans.	BC-1005A of SCR-555A
2Z9632.180	Trans.	P/o RM-35B
2Z9632.197	Trans.	RA-70 Rectifier of SCR-584
2Z9632.206	Trans.	R-58 ARQ-8
2Z9632.213	Trans.	TCS-5-8-9 and 11
2Z9632.248	Trans.	HT.4B
2Z9632.362	Trans.	AN RT-72, UPN-1
2Z9632.365	Trans.	PA-6-A Public Address
2Z9632.366	Trans.	PA-6-A Public Address
2Z9634.4	Trans.	BC-745A, SCR-511
2Z9634.5	Trans.	BC-654 of SCR-234A
2Z9634.35	Trans.	
2Z9634.39	Trans.	BC-1306
2Z9634.46	Trans.	Hallicrafters HT-12
2Z9634.49	Trans.	Sig. Gen. 1-198A. RC-148

SIG. CORPS STOCK NO.	ITEM	USED IN SIGNAL CORPS EQUIP.
2Z9635.8	Trans.	
2Z9635.25	Trans.	T-67/ARC-3
2Z9636.16	Transf.	BC-642
2ZK9638.6	Trans.	Radio Compass, SCR-269G
2Z9638-14	Trans.	RC-148
2Z9638-16	Trans.	BC-1160A of RC-150B.C.D.
2Z9638-19	Trans.	AN/AN4
2Z9638-27	Transf.	AN/APS-13
2Z9638.44	Trans.	PA-6-A, Public Address
2Z9639.7	Transf.	AN/APQ-2A
2Z9643.42	Trans.	RC-150 B. C. D.
2Z9647.11	Trans.	CF-1A and Repeater CF-3A
2Z9702-2	Trans.	Speaker LS-3
2Z9713	Trans.	Used in Diversity Equip.
2Z9759	Trans.	BC-222 and BC-322
2Z9760	Trans.	BC-312, BC-314, BC-342
2Z9823	Transf.	BC-223
2Z9805	Trans.	BC-312, 314, 342, BC-344
2Z9808	Trans.	BC-212A of BC-212B
2Z9851	Trans.	Interphone Amp., BC-347
2Z9853	Trans.	Interphone Amp., BC-367
2Z9854	Trans.	BC-367
2Z9855	Trans.	Interphone Amp., BC-367
2Z9876-2	Trans.	Modulator Unit RA-18
2Z9878-1	Trans.	Rectifier Unit RA-57A
2Z9878-11	Trans.	BC-941A of SCR-547A
2Z9878-13	Trans.	BC-957A of SCR-547A
2Z9879	Trans.	RC-103A and AZ
2Z9879-2	Trans.	BC-1094 of SCR-547A
2Z9879-3	Trans.	MC-363A of SCR-547A
2Z9900-5	Trans.	Test Unit 1-176
2Z9944	Trans.	BC-191 and BC-375
2Z9947-3.1	Trans.	BC-456-B of SCR-274-N
2Z9954	Trans.	BC-438 of SCR-268
2Z9975.17	Trans.	BC-441-B of SCR-281A
2Z9979	Trans.	P/O Radio Set-SCR-593A
2ZK9982-3	Trans.	SCR-729A
2Z9984	Trans.	Collins 32RA Xmitter
3C279	Choke	BC-367
3C307-1	Choke	SCR-211 Freq. Meter
3C307-46	Choke	PP-87/APT4
3C315-51	Choke	Xmitter BC-339K
3C16-15	Choke	Public Address PA-1-C
C317-14	Choke	
3C317-15	Choke	Dumont Oscillagraph #208
3C317.33	Choke	Power Unit PE-120A
3C317-43	Choke	SCR-536
3C317-44	Choke	Coder Unit R-56/CPN-8
3C323-6C	Choke	Test Set 1-61-B
3C323-14A	Choke	SCR-614A-B
3C323-24B	Choke	MD1/FRC
3C323-29E	Choke	T-28/APR-1
3C323-54B	Choke	BC-1006-A
3C323-122B	Choke	Power Unit PP-127/TPS-10
3C323-145B	Choke	Xmitter Mod. T-50 CPN-8
3C324-4	Choke	BC-191C and BC-375
3C324-40	Choke	BC-1090-B
3C324.86	Choke	AN PP-144/CPS-4
3C325-2	Choke	BC-1016 Recorder
3C325-3	Choke	BC-1016 Recorder
3C328-28	Choke	RC-192A — BC-800-B
3C332-820	Choke	BC-1348 Scope
3C335-11	Reactor	RA-34-4
3C337-2	Choke	PE-104A of SCR-284A
3C343-2	Choke	BC-357-M
3C344	Choke	GN-45-B of SCR-284A
3C344-9	Choke	SCR-808A
3C362-8	Choke	BC-728A of SCR-593A
3C362-14	Choke	PE-97A of SCR-620
3C262-23	Choke	BC-7456 of SCR-511
3C362-24	Choke	CH2 for PE-157A
3C362-39	Choke	APG-5 U/W AN-APG-13
3C375-15	Choke	Rec. BC-787A of SCR-607
3C549	Choke	BC-620A
3C570-6	Choke	
3C573	Choke	RM-13-C
3C575G-1-3C375G-1	Choke	AN Radar APG-13
3C1987-14	Choke	RA-57-A of SCR-547-A
3C1987-28	Coil	BC-957A of SCR-547A
3C1987-29	Coil	RC-103A, RC-103-AZ
3C1987-39B	Coil	Telegraph Term. CF-2A
3C4075	Choke	SC-R284A
3D308	Capacitor	BC-212A and BC-667
3D328	Condenser	
3DB2-21	Capacitor	C-204 Freg. Rec. and Ampl. 509 AN
3DB1A25-2	Condenser	Power Supply Unit PE-237
3E1133B	Cord	SCR-177 and 188
3E1441	Cord	BC-223A and PE-55
3E1604	Cord	CD-604
3F54	Ammeter	BC-148-151 and 156
3F4061 B/C1	Coil	Test Set 1-61B
3Z1891-1.2	Filter	R/19A TRC-1
3Z1893-5	Filter	
3Z1893-8	Choke	
3Z3275-11	Fuse Holder	
3Z3405	J5 Key	
3Z3438	J38 Key	
3Z7990-26	Switch	
3Z9587-1	Switch	
4B1109A.13	Handset	
4G1668C/C5	Coil Assy.	
6C8/F1	Coil	PA Set PA-6-A
6Z7564M	Plug	

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Reliance Specials

GEAR ASSORTMENT

100 small assorted gears. Most are stainless or brass. Experimenter's dream! .... Only $6.50

HAYDON TIMING MOTOR

1 R.P.M., 115 V., 60 Cycle...$1.95

TIMING MOTOR

8 RPM 115V 60 cyc
E. Ingraham Co.

$1.79

400 CYCLE INVERTERS

Leland Electric Co.

#10800 in: 20-28 V.D.C., 92 A. 8000 R.P.M. Out: 115V, 400 Cyc. 1 phase, 1500 V.A. 90 PF............ $29.95

3 AG FUSES

Amp.	Per 100	Amp.	Per 100	Amp.	Per 100
1/8	$4.00	3/4	$4.00	8	$3.00
3/8	4.00	1	3.00	10	3.00
1/2	4.00	4	3.00	15	3.00
		5	3.00		

3 AG FUSE HOLDERS (Finger) 25¢

BALL BEARINGS

Mfg. No.	ID	OD	Thick	Price
MRC5028-1	5 1/2	6 1/2	1	$3.75
MRC7026-1	5 5/64	6 15/64	9/16	3.50
MRC106M2	1 17/64	2 7/16	25/64	1.75
MRC106M1	1 13/64	2 7/16	25/64	1.60
Federal LS11	1 1/8	2 1/2	5/8	1.75
Norma S11R	1 1/8	2 1/8	5/8	1.70
Federal AS41	1 1/16	1 1/2	9/32	1.50
Schatz	3/4	1 3/4	9/16	1.00
Norma 203S	5/8	1 9/16	7/16	.90
ND5202-C13M	1/2	1 3/8	1 3/8	1.00
ND 3200	25/64	15/32	11/32	.60
ND R6	3/8	7/8	7/32	.40
MRC39R1	11/32	1 1/32	5/16	.45
MRC38R3	S/16	55/64	13/32	.45

Brand New Meters—Guaranteed

0-10 ma. D.C. 3½"..$3.95 0-80 Amp. D.C. 2½"..$2.50
0-1 Ma D.C. 3½" DeJur..(Scale Reads 0-4 KV)..$5.75

SELENIUM RECTIFIERS

Full Wave 200 MA 115V............................ $1.79
Half Wave 100 MA 115V............................ .91

SOUND POWER HANDSET

BRAND NEW

Includes 5 ft. cord.—Uses no batteries or external power source.
$18.50 pr

Sound Powered Chest Set RCA—With 24 Ft. Cord

Per Pair
USED $17.60
NEW $26.40

POSTAGE STAMP MICAS

mmf	mmf	mmf	mmf	mmf	mmf	mmf	mfd	mfd
10	40	70	125	240	400	680	.0016	.004
20	47	75	135	250	430	800	.002	
22	50	80	150	270	470	820	.0027	.005
23	51	82	160	300	500	910	.0033	.006
24	56	90	175	330	510	.001	.0036	.0065
25	60	100	180	360	580	.0012		.0068
33	62	110	200	370	600	.0013		.0082
39		120	220	390	650	.0015		.01

Price Schedule

10 mmf to 820 mmf.............................. 5¢
.001 mmf to .0016.............................. 8¢
.002 mfd to .0082 mfd.......................... 15¢
.01 mfd.. 28¢

SILVER MICAS

mmf	mmf	mmf	mmf	mmf	mmf	mfd	mfd	mfd
10	50	100	170	360	510	.001	.0024	.0047
18	51	110	180	370	525	.0011	.0025	.005
22	56	115	208	390	560	.0013	.0027	.0051
23	60	120	225	400	570	.0015	.0028	.0056
24	62	125	240	410	680	.0016	.003	.006
25	66	130	250	430	700	.0018	.0033	.0068
27	68	135	255	470	800	.0022	.0039	.0082
30	75	150	260	488	900	.0023	.004	.01
40	82	155	270	500				

Price Schedule

10 mmf to 700 mfd.............................. 10¢
.0011 mfd to .002 mfd.......................... 20¢
.0022 mfd to .0082 mfd......................... 50¢
.01 mfd.. 95¢

PULSE TRANSFORMERS

UTAH—9262 9278 9289 9318 9340 9350
WESTERN ELECTRIC—D166173 D161310
KS8696, KS9800, KS9862, KS13161
GENERAL ELECTRIC—80-G-5
JEFFERSON ELECTRIC—C-12A-1318
DINION COIL—TR1048 TR1049
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AN CONNECTORS
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COAXIAL CABLE CONNECTORS

14¢ UG175/U — $1.20 83-1F — 30¢ 83-1AP — 70¢ 83-1J — 40¢ SO-239 — 12¢ HOOD

83-1AC	$0.42	PL-274	$1.10	UG-87/U	$1.50
83-1AF	.30	PL-275	1.90	UG-88/U	.90
83-1BC	.35	SO-239	.40	UG-89/U	1.10
83-1F	1.10	UG-13/U	1.70	UG-102/U	.80
83-1H	.12	UG-18B/U	1.10	UG-103/U	.68
83-1HP	.22	UG-20B/U	1.65	UG-104/U	1.40
83-1J	.70	UG-21/U	.95	UG-105/U	1.50
83-1RTY	.65	UG-21B/U	1.00	UG-106/U	.12
83-1SP	.45	UG-21C/U	1.05	UG-107B/U	2.75
83-1SPN	.53	UG-21D/U	1.45	UG-167/U	5.70
83-1T	1.30	UG-22/U	1.35	UG-146/U	2.00
83-2AF	1.95	UG-22A/U	1.60	UG-175/U	.14
83-2J	2.10	UG-22B/U	1.20	UG-176/U	.14
83-2R	1.65	UG-23/U	1.20	UG-185/U	.99
83-22AP	1.25	UG-23B/U	1.50	UG-196/U	1.65
83-22F	1.90	UG-23C/U	1.10	UG-203/U	.65
83-22J	1.50	UG-24/U	1.30	UG-224/U	1.15
83-22R	.68	UG-27/U	1.25	UG-255/U	1.98
83-22SP	.80	UG-27A/U	2.25	UG-260/U	.85
83-22T	1.65	UG-27B/U	2.95	UG-261/U	1.10
83-168	.14	UG-28A/U	2.95	UG-262/U	1.10
83-185	.14	UG-29B/U	1.65	UG-273/U	1.45
CW-123A/U	.45	UG-30/U	2.30	UG-274/U	2.30
M-358	1.30	UG-57B/U	1.70	UG-290/U	.90
M-359	.30	UG-58/U	.70	UG-291/U	.95
M-359A	.65	UG-58A/U	.90	UG-306/U	2.65
PL-258	.75	UG-59A/U	1.90	UG-414/U	1.95
PL-259	.45	UG-83/U	1.75	UG-499/U	1.25
PL-259A	.53	UG-85/U	1.70	UG-625/U	1.00

NEW COAXIAL CABLES

	Price per 1000 ft.		Price per 1000 ft.
RG 5/U*	$140.00	RG 22/U*	$135.00
RG 6/U	180.00	RG 22A/U	285.00
RG 7/U*	80.00	RG 24/U	675.00
RG 8/U*	100.00	RG 26/U	475.00
RG 9/U*	250.00	RG 29/U*	50.00
RG 9A/U	275.00	RG 34/U*	300.00
RG 10/U	240.00	RG 35/U	900.00
RG 11/U*	100.00	RG 41/U*	295.00
RG 11A/U*	150.00	RG 54A/U	97.00
RG 12/U	240.00	RG 55/U*	110.00
RG 13/U*	216.00	RG 57/U*	325.00
RG 17/U	650.00	RG 58/U*	60.00
RG 18/U	900.00	RG 58A/U*	65.00
RG 19/U	1250.00	RG 59/U*	55.00
RG 20/U	1450.00	RG 62/U*	70.00
RG 21/U*	220.00	RG 77/U*	100.00

Add 25% for orders less than 500 feet.
* No minimum order—others 250' minimum.

UNIVERSAL JOINT ALUMINUM

Includes Two 6-32 Set Screw Holes

¼" hole x ½" O.D. 1⅛" long **85¢**

TYPE "J" POTENTIOMETERS

100 S.S.*	1,500 1/4S.S.	15K 1/4	200K S.S.*
150 S.S.	2,000 1/4	25K S.S.	250K 5/8
300 S.S.*	2,500 S.S.	70K S.S.	250K S.S.*
400 S.S.	3,000 3/8	80K S.S.	500K S.S.*
500 S.S.	4,000 3/8	100K 7/16	1Meg S.S.
1,000 3/8	5,000 3/4*	100K S.S.*	
1,000 S.S.	10K 5/8	200K 5/8	

*Split Locking Bushing **$1.25 EACH**

TYPE "JJ" POTENTIOMETERS

Ohms	Shaft	Ohms	Shaft	Ohms	Shaft
1000	S.S.	30K-10K	3/8"†	1 Meg.	1/2"
10K	5/16"	3K-90K	1/4"	1 Meg.	S.S.
15K	S.S.			1 Meg.	S.S.

SD—Screw Driver
*—Split Locking Bushing
†—With Switch

PRICE—$2.50 EACH

JONES BARRIER STRIPS

2—140Y	$0.17	3—141W	$0.27	8—141¾W	$0.64
3—140¾W	.21	4—141	.24	9—141	.38
6—140	.28	5—141	.29	9—141Y	.71
10—140W	.59	5—141¾W	.41	3—142	.24
10—140¾W	.59	7—141¾W	.56	2—150	.43
3—141¾W	.27	8—141	.44	3—150	.60

TIME DELAY RELAY

Raytheon CPX 24166
1 Min. Delay. 115 V., 60 Cycle

2½ second recycling time spring return • Microswitch contact, 10A • Holds ON as long as power is applied • Fully Cased •
ONLY $6.50

RADIO FREQUENCY GENERATOR

RCA 1 KW 400 KC: Input: 220 V 60 cycle Needs minor repairs to water circulating system. Otherwise in good condition **$295.00**

PRECISION RESISTORS—¼ WATT—30¢

2	6.68	11.74	14.98	79.81	147.5	414.3
2.8	8.33	12.32	15.8	105.8	147.8	705
3.5	10.48	13.02	16.37	123.8	220.4	2,193
5	11	13.52	20	125	301.8	3,500
	11.25	13.89	62.54	142	366.6	59,148

PRECISION RESISTORS—½ WATT—35¢

.25	11.1	66.6	298.3	4,000	14,825	33,300
.334	13.07	75	400	4,285	15,000	35,888
.444	13.15	87	723.1	4,300	15,750	36,000
.502	13.3	97.8	855	4,451	15,755	37,000
.557	15	97.85	970	5,900	15,810	45,000
.627	25	125	1,000	6,500	16,000	47,000
.76	30	178	1,500	6,650	16,700	50,000
1	35	180	1,800	6,670	17,000	56,000
1.01	46	200	2,250	7,000	20,000	59,000
1.53	50	210	2,280	7,300	20,150	59,905
2.04	52	213	2,500	7,500	25,000	68,000
4.35	54	235	2,850	8,000	30,000	79,012
5.26	55.1	260	3,427	8,500	32,700	100,000
5.89	61	270	3,700	8,800	32,888	150,000
10.48	65	273	3,995	10,000	33,000	180,000
		273.1		12,000		

PRECISION RESISTORS—1 WATT—45¢

.2	2.6	32	89.8	2,000	8,000	50,000
.861	2.66	35.7	125	2,200	8,250	52,525
1.01	3.39	38	250	2,250	9,000	55,000
1.166	5.21	45.1	270	2,550	9,700	56,000
2.55	12	45.5	420	3,300	10,000	65,000
2.58	15	54.25	425	5,000	12,000	68,000
	17.9	56.7	800	5,221	15,000	75,000
	18	60	1,000	6,000	25,000	84,000
	28	71.4	1,530	7,000	30,000	
	28.5		1,750		45,000	

PRECISION RESISTORS—1 WATT—60¢

100,000	149,500	260,000	348,000	590,000
105,000	150,000	270,000	399,000	600,000
120,000	175,000	296,000	413,000	645,000
128,000	200,000	297,000	500,000	650,000
130,000	240,000	310,000	520,000	700,000
132,000	250,000	320,000	522,000	

1 MEGOHM 1 WATT 1%—$1.50; 5%—60¢

PRECISION RESISTORS—2 WATT—75¢

4,385	6,000	19,917	25,000	80,000
5,000	10,000	23,000	65,000	100,000

DIFFERENTIAL Used $4.95

115 V., 60 Cycle
#C78249 **New $9.95**

3⅜" dia. x 5⅝" long
Used between two C78248's as a dampener. Can be converted to 3600 RPM Motor in 10 minutes. Conversion sheet supplied. (Converted)........... $5.50
Mounting Brackets—Bakelite for selsyns, and differentials shown above .... 35¢ pair

OIL FILLED CONDENSERS

MFD	V.D.C.	Price	MFD	V.D.C.	Price
6	400	$0.85	1	3,600	$3.95
3 x 3	400	1.00	3 x .2	4,000	2.50
4	500	.85	2	4,000	7.95
4-4	500	1.30	3	4,000	10.95
8	500	1.35	.01	5,000	.95
1	600	.45	.01-.03	6,000	1.40
.5-.5	600	.40	.03-.03	6,000	1.50
2	600	.80	1	6,000	9.95
4	600	1.63	.02-.02	7,000	1.55
8	600	2.05	.02-.03	7,000	1.60
10	600	2.95	.1	7,000	1.95
4 x 3	600	1.75	.1-.1	7,000	2.25
8-8	600	1.79	.1	7,500	2.25
1	800	.60	.3-.3	7,500	4.50
1	1,000	.75	.075-.075	8,000	1.85
2	1,000	.95	.15-.15	8,000	2.95
3	1,000	1.70	.25	20,000	19.95
6	1,000	2.75			
8	1,000	3.25			
1	1,500	1.45			
.02	2,000	.65			
.1-.1	2,000	1.30			
.1-.5	2,000	1.65			
3	2,000	3.75			
8	2,000	7.95			
.25	3,000	2.25			

1 mfd 6,000 V.D.C. G.E. $9.95

OIL FILLED A.C. CONDENSERS

MFD	V.A.C.	Price	MFD	V.A.C.	Price
.2	750	$0.69	15	440	$6.25
8	660	7.50	4.4	375	2.15
6	660	5.95	25	330	7.50
5	660	5.45	20	330	6.75
4	660	4.95	4	330	2.25
3	660	4.45	3	330	1.45
2.9	660	4.35	1.75	330	.85
2	660	3.95	20	220	4.95
1	660	2.95	7.5	220	2.00

IN34 Crystal Diode..79¢ IN43A (WE400A) $2.25

Dynamotor DM 33A.............................$3.75 ea.

Chokes: 30 Hy. 80MA @...$1.29; 6HY. 80 MA @...79¢

Power Tap Switch—OHMITE (#312-5 Taps) nonshorting 25A 150 V. A.C.......................... $3.95

Timer—Industrial Timer Corp. 15 min. on 15 min. off continuous 115 V. A.C. Fully cased Plugs into octal socket $5.50

BC 221 FREQUENCY METER.................. $80.00

2J1G1 SELSYNS $8.50
400 CYCLE BRAND NEW

Minimum Orders $3 All orders f.o.b. PHILA., PA.

RELIANCE MERCHANDIZING CO.

Arch St., Cor. Croskey Phila. 3, Pa. Telephone Rittenhouse 6-4927

COMMUNICATIONS EQUIPMENT CO.

SHOCK MOUNT RACKS

FT-156	FT-265A	MT-62/ARC-5
FT-162	FT-338	MT-167-U
	FT-449	
FT-185	FT-487	MT-170A
FT-225	MT-5/ARR-2	MT-171A

SILVER MICA BUTTON COND.

MMF	MMF
40	180
50	185
175	500

PRICE $7.00/100
2000 MMF 15.00/100

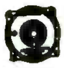
CERAMICON TYPE CAPACITORS

MMF	MMF	MMF
14	50	125
15	51	180
20	60	200
27	62	240
30	65	345
47	82	

PRICE $5.00/100

COAX CABLE

RG8/U
RG9/U
RG34/U
RG37/U
RG57/U



ID-24 ARN-9
Dual 0-200 Micro-amp. Movement in 3" Case. ILS Equipment $9.95

932 PHOTO TUBE

Gas Phototube having SI Response, particularly sensitive to Red and Near infrared Radiation. Can be used with incandescent light source. Send for data. Price .... 75¢

MICA CAPACITORS

CM-45—2500 V. TEST

MFD.	Price	MFD.	Price	MFD.	Price
.01	$0.85	.0024	.60	.0075	.80
.015	.85	.0025	.60	.0076	.80
.02	.85	.0027	.60	.008	.80
.04	.85	.003	.60	.0085	.80
.001	.60	.004	.60	.0005	.60
.0015	.60	.005	.60	.00085	.60
.002	.60	.0056	.60	.00015	.60
.0022	.60	.006	.60	Write for Many Others	
.0023	.60	.0063	.60		

CM-55—2500 V. TEST

MFD.	Price	MFD.	Price	MFD.	Price
.00001	$0.29	.001	.35	.0075	1.79
.000025	.29	.0015	.35	.0076	1.79
.00003	.29	.0016	.35	.008	1.79
.00005	.29	.0017	.35	.01	1.10
.000075	.29	.002	.50	.015	1.10
.0001	.29	.0023	.50	.02	1.10
.00015	.29	.003	.50	.025	1.10
.00025	.29	.004	1.79	.027	1.10
.0003	.29	.005	1.79	.03	1.10
.0004	.29	.006	1.79		
.0005	.35	.0063	1.79	5000 V Test	
.00075	.35	.0069	1.79	.0015	1.75
.0008	.35	.007	1.79	.002	2.00

UNIVERSAL SUPPLY KIT

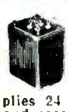
Delivers 230V @ 40MA DC. From 110/220VAC 60 CY. Kit Consists of 1-PWR Transformer, 1-5 HY @ 40MA Choke. 2-8 MFD @ 450V Filter Cond. 1-6x5 Tube. A great buy at only $3.95

INTERPHONE TRANSFORMER SET

Rig your own interphone. Kit consists of 1-Input Transformer (Matches 4 or 6 OHM SPKR to Grid) and 1-Output Transformer (Matches 50L6, 35L6, 25L6, etc., to 4 or 6 OHM Speaker Set of 2 XMRS. ONLY $1.00

12-14V SUPPLY KIT

Delivers 12-14VDC at 3.5A from 115V. 60 cy.. Kit contains 1—Transformer Rated 18.5V. 4A. 1—Selenium Rectifier, F. W. Bridge $6.95



24 VOLT TRANSFORMERS

For operating surplus gear, toy trains, gadgets, etc. Operates from 115V. 60 cy., supplies 24 VAC at 1.2 Amp., herm. sealed and cased .... A Great Buy at Only $1.49

RECTIFIER TRANSFORMERS

Pri: 115V. 60 Cy. Sec: 28V/3.1A, 26V/8.4A 7.3V/14A $12.95
Pri: 210/215/220/225/230/235/240V. 60 Cy.. 1 Phase Sec: 11/10/7.5/5VCT @ 35A $19.50
Pri: 115V 60 Cy: Sec: 8.1V @ 1.5A $1.39
Pri: 115V 60 Cy: Sec: 18.5V @ 5A $4.25

FLEXIBLE COUPLING SHAFTS

MC 215
(ALL LENGTHS IN INCHES)

34	163	260
135	186	

MC 124

(ALL LENGTHS SHOWN IN INCHES)

23	61	120	175
29	65	140	205
39	103	161	241
52	114	166	348

PRICE: MC 124 or MC 215

2¢ PER IN.

SELENIUM RECTIFIERS — Full-Wave Bridge Types

Current (Continuous)	18/14 Volts	36/28 Volts	54/42 Volts	130/100 Volts
1 Amp.	$1.25	$2.10	$3.60	$7.50
2 Amps.	2.20	3.60	6.50	10.50
2½ Amps.	.....	.....	.....	13.00
4 Amps.	3.75	.....	8.75	.....
5 Amps.	4.95	7.95	12.95	27.00
6 Amps.	5.50	9.00	14.00	33.00
10 Amps.	6.75	12.00	20.00	40.00
12 Amps.	8.50	16.00	25.50	50.00
20 Amps.	13.25	24.00	36.00	90.00
24 Amps.	16.00	31.00	39.50	98.00
30 Amps.	18.50	36.00	.....	.....
36 Amps.	25.50	45.00	.....	.....

POWER TRANSFORMERS

Comb. Transformers—115V/50-60 cps Input

CTJ5-2-600VCT/.2A, 5V/6A $5.95
CT-15A 550VCT 085A 6.3V/6A. 6.3V/1.8A 2.85
CT-164 4200V .002A/12KV Test, 5VCT/3A/12KV Test. 6.3V/0.6A/5400V Test 12.95
CT-341 1050 10 MA.—625V @ 5 MA. 26V @ 4.5A 2x2.5V/3A, 6.3V @ 3A 16.95
CR 825 360VCT .340A 6.3VCT/3.6, 6.3VCT/3A 3.95
CT-626 1500V .160A 2.5/12. 30/.100 .... 9.95
CT-071 110V .200A 33/.200, 5V/10, 2.5/10 .... 4.95
CT-367 580VCT .050A 5VCT/3A 2.25
CT-99A 2x110VCT .010A 6.3/1A, 2.5VCT/7A 3.25
CT-403 350VCT .026A 5V/3A 2.75
CT-931 585VCT .086A 5V/3A, 6.3V/6A 4.25
CT-456 390VCT 30 MA 6.3V/1.3A, 5V/3A 3.45
CT-160 800VCT 100 MA 6.3V/1.2A, 5V/3A 4.95
CT-931 585VCT 86 MA 5V/3A, 6.3V/6A 4.99
CT-442 525VCT 75 MA 5V/2A, 10VCT/2A, 50V/200 MA 3.85
CT-720 550-0-550V/250 MA, 6.3V/1.8A 8.95
CT-43A 600-0-600V/.08A, 2.5VCT/6A, 6.3VCT/1A 6.49
CT7-501 650VCT/200 MA, 6.3V/8A, 6.3V/5A 6.49
CT-444 230-0-230V/.085A, 5V/3A, 6V/2.5A 3.49

Filament Transformers—115V50-60 cps Input

ITEM	Rating	Each
FT-38A	6.3V/2.5A, 2.5V/7A, 2.5V/7A. 7500 VDC Test	$3.45
FT-674	8.1V/1.5A	1.10
FT-157	4V/16A, 2.5V/1.75A	2.95
FT-101	6V/.25A	.79
FT-924	5.25V/21A, 2x7.75V/6.5A	14.95
FT-825	2x26V/2.5A, 16V/1A. 7.2V/7A, 6.4V/10A, 6.4V/2A	8.95
FT-468	6.3VCT/1A, 5VCT/3A, 5VCT/3A	5.49
FT-55-2	7.2V21.5A, 6.5V/6.85A, 5V/6A, 5V/3A.	8.95
FT-986	16V @ 4.5A or 12V @ 4.5A	3.75
FT-38A	6.3/2.5A. 2x2.5V/7A	4.19
FT-A27	2.5V/2.5A. 7V/7A, TAP 2.5V/2.5A, 16KV Test	18.95
FT-608	6.3V/3A/750V Test	1.79
FT-873	4.5V/.5A, 7V/7A	2.19
FT-899	2x5V A 5A, 29KV Test	24.50

Plate Trans.—115V, 60 cps

ITEM	Rating	Price
PT-699	300/150V/.05A. 300/150V/.05A	$2.79
PT-302	120-0-120V/350 MA	4.69
PT-108	17.600V/144 MA	120.00
PT-671	62V/3.5A	7.95

Special Fil. Transformers—60 cps

Item	Pri. Volts	Secondaries	Price
STF-370	220/440	3x2.5V/5A. 3KV Test 2.5V/15A	$6.95
STF-11A	220V	2x40V/.05A. 2x5V/6A 12.6V/1A	4.49
STF-608	220V	24V/0.6A, 5V/3A. 6.3V/1A, 6.3V/1A	3.45
STF-968	230V	2.5V/6.5A	3.50
STF-631	230V	2x5V/27A, 2x5V/9A	17.59

Special Plate Transformers—60 cps

Item	Pri. Volts	Secondaries	Price
STP-613	230V	230/.05A, 230V/.05A	$1.79
STP-409	220/440V	136VCT/3.5A	5.69
STP-815	240/440, 3ph	1310V/.67A, 6KV Test	27.50
STP-129	230V	3850V/3.12KVA	42.59
STP-823	137V	222VCT/.3A	2.35
STP-08B	50V	2x750V/.001A	1.79
STP-622	210/220/230	5000V/1A	59.75
STP-945	210/220/230	550-0-550V/.3A	5.95

Special Comb. Transformers—60 cps

Item	Pri. Volts	Secondaries	Price
STC-16A	220V	260V/.03A, 100V/1A, 6.3V/4.2A	
STC-609	220V	220V/3A	6.95

CIRCUIT BREAKERS

AM 1614—80: 28 VDC 80 AMP $1.59
AM 1614—100: 28VDC 100 AMP $1.69
KJ—600V, 115 AMPS, UP TO 1000% OVERLOAD RATING. TRIP ADJ. 10 MIN.—INST $21.95

DYNAMOTORS

Type	Input Volts	Input Amps	Output Volts	Output Amps	Radio Set
PE86	28	1.25	250	.060	RC 36
DM416	14	6.2	330	.170	RU 19
DM33A	28	7	540	.250	BC 456
PE101C	13/26	12.6	400	.135	SCR 515
		6.3	800	.020	
BD AR 93	28	3.25	375	.150	
23350	27	1.75	285	.075	APN-1
ZA0515	12/24	4/2	500	.050	
B-19 pack	12	9.4	275	.110	MARK 11
			500	.050	
D-104	12		225	.100	
			440	.200	
DA-3A	28	10	300	.060	SCR 522
			150	.010	
			14.5	.5	
5053	28	1.4	250	.060	APN-1
PE73CM	28	19	1000	.350	BC 376
CW21AAX	13	12.6	400	.135	
	26	6.3	800	.020	
			9	1.12	
PE94	28	10	300	.200	SCR 522
			150	.101	
			14.5	.5	

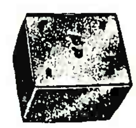
INVERTERS

PE-218-H: Input: 25 28 VDC. 92 Amp. Output: 115 v. 350 500 cy 1500 volt-amperes. New $44.50
PE-206: Input: 28 vdc, 38 amps. Output: 80 v 800-cy. 500 volt-amps. Dim: 13"x5½"x10½". New $22.50
LELAND No. 10536: IN: 28 VDC, 12A. OUT: 115V, 115VA. 400 CY 3 PHASE. EXC. COND $70.00

This Month's Special

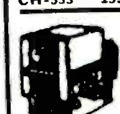
PHASE-SHIFTING HELMHOLTZ COILS 0-360 DEGREES $3.95
BLEEDER RESISTOR. TYPE-HA. 3000 OHM—25W. 7500 OHM—5W. 23 OHM—1W, 23 OHM—1W WITH MTG. BRACK .... .69
SA4A/APA-1 Motor Driven Coaxial Ant. Switch DPDT, Continuous Operation from 24VDC. Completely Enclosed $24.50
MP-22 MAST BASE Mobile Antenna Mount 4.59
SA1A/APN-1 Altitude Limit Switch for APN-1 Altimeter 7.95
ALTITUDE INDICATOR for APN-1 .... 12.50
C-387-D Final P.A. Coil for BC610 2-3-5 MC, Variable Link 4.89
RA-74 Power Supply for Super Pro 69.50
J-17/ARC-5 Junction Box for ARC-5 .... 7.95
J-22/ARC-5 Junction Box 3.49
SUPERSONIC CRYSTALS, Rochelle salt ea. .... .50
MOTOR, 24vdc. 3 HP 3800 rpm. New 75.00
TV LEAD-IN WIRE, 300 ohms, HI-Q, Lo-Loss .... $17.50 M FT Roll
BC 306 ANTENNA TUNING UNIT, NEW 6.95
R9/APN-4, New, With Tubes 75.00
ID6/APN-4, New, With Tubes and Crystal 75.00
A-62 Phantom Antenna 8.50
2 Meter Choke, 1000 MA, 20-144 .... 8/ 1.00
Supersonic Crystal Head, M-1, 22-27KC HI-2 .... 27.45

FILTER CHOKES



Stock	Description	Price
CH-366	20H/.3A	$6.95
CH-322	.35H/350 MA—10 Ohms DCR	2.75
CH-141	Dual 7H/75 MA, 11H/60 MA 5KV DC Test	4.69
CH-119	8.5H/125 MA	2.79
CH-69-1	Dual: 120H/17 MA	2.35
CH-8-35	2/.5H/380 MA/25 Ohms	1.79

Stock	Description	Price
CH-776	1.28H/130 MA/75 ohms	$2.25
CH-344	1.5H/145MA/1200V Test	2.35
CH-43A	10HY/15MA—850 ohms DCR	1.75
CH-366	20H/300MA	6.95
CH-999	15HY/15MA—400 ohms DCR	1.95
CH-511	6H/80MA—310 ohms DCR	2.45
CH3-501	2 x .5H/400MA	2.79
CH-188M	5HY 200MA	1.79
CH-488	10HY .030A	1.19
CH-791	Dual 1.75-.125 HY 100 MA	1.27
CH-981	15HY .110A	1.59
CH-22-1	1 HY .100A	1.17
CH-779	.6 HY .490A	1.25
CH-25A	SW .09/.018 HY 3/.3A	8.95
CH-922	10000 HY O MA	2.75
CH-043	2.2 HY 80 MA	.98
CH-89A	2 x 1.52H @ .167A	1.39
CH-69A	Mult. Choke SECT. 1. Swing 3-12H/.52-.05A SECT. 2. Smooth 5H/.52A SECT. 3. Swing 3.25-18H/.138-014A SECT. 4. Smooth 3.4H/.138A	14.95
CH-445	0.5 HY/200 MA, 32.2 OHMS, 3000V.T.	1.39
CH-170	2X0.5H/380 MA, 25 OHMS	2.79
CH-533	13.5H, 1.0 AMP DC, 13.5KV INS	39.95



INTERPHONE AMPLIFIER

Easily converted to an ideal Inter-Communications set for office, home or factory. Original. New w/conversion diagram $4.75

MAIL ORDERS PROMPTLY FILLED. ALL PRICES F.O.B. NEW YORK CITY. SEND M.O. OR CHECK. ONLY SHIPPING SENT C.O.D RATED CONCERNS SEND P. O. ALL MDSE. SUBJECT TO PRIOR SALE, AND PRICES SUBJECT TO CHANGE WITHOUT NOTICE. PARCELS IN EXCESS OF 20 POUNDS WILL BE SHIPPED VIA CHEAPEST TRUCK OR RAILEX.

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DEPENDABLE ELECTRONIC EQUIPMENT

CHECKED TESTED and APPROVED

It has to be right . . . when it's from Semler. Semler is one of the leading suppliers of precision test equipment to the aircraft industry. Semler is a recognized and approved source of supply for many foreign and U. S. Government agencies.

RADAR LABORATORY EQUIPMENT

Multi-Purpose Test Set for

APS-3, APS-4, APS-6, APS-15, APQ-13 and SCR-720

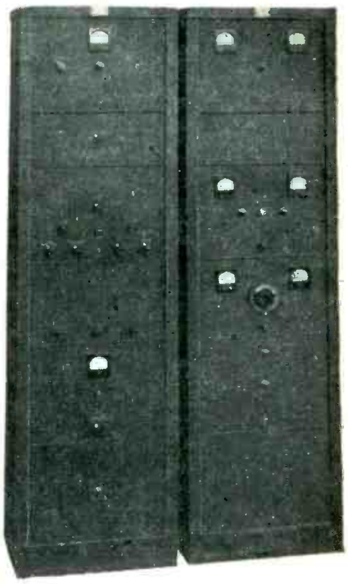
Originally designed for the U. S. Navy by the J. P. Seeburg Company for the primary purpose of testing and calibrating APS-4 Radar. This precision test equipment provides an artificial signal for calibrating the Radar indicator, and indicator amplifier. Although the markers now indicate 4, 20, 50, and 100 miles and Beacon, they may be adjusted for other ranges according to the particular requirement of the Radar set that is to be aligned. • Because of the unusual and versatile power facilities of this equipment, it is readily adaptable for testing other AIRBORNE RADAR equipment, namely, APS-3, APS-6, APS-15, APQ-13 and SCR-720.

This equipment consists of two panel-mounted cabinets with componets as follows:

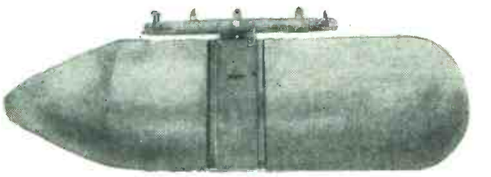
- Rack No. 1 contains:
- Range and Alarm Calibration Unit.
- Antenna Scanning Simulating Unit—*Provides antenna elevation and azimuth control.*
- Noise and Echo Generator—*Gives noise and echo amplitude and echo position.*
- Trigger Generator—*For variation of timing pulses to radar units.*
- Regulated Dual Power Supply.
- Universal Power Supply.
  Dimensions: 20¾"x16¾"x72". Weight: 382 lbs.

Rack No. 2 contains:

- High Voltage Safety Panel.
- 800-Cycle, 500-Watt Power Supply & Power Amplifier.
- Universal Power Supply.
- 800/2400-Cycle, 500-Watt Power Supply and High Voltage Power Unit.
- 800/2400-Cycle Power Supply and High Voltage D. C. Section
- 800/2400-Cycle Power Supply and Amplifier.
  Dimensions: 20¾"x16¾"x72". Weight: 581 lbs.



APS-4 AIRBORNE RADAR



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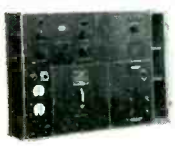
This search-type radar equipment operates at 9, 375 ± 55 mc. Designed primarily for the detection of surface vessels and aircraft. Operates over six ranges—2, 7, 20, 50, 100 and 180 nautical miles. Antenna scans 150° in azimuth; reference tilt adjustable vertically 10° above and 30° below the longitudinal axis of aircraft. • Originally designed for mounting beneath wing of the aircraft, and because of its compactness, it is highly desireable for use on lighter aircraft. Many adaptations have been made for marine and other radar installations. Complete set includes transmitter, receiver, control unit, indicator amplifier, junction box, indicator and necessary connecting cables. Dimen.: 16"x162½". Wt.: 160 lbs.



I-96A TEST SET FOR SCR-522

VHF Signal Generator—Frequency: 100 to 156 mc. Master oscillator tunable or may be crystal controlled. IF Frequency, 12 mc. 110-V, 60-cy. AC power supply or battery operated. A complete test set for SCR-522, BC-639, BC-625, BC-624, or other airborne equipment covering this frequency.

INVERTERS

All merchandise carries our unconditional guarantee. Quotations are on new surplus or completely overhauled equipment.

MG-149F—Holtzer Cabot
Input: 28V-DC-36 Amp.
Output: 26V-400Cy-500VA-Single Phase.
115V-400Cy-750VA-Single Phase...$ 65.00

MG-149H-Holtzer Cabot
Input: 28V-DC-44 Amp.
Output: 26V-400Cy-250VA-Single Phase.
115V-400Cy 500VA-Single Phase..$125.00

MG-153F-Holtzer Cabot
Input: 28V-DC-52 Amp.
Output: 26V-400Cy-250VA-Single Phase.
115V-400Cy-750VA-Three Phase....$125.00

10285-Leland
Input: 27V-DC-60 Amp.
Output: 26V-400Cy-50VA-Single Phase.
115V-400Cy-750VA-Three Phase....$ 90.00

104685-Leland
Input: 27.5DC-12.5Amp-Cont. Duty.
Output: 115V-AC-400Cy-175VA-80PF-ThPh. $90.00

11702 or 10563-Leland
Input: 28½V-DC-12 Amp.
Output: 115V-400Cy-115VA-Three Phase......$ 75.00

PE-109
Input: 12V-DC-29 Amp.
Output: 115V-AC-200VA-400Cy-Single Ph. $ 65.00

PE-206-Leland
Input: 28V-DC-38 Amp.
Output: 500V-800Cy-500VA-Single Phase.
80V-800Cy-500VA-Single Phase....$ 40.00

PU-7-Wincharger
Input: 28V-DC-160 Amp.
Output: 115V-400Cy-2500VA-Single Phase $100.00

PU-16-Wincharger
Input: 28V-DC-60 Amp.
Output: 115V-400Cy-6.5A-Single Phase........$ 90.00

PE-218-Leland-Wincharger-Gen. Electric
Input: 28V-DC-92 Amp.
Output: 115V380/500Cy-1500VA-Single Ph.$ 40.00

778-B-Bendix
Input: 24V-DC-250V Amp.
Output: 26V-400Cy-60VA-Single Phase.
115V-400Cy-190VA-Single Phase....$ 65.00

800-1-Bendix
Input: 24V-DC-75 Amp.
Output: 115V-AC-800Cy-10.5A-Single Ph.....$ 40.00

12116-2A-Pioneer
Input: 24V-DC-5 Amp.
Output: 115V-400Cy-45W-Single Phase ......$ 75.00

12117-2A-Pioneer
Input: 24V-DC-1 Amp.
Output: 26V-400Cy-6VA-Single Phase ....$ 27.50

12117-6B-Pioneer
Input: 28V-DC-0.8 Amp-DC.
Output: 26V-AC-6VA-400Cy-Single Phase..$ 27.50

12119-1-B-Pioneer
Input: 12V-DC-2 Amp.
Output: 26V-400Cy-6VA-Single Phase.........$ 27.50

12126-2A-Pioneer
Input: 27.5V-DC-1.25 Amp.
Output: 26V-400Cy-10VA-Three Phase........$ 35.00

Convert your surplus electronic equipment into cash. Send us listing of what you have and bonded offer will follow immediately.

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STanley 7-5458

WIRE-CABLE TUBES PARTS

CORDAGE

CO-122 3 conductor each #22 AWG neoprene jacket 550' lengths
CO-127 single #14 AWG braided and tinned copper braid shield

MULTI-CONDUCTOR

2 conductor AWG 12	7 conductor AWG 16
7 conductor AWG 14	19 conductor AWG 16
14 conductor AWG 16	6 conductor AWG 20
11 conductor shielded AWG 20	10 conductor AWG 16
2 conductor AWG 18	22 conductor AWG 16

2 conductor shielded AWG 10

AMOUR

DRIA-23 DHFA-100 FRIA-4

SINGLE CONDUCTOR AWG 10

shielded cable with terminal lug each end 100' and 150' lengths

WIRE

AWG 18 copperweld
AWG 29 tinned copper
Resistance wire AWG 32
AWG 22 with nylon core plastic insulation

LINEAR WIRE WOUND POTENTIOMETERS

10 Ohm	25 Watt	$.90	15000 Ohm	25 Watt	$1.70
15	25	.95	20000	25	2.00
20	25	.95	6	50	1.60
25	25	.95	150w/switch	50	2.15
50	25	.95	200 w/switch	50	2.15
100	25	.95	10000	50	2.95
200	25	1.20	15	75	2.95
350	25	1.20	.5 Meg 1" Shaft	AB "J"	1.45
500	25	1.20	200,000 1/8 SD	AB "J"	1.40
1000	25	1.30	200 1/8 SD	AB "J"	1.40

SPECIALS

80-86 Crystal in Holder $2.50
Balloon with Hydrogen Generator $2.50
300 Feet Aerial Wire $2.00

MICROWAVE TEST EQUIPMENT

10 CM echo box CABV 14ABA-1 of OBU-3, frequency range 2890 MC — 3170 MCS. Direct reading micrometer head. Ring prediction scale plus 9% to minus 9% Type "N" input. Resonance indicator meter. With accessories, spares and 10 CM directional coupler. Brand New.

TUBES

2C34	$.45	801A	.25	9006	.30
2X2/879	.55	803	3.60	C5B	8.00
3B24	4.95	826	.65	CK 70	4.15
3C24	1.60	864	.25	E1148	.30
7C4/1203A	.70	931A	4.45	HY 615	.20
10Y	.35	955	.30	RK 73	.45
15R	.65	957	.35	5BP4	4.25
30 Spec	.40	CK 1005	.45	5FP7	1.75
39/44	.25	CK 1007	.90	1J6 G	.70
45 Spec	.35	1626	.35	1B3 GT	.80
WE 203A	6.75	1629	.25	3A4	.60
316A	.60	2051	1.10	5U4G	.57
WL 531	4.95	7193	.50	6K6GT	.60
713A	.90	8011	1.50	371B	.75

HI VOLTAGE FILTER CHOKES

.4 HY 4.5 Amp DC 3 ohms 1230 RMS to ground. New.
1 HY 3.2 Amp DC 3.5 ohm GE69G459. New.
1.7-3 HY 2 AMP DC 34,000 VDC GEY346A. New.

NAVY ENTERING TYPE INSULATOR

Porcelain flanged bowl with brass rod, fittings and aluminum shield. Dimensions 4⅜" high, 6-5/16" OD at base. Brand new $4.50.

10 CM ROTATING ANTENNA

24" Parabola in turret 360° span at 12 RPM DC, motor control and reversing switch New.

TIME DELAY SWITCHES

1 Minute 115 VAC 60 cycle Enc. in Waterproof Metal Case. New $5.25
3 Micro Switches Contact at 40-41-42 Second Time Delay 110 VAC Motor New $4.50
Thermo Switch 50° to 300° F 115 VAC @ 6A 230 VAC @ 5A
Breaks Contact with increase in Temperature. New $1.35

CONTACTORS

DPST 115 VAC 60 cycle 15 Amp De-Ion Line Starter Westinghouse $6.95
DPST 115 VAC "AB" #700 $5.95

RELAYS

12 VDC DPST Allied Control Box 32...$1.25
24 VDC DPDT Allied Control BID36....$1.45
24 VDC 3PDT 8 Amp....................$1.50
110 VAC DPST 1 Amp Contacts Struthers Dunn CKA 1970....................$3.65
115 VAC DPST Struthers Dunn CXA 2997 ....$3.65
220 VDC DPDT Struthers Dunn CK 2122.$4.50
230 V 50 cycle DPDT G.E. 12HGA11A2..$4.00

OIL FILLED CONDENSERS

FD	VDC	Each	Ten	MFD	VDC	Each	Ten
1	600	.85	.80	.5	2000	2.00	1.90
2	600	.95	.95	.25	3000	2.85	2.80
4	600	1.40	1.40	.5	3000	2.95	2.90
5	600	1.65	1.60	.2	5000	4.50	4.25
1–8	600	2.50	2.35	.1	7500	3.95	3.95

METERS

Portable 0-25 Amps AC Weston #433 Brand New $37.50
Switch Board Panel 0-100 Amps DC Weston #269 with 100 Amp Shunt Brand New $24.95

EQUIPMENT

Walkie-Talkies 2.3-4.6 MC
MN-26Y Bendix Compass Receiver
BC-733 Glide Path Receiver
DAB 3—Direction Finder
RDF Receiver Equipment 200-500 KC Fixed Tuned

SWITCHES—BATHTUB—OIL FILLED—MICA CONDENSERS—POTENTIOMETERS. SEND FOR CATALOG

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since 1945 Resistors is our business

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Fixed or variable (EB + GB + HB and others)
Carbon or wirewound
⅛ Watt up to 300 Watt
Precision of ¼ of 1% or 20%
Any, Yes . . . any makes—any types—any values
One piece or one million

ANY CONTROLS

Potentiometers, type J, JJ, JJJ Rheostats, Attenuators
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FOR QUANTITY USERS ONLY

TUBE ELECTRON
Type 1B32/532A
50c

TUBES

1 C 6	Boxed	.10
2 C 26 A	"	.10
19	"	.17
954	"	.12
250 TH	"	6.00
3 B 29	"	6.00
3 E 29	"	6.00
100 TS	"	2.50
1642	"	.10
10 Y (VT25)	"	.12

PLUGS

PLQ 169	1.00
PLQ 171	1.00
PLQ 172	1.00
PL 172	1.00
Teletypewriters M8D1 NEW	150.00
Bias Meters 1-97A	6.50

CONTACTOR
BC 608 A **New 7.50**

SPARK PLUGS
Type LS 465 A for Wright Engines R2600 and R1820 Pratt and Whitney Engines 1830 individually boxed .04 ea.

Tuning Units TU 10 New ... 2.00

Telephone A and B line. Station for shipboard use with dial and handset. New .. 10.00

BC 456	New	2.50
BC 455	Used	5.00
BC 458	Used	5.00

Antenna AS 61 Complete New	1.00
Antenna AS 62 Complete New	2.00
TS 245/TRT-1	100.00
TS 125	125.00
BC 966 Complete IFF with Cables, Mounts—Plugs	35.00
Pilot baloon targets ML 350/AP	.25

CRYSTALS
25,000 Pieces in FT. 241 Holders
New @ $.10 each

P 4 Computers		150.00
E 78 Signal Generator		60.00
Antenna AT5/ARR-1		.50

60,000 used Headsets on sale 1.00 each
HS 18—HS 30—HS 33—HS 38

A5 pilot director indicator	New	5.50
Spare parts for SCR 595 with Antenna—Plugs, etc.		3.00
MG 149 Filters	New	5.00
Micro Switch WZ7RTC		.20
Vibrators for EE 101 A	New	.75
BC929 Oscilloscopes	New	20.00
Loops LP 21	Lousy	5.00
Loop MN 20 E	New	2.50
Motors PE73	Checked	5.00
DM33	New	2.50
Antennas AN 104	Iron	.75
Antennas AN 104	Copper	2.00
PE 218	Checked	9.50
EE65 Telephone Test Set	New	20.00
Vibrators VB8	New	.35
MC125 Remote Tuner	New	.50
MC124 Cable	New	1.50
MC215 Cable	New	.60

PLUGS • CONNECTORS
CLAMPS • AMPHENOLS
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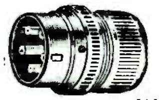

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WE HAVE ALL TYPES WITH CORDS AND CABLES, OR WITHOUT

WE HAVE SERIES OF
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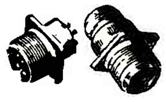
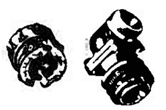
3102 3108
WE HAVE SERIES OF PL, UG, SO
WE HAVE SERIES OF 3057



WE HAVE OVER 1 MILLION IN STOCK in over 3000 TYPES!!



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in 1/8"—3/16"—1/4"—5/16"
Thicknesses
4000 pounds
Available at
50c per pound

Oxygen Gas Masks	New	.25
Control Boxes BC434	New	3.50
Antennas 37-50 MC 72 inch		1.50
AS97/ART—Antenna with coax		1.50
Vinyl tubing 5/16" I.D. x 7/64" Wall 40 ft lgths		1.00
Neoprene tubing 5/16" I.D. x 7/64" Wall 80 ft lgths		2.00
RL42 Antenna motors	Lousy	1.50
BC357 Receivers	Used	3.50
Recorder for underwater sound equipment		60.00
Transmitter—Aircraft T9/APQ-2, 115v. 400 cy. 26VDC NEW		$20.00
Radar Transmitter T-26/APT-2, 115v. 400 cy. 200 Watts. NEW		$30.00
Corner Radar Reflector NEW		$5.00
R5/ARN-7 Type Certificated		$250.00
TS125 Test Set, complete. NEW		$125.00 ea.
TS10 Test Set, NEW		$20.00 ea.
TS16 Test Set, NEW		$20.00 ea.
Tuning Units TU-10 NEW		$2.50
Tuning Units for BC-610 NEW		$12.50

MOTORS
1/2 H.P. 115V. 60 Cy. 3400 RPM
Mfg. Delco Diehl
Good for fans **2.50**

WANTED
ARG-1 or Component Parts
ARG-3 or Component Parts
ART-13 or Component Parts
DC348 or Component Parts
AN/TRG-1 or Component Parts
SCR 720 Material all type
SCR 508 Material all type
SCR 608 Material all type
SCR 609 Material all type
Crystals all types

Test Sets
PE 104 and 98
DM 40, 41, 42 and 43
SCR 808 and SCR 608

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This is only a partial listing. We have a quantity inventory on our shelves. consisting of Coils—Relays—Condensers—Transformers—Radio and Radio Receivers and Transmitters—Handsets—Headsets—Microphones etc. etc. All are ready for IMMEDIATE DELIVERY.

TERMS: Open A/C net 10 days. All prices F.O.B. our warehouse.

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Yes, coming up in June is the great Annual BUYERS' GUIDE issue of ELECTRONICS—the 13th issue of the year.

And it is just that—the buying guide for those in the electronics industry. They find the GUIDE indispensable to them in their work and turn to it whenever they seek sources of supply for equipment or component parts.

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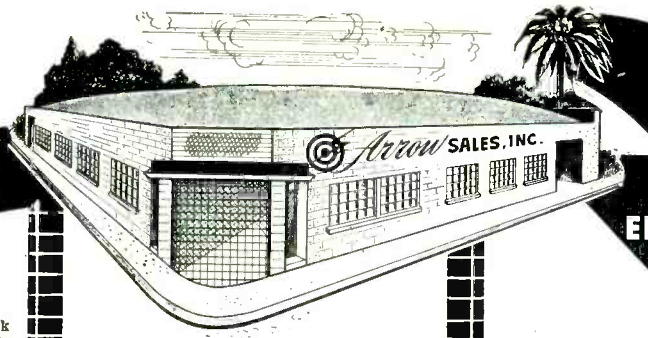
Closing date is May 25.

FOLLOW ARROW FOR MILITARY ELECTRONICS



ATR-13 TRANSCEIVER

Dynamotor powered, either 14 or 28 V. Shock mounted, remotely controlled, transceiver. Tunable receiver, range 108-160 M.C., 4-channel crystal controlled VHF transmitter, built-in provisions for omni. Weight, complete with plugs, less cable, 19 Lbs. Less crystal, new.................. **$245.00**

Radar

APR-4 New. Complete	APT-2	RC-1841FF
APR-5	APT-3	RC-214
APS-4 New. Complete	APT-4	RC-224
APS-6 New. Complete	Mark 16	RC-266
APT-1	MD4/APS2	RT34/APS13
	MD5/APS3	T-85/APT-5
	MD22/UPN2	AN/APN-4
	MD38/APQ13	AN/APN-9

PORTABLE RADAR

Model SQ. 12 cm. Used on small ships. Has PPI indicator. Max. range 20 miles. 1 Kw. output. Operates from 110 VAC, 60 cps. P.U.R.

AN/ART-13 PARTS

Part #	Item
Transmitter	T-47A/ART-13
564916	Barometric Switch
565027	4-Pile Ceramic, Variable Cap.
K7890443	6-Pile Ceramic, Variable Cap.
564605	4 Centralab-Type 843–003 Cap Assembly
Antenna Loa ng	CU-25

TRANSTAT

11-5 KVA50/60 cycles. Commutator range 0-115 V. Max. 100 amp. Good cond...$125.00

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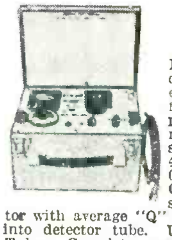
Send for FREE Catalogue No. 112 for complete list of Military, Industrial and Aviation Electronics. WE HAVE THE LARGEST INVENTORY OF SUCH EQUIPMENT IN THE UNITED STATES.



300-600 MC. MICRO-WAVE LAVOIE FREQ. METER

Model is a compact, self-contained, battery powered, precision (± 1 Mc) frequency meter which provides quick, accurate readings. Requires a standard 1.5V "A" and 45V "B" battery. Has 0.5 MIN. time switch. Contains sturdily constructed HI-"Q" resonator with average "Q" of 3000 working directly into detector tube. Uses 957, LS6 and 3S4 Tubes. Complete, new with inst. book, probe. Less batteries **$79.50**

Test Equipment Complete Line

DuMont 224-A Oscilloscope		TS159
1–77 Hickok Tube Checker		TS-159/TPX
1–208 FM Signal Generator		TS170/ARN
RPC Model 644 Multimeter		TS-173/UR
Hewlett Packard 200-C		TS-174/UR
I-198	TS27/TSM	TS175/UR
BC-638	TS-33	TS182/UP
BC-1255	TS34/AP	TS184A/AP
IE-36	TS-35/AP	TS204/AP
I-95	TS36/AP	TS-218
I-96-A	TS-45A/APM-3	TS251
I-122	TS-59/APN	TS311A/UP
I-130A	TS61/AP	TS323/UP
I-139	TS62/AP	1-146
I-145	TS89	TS-268/U
I-212	TS92	Boonton Mod. 78B Sig. Gen.
I-222	TS100/AP	
TS-3A/AP	TS-102	Boonton Type 102F Sig. Gen.
TS10A/APN	TS111/CP	
TS12/AP	TS-118/AP	LAD Sig. Gen.
TS16/APN	TS126	LAE-2
TS19/APQ	TS127/U	LAVOIE Freq. Meter: 300–600 Mc.
TS-23/APN	TS131	
TS24A/ARR-2	TS-148/UP	

SUPREME TEST EQUIPMENT

Model 600 Tube and Set Tester.........$89.50
Model 616 Tube and Battery Tester.... 69.50

TRANSCEIVER—MODEL 52

5W. 2-way, 2-channel radio transmitter-receiver unit. Complete with tubes, battery charger, microphone. Less crystal and antenna. Operates from 6 V. battery. New..............$89.95

Headsets & Handsets

HS-23	HS-38	TS-13-C
HS-30	TS-10-G	HS-18
HS-33	T-26	EE-8

FLUXMETER

Used to calibrate field strength of magnets from 500 to 4000 gauss and indicate polarity. Probe has gap of 1¼". Beautifully built in hardwood case with hinged cover. Instructions for operation on under side of cover. Size 12¾ x 9 x 6 in. Ideal for lab and school use. New. An exceptional value at............ **$29.50**

Specials

RECEIVERS—TRANSMITTERS

ARC-1	PE-125AX	RTA/1B
ARC-3	R-9/APN-4	SCR-522
R-4/ARR-2	BC-733-D	TA2J-24
ID-6/APN-4	R-57/ARN	R-89/ARN
MP-10G	BC-788-A-AM-C	R-1/ARR-1

EQUIPMENT WANTED

To meet government and industrial orders we urgently need all types of new and used Test Equipment, Radar, Receivers, and Transmitters. WE PAY HIGHEST PRICES. Tell us what you have.

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PANEL METERS

SPECIAL ITEMS—JUST RECEIVED

Frequency Meter, 400 cycles, 3½" round flush case, black scale, Vibrating reed type, cal. from 380 to 420 cycles, 115 volts, Reiber model 4008 @ $21.50

Frequency Meter, Dual Range, 50 and 60 cycle, Vibrating reed type, J.B.T. model 30-F, 3½" rd. flush metal case........................@ $14.95

A.C. Voltmeter, 0-150, Weston 476, 3½" rd. flush bakelite case ($15.75 list).............@ $11.50

A.C. Voltmeter, 0-130, Weston 476, 3½" rd. flush bakelite case ($15.75 list).............@ $10.50

A.C. Voltmeter, 0-150, General Electric AO-22, 3½" rd. flush bakelite case..................@ $9.50

R.F. Ammeter, 0-1, Westinghouse NT-33, 2½" rd. flush bakelite case ($16.50 list)........@ $9.50

D.C. Millivoltmeter, 0-10, very low resistance, 4 ohms, Westinghouse RX-35, 3" square, flush bakelite case, Cat. #1159598 (can also be supplied in round case)..................@ $11.00

D.C. Milliammeter, 0-30, Westinghouse NX-35, 3½" rd. flush bakelite case.............@ $6.00

A.C. Voltmeter, 0-15, Roller-Smith, 3½" rd. flush bakelie case, JAN type MR35WO15ACVV @ $5.50

A.C. Ammeter, 0-120, Weston 476, 3½" rd. flush bakelite case, 3 Amp mvt., complete with external current transformer............@ $14.50

All items are surplus, new, in original cartons, and are fully guaranteed.

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INSTRUMENT & ACCESSORIES
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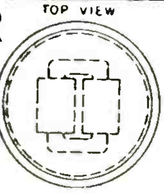
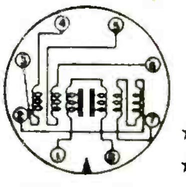
PULSE TRANSFORMER



Tube base plug in type

Here are precision made, high quality compact pulse transformers wound on hypersil cores. They are built in octal bakelite tube bases and can be adapted to many uses. They are completely impregnated and sealed.

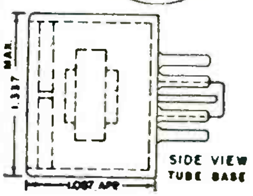


TYPE UX 7350
Each Coil—50-T #36E
Max. DC Res. Ohms
1 & 8= 4.02Ω
2 & 7=4.542Ω
3 & 4=2.357Ω
5 & 6=2.185Ω

SUGGESTED USES

★—Blocking Oscillator, Multivibrator and Scope Circuits.
★—Wherever Accurate Timing and Triggering are necessary.
★—Unexcelled in circuit applications for generating low power and low voltage pulses.
★—Can be used in circuits utilizing repetition rates from 0 to well over 1 MC and pulse widths ranging from .05 Microsecond up.

Price **$4.50** each Immediate Delivery



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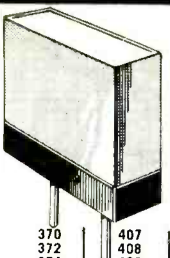
RADIO Surplus Buys



CRYSTALS

. . . in FT 241-A Holders—½" Pin SPC. Marked 54th OR 72nd Harmonic MC Freq. Listed below by fundamental frequency with fractions omitted.

500 KC Crystals ea. **$1.95**

1000 KC Crystals / 200 KC Crystals ea. **$3.95**

370	407	444	476	509
372	408	445	477	511
374	409	446	479	512
375	411	447	480	513
376	412	448	481	514
377	413	450	483	515
379	414	451	484	516
380	415	452	485	518
381	416	453	486	519
383	418	454	487	520
384	419	455	488	522
385	420	456	490	523
386	422	457	491	525
387	423	458	492	526
388	424	459	493	527
390	425	461	494	529
391	426	462	495	530
392	427	463	496	531
393	429	464	497	533
394	430	465	498	534
395	431	466	501	536
396	433	468	502	537
397	434	469	503	538
398	435	470	504	540
400	436	472	505	
401	437	473	506	
402	438	474	507	
403	440	475	508	
404	441			
405	442			
406	443			

$1.00 EACH

10 for $8.00, Postpaid

FOLLOWING CRYSTALS AVAILABLE IN
FT 243 HOLDERS ½" PIN SPACING

3590	5035	7350
4165	5127.5	7450
4280	5285	7750
4335	5587	7875
4350	5660	
4370	5730	
4440	6073.3	
4445	6075	
4540	6140	
4620	6350	
4635	6525	
4710	6700	
4880	6875	
4980	6975	
4995	7150	

$1.00 EACH

11 for $10.00, Postpaid

PLEASE ENCLOSE FULL AMOUNT WITH ORDER
QUANTITIES AVAILABLE
WRITE FOR YOUR REQUIREMENTS

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BOX 356-FT EAST PASADENA STA. • PASADENA 8, CALIF.

YOUR BEST SOURCE FOR NEW JAN TUBES FULLY GUARANTEED

OC3/VR105	1.00	VT166	1.75	954	.45
OD3/VR150	.85	211	.65	955	.45
1B29	2.25	212E	9.75	957	.45
1N23B	2.95	250TH	20.00	958A	.65
1N26	7.50	304TH	6.75	1005	.55
2C21	.50	304TL	7.25	1007	.85
2C26	.25	307A	3.50	HY1269	2.25
2C40	7.25	310A(WE)	5.50	1613	.85
2C46	25.00	311A	6.50	1616	.95
2C51	5.25	354D	19.50	1622	2.25
2D21	1.35	371B	1.75	1625	.65
2E22	1.75	394A	3.50	1629	1.25
2E26	2.75	417A	7.50	1644	.75
2J22	6.75	471A	2.50	2051	1.00
2J26	13.75	507AX	1.25	5726	1.75
2J31	22.50	532A	2.50	7193	.45
2J32	22.50	559	1.25	8011	.95
2J34	22.50	701A	5.50	8020	1.25
2J48	22.50	703A	5.00	9001	1.25
2K22	35.00	705A	1.65	9002	.95
2K23	27.50	715A	5.00	9003	1.35
2X2	.50	715B	6.50	9004	.29
3A4	.79	715C	18.75	9006	.29
3A5	.95	717A	.95	**C. RAY**	
3B24	4.75	721A	1.75	2AP1A	8.50
3B26	3.50	723AB	17.50	3AP1	5.50
3C24/24G	1.75	725A	6.50	3BP1	4.75
3C31/C1B	3.25	726A	12.50	3DP1	3.50
3C45	14.75	805	3.50	3GP1	3.75
3E29	13.75	807	1.25	5CP1	4.00
5D21	15.00	810	8.75	5LP1	20.00
6AS6 W.E.	2.00	811	2.85	5NP1	4.00
C6J	6.25	812	2.75	7BP7	5.75
6C21	18.75	813	9.25	9GP7	9.75
6J4	6.00	814	2.50	**Receiving Types**	
10Y	.45	815	2.25		
15E	1.75	829B	11.50	1LN5	.69
28D7	1.85	832A	8.75	1R5	.59
35TEimac	5.75	837	1.25	1T4	.50
RK72	.95	845	5.50	3D6/1299	.39
100TH	6.75	866A	1.35	3S4	.65
VU111	1.25	872A	3.25	6AC7	.75
120A(WE)	7.50	876	.75	6H6	.55
121A(WE)	2.95	923	.75	6J5	.45
F127A	17.50	931A	3.95	6J6	.65

Write for other types not listed.

Rated firms send P.O. Order. F.O.B. N. Y.

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WHAT DO YOU NEED?
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OUR NORMAL INVENTORY INCLUDES OVER 80,000 DIFFERENT ITEMS IN THE ELECTRONIC, RADAR AND RADIO FIELDS.

RELAYS—Approximately 300,000 in over 1100 types

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OIL • TUBULAR • MICA • FIXED and ADJUSTABLE CERAMIC FEED-THRU • STAND-OFF • APC TRIMMERS • VARIABLES • SILVER MICA

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FUSES—Approximately 800,000 in stock

WIRE and CABLE—Millions of feet

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TIMERS and DELAY RELAYS—Both clock and thermal types

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BUSHINGS and SPACERS—Thousands of pounds

CHASSIS—Dozens of sizes

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INVERTERS— From 110DC to 60 cycle AC; From 20 to 500 Watt; Also some 400 cycle units

RECTIFIERS—Made to your specifications

NU-METAL LAMINATIONS—Thousands of pounds in a dozen sizes

KOVAR GLASS SEALS—Approximately 400,000 in stock in several dozens of types

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TAPE—Celluose, Textile, Masking and Electrical—All sizes

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TUBES—Most receiving types and many special types in stock

IRON CORE SLUGS—Over a million in stock

WE ALSO HAVE A LIMITED ASSORTMENT OF THE FOLLOWING ITEMS IN STOCK:

DIAL LIGHT ASSEMBLIES	TELEGRAPH KEYS
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DIAL PLATES	ALNICO MAGNETS
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SOCKETS	POWER RHEOSTATS
HEADPHONES	ROTARY SWITCHES

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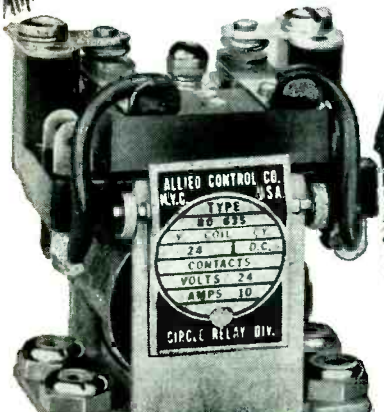

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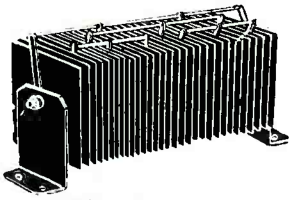

Full-Wave Bridge Types

Current (Continuous)	18/14 Volts	36/28 Volts	54/42 Volts	130/100 Volts
1 Amp.	$1.35	$2.15	$3.70	$7.50
2 Amps.	2.20	3.60	5.40	10.50
2½ Amps.	......	......	6.00	13.00
4 Amps.	4.25	7.95	12.95	25.25
6 Amps.	4.75	9.00	13.50	33.00
10 Amps.	6.75	12.75	20.00	40.00
12 Amps.	8.50	16.25	25.50	45.00
20 Amps.	13.25	25.50	39.00	79.50
24 Amps.	16.25	32.50	45.00	90.00
30 Amps.	20.00	38.50	......	......
36 Amps.	25.00	48.50	......	......

We can manufacture other Selenium Rectifiers, Selenium Rectifier Supplies, XFMRS., & Chokes................

• New Selenium Rectifier Transformers

PRI: 115 V., 60 cycles in.
SEC: 9, 12, 18, 24, and 36 volts
Continuous Ratings

- 4 Amps....... $8.75
- 12 Amps....... 16.75
- 24 Amps....... 35.75
- 50 Amps....... 59.75

● New Selenium Rectifier Chokes

- **4 Amps.—.07 Hy.—.6 ohm** $7.95
- **12 Amps.—.01 Hy.—.1 ohm** $14.95
- **24 Amps.—.004 Hy.—.025 ohm** $29.95

JOBBERS . . . LARGE QUANTITIES OF W.E. COMPONENTS, XFMRS, CAPACITORS, ETC. WRITE.

PARTIAL LISTING OF TUBES AND DIODES IN STOCK

0A2	.90	6BQ6GT	1.20	50C5	.50
0A4G	1.00	6BZ7	1.35	50L6GT	.55
0B2	1.00	6C4	.45	101-F(WE)	1.00
0D3/VR150	.88	6CB6	.55	FG-105	17.00
1A7GT	.80	6CD6-G	1.60	117Z6	1.00
1AE4	.90	6F6-M	.69	F-123A	6.50
1B3/8016	.80	6F8-G	.85	211(GE)	.75
1B23	8.00	6G6-G	.85	**250TH**	17.00
1B27	12.50	6H6	.70	FG-271/5551	55.00
1L4	.60	6J5GT	.45	**274A & B**	3.00
1LA6	.90	6J6	.62	275-A(WE)	3.00
1N21B	2.50	6J7	.70	304-TH	7.00
1N21C	17.50	6K4(Syl)	3.50	304-TL	8.75
1N23A	2.25	6K6GT	.59	310-A(WE)	5.45
1N23B	3.49	6K7 Metal	.70	**311-A(WE)**	6.50
1N34A	.75	6L5-G	.49	328-A(WE)	5.00
1N44/400B	1.21	6L6-G	1.19	359-A(WE)	4.00
1N45/400C	1.39	6L6-GA	1.20	371-B	.85
1N48(GE)	.55	6L6 Metal	1.95	373-A(WE)	4.00
1N54(Syl)	.77	6L7	.80	374-A(WE)	3.50
1X2A	.90	6N7 Metal	.80	387-A(WE)	2.50
2C40	7.95	6Q7GT	.80	403-B(WE)	7.50
2C43(GE)	13.95	6S7 Metal	.98	407-A(WE)	5.00
2C52	5.50	6SD7	.79	**408-A(WE)**	2.75
2D21	1.25	6SG7	.72	421-A(WE)	3.50
2E24	2.50	6SJ7	.69	717-A	.88
2E30	1.95	6SK7GT(Syl)	.62	**725-A**	5.50
2J22	6.50	6SL7GT	.60	803	3.95
2J32	29.95	6SN7GT	.70	805	3.25
2J34	25.25	6V6GT	.55	807	1.59
2J39	40.00	6W4GT	.55	811-A	3.50
2J48	24.25	6W6GT	.85	812	2.70
2K25	27.00	6Y6-G	.88	812-A	3.50
2X2	.50	6X5GT	.55	816	1.25
3A4	.59	7A7	.69	829-B	12.95
3AP1	9.00	7A8	.69	832-A	8.50
3B28	7.50	7C5	.69	837	1.45
3B29	9.95	7C6	.69	838	2.95
3BP1	5.75	7C30	85.00	860	3.95
3BP11	9.50	7F7	.69	861	15.00
3C23(GE)	9.50	7GP7	4.95	866-A(Hyt)	1.55
3C24/24G	1.35	7H7	.72	872-A	3.95
3C27	7.50	12A6	.50	1613	.75
3C33	9.00	12AT7	.75	1616	.70
3D6/1299	.50	12AU7	.62	1622(6L6M)	1.95
3DP1A	6.95	12AV6	.49	1625	.35
3E29	9.95	12AX7	.79	1631	.70
3Q5GT/G	.99	12BA6	.57	1632	.70
3S4	.80	12BD6	2.10	2050(RCA)	1.35
4X150A	25.00	12BE6	.57	2051	1.00
4-125A	22.00	12BH7	1.15	5514(Hytron)	4.50
4-250A	32.00	12SA7	.75	5516(Hytron)	4.50
5D21(WE)	14.75	12SF5	.70	5528/CoL.	12.00
5R4GY	1.25	12SG7	.80	5608-A	3.95
5U4G	.55	12SH7	.63	5646(Syl)	8.25
5V4G	.95	12SJ7	.69	5654	1.75
6AB7	.98	12SK7	.70	CK-5702	3.23
6AC7	.77	12SL7GT	.65	CK-5744	2.25
6AG7	1.25	12SN7GT	.70	CK-5886	3.00
6AH6	1.00	12SQ7GT	.63	5800(Vict.)	6.50
6AJ5	1.30	12SR7	.60	5803(Vict.)	2.75
6AK5	.65	14F7	.80	5814	2.95
6AK5-W	.90	25AV5	1.25	5910	.75
6AK6	.98	25BQ6GT	1.00	5995	3.50
6AL5	.50	25L6GT	.65	8020	.98
6AN5	2.25	25Z6	.67	9001	1.20
6AT6	.60	28D7	1.50	9002	.85
6AU6	.59	35B5	.49	9003	1.45
6AV6	.49	35C5	.40	9004	.35
6B8	.70	35L6	.69	9006	.30
6BE6	.55	35-T(Eimac)	3.00	AX9903	17.75
6BG6-G	1.35	35Z5GT	.49		
6BH6	.60	42	.65		

WRITE ON TYPES NOT LISTED

Terms: FOB-NYC—25% Deposit with order—or send full remittance to save COD charges—Rated Firms (D.&B.) Net 10 days — All merchandise guaranteed. Phone: REctor 2-2562

FILTER CAPACITORS

Capacity	W. Voltage	Ea.
500 MFD.	50 V.	.98
500 MFD.	200 V.	2.50
1000 MFD.	12 V.	.50
3000 MFD.	20 V.	2.25
5000 MFD.	50 V.	3.75

SELENIUM POWER SUPPLY

0 to 12VDC/2 Amp. Variable DC supply, uncased and completely built—inpt. 115v/60 cy........$10.95

TRANSFORMER SPECIALS

- 115V. PRI—5V. @ 190 Amp. SEC.........$49.95
- THORDARSON Boxed Filament XFMR. (T-50F61) 115V.—2.5V. @ 3.5 A....For 816's............$2.00

Western Electric Filter Chokes. Brand New. Hermetically sealed. 8 hy @ 300 ma.-75 ohms D.C. resistance 13 KV Test Ins. Only..............$5.00

- Jones—6 Way Socket—Cat #S-306............15¢
- New Tube Cartons—Holds 100 Tubes—....35¢ ea.
- Pedestal Insulator—3" high.............20/$2.00
- Mallory 12 Volt Vibrapack—NEW—300 V @ 100 MA. ....$9.00 ea.
- Weston Model 788 Tube Tester............$75.00

QUANTITY USERS OF GENERAL ELECTRIC JOBBER'S **2C43** (COLORED) BOXED, CURRENT PRODUCTION IN PLIOFILM PACKAGE $13.95 ea. 10 OR MORE..................$12.95 ea.

7C30 12 KW. POWER TRIODE WITH 16 VOLT FILAMENT XFMR. (TAPPED AT 11V.). 220 V. PRIMARY—COMBINATION—ALL NEW. WRITE FOR DETAILS...........$105.00

CBS — Hytron Cathode-Ray Picture Tubes

First Quality in factory-sealed cartons. Full Year Warranty Card on each tube. Remember . . . no seconds; no rebuilts . . . Prices Include Fed. Tax. C.R. Tubes via Express Collect.

7JP4	18.75	16KP4	28.75	17HP4	25.50
10BP4A	21.00	16RP4	30.00	20CP4A	38.50
12LP4A	21.50	16TP4	30.00	21EP4A	38.50
14CP4	24.00	17BP4A	24.75	21FP4A	36.00
16AP4	31.00	17CP4	25.25		

● RADIO TELEPHONE SETS

Western Electric 4 Channel Ship-to-Shore Sets. Brand new. Made for U. S. C. G., deluxe, compact, includes transmitter, receiver and built-in power supply for 12-volt D. C. operation. Operates from 2 through 3.5 mcs. 5 Watts output. Our price $149.50

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  20 or more.................................$9.50 ea.
- Western Electric ⅛" Steel Comm'l Grey Panels—10½" x 19". Brand new..............$1.00 each

Trimm. Model 100 "Featherweight" Headsets & Band. New, in orig. mfr.'s carton 4,000 ohms.........$4.95

- Bliley-Type SMC100— Crystal Standards New—100 KC and 1,000 KC BAR..........$8.50
- LM FREQUENCY METER—INT. MODULATION —Orig. Book. With external AC Power Supply $115.00

Top Dollar Paid for SURPLUS TUBES & EQUIPMENT — Send List With Details

BARRY ELECTRONICS CORP.

136 LIBERTY STREET • NEW YORK 6, N. Y.

CONDENSERS

MICRO & TOG. SWS. - RELAYS - "J" POTS

OIL CONDENSER SPECIALS

5 mfd-1000 V $1.99
#23F14-G2

1 mfd-1000 V .... $.75
TJU-10010 (Boxed)

15 mfd-1000 V $5.50
#23F19-G2

4 mfd-600 V $1.25
3¼H x 2¼ x 1-3/16

8 mfd-600 V $1.49

6 mfd-150 V .... $.35
Three term, dual 3 mfd oil cond. with brackets, 4¼" x 1¾" x 1". Ideal for audio crossover networks.

MICRO SWITCHES

Number	Actuator	Circuit	Term.	Price
WZR-31	Pin	SPST-N.C.	Screw	.29
WZR 31-M	MC2711 Plunger	SPST-N.C.	Screw	.49
M-WZ-RS13	Plunger	SPST-N.C.	Screw	.59
WZR-31	HO3-RE11	SPST-N.C.	Screw	1.95
WZ-2YST	Plunger	SPST-N.O.	Screw	.69
WZRQ-41	Plunger	SPST-N.C.	Screw	.59
YZR-31	T-Actuator-LH	SPST-N.O.	Screw	.59
YZ7RDTC	Plunger	SPST-N.O.	Screw	.59
YZ3RDT	Plunger	SPST-N.O.	Screw	.59
YZ-2YST	Plunger	SPST-N.O.	Screw	.75
YP3	Button	SPST N.O.	Solder	.39
BZRL2	Roller	SPDT	Solder	.95
BZ3RW2T	Roller	SPDT	Screw	.69
MU-SW(15A 125V)	Lever	DPST N.O.	Solder	.69

CHOKES & FIL. TRANS

5 Hen. 165 ma. .... $.89
50 Hen. 125 ma 2.35
5-25 Hen. 200 ma. 3.55
115 v. Prim 6.3 v. Sec. 6 A 2.25

Mfd	Volts	Price	Mfd	Volts	Price
.005-.005-			1	20KV	P.U.R.
.01	5000	2.95	1	25KV	82.00
.01	10KV	4.75	2	600V	.59-.79
.01	10KV	4.75	2	600V TLAD	.85
.012	25KV	22.50	2	1000V	.85
.02	20KV	17.90	2	1000V TLA	1.29
.025-.025-			2	1500V	1.79
	50KV	55.00	2	2200V	2.30
.03	8000	3.95	2	2500V	3.35
.03	16KV	15.95	2	5000V	14.95
.05	5KV	2.98	2	4000V	8.35
.08	12.5KV	15.95	2	6000V	19.35
.1	1500V	.59	2	12.5KV	P.U.R.
.1	2000V	.49	2-2	600V	1.25
.1	2500V	1.39	3	600V	.59
.1	3000V	1.89	3	4000V	P.U.R.
.1	7500V	1.75	3-3	150V	.35
.1	7500V	3.50	3-3-3	400V	1.05
.1	10KV	9.50	3.75	1000V	1.59
.1	10KV	12.95	4	600V	1.25
.1	12KV	14.95	4	1000V	1.95
.1	15KV	16.95	4	1500V	2.65
.1-.1	7500V	3.50	4	2000V	4.85
.15-.15	8000V	1.95	4	3000V	7.95
.2	10KV	10.95	4	4000V	P.U.R.
.2	15KV	17.95	4	5000V	P.U.R.
.25	2000V	1.35	4-4-4	600V	2.40
.25	3000V	2.05	5	330VAC	1.75
.25	6000V	1.75	5	600V	1.75
.25	18KV	15.95	5	1000	1.99
.25	20KV	19.95	5	1500V	2.98
.25	50KV	85.00	6	330VAC	1.75
.3	2000V	1.45	6	600V	1.85
.4	10KV	14.95	6	1000V	2.49
.5	1500V	1.20	6	1500V	3.65
.5	2000V	1.85	6	2000V	3.95
.5	2500V	2.20	7	600V	1.45
.5	3000V	2.39	7	800V	1.90
.5	4000V	3.15	7	1000V	2.49
.5-.1	2000V	.90	8	500V	1.35
.5-.5	600V	.69	8	600V	1.49-2.25
.5	25KV	55.50	8	600VAC	3.50
1	400V	.45	8	1000V	3.25
1	500V	.59	8	1500V	4.65
1	1000V	.69	8	2000V	7.25
1	1500V	1.35	8-8	600V	1.75
1	2000V	1.95	10	600V	2.75
1	2500V	2.50	10	1000V	4.55
1	3000V	3.50	10	1500V	6.25
1	5000V	5.25	10	6000V	P.U.R.
1	6000V	8.98	12	1000V	4.95
1	7000V	12.00	15	1000V	5.35
1	10KV	P.U.R.	15	2000	9.25
1	16KV	P.U.R.	17	25V	.69

WANTED
Condensers of all types in any quantity. Also other standard components. Top prices.

TRANS. MICA CONDS.

Mfd	Wvdc	Price	Mfd	Wvdc	Price
.00005	2500	.30	.002	2500	.55
.00008	1200	.26	.0024	5000	2.35
.0001	600	.21	.0025	1200	.42
.0001	1200	.24	.003	1200	.43
.0001	2500	.29	.0035	2500	.64
.0001	5000	1.95	.004	1200	.46
.00015	2500	.29	.004	2500	.78
.00015	5000	1.95	.0043	2500	.79
.0002	1200	.26	.0045	600	.32
.0002	2500	.35	.005	600	.33
.00025	1200	.27	.005	1200	.51
.00025	2500	.31	.006	600	.29
.00025	5000	2.05	.0068	2500	.89
.00027	2500	.33	.01	600	.43
.0004	2500	.19	.01	1200	.69
.0005	2500	.39	.01	15KV	P.U.R.
.001	600	.22	.015	600	.39
.001	1200	.28	.015	2500	.95
.001	2500	.48	.0125	6000	P.U.R.
.001	8000	4.95	.02	600	.22
.0015	600	.22	.02	600	.55
.0015	5000	2.25	.02	1200	.79
.0015	20KV	P.U.R.	.02	2000	1.25
.001	6000	P.U.R.	.03	600	.60
.002	600	.24	.04	600	.89
.002	1200	.39			

MICA CONDENSERS

5, 6, 8, 10, 15, 25, 30, 34, 39, 50, 70, 75, 100, 140, 150, 185, 200, 230, 240, 250, 300, 350, 390, 400, 470, 500, 510, 600, 650, 700, 750, 1000, 1200, 1250, 1400, 1500, 2000, 2200, 2400, 3000, 3300, 3700, 3900, 4000, 4700, 5000, 5100, 6000, 6200, 6500, 7900, 7950, 7960, 8000, 9100 & 10,000 MMfd.

PRICE SCHEDULE

5 to 750 mmfd 4c
1000 to 1500 mmfd 6c
2000 to 5100 mmfd 10c
9100 to 10000 mmfd 26c

Special Mica Kit—100 @ $3.50

SILVER MICA CONDENSERS

7, 24, 25, 33, 50, 60, 75, 95, 100, 120, 150, 170, 200, 270, 300, 330, 390, 400, 450, 500, 750, 800, 1000, 1400, 1450, 1700, & 2500 mmfd

7 to 95 mmfd 8c
1000 to 1700 mmfd 14c
100 to 800 mmfd 9c
2500 mmfd 16c

Special S. Mica Kit—100 @ $6.50

TYPE "AB" POTS $.89

OHMS	Shaft	OHMS	Shaft
50	1/8 S	20000	1 1/4 & 1/8 LS
60	1/8 LS	25000	3/8 & 1/8 S
150	1/4 S	3000	1/8 S
300	3/8 S	40000	1/8 LS
500	3/8 & 1/8 S	50000	1/4 & 1/8 S
1000	1/8 S	50000	1/8 LS
1500	1/4 S	100000	1/2"
2000	1/8 LS & 3/8 S	150000	2 1/8
2500	1/8 S	200000	1/8 LS
3000	1/8 LS	250000	1/8 LS, 9/16
6000	1/4	300000	1/8 S & 1/8 S (2 terms.)
5000	1/8 LS & 3/8	5 Meg.	1/8 LS
10000	3/8 & 1 1/7	1 Meg.	1/8 S & 1/8 LS
10000	5/16		
15000	1/8 S		

10 mfd.—600 V .... $.98
Three term, bot. mtg. channel, type. Dims. 3¾" x 2½" x 2". Two 5 mfd. sections rated 400 V at 72 deg "C". 1800 V test. Meets commercial specs. for 600 V operation up to 40 degs "C". Ideal for filter or power factor application. Repeat sales prove this rugged high quality condenser to be of outstanding value. Carton of 24, weight 42 lbs. Large qua. available **$.89**

DIESEL GEN.

25 KW 3 phase 60 cy. Hill diesel, G.E. gen. Complete with control panel & starting batteries. Ready for immediate operation. Guaranteed. P.U.R.

— TRANSTAT —

115 V. 1 phase, 100 amps., Kva. 115, Range 0-115 V. Amertran #29145. Specially priced.

HI-VOLTAGE

Mfd	Volts	Price
.012	25KV	$22.50
.02	20KV	17.50
2x.025	50KV	55.00
.25	50KV	85.00
1	16KV	49.50
1	t 20KV	69.50
1	25KV	89.50

CHANNEL CONDS.

Mfd	Wvdc	Price	Mfd	Wvdc	Price
.025	600	$.19	.4	600	.30
.05	1000*	.22	.5	400*	.21
2x.05	600	.30	.5	500*	.33
.1	500	.28	.5	600	.49
.1	600	.32	2x.5	600	.59
.1	2500	1.25	.5-.1	600	.39
2x.1	400	.34	1	400	.50
2x.1	600	.40	1	500	.58
3x.1	400	.40	1	500*	.58
3x.1	1000	.52	1	600	.63
.25	400V	.34			
.25	600V	.39			
2x.25	600	.48			

* Top Terms.

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Aircraft type-20A2 @ 4VDC-10A @ 125 VAC-C-H

CH#	Govt. Spec.	Circuit
8201K4	B-5A	SPST On-Off
8211 K5	B-6B	SPST Off-Mom. On
8208K4	B-7A	SPST On-Off-Mom. On
8210K5	B-1B	SPST On-On
8200K8	AN3022-1B	SPDT On-Off-On

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CH#	Circuit	Cur. @ 125vac	Price
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8905K-514	SP84Pos	35A @ 24VDC On-Off-Mom. On-Mom. On	.79 L.T.
8905K-526	SPST	5A B-5A-1¼" Bat.	.32 L.T.
8905K-722	3PST	10A Off-Mom. On.	79 L.T.
8911K-524	DPST	15A Push But.-Off-Mom. On	.59 P.T.
8202K-7	SPST	10A 2 Gang B-5A	.32 L.T.

10% Dis. in quas. of 100 or more per Type.

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CH#	Circuit	Price	AH & H	Circuit	Price
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8824K4	DPDT	.75	6A, 125V	DPDT	.50

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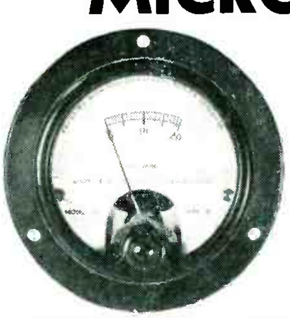

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c. 8TJ13-LDZ—inserts 4⅛"—arm length 8⅛"

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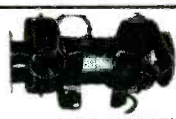

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CK537AX	3.15
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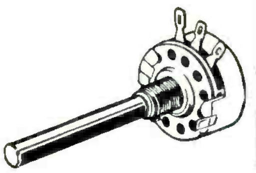

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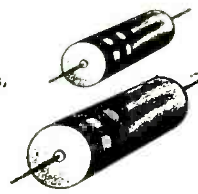

Type	Watt.	Tol.	100 to 499	500 to 999	1000 and over
EB	½	5%	.08	.075	.07
		10%	.04	.037	.035
GB	1	5%	.14	.12	.11
		10%	.07	.06	.055
HB	2	5%	.18	.16	.16
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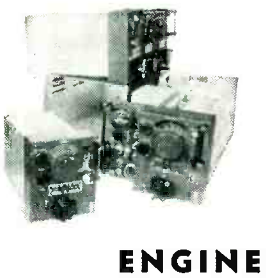

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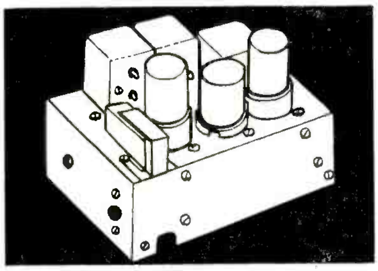

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APRIL, 1953

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BENDIX MK1 J942R460 Set at 28V	9.50
LELAND TYPE A Set at 80V	7.50
BENDIX STYLE A Type 1001 Mod4 Set at 115V	8.50
ECLIPSE STYLE B Type 1339 Mod4 Set at 115V	9.50

We have in stock over 10,000 Motors of all types and descriptions. Also a full line of selsyns, inverters or motor generators. Let us quote on your requirements.

Prices subject to change without notice. TERMS: Rated firms net 10 days, non-rated 25% with order balance COD. Prices FOB Boston. Minimum order $10.00.

ELECTRO Sales Company Inc. ESCO

50 EASTERN AVE., BOSTON 13, MASS. CAPITOL 7-3456

Standard Brands **Electronics, INCORPORATED** *All Items Fully Guaranteed*

We Own and Have In Stock All Items Listed Below.

Note: This is only a partial listing of our vast inventory of electronic components.

TUBES

OA4-G	1.30
OB3/VR-90	.99
O1A/VT-30	.60
1A3	.80
1A5-GT/G	.81
1A7-GT/G	.99
1B22	4.25
1B23	9.50
1B24	14.95
1B26	3.75
1B27	17.50
1B32/GL-532	3.90
1B35	9.00
1C5-GT	.90
1C6	.69
1C21	2.20
1E1	.99
1H4-G	.79
1H5-GT	.68
1J6-GT	.77
1LC6	1.10
1LH4	.89
1LN5	.64
1N5-GT	.64
1P23	4.75
1P28	12.50
1P40	1.85
1P42	5.60
1S5	.60
2AP1	8.95
2AP1-A	10.25
2AP5	9.90
2B22	3.95
2C22	1.50
2C26	.89
2C34	.89
2C39	29.50
2C40	14.95
2C44	2.10
2C46	21.00
2D21	1.65
2E22	2.20
2E30	2.25
2J22	12.50
2J26	22.50
2J27	22.50
2J31	42.50
2J32	31.00
2J34	42.50
2J37	14.50
2J50	67.50
2J54	97.50
2J54-B	147.50
2J61	63.00

2J62	63.00
2K22	68.00
2K23	68.00
2K25	33.50
2K28	37.50
2K29	30.00
2K33	299.00
2K33-A	310.00
2K34	190.00
2K36	398.00
2K43	125.00
2K44	125.00
2V3-G	2.10
2X2	.84
2X2A	1.90
3A4	.73
3B7	.61
3B22	2.95
3B23	5.00
3B24	5.25
3B25	6.25
3B26	5.90
3BP1	5.90
3C21/CEQ	6.50
3C22	90.00
3C23	9.90
3C24	1.75
3C21/CIB	3.95
3C37	32.50
3C45	17.50
3CP1	2.50
3D6/1299	.62
3D21-A	5.50
3DP1	5.00
3DP1-S2	7.50
3E29	11.90
3EP1	4.85
3FP7	4.50
3FP7-A	22.50
3GP1	4.50
3J30	99.50
3JP1	17.50
3Q4	.49
3Q5	.84
SN-4	4.10
4A1	1.25
4B22	6.25
4B25/EL6CF	8.50
4C35	27.50
4D32	26.50
4E27	17.50
4J32	250.00
4J36	250.00
4J37	250.00
4J63/QK-72	320.00

5AP1	6.00
EL5BHD/4B23	11.50
5BP1	5.90
5BP4	5.90
5CP1	5.90
5D21	22.50
5FP7	4.90
5GP1	5.75
GL-5J29	17.50
5J30	47.50
5JP2	32.50
5LP1	22.50
5LP5	47.50
5R4-GY	1.25
5T4	1.60
5U4-G	.75
5UP1	17.50
5W4-GT	.75
BY3-GT	.49
5Y4-G	.59
5Z3	.65
6A3	1.23
6AB5	.99
6AB7	.95
6AC7	.91
6AD7-G	1.40
6AF6-G	.75
6AG5	.87
6AG7	1.10
6AJ6	2.20
6AJ7	2.10
6AN5	3.50
6AQ5	.52
6AR5	.74
6AR6	2.70
6B4-G	1.25
6B8	.95
6BQ6-GT	1.25
6BQ7	1.70
C6J/5C21	14.50
6C4	.65
6C5	.90
6C6	1.05
6C8-G	1.50
6C21	49.00
6C24	57.50
6D6	1.05
6F4	4.90
6F6	.80
6F8-G	1.25
6G6-G	1.25
6G12/7H12	.98
6H6	.71
6J4	6.00

6J5	.65
6J6	.72
6J7	.83
6K4-A	4.75
6K6-GT	.60
6K7-G	.72
6K8	1.10
6L6-GA	1.20
6L6	1.60
6L7	.98
6Q7	.75
6R7	.98
6S4	.63
6SA7	.65
6SC7	.89
6SG7	.75
6SH7	.75
6SJ7	.75
6SK7	.85
6SL7-GT	.82
6SN7-GT	.99
6SN7-GTW	5.50
6SQ7-GT	.65
6SU7-GT/Y	2.75
6U6-GT	.90
6V6	1.55
6V6-GT	.75
6W6-GT	.85
6X4	.51
6X5-GT/G	.51
6Y6-G	.99
7BP7	8.50
7C4	.75
7C23	80.00
7E6	.75
7G7	.99
7H7	.89
7H12	.98
7JP4	21.50
7L7	1.05
7N7	.90
7Y4	.75
10/VT-25	.99
10T1	.75
12A	.85
12A6	.65
12A6-GT	.88

40 KILOWATT TRANSFORMER AND CHOKE KIT FOR THE PRESS WIRELESS PW-40. NEW

12AH7	1.15
12AU7	.75
12AY7	2.25
12C8	.82
12GP7	17.50
12J5-GT	.49
12J7-GT	.91
12K8	.82
12K8-Y	.89
12L8-GT	2.10
12SA7	.70
12SC7	.90
12SF7	.75
12SG7	.82
12SH7	.99
12SJ7	.65
12SK7	.73
12SN7-GT	.85
12SQ7-GT	.65
12SR7	.96
14H7	.91
14J7	1.02
15E	2.75
15R	1.20
FG-17	6.25
19BG6-G	1.90
TUF-20	5.50
D-21	5.25
RX-21	8.50
22	1.25
23D4	1.25
25L6-GT	.69
25-T	8.50
26	.65
FG-27A	17.50
28D7	1.85
33/VT-33	.90
35T	7.50
35T-G	8.00
36	.90
38	.90
39/44	.35
41	.75
42	.75
53-A	5.95
VR-54	1.25
55-1	.99

58	.75
RK-59	1.20
RK-60/1641	2.50
QK-60	100.00
QK-61	100.00
VR-65	1.75
HY-69	3.25
71-A	.85
CEQ-72	.95
RKR-72	1.20
QK-72/4J63	320.00
RKR-73	1.50
B-74	49.50
75-T	13.50
76	.60
77	.80
CTL-77	.75
FG-81A	9.25
82	.89
CRC-83	1.10
83-V	1.05
89	.75
VR-91	1.25
VR-92	1.25
C-100-E	17.50
100-TH	11.50
HF-100	12.50
FG-104	34.50
FG-105	37.50
VU-111	1.25
X-111	675.00
111-A	2.50
111-H	2.50
HY-114B	.89
117N7-GT	1.90
C-120	12.50
121-A	8.75
VR-150/OD3	1.10
211-JAN/VT4C	1.50
212-E	42.50
RX-215	9.25
227	4.50
RX-233A	4.90
233-A	3.75
249-B	8.25
249-C	9.50

250-R	19.25
250-TH	27.50
257-B/4E27	15.75
267-B	5.25
271-A	7.50
274-B	3.25
300-B	12.50
304-TH	13.75
304-TL	14.00
310-A	6.10
311-A	7.50
313-C	3.50
316	1.75
316-A	2.50
327-A	6.25
332-A	45.00
338-A	7.50
350-A	7.50
350-B	5.95
355-A	22.50
CK-359A	7.90
368-AS	8.25
371-B	1.25
388-A	4.25
393-A	13.50
394-A	6.00
FP-400	17.50
410-R	390.00
417-A	22.50
GL-434A	21.00
446	2.90
446-A	4.50
446-B	15.00
464	17.50
GL-471A	12.50
CK-501-LX	1.50
GL-502	1.85
527	15.00
559	3.10
GL-562	92.50
575-A	19.50
HY-615/VT-235	.60
616	35.00
635	11.50
651	75.00
ZP-653	225.00
WL-672	25.00
700-A	37.50
700-D	37.50
702-A	3.10
703-A	5.75
704-A	1.25
705-A	1.95
706-AY	57.50

706-B	57.50
706-BY	57.50
706-CY	57.50
706-GY	57.50
706-EX	57.50
707-A	9.90
707-B	17.50
707-BY	45.00
708-A	4.75
709-A	3.70
713-A	1.25
714-AY	12.50
715-A	5.90
715-B	8.25
715-C	36.00
717-A	1.10
719-A	27.50
721A	4.50
723A/B	27.50
724-A	4.25
724-B	2.90
725-A	9.25
726-A	13.50
726-B	54.00
726-C	105.00
728-EY	250.00
801-A/VT-62	.90
803	4.75
805	4.75
807	1.50
808	7.50
809	3.50
810	12.50
811	2.75
812	3.25
813	11.90
814	3.50
815	2.50
816	1.50
822	19.50
826	1.60
SD-828A	6.00
828	12.50
829	10.50
829-B	13.50
830-B	3.10
832	7.50
832-A	9.75
833	37.50
833-A	47.00
836	4.75
837	1.50
838	2.50
841	1.32
843	.60

849	75.00
851	109.95
860	6.75
CG-861	36.50
864/VT-24	.89
865	3.00
866-A	1.60
869-BX	57.50
872-A	3.90
874	1.60
CRC-876	1.50
884	1.90
885	1.50
886	2.75
902	9.00
902-PI	10.50
SD-917	2.75
918	2.80
921	2.05
925	1.80
927	2.30
930	1.75
931	5.50
931-A	6.10
954	.49
955	.41
956	.49
957	.49
958-A	.75
959	3.50
991/NE-48	.55
CK-1006	3.50
CK-1089	2.75
CK-1090	3.25
R-1130	16.00
R-1130B	17.50
1201	1.25
1201-A	1.50
1203-A	.84
1232/7G7	.99
1273	.90
1294	.90
1299	.65
1299-A	.95
1603	5.75
1612	2.25
1613	1.08
1616	2.25
1619	.49
1624	3.40
1625	.49
1626	.49
1629	.51
1630	1.25

1631	2.59
1632	.99
1633	1.00
1634	.75
1636	3.05
1638	.49
1641/RK-60	1.50
1644	2.75
1655	3.50
1656	12.50
1960	4.50
2050/B2A	1.70
2051	1.25
5558	14.00
CK-5608	5.95
5640-A	12.50
5651	3.30
5672	3.50
5693	6.40
6050	3.65
7193	.71
8000	15.25
8005	7.50
8011	1.65
8012	2.90
8013	2.75
8013-A	5.90
8020	1.90
8025	5.25
9002	1.20
9003	1.75
9004	.57
9005	3.75
9006	.48
38222/3B23	4.90
CK-38233/2C21	.75
D-79512	7.50
VT-24/864	1.50
VT-25/10	1.50
VT-25A/10 Special	1.90
VT-25C	1.90
VT-33/33	.60
VT-49/39-44	.59
VT-52/45 Special	.59
VT-60/850	7.50
VT-62/801	1.25
VT-94/6J5	.60
VT-127A	2.75
VT-137/1626	.49
VT-95/1005	.75
VT-198A/6G6G	1.25
VT-225/307-A	4.90

• *FOR A PARTIAL LISTING OF OTHER EQUIPMENT SEE OUR AD IN THE MARCH ISSUE OF ELECTRONICS (p. 553)* •

Write - Phone - Telegraph

Electronics, INCORPORATED

92 Broad Street, Babson Park 57, Mass.
Wellesley 5-5210-1

TRANSFORMERS

All 115 V 60 Cyc Input TV & CR Pwr Xmfr up to 20" Tubes. Hi VOLTS to 20 KV (w/quadrupler ckt.) ALL Tubes. PL & FIL wndgs; 300 VDC/275Ma Full-Wave, 6.4V/10.3A, 5.4V/8A, 2.5V/3A Hypersil Core. Oil Impreg. $6.49: Two for $12.49
2500V for CRT, 6.3V/.6A, 2.5V/1.75A CSD Kenyon Hvins, 4/BC412, Replmnt $7.98
1000VCT/45MA, 795VCT/80MA, 360VCT/55MA, 3X5V/3A, 6.3VCT/1A, 6.3VCT/1A, 6.3VCT/.3A CSD HVINS CAN BE USED 2X RATING RAYTHEON HIPERSIL CORE $4.98
950VCT/100MA, 5V/2.5A, 5V/5A, 45V/1A, 10V/1.5A WESTERN ELECT $5.49
900V/35MA, 2X2.5V/2A, XCLENT 1800V DBLER TWO 2X2 FIL WNDGS $3.49
900V/3MA, 6.3V/2A, 2.5V/3A $2.98
840VCT/110MA, & 530VCT/21MA, 2X5V/3A, 6.3VCT/1A, 6.3VCT/3A $4.98
780VCT/250MA, 5V/6A, 12.6V/5.5A $7.95
770VCT/200MA, 5V/6A, 12.6V/5.5A $6.95
770V/2.5MA, 2.5V/3A HVINS HMSLD includes FILTER PARTS 4-scope $3.69
760VCT/120MA, 2.5VCT/10A, 6.3VCT/2A, 5V/3A, 10V/3.25A $6.98
720V/85MA, 5V/3.5A, 6.3V/3.5A $2.98
700VCT/120MA, 2X6.3V/3A, 6.3V/1A Price .... $3.98: Two for $7.25
500VCT/60MA, 6.3V/4A HSLD $2.98
480VCT/80MA, 6.3VCT/4A, 5V/3A $2.69

FILTER CHOKES

Dual 30 Hy/60ma Csd 5.98
15Hy/40ma AC/DC sets, 3 for .... .98
12 Hy/80ma/3KVins 2.25
10Hy/75ma 1.25
10Hy/125ma/UTC/Csd/H'Sld/1KVins 1.69
50Hy/125ma/Csd/H'Sld 2.89
12Hy/300ma/5KVins 4.95
20Hy/300ma or 15Hy/400ma/12KVins Kenyon 8.95
13.5Hy/1Amp/17KVins, Raytheon 39.95
Dual 2Hy/300ma USN. $1.25; 2 for 1.98
6Hy 175ma 250 Ohm .... $1.49: 2 for 2.49
10Hy 100ma Freed 1.49

400 CYCLE XFMRS

WE KS9608 1233vct/350Ma, 1140vct/70Ma $4.98
G-E M7472443P1 788V/200Ma, 210V/15Ma, 5V/2A 3.95
G-E M7472469 6.3V/7A, 6.7V/.9A, 6.3V/.3A 3.98
WE KS9604 6.3V/4.65A, 6.3V/3A 2.98
WE KS9603 6.3V/3A, 5V/2A 2.49
LANGEVIN 702556 6.3V/6A 1.49
FREED 11686 5V/10A 3.98
WE KS9602 5V/4A 1.98
FREED 11685 2.5vct/10A CSD 3.98
LANGEVIN 702720 5V/6A, 13 KVINS 4.98
WED164533 6.3V/1.25A, 6.3V/1.25A 1.98
Write for Quantity Price

SCREW DRIVER SET

6 Screw Drivers. Assorted 12" & smaller, including Philips type. Hammer proof, unbreakable plastic (Amber) handles. Hardened & tempered tool steel. $1.10
8-piece set as above $1.25
Write for Quantity Prices

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2.5V/2A @ 79c, 2 for $1.49, 10 for $6.49
2.5VCT/10A 5KVINS 3.59
2.5VCT/20A/12KV INSUL CSD HSLD 7.98
5VCT/10A, 4KV INSUL CSD HSLD 5.95
5VCT/10A/12KV INSUL C.E. 8.25
5V/60AMP CSD KENYON HVINS 13.98
5V/115A CSD KENYON HVINS 16.95
7.5VCT/12A CSD KENYON 15 KVINS 10.98
12.6VCT/1.25A CSD HMSLD 1.98
24V/1.25A CSD @ $1.98 Two for 3.49
2X12V/2A or 24V/2A @ $3.89 Two for 6.98
42.5V/2A SEL RECT TRANS 4.85

AUDIO COMPONENTS

Western Electric Push-Pull Pentode Output Transformer 197A. 10 Watts for 6V6's or 6AQ5's. Excellent Freq Response, Flat 30 to 15,000 Cycles. Secondary 600 Ohm.
"TAB" Special $4.49; .... 2 for $7.98
With UTC Varimatch $5.49
UTC Varimatch 600 Ohm to VC's $1.98
XFMR HMT-SLD UTC Super Electric 3 Wdg. 600 Ohm Ct & 400 Tapped 250 & 150 Ohm. Can be Used Mike to Grid, Line to Line & Line to Grid .... **49c; 10 for $4.49; 100 for $25.00**

SHARPENING STONE

INDISPENSABLE for Lab or Workshop. Finest Silicon Carbide No. 124 Carborundum Co. Unsurpassed for Precision Grinding of Crystals Knives, Fine Tools—6" x ¾" .... **45c; 3 for $1.00**

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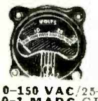


0-5 MA DC Tuning; Aircraft Mfg. "AN" Type $1.29
0-30 VDC "AN" .... **1.98; 4 for $7.**
0-60 ADC "AN" .... **3.25; 3 for $9.00**
0-15 VAC 2½ Rnd 800cy 1.29
0-150 VAC/Wsthgs/2½ Rnd 3.49
0-150 VAC/25-125cy/3½" Sq/RA35/Wstgh 5.58
0-1 MADC GE 3½" Rnd Bklt Csd 5.39
0-1 MADC Wstghs 3½" Sq RA35 .... 6.49
0-50 Microamps Weston 301 3½" Sq 13.98
0-500 MADC/2½" Rnd/221T/Triplett 4.98
VU-20 +3 Weston 301 3" Sq L.P. $41 .... 14.98
0-120 MA RF 3½" Rnd Weston 301 .... 14.98

AUDIO COMPONENTS

GE RPX041 Phono Cart $4.49
GE RPX050 Triple Play Cart 5.69
Electrovoice Triple Play 2.69
Pickup Arm & Xtal Hi-Output 2.39
PM 12" Hi-Fi **British Speaker** 4.98
PM 12" GE S1201D **Speaker** 19.00
Pm 8" **Blue 8T18-1 Permflux** 13.00
PM 5" **Speaker** Gud Tone 1.98
PM 10" Hi-Fi Woofer & Separate horn Tweeter. 10 watt 40-20KC 19.98
Crystal Mike & Cable 3.98
Crystal mike cartridge (Lapel type) 2.98
Crystal mike Cart. ceramic wetpruf 3.98

AUDIO AMPLIFIERS READY TO GO

Model 305MP 5 Watt Ampl. Features Mike & Phono Inpts. W/Sep. Gain Cntrls. Latest Compensated Tone Cntrl Design W/Tubes $14.98
Model 200MO Mike OSC. Broadcasts Through Your Radio with No Direct Connection. W/Tubes. **"TAB" SPECIAL** $6.98
Model 100PO Phono OSC. Phonograph Broadcasts Through Your Radio. No Direct Hookup W/Tube. **"TAB" SPECIAL** $4.98
Model 302PA 3 Tube Phono Ampl. Ideal for Custom Building Your Phonograph. W/Tubes. **"TAB" SPECIAL** $4.98
10 Watt Hi-Fi Triode Push-Pull Amplifier. Rebuilt "Muzak". Complete with Inbilt Stage for GE Pickup $26.95
Same Amplifier for 110VDC $26.95
Philmore 20-30000 cy Hi-Fi 20 Watt Kit. Complete & Ready to Build. Incld Pre Amp & Tubes. W/Alter-Pierless Output $51.00
"Techmaster" TM-15A 15 Watt Hi-Fi "Williamson Kit." **"TAB" SPECIAL** $48.95
"Techmaster" TM-15P Pre Amp Kit $19.55
Meissner Hi-Fi Radio FM/AM & Phono. Complete All Built System. Incld 10 Watt Hi-Fi Amp. 7 Tube AM/FM Tuner. 12" Hi-F Electrovoice Tweeter Woofer 12B Speaker & 3 Speed Webster Changer. Special Prepaid $199.95

"TAB" THAT'S A BUY

TELEVISION ANTENNAS

Conical antenna, sturdy prefab const. Versatile 72, 150 or 300 ohm match. 8 elements & 100 ft twinex cross bar & hardware $5.98
Double Vee all channel antenna. Hvy duty aluminum construction. Inclds mounting clamp & 100 ft of twinex $4.50
Window Antenna 4 element conical, all channel, sturdy construction. Easy to mount $3.95
5 Foot interlocking mast sections, hvy duty; rustproof. Each .... **95c; 2 for $1.59**
300 Ohm Twinex .... 100 ft $1.49; 1000 ft $12.49
RG59U TV Cable .... 100 ft $5.00; 500 ft $22.

MICROWAVE

Klystron Mtg Assy (723AB) & Coupling to 2 Type "N" Co-Ax Fittings. As Shown .... $9.98; 2 for $18.00
1 Microsecond Delay Line .... $2.95; 4 for $10.00
Microwave Lighthouse Assy P/O RT39 APG5 & 15, osc and Tr Cavities. Tunes 24-2700 MC. **SPECIAL** .... **$20.00; 2 for $36.00**
Watt Meter Low Power, Used with Bolometer Bridge Measures Low Level Microwave Power. Balanced Barretter Bridge Direct Reading. Self Calibrating Range, 50 Microwatts to 10 Milliwatts. **SPECIAL** $119.00
X Band Adaptor UG39 to UG40 Choke to Plane Flange Sperry Lab Dsgn .... **$1.69; 4 for $6.00**
X Band Straight Wave Guide Per/Ft .... $2.
X Band Plumbing, 45° Bend, Choke to Straight Flange 32¼" Including Flanges $7.49
X Band Straight Plumbing, Choke to Straight Flange 23" Including Flanges $5.49
AN/APS10 Modulator Assembly. New. Mfgrd **G. E.** Design #ML-780 3911-G1. Includes 2J42 & Magnet, 3C45 & (2) 3B24. All New. **SPECIAL** $225.00

PULSE TRANSFORMERS

PULSE-XFMR 1000 Pulse Per Sec. 5 Watt, TR1025 P/O LU-3 Test Equipment $7.98
7.5 KV Pulse, Pri 4 KV, 50-1000 ohm imped. Permalloy Core. W Eco $12.00
Pulse Blocking Osc. 3 wndgs, 1:1:1 ratio 1 mh wndgs GE H'Sld, HiVins $2.98
PULSE SHAPING Xfmr Raytheon UX12819. 1 MU Sec. 2000 CY $5.00
UTAH 9340 P/O CP-5A/APS15 .... $5.00
Pulse Transformers to "JAN" MLT27 Specs Pt 1, 2, 3, 4, 5, 6 each $8.75

OIL CAPACITORS

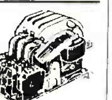
Mfd	Each
50wvdc	
4	$0.40
150wvdc	
1-1-3-5	.98
250wvdc	
2x.25	.19
300wvdc	
1.2	.29
400wvdc	
.1	.39
.5	.45
1	.69
4	.98
6	1.08
10	1.39
2x.1	.75
2x.5	.94
3x.1	.91
3x.25	.99
600wvdc	
.034	.30
.1	.35
.25	.39
.5	.42
1	.52
2	.65
4	1.60
5	2.25
6	2.59
7	2.89
10	3.10
2x.1	.59
2x.25	.78
2x.5	.89
2x1	1.05
2x2	1.25
2x8	3.25
3x.05	.75
3x.22	.85
3x.25	.98
700wvdc	
4	1.50
800wvdc	
.1	.69

Mfd	Each
1000wvdc	
.45	.59
1	.79
2	.85
5	2.98
15	4.98
1400wvdc	
.25	1.29
.5	1.39
1500wvdc	
.5	1.49
.75	1.69
1	1.79
5	3.49
6	3.98
2000wvdc	
.1	1.49
2x.1	1.69
1	1.75
2	3.98
3	3.69
8	9.49
2500wvdc	
.25	2.29
3000wvdc	
.1	2.49
2	4.45
4	7.89
4000wvdc	
2	8.98
5000wvdc	
.2	4.49
4	19.98
6000wvdc	
1	7.49
7000wvdc	
.002	1.69
.0075	1.98
.1	4.98
7500wvdc	
.03	2.98
.05	3.49
10000wvdc	
.03	3.49

Mfd	Each
12000wvdc	
.02	4.98
12500wvdc	
2	95.00
15000wvdc	
.0018	9.98
25000wvdc	
.00025	7.49
1	95.00
AC RATED	
220vac/600dc	
2	.69
4	.89
5	1.29
225vac/630dc	
3.3	.79
230vac 630dc	
5	1.29
330vac 1000dc	
1.25	.63
1.5	.70
1.75	.98
2	.33
2.5	.90
2.8	.95
3	1.00
4	1.29
15	3.98
25	6.49
405vac/1200dc	
.15	1.29
600vac/1800dc	
16	6.98
660vac/2000dc	
6	4.98
10	6.98
16	7.98

2MFD/330VAC/1000WVDC "CD" RND CAN **3 for $1.00; 10 for $3.00; 100 for $25**

CONTACTOR

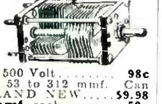


G. E. CR2811C22AQ. Heavy Duty Electric Starter, Transmitter or Motor Starter Switch. For Single or 2 or 3 Phase Appl. Rated 1 Phase 3HP/110V, 7½ HP/220V 10 HP/600V. Rated 2 or 3 Phase 7½ HP/110V, 15HP/220V, 25HP/600V. Control Inpt. 220V/1PH/60-Cy. Contacts rated 45 Amp Enclosed. 50 Amp Open. **SPECIAL** .... **$19.00; 2 for $36.00**

★ TEST EQUIPMENT ★

MODEL 102 Pocket multimeter features; AC & DC 10 rngs to 3000V. AC current 3 rngs to 600 MA. DC current 4 rngs to 1.2 amp, ohms 2 rngs to 1 megohm. Compact, accurate & durable construction. Std. Mfgr. **"TAB"** GTD display Model. **SPECIAL** Post Paid $13.98
MODEL 106 Vacuum tube volt meter, features include: AC & DC 10 ranges to 1000V, ohms 5 ranges to 1000 megohms. 5 DB ranges. AC Range freq. response 25 to 100,000 cycles. Designed for field alignment of TV & Radio sets. Std mfgr. **"TAB"** GTD display model. **SPECIAL** Post Paid $33.49
MODEL 106 VTVM in kit form **SPECIAL** Post Paid $22.98
MODEL HVP 30KV volt probe for Model 106 Display model **"TAB"** GTD. P. P. $8.25

VARIABLE CONDENSERS



BUD Dual 75mf ea. Sect 1000V Gap. HF. **1.10**
JOHNSON 70H30 70mmf/3kv Gap **1.29**
Cardwell Neut ZT/12mmf 500 Volt **98c**
CARDWELL TK-300-US 53 to 312 mmf. Can be made Split Stator. BRAND NEW **$9.98**
Vernier Drive 10 to 365mmf, each **59c**
Midget 3 to 15 mmf, Midline, each **29c**
2½ Meter Butterfly Cndsr 30mmf w/RF Tank & Choke .... **59c; 2 for 98c**

TAB "SUN-FLASH" LAMPS

"Tab" No.	Replaces	W/Sec. Max.	Each
U5W	GE FT105	100	$5.98
U10	GE FT114	100	7.25
No. 1	AMGLO 5804X	100	10.98
23ST	GE FT 210	200	9.98
53GT	GE FT 403	500	13.50
VA	SYLV. 4330	200	9.98
23MT	FT 214	250	9.98
22ST	FT 110	200	9.98
V4X4	X400	200	10.98
DX	SPRGFA100	150	9.00

PHOTOFLASH CAPACITORS

100MFD 500WVDC $1.98
200MFD 450WVDC 2.89
300MFD 450WVDC 4.39
15MFD/330VAC/1500VDC Intermittent 3.98
25MFD/330VAC/1500VDC Intermittent 6.49
16MFD/600VAC/2800VDC Intermittent 6.95
16MFD/660VAC/3000VDC Intermittent 7.95
32MFD/1.2KVDC/23W Sec 7.49
27MFD/1.2KVDC/2KV Int. 54W. Sec 8.95

HIV PHOTOFLASH KIT

Includes V4X4 Flash Lamp Rated 200 Watt Seconds, Flash Lamp Holder & 8" Reflector & Cable. 115V/60Cy Inpt Power Transformer & 50 Watt Sec Multi Section Capacitor Bank. All Resistors, Capacitors, Rectifiers & Sockets. **SPECIAL $24.98**

LABSTROBE MODEL 18

Small, light, inexpensive **stroboscope**. 60 flashes per second. Operates from 115V/60Cy **$9.75**

LO-VOLT PHOTOFLASH KIT

Includes DX Flash Lamp Rated 150 Watt Sec. Flash Lamp Holder & 8" Reflector & Cable Power Transformer & **CD** Flash Capacitors, (5) 200 Mfd Each W/Output of 100 Watt Sec. All Resistors, Capacitors, Rectifiers & Sockets. $29.98
Extra Flash Lamp Holders W/8" Reflector & Cord $3.98; W/Lamp DX $12.98

CHROME VANADIUM SPEED DRILLS

29 Drills Chrome Vanadium Speed Steel. Top Quality for Machinists or All Purpose Use 1/16 to 1/2 by 64th's. With "Huot" Drill Index $9.69
Drills 60 Pcs 1 to 60 C.V. W/Index 7.98
Drills 13 Pcs 1/16" to 1/4" C.V. W/Index. 2.69
Drills 12 Pcs 1/16" to 1/2" C.V. 3.49
1/4" Speed Electric Drill with **Jacobs** Worm-gear Chuck & 60 Pcs Drills & Index $22.00
1/2" Speed Electric Drill with **Jacobs** Worm-gear Chuck & 29 Pcs Drills & Index $39.00

TUBE CLAMPS

926B-5, 926B-16, 926B, 929-1, 930-19 926B-19, 926A-10 .... **5 for $1.00**

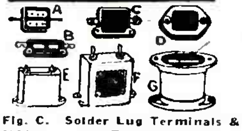
BROKEN KEYS OR CRACKED BASE
"TABS" TUBE SPECIALS
ELECTRICALLY PERFECT & GTD.
1B3GT, 6H6, 6K6GT, 6SN7GT 12SN7GT .... **Each 50c; 5 for $2.00**
6BG6G, 6BQ6GT, 12SG7, 19BG6, 6L6G 6L6GA .... **Each 79c; 3 for $2.00**

★ SOLDERING GUNS & IRONS ★

"WELLER" GUN 115VAC 100 Watt $8.69
"WEN" GUN 115VAC 250 Watt 9.49; **3 for 25.50**
"PRIMAX" GUN 115VAC Korodless Tip. 7.69
PHILIPS "VERSA TOOL" 115VAC 250W Including 4 Tips 10.83

ESICO IRONS 120V AC/DC
55 Watt/3/8 Tip/11½ Lng/.38 Lbs 1.25
60 Watt/¼ Tip/12" Lng/.38 Lbs 1.91
100 Watt/3/8 Tip/12" Lng/.5 Lbs 2.55
130 Watt/⅜ Tip/12" Lng/.75 Lbs 3.17
ESICO INDUSTRIAL CONST. USE IRONS 120VAC/DC
Similar to American Beauty types as shown
61A60/60W/1/8 Tip/7" Lng/2.5 oz 3.20
#38/Am. Beauty 3138/100W/3/8 Tip 5.29
Element #38/Am. Beauty 2138/100W 2.00
#58/Am. Beauty 3158/200W/5/8 Tip 6.30
Element #58/Am. Beauty 3158/200W 2.75
#78/Am. Beauty 3178/300W/7/8 Tip 8.18
Element #78/Am. Beauty 3178/300W 3.65
#98/Am. Beauty 3198/550W/1¼ Tip 10.08
Element #98/Am. Beauty 3198/550W 4.55
Esico Temp Regulating Stand 4.20
WRITE FOR QUANTITY PRICES

MICA CAPACITORS



Brand NEW Made to Rigid Gov't Specs.

Fig. C. Solder Lug Terminals & Mtg Holes

Mfd.	Each	Mfd.	Each
600 WVDC		**600 WVDC**	
.0001	$0.29	.03	1.19
.001	.42	**1200 WVDC**	
.002	.45	.002	.66
.004	.53	.004	.68
.005	.55	.005	.71
.006	.59	.01	.78
.008	.63	**2500 WVDC**	
.01	.66	.00047	.59
.02	.76		

Fig. D. Screw Term & Mtg.

Mfd.	Each	Mfd.	Each
600 WVDC		**1200 WVDC**	
.0001	$0.29	.01	$0.78
.00055	.37	.013	.89
.00085	.42	.03	1.89
.0012	.44	.033	2.39
.003	.49	**2500 Wvdc**	
.005	.54	.0004	.59
.015	.71	.002	1.09
.02	.78	.0022	1.09
.03	1.19	.0024	1.13
.033	1.29	.0035	1.19
.039	1.98	.0036	1.19
.04	2.09	.0043	1.29
.05	2.39	.005	1.45
1200 WVDC		.006	1.55
.001	.61	.01	1.89
.002	.66	.015	2.19
.0051	.71	**3000 WVDC**	
.0068	.75	.005	1.65

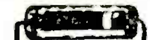
Fig. E. Upright Xmtg Micas

Mfd.	Each	Mfd.	Each
3500 VDC		**3000 VDC**	
.000033	.78	.00005	.78
5000 VDC		.0001	$1.08
.0001	1.79	.0003	1.15
.00015	2.29	.0007	1.19
.0003	2.75	.0055	1.39
.0006	3.59	**3000 VDC**	
.001	3.89	.0055	1.35
.01	4.79	.008	1.79

TYPE G HIGH CURRENT

.01 Mfd	10 KV	30 Amp.	$49.50
.0012 Mfd	20 KV	16 Amp.	35.00
.001 Mfd	30 KV	30 Amp.	60.00
.0025 Mfd	25 KV	22 Amp.	49.00

PRECISION RESISTORS



Over 2½ Million In Stock
"TAB"—Specialists in Precision Resistors
No Mfrs Choice—We Ship Types in Stock

0.116	271	1225	3333	16500	110000
0.42	275	1250	3384	16800	115000
0.425	280	1260	3500	17000	116667
0.607	286	1300	3509	17500	120000
0.7	289	1350	3600	17977	130000
1.03	299	1355	3700	18000	135000
1.3	300	1400	3730	18300	140000
1.75	310	1488	3760	18380	141000
2.5	311.5	1495	3900	18500	145000
3	320	1500	4000	18800	147000
3.83	325	1510	4030	19000	150000
4	330	1518	4200	19500	155000
4.35	340	1600	4220	20000	160000
5	350	1640	4280	20441	165000
5.025	360	1646	4300	20500	166750
6.25	366.6	1650	4314	21000	167000
6.5	370	1670	4440	21500	169200
7	375	1680	4444	22000	175000
7.8	380	1710	4500	22500	180000
7.9	389	1712	4700	22990	180600
8	390	1740	4720	23000	185000
10.38	400	1770	4750	23150	186600
11.25	410	1800	4850	23325	190000
12	414.3	1818	4885	23400	198000
13.52	418.8	1830	4900	23500	200000
14.2	425	1850	5000	24000	201000
14.25	426.9	1865	5100	24600	205000
14.5	427	1892	5710	25000	210000
15	430	1894	5235	25200	215000
16	440	1895	5270	25400	220000
17	450	1896	5300	25833	225000
19	452	1897	5500	26000	229000
19.2	460	1898	5600	26500	230000
20	470	1899	5730	26600	235500
22	475	1900	5770	27000	238000
23	478	1901	5910	27500	240000
24	480	1902	6000	28000	245000
25	487	1903	6100	28430	250000
26	500	1904	6125	28500	265000
28	510	1905	6140	29000	268000
30	520	1906	6200	29500	270000
31.5	525	1907	6300	29990	275000
37	540	1908	6495	30000	294000
48	550	1909	6500	31000	300000
49	560	1910	6800	31500	307500
50	575	1911	6840	32000	311000
51.78	580	1912	6990	33000	314000
55	588	1913	7000	35000	316000
56.7	600	1914	7320	36000	325000
60	612	1915	7500	37000	330000
63	620	1916	7700	38140	333500
68	625	1917	7717	38500	350000
74	633	1918	7900	39000	353500
75	640	1919	7930	39500	375000
80	641	1922	7950	40000	380000
81.4	645	1924	8000	41400	390000
88	649	1926	8094	42000	400000
89.8	650	1960	8200	43000	402000
95	657	1980	8250	45000	420000
100	665	2000	8500	47000	422000
101	670	2045	8700	47500	425000
103.2	673	2080	8770	48000	430000
105	675	2095	9000	48660	450000
105.7	680	2141	9100	49000	458000
107	681	2142	9445	50000	470000
110	684	2145	9500	51000	472000
120	689	2150	9710	52000	478000
121.2	697	2160	9800	55000	500000
125	699	2180	9900	56000	510000
130	700	2187	9902	57065	520000
135	711	2195	10000	58333	521000
147.5	733	2200	10430	60000	525000
150	740	2250	10500	61430	543000
160	750	2300	10600	62000	550000
165	800	2400	10900	64000	560000
170	806	2450	10936	65000	570000
175	820	2463	11000	66600	575000
179	850	2485	11400	66650	600000
180	854	2490	11500	67500	620000
182	899	2500	11690	68000	650000
182.4	900	2525	12000	70000	654000
200	910	2600	12500	72000	660000
209.4	917	2625	12800	73500	680000
210	946	2635	13000	75000	690000
216	978	2700	13100	80000	700000
220	1000	2750	13500	82000	750000
220.4	1030	2850	13550	84000	761300
225	1056	2860	13600	85000	800000
230	1059	2870	14000	85750	813000
235	1067	2900	14250	88000	820000
240	1100	3000	14400	90000	850000
245	1110	3100	14500	91000	860000
245.4	1150	3163	14550	93000	900000
250	1155	3259	14600	93300	910000
260	1162	3290	15000	95000	930000
270	1200	3300	16000	100000	950000

Any Size Above, Each 35c; Ten for $3.29

MEGOHMS

1.	1.579	2.7	4	6.7	10
1.1	1.65	2.75	4.23	7	11.55
1.2	1.75	2.8	4.25	7.5	12
1.25	1.8	2.855	4.5	7.62	12.83
1.3	1.9	3	5	7.74	13
1.35	2	3.3	5.1	8	13.85
1.39	2.11	3.5	5.5	8.02	
1.4	2.2	3.673	6	8.5	51
1.5	2.25	3.75	6.5	9.05	
1.57	2.5	3.9	6.6	9.5	

Any Size Above. Each 70c; Ten for $6.49

ONE YEAR GTD PICTURE TUBES

10BP4 .... $13.98
10BP4A 14.49
12 Inch Glass 17.95
12 Inch Metal 21.98
14 Inch Rectangular 20.95
16 Inch Glass 22.95
16 Inch Metal 23.98
17 Inch Rectangular 23.49
19 Inch Round 27.98
20 Inch Rectangular 29.95
21 Inch Rectangular 30.98
Your old pict. tube is worth money, write for trade-in-allowance toward RMA coded and dated tubes with one year guarantee. Ship your defective picture tubes prepaid only.
When ordering metal tube, defective metal tube is required.

FUSES & HOLDER

3AG: 1/8, 1/4, 1/2 Amp. **5c**; 100 for **3.75**
3AG: 1, 1 1/2, 2, 3, 4, 15, 20 Amp. Each **3c**; 20 for **50c**; 100 for **2.39**
3AG: Slo-Blo; 10, 20 Amp. 20 for **1.00**
4AB: BUSS 10 Amp. **5c**; 100 for **3.98**
4AG: ¼, ½ Amp. **7c**; .... 100 for **5.98**
4AG: 3, 5, 10, 15 Amp. Ea. **5c**; .... 100 for **3.25**
4AG: Slo-Blo; 3, 10, 15, 20 Amp. Ea. **9c**; 100/**7.50**
5AB: BUSS, Littlefuse, 5 Amp. Ea. **3c**; 100/**2.00**
5AG: 35, 80 Amp. Ea. **5c**; .... 100 for **3.98**
7AG: 0.2 Amp. Littelfuse. Ea. **5c**; .... 100 for **3.98**
8AG: 1/32, 2/10, 1/2 Amp. Ea. **8c**; .... 100 for **6.98**
HOLDER 1075 Littelfuse **20c**; .... 10 for **1.75**
DUAL HOLDER 3 or 4 AG 15c; .... **8 for 1.08**

TABOGRAM
WRITE FOR IT
WE STOCK LARGE VARIETY OF COMPONENTS. TELL US YOUR NEEDS
SELL US YOUR TUBES & EQUIPMENT

THAT'S A BUY **"TAB"** THAT'S A BUY

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Money Back Guarantee (Cost of Mdse. Only) $5 Min. Order FOB NYC. Add Shpr. Charges & 25% Dep. Tubes Gtd. via R-Exp. only. Prices Subject to Change Without Notice.

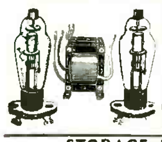
RELAY SPECIAL

SPST Mini Size 115VAC 3A CTS......98c; 3 for $2.75
SPDT Mini Size 115VAC 3A CTS....$1.39; 3 for $3.75
SPDT 24VDC/5A CTS
ALLIED......98c; 6 for $5
SPNO 115VAC/15A CTS S'Dunn..........$2.98
DPDT & SPNO 12VDC/10A CTS.....$2.98; 4 for $10.
DPDT Clare SK5010. Octal Base. 18-28V 2A Contacts, Nitrogen Sld.......$1.49; 4 for $5.00
DPNC & SPNO Clare, Telephone Type. 115VAC Octal Base. **SPECIAL**..........3.95; 2 for $7.

Infrared Snooperscope

Image-Converter Tube HiSensitivity simplified design 2" dia. Willemite screen—Resolution up to 350 line/in. w/data. ea......$4.98; 2 for $9.49
SNOOPERSCOPE PWR SUPPLY
1800VDC/35MA, Using Doubler Crkt. Transformer, Rectifiers, Sockets, Resistors, Capacitors and Diagram **115V/60cy** Oper.......$6.98

866A KIT AND XFORMER



2 Tubes, Sckts, xmf 115v 60cyc Inpt. output, 2.5vct. 10A/Hvinsul. SPECIAL...........$5.49

DIODE PROBE TUBE

Unexcelled for **No-Loss UHF** testing. Ultra sensitive subminiature envelope. New, w/data VR92......**25c; 5 for $1.**

STORAGE BATTERIES

36 Volt WILLARD Mini-BRAND NEW 5 oz Designed Portable Equip. Models..98c; 4 for $3
(4) 36V BATTERIES W/Acid............3.35
2V/20AH Willard PLUS 2V. Vibrator............2.98
2V/20AH Batt. W/Vib & Acid............2.59
6V/6AH Willd NT6/BB214U............2.98
6V/6AH Batt. W/Acid............3.25
6V/40AH Willard............6.98
6V/40AH Batt. W/Acid............9.25
Acid is Shipped in Bottles. R'Exp only

"TAB" THAT'S A BUY

PARTS CABINET

50 Draw Hvy Steel 34¼"H/18"W/9"L/65 lbs Draws 3"W/2⅛"H/8"L...........$40.00
100 Draws as above. 135 lbs...........$65.00
27 Draw Hvy Steel 37"H/30¾"W/14¼"L/120 lbs. Draws 3"H/9"W/12"L...........$39.95
EZC 15 Draws 15¼W/8¾H/6¾D Draws 2¾"W/2"H/6"D & Two moveable Dividers each draw
"TAB" SPECIAL...........**$7.35 or 3 for $20**

CIRCULAR SLIDE RULE

Equiv to 12"—Only 2½" Radius. LAMINATED—Print Stays On! Mult. Div. Sqs. Cubes & Roots, Log. Decimal Equiv. Case and Data..........98c
Parallel Rules. BRUNING 6" wide. **SPECIAL.39c; 3 for $1.00**

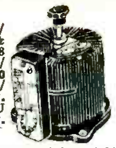
SELSYNS

2J1H1 GE Selsyns...............2 for $6.98
2J1F3 GE Brand New 115V/400cy. ea......9.75
C78248 Sync. Trans. 115/60 cy $39.95; 2 for 75.00
C78249 Sync. Diff. 115/60 cy 12.95...2 for 25.00
Sync Repeater 115/60 cy Type 11-4...2 for 99.00
Bendix Autosyns AY1 & AY5..........2 for 4.95
Bendix AY20 New Orig Crtns..........12.98

DYNAMOTORS

INPT 6VDC. Output 200V/100ma. or 12/24V Output 500V/50ma P' Magnt..........6.95
Inpt 28VDC/1.4A Output 250V/60ma..........3.69
D104 Inpt 12 & 24V. Outpt 225V/100ma 440V/200ma..........$11.98
DA3A 28V/10.5A out 300VDC/260ma 150VDC/10ma, 14.5vdc/5Amp..........6.75
PE94 Plate Supp.. Uses DA3A (SCR522)..........8.98
PE97 Plate Supp., Less Tubes..........9.98

"GR" VARIAC

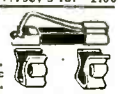


"GR" 200CU/0-130V/1KW/7.5A Reconditioned, Tested & Gtd..........$15.98
General Radio 100R/0-230V/2KW/9A..........$30.00
General Radio 50B/0-270V/7KW/28A..........$110.
Brushes 200CU & 116/116U.......49c; 5 for $2.

RHEOSTATS

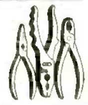
15 ohm 25W w/knob..........1.98; 3 for 5.00
20 ohm 50W Model J..........2.35; 6 for 12.00
60 ohm 50W w/knob..........2.49; 3 for 7.00
100 ohm 50W Model K..........2.25; 3 for 6.00
200 ohm 25W Model D..........1.98; 5 for 9.00
250 ohm 25W..........1.39; 4 for 5.00
300 Ohm 225W Model P..........3.98; 2 for 7.00
350, 500, 5000 ohm Slotted shaft, 25 watt..........79c; 3 for 2.00

CIRCUIT BREAKER FUSES



PUSH TO RESET
Amps 3-5-7-10-15-20 Ea. 27c 4 for $1.; 25 for $5.; 100 for $18.
Circuit Breaker Fuse W/2 Mounting Clips 39c; 3 for....$1.00; 20 for....$5.98; 100 for....$25. Fuse is 3AG Size. Operates up to 24 Volts. Please State Amps (current) desired.
Heinmann Magn Bkrs, Amps: 0.22, 3, 7, 9, 12, 15, 20, 30, 35, 40, 80, 180 **Each $1.69; 10 for $15.98**
Sq. D & CH Toggle Sw Brkrs, Amps; 5, 10, 15, 20, 25 **98c**..........**10 for $8.98**

PLIERS KIT

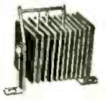


6" Long Nose & Side Cutters. 5.89
Pliers 6" Side Cutters......89
Linesmans 7" Heavy Duty....79
All (3) Pliers Listed Above.. 2.25
"MY BUDDY" 8 PCS Tool Kit. (5) Interchangeable Screw Driver Blades. 3 FT Steel Tape Rule. Combo Pliers. W/Wrap Around Case..........$1.76

FEDERAL RECTIFIER KIT

"FEDERALS"—All Purpose Selenium Rectifier Kit. You can make 24 different Rectifiers ½ Wave/FW/CT/or Bridge. 8 Plates Rated 18V 12Amp each. All Hardware & Lugs & Instructions...$19.59

SELENIUM RECTIFIERS



We specialize in Rectifiers and Power supplies to your specifications. Immediate delivery.

Current Cont.	18/14 Volts	36/28 Volts	54/40 Volts	130/100 Volts
1 Amp	51.35	$2.15	$3.70	$7.50
2 Amp	2.20	3.60	5.40	10.50
4 Amp	4.25	7.95	12.95	25.25
6 Amp	4.75	9.00	13.50	33.00
10 Amp	6.75	12.75	20.00	40.00
12 Amp	8.50	16.25	25.50	45.00
20 Amp	13.25	25.50	39.00	79.50
24 Amp	16.25	32.50	45.00	90.00

Full Wave Rect & Trans. 115V/60cy inputs.
up to 14VDC at 12 amps..........$23.98
up to 28VDC at 12 amps..........31.98
up to 28VDC at 48 amps..........117.00
up to *20VDC at 6 amps..........12.98

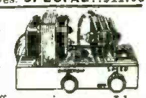
RECTIFIER XFMRS

18.8—19.2—20.4—21.4 Volts/12 Amp....$12.25
31—32—34—36 Volts/12 Amp 2 Kvins....21.98
18—12—9—CT—9—12—18V/4 Amp..........8.75
18—12—9—CT—9—12—18V/12 Amp..........16.75
18V/2A....$1.98; 28—24—20 Volts/4A....4.69

BATTERY CHARGER RECTIFIER

10-0-10 Volts (CT) 120 Amp (Fan Cooled). Replace Your Old inefficient Sulphide Rect. with the New Selenium Types. **SPECIAL**..$11.98

"HO" RAIL PACK



0 to 12VDC/2 AMP Variable DC supply—inpt. 115v/60 cy Usable LAB supply, filament D.C. plating, battery charging, model railroad, includes voltage or speed control and center off reversing sw. Ideal for two "HO" loco's..........$10.95; 2 for $20

TUBES

GUARANTEED "TAB" TESTED

PRICES SUBJECT TO CHANGE

OA2	$0.95
OA3/VR75	1.04
OA4G	1.05
OB2	1.37
OB3/VR90	1.09
OC3/VR105	1.15
OD3/VR150	.90
OY4	2.53
OZ4	.60
C1A/ELC1A	9.75
O1A	.69
VS-1	12.49
1A3	1.10
1A4P	.79
1A5GT	.79
1A6	1.49
1A7GT	.95
1AD4	1.49
1AE4	1.80
ELC1B/3C31	3.45
1B3/8016	.81
1B4P	.89
1B5/25S	.99
1B7GT	.99
1B21/471A	2.85
1B22	2.20
1B23	9.90
1B24	9.45
1B26	2.45
1B27	12.75
1B32/532A	3.90
1B35	9.15
1B37	16.98
1B38	29.95
1B40	4.95
1B41	49.95
1B42	18.00
1B46	1.98
1B53	49.95
1B56	38.50
1B58	175.00
1B60	69.75
1B63	50.00
1B63A	75.00
EL1C	2.70
1C5GT	.89
1C6	.79
1C7G	.89
1D5GP	.99
1D7G	.89
1D8GT	.89
1D21/631P1	3.89
1E5	.99
1E7G	.99
1F4	.69
1F5G	.79
1F6	.89
1F7G	.89
1G4GT	.89
1G5G	.89
1G6GT	.79
1H4G	.89
1H5GT	.72
1H6GT	.79
1J5G	1.20
1J6GT	.79
1L4	.69
1L6	.98
1LA4	1.19
1LA6	.99
1LB4	1.29
1LC5	.79
1LC6	1.39
1LD5	.99
1LE3	.99
1LH4	.89
1LN5	.79
1N5GT	.72
1P5GT	.79
1P42	5.60
1Q5GT	.70
1Q26	69.00
1R4/1294	1.29
1R5	.79
1S4	1.19
1S5	.79
1S21	7.90
1T4	.79
1T5GT	.99
1U4/5910	.73
1U5	.79
1V	.79
1V2	.70
1X2	.95
1Y2	6.98
1Z2	3.98
2A3	1.78
2A4G	1.19
2A5	.69
2A6	.69
2A7	.69
2AC15	4.98
2AS15	4.98
2B22	3.90
2C21/1642	.67
2C22/7193	.33
2C26	.19
2C33/RX233A	3.49
2C34/RK34	.69
2C36	27.00
2C39	21.00
2C39A	29.50
2C40	7.29
2C43	17.75
2C43/464A	9.49
2C44	1.20
2C50	3.69
2C51	5.49
2C52	5.98
2D21	1.26
2E5	1.19
2E22	1.95
2E24	4.69
2E25/HY65	5.15
2E26	2.88
2E30	1.5

2E31	1.49
2E32	1.49
2E36	1.49
2E41	1.54
2E42	1.49
2E43	1.49
2G21	1.49
2J21	8.75
2J21A	8.90
2J22	7.69
2J30	65.00
2J31	27.00
2J31A	79.95
2J32	37.00
2J33	27.00
2J34	27.00
2J36	108.00
2J37	12.70
2J38	11.75
2J39	44.00
2J42	187.00
2J48	24.25
2J49	67.25
2J50	21.25
2J54	249.50
2J55	85.00
2J56	149.00
2J61	49.95
2J62	
2K22	39.45
2K23	39.45
2K25	28.49
2K25/723AB	24.90
2K28	29.00
2K33	259.00
2K34	225.00
2K35	389.95
2K39	130.00
2K41	126.00
2K43	136.00
2K44	130.00
2K45	110.00
2K48	120.00
2K50	459.00
2V3G	.98
2W3GT	.98
2X2	.49
2X2A	1.53
3A4	.99
3A5	.81
3A8GT	1.59
3B4	2.69
3B5	.98
3B7/1291	.69
3B22	2.70
3B23/RK22	4.95
3B24	5.40
3B25	4.50
3B26	3.70
3B28	7.90
3C22	89.00
3C23	9.90
3C31/C1B	3.45
3C33	14.98
3C34/HK24	5.49
3C45	12.89
3D6/1299	.69
3D21A	4.98
3D22	13.95
3D23	4.90
3E29	14.95
3J31	300.00
3K22	275.00
3K23	405.00
3K30	300.00
3Q4	.79
3Q5GT	1.29
3S4	.85
3V4	.79
4-125A	29.00
4-250A	40.00
4-400A	57.50
4-1000A	108.50
4B23	16.98
4B27	4.98
4B28	9.50
4C25/HK54	5.98
4C33	59.00
4C35	22.25
4C36	15.98
4E27/257	14.50
4J22	148.50
4J31	98.00
4J34	194.00
4J42/700	27.00
4J47/720CY	300.00
4J47	485.00
4J52	350.00
4J56	498.00
4X-150A	45.00
4X-500F	85.00
5AX4GT	.54
5AZ4	1.35
C5B/5C30	3.95
EL5BHD	16.98
5C21/C6J	6.95
5C22	42.05
5C30/C5B	3.95
5D21	19.50
5D23/RK65	36.50
5J29	12.40
5J23	59.00
5R4GY	1.55
5R4GYW	1.75
5T4	2.49
5U4G	.69
5V4G	1.10
5W4	.89
5X4G	.79
5Y3GT	.43
5Y4G	.79
5Z3	.99
5Z4	1.49
C6A	6.75

6A3	.90
6A4	1.89
6A5G	2.07
6A6	.80
6A7	.85
6A8GT	.90
6AB4	.79
6AB5/6N5	1.33
6AB7/1853	.98
6AC5GT	1.00
6AC6G	.95
6AC7	.80
6AD7G	1.29
6AG5	.79
6AG7	1.39
6AH5G	1.49
6AH6	1.22
6AJ5	1.40
6AK5	.74
6AK5W	2.98
6AK6	1.05
6AL5	.54
6AL7GT	1.29
6AN5	2.90
6AQ5	.55
6AQ5W	3.98
6AQ6	.81
6AQ7GT	1.29
6AR5	.79
6AR6	2.98
6AS5	.79
6AS6	2.43
6AS6W	3.20
6AS7G	4.65
6AT6	.63
6AU5GT	1.10
6AU6	.59
6AV5GT	1.29
6AV6	.49
6AW6	1.89
6AX4/6U4	.79
6AX5GT	.79
6B4G	1.23
6B5	1.19
6B6G	1.05
6B7	.95
6B8G	.60
6BA6	.63
6BA7	1.27
6BC5	.63
6BC7	1.23
6BD5GT	1.65
6BD6	.83
6BE6	.59
6BF5	.98
6BF6	.65
6BF7	2.55
6BG6G	1.39
6BG7	1.98
6BH6	.63
6BJ6	.69
6BK7	2.15
6BL7GT	1.45
6BN6	1.49
6BN7	1.69
6BQ6GT	1.20
6BQ7	1.65
6BY5G	1.45
EL6C/6C	16.98
6C4	.50
6C5GT	.55
6C6	.57
6C7	1.26
6C8G	.80
6C21	29.45
6CB6	.69
6CD6G	1.69
6D4	2.70
6D6	.89
6D7G	.89
6D8G	.85
6E5	.79
6E7	1.39
6F4	6.20
6F5	.95
6F6	.79
6F6GT	.79
6F7	.85
6F7G	1.29
6F8G	.85
6G6G	.90
6H6	.60
C6J/5C21	6.95
6J4	6.66
6J5GT	.47
6J6	.63
6J7	.72
6J8G	1.19
6K4	5.15
6K4A	6.45
6K5GT	1.09
6K6GT	.59
6K7	.75
6K8GT	1.08
6L5G	.75
6L6	2.09
6L6G	1.35
6L6GA	1.35
6L6GAY	2.29
6L7	.80
6N4	2.39
6N6G	1.69
6N7GT	.80
6P5GT	.89
6Q7	.89
6R7	.77
6R8	1.39
6S4	.85
6S7G	.83
6S8GT	.92
6SA7GT	.63
6SA7GTY	3.37
6SB7Y	1.19
6SC7	.90
6SD7GT	.80

6SF5	.77
6SF7	.73
6SG7	.72
6SH7	.61
6SJ7	.70
6SK7GT	.69
6SL7GT	.69
6SN7GT	.70
6SN7WGT	2.25
6SQ7GT	.63
6SR7	.63
6SS7	.75
6ST7	.98
6SU7GTY	2.65
6SZ7	1.05
6T7G	.85
6T8	.98
6U5/6G5	.99
6U6GT	.83
6U7G	.55
6V3	1.89
6V6	1.39
6V6GT	.57
6V8	1.99
6W4GT	.57
6W6GT	.85
6W7G	.85
6X4	.59
6X5GT	.59
6Y6G	.89
6Y7G	.89
6Z7G	.89
6ZY5G	.89
7A4/XXL	.73
7A5	.73
7A6	.73

12BA6	.59
12BA7	.79
12BD6	1.23
12BE6	.59
12BF6	.85
12BH7	1.29
12BY7	1.35
12BZ7	1.25
12C8	.65
12F5GT	.65
12H6	.65
12J5GT	.49
12J7GT	.75
12K7GT	.89
12K8	.65
12Q7GT	.55
12S8GT	.98
12SA7GT	.69
12SC7	.80
12SF5GT	.72
12SF7GT	.49
12SG7	.83
12SH7	.63
12SJ7GT	.59
12SK7	.72
12SL7GT	.65
12SN7GT	.75
12SQ7GT	.63
12SR7	.63
12X3	.90
12Z3	.89
14A4	.87
14A7/12B7	.75
14AF7/XXD	.83
14B6	.65

35C5	.69
35L6GT	.79
35T	6.95
35TG	5.45
35W4	.59
35Y4	.69
35Z3	.79
35Z4GT	.69
35Z5GT	.59
PEL36/6J4	.49
36	.65
37	.69
38	.59
RK39	2.89
39/44	.59
CRC40	.59
T40	4.29
TZ40	3.98
40	1.09
HY40Z	3.75
41	.79
42	.69
43	.85
45	.69
45S/VT52	.65
45Z3	.69
45Z5GT	.89
46	.89
47	.99
48	1.17
RK48A	6.85
RK49	7.50
49	.89
50	1.19
50A5	1.19
50B5	.79

F123A	7.90
T125	12.49
F127A	19.98
VT127A	3.90
CV148	4.98
150T	14.50
FG166	49.00
FG172	29.00
182B	1.20
FG190	12.00
HF200	21.00
T200	22.98
201A/CX301A	.98
203A	5.98
205B/VT2	1.69
CE206	3.15
211/VT4C	1.25
CE215	8.98
RX215	9.95
WE215A	
217C	8.75
227A	4.98
231	1.20
242C	3.95
244A	4.15
247A	9.95
250R	18.95
250TH	22.25
250TL	17.75
HK254	14.49
262B	3.98
274B	3.45
276A	9.89
300B	11.50
T300	26.98

CK536AX	.99
CK537AX	3.04
CK538DX	.98
CK539DX	2.19
CK541DX	1.99
CK542DX	.99
CK543DX	.99
CK544DX	.99
CK546DX	1.99
CK547DX	1.98
550P1	19.95
CK571AX/5886	2.49
CK573AX/6029	3.49
575A/975	15.95
WL579	10.49
WL579B	12.98
601B	.19
HY615	.25
616	37.00
KU627	18.00
WL652	65.00
WL670A	11.98
WL673	117.00
WL676	39.95
WL686	35.00
701A	5.95
702A	3.29
702B	5.98
703A	4.75
704A	.98
705A/8021	1.98
707A	7.90
707B	13.50
710A/8011	.95

Use Your Priority for SPEEDY DELIVERY—Extend Your DO & Contract Nos.

7A7	.69
7A8	.69
7AD7	1.49
7AF7	.89
7AG7	1.00
7AH7	1.19
7B4	.69
7B5	.73
7B6	.73
7B7	.73
7B8	.73
7C4	.83
7C5	.69
7C6	.69
7C7	.73
7C23	72.00
7C29	69.95
7E5/1201	.65
7E6	.73
7E7	.73
7F7	.73
7F8	1.25
7G7/1232	.89
7H7	.73
7J7	.89
7K7	1.10
7L7	.83
7N7	.79
7Q7	.69
7R7	.83
7S7	.92

14B8	.89
14C5	1.07
14C7	.95
14E6	.85
14E7	1.09
14F7	.95
14F8	.83
14H7	.83
14J7	.83
14N7	.87
14Q7	.73
14R7	.80
14S7	.75
14W7	1.09
14X7	1.23
15E	1.98
15R	.89
FG17	3.95
18	.98
19	.69
19BG6G	1.79
19T8	1.09
19V8	1.62
T20/1623	3.79
TUF20	5.19
TZ20	3.79
20	1.17
RK20A	8.95
RX21	3.75
22	.99
24	.85

50C5	.69
50C6	1.49
50L6GT	.69
50X6	.98
50Y6GT	.79
50Z7G	.98
52	.99
53	.98
T55	8.79
56	1.06
57	.79
58	.79
RK59	1.45
59	1.78
RK60/1641	1.95
RK61	3.05
T60	10.45
HY69	4.98
70A7	1.59
70L7GT	1.59
71A	.79
CRP72	1.20
CRP73	1.49
73	1.67
NR74	.29
HY75	4.59
75	.99
76	.79
77	.69

HF300	24.30
304TH	8.90
304TL	8.90
307A/RK75	4.20
310A	6.25
311CH	10.95
311CT	10.50
311T	10.50
313C	2.98
316A	1.49
323A	24.25
327A	4.95
5340	2.93
350A	5.20
350B	4.95
353A	4.65
HK354	24.98
355A	14.15
368AS	7.49
371B	1.85
380A	.79
388A	1.49
393A	8.90
394A	4.90
FP400	15.98
WE417/5842	18.50
WL417A	8.95
GL434A	12.69
446A	1.05

713A	.98
NL714	5.95
714AY	5.90
715A	6.00
715B	11.90
715C	24.00
717A	.90
718BY	48.45
718CY	48.45
719A	28.50
721A	2.49
721B	12.50
722A/287	2.45
723A	11.95
723A/B	25.00
724A	3.95
724B	3.45
725A	8.49
726A	14.25
726B	45.00
726C	79.95
730A	24.50
800	1.85
801A	.45
803	3.89
805	3.90
807	1.65
808	2.59
809	2.43
810	9.95
811	2.90

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7T7	1.03
7V7	.79
7W7	.95
7X7/XXFM	.89
7Y4	.49
7Z4	.65
8DC-15	4.98
10Y	.35
CV11	5.25
12A	.57
12A5	1.39
12A6	.59
12A7	.90
12A8GT	.65
12AC7	1.19
12AH7GT	1.45
12AK5	1.98
12AK5W	2.98
12AL5	.75
12AT6	.52
12AT7	.81
12AU6	.72
12AU7	.63
12AV6	.49
12AV7	.98
12AW6	1.79
12AX4GT	1.20
12AX7	.79
12AY7	2.95
12AZ7	1.49

24A	1.10
24G/3C24	1.90
25A6	1.09
25A7	2.98
25AC5GT	1.59
25AV5GT	1.29
25BQ6GT	1.19
25C6	1.18
25L6GT	.69
25W4GT	.89
25Y5	.79
25Z5	.79
25Z6GT	.99
26	.79
27	.69
FG27A	8.70
HV27	10.95
RK28A	4.89
28D7	1.95
30	.70
31	.59
HY31Z	2.75
32	.49
FG32/5558	13.85
32L7GT	1.49
33	.59
34	.69
35/51	.89
35A5	.79
35B5	.79

78	1.05
79	.89
80	.69
81	1.69
FG81A	5.95
82	1.19
82V	1.39
83	1.45
83V	1.79
84/6Z4	.99
85	.79
89	.75
VR92	.25
FG95/5560	24.85
FG98	19.95
100TH	7.83
102D	2.98
102G	2.98
FG104	37.98
FG105	17.64
VU111	1.45
HY114B	.75
HY115/145	.79
117L/M7GT	1.59
117N7GT	2.15
117P7GT	1.39
117Z3	.59
117Z4GT	1.39
117Z6GT	1.19
117Z7GT	1.49

446B	3.89
450TH	45.00
450TL	52.00
460/HF200	15.95
WL468	13.95
GL471A	2.69
CK501X	1.26
CK501AX	2.20
GL502A	1.79
CK502AX	1.49
CK503AX	1.49
CK505AX	1.79
CK506AX	1.49
RH507	9.98
CK509AX	1.79
CK510AX	2.49
CK512AX	1.45
CK522AX	1.29
CK525AX	1.29
CK526AX	1.49
CK527AX	2.84
CK528AX	1.49
CK529AX	1.79
GL530	22.00
CK531DX	1.89
531	6.98
CK532DX	1.89
WL532	3.98
CK533AX	1.29
CK534AX	.99

811A	3.50
812	2.70
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816/866Jr	1.07
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829	11.49
829B	12.45
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874	1.39
878	1.95
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885	1.45
893A	250.00
917	2.59
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919	2.75
923	1.00
925	1.69
927/CE25	1.49
930	1.65
931A	6.25
954	.18
955	.39
956	.36
957	.65
958A	1.45
967/FG17	3.95
973	16.95
991	.45
FM1000	1.50
CK1005	.85
CK1006	3.49
CK1007	.89
CK1027	2.98
CK1028	15.98
CK1089	2.99
CK1090	2.98
R1100	5.00
R1130	12.00
E1148	1.35
HY1231Z	5.39
1612	1.90
1613	.89
1616	2.45
1619	.25
1620	4.70
1622	2.69
1624	1.90
1625	.33
1626	.33
1629	.29
1630	.97
1631	1.95
1632	.77
1633	.73
1634	.73
1635	1.89
1636	3.19
1644	.95
2000T	149.50
2050	1.47
2051	1.15
5516	5.98
5517	3.39
5594	6.65
5608A	5.95
5618	3.50
5637	6.99
5638	12.64
5647	8.35
5651	2.35
5654	2.79
5656	6.90
RK5657	350.00
5663	1.85
5670	5.30
CK5672	1.29
CK5676	1.29
CK5678	1.89
5684	14.98
5686	3.90
5687	5.49
5691	7.85
5692	7.85
5693	6.75
5694	3.65
CK5697	3.49
CK5702	3.49
CK5703	1.29
CK5704	1.89
5718	10.15
5719	12.25
5726	1.79
GL5727	4.49
5744/CK619CX	1.69
5749	1.98
5751	5.45
5763	1.70
CK5783	6.69
CK5784	6.98
5812	2.99
5814	3.64
CK5829	4.39
5840	12.34
5842/WE417	18.50
CK5851	8.65
CK5875	1.69
5881	2.69
8002R	99.50
8005	7.25
8008	6.49
8012	2.89
8013	2.75
8013A	6.45
8014A	28.95
8020	1.25
8025A	4.75
9001	1.55
9002	.95

9003	1.50
9004	.42
9005	2.25
9006	.39

C'Ray Tubes

2AP1	9.70
3AP1	9.75
3AP1A	14.25
3AP5	18.00
3BP1	5.75
3BP1A	14.98
3BP5	18.00
3DP1	4.75
3EP1/1806P1	4.85
3FP7	.98
3FP7A	14.98
3GP1	4.20
3GP4	16.50
3HP7	3.40
3GP5	18.00
3HP14	14.98
3GP7	18.00
3JP7	12.50
3JP12	19.95
3JP14	16.95
4AP10	4.40
5AP1	3.45
5BP1	4.89
5BP4	4.25
5CP1	4.50
5CP1A	18.49
5CP7	11.75
5CP5	30.00
5FP4	40.00
5FP7	1.49
5HP1	5.70
5HP4	5.70
5JP2	19.25
5JP4	26.75
5JP5	35.00
5JP7A	39.00
5LP1	22.25
5LP2	27.50
5LP7	29.95
5LP4A	33.00
5MP1	10.50
5SP7	100.00
5RP7A	89.50
7BP1	8.65
7BP7	6.50
7EP4	17.98
7JP4	18.39
9GP7	12.75
9LP7	2.98
12DP7	16.89
12DP7A	49.50
12GP1	49.98
12GP7	14.75
12HP7	14.75
905	3.49
912	89.98
913	9.98
914A	45.00

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1N21	.93
1N21A	1.55
1N21B	2.89
1N21C	21.50
1N22	1.25
1N23	1.35
1N23A	2.20
1N23B	3.49
1N25	4.98
1N26	8.75
1N27	1.55
1N29	3.50
1N32	23.75
1N34	.64
1N34A	.90
1N35	1.65
1N38	1.43
1N38A	1.25
1N39	4.15
1N41	11.00
1N42	17.50
1N43	1.73
1N44	1.24
1N45	1.45
1N46	.69
1N47	4.00
1N48	.55
1N51	.45
1N52	1.62
1N54	.89
1N54A	1.17
1N55	2.35
1N56	.89
1N57	.89
1N58	1.19
1N58A	1.26
1N60	.60
1N61	2.10
1N63/K63	2.49
1N64	.69
1N67	1.95
1N69	1.98
K34	1.35
CK705	.77
CK706	.54
CK707	1.80

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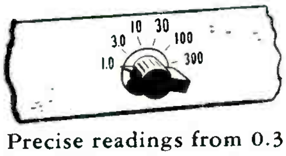

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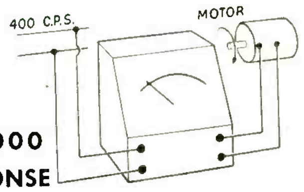

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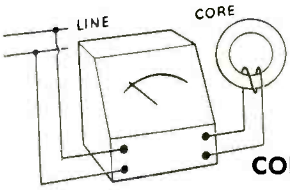

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