MAY · 1953
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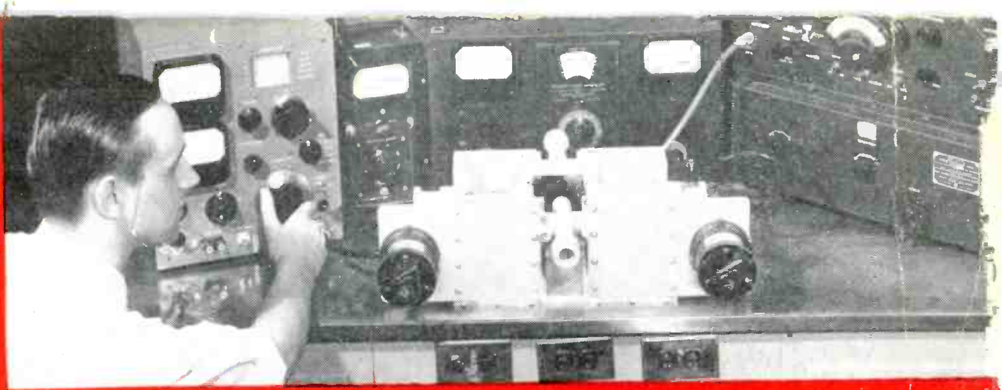
electronics

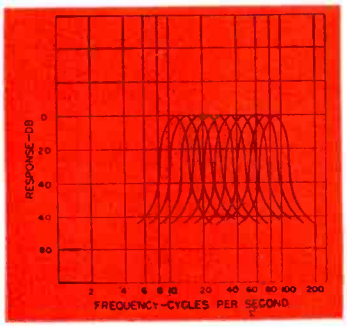
A McGRAW-HILL PUBLICATION

GRID-CONTROLLED MAGNETRON

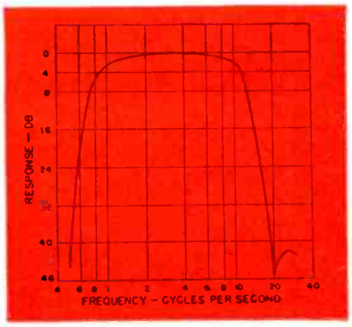


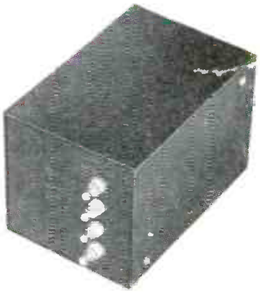
for SPECIALIZED FILTERS

Decades of experience in the design and production of specialized filters have resulted in UTC being a first source for difficult filters. Fifteen years ago UTC was already the largest user of permalloy dust toroids in the world (exclusive of the telephone system). Present designs include a wide variety of core materials, structures, and winding methods to provide maximum performance in electrical requirements and stability. Illustrated below are a few of the thousands of special filter designs in present production.

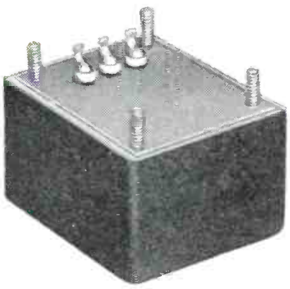


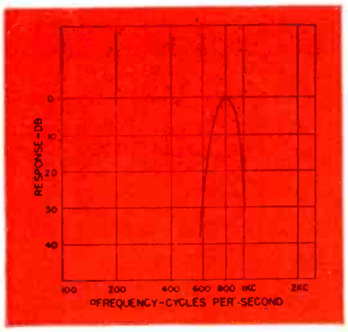
These low frequency band pass filters are held to 1 DB tolerance at the 3 DB crossover . . . 600 ohm . . . 4 filters per 7½" rack panel.



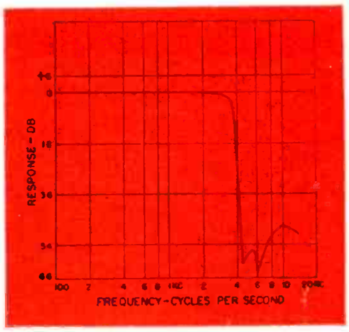


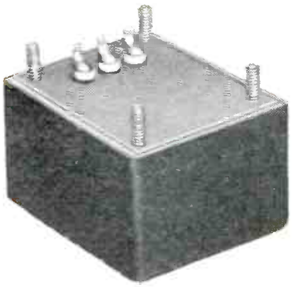
This ultra low frequency filter has a band pass range of one cycle to 10 cycles . . . 50,000 ohms . . . 700 cubic inches.



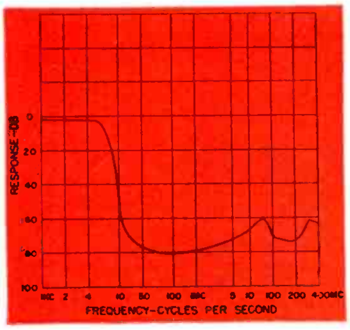


This 600 ohm miniaturized 1 KC band pass filter is housed in a case only 1" x 1¾" x 2½".

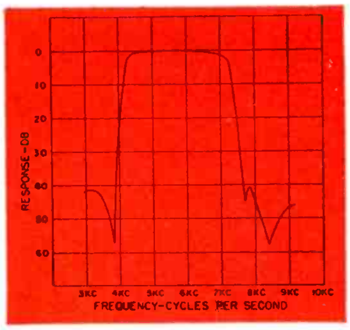




This 600 ohm miniaturized low pass filter is housed in a case only 1" x 1¾" x 2½".



This power line filter provides correct output voltages from sources of 50 to 400 cycles . . . noise attenuation is from 14 KC to 400 MC . . . 29 cubic inches.



This band pass filter is designed for sharp cut-off at both ends of the range . . . 10,000 ohms . . . case dimensions 1⅝" x 2½" x 3¼".

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GRID-CONTROLLED MAGNETRON—Amplitude modulation of Raytheon multiple-cavity magnetron is accomplished by control-grid elements placed between vane tips (see p 148) .... *COVER*

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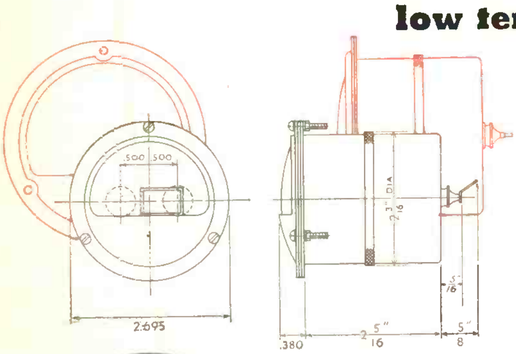

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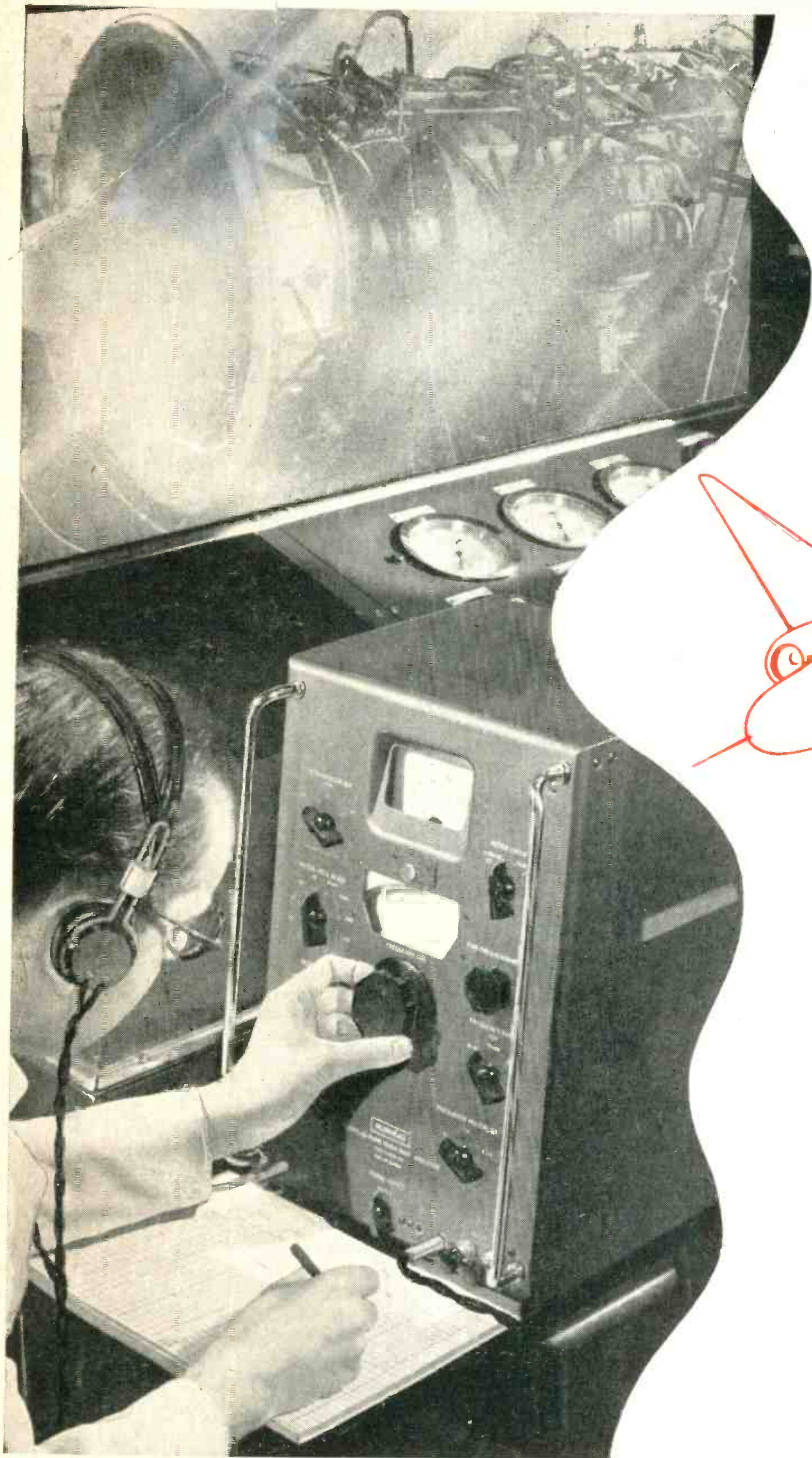
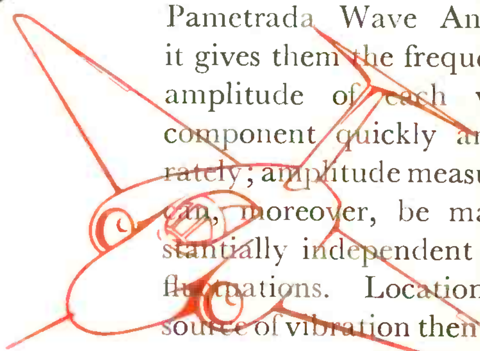


Vibration Analysis with the MUIRHEAD-PAMETRADA WAVE ANALYSER at Armstrong Siddeley works, Coventry

At the high speeds encountered with turbo-jet engines, unsuspected blade resonances can cause serious damage. For this reason exhaustive vibration tests must be made, and the source of each vibration located.
Leading British Aircraft manufacturers rely on the Muirhead-Pametrada Wave Analyser — it gives them the frequency and amplitude of each vibration component quickly and accurately; amplitude measurements can, moreover, be made substantially independent of speed fluctuations. Location of the source of vibration then becomes simply a matter of correlating the measured frequency with known engine data.



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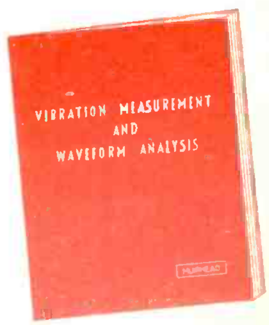

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PRECISION ELECTRICAL INSTRUMENT MAKERS

FIGURES OF THE MONTH

RECEIVER PRODUCTION

(Source: RTMA)	Year Ago	Previous Month	Latest Month
	Feb. '52	Jan. '53	Feb. '53
Television sets	409,337	719,234	730,597
Home sets	312,705	361,921	402,742
Clock Radios	106,103	189,592	210,924
Portable sets	72,866	93,962	87,711
Auto sets	267,779	447,667	491,062

RECEIVER SALES

(Source: RTMA)	Year Ago	Previous Month	Latest Month
		Jan. '53	Feb. '53
Television sets, units	......	640,073	537,122
Radio sets (except auto)	......	414,726	507,527

RECEIVING TUBE SALES

(Source: RTMA)	Year Ago	Previous Month	Latest Month
	Feb. '52	Jan. '53	Feb. '53
Receiv. tubes, total units	28,262,407	37,343,061	40,061,483
Receiving tubes, new sets	17,608,162	25,409,671	27,730,235
Rec. tubes, replacement	6,623,798	9,167,440	9,206,500
Receiving tubes, gov't.	2,877,177	1,576,298	1,442,452
Receiving tubes, export	1,153,270	1,189,672	1,682,296
Picture tubes, to mfrs.	330,431	825,209	699,411

SEMICONDUCTOR SALES

(Source: RTMA)	Year Ago	Previous Month	Latest Month
		Jan. '53	Feb. '53
Germanium Diodes	......	1,470,472	1,466,421

INDUSTRIAL EQUIPMENT ORDERS

Quarterly Figures			
(Source: NEMA)	Year Ago	Previous Quarter	Latest Quarter
	4th '51	3rd '52	4th '52
Dielectric Heating	$620,000	$320,000	$440,000
Induction Heating	$3,400,000	$1,760,000	$2,420,000
Welding Control	$1,430,000	$1,810,000	$1,390,000
Other Electronic Control	$860,000	$920,000	$970,000

INDUSTRIAL TUBE SALES

(Source: NEMA)	Year Ago	Previous Quarter	Latest Quarter
	4th '51	3rd '52	4th '52
Vacuum (non-receiving)	$14,300,000	$10,580,000	$12,790,000
Gas or vapor	$3,170,000	$2,950,000	$3,480,000
Phototubes	$390,000	$570,000	$760,000
Magnetrons and velocity modulation tubes	$6,670,000	$8,500,000	$10,510,000
Gaps and T/R boxes	$2,120,000	$1,700,000	$2,090,000

TV AUDIENCE

(Source: NBC Research Dept.)	Year Ago	Previous Month	Latest Month
	Mar. '52	Feb. '53	Mar. '53
Sets in Use—total	16,535,100	21,907,100	22,551,500

BROADCAST STATIONS

(Source: RTMA)	Year Ago	Previous Month	Latest Month
	Mar. '52	Feb. '53	Mar. '53
TV Stations on Air	108	147	614
TV Stns CPs—not on air	0	221	255
TV Stns—Applications	521	815	740
AM Stations on Air	2,339	2,409	2,424
AM Stns CPs—not on air	74	131	133
AM Stns—Applications	320	252	250
FM Stations on Air	636	611	607
FM Stns CPs—not on air	14	20	21
FM Stns—Applications	6	8	7

COMMUNICATION AUTHORIZATIONS

(Source: FCC)	Year Ago	Previous Month	Latest Month
	Feb. '52	Jan. '53	Feb. '53
Aeronautical	31,707	35,323	37,825
Marine	34,660	38,631	39,001
Police, fire, etc.	10,442	12,234	12,482
Industrial	12,237	15,761	16,002
Land Transportation	4,767	5,531	5,636
Amateur	105,016	117,106	116,697
Citizens Radio	833	1,892	1,924
Disaster	26	90	101
Experimental	359	507	529
Common carrier	895	1,037	1,070

EMPLOYMENT AND PAYROLLS

(Source: Bur. Labor Statistics)	Year Ago	Previous Month	Latest Month
	Jan. '52	Dec. '52	Jan. '53
Prod. workers, comm. equip.	270,700	331,000-r	330,500-p
Av. wkly. earnings, comm.	$65.99	$69.33-r	$69.22-p
Av. wkly. earnings, radio	$60.90	$64.40-r	$64.46-p
Av. weekly hours, comm.	42.6	42.2	41.8-p
Av. weekly hours, radio	41.6	41.2-r	40.9-p

STOCK PRICE AVERAGES

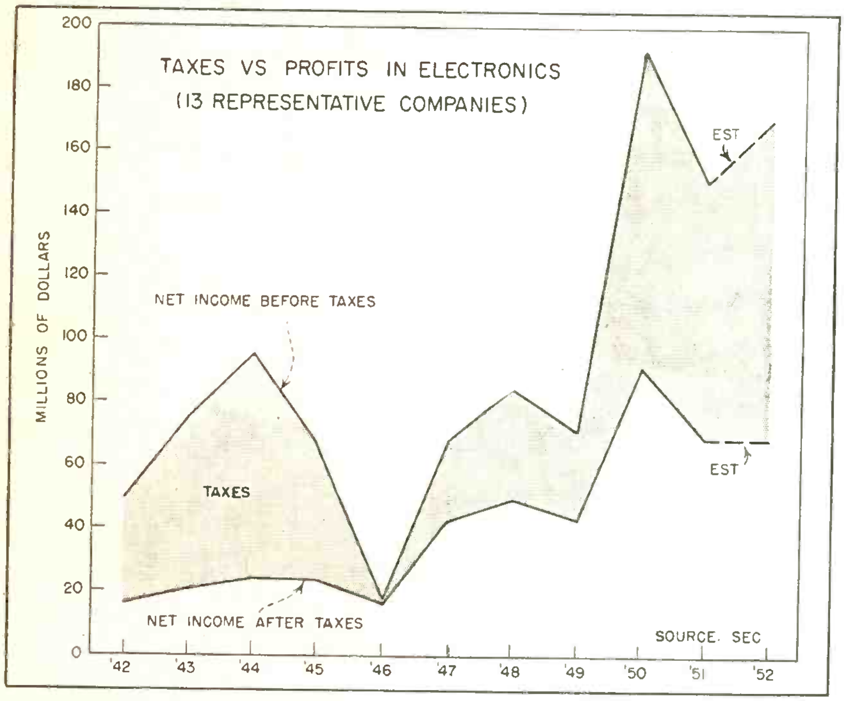
(Source: Standard and Poor's)	Year Ago	Previous Month	Latest Month
	Mar. '52	Feb. '53	Mar. '53
Radio—TV & Electronics	295.7	304.5	310.7
Radio Broadcasters	286.9	285.1	294.3

p—provisional; r—revised

FIGURES OF THE YEAR

	1952 Total	Jan.-Feb. Totals 1952	1953	Percent Change
Television set production	6,096,279	814,270	1,449,831	+ 78.1%
Radio set production	9,711,236	1,391,908	2,285,581	+ 64.7
Television set sales	6,144,990	872,532	1,177,195	+ 34.9
Radio set sales (except auto)	6,878,547	823,229	922,253	+ 12.3
Receiving tube sales	368,519,243	54,999,102	77,404,564	+ 40.7
Cathode-ray tube sales	6,120,292	670,623	1,524,620	+126.9

electronics—MAY • 1953



RISING TREND in income levies is seen as . . .

Electronics Firms Look At Taxes

Amounts set aside for taxes by manufacturers indicate that 1952 levies were tops

YEARLY tax payments by thirteen electronic manufacturers for the past ten years show that the 1952 tax total of nearly $103 million represents the largest payment ever made by these companies. It accounts for 59 percent of income before taxes, the highest percentage since 1945.

For these firms, taxes have represented more than half of net income before taxes for the past 3 years and have been larger than total dividend payments that were made to stockholders during that period.

Although net sales rose substantially in 1952 for many manufacturers net income did not keep pace with the increased volume in many cases because of "a substantial increase in the provision for federal taxes."

Fiscal 1952 was the first time since the war for many electronic manufacturers that a whole year's earnings were subject to a higher combined rate of federal income and excess profits taxes. As a result net income was lower.

▶ **Companies**—Annual reports of individual electronic manufacturers point up the effect of taxes on company earnings. General Electric's provision for federal taxes on income in 1952 amounted to $264 million. Although this was 4.9 percent less than the 1951 bill for federal income and excess profits taxes, the provision equalled $9.15 per share of common stock and 10.1 cents per dollar of sales.

RCA's total tax bill for 1952, including $22.3 million in excise taxes, came to a total of $66.6 million, an amount equivalent to $4.80 per common share, or more than double the year's net earnings.

Taxes for Bendix in fiscal 1952 were $35.3 million or $16.70 a share. This was 70 percent of earnings before taxes, or over 4 times as much for taxes as the Bendix stockholder received in dividends.

▶ **Future**—The excess profits tax expires on June 30, 1953, unless extended by Congress. The House Ways and Means Committee has favored letting the tax expire on schedule and so have most manufacturers, electronic and otherwise.

If no extension is voted, electronic manufacturers whose fiscal year ends on that date will no longer pay the levy while those with other fiscal years will pay their proportionate share.

Transistor Standards Planned for June 30

Electrical specs by joint-service-industry committee to bring mass availibility

TRANSISTOR manufacturers have been forced to proceed cautiously in introducing their products for general use because of the widespread confusion as to what constitutes a *good* transistor. Through the initiative of the Signal Corps, in collaboration with the Navy, Air Force and representatives of leading manufacturers (JETEC), a set of standards is to be completed by June 30 that will settle many of the perplexing questions in the minds of both makers and users.

The mid-year deadline is expected to serve as a break point for mass availability of transistors on an industry-wide basis. Some manufacturers have been holding back and stockpiling production of transistors pending such standards. They will soon be able to publish data on their products with assurance that claims will not be misinterpreted due to lack of understanding.

▶ **Physical Specs**—The June 30 specs will supplement already-accepted standards for physical dimensions and spacing of leads set several months ago. These earlier specs were adopted to curb a trend which would ultimately lead to the necessity for having a different socket for each transistor type.

Transistors will ultimately be supplied with two-inch leads (for soldering directly into circuits) that may be clipped if socket insertion is desired and spaced to fit standard 5-pin in-line subminiature sockets. Emitter and collector leads will occupy the end socket holes, the base lead spaced to fit the hole adjacent to the emitter, leaving two holes between base and collector.

Business Briefs

Labor—Secretary Durkin's conferees on Taft-Hartley revision could not agree on procedure, conference was ended. In Congress, hearings add up to much talk. Little chance of change this year.

Copper—Multiple-price situation on mine, custom-smelter output, domestic and foreign supplies makes costs vary from 27½ to 36½ cents per pound. Anaconda's Chilean mine is adding 50,000 tons per year to present 200,000-ton output.

Defense—Congress wants a $43 billion ceiling on defense spending, holding present rate. Treasury Secretary Humphrey estimates a $4 billion reduction starting July 1, with taxes held at present level.

Outlays—McGraw-Hill surveys show 1954-56 capital plans at $18 to $20 billion a year level. First quarter 1953 plants and equipment outlay was at $27.5 billion annual rate.

Aluminum — Production capacity of domestic industry will rise to more than 3 billion pounds a year before the end of 1953, according to Industrial Smelting Corp. Alcoa's annual report predicts easing of pressures on civilian aluminum market as military and stockpile needs are met.

Tools — Deliveries of machine tools are back to normal for first time since Korean outbreak. Makers of nondefense products can order now for replacements, modernizations, expect deliveries soon.

Zinc—Government's General Services Administration is requesting zinc for national stockpile after a purchasing slack-off last year. Present price is 11 cents a pound, old ceiling price was 19½.

Demand — Federal Reserve Board's Survey of Consumer Finances says 'Plans to purchase major household goods, especially tv sets and furniture, are substantially more numerous than they were a year ago.' General agreement among economic observers is that prices will stay up and firm.

Trade — President Eisenhower asked Congress to extend the Reciprocal Trade Agreements Act one year beyond its June 12 deadline, to permit a full study of trade policies before trying to rewrite the bill.

Clock-Radios Hit Big Time

Production has climbed steadily since 1946 and may exceed 2 million units this year

ELECTRONIC alarm clocks, better known as clock-radios, have become big business for radio manufacturers in the past 2 years. Both unit and dollar volume doubled in 1952 and this year output is expected to reach 2 million, accounting for 25 percent of total radio sales.

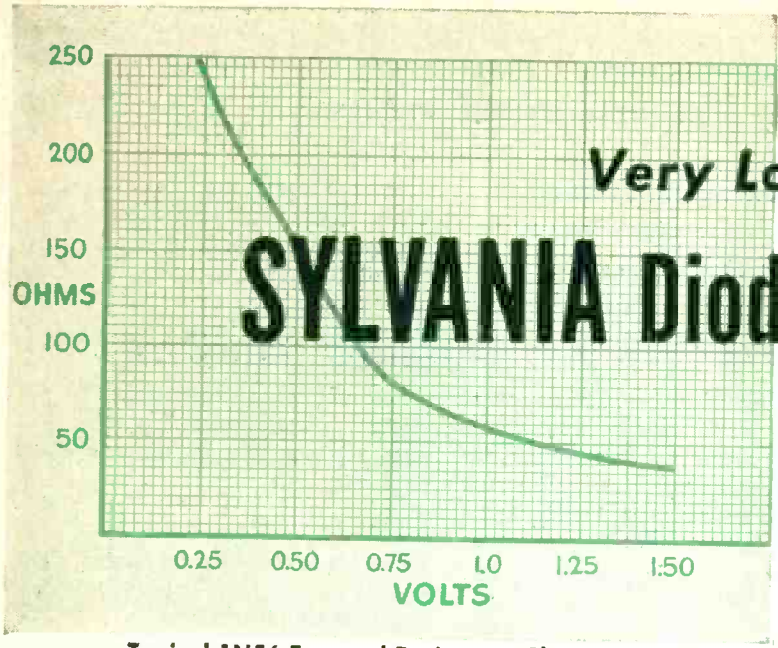
Although clock radios were introduced years ago by some radio companies it was not until 1951 that the industry as a whole began to sit up and take notice of rising public acceptance. In that year 777,000 were produced, with a retail value of over $30 million. In 1952, 1.6 million had been made, with a retail value of $64 million. In the first two months of 1953 more than 390,000 were produced, compared to 186,000 for the same period last year.

▶ **Manufacturers**—In 1946, six companies had clock-radios on the market and the sets were more of a novelty item than anything else. Clock manufacturers were the real promoters, and in some instances marketed clock-radios themselves to show the radio industry that they could be sold.

There are now very few radio manufacturers who don't have clock-radios in their lines. A few companies even have clock-television sets available.

▶ **Market**—Clock-radios have been bought mainly for use in the bed-

(Continued on page 8)



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Typical 1N56 Forward Resistance Characteristic.

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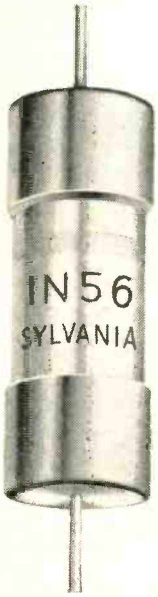
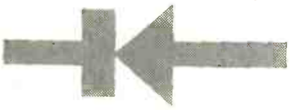
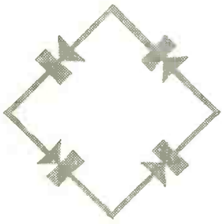
4. Low impedance coils and transformers.





1N56 DIODE with potential of +1 volt will pass a current of 15 ma. or more. With a potential of −30 volts, less than 300 μa will flow.



For Carrier Communications, 1N71 VARISTOR. The 1N71 consists of 4 matched low impedance diodes each of which, with +1 volt impressed, will pass a current of 1 ma. of the average current of the four.

TRY the 1N71 varistor in carrier telegraphy and telephony work. The low shunt capacitance insures high efficiency throughout the high frequency range. You will find this varistor equally efficient in low impedance modulator circuits of the carrier suppression or carrier transmission type.

Both the 1N56 Germanium Diode and the 1N71 Varistor are available from your Sylvania Distributor. New descriptive folder gives ratings, characteristics, and application notes concerning Sylvania Germanium Diodes and Varistors. Mail the coupon for your copy.

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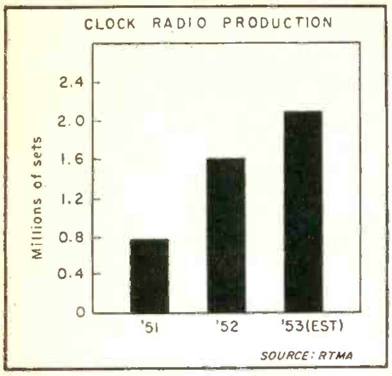


room as a musical alarm clock. But manufacturers now see a growing trend toward use in the kitchen and the living room. As a result, clock-radio styling is changing rapidly. Now there are hang-up clock-radios for the kitchen and even portable clock-radios (see below).

It used to be that the same clock face could be seen on several different radio brands. But now the industry is styling the clock face as well as the cabinet and gets only the works from clock manufacturers.

Large Computers Coming in Quantity

Production of giant 'brains' accelerates as government orders hypo business

ALL BUSINESS is good when Uncle Sam picks up the tab.

In the electronics field, development of large digital computers would probably not have been undertaken until much later but for the needs of national defense.

Most large scale computers have been one-of-their-kind but two giant 'brains', recently introduced by IBM and Remington Rand, will be made in quantity. The machines are also unique in that they lack the exotic names often given electronic computers. The IBM machine is known prosaically as the 701; the Remington Rand job as the 1103 under the new nomenclature.

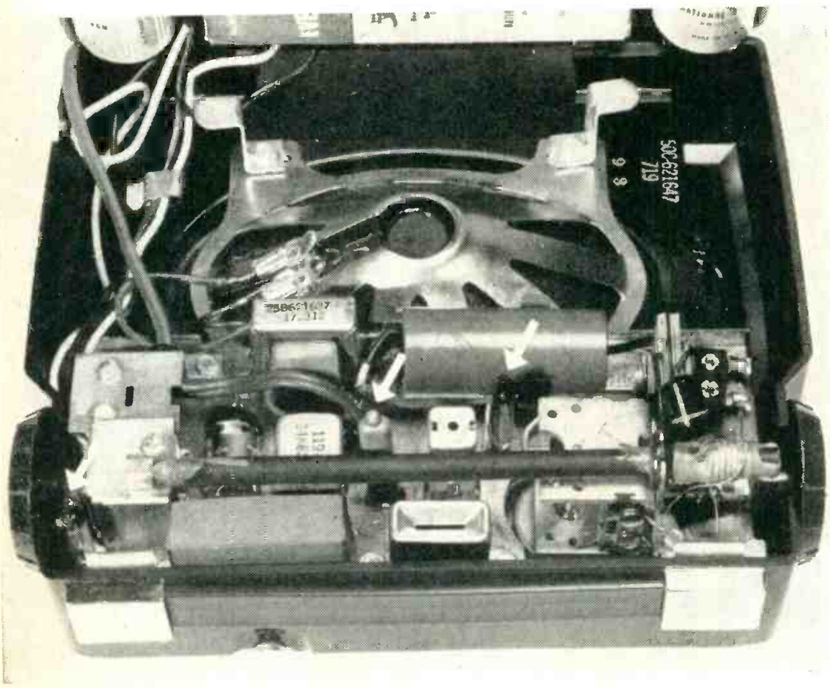
► **Design**—The machines are technically comparable. Both cost just under one-million dollars. Both have three information storage systems or memories: electrostatic tubes, magnetic drum and magnetic tape.

The machines will both work on engineering and scientific problems such as future airframe design, missile-guidance systems analysis, air defense and all nuclear research.

► 1103—The first 1103, built by Rem Rand's Engineering Research Associates Division of St. Paul, Minn., will soon be delivered to the Department of Defense. A commercial model will be available in March 1954; six units are scheduled for that year. The machines sell for $850,000. R-R also plans computation centers for the present in New York and Washington where work will be done on hourly rates.

► 701—In Production at the company's Poughkeepsie plant, the IBM 701 will be installed on customers' premises at rentals of $11,900 a month and up. The first machine will soon be shipped to Los Alamos Scientific Laboratory. A 701 has already been installed at IBM headquarters in New York and will do job work for $300 an hour. Production rate for 701's is one per month.

Portable Clock Radio Uses Subminiatures



Transistors aren't the only way to cut battery drain. Note subminiature tubes (arrows) used in this new Motorola clock portable. It operates from two 1½-volt A batteries and a 67½-volt B or from 117 volts a-c/d-c. Magnet and associated components are within cone of loudspeaker, saving still more space

Miltronic Standards Making Progress

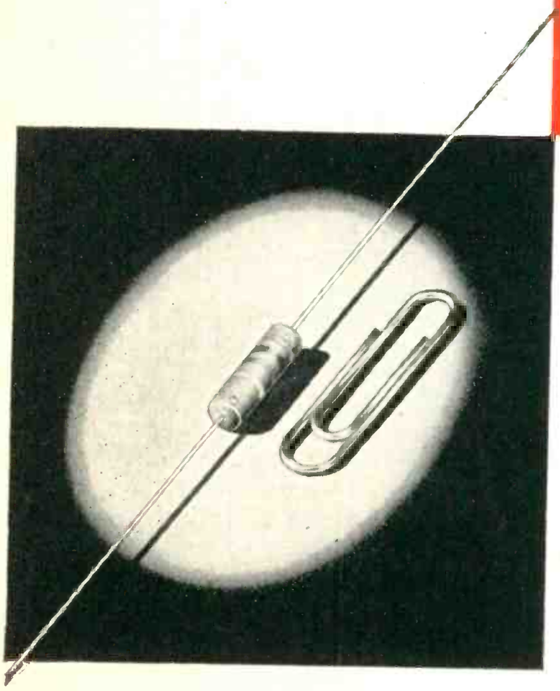
CATALOGING of all electronic equipment used by the military is moving in high gear with the first of the catalogs scheduled for completion this year. The equipment will be divided into twenty categories and standardized with duplications eliminated.

The first catalog, electron tubes, is due in November of '53. Resistors will follow in January, 1954, with circuit breakers, switches, and filters and networks following in February. The catalog for capaci-

(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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tors is due in April 1954. A new standard for packaging electron tubes will be also issued.

Industrial Electronics Gains Momentum

Sales are rising rapidly as new equipment and new organizations enter field

EVIDENCE of the growing importance of the industrial market to electronic manufacturers is mirrored in recent activities in the field. Industrial tube sales have almost tripled since 1950, rising from $38.7 million in that year to an estimated $95.9 million in 1952. Biggest gain was made by non-receiving-type tubes, with magnetrons and velocity-modulation tubes following in dollar volume. These three classifications accounted for over 80 percent of industrial tube sales last year.

▶ **Equipment**—New, simpler industrial television equipment recently introduced also indicates the growing importance of industry as an electronic market. Five manufacturers, Dage, DuMont, Federal, General Precision and RCA, have brought out industrial tv equipment that is not only easier to use in industry but lower in cost than previous itv equipment. Now it is possible for manufacturers and business in general to buy a tv camera that will operate into a home tv receiver. With prices cut to about half that of last year's models, manufacturers see industrial television sales for 1953 far exceeding last year's sales of $6 million.

▶ **Organizations** — Further evidence of rising industrial sales are the new organizations that have been formed to specialize in industrial electronic servicing and maintenance. Previously, industrial volume was evidently small enough to allow manufacturers to send an engineer to a customer when servicing was needed. But now more independent organizations are doing the servicing job.

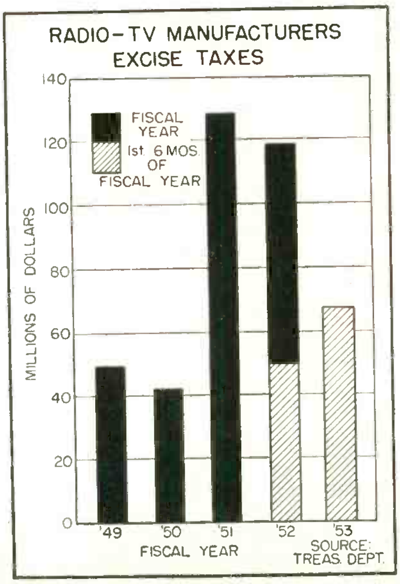
Excise Tax Collections Rise

Yield in fiscal 1953 tops last year's take, reflecting increased television sales

SALES TRENDS in the electronics industry are accurately pictured in the Treasury Department's figures on excise tax collection from radio-tv set and component manufacturers. Collection for fiscal 1953, which began in June of last year, totals almost $68 million compared to $51 million for the same period in fiscal 1952. If tv sales this year meet expectations the total yield seems sure to exceed $120 million.

▶ **Trend**—Annual collections from radio-tv manufacturers have amounted to over $100 million since the tv excise tax was first imposed on November 1, 1950. Top tax take was in 1950-51 when the U. S. collected almost $130 million from the radio-tv industry. The U. S. Treasury cashed-in on tv's top sales year along with manufacturers. In the 1951-52 period collections dropped by $10 million, reflecting the industry's tv sales slump. But even this total was nearly 3 times the average amount collected when the tax applied only to radio.

▶ **Rank** — Manufacturer's excise taxes are collected on 20 different categories of products, ranging from business machines to matches.



Automobiles and gasoline are the leaders in excise tax yields for the U. S. but since 1950 radio-tv sets and parts have not been far behind. In fiscal '52 they ranked in 6th place, led only by gasoline, automobiles, automobile parts, tires and trucks, in that order.

In the top year of 1951, radio-tv manufacturers excise tax collections stood in fourth place. Before tv excise the industry ranked 10th in total yield. In both 1951 and 1952 the industry's excise payments represented almost 5 percent of total manufacturer's excise tax collections of $2.3 billion in each year.

Cuban Television Attracts Smugglers

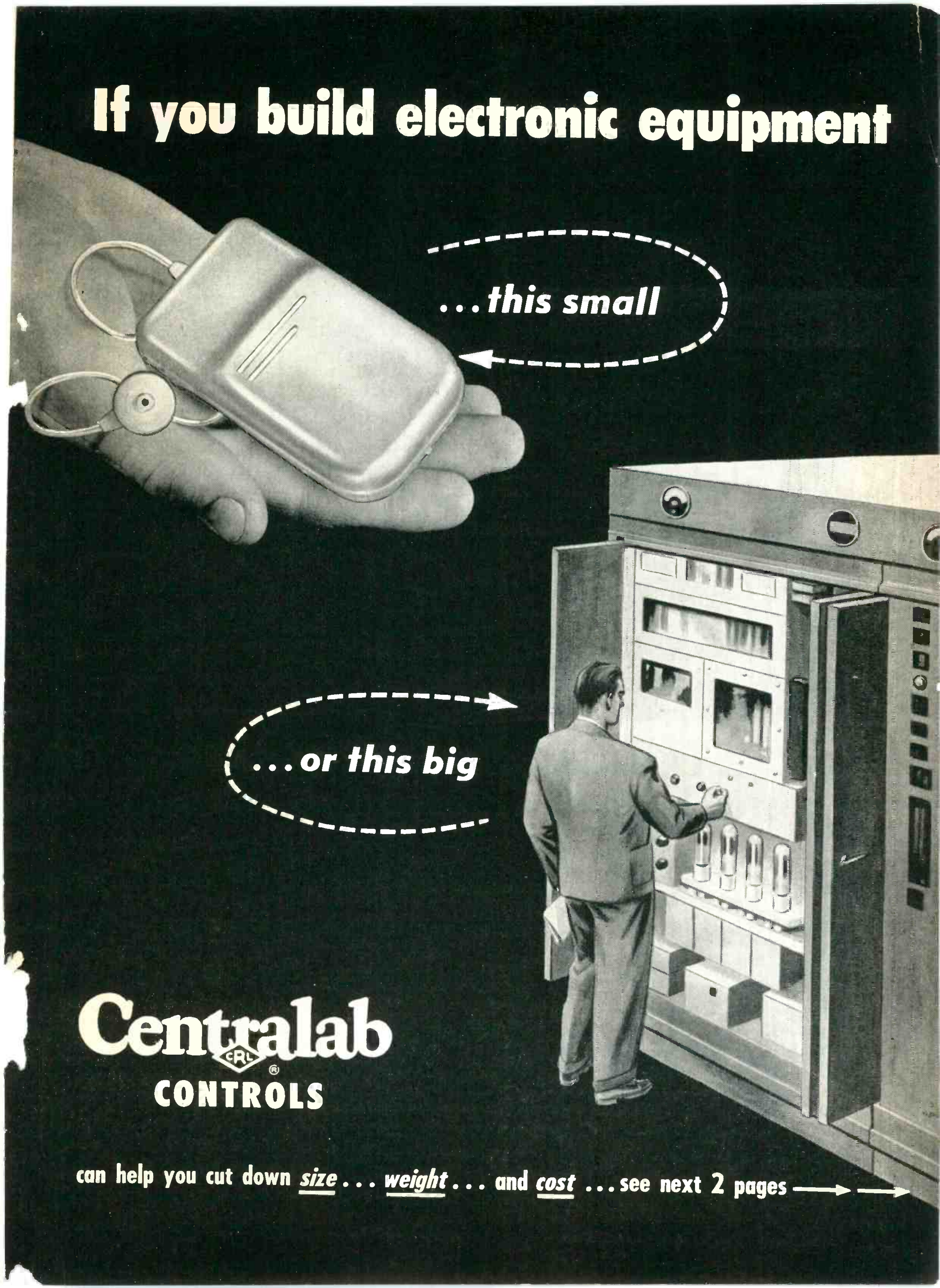
"PACK some clothes and meet me at Sloppy Joe's" was a byword for thirsty Americans during prohibition. Not only did Havana nighteries do a thriving business then but enterprising boatowners also carried on a brisk trade hauling liquid refreshment across the Straits of Florida.

Television sets have now apparently replaced the fruit of vine and cane field as the smuggler's stock-in-trade. Receivers imported from the U. S. without payment of duty are said to constitute nearly 60 percent of the 100,000 sets presently in use throughout the Island Republic.

▶ **Modus Operandi**—Maverick tv traders buy sets in quantity from U. S. dealers or distributors and either fly them via air freight to Cuba or ferry them across in small boats. Saving a 20-percent import duty, the traders then proceed to undersell franchised dealers operating through legitimate channels.

Hard hit by the subrosa trade, Cuban dealers vainly petitioned the government of former Cuban president Carlos Prio for aid in stopping the racket. Recently, the

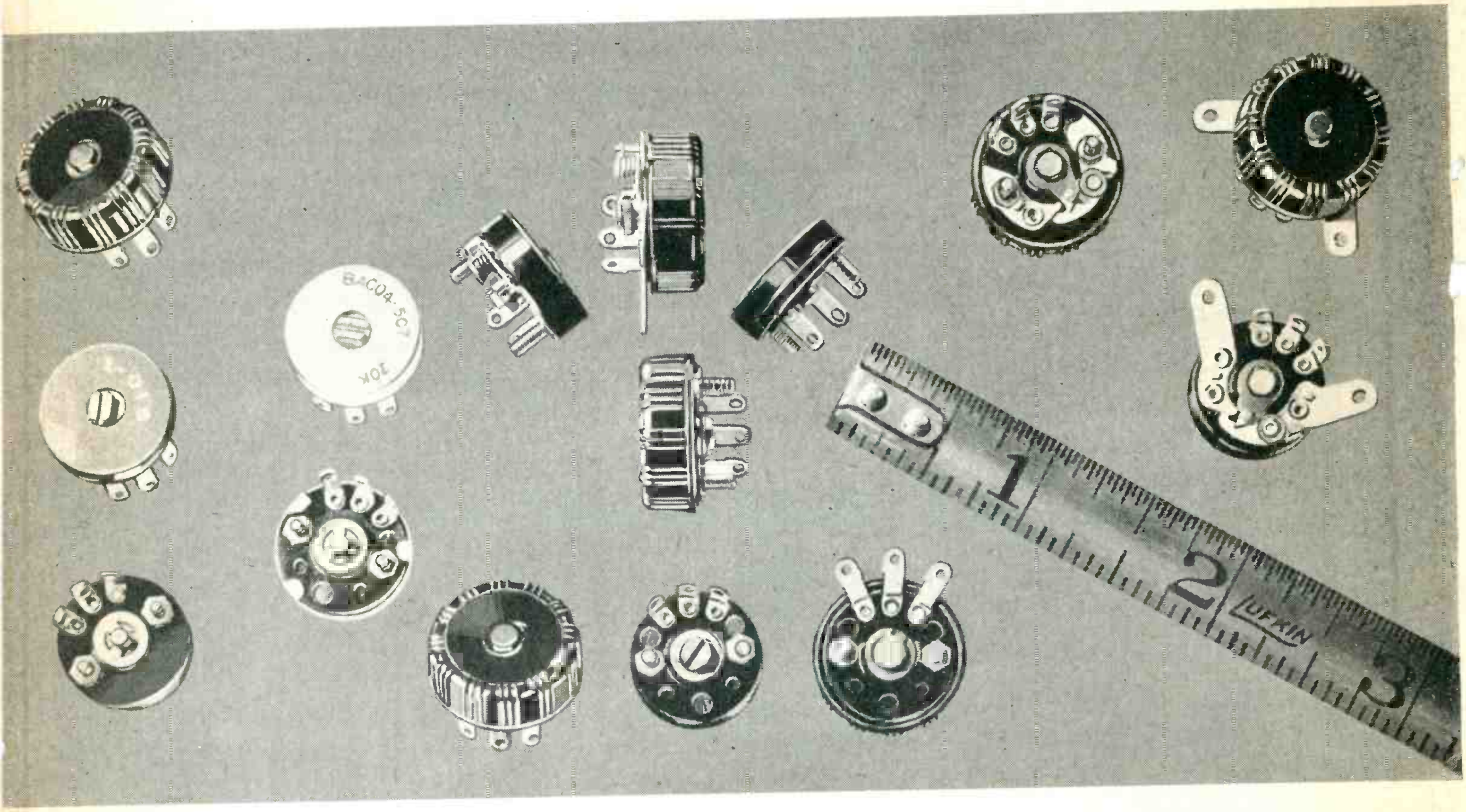
(Continued on page 14)



If you build electronic equipment
...this small
...or this big
Centralab
CRL
CONTROLS
can help you cut down size... weight... and cost ...see next 2 pages

These Centralab Controls give

THEY SIMPLIFY ASSEMBLY . . . LAST LONGER . . . HAVE FINER



NEW MODEL 1 RADIOHM® world's smallest volume control with the longest list of miniature applications

Check these QUICK FACTS on Model 1

- **resistance range:** 500 ohms to 10 megohms, 7 standard tapers
- **tolerances:** standard 500 ohms through 2 megohms ± 20%, above 2 megohms ± 30%
- **resistor element:** tested for 25,000 cycles
- **wattage rating:** 1/10 watt
- **contact:** phosphor bronze double-wiping
- **terminals:** Insulated brass, silver-plated. Furnished straight or bent 90° to mounting surface
- **mounting:** stud or bracket
- **shaft:** plain or switch type
- **switch:** SPST, rated 6.5 amps at 1.5 v d-c; 0.2 amps at 45 v d-c
- **dust cover:** provides full protection
- **shielding, knobs:** optional, may be furnished

THE Centralab Model 1 volume control is the smallest variable resistor on the market today. Its 5/8" diameter makes it no larger than a dime! That's why it was chosen as standard for these typical, important commercial and government applications. These include:

HEARING AIDS • INDUSTRIAL, GEOPHYSICAL TEST EQUIPMENT • MINIATURE RADIOS • TELEPHONE APPARATUS • COUNTING DEVICES • BUSINESS, DICTATION MACHINES • CARRIER EQUIPMENT, OTHER MILITARY AND GOVERNMENT GEAR

But *more* than compactness, Centralab's Model 1 Control gives you such features as smooth, noiseless performance, lighter weight, longer life. Many variations of the Model 1 are available with a complete range of resistance values, tapers and optional mountings. Resistance may be controlled by knob or front or rear screwdriver slot. There's a broad selection in either standard or new Hi-Torque types . . . with or without off-on switch and shielding.

The new Hi-Torque controls hold settings under severe conditions of shock or vibration. Standard torque is 0.3 ounce-inches, Hi-Torque models are 3.0 ounce-inches.

Completely adaptable to varying conditions, the Model 1, and other Centralab Controls illustrated are tops for miniaturization. For engineering assistance, write direct, stating your problem. For further facts, check 42-158 in coupon.

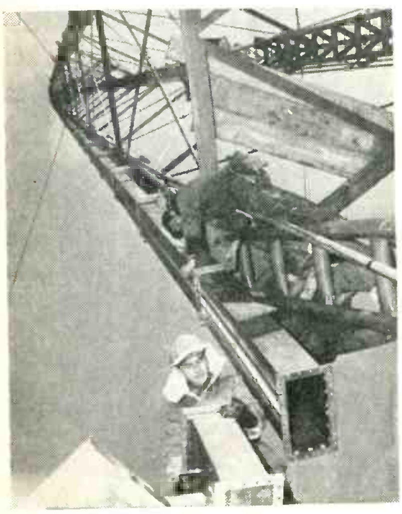
Batista government promulgated a regulation interdicting transshipment of television receivers.

Legitimate dealers throughout Cuba are waiting watchfully to see if the regulation will end the two-year-old racket. Thus far, midnight activity in sheltered coves from El Morro to Varedero seems undiminished.

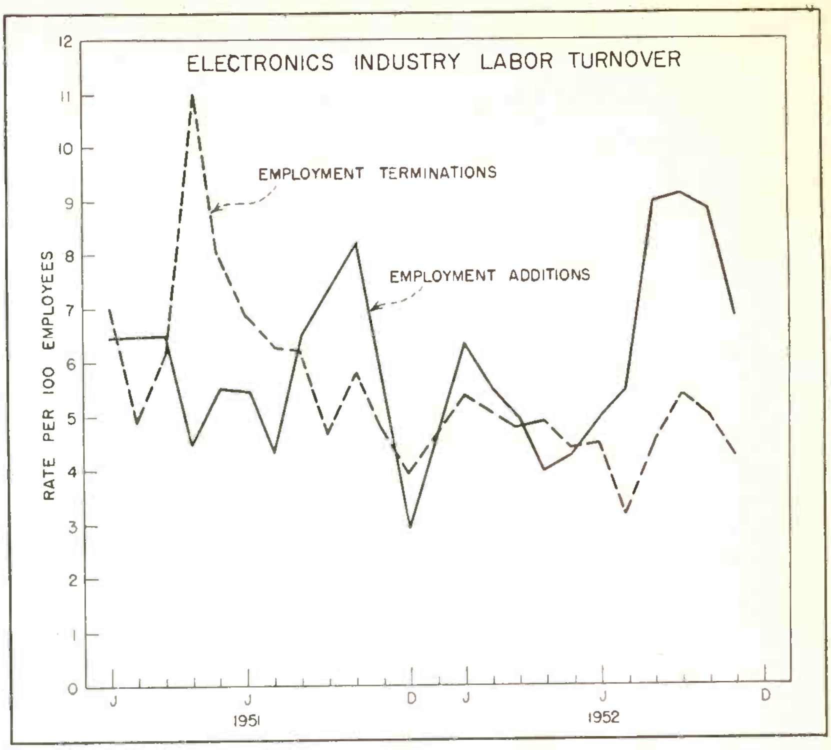
High-Power UHF-TV Moves Up

LATER THAN PROMISED but still the first high-power uhf station was WHUM-TV Reading, Pa., which went on channel 61 during the morning of February 10. Feature of the 260-kw (erp) plant is the GE transmitter employing a Varian 12-kw klystron tube in its final stage.

Scheduled to join the NBC and ABC networks on March 15 was another 12-kw transmitter, also on channel 61, at WWLP, Springfield, Mass. Complementing the uhf program fare, with CBS and DuMont networks, will be still a third high-power transmitter assigned to Holyoke, Mass. Signals from this channel-55 station, WHYN-TV, will serve essentially the same area as the Holyoke station.



First high-power uhf transmitter uses klystron to feed television signals up 1,000-foot waveguide to antenna with power gain of 22



HIRINGS and firings in radio-tv plants fluctuate but . . .

Electronics Labor Turnover Drops

Decline in termination rate reflects industry's increased employment stability

DURING 1952, an average of 4.7 per 100 employees were separated from their electronic jobs every month, representing a decline of 1.6 from the average rate of 6.3 in 1951. Total terminations were made up of resignations, discharges, layoffs and miscellaneous reasons, including military ones.

Most terminations were voluntary. Voluntary separations averaged about 2.7 per 100 employees each month in 1952. Discharges during the year ranged between 0.4 and 1.0 and averaged about 0.6 per month. Miscellaneous terminations never exceeded 0.7 and averaged less than 0.4 per 100 employees in 1952.

▶ **Additions**—Employment of workers in electronic plants reached the highest rate since 1950 in October of last year when manufacturers increased production to meet seasonal demand. The employment addition rate seems to follow the seasonal sales pattern of the industry and August, September and October are traditionally the months of highest employment rates in the industry, as is indicated in the chart.

▶ **Outlook**—Electronic manufacturers look for a continued decrease in labor turnover in the industry in 1953 because they expect high production throughout the year. The usual seasonal fluctuations are taken for granted but they are not expected to be as severe as in 1951 and 1952.

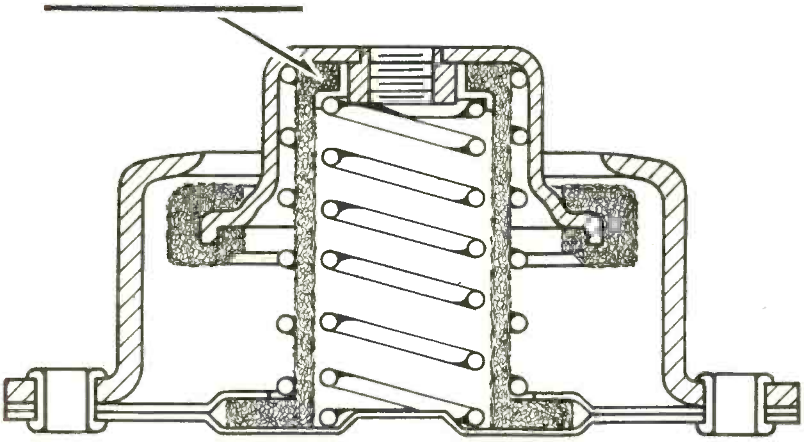
Financial Roundup

PROFIT statements for 1952 along with security transactions were announced by electronic manufacturers in the past month. Twelve

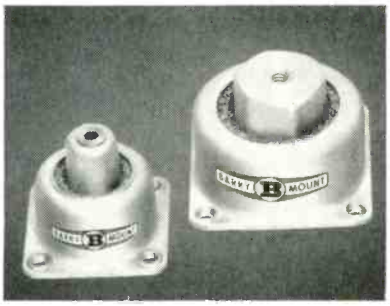
(Continued on page 16)

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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companies showed up in annual reports as follows:

Company	Net Profit 1952	1951
Admiral	$8,711,133	$9,586,833
American Cable and Radio	699,444	1,460,625
Arvin	2,209,733	2,691,063
Burroughs	7,893,419	7,588,724
DuMont	1,424,603	583,377*
IT & T.	22,147,753	17,992,314
Minn. Honeywell	9,081,003	9,277,510
National Union Radio	139,920	370,910
Standard Coil	2,861,290	2,487,944
Sylvania	6,960,625	8,253,973
Thos. A. Edison	1,201,782	1,305,548
Zenith	5,845,933	5,370,740

* Loss

▶ **Stocks Filed**—Avco filed with SEC for 11,500 shares of common stock (par $3) to be offered at the market (approximately $8.50 per share) for the account of the selling stockholder.

Radio Condenser filed with SEC for 27,000 shares of common stock (par $1) to be offered at $11 per share. Net proceeds together with $1.5 million to be received from sale of 4½-percent serial notes will be used for expansion program, debt financing and for working capital.

Telecomputing Corp. filed with SEC for 5,639 shares of capital stock (par $1) to be offered at $15 per share. Proceeds will be used for working capital and for the account of selling stockholder.

Inter-America Electronics of Puerto Rico filed with SEC for 938 shares of preferred stock at $100 per share and 7,900 shares of common at $10 per share. Proceeds will be used to purchase equipment.

Packard-Bell registered with SEC for 100,000 shares of its capital stock, $.50 par value, to be offered for public sale. Net proceeds will be used for expansion of main plant. It is expected that $500,000 will be used for construction of a new cabinet plant, $100,000 for additional machinery and equipment and $300,000 to replace working capital used in 1952 for construction. Remainder will be used to pay debts and for working capital.

▶ **Security Offerings** — Cinerama offered $2 million in 4-percent convertible debentures due March 1, 1958. Net proceeds will be added to general funds and used to furnish and install exhibition equipment for 3 additional theaters.

Mohawk Business Machines offered 144,000 shares of 12-cent cumulative preferred stock (par $1) at $2 per share. Proceeds will be used for working capital and to acquire additional machinery for the production of an electronic stapling machine and a midget battery recorder.

Radar-Electronics offered 5,996,000 shares of common stock (par 1 cent) at 5 cents per share. Proceeds will be used for working capital and for the expansion of operations.

Arcturus Electronics offered $200,000 in 5-year 6-percent convertible debentures due April 1, 1958. Proceeds will be used for general corporate purposes.

P. R. Mallory offering of 150,000 shares of 4½-percent cumulative convertible preferred stock at par ($50 per share) was oversubscribed. Proceeds will be added to general funds for general corporate purposes.

▶ **Other Transactions** — Westinghouse has borrowed $50 million from a group of institutional investors completing a $300 million credit set up in November, 1951. The lenders include insurance companies, pension funds, savings banks and universities. Loans will be used to finance the company's $296 million expansion program and to provide additional working capital.

CBS sold privately $25 million in 4¼-percent promissory notes due Jan. 15, 1973 to insurance companies. Proceeds of initial borrowings will be used for general corporate purposes.

Clevite Corp. will offer 200,000 shares of stock for sale. Proceeds will be used for general funds and working capital.

EAST GERMAN family gathers around Russian-designed receiver, as . . .

TV Gains Slowly Behind Iron Curtain

East Germans build sets but Russia takes output as part of war reparations

TELEVISION progress in Russia and satellite countries has been slow, due largely to lack of essential raw materials and particularly those needed by tube manufacturers. Demands arising from Soviet-army build-up and enlargement of telephone and telegraph networks are so high that other needs receive less consideration.

▶ **Stations**—Transmitters are operating in Kiev, Leningrad and Moscow. Pravda reports 80,000 sets in use. Poland and Czechoslovakia, both of which had experimental transmitters before World War II, are still testing. In East Germany, a Soviet-controlled transmitter is

(Continued on page 18)

For Accurate — Reliable — and FCC Approved —

Measurements of MODULATION, DISTORTION and NOISE

in the Broadcast Station

The G-R Type 1931-A Modulation Monitor and Type 1932-A Distortion and Noise Meter are highly accurate instruments widely used in broadcast stations for monitoring modulation and measuring distortion and noise in audio frequency circuits. Transmitter operators find these instruments convenient and extremely reliable in operation. They meet all FCC specifications.

The Distortion and Noise Meter is a most versatile laboratory tool. It permits complete and accurate wave analysis of fundamentals from 50 to 15,000 cycles and harmonics to 45,000 cycles, when used with an oscilloscope. Its ability to rapidly and accurately measure frequency, audio voltage, AVC characteristics and hum level, has adapted it to a wide variety of measurements in the communications laboratory. This Meter is also used for the production checking of radio receivers, attenuators, audio amplifiers and oscillators, and electronic instruments and components.

Type 1931-A *Modulation Monitor* ..0.5 *to* 8 *Mc. or* 3 *to* 60 *Mc.* ... **$440.00**

Type 1931-P5 ...0.5 *to* 8 *Mc. Extra Tuning Coil* **16.50**

Type 1931-P6 ...3 *to* 60 *Mc. Extra Tuning Coil* **16.50**

The G-R Type 1931-A Modulation Monitor

★ *Operates over a wide carrier-frequency range — 0.5 to 8 Mc. or 3 to 6 Mc. depending upon tuning coils used; either set supplied with instrument.*

★ *Continuously indicates percentage modulation of either positive or negative peaks, as selected by a panel switch — meter range is 0 to 110% on positive peaks, 0 to 100% on negative peaks.*

★ *Provides a very useful overmodulation alarm whose flashing rate increases markedly when modulation peaks are in excess of a predetermined level set by a panel dial.*

★ *Requires about 0.5 watt input R-F power.*

★ *Measures the relative magnitude of any carrier shift occurring during modulation.*

★ *Has two low-distortion audio-output circuits operating from separate diode rectifiers:*
One is matched to a 600-ohm line for audible monitoring. Other output supplies a faithful reproduction of the carrier envelope for measurement of transmitter distortion and noise with the aid of a distortion and noise meter — output amplifier is flat to within 1.0 db. from 30 to 30,000 cycles.

Type 1932-A *Distortion and Noise Meter* .... **$595.**

The G-R Type 1932-A Distortion and Noise Meter

★ *Features rapid and continuous frequency adjustment over the entire audio frequency range — one main tuning control and push buttons are used.*

★ *Includes a high gain amplifier which balances to a null at frequency set by the main tuning dial, and thus passes to the meter circuit only the distortion components present.*

★ *Measures distortion values as low as .05%; 0.10% above 7,500 cycles.*

★ *Detects noise levels down to 200 μv — instrument noise is considerably less than 80 db.*

★ *Accuracy is essentially ±5% of full scale for distortion, noise and dbm measurements.*

GENERAL RADIO Company®
275 Massachusetts Avenue, Cambridge 39, Massachusetts, U. S. A.
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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

operating in Berlin. Another transmitter at Brocken, highest point in the Hartz Mountains, is testing and will soon be beaming programs to West Germany.

Plans are afoot to install by 1955 transmitters in all 14 district capitals of East Germany. These will be linked in a network diverging from Berlin.

▶ Receivers—The set shown in the photograph is the Russian-designed Leningrad T-2 model. It has a 7-inch screen and no provision for radio reception; price in East Berlin is 3,500 East Marks, $117 at official rates.

Although East German plants have made these sets for some years under Soviet license, their output has been delivered largely to the Soviet Union as war reparations. When television service was inaugurated last December the East Germans were promised 2,000 sets. Only 800 were delivered. Production quota for 1953 is 4,000 sets. So far sets are seen only in public buildings, party offices and homes of high officials.

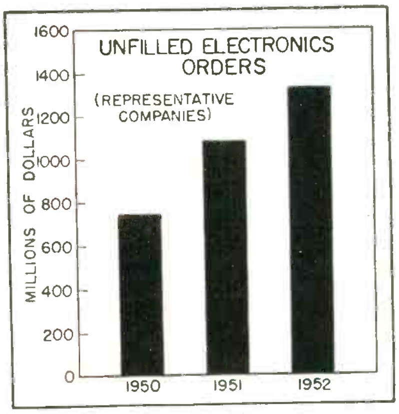
German engineers, many of whom worked in television before the war, complain that they are hampered by Russian engineers assigned as consultants but actually running the show, thereby slowing up progress and initiative. Another difficulty is that East Berlin transmitter operates on the same frequency as the West German station in Hamburg, Germany.

Electronics Backlog Still Growing

ABUNDANT health of the electronics industry is indicated by growth in the backlog of both defense and civilian orders of several representative companies in the field. Although the amounts shown in the accompanying graph are but a fraction of the total electronic equipment backlog, they indicate the rising trend.

Another indication of the volume of unfilled orders for the industry is the backlog of orders for the Electrical Machinery classification of the Department of Commerce in which electronics is included: 1950, $3.8 billion; 1951, $8.9 billion; 1952, $11.3 billion.

Further evidence of the rising backlog is the recent announcement by GE that its backlog now is greater than at any time in the history of the company.



▶ Future—Manufacturers point out that backlogs do not tell the entire story of the amount of work that the industry or a company expects to do. Many contracts are just initial orders and contracts for additional quantities may be reasonably expected.

Many manufacturers expect unfilled orders to continue high throughout 1953 but feel that the industry will be able to fill most of its orders during 1954.

New Material for Electronic Memories

COSTING more than gold ($560 a pound) a new super-thin nickel-alloy steel has been developed by Armco for use in electronic memories. The gossamer steel, made in strips up to two inches wide, is as thin as one 125-millionth of an inch, or 8×10^{-9}, or 1/20 the thickness of a human hair.

Because the material is so thin a few cents buys a foot of it.

Antenna Industry Reviews UHF

New tv markets bring many changes to the highly-competitive sky-hook business

ALMOST a year has past since the first uhf television station went on the air and antenna and set manufacturers are reviewing the uhf antenna business as it stands today.

▶ Market—There are 25 uhf television stations on the air now in nearly as many different market areas. They have made more than a million homes potential uhf antenna customers for a possible sales volume of over $10 million. In addition, of the 324 cp's that have been granted, 213 or 2/3 are for uhf stations that will eventually come on the air bringing in more business.

Nearly half of the existing uhf markets are actually combination uhf-vhf markets. And, nearly every existing vhf market is also a potential combination market. Thus, antenna manufacturers must now serve three types of markets: the vhf, the uhf and the combination uhf-vhf.

▶ Merchandise—Unlike receiver manufacturers, the antenna manufacturer cannot serve these varied markets with one product for best results. He must have a line of merchandise that not only serves all markets but that also meets the various reception conditions within each market. As a result, antenna manufacturers now offer as many as 12 different models of uhf antennas to meet these conditions at prices ranging from $5 to $50.

However, experience in the new markets has indicated to some antenna makers and users that there are four basic antennas that will meet nearly all requirements. These are the rabbit-ear indoor for primary signal areas, the stacked-V antenna for combination markets, the bow tie with a selection of backing elements for uhf only and the corner reflector for fringe area uhf reception.

But these basic models are by no

(Continued on page 20)

means the last word in uhf reception. Antenna and receiver manufacturers are constantly investigating old and new configurations. With uhf less than a year old commercially, definite trends are difficult to detect, but some industry observers feel that there is the beginning of a trend away from the all-wave antenna for combination markets. They feel that separate vhf and uhf elements mounted on the same or separate masts will eventually be the standard set-up for the combination markets.

▶ **Outlook**—Sign of the bright sales outlook in the antenna business was the recent expansion by General Motor's United Motors Service Division of its line of electronic parts to include uhf and vhf antennas. They will be marketed under the Delco name and sold through electronic parts distributors throughout the country.

Another bright sign in the antenna picture today is the growing accessory business. Rotator sales are increasing markedly in uhf markets. In addition, each uhf antenna means the sale of crossover networks, usually the printed-circuit type, to handle the two types of transmission line and a new lightning arrestor for uhf lead-in. Thus despite lower unit prices for uhf antennas, the industry is finding uhf-tv markets a lucrative addition to the still substantial vhf antenna business.

Bank Accounting Work Cut by Television

LINKING six tellers to a central accounting room by a closed circuit tv system has increased speed of banking service and eliminated a large part of the clerical work involved in withdrawals.

The new system, now in use at the New York Savings Bank, permits the tellers to check the signature and bank balance on any account without leaving their windows. An intercom system is used to give the bankbook number to the accounting room. The customer's account card, bearing his signature, is removed from the file and placed in front of a tv camera. The teller compares the information on the withdrawal slip with that on the account card, visible on a tv screen built into the counter.

Since the system uses only one camera, the account cards show on the screens at all six windows. A portion of the screen is assigned to each teller and cards requested by that teller are shown on that portion of the screen.

▶ **Microwave**—A new branch of the bank soon to be opened at Rockefeller Center will be connected with the central office by tv and telautograph systems. The possibility of using microwaves for the two-mile tv link is being investigated.

In addition to making all accounts available at all branches, use of the centralized system would permit the bank to open smaller offices in high rent areas where cost of floor space for an accounting department would make the operation too expensive.

Account cards requested by tellers are placed under tv camera in accounting room

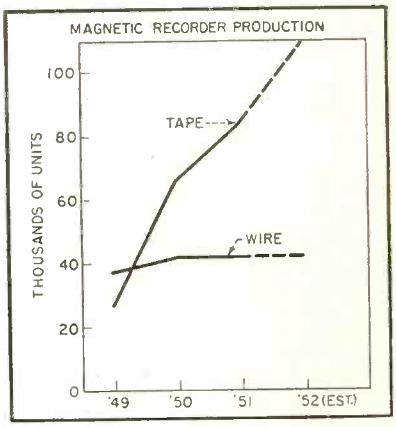
Teller compares customer's signature with that on account card in the bank's files

Recorder Sales On Way Up

Volume has tripled in three years, with tape leading the race

INDICATION of the growing importance of magnetic recorders is the production total of 26 companies in the field. According to latest figures, 152,000 magnetic recorders were made in 1952 by these companies. At an average retail value of $170, this has meant sales of at least $26 million for the industry.

▶ **Tape vs. Wire** — Projection of past trends indicates that tape recorders accounted for the bulk of the business in 1952. Another indication of rising tape recorder sales is the fact that sales of tape alone last year amounted to about $5 million. With new and better tapes coming on the market, this volume may well double in 1953.



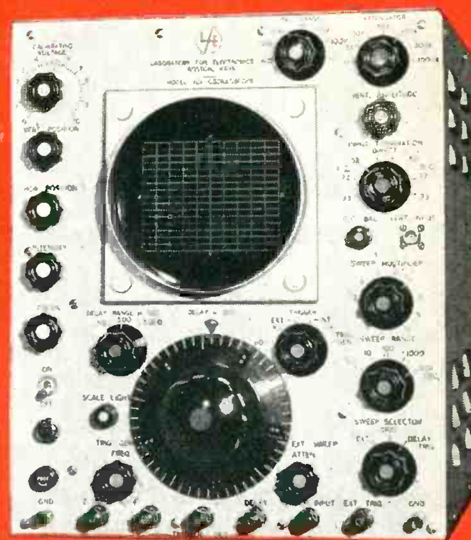
In 1952 there were 39 manufacturers of magnetic recorders in the U. S. Eight of these companies made wire recorders, and four made wire recorders exclusively. In 1951 10 of the 39 companies in the field made wire recorders.

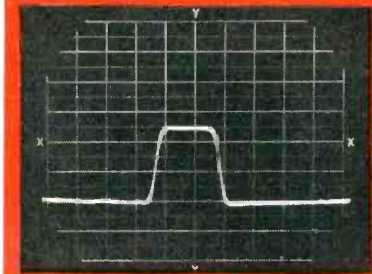
About 70 percent of all magnetic-recorder sales are to people who use

(Continued on page 22)

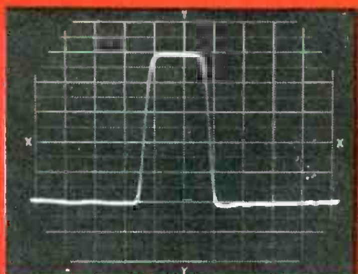
ONLY THE LFE 401 OSCILLOSCOPE

Offers all these Important Features



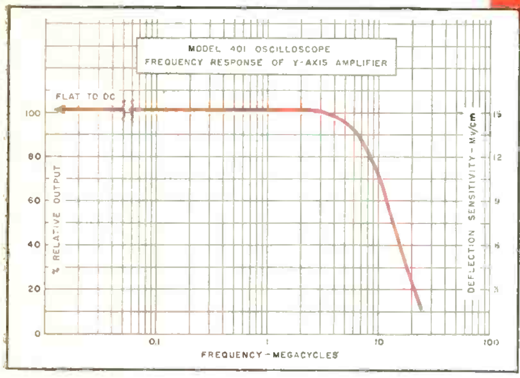


37.5 Mv., 0.2 μ sec width, 1 μ sec sweep full scale



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.



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, D-C and A-C.

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 $\mu\mu$ f
Probe—10 megohms, 10 $\mu\mu$ 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, or 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

LABORATORY for ELECTRONICS, INC.
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PRECISION ELECTRONIC EQUIPMENT • OSCILLOSCOPES • MAGNETOMETERS • COMPUTERS • MICROWAVE OSCILLATORS

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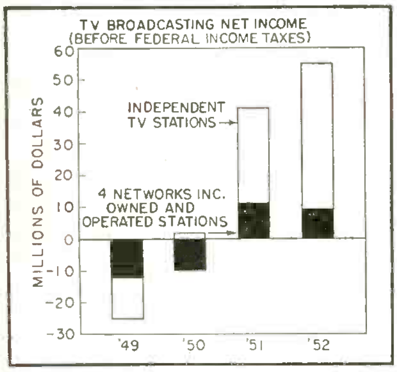
them for professional purposes. Remaining sales are to home users, according to a survey of the magnetic recording field.

TV Broadcasters Set New Income Record

Net before taxes for 1952 reached 54.5 million, 31 percent above 1951

TELEVISION NETWORK and independent stations in the U. S. had a banner year financially in 1952, according to preliminary reports submitted to the FCC by all tv broadcasters. Total broadcast revenue from time, talent and program sales was estimated at $336.3 million, 43 percent above the 1951 volume of $235.7 million. Income after expenses but before taxes was estimated at $54.5 million, or 31 percent above the 1951 volume of $41.6 million.

▶**Networks**—Four tv networks (including 15 owned-and-operated stations) reported tv revenues of $191.9 million, expenses of $182.9



million and income of $9.0 million. The 1952 network tv revenues were almost 50 percent above 1951. However, as a result of a 56-percent increase in expenses, network tv income was reported at $2 million below the 1951 figure of $11 million.

▶**Independents**—Ninety-three tv stations (not owned or operated by the networks) made a better showing than the networks in 1952. Their revenues were estimated at $143.7 million, 33 percent above 1951. Station expenses increased at a slower rate (28 percent), so that the income of these stations rose to $45.6 million, or 51 percent, above 1951.

Fourteen other tv stations that were authorized in 1952 after the lifting of the freeze estimated total revenues at $700,000, expenses of $800,000, for a loss of $100,000. Of the 14 stations, only 3 were in operation more than 2 months during 1952.

Doerfer Approved As FCC Commissioner

Senate Commerce Committee okays Eisenhower choice unanimously

JOHN C. DOERFER is at work on the Federal Communications Commission, the first Eisenhower appointment to the agency. Another is due in midyear when chairman Walker's term expires.

The Senate Commerce Committee, evidently favorably impressed by Doerfer's background and his manner of handling questions directed to him at the hearing on confirmation, unanimously approved him for the post. He replaces Eugene Merrill (Utah, D), appointed to fill the unexpired term of Robert Jones, who resigned last year. The term runs to June 30, 1954 but it is considered likely that at that time Doerfer will get a full seven-year appointment.

▶**Background**—The new commissioner is 49 years old, a native of West Allis, Wisconsin and a graduate of the University of Wisconsin and Marquette University Law School. He became a member of the Wisconsin Public Service Commission in 1949 and subsequently was elected chairman. He was a member of the National Association of Railroad and Utilities Commissioners and was chairman of its committee on regulatory procedures.

While he has had no experience in the radio-television field, commissioner Doerfer has had wide experience in utilities, including wire communications.

John C. Doerfer, new FCC Commissioner. He may become chairman when Walker's term expires June 30. Another possibility is Commissioner Hyde.

The Commission now stands with 3 Republicans, 3 Democrats and 1 Independent, assuming that Doerfer lines up with the Republicans. The division is as follows: Rosel Hyde (Idaho, R), George Sterling (Maine, R), Edward Webster (D.C., Independent), Paul Walker (Okla., D), Robert Bartley (Texas, D) and Frieda Hennock (N. Y., D).

Tube Industry Sets TV Picture-Tube Trends

New focusing method, changed face plates and bigger sizes are on the way for 1953

TREND to simplify receivers was accelerated by GE's introduction of an internal magnetic focus gun at the recent IRE show. The new tube eliminates the external focus coil and ion trap magnet. Focusing is done by three built-in tiny Alnico 5 magnets. A fourth magnet is used in the ion trap. The new tube will cost about $1.50 more than present magnetic tubes.

▶**Faces**—Picture tube face plates shown at the show in 24-inch and

(Continued on page 24)

POSITION WANTED

with a coil that has an important job to do, by a core made of G A & F Carbonyl Iron Powders. Core offers know-how born of long experience, high permeability, high Q, unusual stability and references from many major employers....

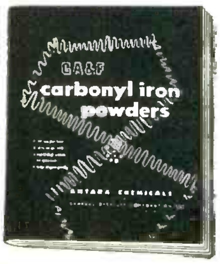
G A & F Carbonyl Iron Powders are used to produce cores for transformer and inductor coils of every form—to increase Q values, to vary coil inductances, to reduce the size of coils, to confine stray fields and to increase transformer coupling factors.

These powders are microscopic, almost perfect spheres of extremely pure iron. They are produced in seven carefully controlled types, ranging in average particle-size from three to twenty microns in diameter.

Similarly, their properties vary, making them useful in many different applications. Engineers have commented on the fact that cores made from these powders lend themselves to smoothness of adjustment and to ease of grinding. The extremely small size of the particles is of enormous value, since eddy currents develop only within each particle—proportional to the square of the particle diameter.

We urge you to ask your core maker, your coil winder, your industrial designer, how G A & F Carbonyl Iron Powders can increase the efficiency and performance of the equipment or product you make, while reducing both the cost and the weight.

Write for wholly new 32 page book—the most comprehensive treatment yet given to the characteristics and applications of G A & F Carbonyl Iron Powders. 80% of the story is told with photomicrographs, diagrams, performance charts and tables. For your copy—without obligation—kindly address Department 50.



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Division of GENERAL DYESTUFF CORPORATION

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27-inch sizes used spherical-faced bulbs. Envelope manufacturers say that they use less glass than cylindrical-faced tubes. Weight of the latter has brought problems in shipping and handling.

▶ **Sizes**—The 24-inch and 27-inch tubes are expected to take their place in production this year. Some manufacturers expect the 24-incher to account for 20 percent of production and as much as 10 percent for the 27-inch. They expect the 21-inch to account for the bulk of production followed by the 17-inch.

FCC Clarifies Rules of Emergency Radio

TERMS and extent of possible use of the Special Emergency Radio Service were clarified and enlarged by the FCC in a report and order effective March 27, 1953.

The amended rules do the following:

- Set forth the eligibility, class and number of stations available, kinds of communications permitted and other particulars concerning the use of the service.
- Clarify the eligibility of physicians to use this service by changing their present limitation of "remote area" to "rural area" (any area outside a population center of more than 2,500 population).
- Delete the present requirement that other communication facilities be unavailable before rural area physicians, veterinarians and school bus operators can take advantage of this service.
- Make communication common carriers eligible for mobile operation in this service to facilitate repair of interrupted public wire facilities involving intercity circuits or service to many subscribers.
- Provide for the secondary use of certain ship-telephone frequencies by special emergency fixed stations in isolated areas, such as an island where the applicant can show arrangements made with the public coast station for the radio service desired.
- Give emergency stand-by radio facilities for private as well as common carrier communication circuit operators for use during periods of failure of the normal circuits. In the case of the private operator, this facility is restricted to circuits which normally carry essential communications which, if disrupted, endanger life or public property.

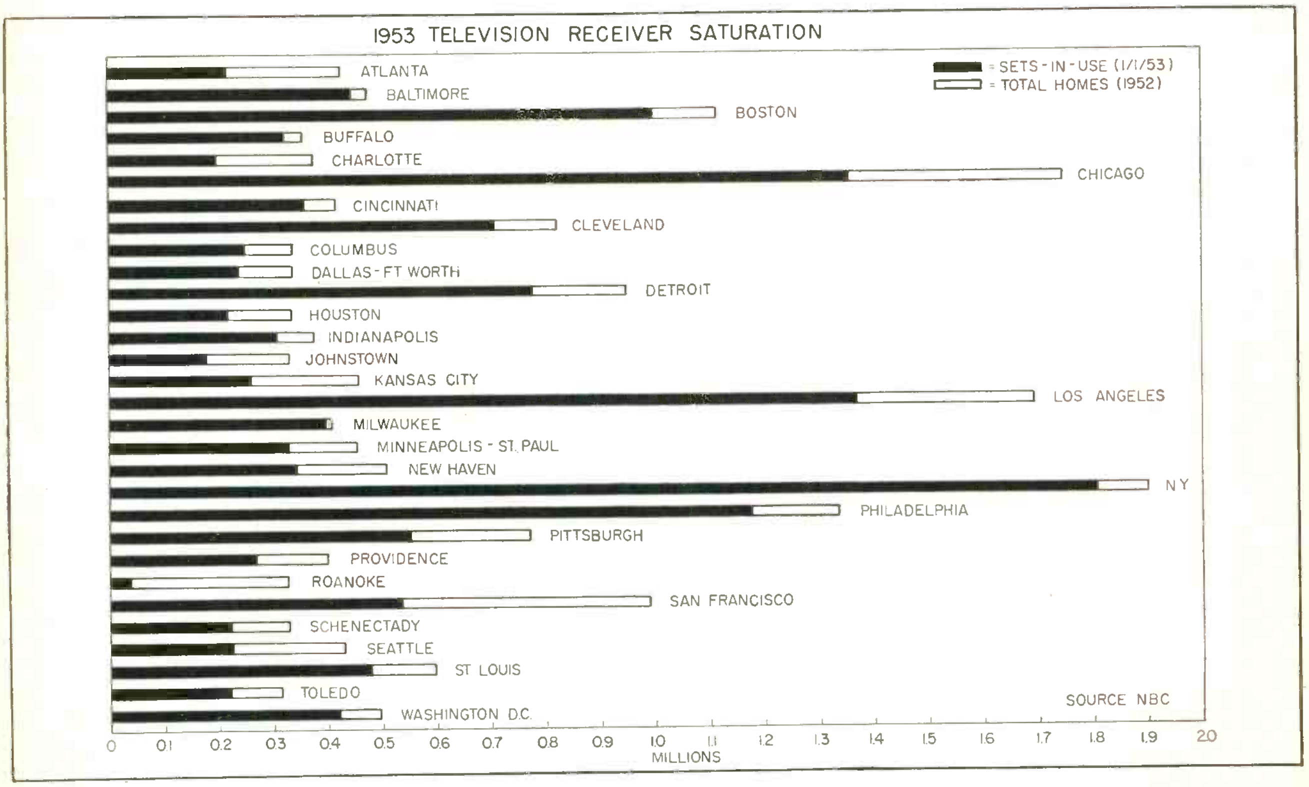
Electronic Heaters Require Certificates

DRYING, sealing, gluing and molding operations that use radio-frequency heat must be inspected by a competent engineer before June 30 of this year, according to an announcement from Federal Communications Commission.

▶ **Interference Reduction**—Among other things, the required inspec-

(Continued on page 26)

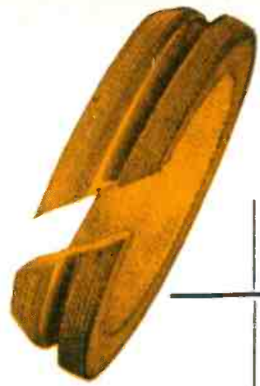
Where 93% of U. S. TV Sales Were Made



As of January 1, 1953 there were 76 U. S. tv markets containing 30 million homes and 21,234,100 sets. The 30 areas shown in the chart contain 22.3 million homes (75 percent of potential market) and 19.8 million tv receivers (93 percent of total sets in use). Saturation in these 30 areas is about 89 percent, in the other 46 markets, only 18 percent

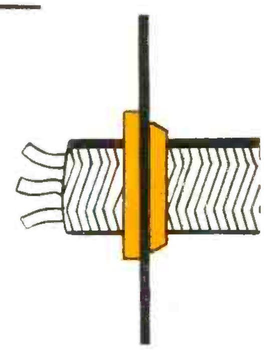
C-D-F *know how*

Designed and Fabricated this DILECTO GROMMET



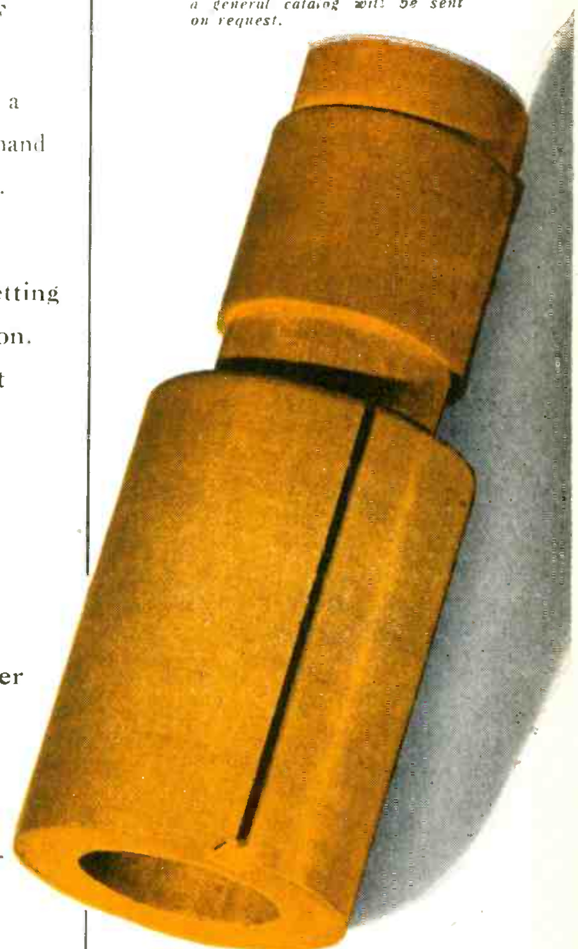
It springs out and holds tight!

Here's an idea and an example of C-D-F engineering skill teamed up with versatile Dilecto — laminated rolled plastic tubing — that can help you. Thousands of Dilecto grommets are being used in the aircraft industry for wire and cables that pass through bulkheads. Made from fine weave canvas, the C-D-F Dilecto grommet is cut into rings. The rings are grooved and beveled, then slit diagonally. The Dilecto grommet has a built-in tension that permits it to be easily compressed by hand and inserted in the bulkhead. Tension holds it tightly in place. It cushions. It insulates. It reduces assembly time.



Here's a side-view of a Dilecto grommet, machined to close tolerances from laminated rolled tubing. Sample of grommet and a general catalog will be sent on request.

DILECTO is a C-D-F top quality laminated thermosetting plastic whose uses are limited only by the imagination. Supplied in sheets, rods, tubes, Dilecto answers most electrical and radio needs for a material that is mechanically and dielectrically strong . . . resistant to high heat, hot oil, excessive humidity. It can be punched, stamped, formed and machined to close tolerances. Investigate its possibilities. Available in many grades to meet a variety of requirements. A qualified plastics specialist, your C-D-F sales engineer (offices in principal cities) will help you engineer a better product. Why not call him today!



Another example of a part machined from Dilecto rolled tubing. Notice variety of machining steps and the possible versatility of this mechanically strong material. Only C-D-F makes Dilecto in sheet, tube and rod forms.

THE NAME TO REMEMBER CDF DILECTO LAMINATED PLASTIC

Continental-Diamond Fibre Company

NEWARK 16, DELAWARE

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tion certificate must show that industrial heating equipment is sufficiently shielded and filtered to prevent interference to radio communication services and television.

The certificate must also show that the equipment can be expected to remain in proper adjustment for at least three years. Such proof is to be kept available near the machine for inspection by FCC representatives.

MEETINGS

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.
APRIL 29-MAY 1: AIEE North Eastern District Meeting, Sheraton-Plaza Hotel, Boston, Mass.
MAY 9-25: 1953 Paris International Trade Fair, Porte de Versailles, Paris, France.
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 20-22: 1953 National Telemetering Conference, Edgewater Beach Hotel, Chicago, Ill.
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.
MAY 27-29: 1953 7th Annual Convention, American Society For Quality Control, Convention Hall, Philadelphia, Pa.
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: WESCON (Western Electronic Show & Convention), IRE (7th Region) and WCEMA (West Coast Electronic Manufacturers' Association) cosponsors, 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.

Low-Power Stations Can Economize

SMALL-COMMUNITY radio broadcast stations, beset by licensed-operator shortages and decreasing advertising rates, have received help from the Federal Communications Commission. As of April 15, rules previously announced but held in abeyance, became effective for a-m and f-m stations under 10 kw using nondirective antennas.

▶ **Reduced Requirement** — Under the new setup, only one first class radiotelephone operator need be on call to perform maintenance and adjustment on transmitting equipment. Announcer-operators who now spin platters and deliver the commercial can throw the switches.

New rules also allow remote control. Although some mountain-top transmitters have been operating in this manner under special authority, it is expected that the bulk of new remote-control operations will extend over very short distances—perhaps from the ground floor to the roof.

Industry Shorts

▶ **Employees** assigned to guided missile research, development and production number over 3,300 at Northrup Aircraft.

▶ **More** than 35,000 pleasure boats in the U. S. are now equipped with radiophones.

▶ **Projection** television receiver on sale in Germany for $600 throws a 30 by 39-inch image on a screen, using a projection tube less than 2½ inches in diameter.

▶ **Italian** tv industry's preliminary estimate of 1953 receiver production is 50,000 units.

▶ **France** will have about 100,000 tv sets in operation by the end of 1953, according to the country's Ministry of Information.

▶ **Average** tv service dealer is revealed by a GE survey to have grossed $21,000 last year at the rate of $8 per call. His 5.3 servicemen each handle 37 calls a week. Eighty percent of the work is performed in the set owner's home. The average dealer has more business than he can handle. His 1952 gross service income will be 27 percent higher than last year's.

▶ **Two Billion** dollars will be spent by the Federal Government in 1953 for research, most of it essential to national defense. More than half this sum will be spent for work in private research laboratories, the balance going to universities and government-owned labs.

▶ **Atomic** reactor components will be produced by Sylvania with its own capital and sold to the Atomic Energy Commission and to other interested parties on a competitive price basis as soon as practical. At present, the company is under contract to the AEC for the advanced development of new types of reactor components.

▶ **Million Dollar** radio center with 15 transmitters is planned for Bloemfontein, capital of the Orange Free State, in Africa.

▶ **Dollar** value of guided missile deliveries is currently running over twice that of third quarter 1950 deliveries.

making "SPECIALS"* out of STANDARDS...

at SPECIAL CONTROLS HEADQUARTERS

*There isn't the price differential you'd expect between Clarostat *standard* controls and those *special* controls you need.

Using established designs, elements and production facilities for standard controls made by the tens of thousands, Clarostat engineers can come up with ingenious modifications at *marked savings to you.*

Note the standard 1⅛" carbon control that became a dual-concentric with locked semi-permanent settings. Or the 15/16" standard which, with rubber gaskets, meets water-tight requirements.

Making "specials" out of "standards" is all in the day's work at Clarostat, when you're *economy-minded.*

STAND PAT WITH

Send us those "special" control requirements for the most economical solution. Engineering data, quotations, delivery schedules, on request.

CLAROSTAT Controls and Resistors

CLAROSTAT MFG. CO., INC., DOVER, NEW HAMPSHIRE

In Canada: Canadian Marconi Co., Ltd., Toronto, Ontario

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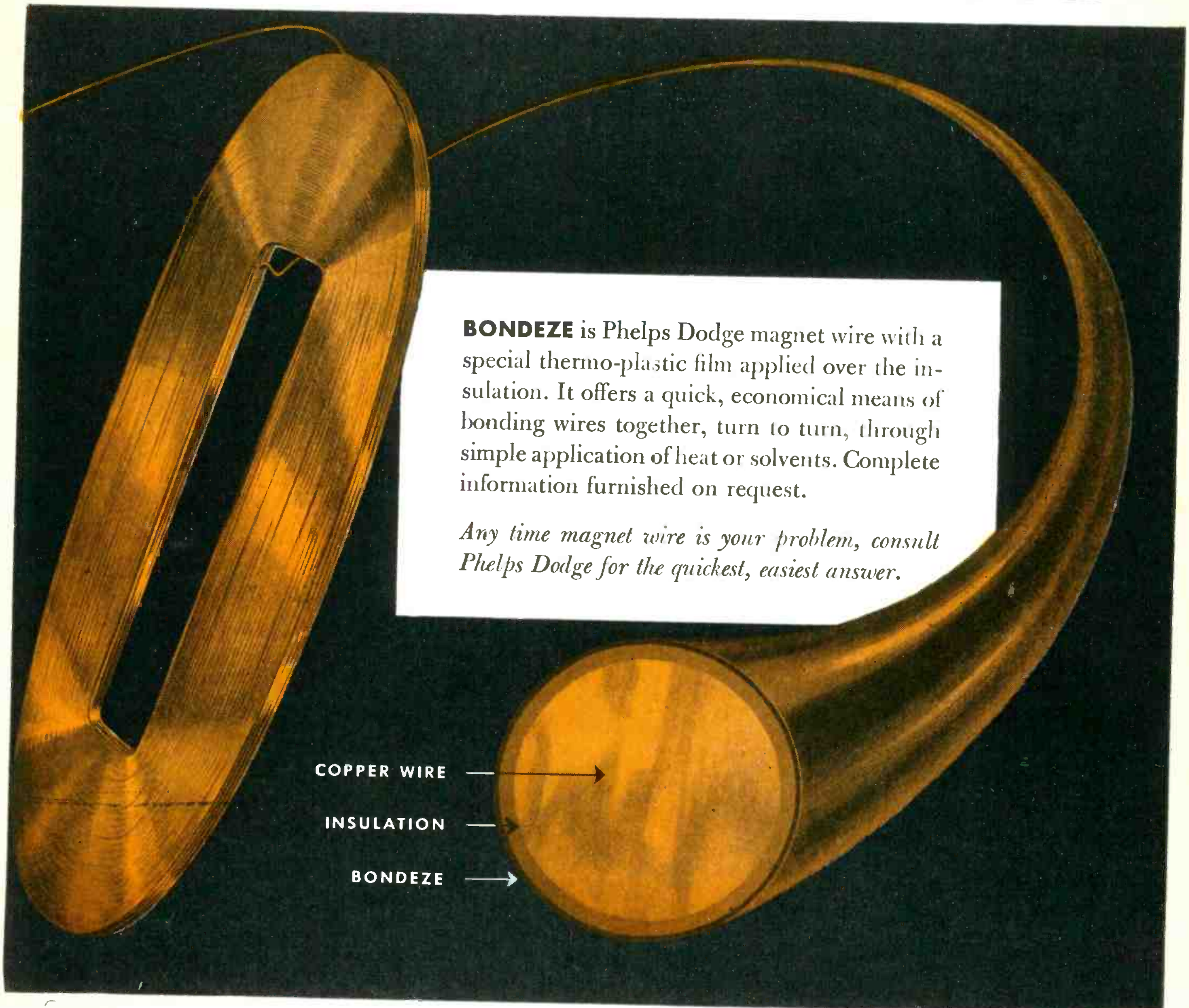
in Magnet Wire--BONDEZE*...

COIL WINDING COSTS!



BONDEZE is Phelps Dodge magnet wire with a special thermo-plastic film applied over the insulation. It offers a quick, economical means of bonding wires together, turn to turn, through simple application of heat or solvents. Complete information furnished on request.

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

*Bondeze is a Phelps Dodge Trade Mark

to make the best!"

PHELPS DODGE COPPER PRODUCTS CORPORATION

INCA MANUFACTURING DIVISION

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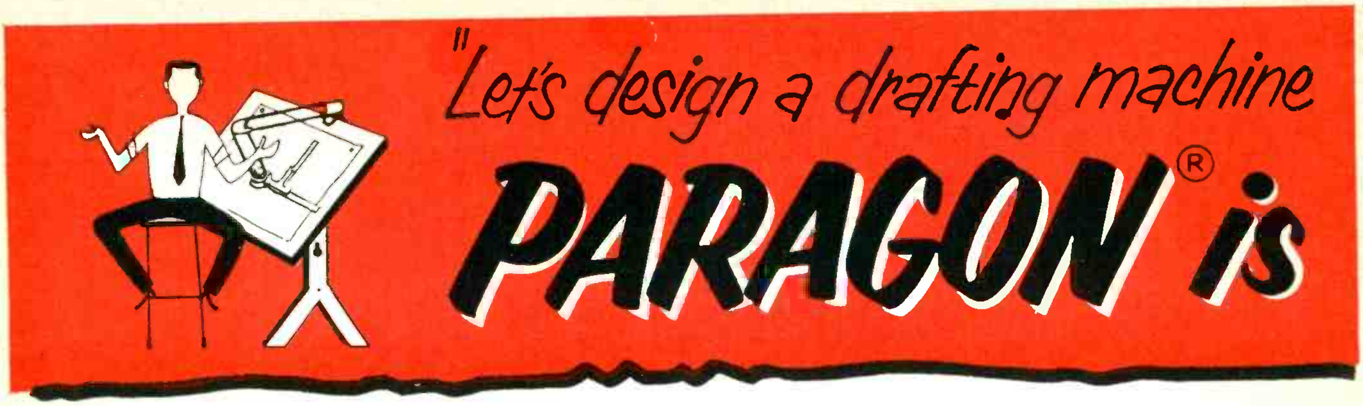
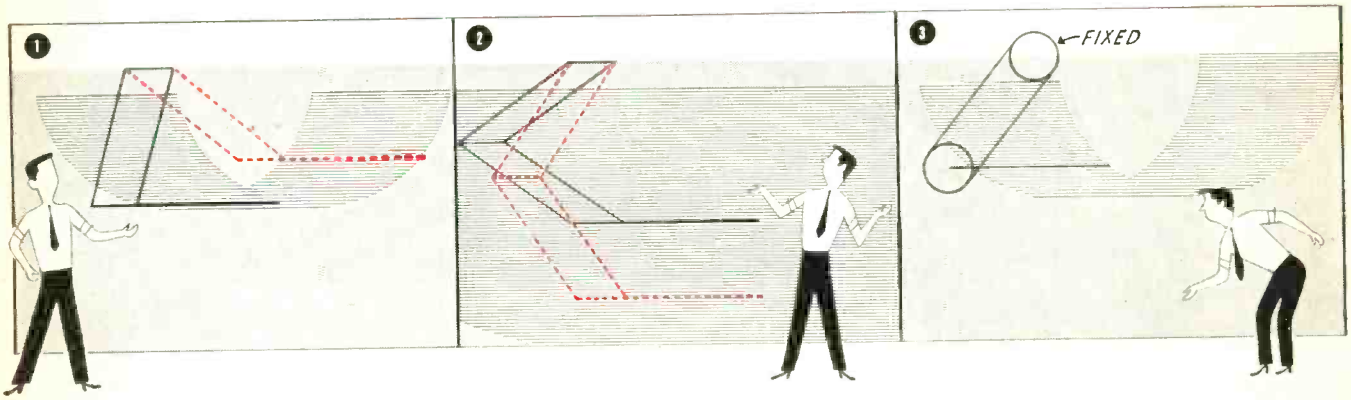
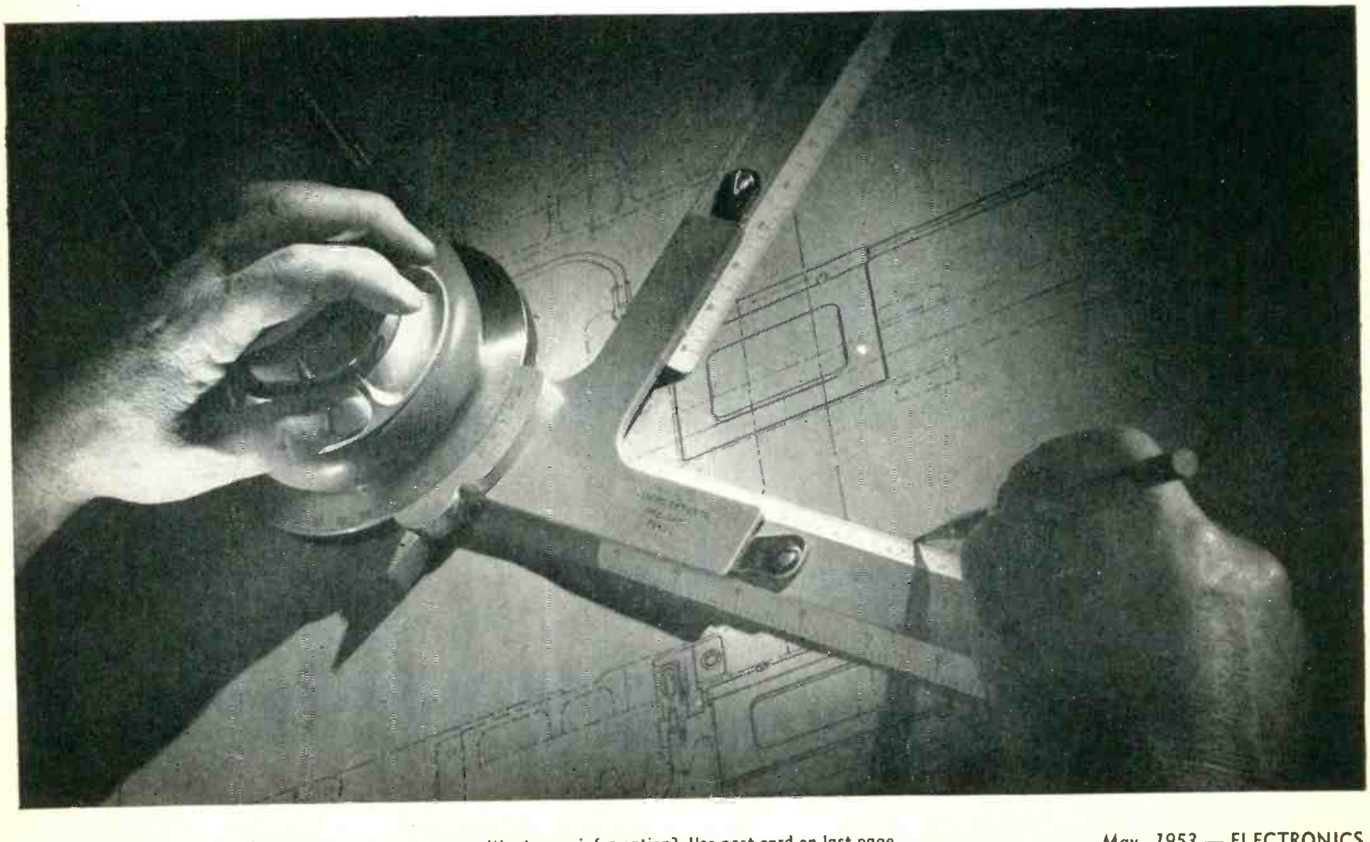




Start with a parallelogram somewhat like this. Visualize one of its short sides anchored to the top of a drawing board parallel to your base line, and let the remaining three sides be free to move together. Add a projecting straightedge to the bottom side as shown, and it will theoretically stay parallel to the base line. Parallel lines could be drawn anywhere within the shaded area above. But clearly, that field of action is too limited.

To obtain parallel motion over the entire working surface of the board, a second parallelogram could be coupled to the bottom of the first so that both have one short side in common. An elementary drafting machine would result . . . at least in principle. In practice, it would fall short because the slightest play at any of its 8 joints would create gross error at the straightedge.

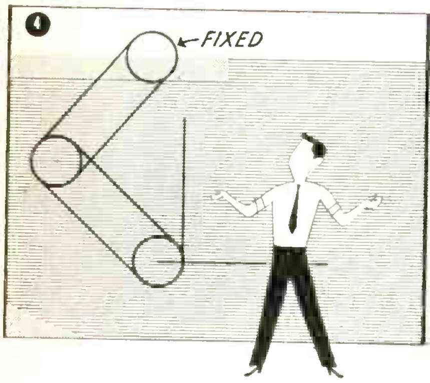
What is needed is a better mechanical design based on the same parallelogram principle. Take a pair of rotating drums, connect them with a tight steel band, and the assembly will behave like a parallelogram if the drum diameters are equal. Now couple a second band-and-drum assembly to the first in such a way that they have the middle drum in common . . . and you have the basis of a modern drafting machine.

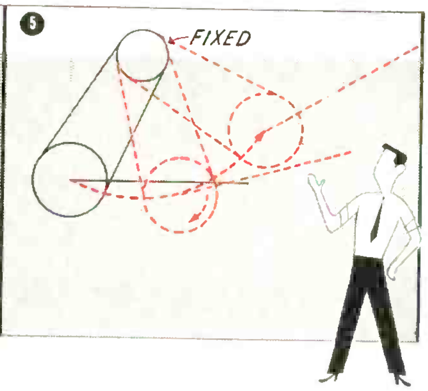


and find out WHY—

BETTER!"

The Right Angle





The band-and-drum machine, with all three drums of precisely equal diameters and with bands which will not slip, will draw absolutely parallel lines over the entire working area. But if the drum diameters are not equal, the parallelogram principle is violated and the machine cannot draw parallel lines. The greater the difference in diameter the more the lines will be out of parallel.

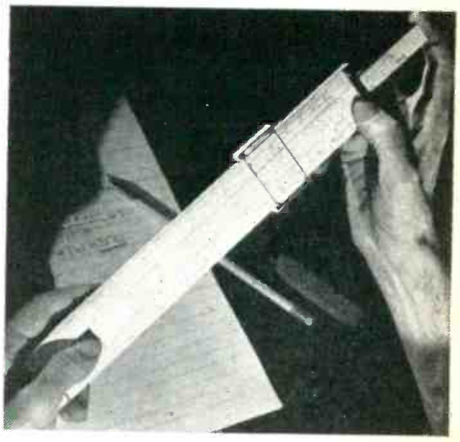
Here, in exaggerated form, is what happens when two of the drums are not equal in diameter. This could occur in either arm of the machine, conceivably in both arms with the errors being additive. From this it is clear that a central factor in the accuracy of a drafting machine is the accuracy of all drum diameters. That is why K&E goes to very extraordinary lengths in this regard in building PARAGON Drafting Machines.

These basic principles and the advanced engineering design in the PARAGON combine to give you the finest in drafting machines. You realize this as soon as you place your hand on the controls.

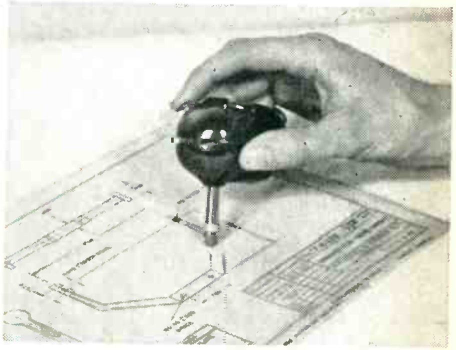
The scales rotate freely with the lightest pressure on the protractor control ring. Release it and they are locked at the nearest 15° position. Intermediate angles are easily set.

Another PARAGON feature is the open center construction of the arms. Even when they are twisted by lifting the head of the instrument off the board, it is impossible to disturb the factory-set band tension.

Ask your K&E Distributor or Branch to tell you about other PARAGON features or give you an actual demonstration.



An engineer without a K&E Slide Rule is like a doctor without a stethoscope. It's the badge of the profession . . . with good reason. The first American-made slide rule was a K&E, and generations have known these rules for their precision, readability and velvet-smooth operation. They come in all types.



After you've once used a K&E MOTORASER,† you'd no more go back to hand erasing than you'd take to drawing with your gloves on. With MOTORASER you can either pin-point your objective, or cover a larger area without damage to the drawing surface. Runs on 110 volt 60 cycle AC, or DC with an inexpensive adapter.

†TRADE MARK

K+E

PARTNERS IN CREATING

KEUFFEL & ESSER CO.

EST. 1867

Drafting, Reproduction, Surveying Equipment and Materials, Slide Rules, Measuring Tapes

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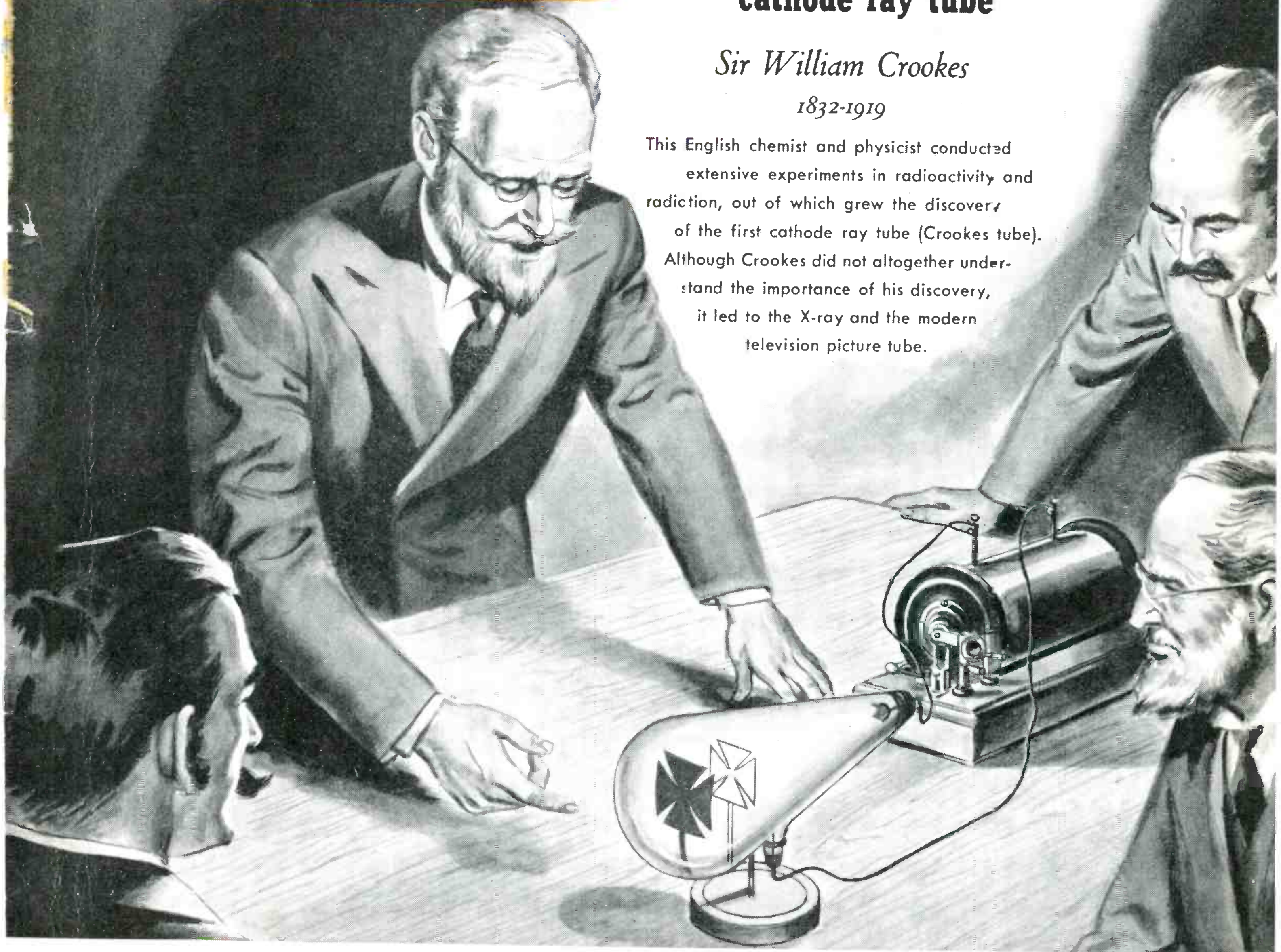
CROOKES... FIRST to produce the cathode ray tube

Sir William Crookes

1832-1919

This English chemist and physicist conducted extensive experiments in radioactivity and radiation, out of which grew the discovery of the first cathode ray tube (Crookes tube). Although Crookes did not altogether understand the importance of his discovery, it led to the X-ray and the modern television picture tube.



From an original drawing made for Ohmite

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Be Right with

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RHEOSTATS

RESISTORS

TAP SWITCHES

Industry *prefers* Ohmite wire-wound resistors . . . more manufacturers *use* Ohmite resistors than any other make. Their popularity is due to Ohmite's emphasis on *quality* . . . on "extra" design and construction features that insure long, trouble-free life and unfailing dependability. Ohmite means *wider choice*, too—the most complete line on the market!

OHMITE® Wire-Wound RESISTORS
Built FOR LONG LIFE AND DEPENDABLE OPERATION
EVEN, UNIFORM WINDING
The unsurpassed uniformity of the resistance winding prevents "hot spots" and resultant failures. This uniformity is *permanent* — locked in by vitreous enamel.
VITREOUS ENAMEL COVERING
Acts as both heat conductor and electrical insulator. Holds the winding rigidly in place, and protects it against mechanical damage, moisture, and fumes.
TINNED TERMINALS
Terminal lugs are tin-dipped for ease in soldering to connecting wires. Resistance wire is welded or brazed to the lug, assuring perfect electrical connection.
STRONG CERAMIC CORE
The high-strength ceramic tube provides a sturdy insulating base for the resistance winding. It is unaffected by cold, heat, fumes, or high humidity.
RESILIENT MOUNTING BRACKETS
Hold resistor firmly in place, yet have resilience to prevent shock damage. Brackets are simple to attach; can be easily removed by a slight upward pressure at the base.
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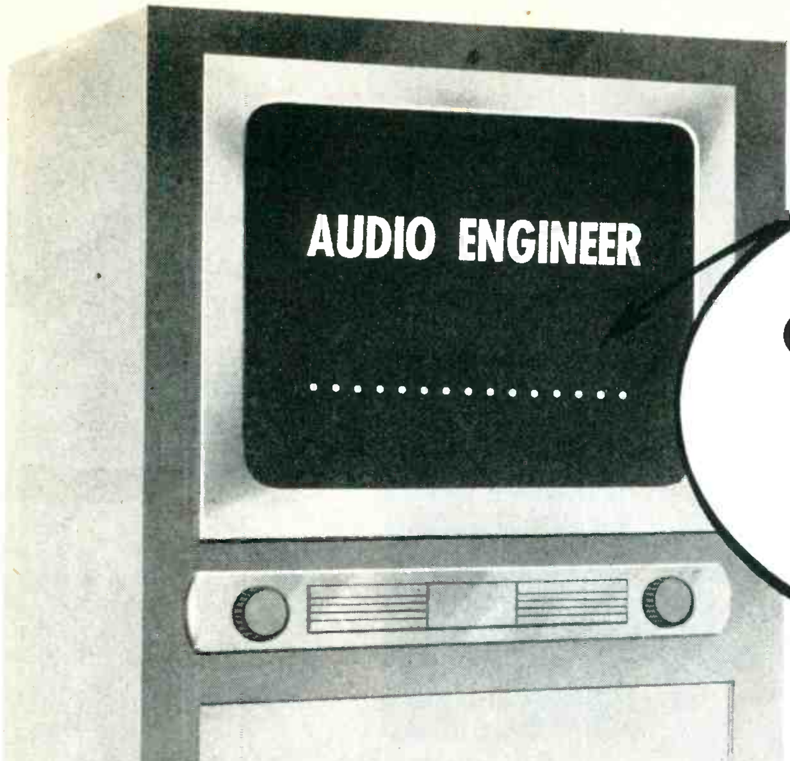
RHEOSTATS • RESISTORS • TAP SWITCHES



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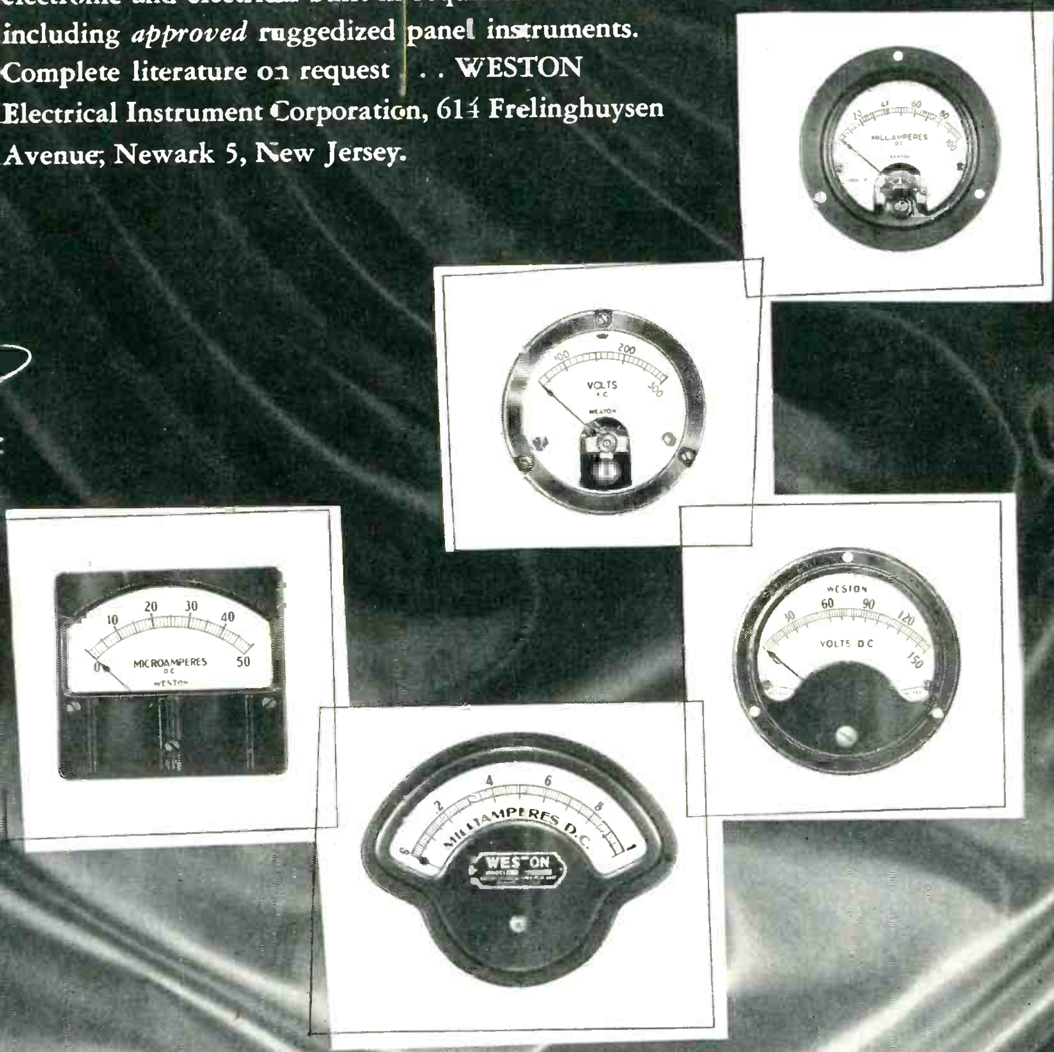

Weston PANEL INSTRUMENTS

The resistors that

NEW

Above & beyond MIL-R-93A specifications

PERFORMANCE DATA AND CHARACTERISTICS:

DIMENSIONS:

The physical sizes of Durameg Molded Precision Resistors are identical in dimension with MIL styles.

SPRAGUE TYPE	MIL-R-93A STYLE
82E	RB09 (Proposed)
83E	RB15
84E	RB16
85E	RB17
86E	RB18

COMPARATIVE WATTAGE RATINGS:

SPRAGUE		MIL-R-93A	
Type	Wattage at 105°C	Style	Wattage at 85°C
82E	0.75	RB09 (Proposed)	
83E	1.25	RB15	0.25
84E	1.80	RB16	0.33
85E	2.10	RB17	0.50
86E	2.50	RB18	0.50

MAXMIMUM RESISTANCE VALUES:

Durameg Resistors meet MIL performance requirements not only with 1.5 mil. dia. wire specified in MIL-R-93A, but with 1.3 mil. dia. wire as well.

	MAXIMUM MEGOHMS	
SPRAGUE TYPE	1.5 Mil.	1.3 Mil.
82E	0.10	0.15
83E	0.18	0.27
84E	0.34	0.50
85E	0.63	1.00
86E	1.05	1.60

LOAD LIFE:

Durameg Resistors withstand a 500-hour life test with rated wattage applied intermittently with 1½ hours on and ½ hour off for a total of 500 hours without changing in resistance more than the tolerance specified or 0.5%, whichever is smaller.

SHORT TIME OVERLOAD:

Exceeds MIL-R-93A requirements.

MOISTURE RESISTANCE:

Exceeds MIL-R-93A requirements.

SALT WATER IMMERSION CYCLING:

Exceeds Characteristic A JAN-R-93 requirements.

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SPRAGUE ELECTRIC COMPANY
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DURAMEG RESISTORS WATTAGE RATINGS ARE BASED ON FULL RATED DISSIPATION AT 105°C AMBIENT TEMPERATURE. THESE RATINGS ARE FROM 4 TO 5 TIMES THE 85°C MIL RATINGS FOR THE BEST OF CONVENTIONAL RESISTORS.

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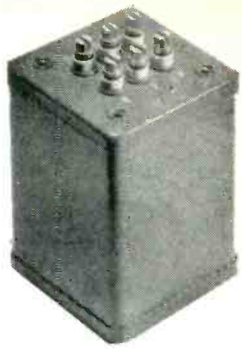
AIRCRAFT TRANSFORMERS



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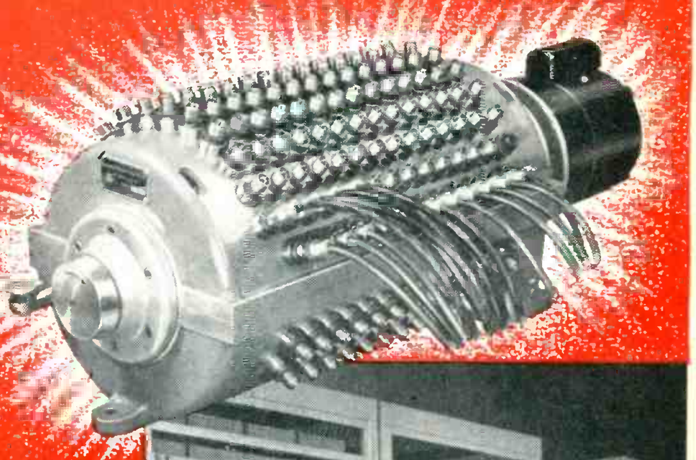

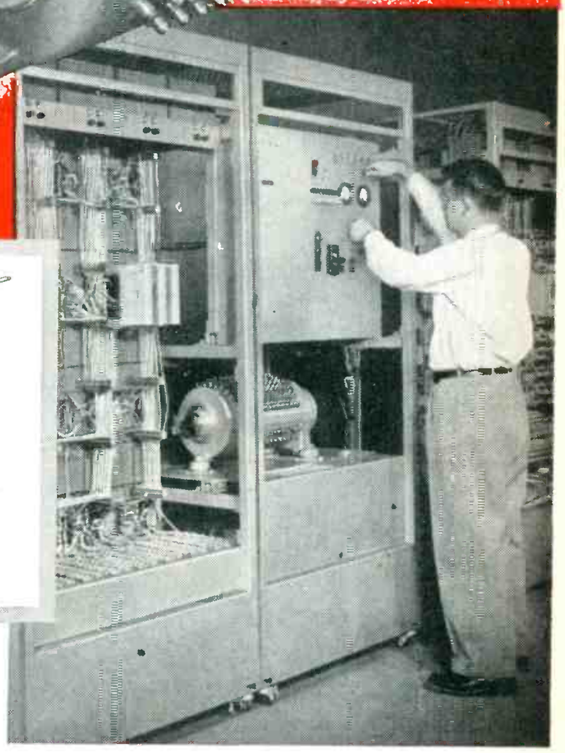

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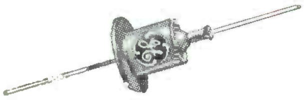

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Developed for radar and military communications. May be applied to computers, magnetic amplifiers, telephone switchboards, and many other electronic fields.

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St. Paul, Minnesota

400 General Electric JA1A1 rectifiers were used in the storage system shown under construction above.

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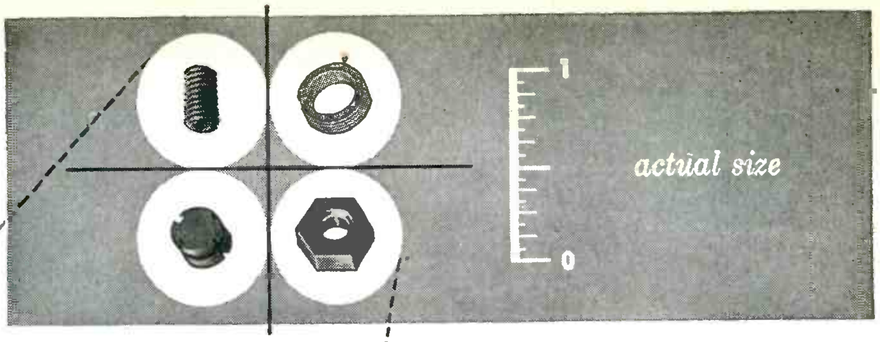

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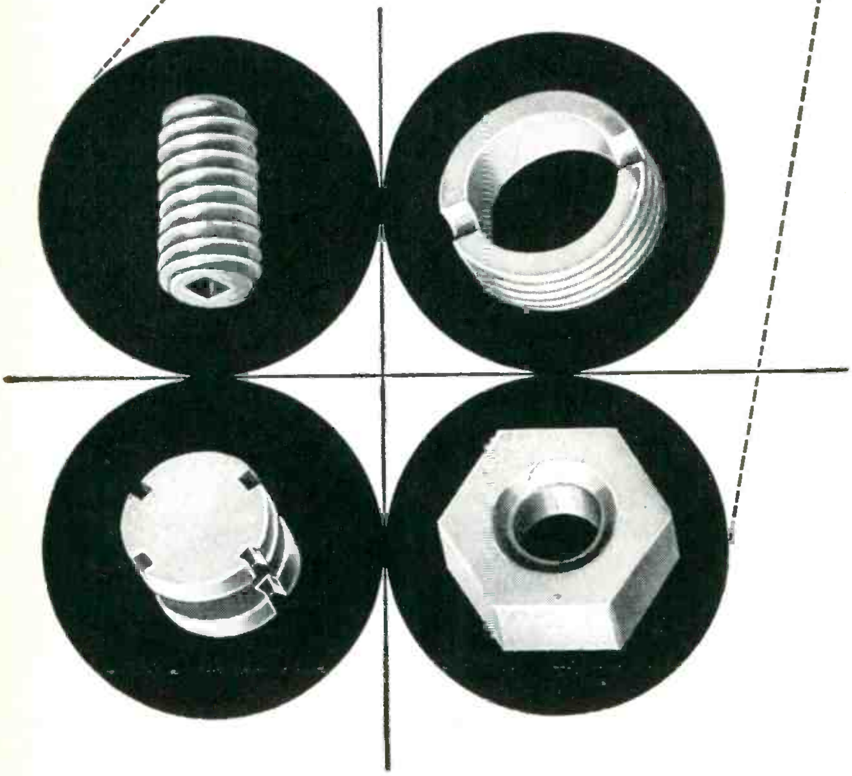

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will bring you complete information
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cores, their electrical properties,
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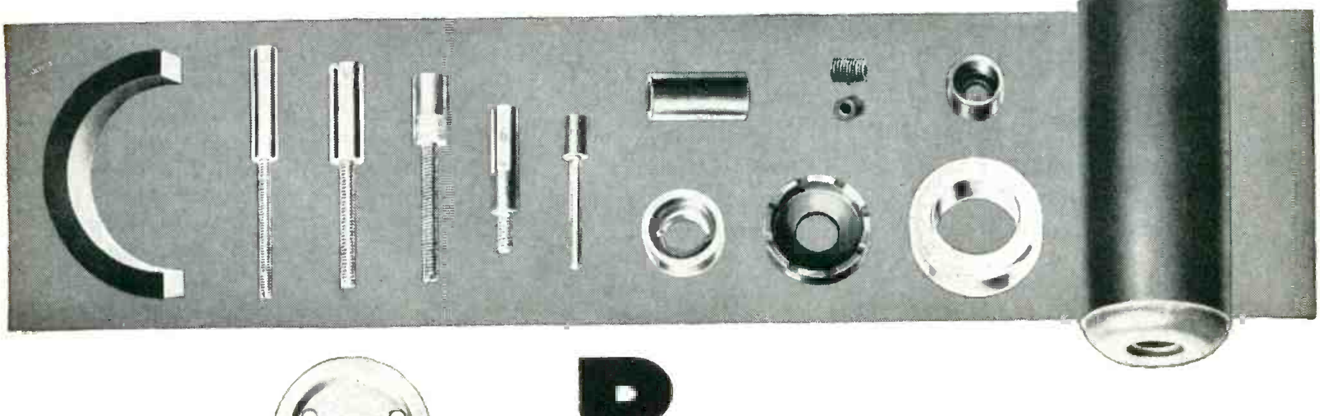

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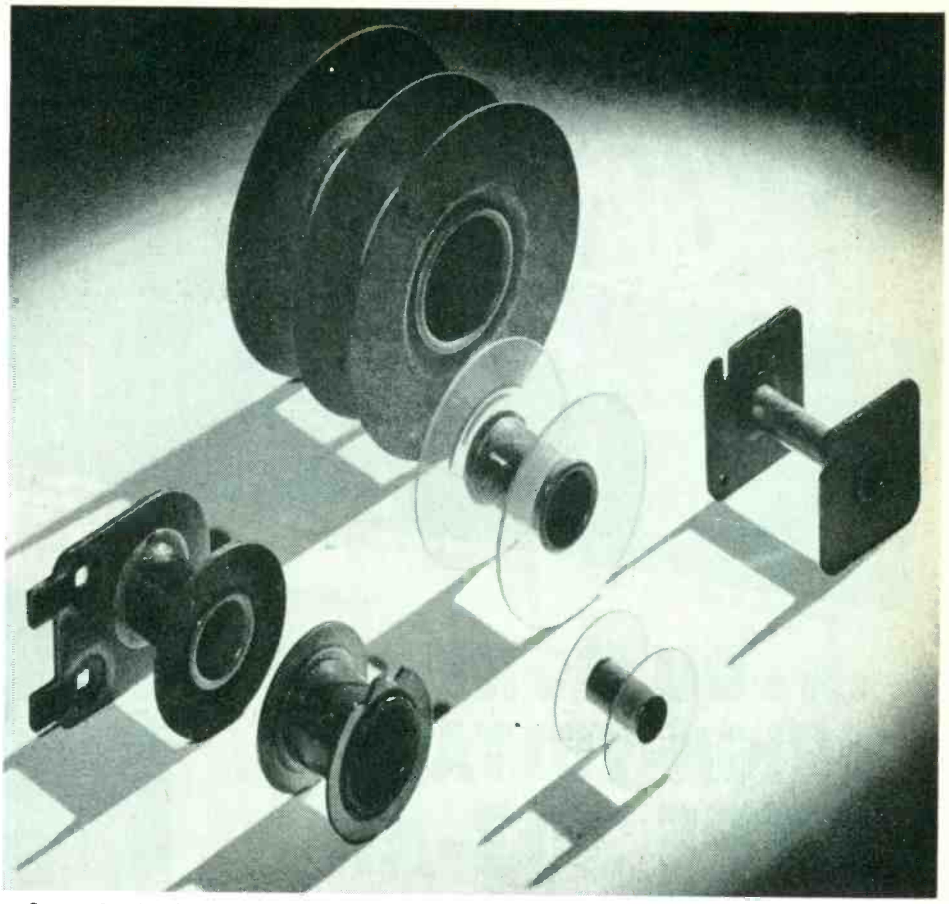

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CHANCES are you can come up with a possible use for a Stone paper tube with the resulting benefit . . . *quality at low cost.* And we will help you make its use practical . . . gladly.

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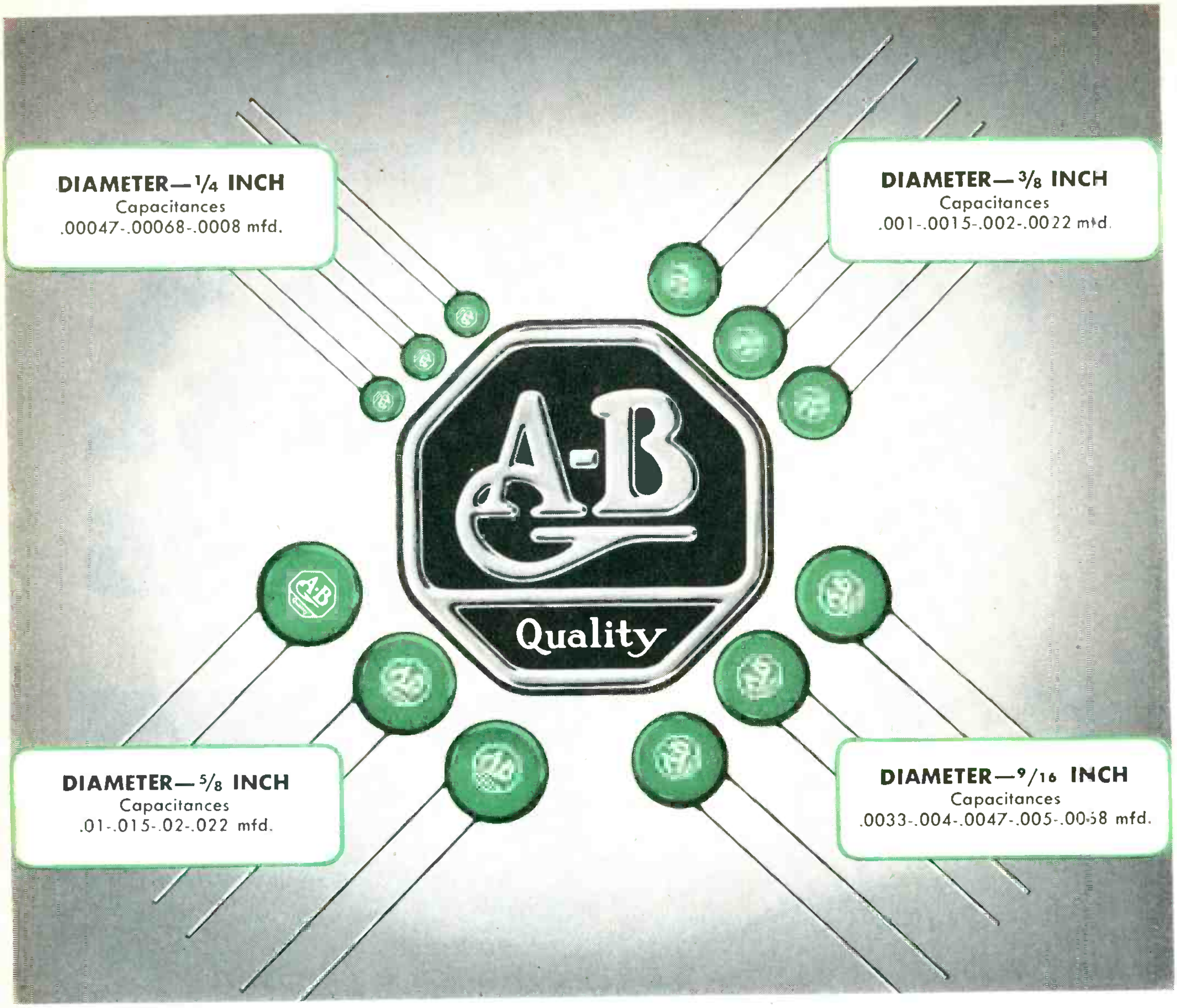

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Scientific supervision is maintained at every step in the production of Allen-Bradley ceramic capacitors. Starting with the compounding of the materials for the ceramic discs and continuing, step by step, through the molding, sintering, silvering, soldering, and wax impregnating of the finished capacitors . . . every operation is under Allen-Bradley precision control. A quality product is the consistent result.

Allen-Bradley capacitors are made in four sizes with a range of .00047 to .022 mfd. Minimum capacitance values are guaranteed over a temperature range from plus 10C to plus 65C. Since the ceramic discs of high K dielectric are molded and sintered in the Allen-Bradley factory, not only is the production of an ample supply of ceramic discs assured but the uniformity of the finished capacitors can be rigidly maintained at all times under Allen-Bradley production controls. Because of their uniformity of quality and performance, Allen-Bradley ceramic capacitors have been approved by the engineering departments of the largest electronic, electrical, and telephone laboratories.

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Specify Allen-Bradley ceramic capacitors . . . they are as dependable as the well-known Allen-Bradley resistors and potentiometers. The A-B trademark is your guarantee of quality capacitors. Samples will be furnished on request for qualification tests and type approval.

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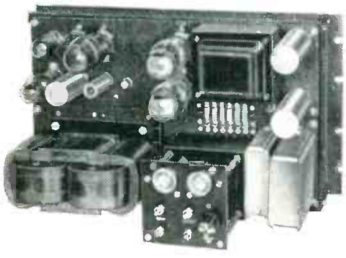
TYPE IE INSTANTANEOUS ELECTRONIC



For the most exacting control

featuring:

INSTANTANEOUS CORRECTION — as compared with any other type. Operation is entirely electronic without moving parts. Complete correction is effected in 3 to 10 cycles depending on variations in line voltage, load current, load power factor and other conditions.

EXCELLENT STABILIZATION AND REGULATION — The maximum change in output voltage will not exceed: ±0.25 per cent for any or all changes or variations in operating conditions — ±0.1 per cent for input voltage changes — ±0.15 per cent for load current or power factor changes from lagging 0.5 to leading 0.9.

MINIMUM WAVEFORM DISTORTION — Except under the most adverse conditions, distortion is usually under 2 per cent.

MUCH WIDER INPUT RANGE — than most competitive types. Ranges are 95-135 volts for a nominal output of 115 volts and 195-255 volts for a nominal output of 230 volts.

ADJUSTABLE OUTPUT VOLTAGE — Output from a nominally 115 volt unit is adjustable from 110 to 120 volts and from 220 to 240 volts on a nominally 230 volt unit.

INSENSITIVITY TO FREQUENCY CHANGES — but to maintain optimum correction characteristics, tolerances should not exceed ±10 per cent of the specified frequency.

STANDARD MODELS — are available in numerous ratings in capacities up to 5.0 KVA.

TYPE EM ELECTRO MECHANICAL

to control industrial loads — offer zero waveform distortion

featuring:

UNUSUALLY HIGH EFFICIENCY — is an outstanding feature of the Type EM. It is comparable to that of the most conservatively designed fixed-ratio transformers.

ZERO WAVEFORM DISTORTION — is a primary requirement for many electronic applications. Type EM provides a constant output voltage which is a faithful and distortionless reproduction of the applied input waveform.

RAPID CORRECTION — Type EM is an electro mechanical device. While it does not correct instantaneously, it provides faster correction than most other automatic voltage regulators.

WIDE INPUT RANGE — is another important feature. Range is 95-135 volts for a nominally 115 volt unit; 195-255 volts for a 230 volt unit; 400-520 volts for the 460 volt units.

ADJUSTABLE OUTPUT VOLTAGE — Output from a 115 volt unit is adjustable from 110 to 120 volts; output from a 230 volt unit is adjustable from 220 to 240 volts; output from a 460 volt unit is adjustable from 420 to 460 volts.

INSENSITIVE TO FREQUENCY AND SYSTEM POWER FACTOR — Designed for 50/60 cycle power lines, all of the Type EM will perform satisfactorily at any frequency from 45 to 65 cycles. In addition, Type EM is insensitive to the magnitude and power factor of the load and has no effect on the system power factor.

STANDARD MODELS — are available for 115, 230 or 460 volt, 50/60 cycle, single and three phase operation in capacities up to 100 KVA.

. . . AND SPECIAL TYPES application engineered to meet individual requirements

Specializing in the design, development and manufacture of Voltage Control Apparatus, The Superior Electric Company offers its experience to help in solving any voltage control problem. The Superior Electric Company is pleased to analyze your individual needs and will recommend the STABILINE Automatic Voltage Regulator best suited to your application.

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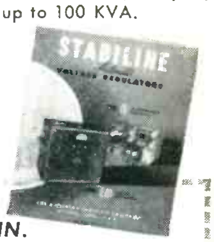
SEND COUPON TODAY FOR BULLETIN S351 featuring engineering and application data on STABILINE Types IE and EM.



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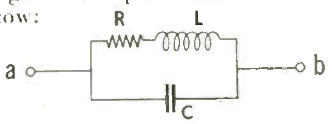
WHAT ABOUT

Frequency Response

IN *PRECISION WIREWOUND* RESISTORS?

Precision wirewound resistors have residual parameters that change the resistor from a simple resistance to a complex impedance which is a function of frequency. The effective resistance and reactance of a precision wirewound resistor can be computed from a knowledge of the parameters in the equivalent circuit below:



The d-c resistance is R, the equivalent inductance in series with the resistor is L, and C is the equivalent capacitance in parallel with the resistor. With L and C small, as they usually are, it can be shown that:

$$Z_{ab} = \sqrt{R_e^2 + X_e^2} \, \angle\theta \qquad \omega = 2\pi f$$

$$R_e \cong R[1 + \omega^2 C(2L - CR^2)] \qquad X_e \cong \omega(L - CR^2)$$

$$\tan\theta \cong \frac{X_e}{R}$$

where Z_{ab} is the impedance at terminals a-b, R_e is the effective resistance, X_e is the effective reactance, and θ is the resistor phase angle. From these expressions it is apparent that:

1. The effective resistance will be constant and independent of frequency only if C=O. This does *not* make the phase angle or the reactance zero.
2. The condition for zero reactance and zero phase angle is the same, $L = CR^2$. However, the resistance still varies with frequency when this condition is met.
3. Zero phase angle, zero reactance, and constant resistance with frequency are achieved simultaneously only when both L and C are zero.

PRODUCTION RESISTORS AND FREQUENCY RESPONSE: Ninety percent or more of the precision wirewound resistors manufactured by the industry are the reversed section or "pi" type. In the range below about 100 ohms the series inductance L predominates. In the range above about 2,000 ohms the shunt capacitance C predominates. In between, both parameters must be considered.

In standard resistor production, desired parameters can often be obtained by varying wire size, bobbin size, number of turns, number of sections or pies, and, to a lesser extent, by varying termination and impregnant. In this way the parameters are predictable at only slight extra cost, barring difficulties due to too large or small a wire size for the resistor value or a need for an entirely new bobbin design. It is unlikely, if not impossible, that any variation in reversed-pi construction can ever make an inherently capacitive high ohmic value resistor inductive or an inherently inductive low ohmic value resistor capacitive. For a given resistance value the possible variation of parameters cannot achieve the desirable conditions C=O and/or L=O. It might be possible by selection to achieve the condition $L = CR^2$ for a particular resistor value, but this could not be done on a production basis. For most values it would not be possible even by selection.

For a given resistance value with the parameters known, the user can often add capacitance or inductance to compensate and achieve zero phase angle—zero effective reactance. However, the effective resistance still varies with frequency and compensation is obtained at only one frequency.

RESISTANCE ERROR WITH FREQUENCY: For high ohmic value resistors with C predominant, the effective resistance will be less than the d-c resistance; with L predominant, the effective resistance will be more than the d-c resistance. The actual percentage error in resistance defies simple expression. For a given resistor it is a function of frequency, but unless the resistor has been compensated to zero reactance, effective impedance rather than resistance should be considered. For a 1,000 ohm resistor in the 1″ x ½″ commercial 1-watt size, X_e/ω can be as high as $100\mu h$. A 10,000 ohm resistor of the same size may have an X_e/ω negative and equivalent to only several micro-microfarads.

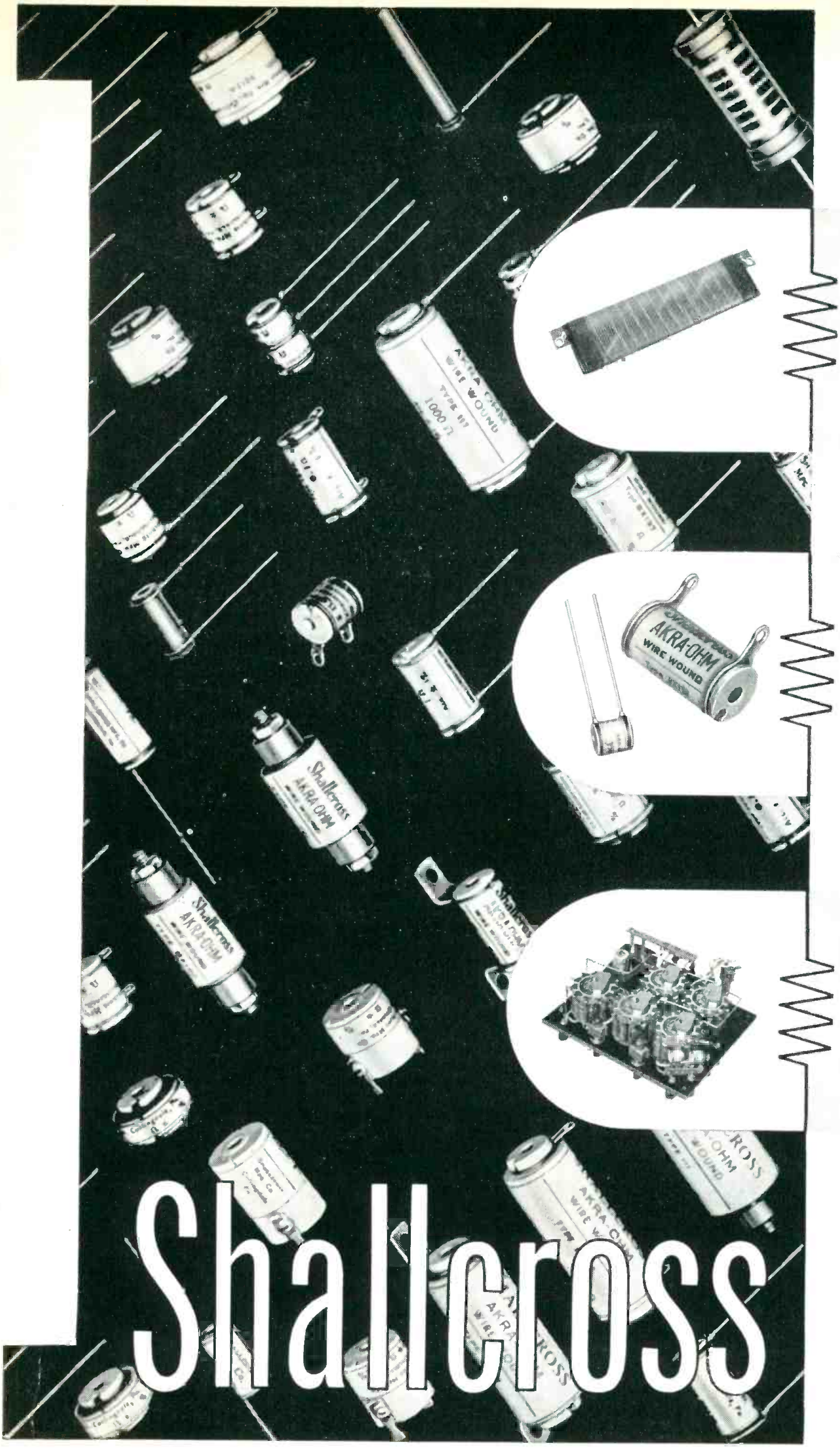
This is a very important design consideration. The location and mounting of the resistor and associated wiring can often contribute more capacitance and occasionally more inductance than is residual in the resistor.

Often the only solution to the residual parameter problem is the use of other than a conventional reversed-pi wound bobbin. Shallcross can supply many other types of windings on special order—each with its own special frequency characteristics.

Further details on Frequency Response and other resistor characteristics are available in Shallcross Bulletin R-3C.

SHALLCROSS MANUFACTURING COMPANY • 522 PUSEY AVENUE, COLLINGDALE, PA.

The fourth of a series to promote a better understanding of the performance characteristics of precision wirewound resistors.



NON-INDUCTIVE SURGE RESISTOR

The Shallcross Type R-9073 high voltage precision card resistor has an Ayrton-Perry winding to obtain residual inductance of only a few micro-henries below 1,000 ohms. Resistances from 5 to 1,000 ohms available. Standard tolerance 1%.

STANDARD REVERSED-PI RESISTOR

Standard Shallcross resistors have reversed-pi windings. The inductance of this type of winding decreases below 1,000 ohms. Above 10,000 ohms the winding becomes increasingly capacitive.

BIFILAR WINDING FOR INSTRUMENT RESISTORS

Shallcross Type 245-S resistors are mounted on the switch decks of the Shallcross Type 6100 Wheatstone Bridge shown at left. Available in values up to 1,000 ohms, their low inductance makes these resistors ideally suited for precision instruments.

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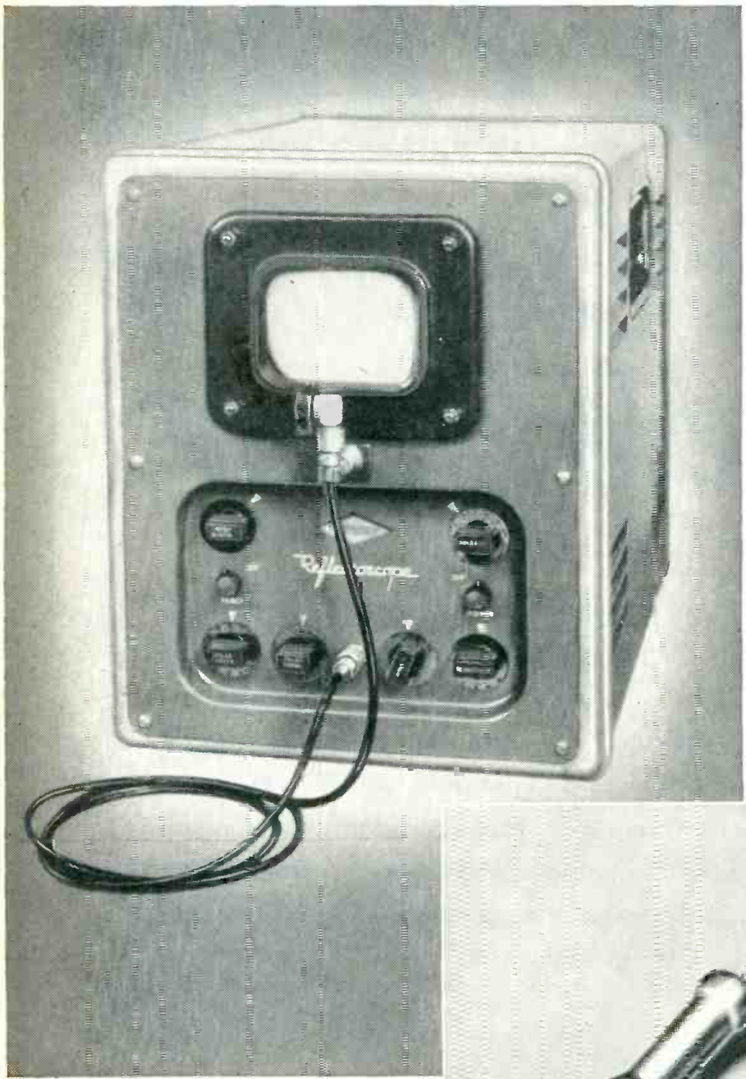
Flaw finder switches to
AXIOHM RESISTORS

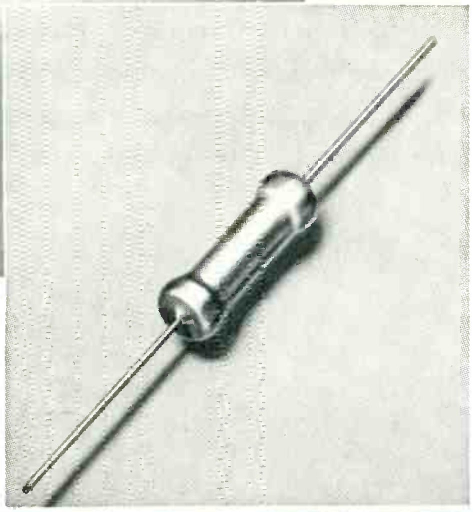


Sperry Reflectoscope,
made by Sperry Products, Inc.,
Danbury, Conn.

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

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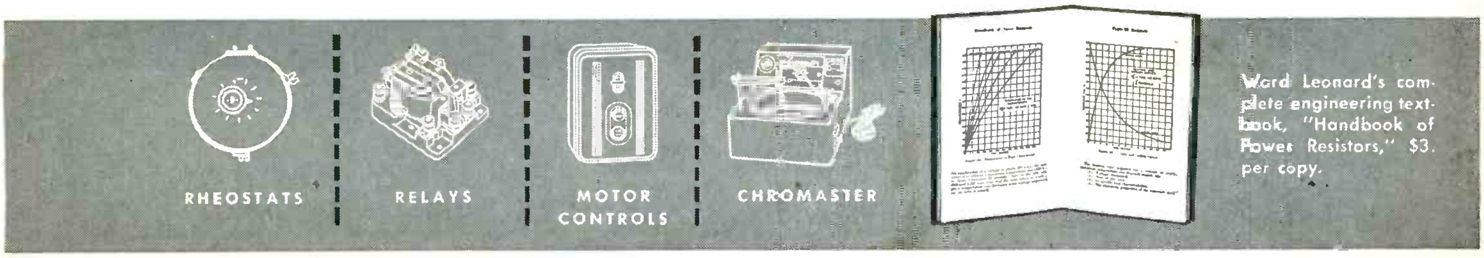
WARD LEONARD makes 19 distinct inspections and tests on every Vitrohm resistor

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.



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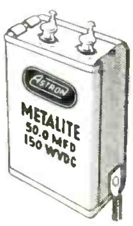
CUT YOUR CAPACITOR PROBLEMS DOWN TO SIZE

with ASTRON Subminiature METALITE* CAPACITORS

Astron METALITE* metallized paper capacitors help you solve the problems of size and weight —with *no sacrifice of performance*. The ingenious use of metallized sections makes them the world's smallest paper capacitors, and accounts for their extremely light weight and their unique self-healing properties. Available from stock in a wide range of standard ratings and case styles, they are ideal for commercial and military applications alike, conforming to strictest government specifications. Special sizes can be supplied upon request or to specification.

Many of the new techniques Astron has developed for the subminiaturization of metallized paper capacitors and filters can be utilized to reduce the size and weight of its extensive line of standard type capacitors and filters. For complete information on Astron capacitors and filters, write for Catalog AC-3.



DEPEND ON—INSIST ON

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255 Grant Avenue, E. Newark, N. J.

Export Division: Rocke International Corp., 13 E. 40th St., N.Y.C.
In Canada: Charles W. Pointon, 1926 Gerrard St. East, Toronto.

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Astron manufactures a complete line of dry electrolytic capacitors, metallized paper capacitors, plastic molded capacitors, subminiature paper capacitors and standard and subminiature RF interference filters for every radio, television and electronic use.

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To clock-radio designers
who fall back to sleep

don't forget the Signal Alarm

...available only on Telechron Timers

Model C-78

Sleep through the soft morning music of your clock-radio *just once*, and you'll see an important reason to specify Telechron Timers with signal alarm for your new models. And you'll see, too, how this exclusive feature can help your clock-radio become a sales success.

There are other exclusive advantages in Telechron Timers. The sealed lubricant reservoir gives better assurance of long timer life and quiet operation. There's extra simplicity of operation in the two knobs that do the work of three.

For any clock-radio price class, there's a Telechron Timer that will meet your needs. We custom style to meet your design requirements. Write for details. Telechron Department, General Electric Company, 45 Homer Ave., Ashland, Mass.

Telechron SEAL OF ACCURACY

EXTRA SALES ADVANTAGE

Telechron Seal of Accuracy on the clock crystal or our trademark on the dial gives the buyer confidence in the accuracy of your clock-radio.

Telechron®

MARK OF TIMING LEADERSHIP

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

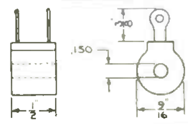
TOLERANCE SYMBOL	RESISTANCE TOLERANCE	PERCENT OF NOMINAL WATTAGE
B	0.10 %	50 %
C	0.25 %	50 %
D	0.50 %	75 %
F	1.00 %	100 %

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

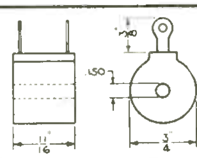
SYMBOL	EXPRESSED IN PERCENT PER DEGREE C. NEGATIVE, MAX.	POSITIVE, MAX.
E	0.0022	0.0022
J	0.0040	0.0155
K	0.0050	0.0255

SPECIAL REQUIREMENTS

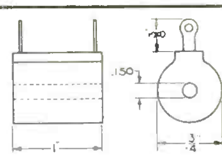
Variations of the above ratings, tolerances, temperature coefficient, etc. can be supplied to special order.



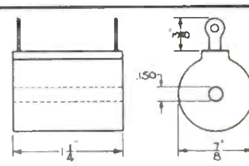
MIL RB15 MEPCO M15



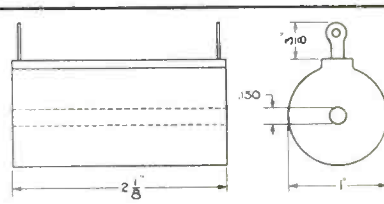
MIL RB16 MEPCO M16



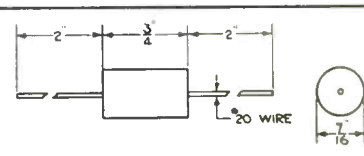
MIL RB17 MEPCO M17



MIL RB18 MEPCO M18



MIL RB19 MEPCO M19

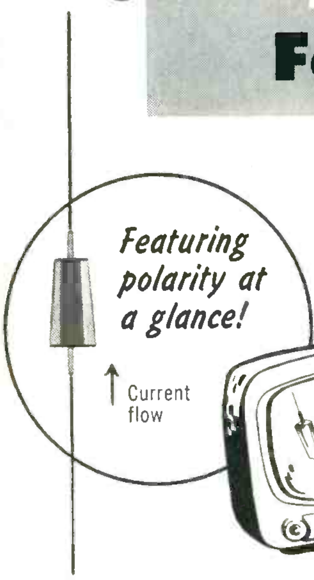


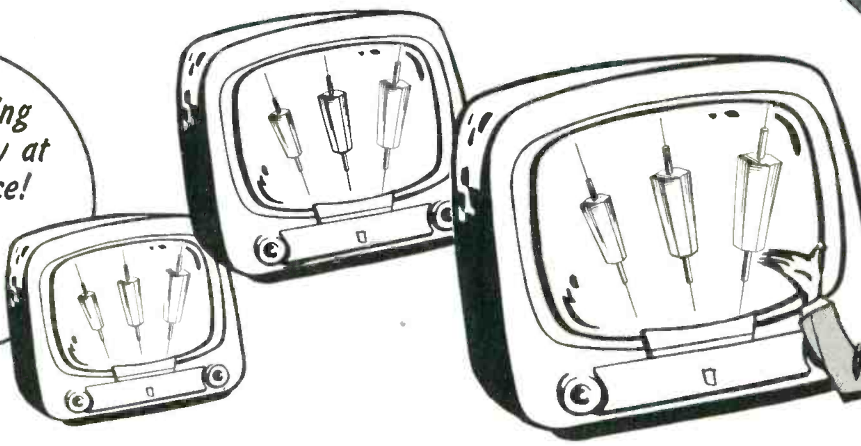
MIL RB52 (PROPOSED) MEPCO M52

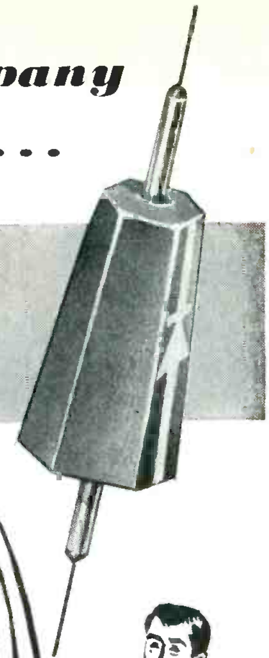
MEPCO, INC. MORRISTOWN, NEW JERSEY

Yes . . . of course Radio Receptor Company is hard at work producing . . .

MIXER DIODES
For U.H.F.–TV Tuners







CODE NO.	R.R. CO. SPECIFICATIONS	DESCRIPTION
1N72	Noise figure as a mixer better than 15DB @ 750 MC with 43.5 MC-IF circuit having a noise bandwidth of 3 MC and a noise figure of 4 DB.	Germanium
1N82	Noise figure as a mixer better than 12DB @ 750 MC with 43.5 MC-IF circuit having a noise bandwidth of 3 MC and a noise figure of 4 DB.	Silicon
1N110	Noise figure as a mixer better than 12DB @ 750 MC with 43.5 MC-IF circuit having a noise bandwidth of 3 MC and a noise figure of 4 DB.	Germanium

- Supplied with or without pigtail leads.
- The taper of the diode case allows polarity identification at a glance or at a touch thus speeding up assembly and reducing the possibility of error in connecting the diode into the circuit.

Let Radio Receptor Co. Standard U.H.F. Diodes figure in your N.F. problems . . . Send us your specifications!

Radio Receptor Co. is one of the major producers of Standard Germanium Diodes, Germanium Transistors and Seletron Selenium Rectifiers for radio, TV and other electronic circuits. Engineers who submit their problems to us are assured of immediate recommendations without obligation.

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RADIO RECEPTOR COMPANY, INC.

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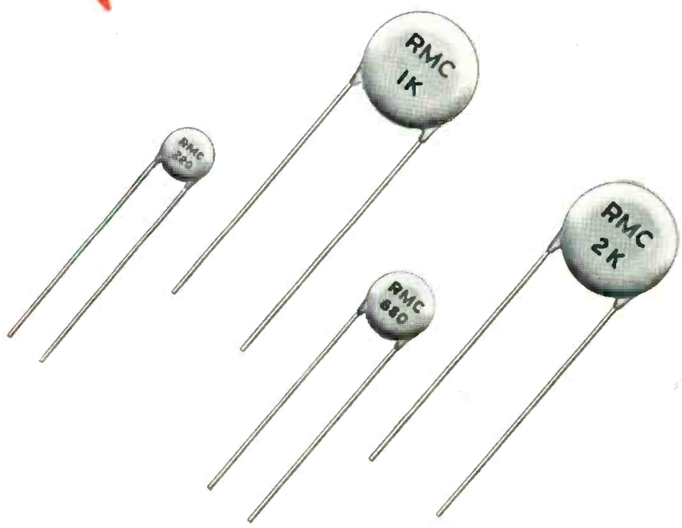
STABLE CAPACITY DISCAPS®

Type J

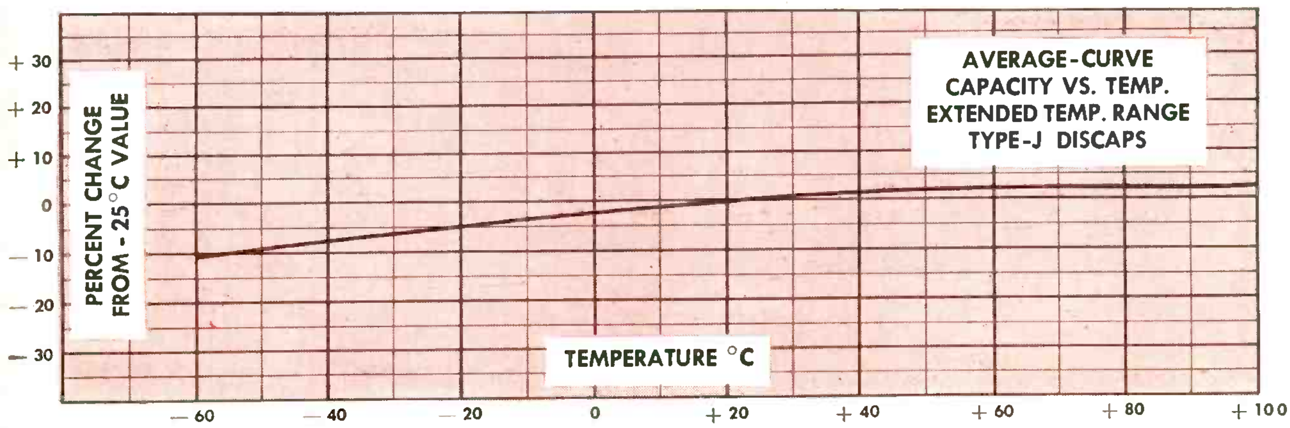


When you have an application requiring a capacitor with maximum stability over an extreme temperature range specify RMC's new Type J DISCAPS.

Because of RMC's exclusive dielectric element design the actual capacity change of Type J DISCAPS between —60°C and +100°C is only ±15% of the capacity at 25°C. Between +25°C and +85°C the change is only ±5% of the capacity at 25°C. Type J DISCAPS are rated at 1000 working volts.

Now available in capacities between 220 MMF and 2000 MMF, Type J DISCAPS combine exceptional mechanical and dielectric strength with a moderate price for trouble free performance and lower production costs.

If you have a design problem requiring a standard or special type of ceramic capacitor we invite your inquiry.



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RADIO MATERIALS CORPORATION

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POWER CONVERSION

BULLETIN NO. 118

D.C. OUTPUT VOLTS	D.C. OUTPUT WATTS	A.C. INPUT VOLTS 1Ø	CATALOG NO.
115	125 125 125	115 230 440	A10 A11 A12
	250 250 250	115 230 440	A13 A14 A15
	375 375 375	115 230 440	A16 A17 A18
	500 500 500	115 230 440	A19 A20 A21
	750 750 750	115 230 440	A22 A23 A24
	1000 1000 1000	115 230 440	A25 A26 A27
230	125 125 125	115 230 440	B10 B11 B12
	250 250 250	115 230 440	B13 B14 B15
	375 375 375	115 230 440	B16 B17 B18
	500 500 500	115 230 440	B19 B20 B21
	750 750 750	115 230 440	B22 B23 B24
	1000 1000 1000	115 230 440	B25 B26 B27

Typical Applications

- Motors
- Generator Fields
- Relays, Solenoids
- Magnetic Chucks
- Brakes, Clutches, Pulleys
- Business Machines
- Alarm Systems
- Impulse Clocks

Selenium Rectifier POWER SUPPLIES

Long Life
High Efficiency
No Warm-up Time
Zero Maintenance

GENERAL PURPOSE

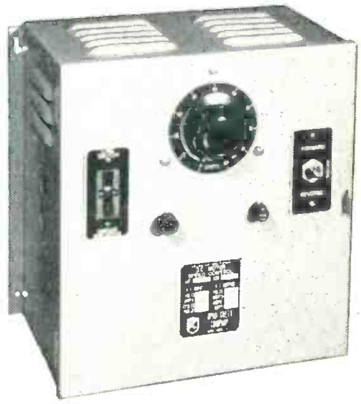
BULLETIN NO. 147

D.C. OUTPUT VOLTS	D.C. OUTPUT AMPERES	CATALOG NO. 115 V.A.C. 60 ~ 1Ø	CATALOG NO. 230 V.A.C. 60 ~ 1Ø
0-6	25.0	K38	—
	50.0	K47	K48
	100.0	K56	K57
0-12	12.5	K65	—
	25.0	K74	K75
	50.0	K83	K84
0-28	10.0	K92	—
	20.0	K101	K102
	40.0	K110	K111

Typical Applications

- Aircraft Motors
- Dynamotors, Inverters
- Relays, Solenoids
- Electroplating
- Actuators, Valves

MOTOR SPEED CONTROL



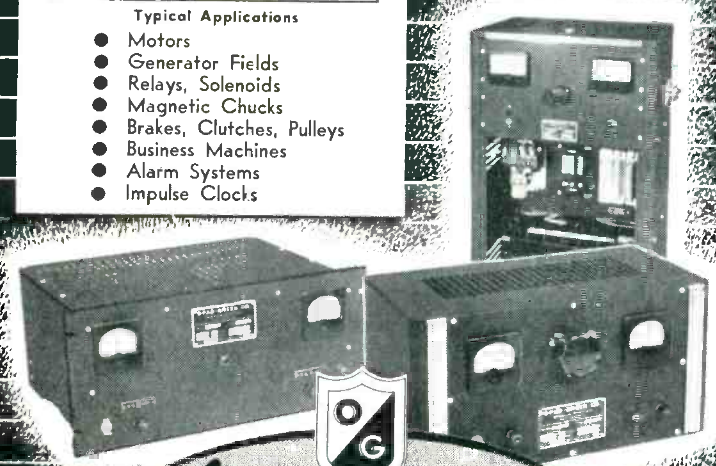
BULLETIN NO. 125

INPUT POWER REQUIREMENTS: 105-125 VOLTS 60 cycles A.C.

MOTOR TYPE AND H.P. RATING	CONTROL RANGE IN PERCENT OF RATED SPEED	DYNAMIC BRAKING	CATALOG NO.
SHUNT UP TO 1/15 H.P.	0—100% OR 0—200%	NO	GM30
SERIES OR UNIVERSAL UP TO 1/15 H.P.	0—100%	NO	GM35
COMPOUND 1/4 AND 1/3 H.P.	0—100% OR 0—115%	YES	GM40
COMPOUND 1/2 AND 3/4 H.P.	0—100% OR 0—115%	YES	GM50

Typical Applications

- Coil Winders
- Lathe Feeds & Drives
- Drilling and Tapping
- Precision Grinders
- Conveyor Systems



The applications listed on this page are typical of the many fields, in which OPAD-GREEN standard power supplies are effecting economies and assuring satisfaction. In many cases, equipments have been custom-built to fill particular requirements. Our engineers are always ready to provide the best solution for your D.C. power problem. Send us your specifications, or request our form PEQ to aid in establishing your needs.

Opad-Green COMPANY

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TAYLOR *Bone Grade Vulcanized Fibre*
is an extremely tough and dense grade of vulcanized fibre. It is excellent for applications where difficult machining operations are required . . . resistant to organic solvents, oils and gasoline . . . has excellent electrical characteristics.

Want to make something of it?

Make it into gears, cams, fairleads, bushings and grommets, slot wedges, threaded and tapped pieces, rail joint insulation and other applications where mechanical strength, good finish and intricate machining are required. Color: gray.

Make it from sheets or rolls with these specifications:

SPECIFICATIONS

Thickness range . . . 1/32″ to 1/2″
Finish . . . Pressed and calendered
Punching . . Up to 3/16″ thickness
Sheet size . . . Approx. 56″ x 90″

Roll width . 56″ for thicknesses of 1/32″ through .060″. Coils down to 7/32″ for thicknesses of 1/32″ through .090″.

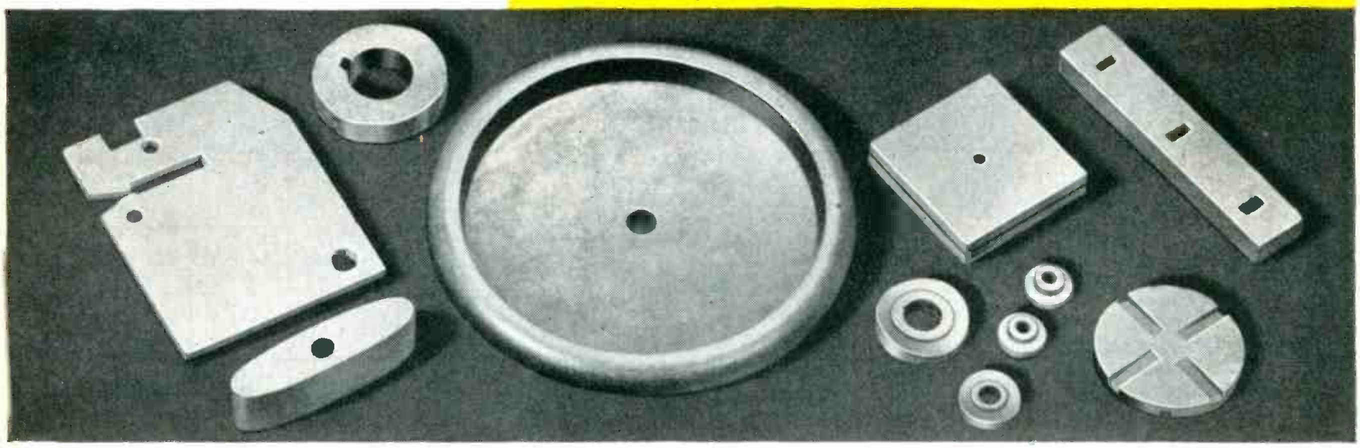
PROPERTIES

Mechanical

Flexural Strength, psi		
	(Lengthwise)	14000 min.
	(Crosswise)	12000 min.
Tensile Strength, psi		
	(Lengthwise)	7500 min.
	(Crosswise)	5500 min.
Compressive Strength, psi		
	(Flatwise)	30000 min.
Izod Impact Strength, Ft.-Lbs./inch		
	(Lengthwise)	3.0
	(Crosswise)	2.4

Electrical

Dielectric Strength, VPM		
	(1/32″)	250 min.
	Short Time Test (1/8″)	175 min.
Arc Resistance, seconds		100



Make it from turned rods. Diameters from 1/8″ through 1/2″ with ground or buffed finish.

Make it easy for yourself the next time you are looking for an extremely dense, abrasion resistant material. Call your Taylor Engineer . . . he will be glad to work with you . . . go over your requirements . . . and help you select the correct grade of Taylor Vulcanized Fibre to fit your needs—Bone, Commercial, Super White, Abrasive and Built Up. Ask him about Taylor Laminated Plastics, too. He will be glad to give you samples of *Phenol, Melamine and Silicone Laminates* for your inspection.

Taylor Fibre Co., Norristown, Pennsylvania—La Verne, California

TAYLOR
Laminated Plastics
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FOR REAL HELP TO SMALL BUSINESS

It is ironic that one of the first jobs of the Eisenhower administration, so widely, and erroneously, tagged as a "big business" administration, must be to go to the relief of small business. This is necessary because the preceding administration, while continually proclaiming its tender regard for small business, actually impaired gravely the ability of small business to carry on successfully. This it did in the necessary haste of devising an emergency tax program to finance rearmament and the Korean War. Now the new administration must revise this tax structure to give small business a chance to make its key contribution to an expanding American economy.

How Taxes Hurt Small Business

Since the outbreak of the Korean War, small business has been handicapped by two principal features of the emergency tax program:

1) Many small firms are unable to retain enough of their earnings to provide for expansion because these earnings are drastically limited by the excess profits tax.

2) Small companies have received a very small share of the tax concessions allowed by the federal government to encourage construction of defense facilities.

A small business that succeeds and hence grows is particularly hard hit by the excess profits tax. That tax, of course, applies to corporations having a net income of more than $25,000 per year. It results in taking up to 82 cents on every dollar of profit that the company earns above what is called an "excess profits credit." For most small companies the credit depends on what was earned in 1946-49. This creates an element of gamble and discrimination in determining the amount of tax to be paid. Time has proved that it is impossible to select a base period for the tax that is fair to all companies. A young company starting in 1946-49 is peculiarly vulnerable, as its earnings in that period were necessarily low. Even on modest earnings today, it would pay a high excess profits tax.

It is true that Congress wrote into the excess profits tax law provisions to lessen the impact of the tax on growing companies. However, none of these provisions in practice has given much relief to small business.

"Relief" Provisions Give Little Relief

Small firms rely almost entirely on retained earnings to provide funds for improving their plants and equipment. They get very little help from the provisions (1) that no more than 70 per cent of total profits can be taxed away, (2) that additional earnings are allowed on an increase of invested capital or (3) that growing companies are allowed a rate of return on capital equal to the industry average.

Most large firms can obtain additional funds in the securities market. But small firms find it difficult to increase their capital by selling securities, since investors generally prefer the stocks or bonds of nationally known and seasoned companies. Few small companies, therefore, can reduce their tax burdens by increasing their invested capital, and few can meet their needs for equity capital if their rates of profit are no higher than those of the leading companies which generally set the average profit.

Small business has been equally at a disadvantage in the matter of accelerated depreciation for tax purposes. The government has encouraged a great expansion of our industrial plant, despite the very high rate of taxation on corporate earnings, by granting certificates of accelerated amortization on new plants built to support the defense program. These certificates allow business to charge off the cost of defense plants at a rapid rate. This decreases the earnings that are subject to taxes, and so increases the part of the earnings that may be retained in the business.

Growth is Stifled

But most of these tax concessions have been made to large firms especially equipped to handle the complex problems of defense production. Of the $12 billion of new facilities so far approved for fast amortization, only 11 per cent are for companies with less than 500 employees, although the share of such companies in the normal civilian business is about 30 per cent. In only 2 of 12 industries studied by the Small Defense Plants Administration were small firms receiving what was estimated to be a fair share of the total tax amortization awarded.

Because they are unable either to retain enough earnings after taxes or to step up their depreciation allowances, most small firms are unable to keep up in the race to expand and modernize plant capacity. The Small Defense Plants Administrator, in his report to Congress, emphasized that small companies have been unable to do their full part in the defense program for lack of capital.

The Council of State Chambers of Commerce recently published an eight-state survey showing widespread cutbacks of plans for new plants by small and medium-sized companies. According to this report, "high federal taxes enacted since the beginning of the Korean War appear to be placing an effective brake on the rate of industrial expansion in all the states surveyed and probably in the 48 states generally . . . It is principally the small and medium-sized companies whose growth is being stifled."

Some Ways to Help

The first step to relieve small companies should be to free them from the excess profits tax. The nation as a whole would be far better off if the excess profits tax were allowed to die as scheduled on June 30, since the tax promotes waste as it stifles incentives. It is quite possible, however, that the politics of tax reduction, as opposed to the economics, will prevent the elimination of the tax during 1953.

If the tax is extended, provision should be made for a much broader exemption to smaller corporations. If net income up to $100,000 a year, which in these days still constitutes small business, were exempted from the tax, the loss of revenue to the government would be about $175 million. This relatively small amount could easily be offset by an increase in employment and incomes if small business is freed from its financial strait jacket and allowed to expand. Careful attention should be given also to the possibilities of allowing a higher rate of return on the first $1 million of capital (roughly the amount it takes to provide 100 jobs) and of making special accelerated depreciation allowances to smaller firms. This is a matter so important that we shall return to it in a future editorial.

Relief for small business — relief from a financial paralysis that has kept it from playing its dynamic part as a growth element in our economy — would do much to give the lie to the notion that the Eisenhower administration is a "big business" operation. Much more important, it would be a long stride toward releasing the dynamic energies of many small businesses and businessmen to forward a continuing and expanding prosperity.

McGraw-Hill Publishing Company, Inc.

YOUR FILTER NETWORK PROBLEMS . . . *Solved in Jigtime*

Selecting the proper filter network component for a critical electronic application is not exactly comparable to fitting a piece to a puzzle. In filter networks the criteria are not quite as superficial as proper size, shape, etc. Even compliance with attenuation requirements is not usually sufficient. There are a multitude of hidden factors in the manufacture of an audio filter that go much deeper than these qualifications.

Here at Burnell & Co. we concern ourselves with all the phases in the design of a filter of superior quality. To maintain our high standard we manufacture our toroids with the most modern facilities and quality controlled methods. The capacitor components employed are either the finest silver mica type or are wound with plastic dielectric material employing no impregnants that may affect the life or long term stability. All other components are just as carefully selected and controlled.

This policy of incorporating only the best ingredients coupled with our advanced design method insure our customers that not only will our filters meet the basic requirements but that they will also maintain **all** of their characteristics under all the service conditions of equipment in which they are used.

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EXCLUSIVE MANUFACTURERS OF COMMUNICATIONS NETWORK COMPONENTS

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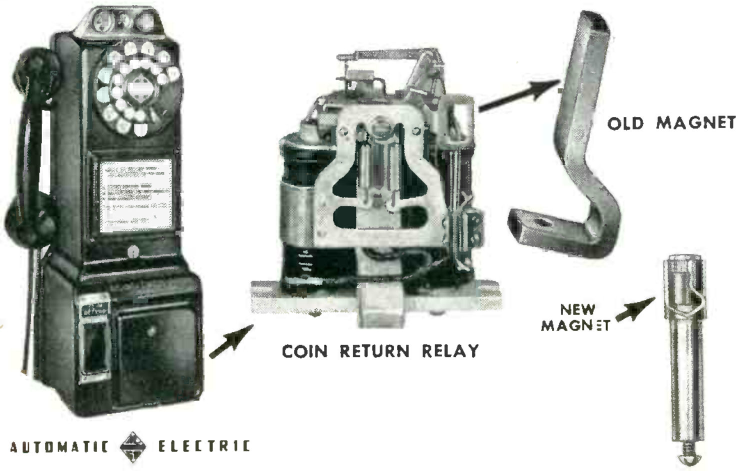
New

PERMANENT MAGNET DESIGN

RESULTS IN A

DOUBLE-BARRELED SAVINGS!

FOR TOP ENGINEERING COUNSEL ON PERMANENT MAGNETS CONSULT INDIANA



. . Double-barreled Savings!

- **Lower first cost—70% saving**
- **Positive mechanical action—fewer service calls needed**

This is another example of how INDIANA's top engineering "know-how," secured from experience gained in successfully solving the design needs of over 35,000 permanent magnet applications, resulted in an improved product design.

You, too, can look to INDIANA for quality permanent magnets —for skill in manufacture—for cost cutting engineering aid. Rigorous quality control in every step of production is your assurance of exact magnetic and mechanical characteristics.

INDIANA is the only manufacturer furnishing all commercial grades of permanent magnet alloys. Furthermore, it has the ability and facilities to develop and produce the permanent magnets you require on a regular production schedule. For help with your problem, write INDIANA, today.

THE INDIANA STEEL PRODUCTS COMPANY
VALPARAISO, INDIANA

World's Largest Manufacturer of Permanent Magnets

DESIGN SUMMARY

Equipment
Telephone pay station manufactured by Automatic Electric Company, Chicago.

Application
Polarized coin return relay.

Situation
Automatic Electric previously used a chrome steel magnet. Automatic Electric and INDIANA engineers worked together in redesigning the permanent magnet assembly used in the polarized coin return relay, switching to the use of Alnico III material.

Results
1) An increase in flux of 27%—from 2750 Maxwells with old chrome steel magnet to 3500 Maxwells with Alnico III. 2) 70% Savings in cost of permanent magnet. 3) Saving in weight. 4) Simplified design and assembly. 5) Fewer service calls needed since, with the new design, a positive mechanical coin return action was secured—*permanently!*

To help you with your permanent magnet design problems, write for Design Manual No. 4-A5.

INDIANA PERMANENT MAGNETS

PERMANENT MAGNETS MAY DO IT BETTER

TRANSISTOR CIRCUIT ELEMENTS
BY FORTIPHONE LTD, ENGLAND

Component quality determines equipment performance!

EARPHONE, TYPE MME/T

This miniature unit is designed for use in circuits with junction type transistors. Impedance is normally of 1000 ohms at 1000 cycles per second, and reversal of polarising current of 2.2 milliamps changes the overall response by less than 1 db.

Four alternative types of frequency responses are available, and the output is generally of the order of 63 decibels relative to 1 dyne/cm^2/volt at 1000 cps for an input power of 0.8 milliwatt. The sound pressures are measured in an artificial ear of 1.5 cubic centimetres and 240 ohms acoustic resistance.

The unit takes a standard round-pin non-reversible plug fitting with a firm detent action. The socket contacts are of unique double spring design to ensure low contact resistance and to minimise fatigue.

A standard earmold can be fitted to the instrument, the fit being carefully arranged to eliminate acoustic leakage.

The air gap is controlled to within 0.00025 inch, and after a prolonged test at overload conditions the output is measured throughout the frequency band.

The colour is normally flesh pink, but alternative colours are available. Alternative impedances are also available.

Flexible connectors with molded plugs are available together with standard sockets.

The overall dimensions are 0.82 *inch diameter by* 0.38 *inch wide (excluding nipple) or* 0.47 *inch including nipple. The weight is* 0.3 *ounce.*

TRANSFORMER, TYPE T9

This is a miniature coupling transformer designed for transistor circuits having a wide frequency range.

Response is within 2 db relative to response at 1000 cps over a range from 250 cps to 5000 cps. Ratio is normally 4.5:1

The windings are terminated at solder tags molded into the robust thermo-setting bobbin, thus economising in winding space and increasing efficiency.

Before lamination, each winding is checked to ensure no short-circuited turns. Each transformer is tested for efficiency throughout the frequency range.

Overall dimensions are 0.66 *inch by* 0.48 *inch by* 0.46 *inch. The weight is* 0.2 *ounce.*

VOLUME CONTROLS, TYPE VC7

These controls are for use on miniature equipment, including transistor amplifiers.

An internal single pole switch of less than 0.05 ohm contact resistance is incorporated, capable of handling current of 0.25 amp at up to 10 volts. Insulation is greater than 100 megohms at 100 volts.

The resistance rotation law can be logarithmic or linear, having a total resistance of 5000 ohms or more. Noise level is below 270 microvolts when one volt is applied and the control rotated at two turns per second.

Power dissipation is 0.1 watt when uniformly loaded.

The action of the control is smooth, and the switch has a loud "click" operation.

Rotational torque lies between 0.18 ounce inch and 1.5 ounce inches, and end stop torque is greater than 30 ounce inches.

The units are able to withstand a life test of 20,000 operations without deterioration.

Overall dimensions are 0.78 *inch diameter by* 0.54 *inch. Knob width is* 0.19 *inch and weight is* 0.13 *ounce.*

RESISTORS, TYPE S

These are tiny robust carbon upon ceramic resistors capable of 0.1 watt dissipation. Preferred values between 470 ohms and 10 megohms are available.

They bear the international colour code.

Overall size is 0.310 *inch by* 0.125 *inch. Dimensions between fixing wires is* 0.180 *inch and length of lead out wires is* 1.30 *inches.*

Cable or write for prices, further details and samples. Please state possible quantities required

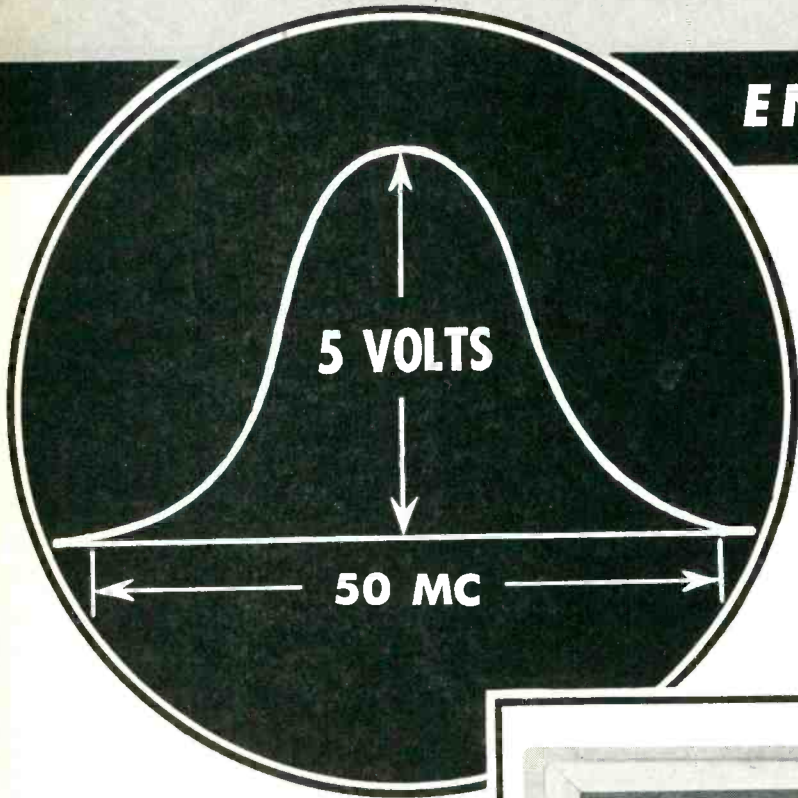
FORTIPHONE LIMITED

FORTIPHONE HOUSE, 247 REGENT STREET, W1, LONDON, ENGLAND

Established 1925 — *Cables: Sonomax, Wesdo, London*

SPEEDY DELIVERY!

YOU ASKED FOR HIGHER UHF OUTPUT!



ENTIRELY NEW

UHF SWEEPING OSCILLATOR GIVES YOU
5 VOLTS

SPECIFICATIONS

FREQUENCY RANGE: 450-900 mc

SWEEP WIDTH: Continuously variable from 0 to 50 mc

OUTPUT: 5 volts into 75 ohms terminated

ATTENUATORS: Switched — 20 db, 20 db, 10 db, 6 db, 3 db. Continuous: Approx. 3 db.

ZERO LEVEL BASELINE produced on oscilloscope pattern.

DETECTOR BUILT IN.

PRICE: $650 f.o.b. Pine Brook, N. J.

The Ultra Sweep

For further details and information regarding markers, please phone or write

KAY

KAY ELECTRIC COMPANY

14 Maple Avenue — Phone CAldwell 6-4000 — Pine Brook, New Jersey

RAYTHEON

PRODUCTS *wired for life*

with WARREN WIRE

The Raytheon Digital Automatic Computor — known as "RAYDAC" — was developed for use by the Departments of the Navy and Air Force to help analyze the behavior of guided missiles. To do its highly complicated and exacting work at incredible speeds this compact "marvel" combines the best engineering skills and manufacturing processes with the finest quality materials. Here, as in the manufacture of many other fine electric and electronic products, Warren Wire is used for its easy handling, efficiency and dependability. There's a Warren Wire Engineer near you trained to help you solve your wire problems right in your own plant. There is no obligation, of course.

Write for new Teflon Specification #1001, dated February, 1953

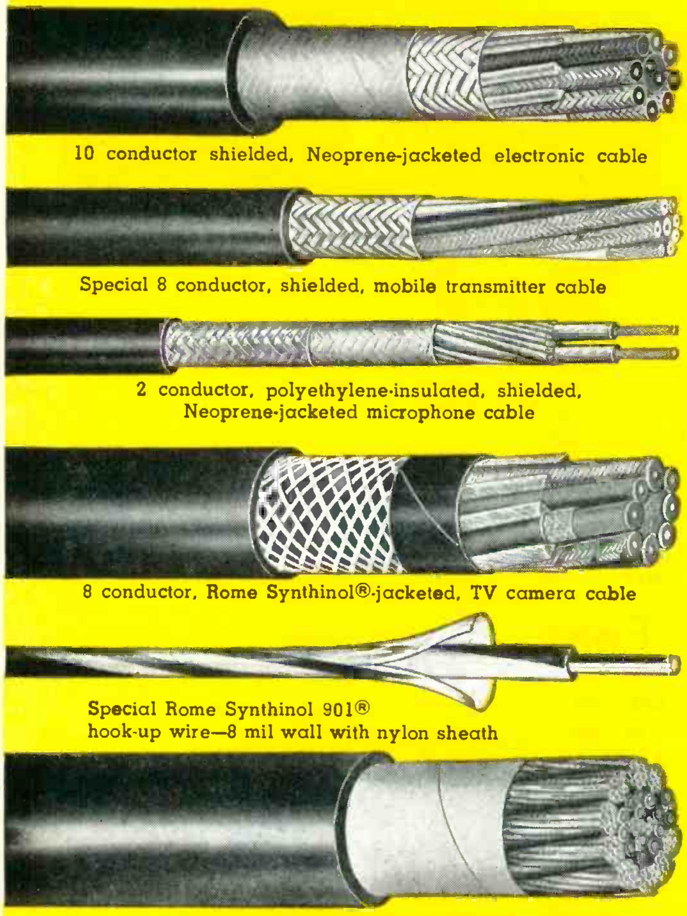
WARREN WIRE COMPANY

Plant and Main Office: POWNAL, VERMONT

NEW YORK • SYRACUSE • NEW HAVEN • PHILADELPHIA • PITTSBURGH • CLEVELAND
DETROIT • CHICAGO • ST. LOUIS • ST. PAUL • LOS ANGELES • SAN FRANCISCO

Manufacturers of Plain Enamel, Nylon, Formvar, Teflon and Served Magnet Wires . . . Teflon Hook-up and Lead Wire . . . Tinned and Bare Copper Wire.

Why it pays to make Rome your source of special electronic cables



10 conductor shielded, Neoprene-jacketed electronic cable

Special 8 conductor, shielded, mobile transmitter cable

2 conductor, polyethylene-insulated, shielded, Neoprene-jacketed microphone cable

8 conductor, Rome Synthinol®-jacketed, TV camera cable

Special Rome Synthinol 901®
hook-up wire—8 mil wall with nylon sheath

Special 136 conductor, Rome Synthinol-insulated, electronic cable

When you have an electronic wiring problem it pays to go to a specialist, such as Rome Cable. Wires and cables made by Rome, first, are designed by engineers with training and experience in electronic applications. Further, Rome Cable has the manufacturing knowledge and facilities to produce unusual constructions . . . with quality controlled step by step. By standardizing on Rome wires and cables you assure dependable performance for your product and add obvious quality . . . with a component *engineered to your requirement.*

Rome manufactures a wide range of hook-up wires, intercommunication cables, coaxial cables, electronic computer cables, R. F. transmission line, television camera cables as well as other special constructions.

COMMERCIAL TYPE HOOK-UP WIRES

Rome offers commercial type hook-up wires with three standard insulations.

Rome Hi-temp—a rubber insulation with exceptionally high resistance to heat and moisture. Underwriters' approved for 75° C.

Rome Synthinol—a polyvinyl chloride thermoplastic compound, highly resistant to acids, oils, alkalies, moisture and flame. Underwriters' approved for 80° C.

Rome Synthinol 901—offers all the advantages of Synthinol plus higher resistance to heat deformation, shrinkage and cracking, also improved solderability. Underwriters' approved for 105° C.

MILITARY HOOK-UP WIRES

Rome manufactures military type SRIR, SRHV and WL, complying with Army-Navy Joint Specification JAN-C-76, as well as shipboard types SRI and SRIB conforming to Specification MIL-C-915. Insulated with Rome Synthinol, these wires are made in a complete range of specification sizes.

ROME CABLE CORPORATION, Dept. ET-5 Rome, N. Y.
Please send me information on Electronic Wiring

Name..

Company..

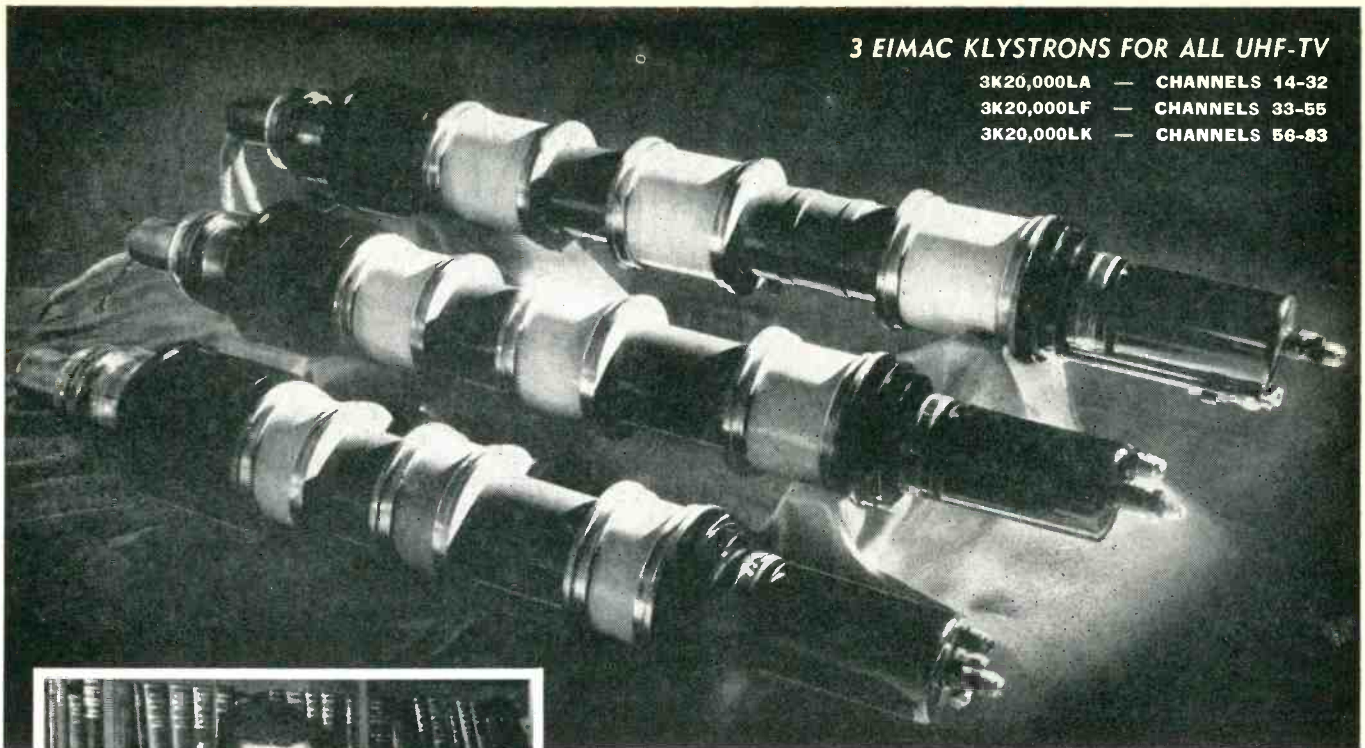
Address..

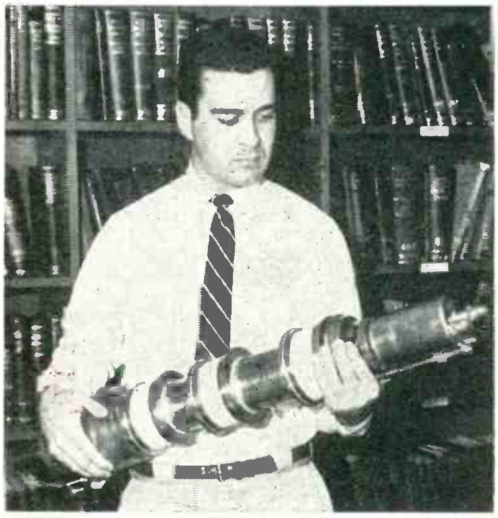
City.......................... Zone........ State..................

It Costs Less to Buy the Best

ROME CABLE Corporation
ROME · NEW YORK
and
TORRANCE · CALIFORNIA

ROME CABLE ROME, N.Y.





Only Eimac 5 kw Klystrons Offer These Features for UHF-TV . . .

THREE TUBES that cover the entire spectrum, 470-890 mc. This means simplification of equipment design, economical mass production and a minimum of stock piling problems.

HIGH POWER AND SMALL SIZE that not only makes top performance possible but allows easy handling for maintenance and installation. In typical operation the Eimac klystrons deliver a peak sync output of 5.5 kw., with a collector dissipation of 14 kw., and a power gain of 20-25 db.

MASS PRODUCTION that means early delivery and guarantee of klystrons in the future. All three of the series are now coming off the production line.

EXTERNAL TUNING that increases the tuning range; eliminates mechanical distortion of tube structure; permits use of optimum cavity construction and provides design freedom in R-F circuits for equipment engineers.

LOW-LOSS CERAMIC CAVITIES AND COPPER-TO-CERAMIC SEALS that eliminate off-the-air hours caused by heat and thermal shock.

FOR FURTHER INFORMATION CONTACT OUR TECHNICAL SERVICES DEPARTMENT.

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

EITEL-McCULLOUGH, INC.
SAN BRUNO, CALIFORNIA
Export Agents: Frazar & Hansen, 301 Clay St., San Francisco, California

REVOLUTIONIZING DIGITAL

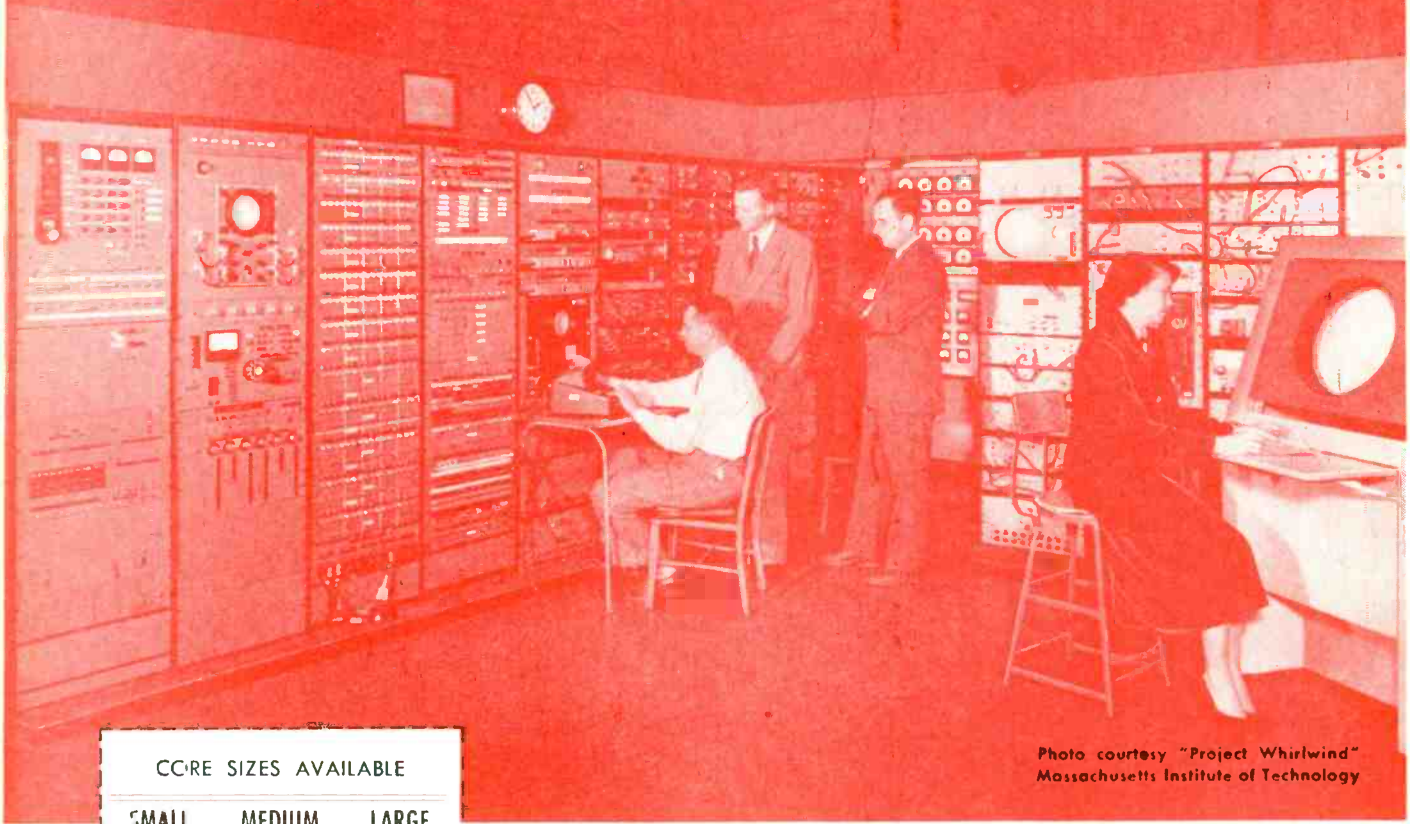


Photo courtesy "Project Whirlwind"
Massachusetts Institute of Technology

CORE SIZES AVAILABLE		
SMALL F291	MEDIUM F259	LARGE F262
.090 O.D.	.230 O.D.	.375 O.D.
.060 I.D.	.120 I.D.	.187 I.D.
.030 THICK (approx.)	.060 THICK (approx.)	.125 THICK (approx.)

MAGNETIC PROPERTIES
INITIAL PERMEABILITY 43
MAXIMUM PERMEABILITY 700
SATURATION FLUX DENSITY 2350 GAUSS
$\frac{\text{RESIDUAL MAGNETISM}}{\text{SATURATION FLUX DENSITY}} = .91$

Physical Advantages—

Laminations unnecessary. Molded in one piece to close tolerances. Miniature size saves space. Ferramic cores generate no heat, eliminate heat dissipation requirements.

Electrical Advantages—

Properties are stable and not affected by rough handling or aging. Response time 20 times faster than other magnetic materials, switching time about one micro-second. Square hysteresis loop, high volume resistivity and low loss factor. High efficiency at high and low frequencies.

Cost Comparison—

Ferramic cores permit important savings in the construction and maintenance of computer equipment, and reduce service interruptions by reduction of component failure.

GENERAL CERAMICS AND STEATITE CORPORATION — STEA-TITE INSULATORS

General CERAMICS and STEATITE CORP.
Perth Amboy 4-5100
GENERAL OFFICES and PLANT: KEASBEY, NEW JERSEY

MAKERS OF STEATITE, TITANATES, ZIRCON PORCELAIN, FERRAMICS,

COMPUTER DEVELOPMENT!

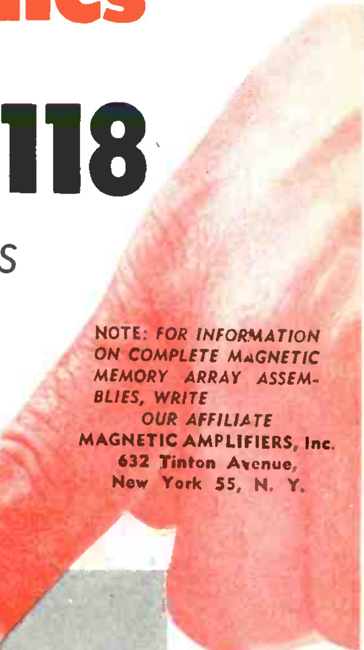
WITH NEW **General Ceramics'**

FERRAMIC* MF 1118

*TRADEMARK

UNIQUE SQUARE LOOP CHARACTERISTICS
STORE DIGITAL INFORMATION—

...eliminate heat dissipation problems
...reduce space requirements
...afford years of service without replacement



NOTE: FOR INFORMATION ON COMPLETE MAGNETIC MEMORY ARRAY ASSEMBLIES, WRITE OUR AFFILIATE
MAGNETIC AMPLIFIERS, Inc.
632 Tinton Avenue,
New York 55, N. Y.

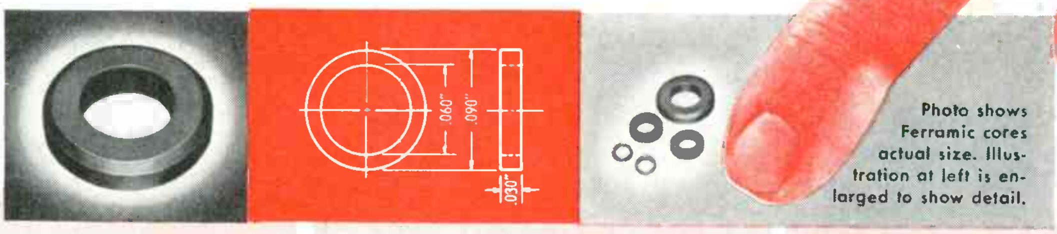


Photo shows Ferramic cores actual size. Illustration at left is enlarged to show detail.

FERRAMIC MAGNETIC MEMORIES — Molded of Ferramic MF1118, a soft magnetic material featuring square hysteresis loops, high volume resistivity and low loss factor. Maintains high efficiency at both high and low frequencies. Response time approximately 1.0 microsecond.

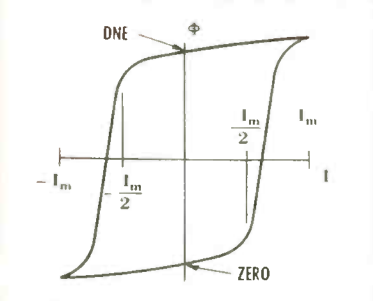
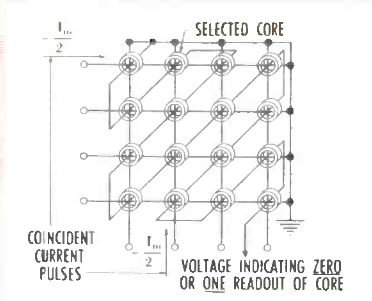


DIAGRAM ILLUSTRATES FLUX-CURRENT CHARACTERISTIC OF FERRITE TOROID WITH NEARLY RECTANGULAR HYSTERESIS LOOP

COINCIDENT-CURRENT MEMORY ARRAYS—Ferramic Memories are strung on a criss-cross of enameled wires with one Ferramic core at each 3 wire intersection. Pulses sent through the wires magnetize selected cores; one polarity stores 0, the other stores 1.



4-By-4 COINCIDENT-CURRENT MEMORY ARRAY SHOWING PATH OF PULSE STORED IN SELECTED TOROID

FERRAMIC MAGNETIC READ-IN AND READ-OUT METHODS — The same pair of wires is used for read-in and read-out. The presence or absence of induced voltage pulses in the third wire is interpreted by associated equipment as 0 or 1.

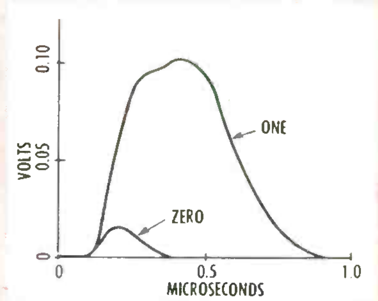


CHART SHOWS VOLTAGES OBSERVED READING ONE OR ZERO FROM A SELECTED TOROID. RESPONSE TIME 0.5 MICROSECOND

CALL OR WRITE FOR ENGINEERING DATA ON FERRAMICS FOR SPECIFIC APPLICATIONS

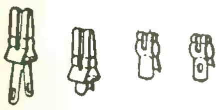
LIGHT DUTY REFRACTORIES, CHEMICAL STONEWARE, IMPERVIOUS GRAPHITE

Want more information? Use post card on last page.

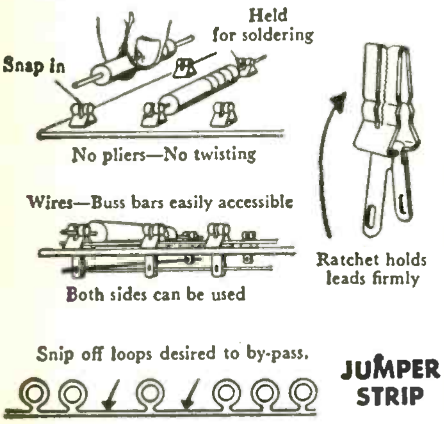
Here is Plug-in Unit Construction

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.



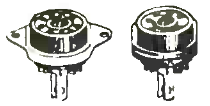
Stake under Terminals for common circuits. Loops match prepunched holes in Terminal Cards. Snip off loops desired to by-pass.

FOR YOUR SMALLER UNITS.

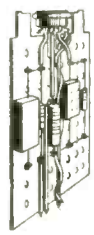
2nd Take Pre-punched Terminal Mounting Card ready-cut to size you require. Stake in Alden Miniature Terminals to mount your circuitry.

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.

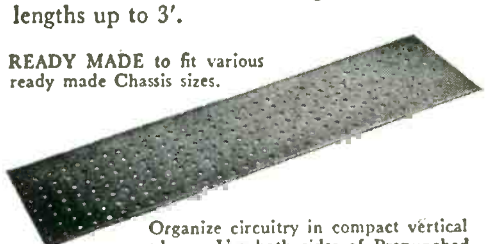


Mounting Brackets stake to the Prepunched Card, mount Card to Package Base and Lid.

FOR YOUR LARGER UNITS.

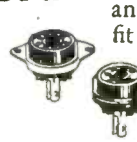
2nd Lay out circuitry with Prepunched Terminal Mounting Card in lengths up to 3'.

READY MADE to fit various ready made Chassis sizes.

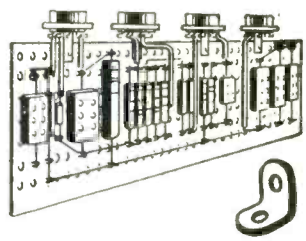


Organize circuitry in compact vertical planes. Use both sides of Prepunched Card to stake in Alden Miniature Terminals to your circuitry layout. Vertical position gives ready accessibility; there is no "underneath" in Alden design.

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.

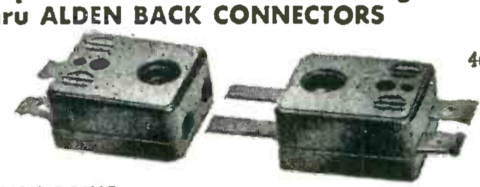
ALDEN "FUSE-LITE"

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.

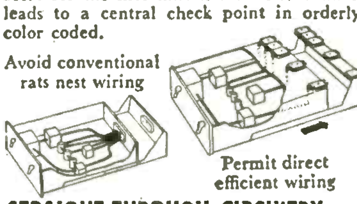
Free Samples Sent Upon Request

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



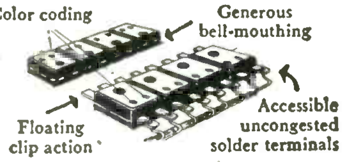
SINGLE CHECK POINT

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**

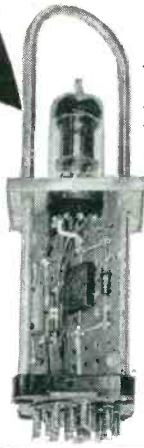
READY-MADE for your Electronic Equipment

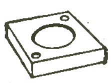
All designed — all tooled — production immediately available — no procurement problems. *Apply ALDEN Standards wholly or in part.*

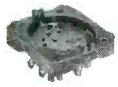
ALDEN PLUG-IN PACKAGES

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.

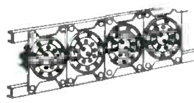






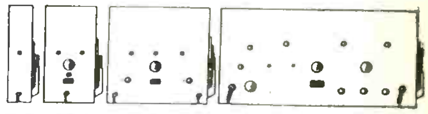
ALDEN PLUG-IN PACKAGES

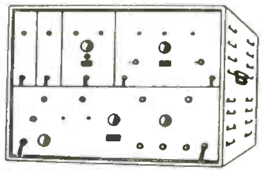
Using standard Alden Plug-in Packaging Components you can mount a tremendous variety of circuits on chassis or in racks.



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

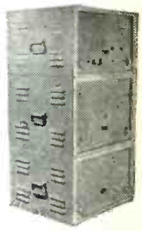




FOUR SIZES OF CHASSIS MOUNT IN ANY COMBINATION IN ALDEN UNI-RACKS

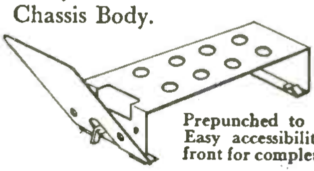
STACKED

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.

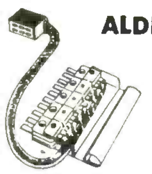


Prepunched to your specs. Easy accessibility at sides, front for completing wiring.

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.
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3. Given the circuitry, nothing further to design—make up from standard Alden components.
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7. No tooling costs—no delays—no procurement headaches.
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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.

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

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

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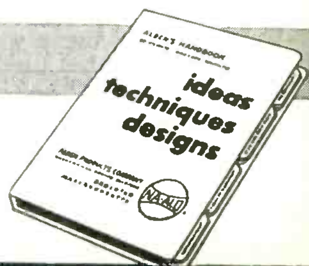

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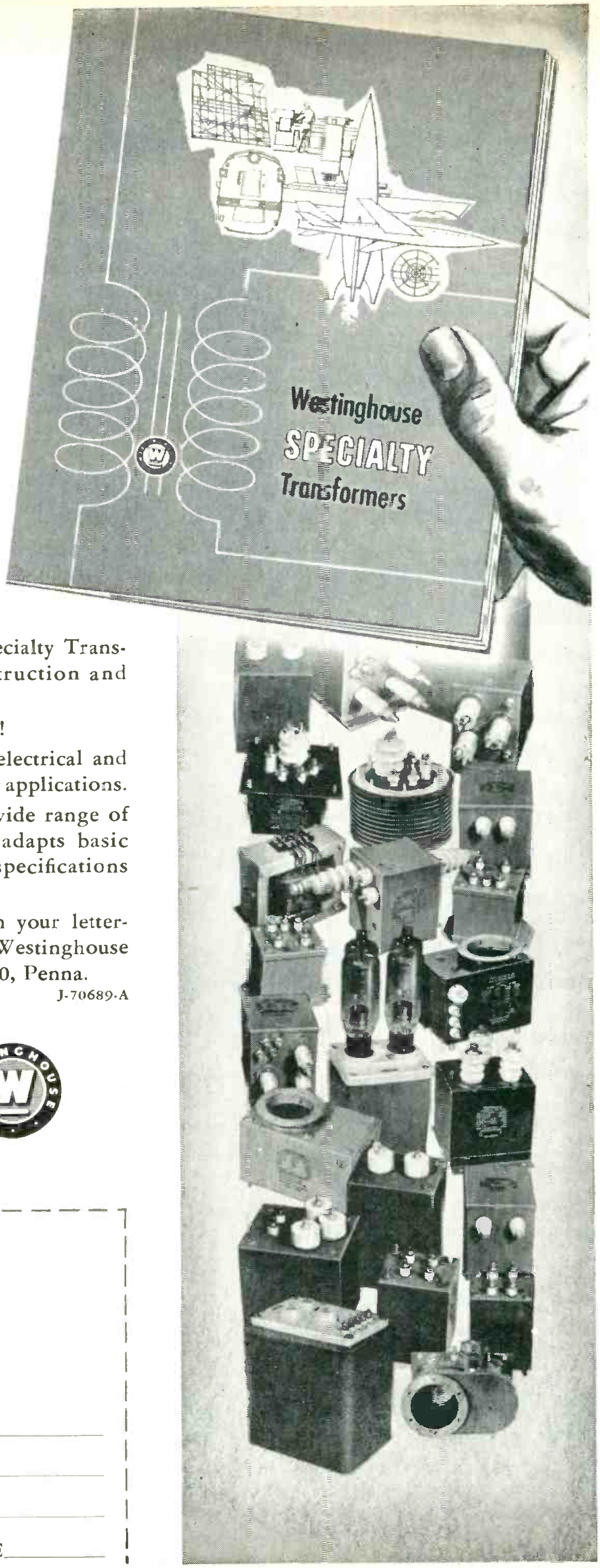

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☐ MODULATORS	☐ D. C. VALVES
☐ CURRENT LIMITERS	☐ BIAS SUPPLIES
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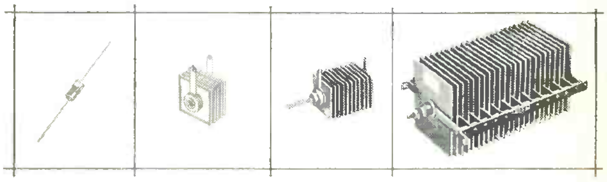

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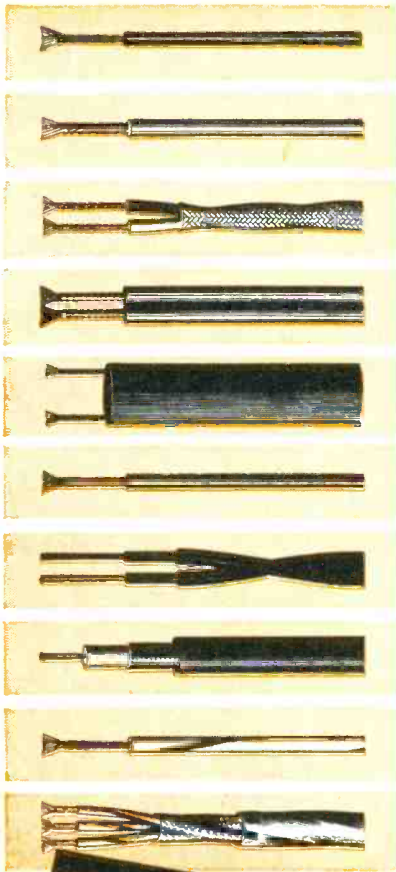

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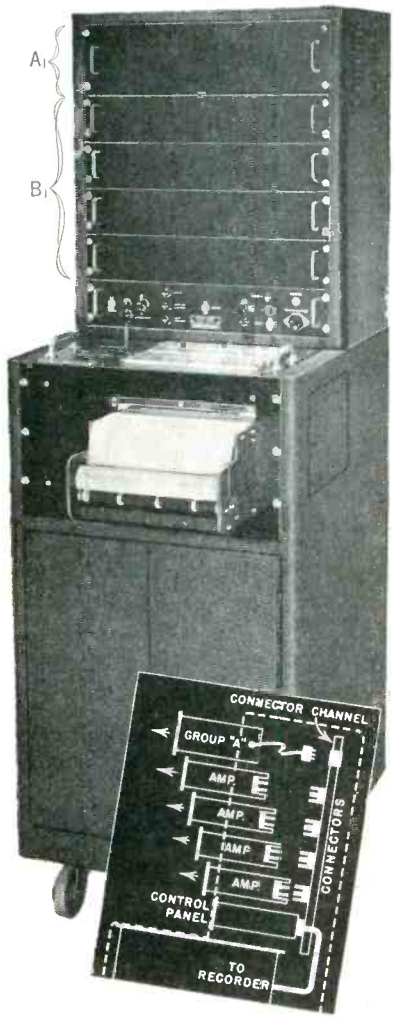
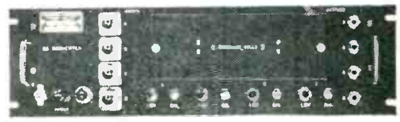


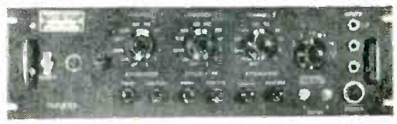
A

DC PREAMPLIFIER

AC PREAMPLIFIER



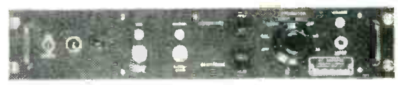
DC CONVERTER—for low level DC recording such as thermocouple output.



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

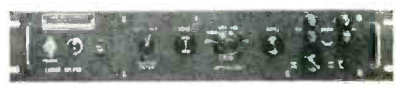
THRESHOLD MONITOR provides means for the control of voltage levels or rate of change.

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.

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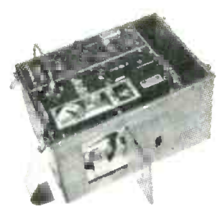
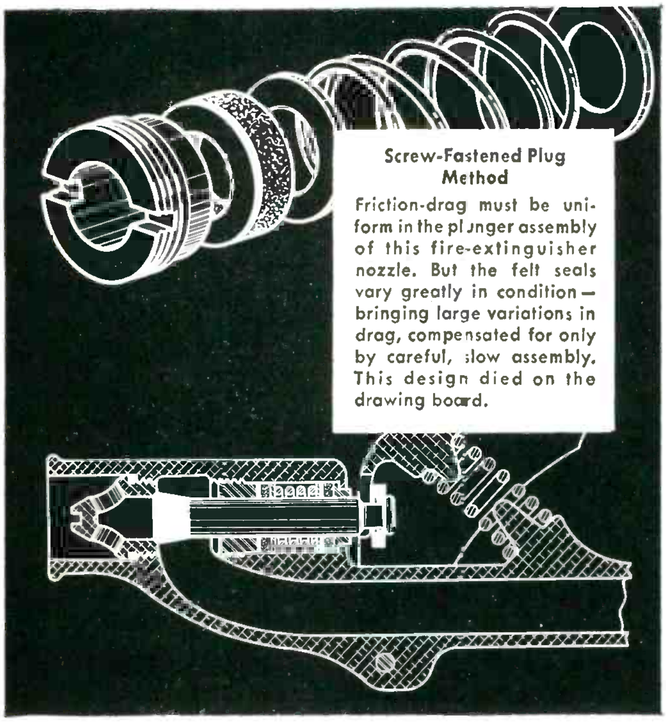
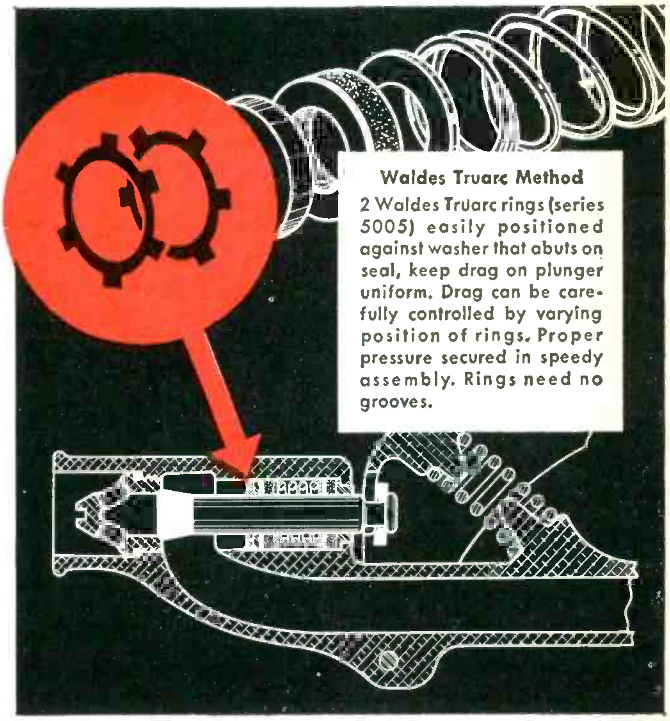


One channel Model 128/141 above and two-channel Model 60 at right both incorporate Sanborn recording advantages which include interchangeability of amplifiers and (with Model 60) preamplifiers.

2 Truarc self-locking rings replace threaded plugs. Save 6¢ per unit, speed assembly by 140%.





Ansul Chemical Company's new watertight precision nozzle for their dry chemical fire extinguisher replaces conventional stainless steel plug with two Waldes Truarc Self-Locking Retaining Rings and washer. Rings hold entire nozzle packing securely in place — keep friction drag of plunger uniform. Adjustable in final assembly, Truarc rings speed production from 25 to 60 units per hour. They save 6¢ per unit in overall costs, 1/8" in length.

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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. They're precision-engineered... quick and easy to assemble and disassemble. They give a never-failing grip. Find out what Truarc Rings can do for you. Send your blueprints to Waldes Truarc engineers for individual attention, without obligation.

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telling the story of 'dag' dispersions

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Many speak about *dagging* CRT's when they refer to the application of opaque wall coatings. The word *dag* is loosely and incorrectly used in this sense; actually 'dag' is a registered trademark of the Acheson Colloids Company, the world's largest producer of colloidal graphite dispersions for the electronic and metalworking industries.

'dag' Exterior Wall Coating is a unique material. It is a dispersion of extremely fine graphite in lacquer, easily applied by spraying. It dries for handling in 2 to 3 minutes. After 24 hours at room temperature, or ½ hour of 100°C. infra-red heat, it results in a smooth, pitch-black coating which adheres tenaciously. Scratching is almost an impossibility. Water won't loosen the coating either.

Acheson Colloids can also supply appropriate 'dag' dispersions for coating interiors of tubes.

More detailed information available in our Bulletin No. 433-5E.

Dispersions of molybdenum disulfide are available in various carriers. We are also equipped to do custom dispersing of solids in a variety of vehicles.

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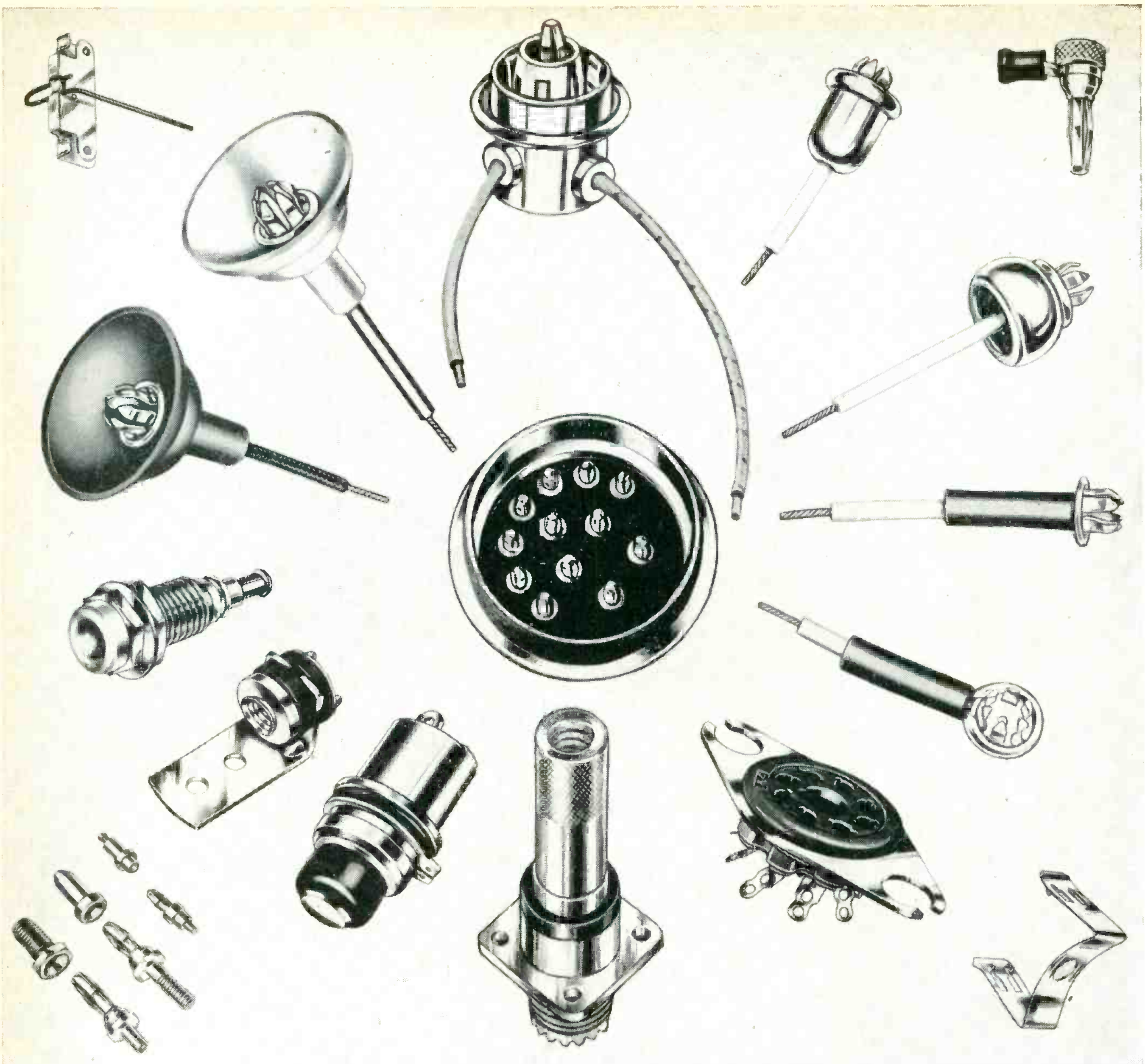

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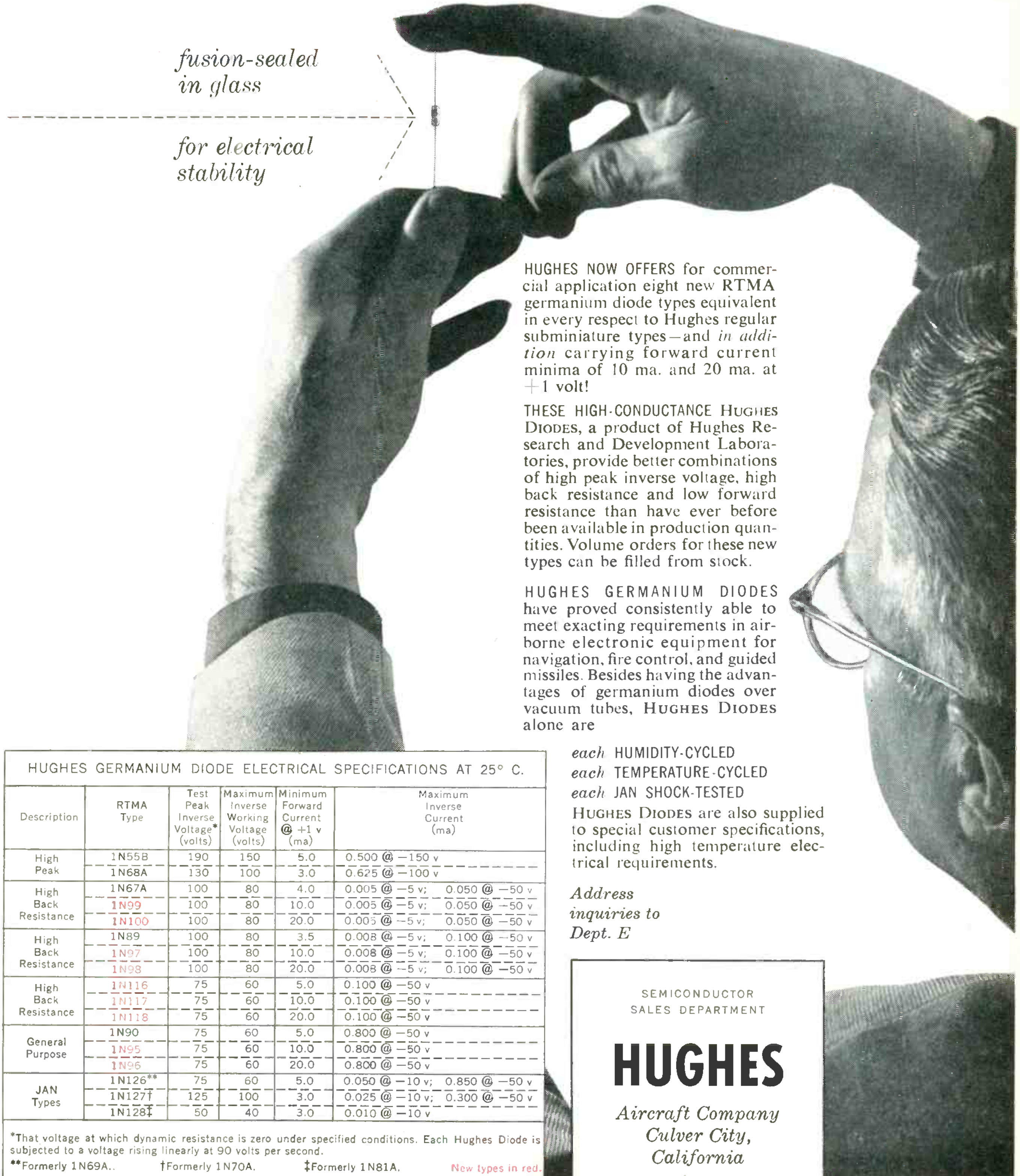
HUGHES SETS NEW STANDARDS OF DIODE CONDUCTANCE



HUGHES NOW OFFERS for commercial application eight new RTMA germanium diode types equivalent in every respect to Hughes regular subminiature types—and *in addition* carrying forward current minima of 10 ma. and 20 ma. at +1 volt!

THESE HIGH-CONDUCTANCE HUGHES DIODES, a product of Hughes Research and Development Laboratories, provide better combinations of high peak inverse voltage, high back resistance and low forward resistance than have ever before been available in production quantities. Volume orders for these new types can be filled from stock.

HUGHES GERMANIUM DIODES have proved consistently able to meet exacting requirements in airborne electronic equipment for navigation, fire control, and guided missiles. Besides having the advantages of germanium diodes over vacuum tubes, HUGHES DIODES alone are

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HUGHES DIODES are also supplied to special customer specifications, including high temperature electrical requirements.

HUGHES GERMANIUM DIODE ELECTRICAL SPECIFICATIONS AT 25° C.

Description	RTMA Type	Test Peak Inverse Voltage* (volts)	Maximum Inverse Working Voltage (volts)	Minimum Forward Current @ +1 v (ma)	Maximum Inverse Current (ma)
High Peak	1N55B	190	150	5.0	0.500 @ −150 v
	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.
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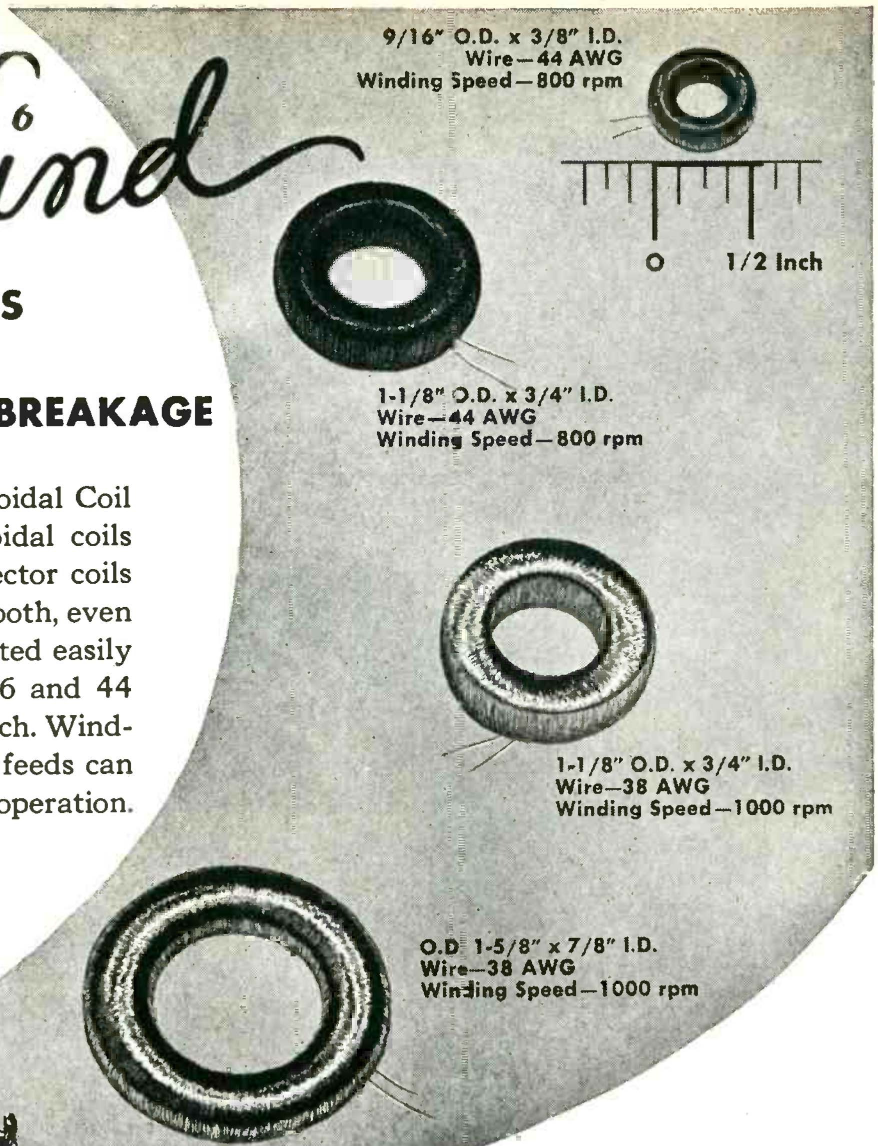

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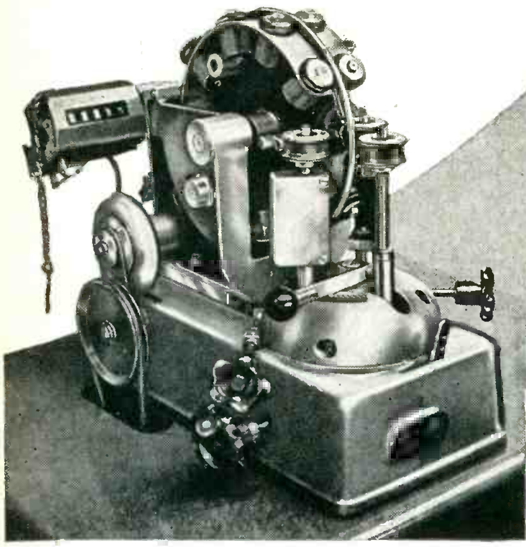
The MICAFIL Model RW-0 Toroidal Coil Winder automatically winds toroidal coils continuously around 360° and sector coils from 30° to 270°. To produce smooth, even layers of wire, the winder is adjusted easily to wind any wire size between 26 and 44 AWG and to obtain the proper pitch. Winding direction can be changed and feeds can be adjusted while machine is in operation.



CAPACITY

Coil Sizes
- Minimum finished I.D. . . . . ¼"
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- Minimum finished O.D. . . . . ½"

Wire Sizes . . . . 26 to 44 AWG

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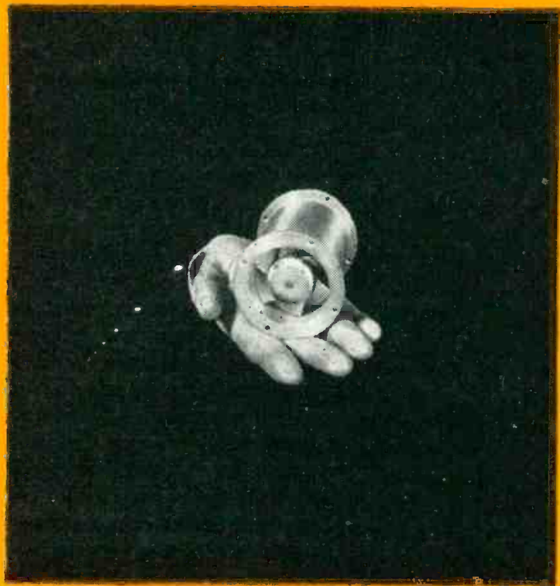

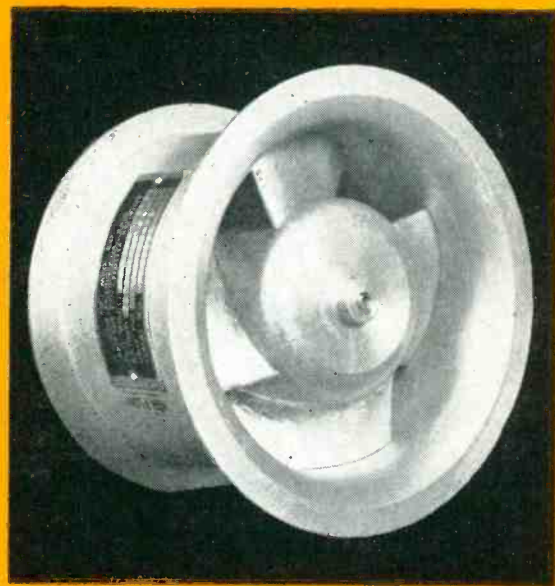

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Available in sizes from 2″ I.D. up, these Joy Fans are built to meet all present Air Force and Naval electronic specifications. They can be furnished with totally enclosed or explosion-proof motors, if desired.

In general, keep these facts in mind: that the light, compact design, low power consumption and high overall efficiency of Joy AXIVANE Fans provide more satisfactory cooling for electronic equipment in either air-borne or surface units. ● If you have a problem in heat dissipation from electronic units, let us place at your disposal JOY's experience as the world's largest manufacturer of vaneaxial-type fans.

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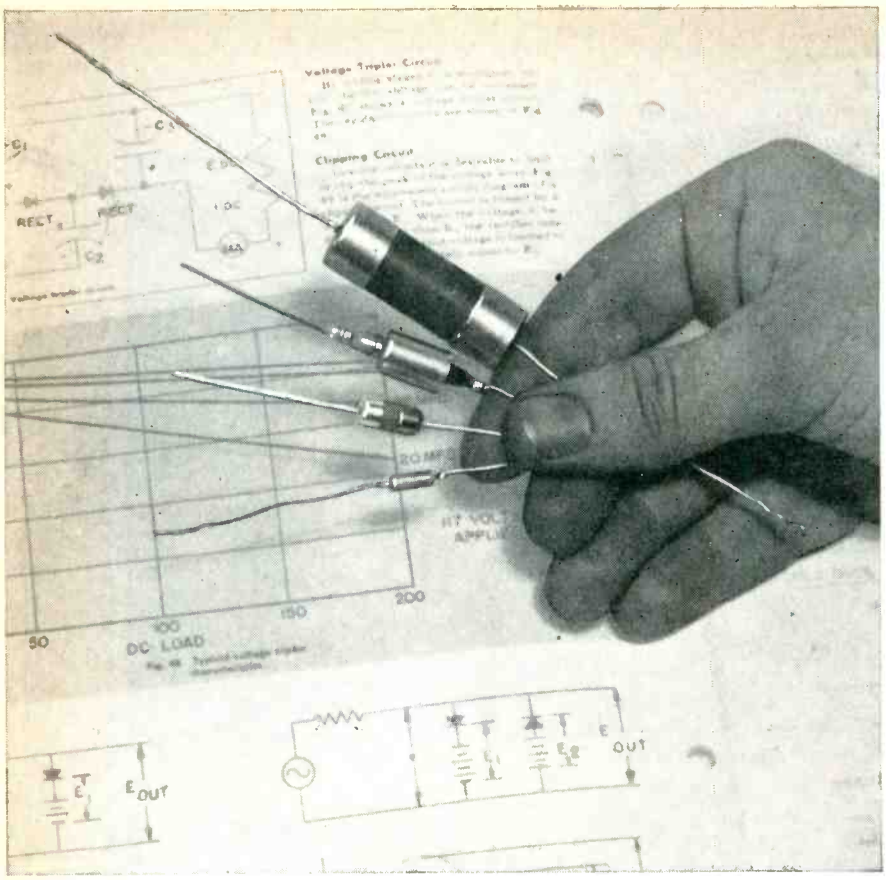

STACKS ARE AVAILABLE IN TEXTOLITE* TUBES OR HERMETICALLY SEALED CASINGS

G.E. Announces A New Line of Miniature Selenium Rectifiers

General Electric's new miniature selenium rectifiers are produced by the same carefully controlled process, and offer the same outstanding characteristics as larger G-E selenium rectifiers.

APPLICATIONS. In electronic applications, G-E miniature selenium rectifiers may be used in blocking, electronic computer, magnetic amplifier, communication, and signal circuits. They also can be used to operate small relays, solenoids, and precipitators.

ADVANTAGES. G-E miniature selenium stacks have long life, good regulation, and high reverse resistance. They will function over an ambient temperature range from minus 55 C through 100 C, and their totally enclosed construction provides excellent environmental protection. Their small size and low heat rise permit compact mounting close to other components.

RATINGS. At an ambient temperature of 35 C, ratings for single stacks range from 0.5 ma d-c at 26 volts RMS, to 25 ma d-c at 5200 volts RMS. Higher ratings may be obtained by combining stacks. Two types of totally enclosed casings are used: Textolite* tubes for ordinary operating conditions, or hermetically sealed, metal-clad casings to meet government specifications for severe environmental conditions. Stacks can be furnished for either lead or bracket mounting.

FOR MORE INFORMATION consult your nearest G-E Apparatus Sales Office, or write Section 461–28, General Electric Co., Schenectady 5, N.Y.

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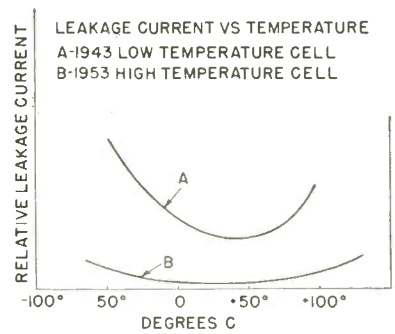
METALLIC RECTIFIER FACTS FOR ENGINEERS

High Temperature Operation

by C. E. Hamann

The rapidly expanding use of metallic rectifiers in the last few years has brought about a concerted effort within the industry to improve their quality and electrical characteristics through technological developments.

One of the outstanding accomplishments has been the great improvement in temperature characteristic of selenium rectifiers. Not only is it possible for selenium cells to be operated at higher temperatures, but in addition their range of operating temperatures has been increased. Selenium cells manufactured only a few years ago utilized a low melting-point metal alloy as a counter-electrode material. Recently, methods have been developed for applying alloys having melting points from 50 to 100 per cent higher than previous types. Thus higher operating temperatures are possible.



Concurrently, there has been considerable improvement in blocking characteristics. Thus, quality selenium rectifiers now give greater stability at both high and low extremes of temperature. These facts are highly important in meeting essential requirements for military applications and commercial uses.

Only continuing research and development programs make possible the improvements in the quality of metallic rectifiers necessary to meet the increasingly severe requirements of their applications.

C. E. Hamann

General Electric Company

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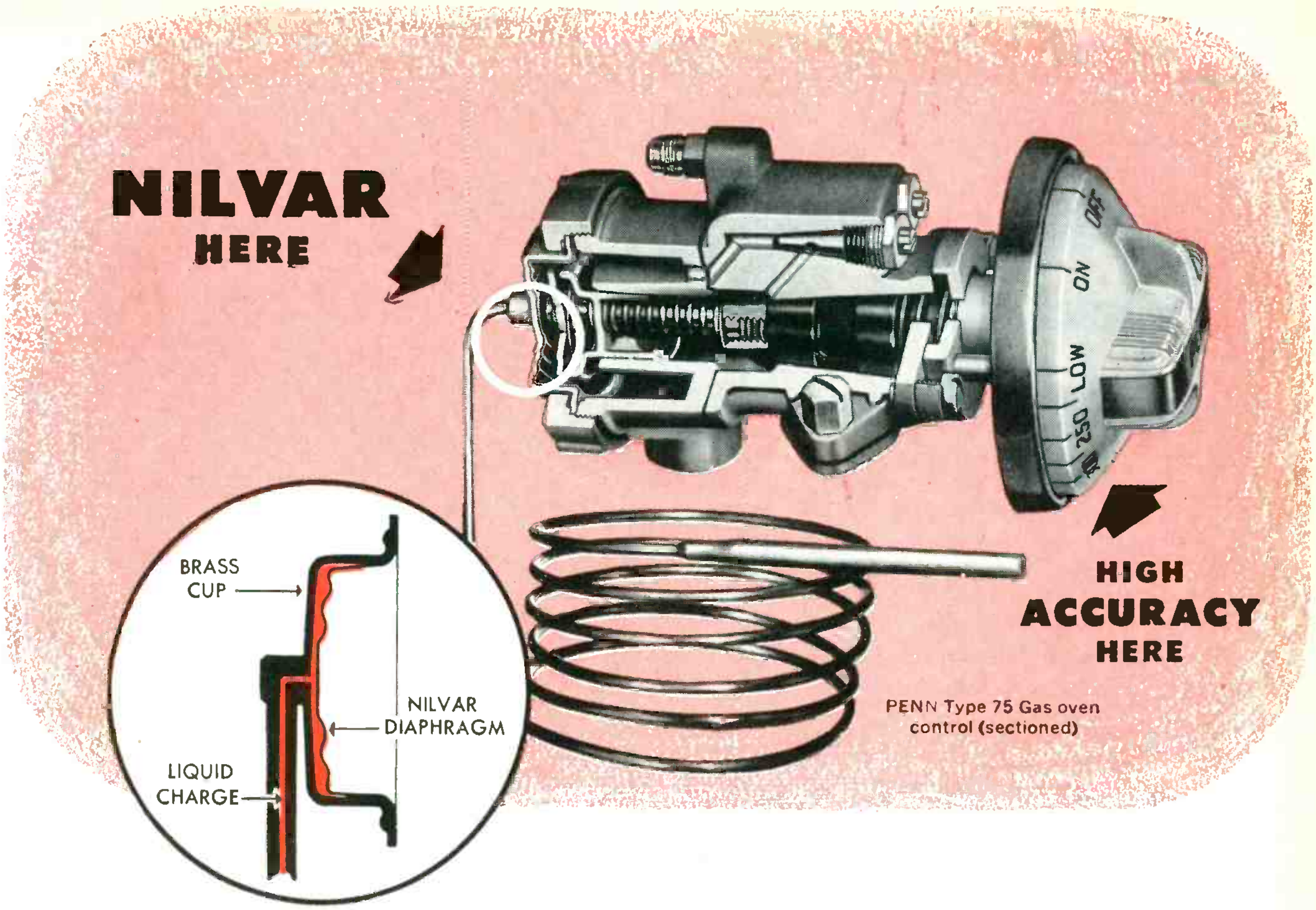

PENN Type 75 Gas oven control (sectioned)

Nilvar* Alloy Makes New PENN Gas Oven Controls Self Compensating

By providing a self-compensating flexible diaphragm assembly for its liquid expansion controls, PENN Controls, Inc. compensates for ambient heat and eliminates control time-lag. Result: controls *accurately* maintain the temperature dialed.

The PENN Self-compensated Diaphragm assembly utilizes a brass retaining cup and a flexible Nilvar diaphragm to form a hollow chamber. This connects to the temperature bulb through a capillary tube, the entire unit being filled with a liquid charge.

Because brass expands much more than Nilvar, ambient heat *simultaneously* increases the volume of the chamber, when it increases the volume of the liquid charge. This self compensation reduces the effect of ambient heat on the diaphragm to zero and permits the diaphragm to respond *only* to bulb temperatures.

PENN specifies Nilvar for this application because it has a very low temperature coefficient of expansion —as low as .000001/C°— lowest of any alloy, and comparable to that of quartz. And its consistent uniformity helps maintain the high accuracy which PENN production standards require.

The remarkable dimensional stability of Nilvar may answer your engineering problems too. Why not talk it over with us. We'll be glad to make recommendations geared to your specific needs.

*T. M. Reg. U. S. Pat. Off.

Nilvar is produced only by

Driver-Harris Company

HARRISON, NEW JERSEY

BRANCHES: Chicago, Detroit, Cleveland, Los Angeles, San Francisco

In Canada: The B. GREENING WIRE COMPANY, Ltd., Hamilton, Ontario.

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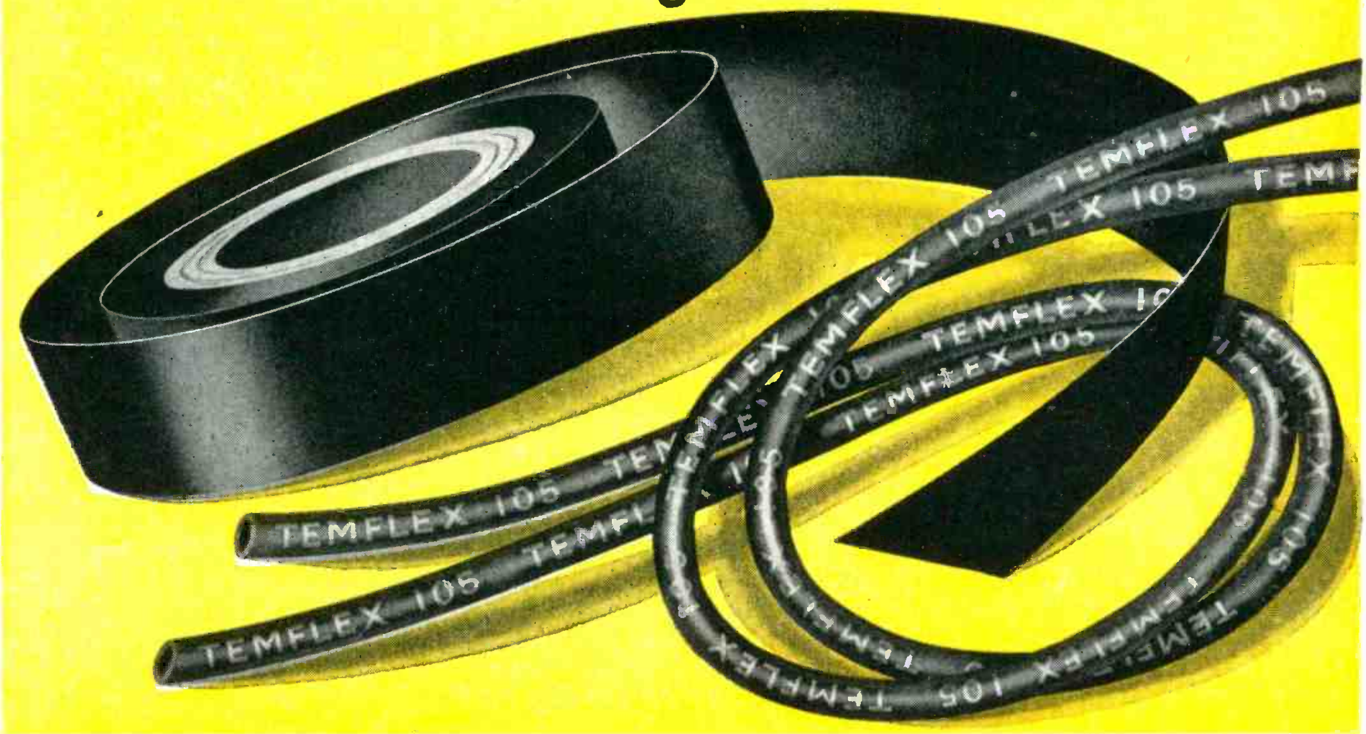
Now— an Irvington PLASTIC INSULATING TAPE

with the heat- and oil-resistance of Temflex® 105 Tubing



Here is a new addition to the Irvington family of insulating tapes— Temflex 105 Plastic Tape, based on the *same* formula that has made Temflex 105 Tubing the leader where service calls for continuous operation in air at 105° C.—or in oil at 90° C.

Temflex 105 Tape is strong and flexible—possesses exceptional elongation. It can be easily hand wound over bus bars, coils, cables —even over very irregular surfaces—or can be used in taping heads. Temflex 105 Tape frequently offers substantial savings as compared with varnished cambric. Easily baked to a homogeneous mass, it also offers cost economies over pressure-sensitive tapes.

Made in thicknesses of .007", .010" and .012"; widths from ½" to 34". Dielectric strength as high as 1200 vpm *even at 100° C.* Tensile strengths up to 3100 psi—elongation 165% to 240%.

You probably know Temflex 105 *Tubing*—you'll certainly want to learn about Temflex 105 *Tape*. Mail the coupon for technical data sheet.

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

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Please send me technical data sheet on your new Temflex 105 Tape.

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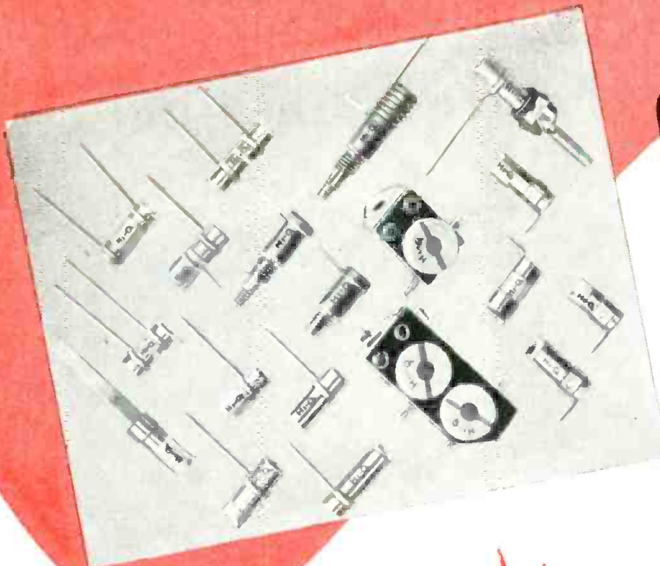
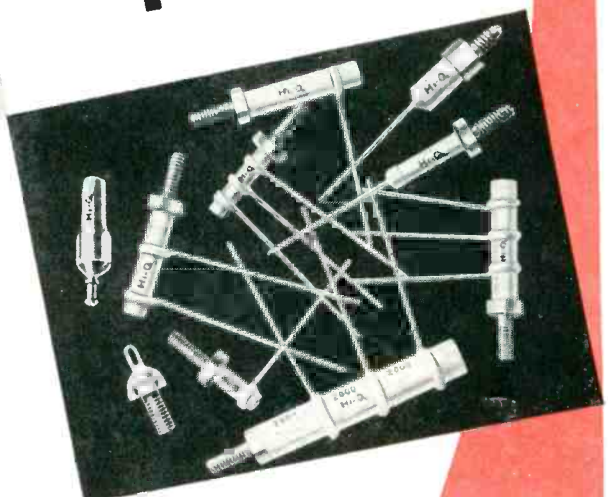
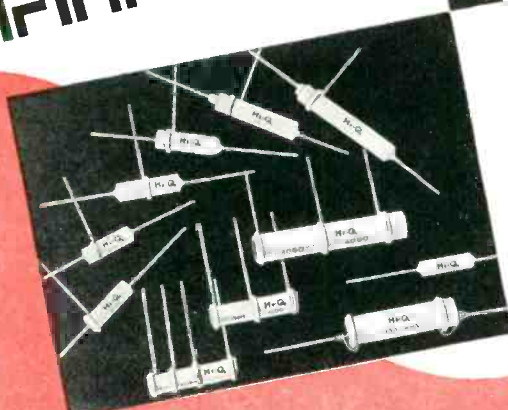
ceramic capacitors





FUNCTION* FITTED



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These trimmers, stand-off capacitors and resistor-capacitor combinations are typical of Hi-Q special components developed largely to meet special needs. They suggest what Hi-Q specialists can accomplish in designing and producing ceramic units for any and all purposes.

Capacitor elements in Hi-Q special components meet all requirements as established by RTMA for Class 2 ceramic dielectric capacitors specifically suited for by-pass and coupling applications, or for frequency discriminating circuits where Q and stability of capacitance are not of major importance. Where Class 1 capacitors are required, Hi-Q specialists are again ready to study your most rigid specifications.

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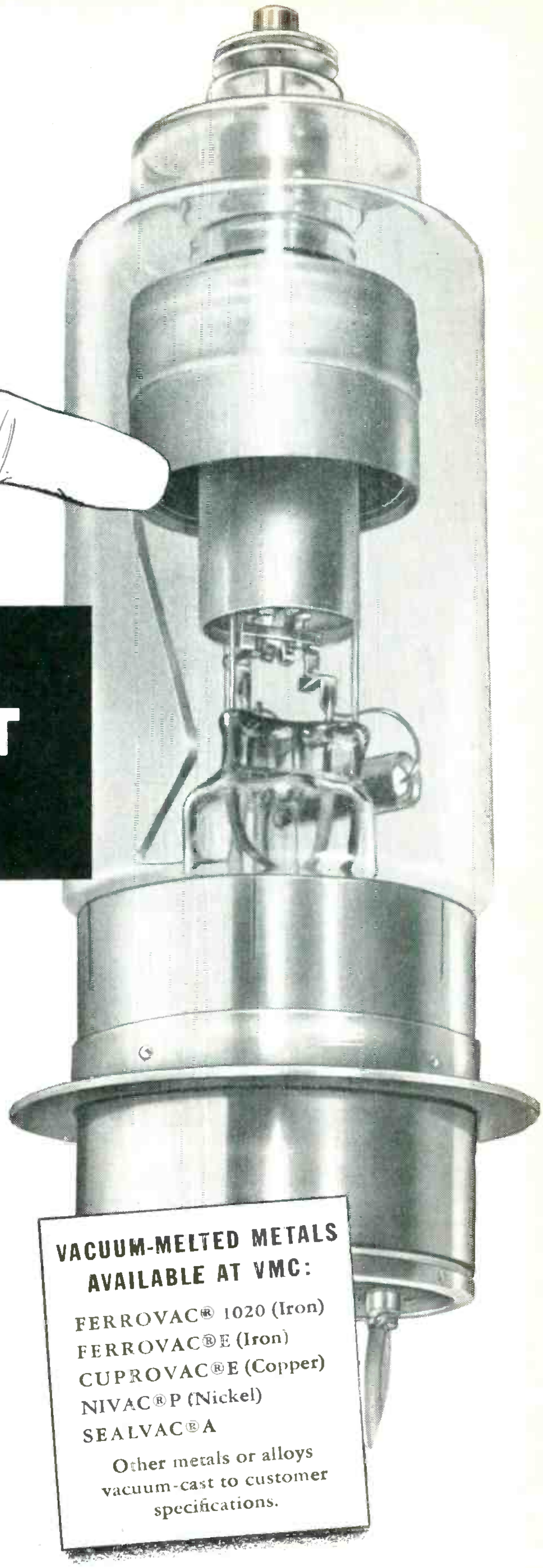

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Vacuum-melting removes gases and inclusions from metals. Tube elements made with vacuum-cast metals have a minimum of dissolved and trapped gases to spoil tube pressures.

Right now vacuum-cast metals are being evaluated to reduce pump-down time and to provide longer life for tubes like the thyratron pictured above.

Such improved properties are typical of vacuum-melted metals. Their better physical, chemical and electrical characteristics indicate that they can solve problems formerly considered difficult or impossible.

Commercial quantities of ferrous and non-ferrous metals and alloys are now being vacuum-cast at pressures as low as one millionth part of atmospheric by Vacuum Metals Corporation. Available in either billet or fabricated forms. Write for more information.

VACUUM-MELTED METALS AVAILABLE AT VMC:

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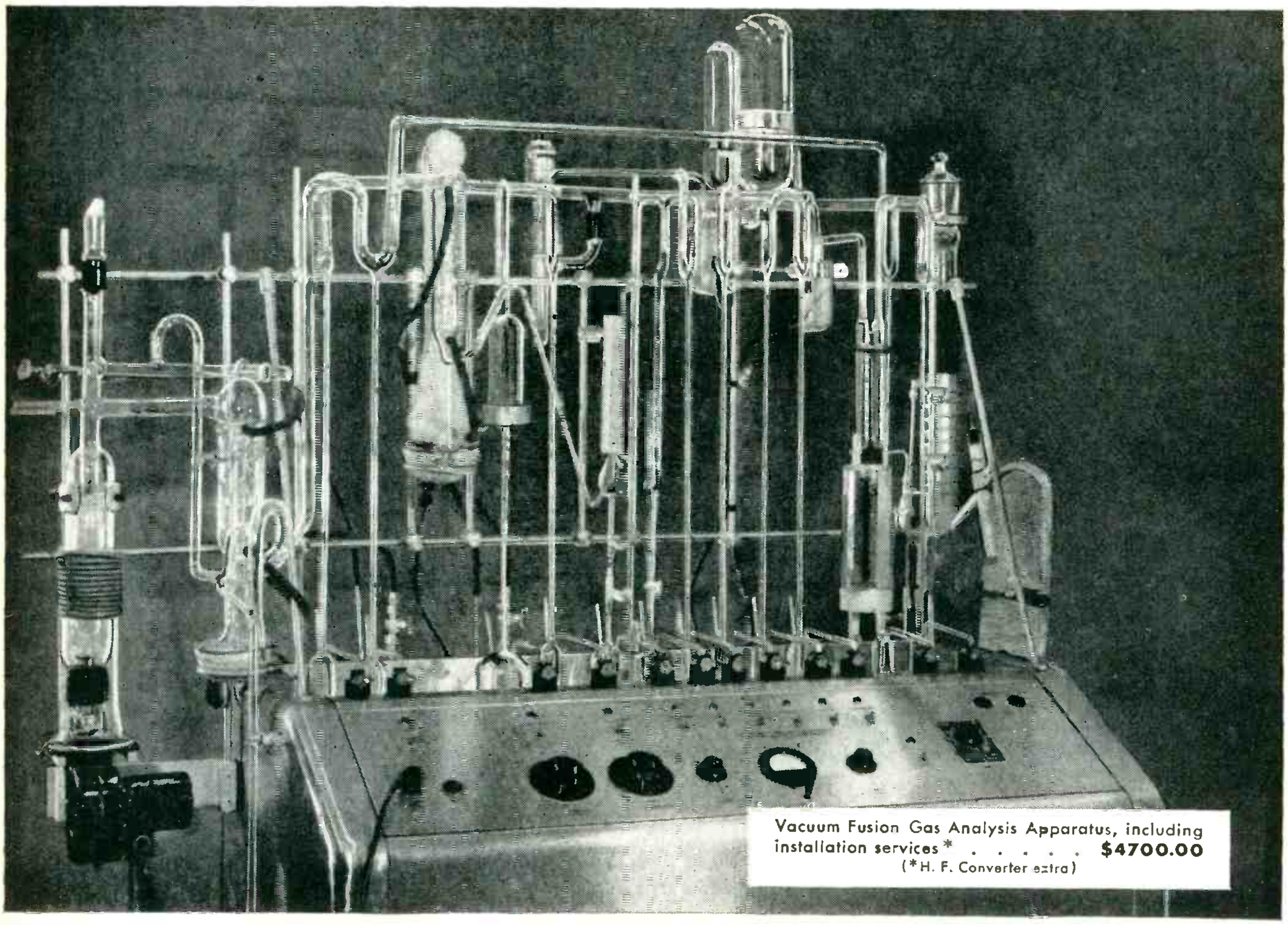
Vacuum Fusion Gas Analyzer

with complete installation and instruction



Vacuum Fusion Gas Analysis Apparatus, including installation services* $4700.00
(*H. F. Converter extra)

A packaged unit to determine the content of oxygen, nitrogen and hydrogen in metals

A wide variety of metals and alloys, including titanium, can be analyzed to determine the amount of oxygen, nitrogen and hydrogen contained either as combined or dissolved gas, in the range from one per cent to approximately 10^{-4} per cent by weight.

Total gas contents of titanium are reported within approximately the same range for oxygen and hydrogen as for other metals.

The apparatus incorporates the best features and techniques reported in the literature or known to our laboratory and has been employed for some time in connection with our own metallurgical research activities.

Operating procedure is relatively simple and can be readily mastered. Installation, final testing and instruction of your operator is performed by one of our trained analysts.

Write for details of Type 09-1240 Vacuum Fusion Gas Analysis Apparatus.

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Write for information about NRC Gas Analysis Service if your requirements do not justify the purchase of an instrument.

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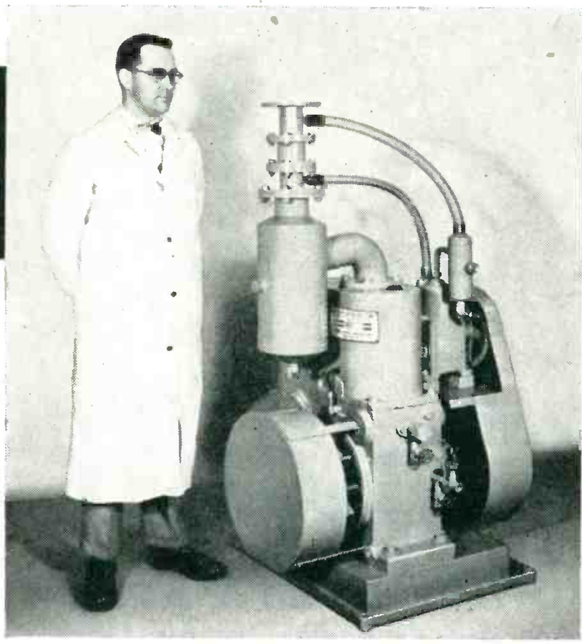
End Your Water Vapor Troubles



NRC Rotary Gas Ballast Pump — Model NRC 100M — a 2-stage pump unit

New — NRC High Vacuum Rotary Gas Ballast Pumps

- **Maintains fast pump down time**
- **Eliminates oil reclaiming units**
- **Provides greater capacity under 1 mm Hg**
- **Requires up to 80% less oil charge**
- **Capacities from 1¼ cfm to 400 cfm**
- **Pressures down to 10^{-4} mm Hg**

This is important news for every user of rotary vacuum pumps. At last, an "anti-water-vapor" pump that does not blank off at increasing pressures because it is trying to pump condensable vapors.

Water vapor is no problem to the new National Research Rotary Gas Ballast Pump. It operates on a principle that *prevents* the water vapor from condensing and contaminating the pump oil.

The pump is available in capacities from 1¼ cfm to 400 cfm; pressures down to 10^{-4} mm Hg; a full line of vane, piston-type and 2-stage pumps.

Send in the coupon today for your copy of the new bulletin that gives a full explanation of the Gas Ballast principle and complete engineering data on the construction and operation of the NRC Rotary Gas Ballast Pumps.

NRC

National Research Corporation

EQUIPMENT DIVISION, *70 Memorial Drive, Cambridge, Mass.*

Send me more facts about the NRC Rotary Gas Ballast Pump ☐ Have your Salesman call ☐

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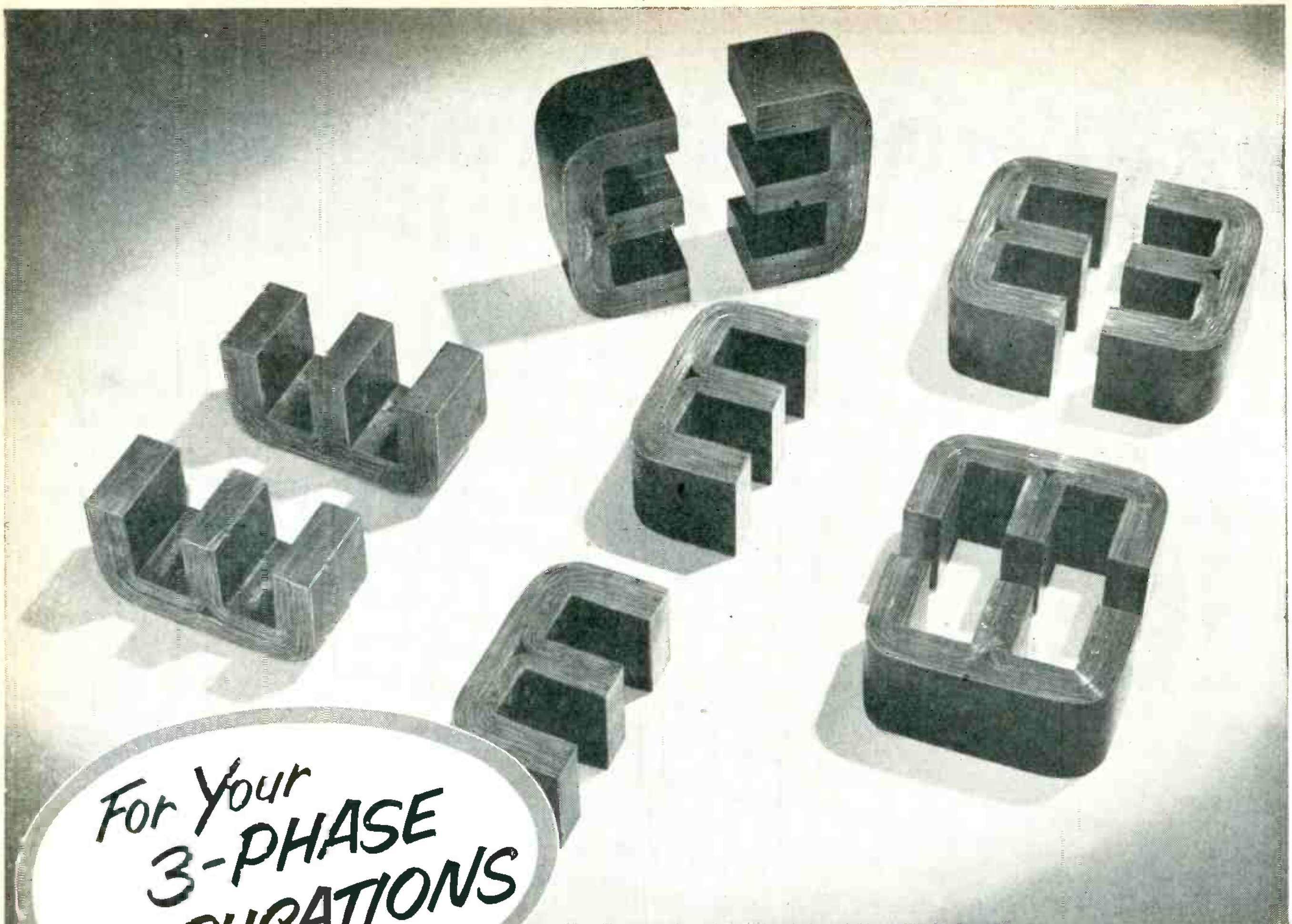

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3-PHASE
APPLICATIONS

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made from SILECTRON strip
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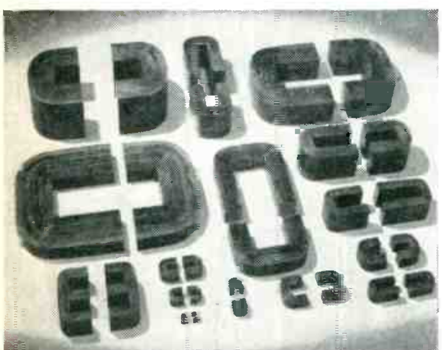

C-Cores to meet any requirement
For your single phase applications, Arnold "C"-Cores are available in any shape and quantity, and in any size from fractions of an ounce to hundreds of pounds . . . wound from Silectron strip in a wide range of ultra-thin and heavier gauges. (Sizes up to 10 lbs. in 12-mil strip; to any weight in thinner gauges)

The use of "E" cores, wound from grain-oriented silicon steel, results in weight and size reduction as well as higher efficiency and possible cost savings. "E" cores can be supplied in a variety of window sizes and core areas from 1, 2, 4 or 12-mil Silectron strip, for high or low frequency 3-phase applications. ● All Arnold cores are made by precision methods, and carefully tested under closely controlled conditions to assure highest quality and reliability. *We'll welcome your inquiries.*

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W&D 4658

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DU MONT *Teletrons**

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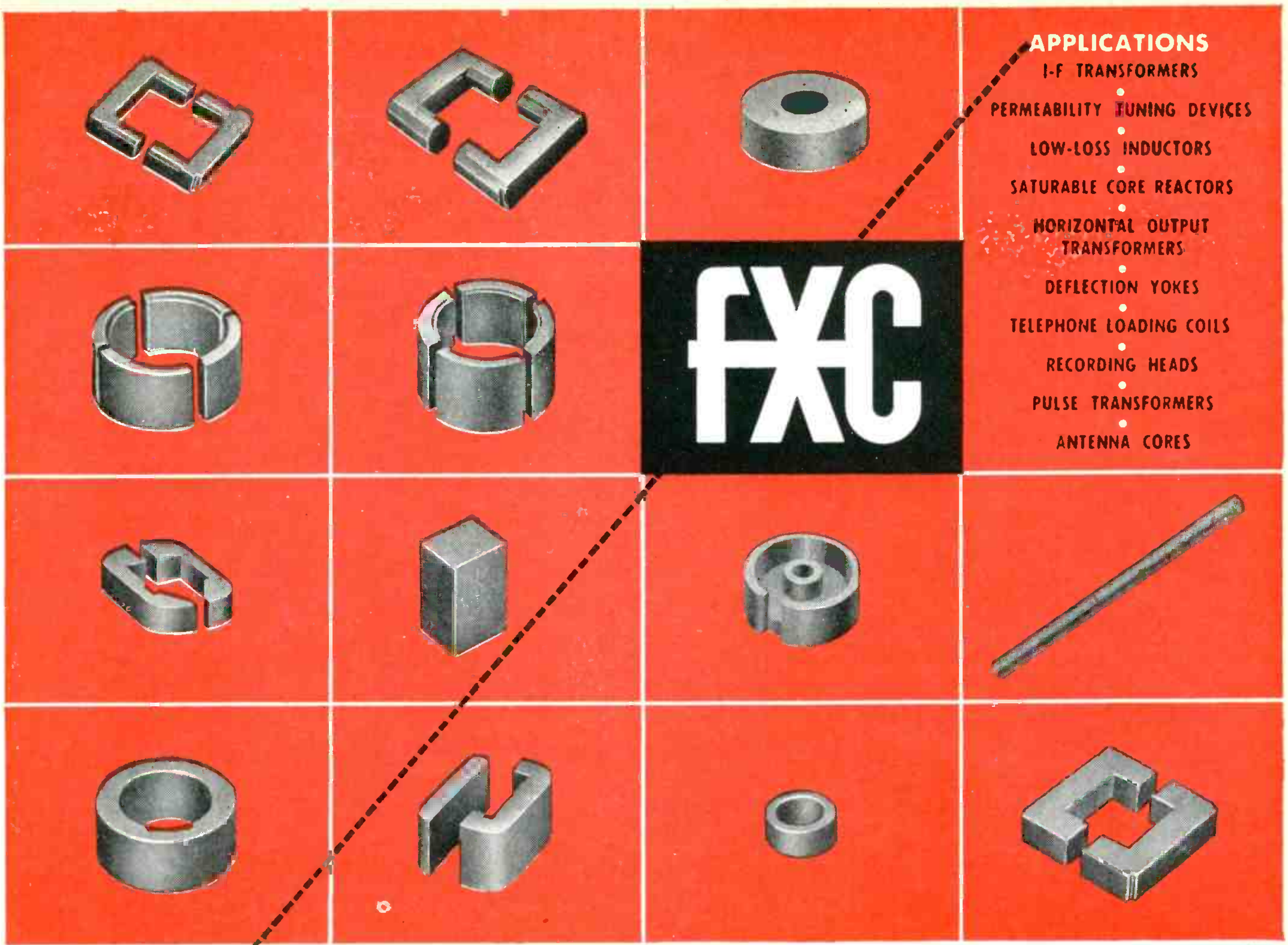

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Nickel-free Ferroxcube 3 and 3C cores are the modern, superior ferrites now performing with outstanding success in television and military electronics. Both materials have higher permeabilities than the nickel-zinc ferrites that are sometimes supplied for these applications.

For the higher-temperature applications, Ferroxcube 3C cores are recommended. Where maximum initial permeability is the prime requirement, Ferroxcube 3 is generally indicated.

In any case, you can specify either of these excellent manganese-zinc ferrites with full assurance that deliveries will be made to meet your specified schedules.

For higher-frequency applications, where minimum eddy-current losses are more important than maximum permeability, the Ferroxcube 4 series of nickel-zinc ferrites are recommended. Their uses include I-F Transformers, R-F Tuning Coils, Antenna Cores, etc.

The broad experience of Ferroxcube Corporation Engineers — an accumulated knowledge of manufacture and application over a 16-year period — is the "reference library" which is available to assist you. Write for technical data applicable to your design problems. ★ ★ ★ ★

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For High Conductive Electrical Spring Parts at Low Cost

Here's a new General Plate Composite Metal — *CONFLEX copper clad on hardenable medium carbon steel!* — that can solve many of your electrical spring problems.

Comparable to beryllium copper in many respects, its primary advantage is *lower cost*. In addition, *CONFLEX copper-clad hardenable steel* has greater stiffness than hardenable copper alloys.

General Plate single or double copper-clad hardenable steel offers high electrical and thermal conductivity. Thickness ratios can be produced to give higher electrical conductivity than hardenable copper alloys when the same overall thickness of materials are compared.

CONFLEX copper-clad hardenable steel can be used advantageously for such applications as fuse clips, flat springs and electrical connectors. In other applications, such as pen and pencil clips, the layer of copper provides an excellent surface for an electro-plated finish.

General Plate products include . . . precious metals clad to base metals, base metals clad to base metals, silver solders, 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.

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SILICON DIODES

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- Top Performance
- Uniformity
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Bomac produces a complete line of gas switching tubes, TR, ATR, Pre-TR and Attenuator Tubes, Pressurizing Windows, Hydrogen Thyratrons, & Crystals.

We invite your inquiries regarding

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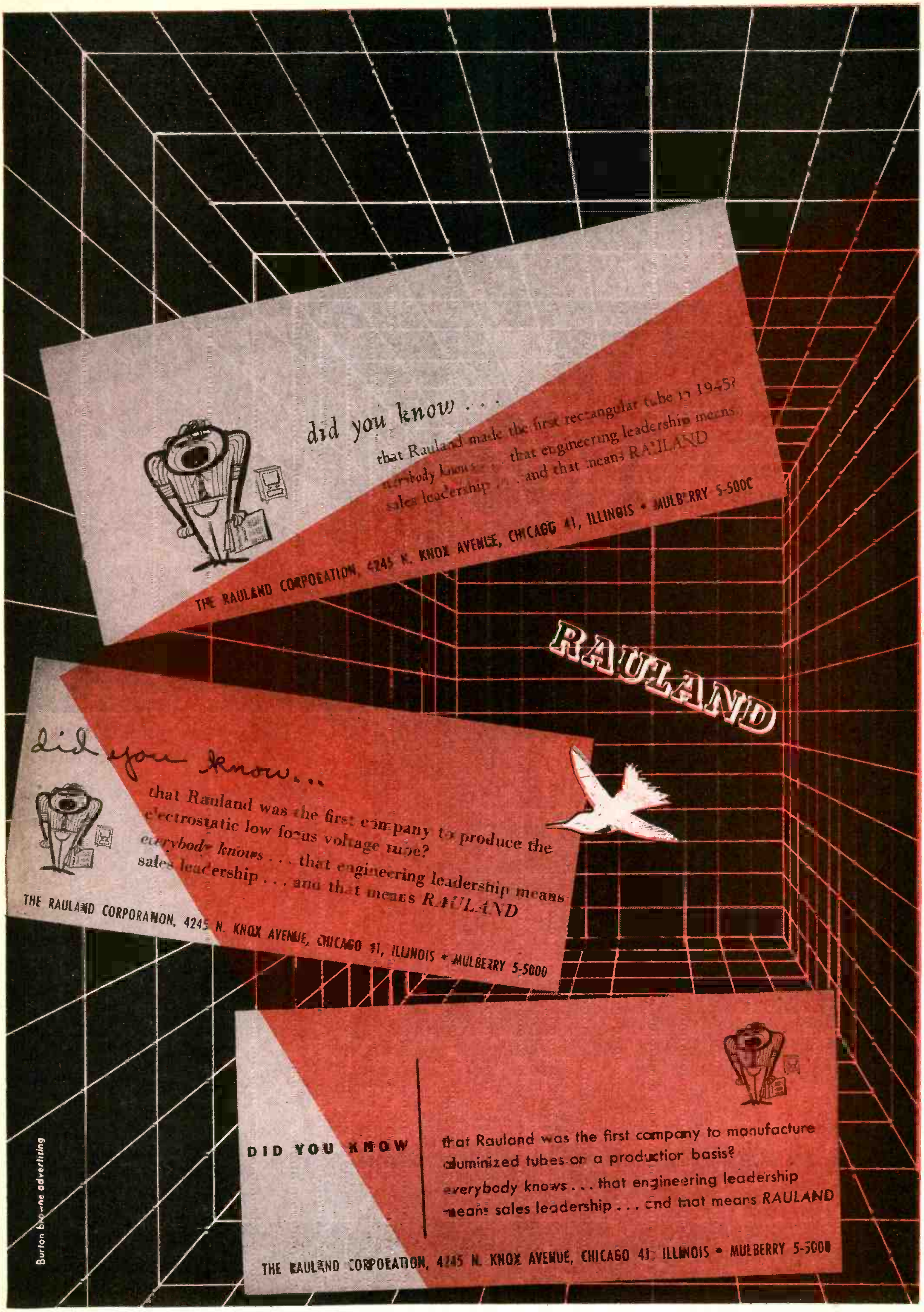
TYPE NO.	FREQUENCY	CONVERSION LOSS	NOISE RATIO	BURNOUT
1N21B	3,000 mc	6.5 db. max.	2.0 max.	2.0 ergs
1N21C	3,000 mc	5.5 db. max.	1.5 max.	2.0 ergs
1N23B	10,000 mc	6.5 db. max.	2.7 max.	1.0 ergs
1N23BM	Matched pair of 1N23B diodes for balanced mixer use.			

Bomac LABORATORIES, INC.
BEVERLY, MASSACHUSETTS



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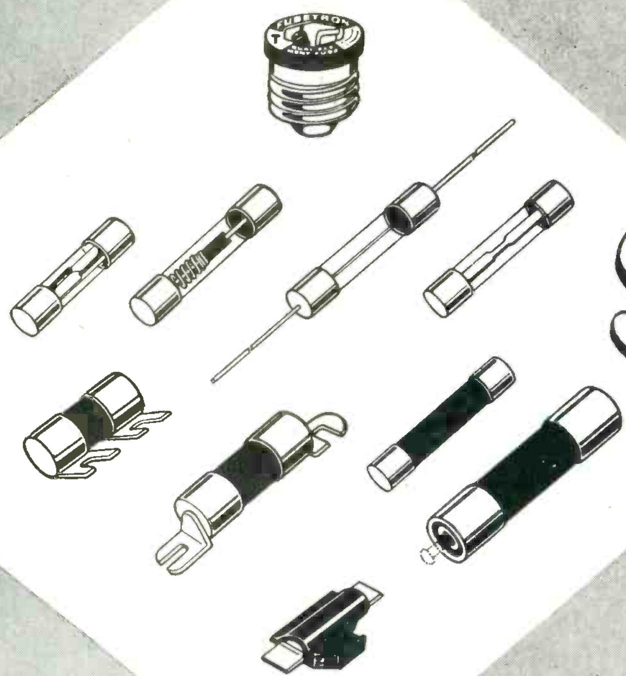

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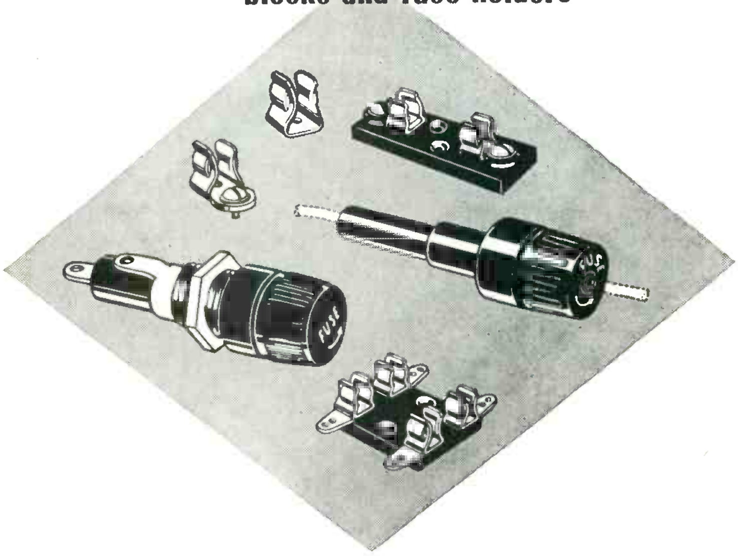

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To assure protection to both the product and your good name, every BUSS fuse is tested on a sensitive, electronic device for correct construction, calibration and physical dimensions.

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BUSS Fuse Engineers will gladly assist you in selecting the fuse to suit your needs best . . . a fuse that if possible will be available in local wholesalers stocks.

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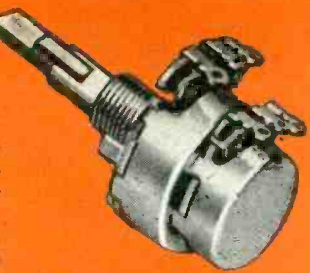
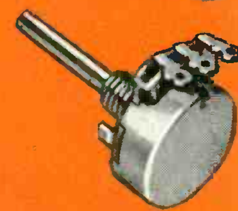
***Exceptionally* good delivery cycle on civilian orders due to tremendous mass production facilities.**

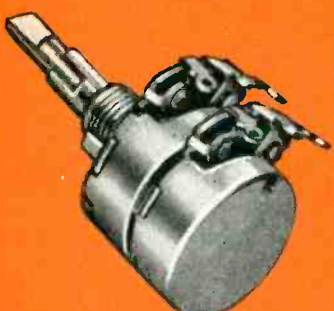
TYPE C45-70



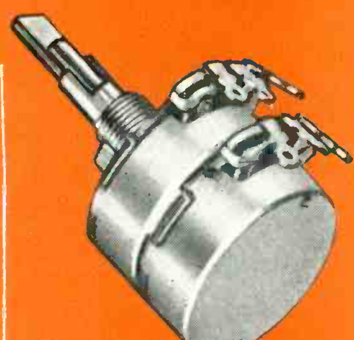


NEW HIGH QUALITY MINIATURIZED "DIME-SIZE" CIVILIAN CONTROL—*Performance Fully Equals Larger Types.*

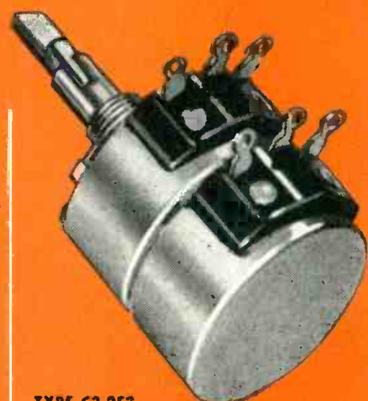
TYPE 70, 3/4" diameter variable composition resistor. Wattage rating: .3 watt for resistances through 10,000 ohms, .2 watt with 350 volts maximum across end terminals for resistances over 10,000 ohms. Also available in concentric shaft tandem construction C45-70 as shown above.



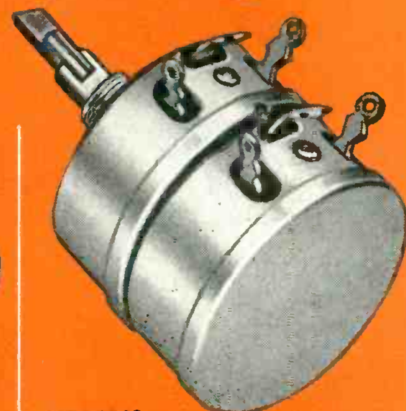
TYPE C2-45



TYPE C2-35



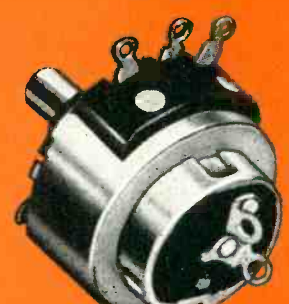
TYPE C2-252



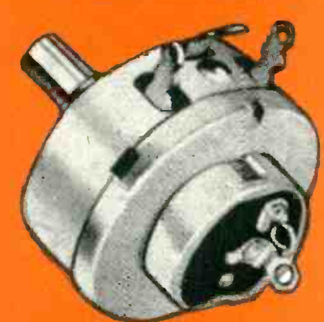
TYPE C2-25

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.

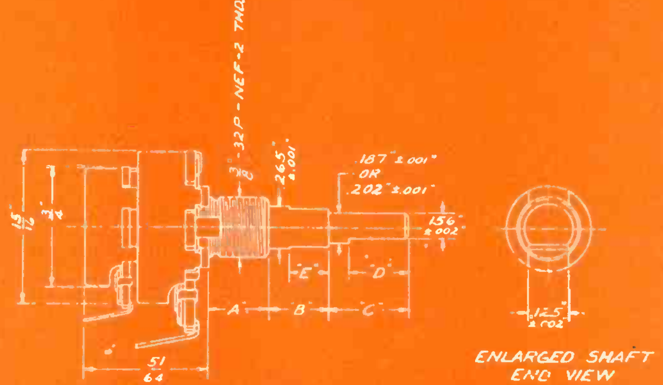


TYPE GC-252, 2 watt, 1 17/64" diameter variable wirewound resistor. Available with or without illustrated attached switch and in concentric shaft tandem construction C2-252 as shown above.



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.



TYPE C45-70

COMPLETE MILITARY LINE

Immediate delivery from stock on 189 types including JAN-R-94 and JAN-R-19 types of variable resistors.

NEW 38-PAGE ILLUSTRATED CATALOG—
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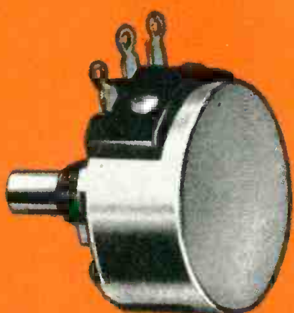
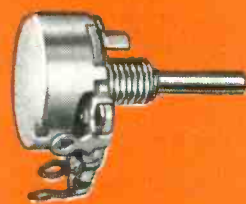
TYPE 45, (JAN-R-94, Type RV2)
1/4 watt, 15/16" diameter variable composition resistor. Also available with other special military features not covered by JAN-R-94 including concentric shaft tandem construction. Attached switch can be supplied.

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.



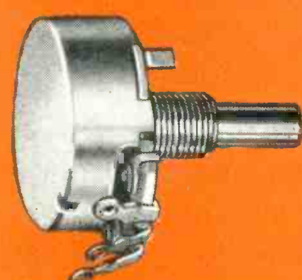
TYPE 252, (JAN-R-19, Type RA20)
2 watt, 1 17/64" diameter variable wirewound resistor. Also available with other special military features not covered by JAN-R-19 including concentric shaft tandem construction. Attached switch can be supplied.

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.

UNPRECEDENTED PERFORMANCE CHARACTERISTICS

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

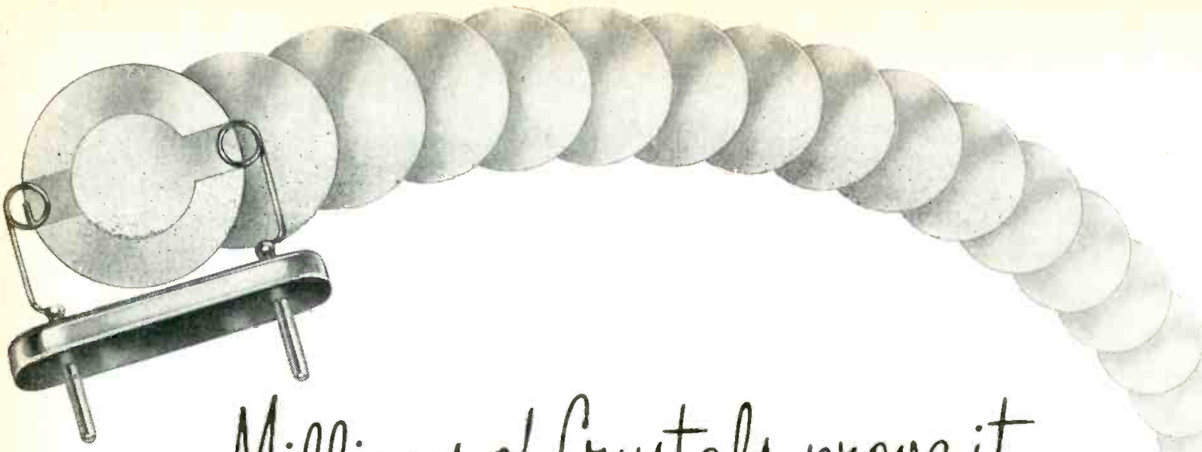
Burton Browne Advertising

CTS

CHICAGO TELEPHONE SUPPLY *Corporation*

ELKHART • INDIANA

Precision Mass Production of Variable Resistors



Millions of Crystals prove it...

Midland QUALITY DOES A BETTER JOB

In every type of two-way radio communications literally millions of Midland crystals are proving that Midland's combination of scientific skill and finest production facilities pays out in better crystal performance.

How did Midland become the world's largest producer of radio frequency control units? Through the merit of a consistently better product. This is the result of Midland quality control—exacting inspection and test procedures, including precise angular control by X-ray—through every step of processing. It starts with selection of only the finest raw quartz; proceeds through slicing, lapping, etching, and final sealing.

That's why your Midland crystal is invariably a masterpiece of stability, acccuracy, high output, and long life—a crystal you can depend on under roughest conditions.

Whatever your Crystal need, conventional or specialized
When it has to be exactly right, contact

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MANUFACTURING COMPANY, INC.
3155 Fiberglas Road • Kansas City, Kansas

WORLD'S LARGEST PRODUCER OF QUARTZ CRYSTALS

An Isotronic* First

±0.01% AC Regulation!

That's the degree of accuracy attained by Sorensen's new Model 1001 AC Line Voltage Regulator!

Heretofore, the closest regulation in commercially available regulators has been ±0.1%, regardless of manufacturer or circuit approach. Now, Sorensen's continuing study and design refinements have produced a super-accurate regulator — the Model 1001 — as a *standard* catalog item.

GENERAL SPECIFICATIONS

Load range	0 — 1000 VA
Input voltage range	95 — 130 VAC, 1φ, 55 — 65~
Load P. F. range	0.7 lagging to 0.95 leading
Output voltage	115 VAC, 1φ (adjustable from 110-120 volts)
Distortion	3% max.
Time constant	0.1 seconds
Regulation accuracy	±0.01%

The accuracy is *guaranteed* at room temperature, for a resistive load, an input variation of ±10%, and over a two-to-one load change. For *all* other conditions within the specifications, the Model 1001 has a proportionate amount of accommodation.

* Isotronics is a trade marked word pertaining to the electronic regulation and control of voltage, current, power, or frequency.

model 1001

WRITE FOR FULL INFORMATION

Note these extra features

- Combination twist-lock and double-T receptacle, or, output terminals to eliminate contact resistance.
- Three-function output switch for
  1. Normal regulator functioning.
  2. Operation with integral semi-fixed resistance in place of potentiometer.
  3. Direct load connection with the control diode for regulation of voltages other than 115 volts.
- Only FOUR vacuum tubes and NO relays are used.
- All tube filament voltages are regulated for long dependable life.

FOR THE LATEST AND BEST IN ISOTRONICS . . .

Specify **SORENSEN**

SORENSEN AND COMPANY • 375 FAIRFIELD AVE., STAMFORD 1, CONN.

—Mr. G. J. Werner, Traffic Manager, Motorola, Inc., on screen of new Model 21T4.

"Our program never goes off the air!"

"Tens of thousands of component parts . . . thousands of suppliers all over the country . . . a daily 'hot sheet' of critical items needed within 24 hours or less . . . that's just a glimpse of our traffic picture at Motorola!

"Yet our production lines never stop for lack of available parts – because our production program never goes 'off the air.' We use Air Express! With our tremendous, and steadily growing overall shipping volume, there is daily need for this top-speed, *reliable* service.

"Many times a day, we specify Air Express – and exacting production schedules are met. Show models, advertising matter, itinerant displays and penalty contract shipments are always subject to deadlines–and Air Express gets them there on time.

"Shipping costs are secondary on such shipments. Yet we find that Air Express costs compare favorably with other air services. In many weights and distances, its rates are lowest of all!

"Day in, day out, Air Express is an integral and important cog in Motorola's overall operation."

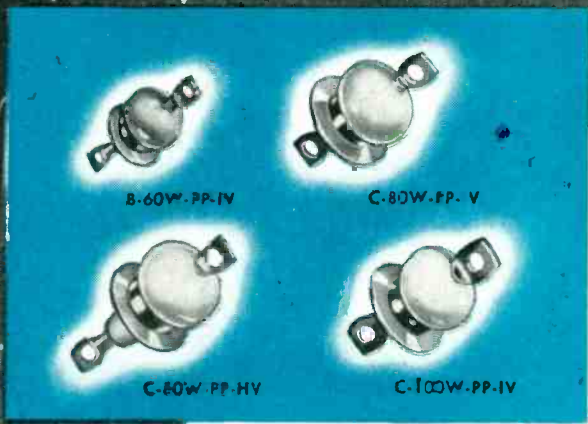
Whenever you ship by air, it pays to say–Air Express! Division of Railway Express Agency.

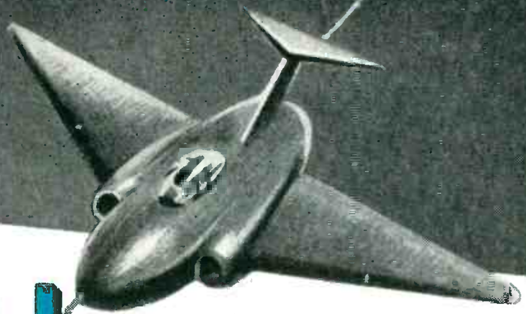
AIR EXPRESS

GETS THERE FIRST

via U. S. Scheduled Airlines

The Complete Answer to TRANSFORMER TERMINAL PROBLEMS

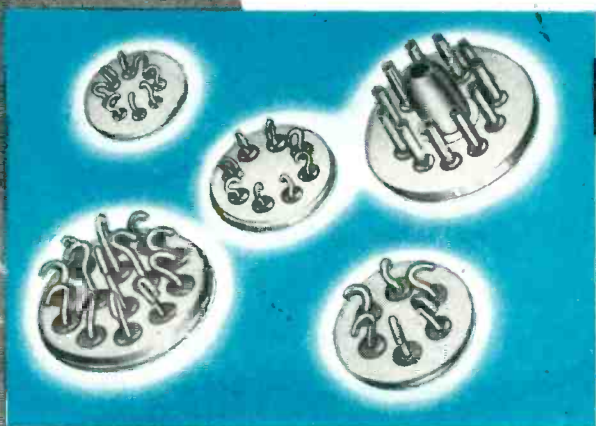




E-I High Creepage Terminals

—WITH LONG LEAKAGE PATHS TO COUNTERACT HIGH MOISTURE AND CORROSION TROUBLES

E-I Terminals of this type provide maximum protection against leakage due to moisture or surface films. The glass bead is specially shaped to increase the leakage path yet the terminal requires no larger mounting area. Double protection is afforded by a silicone treating of the terminal. Rugged construction, plus carefully annealed glass permits rough handling in shop assembly thereby reducing rejects of assembled components. All E-I terminals are hot-tinned



E-I Rigid Multiple Headers

— FOR EVERY GROUPED TERMINATION REQUIREMENT INCLUDING PLUG-IN TYPES

E-I Rigid Headers feature an entirely new method of hermetic sealing developed by Electrical Industries. This method of construction which includes solid metal blanks in place of the usual thin metal stamping, yields a header that is far more rugged than any other type yet produced. The result is effective, permanent sealing under the most extraordinary conditions of shock and vibration.

E-I . . . YOUR HEADQUARTERS FOR HERMETICALLY-SEALED MULTIPLE HEADERS, OCTAL PLUG-INS, TERMINALS, COLOR CODED TERMINALS, END SEALS, etc. WRITE FOR CATALOGS.

DIVISION OF AMPEREX ELECTRONIC CORP.

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ELECTRICAL INDUSTRIES

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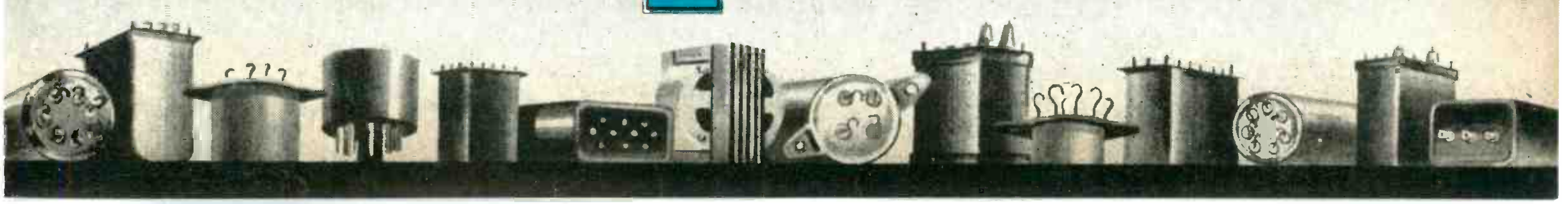
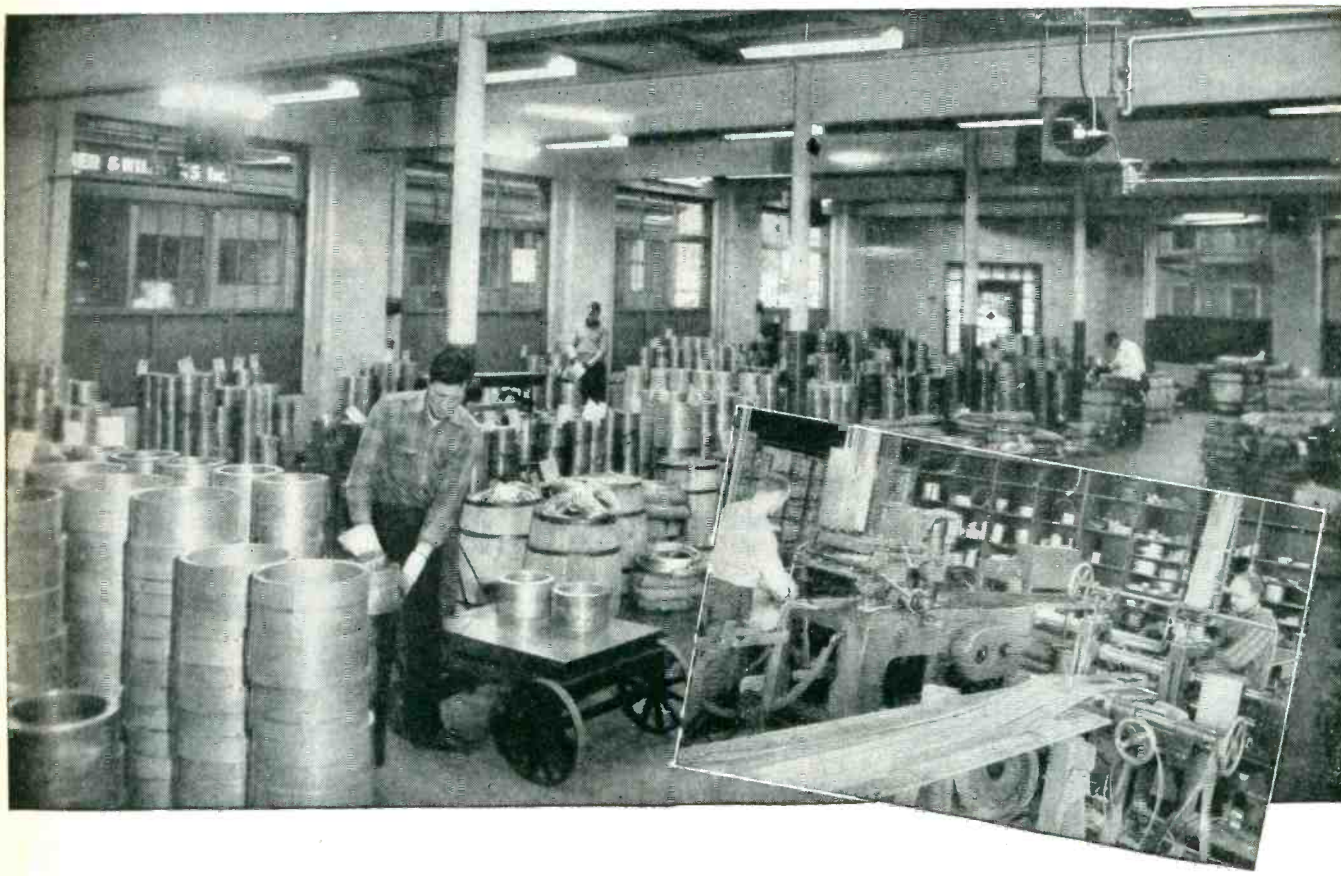


for BRASS Bridgeport CO. *Service*

OFFICES AND WAREHOUSES IN PRINCIPAL CITIES



BRIDGEPORT WAREHOUSE SERVICE

The Bridgeport warehouses are designed to supply from stock limited quantities of sheet, rod, wire or tubing. It is the policy of the company to maintain adequate warehouse stocks at all times so that small orders can be filled without delay.

The fabricator is in a position to obtain promptly metal to fill orders for experimental work or to start production runs, while waiting for mill shipments.

Bridgeport warehouses make every effort to carry the variety of alloys, sizes and gages which fulfill the requirements of the locality they serve.

To take care of the maximum range of widths of strip metal, slitting service is available—not only to serve warehouse stocks, but also to make customers' stocks of non-ferrous strip metal more flexible.

Bridgeport's Warehouse Stocklist carries weight tables and a technical digest giving the properties of the most popular copper-base alloys. If you do not have a copy, ask your nearest Bridgeport office.

Mills in Bridgeport, Conn. and Indianapolis, Ind.
In Canada: Noranda Copper and Brass Limited, Montreal

BRIDGEPORT BRASS COMPANY

30 GRAND STREET, BRIDGEPORT 2, CONNECTICUT

All Band, Direct Reading

SPECTRUM ANALYZER

10 MC to 21,000 MC

The Model LSA is the result of years of research and development. It provides a simple and direct means of rapid and accurate measurement and spectral display of an rf signal.

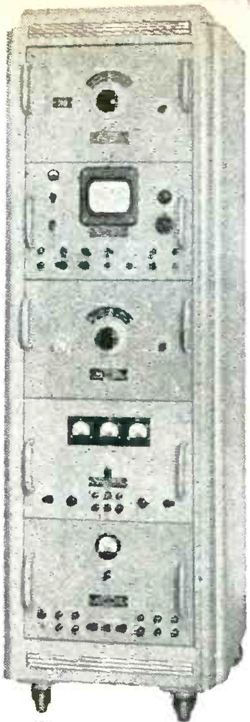
Outstanding Features:

- Continuous tuning.
- One tuning control.
- Resolution is 5KC when dispersion is 5MC per inch per sec.
- 250 KC to 25 MC display at all frequencies.
- Tuning dial frequency accuracy 1 percent.
- No Klystron modes to set.
- Broadband attenuators supplied from 1 to 12 KMC.
- Frequency marker for measuring differences 0-25 MC.
- Only four tuning units required to cover entire range.
- Microwave components use latest design non-contacting shorts for long mechanical life.
- Maximum frequency coverage per dollar invested.
- 5 inch CRT display.

Model LSA

The instrument consists of the following units:

Model LTU-1 RF Tuning Unit—10 to 1000 MC.
Model LTU-2 RF Tuning Unit—940 to 4500 MC.
Model LTU-3 RF Tuning Unit—4460 to 16,520 MC.
Model LTU-4 RF Tuning Unit—15,000 to 21,000 MC.
Model LDU-1 Spectrum Display Unit.
Model LPU-1 Power Unit.
Model LKU-1 Klystron Power Unit.



Polarad PRECISION LABORATORY INSTRUMENTS

MICROWAVE SIGNAL SOURCES

Models SSR, SSL, SSS, SSM, SSX
634 MC to 10,750 MC

For use as a reliable source of microwave energy in transmission loss measurements, standing wave determination, etc. Unidial Control for accuracy and ease of operation. Direct reading (no mode charts to consult). Frequency determination accurate to 1% through use of present calibration and temperature compensated klystrons.

Five Microwave Signal Sources are available to cover the frequency range from 634 MC to 10,750 MC. Units ruggedly constructed, mounted on aluminum castings to insure mechanical stability. Klystron reflector voltage automatically tracked with tuning of the klystron cavity to provide unidial control. Signal sources supplied complete with klystron.

WIDE BAND VIDEO AMPLIFIER

Model VT 10 CPS to 20 MC

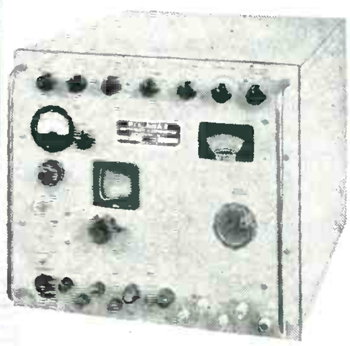
Designed for use as an oscilloscope deflection amplifier for the measurement and viewing of pulses of short duration and rise time. Excellent for TV, both black and white and color applications.

Features:

- Flat frequency response from 10 cps to 20 mc ±1.5 db.
- Uniform time delay of .02 microseconds.
- Gain of 50 db.
- Frequency compensated high impedance attenuator calibrated in 10 db steps from 0-50.
- Fine attenuator covers a 10 db range.
- Phase linear with frequency over entire band.

MICROWAVE SIGNAL GENERATOR

Model MSG-4
7,000 mc — 10,750 mc



Polarad's Microwave Signal Generator, Model MSG-4, is an ideal source of an accurately known signal voltage, precisely modulated. Sensitivity, frequency and performance of radio and radar equipments in the frequency range from 7 to 10.75 kmc can be readily measured on this continuously variable, direct reading signal generator.

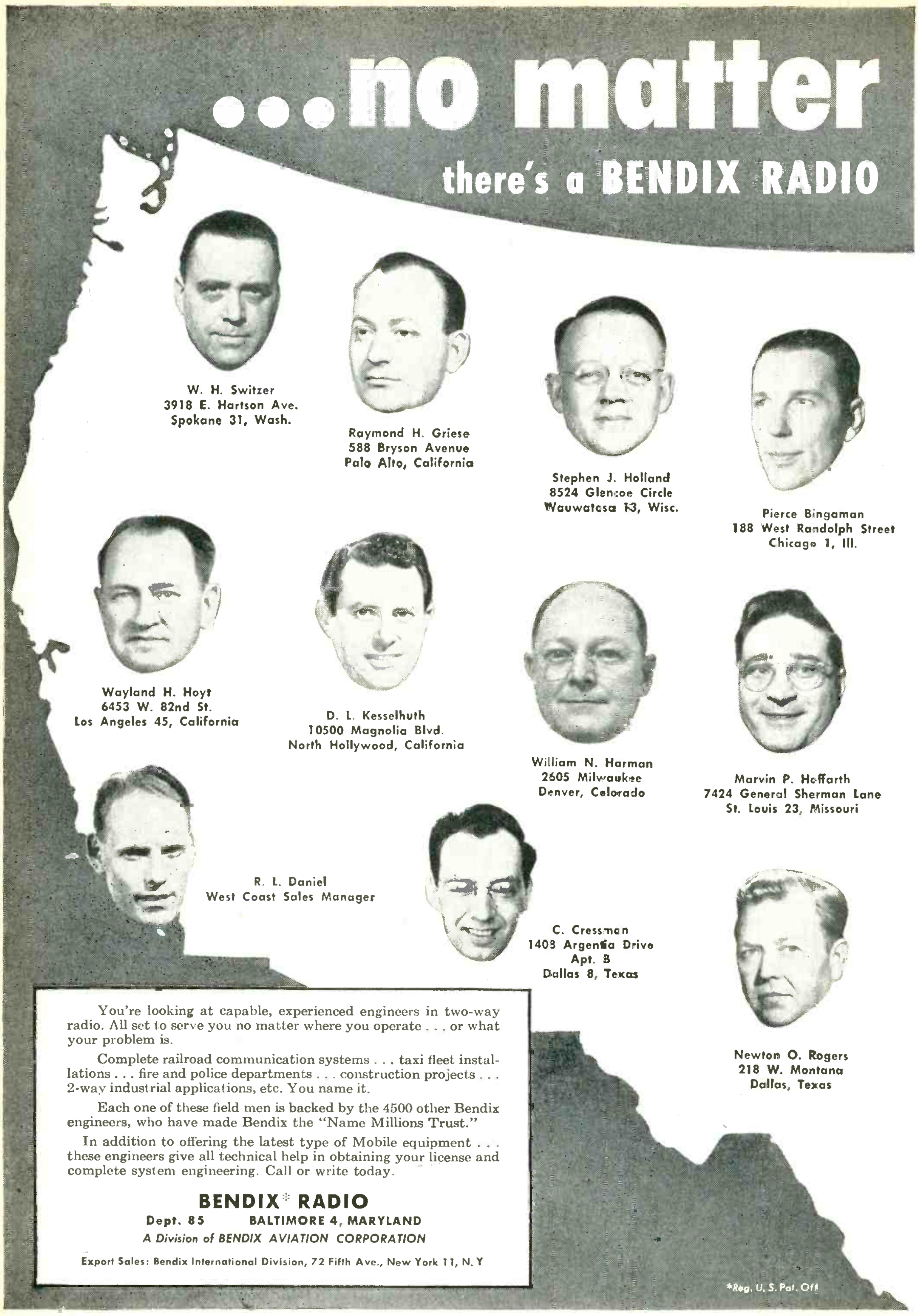
Features:

- Continuous tuning
- One tuning control
- Tuning dial accuracy — 1%
- No Klystron modes to set
- Accurate stable power measurement
- Non-contacting shorts guarantee long life
- Modulation — Internal Pulse, FM and external
- Sync output — delayed and undelayed.

Polarad Electronics Corporation

100 METROPOLITAN AVE.
BROOKLYN 11, N. Y.
STagg 2-3464

Export Dept.: 13 East 40 Street, New York 16, N. Y.
Cable Address: "ARLAB"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Each one of these field men is backed by the 4500 other Bendix engineers, who have made Bendix the "Name Millions Trust."
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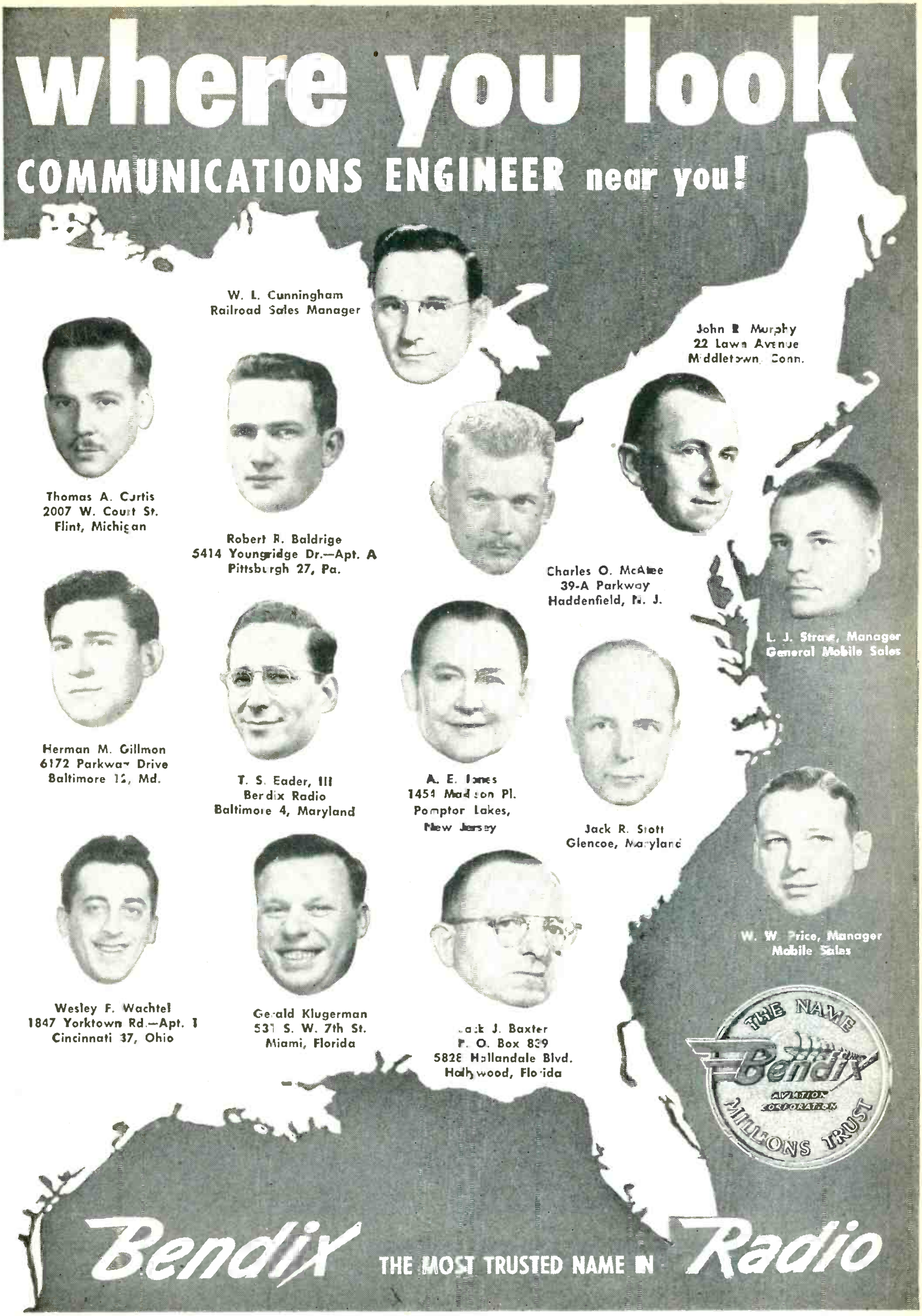

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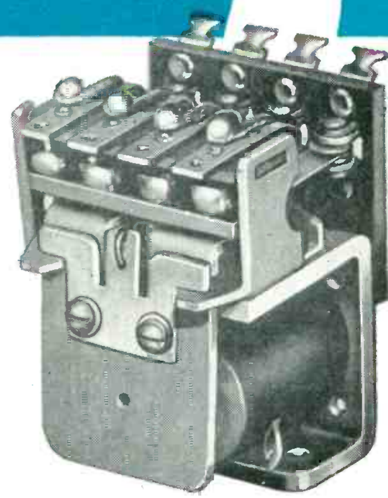
NEW

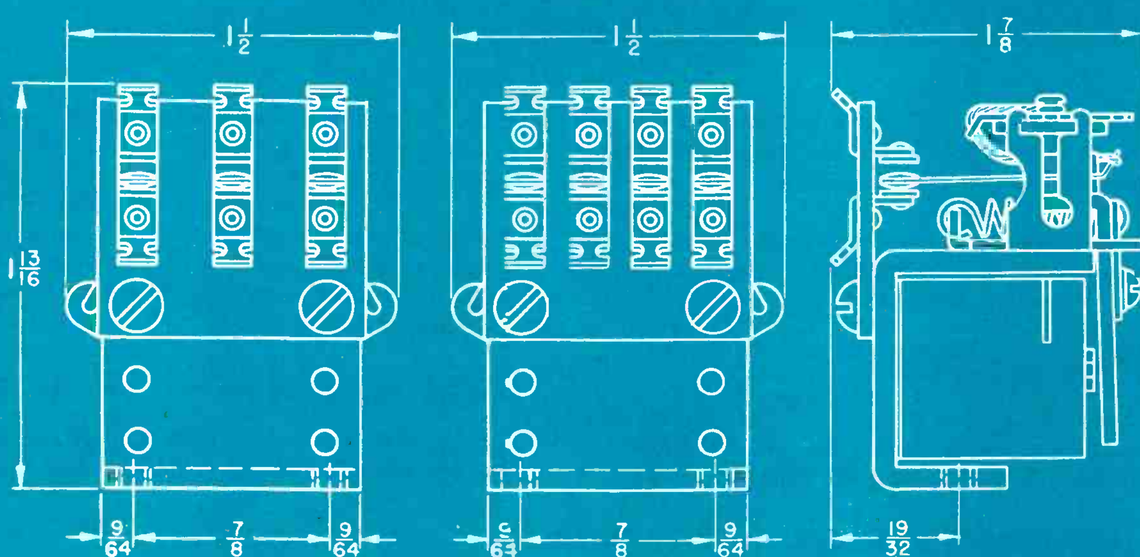


ACTUAL SIZE

4-POLE TYPE PB RELAY

TYPE PB-9

TYPE PB-12



MOUNTING

2- 6-32 TAPPED HOLES

COMPACT 10 AMPERE RELAY

Developed primarily for the aircraft industry*, where size and weight must be kept to a minimum, this compact power relay is suitable for hundreds of industrial applications. Available in two, three and four pole, double throw contact arrangements, for A.C. and D.C., the Allied Type PB withstands 50G shock and 10G vibration (up to 55 cps) without any false operation of the contacts, due to the semi-balanced armature and extremely compact design.

***The Allied Type PB Relay has the following AN approvals: AN 3306; AN 3307; AN 3308; AN 3310; AN 3312**

Here are the Facts and Figures

Contact Ratings: 10 amperes non-inductive 29 V.D.C. or 115 V. rms 60 or 400 cycles. **Nominal Coil Power:** 2.5 watts for D.C. operation, 6.0 Volt-Amperes for A.C., 60 cycle operation.* **Maximum Coil Power:** Input at 25°C for 85°C Temperature Rise: 5.5 watts for D.C. operation and 10.0 Volt-Amperes for A.C. operation. **Ambient Temperature Range:** —55°C to +71.5°C.*

• The Allied Type PD relay, similar to the Allied Type PB except for smaller contacts, has a contact rating of 3 amperes. Nominal coil data for D.C. operation is 1.5 watts and 3.6 volt-amperes for A.C., 60 cps. **Input power for 2 and 3 pole types may be reduced if sensitivity or temperature rise are factors. Special coils are available for higher ambient temperatures.*

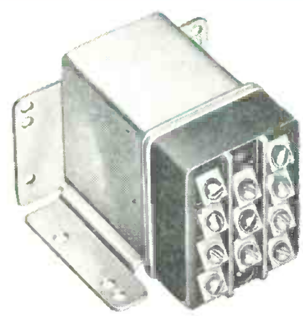
Contact your Allied Control Representative or write us for full details.

AVAILABLE HERMETICALLY SEALED

DIMENSIONS AND WEIGHTS FOR 4-POLE RELAYS

TYPE PB
AN PLUG

TYPE PD
SOLDER TERMINALS



TYPE PB
SCREW TYPE

PB, Open—$1\frac{9}{32}''$ x $1\frac{13}{16}''$ x $1\frac{13}{32}''$—4 oz. **PB, Sealed,** Cannon Plug—$3\frac{5}{32}''$ x $1\frac{41}{64}''$ x $1\frac{49}{64}''$—8 oz. **PB, Sealed,** Solder Terminals—$2\frac{9}{16}''$ x $1\frac{49}{64}''$ x $1\frac{41}{64}''$—7.5 oz. **PB, Sealed,** Screw Type—$3''$ x $2\frac{5}{8}''$ x $3\frac{5}{32}''$**—13 oz. **PD, Sealed,** Solder Terminals and Plug-In—$2\frac{7}{16}''$ x $1\frac{19}{32}''$ x $1\frac{13}{32}''$—6.5 oz.

**** Includes mounting ears and terminals.**

ALLIED CONTROL COMPANY, INC.

2 EAST END AVENUE, NEW YORK 21, N. Y.

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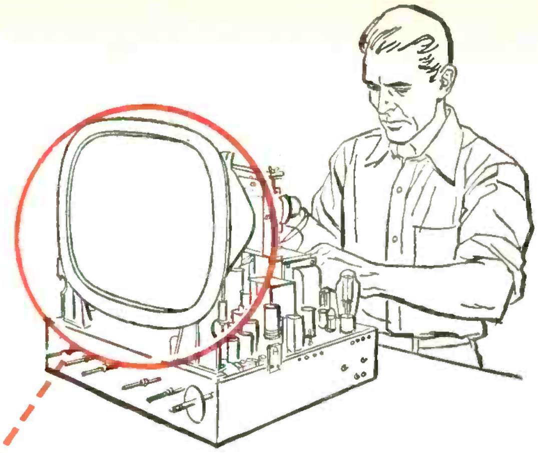
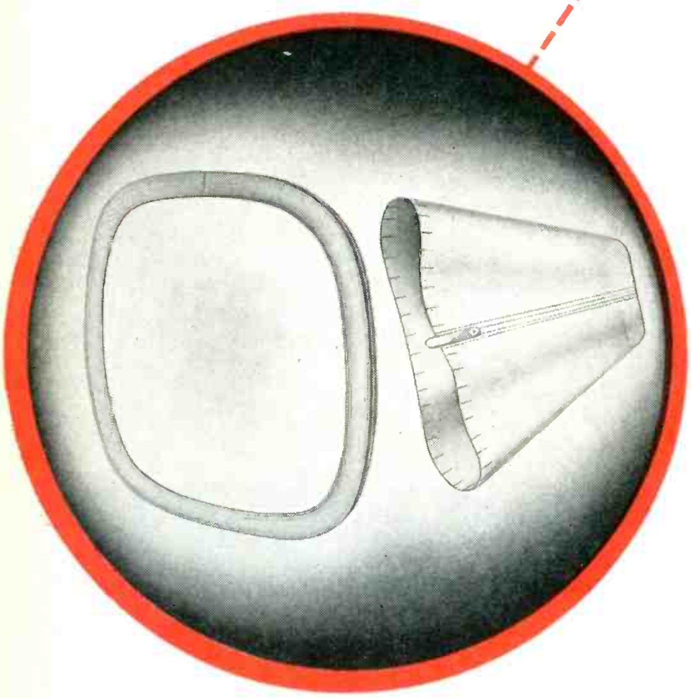


Du Pont "Alathon"* insulates TV tube carrying 20,000 volts



Rings and sleeves extruded by
Anchor Plastics Co., Inc.
New York, N. Y.

*REG. U.S. PAT. OFF.

DU PONT
REG. U. S. PAT. OFF.

Better Things for Better Living
. . . through Chemistry

Polychemicals
DEPARTMENT
PLASTICS • CHEMICALS

Ring and sleeve of "Alathon" retain dielectric properties . . . pass humidity tests . . . lower shipping costs

When television-set manufacturers started using metal picture tubes, they were faced with the problem of insulating the outer portion of the tubes that carry up to 20,000 volts. A material was needed that could withstand the voltage, while resisting humidity that would ruin its insulating value.

The solution was this ring and sleeve extruded of Du Pont "Alathon" polythene resin. Of all the materials tested, only "Alathon" retains its electrical properties in service. "Alathon" has excellent dielectric strength, low dielectric constant (2.3), and low power factor (0.0005). Because of its very low moisture-absorption rate (0.01% by A.S.T.M. test), "Alathon" easily passed exacting humidity tests.

Du Pont "Alathon" offers other important advantages. Its flexibility simplifies installation. Shipping costs are reduced because "Alathon" absorbs shock . . . makes possible packing of sets as units . . . eliminates shipping the delicate tubes separately. And reassembly time and labor at outlets are eliminated. Many TV manufacturers now use these rings and sleeves.

Du Pont "Alathon" is widely used for such insulating applications as TV lead-in wire, high-voltage TV lead wire, and police and fire-alarm cable. We will gladly suggest suppliers who can meet your specific needs for electrical or other uses of "Alathon." For further information, write:

E. I. du Pont de Nemours & Co. (Inc.)
Polychemicals Department,
Room 225A, Du Pont Building
Wilmington 98, Delaware

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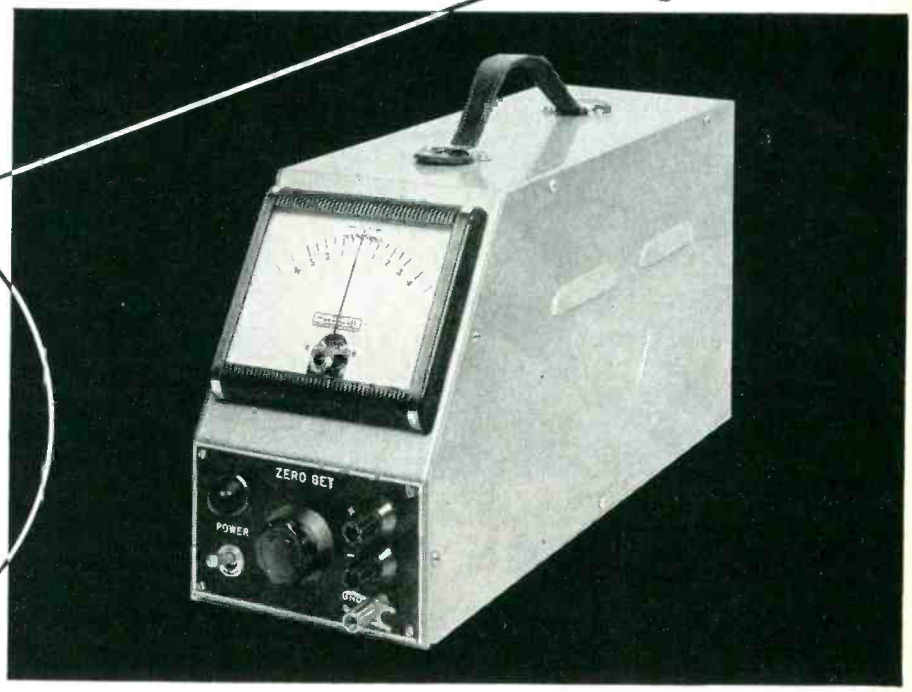
NOW—the modern successor to the galvanometer



the new *ElectroniK* Null Indicator

electrical characteristics

INPUT IMPEDANCE

680 ohms

SENSITIVITY

2.5×10^{-9} amperes per millimeter

OPERATING VOLTAGE

110-120 volts, 60 cycles

If you use galvanometers, you'll be interested in the new *ElectroniK* Null Indicator. For here, at last, is the lab man's ideal null balance detector . . . completely free from all the limitations of galvanometers.

It's easy to use—no "loss of spot" from excess signal; bridge balancing operation is simplified.

It's self-protecting—will take heavy over-loads without damage.

It's vibration-proof—undisturbed by nearby traffic or machinery.

It goes anywhere—needs no leveling or special mounting; plugs into 115-volt 60-cycle line; small case fits readily into experimental set-ups.

It's stable—holds steady zero after warm-up.

It's fast—indicates in less than one second; ideal for production testing.

It's sensitive—suitable for use with high precision measuring circuits.

The *ElectroniK* Null Indicator is priced within reach of any budget. It will be a valuable asset to your lab. Write today for complete information.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4428 Wayne Ave., Philadelphia 44, Pa.

● **REFERENCE DATA:** Write for Instrumentation Data Sheet No. 10.0-12.

H HONEYWELL

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS

First in Controls

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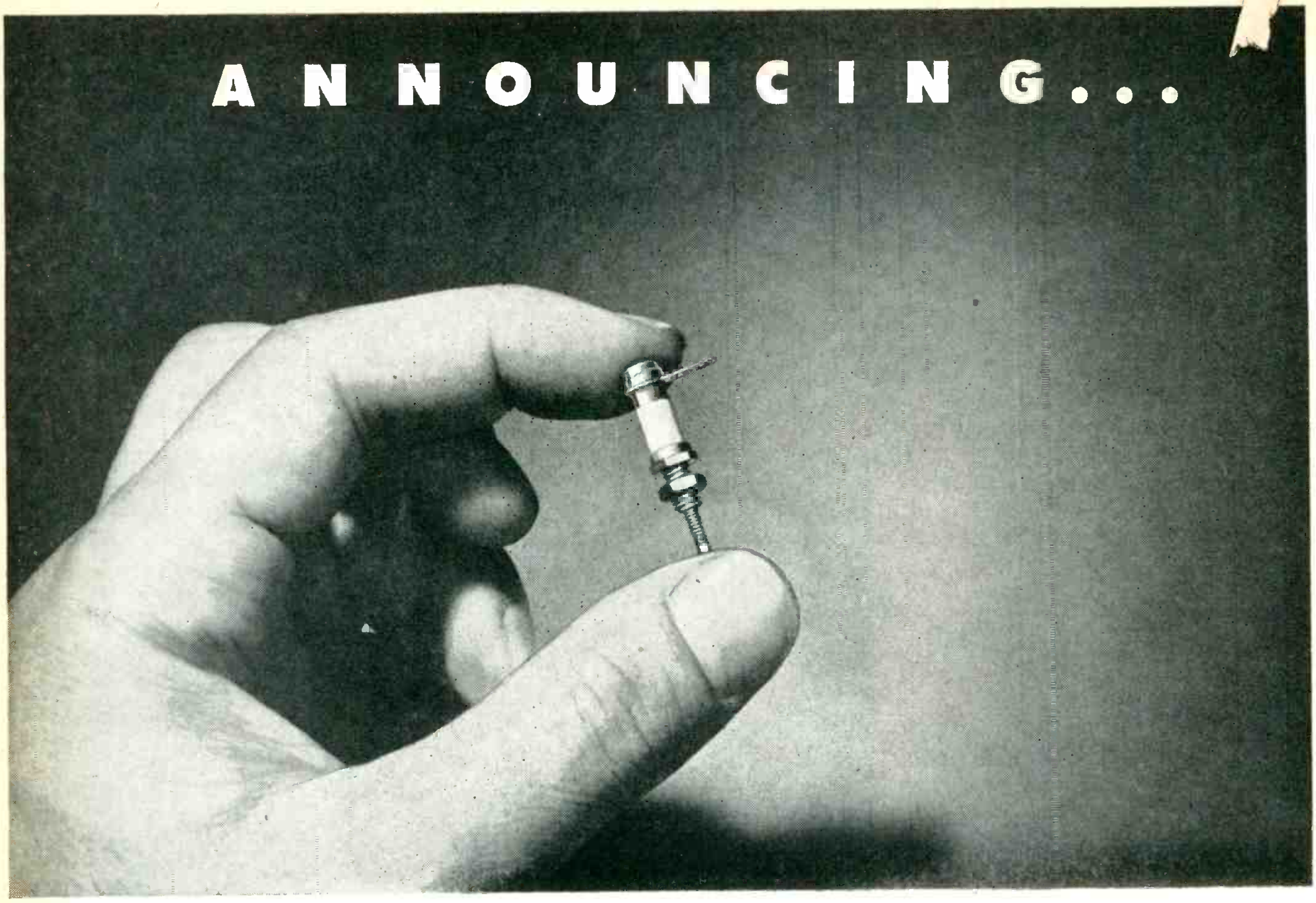
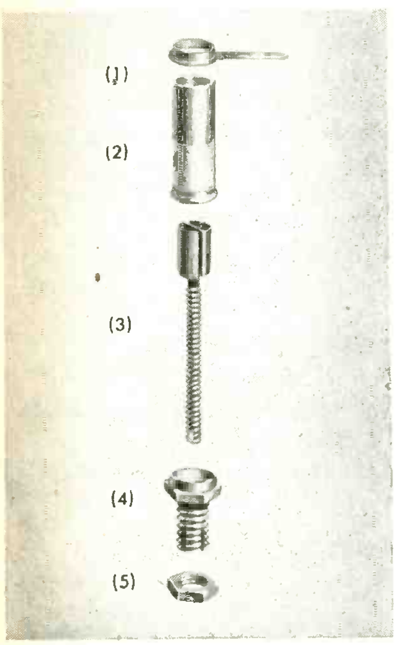


Shown approximately full size.

C.T.C.'s new CST-50 capacitor

with greatly increased range, greater stability



Exploded view of the CST-50 capacitor shows: (1) ring terminal with two soldering spaces; (2) metallized ceramic form; (3) spring-type S-shaped tuning sleeve*; (4) split mounting stud; (5) locking nut.

* Patent Applied For

Surpasses the range of capacitors many times larger in physical size.

The new CST-50 variable ceramic capacitor embodies a tunable* element of such unusual design it practically eliminates losses due to air dielectric. As a result, a large minimum to maximum capacity range (1.5 to 12 MMFD) is realized — despite the small physical size of the capacitor. This tunable* element is a spring-type, S-shaped tuning sleeve* which maintains constant maximum pressure against the inside wall of the ceramic form.

Other Design Features

The CST-50 stands only 19/32″ high when mounted, is less than ¼″ in diameter and has an 8-32 threaded mounting stud. The mounting stud is split so that the tuning sleeve* can be securely locked without causing an unwanted change in capacity. The tuning sleeve* is at ground potential. The CST-50 is provided with a ring terminal which has two soldering spaces. Cambridge Thermionic Corporation, 437 Concord Avenue, Cambridge 38, Mass. West Coast manufacturers contact: E. V. Roberts, 5068 West Washington Blvd., Los Angeles and 988 Market St., San Francisco, California.

ANNOUNCING THE WINNERS

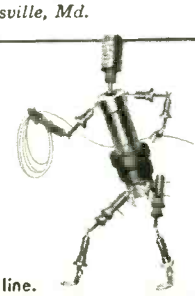
of the C.T.C. contest held during the IRE show in March in New York City.

E. M. SZLOMPEK
White Plains, N. Y.

R. R. WARNER
Brooklyn 9, N. Y.

J. CLAUDE LA POINTE
Hyattsville, Md.

CAMBRIDGE THERMIONIC CORPORATION



custom or standard . . . the guaranteed components

Write for Free Catalog #400 containing complete data on the entire CTC line.

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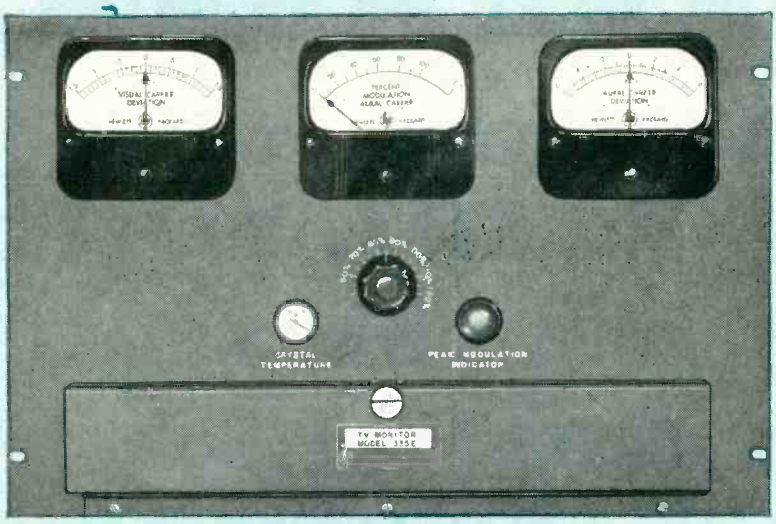
ELECTRONIC TEST INSTRUMENTS



TV MONITOR

MODEL 335E

All channels 2 to 83

Exceeds F. C. C. requirements

12¼" high; rack mounted

High stability, accuracy, long-term dependability

Monitors visual, aural frequencies; percentage aural modulation

New! Small, low-cost monitor for all TV channels gives continuous, precise indication without adjustment

The unusually compact, low-cost Model 335E occupies just 12¼" of a standard relay rack. Yet it accurately and continuously performs all VHF and UHF television monitoring functions including visual and aural carrier frequency and aural carrier percentage modulation measurement.

Carefully engineered crystal reference oscillators provide accuracy in excess of F. C. C. requirements for all channels. Because discriminator accuracy does not depend on a tuned circuit, no time-consuming adjustments are required during operation. It is never necessary to reset carrier level or realign circuits. Proper operation of the monitor can be checked conveniently by controls located behind the front panel cover.

Trouble-Free Dependability

The monitor is specifically designed to operate at full accuracy over long periods of time without maintenance. Highest quality components and construction are used throughout. A new chassis design increases accessibility of components and makes possible cool operation through forced ventilation. Extra features include provision for remote indicating meters, remote peak modulation indicator lamp, and a demodulated signal for aural monitoring.

The instrument also includes a front-panel crystal temperature indicator and illuminated meter faces. It fits a standard relay rack, and can be color finished to match your transmitter installation.

SPECIFICATIONS

AURAL FREQUENCY MONITOR

Deviation Meter Range: +6 kc to −6 kc.
Accuracy: Better than ±1,000 cps for at least 10 days.

AURAL MODULATION METER

Modulation Range: Meter reads full scale on 33.3 kc swing. Calibrated to 100% at 25 kc swing; 133% at 33.3 kc swing.
Accuracy: Within 5% of mod. full scale.
Meter Characteristics: Meter damped in accordance F.C.C. requirements. Reads peak value of modulation peak of duration between 40 and 90 milliseconds. Meter returns from full reading to 10% of full value within 500 to 800 msec.
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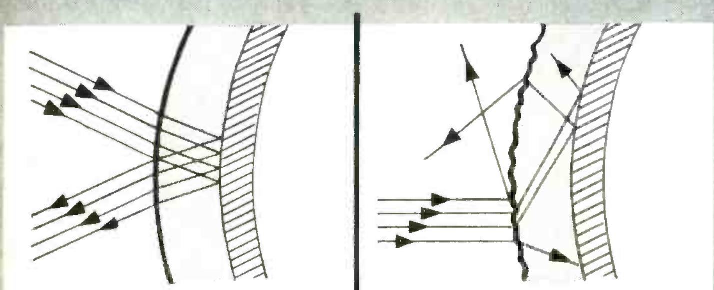
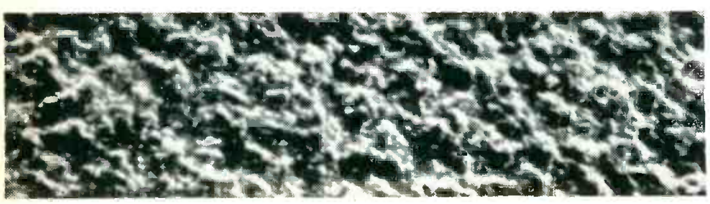


Ordinary face plates act as a polished mirror, reflect majority of light into viewers' eyes.

Etched faceplates scatter ambient light, absorbing a large amount, dispersing remainder unnoticeably.

300X photomicrograph of smooth face shows smooth reflecting surface; tiny scratches are invisible to naked eye.



300X photomicrograph of etched face shows surface which disperses ambient light, does not affect picture quality.

"No glare, no room reflection, less distortion, clear picture over full tube area!" Your sets can have these hard-selling, practical advantages if you use Westinghouse 21-inch metal-cone tubes in your designs.

Their etched spherical face plates completely eliminate the annoying problem of room reflections. And best of all—this factual, appealing sales feature can be demonstrated in any retail show room by the purchaser himself.

Westinghouse metal-cone tubes have less distortion due to uniform face plate thickness: Corner focus is better, brightness is uniform. These stronger tubes save money due to less weight, easier handling. Both the 21AP4 and the 21MP4 are available now in production quantities. For technical or application information, write, wire, or phone

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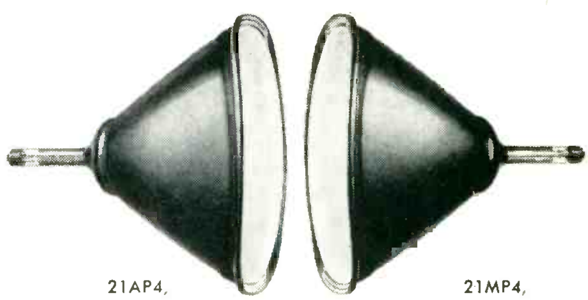

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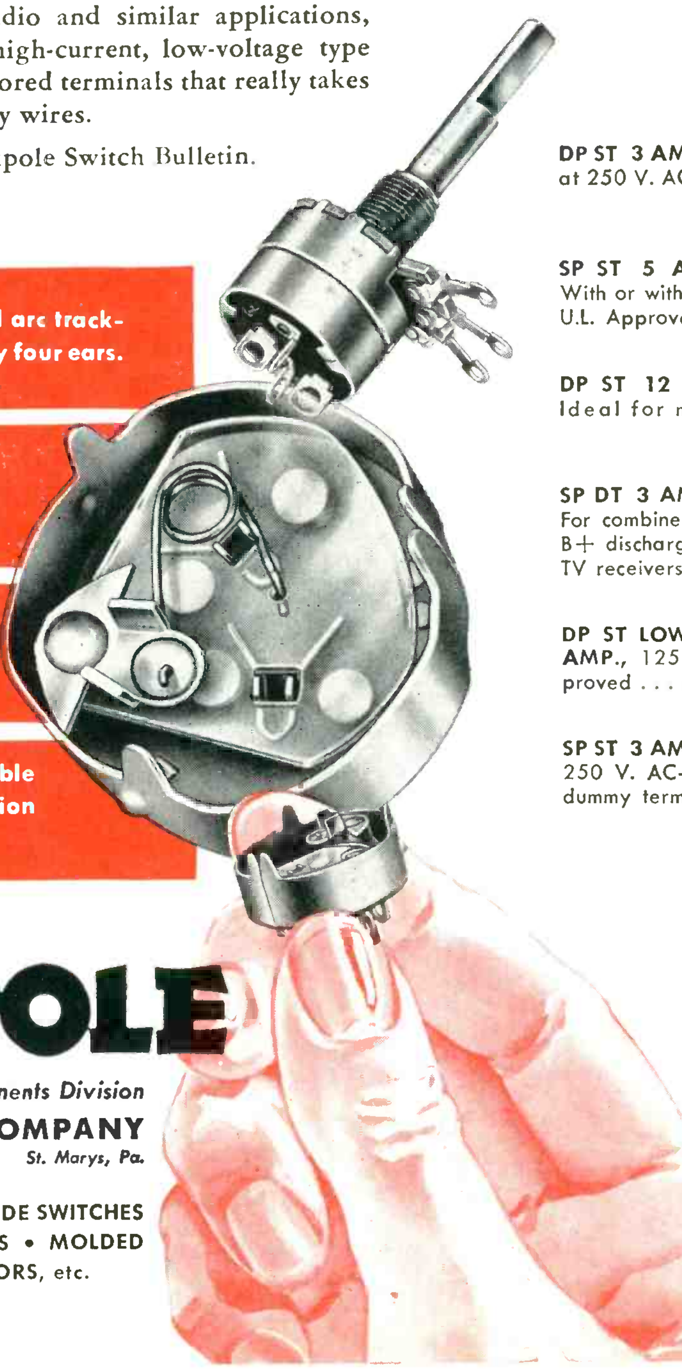

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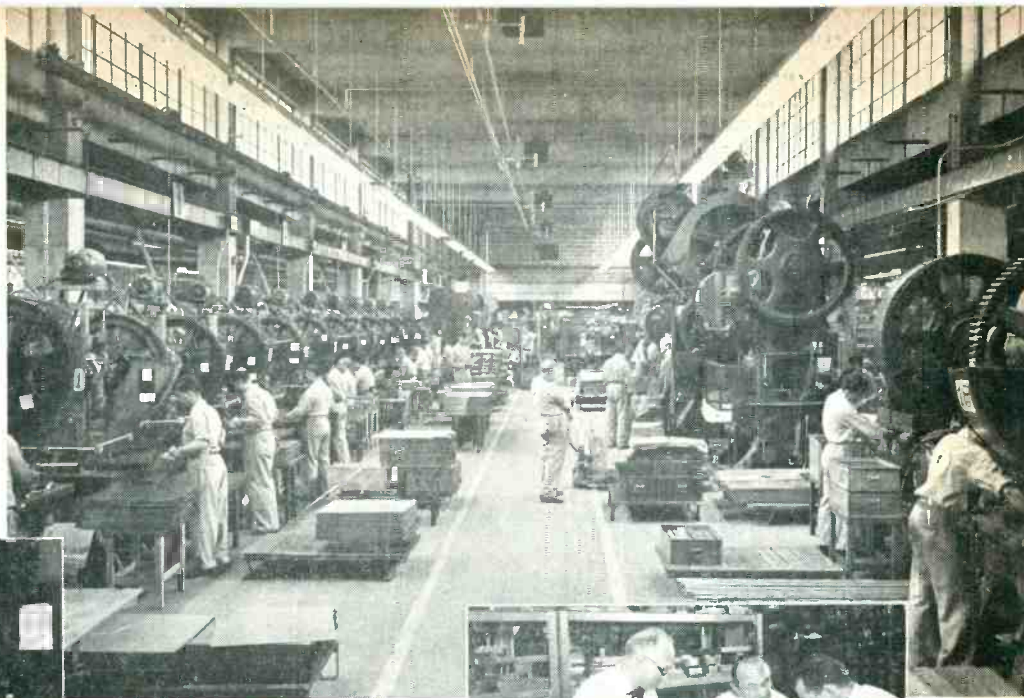

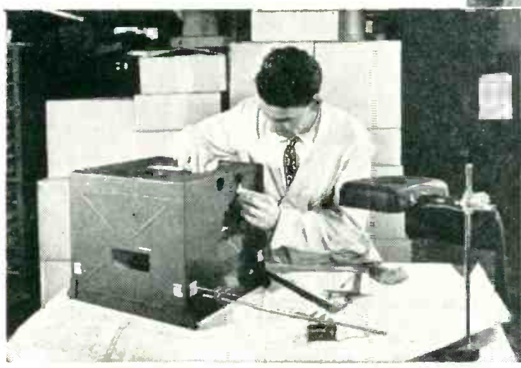

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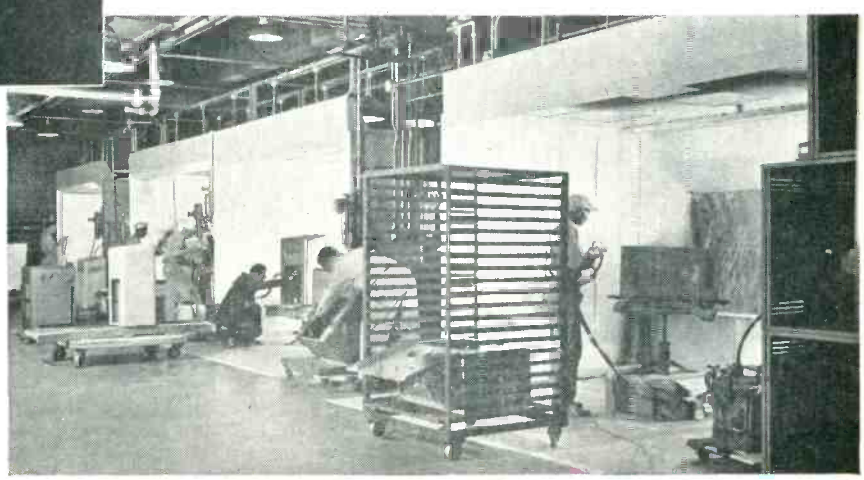

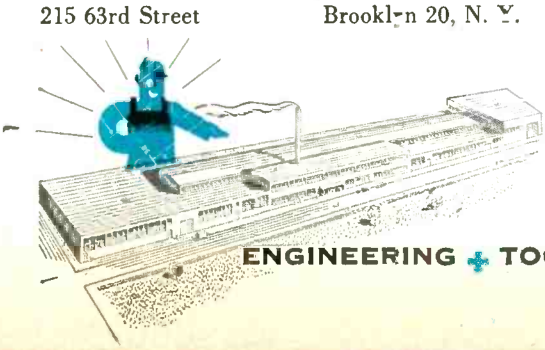

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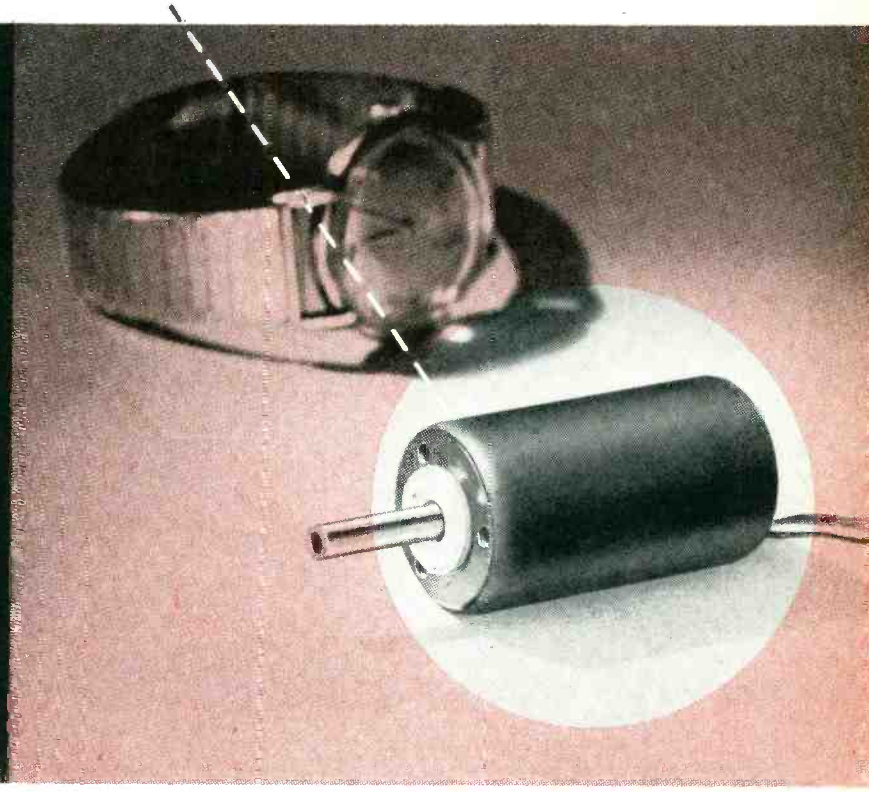

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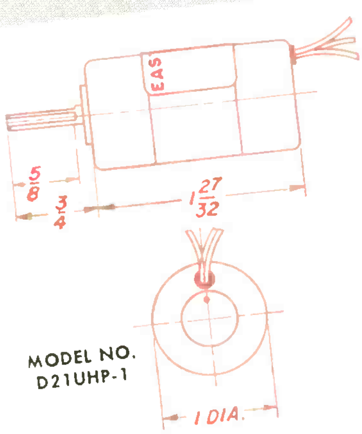

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Capacitor run induction motor, 115 volts, 400 cycles, single phase, 11,000 R.P.M., .1 Amp., 1/300th H.P., .1 MFD.-220 V., 35% efficiency, weight—3½ oz.

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APPROXIMATE R.P.M.	7,000	10,500	21,000
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CROSS TALK

▶ **COLOR** . . . Twin congressional investigations of color-tv's status serve little useful purpose. Most well-informed men believe that

The public is not now waiting with baited breath for color.

NTSC intends to submit compatible standards before the end of the year.

The FCC will eventually accept such standards.

Industry will build color sets as soon as it can do so and make a dollar.

The broadcasters will expand their service in precise proportion to advertising support.

Premature pressure can do both the public and the industry a disservice. Even after all technical problems are solved it will take time and orderly economic processes to superimpose color on top of the present monochrome system. Public hearings can, meanwhile, only induce stagnation of existing inventories, and will not bring the supplementary service any closer.

▶ **BUREAUCRACY** . . . We have it on good authority that one of the services contemplates inspecting tubes at many points during production, as well as at the final test position.

This, we think, would be a great mistake. It is one thing to lay down rigid specifications and to make sure they are reflected in the finished product, but quite another to have government inspectors stand cheek by jowl with industry's own men at every step in the manufacturing processes for tubes.

We doubt that better tubes would result from such a duplication of effort; this is perhaps the most highly specialized area of the electronics industry. And we know there would be a slowdown in production.

▶ **UNFORTUNATE** . . . Speaking of tubes, the word "reliable" leaves much to be desired when describing premium types. For one thing, it implies that other types are unreliable. For another, it brings up the question of how reliable "reliable" is.

Dictionary synonyms such as "trustworthy" and "dependable" have the same weaknesses. "Infallible" is right off the deep end. "Premium" puts too much emphasis upon cost rather than quality. Other single adjectives seem similarly unsuitable.

The British Radio Valve Manufacturers' Association is currently planning to get around the knotty problem in nomenclature by using the words "special quality." This leaves room for additional words if such are needed to identify particular virtues or applications.

▶ **BIGNESS** . . . There is a growing tendency on the part of big companies in other fields to buy their way into electronics by acquiring smaller firms. Often they have much to contribute in the way of operating capital and other resources.

In general, when a company unfamiliar with electronics buys a smaller firm already established in the business it is buying technical know-how. It is also buying highly specialized market knowledge. Too often, in the interest of rapid exploitation, the latter point is forgotten. Which explains why so many good little companies pass into oblivion soon after they are acquired.

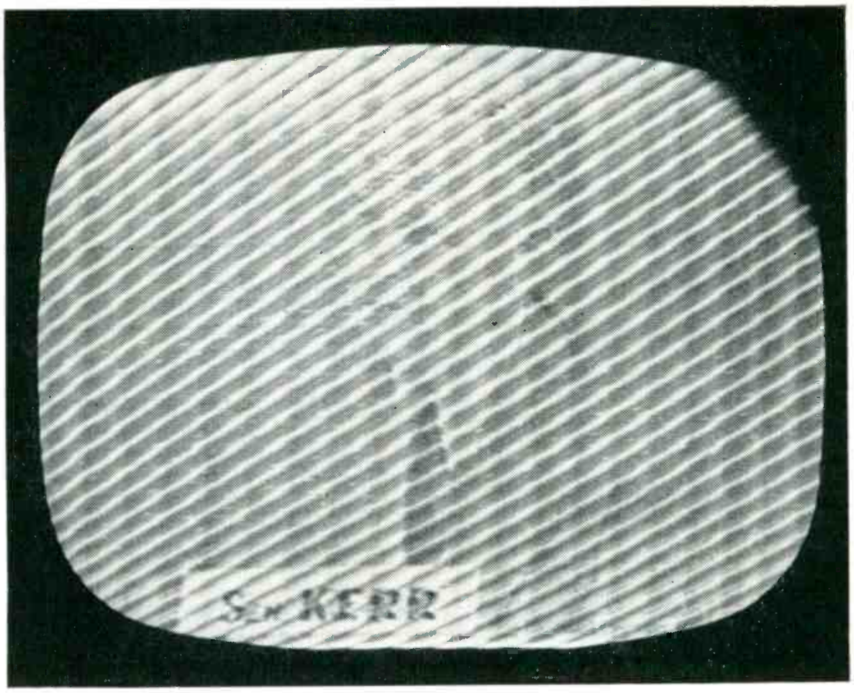
▶ **MORE ON BIGNESS** . . . The field of electronics itself is growing rapidly. Witness the terrific turnout at the Grand Central Palace engineering show in New York just a few weeks ago, the number of requests for our new "Buyers' Guide" of companies and their products nearly two months before publication.

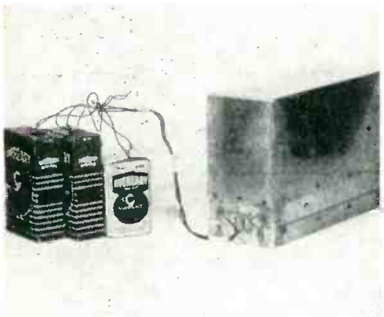
ELECTRONICS itself reflects the size of the industry, and we've already mentioned in past issues several things that have been done to help readers through this very busy book. Editorial content is at the highest level in our history. Feature articles run on sequential full pages, do not turn over to the back.

Now take a look at our departments, such as *Electrons At Work*. We have reduced the amount of advertising interleaved between them, so that editorial matter runs more continuously.

▶ **SIGN-OFF** . . . Chairman of an industry committee of which we are a member: "Let's make some tests and put more points on our curve of ignorance."

Interference on channel 5 from unshielded test oscillator located at a distance of 150 feet from receiver ▶





▲ Test oscillator completely shielded but with batteries and supply leads external

Reducing Radiation

Quantitative measurements of radiation from battery-powered oscillator show effects of various shielding and filtering measures. Tests show complete suppression of spurious radiations is possible and economically feasible

By P. S. RAND
Laboratory of Advanced Research
Remington Rand Inc.
South Norwalk, Conn.

Spurious radiations from tv receivers continue to plague not only the tv viewer but also users of other radio services such as the broadcast band, short waves, government services and airport marker beacons. Interference of this sort is on the increase in proportion to the tremendous increase in tv stations and tv receivers.

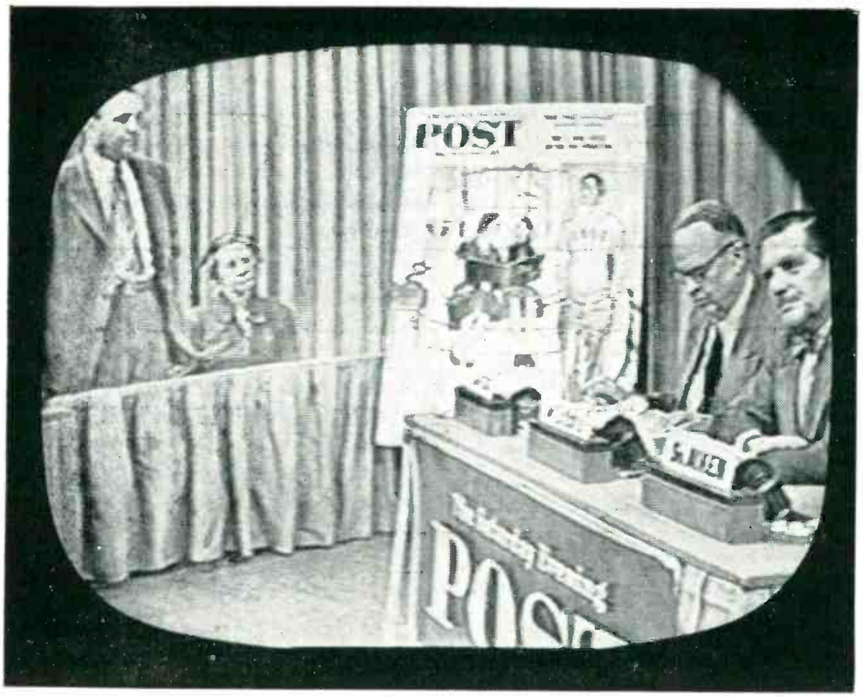
Four years ago in these pages,[1] I pointed out the seriousness of tv receiver radiation. In 1951, I pleaded with the receiver designers to eliminate spurious radiations from their tv receivers.[2] In June of 1952, in an address before the Service Committee of the Radio-Television Manufacturers Association, I again emphasized that spurious radiations from tv receivers should be eliminated.

With the FCC and the military services expressing considerable alarm over the worsening conditions, the RTMA is beginning to take action and several committees have been appointed.

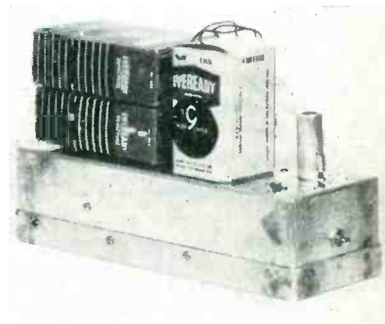
The Author

THE READER may think that elimination of receiver radiation is a difficult and almost insurmountable task.

Such is not the case. The author's own tv receiver does not radiate appreciably because a few simple precautions have been taken. Suppression of radiation becomes difficult only when the design engineer must stop radiation in a new design and, at the same time, effect a 50-percent saving in cost of manufacture. The general principles for prevention of radio interference are well known. It remains only to apply these principles to a



◀ With the test oscillator only six inches from the receiver, no interference is visible after effective shielding and filtering



▲ Test oscillator with top cover removed to show batteries and leads

from TV Receivers

tv receiver. They are, briefly: shielding, filtering and preventing metal mass from being excited by r-f so as to act as an antenna.

The main reason for not applying these principles seems to be the effort to reduce the cost of the tv receiver. Many essential parts have been left out to effect a small saving in cost. But the manufacturer has gone overboard in the other direction by putting the chassis in an expensive blond-mahogany cabinet.

Method

The basic techniques for preventing radio or television interference apply equally to all types of interference regardless of whether the source is an electronic business machine, radio transmitter, diathermy equipment, radiating f-m or tv receiver, or any other electrical or electronic device. To prevent radio interference, we need only prevent r-f from the interfering device from reaching the nearest receiver.

How do you accomplish this? First, completely shield the source of the interference to prevent direct radiation by coils or other circuit components.

Second, effectively filter out the interference from any wires carrying necessary or desired voltages or currents that enter or leave the shielded compartment. Use the appropriate filter types: high, low or band pass.

Third, prevent shock excitation of nearby metal objects that may act unintentionally as antennas and radiate the interference.

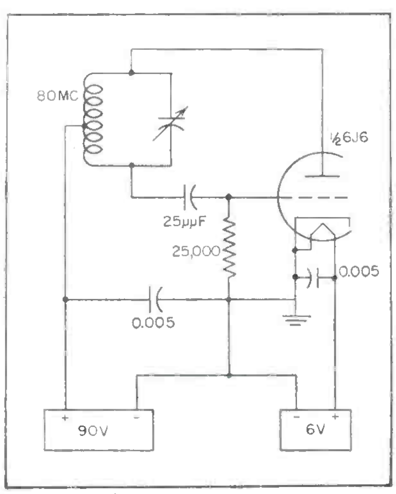


FIG. 1—Circuit of low-power oscillator used to simulate local oscillator of a tv receiver

Oscillator Radiation

Using a small bread-board oscillator let's conduct a practical experiment in shielding and filtering. The tube type and circuit are not important, so long as the frequency of the oscillator is in the range of a tv receiver oscillator.

Figure 1 shows the circuit using a 6J6 with battery power so that it can be completely shielded. It's frequency is 80 mc, so that interference can be observed on channel 5, similar to that coming from a receiver having a 21-mc i-f and tuned to channel 2.

On channel 5, the interference was strong even with the oscillator located in a building 150 feet from the tv receiver. A tv antenna was

Filtering	Shielding	Radiation
Shielded hook-up wire should be used to prevent otherwise clean wires from picking up r-f. Disc ceramic capacitors are excellent for by-passing ends of shielded wire. For best results, r-f chokes should be used with feed-through capacitors in preference to resistors. Output section of filter should be shielded to prevent r-f from getting into wire after filtering. A two-section filter is best. High-pass feed-through capacitors are best. Filters should be located away from strong r-f fields of coils.	Shielding must be continuous, almost water tight. Coils should be spaced away from shielding. Coils should preferably have their own shields within the main shield. Best material is copper-plated iron. Ventilation holes should be covered with copper screening. Tubes should have their own shields. All cracks or joints should be covered, bonded, or soldered. Screws in shielding should be close together and tight. At joints, a generous overlap should be used.	Strong fields should be kept away from shielding. Double shielding should be used over coils and tubes Copper-plated iron should be used. All cracks should be soldered closed. Any wires leaving shielding should be filtered. A single point ground should be used in circuit to prevent r-f from flowing in shielding. Shielded oscillator chassis should be mounted on main chassis so as not to excite main chassis.

connected to the chassis and an increase in tvi was observed on channel 5. Next, the chassis was connected to the a-c line through a capacitor, and the tvi was stronger.

All tvi disappeared when the oscillator and batteries were placed in a shielded box. The oscillator could be placed within six inches of the tv receiver with no trace of tvi. See Fig. 2. Note that the battery leads are inside the shield.

Need for Filters

The next set of experiments employed various combinations of shields and filters. Figure 3 demonstrates that shielding does no good if the undesired signal leaks out of the shield via the power-supply leads. Figure 4 shows how to correct this situation by inserting suitable filters in each supply lead. Figure 5 shows that a partial shield is not too effective, even with filters in the supply leads.

The experimental set-up was moved into a screened room and a set of field-strength measurements made with various combinations of filtering and shielding. These are tabulated in the Tables.

The field-strength measuring equipment used was the Measurements Corp. Model 32B radio-noise and field-strength meter with a 150-kc pass band. The readings shown in the Tables are in average indicated microvolts using a 3-inch-diameter loop-probe antenna.

In Tables I, II and V, the loop was maintained 24 inches from the hot end of the oscillator and oriented for maximum pickup. In Tables III, IV and VI the loop was coupled as tightly as possible to the power cable or chassis and oriented for maximum pickup.

Experiment 1 of Table I shows a reading of 7,000 μv with the oscillator well shielded, but with the 18-inch unfiltered battery cable exposed. This shows that shielding alone does no good. See Fig. 3.

In experiment 2 of Table I, the batteries and cable were completely shielded in the top of the cabinet, but the bottom of the oscillator chassis was legt off. Here, a reading of 2,000 μv shows that shielding is a necessity.

In experiment 3, the bottom cover of the oscillator chassis was loosely put in place and a reading of 1,800 μv obtained. This proves that the shielding is no good if not put on properly. See Fig. 5.

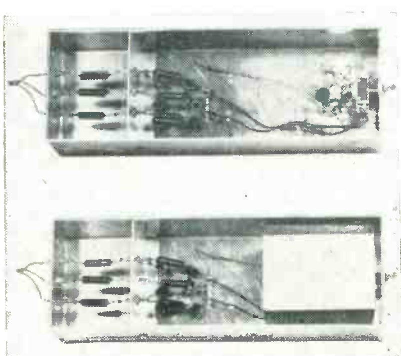
In experiments 4, 5, 6, 7 and 8, the shielding was progressively improved by tighter fits, better bonding, and more screws. The reading dropped until in experiment 8 it was about 1 μv. See Fig. 2.

Batteries were enclosed in the box so that there were no external wires to conduct r-f out of the box or shield.

Table II shows that, even with as good a shielding job as in experiment 8 (Table I), a reading of 7,000 μv results if the power-supply cable is brought out of the shielded enclosure through an ordinary hole without filtering. All the usual bypassing has been done in the oscillator circuit.

In Table II, experiment 1 shows a field strength of 7,000 μv while experiment 2 shows a mere 45 μv after a one-section filter has been added to each wire leaving the shielded enclosure. See Fig. 4. The latter reading was reduced to a barely detectable trace (3) after adding another filter section. This filter is shown in Fig. 6.

The next experiment consisted of moving in close with the loop probe of the field-strength meter to locate any leaks. Table III shows the results of filtering in the power-supply leads with the loop coupled for maximum pickup from these leads.



View at top shows bottom of test oscillator chassis with shielded output section of second filter. At bottom, inner shield over tank coil provides double shielding on five sides of oscillator

For experiment 1, with no filtering, the meter read completely off scale. Next (2), with a one-section filter, it read 1,200 µv. With a two-section filter (3), it read only 120 µv.

Effect of Shielding

Table IV shows the readings obtained by searching the entire outside of the cabinet with the loop looking for maximum pickup. This maximum was located on the outside of the chassis directly opposite the oscillator coil. This signal was reduced considerably by placing the coil in the center of the chassis, away from the shielding. Experiment 1, Table IV, shows that the meter read 9,000 µv with the screws removed from the tight-fitting bottom cover. Experiment 2 shows the reduction from 9,000 to 2,000 µv produced by adding a loose-fitting iron shield over the oscillator coil/capacitor assembly under the chassis. Tightening the screws on the bottom cover reduced radiation further (3). Further reduction in r-f on the outside of the cabinet was achieved by adding the second filter in the power-supply leads (4). See Fig. 6.

Table V shows the reduction in field strength by using a tube shield. In this test the top cover of the test oscillator was removed so as to expose the tube and the pick-up loop was moved in to get a convenient reading in this case: 1,400 µv. A tube shield was placed on the tube and another reading taken, 600 µv.

Table VI gives a comparison in filtering effectiveness of various combinations of capacitors, resistors and chokes as measured in the external B-plus supply lead of the test oscillator.

The experiments listed in Table VI were conducted to get actual figures on the effectiveness of lead filtering using various combinations of capacitors, r-f chokes and resistors. Lead filtering is of utmost importance if the interfering signal is to be kept bottled up in the shielded enclosure. The three important factors in designing a lead filter are the frequency to be attenuated, the current in the lead and the voltage.

Filter Data

Radio-frequency chokes must be used in filament or heater circuits, as well as in a-c line circuits. If the current is high, a large wire size should be used, but the inductance should be maintained in the vicinity of 6 to 10 µh. Resistors are satisfactory in avc circuits or low-current B-plus lines. Small disk ceramic capacitors are good (500 to 5,000 µµf) if the voltage is 300 volts or less. Bulkhead or feed-through capacitor types are preferable when passing a lead through a shield. The high-pass type is good, especially for the higher voltages. The best attenuation is attained when each section of the filter is shielded, as illustrated in Fig. 7.

The data shown in Table VI were obtained by placing the filter shown in the table in the external B-plus

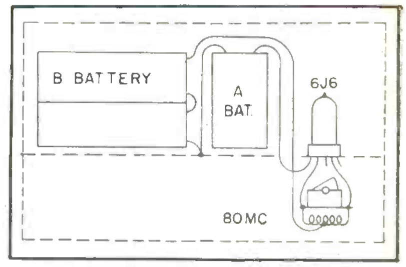


FIG. 2—Complete shielding of batteries, leads and oscillator proved most effective in tvi elimination

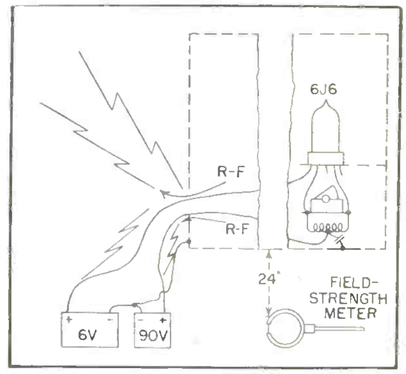


FIG. 3—Power leads conduct r-f out of shielded compartment

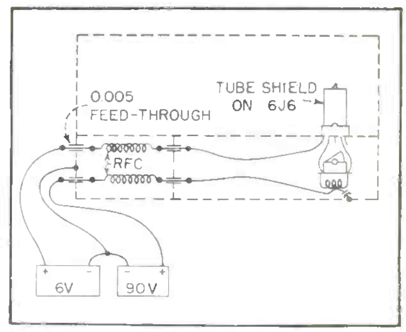


FIG. 4—No r-f leaks out on filtered power leads

Table I—Pick-up Loop 24 inches From Oscillator

Experiment		Field Strength
(1)	Oscillator shielded, batteries external, no filtering. See Fig. 3	7,000 µv
(2)	Oscillator unshielded, batteries shielded	2,000 µv
(3)	Oscillator partly shielded, batteries shielded	1,800 µv
(4)	Oscillator and batteries shielded, but poor contact	1,400 µv
(5)	Oscillator and batteries shielded, but better contact	730 µv
(6)	Oscillator and batteries shielded, fair contact, no screws	114 µv
(7)	Oscillator and batteries shielded, good contact, no screws	40 µv
(8)	Oscillator and batteries shielded, good contact with all screws in place (Fig. 2)	1 µv

Table II—Pick-up Loop 24 inches from Oscillator

Experiment		Field Strength
(1)	Oscillator shielded as in (8) of Table I, but with external batteries	7,000 µv
(2)	Oscillator shielded with one-section lead filters. See Figure 4	45 µv
(3)	Oscillator shielded with two-section lead filters, See Figure 6, plus extra iron shield over coil	>1 µv

Table III—Pick-up Loop ¼ inch from Power Cable

Experiment		Field Strength
(1)	Oscillator completely shielded, no filter in leads...	off scale
(2)	Oscillator completely shielded, one-section filter..	1,200 μv
(3)	Oscillator completely shielded, two-section filter..	120 μv

Table IV—Pick-up Loop ¼ inch from Chassis, Opposite Oscillator Coil

Experiment		Field Strength
(1)	Oscillator shielded, one-section filter, no screws in bottom shield..................................	9,000 μv
(2)	Oscillator shielded, with second iron shield on coil, no screws in bottom shield.....................	2,000 μv
(3)	Same as above, all shielding tight...............	350 μv
(4)	Same as above, with additional lead filter........	95 μv

Table V—Oscillator Shield

Experiment		Field Strength
(1)	Oscillator tube unshielded......................	1,400 μv
(2)	Oscillator tube shielded........................	600 μv

lead of the oscillator with the field-strength meter pickup loop probe taped to the external battery lead at a point of maximum pickup. The oscillator shielding was complete with all screws tightened.

A single small 75-μμf feed-through ceramic capacitor hardly attenuates the signal (test 2) unless used in combination with a resistor (4). An r-f choke is considerably better than a resistor for filtering (5).

In test 6, a 0.01-μf high-pass capacitor of the feed-through type does an excellent job; but two of them with an r-f choke between them in a shielded compartment are much better (12).

Next best is the two-section rfc filter (11). In test 3 of Table VI, note the improvement when using shielded hook-up wire by-passed at each end with a 0.005-μf disk ceramic for all wiring inside the shielded compartment.

Experimental Results

The experiments prove that an interfering signal can be bottled up in a shielded enclosure, even with several wires leaving this shielded enclosure. To do this, the source of the interference must be completely shielded; any wires leaving the shielded enclosure must be filtered; no r-f can be allowed on the outside of the shielding where it can be radiated. Some basic principles in the reduction of all types of interference are shown in the accompanying boxes.

Radiating Receivers

There are at least three types of spurious radiations from tv receivers that cause interference to various radio services. They are local-oscillator radiation; horizontal-sweep-circuit radiation; and i-f amplifier radiation. In all three cases it is not only the fundamental, but also various harmonics that are radiated and cause radio and tv interference from the long waves down through the tv frequencies.

In each case, the interference leaves the tv receiver by one or more of three escape routes, via the tv antenna; via the 117-volt a-c line; and by direct radiation from the receiver chassis or associated wiring and components.

All interference received by a television set enters by these same three routes. Thus, anything done to prevent radiation of spurious signals will also help prevent reception of interference by that same receiver.

Antenna Filter

An effective, properly designed, high-pass filter installed at the front end of a tv set will prevent radiation by the antenna of signals from the i-f amplifier and signals and harmonics from the 15-kc horizontal sweep cricuit.

Use of this type of filter will also prevent reception of radio signals lower in frequency than the tv channels. Band-pass filters and screen-grid tubes in the r-f and mixer circuits when combined with proper shielding and filtering of these stages will prevent radiation of the local oscillator frequency and its harmonics.

The a-c line can easily be filtered for all frequencies with high-pass capacitors plus r-f chokes.

This will not only stop any local-oscillator voltage that has leaked out of the front end, but also the i-f and sweep-circuit signals. In addition, it will prevent electrical noise

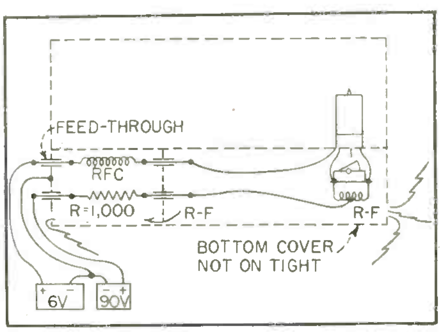


FIG. 5—Cracks in shielding permit r-f to leak out

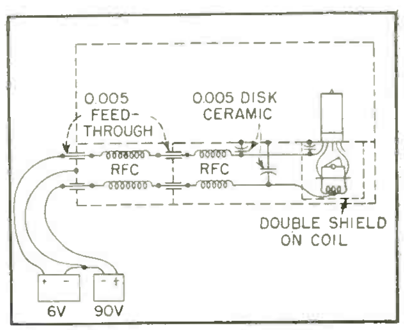


FIG. 6—Coil shield and second filter section are added

from the a-c line from entering the chassis and causing interference.

Chassis Radiation

The easiest way to stop direct radiation from the chassis is to keep the chassis from being excited by the r-f signal. In the case of the local oscillator, this problem is solved by the measures described. If there is any oscillator r-f outside the tuner shielding, care should be taken in the mechanical methods of mounting the tuner on the main chassis. It should be mounted at points of equipotential to minimize excitation of the larger surfaces.

To eliminate radiation by the i-f amplifier and its harmonics, a bottom shield should be placed on the main receiver chassis together with shields for all tubes and i-f coils. Any exposed wiring should be in a shield and the shielded wire well bonded where it penetrates the chassis. This also eliminates the annoying pickup of interfering signals on either the sound or picture i-f by circuit wiring.

This bottom shield when combined with tight shielding of the horizontal sweep circuits and high-voltage supply and proper lead dress to deflection yoke also helps to bottle up the 15-kc harmonics, so bothersome to nearby broadcast receivers. A metal or metal-lined cabinet is helpful in many cases.

A book on radio interference, which should be read by all receiver and transmitter design engineers, has been published by the USAF.[4]

F-M Receiver Radiation

Wide-spread tv interference can be caused by the local oscillator of an f-m receiver. Its frequency falls between 78 and 118 mc, causing either direct or image interference to most of the low channels.

The strongest tv interference will be on channels 5 and 6. The second harmonic from the oscillator falls between 156 and 236 mc, covering all the higher channels.

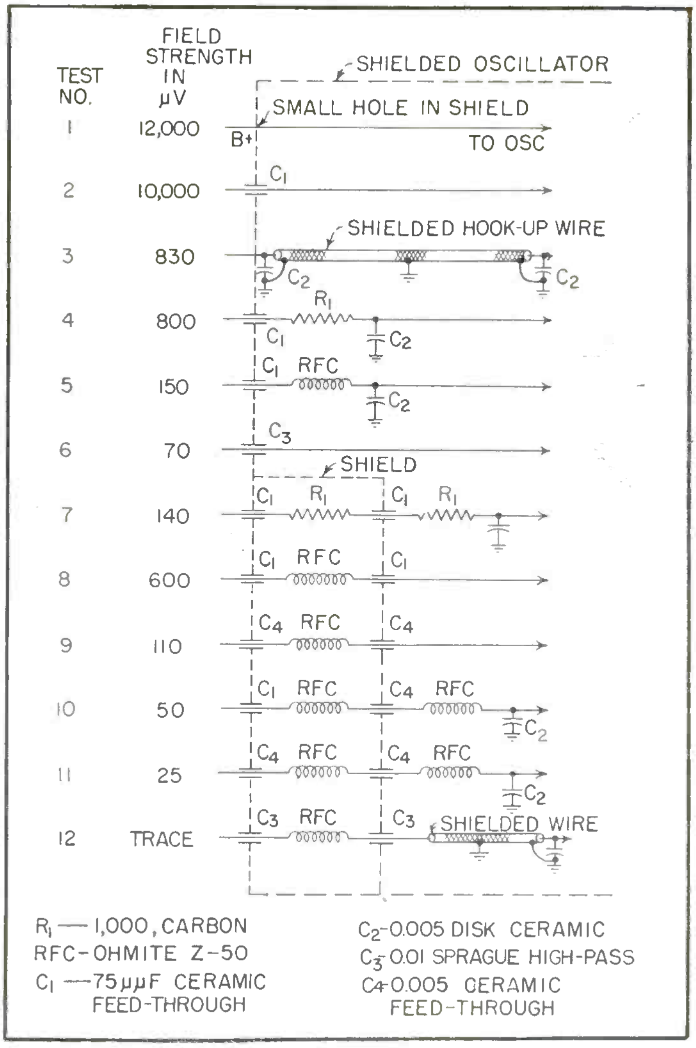
Everything stated about reducing tv oscillator radiation also applies to f-m oscillator radiation.

The shift in i-f from 21 to 42 mc is no more a solution to the oscillator radiation problem than to ask boys playing ball to throw the ball higher so it will not break windows in a first-floor apartment. When the ball is thrown higher, it breaks windows on the second or third floors.

The higher i-f prevents local-oscillator interference to other tv receivers, but it puts the oscillator radiation where it may bother airport and other commercial channels.

The real solution is to prevent radiation. Preventing this radiation in uhf tuners is going to be a problem.

Table VI—Filter Circuit Arrangements



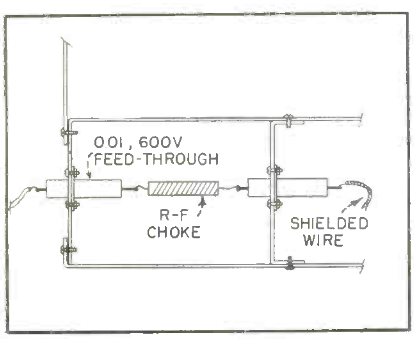


FIG. 7—Recommended construction of shielding for filter section

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Noise Analyzer for

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ONE test necessary to classify transistors properly and to determine the effects of different materials and processes is the measurement of noise figure. Noise figure is defined as the total noise power in the output divided by the noise power in the output due to thermal agitation in the input resistance.

In Fig. 1 the input resistance to the transistor is R_i with e_i representing the thermal noise within R_i. The value of this voltage is

$$e_i^2 = 4\,KTR_i\,(f_2 - f_1) \qquad (1)$$

where K is Boltzmann's constant and is equal to 1.347×10^{-23} (watts per degree K, and T is the absolute temperature in degrees K.

If the ratio of the output voltage, e_o to e_i is $A = C_o/C_i$ then the power in the output due to e_i is

$$P_i = \frac{4KTR_i\,(f_2 - f_1)}{R_L}\,A^2 \qquad (2)$$

which is then the output power due to thermal noise in the input resistance.

If the total noise voltage in the output is V_n then the total noise power in the output is

$$P_T = \frac{V_n^2}{R_L} \qquad (3)$$

The noise figure which is the ratio of P_T to P_i is then

$$F = \frac{V_n^2}{4\,KT\,R_i\,(f_2 - f_1)\,A^2} \qquad (4)$$

which is usually expressed in db.[1]

In Figure 2 is shown a simple block diagram of one method of measuring noise. If e is a calibrated noise source the output noise can be measured by increasing the value of e until the power output is doubled that with e equal to zero. The value of noise voltage or noise figure can then be read directly from the calibrated noise generator dial setting.

A somewhat more convenient method which does not require a calibrated noise source is used in the analyzer to be described. In this system direct measurement of noise voltage and the value of A is made with readings taken from previously calibrated attenuator dials.

The Circuit

Figure 3 shows a complete block diagram of the noise analyzer. It is basically the same as Fig. 2 with the addition of the two calibrated attenuators and SW_2.

In the first position of SW_2 the input is set to some arbitrary setting (80) on the meter. In position 2 the gain attenuator is adjusted until the same reading (80) is obtained. Since the attenuator is calibrated the gain is read directly from the attenuator dial. In the third position of SW_2 the input signal is removed and the noise attenuator adjusted to the calibration point (80 again for convenience). The noise figure is then read directly on the attenuator dial. The meter time constants in this position are greatly increased to facilitate easier reading.

Gain measurements from 20 to 59 db in one-db steps and noise figure measurements of 10 to 48 db in 2-db steps are possible with the unit that was constructed. The complete schematic is shown in Fig. 4. The grounded-emitter connection is used on the transistor because of the higher outputs obtainable over the grounded-base connection. Noise figures for both these connections are very nearly equal.[2]

The amplifier between the transistor and gain attenuator increases the very small noise voltages to a reasonable level for measurement.

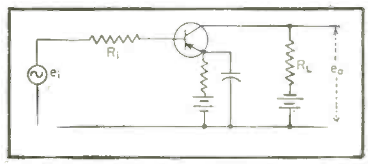

FIG. 1—Grounded-emitter transistor

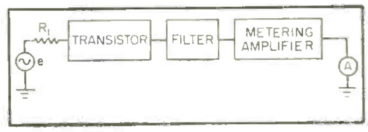

FIG. 2—Transistor noise measurement

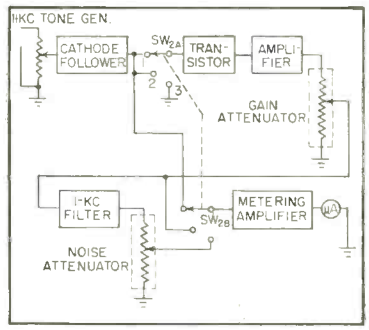

FIG. 3—Direct-reading noise analyzer

The 1-kc filter is a selective amplifier with a parallel-T network in the negative feedback loop.[3] The selective amplifier gain at its tuned frequency is approximately 60 db and has a bandwidth of somewhat less than 5 cycles.

If the analyzer is calibrated with this bandwidth taken into account, the measurements will be essentially the same as for a one-cycle bandwidth, since the noise output will be substantially constant over such a small bandwidth.

Metering

The metering amplifier is a common circuit for this purpose[4]. Instead of using the usual bridge rectifier in the meter circuit, however, a half-wave rectifier was used because of the ease of increasing

Transistor Production

An instrument designed to measure noise figures at 1,000 cps at a one-cycle bandwidth, using calibrated attenuators which facilitate direct reading with no calculations necessary

Readings are direct, no calculations needed

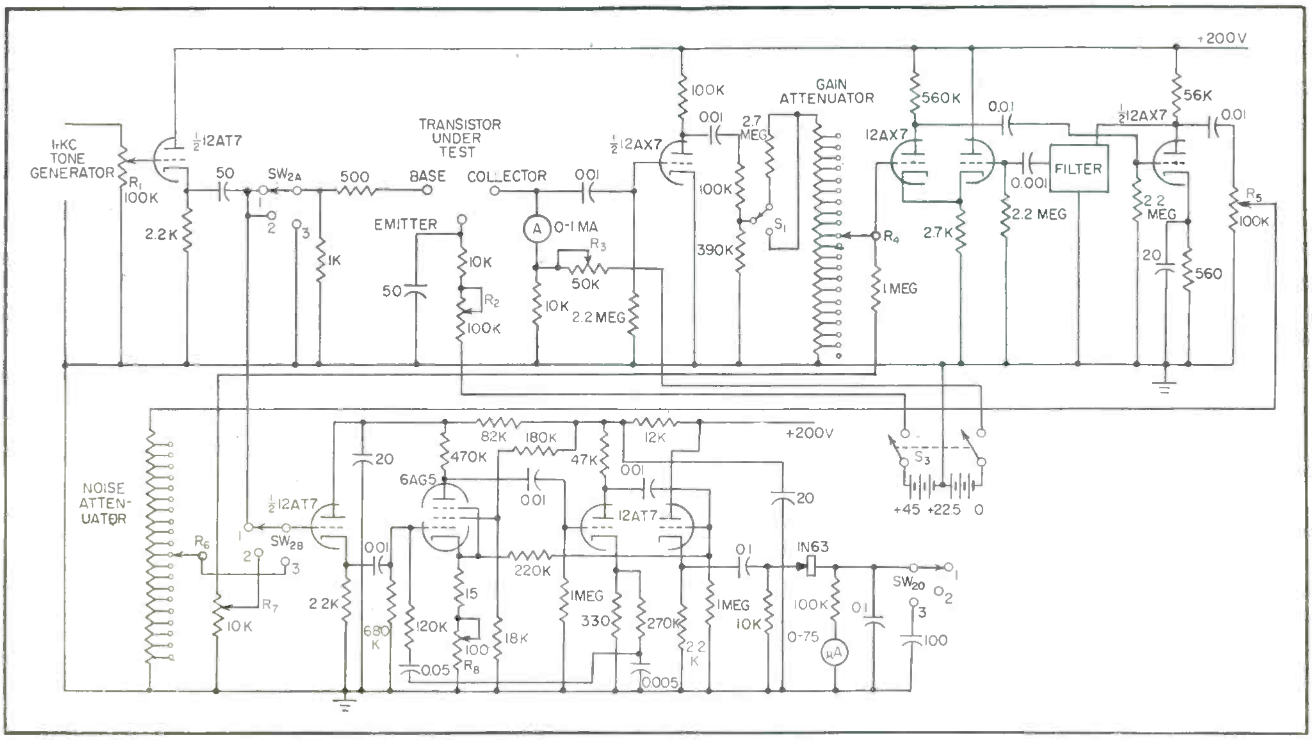

FIG. 4—Complete schematic of noise analyzer

the time constants in the noise position.

Batteries are used to bias the transistor since even very small values of ripple voltage on the collector or emitter circuit will upset the noise measurements. Potentiometers R_2 and R_3 adjust the bias, R_3 being a chassis mount since once it is set it will remain nearly constant for all transistors with the proper setting of R_2 which is placed on the front panel.

The instrument is calibrated by feeding an input signal of -50 dbm to the input terminals. With the meter switch SW_2 in the first position the meter is set to some arbitrary setting (80) by means of R_8. With SW_2 in the second position a -30 dbm signal is fed to the collector terminal of the transistor. The gain attenuator is then set to the 20-db position and R_7 adjusted until the meter reads the same as in the first step (80).

The noise attenuator is calibrated in position 3 of SW_2 with a 50.6 μ-volt input fed to the collector terminal. (This value is calculated using Eq. 4 and solving for V_n with $F = 48$d6. $A = 30$d6. $R_o = 500$ and $(f_2 - f_1) = 5$.)

For this calibration it is necessary that the signal source be tuned exactly to the selective amplifier frequency. The noise attenuator is set to read 48 db and the gain attenuator to 30 db. The meter is then adjusted to the same arbitrary setting as in the first two steps (80) by means of R_5.

A good check of the accuracy of measurements is to test a transistor in the analyzer. A direct check of the Value A can be made with an external vacuum-tube voltmeter. Then with the transistor removed a voltage is fed to the collector terminal and the signal adjusted until the same readings as with the transistor in the circuit are obtained. The voltage read is used to calculate the noise figure using Eq. 4.

Accuracy using this method has been found to be ± 2 db.

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Placing original copy on Roneo stencil machine. Stencil is rolled around left-hand cylinder. Adjustable cam disks at right, acting on snap-action switches, can be set to crop top and bottom of copy

Machine with chassis drawer open. Pointers on slide-rule dial, controlled by hand wheels show side-border limits to which machine has been set. High-voltage power supply for stencil-cutting spark is on a lower chassis along with electrode feed circuit

Photoelectric Printing

Operating principles and performance details of two automatic stencil-cutting machines, a typesetting machine that delivers negatives instead of slugs, room-size scanners for correcting color-separations, and a desktop engraver for making printing plates

By JOHN MARKUS

Associate Editor, ELECTRONICS

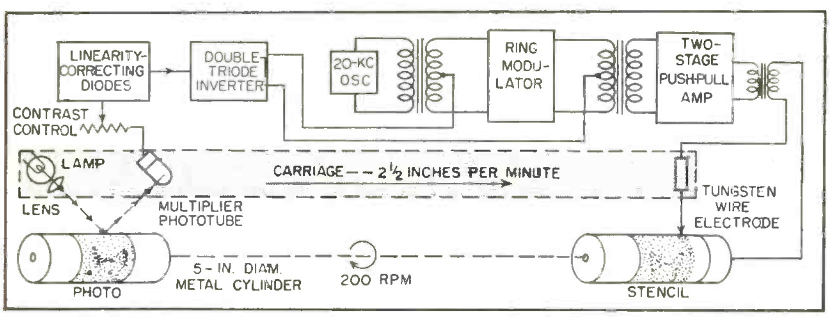
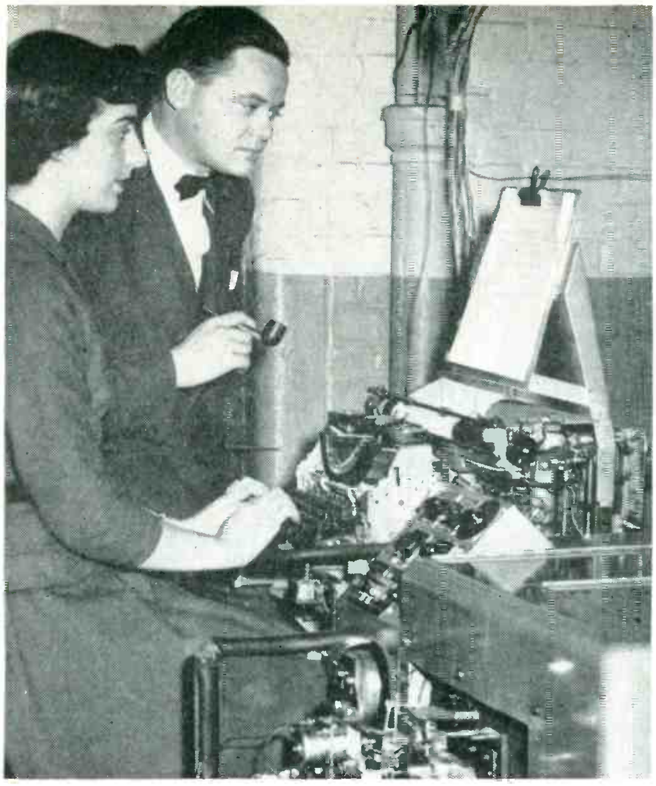
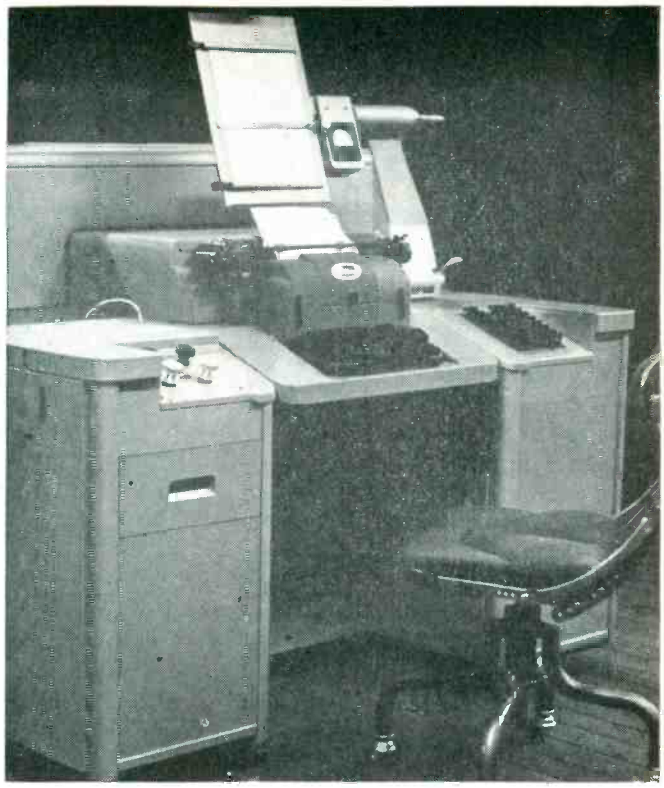


FIG 1—Operating principle of electronic stencil-cutter capable of transferring photos to stencils, with 500-line resolution of detail

THE POSSIBILITY of substituting phototubes for human eyes in connection with the production of stencils, plates and negatives for reproducing copy and illustrations has long been known. In the past, however, equipment has usually developed serious bugs in the field. The engineers who designed and built the electronic machines could make them work beautifully during demonstrations, but continuous



Electronic photocomposing machine used to make negatives from which an entire book, "The Wonderful World of Insects", was recently produced. Housing of this developmental model has been removed to show mechanism



First commercial production model of Photon typesetter. Negative-exposing unit is at rear. Choice of type size and style is made on keyboard at right of electric typewriter. Machine delivers strip of exposed film, resembling galley proofs

and Engraving Machines

daily use by non-engineering personnel under actual shop conditions was something else.

This year, for the first time, developmental troubles appear to be largely over. Six firms that have been active in the field are placing in production new designs incorporating the results of extensive field tests. These offer improved product quality, give faster results, ease personnel training requirements and in most cases also lower the cost. This article surveys the new models one by one, with emphasis on the design changes that contribute to the success of electronic printing techniques.

Electronic Stencil Cutters

Two different makes of machines are now on the market for cutting mimeographing stencils electronically in a few minutes from photographs, line drawings and printed forms as well as from typed copy. Both machines resemble combined facsimile transmitters and receivers, using photoelectric scanning of copy and spark cutting of the stencil. Chief differences are in resolution of detail and speed of operation. Both eliminate tedious proofreading of stencils.

Roneo Electronic Stencils

In the machine made by Roneo Ltd., London, two metal cylinders are mounted on a common shaft driven at 200 rpm, as indicated in Fig. 1. Copy is placed on the cylinder which is adjacent to the light source and phototube. A special stencil loaded with a conducting material is placed on the other cylinder.

When the machine is set in motion, the phototube traverses the rotating copy cylinder from left to right at a speed of $2\frac{1}{2}$ inches per minute, giving a resolution of 500 lines per inch. The other end of the carriage moves correspondingly across the stencil cylinder. Here, sparks that are controlled by the phototube output signal jump from a pointed tungsten wire electrode through the stencil to the metal cylinder, burning holes in the rotating stencil. Time for cutting the full width of an 8-inch stencil is 20 minutes, and initial setup and adjustment of controls usually takes about 10 minutes more.

The output signal of the multiplier phototube varies linearly with light and hence varies inversely with opacity. The double-triode inverter stage serves to invert the phototube signal voltage so it is inversely linear to density as required for stencil-cutting. Four vacuum-tube diodes provide linearity correction over four regions on the characteristic curve of the electronic system.

The inverted and corrected signal is fed into a ring modulator arrangement for amplitude-modulation of a 20-kc carrier signal generated by a self-excited oscillator. The resulting modulated signal is amplified and then applied to the cutting electrode.

Since sparking erodes the electrode point rapidly, the electrode is constructed from fine tungsten wire that feeds from a reel through a capillary to the stencil. An electronic control circuit advances the electrode wire automatically as it is consumed, much in the manner of the electrode-moving system for an arc light.

Circuit action is such that the size of hole made by a spark is constant, but the number of holes produced per second varies with copy density. The range is from about one hole per second for solid white copy to about 12,000 holes per second for solid black areas where the stencil must pass maximum ink. Adequate reproduction of thin white lines requires a carrier frequency about 1½ times the maximum dot frequency, accounting for the choice of the 20-kc carrier.

The machine has several advantages over conventional stencil-making techniques for illustrated material: (1) The stencil is made directly from the original, without any intermediate photographic work; (2) cost per processed stencil is constant regardless of the nature of original copy, hence is often less than for manual or photographic stencil-cutting of illustrations; (3) quality of reproduction made from the stencils is exceptionally good, and often actually comparable to original photos; (4) the electronic cutting time of 20 minutes is generally much faster than other methods. The machine is being made available in the United States on a sale or rental basis.

Placing copy of printed form on cylinder of Stenafax machine. Finished stencil, ready for use, is obtained in 6 minutes on right-hand cylinder

Times Stenafax Machine

Where less detail is required, the Stenafax machine made by Times Facsimile Corp. offers advantages of lower stencil-cutting cost, lower machine cost and faster cutting time. Operating principles are essentially the same, but the circuit is simpler and more stable. Resolution is about 140 lines per inch, comparable to that of a 144-screen halftone, with a cutting time of six minutes. Loading and unloading takes less than a minute more, giving an operator ample time to run mimeographing machines during stencil-cutting.

Special vinyl plastic stencils loaded with conductive powder are used. These are capable of mimeographing upwards of 10,000 copies on standard equipment. Photographs and screened halftones with good contrast can also be transferred to stencils.

When only a single copy is required, special recording paper can be used in place of a stencil; the machine speed can then be doubled. This technique gives a dry, permanent record in three minutes with no processing required, at a fraction of the cost of a photostat.

Special Timefax recording paper containing a dye for making copies by the hectograph or gelatin process can also be cut electronically on the machine.

With electronic stencil cutting, stencils can be thrown out after use as the original copy is available for cutting new stencils when needed.

Photon Typesetter

An electronic equivalent of the linotype machine, now in commercial production, delivers film negatives instead of type slugs. These can be used directly to expose plates for offset printing, or can be converted to a line cut by an engraver for conventional printing.

The new photocomposing machine, being manufactured under the name Photon, was designed by French engineers Rene A. Higonnet and Louis Moyroud. Development to the production stage has been carried out by the Graphic Arts Research Foundation, Inc. of Cambridge, Mass.

The heart of the machine is a 1½-pound glass disk rotating at 600

Example of Roneo electronic stencil

Comparison of mimeographed copy (right) with original photo

rpm, on which is the equivalent of 16 different complete fonts or families of type arranged in circles as in Fig. 2. On one side of the disk is an electronically controlled flash lamp that gives an intense light for a few microseconds to expose film when the desired character on the whirling disk is precisely in the correct printing position. The film is exposed one letter at a time in this way. A mirror in the associated optical system advances the printing light beam the right amount for each character width automatically. Since the light leaving the disk lens is collimated, the mirror can be placed at any position in the beam without changing the focus at the plane of the film. This arrangement avoids the necessity for moving the heavy film and film holder.

Type size can be changed as often as desired, even in the same line, by means of a turret of lenses in the optical system. Range of size, from 5 point to 36 point, is controlled from the operator's keyboard. The size of a character is increased simply by projecting a bigger image of it onto the film. Line length, vertical spacing between lines and other operations are controlled by means of pushbuttons and knobs on a panel alongside the typewriter.

The input to the machine is a specially designed electric typewriter having a standard keyboard. Pressing a key types a character conventionally on paper for visual checking, and actuates a set of permutation bars through which nine electrical contacts are closed. Each key on the typewriter actuates its own unique combination of open and closed contacts.

Some type of storage device is needed in any composing system which produces a justified output. The characters and spaces in a line must be remembered as they are set, so that a few seconds later they can be combined with the right interword spaces to produce a given length of line.

Immediately behind the typewriter there is a flat, rectangular frame filled with rows of horizontal metal pins. These pins can be pushed back and forth so that they project outward from either face of the supporting frame. A spring holds each pin in place on either side of the frame. There are nine pins in a vertical column and there is a column of pins for each position the typewriter carriage can occupy.

Mechanical Memory

A vertical column of nine solenoids is carried on the typewriter carriage. The solenoids are connected to the contacts which are operated by the permutation bars of the keyboard. Each solenoid can drive a hammer toward one pin in the vertical row associated with each position of the typewriter carriage.

Normally all pins in the frame project toward the typewriter. When the solenoids operate, they drive the corresponding pins through the frame. The carriage then spaces one step, and with the next key operation the solenoids push in a group of pins in the next vertical row. Thus the code description of one line of copy is stored at the back of the typewriter as an array of pins.

Justifying Lines

The justification computer is an electrical unit that is fed directly by the nine electrical contacts on the typewriter (the same contacts that control the nine solenoids on the carriage) and by a stepping switch actuated by the space bar of the typewriter. This telephone-type switch advances one position for each word, so that its position

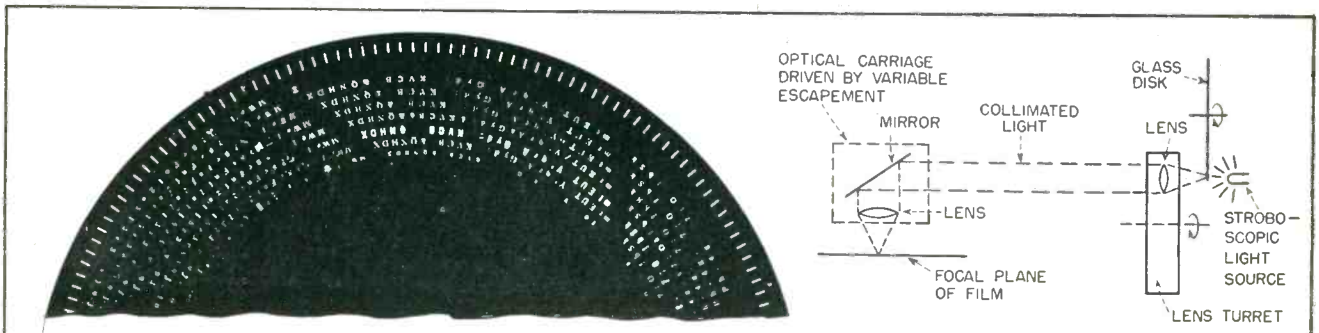


FIG. 2—Portion of typical matrix disk for typesetter, containing 16 completely different fonts of type. This 1½-lb disk is equivalent to 4,000 pounds of lintoype matrixes costing over $25,000. Precision character-positioning slits fill outermost circle. Optical system for disk is shown at right

at the end of the line indicates the number of interword spaces.

Each character is identified electrically by the same nine-digit code used for the mechanical pins. Five of the digits indicate the width of the character and the remaining four distinguish among characters of the same width. If an open contact represents zero and a closed contact represents one, a typical character might have the code number 010010111 when written in binary form. Expressed in the decimal system this would be 9-7, and would mean that the character is nine units wide and is character number seven of that width.

An accumulator adds the width-specifying binary numbers transmitted from the keyboard and subtracts the sum from the final line width. The difference is the amount of space which must be distributed among the interword spaces; this is divided by the number of interword spaces indicated by the stepping switch to get the required space between words. The calculation is obtained automatically at high speed by a special adding process in the justifier.

After the operator has checked the typed line and corrected any errors by punching new keys for those character positions, a single key is pressed to release the operation for photography. Now the decode and control unit automatically begins the final composition of the line. A reading carriage moves across the back of the typewriter storage unit. As it reaches each vertical column of pins it senses which pins are projecting through, and closes contacts to convert these pin settings back to nine-digit electrical binary code for operating the decoding relays which initiate the photographic operation.

Clearing of the mechanical memory and exposing of the film is known as reading out, and takes place faster than the typist can work. The typist can therefore start on the next line while the last line is being read out.

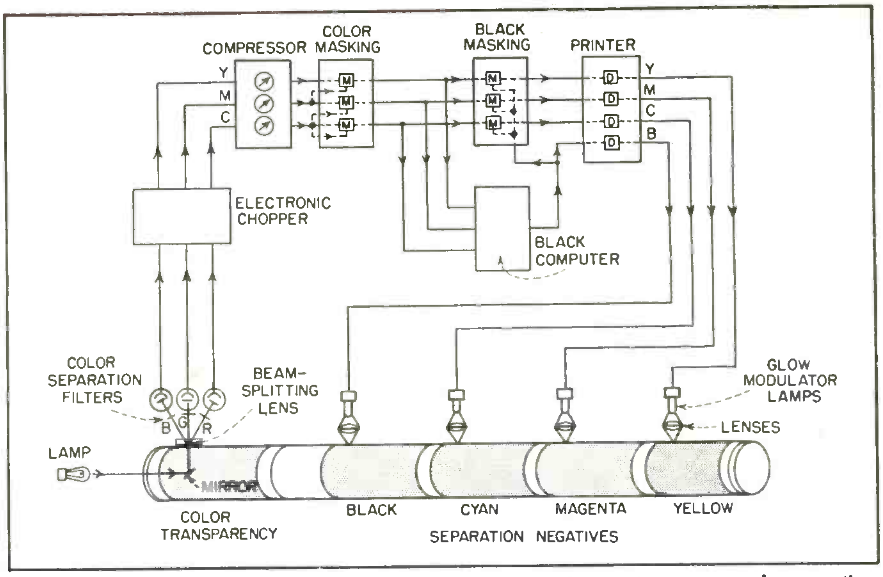


FIG. 3—Functional diagram of *Time-Life* scanner for producing four corrected separation negatives from one color transparency simultaneously

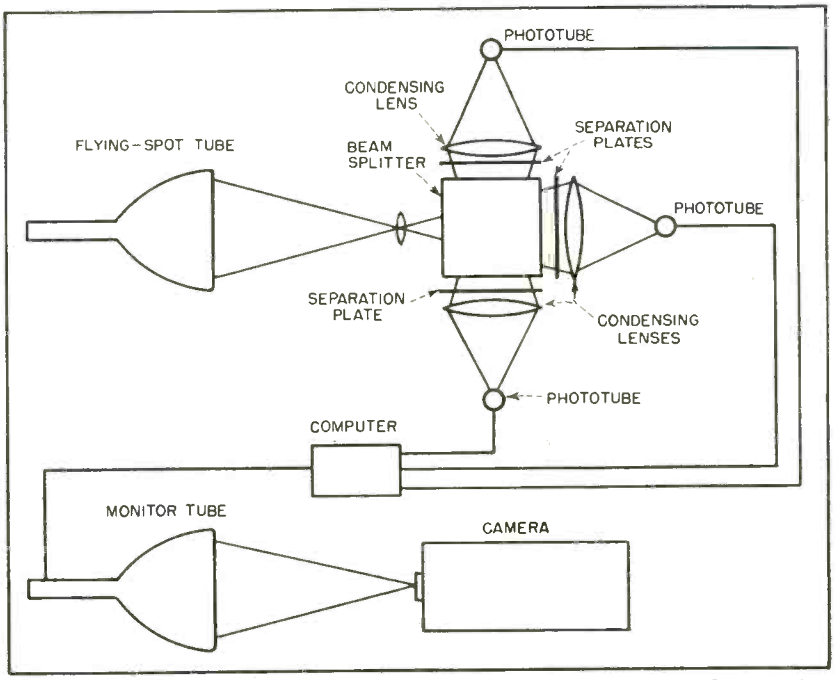
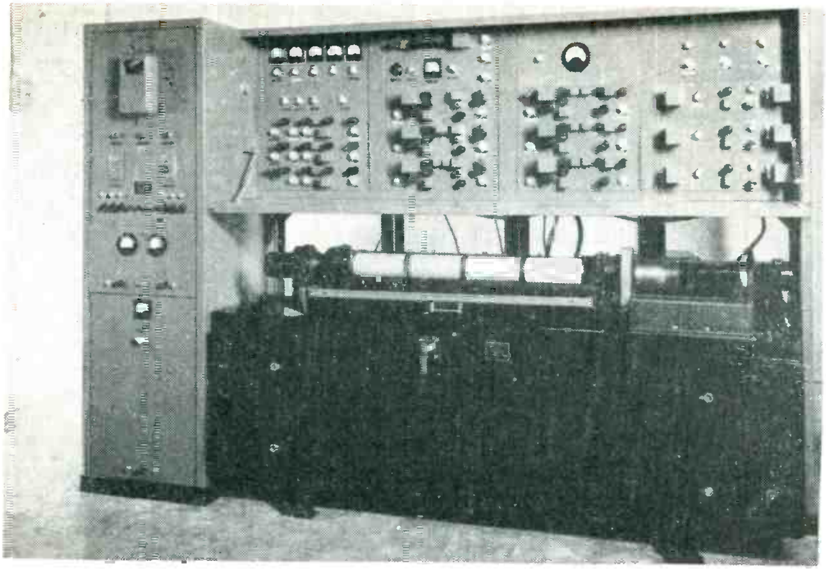


FIG. 4—Method of using cathode-ray tubes in RCA all-electronic machine equipment. This system converts separation plates into four corrected negatives

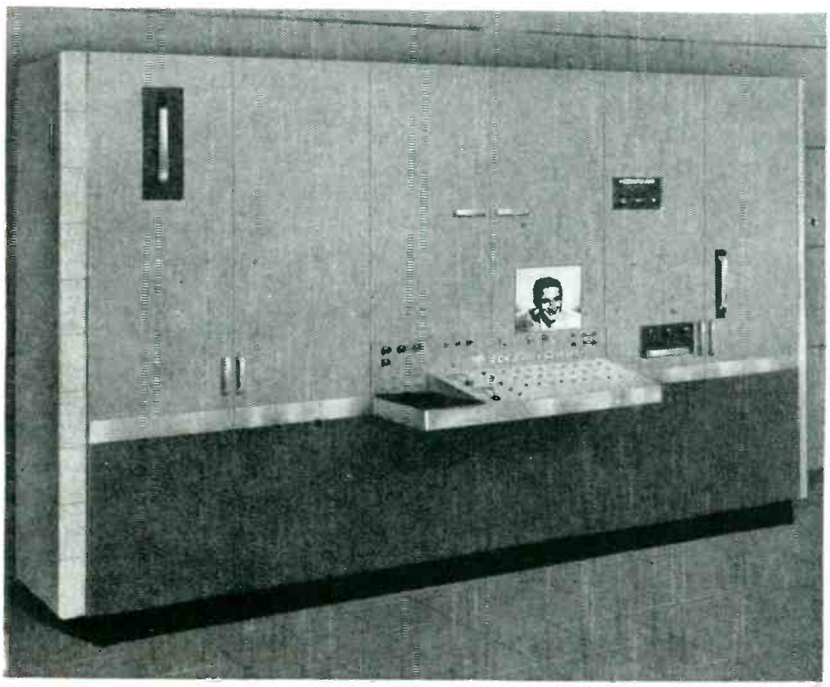
Exposure of Film

As the 1,440-character matrix disk in the photographic unit rotates, each character in a particular circle is swept past the aperture of the optical system once for each revolution. A commutator which rotates synchronously with the disk is composed of conducting and insulating segments so arranged that when a character is in the aperture of the optical system its identification code, expressed in terms of conduction and insulation, is under the brushes of the commutator. When coincidence is obtained with the character called for by the electrical memory, an impulse is fed to an electronic gate in the stroboscope circuit.

Final control of the photographic impulse is exercised by a narrow slit on the outermost circle of the disk. Each character is associated with a slit, and the relative location of the character and its slit is maintained with high precision. The slits are scanned by a light beam and phototube combination as the disk revolves. The electrical impulses from the phototube also go to the gate circuit, but neither the impulse from the electrical memory nor the impulse from the phototube alone will actuate the light source. Only when the two signals appear simultaneously can the stroboscopic light fire. Thus the desired character is selected by a signal of



Time-Life color scanner, with light-tight housings swung forward to show the four cylinders on which corrected negatives are exposed



Artist's sketch of production model of RCA color corrector

relatively long duration but it is given its precise position on the film by the brief impulse from the phototube.

Film Transport System

After the character is projected on the film, a variable escapement moves the beam-shifting mirror an amount proportional to the character width called for by the decoding relays. Interword spacing signals from the justifier similarly operate the variable escapement.

When a signal calling for a typographic change is encountered, the control unit momentarily halts the composition process and initiates the operation of servomechanisms which either rotate a lens turret to a new position or swing the disk to a new operating radius, or both operations.

When exposure of one line has been completed, a vertical escapement spaces the film vertically a predetermined amount to place it in position for the start of the next line.

The information placed in storage by keyboard operation is sufficient to control all phases of the photographic process, allowing the operator to work on the next line while the negative for the previous line is being exposed. A typist without special training was able to operate the machine at a rate of 12,000 characters an hour in setting copy for the first book to be produced in its entirety by the machine.

Time-Life Color Scanner

The *Time-Life* electronic color-correction scanner was designed to work at same-size ratio for the production of balanced three-color and black separation negatives from 8 x 10-inch or smaller color transparencies.

The color transparency is wrapped around a glass cylinder which is a continuation of a steel drum around which are wrapped four sheets of unexposed process film, as shown in Fig. 3. White light from an incandescent lamp is focused to a minute spot on the inner surface of the color transparency. The colored light emerging is split by a lens into three paths. Conventional red, green and blue color-separation filters are inserted in each of the three paths, and a phototube is placed behind each filter.

The three phototube output signals are fed into an electronic compressor circuit which permits adjustment of the density ratio to a usable or desirable figure. The three outputs are then fed into a masking computer, where pre-determined values of each color are used to compensate the other color values.

The output of the masking computer is fed into a black computer, which evaluates the ratio of the three signals and determines how much black should be added. This output is divided and modulates the three color values in addition to setting up black printer values.

Four signals, one for each color and black, are then fed into a printer control unit. This unit controls the intensity of a glow tube which prints the spot on the four pieces of film that are to be the color-separation negatives. The elapsed time from reading to exposure is about 1/1,000th second.

Scanning of the picture is accomplished by rotating the entire drum while advancing it lengthwise. The entire scanning process takes 65 minutes for an 8 x 10-inch subject scanned at 500 lines to the inch. This time is doubled when the scanning is done at 1,000 lines to the inch.

An auxiliary circuit provides for added highlight controls. Masking ratios may be changed at will by means of plug-in control coils.

The separation negatives taken from the machine are the same size as the transparent copy scanned, but 500-line scan allows a blow-up after scanning of 3 to 1, based on experience with *Life* editorial copy. For 1,000-line scan, permissible blow-up is practically unlimited.

Approximately 90 percent of all the work now produced in the Eastman Kodak engraving shop is made from separations made on the scanner, in operation at the New York demonstration shop of Printing Developments, Inc. Kodak now finds it possible to reproduce medical and dental subjects with a degree of authenticity and fidelity hitherto unattainable. This is possible because of the superior color rendition and delicacy of tone which is maintained in electronically scanned separations.

RCA Color Corrector

An all-electronic corrector now nearing production by RCA works from three uncorrected positive color separations that are produced photographically. It provides rapid, automatic, dot-by-dot color correction of the positives.

The instrument uses a flying-spot cathode-ray tube as a scanning light source. Lenses focus the light into a beam, and an optical beam splitter divides this into three identical scanning beams, each directed through one of the three uncorrected separations as in Fig. 4. The moving spot of light takes 10 minutes to scan the full image area. Phototubes behind the separations convert the transmitted light into three electrical signals, each representing one of the primary colors of the subject. These signals are then fed to an electronic computer.

Ink data representing the characteristics of the inks and paper to be used in the reproduction are set into the computer before the correcting operation starts. In appropriate circuits the ink data signals are compared with those from the phototubes. Any difference between the signals shows up as an error voltage that is amplified and fed back into the ink color generating circuits. There the error signal is used to change the output of the ink color generators in a way that reduces the difference voltage. This is the equivalent of the color etcher or dot etcher's changing of dot sizes manually.

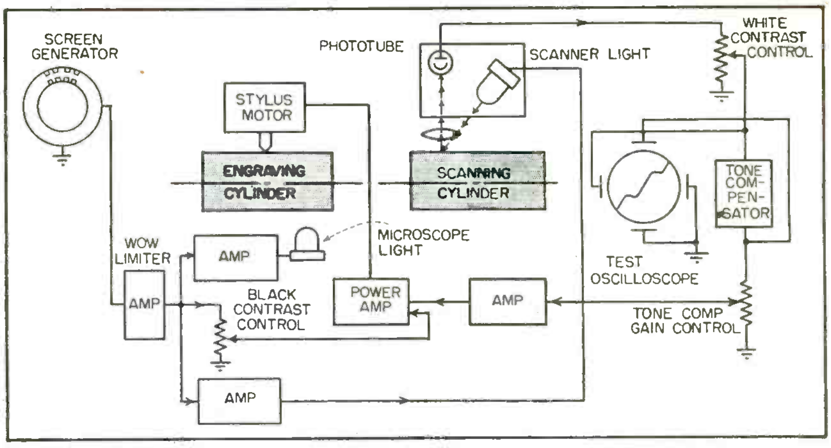


FIG. 5—Simplified block diagram of photoelectric engraver. Tone compensator is needed because depth of penetration of point does not vary linearly with surface area burned out of plastic plate

The copy color is compared to this second "proof". The comparison operation is fast and continuous, so that almost instantaneously the difference between inks and copy is reduced to a minimum. Actually the computer is solving three simultaneous equations of the fourth degree at a rate of several thousand solutions per second.

The solutions of the simultaneous equations provide, element by element, the characteristics of the separation for each process printing color. The relation between the solutions determines the characteristics of the black printing plate, the signals for which are generated by a fourth channel.

Each of the four corrected signals in turn becomes the input to a cathode-ray monitor tube, producing there the image for one of the final color-corrected negatives. This image is photographed with an ordinary camera, for use by the engraver in making the corresponding color plate. The entire scanning, correcting and photographing process is repeated four times, once for each ink signal.

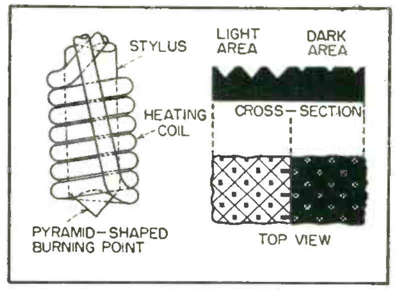


FIG. 6—Construction of heated stylus, and holes produced by it in plastic plate for light and dark areas on photographic copy

Use of this combination electronic and camera system permits corrected separations to vary in size within reasonable limits. The all-electronic system scans in about ten minutes, hence total time for producing a set of four corrected separations is 40 minutes plus setup time and camera loading and unloading time.

Electronic Engraver

A photoelectric machine for producing a half-tone printing plate on plastic material is made by Fairchild Camera and Instrument Corp. It utilizes operating principles that combine various photoelectric engraver inventions by Walter Howey and George Washington, Jr. Chief application is for newspaper reproduction of photographs. The finished plate compares favorably with plates made by the conventional photochemical process.

Over 1,000 of the electronic engravers are now in use on a rental basis at daily and weekly newspaper plants and at commercial printers.

Console model of engraver, with operator holding finished plate. Flashing-lamp microscope is provided for examining dot-burning operation while machine is in operation. All amplifiers are underneath, along with a fireproof compartment for plates

Tabletop model of photoelectric engraver, known as Fairchild Scan-a-graver Cadet, produces 85-screen four-column halftone in 24 minutes after photo is loaded as shown. Amplifiers and tone-correcting circuits are in separate housing on shelf at rear

The majority of the machines make 65-screen or 85-screen halftones for use on newsprint; so far, only about 10 percent of them are factory-set to make 100-screen and 120-screen halftones for coated paper.

In appearance, the photoelectric engraver resembles a small screw-cutting lathe having two cylinders mounted end to end on a common arbor. A positive photographic print, cropped or projected to the size of the engraving desired, is attached to one cylinder for scanning by a phototube mounted on the belt-driven lathe carriage. The light source for this phototube is chopped by a commutator-type screen generator in the lamp filament circuit as indicated in Fig. 5, so that the phototube sees dot areas of the copy rather than a continuous scanning line.

A sheet of plastic is curved over the other cylinder and clamped in position under the engraving cutterhead also mounted on the carriage. The cutter is a heated stylus ground to a pyramid-shaped point and driven in and out by a magnetic armature which receives the amplified and tone-corrected output of the phototube. As the point penetrates the surface of the celluloid it burns small pyramid-shaped depressions in the surface.

When the photoelectric input is scanning a white area, the signal voltage is high and the hot stylus burns a deep crater as shown at the left in Fig. 6. When a black area is being scanned, the signal voltage is low and only a shallow hole is burned as at the right in Fig. 6. With shallow holes, there is maximum plate surface to take printing ink and the plate prints the desired corresponding black area.

Electronic amplifiers, control circuits and tone-correcting circuits involving about 20 tubes are used between the scanning system and the cutter head, so that the depth of the depressions formed in the surface of the celluloid corresponds to graduations of shade of the photographic print being scanned.

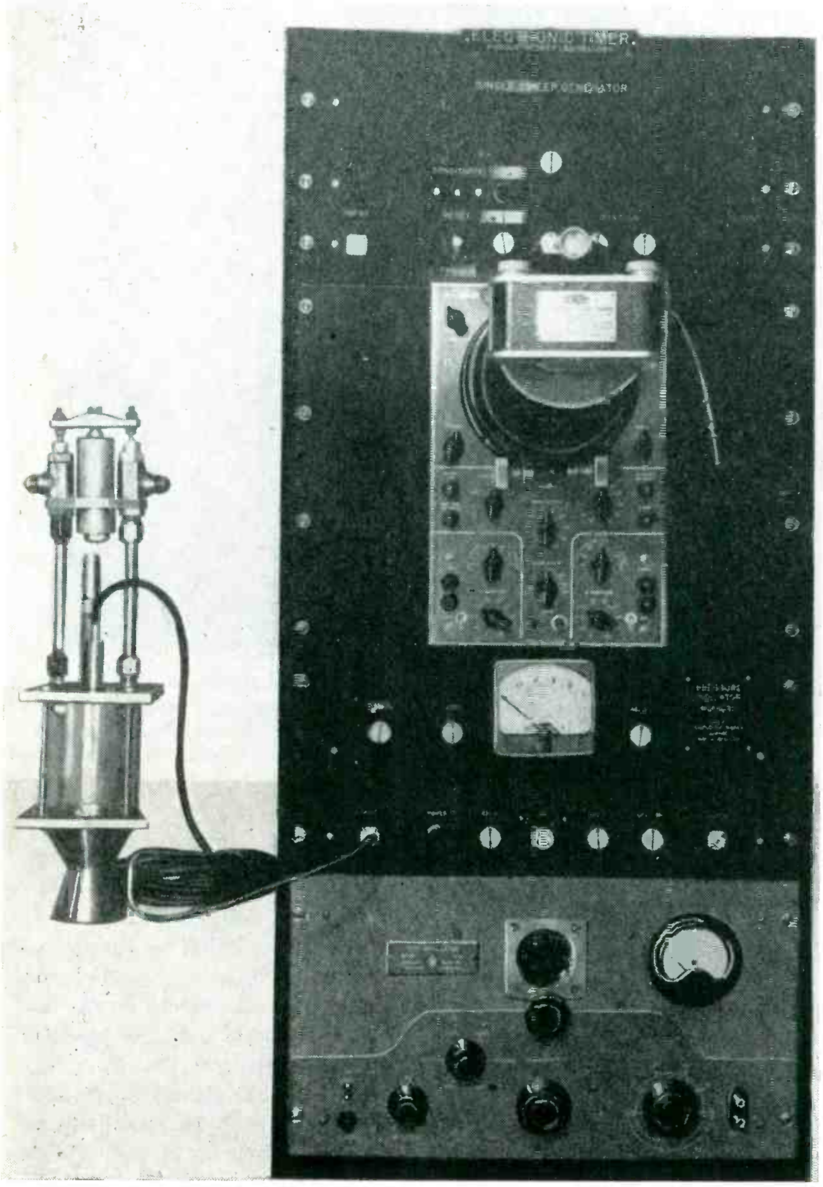
A tone wheel is used as an electrostatic generator to produce an a-c signal for creating a half-tone screen. A toothed wheel, mounted on the same shaft as the cylinders, rotates within a coplanar coaxial outer ring having a like number of internal teeth. A d-c potential is applied between the two sets of teeth, so that relative movement of teeth past each other varies capacitance and hence current. To obtain the conventional staggered-dot halftone pattern, the outer wheel rotates half a tooth space for each revolution of the inner wheel.

The maximum size of engraving that can be made on present machines is 8 by 10 inches. An engraving of this size with a 65-line screen can be cut in 30 minutes, since the linear travel of the carriage is ⅓ inch per minute. Finer screens require more engraving time. After taking the completed engraving off the machine, it is trimmed, scrubbed in clear water, and mounted on a wood or metal block with adhesive tape that is coated on both sides.

Pressure Recorder for

By JAMES ALMAN

Purdue University
West Lafayette, Ind.



Pressure test cell at left is used to test the recorder built into table-mounting rack. Single-sweep oscillator at top provides timing marks

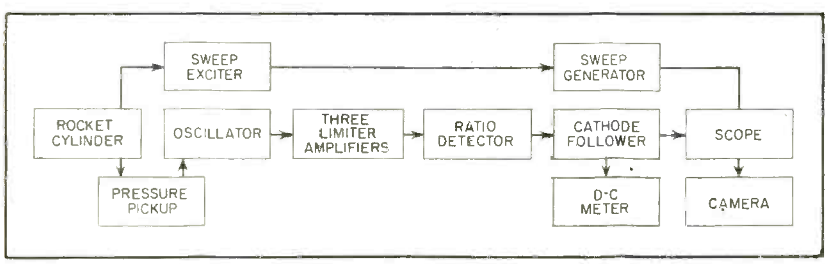


FIG. 1—Block diagram of the rocket pressure recorder. The instrument gives a graph showing pressure variations and time

In the study of rocket motors, pressure variations encountered are not only extremely high but may contain high rates of change. The instrument developed here is capable of measuring these pressures from vacuum to 30,000 psig over a frequency-response range from zero to 110,000 pressure variations per second.

This system shown in the block diagram, Fig. 1 employs a capacitance probe as a pressure pickup. Change in capacitance owing to pressure change on the pickup frequency-modulates an oscillator. This oscillator in turn feeds its voltage through three limiter amplifiers. The amplifiers are followed by a ratio detector coupled to the oscillograph through a cathode follower. A probe in the rocket cylinder triggers a sweep generator that supplies the time base on the oscillograph. An oscillator is then employed to intensity-modulate the oscillograph beam; therefore, the oscillograph presentation contains both pressure variations and time marked directly on its face. Thus the camera has a complete graph of pressure variations in the rocket engine with respect to time.

Detailed Circuit

The pressure pickup, a pressure-responsive capacitor made by H. Rutishauser Scientific Instruments Corporation, Altadena, California, has a replaceable diaphragm and back-pressure connection. Diaphragms are available for pressures from vacuum to 30,000 psig in eight ranges.

Fifty feet of Belden 8229 cable

Rocket Motor Studies

Capacitor pickup responsive to pressure and frequency-modulated oscillator permit oscillograph studies of high-pressure variations having high rates of change. System can be operated with other types of pickups that present a change of resistance, capacitance and inductance or combination of same

connect the pressure pickup to the indicator. This length of cable was chosen as approximately a half wavelength at 10.5 mc. It therefore reflects the same impedance as the pressure pickup imposes on the receiving end. A series capacitor couples the cable to the oscillator. This capacitor is directly coupled to a shunt capacitance across the oscillator's tank coil. The combination allows calibrating the devices without changing the operating frequency.

Frequency-Modulation Detector

The oscillator employed here and shown in Fig. 2 is an electron-coupled Hartley type. Overall frequency response of the three limiter stages is such that the three-db points are 300 kilocycles apart centered around the carrier frequency of 10.5 megacycles. The oscillator and three limiter stages employ type 6AK5 tubes. A 6AL5 is employed as a ratio detector biased negative so it can drive the 12AU7, which is a cathode follower. This negative bias is necessary to keep the output at zero potential with no pressure applied to the pressure pickup. The cathode follower also contains a 100-microampere meter that can be directly calibrated in psig.

The power supply used in this system supplies a positive potential of 125 volts with a ripple of three mv, rms. A v-r tube provides a regulated potential of −75 volts. The scope used for the presentation pattern is a Dumont 304-H with a P11 screen. The results obtained with this system during test procedure had rise times of less than six microseconds. These results were obtained by dropping a tempered steel ball on a highly tempered piston exerting pressure on a small column of mercury that was against the pickup diaphragm.

Such a system can work with any type of transducer that presents a change of resistance, capacitance, inductance or any combination of these quantities. Therefore, this system would operate with a resistance-wire strain-gage as transducer, a capacitance microphone and many other transducers.

Acknowledgments

The writer wishes to express his thanks to J. M. Cage and A. C. Todd for their encouragement, guidance and consideration during his work on this project.

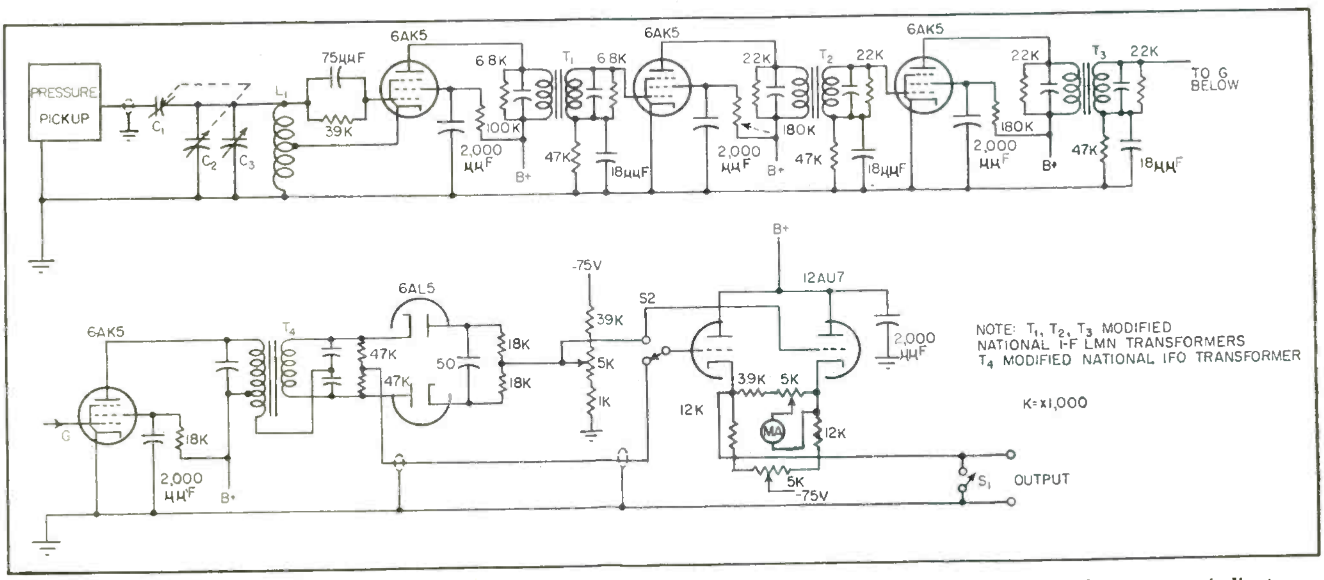
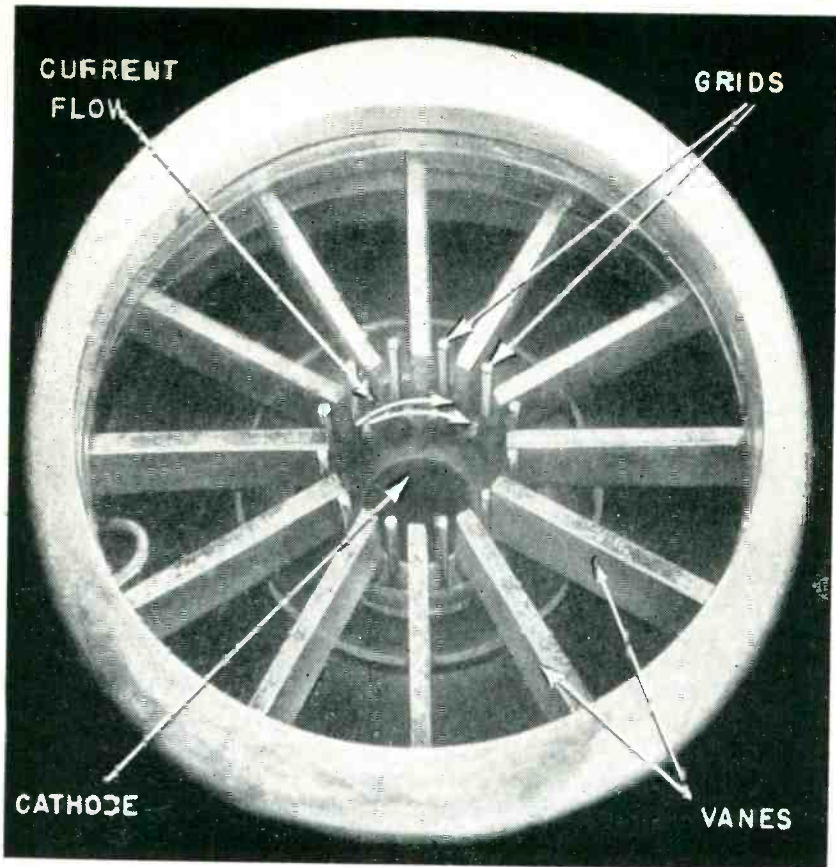
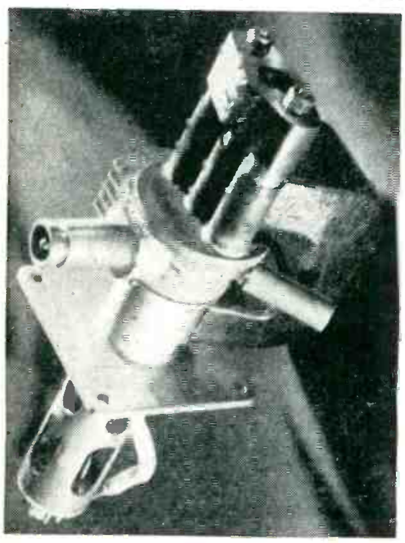
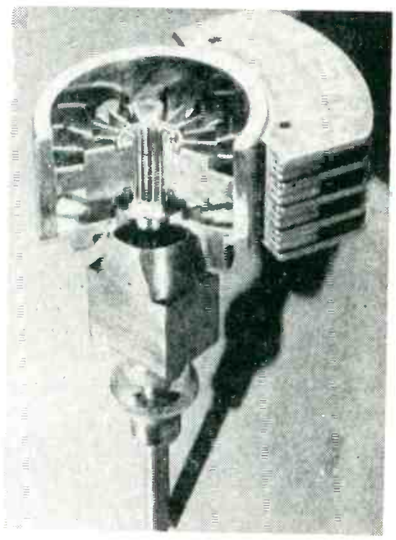


FIG. 2—Circuit diagram of the pickup, oscillator, limiter, detector and cathode-follower drive portions of the pressure indicator

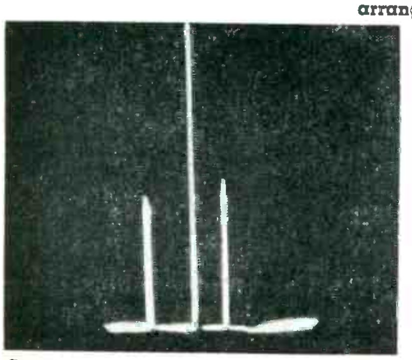


Top view of tube's anode section shows placement of vanes and grids; also tangential beam-current flow near vane tips

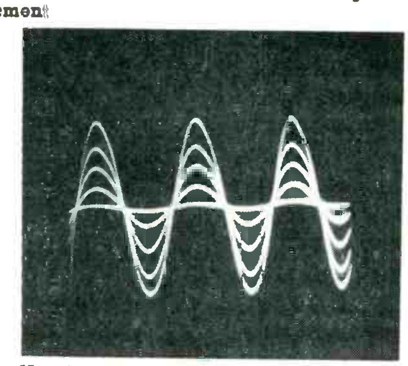




Grid-controlled magnetron: cutaway view of anode section shows vane-and-grid arrangement



Spectrum-analyzer view of magnetron output with one-mc modulation



Varying percentages of 60-cycle grid modulation

P. L. SPENCER

Vice President and Manager
Power Tube Division
Raytheon Manufacturing Co.
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Uses for Grid-Controlled Magnetron Oscillators

PULSED RADAR

By eliminating high-voltage pulsed modulators, the low-power grid-pulsing technique of grid magnetrons opens a new approach to radar design problems

MOVING-TARGET RADAR

Microwave stabilization of the magnetron oscillator by grid-element injection enhances usefulness of Doppler principle while modulation of carrier provides a powerful antijam feature

HIGH-POWER RADAR

Selected and adjustable division of electron flow within an oscillating magnetron can reduce tube-surface erosion and sparking by providing additional heat-dissipation surfaces

TELEVISION RELAY

Video modulation of a subcarrier can provide reliable and inherently stable microwave radio-relay systems

MICROWAVE WIDE-BAND NOISE GENERATORS

Noise modulation of the grid element furnishes test-signal sources for complex bandwidth investigations

ULTRAHIGH-FREQUENCY TELEVISION

Video modulation of high-power grid-controlled magnetrons can provide uhf-tv broadcast service. Required frequency stability can be achieved by grid-element injection

LINEAR-ACCELERATOR RESEARCH

The grid element permits injection and phase locking of an efficient source of microwave energy

RADIO-FREQUENCY HEATING

The grid-control element may be linked to provide automatic load protection for the magnetron during transmission-line variations

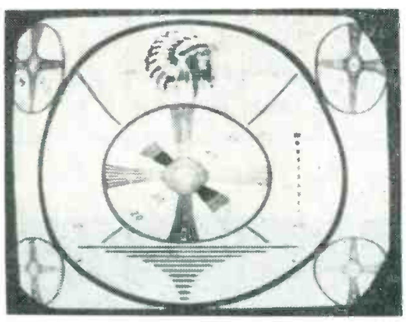
Grid Magnetron Delivers Modulated UHF Output

Control grid placed between vane tips in multiple-cavity magnetron governs power output to load. Microwave carrier can be amplitude modulated with video or other intelligence. Tube may be used for tv relaying, subcarrier telemetering, grid-pulsed and moving-target-seeking radar

MICROWAVE POWER may be generated efficiently by the multiple-cavity magnetron. Its growth in importance since the start of World War II has been tremendous and magnetrons for radar and other applications today constitute a major portion of transmitting-tube production.

Application of the magnetron in the communications and television fields has been limited chiefly by lack of an accurate control element. Problems of inherent frequency instability and lack of simple modulation systems have forced the adoption of lower efficiency devices.

A highly stable three-element magnetron may be constructed by locating control grids near the magnetron's vane tips. Power output, pushing and pulling factors and oscillator starting current can be controlled electronically by this grid. The photograph shows a tunable grid magnetron capable of delivering 50 watts c-w. The tube tunes approximately ±50 mc with the center frequency near 2,350 mc. The vane-and-grid arrangement is visible in the cutaway view of the magnetron's anode section. The grid magnetron has been used in wide-band television applications and video subcarrier service. It has been possible also to lock the magnetron's frequency to an external low-level, crystal-controlled signal. The photograph shows a video-modulated grid magnetron employed in an experimental television relay system.



Television test pattern received from grid-magnetron transmitter

Proposed applications for the grid-controlled multiple-cavity magnetron are found in radar, uhf television, microwave communications, nuclear research and radio-frequency heating.

Grid Operation

Frequency stability, achieved through grid injection, should prove particularly important both in uhf television broadcasting and in sub-carrier multiple-relay service. Frequency stability is also advantageous in Doppler radar.

The low-power grid-pulsing technique used with the grid-controlled magnetron may open a different approach to radar circuit problems by eliminating the need for

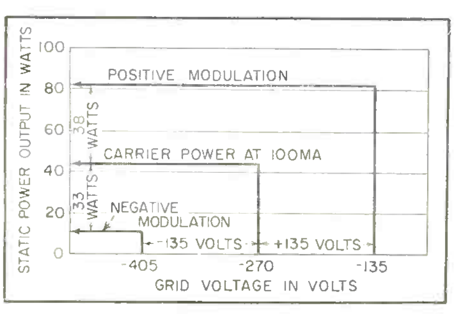


FIG. 1—Magnetron power output versus control-grid voltage

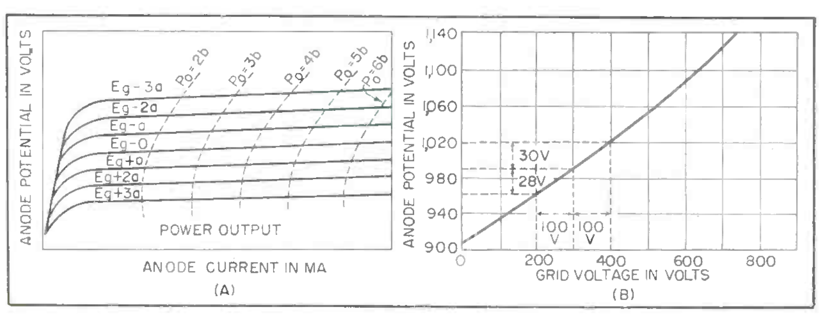


FIG. 2—Plate characteristic and grid-to-plate transfer characteristic for grid-controlled magnetron

high-voltage pulsed modulators.

The grid principle makes use of the fact that grids may be placed between the vanes of a multiple-cavity magnetron in such a way that they are not coupled to the radio-frequency field yet will affect the total anode current.

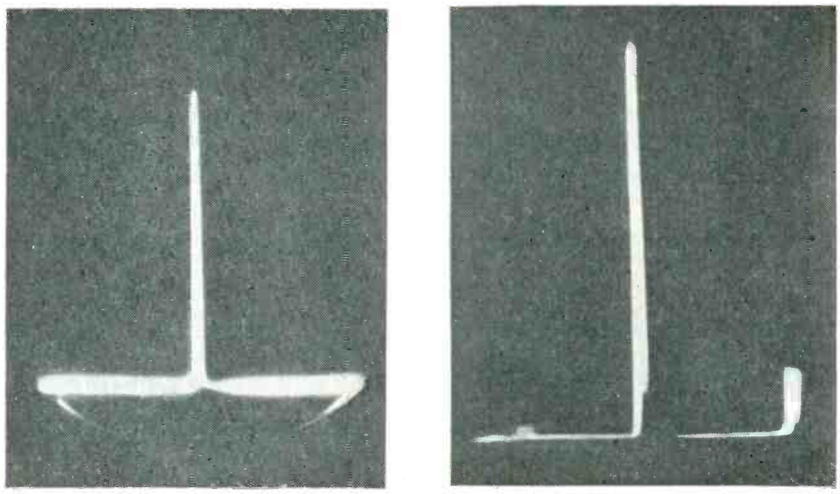
Furthermore, by placing the grids slightly behind the vane tips, the current to the grid may be made substantially zero.

This arrangement is illustrated in the photograph. Also shown is the tangential flow of the electron beam in the neighborhood of the vane tips. Unlike the two-element magnetron, which requires a change in anode voltage to modulate anode current, the grid magnetron may be modulated with constant voltage.

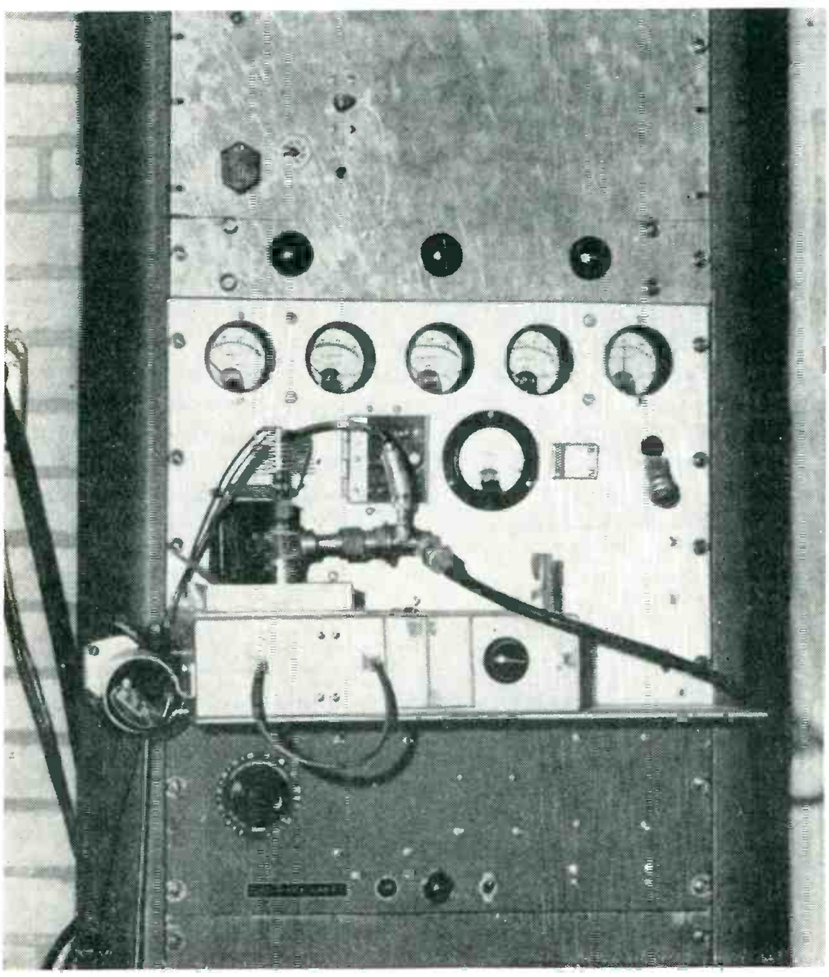
Power Output

Figure 1 illustrates the effect of grid voltage on output power for a grid-modulated magnetron operated with constant anode potential (980 volts) and constant magnetic field. The mean carrier power of approximately 45 watts may swing from 82 to 10 watts with a grid-voltage swing of ± 135 volts. The magnetron's output power is therefore proportional to its grid voltage. Unlike normal amplitude modulation, the r-f output voltage is proportional to the square root of the grid voltage. The waveform on page 148 shows varying percentages of 60-cycle grid modulation. The center line indicates the 50-watt carrier. The signal was recovered from the magnetron's 2,350-mc r-f output using a crystal pickup in a coaxial transmission line.

LOCKING THE GRID-MAGNETRON FREQUENCY



Spectrum-analyzer waveforms illustrate technique for locking magnetron's r-f output to a crystal-controlled signal. Sidebands appear as locking oscillator is turned on two megacycles above the magnetron's unlocked frequency. Waveforms (3) and (4) show



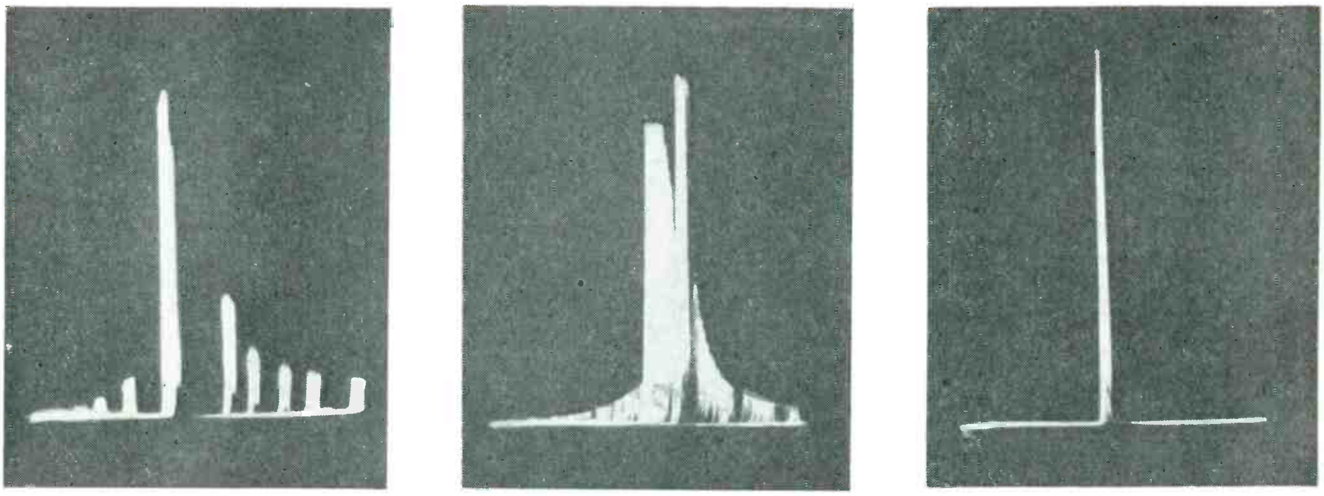
Video-modulated grid magnetron used in experimental television relay

Magnetron Characteristics

The equipment designer is accustomed to the voltage, current and gauss characteristics showing overall magnetron performance. In the case of the grid magnetron, with fixed magnetic field across its interaction space, magnetron performance may be shown by the plate characteristic, Fig. 2A. Here we see the need for maintaining constant anode potential; should the anode power-supply voltage increase when the grid bias is increased a partial cancellation of the modulation will occur. Figure 2B shows the magnetron grid-plate transfer characteristics for a fixed magnetic field and constant anode current.

To maintain constant anode potential and avoid the partial cancellation of modulation that would occur should the anode supply volt-

TO A CRYSTAL-CONTROLLED SIGNAL—



unlocked carrier and sidebands as external signal is tuned continuously, coming closer and closer to unlocked carrier. Finally the grid magnetron's output locks in frequency with the external signal and sidebands disappear

age vary under load, an electronically-regulated power supply is used with the grid magnetron. This circuit maintains constant regulation of its output voltage as the control-grid voltage varies the magnetron anode current in accordance with the modulation.

Other Parameters

Normally, the two-element magnetron, when modulated by varying the anode voltage, delivers a combination of frequency and amplitude modulation and provides substantially a single-sideband output. The spectrum analyzer presentation shows the r-f output of a grid magnetron modulated by a one-mc subcarrier. The two sidebands are relatively equal showing negligible electronic frequency pushing of the magnetron oscillator.

Two problems frequently encountered in multiple-cavity magnetrons are the lack of the ability of the oscillator to start oscillation and its lack of its ability to stay in continuous oscillation at high peak-current values. Both of these problems may be grid controlled. Figure 3A shows the magnetron oscillator starting current as a function of the grid voltage. This characteristic, which previously was considered an inherent mechanical design parameter, now becomes an electrical function.

Normally the moding problem, or

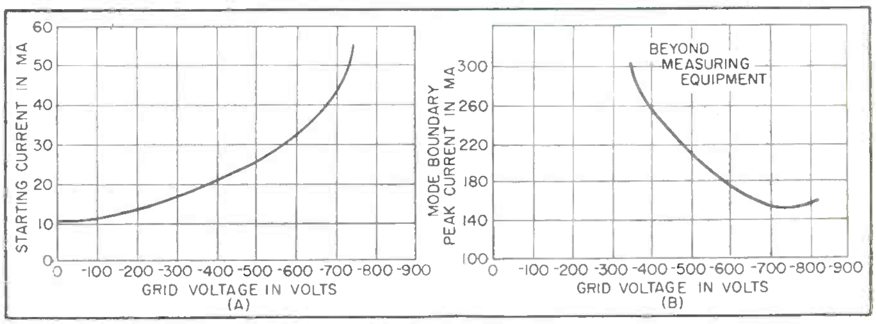


FIG. 3—Oscillator starting current and mode-boundary current versus magnetron grid voltage

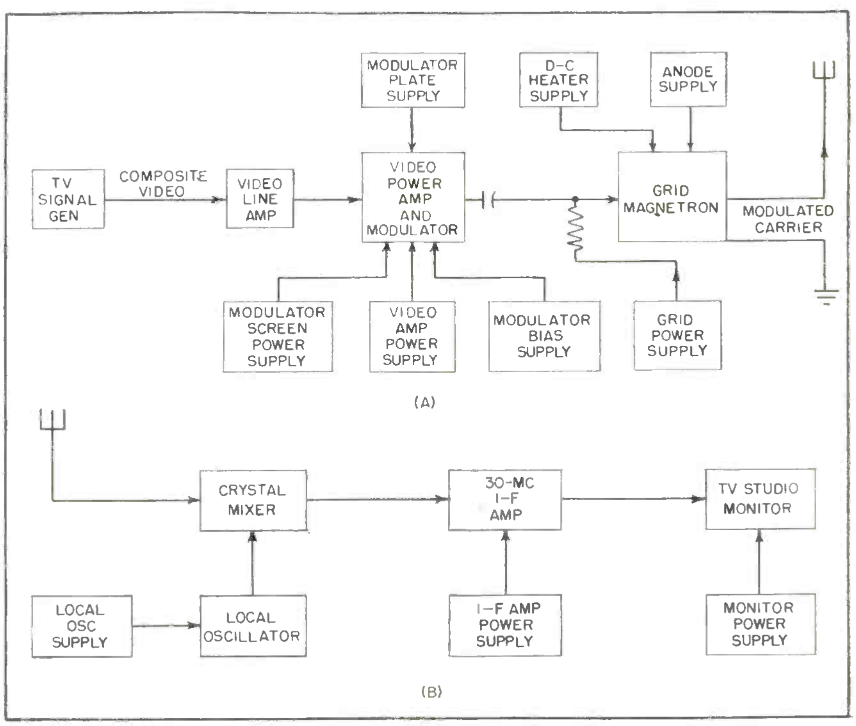


FIG. 4—Grid-magnetron video transmitter and microwave receiver used in television transmission test

the inability of the magnetron to deliver high peak currents, is a troublesome problem in the field. In the case of the grid-controlled magnetron, the mode boundary of the oscillator is increased as we decrease the bias. This tends to alleviate the moding problem. Figure 3B shows the typical curve of mode-boundary peak current versus negative grid voltage for fixed magnetic field. Observations were made using 60-cycle modulation.

Video Modulation

The grid provides an excellent means of injecting video modulation on a microwave magnetron. Tests have been conducted using the microwave transmitter and receiver shown in the black diagram, Fig. 4. Television transmission of a standard video pattern has been accomplished. The results of actual over-the-air tests can be seen in the photograph of the received pattern.

The 50-watt grid magnetron was modulated with a 200-volt peak-to-peak video signal of 4.5-mc bandwidth. Figure 5 illustrates schematically the 4-250 modulator shown in the photograph.

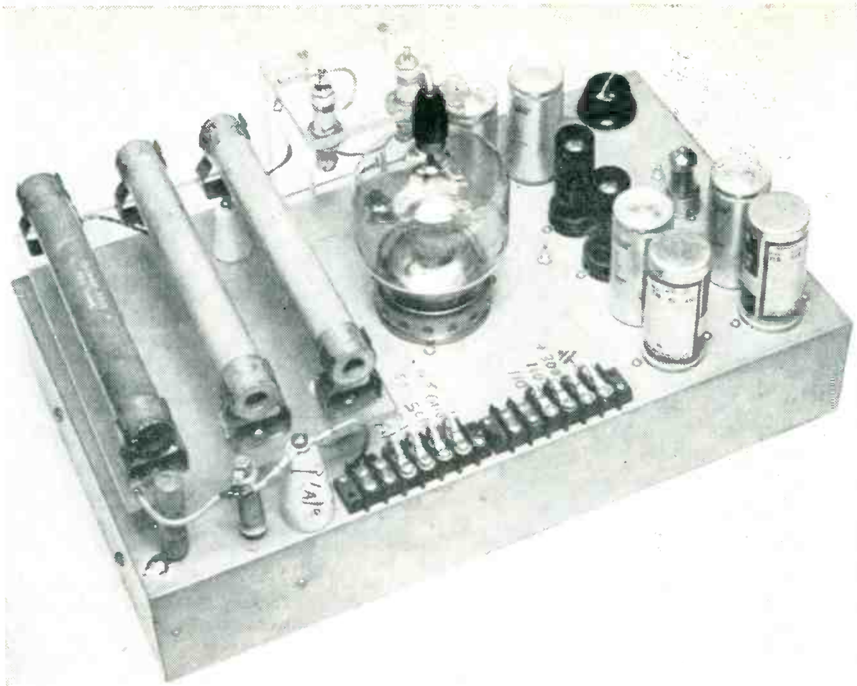
The receiver consists of a standard crystal mixer, klystron local oscillator, a 30-mc i-f strip with a standard television second detector feeding a studio-type monitor.

The operating conditions of the grid magnetron and of the receiver are listed below:

- Magnetron Grid Modulation Voltage .... 200 volts p-p
- Magnetron Grid Bias .... 270 volts
- Magnetron Grid Current .... 2.5 ma
- Magnetron Anode Voltage .... 975 volts
- Magnetron Anode Current .... 65 ma
- Receiver Crystal Mixer Current ..... 0.4 ma

Subcarrier Modulation

Tests have been conducted to investigate use of the grid magnetron subcarrier relay systems. Preliminary results indicate that subcarrier modulation is feasible, but that the subcarrier frequency is limited by the Q of the magnetron reso-



Video modulator for grid magnetron uses 4-250A pentode

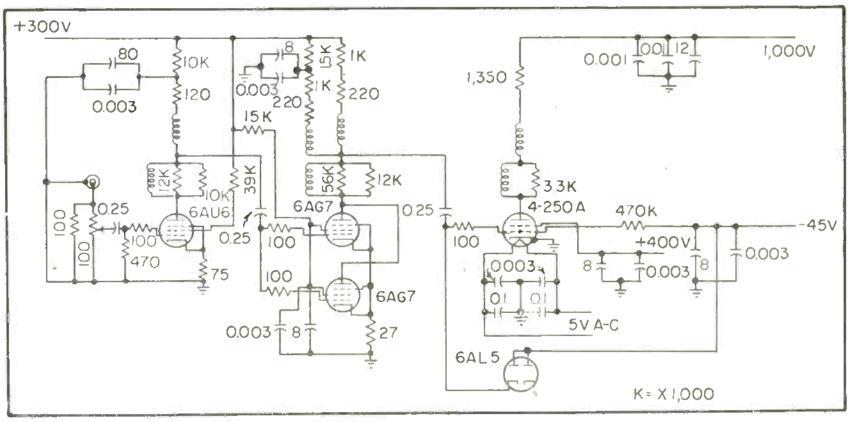


FIG. 5—Schematic of video amplifier and modulator. Modulator uses a type 4-250A pentode and delivers a 200-volt peak-to-peak video signal of 4.5-mc bandwidth to the magnetron grid

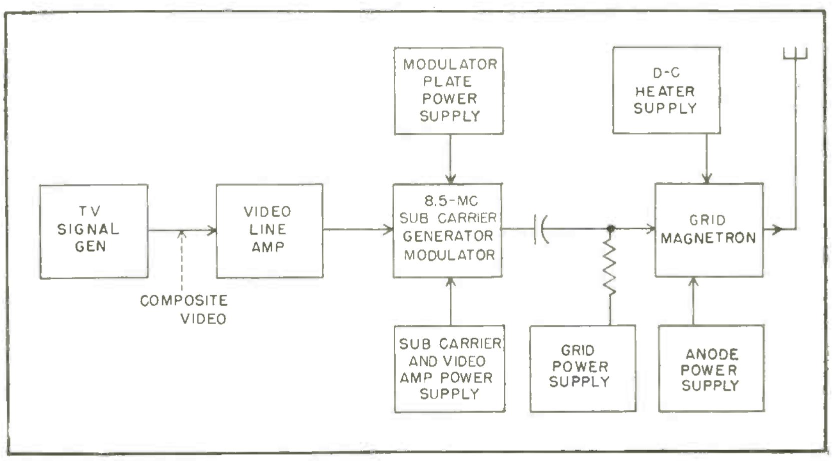
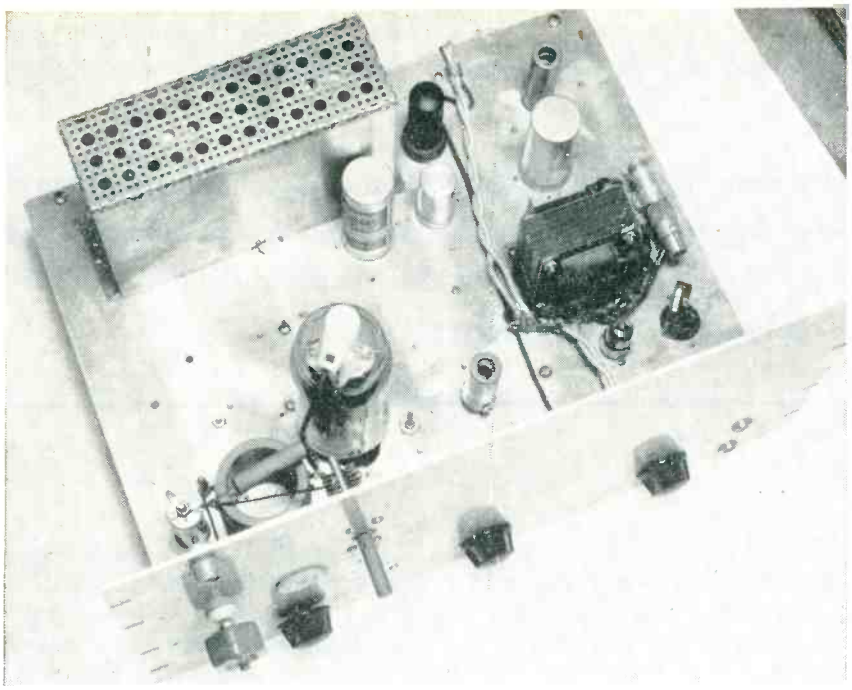


FIG. 6—Subcarrier modulation system using grid magnetron



Type RK28A subcarrier final is suppressor modulated by video signal

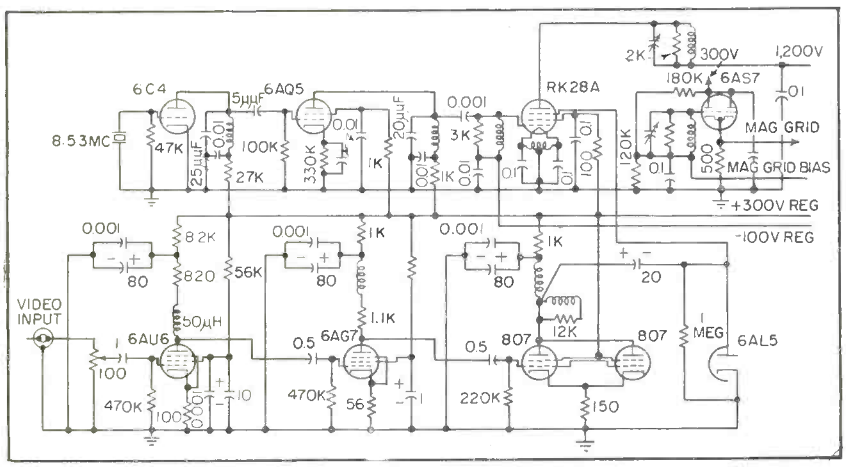


FIG. 7—Frequency generator, video amplifier and modulator for subcarrier system. Amplified composite video is applied to suppressor grid of RK28A pentode. Magnetron grid drive is taken off cathode follower

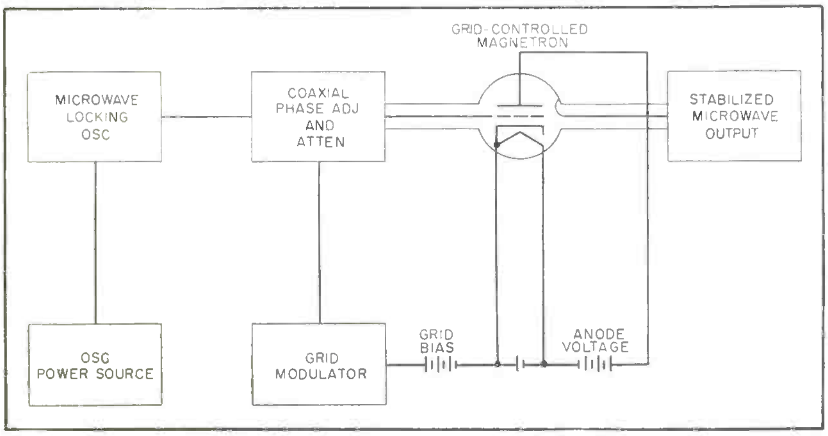


FIG. 8—Frequency-stabilization system for grid-controlled magnetron

nator. Special grid-control magnetrons suitable for 30-mc subcarrier service may be designed at the higher frequencies.

Subcarrier modulation of the microwave carrier may be accomplished as shown in the block diagram, Fig. 6. Figure 7 shows the subcarrier generator and modulator schematically. The subcarrier frequency is furnished by an 8.53-mc Pierce oscillator, amplified by a single 6AQ5 and impressed on the control grid of an RK28A pentode. The amplified composite video signal from a television signal generator is injected at the RK28A's suppressor grid. The modulated subcarrier signal is then taken off a cathode follower consisting of both sections of a 6AS7 dual triode and applied to the magnetron control grid.

Microwave Stabilization

The injection of microwave frequencies into the magnetron by means of the control grid have shown promising results. Through the use of the system shown in Fig. 8 the grid-controlled magnetron may be locked to an external microwave signal thus allowing crystal control of the microwave frequency. The oscilloscope photographs show the sequence of locking the grid magnetron.

As the external signal approaches the frequency for which lock-in is possible, the grid magnetron is pulled toward the external signal, and at the same time side bands are built up separated from the grid magnetron's frequency by the integral multiples of frequency separations between them.

The sidebands increase in amplitude as the external signal becomes closer to locking the grid magnetron. Finally the lock-in occurs. The sidebands disappear. The grid magnetron operates at the same frequency as the external signal.

Under these conditions the magnetron, which normally would pull 5 megacycles with a 1.5 vswr, remains at a constant frequency throughout all phases of the 1.5 vswr; and in effect, the results indicate a magnetron with zero pulling factor for a given transmission line mismatch.

A Signal-Seeking

Tuning mechanism scans broadcast band at 200 kc per second and stops within a kilocycle of the next usable signal in sequence. Action depends upon second-detector trigger circuit to actuate solenoid that cocks spring motor. Device has been used experimentally to tune a turret-type television receiver

SINCE commercial broadcasting first put radio receivers into the hands of nontechnical persons, there has been a natural trend toward designing such equipment for ever-increased simplicity of tuning. The signal-seeking tuner discussed here is such a device, which may have application in television.

On signal from the operator, it scans the frequency spectrum and stops when it encounters a signal. Every signal in the spectrum may be tuned in simply by pushing a switch with the finger or foot each time a new station is desired. It is not necessary to stop on all signals. If the gain of the receiver is reduced during the tuning cycle to a preset level, the tuner will stop only on strong local stations. When the button is held down, the tuner will pass over signals until the button is released. This type of tuner is particularly useful on a high-speed automobile trip during which local signals may fade down to unusable values within an hour.

General Design Problem

In designing a tuner of this type, any good engineer will think of a multiplicity of solutions. To the author's knowledge, a set such as that described here is the first commercially produced signal-seeking receiver that will automatically tune all stations strong enough to have entertainment value.

Because of the electromechanical nature of the device, calculations of the operation are especially difficult. There are numerous mechanical operations in which the operating time is an unknown function of manufacturing tolerances, lubrication and age. For this reason, the approach has been to obtain a design that will tune with an indexing accuracy independent of these factors. Any calculations are aimed only at insuring that the speeds of the mechanical operations are high enough to be neglected in the overall result.

It is apparent that if a superheterodyne receiver is used, the proper tuner indexing is indicated by the proper intermediate frequency appearing at the second detector. The tuner stopping signal, then, may be obtained from some frequency-discriminating device located in the intermediate-frequency circuits. This leads to the consideration of beat-frequency oscillators, discriminator circuits such as those used for f-m demodulation or extremely sharp filters as provided by multiple-tuned circuits or piezoelectric crystals.

Such systems and probably others can all be made to work, but examination of the possible approaches indicated that the complexity, cost, performance and reliability problems were best met for the auto radio application by a simpler resonance indicating circuit. The circuit devised for this purpose uses only a few more second detector components than are already present in commercial receivers. The final controlling or trigger circuit is most easily made to be voltage-operated and this resonance indicating circuit will provide a trigger voltage of several volts just ahead of the in-tune point of the receiver.

All practical mechanisms require an appreciable time to operate so that this circuit is designed to give the stopping signal just far enough ahead of the stopping point to allow for coast. If the mechanism is made to operate faster, the stopping signal can be given closer to resonance or the electrical approach speed can be increased.

Auto Radio Design

While the electrical triggering voltage can be designed and held to close tolerances on frequency discrimination and time lags, the electromechanical system is inherently slower in operation and subject to more uncontrollable tolerances.

For this case, it is desired to design for a tuning accuracy within ±2 kc. The tolerance was determined empirically and was chosen at a value that would allow detuning just observable by a trained listener. Most people tune their radios less accurately and attempts to hold a closer tolerance involve the designer in the definition of resonance. Variations between the maximum output frequency, the minimum-noise frequency and the frequency halfway between the two-times-down selectivity point will vary in a commercial 260-kc i-f amplifier about ±1.5 kc.

A good deal of field testing has shown that if a signal-seeking broadcast receiver takes more than 7 seconds to traverse the band, the user definitely gets the impression of sluggishness and 4.5 to 5 seconds is more acceptable. If the tuning mechanism has a speed-regulating device that limits the maximum

Automobile Receiver

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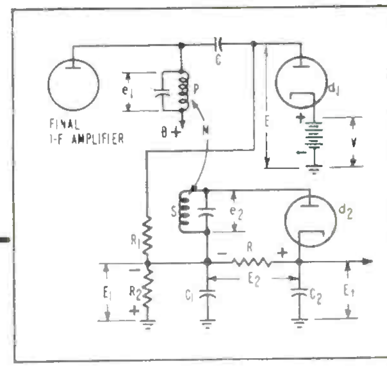

FIG. 1—Trigger voltage circuit

tuning speed to one covering the broadcast band in 5 seconds, there results a maximum electrical speed of 200 kc per second with a straight-line-frequency tuner. The speed at which a signal is approached may be much less than this, as in tuning from one channel to the adjacent channel, since this close spacing does not allow the tuner much time to accelerate.

To take care of all possible approach speeds the tuner must stop accurately with tuning speeds between 200 kc per sec and something around 10 percent of this figure. This requirement can be met by designing the tuner to stop very quickly and by giving the stopping signal close to resonance. In other words, the wide variation in approach speed requires the tuning system to perform all of its stopping-cycle functions during a period less than the minimum interval of passage through the specified tolerance. At maximum speed of 200 kc per sec the time required to pass through the ±2 kc is 20 milliseconds. Inasmuch as many other factors affect the tuning, such as varying supply voltage, mechanical tolerances on stopping time and slight change of circuit tuning with age, temperature or humidity, 10 milliseconds was tentatively established as a target for performing and stopping functions. This time must include all electrical lags and mechanical coast as well as backlash in the tuner.

Electrical Triggering Circuit

From this discussion, it can be seen that the electrical frequency distinguishing circuit must operate some mechanical device, usually a relay, between stop and go positions with a frequency change of 2 kc or less. The d-c voltage developed by the signal across the second detector diode load is an attractive source of triggering voltage because of its availability. This voltage is, however, subject to serious limitations. If only reasonably strong signals are to be indexed, this arrangement can be made to work acceptably. The chief problem here is that the curve of diode load voltage versus frequency varies in amplitude widely with signal strength.

Good avc systems can minimize this effect, but at the tuning speed discussed above, the avc system does not have time to operate as the station is tuned in, resulting in a decided tendency to stop prematurely on local stations. Commercial receivers built on this principle operated acceptably if the tuner was not expected to stop on signals weaker than about 20 μv at the antenna terminals, although there are many signals of entertainment quality providing only 1 to 5 microvolts to the receiver input.

The circuit of Fig. 1 avoids the limitations of operation from the second detector voltage by providing a triggering voltage with an amplitude and selectivity curve reasonably independent of input signal or avc action. Its operation is as follows: Let e_1 be the peak a-c voltage across the primary of the i-f transformer and let E be the d-c rectified voltage across R_1 and R_2 in series. The voltage E is pro-

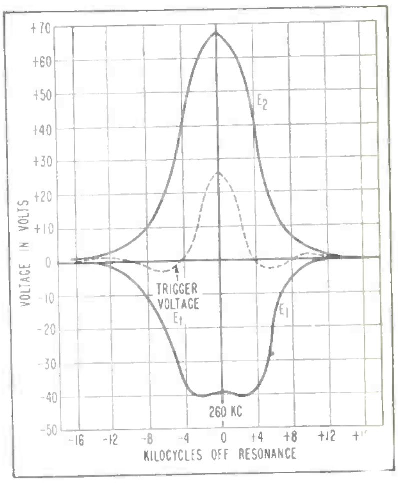

FIG. 2—Selectivity voltage of Fig. 1 circuit

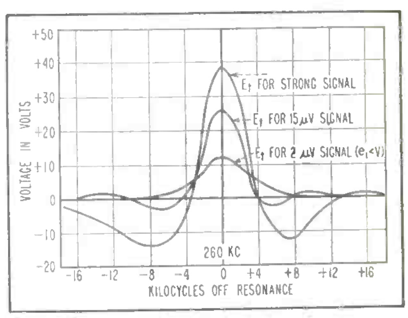

FIG. 3—Selectivity curves for the circuit described in text

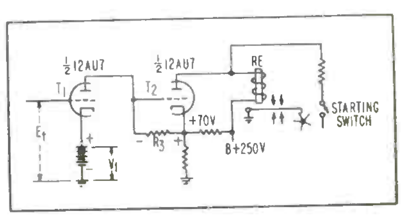

FIG. 4—Trigger circuit that actuates fly fan

vided by the operation of diode d_1 which has a voltage delay V. Voltage e_2 is the peak a-c voltage across the secondary and develops a d-c voltage of E_2 across the diode load resistor R.

If $K = \frac{e_2}{e_1}$

when K is the voltage ratio of the i-f transformer and R_2 and R_1 are adjusted so that

$$K = \frac{R_2}{R_1 + R_2}$$

then, assuming peak rectification, the following relations will hold when $e_1 > V$

$E = e_1 - V$

$E_1 = KE$

$\quad = K(e_1 - V)$

and

$E_2 = Ke_1$

The trigger voltage E_t is the algebraic sum of E_1 and E_2 and is

$E_t = E_2 - E_1.$

$\quad = Ke_1 - K(e_1 - V) = KV \quad (1)$

The interesting point in connection with this expression is that E_t is independent of signal strength e_1 and thus independent of such things as avc action, tuning speed, moderate modulation and overload of the i-f tube. This analysis does not involve the frequency discriminating feature of the circuit. The graph in Fig. 2 shows the various voltages as a function of frequency. It can be seen that to produce a sharp positive trigger voltage E_t, there must be a broader response curve for the voltage e_1 as compared to that for e_2.

A surprisingly low selectivity differential will produce a selectivity of E that is entirely satisfactory. Good quality i-f transformers give acceptable selectivity differential between primary and secondary. No special shaping reactances need be used.

The curves are for a transformer adjusted for slightly less than critical coupling. This is standard practice in auto radio use and gives a good compromise between a broad nose and sharp skirt selectivity. The double-peaked primary resonance curve is typical of double-tuned coils near critical coupling and the circuits are easily aligned in production and in the field without the use of oscilloscopes and sweep oscillators.

The voltage ratio in this permeability-tuned i-f transformer is determined by the fixed tuning capacitors, the load resistors and the mutual reactance including both inductive and stray-capacitance coupling. To insure that each transformer will meet the requirement of Eq. 1, the critical components are purchased to close tolerances, assembled in the can and the mutual coupling adjusted after assembly, through the slot in the can, by moving the tertiary winding slightly and cementing it in place. This coupling adjustment compensates for slight variations in stray coupling and component tolerance.

The coupling is quite critical. In some receivers the diodes d_1 and d_2 are best contained in one envelope and in others they are separate tubes. Two different tolerance ranges are used on tertiary adjustment owing to the small differences thus introduced in external capacitive coupling. Fortunately, the two tolerances overlap sufficiently so that only one service part is required.

In practice, the standard minimum limit coupling is set so E_t rises slightly as e_1 increases. This is to avoid any possibility of the tuner skipping strong stations because of some slight changes in the adjustment with time or use that would cause the peak trigger voltage to be lower on strong signals than on weak or medium-strength inputs. Selectivity curves of trigger voltage at various inputs are shown in Fig. 3 for a representative production receiver. In the commercial version, a voltage step-down ratio is used in the transformer chiefly to accommodate a desirable low value of diode load R across which the audio signal is developed when the tuner is stopped.

Electromechanical Coupling

Having provided a stopping signal voltage E that satisfies requirements, there remains the electromechanical coupling problem. A separate double triode is used in a circuit similar to that used in the qavc circuits popular in the early 1930's, except that a relay coil, shown in Fig. 4, is placed in the plate circuit of the second direct-coupled triode instead of the usual audio coupling impedance.

Experience with this circuit showed that the relay RE could be held down by plate current of T_2 until positive input voltage of a volt or two less than V_1 was impressed on the grid of T_1 which then started to conduct plate current through R_3, biased off T_2 and thus released the relay armature. If a small residual gap is placed between the armature and pole piece of the relay RE, it can be expected to drop out reliably about 4 milliseconds after sufficient triggering voltage is applied. Assuming the tuner can be stopped with only 1 kc or 5 milliseconds backlash and coast, and allowing no electrical lag, total stopping time adds up to about 9 milliseconds, which is uncomfortably close to the 10 milliseconds set as a target.

Mechanical Tuning System

Since we have used all of the allowable time to open the relay, the relay itself must perform the mechanical function of stopping the tuner. A low-mass, fast-accelerating, relay-indexed tuner mechanism that satisfies the requirements was developed, the elements of which are shown in Fig. 5. In the interest of clarity, a number of parts have been omitted.

The core bar that mounts the movable tuning cores is spring-loaded by a motor spring. This spring force is transmitted through the three-gear and pinion assemblies to the fly fan. The fan is a light-weight molded-nylon part with five vanes normally prevented from rotating by an interfering arm on the controlling relay armature. When the relay is energized by pushing a button, the tuning sequence is started by the removal of the relay arm. The gear ratio is designed so one blade of the fly fan passes the relay arm for every kilocycle of core bar travel.

Air resistance of the fly fan varies as the square of the speed. The tuner is designed to have frictional losses well below the energy of the spring so most of this energy is absorbed by the fly fan. By this means, the maximum tuner speed is held constant even though frictional forces in the mechanism vary

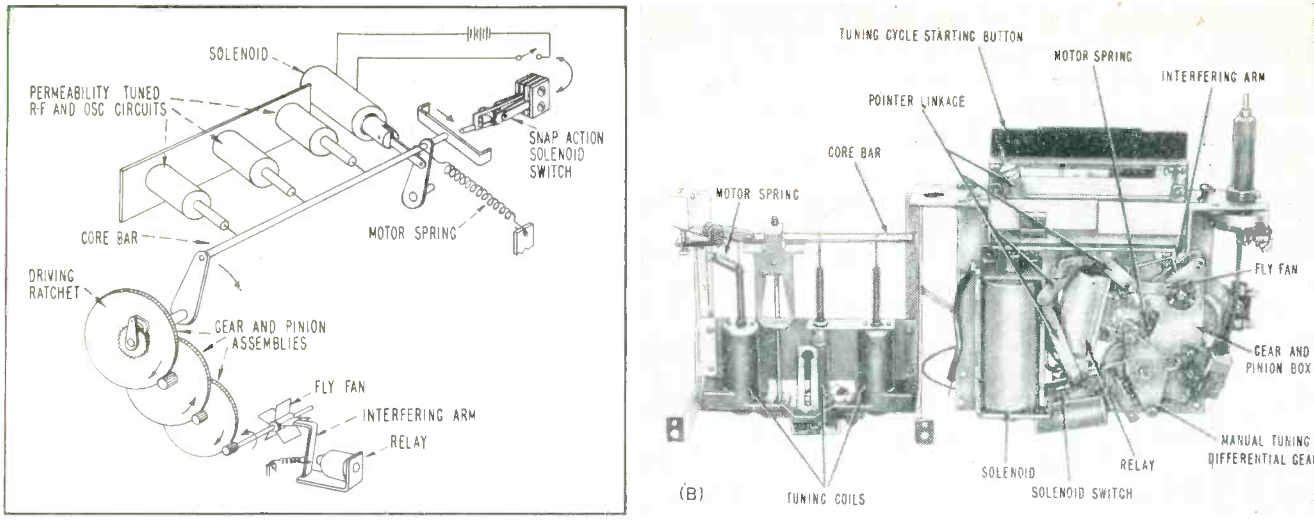

FIG. 5—Simplified tuning mechanism (left) and side view (right) of actual mechanism used in Oldsmobile car radio

widely with bearing fits, dirt, lubrication and age.

When the core bar comes to the end of its travel, the switch S is thrown to energize the solenoid. The cores are returned to the other end of the band through the ratchet drive, the solenoid shuts off and the tuner cycle is repeated. If a station is encountered, the relay quickly drops out, the fly fan is stopped at the next paddle wheel, not more than 1 kilocycle away, and the station is accurately indexed. There is no appreciable backlash in the gearing and close tolerance on the gears is not required, since most of the spring load is transmitted through the entire chain whether the tuner is in motion or stopped.

Overall Performance

In Fig. 3, the trigger voltages were shown to have some variation in amplitude and selectivity with different input levels. For this reason the tuning accuracy of the complete mechanism is, to some extent, a function of input signal. A representative accuracy curve is shown in Fig. 6. Shown are the boundary curves of the stopping points obtained by approaching signals of various strengths at 200 kc per second speed. Distance between the two curves is caused by the fact that the tuner can stop only at discrete intervals.

It will be noted that at low signal strengths, where the triggering voltage drops ($e_1 < V$) the tuner tends to index past the signal and as the input is increased to 8 or 10 microvolts, the tuner stops a bit prematurely. At higher input, the receiver may index on either side of resonance, but within $\pm$ .2 kc depending on such things as the battery supply voltage, frequency of the received signal, frequency and percentage of modulation and circuit detuning produced by whatever avc voltage appears during the stopping cycle. All these are second-order corrections, however, and the indexing is entirely satisfactory.

Relay Functions

For good operation of the system, it is desirable to perform a number of electrical switching functions with the relay. The problem here is straightforward and consists chiefly of devising more or less ingenious methods of performing the following operations with the minimum number of relay contacts.

(1) The audio circuits are squelched for quiet operation during tuning.

(2) A front panel sensitivity control is connected into the circuit during the tuning cycle so that if only strong stations are desired, the gain of the set will be automatically switched to a lower value during the search period.

(3) The trigger tube is disabled when the tuner is stopped. This avoids the embarrassment of the tuner starting to hunt a new station when the signal momentarily disappears, as might happen when the car is driven through a tunnel or over a steel bridge.

(4) The triggering circuit is switched so the same second detector elements are used for providing the triggering voltage when tuning and for modulation detection when indexed on a signal.

(5) The output tubes are biased off during the tuning cycle so the extra current drawn by the relay tube will not overload the vibrator power supply.

(6) An interlock arrangement is provided so the tuner solenoid cannot cock the mechanism when the set is tuned manually to the high-frequency end of the dial.

(7) The set gain is reduced practically to zero while the solenoid is cocking the tuner to prevent stopping on the solenoid back stroke.

Noise Rejection

Signal-seeking auto receivers are designed to stop on all signals producing at least a field strength of 15 μv per meter at a typical auto radio antenna. It has been found in many instances that the random electrical noise level found along streets and highways greatly exceeds this figure. Unless some precautions are taken in designing equipment, the tuner will sometimes recognize these interferences as signals and stop immediately when the tuning button is released, regardless of whether a station is in tune or not.

The tuner was made to ignore random noise. The principle employed was based on the fact that random noise, in most instances, has an envelope of low form factor. In other words, the peak voltage is much higher than the average voltage. This envelope contains frequencies up to the bandwidth of the i-f amplifier and if the higher frequencies are not predominant, they are at least present in large proportion.

Noise Discriminator

By making the time constant of the rectifying circuit C, R_2, R_1 and d_1 (Fig. 1) long compared to the period of the top bandpass frequency of 5,000 to 10,000 cycles the d-c voltage E can be made nearly the peak of e_1 when high noise voltages are present. If, at the same time, the time constant of the secondary circuit consisting of R and C_1 and C_2 in series is made fast compared to the minimum noise modulation interval, the voltage developed by d_2 across R will be appreciably below the peak noise voltage and the balance represented by Eq. 1 will be upset.

There will be an inordinate amount of negative voltage fed into the trigger voltage circuit and E_t will never reach the positive value required to stop the tuner. The frequency difference between the top noise envelope frequency and the intermediate frequency of 260 kc is sufficiently large to permit the use of these R-C filters to distinguish between the two and give peak rectification at 262 kc and poor efficiency at 10,000 cycles.

Noise-Peak Clipper

When the noise signal is too low to produce rectification in the biased diode d_1 the average trigger voltage is kept low by the use of a large capacitor at C_2 which clips off the noise peaks and produces a low average positive value at E_t. The mechanical lag in the relay also assists this discrimination.

The resultant tuner will not stop on noise produced by an electric razor held near the antenna. In high ambient noise as found near some power substations, the tuner will not stop on very weak signals, but will stop on signals that are unintelligible and sometimes unrecognizable in the noise. This can be checked by driving out of the noise area after the tuner has stopped. The station is found to be accurately tuned.

It is apparent that by reversing the decay times of the two circuits, the tuner can be made to index on signals of predetermined low form factor such as repetitive pulses and to reject sine-wave signals.

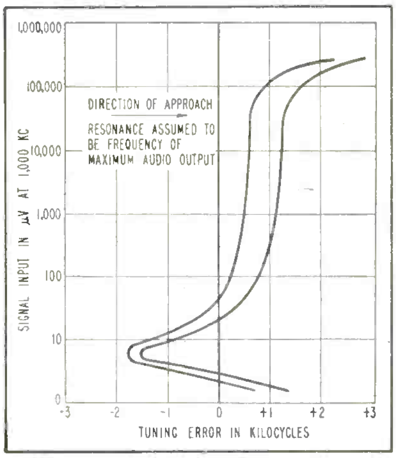

FIG. 6—Accuracy of tuning by automatic selector is described in text

Other Applications

Empirical rules that should lead to a successful design for other applications include the following.

(1) Mechanical stopping time of the tuner, including all tolerances, must be smaller than the time taken by the drive mechanism to tune through the allowable indexing error.

(2) The frequency-selective circuit must provide a definite signal sufficient to operate the electromechanical device with less frequency change than the allowable indexing error.

(3) All speeds and stopping-time intervals should be as repeatable as possible.

(4) If the tuner is to index on weak signals, some random noise protection should be provided.

These principles can be applied to a variety of similar applications. In one case, the tuner was successfully used on laboratory model tv receivers. If continuous tuning is to be used, two problems present themselves. One is the large percentage of the spectrum that contains no carriers. If the tuner does not stop in an extremely short time, the tuning speed must be made so low as to give a decided impression of sluggishness. The second problem is that there are two carriers associated with each television station and the tuner should index only on one.

Variable-Speed Drive

The first problem can be solved by using a variable-speed drive that quickly covers the spectrum between carriers and slows down in the vicinity of the carrier. One solution to the second problem is to design for indexing on the sound carrier, employ a noise-discriminating circuit such as described above, and design it to recognize the horizontal sync pulses as noise and thus reject the video carrier.

A satisfactory solution for a vhf turret-type television receiver was obtained by using a quick-declutching a-c motor to drive the vernier control directly and operate the band-channel switch through a Geneva drive. The electrical tuning speed of the vernier was so low that the limiting factor in determining the scanning speed was the ability of the motor to drive the Geneva motion.

This result was obtained despite the fact that the declutching time of the motor was as high as 20 milliseconds. This tuner, with a minimum of parts, indexed accurately enough to permit use of a separate audio, i-f amplifier and discriminator in the receiver. It was more than adequate for an intercarrier sound receiver type of television.

The reliability and performance of any system is determined to a great extent by the care and thought given to details of the design. For the auto radio shown, reliable operation and accurate indexing has been experienced in the field.

CdS Detector Checks Propeller Thickness

Minute x-ray sensitive crystal is drawn through spinning prop blade and picks up externally-produced x-rays in an amount proportional to thickness of blade. Comparison of absorption with standard yields highly accurate measurements

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CADMIUM-SULFIDE x-ray detectors have been applied to a number of interesting industrial applications, including detection of flaws or voids[1] and height of fill[2] in canned and packaged products, and in certain other types of industrial gaging[3].

The equipment described here is now being used as a production tool to measure the wall thickness of long slender airplane propeller blades varying in thickness from 0.070 to 0.500 inch. A complete survey of the wall thickness of each propeller blade is made before costly machining operations are begun, with a resulting saving in overall cost of fabrication.

Blades are held and manipulated by the lathe carriage illustrated in Fig. 1. The tiny CdS detector is drawn through the spinning blade in a fashion that allows the thickness of the entire surface to be measured. Figure 2 is a block diagram showing the physical setup and equipment used.

Previously gaging was done with a pair of 18-foot mechanical calipers and required approximately eight hours to complete. By scanning the blade continuously while recording deviation meter readings, a more complete and much faster survey is possible. Accuracy of gaging is within ±2.5 percent over the entire range of 0.070 to 0.500 inch with an accuracy within 0.5 percent over the range of each step. Due to the bridge-type circuitry long-term drift is less than 0.5 percent per hour.

CdS Crystals

Cadmium-sulphide crystals are sensitive to both light and x-rays. Maximum sensitivity is through the green portion of the spectrum and falls off rapidly toward the reds. As an x-ray detector, these crystals are best used with x-ray generators of 500 kv peak or less but may be used with higher kilovoltage generators with reduced sensitivity.

When subjected to radiation, the electrical resistance of these crystals varies inversely as the intensity of radiation. The usual method of instrumentation is to place a resistance in series with the detector and to apply a d-c voltage of 300 volts or less to the series combination, as shown in Fig. 3A. Figure 3B shows the response characteristics of the detectors when radiation is applied suddenly. Response times of several seconds

This article is based on a paper delivered at the 1952 National Electronics Conference. The conference paper appears in the *NEC Proceedings*.

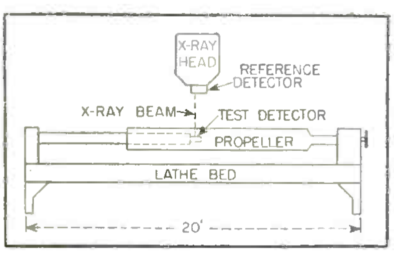
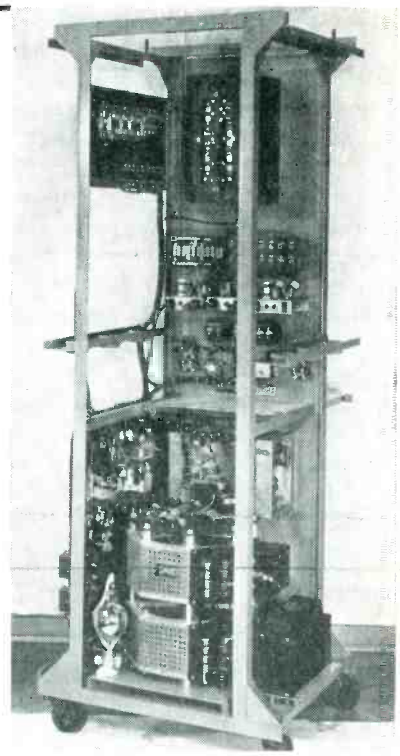
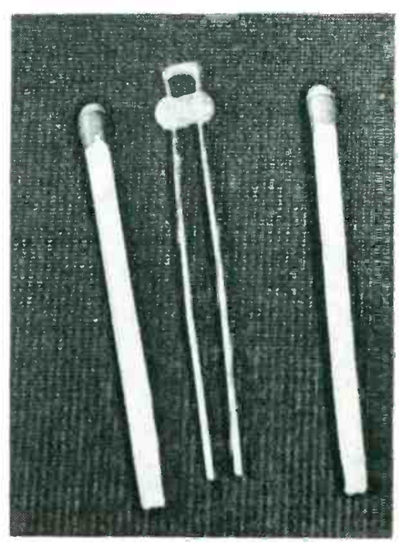


FIG. 1—Cadmium sulphide detector is drawn through spinning propeller



All equipment is contained in rack, including x-ray high-voltage supply



Comparison of CdS detector with ordinary match shows small size

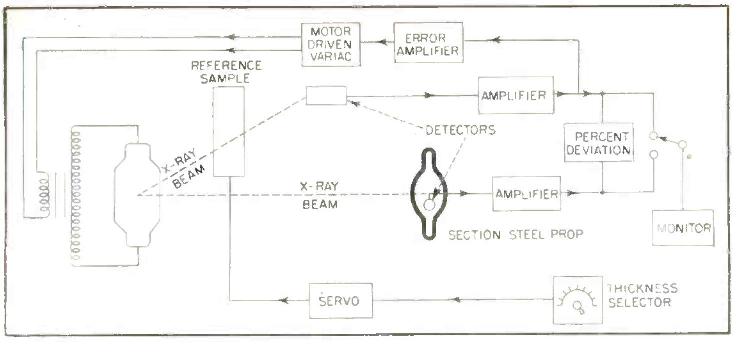


FIG. 2—Block diagram shows arrangement of system components for comparison measurements

are typical. By applying pulses of radiation, as produced by self-rectifying x-ray generators, an alternating component is present as illustrated in Fig. 3B. This component may be coupled with an R-C network into a simple two-stage amplifier to give 60 or more volts ouput.

Cadmium sulphide has several important advantages over the other x-ray detectors. Its low impedance lowers voltage requirements and allows the use of long connecting cables without pre-amplification. Small size and apparently unlimited life are further advantages. A disadvantage of the detector is its dependency upon its immediate past radiation history.

Comparison System

The principle of the gage is illustrated in Fig. 2. Such a system may be used with constant-density material for thickness measurements or with constant thickness material for density measurements.

Two finely collimated beams from one x-ray generator impinge upon the detectors. In the x-ray path, before one of the detectors, is placed the material being gaged. In the x-ray path of the other detector, is placed a sample of material with known thickness or density, depending upon whether the thickness or density is being gaged. Comparing the detector outputs with a bridge-type metering circuit, an unbalance of the outputs indicates the direction and degree of difference between the known sample and the material being gaged. Line voltage fluctuations and detector drift are balanced out in the comparator-type circuit.

For comparator-type measurements, the detectors themselves must match or track both in sensitivity and wavelength characteristics. Tracking may be effected not only by the characteristics of the detectors themselves but also by differences in generator-detector distances, detector housing windows, and even the plastic coating on the detectors.

Matching Detectors

Due to the extreme sensitivity of CdS crystals to structural and compositional variations, it is not practical to pick two perfectly matched detectors, so a method of artificial matching is used. Starting with two detectors fairly closely matched (Fig. 4A), both sensitivity and wavelength characteristics must be corrected. Sensitivity may be varied by varying the voltage applied to the crystal. If the wavelength is held constant and the voltage applied to one crystal adjusted until the detector outputs match (Fig. 4B), the match only holds at one wavelength.

Since the x-ray path is always through the reference sample, the wavelength response of the reference detector is dependent upon the absorption characteristics of the sample. By adding to or subtracting from the thickness of the sample, the output response of the detector will be shifted along the wavelength axis (Fig. 5) and, along with the sensitivity adjustment, a match can be achieved.

Since the output of the detectors depends upon the absorption curve of the materials being gaged, percentage variations in thickness are indicated by linear divisions on the meter scale. Meter indication becomes nonlinear with material thickness differing by more than 20 percent. Therefore, full scale reading of the gage metering circuit is limited to a maximum of ±20 percent. However, the gage may be used to measure any thickness by changing the reference sample as needed so that the refer-

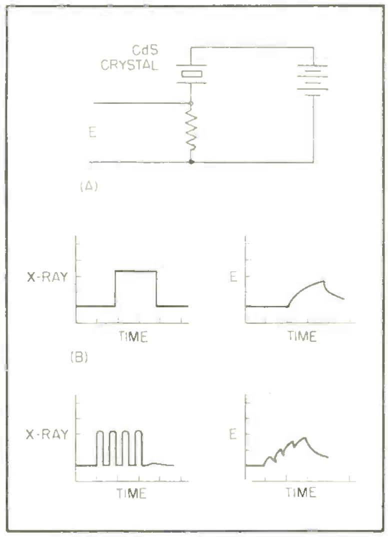


FIG. 3—Connection of CdS crystal and typical response curves

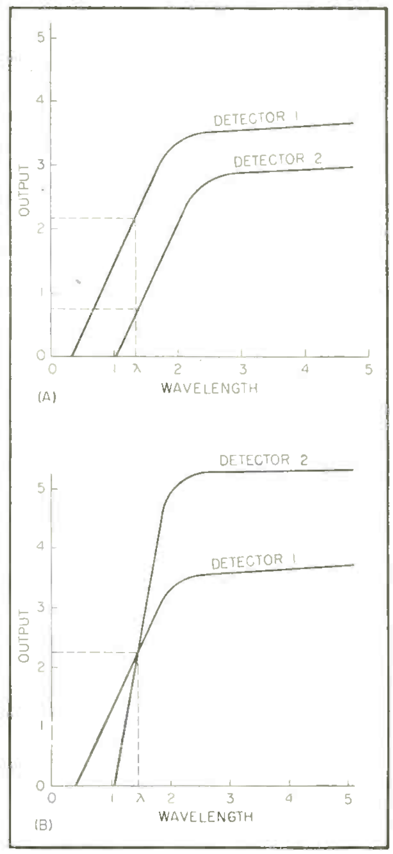


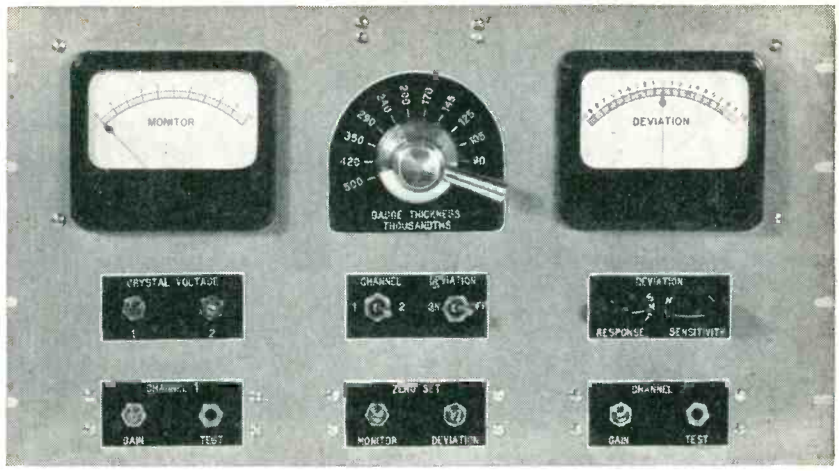
FIG. 4—Output vs wavelength curves for unmatched detectors (A) and curves showing result of attempt to match detectors by sensitivity control only

ence sample is never more than 20 percent different in thickness from the material being tested. Similarly the density of the reference sample must remain within the 20-percent maximum in density gaging.

Changing Thickness

Each time the base or reference thickness is changed the kilovoltage must be changed since calibration of the deviation meter depends upon the reference amplifier output remaining constant, and since it is necessary to operate on the steep portion of the absorption curve to obtain the high sensitivity desired.

With an arrangement shown in Fig. 2, reference samples of different thicknesses may be selected at the control panel remote from the x-ray hazard. A servo system places the selected sample into place. An error amplifier and associated servo system control the quantity and quality of x-radiation produced by the generator to hold the reference amplifier output constant. This servo system serves as an x-ray regulator that adjusts the x-ray output as different reference samples are selected and regulates for power line variations.



All adjustments are brought out to gaging panel shown

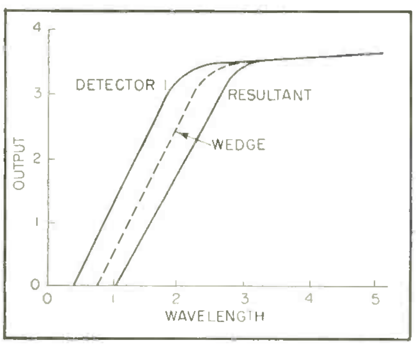


FIG. 5—Detector output vs wavelength response shifted by addition of absorbing material

As the error signal for the regulator comes from a detector operating on the steep position of the x-ray absorption curve, regulation of better than 0.5 percent is achieved. Regulation is not impaired by power line waveform, frequency or voltage variations as the error signal is dependent only upon the x-rays produced by the generator.

Equipment Design

In the unit designed for gaging the wall thickness of aircraft propeller blades, twelve reference samples are arranged around a disc and may be rotated automatically into position by setting a selection switch to the thickness desired. The samples were chosen to cover the range of the blade in twelve overlapping steps of ±10 percent. The deviation metering circuit provides a choice of three time constants and two full-scale sensitivities of ±10 and ±20 percent.

All of the equipment including power supplies, servo amplifiers, x-ray control and gaging circuits are housed in the cabinet shown. The schematic of the amplifier and metering circuit is shown in Fig. 6. Also included is a strip recorder that duplicates the reading of the deviation meter. The gaging panel contains all controls for operating the unit over the entire range of thicknesses. Ganged with the reference sample selection switch are a group of twelve potentiometers for adjustment of reference detector voltage to match the detectors for each step.

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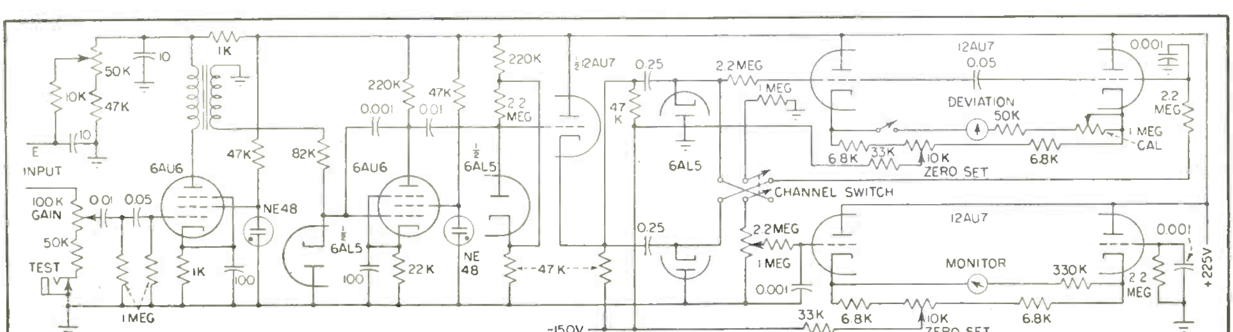

FIG. 6—Circuit diagram of crystal-signal amplifier and metering circuit

Physical Properties

Part III

By ABRAHAM COBLENZ and HARRY L. OWENS
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THERE is considerable evidence that the electron is a small solid particle. Equally convincing evidence has been found that the electron is a wave phenomenon. In dealing with transistors it is advantageous to accept a compromise concept, as will be defined in this article.

Some of the experiments which strengthen the idea of a corpuscular electron are already known to the reader. For instance, the electrons emitted from a hot filament in a cathode-ray tube are known to strike the fluorescent screen and by their bombardment create a small bright spot. A simple explanation of this bright area is based on the assumption that the electrons are small solid particles whose action on the screen is analogous to the action of the sand in a sand-blasting gun such as is commonly used to clean walls.

Corpuscle Proofs

One of the proofs that electricity is granular in nature and occurs in integral multiples of a reference or unit amount was established by Milliken in his oil drop experiment. In this experiment, fine drops of oil were suspended between the plates of a capacitor. Each drop of oil was electrically charged. By adjusting the electric field between the plates, the gravitational force on these oil drops was carefully counterbalanced by the strength of the electric field, and the rate of rise or fall of the drops was measured. From computations it was then evident that in all cases the charged oil drop behaved as if it carried a charge which was some integer times a fixed amount of charge. This fixed amount of charge is now considered to be the charge on the electron. Present day belief that the electron is corpuscular in nature is based in part on the results of this experiment.

Another in the series of experiments which furnishes evidence that the electron is corpuscular in nature is the familiar Wilson cloud chamber experiment.

While the above-mentioned experimental data appear to prove that the electron behaves like a corpuscle, it is a paradox that equally convincing data is available to prove that the electron behaves like a wave. The experimental results that follow can only be interpreted by assuming that the electron is a wave. A wave is considered to be an energy front that varies or oscillates at a definite frequency, but has itself no physical or tangible existence.

Electron Diffraction

On the basis of a mathematical analysis, de Broglie predicted that electrons should be subject to diffraction in the same way light waves are diffracted when they pass through a fine slit in a piece of opaque material. In about 1927 two experimental physicists, Davisson and Germer, devised an experiment to test de Broglie's hypothesis by passing electrons through a nickel slab. Since only a wave can suffer diffraction, a diffraction pattern should be obtained only if the electron possesses wave properties. On the strength of de Broglie's prediction, Davisson and Germer performed the electron diffraction experiment using nickel crystals and obtained clear and unmistakable diffraction patterns, such as in Fig. 1. Knowing the width of the slit and the distance to the surface on which the pattern appeared, computation was made for this experiment. The value of λ (wavelength) obtained agreed almost perfectly with that predicted by de Broglie.

The great interest in quantum

The Electron at Second Glance

The concept of an electron as a negative point charge is sufficiently adequate to account for most electron tube phenomena. This simple concept, however, falls short when it comes to explaining effects in semiconductors that form the foundation of transistor electronics.

To understand fully the inner workings of transistors, it becomes necessary to examine the microscopic structure of solids, since transistor action is based on interaction between the electron and its environment within a solid material.

This article presents a detailed picture of the electron and its environment as it must be viewed in the study of transistors. The material presented here, together with that given in last month's article on energy levels and quantum mechanics, will prepare the reader for discussions of semiconductors to appear in Part IV and subsequent articles of this series

# of Electrons in Solids

This, the third in a series of articles on transistor electronics, presents a concept of the electron that fits generally accepted explanations of phenomena within semiconductor materials that are responsible for transistor action

mechanics which gathered momentum with Bohr's formulas for the spectral lines led to a rapid development of quantum mechanics and its extension by men such as de Broglie to an even more general and powerful science called wave theory. It was from the fundamental concepts of wave theory that de Broglie predicted the wavelength of the electron and therefore the possibility for diffraction of the electron.

Physicists have considered that there is a finite probability that the diffraction patterns observed may be explained on the basis of collisions between the electrons and the atomic layers in the nickel crystal. The probability of collisions is influenced by the following: (1) The diameter of the electron as obtained from data where its corpuscular nature is evident is of the order of 10^{-13} cm; (2) The atomic layers of the nickel crystals are spaced 10^{-8} cm apart; (3) From 1 and 2, the spacing is 100,000 times the diameter of the electron; (4) The current used in the experiment was only 10 to 15 electrons per second; (5) The dimensions of the atomic layers are very large compared to the diameter of the electron.

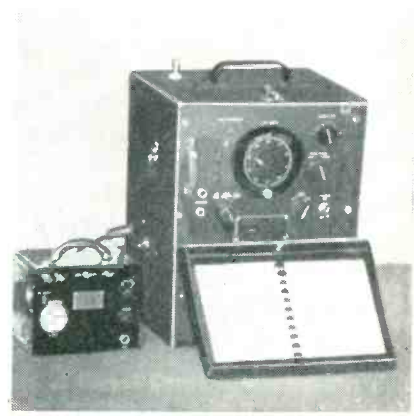
Taking into consideration all of these facts, it is possible to show that the probability of collisions between electrons and atomic layers is negligibly small. With the possibility of collisions ruled out, science knows of only one explanation for the diffraction patterns observed: the electron behaves like an electromagnetic wave.

Wave Packet

In the two preceding sections it has been indicated that in some experiments the observed results are explainable only by assuming that the electron is a particle, and in others only by assuming that it is a wave. The concept of the wave packet has been developed to assist in reconciling the wave and particle dualism of the electron.

The point of view to which the number of objections is minimum is the assumption that the electron, exhibiting as it does both wave and corpuscular properties, consists of a fortuitous conglomeration or concentration of waves of different frequency as in Fig. 2. The common intersection of these waves produces a core or center which acts, it is thought, like the solid particle observed in the experiments mentioned in the opening paragraphs of this article while the wavelets can obviously account for the wave properties. This is clearly

TRANSISTOR APPLICATIONS ANNOUNCED AT 1953 NATIONAL IRE SHOW



Miniaturization made possible by transistorizing is illustrated by "before and after" photographs of Signal Corps Geiger counter (left) and frequency meter (right). Center photo shows tiny Bell Labs transistor amplifier that contains fourteen parts in a case no bigger around than a piece of No. 10 wire

an ad hoc solution to the problem of reconciling the wave and particle dualism, but it is the best theory available.

Henceforth here, when speaking of electrons, the reader is asked to bear in mind that wave packets are meant. Holes, which are similar to electrons in many ways, are also thought to be best represented by wave packets.

Electron Location

Having concluded that the electron may be regarded as a wave packet, consider next the problems associated with the location of the electron at any time. The location of electron position is limited in practice by a principle first enunciated by Heisenberg in 1927 and called the indeterminacy or uncertainty principle.

Heisenberg's equation defines the limits of accuracy with which can be determined certain extrinsic parameters which describe microscopic particles

$$\Delta(mv)\Delta x \geqq h \qquad (1)$$

The momentum p is defined as the product of mass times velocity, written $p = mv$ analogously to the way in which energy E is defined as the product of force F times distance x, or $E = Fx$.

The mv in Eq. 1 may be the momentum of an electron, for example. This momentum is frequently useful in describing the behavior of particles.

Equation 1 states that the error in the determination of measurement of the momentum mv times the error in determination or measurement of its position x from some reference point will always be equal to or greater than Planck's constant h in magnitude.

It is unnecessary to go into the derivation of this equation now, but it is important to note that this equation was derived from rigorous mathematical physics and no experimental evidence has ever been found which contradicts it. This equation sets a limit to the accuracy with which may be measured any two quantities which describe an electron when the product has the units of Planck's constant, and when both quantities are being measured at the same time. Substitution of figures in this equation will give some idea of the orders of magnitude.

The mass of the electron is approximately 9.1×10^{-28} gram. The velocity of an electron when accelerated by a potential of approximately 1,000 volts is of the order of 2×10^{9} cm per sec, and this velocity can be measured to within about 1,000 cm per sec, so that Δv, the error in v, is 1,000 cm per sec. In Eq. 1 there are actually three quantities involved on the left-hand side: m, v and x. Assume that in a given experiment, as is most usually the case, only the velocity v and the displacement x would be measured. The mass is usually assumed to be known in such experiments where the indeterminacy principle is applied. If the Δ in Eq. 1 is to have the same effect as the differential symbol of elementary calculus, Eq. 1 may be written, since m = constant

$$m\Delta v\Delta x \geqq h \qquad (2)$$

Using now the values mentioned, $9.1 \times 10^{-28} \times 10^{3} \times \Delta x = 6.6 \times 10^{-27}$ erg sec, $\Delta x = 0.73 \times 10^{-2}$ cm. This figure may be rounded off to one hundredth of a cm. This is not too large an error and it would seem that ability to measure a distance to within 0.01 cm should be satisfactory for most applications.

In measurements on a microscopic level, however, 0.01 cm is a tremendous error because it is so large compared to the dimensions of the particles. It has already been mentioned in connection with the grating experiment that the diameter of the electron is of the order of 10^{-13} cm. If the error in determining the position of the electron from some reference point is of the order of 10^{-2} cm, its position can be determined to within $10^{-2}/10^{-13}$, or 10^{11} diameters.

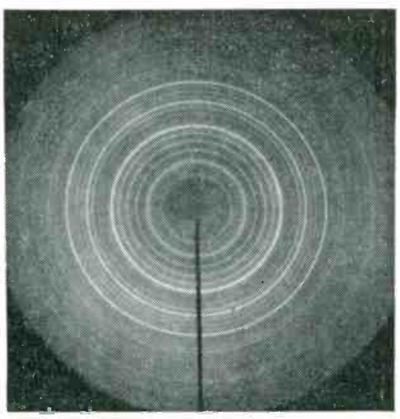


FIG. 1—Diffraction pattern, such as may be observed due to electron diffraction through nickel crystals, shows wave properties of electron. Pattern shown in for thallium chloride ($TlCl_3$)

Typical Example

Stated somewhat differently, the average room is under 20 feet long, but the actual dimension is not too important here. One hundred billion times the length of the room is approximately four hundred million miles. With the above accuracy a physicist could locate such a room from some reference point—say the North Pole—with an error no less than 400 million miles.

Suppose that in the measurement of velocity a larger error, such as 100 percent, can be tolerated. To compute the new Δx the Δv of Eq. 2 is now 2×10^{9}, hence $9.1 \times 10^{-28} \times 2 \times 10^{9}\ \Delta x = 6.6 \times 10^{-27}$, or $\Delta x = 0.36 \times 10^{-8}$. Again rounding off this figure, since only orders of magnitude are important, the error in position is now fully 100,000 times the electron diameter. From a physical experimental viewpoint such data have no important value, and this in spite of the fact that a 100-percent error in the determination of the velocity or the momentum has been assumed.

This means that in a simultaneous measurement of momentum and position or of energy and time, or of any two parameters whose product has the dimensions of Planck's constant, ability to obtain precise information is extremely limited because of work on a microscopic level. To measure the position of an electron alone, having no knowledge at the same time of its momentum or energy, provides the physicist with rather useless data. When he tries to measure both at the same time the uncertainty principle shows that if he wants to measure the momentum he has virtually no knowledge of where the electron may be. It is for this reason that the physicist does not attempt to specify the exact location of an electron at a given time.

Physical Picture

The reader will see a physical reason for the validity of the uncertainty principle from the following analysis.

The sight of an object indicates that light has struck the object, has been reflected into the eye, and has energized the nerve impulses that convey to the brain a specific intelligence. As pointed out in the first article of this series (see box below), the emission of electrons from a surface bombarded by light is a quantum effect. It is convenient to speak of particles called photons, each with an energy hf, that do the bombarding. Saying that light strikes an object is equivalent to saying that photons, each of energy hf, strike the object. When these photons strike a large object, for instance a ball, the action of the photon on this very large mass produces no perceptible motion of the ball.

If, however, the object under scrutiny were an electron, the photon striking the electron would cause a large and important displacement of the electron. When the photon bounces off the electron and into the eye of the observer, it appears to come from a point where the electron was before its displacement by the photon. By the time the light information arrives at the eye, however, the electron is far removed from the point where the light information says it is. Hence on a microscopic level the tools for observation so seriously disturb whatever is being observed that information is subject to the very large errors specified by the indeterminacy principle.

Probability

Inability to specify exactly or even within some reasonable error the position of an electron has led to an entirely new approach in the specification of the position of an electron when at the same time other useful information must be known.

The physicist, therefore, as an outgrowth of the uncertainty principle, does not say that an electron with a certain energy will be at a given point at a certain time, but he speaks of the probability that the electron will be at a certain point.

In picturing the electron, therefore, it is naive to the point of being incorrect to think of the electron as being represented by a point which is in motion about a nucleus. In the case of the hydrogen atom with one electron outside of the nucleus, a more correct picture is that in which the electron is represented as a smeared-out or hazy region about the nucleus.

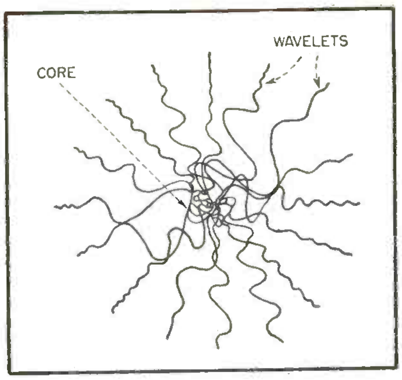


FIG. 2—Artist's conception of a wave packet. Various frequency, phase and amplitude components synthesize to give a knot of waves having the characteristics both of a wave and a corpuscle

In regions further from the nucleus smaller orders of probability exist that the electron may be found there.

The probability of finding the electron is actually the highest in carefully-defined mathematical orbits which are of no particular interest at this time. It is important to realize that thinking about an electron as a point charge or even as a wave packet as in Fig. 2 is not strictly correct because of the impossibility of actually seeing such a picture in practice.

Consider a propeller blade spinning at high speed. If the propeller never came to rest, and one never saw it except spinning, the only picture of the system that could be permitted would be a blur. By analogy, the electron, which can never be brought to rest and examined, can only be visualized as a blur or hazy region.

With these ideas in mind it is essential to remember that pictures or sketches that show electrons as little dots or small dashes (for the negative sign) are symbolic only, much as a capacitor represented by two parallel lines on a schematic diagram does not necessarily consist of two plates at all. Failure to remember that these pictures are symbolic only will lead to confusion when in subsequent articles transistor action in the solid germanium material is discussed on a microscopic level.

Summary

In summary, the reader should retain from this article the following salient points:

(1) In certain phenomena, particularly when the surroundings in which the electron finds itself are very large compared to its diameter, the electron behaves like a minute bit of matter, or a corpuscle.

(2) In certain phenomena where the surroundings are of the order of magnitude of its size, the electron behaves like an electromagnetic wave.

(3) This wave-particle dualism of the electron is conveniently expressed by the concept that the electron is a wave packet, representing a fortuitous combination of waves of suitable frequency and amplitude into an entity having characteristics both of a particle and a wave.

(4) In specifying the position of an electron, the probability of its being at a certain point is given; because of this fact it is best to consider the electron as a smeared-out or diffused wave packet in the region about the nucleus.

(5) The pictorial representation of the electron as a dot or dash is symbolic only.

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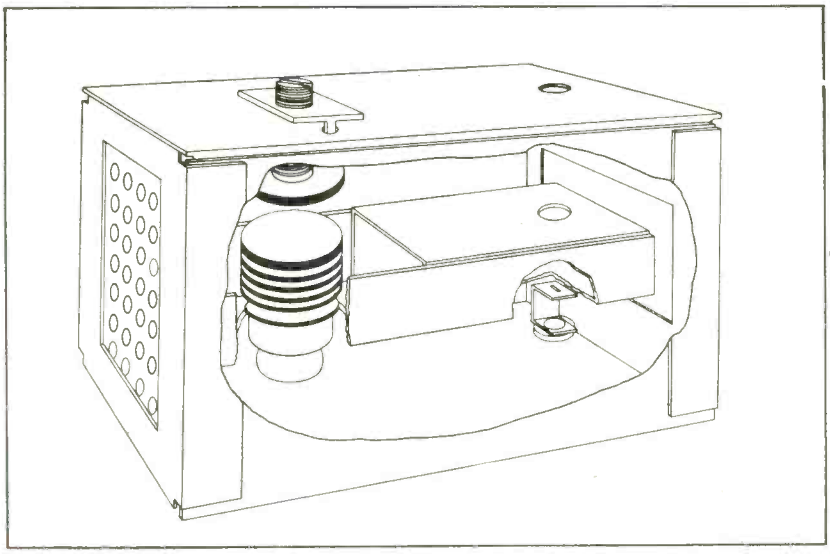
Previous Articles in This Series

Part I—
Introduction to Transistor Action, p 98, March 1953.

Part II—
Energy Levels in Transistor Electronics, p 138, April 1953.

Citizen Radio


Internal construction of the transmitter tuned cavity

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In 1949 the FCC established two new sets of frequency allocations. Channels between 450 and 460 mc were allocated to the land-mobile services to relieve channel shortages and congestion in the lower frequency bands. The range 460 to 470 mc was given to the citizen's radio service making the advantages of two-way radio available to private citizens and organizations not eligible under other sections of the FCC regulations.

The transmitter must meet all requirements of the FCC and in addition should meet all current or proposed RTMA and IRE standards.

The basic problems of audio response and deviation limiting were already solved through the use of the Motorola deviation control circuit, (Instantaneous Deviation Control, ELECTRONICS, Sept. 1949). This left the problems of frequency stability, spurious emission, audio distortion, r-f power output and power consumption to be resolved.

Frequency stability, distortion and spurious emission are all closely related to the crystal multiplication factor. The crystal operating at a low frequency has a small drift, but a high multiplication factor magnifies a small crystal error. An overtone crystal, properly employed, has a smaller percentage drift than its fundamental counterpart.

For minimum distortion, the phase modulator should shift the frequency a minimum number of degrees; the desired deviation is achieved by high multiplication factors. The problems of spurious emission, however, dictate that minimum multiplication be used to prevent multitudinous crystal harmonics from appearing at the output. After careful investigation, a frequency multiplication of 24 times was chosen.

Frequency Control

A series mode, third overtone crystal oscillator, operating at approximately 19 mc provides the fundamental signal. The practical frequency stability is approximately ±0.0005 percent. A drift of this amount in both transmitter and receiver can produce an overall system error of ±0.001 percent. Nevertheless, field testing has shown that when a receiver with a modulation acceptance of ±15 kc is used, the overall system stability must be confined within approximately ±0.0005 percent to avoid performance degradation owing to drift. To meet this limit the receiver must be equipped with automatic frequency control.

With a multiplication of 24 times, distortion is approximately the same as that of a 150-mc transmitter, less than 2 percent at ±10-kc deviation. The modulator is required to provide a phase shift of only 36 degrees for full ±15-kc deviation.

The spurious emission problem is also adequately solved. A low multiplication factor widely spaces the crystal harmonics. Careful attention to coupling between tuned circuits and the Q of these circuits attenuates spurious frequencies. Stray coupling, particularly in the laced cables, is likewise eliminated.

From past experience, an r-f power output of 20 watts appeared to be adequate for the desired coverage between mobile units and a tower-mounted base station antenna.

The tube to do this job as a final amplifier would also have to be efficient in operation, capable of withstanding the shock and vibration of mobile operation, conservatively rated, and operated well within its ratings. The 2C39A coplanar triode capable of surviving 200 g shock or vibration fulfills these requirements.

Output Tube Choice

The 2C39A is designed for use in grounded-grid, cavity-type circuits. Such circuits themselves provide better efficiencies because they are inherently well shielded, minimizing stray radiation losses. Stability and complete freedom from neu-

Class A Equipment

Design of a production transmitter and companion receiver for the 450-mc region with class A approval by FCC for use in citizens radio service. The same equipment is being installed by taxi, petroleum, public safety and other services having frequency assignments in the same region

tralization problems makes this type of circuit desirable.

As used in the transmitter, a plate circuit efficiency of approximately 65 percent is realized. A good, conventional tube of a type suitable for use at 160 mc could provide a plate efficiency of only 25 to 30 percent when used at 450 mc. This difference in efficiency in a 20-watt transmitter can represent a difference in battery drain of as much as 18 amperes in a 6-volt vehicular system.

The 2C39A is rated at 100 watts maximum plate dissipation. As used, the dissipation is less than 10 watts. Although higher in original cost, the 2C39A, operated at such a small percentage of its ratings, has a life expectancy many times that of a lower cost tube operated at or near its maximum ratings. Life tests conducted at a 33-percent duty cycle have shown an expected tube life of nearly 1.5 million transmissions.

The tuned cavities are essentially the same for both the tripler-driver, using a grounded-cathode 2C39A, and the grounded-grid-power amplifier stages. As shown in the illustrations, the cavity is a rectangular metal box. Within the cavity, a hollow rectangular center conductor serves the purpose of forming a part of the r-f circuit and also as a duct for cooling air directed to the heat radiating fins of the tube. The end of this inner pipe is flared out into a flange, forming one plate of a bypass capacitor whereby the inner pipe is connected to the outer cavity. A similar capacitor bypasses the grid of the final amplifier to ground. In the final amplifier, the cathode is inserted into a flat tuned line constructed of aluminum. This connector, like that of the tripler stage, provides a high conductivity path to draw heat away from the tube filament seal.

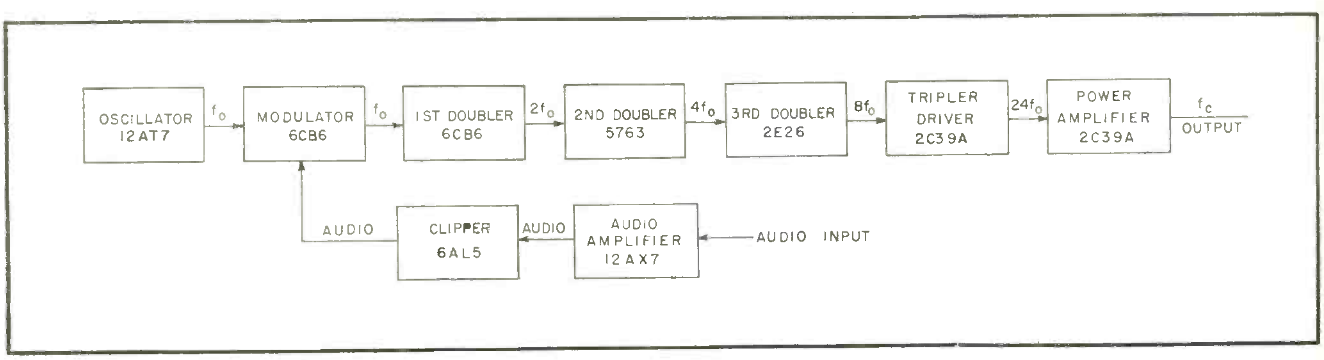
The cavities are capacitively tuned with an adjustable disk located directly over the tube anode. The output coupling is adjusted by varying the orientation of the output coupling loop located at a high-current portion of the cavity.

Receivers

A working model receiver with appropriate sensitivity and selectivity had been constructed as early as 1946. To perfect the receiver for normal applications, it appeared that four problems remained to be solved: (1) design of suitable 450-mc tuners, (2) choice of r-f amplifier tubes for best sensitivity and highest signal-to-noise ratio, (3) attainment of the necessary degree of frequency stability and (4) choice of intermediate frequencies for the best spurious response rejection.

After extensive research, a coaxial tuned cavity was developed and proved to be the practical answer to the 450-mc tuner problem. Cavities are stable, efficient and mechanically strong as well as possessing high Q and being easy to tune. Specially dimensioned and positioned input and output coupling loops achieve optimum impedance match to the tubes to insure the highest signal-to-noise ratio and achieve best gain characteristics. Careful dimensioning of the loading drum accomplishes a smooth tuning characteristic.

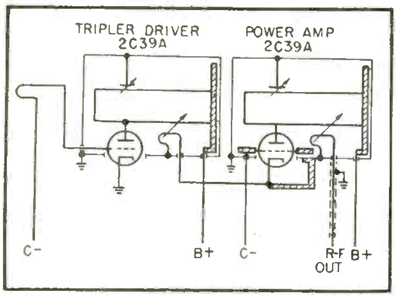
Bimetallic construction of the center conductor provides temperature compensation. The top cap of the cavity is soldered in place, the coupling loops are brought out through glass seals, and the bottom cap uses a neoprene seal ring to seal the cavity against



A simplified block diagram of the 450 to 470-mc transmitter

the harmful effects of humidity, dust and corrosive gases. Tuning is accomplished by removing the lower seal and inserting any standard screwdriver into the slot of the movable center conductor.

The vital problem of sensitivity depends primarily upon proper choice of r-f amplifier tubes. Of all the tubes tested for noise figure and gain, the 6J4 was chosen for immediate production. The maximum r-f gain was then achieved by matching the r-f tuners to the tubes. Sufficient gain must be provided to override the noise of the first mixer stage. A vacuum-tube first mixer stage was used in preference to a crystal mixer to achieve additional gain, protect the signal-to-noise ratio and provide uniformity of performance under all conditions of temperature, humidity, shock and vibration.



Circuit diagram of the r-f deck used in the transmitter

As stated previously, automatic frequency control was deemed essential to prevent degradation of performance because of either transmitter or receiver frequency drift. A reactance tube, operating from the discriminator output, tunes the high-frequency local oscillator to receive the desired carrier. This one oscillator, through multipliers, provides the injection frequencies for both the first and second mixer stages. Automatic frequency control will compensate for frequency errors up to 25 kc but cannot jump to adjacent channel signals.

Receiver Stabilizing

A further consideration toward stability is the drift of the tuned circuits. The best practical temperature-compensating capacitors have a temperature coefficient of ±30 parts per million per degree centigrade. This can be interpreted into approximately 30 cycles per megacycle per degree centigrade. At intermediate frequencies of 1 mc the drift over a 100-deg C temperature range is approximately ±3 kc. At 4 mc the drift is an intolerable ±12 kc.

Through the use of properly distributed gain and selectivity, this problem is solved. The primary selectivity-determining element is a fixed-tuned plastic-encased bandpass filter with a center frequency of 455 kc. This approach was used in the basic lower frequency Sensicon receiver (Adjacent Channel Rejection Receiver, ELECTRONICS, Jan. 1951) and was again proved practical. The basic circuits are essentially the same as in this earlier receiver with the exception of an additional intermediate-frequency stage at approximately 73 mc.

The mixer circuits themselves provide a spurious response rejection of 50 to 60 db at half the intermediate frequency and 70 to 80 db at one-third the intermediate frequency. The high-Q tuners and coils in the r-f and i-f sections increase this rejection and that of the image frequency to well over 86 db. Backward gain and backward selectivity, that is, passage of the local-oscillator frequency backward into the r-f stages, are held to the desirable levels with the use of grounded-grid amplifiers and high-Q tuners in the r-f stages. This prevents mixing and generation of spurious responses in the r-f or antenna stages. It also holds radiation of the local-oscillator injection frequency to less than 100 microvolts at the antenna terminal. Similarly, high-Q coils and a tuner preceding the mixer stages preclude entry of spurious crystal frequencies into the mixers.

Local-oscillator frequencies are so arranged that the combination of 20 first oscillator crystals and 10 i-f oscillator crystals covers all 200 channels in the frequency range. Although the receiver uses 21 tubes, more than its 150-mc counterpart, only 7 tube types are used and the power consumption is minimized by omission of the crystal heater oven and use of an audio-amplifier squelch cutoff bias.

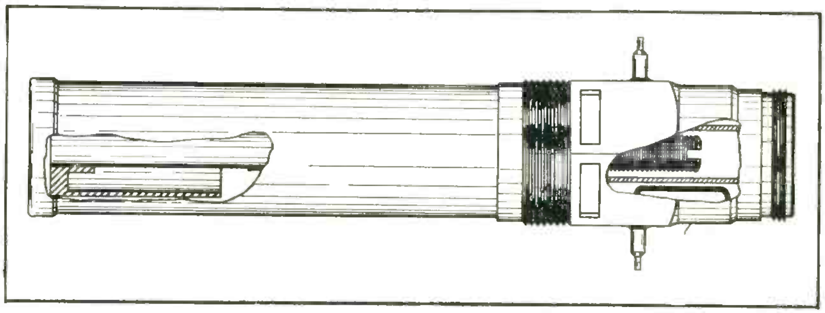
Power Supplies

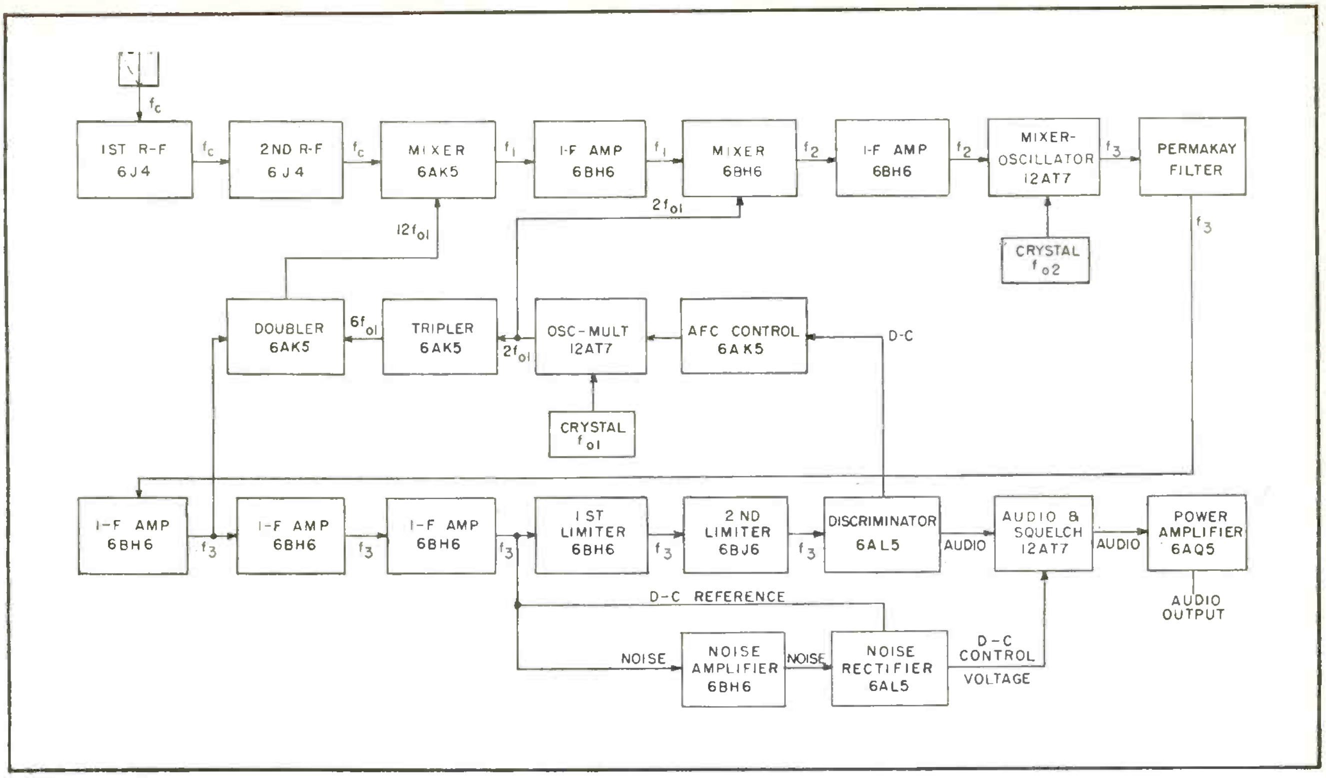
New high-current, long-life vibrators provide a fresh approach in mobile power supplies. They are used for both the transmitter and receiver units. For reception, the receiver vibrator alone supplies the receiver B+ voltage; for transmission, its output is added in cascade to the output of the transmitter supply to achieve the desired high voltage. This approach insures that as the vibrators age, the more heavily used receiver vibrator will not affect r-f drive as its output voltage decreases.

Performance

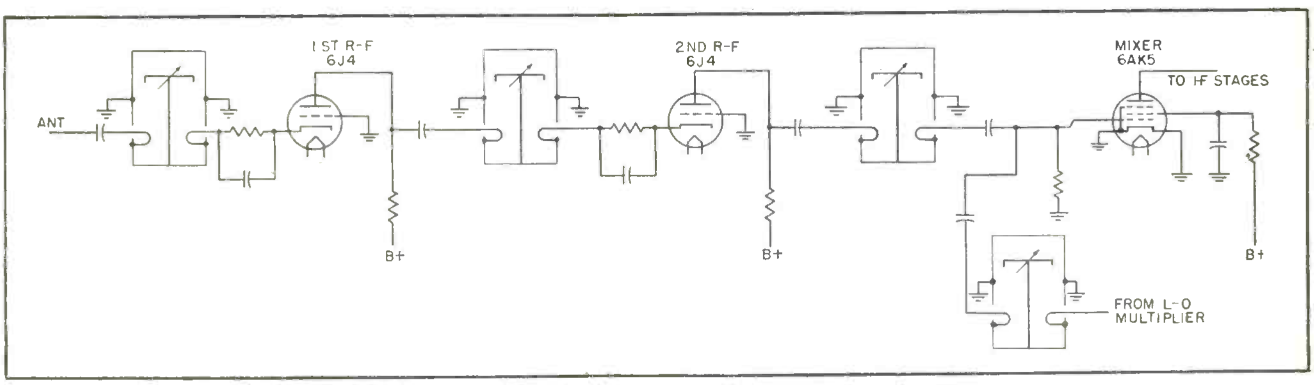
Transmitter r-f power output is 18 to 20 watts throughout the 450-470 mc range. Frequency stability of the transmitter is approximately ±0.0005 percent. The afc circuit in the receiver provides an overall transmitter-receiver frequency stability of better than ±0.0005 percent. Tests have also shown that the transmitter will tune to and is applicable for use in the various ranges down to 400 mc.

The receiver sensitivity is 1.0 microvolt for 20-db quieting. Squelch threshold sensitivity is at the approximate r-f noise level, 0.3 microvolt. For reception of weak


Receiver tuned cavity has input and output probes and loading drum



Block diagram of the 450 to 470-mc receiver



Circuit diagram of the receiver r-f deck

signals, there is less than 6 db attenuation at ±15 kc at the edges of the transmitter modulation spectrum. Approximately 100-db attenuation is realized at ±85 kc the edges of the adjacent-channel modulation spectra. Because of difficulties in obtaining high signal levels for selectivity determination at 450 mc the receiver is rated at 85 db attenuation at +60 kc.

In use, the radio equipment performs similarly to that operating at 150 mc. In urban areas, the multiple reflections between tall buildings and under bridges provide better coverage than at 150 mc. In suburban and rural areas, foliage attenuation is noticeable and sometimes a limiting factor. In comparative test of 150 and 450-mc units, equal performance was obtained in relatively flat areas with antennas mounted at the same height.

A high-gain 450-mc antenna, more practical at these frequencies, is used. For best coverage, it is required that a high-gain antenna be mounted as high as possible. Reliable communications have been realized within a radius of 30 miles and extended ranges up to 57 miles have been recorded. However, mobile-to-mobile coverage is not as good as with 150-mc units.

In order to achieve satisfactory long-range mobile-to-mobile communications, a central-station repeater is necessary.

The FCC has completed tests of these transmitters and has given type approval for class-A citizen's band operation.

This equipment was designed and produced under the guidance and direction of Dan Noble, vice-president, Motorola Communications and Electronics Div., and John Byrne, director of engineering, and by many members of the engineering staff.

Although it is not possible to list all participating engineers, thanks are given to James Clark, receiver project engineer and Fred Hilton, transmitter project engineer who perfected the final design and gave invaluable assistance in preparation of this paper.

Synchronization in

Synchronization of color allows timing error of 0.004 microsecond, according to NTSC requirements, but the science of electronics can measure five degrees at three megacycles almost as easily as five degrees at sixty cycles, and phase synchronization of the NTSC signal can be accomplished in several ways

A TELEVISION SYSTEM is said to be frequency synchronized when the frequency of a repetitive process at the receiver (such as scanning motion or color sampling) is the same as that of the corresponding process at the transmitter. Frequency synchronism is a necessary, but not sufficient, condition for satisfactory operation. For example, the top half of the picture may appear at the bottom of the screen and the bottom half at the top, because the vertical scanning motions in camera and picture tube do not possess the proper phase relationship.

The system must also be phase synchronized. The phase angles between the repetitive processes must be adjusted until they have the proper values to reproduce picture and sound in the appropriate temporal and spatial relationships. Phase synchronism is a necessary and sufficient condition of proper operation, since the existence of a stationary phase relationship implies frequency synchronism. This paper discusses four types of phase synchronization which must be performed in a satisfactory color television system.

Picture-sound Sync

Experience with sound motion picture projection has proved that the sound heard by the observer must be phase-synchronized with the visual image within the time occupied by two frames of the film. At the standard projection rate of 24 per second, this corresponds to a time tolerance of $\frac{1}{12}$ second or 83 milliseconds. Recent tests[1] show that the majority of nontechnical viewers can perceive sound delays as small as 50 milliseconds, although they do not usually find delays definitely objectionable until they reach values of about 250 milliseconds.

It appears, therefore, that if the sound and picture correspond at the viewer position to within 100 milliseconds, little objection will be voiced. This time delay corresponds to a distance of sound propagation in air at room temperature and at sea level of 113 feet, which is well beyond the usual viewing distance of home television receivers. We may, therefore, disregard the acoustic delay at the receiver. The electrical delay of the sound signal within the receiver circuits may also be discounted, since in typical receivers it amounts to less than 25 microseconds.

Television broadcasters must pay attention to sight-sound synchronization, not only in operating motion picture projectors and tape recording machines, but also in guarding against excessive delay of the sound signal over long network circuits. For example, the A. T. & T. transcontinental telephone circuits of the open-wire type between Los Angeles and New York have a total time delay well in excess of 100 milliseconds, whereas the delay in the microwave relay for the corresponding picture transmission is less than one half millisecond. To keep the sound in step with the picture, therefore, the A. T. & T. Long Lines engineers have had to adopt carrier-type circuits for the accompanying sound transmission.

Vertical Synchronization

Vertical synchronization relates to the initiation of each field in the scanning process, which occurs at a rate of 60 fields per second or 16.7 milliseconds per field. Vertical scanning at the receiver might be allowed to fall out of phase synchronism by one percent or 167 microseconds without adverse effect, since this time difference would displace the received picture upward or downward a negligibly small amount, if all successive fields are delayed or advanced by the same amount.

Interlacing imposes a much stricter tolerance. To avoid noticeable pairing of the interlaced lines in the image, each pair of field scans must be initiated correctly within a fraction of the duration of each scanning line, which is about 60 microseconds. Accordingly, vertical deflection circuits should be designed to maintain correct synchronization between two successive fields within 10 microseconds. Any variation greater than this produces pairing of the interlace which would be plainly observable by the viewer.

We may, then, attach a nominal tolerance to the vertical sync process of 10 microseconds, which is 10,000 times smaller than the sight-sound requirement previously discussed.

Horizontal Synchronization

Horizontal synchronization relates to the initiation of each line in the scanning pattern. If the scanning lines are out of position by more than a fraction of the width of a picture element, noticeable impairment of horizontal resolution results.

At a nominal video bandwidth of 4 mc, a picture element is formed in 0.125 microsecond. The FCC Standards of Good Engineering Practice specify the time of rise of each horizontal sync pulse to be not more than 0.4 percent of the line scanning interval, and the

Color Television

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RTMA apparatus recommendation is 0.3 percent, corresponding to 0.18 microsecond. The intercept of the pulse edge with the voltage level at which the synchronization circuit is actuated may be maintained within one tenth of the pulse height. Therefore, in the absence of noise, the inherent accuracy of horizontal synchronization, using not less than 3-mc bandwidth in transmitting the sync pulses, is better than 0.02 microsecond, or less than one sixth of the duration of a picture element.

When noise is present, it can disturb the intercept of pulse edge and the sync level as much as 10 microseconds. It is necessary to stabilize horizontal synchronization by an averaging process. In such stabilized circuits, the scanning process is controlled by another series of pulses whose timing is controlled by the average of a large number of horizontal sync pulses, typically 100. Any noise disturbance to an individual sync pulse then has negligible effect on scanning.

By use of these time-averaging horizontal stabilizing circuits, adequate horizontal synchronization accuracy is obtained even at signal-to-noise ratios near unity. Stabilized receivers can maintain horizontal scanning accuracy to within one half the duration of a picture element, or 0.06 microsecond, even in the presence of noise whose rms voltage is two thirds the peak signal level (signal-to-noise ratio less than 4 db).

This timing accuracy of 0.06 microsecond is one 17-millionth of a second. The FCC was much concerned, in the color hearing of 1949, that the then-proposed compatible color system appeared to require a

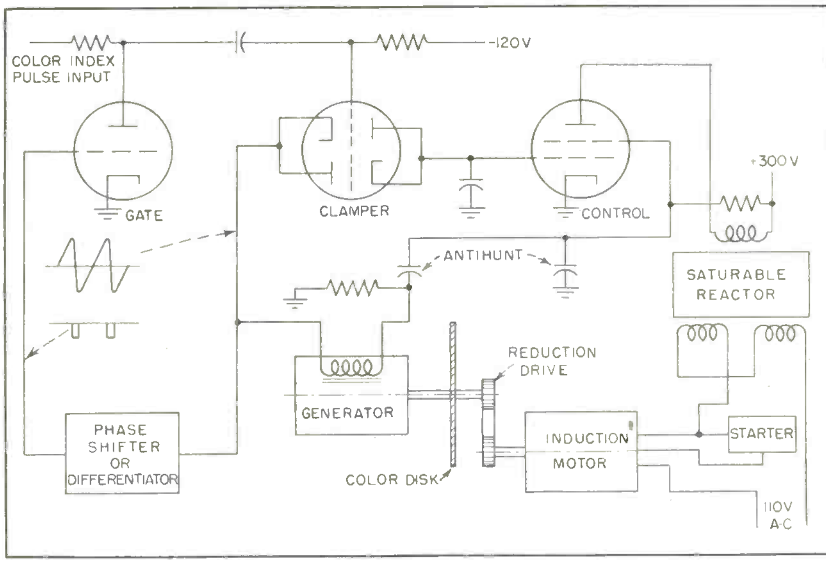

FIG. 1—Color synchronization in the field sequential system commonly employs a filter disk driven at 1,440 rpm. Disk is 23 inches in diameter and may weigh several pounds

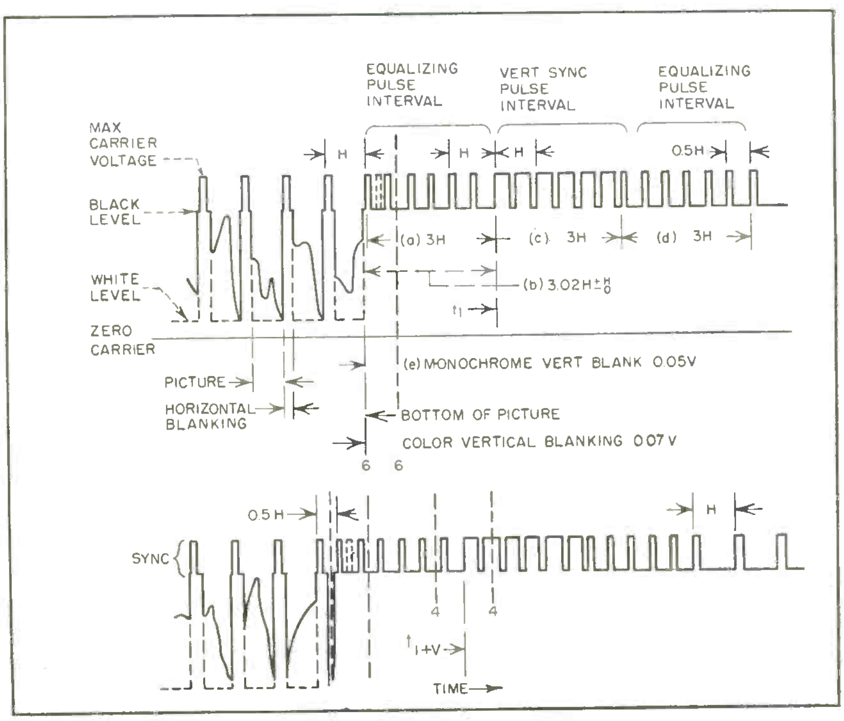

FIG. 2—Color-index pulse in FCC field sequential system has frequency of 48 cps, time rise of about 0.24 microsecond and provides automatic correction of color-index-errors

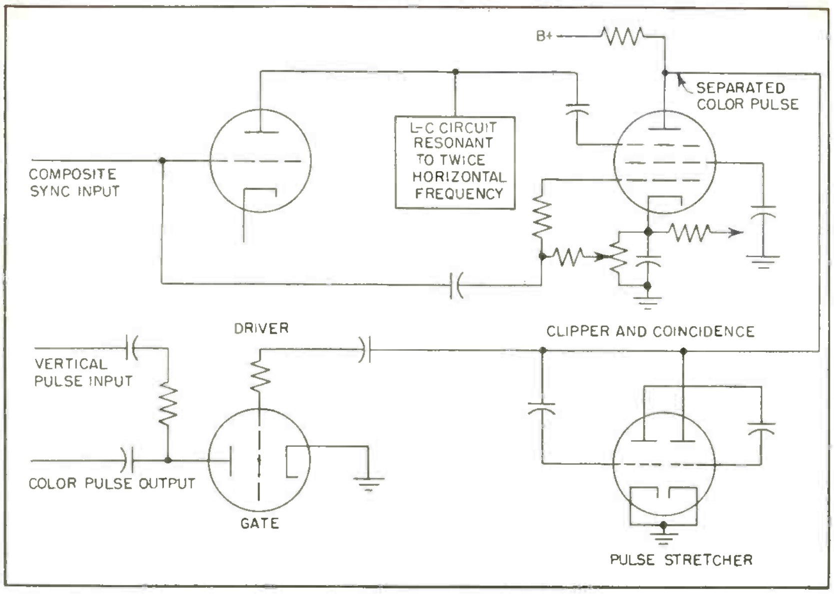

FIG. 3—Typical receiver circuit separates color-index pulse from horizontal and equalizing pulses in a coincidence amplifier and uses color pulses to index color disk to proper position

timing accuracy of one 11-millionth of a second. Apparently it was not generally realized that virtually all of the three million black-and-white receivers manufactured during that year had horizontal sync accuracy greater than one 11-millionth of a second.

Field-Sequential System

In field-sequential color, the system officially adopted by the FCC for public service[2], the most commonly used receiver in closed-circuit transmissions employs a filter disk having six transparent colored segments, two in each of the primary colors. The disk rotates in front of the picture tube at a rate that positions the filter segments in synchronism with the field scanning. A similar disk rotates synchronously in front of the camera tube. The filter segments are shaped so as to cover the viewing screen, with due allowance for the motion of the scanning spot through each field.

To assure adequate phase synchronism between the color disks at receiver and transmitter, it has proved necessary to control their rotation so that neither departs from its proper angular position by more than two degrees of rotation. Since each filter segment occupies 60 degrees, the corresponding timing tolerance is 1/30th of the duration of each field, which is 1/144th second. Accordingly, the phase synchronizing accuracy required is 1/4,320 second or 230 microseconds.

This requirement is substantially less strict than the timing accuracy needed in vertical and horizontal sync. If the color synchronizing action were substantially inertialess, as it is in vertical and horizontal scanning, no problem would be created. Unfortunately, in the rotating-disk receiver, the device to be synchronized is a 23-inch disk weighing several pounds, rotating at 1,440 rpm, and it must not lose phase synchronism for more than a second or two when the receiver is switched from one color transmission to another.

The electromechanical synchronizing device that meets these requirements is not simple; in fact it represents a substantial part of the cost of a field-sequential color receiver. A typical arrangement for maintaining phase synchronism in such a receiver is shown in Fig. 1. The disk is driven at 1,440 rpm by an induction motor through a 17/14-ratio belt drive. The motor itself tends to run above synchronous speed (1,748 rpm) throughout the design range of primary voltage from 105 to 125 volts and frequency from 59.5 to 60.5 cps.

To keep the disk in phase synchronism within the two-degree error, over these ranges of primary power, it has proved necessary to set up a phase-comparing system. The 144-cps vertical synchronizing pulses are compared in phase with a 144-cps sawtooth wave produced by a generator on the disk shaft. The downward slope of the sawtooth wave is 10 volts per degree of disk rotation. The gate tube prevents the vertical synchronizing pulses from passing to the clamper tube except during this downward slope.

When coincidence between vertical pulse and sawtooth slope is achieved (by the faster-than-synchronous speed of the motor), the clamper tube becomes operative and its output is supplied to the grid of the control tube. A saturable reactor, controlled by the plate circuit of the latter tube, is in series with the induction motor input. The motor speed is thus maintained in phase synchronism.

The circuit achieves phase synchronism at any one of six positions on the disk, since each such position represents one cycle of the 144-cps field scanning rate. There are, ac-

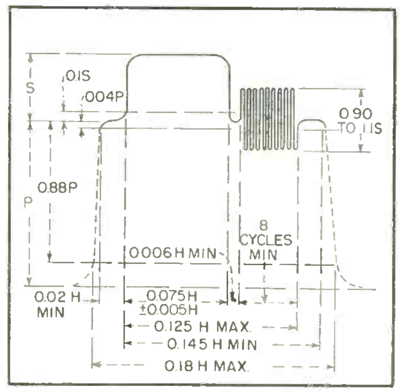

FIG. 4—Simultaneous compatible system employs as color sync signal a burst of sine wave at subcarrier frequency, imposed on each horizontal sync pulse

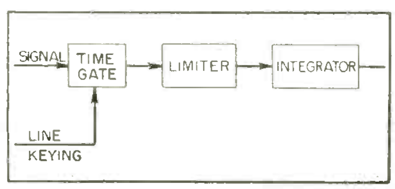

FIG. 5—Meeting phase error specification of five degrees is done by basic arrangement shown above

cordingly, two chances in three that the color phase will be in error. For example, a green or a blue filter segment may be positioned before the picture tube when a red segment is in front of the camera tube. A manually operated push-button is provided to correct such color-index errors.

It is possible to correct such errors automatically. The FCC field-sequential color standards make automatic correction possible by providing a color-index pulse. This pulse, shown in Fig. 2, appears between the first two equalizing pulses, immediately preceding each field during which red information is transmitted.

The color-index pulse has a frequency of 48 cps, and has a time of rise of about 0.24 microsecond, which easily satisfies the timing requirement of 230 microseconds.

At the receiver, the color-index pulses may be separated by the typical circuit shown in Fig. 3. The composite sync pulses, including the color-index pulses, are applied to the control grid and third grid of a coincidence amplifier tube. A resonant circuit connected to the latter grid and tuned to twice the horizontal frequency, is so phased that it depresses the grid during each horizontal pulse and equalizing pulse. Consequently the circuit is not responsive to these pulses. When the color-index appears, its phase is such (intermediate to the equalizing pulses) that it elevates this grid to a sufficiently positive voltage to cause the coincidence tube to conduct, thus producing an amplified color-index pulse that may be used to index the color disk to the proper position.

Simultaneous Compatible System

The compatible color television system currently under development by the member organizations of the National Television System Committee employs two video carrier signals, a luminance carrier and a color subcarrier. The luminance carrier is modulated in amplitude by the brightnesses (luminances) of the scene; this signal is essentially identical to that radiated by present-day black-and-white stations. It is the component to which black-and-white receivers respond and which, thereby, establishes the basic compatibility of the color system.

The synchronizing functions applying to the luminance signal are similar to those applying to black-and-white transmissions, with one important exception. In monochrome transmissions, the FCC regulations permit substantial variations in the absolute values of vertical and horizontal scanning frequencies, subject only to the restriction that there shall be exactly 525 horizontal pulses for each pair of vertical pulses.

For example, it is customary, when using an intermittent-type movie film projector, to tie the vertical pulse rate to the local primary power frequency so that a synchronous motor can be used to drive the projector. It is not unusual for the primary power frequency to vary as much as 2 percent of its nominal value. In such synchronized transmissions the field scanning frequency must vary by the same percentage. At the moment there is no prohibition in the FCC standards against such variations; one result is the universal presence of vertical and horizontal hold controls in present-day television receivers.

Color Standards

In a compatible color system no such scanning frequency tolerances can be permitted. In fact, the horizontal and vertical scanning rates must be held to the same percentage as the color sync frequency, which must be held to ±0.0003 percent. This rather strict requirement for frequency synchronism is met by deriving the vertical and horizontal sync-pulse timing from the color-carrier source.

For this reason, it is customary in writing color system standards to state the horizontal scanning frequency, not as an absolute value, but as a fraction (2/455) of the carrier subcarrier frequency. According to the latest version of the NTSC specifications, the absolute value is 15,734.3. Similarly, the vertical frequency is expressed as a fraction (2/525) of the horizontal frequency; its absolute value is 59.92 cps.

In contrast to the stricter frequency-synchronism requirements, the phase-synchronism requirements of the luminance signal are the same as for monochrome transmissions; that is, 10 microseconds for vertical timing between successive fields to avoid pairing of the interlace, and 0.06 microsecond for horizontal timing to avoid loss of horizontal resolution.

The second carrier signal in the compatible system is the color subcarrier frequency whose value is 3.579545 mc ± 11 cps. The subcarrier is modulated in two ways, in phase to represent the hue, and in amplitude to represent the saturation, of the colors in the scene.

The color subcarrier has maximum amplitude for intense (highly saturated) colors, smaller amplitude for pastel shades (lower de-

Table I—Phase Synchronism Requirements in Color Television

Type of Sync	Frequency of Sync (in cps)	Permissible Phase Error (in microseconds)	Permissible Phase Error (in electrical degrees)
Sight-sound	5* (max)	100,000	180 (max)
Vertical	60	10**	0.22
Horizontal	15,750	0.06	0.34
Color (field-sequential)	144	230	12
Color (simultaneous compatible)	3,579,000	0.004	5

* Syllabic rate in speech or percussion beat in music, when source of sound is visible
** Between the initiation of two successive field scans

grees of saturation), and zero amplitude for the zero-saturation colors (white, gray and black).

The phase modulation of the color subcarrier represents hue by the phase angle of the carrier relative to a fixed reference phase. Thus, for example, in the so-called circular chrominance version of the NTSC signal, if the phase angle of zero degrees represents the blue primary, then an angle of 103.6 degrees represents the red primary and 243.5 degrees the green primary, while intermediate phase angles represent the intermediate hues of the spectrum.

Briefly stated, two synchronous demodulators measure the instantaneous phase of the color subcarrier against the fixed reference. Ultimately three color-difference signals are derived which, when applied to the picture tube in conjunction with the luminance signal, produce the hue and saturation values of the image while the luminance signal itself provides the brightness values.

Any error in the phase information recovered in the receiver produces a corresponding error in the reproduced hue. Such errors may occur due either to a shift in the fixed phase reference or to a shift in the phase of the subcarrier itself caused by noise or other disturbances.

There are, then, two factors that establish the requirements for phase synchronization of color sampling in the compatible system: (1) how much phase shift can be recognized by typical viewers as producing a noticeable shift in the hues of the image, and (2) how much noise can be tolerated before a phase shift greater than the tolerable amount is produced.

Phase Error

Recent tests[3], have indicated that a phase error of 10 degrees is tolerable, particularly if the observer has no prior knowledge of the correct hue. To be on the safe side, the NTSC is basing its investigations on a phase error of half this amount, namely 5 degrees, rms.

The permissible timing error corresponding to 5 degrees phase error is $5/360 \times 1/3.58 = 0.004$ microsecond. This requirement is 15 times smaller than the permissible timing error in horizontal sync. It is, incidentally, a timing error of one 250-millionth of a second, about 22 times smaller than the one 11-millionth of a second which the FCC worried about in 1949. It is, therefore, a very good question whether this timing accuracy can be maintained in practical color television receivers. The answer is, fortunately, yes, and by a safe margin against the effects of noise.

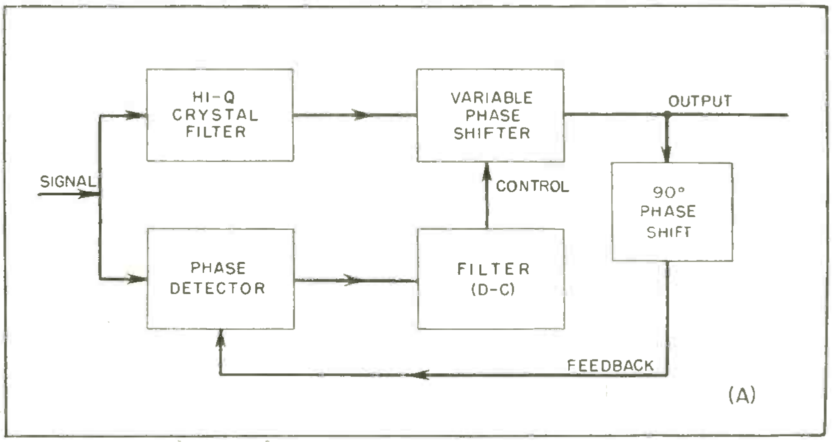

FIG. 6—Passive integrator circuit employs high-Q quartz crystal filter at subcarrier frequency, with 3-db bandwidth in order of 100 cycles. Circuit is sensitive to mistuning

To show that this is true, first consider the methods by which the fixed phase reference is established at the receiver. The reference phase is transmitted by the color sync signal, a burst of sine wave at the subcarrier frequency, imposed on the back porch of each horizontal sync pulse, as shown in Fig. 4. This sine wave, in the present version of the NTSC signal specifications, is in quadrature with the red-primary color difference signal. It will be noted that the lower half of this color burst extends below the blanking level and hence can produce a visible effect during horizontal retrace. However, in practice the brightening of the retrace is so small as to pass unnoticed. At the receiver, the color sync burst is used to control the phase of the color reference oscillator.

The ability of the burst to control the reference oscillator phase in the presence of noise has been under investigation for several years. One of the first studies of the problems[4] revealed that color sync performance was surprisingly good; the hues in the image were found to hold true even at noise levels so high that the vertical and horizontal sync systems were adversely affected. This work was done in 1950, but is was not then considered advisable to reveal circuit details. Now it can be revealed that the circuits used were remarkably like those of the present day. The reference oscillator used an L-C tuned circuit and was controlled by a reactance-tube automatic-frequency-control circuit. The reactance tube was in turn controlled by a phase detector that compared the phase of the L-C oscillator with that of the incoming color sync bursts. The phase detector output was passed through an R-C filter of 200-cps bandwidth.

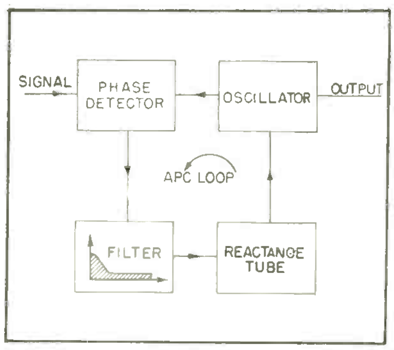

FIG. 7—Automatic phase control compares burst signal with oscillator

A recent study[5] of the performance of color sync in compatible color systems concludes that the automatic phase comparison circuit, of the type just described, can meet the phase error specification of 5 degrees, rms, against thermal noise whose rms value equals the peak value of the color sync burst, that is, at a signal-to-noise ratio of unity.

Moreover, more elaborate circuits, sensitive to frequency differences as well as phase differences, are found to possess a further safety factor that permits the circuit not only to hold the phase within the 5-degree tolerance once synchronization is established, but also to perform the more difficult task of pulling into phase synchronism after an interruption (as when switching from station to station) in a tenth of a second, that is, for all intents and purposes instantaneously.

Phase Comparison

The following figures, taken from Richman's paper,[5] show block diagrams of several types of phase control circuits.

Figure 5 shows the basic arrangement. The composite sync signal, fed in at the left, is gated by the line-deflection system so that the signal is passed only during the duration of the burst, thus cutting off noise occurring at other times. The separated burst is then limited to remove amplitude variations due to the remaining noise, and the burst is then ready for integration —that is, conversion into a stable phase in the reference oscillator as defined.

Integrators

Three types of integrators are discussed by Richman. The first is the passive circuit shown in Fig. 6. The gated and limited signal is passed to a narrow-band filter (piezoelectric quartz filters are needed to achieve the necessary high Q of about 35,000). This filter rings at the subcarrier frequency of 3.579 mc and has a 3-db bandwidth of the order of 100 cycles.

The signal is also fed to a phase detector where its phase is compared with the output phase through a feedback path. The phase detector output is filtered and the slowly-varying control signal, thereby derived, controls a phase shifter that corrects any phase variation in the output of the quartz filter. If suitably high Q filters are used, this circuit meets the phase specification, but it is open to some objection in that it is sensitive to mistuning.

The second circuit shown in Fig. 7 is the automatic phase control arrangement used in 1950 by Creamer and Burgett. The gated and limited burst signal is compared with the oscillator in a phase detector whose output is filtered and applied to the reactance tube. This circuit has performance roughly the same as the passive circuit but is less sensitive to mistuning.

A more elaborate circuit, described by Richman, is shown in Fig. 8. This circuit appears to provide a new order of phase synchronism performance when applied to a compatible color system. The additional elements, shown in heavy line, cause the reactance tube to respond to frequency changes between input and output. This improves the pull-in time following an interruption to the order of a tenth of a second, as compared with a second in the simpler circuits.

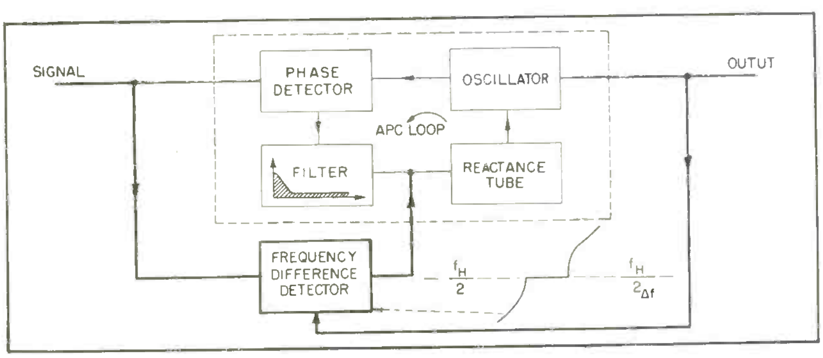

FIG. 8—More elaborate circuit adds frequency difference detector to Fig. 7, improves pull-in time after interruption to about 0.1 second

Conclusions

The conclusion is that the phase synchronism requirement of the NTSC signal can be met, not in one way but in several, despite the fact that the circuit is required to distinguish an error of one 250-millionth of a second.

Table I summarizes the phase synchronism requirements and states them, in the righthand column in electrical degrees.

Electronic science has learned to deal equitably with fractions of cycles, regardless of the absolute frequency, up to many millions of cycles per second. It is, in other words, almost as easy to measure 5 degrees at 3 megacycles as it is to measure 5 degrees at 60 cycles.

From this viewpoint, the most difficult synchronization problem in color television is not color phase. By a small margin, maintaining vertical scanning sufficiently precise to secure proper interlace is the most difficult problem. The phase angle requirement is 0.22 degree, twenty times as tough an assignment as 5 degrees for color phase in the compatible color system.

What is needed is a relaxation oscillator whose output displays highly constant amplitude irrespective of frequency variations. This oscillator should certainly prove discoverable.

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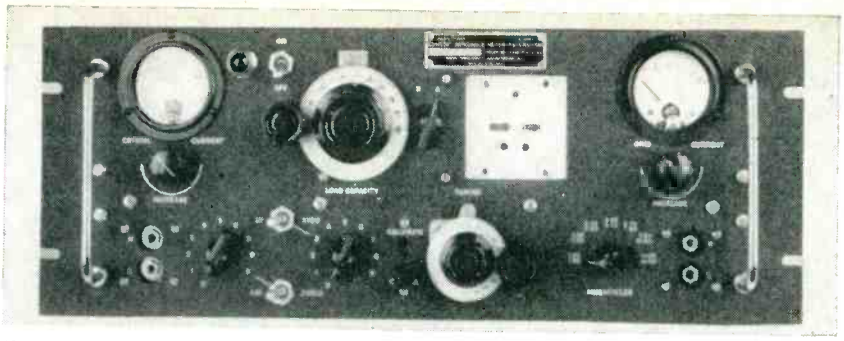

Front panel of crystal impedance meter covering range of 1 mc to 15 mc, used for production testing of finished quartz crystal units

Crystal Impedance Meters

Design and performance details of new crystal-checking circuit adopted by Armed Forces to replace reference standard test sets used in World War II for checking crystal units. Accurate measurements of crystal characteristics are essential for interchangeability

IT IS necessary, in case of military communication equipments manufactured and used in large quantities, that any vital component common to these equipments be standardized so that interchangeability is obtained. A typical example of such a component is the quartz crystal unit used for precise frequency control. In order that complete standardization of crystal units may be practically realized, satisfactory means of testing the conformance of the crystal unit to its specifications must be available.

Wartime Standards

Before and during most of World War II, crystal units were tested in circuits reasonably identical with the oscillator circuits in which they were to be used.

It was necessary to design crystal test sets which could be accurately adjusted to correspond to the various oscillator circuits used in different radio sets. These test sets, designated as reference standard test sets, had to be capable of maintaining their adjustments so that they could be used as standards by Signal Corps inspectors at the manufacturers' plants. Several types of such test sets were used, the best-known being the test oscillators TS-39/TSM and TS-221/TSM developed by the Bell Telephone Laboratories, and the CES-1 developed by Motorola.

For these test sets to be considered reliable, they had to be returned periodically to the Signal Corps Engineering Laboratories for check against the corresponding primary standard test sets. This procedure entailed a great deal of inconvenience and loss of time, without perfect assurance that the test set upon its return to use had retained its new calibration.

General Requirements

All of these arbitrarily established test sets had several faults. Their corresponding components had to be exact duplicates. Operating voltages were critical. They depended absolutely upon a meter reading, rather than relatively, to measure the activity of the crystal unit under test. The accuracy of any given test could be established only by a check or correlation against the corresponding primary standard.

It had long been accepted that crystal units should be specified and tested in terms of their equivalent electrical parameters, but practical means for such measurements were not available. To make these measurements, the idea which undoubtedly first came to mind was to use an impedance bridge; this and other forms of transmission networks were, indeed, used in laboratories. The use of a bridge for general testing of crystal units, however, requires a signal source which has frequency stability comparable to that of a crystal-controlled oscillator, is variable in frequency over a very wide range, has an accurate and finely divided frequency calibration, has low harmonic content and has sufficient power output for proper operation of the bridge. Construction and maintenance of such a signal source present rather formidable problems.

It is preferable that the crystal unit be used to control the fre-

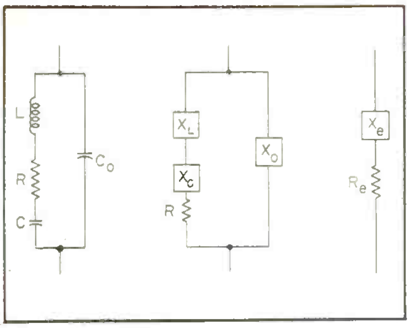

FIG. 1—Equivalent electrical circuits of crystal unit

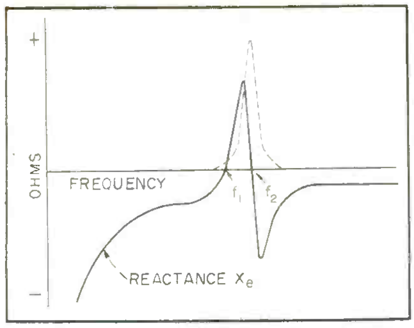

FIG. 2—Impedance characteristic of crystal unit

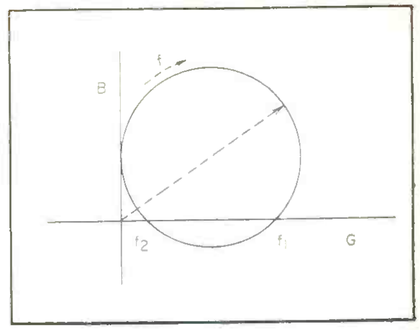

FIG. 3—Admittance diagram of crystal unit

Replace Test Sets

By A. C. PRICHARD and M. BERNSTEIN
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quency of the signal applied to its own measurement and be useful in a circuit capable of supplying enough power for these measurement purposes. If possible, the test circuit should be an accurate, reasonably simple and reproducible piece of equipment. Of greatest importance, it should be one which can be constructed and used at any place where accurate standards of impedance are available, without reference to any other crystal test set.

The crystal impedance meter described here is the result of attempts made at the Signal Corps Engineering Laboratories to satisfy these requirements.

Properties of Crystal Units

A crystal unit may be considered as having the equivalent electrical circuit shown in Fig. 1. The series arm, as indicated by L, C and R, represents the motional impedance of the quartz blank, and the capacitance C_0 in parallel with this motional impedance represents the static capacitance. This circuit has an impedance characteristic shown in Fig. 2, in which the solid line represents the reactance characteristic and the dotted line represents the resistance characteristic. The admittance diagram is shown in Fig. 3. This diagram should really have a shape similar to a Cartesian leaf, but as most of the pertinent variations in impedance of the crystal unit occur over a quite small frequency range, it can be shown as a circle.

In reality, a crystal unit has many resonance frequencies or responses, since the resonant element is a nonisotropic vibrating plate; the impedance and admittance curves would, therefore, indicate such response frequencies if truly drawn. These undesired responses usually are far enough removed from the main or fundamental response, however, that the simple circuit applies.

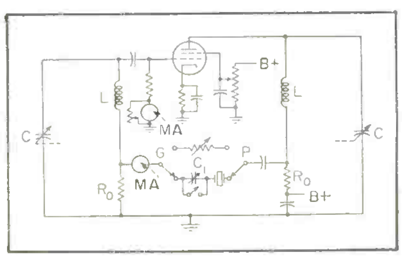

FIG. 4—Simplified circuit of crystal impedance meter

As shown in Fig. 2, there are two frequencies of zero reactance. One of them (f_1) is the frequency corresponding to the smaller of the two resistance values, and is termed the resonance frequency of the crystal unit. The second frequency of zero reactance (f_2), corresponding to the larger resistance value, is the parallel resonance frequency of the crystal unit. The region between f_1 and f_2 is the only one in which the crystal unit has inductive reactance.

Basic crystal-controlled oscillator circuits such as the Pierce and Miller circuits will oscillate only at some frequency (f_o) where the crystal unit is inductive. Thus, fortunately, neither circuit will oscillate when the crystal unit is out of its socket or when it is broken.

A crystal unit operating at its resonance frequency (f_1) must look into a load which is purely resistive. Otherwise, since it is an element of an oscillating circuit, it would have to develop a reactance equal and opposite to that of the rest of the circuit.

A crystal unit operating in the region between f_1 and f_2, where it is inductive, must look into a load reactance which is capacitive and of such a value as to result in the desired frequency of oscillation. This is a very important characteristic, because it imposes the requirement on the crystal unit manufacturer to adjust his crystal unit to the correct frequency when it looks into the proper load capacitance, and it imposes an equal requirement on the equipment designer to make his equipment present the proper load capacitance to the crystal unit.

In addition to frequency variations due to temperature fluctuations, the equipment designer should consider frequency variations which result from small and perhaps unavoidable deviations from the correct value of load capacitance. Crystal units are designed to reduce this error as much as possible, but its magnitude may be of the same order as that due to temperature variations (except for overtone crystal units, which have extremely small values of motional capacitance C and which usually are operated at resonance).

In order that crystal units may be standardized, specifications of standard load capacitances must be established. Such standardization has been effected to a large degree for crystal units used by the Armed Services.

Crystal Impedance Meter

The crystal impedance meter circuit is essentially a tuned-grid tuned-plate oscillator circuit in which the crystal unit to be tested is placed in the main feedback path. The crystal unit thus controls the oscillation frequency of the circuit and the amplitude of oscillation. The basic circuit diagram is given in Fig. 4.

The crystal unit parameters are measured by application of the principle of substitution: In any system, if an element of the system is removed and a substitute element inserted in its place so that the original set of boundary conditions is satisfied and no new ones are added, then the substitute element is operationally equivalent to the original element.

In the case of the crystal impedance meter circuit, the boundary conditions are the oscillation frequency and the amplitude of oscillation as measured at some point in the circuit. If a network of resistance and reactance be substituted for the crystal unit, so that the oscillation frequency and amplitude are the same as they were before the substitution, then the network represents the crystal unit at that particular frequency and amplitude of oscillation.

A crystal unit usually is operated either at resonance, where it appears as a pure resistance, or at antiresonance, where it looks like an inductance. At antiresonance operation, if the correct value of load capacitance is connected in series with the crystal unit, the combination of crystal unit and load capacitance appears at the correct operating frequency as a pure resistance. In either case, therefore, a resistance of appropriate value may be substituted for the crystal unit or for the combination of crystal unit and load capacitance. This value of resistance is, then, the effective resonance resistance or the effective antiresonance resistance, as the case may be.

The values of the other parameters may be determined from Eq. 1, 2, 3, 4 and 5 in the appendix. Equation 6 relates to frequency stability, and Eq. 7 defines a limiting condition of operation.

In use of the crystal impedance meter the exact resonance frequency or antiresonance frequency of a crystal unit may not be known, nor is it necessary for it to be known to measure the effective resistance values. The circuit is first tuned to the approximate frequency. Then, by alternately switching the crystal unit and the substitution resistance in the circuit, and by adjustment of the value of the substitution resistance and of the circuit tuning, the frequency and amplitude of oscillation may be set at values which remain constant

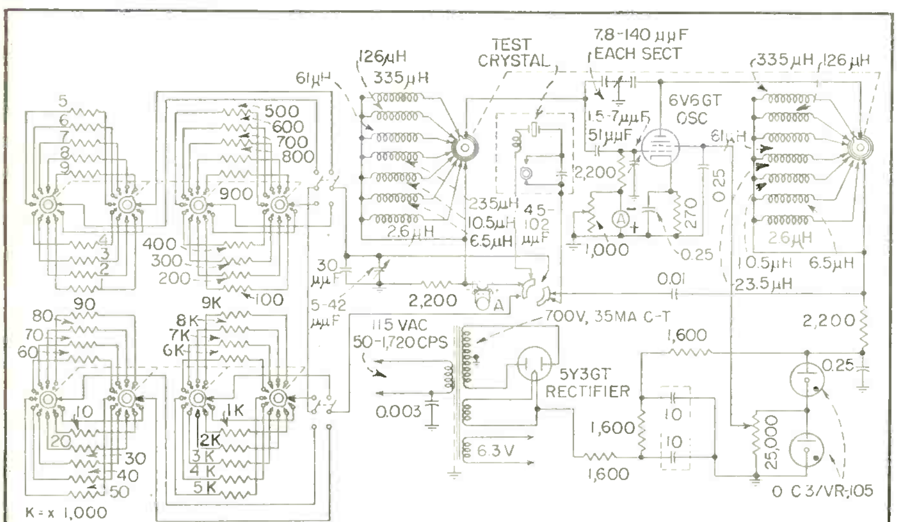

FIG. 5—Circuit of TS-330/TSM crystal impedance meter covering range of 1 mc to 15 mc now adopted by the Armed Forces as a standard test instrument

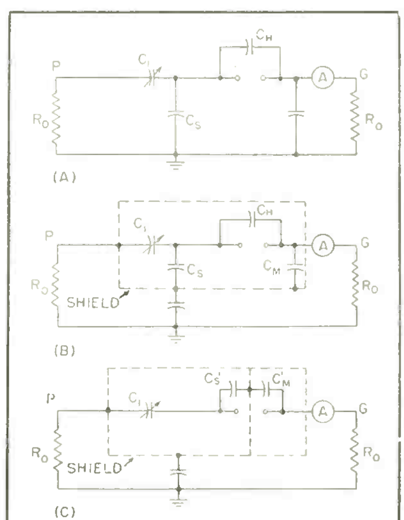

FIG. 6—Evolution of socket shield for crystal tester

when either the crystal unit or the substitution resistance is in circuit. This cycle of adjustment may appear to be complex, but in fact must be gone through only two or three times before quite complete satisfaction of the boundary conditions occurs. These adjustments may be thought of as analogous to the resistance and reactance adjustments performed in balancing an impedance bridge.

Front panel of newest addition to crystal-testing series, the TS-683/TSM. This is intended for the range of 10 mc to 75 mc, but has actually been calibrated up to 140 mc

General Description

The two crystal impedance meters which have been adopted by the Armed Forces as standard test instruments are the TS-537/TSM which covers from 75 kc to 1,100 kc, and the TS-330/TSM which covers from 1.0 mc to 15 mc. Each instrument is used to test crystal units at resonance or at antiresonance over a range of load capacitance of from 12 $\mu\mu$f to 120 $\mu\mu$f. The detailed circuit diagram of the latter impedance meter is given in Fig. 5.

The projected TS-683/TSM standard test set to measure military crystal units over the frequency range of 10 mc to 75 mc uses the same basic circuit but differs in design. Since this test set is primarily intended for measurement of crystal units at resonance, no built-in load capacitance is provided. Tuning is by inductance variation rather than by capacitance variation.

Design Features

The exact boundary conditions which obtain when a crystal unit is in the circuit cannot be satisfied completely by the substitution of a resistor, because a resistor does not discriminate against harmonics generated by the oscillator tube. In other words, new boundary conditions (new values of harmonic frequency amplitude) are added. An increase in amplitude of harmonics tends to reduce the fundamental-frequency signal amplitude on the oscillator tube grid, percentage-wise. for a given value of grid current.

As the amplitude of oscillation is primarily dependent upon the fundamental frequency and not its harmonics, the amplitude of oscillation tends to decrease. The value of the substitution resistance must be reduced, therefore, to permit the oscillation amplitude (as measured by rectified grid current) to build up to the value observed when the crystal unit was in circuit. This reduction results in an incorrect value of resistance being observed. Discrimination against harmonics is quite good in the crystal impedance meter, however, and negligible error results; both grid and plate circuits are tuned quite closely to the operating frequency.

The presence of crystal socket capacitance can cause an appreciable error in the measured value of effective resistance at antiresonance operation of the crystal unit; this error is

$$\frac{dR_e}{R_e} = \frac{2C_h}{C_o + C_L}$$

where C_h = socket capacitance, R_e = effective resistance at antiresonance, C_o = holder capacitance and C_L = load capacitance.

As an example, let $C_o = 7$ $\mu\mu$f, $C_L = 25$ $\mu\mu$f and $C_h = 1$ $\mu\mu$f. Then $dR_e/R_e = 2/32 = 0.0625 = 6.25$ percent.

At resonance operation of the crystal unit, however, errors due to holder capacitance are negligible. The effect of socket capacitance, in any case, is virtually eliminated by means of a cross-socket shield which transfers this capacitance so that it is effectively in parallel with the coupling resistors R_o.

In both versions of the crystal impedance meter, the substitution resistance is made up of either a single resistor or of two resistors of proper values, selected by means of the decade switches. If two resistors are selected, as is usually the case, they are connected in series; in this case there is, unavoidably, stray capacitance to ground between the two resistors.

Errors

For very high values of resistance, this network may introduce enough reactance in the substitution network to result in large errors. Fortunately, these errors are small over the resistance and frequency ranges as specified for standard crystal units used by the Armed Forces; there is a considerable safety factor except for the minimum-quality (highest allowable resistance) crystal units at the very lowest frequencies. In any case the errors caused by this network may be eliminated, when quite accurate results are desired, by inserting a variable resistance of low capacitance in the socket and not using the decade resistance at all.

Other Considerations

In the design of the crystal impedance meter circuit, logical precautions were observed to assure that the measurement accuracy be as great as possible.

Either the crystal unit or the substitution resistance of Fig. 4 may be switched into the feedback path. When the crystal unit is in the feedback path, the selector switch is said to be in the crystal position; when the decade substitution resistor is in the feedback path, the selector switch is in the calibrate position.

For resonance operation of the crystal unit, the capacitor in series with the crystal circuit is short-circuited; for antiresonance operation this short-circuit is removed and the capacitance set to the value of load capacitance specified or desired for the crystal unit being measured.

With the selector switch in the calibrate position, the substitution resistor operates at an impedance level, above ground, of usually less than 200 ohms. In the crystal position and with the crystal unit operating at antiresonance, however, the stator of the load capacitor, the shorting switch, and the adjacent terminal of the crystal socket may operate at an impedance level above ground of many thousands of ohms. The load capacitor, shorting switch and crystal socket must therefore be constructed of low-loss dielectric material, and no stray capacitance can exist between these components and ground. If such precautions are not observed, errors in measured values of effective resistance and operating frequency will result. These elements are inclosed in a shield box, with the rotor of the variable capacitor electrically connected to the box. In this way, stray capacitance is collected by the shield can and appears as a small capacitor in shunt with the series load capacitor; this is taken into account in the calibration of the capacitor. The shield box is insulated from chassis ground and is connected into the circuit as shown in Fig. 6. A test set intended for making equivalent resistance measurements only at resonance can be made without this shield box (as for example, the TS-683/TSM).

It is necessary that the circuit containing the substitution resistance be identical with that containing the crystal unit as far as stray admittances are concerned. The shield box described above has a capacitance to chassis of between 50 and 100 μμf. The substitution resistance circuit has capacitance added so as to make the total of stray and added capacitance equal to that of the circuit containing the shield box.

At higher frequencies, another important requirement is the necessity for balance between the stray lead inductances of each circuit. The lead length usually is greater

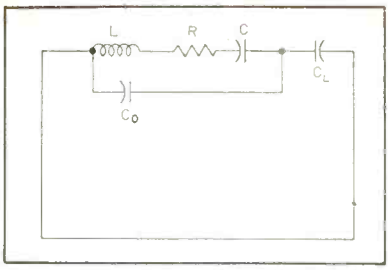

FIG. 7—Crystal unit connected to its load impedance

in the resistance substitution circuit, and a small compensating inductance must be added to the crystal circuit. This inductance adjustment is made after the capacitance balance has been achieved.

An important design consideration is the ratio of C to L in the grid and plate resonant circuits. A large ratio results in a low loop gain around the circuit and, consequently, high values of circulating r-f current. This current travels through the crystal unit and results in excessive power dissipation in it.

The grid and plate inductances are alike within a tolerance of ± 0.5 percent and the two sections of the variable tuning capacitor track within ± 2 percent throughout the capacitance range. The grid and plate circuits are adjusted to correct any unbalance caused by differences in the input and output capacitances of the oscillator tube and by stray wiring capacitance. In general, it is necessary to reduce the maximum capacitance as the frequency of operation is raised. Above 20 or 30 mc it is desirable to use a variable inductor for tuning, as small C/L ratios are more readily obtainable by so doing.

Since the main feedback path is that which includes the crystal unit, a reasonable amount of care is taken in placing other circuit components so as to avoid coupling between them. Coils are well separated and shielded from each other, and circuit wiring is placed to avoid stray coupling as much as possible.

Performance

Measurements were made of simulated crystals, or combinations of physical inductance and resistance, which at a given frequency have reactance and resistance values similar to those of representative crystal units. These simulated crystals were used, rather than actual crystal units, because they are linear networks; that is, their reactance and resistance do not change over large ranges of current through them. This is not true in the case of crystal units. Agreements obtained between measurements made with the 1 to 15 mc crystal impedance meter and a General Radio twin-T bridge at various frequencies were within 1 percent for reactance values, within 5 percent for resistance values when using the built-in decade substitution resistance and within 1 percent for resistance values when using a low-capacitance variable resistor, inserted in the crystal socket, instead of the decade resistance.

Development of the crystal impedance meter in its various forms covered a period of several years, during which M. Bernstein accomplished most of the actual design work and model construction. C. J. Miller (now with Ohio Brass Co.) and G. Bower (now with National Bureau of Standards) contributed to its development.

Appendix

Crystal unit parameters

$$C = 2(C_o + C_L)\left(\frac{f_o - f_1}{f_1}\right) \qquad (1)$$

$$L = \frac{1}{4\pi^2 f_1^2 C} \qquad (2)$$

At antiresonance

$$R_e = R\left(\frac{C_o + C_L}{C_L}\right)^2 \qquad (3)$$

At resonance

$$R_e = \frac{2R}{1 + \sqrt{1 - \left(\frac{2}{Q} \cdot \frac{C_o}{C}\right)^2}} \qquad (4)$$

Note that $R < R_e < 2\,R$ when $Q = 1/2\,\pi\, f_1\, CR$ lies in its permissable range of values of $(2C_o/C) < Q < \infty$.

$$\text{PI} = \frac{1}{4\pi^2 f_o^2 C_L^2 R_e} \qquad (5)$$

where Performance Index (PI) is the impedance of the crystal unit and its load capacitance at antiresonance, as shown in Fig. 7.

Frequency stability

$$\frac{\Delta f}{f_o} = \frac{-\,CC_L}{2(C_o + C_L)^2} \cdot \frac{\Delta C_L}{C_L} \qquad (6)$$

A crystal unit cannot be inductive when

$$R > \frac{1}{4\pi f_o C_o} \text{ or } R_e > \frac{1}{2\pi f_o C_o} \qquad (7)$$

UHF Mobile Antenna

Center-fed vertical antenna eliminates transmission-line interference by using shield of coaxial feed line as lower half of antenna. Moulding the assembly in low-loss plastic gives structural strength

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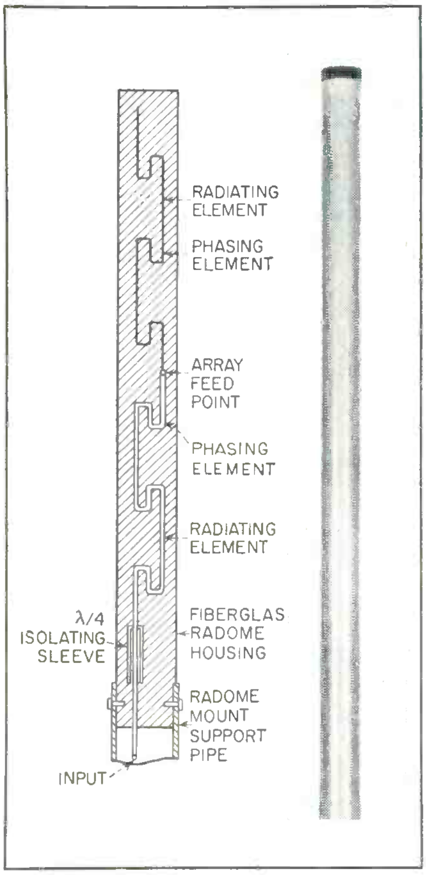
ANTENNA gain can be obtained by stacking vertical elements and feeding them in phase.[1,2,3] But vertical radiating elements present problems for the designer, who must fabricate means of support and also arrange to feed each element with the proper magnitude and phase of energy. Use of a vertical metallic support with vertical radiating elements causes distortion of the radiation pattern due to excitation of the support. The feed system may also cause a distortion of the pattern since it is general practice to employ coaxial cable feeders which must run to the elements from below.

Effective operation of this type of array generally demands a symmetrical feed, so that the feed normally would progress from the center elements outward. Bringing the feed to the center of the array through a coaxial cable requires that it pass in proximity to the lower elements of the array and thereby distort the radiation pattern.

At the lower frequencies and up to about 100 mc stacking is not used because of the size of the half-wave element. At about 150 mc it has been found economically sound to employ up to three half-wave elements to produce gain in an omnidirectional array. With the advent of new mobile services in the 450 to 470-mc region applications will demand the use of many vertically stacked radiating elements.

The element is about 12 inches overall so that a simple half-wave radiator presents a very meager aperture, however its short length allows many units to be stacked in an economically realizable structure should the support and feed problem be solved in a practical manner.



Seven-element array and cross section showing coaxial element imbedded in Fiberglas tube

It is believed that the antenna to be described here produces the desired radiation pattern in an economical, easily manufactured form.

Development

Reference to Fig. 1A shows a configuration that was first described by Franklin.[4] The feed point should be at the center of the unit to produce a symmetrical pattern that is not particularly frequency sensitive. When the antenna is used in a horizontal plane the feed is easily brought to the radiator with a transmission line, but with vertical polarization the feed line would run parallel to the lower elements.

It is necessary to provide support for the configuration and if a metallic support is used it would cause trouble. Basically the feed line and support would disturb the radiation pattern, making it other than omnidirectional in azimuth, and excitation of the line would cause high-angle radiation.

Coaxial Antenna

A method for preventing transmission-line interaction with the elements of the array is shown in Fig. 1B. A coaxial line is bent to form the radiating elements and phasing sections of the lower portion of the array shown in Fig. 1. The center conductor of the coaxial cable is extended from the feed point and bent to form the upper half of the antenna.

A quarter-wave isolating sleeve suppresses radiation from the line below the lowest half-wave section. The suppressor section actually forms the lower portion of the bottom radiating element.

Another embodiment described in the Franklin patent is shown in Fig. 1C. Again pattern interference would result if the transmission line were run alongside the array. Figure 1D shows the details for combining the integral coaxial feed system and lower quarter-wave isolating section with the basic configuration of Fig. 1C to prevent interaction of the feeder and allow for the use of vertical polarization.

In both Fig. 1B and 1C the outer surface of the coaxial line is substituted for the lower portion of the array since it may be bent into the desired form. The inner surface of the outer conductor then becomes the outer conductor of the coaxial feed line. By this means excitation takes place at the center of the array as desired.

Support

As has been mentioned a metallic support for the type of array under discussion would interfere seriously with the radiation pattern. This difficulty is overcome by using a support tube fabricated of molded Fiberglas cloth and polyester resin. Applications of this material in low-loss, high-strength radomes have proved its practicability. The antenna array and coaxial line are molded into the tube and the tube is fitted with a metallic support mast at its lower end. The molded tube supports and seals the array from the effects of weather.

Figure 2A shows the results of measurements made on a seven-element array. The vertical pattern is considerably narrower than that of a half-wave dipole. With this type of antenna and feed it has been possible to obtain beam widths of the order of 10 deg using ten or more radiating elements. Practical considerations indicate that the most economical arrangement for maximum gain with practical design is reached with seven elements and their associated phasing sections. For a 450-mc unit this results in an overall length of about nine feet plus the metallic support mast.

Although maximum gain is generally to be desired there are applications where size and weight must be considered. Therefore arrays employing as few as three elements will have considerable utility at 460 mc. The radiating aperture in this case is somewhat less than 4 feet. The measured vertical pattern of a three element array is shown in Fig. 2B. The 28-deg total beam width shows considerable improvement over that of a dipole and the measured gain for this unit is 4 db above a half-wave dipole. For the seven-element array shown in the photograph and drawing, the measured gain is 7.2 db above a dipole.

Figure 3 shows a typical vswr versus frequency curve for these arrays. Over the range from 440 to 450 mc the match is 2 to 1 or better and only goes to 2.2 to 1 at 470 mc. Thus it is possible to employ a single design to cover a rather wide range of applications.

Beam Tilt

Preliminary propagation study in the 450-mc region for central station to vehicle communication indicated that much of the utility of this range within urban limits stems from reflections making it possible for the signal to penetrate between high buildings and even into tunnels.

While it is always desirable to utilize antenna gain by restricting the vertical pattern to a narrow beam, in this application another factor appears which allows the designer further to increase the antenna efficiency even though he may have reached the limit of antenna gain obtainable by narrowing the vertical pattern. The vertical radiation patterns show that the maximum of the beam falls on the horizon. In vehicular service the half of the energy above the horizon is wasted since it never excites an antenna near the ground. If however the beam is tilted downward more of the total radiated energy will be used. Actually such tilt will cause increased illumination of the primary area and propagation via reflections should improve. It has been found desirable to tilt the beam down so that the upper half-power point falls on the horizon. This does not decrease the signal at the fringe a great deal but it does greatly increase the illumination of

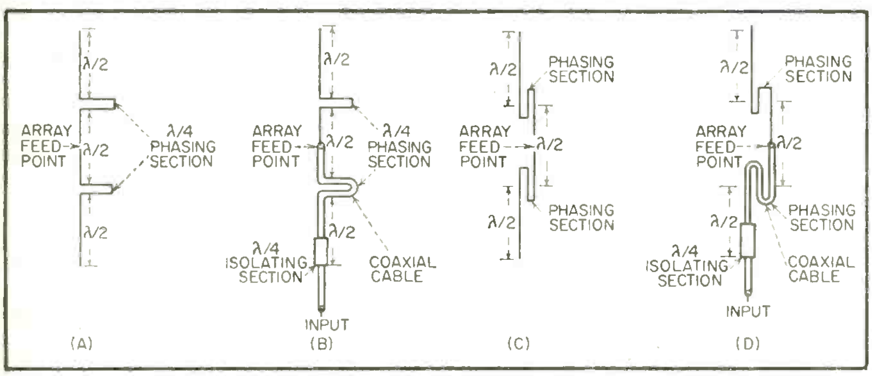


FIG. 1—Development of antenna system from two arrangements of the Franklin colinear array (*A* and C). The portion of the antenna above the feedpoint, in *B* and *D*, is an extension of the center conductor of the coaxial cable. Outer shield of cable is used as lower portion of radiator. A quarter-wave isolating sleeve terminates lower radiator in this type of arrangement.

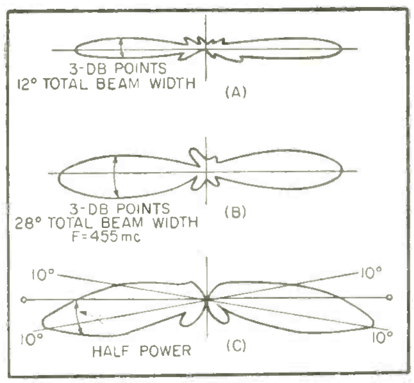


FIG. 2—Radiation patterns of three arrays. Pattern of seven-element unit is shown at *A* and a three-element unit in *B*. Pattern C is produced by a five-element array with 8-deg beam tilt

the primary communications zone. In the case of a five-element array producing a 16-deg beam width the tilt should be approximately 8-deg. Under these conditions the gain on the horizon is still considerably above that of a dipole.

With the array described it is a simple matter to tilt the beam either up or down by adjustment of the feed point. The total beam width remains essentially uniform even though tilt is introduced and the adjustment does not seriously affect the bandwidth of the match to the transmission line. Figure 2C shows the measured pattern of a tilted beam five-element unit constructed essentially as the units previously described except that a variation in the symmetry of the feed point at the center of the array has been introduced.

In the end-fed array the electrical spacing of the elements and therefore the phase of excitation of the radiating elements is a function of frequency. The inclination of the phase front of the antenna is therefore also a function of frequency.

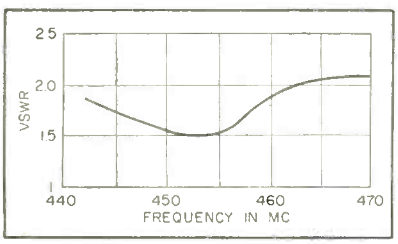


FIG. 3—Graph of vswr versus frequency for a seven-element antenna

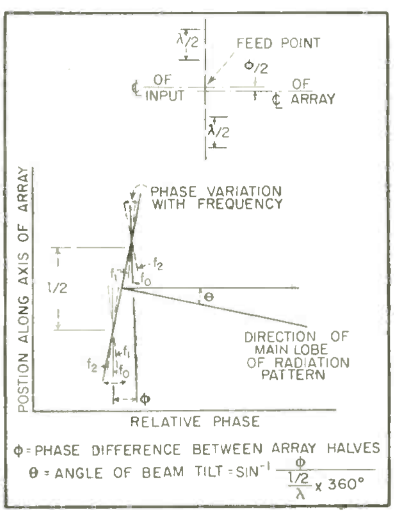


FIG. 4—Relation of beam tilt to displacement of feedpoint from center

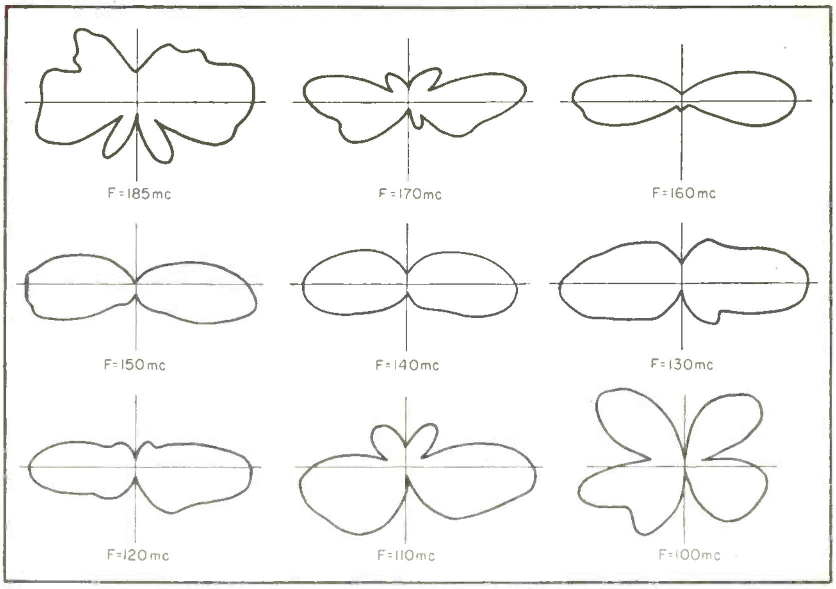


FIG. 5—Radiation patterns of three-element array at various frequencies

Because the direction of maximum radiation is perpendicular to the phase front the position of the beam maximum varies with frequency.

To prevent beam-tilt variation, the antenna array should be fed at its center. The two halves of the antenna are thus excited by two waves propagated in opposite directions from the center, with the result that the tilt variations of the halves are in opposite directions. These opposed tilt variations cancel and the resultant beam of the complete array has no tilt variation with frequency. As illustrated in Fig. 4, beam tilt is obtained by displacing the feed along the array axis from the center of the array. This causes a phase difference between the halves producing the proper beam tilt.

Bandwidth

It is well known that the end-fed colinear design exhibits a marked frequency sensitivity in that the pattern will break up at frequencies slightly removed from the design frequency. To check the sensitivity of this center-fed design, a three-element unit was constructed and measured. The design frequency of 150 mc was chosen since bandwidth requirements are more severe in applications in this region. The measured radiation patterns for the three-element unit are shown in Fig. 5. Frequency range covered is from 100 mc to 185 mc. At 100 mc the pattern has become multilobed and is not suitable for the required service. However from 110 mc through 185 mc the vertical patterns hold up very well with the highest gains occuring from 140 through 160 mc. This represents a satisfactory operating bandwidth of more than 50 percent, a value greater than originally expected.

Complicated cabling harnesses are not required. The structure is rigid and circularity of the horizontal pattern is excellent since symmetry is well maintained. Power gains depend upon the number of elements employed and the only limitation is overall physical length which may be handled economically. No metallic mast is present to disturb the field pattern and the decoupling sleeve on the lowest element effectively isolates the feed line from radiation effects. Material requirements are kept at a minimum; the only metallic components are the elements and the coaxial line. In addition most of the components used in the fabrication of the antenna may be constructed of noncritical materials.

The assistance of members of the laboratory staff is gratefully acknowledged for construction of prototypes and extensive measurements of patterns and impedance.

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(1) Hansell, U. S. Patent No. 2,113,136.
(2) Scheldorf, *FM and TV*, Sept. 1950.
(3) Lindenblad, U. S. Patent No. 2,199,375.
(4) Franklin, U. S. Patent No. 1,957,949.

Measuring Wavelength

Optical methods employing the diffraction grating spectrometer, Boltzmann interferometer and the Michelson interferometer can be used to plot wavelength in the centimeter and millimeter regions. Measurements described were made on klystron and magnetron sources as well as the Righi doublet

FREQUENCY and wavelength measurements become increasingly difficult when the highest frequency boundary of the radio spectrum is extended beyond centimeter wavelengths into the millimeter region. Transmission line and cavity resonator techniques of the centimeter region become useless as the physical dimensions of the measuring circuit diminish and practically disappear with increasing frequency. In addition to the diminishing dimension problem, many of the sources used at these short wavelengths are of a broadband character and frequently have erratic variations with time. The problem clearly calls for a solution suitable for extremely short wavelength and quite different from conventional radio techniques.

With increasing frequency, electromagnetic radiation is found to exhibit more and more optical properties, so it is logical to examine the wavelength measuring techniques of optics for possible modification to cm and mm wavelengths. Such optical techniques have been used by a number of investigators from the earliest in 1925[1], to very recent studies. In most cases diffraction gratings have been used, including echelon, venetian-blind and slit systems.

Three Techniques

A comparison of several types of optical methods has been made, using nearly identical components, to determine which can be most easily utilized for free-space determinations of wavelength, and which, under similar conditions will yield the greatest accuracy.

Consideration of those optical techniques that seem most suitable led to the investigation of the diffraction grating spectrometer, the Boltzmann interferometer and the Michelson interferometer. These devices are described in the form used for cm wavelengths measurements by the authors.

Diffraction Grating Spectrometer

In Fig. 1 the essential parts of a diffraction grating spectrometer are shown. Source and receptor are mounted on movable arms to permit setting for any desired incidence and diffraction angles about the normal to the plane of a grating. The grating consists of slots milled in a metal plate of some definite slot width and spacing as required for the experiment.

Moving the receptor arm about its axis will cause maxima of received signal strength to be found at diffraction angle d related to the incidence angle i and the wavelength by the formula $\lambda = s/n$ (sin i + sin d) where s is the slot spacing and n is the order of the spectra. Thus for a given slot spacing, observed values of i and d for maxima of signal, with the integer representing the order of the spectrum, serve to determine the wavelength of the source.

In this apparatus the gratings were aluminum sheets with milled slots, while the source was an electromagnetic horn excited by a waveguide from the several sources. The receptor was a similar horn exciting a waveguide containing the detector.

Microwave crystals and bolometers of both the barretter and thermistor type were used. The crystal detectors were used for all measurements at wavelengths of a few centimeters, but the bolometers are to be preferred for shorter wavelengths.

Boltzmann Interferometer

Figure 2 shows the essential parts of a Boltzmann interferometer as used by the authors. In this device, the source and receptor are mounted side by side, the signal reaching the receptor by reflection from the plates. Normal incidence was preferred although other suitable in-

Table I—Wavelength Measurements On Several Sources

Method	Source	Number of Observations	Mean λ cm	Probable Error, Single Observation	Probable Error, Mean
Grating Spectrometer (4 grating spacings, 6 different incident angles)	klystron	31	3.167	±0.256	±0.046
Boltzmann Interferometer	klystron	3	3.073	±0.156	±0.090
Michelson Interferometer	klystron	14	3.062	±0.109	±0.029
Michelson Interferometer	60-cycle spark	6	2.946	±0.017	±0.007
Michelson Interferometer	pulsed spark (different electrodes from 60-cycle spark)	6	3.015	±0.073	±0.030
Michelson Interferometer	1.25 cm magnetron	14	1.2495	±0.0093	±0.0025

in Millimeters

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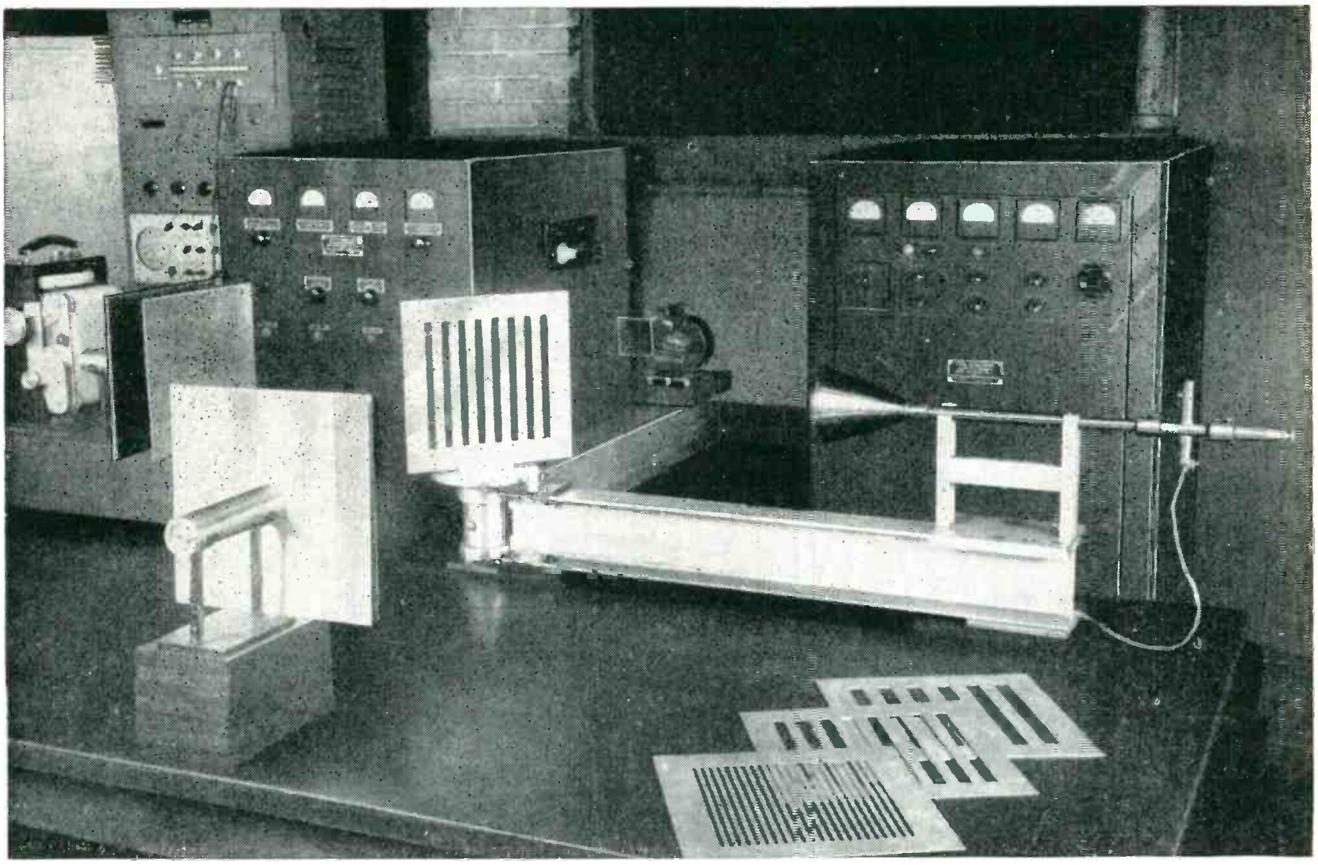


Michelson interferometer arrangement of equipment for determining frequency with a 1.25-cm magnetron. These components can be rearranged for Boltzmann interferometer measurements or as a diffraction grating spectrometer

cidence and reflection angles may be used. The two reflecting plates, one fixed in position and the other movable in a direction normal to their parallel planes, are so proportioned as to contribute equally to the signal received, and therefore must have about equal effective reflecting areas. This maximizes the interference effects that are the basis of measurement in this particular device.

As the distance between the movable and fixed plates is increased, the signal path length to the movable plate is reduced while that to the fixed plate remains constant. This change in path length causes a proportional change in relative phase of the signal components received from the two plates.

Thus as the one plate is moved by its micrometer drive, the received signal level goes through alternate maxima and minima, the maxima occurring when the two path lengths differ by an integral number of wavelengths giving in-phase addition of the two signal components. Minima of signal occur when the path lengths differ by an odd number of half-wavelengths. Complete cancellation is obtained if the plate areas are proportioned so that the two signal components are of equal intensity.

Since a given displacement of the movable plate causes its reflected path length to decrease by twice that amount, the wavelength is twice the distance between adjacent nulls on the resulting plot of signal intensity versus plate displacement. Care must be taken with other than normal incidence that multiple reflections between the fixed plate and the back of the movable plate do not occur or a much shorter wavelength

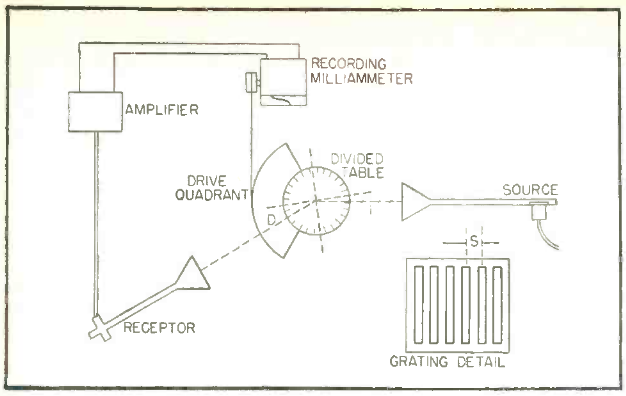


FIG. 1—Diffraction grating spectrometer

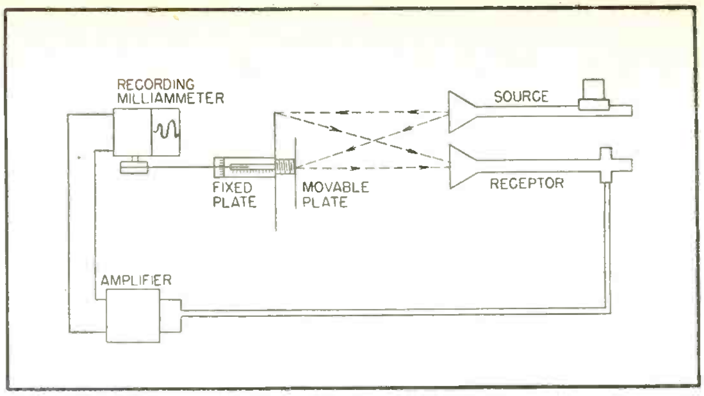


FIG. 2—Boltzmann interferometer

than that of the source could thus be indicated.

Michelson Interferometer

The Michelson interferometer is similar in principle to the Boltzmann, depending upon difference in two path lengths causing an interference pattern when one reflecting plate is moved. However, the arrangement of path lengths is as shown in Fig. 3, necessitating the use of what might be termed a half-silvered mirror. In optical applications the device is literally a half-silvered mirror. In these cm wavelength applications it is a plane of material that transmits one half and reflects one half of the incident radiation.

At frequencies in the neighborhood of 10,000 megacycles the reflection and transmission of ¼-inch black tempered Masonite is such that a good approximation of a half-silvered mirror is obtained. Spectrometer gratings of equal slots and lands are also satisfactory.

Examination of the signal path lengths in this arrangement shows, as in the Boltzmann, the wavelength is twice the movable plate displacment between adjacent nulls. While similar to the Boltzmann in principle and results, the Michelson is preferable for many generators where the side by side placement for normal incidence with the Boltzmann is not practical.

Recording Meters

All of the devices lend themselves especially well to use with recording meters. The desirability of a recording technique becomes evident when considering erratic variations with time of the output of some experimental sources used at these frequencies. Use of a recording meter eliminates the necessity of point-by-point plotting of spectra and interference patterns, gives increased accuracy to such plots and allows a wavelength determination to be made in a short time. The effect of slow variations of generator output level is thus removed. Recording techniques are mandatory in using spark-excited Righi doublets.

An Esterline-Angus recording milliammeter was used with a mechanical linkage provided for chart displacement directly proportional to the angular or linear displacement of the movable element. Motor drive of the movable element may be used further to facilitate the rapid accumulation of data.

Signal Sources Used

Modulated sources were used because of the ease of amplifying the detected output to a suitable magnitude with conventional audio amplifiers, although d-c amplifiers were also used with unmodulated sources. The modulation of the source was detected by the crystal in the receptor, amplified and rectified so as to apply to the recording meter a d-c signal whose amplitude is proportional to the received signal.

The variation of the amplitude occurring in the spectra or interference patterns thus appears on the meter chart in a convenient form. In the case of the interference patterns, use of the displacements for several nulls rather than simply one yields greater accuracy of the wavelength determination, a technique that is standard in such measurements.

These optical types of wavelength measurements were applied to several centimeter wavelength sources. A 3-cm klystron, a 1.25-cm pulsed magnetron, and a Righi doublet excited both by 60-cycle sparking voltage and pulsed d-c were used.

It is interesting to note that the last source mentioned is of the same type as that used by Nichols and Tear in 1925[2] to extend the known radio spectrum to 0.42 millimeter, with the exception that a modern magnetron pulser was used in place of the mechanical commutating d-c supplies used by the early investigators.

The Righi doublet consists of two short thin cylinders of tungsten placed end to end with a narrow spark gap in kerosene between their adjacent ends. A spark is caused to jump the small gap by employing a high voltage to break down two large secondary gaps from the power source to the extreme ends of the cylinders. This energizing of the primary gap causes the Righi doublet to generate and radiate electromagnetic radiation of a wavelength very roughly equal to twice the overall length of the doublet. This type of generator has been used by several investigators with various values of the ratio of wavelength to doublet length reported. The Righi doublet is critical as to primary gap adjustment and at best has rather appreciable erratic variations of output with time, making the recording technique described above essential for good wavelength measurements.

Description of Apparatus

Essential features of the equipment used are shown in the photograph. The arrangement is for the Michelson interferometer measurement on a 1.25-cm magnetron. Power supply, modulator and pulsing units are shown in the background as is the magnetron and its radiating horn, while the receptor horn and detector mount are shown on the right. The half-silvered mirror, in this case a grating with equal slots and lands, is shown in the center, while other typical gratings are in the right foreground. The recording milliammeter is on the left, with the movable reflecting plate. The micrometer drive provided for motion of the plates is evident as the cylindrical portion of the plate assembly, shown in the left foreground.

These items of equipment may be rearranged for use as a Boltzmann interferometer and as a diffraction grating spectrometer. For the interferometer, this simply necessitates the repositioning of the transmitter and receptor elements, and one of the reflecting plate assemblies, to provide the desired signal paths. The two reflecting surfaces required are provided by one of the plate assemblies with the front plate replaced by a smaller one of properly proportioned area as previously described.

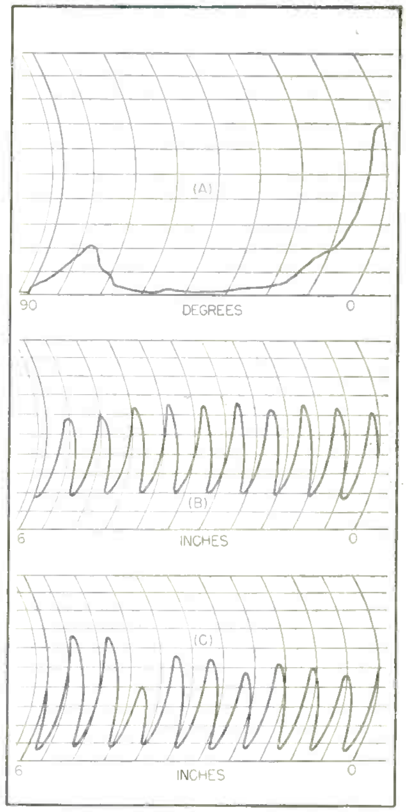
To use this equipment as a diffraction grating spectrometer, the reflecting plate assemblies are removed. The aluminum channels shown in the photograph are the arms of the spectrometer. A central axis is provided about which the receptor arm moves as shown in the functional diagram, Fig. 1. The grating mount may be independently rotated about the same axis to permit setting for any desired incidence angle, and has a graduated face plate from which incident and refraction angles may be read. A mechanical linkage was provided for recorder chart displacement proportional to angular movement of the receptor arm.

Results

Measurements of wavelength were made on several microwave sources with results as given in Table I. It will be noted that the measurements using the Michelson interferometer arrangement show the best agreement and seem to be the most satisfactory and convenient of the three systems used. No anomalous conditions were encountered with this method and it can easily be extended to much shorter wavelengths than those reported in this paper. Probable errors as tabulated show the agreement between observations of the same type and are of course no indication of the absolute validity of the wavelength values reported.

Typical data charts for the various measuring schemes on several sources are shown. The actual charts used for the tabulated measurements had a larger ratio of chart displacement to movable element displacement for increased accuracy, but otherwise are identical with the typical charts shown.

The pulsed spark measurements yielded a mean wavelength of 3.015 cm for a Righi doublet 1 cm long. This gives a ratio of wavelength-to-doublet length of 3.0 as compared to 2.8 reported by Nichols and Tear.[3] It is considered in good agreement because of the variation of the ratio reported by other investigators for doublets of different diameters and length.



Typical recordings from grating spectrometer (A), Boltzmann interferometer (B) and Michelson interferometer (C)

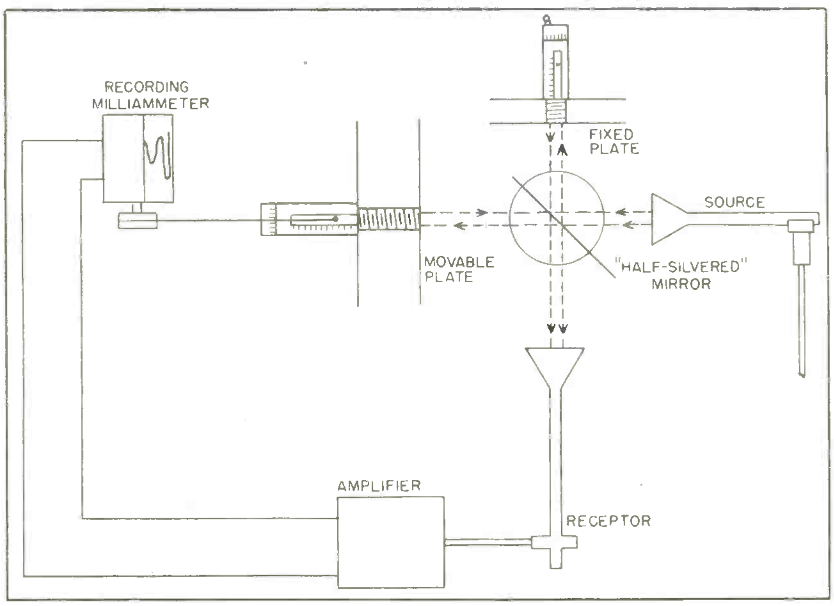


FIG. 3—Michelson interferometer

It is believed that optical methods can be usefully applied to free-space determination of wavelength for electrical radiation well down into the millimeter region. With automatic recording systems a large number of determinations may be made in a comparatively short time, making possible a statistical study of the several variables that may be frequency factors. The Michelson interferometer has been found to be especially suitable for this type of measurement.

REFERENCES

(1) Nichols and Tear, *Astrophysical Journal*, p 17, Jan. 1925.
(2) Same as ref (1).
(3) Nichols and Tear, *Phys. Rev.*, June 1923.

How to Design

By C. J. SAVANT, JR.
California Institute of Technology
Pasadena, California

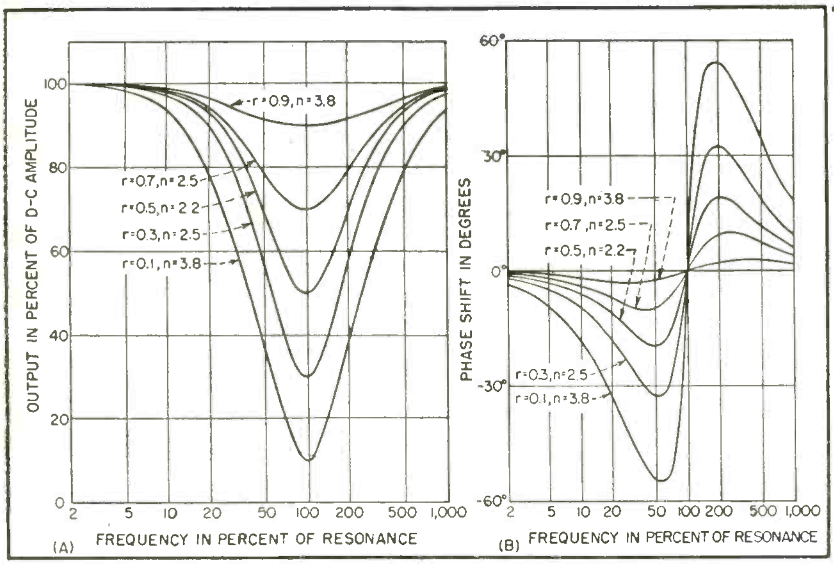


FIG. 1—Amplitude and phase response of bridged-T network as notch ratio, r, is varied. Minimum notch width, n, is chosen for each value of r

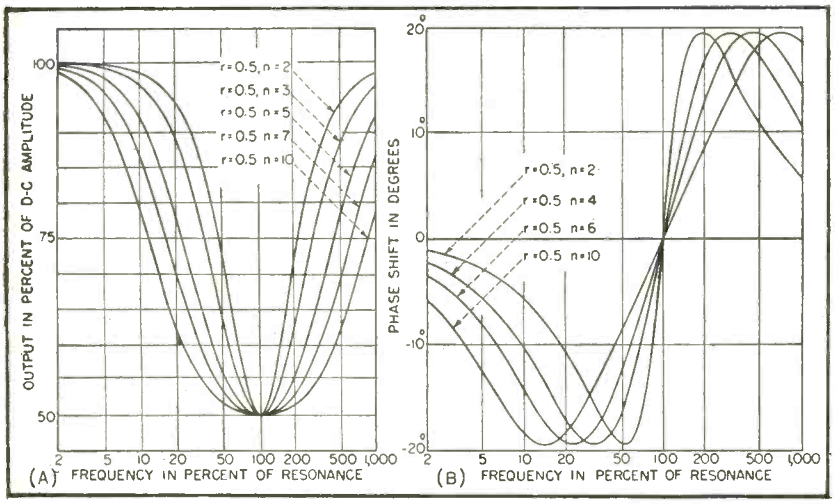


FIG. 2—Amplitude and phase response of bridged-T network as notch width is varied with notch ratio held constant

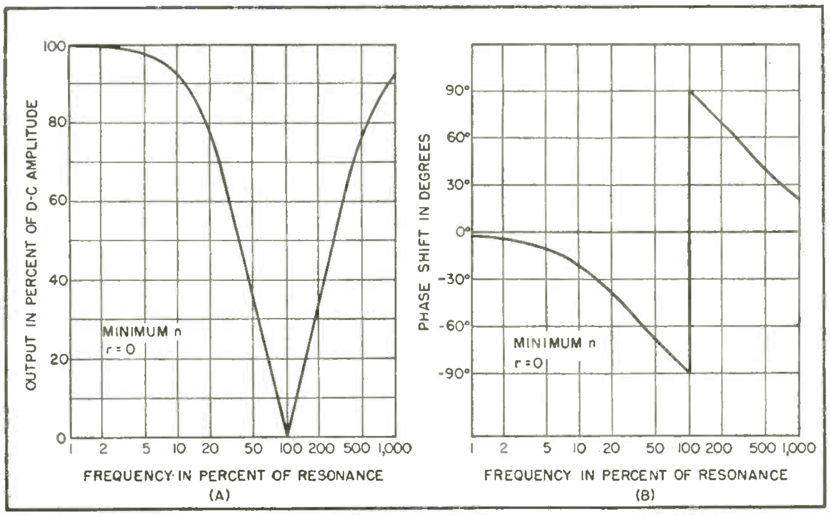


FIG. 3—Amplitude and phase response for infinite-notch, minimum-width, parallel-T network

IN DESIGN of feedback control systems, one is often faced with the problem of reshaping the Nyquist plot. In some cases it may be necessary to attenuate the amplitude response infinitely at a particular frequency, calling for the use of a parallel-T network, whereas in other cases only a fractional notch may be desired. Although this latter situation can also be accomplished with the parallel-T network if space or weight are criterions, as in airborne devices, the bridged-T is more appropriate.

The network to be used is selected as follows:

If infinite attenuation is desired, a parallel-T network should be used.

If only a fractional notch is desired, the bridged-T network should be used since it requires fewer components.

This article contains several curves that simplify the rapid design of capacitor-shunt bridged-T, resistor-shunt bridged-T, and parallel-T infinite-attenuation networks. Also included are Nyquist plots, design curves and explanations of the use of these curves for the three networks.

Design Considerations

To design either the capacitor or resistor-shunt bridged-T network, four parameters must be specified:

(1) Notch frequency f_0, the frequency at which the notch is to occur.

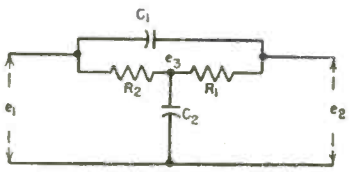
(2) Notch ratio r, the ratio of the amplitude at f_0 to the amplitude at zero frequency.

(3) Notch width n, the relative width of the notch. The choice of this parameter is not independent, however, but depends on the notch ratio.

(4) The d-c impedance level R_{d-c}, the total series resistance that the

Notch Networks

Resistance-capacitance attenuating networks are useful in feedback control systems. These notch networks can readily be designed with aid of convenient nomographs. Design procedures are given for both bridged-T and parallel-T types



Capacitor-Shunt Bridged-T Network

(1) Enter Fig. 5 with known notch ratio r, and choose ratio C_1/C_2 corresponding to value of r desired. Although minimum width corresponds to low values of n, a limit is reached beyond which the ratio approaches zero. Therefore select values of n such that C_1/C_2 is greater than 0.04.

(2) Calculate $n\ (1 - r)$ and obtain both R-C products from Fig. 6. Note that R_1C_1 is obtained when $\gamma = 1/[n(1 - r)]$ and that R_2C_2 is obtained when $\gamma = n\ (1 - r)$.

(3) Choose $R_1 + R_2 = R_{d\text{-}c}$ according to the desired d-c impedance level and calculate circuit parameters from the following

$$R_1 + R_2 = R_{d\text{-}c} \qquad (1)$$
$$R_1/R_2 = R_1C_1/R_2C_2\ (C_2/C_1) \qquad (2)$$
$$C_1 = (R_1C_2)\ 1/R_1 \qquad (3)$$
$$C_2 = (R_2C_2)\ 1/R_2 \qquad (4)$$

For closer interpolation between curves, calculate network components using

$$R_1C_1 = \frac{1}{2\pi f_0}\ \frac{1}{n(1 - r)} \qquad (5)$$

$$R_2C_2 = \frac{1}{2\pi f_0}\ n(1 - r) \qquad (6)$$

$$R_1 + R_2 = R_{d\text{-}c} \qquad (7)$$

$$\frac{C_1}{C_2} = \left[\frac{r}{1 - r} - \frac{1}{n^2\ (1 - r)^2}\right] \qquad (8)$$

Example—Consider the following requirements: $R_{d\text{-}c} = 200$ K (K $= \times 1{,}000$), $r = 0.2$, and $f_0 = 20$ cps. From Fig. 5, $C_1/C_2 = 0.05$ and $n = 2.8$. Then calculating, $n(1 - r) = (2.8)\ (0.8) = 2.24$. From Fig. 6, $R_1C_1 = 0.0036$ and $R_2C_2 = 0.0175$. Hence

$$\frac{R_1}{R_2} = \left(\frac{0.0036}{0.0175}\right) 20 = 4.11$$

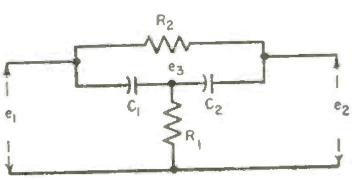
$$R_2 = \frac{R_{d\text{-}c}}{1 + 4.11} = \frac{200\text{ K}}{5.11} = 39.2\text{ K}$$

$$R_1 = R_{d\text{-}c} - R_2 = 200\text{ K} - 39.2\text{ K} = 160.8\text{ K}$$

$$C_1 = \frac{0.0036 \times 10^{-3}}{160.8} = 0.0224\ \mu f$$

$$C_2 = \frac{0.0175}{39.2\text{ K}} = 0.445\ \mu f$$

If a component calculates out higher or lower than would be used practically, it may be necessary to use a larger value of n



Resistor-Shunt Bridged-T Network

(1) Enter Fig. 5 with notch ratio n, and choose ratio R_1/R_2 corresponding to the permissible value of n. Minimum width corresponds to the smallest value of n consistent with a nonzero value of R_1/R_2.

(2) Calculate $n\ (1 - r)$ and obtain both R-C products from Fig. 6. Note that R_1C_1 is obtained when $\gamma = 1/[n\ (1 - r)]$ and that R_2C_2 is obtained when $\gamma = n\ (1 - r)$.

(3) Choose $R_2 = R_{d\text{-}c}$ according to the desired impedance level and calculate circuit parameters from the following equations

$$R_2 = R_{d\text{-}c} \qquad (1)$$
$$R_1 = (R_2)\ R_1/R_2 \qquad (2)$$
$$C_1 = (R_1C_1)\ 1/R_1 \qquad (3)$$
$$C_2 = (R_2C_2)\ 1/R_2 \qquad (4)$$

For closer interpolation between curves, calculate network components from the following

$$R_1C_1 = \frac{1}{(2\pi f_0)n(1 - r)} \qquad (5)$$

$$R_2C_2 = \frac{n(1 - r)}{2\pi f_0} \qquad (6)$$

$$\frac{R_1}{R_2} = \left[\frac{r}{1 - r} - \frac{1}{n^2\ (1 - r)^2}\right] \qquad (7)$$

If a component value calculates out either too high or too low, it may be necessary to use a larger value of n.

Example — Consider the following: $R_{d\text{-}c} = 575$ K, $r = 0.25$, and $f_0 = 26$ cps. From Fig. 5, $R_1/R_2 = 0.048$, $n = 2.5$, and $n(1 - r) = 2.5(0.75) = 1.875$. From Fig. 6, $R_1C_1 = 0.0032$ and $R_2C_2 = 0.0115$.

$$R_2 = 575\text{ K}$$

$$R_1 = (0.048)\ (575) = 27.6\text{ K}$$

$$C_1 = 0.0032 \times 10^{-3}/27.6 = 0.116\ \mu f$$

$$C_2 = 0.0115 \times 10^{-3}/575 = 0.02\ \mu f$$

network resembles at zero frequency.

In the design of the infinite-attenuation parallel-T network with minimum width, only two parameters need be specified, the notch frequency f_0 and the impedance level. The notch ratio is zero, and n is chosen as a minimum so that the sharpest notch is obtained.

Amplitude and Phase Response

Figures 1 and 2 show the effect of varying notch ratio r and notch width n in a bridged-T network. In Fig. 1 amplitude and phase response are plotted against frequency for various values of r. In these curves the minimum width, corresponding to the smallest value of n, is chosen for each value of r. In Fig. 2 amplitude and phase characteristics are plotted with $r = 0.5$ and with n as a running parameter. It should be noted, however, that for each value of r there exists a certain corresponding minimum value of n.

Figure 3 shows amplitude and phase response of the infinite-notch, minimum-width, parallel-T network. The curves are plotted as functions of the frequency ratio $p = f/f_0$.

Effect of Loading

The effect of input and output loading on amplitude and phase response of the bridged-T network was studied. A very general case of loading can be reduced to a series input resistor and a shunt output resistor. Because of the complexity of the resulting transfer function, the effects of input and output impedance are considered separately. Two new parameters are by definition: λ = ratio of shunt output resistance to R_{d-c} and ε = ratio of series input resistance to R_{d-c}.

It is possible to reduce the transfer functions to a form that permits calculation of the response as a family of curves. This calculation was performed for $r = 0.2$ and $n = 2.8$.

The results, plotted in Fig. 4, show the detrimental effect of loading on the networks. The curves in Fig. 4A are attenuated at zero frequency, which accounts for an apparent rise in response at higher frequencies.

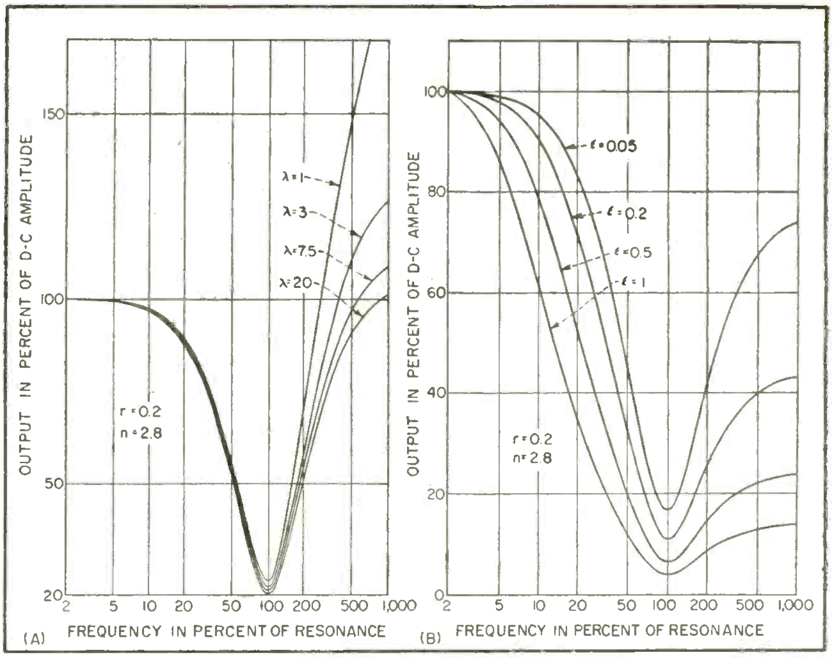


FIG. 4—Effect of output and input loading on bridged-T amplitude response

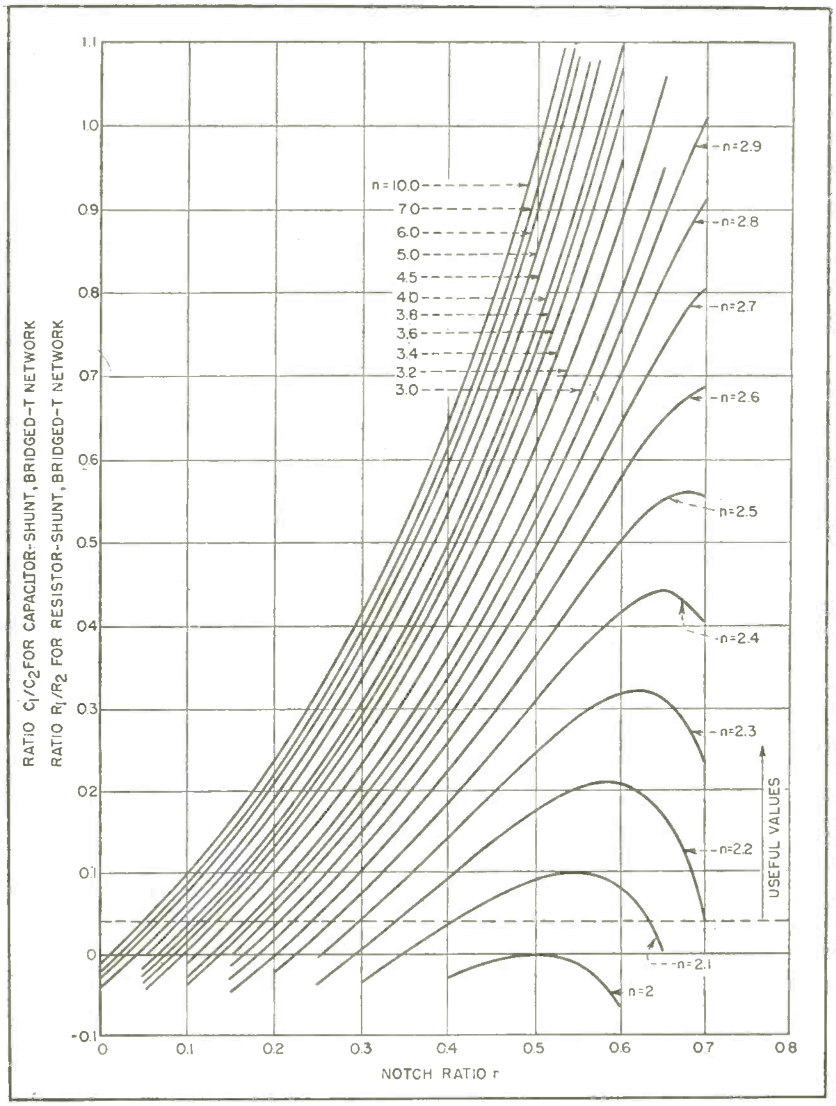


FIG. 5—Nomograph for finding C_1/C_2 or R_1/R_2 ratio for bridged-T network

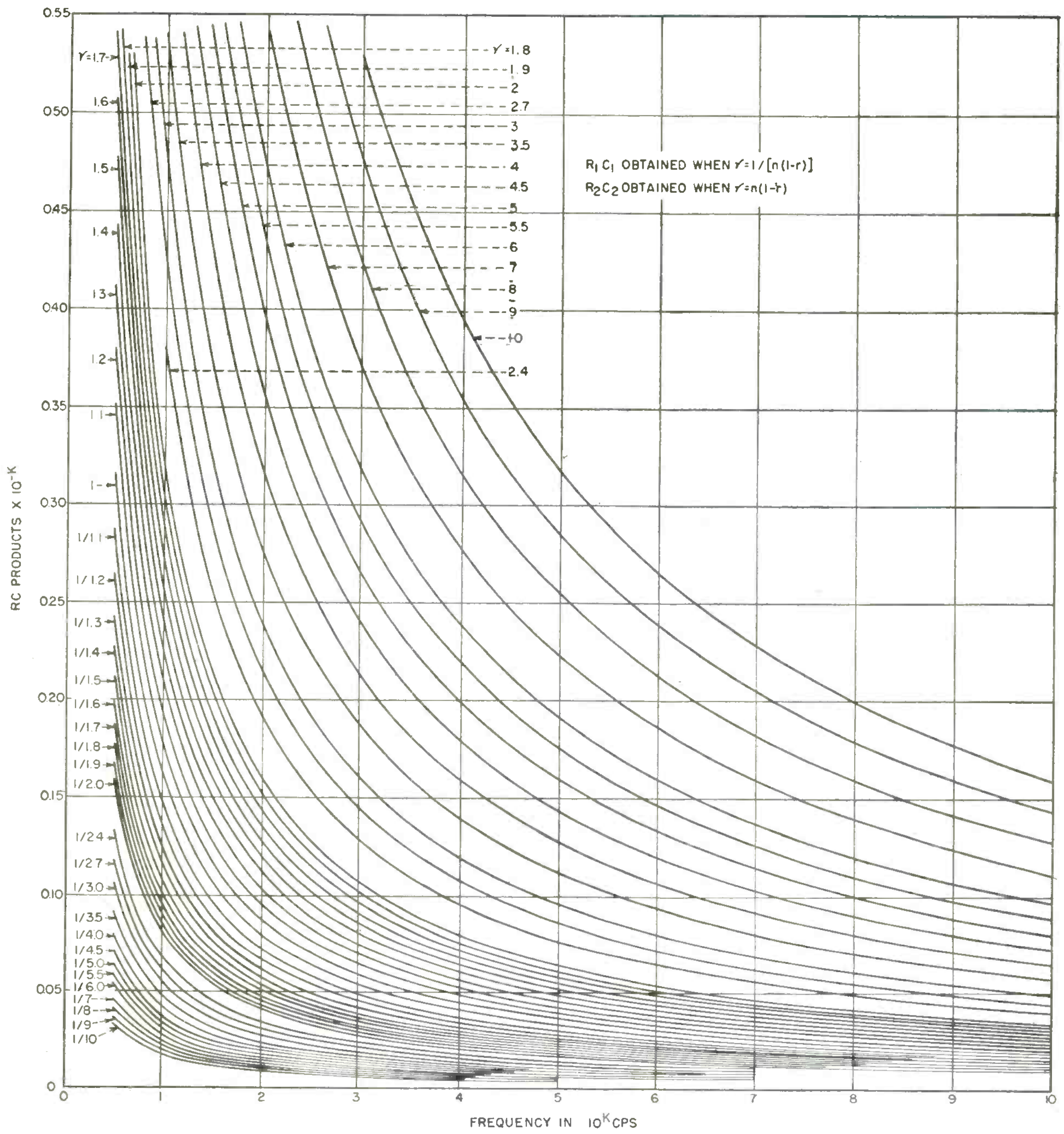
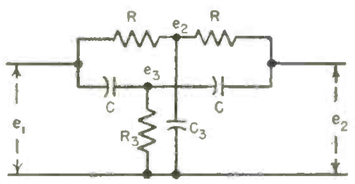


FIG. 6—Nomograph for finding R-C products for bridged and parallel-T networks



Infinite-Attenuation Parallel-T Network

(1) Enter Fig. 6 and read from the $\gamma = 1$ curve the value of the R-C product corresponding to the desired resonant frequency.

(2) Choosing $R_{d\text{-}c}$ according to the desired impedance level, the necessary parameters may be found from the following equations

$$R = R_{d\text{-}c}/2 \quad (1)$$
$$R_3 = R/2 \quad (2)$$
$$C = (RC)\ 1/R \quad (3)$$
$$C_3 = 2C \quad (4)$$

Example — Consider the following: $R_{d\text{-}c} = 26.6$ K and $f_0 = 400$ cps. From Fig. 6, $RC = 0.0004$.

$$R = R_{d\text{-}c}/2 = 13.3\ K$$
$$R_3 = R/2 = 6.65\ K$$
$$C = 0.0004 \times 10^{-3}/13.3 = 0.03\ \mu f$$
$$C_3 = 2C = 0.06\ \mu f$$

Phase Shift by CRO

Two measurements of crt deflection against a cross-hatch grid-overlay show possible phase angles when entered in the nomogram. Rotation of beam resolves the ambiguity

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PHASE ANGLE is most frequently measured by the cathode-ray oscilloscope pattern method. In this technique a reference-phase alternating voltage is one input and an unknown-phase alternating voltage is the quadrature input to the cathode-ray tube. The resulting pattern is a straight line, circle or ellipse depending upon the phase difference. The sine of the phase angle is the ratio of the intercept B to maximum A as shown in Fig. 1A.

Procedure

Adjust the undeflected beam to the crt center as indicated by the intersection of the midlines of the cross-hatch grid. Apply the unknown voltage to the vertical or y-input terminals and adjust the gain for any convenient deflection. Disconnect or turn off this input and apply the reference voltage to the horizontal or x-input terminals. Adjust this gain for an equal deflection. Reconnect the unknown voltage without changing amplification controls. Measure B and A in any equal units such as centimeters or tenths of inches. The arc-sine of the B-to-A ratio is the desired angle.

The nomograms shown in Fig. 2 facilitate this calculation. A general solution can be obtained by using scales A, B, and Θ. Place a straight-edge between the pattern height value on the A scale and the intercept value on the B scale. Read the unknown angle on the Θ scale at the intersection of the straightedge and this scale.

The 20-unit chart (C) shown in Fig. 2 is a simplified version designed on the basis that crt cross-hatch grids are often divided so that 40 divisions of total deflection along each axis can be used conveniently. Thus, A is a constant 20 units and need not be used with this nomogram. In fact, the peak of the composite trace may be off the circular crt without concern since constant input amplitude is essential in any case.

In using this calculator simply read phase angle opposite the intercept value. Multiples and submultiples of the intercept scale may be substituted if desired. For example, if the maximum is 10, divide intercept scale values by 2 and read.

Beam Rotation

The nomograms show that two answers can be obtained for each pattern. This ambiguity can be resolved by determining the crt beam rotation. One method of resolution is that of superimposing a low-amplitude, higher-frequency sawtooth voltage upon the vertical input.[1] A typical pattern is shown in Fig. 1B.

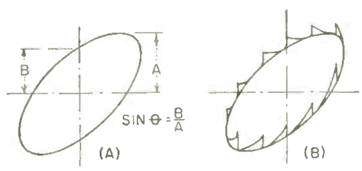


FIG. 1—Ratio of B to A is sine of the phase angle (A); typical pattern with sawtooth superimposed (B)

Another method requires delaying the unknown phase by a small amount. This can be done by means of a phase-shifting network connected in series between the source and the oscilloscope. The small additional delay will modify the pattern. This modification will be toward different limiting patterns depending upon the beam rotation. For example, a 45-deg ellipse will become rounded and tend toward a circle when delayed. On the other hand the 315-deg pattern that looks similar will shift toward a straight line when the delay is added.

As an example in the use of the chart, assume that the maximum deflections are 32 units, the intercept is 5 units, the ellipse major-axis tilt is to the right, and the beam rotation is clockwise. Construct a straight line from 32 on the A scale to 5 on the B scale. This line intercepts the Θ scale at the 9, 171, 189 and 351-deg point. By the ellipse tilt the choice is reduced to 9 or 351 deg. For clockwise rotation of the beam select 9 deg. Thus, there is a 9-deg phase difference between the applied voltages.

REFERENCE

(1) J. R. Haynes, Direction of Motion of Oscilloscope Spot, *Bell Labs. Rec.*, 14, p 224, March 1936.

(Continued on p 194)

Phase Shift by CRO (continued from p 192)

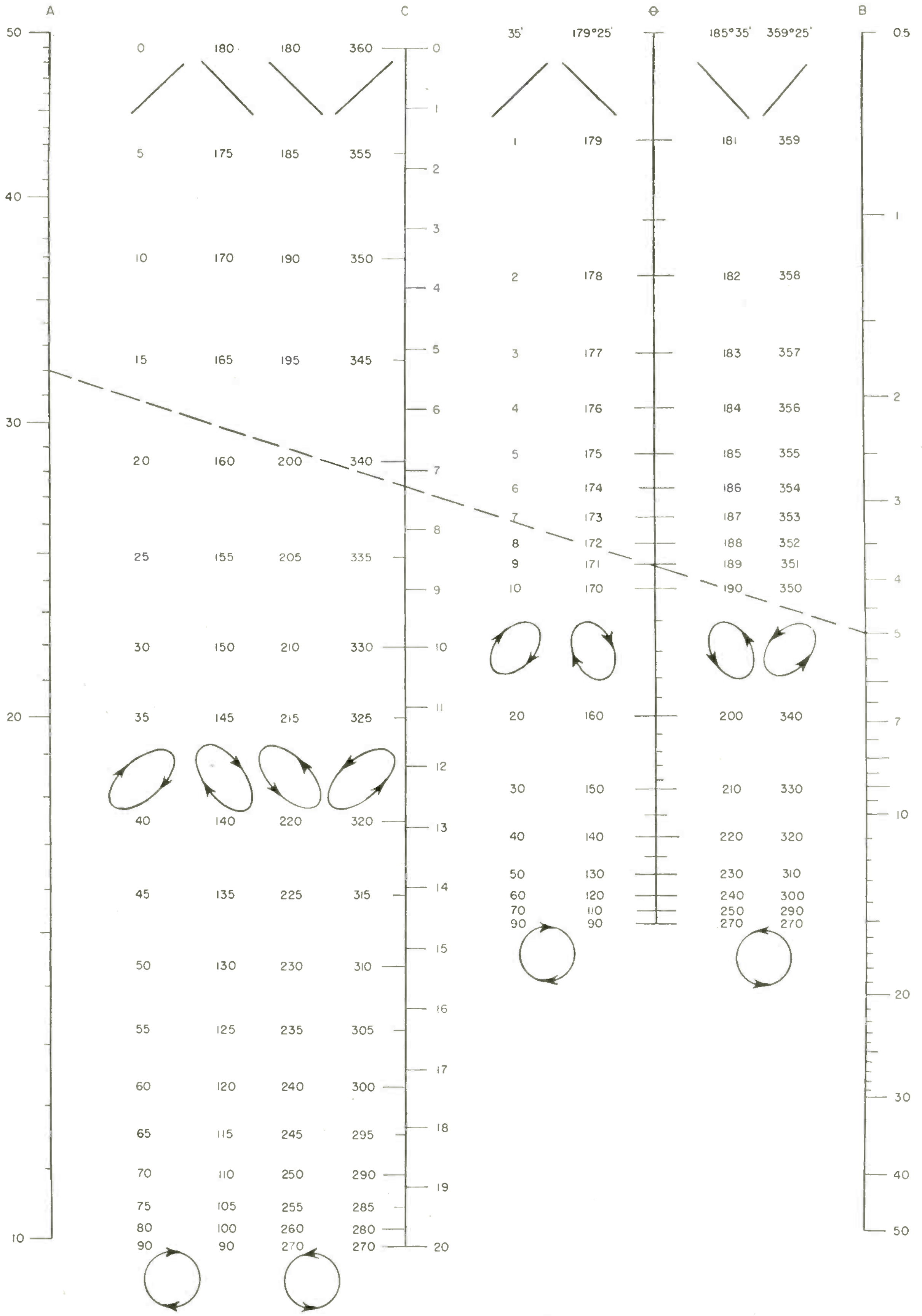
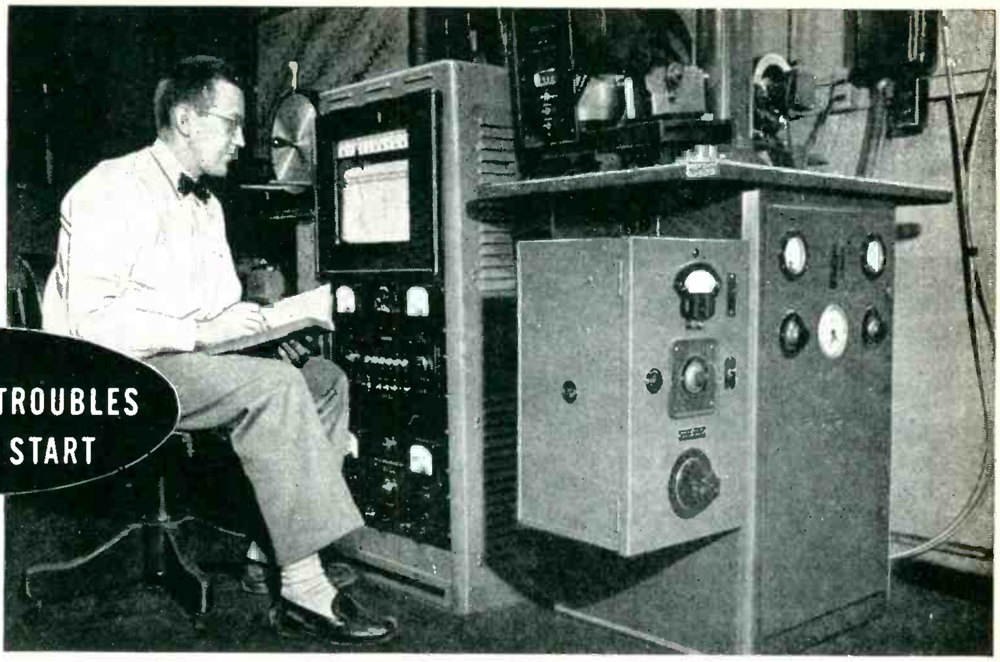


FIG. 2—Nomograms convert intercept-to-maximum ratios into phase angles as explained in text

STOP YOUR CONTACT TROUBLES BEFORE THEY START



X-ray diffraction equipment in the Mallory Contact Engineering Laboratory. It is so sensitive it will identify contaminating films of less than a hundredth of a micron.

Less Than a Hundredth of a Micron!

The slightest trace of contaminating films on contact surfaces can be identified by X-ray diffraction equipment.

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ELECTRONS AT WORK

Including INDUSTRIAL CONTROL

Edited by ALEXANDER A. McKENZIE

OTHER DEPARTMENTS featured in this issue:

Radar-Controlled Antiaircraft Gun

TIME LOST in aligning antiaircraft gun batteries with early radar types introduced errors and was responsible for a number of aircraft that "got through" during World War II. This fact, plus advances in blind bombing techniques and increased aircraft speeds, presented a new challange for defense weapons designers. One answer is the Skysweeper, recently shown to the public by Sperry Gyroscope for the first time (ELECTRONICS, p 8, April 1953).

Operation

The weapon is a self-contained (except for power plant) radar-controlled 75-mm antiaircraft gun that can be placed in operation in less than five minutes. The radar system, sharing a common mount with the gun, is permanently fixed with respect to the gun barrel, and is so arranged as to provide automatic tracking of a target. A built-in computer system determines firing azimuth and quadrant elevation on the basis of present position, aircraft speed and direction, muzzle velocity, air density and trunnion tilt, as indicated in Fig. 1.

In operation, the unit is placed in ppi scan and the entire sky is swept in 40 seconds over a 15-mile radius. When a target is picked up on the ppi cathode-ray tube, the system is switched to automatic tracking and the computing elements go to work extrapolating the aircraft's future position and automatically making necessary corrections for firing shells on a collision course with the target.

The gun is provided with an automatic loader-rammer, loads and fires 45 proximity-fused shells a minute.

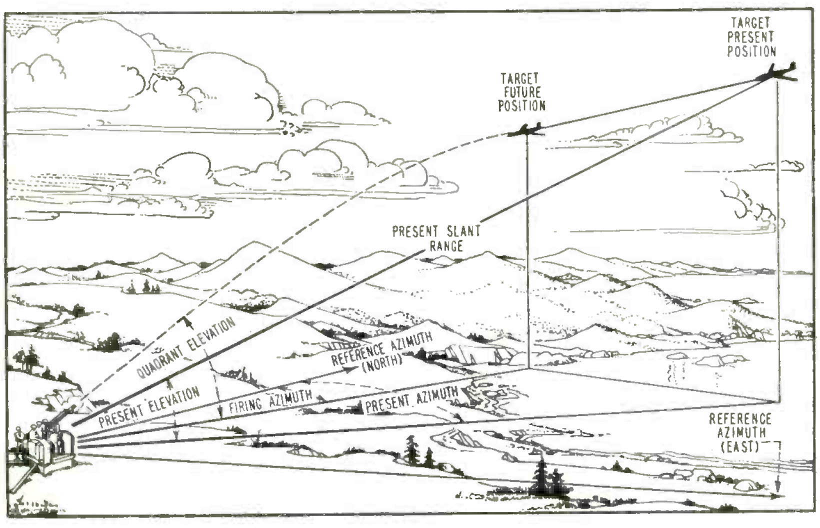


FIG. 1—Pictorial representation of fire-control problem

Radar

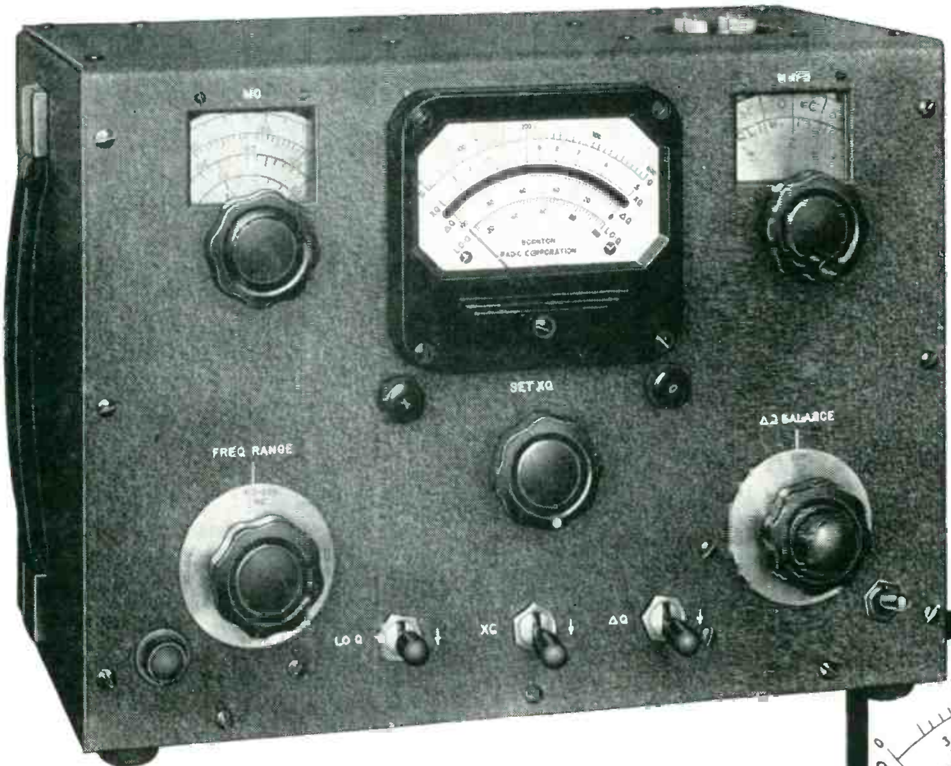
The radar system uses a two-foot parabolic reflector with a waveguide-fed antenna that is mechanically switched to send out two overlapping beams. When the antenna system is pointed so that equal signals are received from reflections of each beam the target is on the beam. When unequal signals are received, error or difference signals set servomechanisms in motion that correct the deviation.

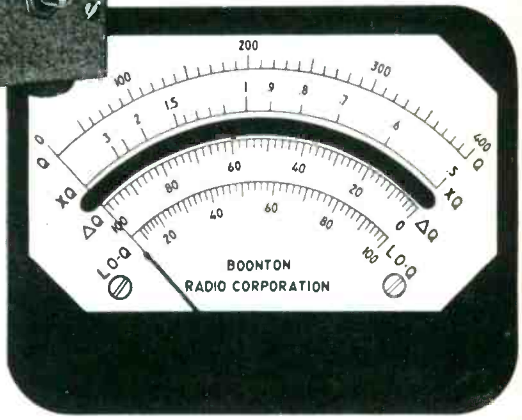
The radar console houses all subassemblies except the antenna assembly, which is mounted on a hinged yoke on top of the console so it may be lowered in transport. The radar is divided functionally into a synchronizing system, transmitter, antenna, receiving system (the r-f portion being separate), and servo, indicating, data transmission and control systems.

Computer

When a target is sighted on the search radar crt and the operator switches to radar tracking this

Measure Difference In Q with The Q METER Type 190-A





In Designing Tuned Circuits the effect on Q of adding capacitors, iron cores, or resistors must frequently be determined. The Q of the separate components is also often needed. These measurements made on Q Meters formerly available required the use of a small difference between two large Q values in various formulæ. This led to large errors. The Q Meter Type 190-A reads the difference between the Q of a reference circuit and the Q of this circuit when new components are added. The scale that indicates this *Differential Q* has a sensitivity 4 times as great as the scale which reads *Q*. The accuracy and ease with which *Differential Q* can be read is greatly improved by use of the *190-A Q Meter.*

The Q Meter Type 190-A has a "Lo Q" scale which reads Q down to a value of 5. The internal resonating capacitor is directly read and has a vernier arrangement for accurate reading of capacitance. The dial rotates approximately 10 times in covering the capacitance range. All readings are made on a single meter corrected for parallax.

SPECIFICATIONS

FREQUENCY COVERAGE: 20 mc to 260 mc. Continuously Variable in Four Ranges.

FREQUENCY ACCURACY: Calibrated to ± 1%.

RANGE OF Q MEASUREMENTS: 5 to 1200.

RANGE OF DIFFERENTIAL Q MEASUREMENTS: 0 to 100.

ACCURACY OF Q MEASUREMENTS: Circuit Q of 400 read directly on meter can be determined to accuracy of ± 5% to 100 mc and to ± 12% to 260 mc.

INTERNAL RESONATING CAPACITANCE RANGE: 7.5 mmf to 100 mmf (direct reading) calibrated in 0.1 mmf increments.

ACCURACY OF RESONATING CAPACITOR: ± 0.2 mmf to 20 mmf
± 0.3 mmf to 50 mmf
± 0.5 mmf to 100 mmf

POWER SUPPLY: 90-130 volts—60 cps (internally regulated). Power Consumption—55 watts.

(Specifications subject to change without notice)

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- Multiply Q scale: 0.5 to 3.0.
- A differential Q scale for accurately indicating the difference in Q between two test circuits.
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- A counter type resonating capacitor dial for improved setting and reading accuracy.
- Regulated power supply for increased stability and accuracy.
- Careful design to minimize instrument loading of circuit under test.

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action sends present azimuth, present elevation and slant range information to the computer.

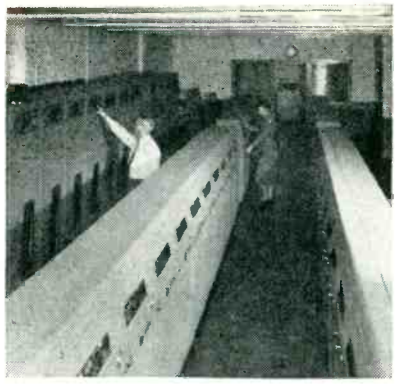
Using this information, computer servos actuate computing elements that automatically calculate gun aiming data.

Twenty-two electronic chassis control the movement of the mechanical computing elements.

Aided manual ranging, used to track the target in range when automatic range tracking is impossible, involves keeping the target at the tracking point by rotation of the range handwheel. Under this condition, all other automatic functions are maintained. Other alternative ranging methods include estimated altitude and stored altitude operation.

The computer transforms data representing the present position of the target into data for aiming the gun, with correct lead. Under normal tracking conditions, the present-position data consists of the target azimuth with respect to the chosen reference line, target elevation with respect to the horizontal plane of the gun mount, and slant range. These quantities, shown diagrammatically in Fig. 1, are utilized by the computer in the solution of the fire control problem. The computer output consists of quadrant elevation and firing azimuth of the gun tube.

The computing action takes place almost instantaneously. The point of intersection of the target and the projectile paths and the correct gun positioning data are continuously computed. The power control unit keeps the gun positioned. —V. Z. AND J. D. F.



Manual forwarding units are at left, and cross-office units and multiple call processing equipment are at center and right in this view of the teletypewriter switching center

New Army Teletypewriter Relay Station

TIME REQUIRED for routing Army teleprinter messages has been cut by as much as eighteen minutes by the new completely automatic relay center recently put into operation in Chicago. By the use of coded symbols at the beginning of each message, the new center copies the incoming message, determines its destination and priority, locates an open line to that destination and then retransmits the message as shown in Fig. 1.

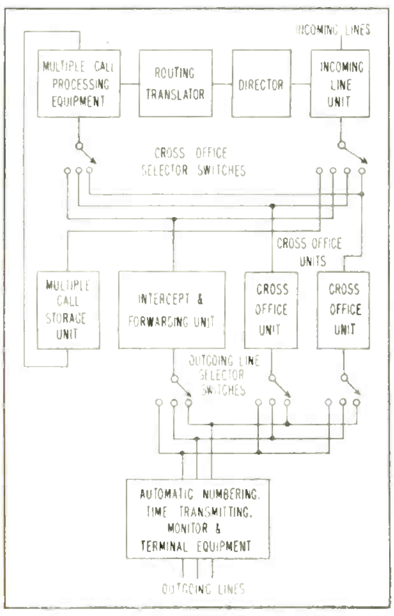


FIG. 1—Block diagram of message handling system in Army switching center

A reading unit scans the coded information as the incoming message is punched out on paper tape. The reader actuates a director device that locates an open line. When a line has been found, the code symbols are fed to a translator that sets up a circuit for that combination of symbol. The circuit is cross-connected to a particular line for which a corresponding indication is returned and registered with the director.

The director now searches for a recording and retransmitting unit, called a cross-office unit, associated with the selected outgoing line. When it locates a cross-office unit that is not in use, the director connects the incoming line to it and then disconnects itself, becoming available for routing another message. The cross-office unit makes a punched tape recording of the message identical with that made by the incoming recording unit. This tape is then stored until the line is available at which time it is transmitted to its destination.

Priority of outgoing messages is taken care of at the cross-office unit. When the outgoing line becomes available for transmission, one of the cross-office units bearing messages of the highest priority automatically takes the line and begins to transmit.

A message addressed to a number of destinations is identified as such by a code symbol at the beginning of the message. When received by the director, this type of message is switched to a multiple-call processing unit. Here, the addresses are read and cross-office units for the required number of lines are obtained. The multiple call unit then makes up a pilot message instructing other relay stations on the routing of individual messages. The pilot messages are then transmitted followed by a multiple transmission of the body of the main message.

The system, compatible with existing equipment and methods, uses over 4,400 relays.

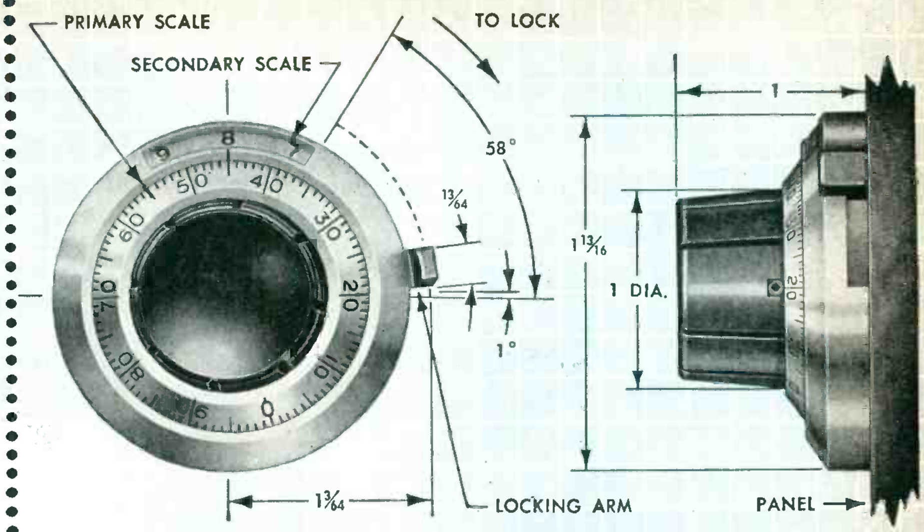
Magnetic Memory for ENIAC Computer

USING MAGNETIC toroids, a new memory constructed for the ENIAC digital computer, will increase the computer's memory capacity from 20 to 100 numbers. Numbers can be read in and out of the memory at the rate of 50,000 digits per second.

A matrix consisting of 4,100 toroids acts as the storage unit. A digit is read in by a pulse through one of the toroid windings leaving a positive or negative magnetic

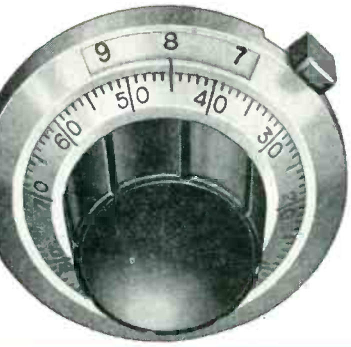
Save Time,
Eliminate Errors,
with the new multi-turn

model RA precision Duodial



Instant, accurate readings

distinctive beauty... quality "feel"... simple installation!



The new RA Duodial—product of the world's largest manufacturer of precision potentiometers—establishes a new standard of beauty and quality in multi-turn indicating dials. Finished in satin-chrome, with non-metallic parts of black nylon, the unit adds a distinguished appearance of quality and excellence to the finest instrument panels—and its precise operation gives a smooth "feel" that is unequalled. *From every standpoint—readability, appearance, operation, construction—here is a dial worthy of the highest quality electronic instruments!*

Unique Jump Mechanism

With its glare-proof satin finish and recessed black numerals that will not wear off, the RA Duodial is not only beautiful but is unusually easy to read. Moreover, the secondary dial is driven by a unique jump mechanism that keeps the dial stationary until the primary dial has completed a full revolution—then the turns-indicating dial "jumps" to the next numeral. Thus, the index always points *directly* to the number showing the particular helical turn on which the slider is positioned, eliminating errors in dial readings and settings.

Another convenience feature—three numbers show in the window at all times so that the operator knows instantly in which direction the dial is to be rotated to make the next setting. And with 10 turn potentiometers, readings are made directly in decimal equivalents of the slider position on the resistance winding—simply, accurately, and with maximum convenience for any resistance range.

Vibration-Proof Lock

All RA Duodials are equipped with a positive *vibration-proof* locking mechanism that can be easily and instantly set by the same hand that is adjusting the knob. Locking is accomplished by means of a cam actuated brake shoe which acts radially against an inner drum. This arrangement eliminates any possibility of dial movement during or after setting.

Easy To Mount On Panel

The RA is unusually compact—only 1-13/16" diameter (the same as a Model A Helipot)—and comes completely assembled, with mounting parts and hex wrench included. Installation is extremely simple. Set the dial and potentiometer at zero. Place the shaft through panel hole. Place lug plate over shaft, and mounting nut on potentiometer bushing. Then place the RA dial over shaft, lining up the register hole with lug—and tighten set screws. *It's as easy as that!*

In addition, the mounting nut is so designed that it is adaptable to thin (1/8" and under) or thick panels by simply reversing ends. No problems of adapting the unit to *your particular* panel requirements!

Finest Construction Throughout

In all respects the RA Duodial is built to maintain its attractive appearance and quality "feel" throughout its long life. Metal parts are machined from die-cast alloy and plated in accordance with specifications MIL P6871 and QQ P416 (1) for corrosion resistance. Non-metallic parts are made of long-lived nylon, with nylon jump gear to assure smooth quiet operation of the secondary dial. And since the primary dial is connected directly to the potentiometer shaft, no wear or backlash can affect the accuracy of the settings.

Two allen-head set screws—positioned at 90°—lock the dial to the potentiometer shaft, and the black nylon knob insulates the instrument from hand capacity.

The RA DUODIAL is primarily designed for use with the 10-turn Model A HELIPOT. However, it is equally ideal for use with the 3-turn Model C or the ultra-precision models AN and CN when these potentiometers are equipped with bushing mounting. Additional numerals provided on the secondary dial make the RA adaptable for readings up to 15 turns for special applications.

An RAJ version of the RA Precision DUODIAL is available for use on the miniature Model AJ 3/4" 10-turn HELIPOT. The RAJ also fits other multi-turn devices with 1/8" shafts.

Contact your nearest HELIPOT representative for complete details—or write direct for Data File 502.

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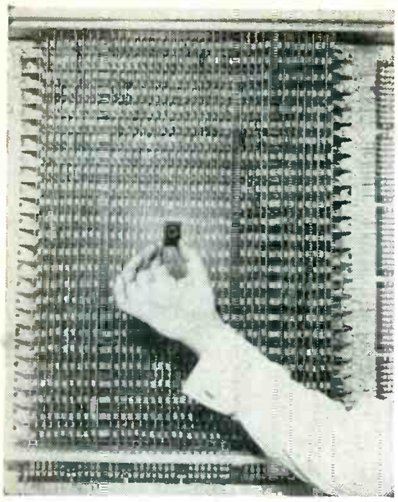


FIG. 1—Magnetic toroid and coils are sealed in plastic. Background is memory matrix using the toroids

charge on the toroid. This charge will effect the amplitude of a readout pulse applied when the number is needed by the computer.

Carrier Radio Aids Mine Communications

USING THE POWER line to guide carrier currents, eight electric mine locomotives maintain constant communications with each other and the operator of the dumping mechanism. By this means the dump operator can maintain an efficient traffic flow of loaded cars out of the mine and keep enough empty cars flowing back to the work area.

The system uses an 88-kc f-m carrier with an average modulation of 3 kc, which does not interfere with the regular mine telephone system. A voltage divider is used to drop the power line voltage from 550 v d-c to 275 required by the carrier system. A squelch circuit keeps the receiver quiescent until a message is received from another unit.

Normally the phone units are in the receive position with the transmitter idle. A push-to-talk switch cuts out the receiver and turns on the transmitter unit. No provision is made for point-to-point communication, all messages being heard at all receivers.

The system installed by the Mine Safety Appliance Co. has been found valuable in the event of emergencies such as roof falls, derailments or locomotive breakdowns. Repair crews can be sent to the scene directly, knowing in advance the type of emergency with which they must cope.

Mine locomotive with carrier radio communication system mounted in front of operator

High-Speed Number Generator Uses Magnetic Memory Matrices

BY AN WANG
Wang Laboratories
Boston, Mass.

INCREASING USE of the digital technique in data processing equipments makes the need for a fast output acute. This paper presents the use of static magnetic memory devices as a number generator or for cathode-ray tube display.

Scanning System

One system for displaying a number on the cathode-ray screen is to scan the entire field intensifying the trace at appropriate places in a manner similar to tv operation. Figure 1 shows a number 4 displayed by this method.

This display system requires three sets of waveforms to be applied to the cathode-ray tube: the X-sweep, the Y-sweep and the Z-intensity. These waveforms are shown in Fig. 2. For the display of different numbers, it is only necessary to use different Z-waveforms.

The X and Y sweeps can be generated easily by any standard means, and will not be considered here except for their timings relative to the Z-intensity.

The magnetic memory matrix system as presented here gives all the required Z-waveforms at the same time. To display a number, it is necessary only to select that particular Z-waveform from the matrix. The shape of any number can be altered or additional number forms can be added within a short time.

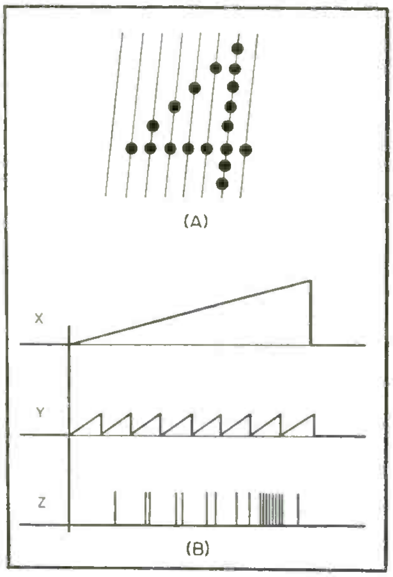
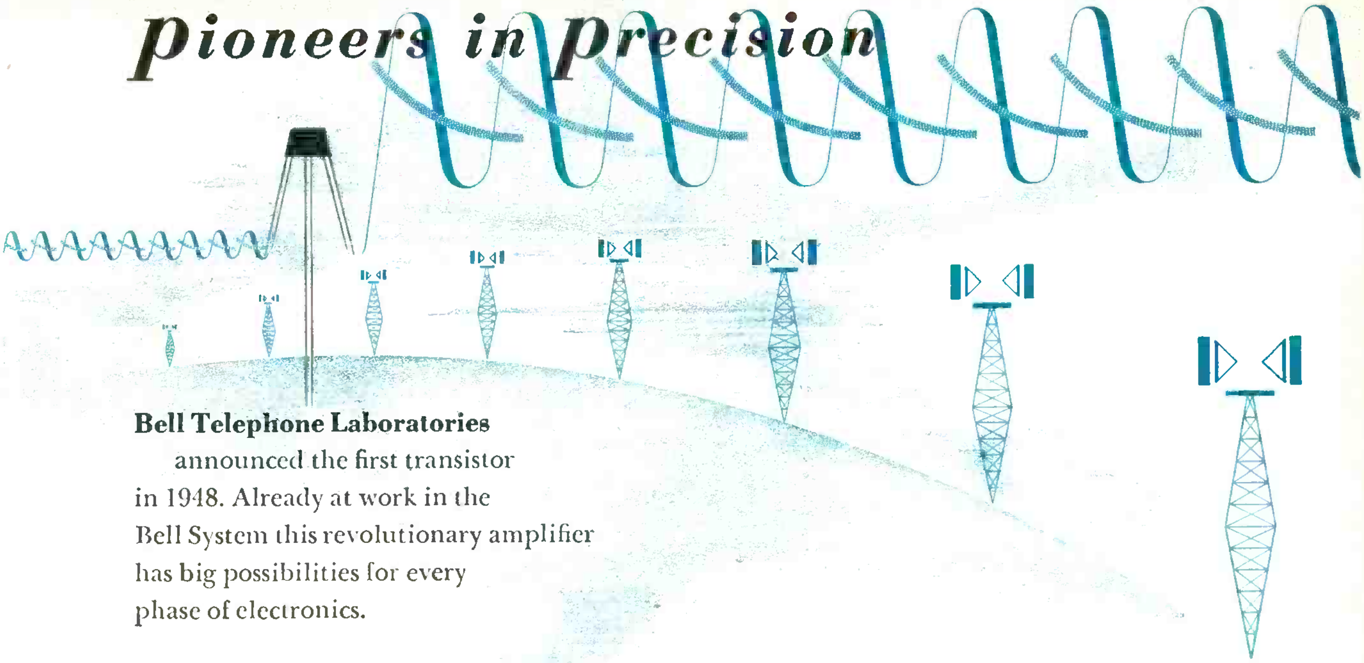


FIG. 1—Number produced (A) by intensifying crt scanning beam. Three waveforms (B) are required

An 8×8 array of magnetic memory units is arranged as shown in Fig. 3. Each unit has two windings around the magnetic core, which has a rectangular hysteresis characteristic shown in Fig. 2. Normally these cores stay at the 0 position.

Pulse of about 50 kc (this frequency determines the speed of number display) are fed into the matrix. This pulse is amplified and causes a pulse current to flow horizontally across the bottom row of eight cores. The polarity of this horizontal pulse is such as to saturate the core negatively as shown in Fig. 2. The same pulse is delayed for a short time and then it actuates the next pulse amplifier H_2 to send a current pulse to the second row of cores. This delay and pulsing advances upwards until H_8

Pioneers in Precision



Bell Telephone Laboratories announced the first transistor in 1948. Already at work in the Bell System this revolutionary amplifier has big possibilities for every phase of electronics.

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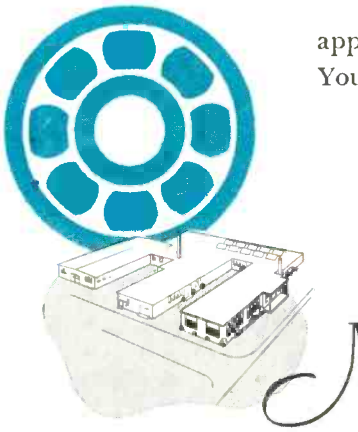

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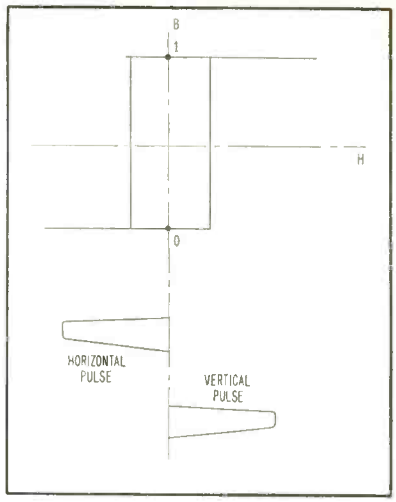

FIG. 2—Cores have square hysteresis loop. Vertical pulse will move core from 0 to 1 position

sends a pulse through the top row of cores.

Normally, all the cores are in the 0 position and no appreciable flux change takes place in any one of the cores during the pulsing. When a number is to be displayed, an initiating pulse is sent in to the matrix. This pulse sets core A into its 1 position. The following H_8 horizontal pulse will then reset core A from 1 to 0. This flux change induces a positive pulse voltage to actuate the V_1 pulse amplifier, which in turn sets the whole second vertical column of cores into their 1 positions.

The subsequent H_1, H_2, through

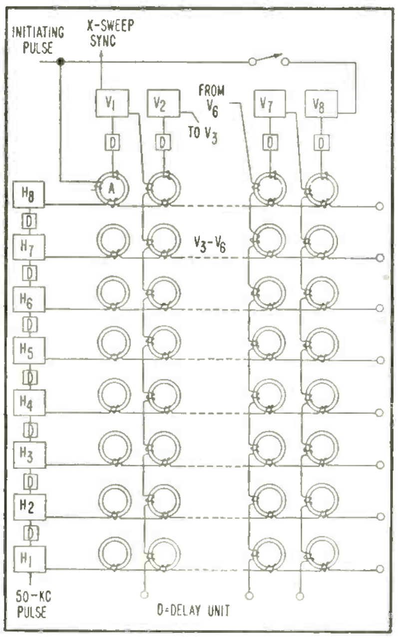

FIG. 3—Eight-by-eight magnetic matrix used in number generator

FIG. 4—Numbers produced on crt by generator

H_8 horizontal pulses will reset these cores from 1 to 0, one at a time. The resetting of top core of the second column actuates amplifier V_2 to set the third column of cores. This process of scanning of cores goes on until the last core of column 8 is reached. Thus the array of the magnetic memory cores along with the pulse amplifiers make up a network that at the control of an initiating pulse produces a successive flipping of cores similar to the scanning of an electron beam across the face of a cathode-ray tube. Synchronizing signals for the X and Y crt sweep are brought out of the matrix so that the scanning of the cathode-ray tube will go on simultaneously with the scanning of the cores.

If a single wire is threaded through the proper cores of the magnetic array in the shape of the number to be displayed, a voltage will be induced along this wire by the flipping of the cores. This voltage will automatically give the proper Z-intensity signal to generate the number on the face of the cathode-ray tube. Since only a single wire is necessary for each number, several hundreds of different numbers can be generated at the same time by threading separate wires through the proper cores of the magnetic array.

Numbers generated and displayed on the face of a standard cathode-ray tube are shown in Fig. 4.

A switch on the output of V_8 permits reinjection of the signal in V_1 to permit automatic recycling for continuous display of numbers. To provide time for selection of different numbers in between successive display, the first vertical column of cores can be omitted. During the scanning time of this column, electronic switching can be used to select different numbers. The number generator has been built and tested to operate up to 8,000 numbers per second. The results from the test model indicate that a number generator of this type could be developed without much difficulty to display numbers up to 100,000 characters per second.

Double Flash Measures Shock Waves

AVERAGE VELOCITY can be determined from double-exposure photographs in which the time interval between exposures is accurately known. A silhouette or shadow method is employed with two light pulses to make shock waves visible.

Electrical and optical arrangements used in photographing the post-explosion wave from a dynamite cap are shown in Fig. 1. Three electrode gaps time the discharge from two capacitors into the illumination spark. The circuit is given in Fig. 2.

If the same energy is used in each capacitor, light from the second flash is weaker than that from the first. Accordingly, C_2 has twice

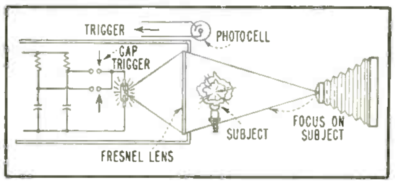

FIG. 1—A plastic Fresnel lens collects sufficient light from the spark source to make shock waves visible. The photocell triggers the spark

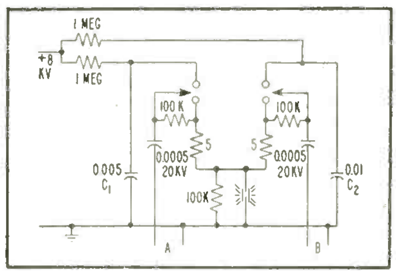

FIG. 2—Flash circuit provides double spark from main and delayed trigger

All Moloney HiperCore Electronic Cores, including over 1000 standard sizes, are manufactured under rigid quality controls. Electronic manufacturers will find this to be of great importance when performance specifications demand tranformer cores that have lower losses and greater flux carrying capacity. HiperCore Electronic Cores test well within industry standards. Typical test requirements for various types are listed in the panel at right. Special tests for specific operating conditions are also made when required. If your product demands better performance, smaller size and less weight, we can help you.

A booklet containing performance characteristics, sizes and weights, along with price information is available upon request. Write for it today.

ME53-2

STANDARD TESTS

All 12 mil cores are tested for core loss (true watts) and exciting volt-amperes (apparent watts) at 60 cycles. 4 mil cores are tested at 400 cycles. Following table gives maximum test values. Average values are approximately 20% less than maximum.

	12 Mil — 60 Cycle @ 15000 gauss	4 Mil — 400 Cycle @ 10000 gauss
Core Loss (TW)	0.95 x lbs.	3.75 x lbs.
Exciting Volt-Amps (AW)	1.85 x lbs. + 6.25A*	4.6 x lbs. + 16.6A*
* A = Gross Area of core face in Sq. In.		

All 2 mil cores are tested for pulse permeability by using a 2 microsecond pulse width at 400 P. P. S. and maximum net flux density of 10000 gauss. The minimum permeability will be 550.

All 1 mil cores are tested for pulse permeability by using a 0.50 microsecond pulse width at 1000 P. P. S. and maximum net flux density of 3000 gauss. The minimum permeability will be 350.

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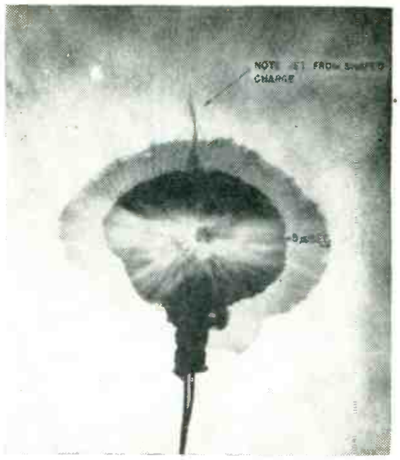

Double-flash photograph, with exposure about 0.3 μsec and interval 5 μsec, of dynamite cap

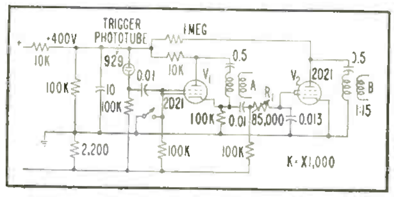

FIG. 3—Trigger circuit with time delay energizes circuit of Fig. 2

the capacitance of C_1. Critical damping resistance for the conditions shown is about 20 ohms, but a lower value is chosen and some oscillations are tolerated for the resultant increased light output.

The trigger and time-delay circuit in Fig. 3 is initiated by light from the explosion falling upon the phototube. Firing of V_1 sends a pulse through transformer A to the flash circuit. Time-delay control R_1 is adjusted for the desired initiation of the second flash impulse through transformer B.

Material for this summary has been furnished by Edgerton, Germeshausen & Grier, Inc. and includes excerpts from an article by Harold E. Edgerton in *The Review of Scientific Instruments*.

Transistor Frequency Standard

BY PETER G. SULZER

National Bureau of Standards Washington, D. C.

FREQUENCY-STABLE oscillators are required for reference purposes and can be used as time standards when suitably calibrated and maintained. The best standards in use at the present time require the use of

two or more tubes in an amplitude-stabilized oscillator employing a highly stable quartz crystal and regulating element in a bridge circuit[1]. When properly adjusted the frequency of such an oscillator is practically independent of tube parameters; however, several watts may be required to power the tubes and the constant-temperature oven for the crystal and its associated network may require about 50 watts. Consequently, a heavy standby power system is required if a phase reference and uninterrupted service are to be maintained.

In another approach[2] to the frequency-standard problem a crystal

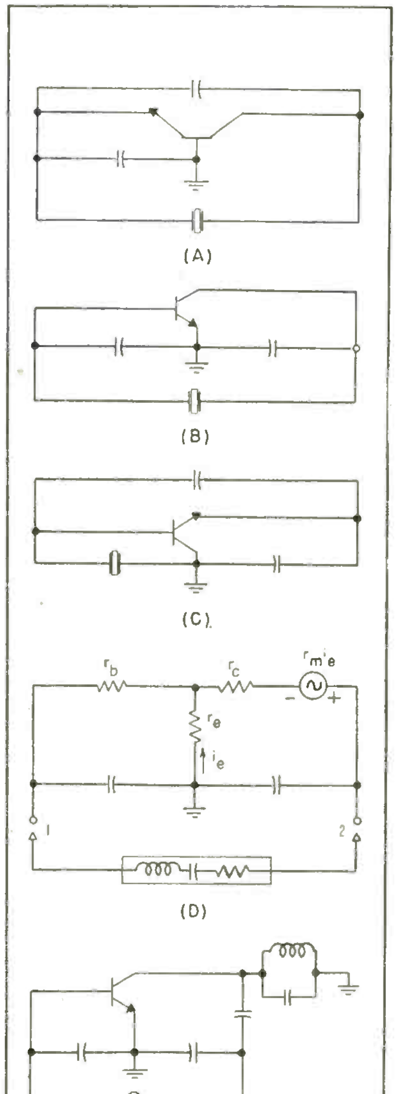

FIG. 1—Simple junction-transistor crystal oscillators

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resonator, which is used for reference purposes only and is not continuously energized, is maintained at a constant temperature by being kept at a depth of 50 or more feet in a well. As such it does not provide a phase reference or a crystal clock. In converting a resonator standard for use as an oscillator it would be undesirable to place the oscillator tubes at the bottom of the well because of replacement difficulties and because of the heating of the surrounding soil, although it is desirable that the oscillator crystal unit and circuit be temperature controlled. If the oscillator power could be decreased and its reliability increased, the underground oscillator would become practical.

An oscillator employing one or more transistors may be a solution to this problem, and it is the purpose of this paper to give a brief report on one simple circuit that has been given preliminary trials.

Of the two types of transistors available, the junction transistor[3] appears to be superior to the point-contact type in this application because of its low noise level and excellent stability. Consider the three simple junction-transistor oscillators shown in Fig. 1. The first, Figure 1A, employs the grounded-base connection, which permits a high gain, but has a very low input resistance. The low input resistance across a portion of the crystal circuit will produce a phase shift, which may produce frequency changes as the transistor characteristics change. Figure 1B, the grounded-emitter connection, also produces a high gain, and has the advantage of a higher input impedance. Figure 1C, the grounded collector connection, has a very high input impedance, but does not furnish sufficient gain.

Considering, then, the grounded-emitter oscillator of Fig. 1B, the equivalent circuit Fig. 1D can be drawn, where the parameters are defined in reference 3. Analysis will show that the impedance measured across points 1-2 can be a negative resistance in series with a capacitive reactance. With the proper adjustment of the circuit constants, oscillation will be obtained slightly above the series-resonant frequency of a crystal connected across these

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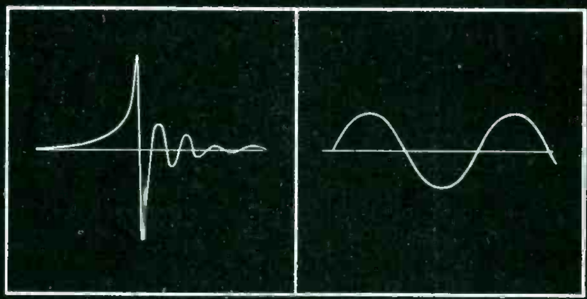

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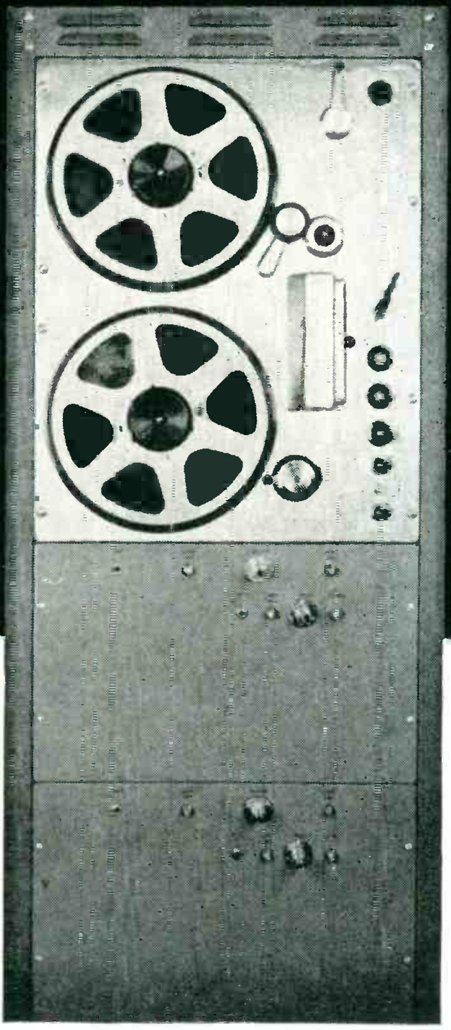

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points. The amplitude of the oscillation will increase until limiting occurs either in the collector circuit or in the emitter circuit. However, the amplitude may be much too great for a high-quality 100-kc GT-cut crystal, which should operate at a current of 100 microamperes or less, and may fracture or be otherwise damaged at currents of several milliamperes.

One method of obtaining satisfactory limiting at low crystal currents is shown in Fig. 1E, in which a capacitive attenuator is inserted between the collector circuit and the crystal. The collector will then limit at a peak voltage approximately equal to the supply voltage, but the attenuator will decrease the crystal drive to several millivolts, producing the desired effect. The collector circuit must then be tuned to obtain a sufficiently high gain to overcome the attenuation necessary to produce the low crystal current.

Figure 2 shows the schematic diagram of one such oscillator constructed for test purposes. The components mount in a 1¾-inch diameter by 7-inch brass tube. The transistor, coil, capacitors and resistors are supported by a Bakelite frame, while a mercury cell is held in a Bakelite cup. The cell, which delivers 1.35 volts at 100 microamperes, should last over 5 years. The crystal current is approximately 60 microamperes, while the output of the unit is 3 millivolts at 100 kilocycles. The overall temperature coefficient of frequency is $+ 1.5 \times 10^{-9}$ per degree centigrade at normal temperatures, which compares favorably with $+ 1.3 \times 10^{-9}$ per degree centigrade for the crystal resonator alone.[4] The voltage coefficient of frequency is $- 1 \times 10^{-8}$ per 1/10 volt, which is satisfactory when it is pointed out that the voltage of the mercury cell should be very constant. It is interesting to note that the unit has a pressure

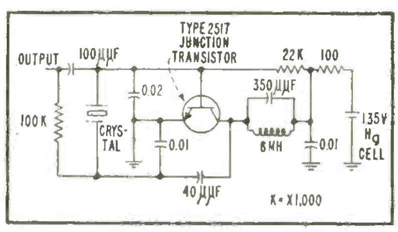

FIG. 2—Experimental transistor crystal oscillator

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coefficient of frequency of about -1×10^{-9} per pound per square inch.

For its early tests the oscillator was placed in a constant-temperature bath of clear ice. The initial rate of drift was approximately 3×10^{-9} per day. The oscillator was subsequently placed in a constant-temperature well, and the drift was found to be 1×10^{-8} per week, which is several times that of a well-aged vacuum-tube oscillator. It is expected that the drift will decrease as the unit ages.

It is to be expected that improvements will be made as better transistor oscillators are developed. One worthwhile addition to the circuit should be the use of an automatic gain control to permit class-A operation. It should also be desirable to build a transistor bridge-stabilized oscillator, although it may be difficult to obtain a suitable low-level amplitude-control element. Transistors should also find application in locked-oscillator frequency dividers[5] and, indeed, it may be possible to construct a primary standard or crystal clock requiring a total power of about 1/100 watt by using transistors throughout, with an electrostatic motor to drive the clock mechanism. The use of a temperature control slightly higher than ambient in connection with such a system would produce a truly portable primary standard of frequency.

The writer wishes to acknowledge the encouragement and assistance of Mr. W. D. George.

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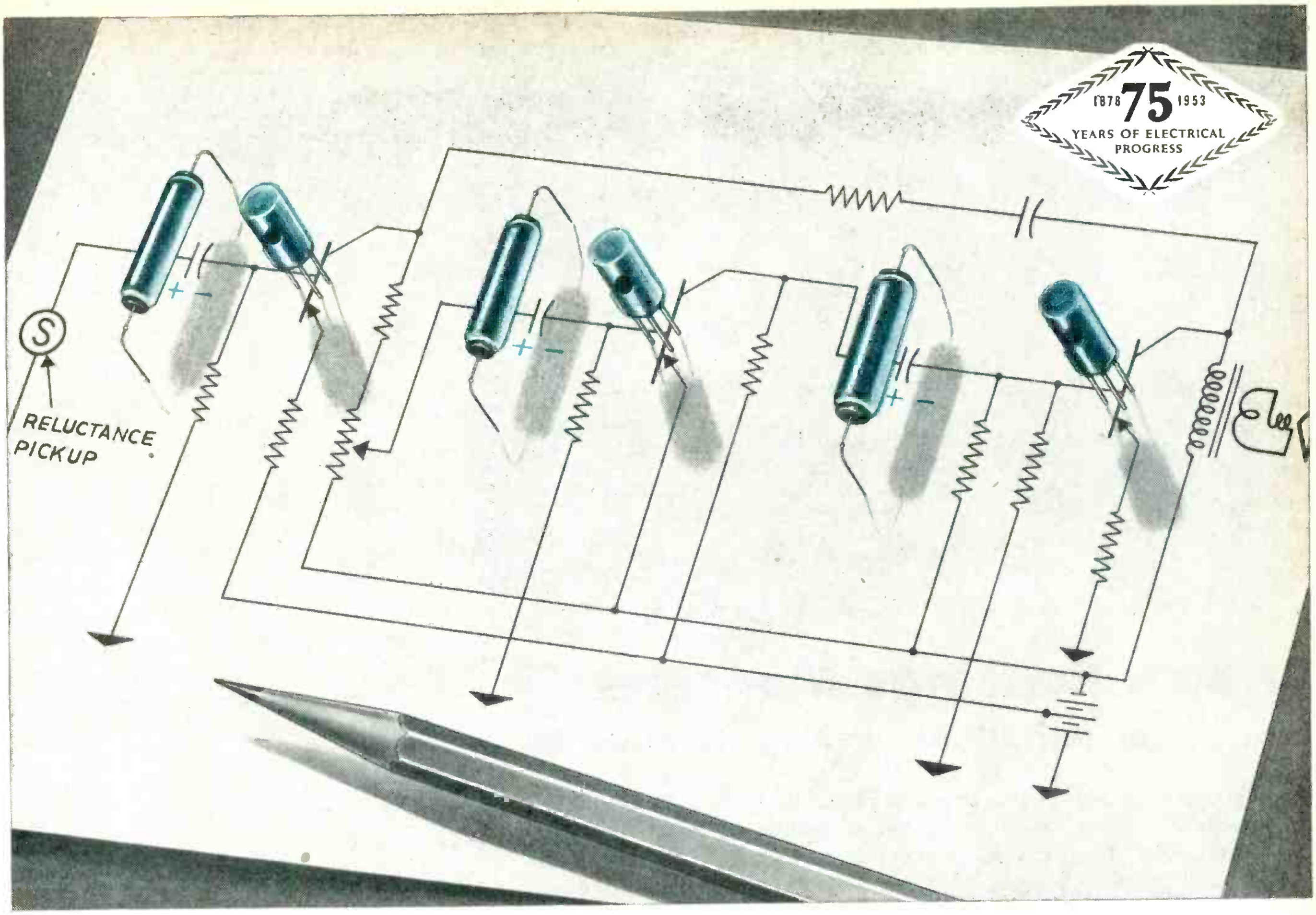
(4) J. P. Griffin, "High Stability Quartz Crystal Unit for Frequency Standards," Bell Lab Record, 30, No. 11, 1952.

Mobile Radio Transmission

NEED FOR MORE mobile radiotelephone communications channels to alleviate crowding in the region of 150 mc will force increasing use of frequencies above 400 mc. Experiments show that the higher fre-



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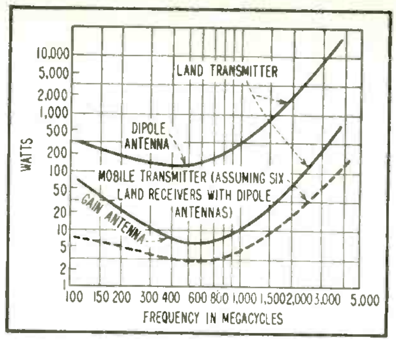

FIG. 1—Transmitter power into antenna required for urban and suburban coverage

quencies can be used and performance at 150, 450, 900 and 3,700 mc has been compared. Results show that 450 mc has superior transmission characteristics to 150 mc in urban and suburban areas.

As shown by the curves in Fig. 1, a broad optimum occurs in the region of 500 mc. Although higher frequencies are less desirable, the tests show that with gain antennas 900 mc may even prove superior to 150 mc.

Above 900 mc, transmission characteristics appear less favorable even with maximum practical antenna gain. At 3,700 there is difficulty from carrier fluctuations occurring at an audible rate as the mobile unit moves at normal speeds.

The tests produced significant information about antennas. When noise collected by a dipole antenna was discernible over set noise, the noise collected by a 7-db gain antenna at the same site was less. Since it picks up 7 db more signal from a distant car, such an antenna thus provides a double improvement in transmission at locations where ambient noise is the predominant type.

This effect may be explained on the basis that sources of noise are numerous and emanate mostly at street level from motor vehicles. Received noise is the sum from all sources and its strength depends upon distance and the receiving antenna pattern. An antenna with gain tends to ignore strong nearby noise because it is below the antenna beam. Sources in the beam of the antenna are generally far enough away so that they are attenuated by distance.

The information summarized here has been abstracted, with per-

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mission, from "Comparison of Mobile Radio Transmission at 150, 450, 900, and 3,700 Mc" by W. Rae Young, Jr. in the Nov. 1952 issue of *The Bell System Technical Journal*.

Low Capacitance Bifilar Winding

By Sidney Wald

UNTUNED R-F TRANSFORMERS when utilized to couple a single-ended circuit to a push-pull circuit over a wide frequency range must be tightly coupled to minimize leakage reactance effects and have low primary to secondary capacitance to avoid unbalance of the secondary voltages.

Such requirements are difficult to fulfill simultaneously because unity coupling implies the closest space relationship between the windings.

A typical unbalanced-to-balanced coupler is shown in Fig. 1. The primary-to-secondary capacitance appears effectively across one-half the secondary winding.

This article describes a bifilar winding in which this capacitance may be effectively halved without sacrificing either total inductance, losses or coupling.

As shown in Fig. 2A, the winding is fabricated in the customary manner except that the two conductors are transposed once per coil turn. As the winding progresses, the location of the crossover is offset progressively so that cumulative bunching of the winding does not occur.

Typical experimental results are as follows: A normal bifilar winding consisting of 39 turns of no. 18 dcc wire side-by-side on a ⅜-in. diameter form had an inductance of 1.8 microhenrys and a capaci-

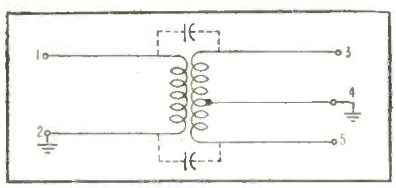
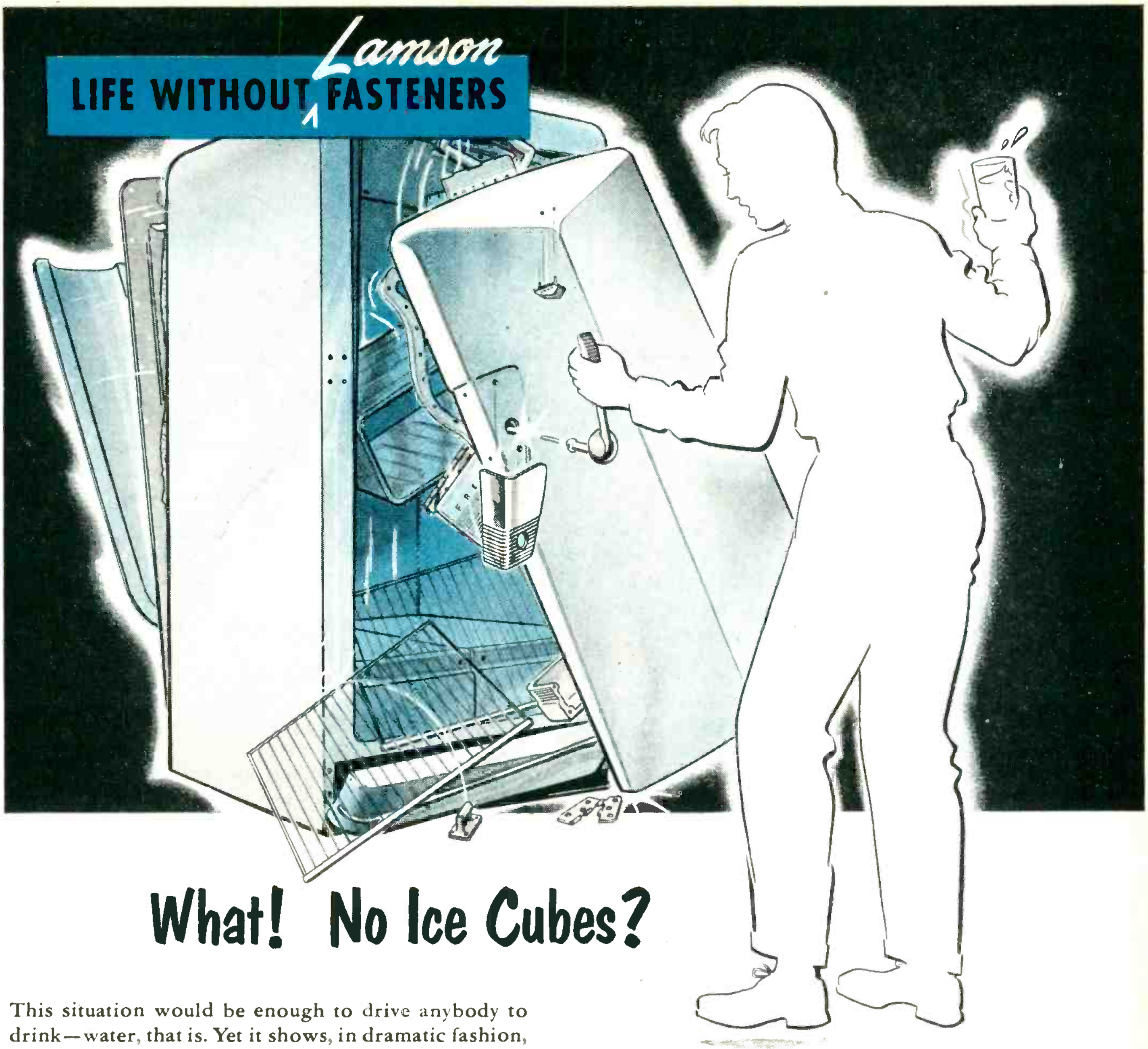


FIG. 1—Coupling circuit showing effective primary-to-secondary capacitance



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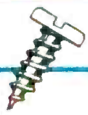

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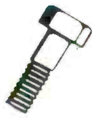

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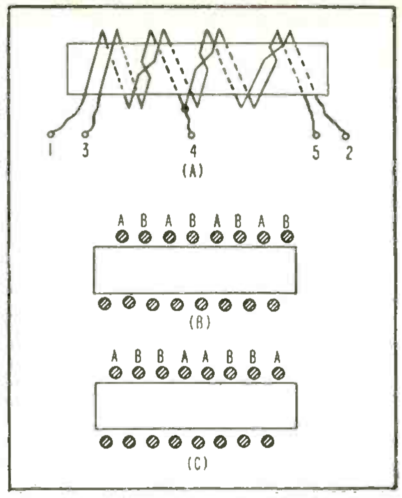

FIG. 2—Bifilar winding technique (A) showing method of crossing conductors. Cross section of conventional (B) and new winding (C) shows how conductors are placed

tance between windings of 200 $\mu\mu f$.

Using the improved transposition technique described above all constants remained the same but the capacitance between windings was reduced to 100 $\mu\mu f$.

Why transposing the conductors once per turn results in a reduction in capacitance is shown in Fig. 2B and C. For the conventional winding each *A* conductor is adjacent at all times to two *B* wires and each *B* wire is adjacent to two *A* wires.

In the new winding neither of the conductors is ever adjacent to more than one of the opposite winding.

If the time interval used in the calibration had been extended, the accuracy would have increased accordingly. It was possible to repeat the calibration readings to the nearest second even after considerable time had elapsed. The short-time accuracy of the oscillator was checked by operating against a Western Electric 6010B oscillator. When the two instruments were compared with an oscilloscope, a maximum drift of one-half cycle over a five-minute period was observed. A block diagram of the connections used for calibration is shown in Fig. 2.

To use the instrument to measure frequency, the output of the oscillator is connected to the vertical amplifier of an oscilloscope and the power source is connected to the

horizontal amplifier. The dial of the oscillator is adjusted until the trace on the screen of the oscilloscope is stationary. The calibration curve will then give the frequency corresponding to the dial reading.

If the signal is adjusted so that the trace on the oscilloscope is a straight line, the visual accuracy of the measurement will depend on the focus limitations of the oscilloscope. When a sharp image on the oscilloscope is used, a drift of one degree becomes apparent in the thickening of the trace with the straight line adjustment. When care is used in making the adjustment, the method is quite accurate.

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Tubes for UHF Application

TUBES now available for use in uhf-vhf tuners and converters include Sylvania's 6AN4 and 6T4 and General Electric's 6AJ4, 6AF4 and 6AM4 (See also p. 118, ELECTRONICS, Dec. 1952). The 6T4 and

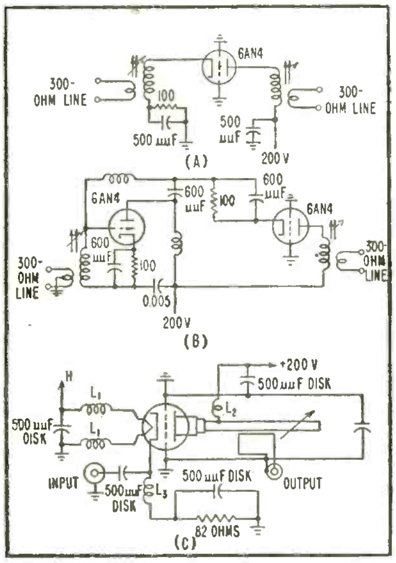
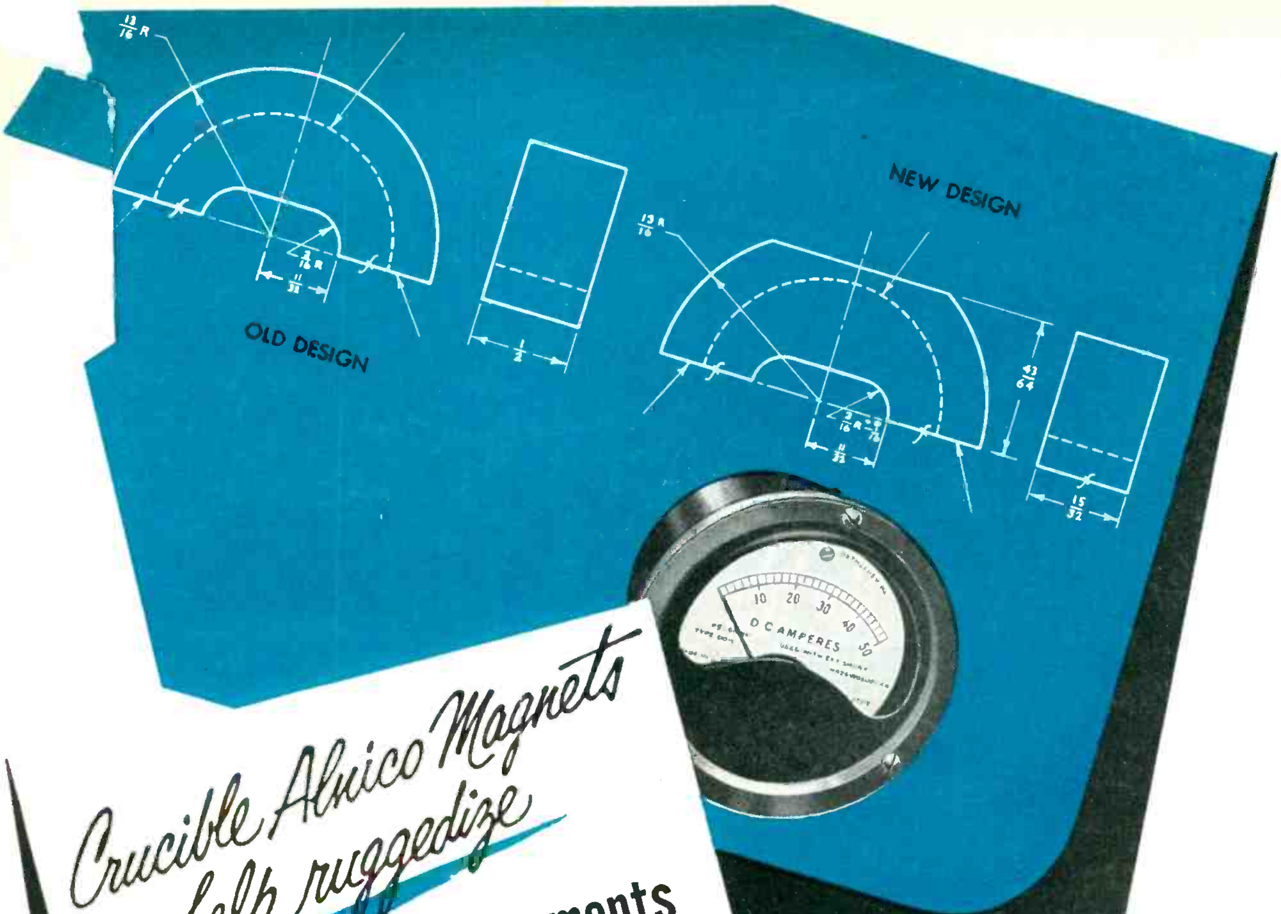


FIG. 1—Two booster circuits (A, B) used to obtain performance characteristics of tubes at vhf. Performance at vhf was obtained from tuned-line amplifier (C)



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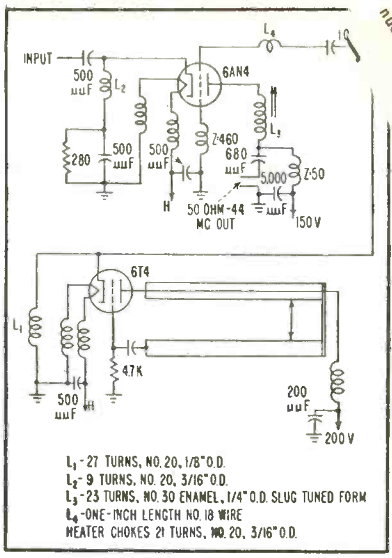


FIG. 2—6AN4 used as mixer with 6T4 oscillator

6AF4 are designed for use in oscillator circuits, while the 6AN4 can be used as an amplifier or mixer. The 6AJ7 and 6AM4 are for use as a grounded-grid amplifier and mixer respectively.

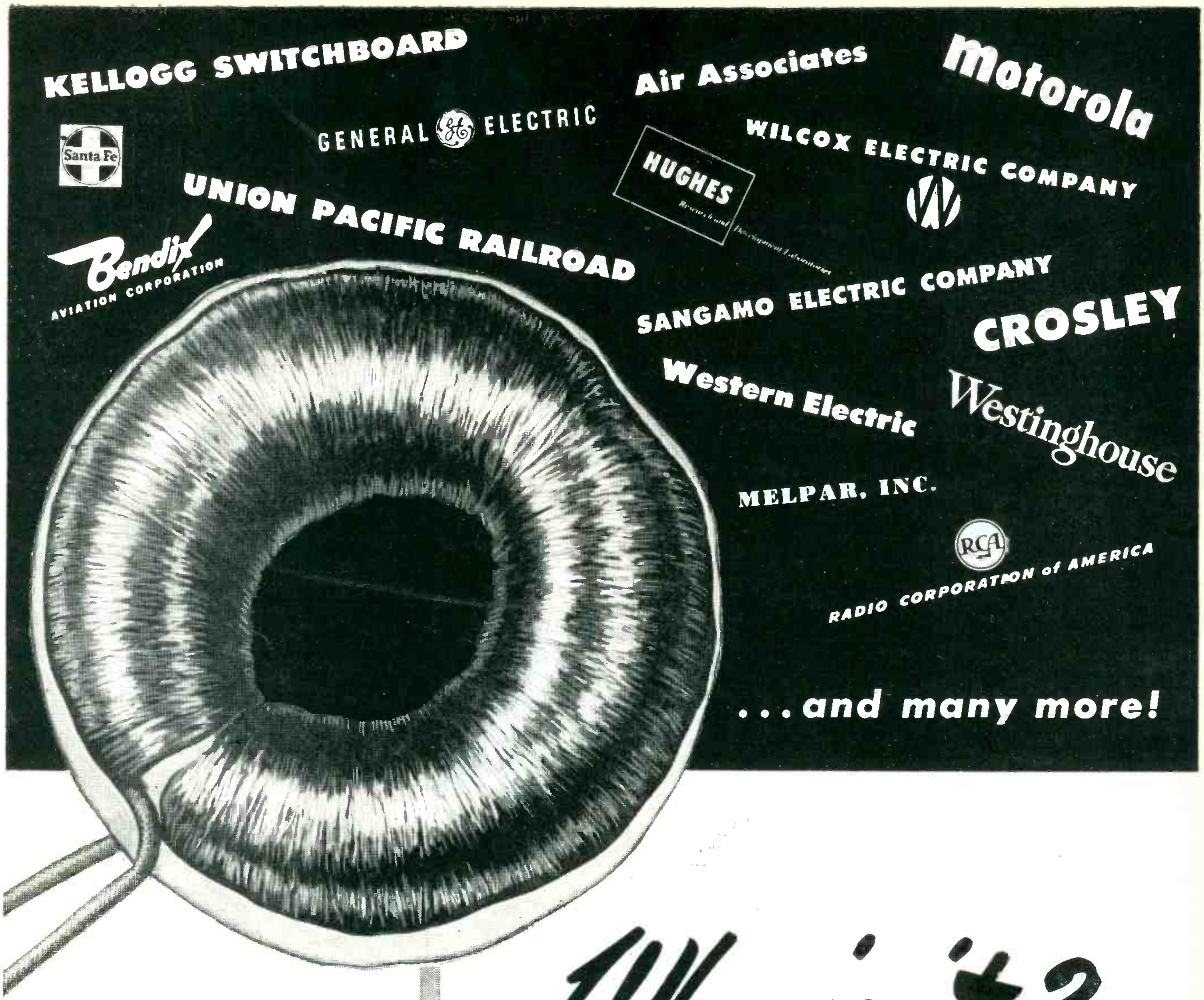
Applications of the 6AN4 as a mixer or amplifier can be made at frequencies up to 1,000 mc.

Performance at vhf of the 6AN4 was tested in two channel-13 boosters. One employed a single 6AN4 in a grounded-grid amplifier and the other used two 6AN4's in cascode. Circuits are shown in Fig. 1A and 1B.

The single-tube circuit had a voltage gain of five with 10-mc bandwidth and noise figure of 9.2 db. The two tube cascode circuit provided a gain of 11.1 with 7.5-mc bandwidth and 8-db noise figure.

Performance at uhf was determined by using a single tube in a half-wave tuned-line amplifier shown in Fig. 1C. The amplifier has a tuning range from 450 to 900 mc. Gain at 450-mc was 12 db and 10 db at 900-mc. Noise figures were 13 db and 15 db respectively.

Because of its high conversion transconductance, a high conversion gain can be obtained when the 6AN4 is used as a mixer. In the circuit shown in Fig. 2, a 6AN4 mixer is used with a 6T4 oscillator. Relationship of conversion gain to oscillator injection voltage is shown in Fig. 3. Noise figure varied from 14 db at 500 mc to 17.1 db at 800



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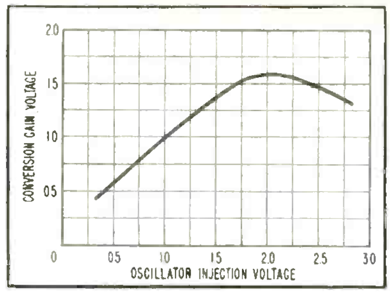

FIG. 3—Conversion gain characteristics of 6AN4

megacycles per second.

Used as a grounded-grid amplifier, the 6AJ4 provides a gain of 5.8 db at 900 mc, with a noise figure of 15.3. This tube has a high transconductance with an amplification factor of 42 at a plate current of 16 ma. Probable circuit applications include the use of two tubes in cascode or direct-coupled circuits.

The 6AF4 and 6AN4 are recommended for use as oscillator and mixer tubes in tuners employing the 6AJ4 amplifier.

Printed Circuit Military Multimeter

By HERBERT CAHN
Coles Signal Laboratory
Fort Monmouth, N. J.

A NEW MULTIMETER for use by military repair and maintenance personnel in forward tactical units uses a printed circuit and a recently developed overload protection device to provide ruggedness and dependability.

In designing this meter, designated the ME-77, a survey of existing measurement circuits was made, leading to the selection of a 50 μa indicating meter with conventional associated circuitry.

Additive series multiplier resistors provide the d-c voltmeter circuit employing the full sensitivity of the indicating meter, 20,000 ohms per volt, in five ranges from 100 millivolts to a maximum of 1,000 volts.

The a-c voltmeter circuit, using a copper-oxide rectifier, also employs additive series multiplier resistors, but in a 1,000-ohms-per-volt system. The optimum lower limit established as the full scale value is three volts.

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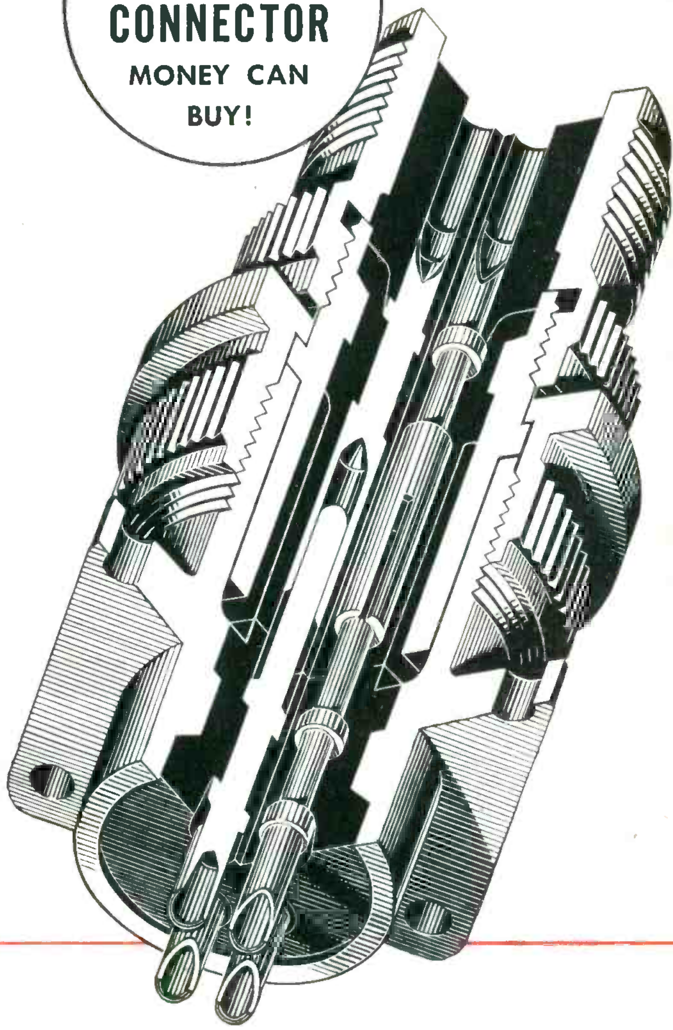

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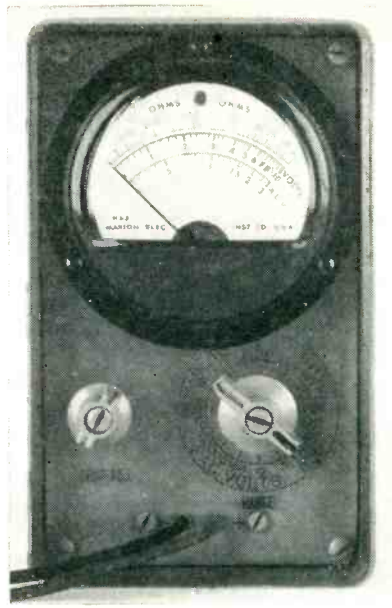

Meter dial and controls of multimeter. Note nonlinearity of meter scales

ranges and their associated calibration scales has been held to a minimum by the use of a specially developed microammeter having a nonlinear response. As can be seen from the photograph, Fig. 1, the middle dial scale, which is directly proportional to the response of the indicating meter to direct current, is essentially linear for the first ten microamperes, and approaches a logarithmic distribution thereafter from ten to fifty microamperes.

Thus, a scale with essentially constant accuracy of readability over most of its length has been obtained. By establishing the lowest range for the d-c voltmeter at 100 millivolts and increasing each of the five steps respectively by a factor of ten, a simple scale with a single set of numerals is sufficient to achieve an accuracy within plus or minus three percent of full-scale values.

The essentially linear response of the a-c voltmeter circuit employed makes it possible to establish ranges of the same magnitude as those of the d-c voltmeter except for previously mentioned minimum full-scale value of three volts. This makes it possible for all voltage indications, save those of a-c below three volts to be read on a single calibrated scale by means of a single set of numerals.

The d-c resistance-measuring

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circuit is a conventional adaptation of the series type ohmmeter. A five-step arrangement provides overall measurement capabilities from one ohm to twenty megohms. The nonlinear response of the meter helps to relieve the usual compression of the left hand portion of the scale with simultaneous compression of the normally more than adequate right-hand portion. Battery voltages of 1.5 and 22.5 serve respectively for the lower three and the upper two ranges of resistance measurement.

The simplicity of circuit design is apparent from the schematic diagram in Fig. 2. Only twenty-one accurate fixed resistors are employed in addition to the indicating meter and its rectifier unit, the ohmmeter adjusting variable resistor, and the batteries.

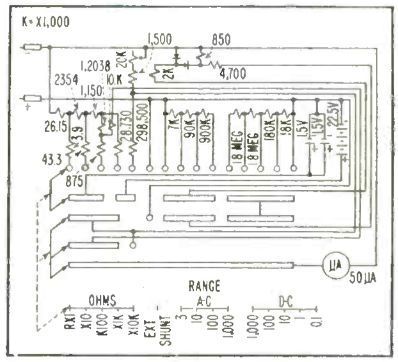
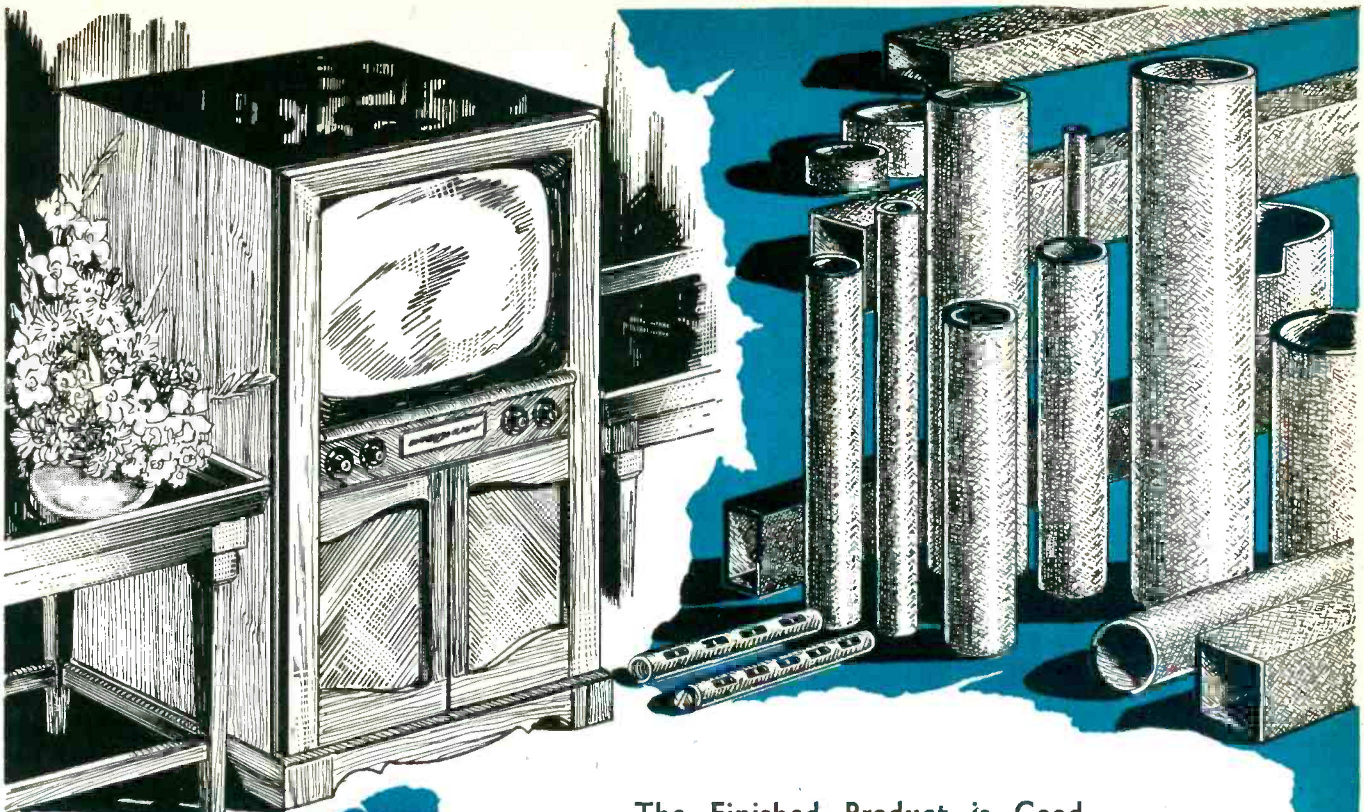
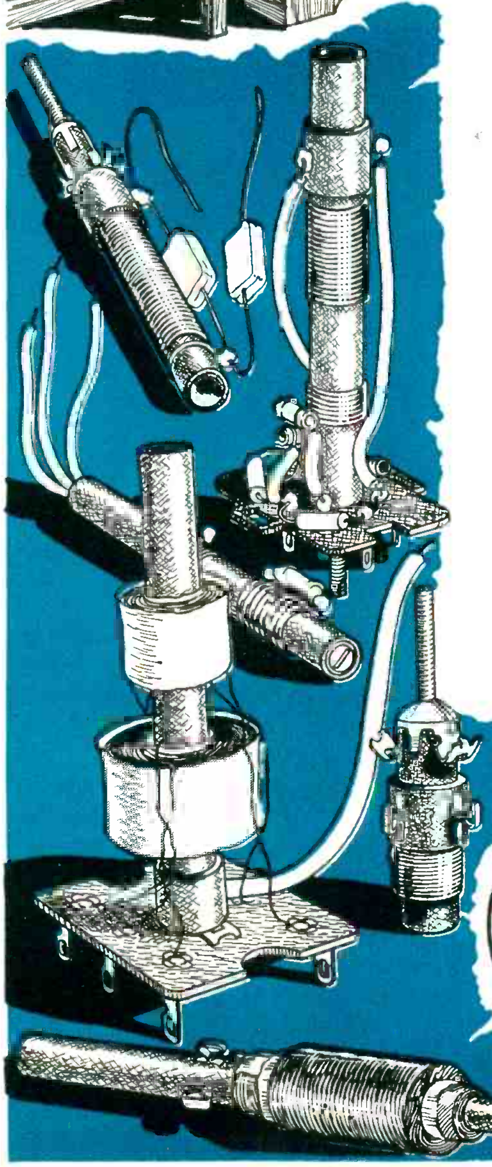


Fig.1—Complete diagram of the printed circuit multimeter

One feature of the multimeter is the use of printed circuits. An etched pattern has been produced from a copper foil laminate. This pattern includes not only the conductive pattern equivalent to hook-up wiring, but also the stator portion of the function-and-range selector switch. The rotor and detent mechanism for the switch is fastened directly to the printed circuit pattern laminate to complete the switch and wiring assemly. In addition the printed-circuit pattern laminate serves as a mounting board for all twenty-one fixed resistors, the variable resistor, the rectifier unit and battery mounting board. The test leads are also permanently attached directly to this board. Use of printed wiring tech-





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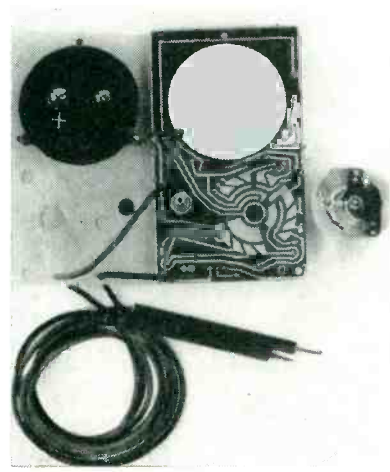
nique has limited the number of conventional wires to only five flexible leads. Two of these connect the meter to the printed circuit pattern and the remaining three connect the battery terminal contacts to the printed pattern.

The entire printed-circuit assembly, which contains all circuit elements except the meter, attaches to the rear of the recessed control panel. The meter is fastened directly to the control panel. The complete unit weighs about two pounds and is able to survive being dropped from a height as great as three feet. Improvement in reliability of the electrical performance over that normally expected of a sensitive multimeter utilizing a ruggedized

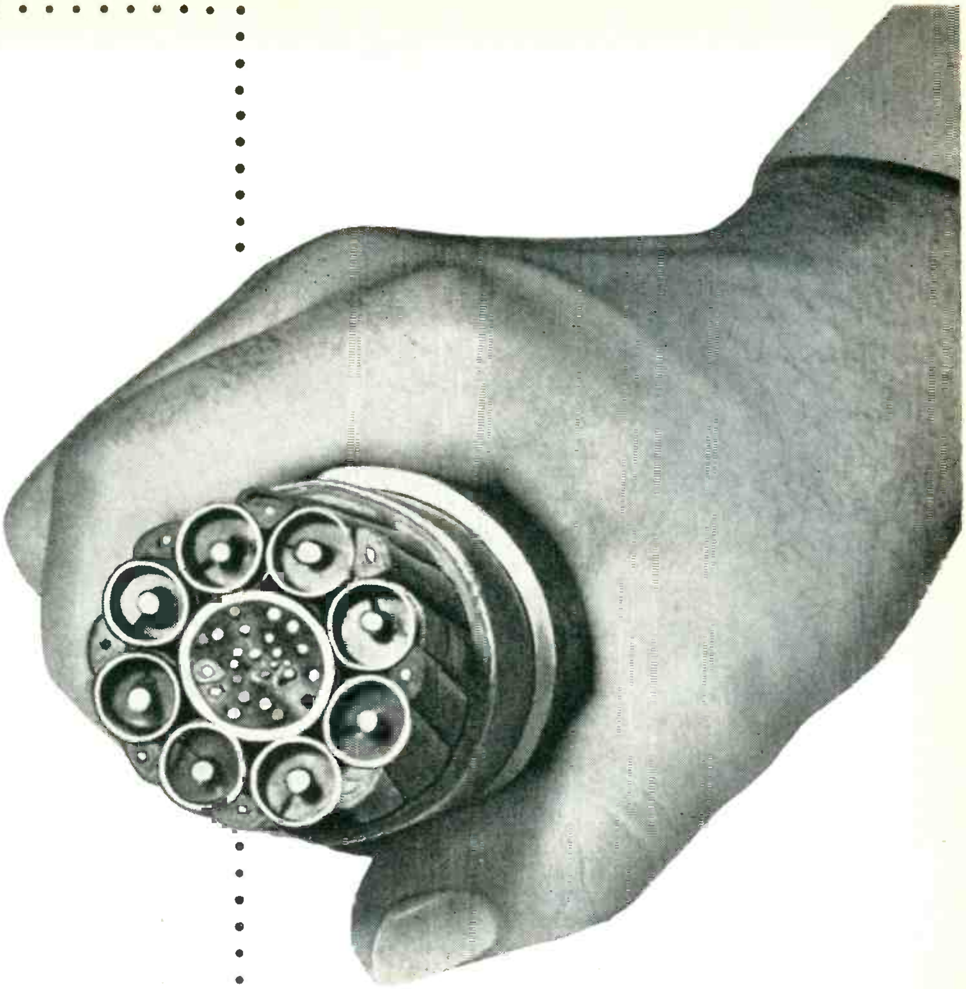


Internal parts of multimeter showing printed circuit and switch, at right, that mounts on it

and sealed meter, can be expected to result from the use of a newly developed overload protection device supplied as an integral part of the indicating meter.

An overload that would ordinarily cause permanent damage to the meter is prevented by two tiny circuit breakers at either end of the scale. The force of the pointer striking against this device breaks the meter circuit by opening a pair of contact points in the circuit of the moving coil. These contact points, ordinarily held together by spring pressure, are held open by a tiny permanent magnet after an overload occurs. A turn of 360 degrees

Pipes that grew without getting bigger



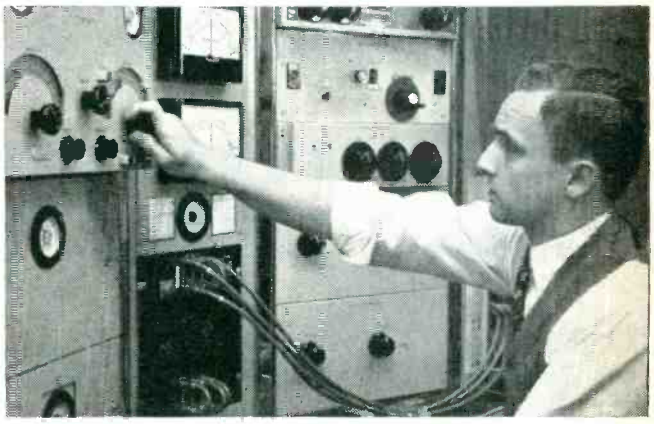
Cross-section of coaxial cable. To triple capacity, Bell Laboratories and Western Electric engineers had to make 1000 amplifiers work perfectly in tandem . . . feed repeater power along the same cable that carries messages . . . put signals on and off the line at numerous cities along the route without distortion.

Pencil-size pipes carry telephone messages and television across country through the Bell System's coaxial cable. Once, each pipe could carry 600 voices, or one television program. Now it can carry 1800 voices, or 600 voices *plus* a broadcast quality television program.

Yet the pipes aren't any larger. They are being made into triple-duty voiceways by new repeaters, new terminal equipment and other transmission advances developed by Bell Laboratories engineers.

The conversion expense is less than the cost of laying extra coaxial cables. But it calls for highly refined manufacturing procedures, made possible only by close co-operation of Bell Laboratories and Western Electric, manufacturing unit of the Bell System.

In improving the coaxial cable system they created more than 20 years ago, engineers at Bell Telephone Laboratories devised a new way to give America still better telephone service, while the cost stays low.



Laboratories engineer tests new triple-duty coaxial system. It marks the first time that telephone conversations and television can travel through the same pipes at the same time. With a wider frequency band being transmitted, big problem was to eliminate interference between the two types of signals.

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on the zero adjust screw of the meter returns the points to the closed-circuit position.

Magnetostriction in Alnico V

By James R. Ireland

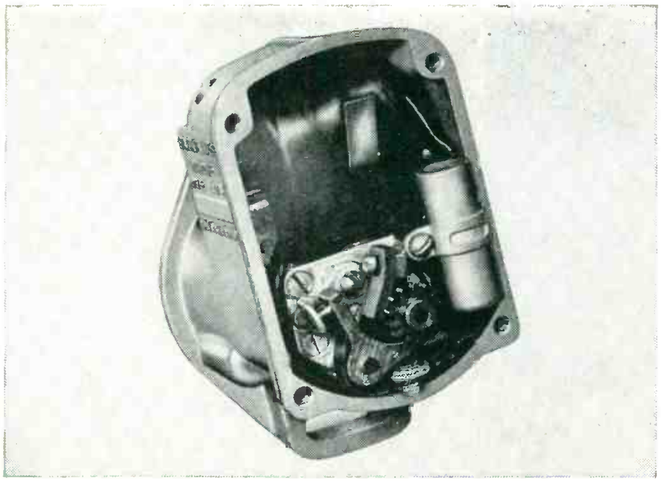
Chief Engineer
Thomas & Skinner Steel Products Co.
Indianapolis, Ind.

In the development of Alnico V magnets for use in vibration pickups operating on magnetostrictive principles, the Thomas and Skinner Steel Products Co. made an investigation of the effects of production processes on the magnetic and magnetostrictive properties of Alnico V.

The normal heat treatment of Alnico V consists of heating to approximately 1,650 F and then cooling at a controlled rate in a strong magnetic field. The direction of this field must be that in which final magnetization is performed. Following this treatment, the material is given a five-hour draw at approximately 1,090 F. After this treatment, the magnetic properties are high in the direction of orientation, and lower in all other directions. Since this orienting treatment is believed to have an effect upon magnetostriction, it was decided to investigate this first before proceeding with the investigation of such variables as temperature, cooling rate, draw time and draw temperature.

Heats of Alnico V were poured for this investigation, and samples of each were run through the same treatments concurrently. Three variations of orienting methods were used. The first group of samples was oriented in the normal manner, which was parallel to the cylindrical axis of the bar. A second group was oriently at right angles, or across the diameter of the bar. A third group was put through the normal heat treatment, but was cooled without benefit of a magnetic field of any kind. These samples were then tested, drawn, and then retested. The results of this investigation showed that inherent magnetic properties as indicated by the flux values bear little, or no

How many of these electrical insulation problems do you have?



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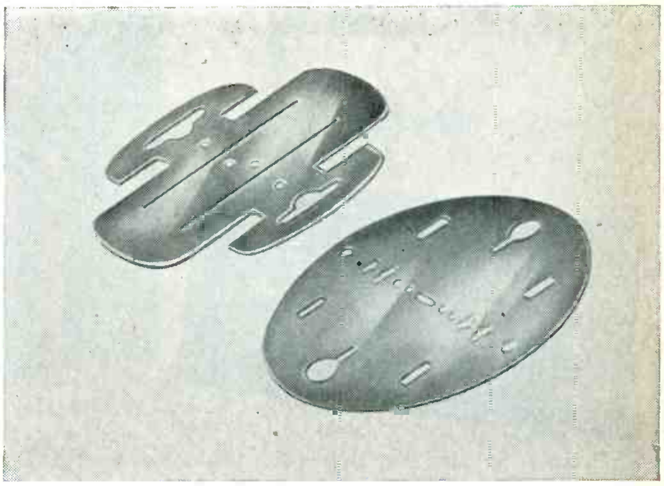

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relation to the magnetostrictive properties.

Best magnetostrictive properties are obtained by heat treating the material, and then allowing it to cool without a magnetic field being applied. If a slightly higher coercive force, which indicates resistance to demagnetization, is desired, it may be obtained by giving the material a draw. But this, will lower the magnetostrictive properties somewhat. This method of heat treating has been put into production and has eliminated many of the unpredictable variations in magnetostrictive properties that were experienced with the usual heat treatment. It has also raised the general quality level and has cut rejections for magnetostrictive causes to a minimum.

This work was instigated and completed under a contract with Sperry Gyroscope Corp.

Moisture-Aging of Powder-Core Toroids

By Ernest J. Oelbermann
Robert E. Skipper
William J. Leiss
Ordnance Research Laboratory
Pennsylvania State College
State College, Pennsylvania

Aging effects in magnetic materials, such as molybdenum permalloy, up to this time, has been attributed to magnetic and elastic after-effects in the core substance[1]. It has been noted, however, in a series of experiments in this laboratory that aging may be halted by hermetic sealing of the whole assembly leading to the conclusion that aging must also be closely connected with exposure to something in the atmosphere, namely, water.

Moisture aging was first encountered at the Ordnance Research Laboratory when a number of oscillators containing toroids were heat-dried and hermetically sealed. All of the oscillators showed decreases in frequency of from 0.16 percent to 0.47 percent and it was not known whether the shift had been caused by heating or by drying. Two other oscillators vacuum-dried at a pressure of 0.8 micron of mercury for one hour showed no change of frequency. The fre-

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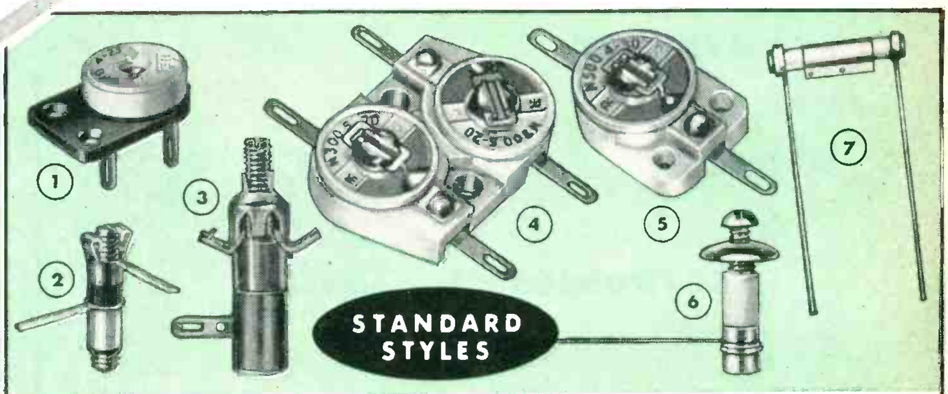

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2. Standard Style 535 miniature tubular plastic dielectric trimmer.

3. Standard Style 531 tubular plastic dielectric trimmer.

4. Standard Style TD2A dual ceramic dielectric trimmer.

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8 and 9. Two trimmer elements become an integral part of this coil form and I. F. top section.

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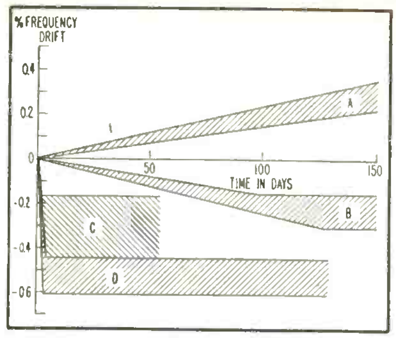


FIG. 1—Frequency drift in oscillators with powdered core toroids that have been (A) open and undried, (B) Vacuum dried and (C) (D) heat dried. Oscillators in (D) had lower frequency range than those in (C)

quency shift in the heat-dried oscillators would have been attributed to the heating effect alone had not one of these oscillators been opened to the atmosphere and observed to undergo a 0.2 percent increase in frequency in a few days.

To investigate the vacuum-drying process and its application to hermetic sealing, a test jig was constructed on which the frequencies of various assemblies of the same oscillator were measured before, during and after evacuation. This apparatus was especially set up for these particular experiments. A brass manifold was used to exhaust eight of these assemblies simultaneously to a pressure of one micron. The vacuum system consisted of a rotary oil pump, mercury diffusion pump, liquid air cold trap and McLeod gage.

Using this apparatus two assemblies with toroids only, two assemblies with capacitors only and four complete assembles were satisfactorily dried.

Two other complete assemblies were left undried and open to the atmosphere for use as controls.

Figure 2 illustrates the effect of drying and sealing oscillators containing these toroids, and it also shows the rapid regain that occurs when four of these dried units were opened. It also shows the effect of a moist atmosphere on a dried assembly.

Two of the oscillators in Fig. 2 were opened under a bell jar with pans of water and the other two were exposed to a normal humidity. Decrease of inductance and therefore increase of resonant frequency

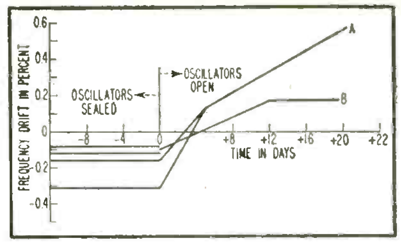


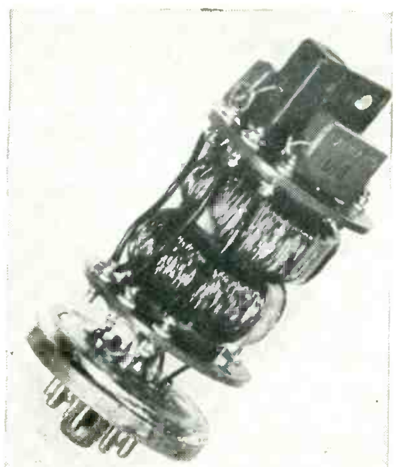
FIG. 2—Chart showing the effect of sealing oscillators. Units maintained in moist atmosphere (A) showed greater drift than those exposed to normal atmosphere (B)

occurred nearly three times faster for the oscillators in the moist atmosphere under the bell jar.

Changes in interwinding capacitance of the toroid seem to be ruled out because the observed variations in frequency are opposite in direction to what one would expect by increasing the dielectric constant from air (1) to that of water (approximately 80).

When nine toroids were dried by heating to 130 degrees F for 72 hours while passing dry air over them, it was found that all the inductances but one had increased from 0.1 to 1.7 percent. These experiments lead to the conclusions that absorption of moisture into the powdered core of certain toroids decreases the inductance and removal of moisture from the powdered core produces the opposite effect. Hermetic sealing, which apparently limits the amount of moisture available for absorption, halts the moisture-aging process.

Acknowledgement is given to G. R. Fleming, The Pennsylvania



Complete oscillator assembly showing placement of toroids under investigation

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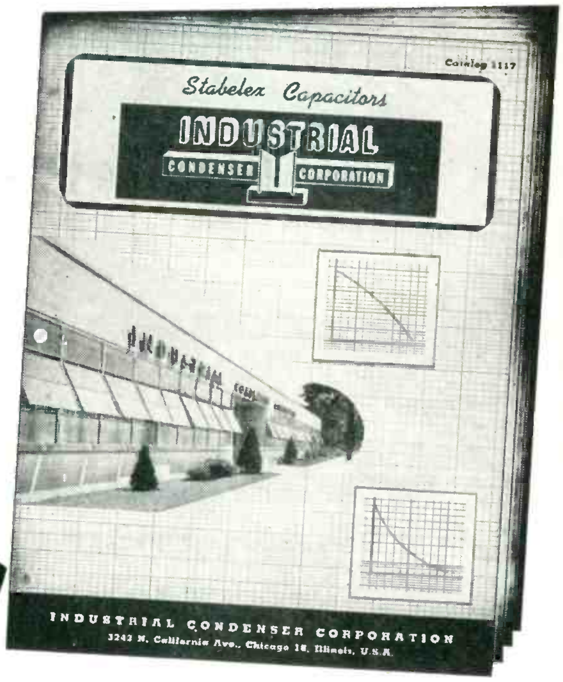

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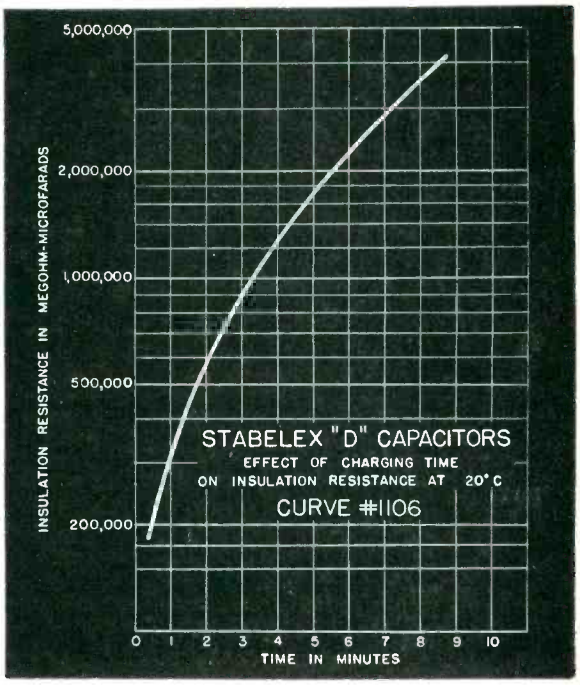

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State College, for moisture measurements; to Ralph Ascah, The Pennsylvania State College, for his advice on vacuum techniques and calibration of the capillaries of the McLeod gage.

Special acknowledgement is given to Mrs. J. D. Hunt for her aid in building the oscillator assemblies and the test jig used in the experiment.

REFERENCE

(1) R. M. Bozorth, Ferromagnetism, Van Nostrand, N. Y., 1951, p 797.

Tantalum-Foil Capacitors Save Space

By L. W. Foster
General Electric Co.
Capacitor Dept.

PAPER CAPACITORS are available in a variety of forms, voltages and capacitance ranges to fit the requirements of electronic circuits with good qualities delineated in Table I. The trend to lower-voltage electronic devices has made the size, weight and cost of paper capacitors prohibitive in many applications. Paper tubular capacitors used for r-f blocking and bypassing in early television sets have been largely replaced by mica and ceramic capacitors for reasons of smaller size and lower cost. It appears that at the present time metalized paper capacitors approach the ultimate in the size reduction of paper capacitors. Even these capacitors have not kept pace with the drastic size reductions of other electronic components such as tubes, resistors and transistors.

Since none of the electrolytic ca-

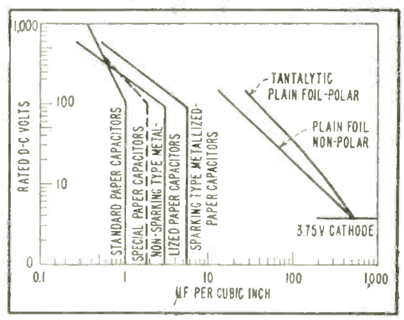

FIG. 1—Volume comparison of tantalum-foil and paper capacitors

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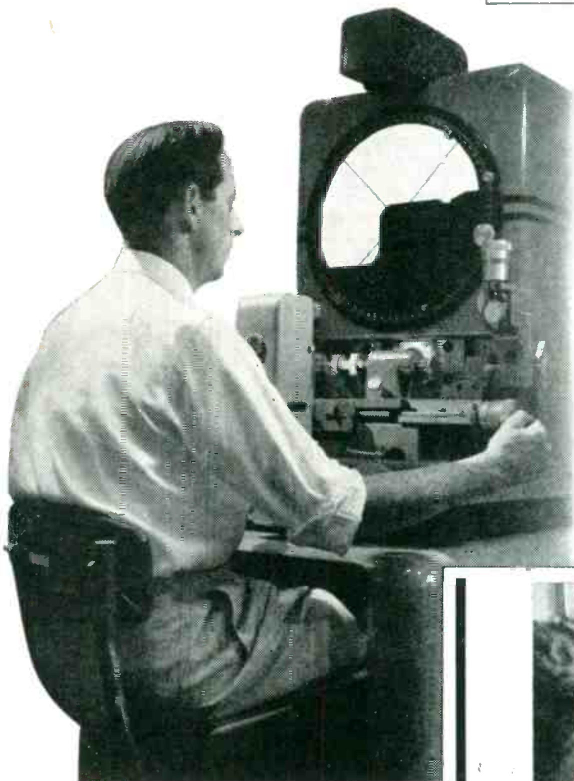

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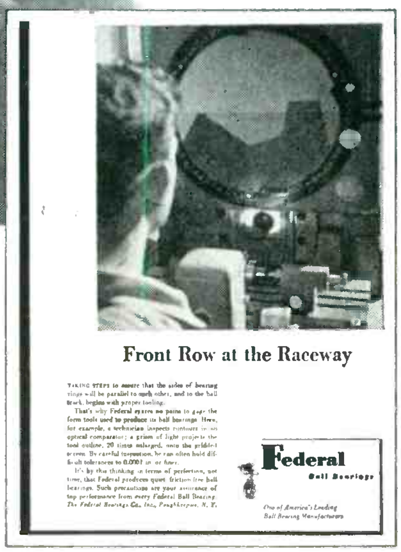

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Table I—Comparison of Tantalytic, Paper and Aluminum-Electrolytic Capacitors

	Tantalytic	Paper	Aluminum-Electrolytic
Voltage Range			
D-C 0–150	G	G	P
150–500	P	G	G
500–1000	P	P	G
A-C	L	L	H
Capacitance Temperature Coefficient			
−20 to +85	G	G	G
−55 to +85	G	P	G
−55 to +125	F	P	G
Power Factor	H	H	L
Insulation Resistance	L	L	H
Service Life			
40 deg C	G	G	E
85 deg C	G	F	E
125 deg C	F	P	G
Shelf Life			
−55 deg C	G	G	E
25 deg C	G	F	E
85 deg C	G	P	G
Size	Sm	Sm	La
Weight	L	L	H
Vibration and Shock	G	G	G
Cost			
0–150 v d-c	H	L	H
150–500	H	L	M
500–5000	H	H	L
Availability	F	G	G
Chance of further improvement			
Wider temperature range	G	P	F
Size reduction	G	P	P
Cost reduction	G	P	P

E = excellent, G = good, F = fair, P = poor, H = high, M = medium, L = low, Sm = small, La = large.

pacitors of the aluminum foil variety now available can satisfactorily perform in the place of paper capacitors, particularly in military electronic equipment, the tantalum-foil capacitor, which has overcome many of the inherent deficiencies of the electrolytic capacitor, is becoming a solution to the miniaturization problem.

Tantalum-foil capacitors have their greatest volume advantage at ratings below 100 v d-c. This occurs because the dielectric film in paper capacitors cannot be made thinner, whereas the tantalum capacitor dielectric film can be made any de-

How Would You Solve This Problem?

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Everybody runs them. We do, too. And they help attract important and valuable men.

But somehow they don't quite seem to measure up to the situation we have here.

None of the usual words or phrases gives exactly the picture we'd like people to see.

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You see, we have a contract with the Atomic Energy Commission. We aren't making bombs or turning out isotopes. We are building a nuclear engine for a submarine—and our next big job is to build one for a large naval vessel. Maybe that sounds more like war work and less like putting atomic energy to useful work for mankind. But—the next steps will be atomic power equipment for peacetime purposes.

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And that's our primary purpose. Because Westinghouse's business is power.

We have some great things going on in our Atomic Power Division. And we have wonderful people out here, brilliant and inspiring to work with.

The point is that we need more of them . . . of the right kind. They don't have to know anything about atoms or atomic power, but they do have to know a lot about electronics or electrical engineering or mechanical engineering.

. . . Electronic Engineers

The electronic engineers we need should have had four to ten (or more) years experience with electronic computers employing pulse amplifying, wide range linear amplifying and rate circuits . . . or they must have dealt with null balance devices employing both vacuum tube and magnetic amplifiers . . . or with servomechanisms and plant control systems . . . or they should have had experience in liaison in those fields with customers or contractors and designers of component equipment.

Other Engineers Needed

We also need mechanical engineers with skill and experience in fluid flow and heat transfer, or with the design and operation of central station or marine power plants . . . and electrical engineers skilled in the design of process regulators, indicators and control devices for liquid level, flow, temperature and pressure.

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There are good jobs here, at good money. And there will continue to be good jobs in this division . . . no matter what happens. Work on the atomic engines will go on. National security dictates that.

Your Wife Will Like It Here

And the wives of the men we are after will like it here, too. Sure, they'll have to live near Pittsburgh, but that's no punishment these days. This is not the Pittsburgh of old. Someone has said that Pittsburgh is now one of the most exciting cities in America. They've cleaned up the old smoke and dirt. They've torn down many of the old buildings. They're pouring billions into new residential areas, new high-speed boulevards, new parkways and other facilities for good living.

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sired thickness, depending on the formation voltage used. Volume comparisons of General Electric Tantalytic capacitors with paper capacitor are shown in Fig. 1.

The market price for paper capacitors has long been established and the opportunities of further decrease in prices due to large quantity production may be small. The tantalum-foil capacitor line is not yet in mass quantity production and with further development and simplification of manufacturing processes, large reductions in prices are possible.

A Control System for Microwave Radio

A SUCCESSFUL MICROWAVE radio relay system requires that many of the radio stations be located on mountain tops and other places far removed from thickly populated areas. These stations are normally unattended, and it has been necessary to develop a remote control system so they may be operated by men in convenient locations.

The remote control system used for operating unattended radio stations utilizes telephone lines known as radio order circuits for transmitting some of the required signals.

Remote control signals are transmitted over the radio order circuit. The sending circuit in the alarm center consists of a 1,600-cycle Wien bridge oscillator, a balanced modulator and a second Wien bridge oscillator adjustable to 12 frequencies spaced 15 cycles apart between 277.5 and 442.5 cycles. A complete director signal or order consists of a 1-second spurt of the 1,600-cycle tone. This tone is modulated for the first half second by one of the lower frequencies and for the second half second by another of these frequencies. Each combination is individual to the auxiliary station called.

The remote control signals are transmitted over a telephone order circuit also used for voice transmissions. It is, therefore, necessary that the signal receiving device at the auxiliary unattended station be designed in such a way that it will not be falsely operated by voice currents. This device is shown in block form in Fig. 1. The signals

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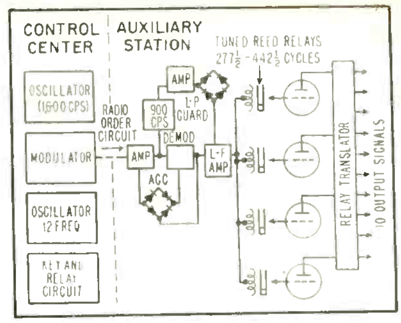

FIG. 1—Block diagram of the remote control system for microwave relay stations

from the line are amplified and passed through a modulator to obtain the lower or modulating frequency.

This frequency is amplified and applied to a group of 4 or 5 tuned reed relays. When the first half of a signal is received, one of the relays operates to close its contact and, by means of a vacuum-tube amplifier, operates a relay in the associated relay translator. This relay remains operated for approximately 1 second to await the arrival of the second half of the signal to operate a second tuned reed relay. The relay translator then connects ground to one of 10 output signal leads.

When 4 tuned reed relays are used 12 sequences are possible. This system is arranged, however, so that only 10 sequences are used at any one auxiliary station.

The sending end of the director system is arranged to produce 12 different modulating frequencies making available 132 sequences. Only 120 of these sequences are used. The sequences are divided into groups of 10 and assigned to as many as 12 different auxiliary stations permitting operation of a maximum of 12 auxiliary stations on any one radio order circuit or from any one control center.

The receiving end of the director system is protected against false operation on voice currents by a guard circuit, an automatic gain control feature and the sharp tuning of the reed relays. The guard circuit consists of a 900-cycle low-pass filter and amplifier and a rectifier arranged to disable the low frequency amplifier in the signal receiver in the presence of voice currents or other low frequency dis-

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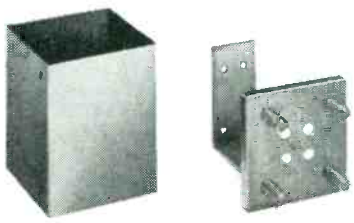

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turbances. The automatic gain control feature on the input amplifier of the signal receiving device operates partly from the level of the 1,600-cycle carrier current and partly from the low frequency output of the demodulator.

The armatures of the tuned-reed relays are miniature tuning forks equipped with contacts. These relays are capable of operation over a band of frequencies only 2 cycles wide. Their contacts are quite delicate so that it is necessary to provide vacuum-tube amplifiers between these contacts and the heavier telephone type relays used in the relay translator.

This narrow band operating feature of the tuned-reed relays aids in preventing false operation on voice currents but does require that the low-frequency tones operating these relays be transmitted by modulating a 1,600-cycle tone. This technique prevents frequency shift of the tuned-reed frequencies in cases where a single sideband carrier system is used for the radio order circuit.

The 10 output or order leads shown in Fig. 1 may be used to control various circuits in the unattended station. These are used for starting the emergency gas engine for test, for starting the indicator system, operating transmission switches, etc.

This article has been abstracted from a paper entitled "C1 Alarm and Control System for Microwave Radio" by H. M. Pruden, presented at the AIEE Winter Convention, 1953.

Power Required by a Shunt Impedance

IT IS OFTEN necessary to shunt an impedance across some portion of a linear circuit and the question then arises as to the amount of additional power the generator in this circuit will have to supply. Zepler[1] gives a simple method of finding this additional power. It involves the use of Thevenin's theorem to set up an intermediate circuit by which a new impedance can be found, which, shunted directly across the generator, will cause the generator to supply the same additional power

LITTON ENGINEERING NEWS

NOW! Dependable pressure monitoring of high vacuum systems during processing

The new Litton Ionization Gauge is a rugged and completely dependable production tool for monitoring pressures from 10^{-4} to 10^{-7} mm Hg. The instrument is a Philips-type gauge*, specifically engineered for constant production monitoring of high vacuum pressures. It eliminates annoyance and costs of burned-out gauges, activation of poisoned cathodes, heating of grids, etc. Even in steady, day-after-day use, it requires no attention other than a chemical cleaning about twice a year.

Cold Cathode Emitter

The Type L-3032 gauge was developed within Litton Engineering Laboratories to facilitate our own manufacturing of vacuum tubes. It utilizes crossed electric and magnetic fields which enhance collision probability in a small volume so that a cold cathode emitter can be used. Thus operation, even at atmospheric pressure, will not damage the tube. (In normal use, the tube is not operated until black-out of the vacuum system is reached. Good relative pressure readings are available throughout the range of 10^{-4} to 10^{-7} mm Hg.) Type L-3032 tubes have been tested during the past two years on Litton vacuum tube production lines. They are now installed on every exhaust station in our plant.

Monel-Encased

The Ion Gauge Tube is composed of a monel-encased interaction space with the case near ground potential. A nichrome wire anode at 2,500 volts is centered within the case. An outgassing 6.3 volt heater is mounted near the

Type L-3032 Ionization Gauge

monel case, but insulated from it. A 3/4" diameter kovar tube, insulated from the monel case by a glass seal, is supplied for connection to the vacuum line. The magnetic field is provided by permanent magnets mounted in a sheet steel shell. This shell also serves as a return magnetic path, connection block, package envelope and oven for the outgassing heater. Electrical connections are made to binding posts on the steel case. The tube weighs but 22 oz. and measures 7" x 5" x 3½".

Model 4301 Ionization Gauge Amplifier

This amplifier is a companion instrument for Type L-3032 Ionization Gauge Tube. It includes range switches for measuring from 10^{-4} to 10^{-8} mm Hg., a special leak-check range providing full scale deflection at any pressure, built-in calibrating circuits and a switch for outgassing the gauge tube heater.


Model 4301 Amplifier

It consists of a high voltage rf power supply, a vacuum tube voltmeter circuit with current-sampling resistors, a 6.3-volt transformer (to provide current for the outgassing heater in Type L-3032 Ionization Gauge Tube) and a self-regulating low voltage power supply providing wide input voltage variation without affecting performance. Electrical connection is by cable with banana plugs to Type L-3032 Ion Gauge. Power supply requirements are 110 volts, 60 cps. The instrument measures 10" x 8" x 8". Weight is 17½ lbs.

*Licensed under Philips Laboratories, Inc. Patent No. 2197079

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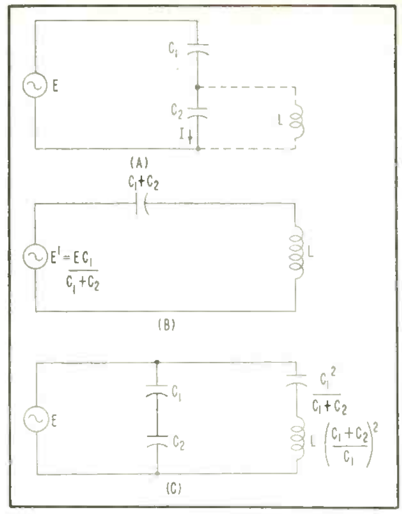


FIG. 1—Circuit simplification for shunt impedance calculations

that it must supply when the desired point of the original circuit. The steps are as follows:

1. Remove the shunting impedance Z and determine the voltage at the point where Z is to be connected.

2. With Z removed and the generator E shorted, determine the internal impedance of the circuit.

3. Now set up an intermediate circuit composed of the voltage, E', determined in step 1, the internal impedance Z_i determined in step 2 and the shunting impedance Z.

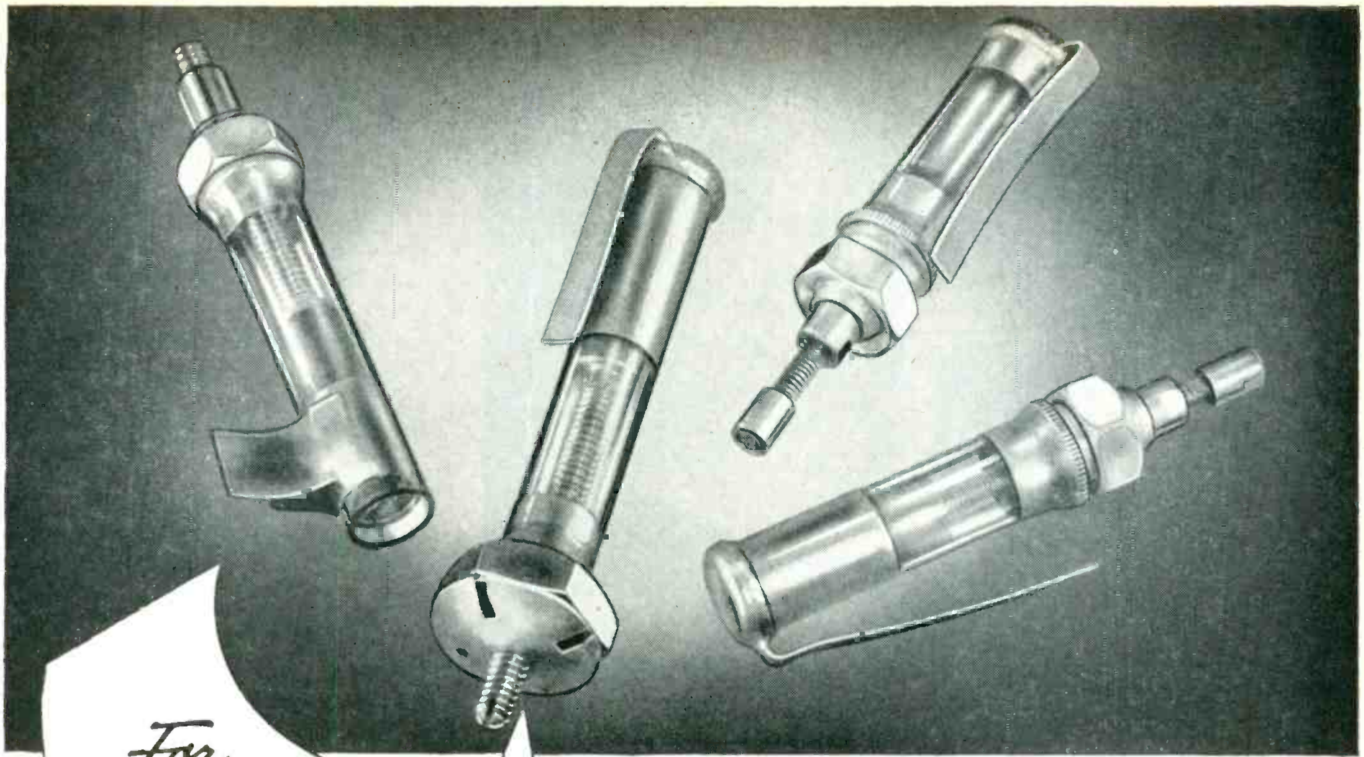
4. Now with this intermediate circuit, determine a new impedance Z_x, which shunted directly across the generator will cause the same additional power to be supplied that will be required when Z is shunted across the desired point in the original circuit. That is

$$\frac{E^2}{Z_x} = \frac{E'^2}{Z + Z_i} \text{ or } Z_x = \left(\frac{E}{E'}\right)^2 (Z_i + Z)$$

5. Now make the final circuit composed of E, the new value of Z_i and Z and the power supplied by E will the desired additional power required.

Note that this is not the power that Z takes from the generator but is the extra power the generator must supply because Z is shunted across part of the circuit. Some of this extra power will be consumed in Z and the rest of it will be dissipated in the remainder of the circuit.

As an example, consider Fig. 1 where it is desired to know the effect on the generator of shunting



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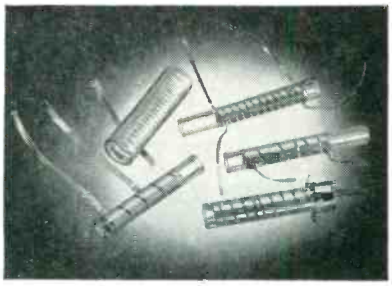

CORNING Metallized Glass Inductances also afford high stability. They can be manufactured to exacting specifications in uniform, variable or double pitched windings. Fixed tuned, permeability tuned or permeability tuned inductance-trimmer combinations can be supplied with appropriate cores and convenient mounting bushings. Automatic machinery keeps unit cost low, precision high.

CORNING Metallized Glass Midget Trimmer Capacitors are produced by permanently bonding metal to tubes made of glass with practically zero temperature coefficients in the VHF range. This means negligible capacity change even with widely variable ambient temperatures.

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For general high frequency uses, CORNING Midget Trimmer Capacitors can be furnished with more economical rotating slugs. Both types are available from .3 to 12 u.u.f., or can be designed to meet your own particular requirements, including split stators. Their compact coaxial shapes and convenient mounting bushings simplify multiple installations, as in multi-channel fixed tuned high frequency circuits.

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L across C_2.

1. The voltage across

$$C_2 = \frac{EC_1}{C_1 + C_2} = E'$$

2. The internal impedance is made up of C_1 shunted by C_2.

3. The intermediate circuit is given in Fig. 2.

4. The equivalent impedance, Z_x, which can be shunted directly across the generator to determine the extra power required is

$$Z_x = \left(\frac{E}{E'}\right)^2 (Z_i + Z_L)$$

$$= \left(E \div \frac{EC_1}{C_1+C_2}\right)^2 \left(\frac{1}{\omega\,(C_1+C_2)} + L\omega\right)$$

$$= \left(\frac{C_1 + C_2}{C_1}\right)^2 \left(\frac{1}{\omega\,(C_1+C_2)} + L\omega\right)$$

$$= \frac{C_1 + C_2}{\omega C_1^2} + L\omega\left(\frac{C_1 + C_2}{C_1}\right)^2$$

The first term of this equivalent Z represents a capacitance

$$\frac{C_1^2}{(C_1 + C_2)}$$

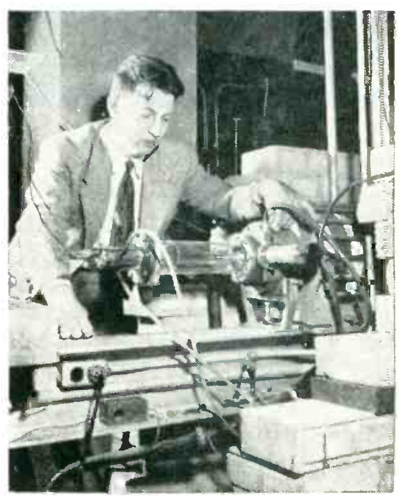
and the second term an inductance

$$L\left(\frac{C_1 + C_2}{C_1}\right)$$

5. The final circuit is given in Fig. 3, where the power is fictitious since there is no resistance.—K. H.

(1) E. E. Zepler, A Network Theorem, *Wireless Engineer*, p 44, Feb. 1952.

Stanford Atom Splitter



Linear accelerator used in nuclear research uses the firing chamber shown in the photograph. Edward L. Ginzton, Director of Stanford University's microwave laboratory is shown aiming electron bullets shot down the 200-foot gun. They attain a speed 99.9 percent that of light in the first foot traveled

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Heater Current (Amps)	3.8	32.0
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Anode Current (Amps)	0.125	0.25
Min Po (Watts)	85.0	700.0
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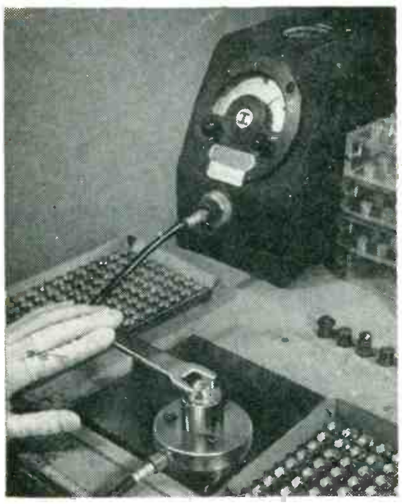
Production Techniques

Edited by JOHN MARKUS

OTHER DEPARTMENTS featured in this issue:

Air Comparator Tests Electron Guns



Setup for using air stream to measure electrode spacings on a production basis

IN THE PRODUCTION of electron guns for Sylvania television picture tubes, the important and critical grid-to-cathode spacing is adjusted to within 5/10,000 of an inch by directing a stream of clean air through the opening between the grid and cathode. A comparator then measures the resistance to the air flow. If the spacing is too great, the air resistance will be low. Close spacing gives too high a resistance to air flow.

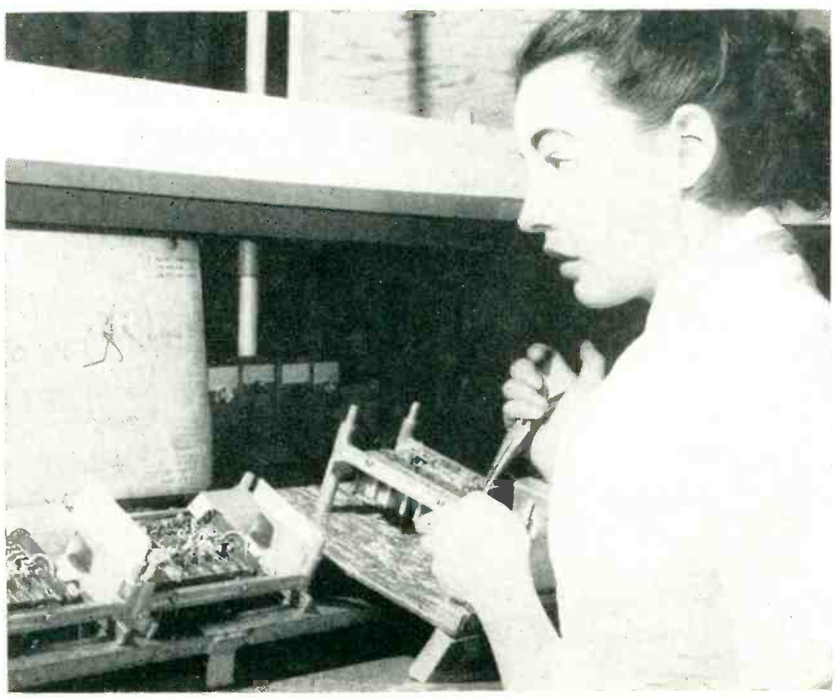
The operator places the gun structure in a jig to which the air stream is fed with flexible tubing. A lever on the jig is then pushed to actuate rubber gaskets that give the required air-tight seals around the gun, and the reading of the comparator is noted. Arrows are marked on the comparator scale window to indicate tolerance limits for a particular type of gun.

The technique has the important advantage that no gage or other tool comes in contact with the surface of the cathode. This eliminates the possibility of chemically contaminating the cathode. Operators wear finger protectors to prevent contaminating the outer structure of the gun with body salts due to perspiration. Gun structures awaiting tests are stored in transparent Lucite tote boxes.

Work Carrier for Pass-Along Line

PRODUCTION-LINE assembly of the chassis for the PRC-6 hand-carried f-m transmitter-receiver is expedited by Raytheon through use of a special die-cast cradle that can easily be pushed along the line on steel tracks.

Corner posts on the cradles are designed to permit safe stacking when finished units must be stored



Use of self-stacking die-cast carriers on pass-along assembly line

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temporarily before being placed in housings. For stacking, projecting pegs at the top of one carrier fit into holes in the bottom posts of another carrier.

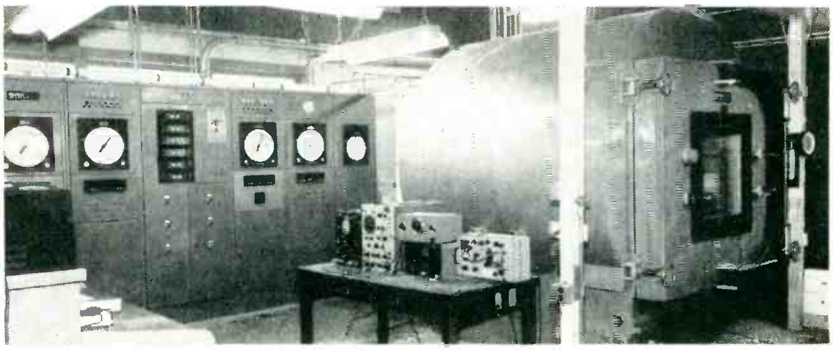
Each chassis is locked in position in its carrier with four nuts and bolts. Since chassis holes for these bolts are slotted, the bolts need only be loosened slightly to remove a finished chassis.

With a pass-along line, the work must progress in orderly succession, whereas with power-driven conveyor belts a chassis may occasionally get past without receiving its quota of parts or work.

A wood bridge is placed over the pass-along line at each work position. This blocks passage of carriers and at the same time allows the operator to bring the carrier to a more convenient closer position for assembly work.

Stratosphere Chamber Tests Missile Controls

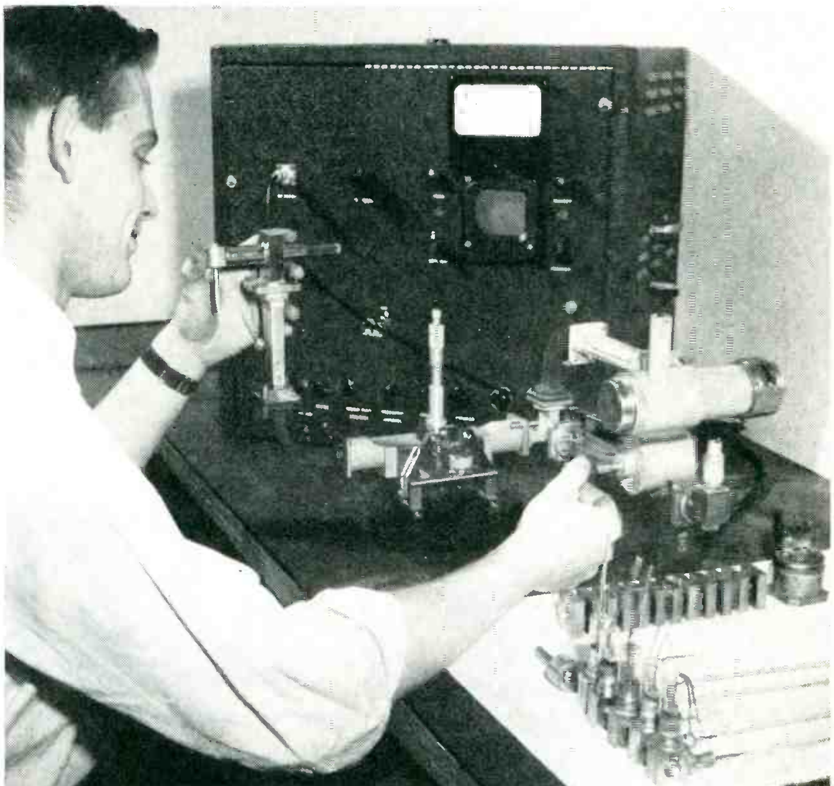
TO EXPEDITE environmental testing of prototype electronic components for guided missiles, the Pacific Division of Bendix uses a 64-cubic-foot chamber that can take equipment up to the equivalent of 150,000 feet of altitude, practically a vacuum. Temperature and humidity are also variable to simulate atmospheric conditions to which electronic controls would be subjected during the flight of a missile.



Stratosphere chamber made for Bendix by Bemco Inc., using Square D equipment for power control and Honeywell recorders on the control racks at the rear

Production Testing of Magnetron Cavities

By MARKUS NOWOGRODZKI
*Amperex Electronic Corp.
Hicksville, L. I., N. Y.*



Production setup for cold-testing anode blocks of type 2J55 magnetrons. Blocks for 2J48 and 4J52 tubes are on bench also, awaiting test. Cabinet contains klystron power supply and oscilloscope circuits. Operator is adjusting klystron oscillator with right hand

THE usual unloaded, loaded and coupled Q-factor measurement procedures are hardly adaptable to production-type quantity testing of cavity resonators. It is desirable, however, to perform Q-factor measurements on a production basis in magnetron assembly work, where the resonant cavity properties are of major importance to the operation of the oscillator. In visual display methods for this type of test, the determination of loaded Q depends upon the evaluation of the half-power bandwidth, which is always a somewhat involved procedure. This article presents a method wherein the difficulty is overcome by measuring the detuning with a known mismatch rather than the bandwidth, so that the coupled Q rather than the loaded Q is obtained experimentally. This together with a standard measurement of the voltage standing wave ratio suffices to determine all three Q-factors of the resonant structure.

The apparatus required, shown in Fig. 1, is similar to that used in the absorption method of cavity wavelength measurements. A hybrid junction is used to monitor the wave reflected from the cavity under test. The klystron oscillator is swept in frequency by a sawtooth waveform derived from the oscilloscope time-base circuits.

If the klystron oscillator, for a given adjustment of its tuning

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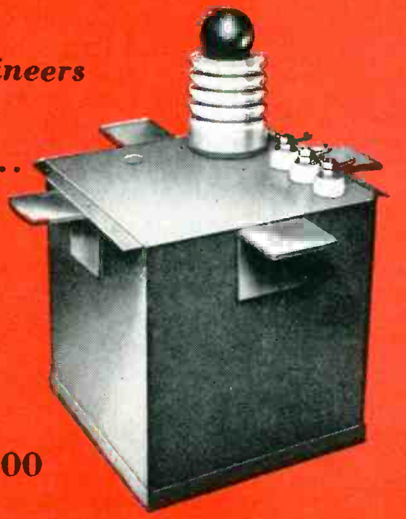

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Taking advantage of hermetic sealing and oil-filled construction in addition to new techniques and use of plastic film for high voltage capacitors, Condenser Products' Engineers developed type PS30-3C400 to comply with all requirements. Size of unit is 5½ x 5½ x 6¼". Total weight: 11 lbs.

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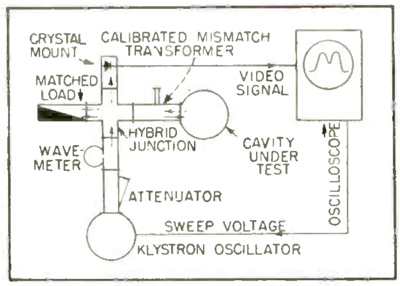


FIG. 1—Setup for testing microwave cavity resonators before assembly in magnetrons

mechanism, is being swept through a range of frequencies which include the resonant frequency of the cavity, an absorption dip in the klystron mode pattern will be observed on the oscilloscope. The exact frequency f_o of the dip can be determined by superimposing a wavemeter marker upon this absorption pattern as in Fig. 2A.

Next, the calibrated mismatch transformer is adjusted for a predetermined value of mismatch. For magnetron cavities, the mismatch of interest is usually that introducing a vswr of 1.5:1, since the magnetron pulling factor is usually defined as the maximum variation in magnetron frequency when a mismatch of that value is introduced in the magnetron output transmission line and varied over all phases. The detuning of the cavity is measured by observing the change in the resonance absorption dip as the mismatch is varied in phase. Thus the maximum frequency variation F is determined. The value of Q_c for coupled Q can now be calculated, for a mismatch of 1.5:1 in vswr, from $Q_c = 0.417\ f_o/F$.

To obtain the value of the vswr at resonance r_o, the calibrated mismatch transformer is changed both in insertion and phase until the resonance dip in the klystron mode

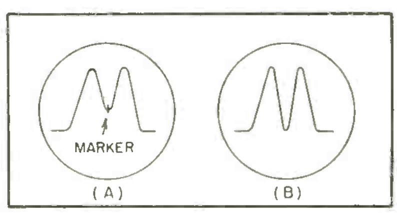
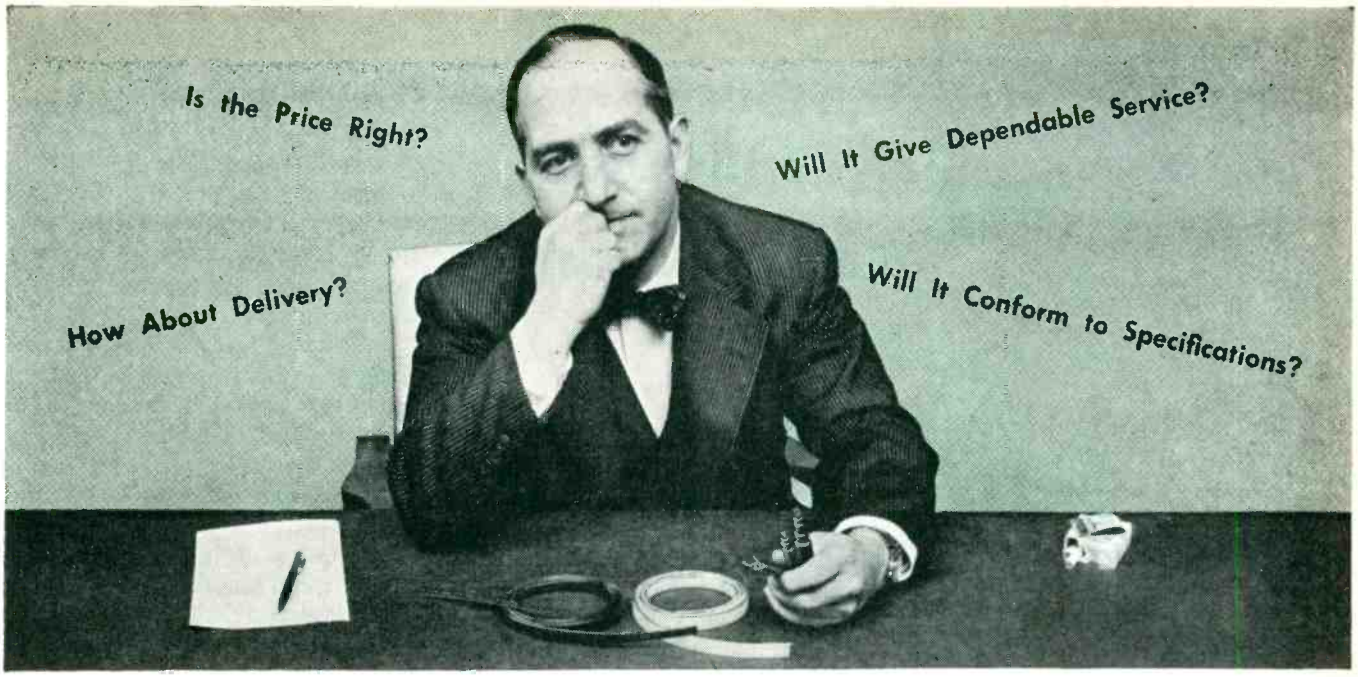


FIG. 2—Resonance absorption patterns seen on cathode-ray screen, for cavity resonance with wavemeter marker at f_o (left) and for match at f_o

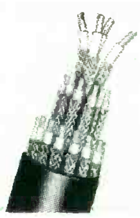


CHOOSE SYNKOTE CABLE AND WIRE

for Value — for Service — for Dependability

FIRST IN COMMUNITY TV: this ultra-rugged Synkote coax cable (RG 59/U and 11/U) is *double-shielded* and *double-jacketed*, transmits signals over long distances with virtually no radiation losses.

NEW FOR UHF: Synkote "Ovaltube" twin-lead is a tubular air-dielectric construction, features low attenuation. Fits ordinary hardware, can be made weathertight in seconds. Uniquely practical, nothing else like it.



30 CONDUCTOR CABLE: — a Synkote custom-engineered cable designed and manufactured from simple specifications read *over the telephone*. Difficult-looking, but "duck-soup" to Plastoid engineers.

"JUMBO" TWIN-LEAD: — 185 mil web—the strongest TV lead-in ever introduced. Withstands gales, extreme heat, cold and humidity. Low loss — gives excellent reception in fringe areas.

1. Choose for Dependable Construction

You want to be sure that the wire you buy will give dependable service. SYNKOTE wire is *warranted by Plastoid* to be made of the finest materials, and will meet all applicable specifications.

2. Choose for Engineering Know-How

Possibly, you may know what general characteristics you desire, but not how to put these into wire. Plastoid's large staff of engineers can transform your generalized requirements into a finished wire or cable. Simply give us your electrical and physical requirements — we'll design the cable.

3. Choose for Rapid Delivery

Plastoid's modern manufacturing facilities mean faster production . . . more rapid deliveries to you.

4. Choose for Friendly Service

You'll find everyone at Plastoid — executive, salesman or engineer — friendly, warm and informal . . . pleasant to work with and eager to do business with you.

5. Choose for Reasonable Cost

Remember, "bargains" seldom save you money. In the long run, it pays to pay a fair price and get dependable wire. For true wire economy specify SYNKOTE — manufactured only by Plastoid Corporation, Long Island City, New York

Synkote®
DEPENDABLE
Wire and Cable

"Manufactured by the mile - tested by the inch"

PLASTOID Corporation

plant: HAMBURG, N. J. • offices: 42-61 24th St., Long Island City, N.Y.

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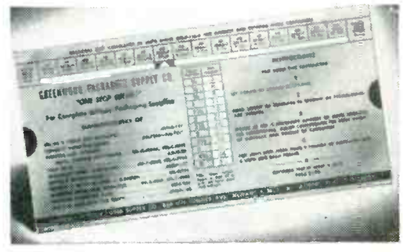
pattern is matched out at the cavity resonant frequency f_o, until no reflected wave is observed at the center of the resonance dip, as shown in Fig. 2B. The value of r_o can then be read directly from the calibration curve of the mismatch pad, after which unloaded Q_U for an overcoupled cavity (the usual case of interest in microwave oscillator design), is obtained from $Q_U = r_o Q_C$. Now the loaded Q_L can be obtained from $Q_L = Q_U/Q_C$ if desired.

An added advantage of the method as applied to magnetron production testing is the fact that F, the cold magnetron pulling factor, is determined empirically. In a comparison check on 15 X-band magnetrons with varying degrees of coupling, the values of F obtained by the method presented here showed closer agreement with the measured pulling factors on operating tubes than those calculated from a standard Q-measurement procedure. Generally, values of Q_U and Q_C obtained by this method were about 15 percent lower than those measured by standard techniques.

The method, because of its simplicity and rapidity, may be used to advantage in magnetron resonator testing to discover and reject cavities with improper coupling at an early stage in the costly and complicated procedure of magnetron assembly and processing.

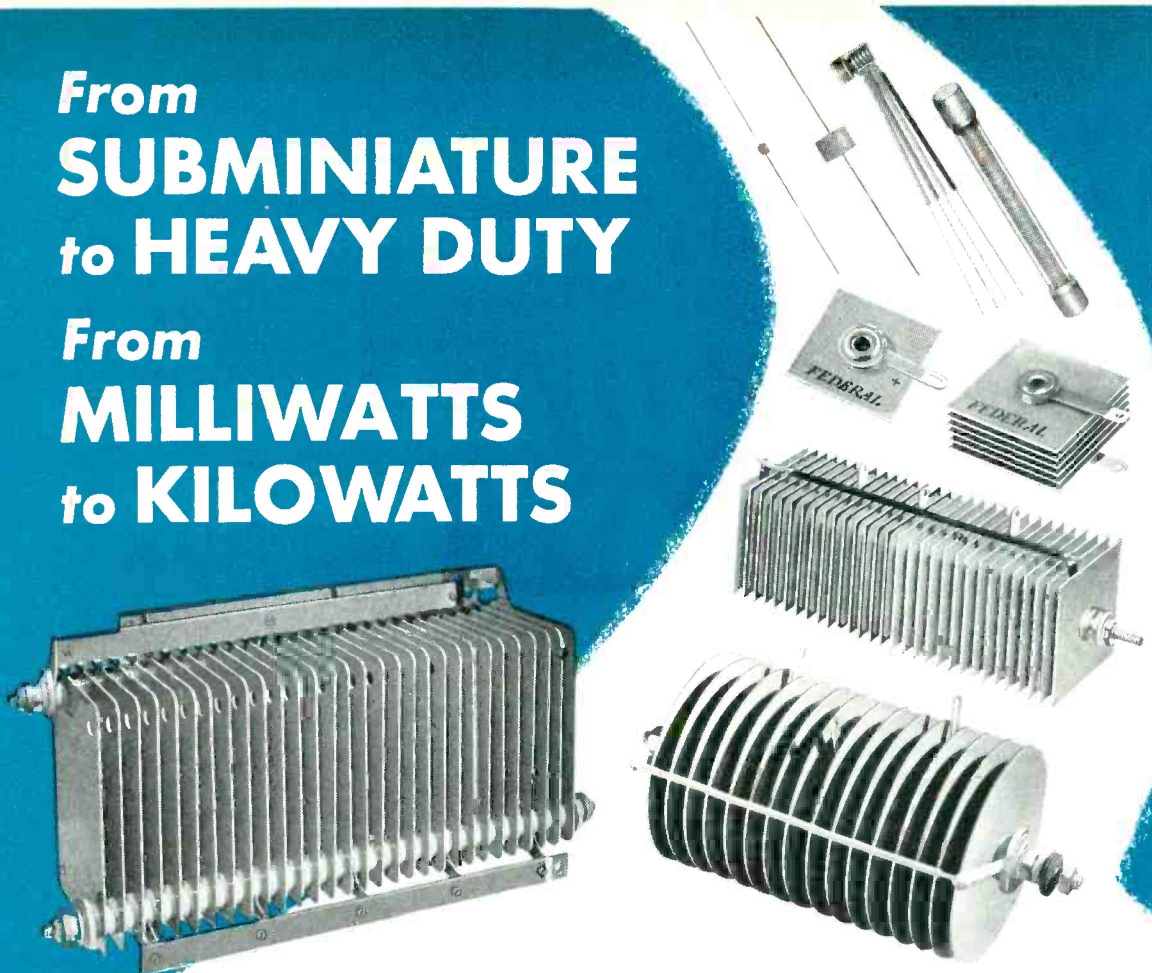
Desiccant Calculator

A SLIDE-TYPE calculator made from transparent Vinylite accurately indicates in a second the number of desiccant units required per package of electronic equipment that has been packed for export. One side of the calculator is used for rigid containers and the other for



Desiccant calculator for military packaging of electronic equipment

From
SUBMINIATURE to HEAVY DUTY
From
MILLIWATTS to KILOWATTS



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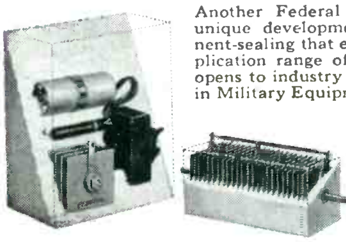
Now Federal Offers ENCAPSULATION
OF SELENIUM RECTIFIER STACKS —plus other components



Another Federal "First" . . . a unique development in component-sealing that expands the application range of rectifiers and opens to industry a new concept in Military Equipment Design.

Applications range from tiny rectifiers to sub-assemblies and complete power supplies.

FOURTEEN years ago Federal introduced the selenium rectifier to America's electronic engineers and product designers.

Today, *tens of millions* of these versatile AC-to-DC power conversion units are at work in almost unlimited fields of application . . . from subminiatures with milliwatts of output to heavy duty stacks for the biggest DC-operated equipments.

Here's *proof* of the *high quality* built into Federal's compact, economical, long-life, fully inert selenium rectifiers . . . here's *proof* of their *efficiency* and *dependability* in consumer, industrial and military power conversion jobs!

Write Federal today for information on *your* rectifier requirements . . . whatever the size, type or rating. Give your design the benefit of the research, engineering and manufacturing skill that *pioneered* the selenium rectifier . . . and now *keeps* "Federal" the standard of industry! Address Dept. F-413A

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AN IT&T ASSOCIATE

Federal Telephone and Radio Corporation

SELENIUM-INTELIN DIVISION 100 KINGSLAND ROAD, CLIFTON, NEW JERSEY

In Canada: Federal Electric Manufacturing Company, Ltd., Montreal, P. Q.
Export Distributors: International Standard Electric Corp., 67 Broad St., N. Y.

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flexible containers.

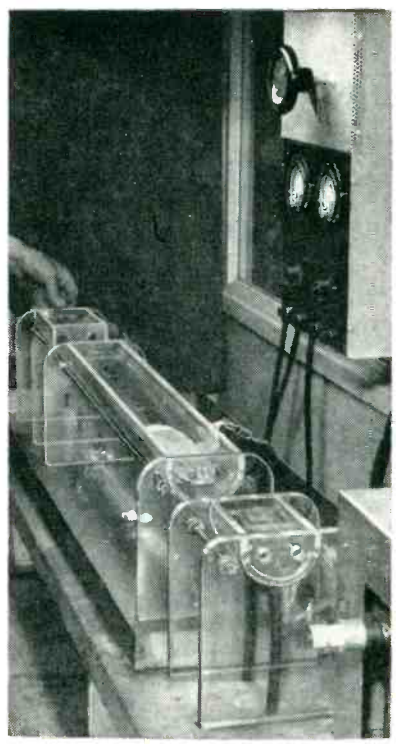
An arrow on the calculator is set to the desired type of container, and the weight of dunnage is located in a window at the pound-dunnage column. Alongside this figure is the necessary number of units required for dehydrating, taking into account both the weight of dunnage ana the volume of the container. The calculator is made by Greenwood Packaging Supply Co., 859-879 Summer Ave., Newark 4, New Jersey.

Silver-Plating Fine Wire

NICKEL alloy wire thinner than human hair is continuously plated with silver by the three-bath setup illustrated. The wire enters and leaves each clear plastic plating trough through end holes so small that capillary action prevents leakage of solution.

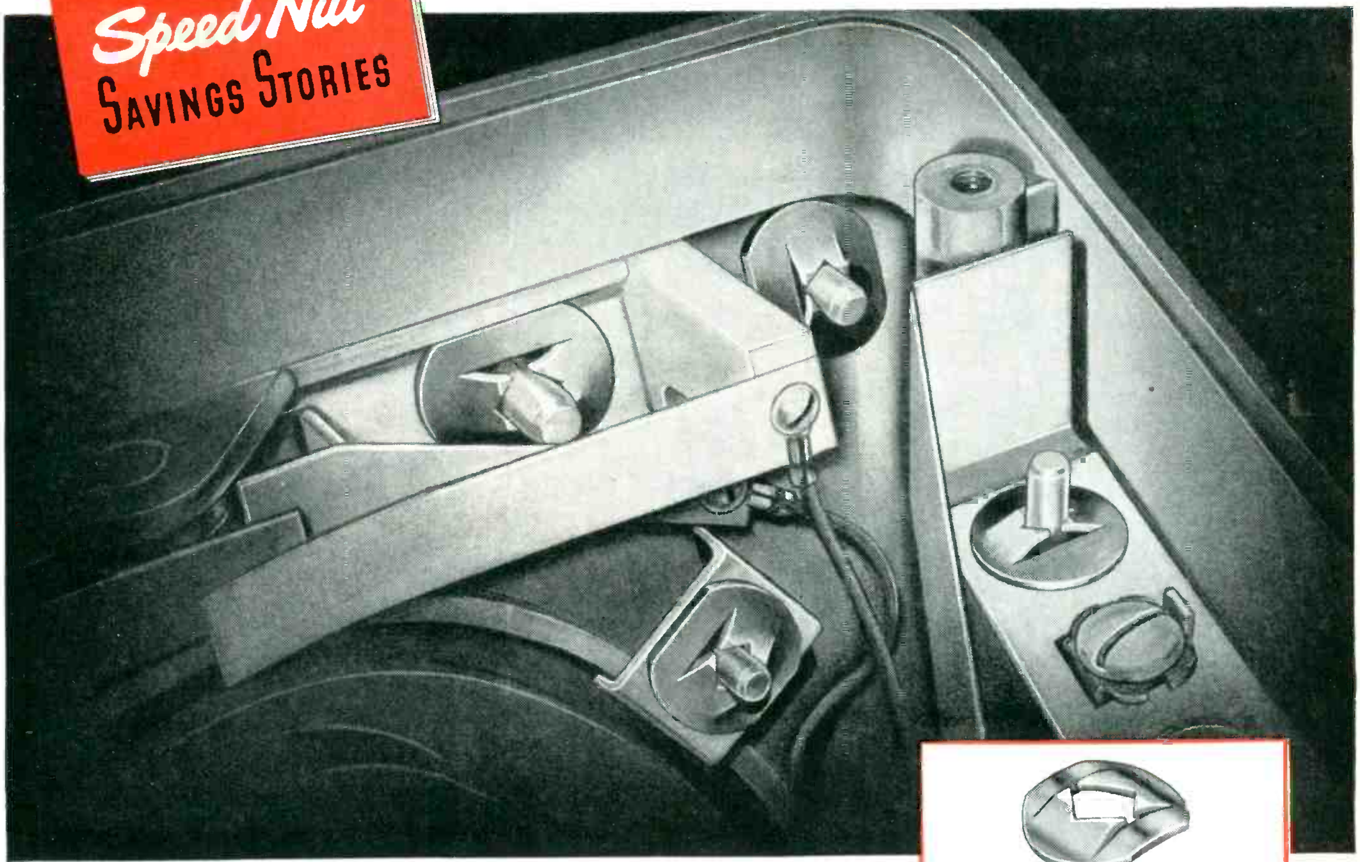
The spool of wire to be plated is placed on one end of a free-running shaft, threaded through the ends of the tanks and fastened to a take-up on a motor-driven shaft outside the last tank.

The wire first passes through an electrolytic cleaning bath. The next

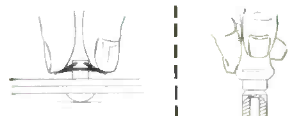


Reel of unplated wire is at left. Take-up reel for silver-plated wire is at right, on shaft of motor housed in metal box

TINNERMAN® Speed Nut SAVINGS STORIES



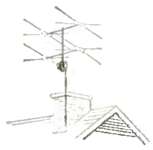
PUSH-ON SPEED NUTS®



Start by hand

. . . zip over integral studs, rivets, tubing, or other unthreaded parts; bite into smoothest, hardest surfaces — lock with firm spring tension on metal, plastic or wood. Eliminate costly inserts in plastics; save machining of die castings!

alliance TENNA·ROTOR "TURNS" TO TINNERMAN ...BEAMS-IN 50% ASSEMBLY SAVINGS!



Engineers at Alliance Manufacturing Company, Alliance, Ohio, knew from experience how SPEED NUT brand fasteners change fastening problems into production savings. That's why they "turned" to Tinnerman for a clear savings picture in designing the Tenna-Rotor! Push-On SPEED NUTS were selected right from the Tinnerman catalog for tremendous time and engineering savings at the design stage! 16 Push-Ons, zipped over integrally molded studs, attach the electronic mechanism to the plastic control panel and box! They eliminated metal inserts, nuts, and lockwashers — reduced materials handling — stepped-up production, and netted a 50% savings in assembly costs.

A call will bring your Tinnerman representative with complete, detailed information to help solve your fastening problems . . . and maybe find savings like this!

Write today for your copy of SPEED NUT "Savings Stories" a booklet of amazing examples of Tinnerman savings to industry:

TINNERMAN PRODUCTS, INC., Dept. 12, Box 6688, Cleveland 1, Ohio. *In Canada:* Dominion Fasteners, Ltd., Hamilton, Ontario. *In Great Britain:* Simmonds Aerocessories, Ltd., Treforest, Wales. *In France:* Aerocessoires Simmonds, S. A. — 7 rue Henri Barbusse, Levallois (Seine).

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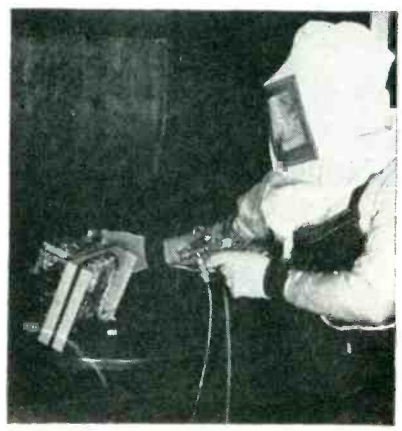
bath, separated by an air space, is the cyanide plating bath. From here it passes through a water rinse fountain in the third plastic tank, and emerges to dry in air for a short distance before being spooled.

Leveling clamps with wing nuts are provided on the cleaning and plating tank supports. The solutions need replenishing only about once a day.

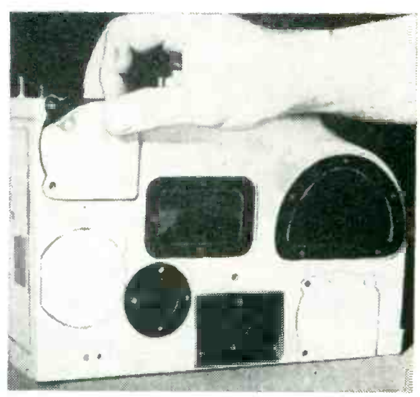
Wire 0.8 mils in diameter, required for lateral grids of uhf pencil triodes, is silver-plated in this setup at RCA's Harrison, N. J. tube plant.

Precut Masks Speed Spraying for Tropicalizing

PREPARATION of electronic equipment for tropicalizing or for application of sprayed finishes usually involves masking certain terminals,



Example of application requiring masking of certain regions during spraying for tropicalizing. The electronic unit here is a Philco-built radar set, being given a special varnish to inhibit moisture absorption and fungus growth in tropical climates

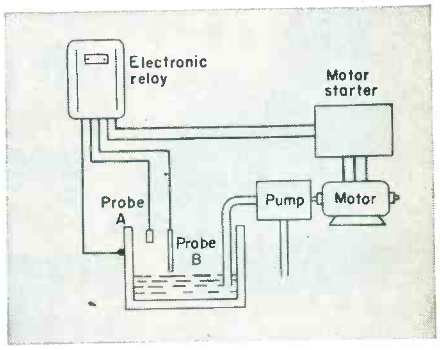


Method of applying precut pressure-sensitive mask to irregular area requiring protection during spraying of electronic equipment housing

New G-E Electronic Relay: Highly Sensitive to Resistance Changes

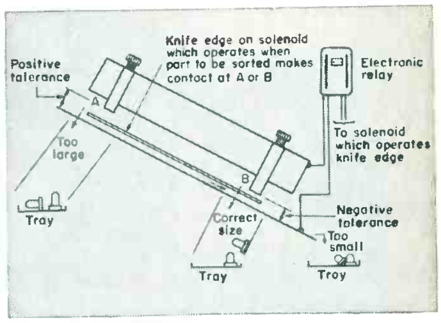
Can Be Used for Liquid-Level Control

This new electronic resistance-sensitive relay can control liquids between two predetermined levels. Relay will start a pump when liquid-level reaches probe A, will continue pumping until liquid falls below probe B. Then it shuts itself off until liquid again reaches probe A. This operation can be reversed to keep the tank full.



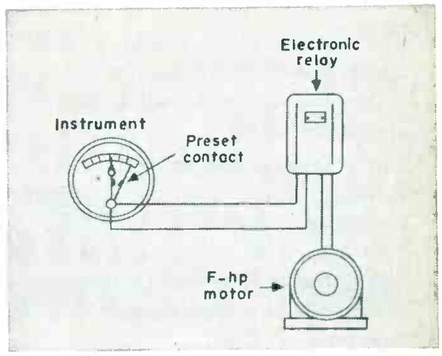
Can Be Used for Sorting Small Parts

Oversize parts touch contact "A," closing electronic relay input circuit. This relay energizes solenoid which directs part into a container for oversize parts. Point of contact "B" is set at standard height less tolerance. Parts touching this contact point are acceptable and are "shot" down another chute. Undersize assemblies do not touch either point and slide to a third tray.



Can Operate from Contact-Making Instruments

The G-E electronic resistance-sensitive relay is able to amplify even the minute currents carried by the delicate contacts of contact-making instruments. For instance, the relay can be arranged so that it will start or stop a f-hp motor directly when an ammeter, voltmeter, or wattmeter reaches the required meter reading.



SPECIFICATIONS

HIGHLY SENSITIVE

Even a wet thread will provide enough signal to operate this relay.

TWO TYPES OF OPERATION

Relay can be set for either "normal" operation (relay "drops-out" when external resistance is decreased to a value between zero and four megohms*) or "reversed" operation (relay "picks-up" when external resistance is decreased to a value between zero and two megohms*).

*Depending on dial setting.

DIAL ADJUSTMENT

Sensitivity level set by adjusting dial, which can be locked in place. Relay may be remote controlled from as far away as 500 feet.

CONSTRUCTION

Enclosure is weather-resistant and dust-tight (NEMA Type III and V).

PHOTOELECTRIC RELAY CR7505-K100

One of a complete line of devices for all photoelectric applications. Inexpensive, has broad application. Bulletin GEA-3533D.

ELECTRONIC TIMER CR7504-A142

Handles timing over three ranges, .06-1.2, .6-12, 6-120 seconds. Highly accurate, versatile. Bulletin GEA-5255B.

FOR MORE INFORMATION, contact your nearest G-E Apparatus Sales Office or authorized G-E distributor, or write General Electric Company, Section B785-4, Schenectady 5, New York, for the following bulletins:

- ☐ Electronic Resistance-Sensitive Relay, GEA-5893
- ☐ Photoelectric Relay, GEA-3533D
- ☐ Electronic Timer, GEA-5255B

NAME .... TITLE ....

COMPANY ....

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CITY .... STATE ....

ELECTRONIC DEVICES

GENERAL ELECTRIC

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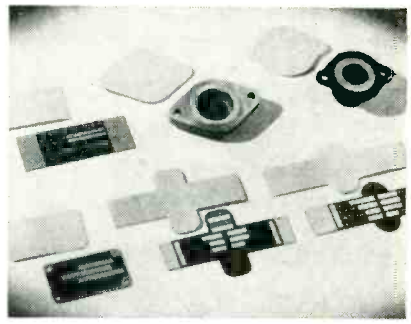
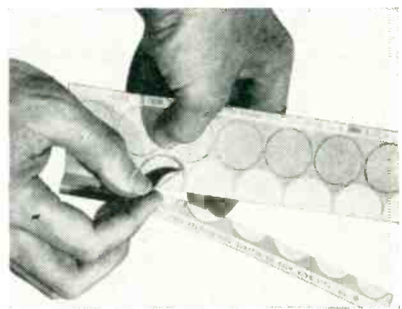
threaded holes and other regions that would be impaired by the spray. For large areas, masking tape in appropriate widths is generally used directly from the roll.

For irregular shapes of openings and even for covering circular openings or terminals when minimum overlap of tape is required, production costs can be lowered through use of precut masks such as are available from W. H. Brady Co.,



Examples of precut masks used for protecting name plates and openings during spraying



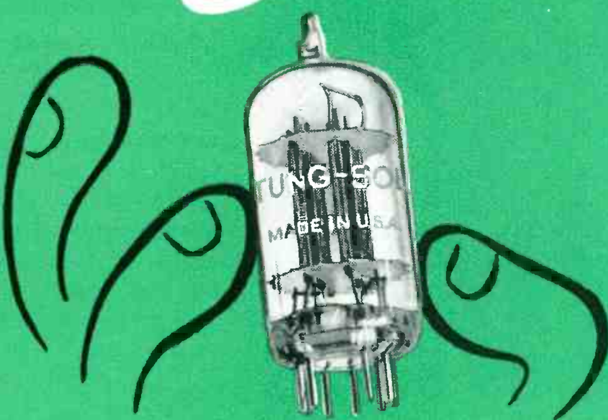
Method of removing circular masks mounted on card

Chippewa Falls, Wisconsin. These pressure-sensitive masks can be obtained mounted on cards, with several masks to a card, or can be obtained mounted individually with each mask having its own folded liner on the adhesive side. After pealing from the card or removing the liner, the masks can be applied instantly without moistening.

Precut masks are also being used for insulation in electronic equipment; here, the backing is of plastic, woven glass or other appropriate insulating material.

In another application, all of the masks needed for one piece of equipment are mounted on a single backing sheet. These masks include

Why Electron Tube Buyers do business with Tung-Sol



Tung-Sol's modern manufacturing techniques and advanced quality control methods assure you of a product that is second to none. Tung-Sol makes tubes—no sets—no equipment—just tubes. We do not compete with our customers. Tung-Sol design, development and application engineers work closely together for the sole purpose of producing a better tube so that you can make a better product. Engineering assistance is strictly confidential. Tung-Sol service by competent field sales representatives is nationwide. A Tung-Sol delivery promise is a promise. Closest cooperation is maintained to keep deliveries up to your production schedule requirements.

TUNG-SOL ELECTRIC INC.

Newark 4, N. J.

Sales Offices: Atlanta, Chicago, Culver City (Los Angeles), Dallas, Denver, Detroit, Newark, Seattle

TUNG-SOL® MAKES ALL-GLASS SEALED BEAM LAMPS • MINIATURE LAMPS • SIGNAL FLASHERS
PICTURE TUBES • RADIO • TV AND SPECIAL PURPOSE ELECTRON TUBES • SEMICONDUCTOR PRODUCTS

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hard-to-cut oval and trapezoidal shapes as well as rectangular pieces and circles.

Instrument Grounding Braid

FLEXIBLE bonding braid nailed to the edge of an instrument shelf serves as a convenient ground for all instruments at each test and alignment position for combination uhf-vhf rotary tuners in the Indianapolis plant of RCA Victor.

The braid is securely grounded at one point to the metal frame of the building. Individual instruments are grounded to this braid with short lengths of smaller braid, generally by looping the braid under an instrument panel screw and soldering the other end to the master braid.

Simple instrument-grounding system at uhf test position

Picture Tube Positioning Fixture

PRECISE positioning of 20-inch rectangular picture tubes on a television receiver chassis is achieved in Sylvania's Buffalo plant with a heavy metal fixture that fits over the entire front end of the chassis. The fixture is equipped with slide pins that go into holes on the sides and top of the chassis. This locking arrangement insures rigidity and precise positioning despite jarring when shifting the heavy picture tube.

After the fixture is in place, the picture tube is pulled forward on the chassis to approximately the correct position, without bringing it up against the fixture. Gage pins on

Anaconda's new and better molded shipper

Now offered to other magnet wire producers. It means safer shipments, better protection for wire, more compact storage, easier return of empties.

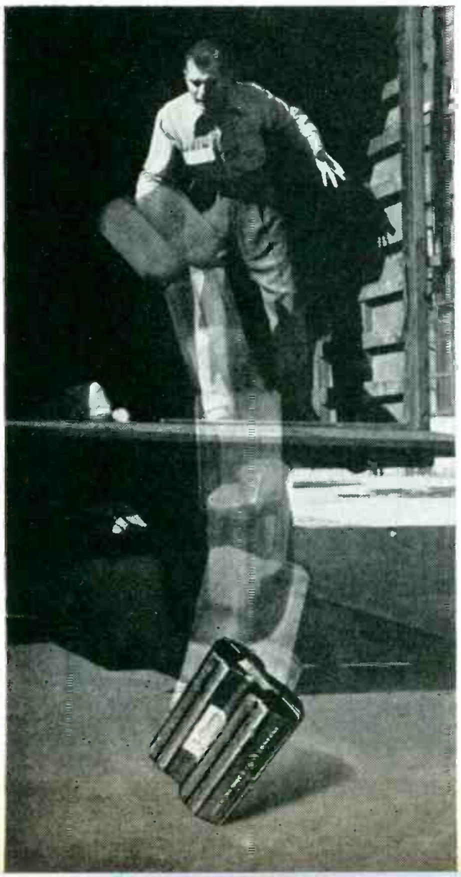
1. New Safe-Shipment Record. To assure safe handling and compact in-plant storage of spools, Anaconda tested many types of cases. Of nearly 70,000 cases now in use less than ¼ of 1% have suffered *any* damage in shipment. Quite a record!

It's news—good news for magnet wire users—when Anaconda boldly breaks industry precedent to arrange with *any* magnet-wire maker to ship spools in its newly developed molded container*. Anaconda's action in releasing its rights and allowing industry-wide use is important to you.

This modern, protective package was designed to safeguard the exceptional quality built into all ANACONDA Magnet Wire. It is typical of Anaconda's program for constant betterment of product, spools and packaging. It's one more reason why you make the right decision when you specify ANACONDA. *Anaconda Wire & Cable Company, 25 Broadway, New York 4, N. Y.*

*Patent applied for 5835

2. Crash-Tested. Accidents like this can't harm spools packed firmly in new molded case. After 100 test drops on concrete, the shipper retained its spools *in perfect shape.*



3. New Molded Shipper has a soft lining to cradle wire spools gently. Top half rests in bottom . . . and stores in one-third the space required by wood empties.

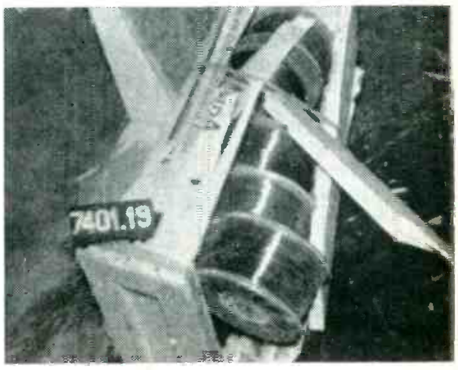
ANACONDA®

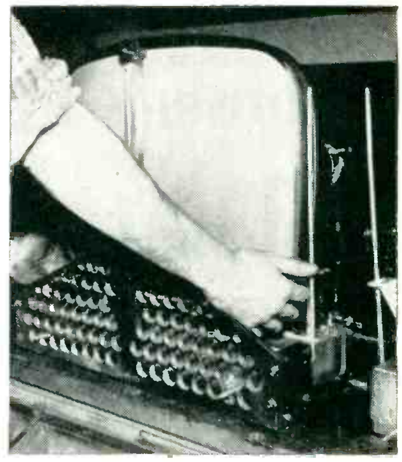
TODAY'S HEADQUARTERS FOR MAGNET WIRE

Class A	Class B	Class H
ENAMEL FORMVAR NYFORM NYLON	VITROTEX**	SILOTEX**

**Trademark

4. Old Style Wood Box is very easily damaged. 61 falls in a test tumbler did this to the best wood crate. Heavy and bulky, the old-type box irks handlers, costs more to ship.





Adjusting position of picture tube with respect to fixture locked in position over front of television receiver chassis. Drilled holes lighten weight of fixture without impairing the rigidity

the upright rod of the fixture are now pushed carefully against the glass face plate. One of these pins should touch the glass and the other should not. Usually only one readjustment is needed to position the tube within its tolerance range.

By maintaining uniform positioning of picture tubes on the chassis, need for centering the chassis in the cabinet is eliminated. The fixture has thus quickly paid for itself through savings in time.

Stockroom Ratio Scale

COUNTING of large quantities of screws, hardware, lugs and other small parts is speeded through use of a ratio scale in the stockroom. In the type of scale used at

Use of ratio scale to count out 2,000 screws. The stock man previously placed 20 screws in the right-hand small pan. Scoop is easily made by nailing sheet metal to half-circle of wood and drilling hole for handle

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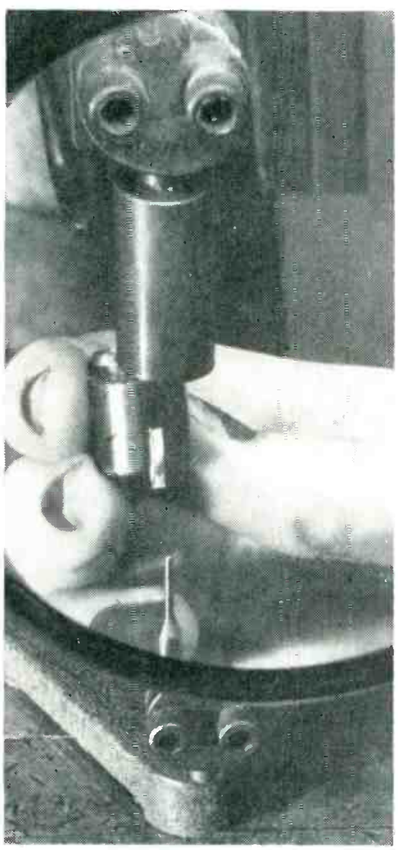
Emerson, ratios of 99 to 1 and 9 to 1 are available. As an example, if 20 units are counted into the higher-ratio pan, the scale will balance when the large and small pans together contain 2,000 units. This balance is obtained when 1,980 units have been shoveled into the large pan.

This type of scale is used in stockrooms of many other electronic manufacturing plants, where it gives more accurate control of inventory and more accurate dispensing of needed quantities to assembly-line positions.

Magnet Lifts Grids

To INSURE cleanliness and at the same time speed up the handling of extremely tiny parts, operators in the Harrison, N. J. tube plant of RCA use small permanent magnets to pick up the grids for pencil triodes. One use of the magnet is the flaring operation shown; another is for the operation of welding the flared grid to the grid disk of the envelope assembly. The

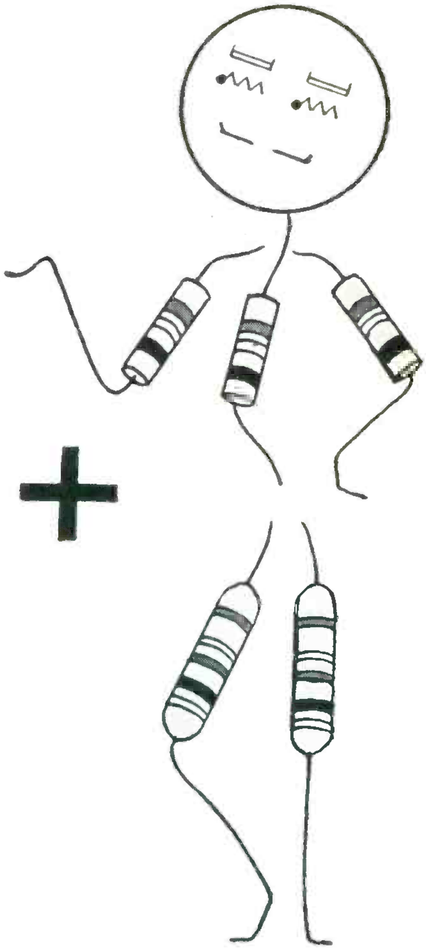


Use of permanent magnet to place grid over flaring tube, as viewed through illuminated magnifying glass

The

PERFECT

Wedding



TYPE 2003 FREQUENCY STANDARD

The Type 2003 contains, in addition to the tuning fork, all circuit components which are selected or critical.—The tube and remaining components — three resistors and two .01 capacitors — are external and can be laid out and integrated with your equipment.

TUNING FORK STANDARD, hermetically sealed.
SIZE — 4½ inches long. 1½ inches diameter.
SIMPLE EXTERNAL CIRCUIT, 1 tube, 3 resistors, 2 capacitors.
TUBE — Choice of 12AT7, 6201, 5751, 6BF7, 6BG7 or 6021.
POWER REQUIRED, 75 to 300 V at 1 to 5 m.a. — 6.3 V at 300 or 350 m.a.
AVAILABLE — in 400 or 500 cycles
ACCURACY guaranteed to .002%, 15° to 35° C.

Write for descriptive literature, specifying Type 2003.

Also TYPE 2007

(4½" x 1½")

COMPLETELY SELF-CONTAINED INCLUDING VACUUM TUBE

Manufacturer of high precision frequency and timing instruments controlled by tuning fork oscillators.

American Time Products, Inc.

580 Fifth Avenue ***New York 36, N. Y.***

OPERATING UNDER PATENTS OF THE WESTERN ELECTRIC COMPANY

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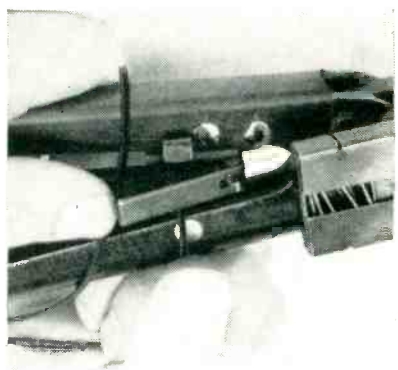
technique works even through the nickel mesh used for the grids is only slightly magnetic.

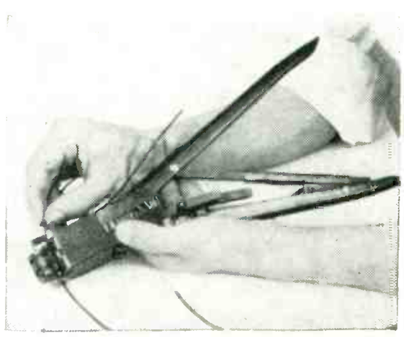
Wire-Splicing Tool

A NEW light-weight wire splicer developed by the Signal Corps Engineering Laboratories permits making a splice in broken field wire in less than 30 seconds, as compared to at least 3 minutes formerly required even by an expert repair man under ideal conditions. The old method required careful scraping of insulation from both ends of the wire to expose the strands. The strands were then tied together in a square knot, the ends wound around the knot, and the splice then taped first with rubber tape and then friction tape to give good insulation and strength.

With the new tool, which looks much like a long pair of pliers, the repair man has only two operations to perform. First, he places each broken end in turn into a specially



Method of using wire-stripping section of new tool



Inserting stripped wire into connector. Cartridge-holding magazine is under thumb of left hand

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Tool with handles open, and examples of completed splices in a twisted pair. Wire stripper is on left handle

designed wire cutter and stripper that is attached to the handle, and squeezes. A built-in guide insures that the right amount of insulation is stripped off. Next, he feeds the bare wires into each end of the cartridge connector which was previously loaded into the tool, and gives another squeeze to complete the job. The center section and both ends of the connector are crimped, giving a water-proof insulated joint with a perfect connection.

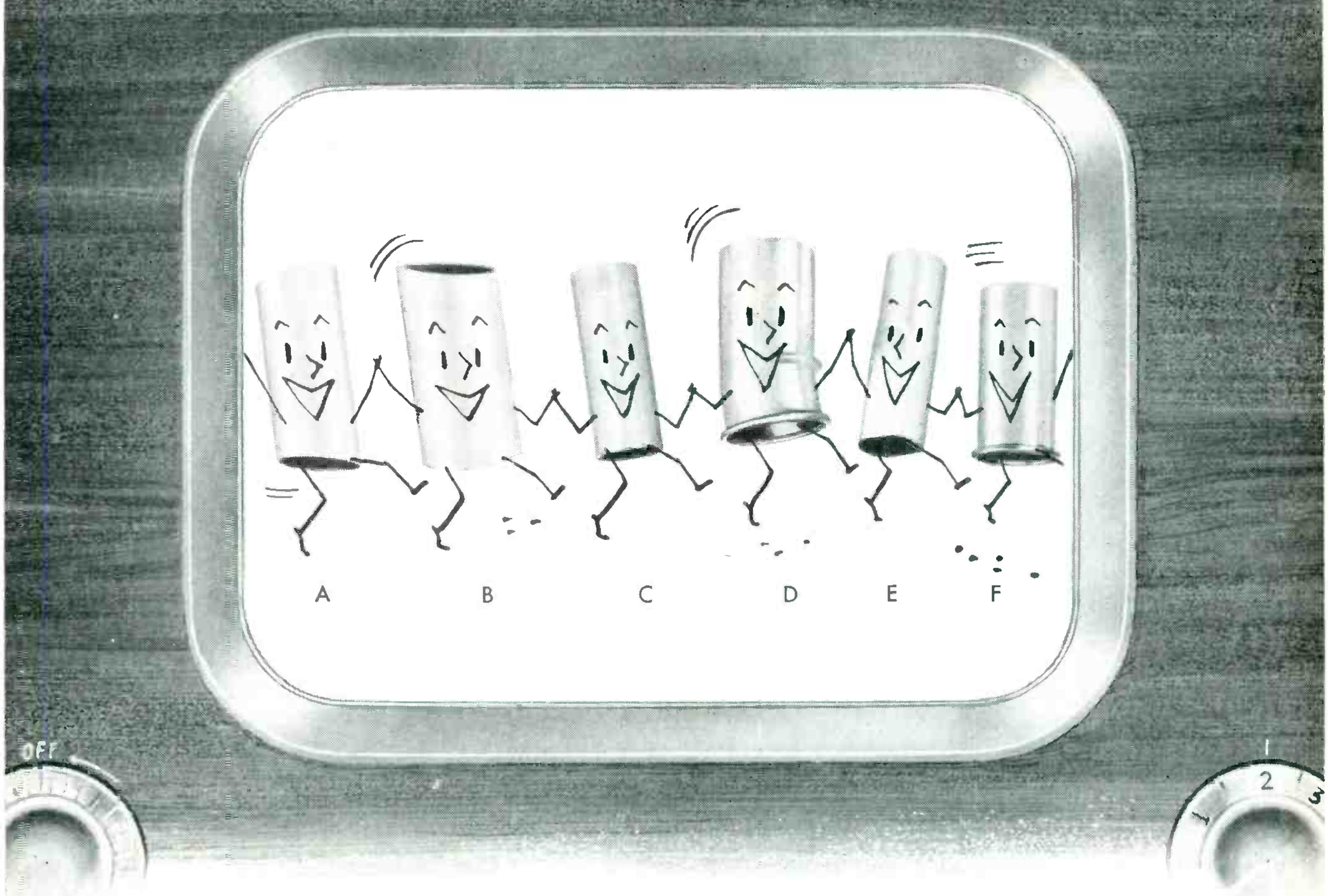
The tool is loaded with a magazine holding ten repair cartridges. New magazines are easily inserted as needed. Manufacturer of the tool is Aircraft-Marine Products, Inc., Harrisburg, Pa.

Germanium Melting Furnace

A THREE-SECTION electric furnace developed especially for the production of germanium ingots uses a crank and cable arrangement to move boats of germanium oxide powder through the furnace sections, which are arranged on an incline.

In operation, the operator places the light, fluffy germanium oxide powder in small boats or trays and places these at the lower end of the incline. The boats are then moved up the incline to the first stage furnace, which heats the oxide to 650 deg C for a four-hour soak in a hydrogen atmosphere. This temperature must be accurately controlled because the oxide vaporizes at a slightly higher temperature. After soaking, the boats

The Superior anode family is on the air



When you meet anyone in radio or television circles named Anode, the chances are favorable that he was born in Norristown, Pa., at Superior Tube Company.

Millions of Anodes have started life at Superior—all types and sizes—stainless steel, nickel, Monel*, Inconel*, straight cut, angle cut, rolled—one or both ends, flattened, bent—and for all types of vacuum tubes.

If the anode you want isn't pictured, tell us about it.

A—Weldrawn†, 304 Stainless Steel, Double angle cut. .520'' O.D. x .500'' I.D. x 1.321'' long.

B—Weldrawn, 305 Stainless Steel, Single angle cut. .520'' O.D. x .500'' I.D. x 1.102'' long.

C—Weldrawn, 305 Stainless Steel, Straight cut. .520'' O.D. x .500'' I.D. x 1.750'' long.

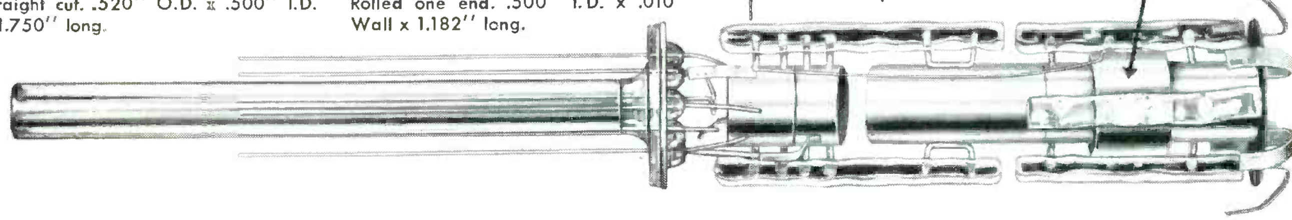
D—Weldrawn, 305 Stainless Steel, Rolled and bent 10°. .449'' I.D. x .010'' Wall x 1.050'' long.

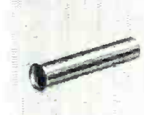
E—Seamless Nickel, Flattened one end. .500'' O.D. x .025'' Wall x 1.625'' long.

F—Weldrawn, 305 Stainless Steel, Rolled one end. .500'' I.D. x .010'' Wall x 1.182'' long.

GUN ASSEMBLY FOR ELECTRO-STATIC TYPE TELEVISION PICTURE TUBE

All of the anode elements (as well as the disc cathode) are fabricated from Superior Tubing. A critical part of this assembly is the "focusing anode" or "focusing ring", produced from Superior Stainless Steel ⅝'' O.D. x .028'' wall, cut to ½'' lengths. It is of extreme importance that the finish of the focusing ring be smooth, and that the I.D. be burr-free else corona would occur and the flow of electrons to screen would be distorted. Superior achieves its degree of smoothness and freedom from burrs by a special and exclusive process.





Seamless Nickel Cathode. Round, flanged one end, .070''/.072'' I.D. x .0025'' Wall, .295'' long.

Disc Cathode .121'' O.D., .312'' long.

Lockseam†† Nickel Cathode Round, tabbed, single bead, .045'' O.D. x .0021'' Wall. 27 mm long.

No. 1 Grid Cup, 305 Stainless Steel. .499'' I.D. x .010'' Wall x .438'' long.

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THE BIG NAME IN SMALL TUBING

SUPERIOR TUBE COMPANY
Electronics Division
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*Registered U. S. Trademark, International Nickel Company

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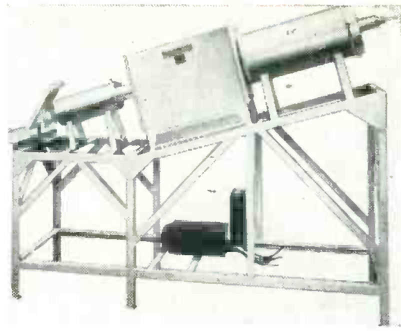

New germanium production furnace made by Hevi Duty Electric Co., Milwaukee, Wisconsin. Crank at upper left on machine is used to pull the boats of germanium oxide through the various stages of the furnace. Square center section is 1,000-deg C second-stage furnace

are pulled into the square second stage of the furnace and heated at 1,000 deg C for about 60 minutes in a hydrogen atmosphere to fuse the material into a solid ingot. After this fusion the boats are pulled into the water-cooled section of the tube for cooling and removal.

The next step in the process is purification, achieved by drawing the ingot through the coils of an induction heating furnace in a nitrogen atmosphere. As the germanium melts, the impurities travel to one end of the bar. This end is then sawed off, leaving a pure bar for cutting into 100-gram pieces from which crystals are formed in a crystal-growing induction furnace. Single crystals are used for transistors and the polycrystalline material is used for varistors.

Cutting Gummed Paper

TABS OF gummed Kraft paper for anchoring wrappings on coils are cut from rolls of the required width by a technique that gives hundreds or even thousands of tabs at a time, using a hand-operated 28-inch paper shear of the type made for printing plants. The operator wraps the paper lengthwise on a long strip of cardboard, with the gummed side out, to a thickness of about an inch on each side or two inches total. The strips may be as long as three or four feet. Next, masking tape is wound spirally around the gummed paper, using a pitch for the spiral that will give at least one complete turn

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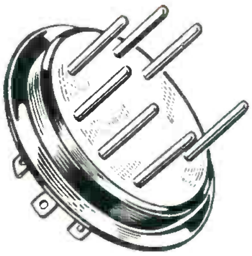

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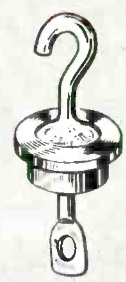
Because there is infinite application for these new units, they are available in a wide variety of mounting flange arrangements to fit existing or new designs.

And, of course, HERMETIC also offers its complete regular line of individually glassed multi-headers and plugs, plus single terminals, feed-throughs and stand-offs.



Write for complete information on how HERMETIC engineers can apply "All-Glass" Compression Seals to your regular or special applications. Available, too, is HERMETIC's Brochure CS on compression seals, as well as a 32-page catalog on its standard line.

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of masking tape per tab length. When a number of these sticks of paper have been prepared, they are brought to the paper shear and cut to the desired tab lengths. The shears are sufficiently powerful to cut through two inches of paper even when filled to the entire available 28-inch width of the guillotine cutting blade.

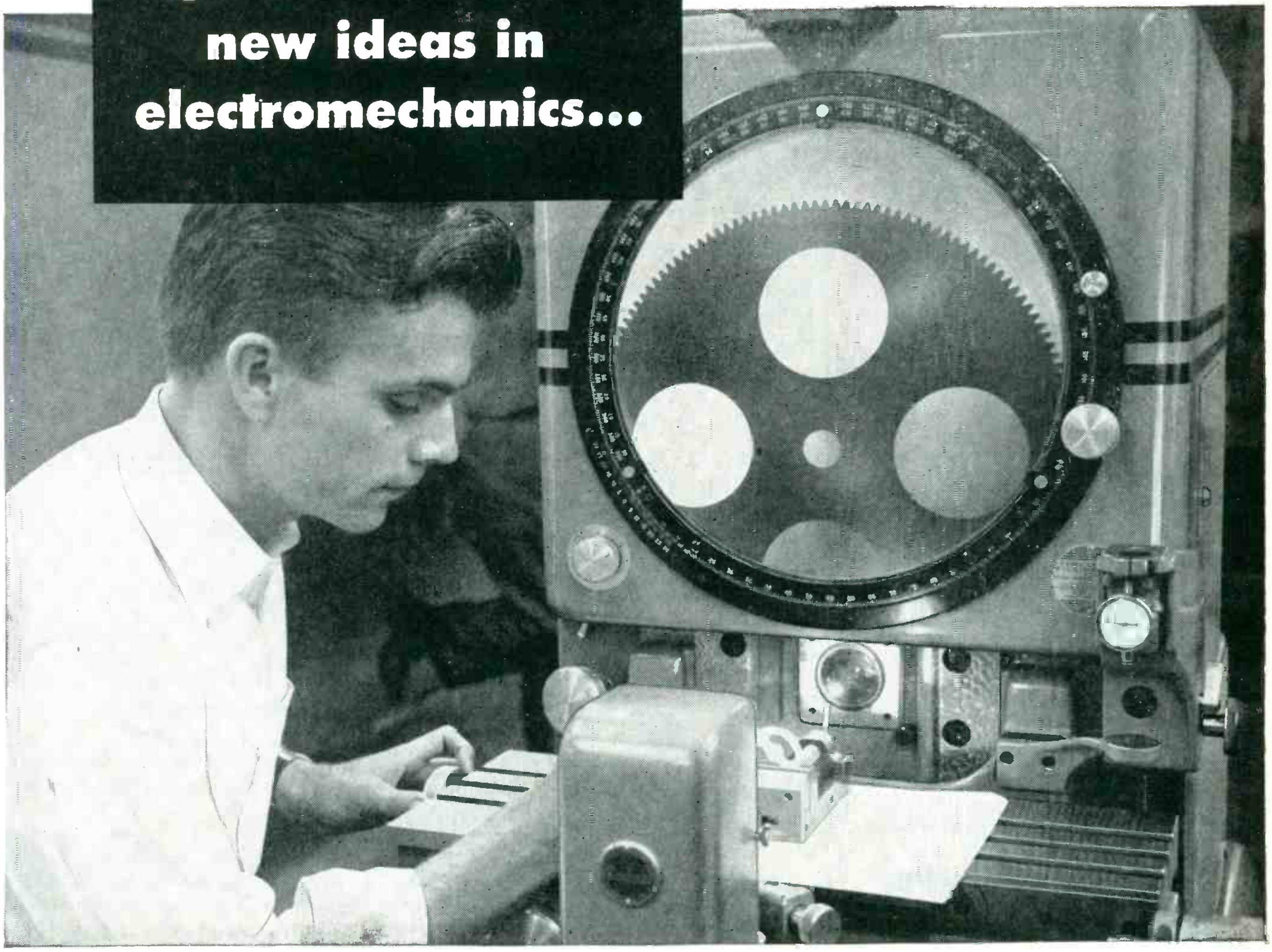
The cut bundles of tape are stored on steel shelves until needed. Stocks of various sizes are thus easily maintained. The spiral of masking tape is easily peeled off a bundle to make the tabs available for use. This technique, as used in the Union City, N. J. plant of Keystone Products, has greatly reduced the cost of tabs for their magnetic amplifier coils.

Water-Cooled Vise for Soldering Cans

AFTER assembly and preliminary testing of discriminators for Raytheon's PRC-6 f-m transmitter-receiver, the unit must be sealed in a metal can without damaging the parts with excessive heat. To achieve solder-sealing under this restriction, the can assembly is placed in the jaws of a water-cooled vise-type jig. In addition, a blower is directed at the exposed base of the can to hold down its temperature during the soldering operation. These two measures prevent

Production setup for keeping discriminator cool while making hermetic solder seal

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.

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excessive rise in internal temperature.

For inserting and removing cans, the rear jaw of the vise is moved in and out by air pressure, controlled by a foot pedal so as to leave both hands of the operator free for soldering.

Coil Turns Counter

FINISHED-EQUIPMENT rejects are being minimized in many plants by checking the number of turns in air-core coils with a new GE counter. The only requirement is that the coils fit over a $\frac{9}{16}$ inch or $\frac{1}{4}$ inch test rod. The instrument checks, in steps of one turn, the effective turns of coils ranging from 0 to 61,110 turns. For coils with outside diameters less than 8 inches, accuracy is 0.2 percent for the larger rod and 0.3 percent for the small rod.

The coil to be tested is placed over the test rod and connected to test clips. With a foot switch the operator then energizes the reversing relay; with each operation of the relay, the magnetizing cur-

Checking large air-core coil with turns counter. Standard coil used for comparison is mounted within the control panel, where it is protected from damage

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rent in the rods is reversed. Dials are adjusted with each reversal until there is no galvanometer deflection, and the number of turns is then read directly from the dials.

Coils wound on nonmagnetic metal forms require special calibration by the user to obtain an accurate count of coil turns. The counter is not recommended for coils having magnetic coil forms.

If the dials are set to the required number of turns, the galvanometer deflection is a measure of the departure from specifications. The galvanometer sensitivity can be adjusted so that any coil which causes deflection beyond a predetermined point on the scale is arbitrarily discarded.

The principle of operation depends upon the fact that a voltage is induced in a coil when the flux linking that coil is suddenly changed. The standard coil, the galvanometer and a coil to be tested are connected in series in such a way that the coils are bucking each other. When the direct current is reversed, the flux in the magnetizing rods is reversed, inducing a voltage in each coil. If the coils have the same number of turns, the voltages induced will be equal and opposite; therefore there will be no deflection on the galvanometer. If one coil has more turns than the other, the voltages induced will be unequal and there will be a galvanometer deflection.

The two test rods, which project under the bench also, are magnetically homogeneous and of uniform cross-section, with uniformly wound d-c windings that give a constant field strength over the entire length of each rod.

New Chemical Process Plates Nickel Uniformly

THE possibility of once again using nickel as a corrosion-resisting finish for electronic components is opened up by a new chemical technique for depositing nickel out of solution without electricity. Chief advantage is that the coating is dense, so that the one mil of coating thickness is adequate for protection. Deposition is uniform on insides as

Spectrum ANALYZER TS-148/UP

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OUTSTANDING PERFORMANCE
MORE RUGGED CONSTRUCTION

TS-148/UP

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Armored foot locker with foam rubber cushion inserted.

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Attenuation (Spectrum Amplitude): 3 — 70 db uncal.
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Frequency sweep: 10 — 30 cps continuous.
Frequency swing (FM sawtooth) of analyzer r-f oscillator: 40 — 50 Mcs.
Maximum error: ±4 Mcs.
Maximum dispersion of spectrum: 1.5 Mcs per inch.
Overall i-f bandwidth at half power point: 50 Kcs.
Sensitivity to CW:
a. Spectrum amplified position: 80 db below 1 W per inch deflection on oscilloscope screen.
b. Spectrum position: 55 db below 1 W per inch deflection on oscilloscope screen.
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MB-2 Marker Beacon Test Equipment, Portable.
TS-E6 Slide Back Voltmeter for E-3, E-4, E-5, etc. Firing Systems).
TS-E7 Moving Target Simulator (for E-3, E-4, E-5, etc. Firing Systems).
TS-170-C ILS Portable Test Equipment.
TS-173-C ILS Portable Test Equipment.
TS-239/UP Wide Band Oscilloscope.
UPM-1 Radar Test Set.
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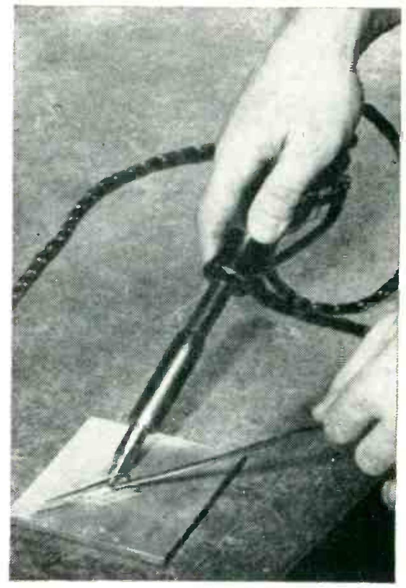
well as outsides of irregular objects since the molecules of nickel deposit out of solution wherever there is contact with the object being plated.

Cost of chemical plating ranges from 50 cents to $1 per mil sq ft, depending on preliminary preparations required. This cost is usually cheaper than cadmium plating because for equal corrosion resistance only about one-tenth the coating thickness is required.

Preliminary preparation is essentially the same as electroplating, involving cleaning and degreasing for various kinds of basis metals and an additional surface-roughening treatment for plastic components on which nickel is to be deposited. Speed of chemical plating is comparable to that of regular dense nickel plating.



Demonstration showing ease of soldering directly to aluminum sheet having a chemically deposited nickel coating

Optimum temperature for nickel deposition out of solution is about 210 deg F. This is entirely feasible for metals. For thermoplastic material, lower temperatures can be used if certain process modifications are made.

Small parts can be chemically plated in tumbling barrels, and larger parts can be suspended conventionally from wires. Where parts are not too heavy (around one pound or less), the solution will plate out perfectly under the

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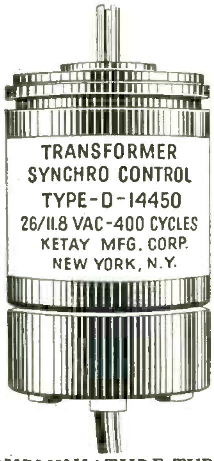

ACTUAL SIZE

SUBMINIATURE TYPE 101A2D SYNCHRO CONTROL TRANSFORMER

Ketay Part No.	D−14450
Voltage rating	11.8v/0.4 v per deg.
Operating frequency	400 cps
Input power	0.4 w max.
Input current	140 ma max.
Input impedance	61 $\angle 77°$ ohms
Secondary voltage	23.2 ± 1 v
Total null voltage	40 mv max.
Fundamental Component of Null voltage	30 mv max.
Time Phase Shift	7°
Moment of Inertia	8.8×10^{-5} slug in^2
Frictional Torque	.05 oz. in.
Electrical Accuracy	—max. 10′

WHEN USED AS A CONTROL TRANSMITTER

Voltage rating	26/11.8 v.a.c.
Input power	0.4 w max.
Input current	65 ma max.
Input impedance	475 $\angle 77°$ ohms
Output voltage	11.8 v ± 0.3 v
Time phase shift	7.3°

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It was gained in developing and designing dozens of the precision control instruments that are today's military standards.

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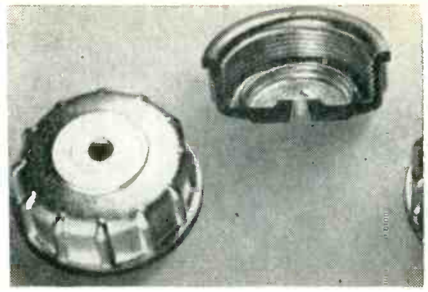

Example and cross-section of plastic knob on which a hard coating of nickel has been deposited chemically with a new process having 100-percent throwing power

supporting wire without leaving marks. The plating can be any desired thickness; this means that the new nickel process can be used for building up worn or overcut surfaces precisely to desired dimensions.

The new process has been named Kanigen by its originator, General American Transportation Corp., Chicago, Ill. It was developed originally by this firm for plating the insides of tank cars, but so many other applications have been found that plans are under way for licensing the process to other plants.

A possible drawback is the hardness of the coating, which precludes deformation in punch presses after plating. All fabricating operations can be performed before plating, however, since the throwing power of the solution is 100 percent. It will plate anywhere that liquid can touch; in experiments, threads of nuts and bolts have been plated without even taking them apart. So far the only metal that can be deposited chemically by the process is nickel.

Heating Iron Anchors Coil Form to Board

An upright mounting arrangement of a special 500-watt heating iron, called the preacher by factory workers, is used in Crosley's Cincinnati plant to join phenolic flyback coil forms to their terminal boards. The setup incorporates an Air-Clamp cylinder made by Meade Specialties in Chicago to raise and lower the iron and to apply pres-

6000 FATHOMS!

Just made available for commercial shipping, the much talked-of Edo deep depth sounder is the first to give continuous readings of any known ocean depth from a moving ship. With a range of 0 to 6000 fathoms, or 36,000 feet, this Edo sonar equipment represents an outstanding achievement in electronic design and efficiency,—just one of a wide number of electronic devices developed and manufactured by the Edo organization.

EDO DEEP DEPTH SOUNDER

VERSATILITY PLUS!

Widely used on vessels of the United States Navy, the Edo deep depth sounder, shown above, has proven useful for many purposes other than recording ocean depths. For instance, with its unusual power, sensitivity and accuracy it has been used to plot the location of bed rock deep under silt. This and other applications show great promise in the use of echo-sounding equipment in many fields of exploration.

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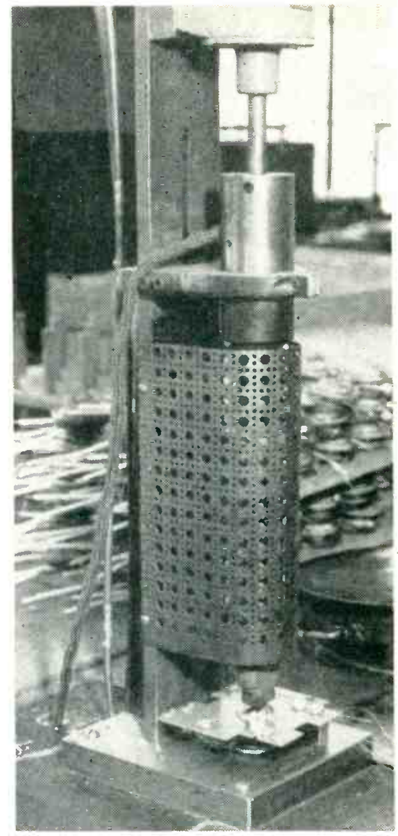


Coil form and terminal board in position ready for heat-and-pressure flaring operation

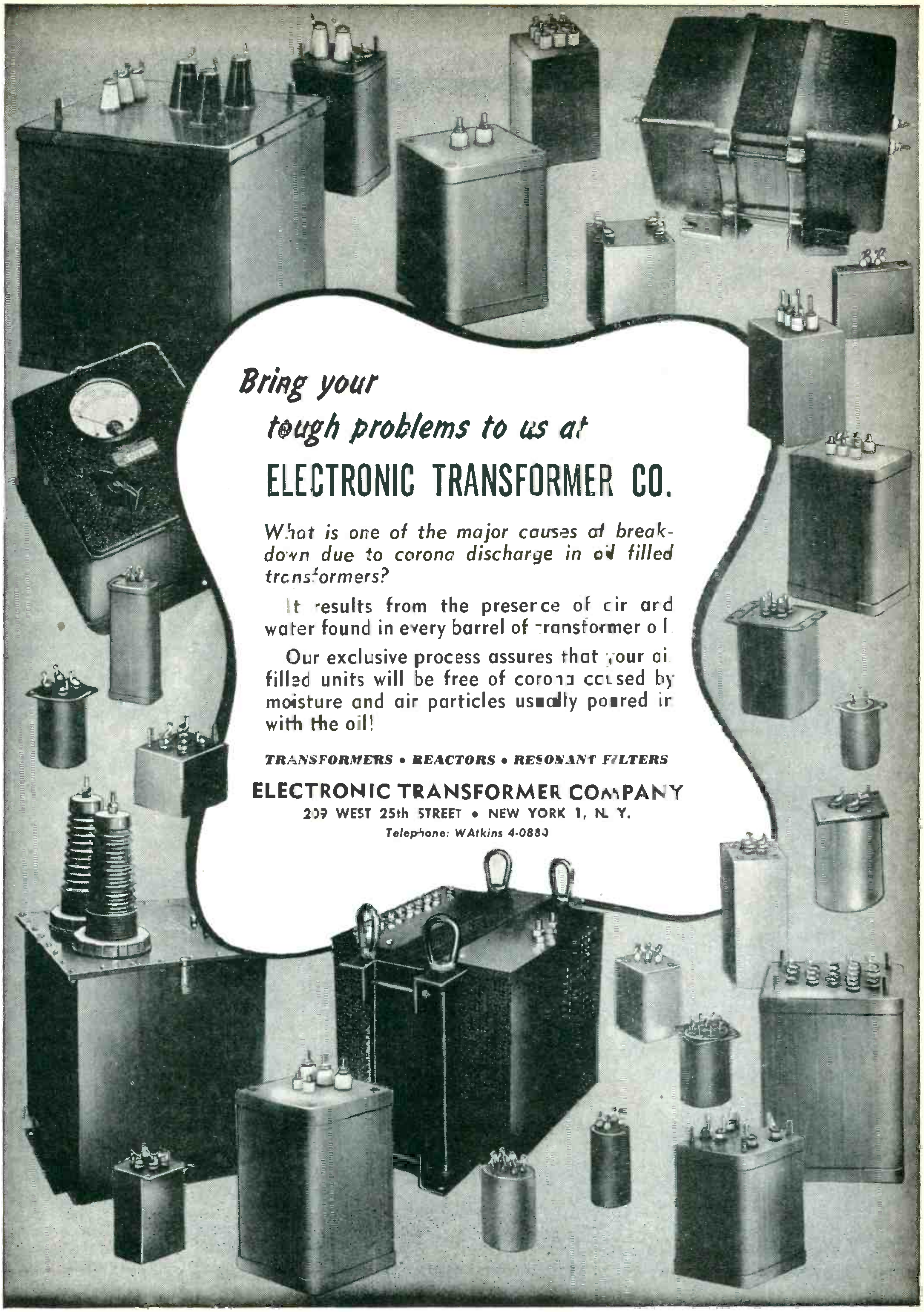
sure under foot-pedal control.

The operator places a coil form over the positioning stud on the base of the fixture, sets over this the flyback transformer terminal board, then presses one foot pedal. This lowers the iron and applies half pressure for about ten seconds to warm the phenolic material. She then presses the other foot pedal to double the pressure. This flares out the coil form sufficiently to lock it firmly on the board.

Cutting Insulating Tabs

CONVERSION of woven glass ribbon to insulating tabs each having one punched hole is achieved with a simple cutting and positioning fixture mounted on a punch press in the plant of Federal Telephone & Radio Corp.

The strip is fed under the female die from the left, and a foot pedal is pressed to operate the press. The operator then pushes the strip in further from the left until the punched hole is directly over a black dot painted on the white bed-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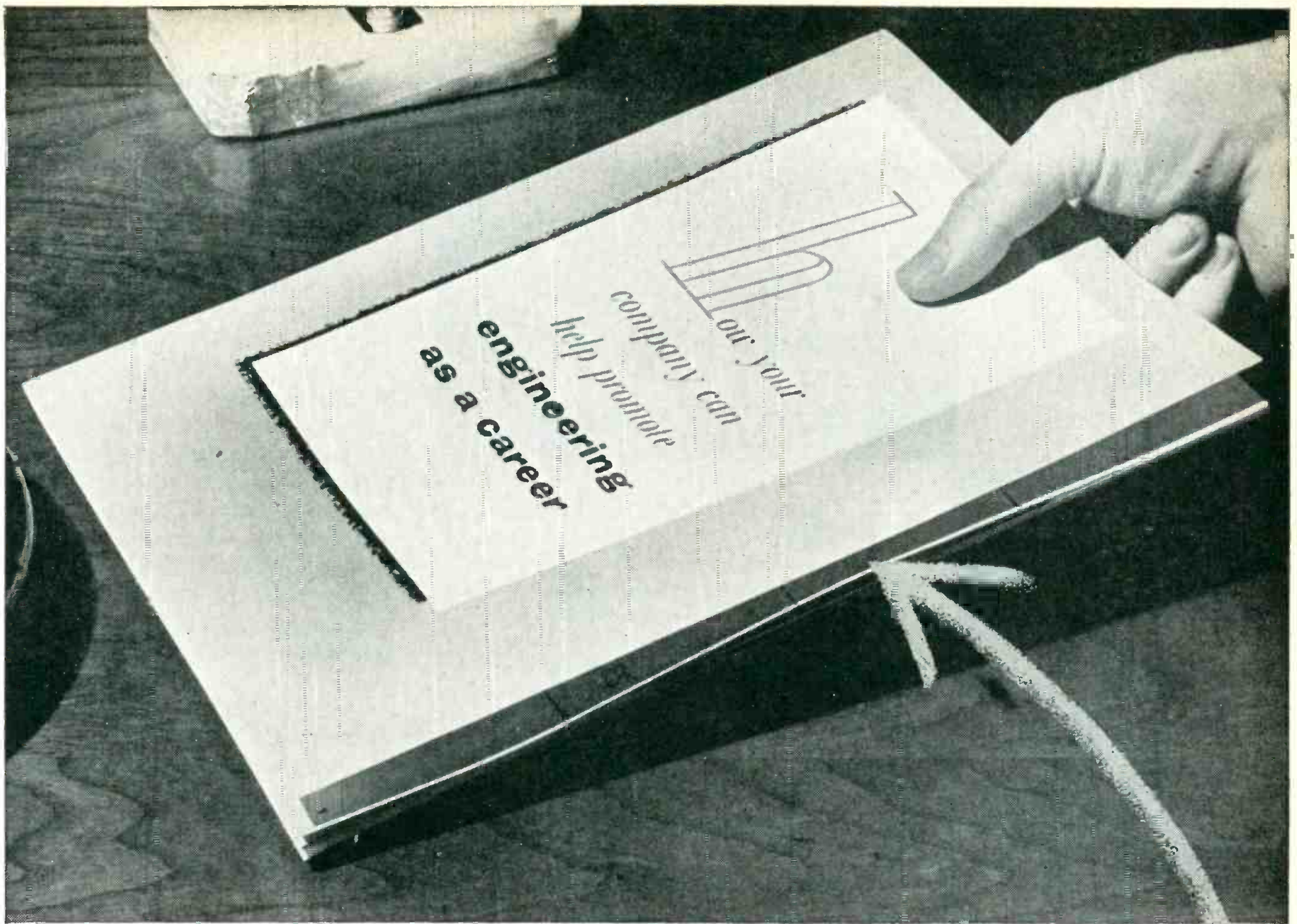
Press setup for producing strips to be used in insulating a toroid board assembly for military electronic equipment

plate of the press. Now the press foot-pedal is operated again. A small chain attached to the pedal brings down a spring-loaded knife for cutting the tape and punching another round hole. This sequence is then repeated, at quite high speeds since exact positioning of the tape is not essential for the intended end use. A stream of compressed air blows out the punched disk to prevent it from jamming under the female die.

Sheet Metal Cost-Cutting

THE ECONOMICS of running a sheet metal fabrication plant discourages many manufacturers of electronic and electrical devices from maintaining self-contained sheet metal departments. Even modest metal-

Checking availability of stock dies for tube socket holes in large rectifier chassis, at Brooklyn, N. Y. plant of Karp Metal Products Co. Prints of all available dies are filed in looseleaf notebooks like that in use here, for quick reference



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working operations require sizeable capital investment for toolroom, presses, welding and finishing equipment. Labor costs are an additional factor, as skilled sheet metal craftsmen come high.

One solution to the problem, used even by some of the largest electronic manufacturers, is to let an independent sheet metal fabricator serve as the fabricating department. When sales engineers of the fabricator are consulted early in the design and planning of cabinets, housings, consoles and other enclosures, they can often suggest minor changes that will trim production costs considerably. Oftentimes tooling costs can be entirely eliminated by making small design changes that permit use of stock dies already on hand.

C-Clamps for Laminations

OUTER laminations of transformers are held tight against the stack with C clamps improvised from piano wire, to prevent varnish from getting under them, during the final varnish-dipping operation for the unit at Keystone Products Co. The clamps are made by winding the piano wire around a mandrel on a lathe, then cutting the turns.

To protect transformer terminals during the dipping operation, a short length of spaghetti is pushed

Method of using piano-wire C clamp to hold down ends of outer laminations over each terminal. The varnish level is controlled so that units are immersed only to the highest point on the coil, and the varnish is sufficiently heavy so it does not creep up inside the spaghetti.

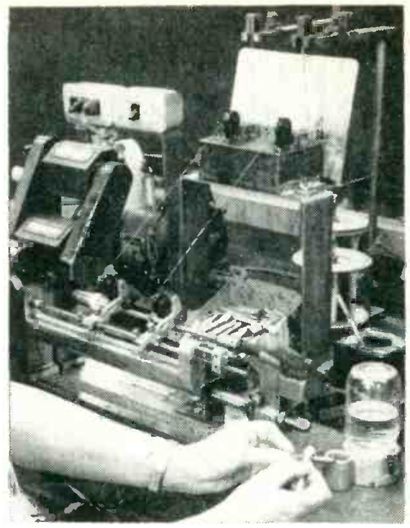
Cement-Dispensing Fountain

A CAST aluminum cement dispenser operating on the principle of poultry water fountains is used throughout the Crosley television plant in Cincinnati to make household cement and other volatile cements or solvents available without need for uncapping a jar. An ordinary mason jar serves as the container. Being transparent, the liquid level can always be seen. Spring steel clips on opposite sides of the dispenser serve as threads into which the threads on the mason jar can be turned, to give a liquid-tight pressure seal against the gasket inside the dispenser.

The level of the liquid in the outer dispensing cup remains essentially constant because of the vacuum developed inside the glass jar, no matter how fast the liquid is taken out with a brush during use. Since only a small area of liquid surface is open to the atmosphere in the cup, evaporation is minimized. For refilling, the jar is turned upright and filled, the dis-

Crosley-designed cement dispenser being used with small brush to apply household cement to a finished coil

Want more information? Use post card on last page.



Dual-mandrel coil-winding setup in which wire is run through rectangular tank filled with solvent just before being wound on the coils. Cement dispenser is at lower right, with electrically heated wax pot behind it

penser is screwed upside-down and the entire unit is quickly inverted.

In the winding operation shown, the wires are run through a bath of resin and alcohol in a rectangular tank mounted above the winding machine. This solution forms an adhesive to prevent breakdown of the fully wound coil. Two coils are being wound simultaneously, using a dual mandrel. After winding a coil. cement from the dispenser is applied to lock the turns in position.

When using plastic-coated magnet wire, methyl Cellosolve solvent is used in the tank to soften the insulation just before winding. The turns of wire then stick to each other automatically, giving a stronger coil. Copper wire coated with baked-on Formvar, then with Bondeze is an example of this type of wire. The Bondeze outer coating is not baked on, hence becomes sticky and soft when run through the solvent.

Capacitor-Testing Merry-Go-Round

METALLIZED paper capacitors are cleared of shorts before impregnation on a turntable arrangement which applies a low voltage initially and builds up the voltage gradually to 1½ times rated working voltage as the capacitor rides around. The operator merely loads and unloads the easy-connecting clips arranged on the circumference of the table. A meter mounted on a bracket in

Turntable arrangement used in East Newark, N. J. plant of Astron Corp. for clearing shorts in metallized paper capacitors

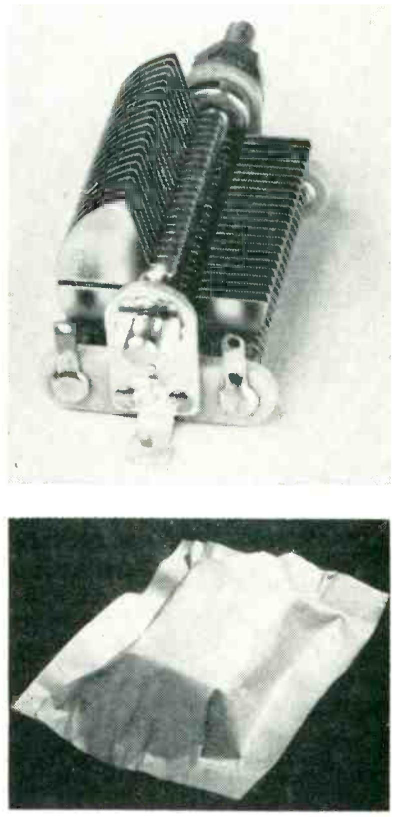
front of the operator indicates solid shorts that have not cleared at the final high-voltage position. The meter bracket also serves as a safety guard for the operator's right hand, and a vertical partition limits the movement of her left hand to the uncharged positions on the turntable.

Phosphor bronze wiping contacts on a fixed disk of tempered Pressdwood bear against contacts on the underside of the rotating turntable to apply the desired voltages to the capacitors. The operator moves the turntable manually each time that she loads in a new capacitor. The arrangement could just as well be motorized, with some increase in output. A similar turntable arrangement is used for testing bathtub-type metallized paper capacitors. This differs only in the use of contacts in place of clips for making connections to the capacitors.

Protective Wrapping

A NEW protective wrapping material for electronic parts has the unique feature of sticking only to itself. After sheets of the material have been cut to size, a piece is wrapped around the part to be protected and the edges are pressed together to complete the seal. This gives a tight, dust-proof, water-repellent, tamper-proof wrap that prevents dirt, finger marks, foreign materials or dust from reaching and damaging the parts.

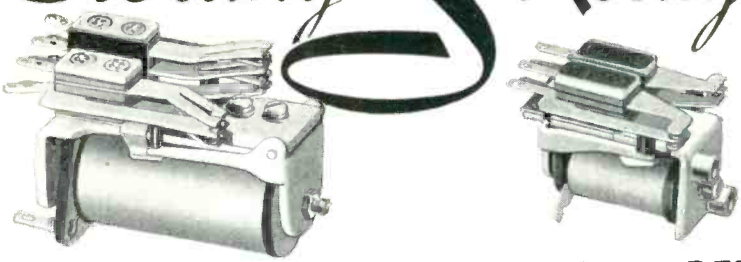
The packages can be opened by pulling apart the seals, much as if opening a self-sealing envelope, but in production operations it is usually faster to cut away a sealed edge with scissors. Code numbers or other identifications of units can be written or stamped on the wrapping.



Example of electronic component that can be protected with new self-sealing wrapping material, and appearance of wrapped unit

Small parts or kits of parts wrapped in this Spot-Seal material cannot be lost, damaged or pilfered from the package. The adhesive coating, though rubberlike in nature, will not damage fine finishes or wiring. The material is available in various widths of 600-foot plain or printed rolls from Sherman Paper Products Corp., Newton Upper Falls 64, Massachusetts.

Sterling Relays



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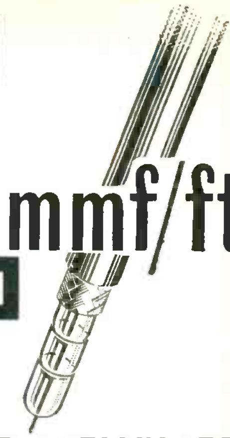

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C.33	4.8	220	0.64″
C.3	5.4	197	0.64″
C.22	5.5	184	0.44″
C.2	6.3	171	0.44″
C.11	6.3	173	0.36″
C.1	7.3	150	0.36″

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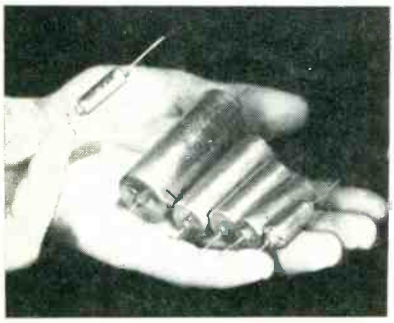
NEW PRODUCTS

Edited by WILLIAM P. O'BRIEN

Control, Testing and Measuring Equipment Described and Illustrated . . . Recent Tubes and Components Are Covered . . . Thirty-Two Trade Bulletins Reviewed

OTHER DEPARTMENTS featured in this issue:

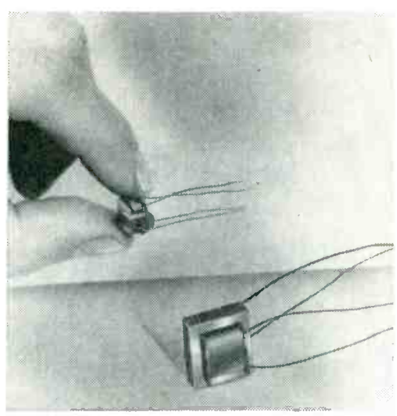


CAPACITORS
with 0.001 to 1-μf ratings

GENERAL ELECTRIC Co., Schenectady 5, N. Y., has two new lines of subminiature metal-clad capacitors with silicone end seals. One line, with solid dielectric, is for operation from −55C to 125C without derating. Their capacitance varies only 1 percent over the 0 to 125C range and only 7 percent over the −55 to 125C range. The second line, with a liquid dielectric, is for operation from −55 to 85C without derating, and are 20 percent smaller than comparable oil-filled units. Both lines can be supplied in either tab or exposed foil designs in ratings from 0.001 to 1.0 μf in voltages of 100, 200, 400 and 600v d-c working. The new units comply with military specifications.

MICROPHONE MIXER
uses three 12 AX7 tubes

MARK SIMPSON MFG. Co., 32-28 49th St., Long Island City 3, N. Y., has announced the model EMM-6 flexible, fully electronic mixer preamplifier. It features electronic mixing of up to four microphones, plus radio tuner and/or phonograph. The amplification provided on all six inputs (four mixing channels) and a cathode follower output allows placement of the mixer preamp up to 400 ft from the amplifier. Output is 1.0 v rms. Harmonic distortion is less than ¾ of 1 percent. Response is 50 to 15,000 cps ± 2 db. Three 12AX7 tubes are used, plus selenium rectifier. The unit is ideal for mixing several program sources, such as organ and choir or solo singer and orchestra into any tape, disc or wire recorder, p-a, school or institutional announcing system or amplifier.



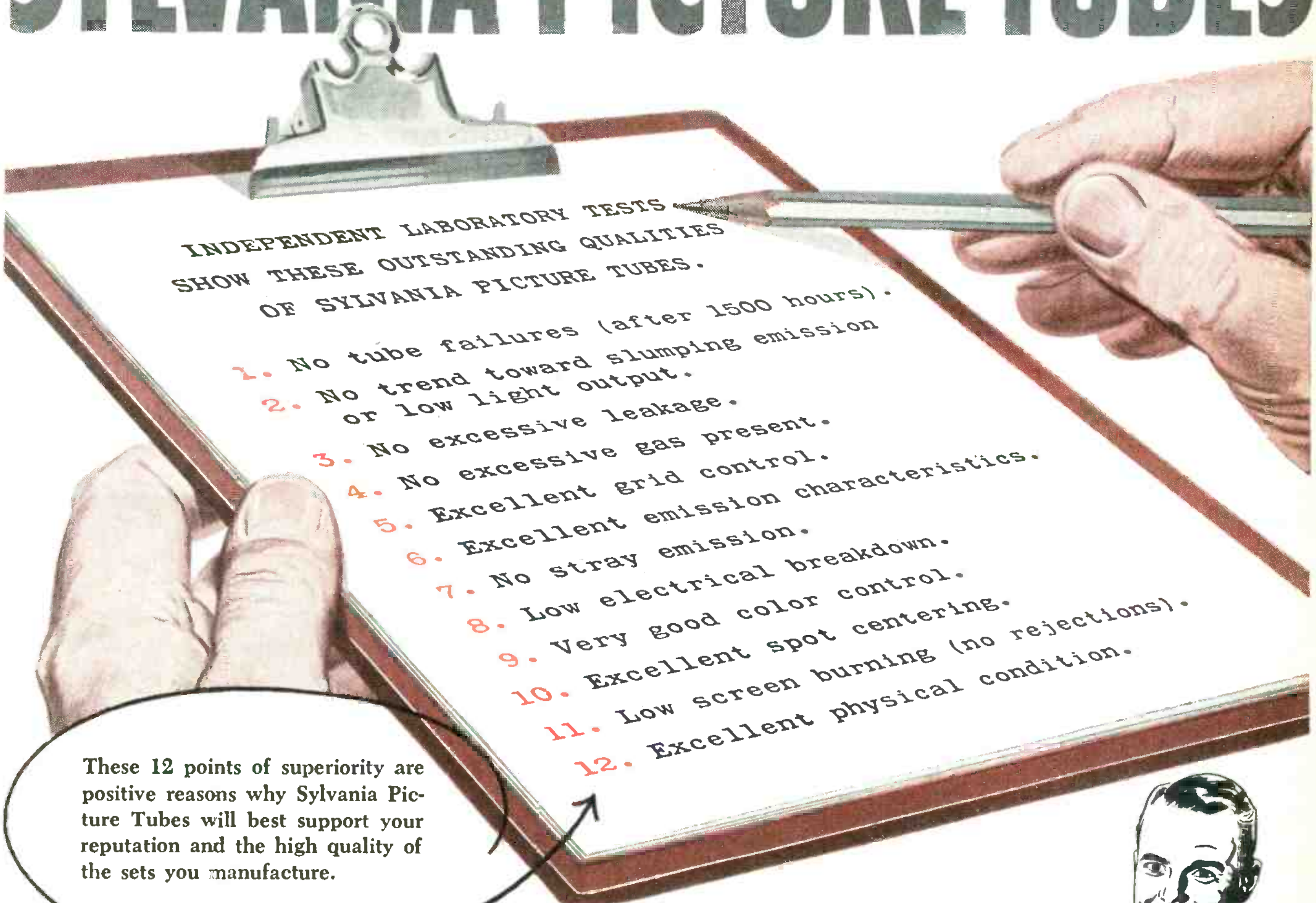
TRANSFORMERS
for use with transistors

STANDARD TRANSFORMER CORP., 3580 Elston Ave., Chicago 18, Ill., has introduced an ultraminiature transistor transformer. Weighing less than 0.1 oz, these units measure as little as ¼ × ⅜ × ⅜ in. and are no larger than the transistors they are designed to work with. Useful below 1-mw level, they are constructed of extremely fine wire, wound on molded nylon bobbins, with special nickel alloy steel laminations. Special ultraminiature transistor transformers, designed and built to individual requirements, also are available.

SCALING UNIT
speeds counting process

NUCLEAR INSTRUMENT & CHEMICAL CORP., 229 W. Erie St., Chicago 10, Ill., has announced a new model 182 scaling unit featuring electrically-reset timer and register to speed counting procedures in radioisotope laboratories. Two models of the scaler are available: 500 to 5,000 or 500 to 2,500-v variable power supply, with electrically reset timer and register, or manual reset register with no timer. Model 182 has a Higinbotham scale of 256 with 8-position scale selection switch. High voltage is indicated on a panel-mounted 4-in. meter and is controlled with coarse and fine adjustments. The unit is ideal for counting applications where low activity radioisotopes are handled. It permits use of scintillation and proportional counters, as well as Geiger

12 Reasons why Television Engineers should specify SYLVANIA PICTURE TUBES



These 12 points of superiority are positive reasons why Sylvania Picture Tubes will best support your reputation and the high quality of the sets you manufacture.

To definitely establish the superiority of Sylvania Picture Tubes, in comparison with other brands, Sylvania called an outside research organization . . . the United States Testing Company.

Eight picture tubes of nine different manufacturers were selected and submitted to identical electrical and mechanical tests.

Shown above is Sylvania's outstanding record. The test results showed that Sylvania Picture Tubes outlasted and outperformed all others tested. For the detailed report of these significant tests, write to: Sylvania Electric Products Inc., Dept. 3R-1005, 1740 Broadway, New York 19, N. Y.

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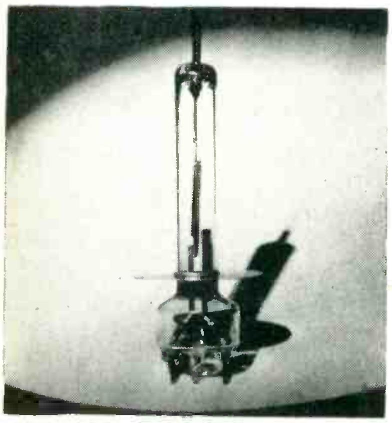
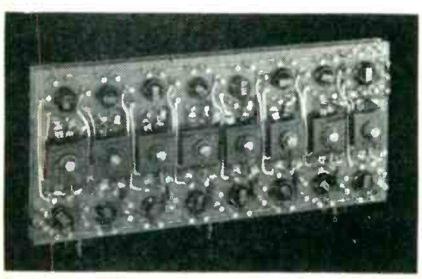
counters, with its wide sensitivity range and linear amplification from 1 mv to 1 v. Resolution time is 2 μsec and the amplifier circuit has a rise time of less than 0.2 μsec.



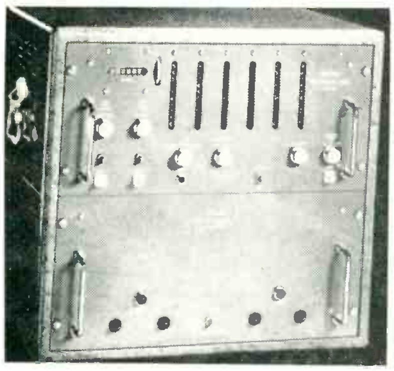
H-V RELAY
used in radar installations

PIONEER ELECTRONICS CORP., Santa Monica, Calif., has developed type PS-32 high-voltage, high-vacuum relay with an externally operated d-c solenoid. The relay is $4\frac{1}{4}$ in. high with a 300-ampere peak pulse current rating, a pulse duration of 3 μsec and a vibration characteristic of 15 g's acceleration. The unit has been designed primarily for partial oil immersion applications for switching pulse forming networks in radar installations. The lower portion of the switch can be hermetically sealed directly into the pulse forming network case, transformer or other oil-filled device. The unit may be specified for use in environments that are corrosive, where explosive atmospheres are encountered, and for high altitude application.



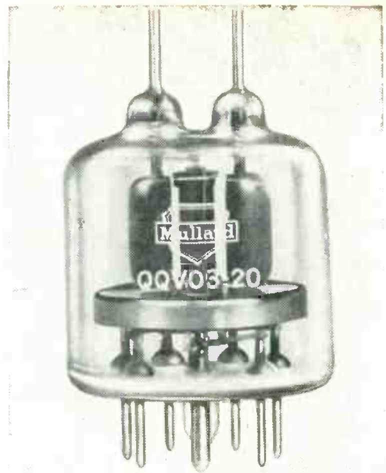
BI-MAG REGISTER
has sixteen stages

AMERICAN MACHINE & FOUNDRY Co., Boston, Mass. The SRA-16 Bi-Mag register is a 16-stage magnetic binary shift register intended for circuits having low energy transfer with an information rate between zero and 25,000 pps. This rapid access storage device for use in the storage, counting and control of digital information in automatic computing or control equipment, is of rugged compact construction with no glass envelope or fragile parts. Read-out interval after read-in can be made in microseconds or as long as desired. Fast access speeds are provided by the ultrathin magnetic materials used and by careful design of the register circuit.



TIME INTERVAL METER
is accurate to $\pm$ 1μ sec

BERKELEY SCIENTIFIC Division of Beckman Instruments, Inc., 2200 Wright Ave., Richmond, Calif. Model 5120 time interval meter provides a direct reading of elapsed time between any two events, in 1-μsec increments, to a maximum of 1 second with an accuracy of ± 1 μsec, $\pm$ crystal drift. Any occurrence that can be translated into changing voltages may be so timed and timing may be started and stopped by independent voltages. Attenuators permit selection of amplitude of start and stop voltages at optimum level for elimination of interference. Power is available from the accessory socket of the unit to operate various transducers. The length of time that the digital reading is displayed can be controlled either manually or automatically up to a maximum of 5 seconds. Ease of reading and simplicity of operation make the unit ideal for even production line work.



UHF TETRODE
for wideband operation

MULLARD LTD., Century House, Shaftesbury Ave., London WC2, England. The QQVO3-20 high-performance double tetrode is especially suitable for use on the uhf wavebands. It is intended for wide-band operation as an r-f class C power amplifier or multiplier in low-power mobile transmitters working at frequencies up to 600 mc. At 200 mc the tube can provide a power output of 42 w. Under reduced input conditions, 22 w can be obtained at 400 mc, and approximately 12 w at 600 mc. Outstanding advantages of the tube are high anode efficiency, excellent power gain, low filament consumption and small physical dimensions.

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AUF WIEDERSEH'N, SWEETHEART *(Vera Lynn—London)*	
I WENT TO YOUR WEDDING *(Patti Page—Mercury)*	✓
HALF AS MUCH *(Rosemary Clooney—Columbia)*	✓
WISH YOU WERE HERE *(Eddie Fisher—Hugo Winterhalter—Victor)*	✓
HERE IN MY HEART *(Al Martino—BBS)*	✓
DELICADO *(Percy Faith—Columbia)*	✓
KISS OF FIRE *(Georgia Gibbs—Mercury)*	✓
ANY TIME *(Eddie Fisher—Hugo Winterhalter—Victor)*	✓
TELL ME WHY *(Four Aces—Decca)*	✓
BLACKSMITH BLUES *(Ella Mae Morse—Capitol)*	✓
JAMBALAYA *(Jo Stafford—Columbia)*	✓
BOTCH-A-ME *(Rosemary Clooney—Columbia)*	✓
GUY IS A GUY *(Doris Day—Columbia)*	✓
LITTLE WHITE CLOUD THAT CRIED *(Johnnie Ray—Okeh)*	✓
HIGH NOON *(Frankie Laine—Columbia)*	✓
I'M YOURS *(Eddie Fisher—Hugo Winterhalter—Victor)*	✓
GLOW WORM *(Mills Brothers—Decca)*	✓
IT'S IN THE BOOK *(Johnny Standley—Capitol)*	✓
SLOW POKE *(Pee Wee King—Victor)*	✓
WALKIN' MY BABY BACK HOME *(Johnnie Ray—Columbia)*	✓
MEET MR. CALLAGHAN *(Les Paul—Capitol)*	✓
I'M YOURS *(Don Cornell—Coral)*	✓
I'LL WALK ALONE *(Don Cornell—Coral)*	✓
TELL ME WHY *(EddieFisher—HugoWinterhalter—Victor)*	✓
TRYING *(Hilltoppers—Dot)*	✓
PLEASE, MR. SUN *(Johnnie Ray—Columbia)*	✓

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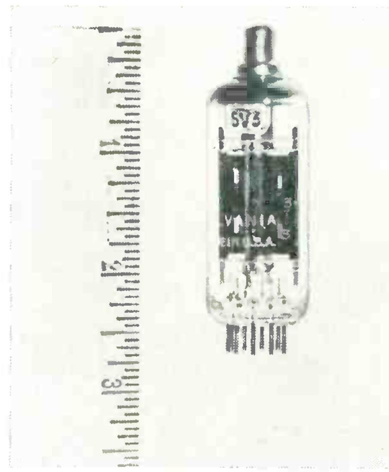
Audiodiscs are manufactured in the U.S.A. under exclusive license from PYRAL, S.A.R.L., Paris new type P toroid coils are hermetically encapsulated in a special tough plastic compound. They will withstand ambient temperatures of −55C to 130C; 95-percent humidity —boiling salt water, and an amazing degree of mechanical shock. The small physical size makes them ideal for use in miniature assemblies, and they may also be mounted compactly on a single screw. A sample of the type P coil for test purposes is available upon request.

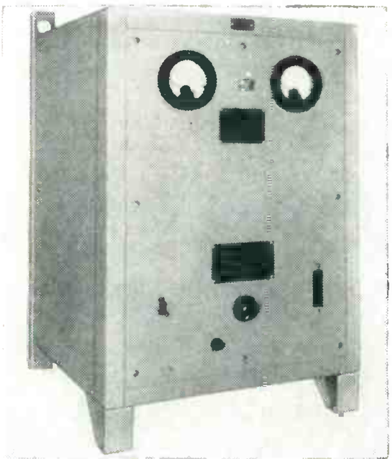


H-V RECTIFIER
for tv damping-diode use

SYLVANIA ELECTRIC PRODUCTS INC., Emporium, Pa., is now producing a miniature cathode-type high-voltage half-wave rectifier, type 6V3. It has a coated unipotential cathode and is designed for use as a damping diode in tv receivers. In new equipment applications, when used within its maximum ratings, it is capable of withstanding a peak inverse voltage of 6,000 v and a steady state peak current of 600 ma. The tube is contained in a miniature T-6½ envelope. The cathode is connected to the top cap.

PLASTICS SHEETS
come big and strong

STRICK Co., Whitaker & Godfrey Ave., Philadelphia 24, Pa. Fiberglas reinforced polyester sheets are now available in sizes up to 4½ × 8½ ft and in a variety of thickness. The sheets are made in two grades: for 20,000 and 40,000 psi. Both grades have excellent dimensional stability and resistance to a great variety of chemicals that make them ideal materials for structural elements in corrosive atmospheres or baths. The materials also exhibit high arc resistance and low power factor, which makes them excellent for use in the electrical and electronic industries. The materials can be formulated in varying degrees of flexibility and can be molded to special shapes in low cost tooling.



POWER SUPPLY
has automatic regulation

RICHARDSON-ALLEN CORP., 116-15 Fifteenth Ave., College Point, L. I., N. Y., has developed an automatic regulated d-c thyratron power supply. The unit is now being used for teletype test and repair and in communications laboratories. The d-c output is 110 v ± 5 v at 5 amperes. The a-c input is 100 to 130 v single phase at 60 cycles. A manual adjustment is provided so that the d-c output voltage to 110 v may be returned at any condition of a-c line voltage or d-c output. The power supply includes d-c instrumentation, a filter circuit to permit 1-percent ripple. The No. 15 cabinet is 16 in. × 16 in. × 25 in. The power supply is air-cooled and is designed for operation in ambient temperatures up to 40 C.

C-R OSCILLOSCOPE
is a portable lab type

TEKTRONIX, INC., P. O. Box 831, Portland 7, Oregon. Type 514-AD portable laboratory type oscillo-

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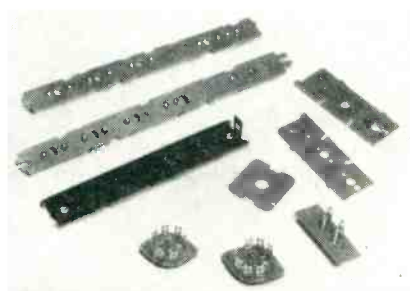
scope has a 6-cm undistorted vertical deflection with new direct-coupled vertical amplifier, flat-faced c-r tube, variable duty cycle calibrator and direct-coupled unblanking. It features vertical amplifier bandwidth d-c to 10 mc at 0.3 v per cm to 100 v per cm sensitivity, 2 cycles to 10 mc at 0.03 v per cm to 100 v per cm sensitivity, rise time of 0.04 μsec and 0.25 μsec signal delay. The square wave calibrator is variable from 0 to 50 v, accurate within 3 percent of full scale, duty cycle variable from 2 to 98 percent. Accelerating potential is 3 kv. All d-c voltages are electronically regulated.

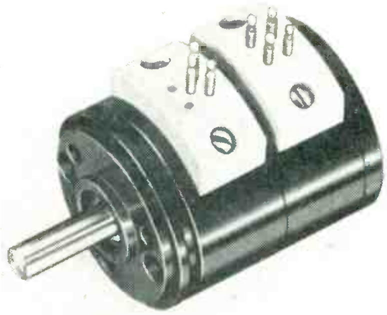
MEDIUM-MU TRIODE for oscillator service

SYLVANIA ELECTRIC PRODUCTS INC., 1740 Broadway, New York 19, N. Y., has produced a new miniature 7-pin medium-mu triode. The 6T4 was designed for the service as an oscillator in tv tuners or converters covering the new uhf bands. The tube features short bulb, T $5\frac{1}{2}$ construction, having a maximum overall length of $1\frac{3}{4}$ in. and a maximum seated height of $1\frac{1}{2}$ in. It also features double plate and grid connections to reduce lead inductance. In circuits designed for its use the 6T4 is capable of operation up to 1,000 mc. When operated with 80 v on the plate and a plate current of 18 ma, it has a transconductance of 7,000 μmhos, an amplification factor of 13 and a plate resistance of 1,860 ohms.



LAMINATE features high resistance

GENERAL ELECTRIC CO., 1 Plastics Ave., Pittsfield, Mass., has announced a new laminate that retains superior insulation resistance under humid conditions to enable greater tuning stability in tv and radio circuits. The phenolic paper base material, called G-E 11541 Textolite, is particularly recommended for electronic component parts. Tests show it to have an insulation resistance of 100,000 megohms minimum after 96 hours in 90-percent relative humidity at 35C. This high resistance has been achieved in the material with no sacrifice of the good hot punching qualities and mechanical strength of conventional laminates. The new material has good low loss properties and high dielectric strength. It is available in sheets from 0.015 to 0.25 in. thick.



POTENTIOMETER
is multiple-section unit

G. M. GIANNINI & CO., INC., 117 E. Colorado St., Pasadena 1, Calif., has introduced a new compact, rugged 1⅛-in. diameter multiple-section potentiometer. This precision potentiometer is available in assemblies of from one to six sections with a six-section unit requiring an operating torque of 0.6 oz in. Assembly of sections is made without external clamps or bolts and a solid stainless steel shaft is used to couple the movable arms of each section. Mechanical shaft rotation is 360 deg continuous. Electrical contact angles can be ordered up to 360 deg. Resistance values from 500 to 70,000 ohms per section are available and each section will dissipate 2 w at 25 C. Standard linearity tolerance is ±0.5 percent for each section and nonlinear outputs

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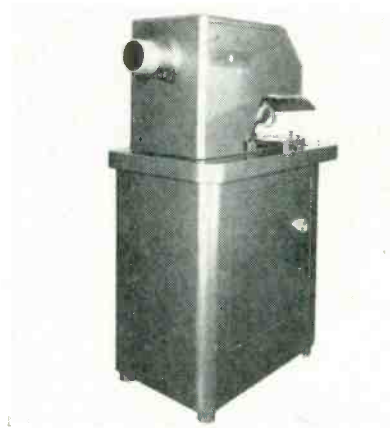
are available on special order. Operating temperature range is from −54 to +71 C and the unit will function during 50 g acceleration applied along any axis.

UHF-VHF ANTENNA
has weighted base

BRACH MFG. CORP., 200 Central Ave., Newark 4, N. J., announces the No. 482 universal indoor antenna for both uhf and vhf signals in the primary area. It has the conventional three-element rods for vhf, which also fall into a 90-deg horizontal position for uhf. This is accomplished by the design of eccentric rotating balls that allows the user to flip the elements to the uhf position. Elements of the antenna can be placed in whatever position desired without fear of tipping because of the weighted base.

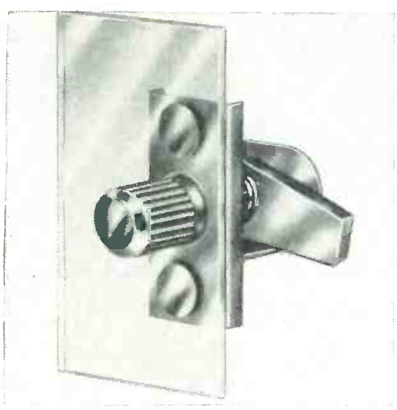


TV SLIDE PROJECTOR
has single lens projection

GENERAL ELECTRIC CO., Syracuse, N. Y., has announced the type PF-4-A tv dual slide projector, featuring single lens projection and simplified handling of special effects. The narrow light beam resulting from use of a single lens allows the new unit to be used simultaneously with one or two film projectors grouped around a single film camera. With its accessories, the projector will handle five different types of slides and materials in addition to the INS news tape. In addition to a mechanical blade method for laps and dissolves, the new unit features variable voltage transformers that control the light intensities of all projection lamps.

RECORDING BLANKS
for immediate playback

AUDIO DEVICES, INC., 444 Madison Ave., New York 22, N. Y., is now producing 7-in. lacquer-coated aluminum-base sound recording blanks for immediate playback on any 45-rpm phonograph. These Audiodiscs have the standard 1½-in. diameter center hole and are designed to use a brass center-hole adapter when recording. The adapter is placed over the center pin on the recorder turntable, fitting snugly within the center hole of the disc. The turntable drive pin engages the drive-pin hole of the disc in the usual manner. After recording, the disc is ready for immediate playback on a 45-rpm phonograph without any additional punching-out operation. This assures a smooth, clean center hole that will operate freely on automatic changer mechanisms.

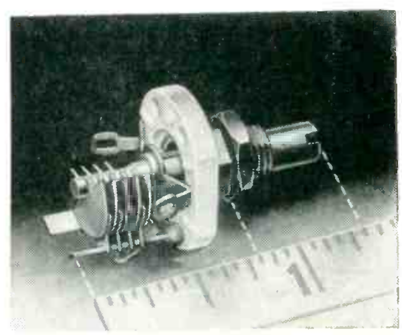


ADJUSTABLE FASTENER
is easily installed

SOUTHCO DIV., SOUTH CHESTER CORP., 1417 Finance Bldg., Philadelphia 2, Pa. Weighing only ½ oz and held in a compact ¾ in. long housing, this miniature fastener is adjustable to door frames varying from 0 in. to 25/32 in. thick. Installation is accomplished merely by slipping its knurled activating knob through a hole in the door and attaching with two rivets or spot welds. No further assembly is necessary. The fastener was designed at the request of manufacturers of electronic equipment for use on doors requiring a small, quickly installed lock that would offer strength, vibration resistance and flexibility in grip lengths.

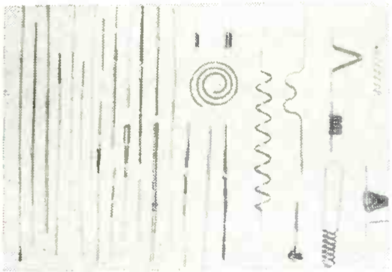
PRESSURE REGULATOR for airborne radar

ACCESSORY PRODUCTS CO., 617 Putnam Drive, Whittier, Calif., is now producing a new pressure regulator for airborne pressurized radar systems. System pressure controlled by the model PR-4 radar isobaric pressure regulator is maintained at a constant value, regardless of altitude. The unit measures 5.75 in. maximum diameter by 3.75 in. maximum depth and weighs 2 lb. Operating temperature range is -65 to $+165$F. Line size is $\frac{1}{4}$ in. Inlet pressure range is 20 to 1,500 psi ga. Flow rate is 0 to 200 cu in. per minute.



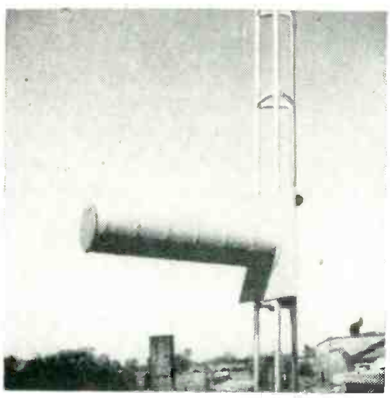
VARIABLE CAPACITOR serves as trimmer at vhf

HAMMARLUND MFG. CO., INC., 460 W. 34th St., New York 1, N. Y., has developed a new tiny variable capacitor, type MAC. This capacitor provides the low minimum capacitance essential for use as a trimmer in the vhf range. Its silicone-treated steatite base is only $\frac{3}{4}$ in. $\times$ $\frac{5}{8}$ in. Rotor and stator are soldered assemblies of brass that are later silver-plated for low losses. A silver-plated beryllium-copper wiper rotor contact is used. Rotor and stator terminals are positioned to permit short leads. The threaded bearing is provided with flat sides to permit single-hole mounting without turning. The new units are available to fulfill capacitance requirements between 1.4 and 19.6 μμf.



COILS AND LEADS are precisely hand-wound

THE ELECTRONIC PARTS MFG. CO., INC., 508 25th St., Union City, N. J., announces the availability of tungsten and molybdenum coils, hand-wound to exacting standards. These coils are made to customers' specifications for use as emitters, filaments and other electronic applications. Also available are leads of uniform quality with or without beadings. These are fabricated from tungsten, molybdenum, nickel, nickel-clad copper and alloys. Stock items are available as well as custom-made types.



HELICAL ANTENNAS for 450 to 470-mc region

MARK PRODUCTS CO., 3547 Montrose Ave., Chicago 18, Ill., announces a new line of helical beam antennas for unidirectional applications in the 450 to 470-mc region. The helix conductor comprising the array is molded integrally into a Fiberglas-polyester resin radome housing that completely seals the unit from the effects of weather and provides the necessary strength properties. The electrical design affords 12 to 14-db gain in point-to-point service and provides certain advantages of cir-

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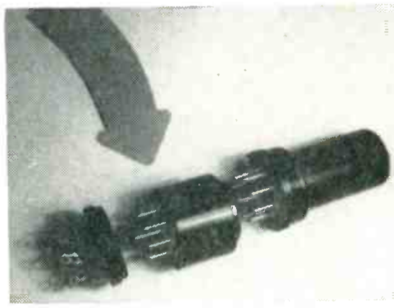
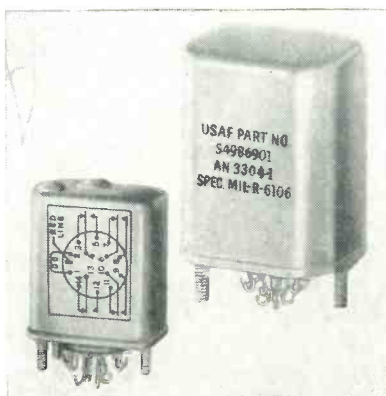
cular polarization propagation over conventional linear polarized propagation. All helical units are designed to withstand 100-mph wind velocity with ½-in. radial ice load.



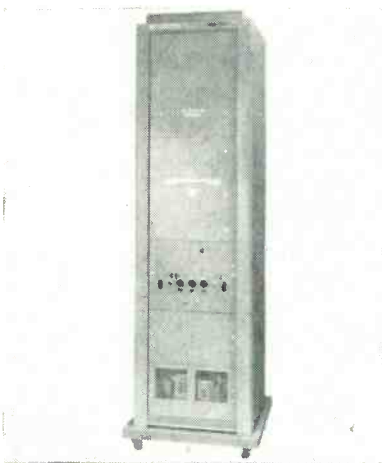
TUBE CONTROL
features plug-in design

YATES ENGINEERING SERVICES, P. O. Box 67, Cranford, N. J., has developed the Tube-Trol, a new plug-in unit containing all necessary components to control proper performance of electronic tubes in all conventional applications. The convenient plug-in feature will reduce or eliminate many hand assembly and wiring operations now required in present-day production of radio, tv and other types of electronic equipment. Chassis wiring can now be reduced to operating potential leads and signal-in and signal-out connections for each tube stage. In-process and complete equipment testing procedures can also be simplified and speeded up.



SEALED RELAY
has reduced size and weight

ESSEX WIRE CORP., R-B-M Division, Logansport, Ind. The series 22300 hermetically sealed relay is the electrical and mechanical equivalent of an AN 3304-1 in a package that is 50 percent smaller and lighter. An improved armature design, plus high temperature molded nylon bobbin, provides greatly improved magnetic efficiency that enables this reduction in size and weight. The 22300 series still retains palladium cross-bar contacts that are identical to those used in the larger telephone type relays. Maximum contacts are 6 Form A or 4 Form C, 3 ampere 28 v d-c. Maximum coil resistance is 5,000 ohms. Minimum operating power is 0.75 w for 4 Form C contact form. The relay is available in AN 3304-type enclosure for dynamotor or low capacitance application.



D-C CALIBRATOR has 1-percent accuracy

BENSON-LEHNER CORP., 2340 Sawtelle Blvd., West Los Angeles 64, Calif. Model GS-1022 electronic d-c calibrator, or Photoformer, has been developed to correct automatically in true time the nonlinearities present in telemetry systems. By the use of a paper calibration mask, cut to the geometric representation of the desired function, both transducer nonlinearities as well as errors inherent in ground receiving equipment can be corrected, thus furnishing an immediate calibrated output for display or recording purposes. The d-c calibrator operates on input signals of from d-c to 1 kc with an overall accuracy of approximately 1 percent of full scale. The unit is constructed on a standard relay

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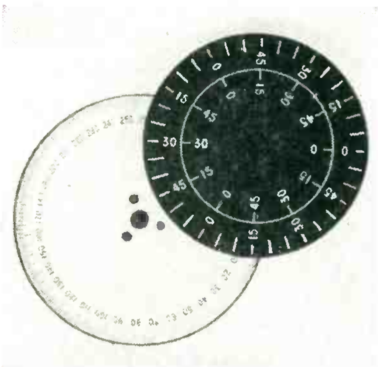
rack mounting and measures approximately 88 in. × 25 in. × 25 in.

CHAIN AMPLIFIER
has 200-ohm impedance

SPENCER-KENNEDY LABORATORIES, INC., 186 Massachusetts Ave., Cambridge 39, Mass. Model 202C wide-band chain amplifier has an extended bandwidth of 1 kc to 210 mc. Twelve 6AK5 tubes in a chain circuit provide a gain of 20 db which is uniform within ±1.5 db over the bandwidth. The rise time of this untuned amplifier is less than 0.0026 μsec (10 percent to 90-percent amplitude). The input and output impedance is 200 ohms with a stabilized power supply that prevents fluctuations of gain due to line voltage changes.

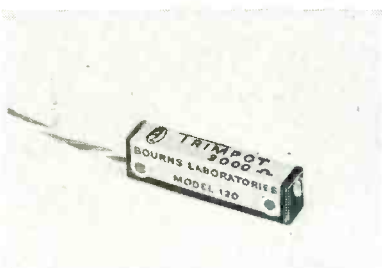
STATIC DETECTOR
works with electrometer

KEITHLEY INSTRUMENTS, 3868 Carnegie Ave., Cleveland 15, Ohio. Model 2005 static detector clips onto a v-t electrometer. The new electrometer accessory consists primarily of two concentric, telescoping tubes and a center aluminum rod. When clipped over the high terminal of the electrometer, the tubes act as a shield for the rod, limiting sensitivity to a narrow cone along their axis. Uses for the electrometer and static detector include virtually every application where electrostatic charges are undesirable and an instrument of extreme sensitivity is needed.



ENGRAVED DIALS
in varied types and sizes

ACKERMAN ENGRAVERS, 75 Warren St., New York 7, N. Y., is now developing a series of standard dials totalling 126 different types and sizes. Advantages to users of standard dials are: (1) saving of designing time; (2) saving of from 15 to 60 percent in cost; and (3) less delivery time. Dials are manufactured to close tolerances. Center hole is a ⅜-in. diameter and runs true to outside diameter within ±0.001 indicator reading. The hole may be easily machined to required size. Dials are supplied in many increment degrees and diameters, and are available in black or white metal or plastic. Specifications and prices are available from the manufacturer.



WIRE-WOUND TRIMPOT
simplifies circuit design

BOURNS LABORATORIES, 6135 Magnolia Ave., Riverside, Calif. De-

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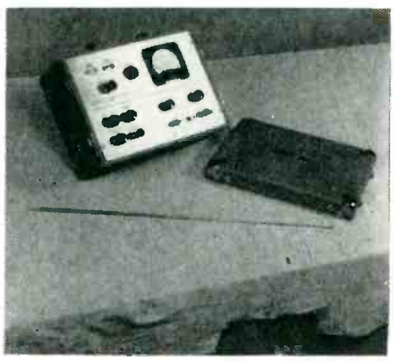
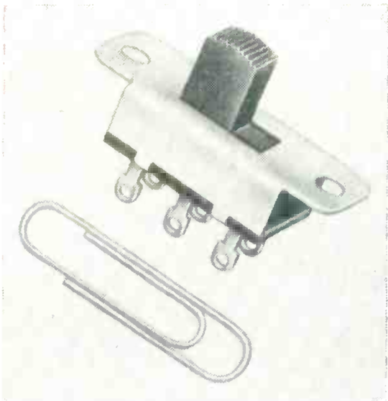
signed for precise circuit trimming in miniaturized equipment, the Trimpot simplifies circuit design. Accurate adjustments are made by turning the exposed slotted shaft with a screwdriver. Electrical settings are securely maintained during severe shock, vibration and acceleration. The Trimpot can be mounted individually or in stacked assemblies with two No. 2-56 screws through the eyelets in the body. Forty of the instruments occupy a space smaller than a standard pack of cigarettes. Resolution as low as 0.25 percent is obtained over the 25-turn adjustment range. Superior electrical characteristics are achieved through the use of precious metal contacts and precision wire-wound resistors. Trimpots are available in standard resistances of 250 to 10,000 ohms.



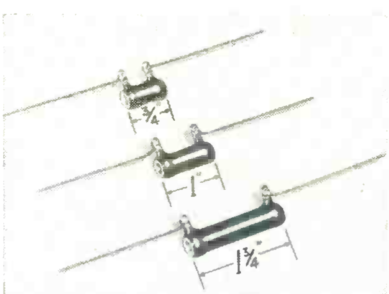
RADIO TESTER
for maintenance use

GENERAL ELECTRIC Co., Syracuse, N. Y. A new frequency and modulation meter for use in the maintenance of two-way radio systems has been announced. Its purpose is to help maintain transmitters and receivers in two-way radio systems on their assigned frequencies, as required by the FCC. The type ST-13-A meter measures modulation swing and carrier frequency of f-m transmitters, and features both high and low r-f output for receiver alignment. It is available with either one or two crystals, for servicing single or two-frequency systems in the low, medium and high bands. The unit may be had with or without a crystal oven, and with crystal tolerances ranging from 0.0005 to 0.0025 percent. The oven, available in two ratings (38 and 75 C), is powered from any external 6-v power supply.



TINY SLIDE SWITCH
has smooth snap action

STACKPOLE CARBON CO., St. Marys, Pa. An inexpensive, miniature dpdt slide switch rated 0.5 ampere at 125 v combines improved snap action with new small size for radios, tv receivers, instruments and similar equipment. It measures $1\frac{3}{8}$ in. long $\times$ $\frac{17}{32}$ in. wide $\times$ $\frac{11}{32}$ in. deep. The switch is available either with (type SS-50) or without (type SS-150) Underwriter's approval. Separate indenting for each pole assures exceptionally positive yet smooth snap action. A special fiber-surface laminated Bakelite base greatly reduces arc tracking and increases the safety factor.



COATED RESISTORS
designed for radio and tv

P. R. MALLORY & CO., INC., 3029 E. Washington St., Indianapolis, Ind., has announced a new line of enamel-coated power resistors designed specifically for the requirements of radio and tv applications. Unaffected by moisture, these resistors feature small size and low wattage. The core provides optimum electrical characteristics,

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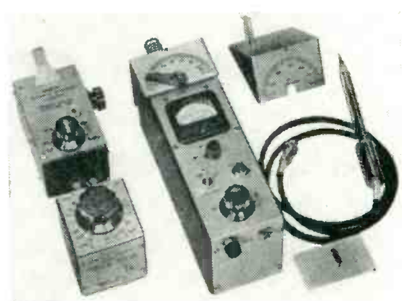
great physical strength and low coefficient of expansion. Wire of low temperature coefficient is used for the resistance element to assure stable resistance values over the entire operating range.

D-C POWER SUPPLY has variable output

ELECTRO PRODUCTS LABORATORIES, INC., 4501 N. Ravenswood Ave., Chicago 40, Ill. Model C-12 filtered d-c power supply provides adjustable d-c voltage (0 to 16), from an a-c source, for all current loads from 1 to 8 amperes continuous output, and operates with intermittent loads up to 12 amperes. Completely variable output makes it possible to test all equipment under practically any voltage input condition. A special filtered circuit reduces a-c hum or ripple to less than 3 percent at 8 amperes. Selenium rectifiers permit overloads far beyond the rated capacitance, in addition to providing cooler operation. The unit is equipped with fuse and terminal connecting clips.

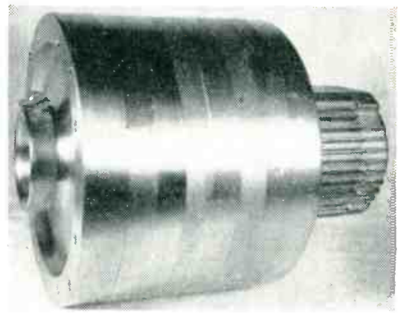


RESONANCE METER is dry battery operated

PREMIER MFG. CO., 409 S. W. 13th Ave., Portland 5, Oregon. A new resonance meter comes in a convenient carrying case that includes a basic resonance grid dip meter, impedance and inductance measuring units, r-f detector probe, and self-contained power. The resonance meter is dry battery operated and completely versatile for use in the field, laboratory or shop. Power drain is minimized to an hourly operating cost of less than 1½ cents. The impedance measuring accessory covers a range of 50 to 500 ohms and is a tuned circuit resistance substitution device that relies upon the r-f detector probe as its detector. The inductance measuring accessory is a variable capacitor calibrated in capacitance and inductance for rapid determination of unknown inductance values in a 0.01 to 100-μhenry range.

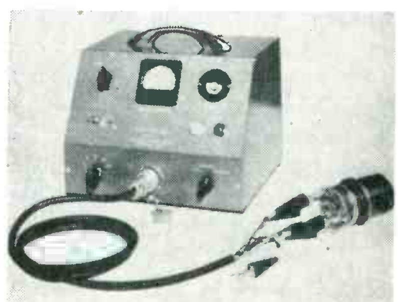
TWIN TETRODE
designed for uhf and vhf

AMPEREX ELECTRONIC CORP., 230 Dufly Ave., Hicksville, L. I., N. Y., has announced the 5894-A uhf and vhf twin tetrode. It is a smaller mechanically and electrically improved version of the AX-9903/-5844 tube. The new tube is designed for wide band operation as an r-f amplifier, modulator, frequency doubler or a tripler. Improved h-f performance is made possible because the cathode and grid structure is supported at the top as well as the bottom of the tube. Being thus held in exact vertical alignment with the plates, the two sections of the tube are in closer electrical balance. A new type of construction enables the tube to withstand greater shock and vibration. The anode seal strength has been increased by replacing the top section of the tube with a powdered glass seal.



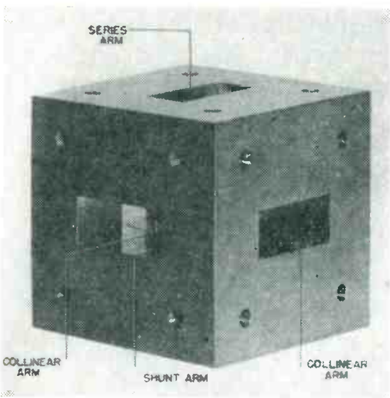
AXIAL-FLOW BLOWER builds high pressure

ROTRON MFG. CO., Schoonmaker Lane, Woodstock, N. Y., has introduced a small, lightweight, direct-driven, brushless, axial-flow blower (turbine) that will build pressures hitherto only obtainable with bulky or noisy equipment. It is expressly designed to be conveniently built into electronic and instrument cabinets, whenever high air pressures are required in combination with relatively low volumes. Units are available for 1, 2 and 3-phase operation, 50, 60 and 400 cps and variable frequency. They meet applicable government specifications for use in military equipment. Overall diameter is 7¼ in. and length varies with number of stages (static pressure) and type of power supply.



SYNCHRO NULL can detect 10 mv

ULTRASONIC CORP., 61 Rogers St., Cambridge 42, Mass. Model U-101 Synchro Null, designed for accurate zeroing of synchros of all types, was developed to meet the demands for a unit adaptable to 26-v 400-cps synchros, as well as 110-v 60-cps and 110-v 400-cps synchros of all standard types and sizes. A simple switching operation automatically selects proper test-circuit connections for each type of synchro, as well as the proper sequence of test circuits for the zeroing operation. This procedure eliminates the possibility of making improper connections, thereby eliminating costly errors in test results and assuring safety of personnel and equipment. High sensitivity in the null-indicating circuit permits the tuning eye to give the ultimate in zeroing accuracy. Ten millivolts, corresponding to about 0.6 minute of angular error, can be clearly and instantly detected.



HYBRID JUNCTION gives isolation of —50 db

GENERAL PRECISION LABORATORY, 63 Bedford Road, Pleasantville, N. Y., has available a precision X-band hybrid junction, using a new type of construction assuring isolation of —50 db or better, as well as low vswr over a broad frequency range. The unit is precision machined rather than brazed waveguide fabrication, permitting the holding of close mechanical tolerances with correspondingly improved performance factors. Stub and septum matching is employed to provide a nominal vswr of 1.05 at the design center, and 1.185 at the 10-percent band extremes, using any arm as input terminal. In addition to its function as a magic tee, it can be used as a highly accurate power divider in the configuration of a shunt or series tee, by blocking the appropriate arms. The component is suitable both as a laboratory standard and for sys-

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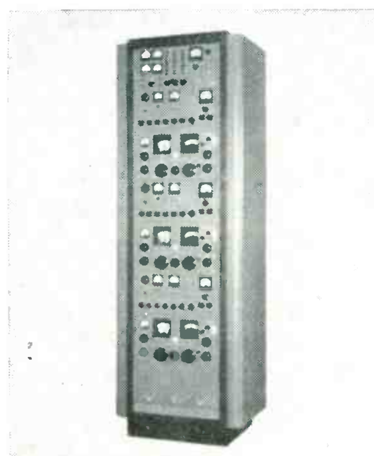
tems use where high isolation is important.

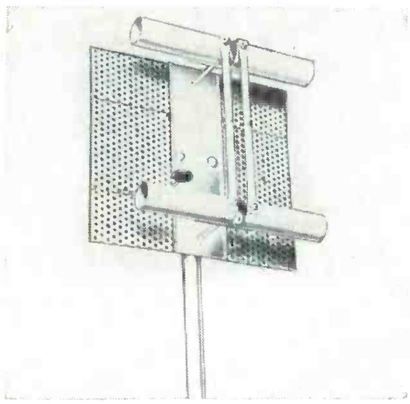
A-C MAGNET ASSEMBLY
does job in a few seconds

AUDIO DEVICES, INC., 444 Madison Ave., New York 22, N. Y., is now offering an a-c magnet assembly designed to permit the removal of residual permanent magnetism from the sound recording heads of magnetic tape recorders. Extended pole pieces of the demagnetizer fit the contours of all standard recording heads. The unit is furnished complete with cord and plug for connection to 110–115 v a-c outlet. Demagnetization can be done in a few seconds.



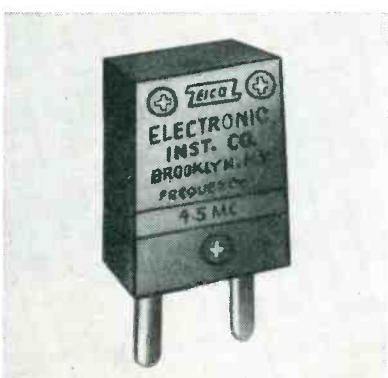
S-S RECEIVER
for high frequency

CROSBY LABORATORIES, INC., Box 233, Robbins Lane, Hicksville, N. Y. Model 155 triple-diversity single-sideband receiver provides the optimum in reception of all forms of modulation used in h-f (3 to 30 mc) communication. This includes reception of reduced carrier single-sideband transmission, and double-sideband transmission by exalted-carrier reception. It is available with either Hammarlund type SP600JX or Collins type 51J communication receivers in triple-diversity, dual-diversity or single receiver arrangements.



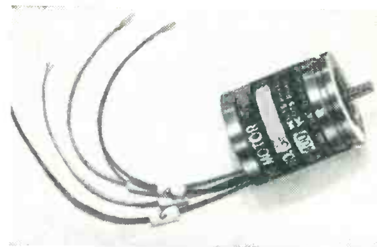
UHF ANTENNA
with uniform gain

CORNELL-DUBILIER ELECTRIC CORP., South Plainfield, N. J., has added to its antenna line the U-4 uhf antenna. Some of the features include: broad-band coverage with uniform gains over the entire uhf spectrum, uniform gain with low vertical radiation, uniform gain with low standing-wave ratio and 300-ohm internal impedance. These may be stacked, measuring 12×12×5 in.



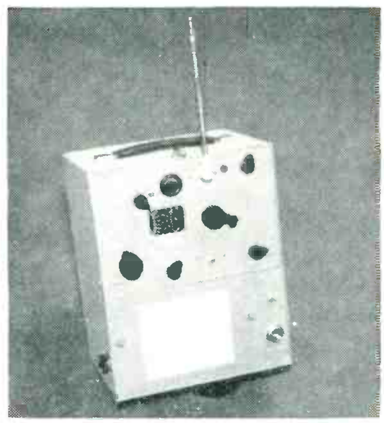
NEW CRYSTAL
for tv servicing

ELECTRONIC INSTRUMENT CO., INC., 84 Withers St., Brooklyn 11, N. Y., has released the new model C4.5, a 4.5-mc crystal designed to facilitate the alignment and servicing of tv sets having the new i-f frequencies. The crystal was intended for use with most f-m and tv oscillators, accommodates standard sockets and circuits, and gives excellent performance with the model 360 tv/f-m sweep generator.



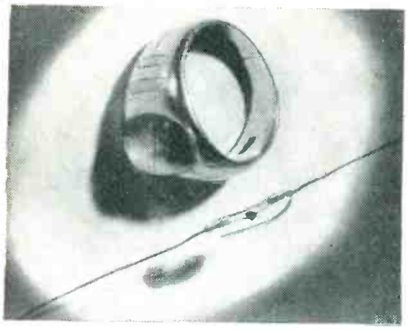
TINY SERVO MOTOR
for 60 to 400 cycle range

G-M LABORATORIES INC., 4300 N. Knox Ave., Chicago 41, Ill., has announced a new miniature precision servo motor approximately 1 in. in diameter and slightly over 1 in. in length. These motors are available for frequencies varying from 60 to 400 cycles, and in 2, 4 or 8-pole construction. Stall torque ranges from 0.25 to 0.35 oz in. The extreme precision required in the motors involves tolerances as small as ±0.0001.



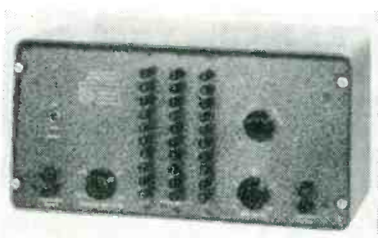
VHF METER
has 20 to 640-mc range

GERTSCH PRODUCTS, INC., 11846 Mississippi Ave., Los Angeles 25, Calif., has issued its new model FM-3 direct-reading vhf meter. Accuracy is ±0.001 percent; stability, ±0.001 percent; resettability, ±0.0005 percent; and range, 20 to 640 mc, though under certain conditions it may be used to 1,000 mc. The instrument is a harmonic device and uses the multiple oscillator method of frequency measurement. Weight with batteries is 32 lb. The meter is 11 in. wide, 9½ in. deep and 14 in. high. It may be used with batteries for portable use and has provision for attaching an external power supply for fixed station use.



THERMISTOR
has varied applications

VICTORY ENGINEERING CORP., Springfield Road, Union, N. J. Type 71A2 thermistor is sealed in a glass rod and has a temperature coefficient of −7.0 percent C at 0 deg C. Its resistance at 0 deg C is 60 megohms and drops to 3 megohms at 50C. This thermistor lends itself to several other applications, among them being to make the period of electronic R-C timing circuits independent of changes in ambient temperature.



OSCILLATOR
has 30 pushbutton switches

THE KROHN-HITE INSTRUMENT CO., 580 Massachusetts Ave., Cambridge, Mass., announces a new model 440-A pushbutton oscillator designed for applications requiring very low distortion or extremely good frequency stability and resetability. It provides both sine waves and square waves at any frequency between 0.01 cps and 100 kc. For fine control of frequency, three banks of ten pushbutton switches are provided. An additional vernier control varies the frequency continuously by an amount equal to the increment between adjacent buttons of the third switch bank. The instrument is

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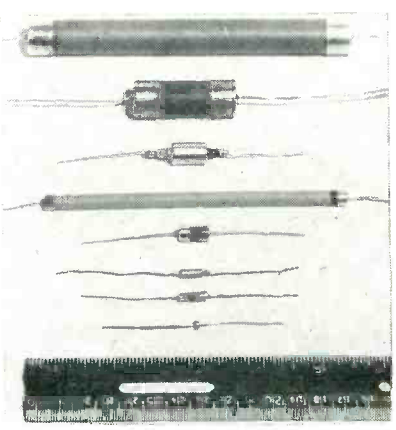
ideally suited for bridge measurements, tuned-filter alignment, rapid spot-frequency checks and distortion measurement.

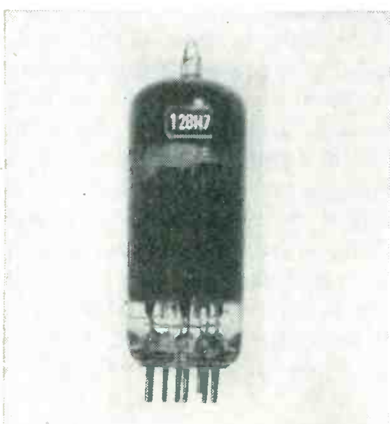
PENTODE AMPLIFIER
for use in computers

SYLVANIA ELECTRIC PRODUCTS INC., 1740 Broadway, New York 19, N. Y. Type 6145 sharp cutoff pentode amplifier is designed particularly for use in electronic computers. It is suitable for applications where long life under cutoff conditions, low supply voltage and high plate current at zero bias are required. It also provides the advantages of T-9 lock-in construction including: compactness, suitable shielding and secure socketing. The design of the tube also provides unusually low interelectrode capacitances.



SELENIUM RECTIFIERS
with varied circuit uses

GENERAL ELECTRIC CO., Schenectady 5, N. Y., has announced a new line of miniature selenium rectifiers ranging from $\frac{3}{32}$ to $\frac{15}{32}$ in. in diameter. Designed as nonexpendable components for industrial and government equipment, the miniature stacks operate small relays, solenoids and precipitators. Circuit applications include: electronic, blocking, computer, signal, magnetic amplifier, communication and control. The assemblies have an ambient temperature range of −55C to +100C. At an ambient temperature of 35C, the single-stack rating ranges from 0.5 ma d-c at 26 v rms to 25 ma d-c at 5,200 v rms. Higher ratings result from combining the stacks. The rectifiers are mounted without spacer washers, as there is no center mounting hole. Two totally enclosed types of castings are available: Textolite tubes for normal industrial operating conditions; and hermetically-sealed, metal-clad casings to meet government specifications.



VERTICAL AMPLIFIER consists of two triodes

SYLVANIA ELECTRIC PRODUCTS INC., Emporium, Pa., is now producing type 12BH7 miniature, high-perveance, double-triode, vertical deflection amplifier. The unit consists of two completely independent medium-mu triodes in a T-6½ envelope. One section may be used as the sawtooth generator while the other section serves as the vertical deflection amplifier. Both sections are designed to withstand the high pulse voltages normally encountered in vertical amplifier service. For certain applications where the plate-supply voltage must be kept low, parallel connection of the two sec-

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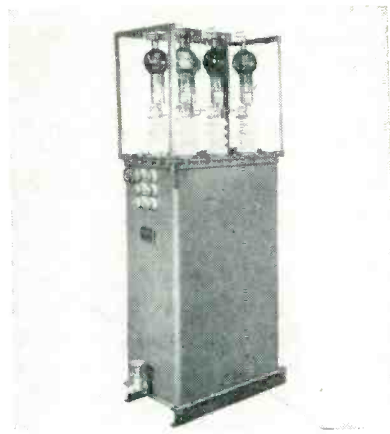
tions may be used. The tube is designed to operate from either 6.3 or 12.6 v.



UNITIZED RECTIFIER
contains h-v d-c source

MAGNATRAN INC., Kearny, N. J., offers a modern rectifier design incorporating a packaged h-v d-c source in its Unitized Rectifier. It features: lower installed cost; a unit ready to connect to a-c line and d-c load; components immersed in Askarel or oil that provide increased cooling and insulation; special winding and insulation arrangements to withstand impulse surges; vacuum filling that removes all moisture; independent bushings for plate and filament a-c source; and output voltages available to 50 kv d-c. Companion filter chokes are obtainable in suitable ranges.

LOCKNUT
has seating-type design

KLINCHER LOCKNUT CORP., 2153 Hillside Ave., Indianapolis, Ind., has available a seating-type locknut

that is re-usable many times over and made in stainless steel and other alloys. It can meet stringent applications on thermocouples, rectifiers, chassis bolt connections and terminal posts, as it takes in stride temperatures up to 1,600 F without thread seizure. The grooved washer at the bottom of the nut is pressed over the threaded section from the main body of the nut. The nut spins freely on the bolt down to the work. After the proper torque has been applied the washer compresses, causing the threaded section inside the washer to move in and lock radially on the bolt. When the threaded section inside the washer picks up all of the load it can carry, it elongates a few thousandths of an inch permitting the bulk of the load to move up into the main body of of the nut. This move evenly distributes the load on the nut and bolt.

D-C GENERATOR is small and lightweight

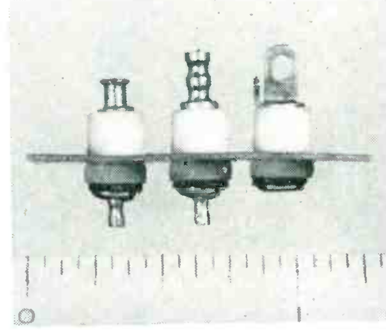
GLOBE INDUSTRIES, INC., 125 Sunrise Place, Dayton 7, Ohio. The generator illustrated is similar to the Moto-Mite, a permanent magnet motor. Design has been refined specifically for generator applications to provide units of high-voltage output per unit of speed. The generator is especially useful as a rate device in servo systems, since it represents an extremely small, lightweight package with sufficiently high output to provide good sensitivity. A specific unit can provide 0.7 v per 100 rpm with a starting torque of 0.15 oz-in., or can produce 1.7 v per 100 rpm with a start-

Want more information? Use post card on last page.

ing torque of 0.5 oz-in. All outputs are based on high-impedance loads (approximately 1,000 ohms per volt minimum) and must be correspondingly reduced if appreciable current is required. Most units can be loaded to 50 ma or higher, depending on the winding.

DOSIMETER CHARGER has 11-battery power supply

THE VICTOREEN INSTRUMENT CO., 5806 Hough Ave., Cleveland 3, Ohio. Model 561 dosimeter charger is designed to charge all makes of direct-reading pocket dosimeters to any voltage of 110 to 225 v. The charger features a single off-on-charge knob and a spring loaded charger socket to prevent damage to the dosimeter due to excessive pressure by the operator. Waterproof, the entire unit is 4 × 5 × 6 in. and weighs 3 lb. Power supply comprises ten 22½-v and one 1½-v batteries.



HERMETIC TERMINAL for operation at 500 v

LUNDEY ASSOCIATES, 694 Main St., Waltham 54, Mass., announces a

IMMEDIATE DELIVERY!

S190A

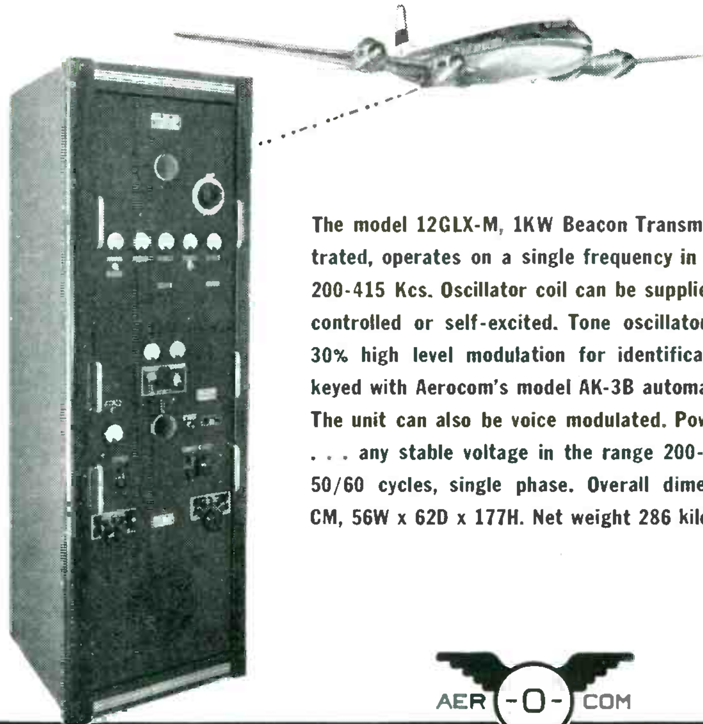
REGULATED OUTPUT AMPLIFIER

Holds output level constant despite 40 db input level variations

- Adjustable noise threshold
- 75 db gain
- Low distortion
- 25/50/250/600 Ohms input
- 600 Ohm output
- $295.00 FOB Washington, D. C.

SCHUTTIG and CO.
INCORPORATED
9th and Kearny St., N.E.
Washington 17, D. C.

AEROCOM MEANS TROUBLE-FREE SERVICE!
From Ground To Air or Point to Point



The model 12GLX-M, 1KW Beacon Transmitter illustrated, operates on a single frequency in the range 200-415 Kcs. Oscillator coil can be supplied crystal-controlled or self-excited. Tone oscillator provides 30% high level modulation for identification when keyed with Aerocom's model AK-3B automatic keyer. The unit can also be voice modulated. Power supply . . . any stable voltage in the range 200-240 volts, 50/60 cycles, single phase. Overall dimensions in CM, 56W x 62D x 177H. Net weight 286 kilos.

AER-O-COM

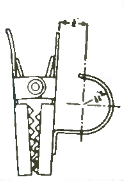
3090 DOUGLAS ROAD MIAMI 33, FLA.

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

Voltage Limiter problems?

NOW IN PRODUCTION

Three types of limiters—each made in strict accordance with customer's and "MIL" specifications. All limiters are manufactured under controlled laboratory conditions; over 50 intermediate inspections.

WE ALSO PRODUCE

Electrical and electronic assemblies, special relays, solenoids, hermetically sealed assemblies, rectifiers, terminal and junction boxes and boards, automatic controls. All work performed in complete compliance with customer's standards.

OUR CONTRACT SERVICE OFFERS REASONABLE PRICES — PROMPT DELIVERY — A FAULTLESS PRODUCT.

FOR A QUOTATION send us your prints, specifications and delivery requirements. Our reply will be prompt.

Manufacturers of Wassco GLO-MELT Resistance Soldering Equipment

WASSERLEIN MANUFACTURING CO., INC.
126 W. Cass St. • Joliet, Illinois

Want more information? Use post card on last page.

new group of miniature, hermetic terminals. The series 199 terminals utilize the superior properties of Teflon and silicone rubber for improved performance and simplified construction. The new design avoids the need of expensive secondary operations such as specially extruded holes for mounting. The terminals are mounted in drilled or punched holes with a minimum center distance of 15/64 in., still providing ample wiring space after assembly. They are designed for operation at a conservative rating of 500 v, with a test voltage of 1,500 v rms. Current rating is 8 amperes. For oil-filled units the inner insulator is of neoprene instead of silicone. These terminals are available in three electrode styles: hollow electrode with eyelet for minimum internal clearance, solid electrode with single turret and solid electrode with double turret.

WWV RECEIVER has high sensitivity

SPECIFIC PRODUCTS, 5864 Hollywood Blvd., Hollywood 28, Calif. For general laboratory use, model WWVR makes it possible to refer instruments to standard WWV transmissions at any time without special setup. It features three plug-in front ends that permit instantaneous switching to optimum frequency for reception of standard r-f transmissions; a highly selective audio system that can be switched in for noise-free presentation of standard audio frequencies; three individual inputs for tuned antennas, one common input for broad-band antenna use (either balanced 300-ohm or unbalanced 72-ohm input may be used); four tuned circuits at signal frequency; and sensitivity better than 1 μv on all frequencies. Completely self-

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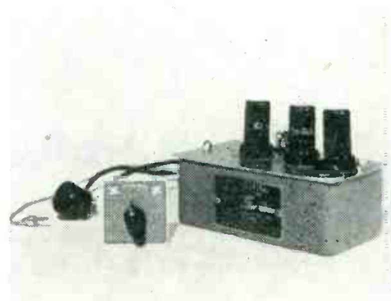
contained, the receiver is mounted on a standard $5\frac{1}{4}$-in. relay rack panel.

D-C POWER SUPPLIES
maintain constant current

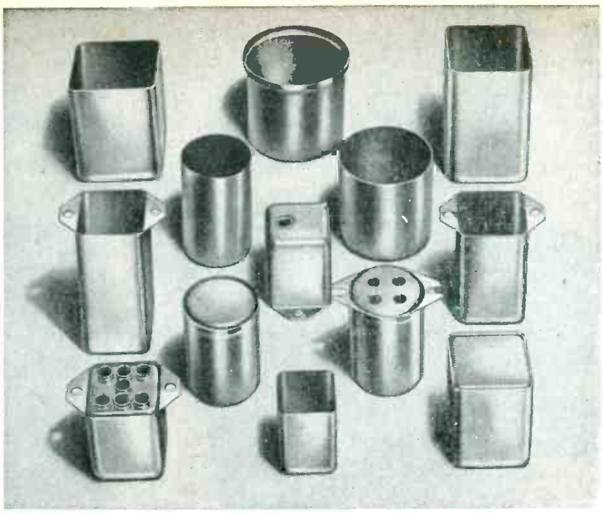
ASSOCIATED SPECIALTIES CO., 1751 Main St., Orefield, Pa., has available new d-c power supplies that will maintain the current in a load constant as the load impedance changes or the line voltage varies. One model may be set at from 0.2 to 55 ma d-c; another covers 0.2 to 100 ma. Separate models are available for 1 percent and 0.1-percent accuracy. The unit is well suited for calibration of current indicating instruments, operation of nonlinear devices and current bucking circuits.



NOISE SUPPRESSOR
attenuates rumble

HERMON HOSMER SCOTT, INC., 385 Putnam Ave., Cambridge 39, Mass. The improved 111-B Dynaural noise suppressor features redesigned dynamic noise suppression circuits, providing improved operation with l-p records and extended bass-response loudspeaker systems. The effectiveness of l-f rumble suppression has also been increased very substantially. The unit is designed to be used with the company's type 214-A remote control

drawn cases

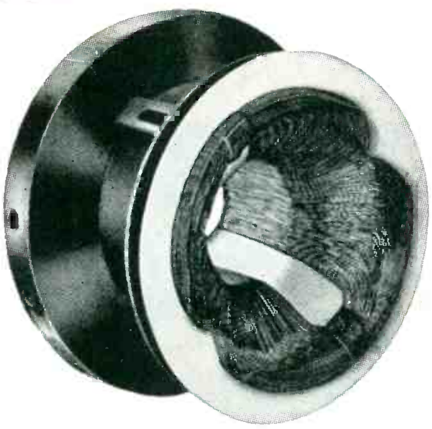


hot tin dipped . . . fabricated terminal and vent holes . . . smooth, one-piece construction using cold rolled steel . . . draw depths up to 2½" . . . **inside fit covers for easy hermetic sealing in all sizes** . . . available as stock sizes and as special fabrications.

OLYMPIC METAL PRODUCTS COMPANY, INC.
P. O. BOX 71A **PHILLIPSBURG, N. J.**

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.

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.

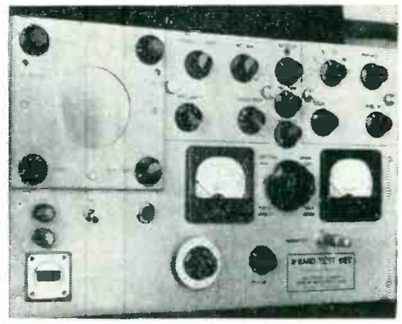
Catalog and samples sent by return mail.

The BIRTCHER CORPORATION
4371 Valley Blvd.
Los Angeles 32, Calif.

Please send catalog and samples by *return mail.*

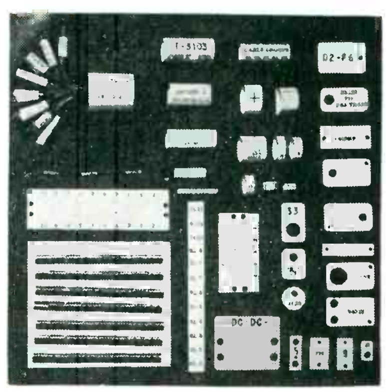
Company________ E-5-3
Attention of:________
Address________
City________ State________

amplifier, but it also may be used readily with many amplifiers of other manufacture.



X-BAND TEST SET
switches waveguides

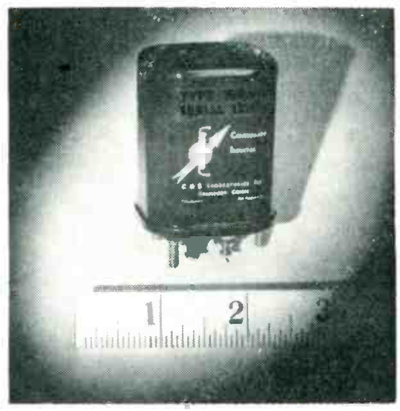
CENTURY METALCRAFT CORP., 14806 Oxnard St., Van Nuys, Calif., has developed the model 109 X-band test set that is capable of meeting all engineering requirements for a complete radar test facility and also has sufficient versatility to perform a variety of test functions on other equipment operating in a frequency range from 8,500 to 10,000 mc. The instrument combines the functions of a signal generator, spectrum analyzer, power monitor and wavemeter in a single package, by a unique combination of waveguide switching and sharing of functions. In spite of its multiplicity of uses, the unit is small enough and light enough to be used as a field test instrument, and is also valuable in a laboratory.



WIRE MARKERS
have split-sleeve design

ACTIONCRAFT PRODUCTS, 8 Sagamore Hill Drive, Port Washington, N. Y. Permatag wire and cable markers

consist of a split sleeve that can be applied to a wire or cable by opening the split with the fingers or an applicator tool. After the marker has been applied to the wire or cable, it snaps on and grips tightly. For severe working conditions the split sleeve can be welded into a solid sleeve by application of a special sealing liquid. They are made of Vinylite plastic with a clear overlay to protect the lettering. The markers are resistant to abrasion, water, oil, gasoline and alcohol and most acids, and are vermin proof and fungus proof as well. They are made in sizes from 0.040-in. diameter up to 3-in. diameter. Flat markers and apparatus name plates are available in any size, shape or thickness, punched with any number of holes of any shape.



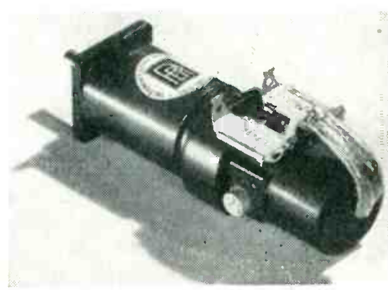
R-F INDUCTOR
reduces bandwidth variations

C. G. S. LABORATORIES, INC., 391 Ludlow St., Stamford, Conn. The 65BA1 Increductor controllable inductor is suitable for wide-range frequency shift or inductance variation between approximately 1 and 2.5-mc starting frequency, at zero control current. This type is especially suitable for frequency sweep in single inductor oscillator circuits. At least a 7-to-1 variation of frequency is obtainable. The upper frequency limit with maximum control current is approximately 30 mc. The unit has a maximum inductance of 30 μh at zero control current, which can be reduced to at least 1/50th of this value by the application of 40 ma control current. Its rising Q characteristic

versus frequency obtained in tuned circuits tends to reduce bandwidth variations.

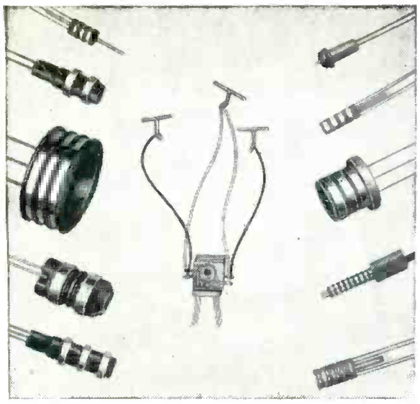
D-C POWER SUPPLY
is precisely controlled

ASSOCIATED ENGINEERING CORP. OF BOSTON, 38 Euston Road, Brighton 35, Mass., has developed a precisely controlled d-c power supply as a source of power for precision electronic equipment and circuits used in computers, calibrating systems, tv broadcast stations, electron microscopes and in specialized laboratory installations. Over the entire video spectrum—from d-c up to the very high radio frequencies—the internal impedance is less than 0.01 ohm. An output voltage of 300 v and a load change of 500 ma will cause a drop in output voltage of less than 5 mv.



P-M MOTOR
for 6 to 110 v d-c

THE PIONEER ELECTRIC AND RESEARCH CORP., Forest Park, Ill. An adaptation of molded PM-1023-M permanent magnet motor by mounting a gear reducer head is featured in a new assembly design recently developed and built for use in a military equipment application. The use of an r-f filter is optional. This same assembly can be equipped with a slipclutch mechanism. The p-m motor features a magnetic structure cast into an aluminum housing



Miniature and Sub-Miniature

SLIP RING ASSEMBLIES
BRUSH BLOCK ASSEMBLIES
COMMUTATORS

and other
Electro-Mechanical Components

PRECISION MADE
TO YOUR OWN SPECIFICATIONS

Precision molded products with exacting tolerances in precious and non-precious solid metals of all alloys. All types of Thermo-Plastic and Thermo-Setting materials.

Slip Ring Assemblies fabricated or one-piece precision molded to your specifications in Nylon, Kel-F, Mineral filled Mellamine, Phenolic, and other materials. Rings and leads spot welded or brazed together for positive electrical circuit.

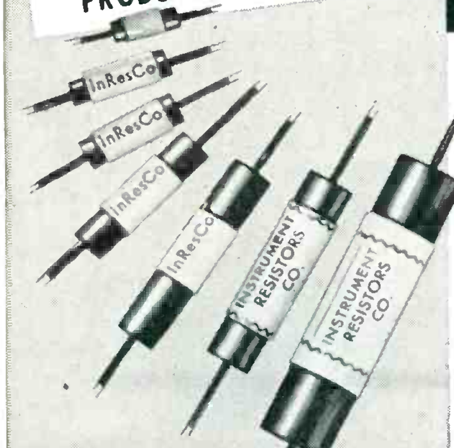
Our Swiss methods and techniques are geared to meet exacting requirements. We invite your inquiries.

COLLECTRON CORPORATION

MUrray Hill 2-8473 • 216 East 45th Street • New York 17, N. Y.

SPACE SAVERS FOR MODERN CIRCUITRY — MONEY SAVERS FOR PRODUCTION ECONOMICS —

IN-RES-CO TYPE IR
WIRE WOUND
RESISTORS



The practical, low cost solution for circuit designers striving for the sub-miniature. Type IR units offer precision resistance values capable of retaining stability through long periods of continuous or intermittent service. Type IR resistors are available at prices based on mass production methods of manufacture. Wound to a tolerance of ±1%, they are permanently accurate. Conservative ratings allow ample safety margin in all classes of service. Special Bakelite forms eliminate shrinking, swelling and temperature effects. IN-RES-CO moisture and fungus proof coating offers absolute protection against climatic extremes. Specify IR Type resistors for all applications where precision performance and limited space are important determining factors.

WRITE FOR NEW RESISTOR HANDBOOK — Contains complete data and recommended applications for resistors for every purpose.

INSTRUMENT RESISTORS CO.

COMMERCE AVENUE (IN RES CO) UNION NEW JERSEY

APPLICATION-DESIGNED RESISTORS FOR ELECTRONICS AND INSTRUMENTATION

A. E. C. GENERATOR insulated by BIGGEST MYKROY Moldings ever made

NOW IT CAN BE TOLD!

The Atomic Energy Commission chose MYKROY *above all other materials* as insulator for its generator. The 4-ft. diameter of the rings was only one of many reasons.

CHECK THESE FEATURES

- can be machined or molded to closest tolerances
- lightweight—with the mechanical strength of cast-iron
- high dielectric and flashover properties
- won't warp; keeps its shape
- low-loss factor at sub-zero or 1000° F.
- bonds with most metals

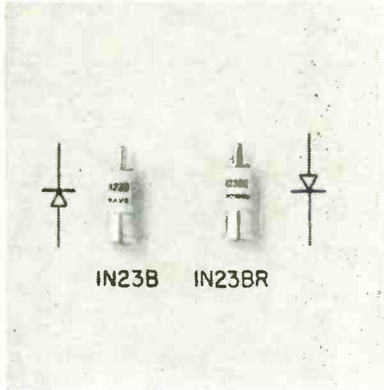
Surely, MYKROY, the perfect glass bonded mica, can solve your insulating problems. Supplied in sheets and rods . . . machined or molded to specifications. We'll be glad to quote on your requirements. Write today for MYKROY Brochure #203. Made exclusively by

ELECTRONIC MECHANICS INC.

101 CLIFTON BOULEVARD, CLIFTON, NEW JERSEY

MYKROY, INC., WHEELING, ILL.

that is totally enclosed. Built to high standards to conform to military specifications, it is available for operating voltages of 6 to 110 v d-c.



MATCHED DIODES for low-noise circuits

MICROWAVE ASSOCIATES, INC., 22 Cummington St., Boston 15, Mass., has available matched pairs of silicon diodes with one unit of reversed polarity. This product, the 1N23-BMR, has been developed to meet the requirement for low-noise circuits. The general use of matched crystals of the same polarity in a balanced mixer greatly reduces the noise contribution of the local oscillator. The use of matched pair with one unit of reversed polarity greatly simplifies both the mechanical and electrical design requirements of the mixer and i-f input circuit.

RECORDER AMPLIFIER is small and lightweight

GOODYEAR AIRCRAFT CORP., Akron 16, Ohio, has developed the model R3 recorder amplifier, a lightweight, portable unit designed

Try HELIX

BONDING AGENT R-313

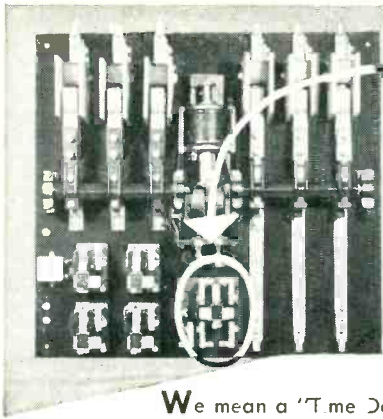
- A thermosetting adhesive that cures at room temperature and needs no pressure. High electrical insulating properties.
- Gives a bonding strength of 3000 psi between metal parts.
- Non-porous — gives high pressure seals between metal and glass, plastics, etc.
- Unaffected by acids, alkalies, fuel and lubricating oils.
- Reduces manufacturing costs by eliminating bolts, screws, rivets.

Write for Literature to Dept. 51

A better product for better production

CARL H. BIGGS COMPANY
2255 Barry Avenue
W. Los Angeles 64, Calif.

NOTE this added Feature* of ASCO Transfer Switches



*TIME DELAY
for ignoring Momentary Outages
Essential for More and More Installations

No. 1 of a series, spot-lighting features to look for in adequate Automatic Transfer Switches.

We mean a "Time Delay" feature, factory set for tripping at any point between 1 and 3 seconds which permits the transfer switch to ignore normal source outages caused by transient conditions. This results in smooth handling of the connected load and reduced wear on the starting mechanisms incorporated in automatically started standby units or plants.

We'll be glad to send details of this Time Delay feature; also the story of ASCO Service to Industry on this particular phase of Electromagnetic Controls which is given in a new booklet, "Automatic Transfer Switches", now on the press.

We also manufacture a complete line of "Solenoid Operated Valves" for automatic and remote control of liquids and gases. To thousands of satisfied users, "ASCO" and "Solenoid Valves" are synonymous.

S53.1a

ASCO Electro-Magnetic CONTROLS

Automatic Switch Co.
385-L LAKESIDE AVENUE · ORANGE, NEW JERSEY

---

4 CHANNEL CARRIER TELEPHONE TERMINALS CFD-B

and Pilot Regulated CARRIER REPEATERS (for use in conjunction with the CFD-B Terminals on long haul circuits.)

COMPLETELY AUTOMATIC PILOT REGULATION OVER A 20 db RANGE. Built-in "SLOPE CONTROL" includes an extra 10 db equalization for non-conforming telephone pairs.

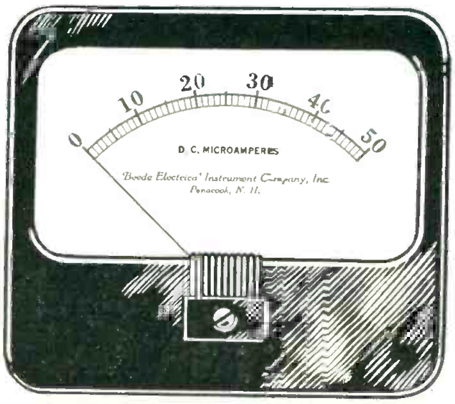
RYCOM'S CFD-B is assembled from Western Electric component parts, and is mounted COMPLETE with ringing, terminating and power supply equipment in ONE STANDARD AAR 8-FOOT RACK. Standard commercial performance is guaranteed. • Basic line equalization of 15 db by manual controls. • The range of operation is through a maximum of 30 db over an operating range of 3 to 32.3 kilocycles. • Two-way pilot-regulated repeaters are available for circuits having more than the allowable 30 db loss. • 1000/20-Cycle Voice Frequency Ringers are available for one-, two-, three-, or four-channel ringing. A FULL LINE OF ACCESSORIES is offered, including: • Voice Frequency Repeater Balancing Nets, • Cable Matching Transformers, • Universal Way Station Filters, and • Mounted Sub-cycle Ringing Power Supplies.

RYCOM'S CFD-B provides FOUR DUPLEX VOICE CHANNELS AND RINGERS at a LOWER COST to you than most three-channel carriers now on the market! And WE CAN MAKE IMMEDIATE DELIVERY!

RAILWAY COMMUNICATIONS INCORPORATED
FLEMING 2121 • RAYTOWN, MISSOURI • FLEMING 2122

ORIGINAL BEEDE ELECTRIC METERS

Accurate to the Dot



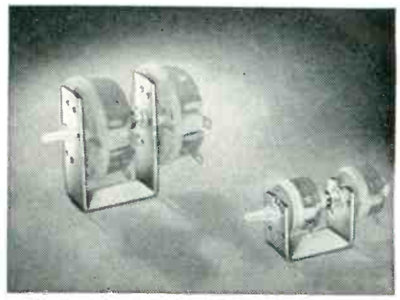
ALL WAYS DEPENDABLE
•
ACCURATE
•
EASY TO READ

CATALOG OR INFORMATION ON REQUEST

BEEDE ELECTRICAL INSTRUMENT CO., INC.
PENACOOK, N. H.

— FOUNDED BY —— WALTER E. BEEDE —— 1880 — 1947 —

especially to plot the solutions to small problems where use of a large recorder would be impractical. It can also be used with other electronic equipment. The R3 works with standard direct-inking or hot-wire recording galvanometers. Accuracy is limited only by the nonlinearities of the galvanometers. Typical units are guaranteed to be within 2 to 5 percent. The R3 records two channels of information within a frequency range essentially flat from d-c to 100 cycles. The amplifier unit supplies its own power and has its own voltage regulator. Amplifier channels have an input impedance of 2.5 megohms on the 0.01 to 0.1 volt-per-millimeter range and greater than 10 megohms on all other ranges.



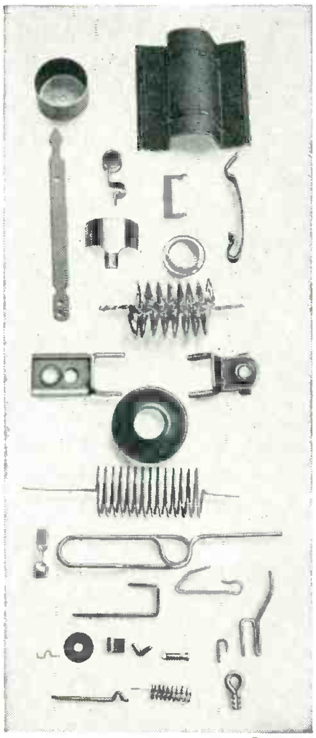
RHEOSTAT KITS
with assembly instructions

OHMITE MFG. CO., Chicago, Ill. Two new rheostat coupling kits are now available. Each kit consists of a steel U frame, mica washer, coupling, Allen wrench and assembly instructions. The large frame is designed for use with model G, K or L rheostats. The small frame is designed for use with model H or J rheostats.

GOLD BONDED DIODES
feature long life

TRANSITRON ELECTRONIC CORP., 407 Main St., Melrose, Mass., announces its new line of gold bonded germanium diodes that feature back resistance greater than a megohm at 100 v inverse, as well as high forward conductance. Designed for extreme ruggedness and reliability,

Priced Right! WIRE FORMS & *Metal Stampings*



High-speed, quality production with custom-made precision. Wire formed to any shape for every need.

IMMEDIATE CAPACITY FOR DEFENSE SUB-CONTRACTS

STRAIGHTENING & CUTTING
Perfect straight lengths to 12 ft.
.0015 to .125 diameter

WIRE FORMS
.0015 to .125 diameter

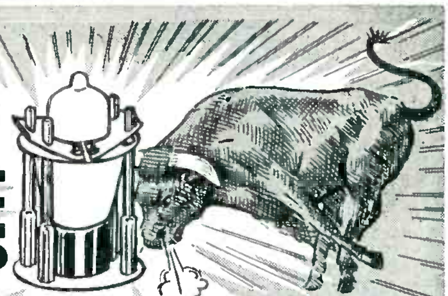
SMALL METAL STAMPINGS
.0025 to .035 thickness
.062 to 3 inches wide

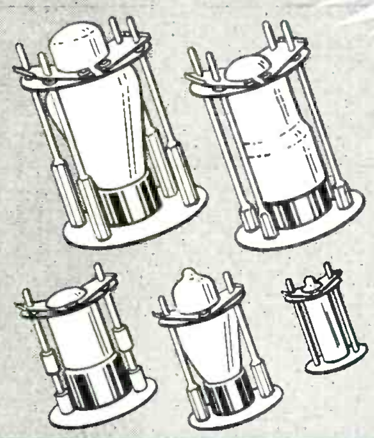
Specializing in Production of Parts for Electronic, Cathode Ray Tubes & Transistors

Write for illustrated folder.
Send Blueprints or Samples for Estimate.

ART WIRE and STAMPING COMPANY
1 BOYDEN PLACE
NEWARK 2, N. J.

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, T122DI, ST14, S14, ST16, T5½, T6½, MT-IC, ST19, T14, ST128CT-9.

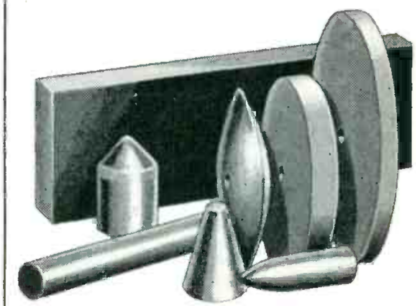
Manufacturers of Electronic Components

JAMES IPPOLITO & CO., INC.
401 CONCORD AVENUE, BRONX 54, N. Y.

Reduce Labor Costs — Speed Production with CRATEX

The World's Finest RUBBERIZED ABRASIVES

"cushioned action performance"



There are over 160 standard sizes and shapes of Cratex Rubberized Abrasives available to meet your needs in

BURRING, SMOOTHING and POLISHING operations

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they are mechanically interchangeable with clip-in types. Long life under adverse conditions is insured by careful quality control of processing, inert humidity-protective filling, and basic stability of the gold bonded junction. These diodes are also available in standard grades.

Literature

Oscillograph Recording Systems. Sanborn Co., Cambridge 39, Mass. A recent single-page bulletin describes the new "150" series oscillograph recording systems (4-, 2- and 1-channel). The versatile recorders discussed feature an a-c/d-c preamplifier, a carrier preamplifier, a servo monitor preamplifier, a log-audio preamplifier, a d-c converter and a coupling preamplifier.

High-Fidelity Recording. Minnesota Mining and Mfg. Co., 900 Fauquier St., St. Paul 6, Minn., has announced a new 4-color, 16-page, illustrated booklet entitled "A new Horizon in High Fidelity Recording." The booklet tells the story of Scotch brand high-output magnetic tape No. 120. Included are the major advantages of the tape—more than double the output of conventional magnetic tape, no increase in distortion, dry lubrication and higher-signal-to-noise ratio. It explains the significance of these advantages in terms of the requirements of the recording and broadcast engineer, as well as the high fidelity enthusiast. Bias requirements and frequency response characteristics are discussed and illustrated in a series of six graphs.

Bimetal Thermostats. Stevens Mfg. Co., Inc., 69 South Walnut St., Mansfield, Ohio, announces an illustrated bulletin on type C bimetal strip thermostats. Hermetically sealed and standard types are described along with suggested applications. Printed in two colors and punched for in-

sertion in standard 3-ring binders, the bulletin describes the operating principle and illustrates it with schematic diagrams. Ratings, typical performance curve, dimensions, construction and various terminal arrangements are shown in diagrams, tabular data and photographs.

Electron Tube Notes. Lewis and Kaufman, Ltd., 50 El Rancho Ave., Los Gatos Ave., Calif. A summary of data-sheet rating interpretations and a series of notes concerning means of improving electron-tube service life are included in a new leaflet, form 153, covering Los Gatos electron tubes. The publication also includes a field-engineering location map.

Aircraft Test Instrument. Collins Radio Co., Cedar Rapids, Iowa. A 2-page bulletin deals with the 479T-2 signal generator, a portable test instrument designed for ramp testing of aircraft navigation, localizer and glide slope receivers. The unit described and illustrated in the bulletin provides singly or in combination all the modulated r-f signals required for preflight functional checks of the receiving equipment and associated instruments. Technical specifications are given.

House Organ. The Helipot Corp., 916 Meridan Ave., South Pasadena, Calif. The first issue of "The Helinews" inaugurates a periodical to be devoted to bringing the reader current developments in precision potentiometers, concise information on potentiometer usage and applications, and news of the company's facilities for giving prompt service to users of their products.

Wiring and Assembly Procedures. American Phenolic Corp., 1830 S. 54th Ave., Chicago 50, Ill. Manual C3 is a new and greatly expanded version of "OK Methods." The book is an instruction and service manual for the wiring and assembly of electrical connectors and components. It represents a composite of better methods used in many aviation, radio and electronic plants, tested by company engineers and verified in the company's own cable

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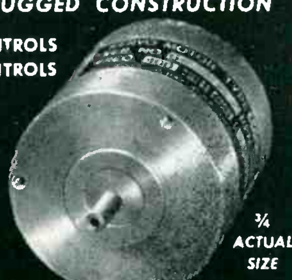

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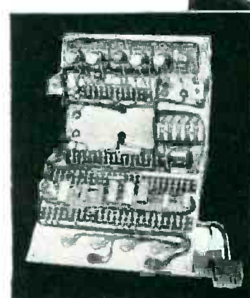

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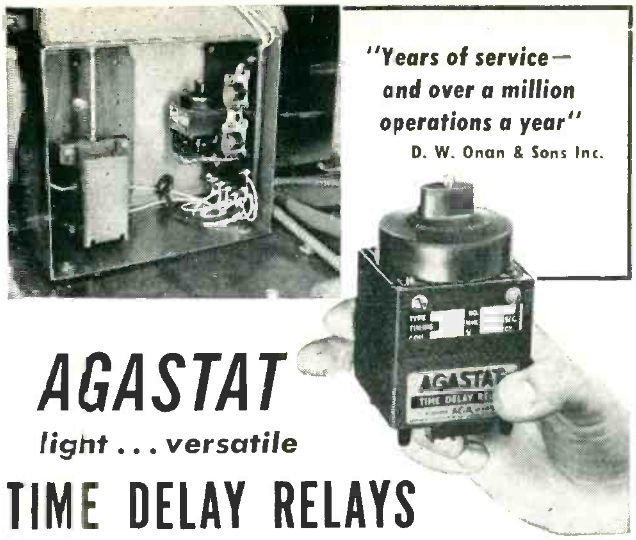
assembly division. The procedures recommended herein conform to government specifications wherever such regulations apply.

Galvanometers. Trans-Sonics, Inc., Bedford Airport, Bedford, Mass., has issued a technical bulletin that is intended to provide helpful information on the selection and proper use of galvanometers. The section dealing with circuits and calculation of damping resistance is common to the application of any galvanometer. The table listing specific galvanometers which can be used with Trans-Sonics pickups without amplification of pickup output also applies to other transducers of similar sensitivity.

Product Catalog. Viking Electric, 1061 Ingraham St., Los Angeles 17, Calif., has just published a loose-leaf catalog giving engineering specifications and templates of its miniature connectors, terminal boards, thermocouple connectors and printed circuit hardware. Copies are available for the asking.

Cans and Covers. Heldor Mfg. Corp., 225 Belleville Ave., Bloomfield, N. J., has published a new, comprehensive catalog incorporating full technical descriptions and dimensional drawings of its complete line of MIL-T-27 and standard cans and covers. The 12-page catalog also features data on hermetic seal bushing assemblies. A special section is devoted to brackets, channels and end bells. Attention is focused on the company's complete assembly sealing service.

Paper-Backed Electrical Tapes. Minnesota Mining and Mfg. Co., 900 Fauquier St., St. Paul, Minn., has announced an 8-page booklet describing in picture-story style applications of seven Scotch brand paper-backed electrical tapes in electric motor, coil and transformer construction. The booklet shows how purified crepe and flat-paper tapes can be used to insulate motor field coils, to anchor lead wires and to insulate coil windings from the core. It also shows how purified paper tapes with thermosetting adhesives can be used where higher temperatures are incurred. Physical and electrical properties of all



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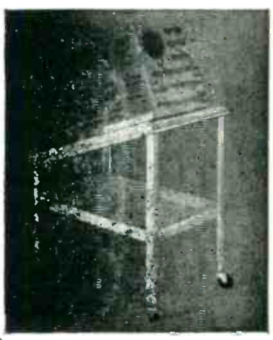

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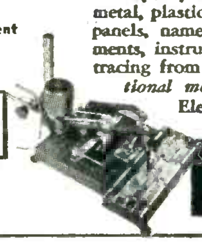

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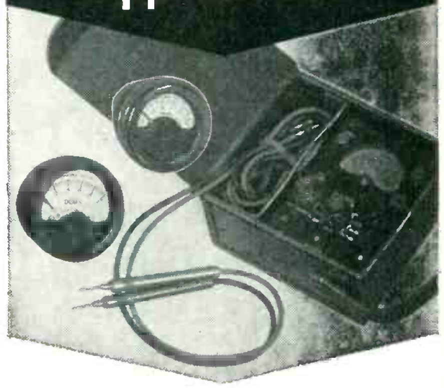

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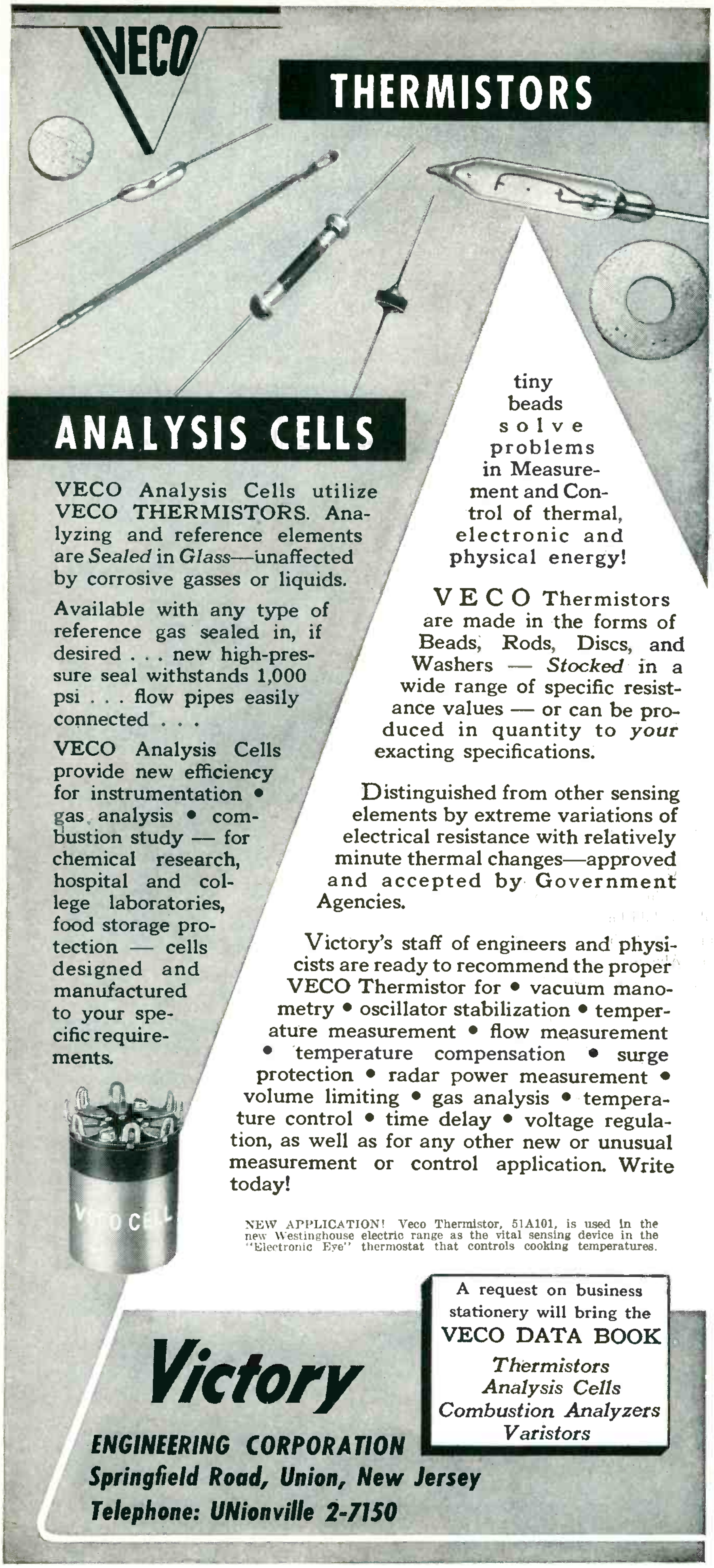

the tapes, together with the electrolytic corrosion factors of each, are listed.

Railroad's System-Wide Telephone. Automatic Electric Sales Corp., 1033 W. Van Buren St., Chicago 7, Ill. Application of a railroad-owned long-distance telephone network in the administration and operation of the Louisville & Nashville Railroad is presented in an illustrated 12-page case history published by the manufacturer of P-A-X business telephone systems. Specific use, advantages and economies provided by this direct telephone communication are discussed in detail, and general specifications of telephone equipment are listed and illustrated.

R-F Fittings. General R-F Fittings Co., 702 Beacon St., Boston 15, Mass. A 4-page folder illustrates a line of 20 r-f components that are produced to industrial and armed services specifications. Also listed and illustrated are the company's standard r-f fittings as they are shown in the armed services index.

Rocket Tube. Sylvania Electric Products Inc., 1740 Broadway, New York 19, N. Y. A single-page mailing piece describes and illustrates the type 2C37 rocket tubes that supplies 450 mw at 3,300 mc. Because of their high power throughout the uhf spectrum, the rocket tubes discussed are especially recommended for service as pulsed oscillators, c-w oscillators, r-f amplifiers and frequency multipliers.

X-Ray Spectrometry. North American Philips Co., Inc., 750 South Fulton Ave., Mt. Vernon, N. Y. A 4-page folder contains a technical article from a trade publication. Illustrated with drawings and photos, data are presented that explain the use of x-ray diffraction and x-ray spectrometry in handling difficult laboratory and production line tasks. Information is also presented on the basic principles of operation for both types of instruments. A diagram shows the arrangement and geometry underlying the basic design.

Sheet Metal Products. The Middletown Mfg. Co., 27 Stack St., Middletown, Conn., has available catalog 53 describing a greatly expanded

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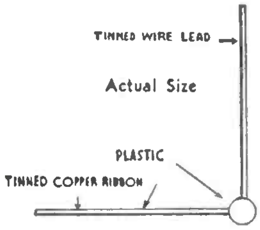

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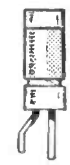

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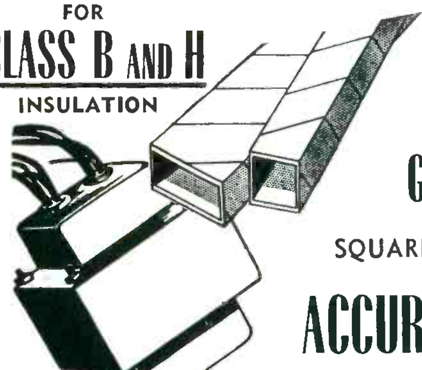

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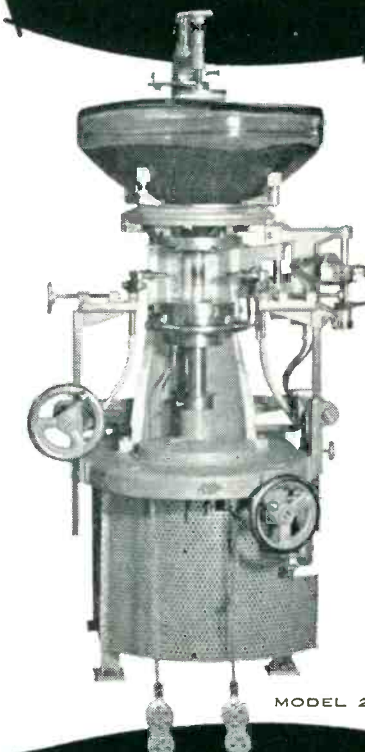

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Insulation Handbook. Johns-Manville, Box 60, New York 16, N. Y. Booklet EL-40A contains 32 pages covering the properties and advantages of Quinterra (the pyrolysis-resistant dielectric) and Quinorgo (a high-temperature insulation for use alone or in composites) in full detail with test data. Its clear construction drawings, plus case studies of leading apparatus manufacturers, show how to apply these insulations for maximum benefit. Also described are Quinterrabord and Quinorgobord, two new base materials for fabrication into electrical insulation.

Sealing For Air, Gases & Liquids. Franklin C. Wolfe Co., Inc., 3644 Eastham Dr., Culver City, Calif., has completed, for general distribution, a new brochure briefly describing its standard products and services for sealing, bolts, studs, rivets, AN fittings, access doors, hatch covers, flanges and electric terminals.

Silicone Rubber. General Electric Co., Chemical Div., Pittsfield, Mass. The properties and processing of silicone rubber as an insulating material for wire and cable are set forth in bulletin CDS-13. A reprint of an article written by a company engineer, it includes a full description of the processing of silicone rubber and a wealth of property data illustrated with charts and tables. A section on applications deals in detail with the use of the heat and flame-resistant material for Navy and ignition cable.

Solder Bulletin. Anchor Metal Co., 244 Boerum St., Brooklyn 6, N. Y. Bulletin 52-A covers the company's regular solder products, which include Shurflo rosin core solder, solid wire solder, bar solders, ribbon and preforms. Solders described are available in all standard

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alloys for radio, electrical, electronic, radar and similar application.

Psychoacoustic Equipment. Grason-Stadler Co., 106-A Hampshire St., Cambridge 39, Mass. A single-page bulletin covers a line of psychoacoustic instruments that include measuring, stimulating and timing equipment. Fifteen instruments are designated by name, model number and a short description in tabular form.

Rectangular Picture Tubes. Hytron Radio & Electronics Co., Danvers, Mass. Bulletin E-201 contains four pages of engineering data on the type 21YP4, a 21-in. rectangular picture tube of all-glass construction, and with a face plate of spherical shape. Other features of the tube described are: low-voltage electrostatic focus, single iontrap gun design, external coating and filter-glass face plate. Included in the data sheets are mechanical and electrical data, terminal connections and dimensional diagrams. Bulletin E-202, also containing four pages of engineering data, gives the same kind of information on the 21ZP4A that features magnetic focusing.

Railroad Radio. Westinghouse Electric Corp., Box 2099, Pittsburgh 30, Pa. The new heavy-duty railroad radio equipment (type FE) is described in the 8-page booklet B-5787-A. The booklet describes features of the equipment that enable it to readily fulfill the five basic needs of railroad radio communication: (1) end to end; (2) train to train; (3) wayside to train; (4) dispatcher to any wayside or train; and (5) bridging wire-line breaks in an emergency. The electrical and mechanical description of the equipment includes ratings, dimensions, weights and power requirements.

Photoelectric Recorder Applications. General Electric Co., Schenectady 5, N. Y., has announced a two-color bulletin on photoelectric recorder applications. The fully illustrated 12-page publication, GEA-5536, describes applications of the recorder with seismology, psychology, textile, metals, fatigue and research testing equipment, as

an aid in the quick detection of pipeline corrosion, and in development and machinability testing, medical research, light-intensity study and paper-machine-speed measuring. A listing of the recorder's typical rating is included.

Shielding Rooms. Shielding, Inc., Riverside Park, N. J. An 8-page folder describes and illustrates the Multi-Cell shielding rooms for r-f interference suppression. Included are typical applications, designs available, construction details, attenuation characteristics, information on the measurement of shielding effectiveness and detail features and advantages of the double-shield, multiple-cell type of construction.

Preset Counters. Berkeley Scientific Division of Beckman Instruments Inc., 2200 Wright Ave., Richmond, Calif. A single-sheet loose-leaf bulletin illustrates and describes the series 5420 preset counters that consist of an input circuit, an electronic gate, cascaded presettable decimal counting units and output circuitry. A table of specifications gives model number; capacitance; input frequency, sensitivity and impedance; output information; power requirements; front panel and overall dimensions; and prices.

Relays. Sterling Engineering Co., Laconia, N. H. Catalog No. 53 is a 24-page two-color brochure that presents in line drawing and general specifications a line of electrical relays and associated electronic components. Included are ordering information, an illustrated description of various types, general specifications and typical operating data.

Microwave Instruments. Douglas Microwave Co., Inc., 338 E. 95th St., New York 28, N. Y., presents its complete line of precision microwave test equipment and component parts in a 4-page folder. The instruments herein described embody the latest design improvements and, where possible, are designed for broadband applications. All conducting surfaces of the units covered are silver plated and rhodium flashed to insure permanent

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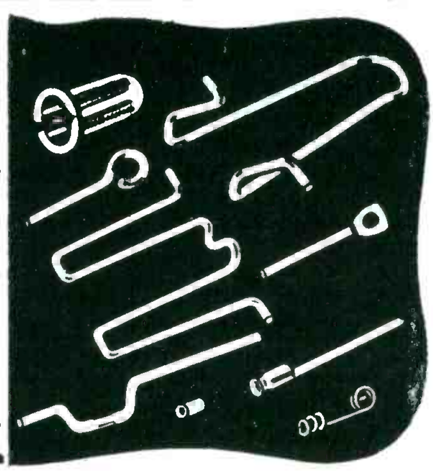

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high conductivity. Detailed specifications concerning the catalog items listed are available.

Audio Equipment. Audio & Video Products Corp., 730 Fifth Ave., New York 19, N. Y., has released a new 4-page illustrated catalog with detailed specifications and prices on the complete line of Ampex recording equipment and audio accessories handled by the company. Included is the new playback that allows up to 8 hours continuous play with automatic reversal. The catalog also announces pre-recorded music-on-tape for use with these machines.

Electronic Controls in Business. Worner Electronic Devices, Rankin, Ill. In a new booklet the use of electronic controls in business is described in easy-to-understand language. It illustrates and simplifies understanding of electric-eye supervision of automatic production operations, packaging, sorting, inspecting, rejection, lighting, safety and property protection. Ask for "How to Use Fotoelectric Systems in Your Business."

Dewpoint Measuring Equipment. General Electric Co., Schenectady 5, N. Y. A new 8-page two-color bulletin on dewpoint measuring equipment for continuous accurate indication and recording of dewpoint temperature in a gas stream has been announced. The booklet (GEC-588A) contains photographs and diagrams of the dewpoint indicator and recorder; gives applications, descriptions and operation principles; and provides a chart showing the relation between dewpoint and moisture content of gases.

Deflection-Circuit Components. Radio Corp. of America, Harrison, N. J. Form No. CTV-1016 is a 16-page booklet that supplies technical information on deflection-circuit components for the type 6198 Vidicon—the new small camera tube for industrial tv applications. Used in the recommended circuits shown in the booklet, these components feature characteristics that provide good sweep linearity, high deflection sensitivity, efficient coupling between circuits, proper focusing and accurate alignment of the electron beam.

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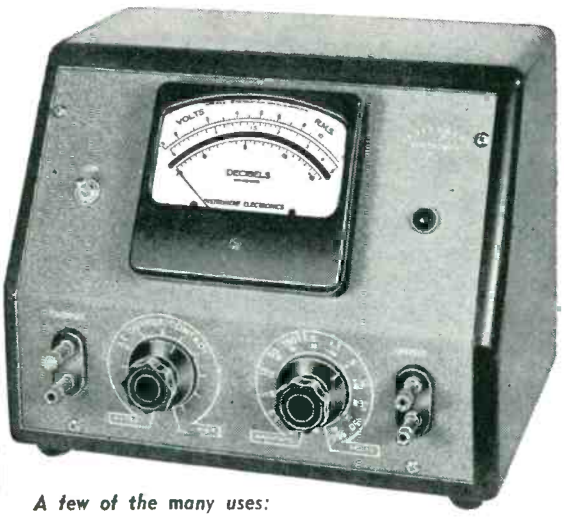

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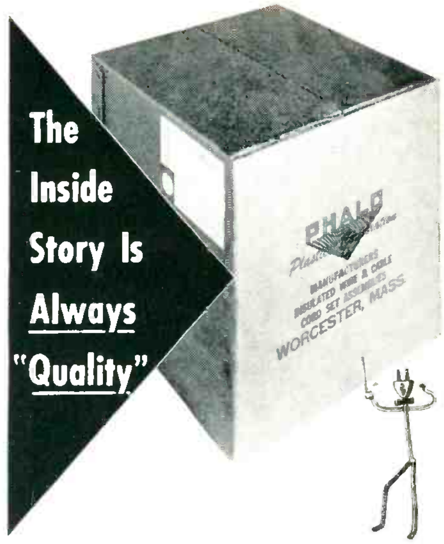

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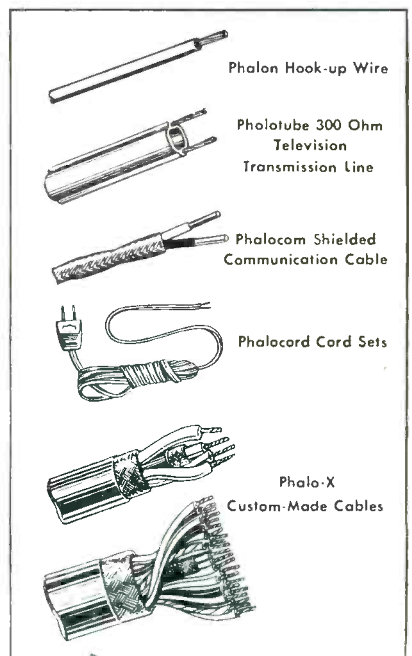

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PLANTS AND PEOPLE

Edited by WILLIAM G. ARNOLD

DuMont Completes Expansion Plans

OPENING of a new plant for the manufacture of cathode-ray instruments for industrial and defense use is planned in March by Allen B. DuMont Laboratories, Inc. The Instrument Division plant, located in Clifton, N. J., adjoins DuMont's cathode-ray tube manufacturing plant and the company's main offices.

In the new plant, the division will be provided with 75,750 sq ft of production and office space equipped with many modern facilities for production and development of cathode-ray instruments. The plant has a total area of 118,000 sq ft. The remaining 43,000 sq ft will allow for future expansion. Meanwhile it will be used for storage and shipping by several of the company's divisions.

The move of the division to its new quarters will make possible a major expansion of the Television Transmitter Division of the company, which has shared its facilities with the Instrument Division. The resulting space will allow transmitter production facilities to be doubled and it will permit the division to increase and speed up its production of both uhf and vhf television transmitters and associated equipment and take care of the increased demand for high-power amplifiers for tv stations.

Present production of new DuMont television transmitter equipment is at a record level, according to Stanley F. Patten, vice-president. Shipments of transmitters in 1952 increased 200 percent over 1951. New sales of equipment rose accordingly. With the increased facilities, the division expects to expand its production at the same rate during 1953.

BROADCAST ENGINEERS KEEP UP ON AUDIO

New audio laboratory excites interest of broadcasters attending RCA Victor's 15th technical television training course. Milton Hutt explains latest professional tape recording equipment to group of visiting engineers including (left to right) R. Morris Pierce, WDOK, Cleveland, Ohio; Jack C. Greenfield, Naval Photographic Center, Anacostia, D. C.; George Levin, Signal Corps Pictorial Center, Long Island, N. Y.; Harold J. Kratzert, WJTN, Jamestown, N. Y.; George Hooper, WIBG, Philadelphia, Pa.; and Welton M. Roy and John Carroll, both of WHBQ, Memphis, Tenn.

OTHER DEPARTMENTS featured for this issue:

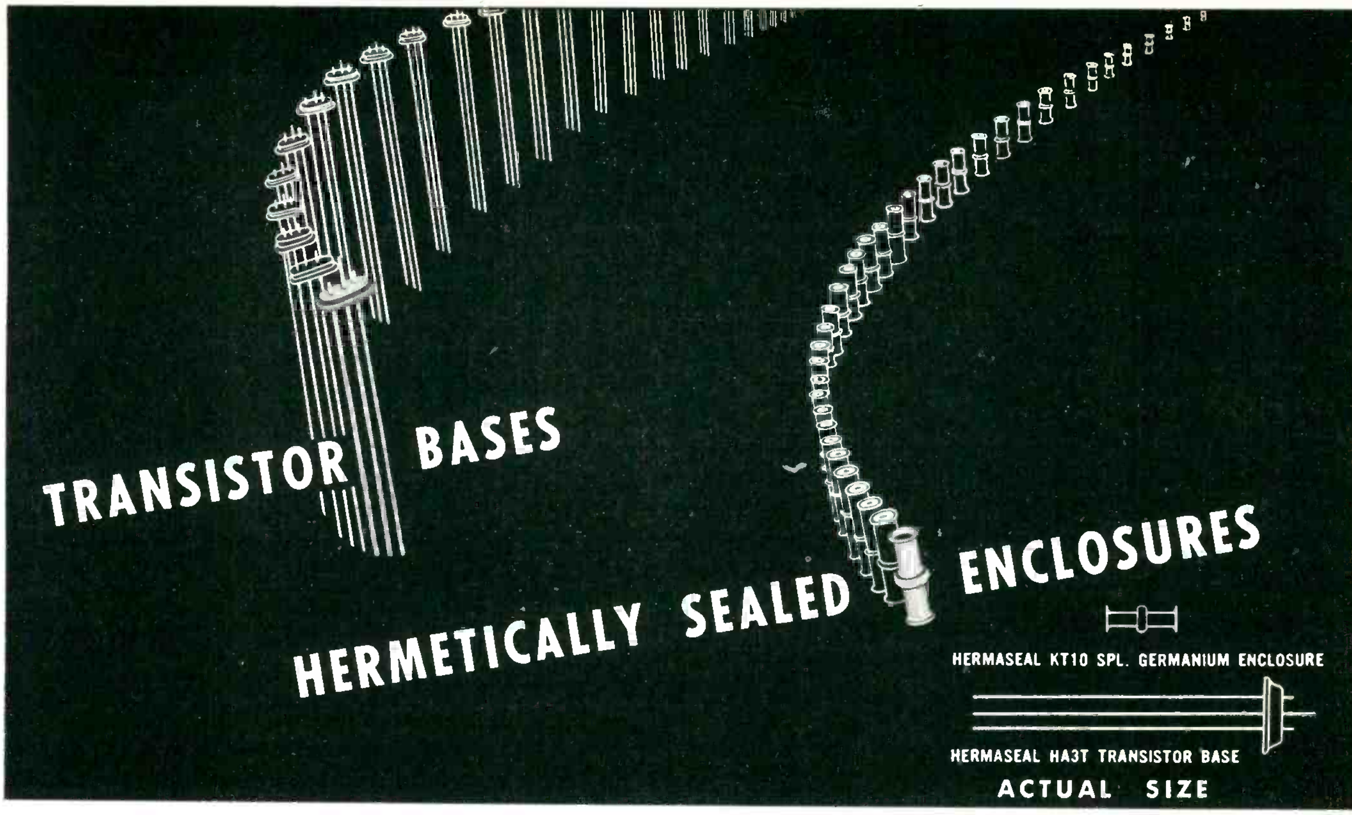
Bendix Names Hyland To Top Engineering Post

Lawrence A. Hyland

ELECTION of Lawrence A. Hyland, who discovered the principle of radar detection of aircraft, as vice-president in charge of engineering of Bendix Aviation Corp. was announced by Malcolm P. Ferguson, president.

Mr. Hyland, who has been in charge of Bendix research with headquarters in Detroit, will have over-all supervision of the company's $50-million-a-year engineering program carried forward by an engineering department of approximately 6,000. He founded the Radio Research Co., which became affiliated with Bendix in 1935. In 1937 he became general manager of radio operations for Bendix, and has been a vice-president since 1949.

In 1950 Mr. Hyland received the



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Navy's highest civilian honor, the Distinguished Public Service Award, for his "great service to science and to the welfare of the U. S. through his early contribution to the development of radar." During experiments for the Naval Research Laboratory in 1931, he observed and proved that radio waves can be used to locate aircraft in flight.

The new Bendix engineering chief is credited with more than 40 inventions, including the radio-shielded spark plug which, by clearing up interference, made possible modern aircraft communications. He also developed the Navy radio wing loop direction finder.

Magnavox Names Sanders Chief TV Engineer

JOHN A. RANKIN, director of engineering of the Magnavox Company, announces the appointment of Robert W. Sanders as chief television engineer. Mr. Sanders was formerly general manager of the television division of the D. J. Roesch Company, manufacturer of Douglas Remote Control Television. Prior to that, he was chief television engineer of the Hoffman Radio Corp.

Frank R. Norton, formerly chief engineer of radar and television for Magnavox, is now chief radar engineer.

Robert W. Sanders

Graham Appointed Head Of ASA Electronics

APPOINTMENT of Virgil M. Graham, director of technical relations, Sylvania Electric Products, Inc., as chairman of the communications and electronic division of the electrical standards board of the American Standards Association was recently announced. Because of this position, Mr. Graham becomes also vice-chairman of the electrical standards board, the group responsible for the administration of the standardization work of the ASA in the electrical and electronics fields.

In his position as chairman of the communications and electronics division, Mr. Graham will assist in the standardization work of ASA in the fields of television, radio and allied industries. He also serves as technical advisor on electron tubes to the U.S. National Committee of the International Electrotechnical Commission (IEC).

Virgil M. Graham

Mr. Graham is active in promoting increased standardization in the electron tube industry throughout the world. In 1952 he was a member of the United States delegation to the annual meeting of the IEC in Scheveningen, Holland.

Mr. Graham is associate director of the engineering department of the RTMA and chairman of the Joint Electron Tube Engineering Council.

Leon Podolsky

Sprague Appoints Technical Assistant

LEON PODOLSKY has been appointed to the newly created post of technical assistant to the president at Sprague Electric Co., it was announced by Julian K. Sprague, president. Mr. Podolsky was formerly manager of field engineering.

Among his responsibilities in this new post will be that of consultant on field engineering problems, supervision of the Sprague carrier-current development program, and representation of the company in national trade association and international standards work.

Carroll G. Killen succeeds Mr. Podolsky as manager of field engineering. In this position, Mr. Killen's duties include the training, supervision and direction of all company field engineers.

Emerson Expansion Plans Move Ahead

GROUND breaking ceremonies marking the start of construction of a new building, expanding the Jersey City manufacturing plant of Emerson Radio and Phonograph Corp. were attended by the mayor of the city and Benjamin Abrams, president of the company.

The new 3-story structure will add 100,000 sq ft to the 470,000 sq ft of the present three buildings comprising Emerson's Jersey City manufacturing plant. Construction

of the new building is expected to be completed September 1st.

Mr. Abrams advised that the company's program for expanded manufacturing and administrative facilities will permit an increase of employment of 2,000 additional factory and office personnel, bringing Emerson's employment to a total of 5,000 in the near future. The increase in manufacturing space and manpower is being made to expedite the manufacturing program for defense electronic equipment for the government.

The company has also acquired the building at 524 West 23rd St., New York City. When redesign work is completed this 140,000-sq-ft building will contain all administrative divisions, as well as the engineering division and research and development laboratories, now located in the Port of New York Authority Building in New York City. The space at the Port building will be utilized to expand manufacturing facilities for government electronic defense equipment.

Auto-Lite Builds Electronics Plant

ELECTRIC AUTO-LITE Company's new $2 million plant in Toledo for which ground was broken in March will produce an electronic product for the armed forces, according to reports. The plant will employ up to 1,000 persons and will contain 225,000 sq ft of floor area.

Maedel Elected President Of RCA Institutes

ELECTION of George F. Maedel as president of RCA Institutes, Inc., was announced by Brig. General David Sarnoff, chairman of the board of RCA. Mr. Maedel, vice-president and general superintendent of RCA's technical school since 1948, succeeds Major General George L. Van Deusen, (USA, Ret.) who retired on March 1. General Van Deusen, Commandant of the Eastern Signal Corps Training Center during World War II, served as head of the Institutes since October, 1947.

Mr. Maedel joined RCA Institutes in 1933 as the first instructor of

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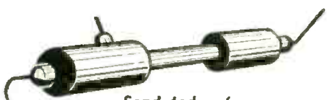

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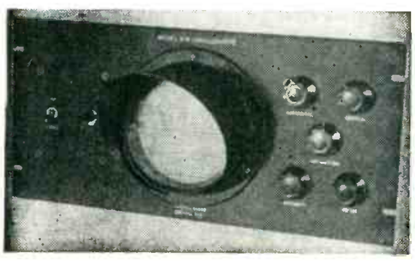

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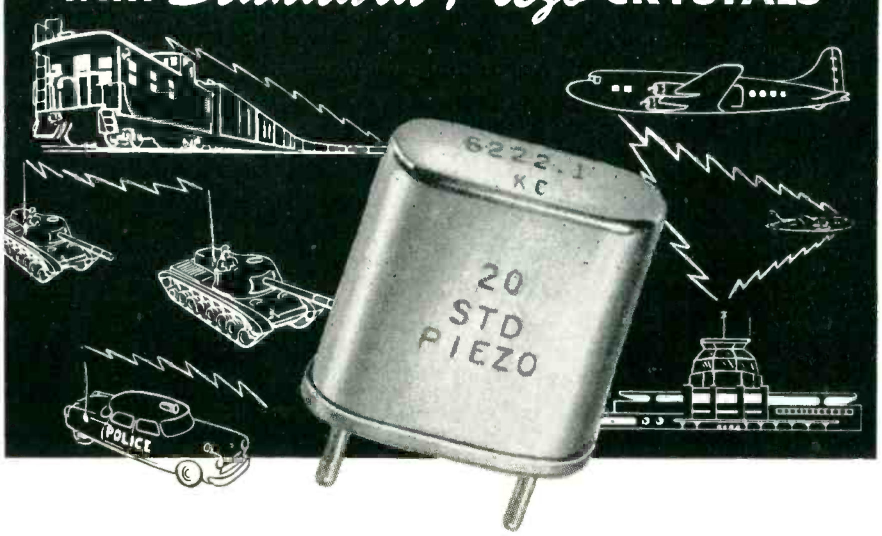

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the mathematics department. He was transferred to the radio-frequency department in 1936 and four years later was appointed chief instructor. In 1944, Mr. Maedel became assistant superintendent and in 1947 was appointed superintendent. During the following year, he was elected vice-president and general superintendent.

Du Mont Promotes Three Engineers

ROBERT T. CAVANAGH, Kenneth A. Hoagland and Eric Pohle were recently advanced by Allen B. Du Mont Laboratories, Inc.

Robert T. Cavanagh

Mr. Cavanagh was appointed to the position of assistant director of research. The promotion follows a leave of absence of 18 months from the Research Division, during which time he served as chief engineer of the Receiver Division. He joined Du Mont as a research engineer in 1947.

Mr. Hoagland has been named chief engineer of the Cathode-Ray Tube Division of DuMont. He was formerly assistant engineering manager of the Tube Division and succeeds Alfred Y. Bentley, recently named chief engineer of DuMont's Television Receiver Division. Mr. Hoagland, with DuMont for 12 years, is credited with developing the DuMont bent gun used in cathode-ray tubes and the DuMont selfocus picture tube. For the past eight years, he has been directing DuMont's design and development engineers in producing many of the DuMont developments in the tube field.

Eric Pohle has been named as-

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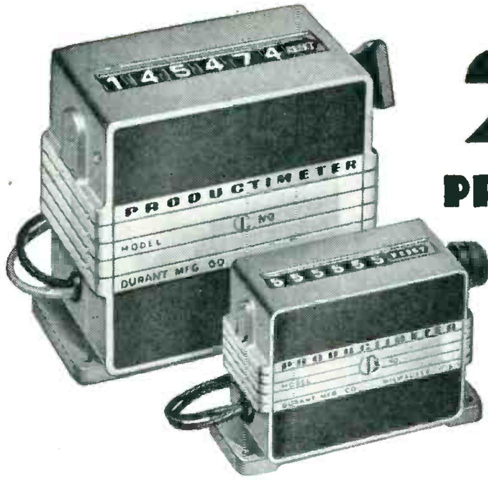

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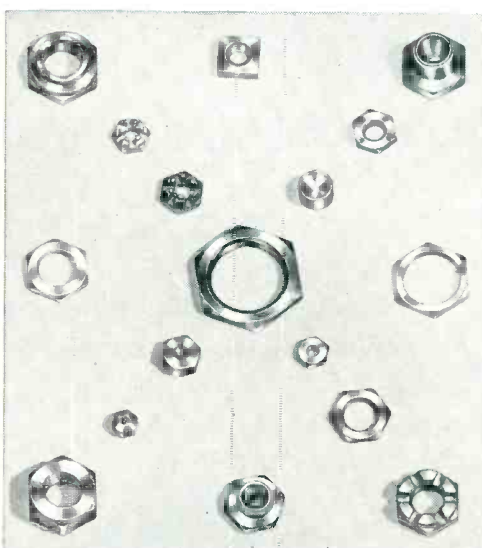

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Kenneth A. Hoagland

sistant engineering manager of the Cathode-Ray Tube Division of DuMont. Mr. Pohle, who has been with DuMont since 1941, was head of the division's product engineering section. In his new post he will supervise and direct product engineering operations of the model shops.

RCA Buys Continental Can Plant in Ohio

THE RCA Victor Division of RCA announced the acquisition of the Cambridge, Ohio plant of the Continental Can Co. for the manufacture of fabricated parts for phonographs and for the assembly of record changers. The plant facilities formerly were used for the manufacture of plastic materials.

The work of equipping the plant for its new activities will begin immediately. It is expected that it will be in production by July 1, according to Henry G. Baker, vice-president in charge of the RCA Victor Home Instrument Department, which will operate the plant. Between 300 and 400 men and women are expected to be employed there. The new plant provides about 135,000 sq ft of floor space on a 12½-acre tract of land.

Schulz Advances at Armour Research

THE PROMOTION of Elmer H. Schulz to act as the director of research at Armour Research Foundation of

Illinois Institute of Technology was announced by Haldon A. Leedy, director.

Dr. Schulz, who is 39, will direct the research and development activities of more than 850 scientists and engineers at the foundation. His former post was manager of the physics and electrical engineering division. In 1951 he was president of the National Electronics Conference and in 1948 was chairman of the Chicago section of the IRE. Currently, he is vice-president of the Chicago Radio Engineers Club.

GE Plans West Coast Tube Warehouse

GENERAL ELECTRIC'S Tube Department announced plans for a new electronic tube warehouse in Los Angeles to meet what was termed a major expansion of the far west electronics market.

The 25,000-sq-ft building will be built to GE specifications and occupied by GE under a long-term lease.

Motorola Appoints Angus MacDonald

DANIEL E. NOBLE, vice-president in charge of the communications and electronics division of Motorola, Inc., has announced the appointment of Angus A. MacDonald to the position of assistant chief engineer

Angus A. MacDonald

in charge of two-way radio development.

In this position, Mr. MacDonald

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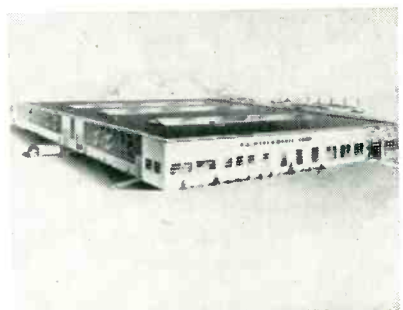
heads a group of design engineers in the development of mobile two-way radio equipment for use in the public safety, land transportation, industrial and related fields. This equipment is designed to operate in the 25-50, 152-174 and 450-470 megacycle bands.

Mr. MacDonald has also been appointed to serve on the committee on land mobile services of RTMA. Other Motorola engineers appointed to RTMA committees are Fred Hilton, manager of Motorola's transmitter development section to serve on the RTMA transmitter subcommittee, and James Clark, manager of the receiver development section to the receiver subcommittee of the RTMA.

U. S. Wire & Cable Moves Into New Plant

THE U. S. WIRE & CABLE CORP. has moved into a new, modern plant in Union, N. J., A. J. Sequeria, president of the firm announced recently. The firm was formerly located in Newark, N. J. The plant with



U. S. Wire & Cable plant

glass brick exterior will permit the firm to triple its production. Mr. Sequeria stated that the firm would continue its heavy schedule of production for the government and expand its commercial wire output to better serve the trade.

Westinghouse Makes Two Appointments

VERNE G. RYDBERG, a veteran of 31 years service with Westinghouse, has been appointed assistant manager of application engineering of the Electronic Tube Division. In his new position, Mr. Rydberg will assist in directing application engineering developments and pre-

paring tube application bulletins. Mr. Rydberg is presently chairman of the electronics section of NEMA.

Joseph Schlig, formerly manager of advertising and sales promotion of the division, has been appointed assistant to Harold G. Cheney, division sales manager. His new functions will include special assignments in the development of the division's current and future sales plans, as well as continued supervision of advertising and sales promotion.

Freed-Eisemann Makes New Moves

HERBERT C. GUTERMAN now heads the executive committee of the board of directors of Freed Electronics and Controls Corp., according to Arthur Freed, president.

Herbert C. Guterman

Mr. Guterman is best known for his role in the merging of American Bosch Corp. with its subsidiary, Arma Corp. He was a director and the president of Arma at the time, and after the merger became a Bosch director and a member of its executive committee.

Earlier the company changed its corporate name from Freed Radio Corp. to Freed Electronics and Controls Corp. Company operations were said to have widened materially, with major emphasis on precision instruments and controls.

Short Joins Clevite

WILLIAM P. SHORT has been appointed director of piezoelectric and sonic products development at

William P. Short

Clevite-Brush Development Co., according to A. L. W. Williams, president. Mr. Short was vice-president in charge of operations for Pleasantville Instrument Corp., a subsidiary of General Precision Laboratories, Inc.

Mr. Short has specialized in the fields of radio, radar and tv. During World War II he received the Presidential Certificate of Merit for work done at MIT Radiation Laboratory.

Burroughs Adds an Instrument Division

AN Electronics Instruments Division has been established in Philadelphia, Pa., by Burroughs Adding Machine Company, president John S. Coleman announced.

"Products of this new division are in many cases the natural outgrowth or by-product of our long-range development program in electronic business equipment, conducted in our research laboratories in Philadelphia since 1949," Mr. Coleman said. "These products have now achieved such stature and independent value in themselves as to warrant the establishment of a separate division in the company for their manufacture and sale."

The new division will produce a line of electronic laboratory apparatus and other special devices. It will also offer to business a scientific computation service. In addition, it will make its facilities available to the Armed Services for the fabrication of electronic instruments.

Perry C. Smith, formerly a department manager in the research activity, has been appointed director of the new division. Mr. Lawrence T. Lapatka, formerly manager of the sound department at RCA Victor, has been appointed sales manager.

Gobus Heads New Philips Testing Department

A NEW nondestructive testing department headed by Alexander Gobus has been established by North American Philips Co., Inc. to

Alexander Gobus

handle new research developments in the industrial x-ray field, it was announced recently. Mr. Gobus was vice-president, chief metallurgist and director of nondestructive testing for Sam Tour & Co., Inc. from 1943 to 1953.

General Instrument Adds New Plant

GENERAL INSTRUMENT CORP. is enlarging its three plants, has acquired a fourth and is searching for a fifth in a large-scale expansion program geared to handle what is expected to be the biggest year in the firm's 30-year history.

The expansion program was announced by Abraham Blumenlet WILLIAMS help you apply ferric oxides to the manufacture of your

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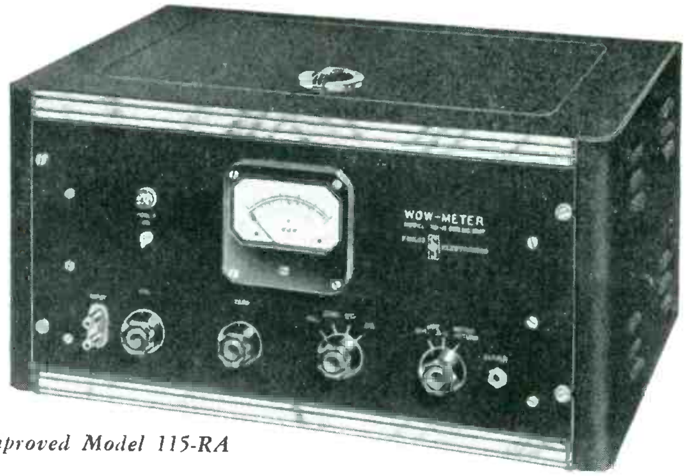

New Improved Model 115-RA

Improved direct-reading instrument simplifies measurements of wow and flutter in speed of phonograph turntables, wire and tape recorders, motion picture projectors and similar recording or reproducing mechanisms. It is the only meter in existence providing direct, steady indication of meter pointer on scale.

The Furst Model 115-RA with improved stability is suitable for both laboratory and production application and eliminates complex test set-ups.

A switch on the front panel permits selection of low frequency cut-off and corresponding meter damping for use on slow speed turntables.

***Frequency Response:** ½ to 120 cycles or 10 to 120 cycles*
***Sensitivity:** 0.2, 0.5, and 2.0% Wow Full Scale*
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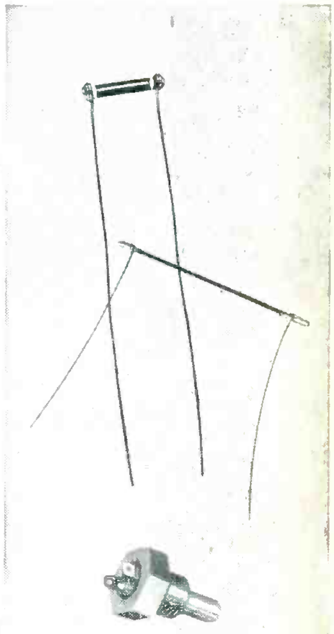

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krantz, chairman of the board, who said that General Instrument and its F. W. Sickles Division, now employing 5,900 persons, will eventually have 7,700 employees and an annual payroll of $17.5 million.

The new plant, to be operated by the F. W. Sickles Division, is located in Danielson, Conn. at the site of a former textile mill which ceased operations last year. Alterations have begun and production is expected to start by late March.

The firm has leased 65,000 sq ft in a four-story building, with additional space available when required. Initially, the plant will be devoted chiefly to assembly work. It is expected that some 700 persons should be employed by the end of the year.

The parent plant at Elizabeth, N. J., now employing 2,000, will enlarge its staff by 500; the Sickles branch at Chicopee, Mass., employing 3,400, already has advertised for 300 additional people; the Sickles branch at Joliet, Ill. employing 500 will enlarge to 800.

Sterling Elects V-P's And Directors

THE BOARD of directors of Sterling Engineering Co., subsidiary of American Machine & Foundry Co., has elected Warren G. Leonard vice-president, general manager and director, it was announced by More-

Warren G. Leonard

head Patterson, AMF board chairman and president.

George Colby, general manager of AMF's electronics division in

George E. Colby

Boston, was also elected a director.

Kenneth A. Killam has been elected vice-president in charge of engineering of the AMF subsidiary.

Test Equipment Company Formed

PULSE TECHNIQUES, INC. of West Englewood, N. J. has been formed for the design, development and manufacture of electronic test equipment, it was announced by W. Oliver Summerlin and Eugene R. Shenk.

Mr. Summerlin was formerly vice-president for engineering with Audio and Video Products Corp.

Mr. Shenk was assistant section head, technical staff at the terminal facilities laboratory of RCA in New York City.

In addition to development of its own line of equipment, the new firm will make available to others its facilities for designing and producing specialized electronic equipment, particularly in applications of the multivibrator.

National Union Radio Appoints Executives

ANNOUNCEMENT was made by Kenneth C. Meinken, Sr., president of National Union Radio Corp., of the appointment of Joseph V. McKee, Jr. as secretary of the corporation, Elwood C. Schafer as vice-president in charge of manufacturing electron tubes and Kenneth C. Meinken, Jr. as vice-president in charge of equipment and renewal sales.

Mr. McKee is a director of National Union Radio Corp. and succeeds Jerome V. Deevy, whose resignation was recently accepted.

Mr. Schafer was formerly manager of the cathode-ray tube division and has been with the headquarters staff at Hatboro for many years in various capacities, including engineering and plant manager.

As vice-president in charge of equipment and renewal sales, Kenneth C. Meinken, Jr. is given increased responsibilities beyond those included in his former position as vice-president in charge of equipment sales.

Halloran Becomes Partner In Electro Engineering

THE APPOINTMENT of James J. Halloran, chief engineer, as a partner in Electro Engineering Works is announced by Alex W. Fry and Wallace W. Wahlgren, partners of the company. Mr. Halloran became associated with Electro Engineering Works in 1945 as a transformer design engineer and has been with the company

James J. Halloran

since that time.

Before joining the company, he was with Westinghouse Corp. in transformer sales and in the transformer engineering department.

Kimble Glass Plans TV Bulb Plant

KIMBLE GLASS CO., subsidiary of Owens-Illinois, will develop a modern television bulb manufacturing plant at Sayreville, N. J.

The manufacture of tv bulbs will start after the work of remodeling and equipping the Sayreville plant of the Kaylo division of Owens-Illinois is completed in September. As additional furnaces and equipment are added the output will approximate 150,000 tv bulbs per month.

Shortly some tv bulbs shipped from other Kimble plants will be completed at Sayreville.

When fully converted and equipped the new plant will handle every phase of television bulb manufacturing from the production of glass to the forming and assembling of the bulb.

Hucke Joins Bendix

HERBERT M. HUCKE has been appointed staff assistant to the general manager of the Bendix Radio Division of Bendix Aviation Corp., it was announced by E. K. Foster, vice-president and general manager.

Herbert M. Hucke

Mr. Hucke will work with long-range planning and the coordination of administrative activities at the Bendix plant in Towson, Md. Prior to his present appointment he was employed by RCA as administrator of facilities planning in the Engineering Products Department at the Victor Division.

In 1925, Mr. Hucke joined RCA as a radio engineer and was promoted through the positions of shop foreman and sales engineer prior to joining United Air Lines as an aviation radio engineer in 1931. He served as chief communications engineer for United before leaving to become a staff radio engineer for the Air Safety Board of the U. S. in 1939.

Mr. Hucke's second tour of duty with RCA was begun in 1940 when he was named manager of commercial and military aviation radio sales for the Engineering Products Department of the RCA Victor Division. He remained with the department through successive promotions as manager of communications and specialty sales in 1947, manager of product coordination two years later, and administrator of facilities planning in 1952.

Giannini Constructs New Western Plant

G. M. GIANNINI & CO., INC. began the construction of a new functional scientific instrument-assembly building in Pasadena. Land and improvements will cost in excess of $400,000. The new building will cover an area of 24,000 sq ft and will have reinforced concrete walls. It will accommodate over 200 employees engaged in assembly operations. Completion of the new plant is expected in six months.

New Giannini plant

According to Gabriel M. Giannini, president of the company, the modern building has been specifically designed to insure the correct lighting, temperature, humidity, dust and sound control necessary in precision instrument manufacture.

Air Associates Name Sereno and Terry

J. E. ASHMAN, president of Air Associates Inc., announced the appointment of C. A. Sereno as chief engineer of the corporation and C. B. Terry as general manager of

the company's electronic equipment division.

Mr. Sereno, formerly chief engineer of the company's aircraft products division, will now head up the overall engineering activities of the corporation.

Mr. Terry, formerly chief engineer of the company's electronic equipment division, replaces C. K. Krause who has resigned.

American Laboratories Plans Expansion

LEON RIEBMAN, president of American Electronic Laboratories of Philadelphia, announced the purchase of 48 acres of land near Colmar, Pa. to be used for expansion purposes.

Two buildings, for research and production, are now under construction. One of them will be used for antenna experimentation while the other will be used as an adjunct to other high-frequency experiments now being conducted. The company specializes in the production of electronic instruments for medical research.

Cinch Makes New Appointments

LESTER W. TARR, president of Cinch Manufacturing Corp., announced that responsibilities within the company have been assigned as follows: vice-president and general manager, E. J. Pool; sales manager, Stewart

E. J. Pool

Pfannstiehl; chief engineer for all plants, A. C. Corner; production manager and planning, Chas. Peterson; factory manager Chicago, Jack Little; assistant factory manager Chicago, George Hart.

Mr. Pool has been associated with the company for 23 years. He was previously vice-president in charge of sales.

GE Changes a Name

A CHANGE in the name of GE's Receiver Department has been announced by W. R. G. Baker, vice-president and general manager of the Electronics Division. Henceforth the department will be known as the Radio and Television Department. The new name was decided upon as being "more descriptive of the nature of the work performed".

Marconi Appoints Works Managers

MARCONI'S WIRELESS TELEGRAPH CO. LTD. has created a new post of general works manager of all works and model shops of the company. It will be filled by Robert Telford who was formerly assistant to the general manager.

Mr. Telford joined Marconi in 1937. When a new factory was opened at Hackbridge in 1941 for making airborne radio and portable radio for the resistance movement, he was made manager. From 1946 and for the next four years Mr. Telford was managing director of a Marconi subsidiary in Brazil.

New Company Born

DELTRON INC. of Glenside, Pa. was recently formed to manufacture precision electronic test equipment. The line features a phasemeter of unique design. An impedance bridge and other items will be added in the near future.

National Elects Johnson to Board

JOHN S. JOHNSON, assistant to the president of the U.S. Rubber Co., was recently elected a member of the board of directors of the Na-

Want more information? Use post card on last page.

tional Co., Malden, Mass.

John S. Johnson

He joined U.S. Rubber in 1931 as a member of the central sales organization. During World War II he headed the Tire Division of the War Production Board and in 1950 was appointed assistant to the president of the company.

Nuclear Company Changes Its Name

JAMES A. SCHOKE, president of Nuclear Instrument & Chemical Corp., has announced that future advertising and sales promotion will identify the company as "Nuclear-Chicago". This step is being taken because of the large number of firms having names similar to the corporate title, which has, in some instances, caused confusion among users of the company's products.

Hughes Appointed Assistant to RCA V-P

APPOINTMENT of Edward C. Hughes, Jr., as assistant to L. W. Teegarden, executive vice-president of RCA, was announced today by Mr. Teegarden.

Mr. Hughes joined RCA in 1930 as a member of the staff of the Tube Advertising and Sales Promotion Department, shortly after his graduation from Rensselaer Polytechnic Institute. In 1937, he

was made assistant to Mr. Teegarden as manager of tube sales to distributors and has been associated with him since that time. His most recent assignment was assistant to Mr. Teegarden when the latter was vice-president in charge of technical products of the RCA Victor Division.

Schick Joins Ebert

ELLIOT SCHICK has joined the engineering staff of Ebert Electronics Co., manufacturers of mercury plunger relays. Before joining Ebert, Mr. Schick was chief industrial engineer of Emerson Radio & Phonograph Corp. He has also served as time study engineer of Driver-Harris and as engineer for the Corning Glass Co.

Managan Advances At Victoreen

THE VICTOREEN INSTRUMENT CO. has announced the appointment of William W. Managan as chief engineer of its Instrument Division.

Mr. Managan, who has been serving as senior physicist specializing in Geiger tube and ionization chamber development, joined Victoreen in 1947 following three years in radar design with Naval Research Laboratory in Washington. His chief work has been in connection with x-ray calibration standards.

Aircraft Transformer Names Skobel, Cavenaugh

AIRCRAFT TRANSFORMER CORP. of Long Branch, N. J. announced the appointment of Max Skobel as director of engineering and research. In this capacity Mr. Skobel will coordinate the expanding research and engineering activities of the company in the field of high-temperature transformers and miniaturization.

Mr. Skobel was formerly chief of the transformer group in the Signal Corps Engineering Laboratories. He was also head of the inductive components section of the Armed Service Electro Standards Agency. Up to the time of this promotion he was chief engineer of the Aircraft

Transformer Corp.

David E. Cavenaugh was promoted from assistant to chief engineer of the company. He was formerly with Bell Telephone Laboratories.

OTHER NEWS

Sangamo and Southern Illinois Cooperate

SIGNIFICANT for immediate industrial use and for national defense is a current research project in which the Southern Illinois University physics department and the capacitor division of Sangamo Electric Co. are cooperating.

Dr. O. B. Young, Southern's physics department chairman, is directing the project, which is a study of the electrical properties of oil-impregnated paper which may be used as dielectric material in capacitors.

For more than two years Southern's physics department and the Sangamo Electric Co. have been cooperating in a continuous research program involving electrical properties of various materials used or having possible use in the manufacture of capacitors. Last summer's project dealt with the electrical properties of untreated paper.

Rutgers Offers Course In Ceramic Dielectrics

THE school of ceramics of Rutgers University is now offering a course in ceramic dielectrics. The course is being given by Richard C. Phoenix, instructor in ceramics. The wide interest in the fifteen symposia on ceramic dielectrics and ceramic dielectric research under way at Rutgers led to the initiation of this course.

German Research Association Founded

BERLIN Ultrasonic Research Association has been established in West-Berlin to promote ultrasonic basic research and development work in West-Germany. President

J. J. Gruetzmacher

of the new organization is J. J. Gruetzmacher.

The activities of the new scientific body will be chiefly devoted to the investigation of basic problems of ultrasonic energy generation and to questions of applied ultrasonic engineering comprising in some cases also practical development, design and production of ultrasonic equipment for industrial and other commercial purposes.

NEDA Asks Lower Freight Rates on Picture Tubes

THAT defective and burned-out cathode-ray tubes being returned to the manufacturer for salvage purposes are entitled to a lower freight rate than new tubes was the contention of Glenn Catlin, counsel for National Electronic Distributors Association, in an appearance before the railroads' Classification Committee.

Mr. Catlin pointed out that there is a substantial difference in value between the two, that this difference affects the carriers' potential claim liability and that it should have a corresponding affect upon the freight rates. Both new and defective tubes presently are rated at one and a half times first class.

"If not prevented by high freight rates," he said "it seems likely that as the more than 22 million tv sets now in operation get older, there will be a marked increase in the

replacement of burned-out cathode-ray tubes with a corresponding increase in the movement of old tubes from dealers to distributors and from distributors to tube manufacturers.

Other appearances before the Committee in support of the reduction were made by Ben Young, assistant traffic manager, Zenith Radio Corp.; Jerry Warner, traffic department, Motorola Radio; Otto Skwarek, traffic manager of the Rauland Corp. All are in Chicago.

The Committee took the request under advisement.

Glinski Conducts Course On Computers at McGill

THE growing demand for the application and use of digital and analogue electronic computers in Canada has stimulated the thinking of Canadian Universities in featuring special courses in the study of this important field.

George Glinski

George Glinski, president and director of development of Computing Devices of Canada is now giving his second year extension course on analogue computers at McGill University. The acceptance of this course at McGill led Ottawa's Carleton College to take up the challenge and their first extension course in digital computers has just been successfully finished under his guidance.

NEW BOOKS

Numerical Methods In Engineering

BY MARIO G. SALVADORI, *Columbia University and* MELVIN L. BARON, *Columbia University. Prentice-Hall, Inc., New York*, 1952, 258 *pages*, $6.65.

PUBLICATION of the first edition of Sokolnikoff's "Higher Mathematics for Engineers and Physicists" in 1934 started a trend which has resulted in publication to date of some 25–30 mathematical texts of a certain genre. The common basis of these books lies in their author's effort to provide the better undergraduate student, the graduate student, or the professional worker in the various domains of technology and applied science with a grasp of that content of mathematical analysis beyond the elementary calculus which is more or less essential to ready understanding and facile use of modern day theory. Among these texts one may remark, as especially suited to the needs of the communications, electronics, or servomechanisms specialist, are those by L. Pipes, S. Schelkunoff and A. Bronwell and—especially—that very inclusive text by A. Angot, "Complements de Mathematiques a l'Usage des Ingenieurs de l'Electrotechnique et des Telecommunications", Editions de la Revue d'Optique, Paris edition 2, 1952, 688 pages.

Salvadori's book, which evolved from a set of mimeographed lecture notes prepared for use in the fifth of an integrated sequence of five courses inaugurated some twelve years ago in the School of Engineering at Columbia University, whereat the author is an Associate Professor of Civil Engineering, is written for much the same reader: in fact, "it is addressed to students of engineering, physics, chemistry, [applied] mathematics, and to any individual desiring to become acquainted with numerical methods in order to apply them in his professional work." However, it complements, rather than parallels, the above-mentioned texts: for its content comprises an area little covered in the latter—namely, "those elementary *numerical* procedures which are needed most often in the solution of technical problems".

The broad aspects, major detail, and general allocation of content in the five chapters of the book are indicated by the following epitomization: I. The Practical Solution of Algebraic and Transcendental Equations (pp. 1–44): encompassing discussion of Descartes' rule of signs, Friedman's method for solving algebraic equations, Newton's method applied both to algebraic and to transcendental equations, and Gauss', Cholesky's, the relaxation, and the Gauss-Seidel iteration methods for solving sets of linear algebraic equations; II. Finite Differences and Their Applications (pp. 45–90): Taylor expansions, backward, forward and central differences, the Gregory-Newton interpolation formulas, the trapezoidal and parabolic rules for numerical integration, and Richardson's extrapolations; III. The Numerical Integration of Initial Value Problems (pp. 91–132): principally, advance of several particularly useful methods for solving such first and second-order differential equations; IV. The Numerical Integration of Ordinary Boundary-Value Problems (pp. 133–166): step-by-step integration, use of central differences, relaxation and certain associated special techniques; and V. The Numerical Solution of Partial Differential Equations (pp. 167–252): solution of the Laplace, Poisson and biharmonic equations by relaxation, iteration and other finite-difference procedures, utilizing rectangular, skew and polar coordinates.

Presentation is concise, discussion is tersely phrased, and content is unified by the basic theme of finite-difference technique; the mode of approach is through emphasis on specific illustration rather than abstract proof; on the whole, the theory advanced appears to be free from gross error; each of the various procedures discussed is elucidated by one or more simple—yet sufficiently general—illustrative problems chosen from among diverse fields of engineering; self-practice and self-test of mastery of content are afforded by inclusion of some four hundred well-chosen and diversified problems, half of which have appended answers. The excellent binding, neat typography, remarkably effective display of numerical data, well-executed line drawings, and a comprehensive index contribute to ease of use and ready grasp of content.

Some who peruse this text will wish that it contained a more complete set of references, suggestive of preferred supplementary reading. In this thought, and complementive of certain of the context, the reviewer would remark: the considerable value of the extensions of Lin's method recently effected by Luke and Ufford (*Journal of Mathematics and Physics*, volume 30, 1951, pp. 94–101) and, especially, A. C. Aitken (*Proceedings of the Royal Society of Edinburgh*, volume 63A, 1951, pp. 174–191); the unique material on the solution of partial differential equations by relaxation and iteration methods encompassed in the book by L. E. Grinter (editor), "Numerical Methods of Analysis in Engineering", Macmillan Company, New York, 1949, see especially Chapter 10; the comprehensive discussions of finite-difference solution of ordinary differential equations contained in W. E. Milne's and in L. M. Milne-Thomson's books on finite differences; and P. S. Dwyer's recent book devoted largely to methods of solution of sets of linear algebraic equations.

The reviewer is of the opinion that within the limitations of content and purpose as projected by the author, the latter has produced an admirable text, one which can be recommended without reservation to the teacher or practicing engineer who seeks—for classroom use or self-study—a well-written, clearly-presented and easily-grasped account of those numerical procedures which over the past decade have come into considerable everyday use in all branches of telecommunications and applied electronics.—THOMAS J. HIGGINS, *University of Wisconsin*

Filter Design Data for Communication Engineers

BY J. H. MOLE. *John Wiley & Sons, Inc., New York*, 1952, 252 *pages*, $7.50.

ALMOST fourteen years have passed since Darlington published his classic paper in which he showed how to design constant-k and m-derived filter configurations which produce optimum desired attenuation shapes. Yet, at a surprising rate we are still being supplied with text books and design data books which deal with filter *synthesis* by the approximate image-parameter method. For introductory text books and books dealing in a very general way with the filter problem, there is some excuse for continuing to present the image parameter method, which can be explained to students in a relatively short period of time. And, though the synthesized network calls for element values which often are in error by more than 100 per cent (compared to optimum element values), at least these non-optimum values are obtained in a very simple manner. However, on an engineering level these reasons should not apply. The continued use of image-parameter methods in a modern book for practicing engineers apparently means that not enough years have passed to produce the engineer with the desire, the knowledge and the time to compile a design data book based on the modern methods of insertion-loss theory.

Dr. Mole mentions Darlington's method but makes the point that it requires greater knowledge of mathematics than is possessed by the majority of design-development engineers; this point does not apply, however, to a design data book such as the present book is purported to be, for as the author himself points out, the interest is not in the mathematical procedures but in the end result—the design data.

Although this reviewer cannot recommend this design book from the point of view that it does not supply the purchaser with modern optimum filter design data, he can recommend it as supplying, in a carefully thought out and useful form, most of the old and also some new approximate image-parameter design data. The author is to be specially commended for the many examples he has included in each chapter.

Chapter I defines the terms and symbols used and gives a summary of his design procedure. From a conveniently-used and approximately-correct graph one finds the cutoff-frequency Q required in the coils of a low-pass filter to satisfy a specified rate of cutoff. Then, knowing the actual coil Q's being used, the graph plus another graph give the approximate number of circuit elements required and the cutoff frequency to be used in the usual image-parameter element-value equations. After finding this cutoff frequency the curves given in Chapter 8 are used to choose a filter and to find the infinite attenuation frequencies so chosen that reject-band Tchebyscheff behavior is obtained. These curves also give the frequency at which the *image* attenuation first reaches the required reject band attenuation, i.e., the important point which defines the edge of the reject band. Because this is not the actual attenuation the usual procedure is recommended of designing for a reject band image attenuation which is 6 db greater than the required attenuation.

The first two graphs mentioned are of no use when high-Q elements are available. In this case the cutoff frequency is apparently then made to coincide with the desired accept band edge and the graphs of Chapter 8 are used directly. However, for this case appreciable ripples will be present in the passband and the recommended method of dealing with this problem is not quite clear; apparently it is to add additional terminating sections if necessary.

The filter synthesis data which an engineer would use is contained in the graphs of Chapters 8 and 9 and the summarizing graphs of Chapter 1. It is of interest to compare some of the performance data given here with the performance which modern insertion-loss theory makes available. Figure 73 gives the rate of cutoff obtainable with a two-section filter.

If a filter requirement calls for the reject band to start 25 per cent above the accept band, Fig. 73 says that 33 db of actual attenuation can be produced by a two-section filter producing Tchebyscheff reject-band behavior. Modern insertion-loss theory would say that, if the accept band is defined by the

3-db-down point and if 3-db ripples are allowed in the pass band, 56 db of actual attenuation can be produced; with 1-db passband ripples, 44 db can be produced; with 0.1-db ripples, 36 db; with 0.01-db ripples 31 db; and with no ripples 24 db of attenuation can be produced. Figure 73 cannot duplicate this performance for two reasons: first, simple image-parameter theory does not trade passband ripple for increased rate of cutoff and, second, Dr. Mole recommends the use of one constant-k section in his "best-performance" filters instead of using all m-derived sections.

Chapter 2 gives in conveniently normalized form the usual equations for the unfortunately unrealizable image impedances and image attenuation and phase of low-pass, high-pass, symmetrical band-pass and band-stop sections. Good clear curves are given for these quantities, useful for circuit analysis by image-parameter methods. Also given in convenient form are the usual element-value equations of image-parameter theory.

Chapter 3 supplies the above-mentioned equations and curves for the 6-, 5-, 4- and 3-element dissymmetrical band-pass filters.

Chapter 4 briefly describes the use of mutual inductance and Nortons T and P_1 reactance transformer for impedance transforming over large percentage bandwidths. The problem of the inconvenient element values called for when one attempts to use constant-k sections for small percentage bandwidth filters is noted. The suggested solution of using the wide-band transformers seems more complicated than that of using the correct number of 3-element sections—for small percentage bandwidths these give the same attenuation as the constant-K configuration with quite practical element values.

Chapter 5 deals with the various two-terminal losses that are of interest, namely the return loss (which is the inverse of our voltage reflection factor magnitude), the reflection loss, the mismatch loss, the bridging loss and the series loss. Charts are given for the calculation of these losses.

Chapter 6 deals with the problem

of analysing the filter to find the actual attenuation it will produce when resistors instead of image impedances are used for terminations.

Chapter 7 deals with the design of the terminating half-sections which are usually necessary with image-parameter design when tight tolerances are set in the magnitude of the reflection factor at the input terminals. It also deals with the problem of connecting filters in parallel.

Chapter 9 deals with the effects of dissipation, gives useful information concerning the minimum inductor Q which can be used to produce the first peak attenuation point in the reject band and gives the relationship between the accept band and reject band attenuation when the rounding off of the edge of the accept band due to dissipation is a limiting factor.

Chapter 10 contains new material concerning the tolerance which must be held on element values if the filter performance is not to be degraded by more than an assigned amount.

In Chapter 11 are tables of useful functions.

The final chapter contains some insertion-loss type of information giving the actual attenuation obtained with 2- and 3-element constant-k configurations, for the low-pass and band-pass case.

In conclusion it can be said that, while the book does not present optimum design data for filters, it does contain much useful information, which with some additional trial-and-error type of design, will enable an engineer to satisfy most filter requirements.—MILTON DISHAL, *Federal Telecommunication Labs., Nutley, New Jersey.*

The Radio Amateur's Handbook

American Radio Relay League, West Hartford, Conn., 1953, 30th edition, 800 pages including tables, index, advertisements, $3.00.

THIS hardy perennial has been published annually for 26 years and the total circulation approaches the three-million mark—some sort of record in the publishing world. As usual it is bigger than previous editions, with many changes and improvements as dictated by advances in the art or by such matters as the advent of television which, according to some amateurs, represents no advance.

Readers will recognize proof that the new edition is up-to-date by noting descriptions of apparatus taken from the pages of *QST* of only a few months ago. The tube section, probably the most up-to-the-minute source of tube data in printed existence, gets larger and larger.

In case there are some who do not already know the general contents of this most useful handbook there are numerous chapters on general radio theory and practice, and many chapters on specific aspects of radio communication with data and circuits useful to virtually anyone wishing to communicate by radio on virtually any portion of the radio spectrum.

Telecommunications Dictionary

BY DIONYSIUS J. BATAIMIS. *Published with funds from the American Mission to Greece (ECA)*, 4 *Churchill St., Athens, Greece*, 495 *pages*.

MODERN technology can bring new promise to old lands only if it can succeed in throwing off a few nasty growing pains. Among these there is none so crippling as the inability to talk with the clarity and precision of science. Adolescence is pretty much the same in automotive engineering, electricity, and in this case telecommunications. As each technology grows like Topsy, the air becomes filled with fresh jargon naming new pieces of apparatus, the work they do and the noises they make. The great problem which must be faced sooner or later is getting everybody concerned to agree to drop his own pet phrase and settle on a common simple technical language.

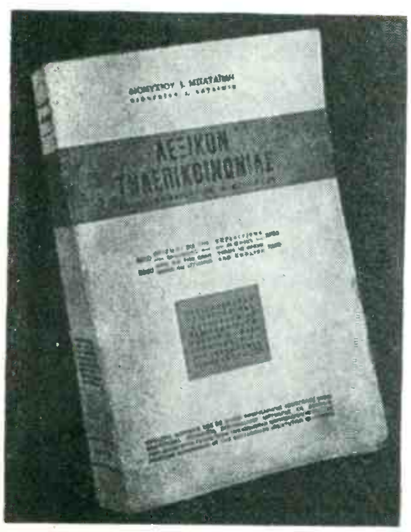
Standardizing terms is difficult enough when the bulk of development is carried on within one country. But imagine what happens when the journals, equipment and experts of the new technology burst upon a small nation from several directions speaking three or four different languages. The result is a terminological jungle that frustrates students, writers and repairmen.

Six for One

In Greece this is precisely what has happened in the fields of telecommunications. During the past forty years Britain, France, Germany and then the United States have successively influenced the rapid adolescence of telecommunications, each bringing their own words for the basic electronic components, and their own phrases for describing circuit characteristics. The imaginative Greek mind has acted as a prism to these source words so that there are as many as six separate terms for a single electronic concept. Confusion and lack of precision penetrate down to the simple resistor.

Conception

For many years a certain radio officer in the Greek Army had realized the necessity for quickly coming to terms with telecommunications. More than this, he planned to do something about it. In 1948 Dionysios Bataimis started work on his own initiative, planning and writing a dictionary of telecommunication terms. This was to give concise definitions in Greek for the basic terminology standardized in Great Britain and in the United States. Furthermore, it was to select, where possible, one Greek



Front cover of first telecommunication dictionary prepared for use in Greece equivalent for each of the standard English terms and occasionally suggest a completely new expression.

Guerilla Action

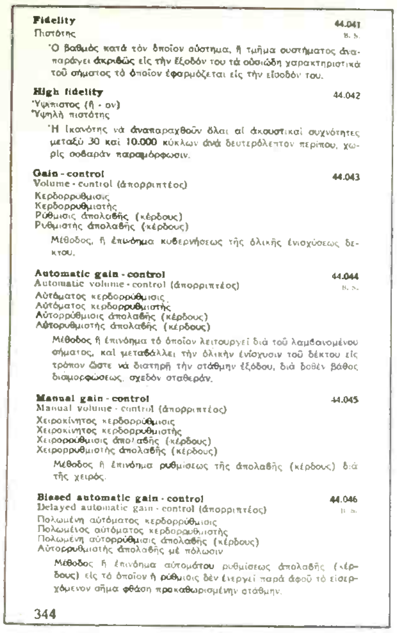
In 1949 Bataimis had finished the initial version of the dictionary and immediately offered his manuscript to the technical services of the Greek Army. They welcomed it, but at that time they were too occupied with Communist guerillas to concern themselves with publishing books. As months dragged on, Bataimis, from his position in the Army, saw daily the cruel effects of imprecise terminology and became impatient. With primary interest in getting some form of the dictionary into use immediately, he completed mimeographing it himself.

Economic Cooperation Administration

Meanwhile, Carl J. Shaw of the American Military Mission to Greece became aware of this lexicographic work and instantly appreciated its significance. Shaw and his successor Lt. Col. William Coeyman suggested that the manuscript be offered to the ECA group to publish, and pushed the project. The Labor and Manpower Division of the Marshall Plan group, who were aiding technical schools, convinced authorities that here was a case where a little money would go a long way to helping Greece build herself. The funds were finally allocated. The dictionary, which Bataimis had now completely reworked, appeared in early 1952.

Organization of Book

The book's 495 pages are divided into three sections. Introductory notes include small essays on the confused points of existing terminology. Indexes, both in Greek and in English, list the alternatives and direct the user to the main section of the work, where the definitions themselves are listed. This principal section is arranged in chapters concentrating on such topics as Basic Terms, Electronic Tubes, Telegraphy, Telephony and Radio. Standardized English terms follow in an order which begins with the most fundamental concepts in each section. Occasionally the English terms themselves appear in several alternatives, in which case



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Ὁ βαθμὸς κατὰ τὸν ὁποῖον σύστημα, ἢ τμῆμα συστήματος ἀναπαράγει ἀκριβῶς εἰς τὴν ἔξοδόν του τὰ οὐσιώδη χαρακτηριστικὰ τοῦ σήματος τὸ ὁποῖον ἐφαρμόζεται εἰς τὴν εἴσοδόν του.

High fidelity 44.042
Ὑψίπιστος (ἡ - ον)
Ὑψηλὴ πιστότης

Ἡ ἱκανότης νὰ ἀναπαραχθοῦν ὅλαι αἱ ἀκουστικαὶ συχνότητες μεταξὺ 30 καὶ 10.000 κύκλων ἀνὰ δευτερόλεπτον περίπου, χωρὶς σοβαρὰν παραμόρφωσιν.

Gain - control 44.043
Volume - control (ἀπορριπτέος)
Κερδορρύθμισις
Κερδορρυθμιστής
Ρύθμισις ἀπολαβῆς (κέρδους)
Ρυθμιστὴς ἀπολαβῆς (κέρδους)

Μέθοδος, ἢ ἐπινόημα κυβερνήσεως τῆς ὁλικῆς ἐνισχύσεως δέκτου.

Automatic gain - control 44.044
Automatic volume - control (ἀπορριπτέος) B. S.
Αὐτόματος κερδορρύθμισις
Αὐτόματος κερδορρυθμιστὴς
Αὐτορρύθμισις ἀπολαβῆς (κέρδους)
Αὐτορυθμιστὴς ἀπολαβῆς (κέρδους)

Μέθοδος ἢ ἐπινόημα τὸ ὁποῖον λειτουργεῖ διὰ τοῦ λαμβανομένου σήματος, καὶ μεταβάλλει τὴν ὁλικὴν ἐνίσχυσιν τοῦ δέκτου εἰς τρόπον ὥστε νὰ διατηρῇ τὴν στάθμην ἐξόδου, διὰ δοθὲν βάθος διαμορφώσεως, σχεδὸν σταθεράν.

Manual gain - control 44.045
Manual volume - control (ἀπορριπτέος)
Χειροκίνητος κερδορρύθμισις
Χειροκίνητος κερδορρυθμιστὴς
Χειρορρύθμισις ἀπολαβῆς (κέρδους)
Χειρορρυθμιστὴς ἀπολαβῆς (κέρδους)

Μέθοδος ἢ ἐπινόημα ρυθμίσεως τῆς ἀπολαβῆς (κέρδους) διὰ τῆς χειρός.

Biased automatic gain - control 44.046
Delayed automatic gain - control (ἀπορριπτέος) B. S.
Πολωμένη αὐτόματος κερδορρύθμισις
Πολωμένος αὐτόματος κερδορρυθμιστὴς
Πολωμένη αὐτορρύθμισις ἀπολαβῆς (κέρδους)
Αὐτορρυθμιστὴς ἀπολαβῆς μὲ πόλωσιν

Μέθοδος ἢ ἐπινόημα αὐτομάτου ρυθμίσεως ἀπολαβῆς (κέρδους) εἰς τὸ ὁποῖον ἡ ρύθμισις δὲν ἐνεργεῖ παρὰ ἀφοῦ τὸ εἰσερχόμενον σῆμα φθάσῃ προκαθωρισμένην στάθμην.

344

Example of typical page in section on radio receivers. For fidelity there is only one English term listed and only one Greek term in use. For many other terms the job is more complicated; the preferred English term had to be selected first, with its source indicated by small letters at the right (B.S. is British Standards Institution). Existing Greek terms are listed next, after which the author defines, distinguishes and selects a single new standard

all are noted and the one preferred by the American or British organizations is indicated.

The principle function of the book is, of course, to offer short explanations in Greek of telecommunication terms, whether or not there is any cause for confusion. In all, 3,250 terms in the two languages appear in the book, for which 2,250 definitions in Greek are given.

The difference of 1,000 between these two figures represents substitute terms, most of which are Greek, and indicates the second role of the dictionary, to enumerate these alternatives and to choose wherever possible a single standard.

Examples of Terms

Reducing the Greek terms for vacuum tube from three to two is an example. The British "valve" was widely used in its Greek form, *valvis*, especially by those who understood its electronic function. But then the increasing volume of equipment and literature from America contributed the equivalent of single term for impedance which he hopes will find consistent use in textbooks, literature, and most important, the thinking of electronic men.

New Words

Quite often the task was not merely to select one Greek word from several alternatives in current use, but to introduce entirely new terms into the Greek technical language. Some of these are quite naturally the names for the latest gadgets which arrive continually from Europe and America. But, surprisingly enough, some of the new words describe the simplest of circuit components.

As an example, until now there has been no distinction made between a circuit component and its particular electrical quality. Thus an inductor was called an inductance and a resistor, whether carbon or wire-wound, a resistance. The dictionary mentions that the distinction has come in other countries only after electronics reached maturity, and suggests that it is now time for Greece to follow. Two new words, corresponding to resistor and inductor for the circuit components themselves, are offered. In the Greek language this is simple to arrange by using the masculine form of the root word for the component itself, while reserving the feminine ending for what it accomplishes. From now on, resistance is a womanly quality possessed by objects which are manly as long as they possess the slightest trace of an ohm.

Americanized Greek Words

Very many of the terms listed are familiar to readers as words in their own language. In telecommunications the most basic of such words is, of course, *electron*. This left Greece centuries ago meaning "amber", only to return as a basic electrical particle. Greeks recognize *hysteresis* as coming from an old verb meaning "to be behind". Much more recently *klystron*, derived from a precipitous rushing of water, as through the break in a dam, returned from America, patented and mispronounced as the family name of certain velocity-modulated vacuum tubes. Mean-

"tube", which as *solin* in Greek appeared falsely to be a cousin to the solenoid. The American terminology was reinforced by the German *rhöre*. Meanwhile the French *lampe*, in Greek *lichnia*, had somehow become more widely used than any of the others. Bataimis discusses the origins of these three exising terms and finally designates *valvis* for those electronic tubes which actually function as valves. Others are classified generally as *lichnia*. The dictionary suggests that *solin* be discarded from Greek usage, but of course notes that Americans seem to be sticking to "tubes".

A far greater feat of standardization came in designating a single term for "channel", in the sense of an allotted r-f band. There have been no less than six Greek expressions in partial use. Certain literature employed the equivalent of "canal" (*canali*); others preferred "conduits". Still, other publications referred to bands in the r-f spectrum as "roads", "passages", "tubes" or the naval term meaning "a charted path through a mine field" which, come to think of it, can be only too accurate. Of these the most common was *canali*, roughly "canal", but there was some national prejudice against this word, which was thought to be not really Greek but a modification, of the Roman *canalis*. Bataimis's researches found, however, that it was the Greeks after all who had the original word for it since the Latin *canalis* had in fact come, from the ancient Greek *canna* or *canni*. He suggests that this term, as old as the Acropolis, become the single way to describe an r-f channel, and hopes that all concerned will be satisfied to short out the other five.

Perhaps an even greater contribution to electronic science in Greece is made by standardizing terms for the basic electrical constants. The slightest misunderstandings on this level cripple basic understanding and the precise transference of knowledge. Thus, for the concept of impedance the Greeks used different expressions, including apparent resistance. But this phrase, especially when spoken, often left confusion as to the exact participation of X_L, X_c and pure R. Bataimis designates and defines a while the television orthicon was named by combining the Greek *ortho* (correct) and *eikon* (image), all of which makes an image orthicon appear to be a camera tube giving a correct image image.

Distribution

Of the 2,000 dictionary copies published by ECA, approximately one half are in use by the Greek armed forces. Others have gone to schools in the vigorously expanding technical training programs. The largest of these schools, the Sivitanidios Institute, aided the publication. The remaining copies have gone to universities, laboratories, technical associations and broadcast units not only in Greece but in the U. S., England, France and Switzerland.

Will the growing group of young Greek telecommunication workers follow these suggestions for standardized terms and new expressions? Only time will tell. But so far it appears that such words as *eanni* and *resistor* are catching on. Of course, if other expressions emerge as common understandings, subsequent editions of the dictionary will have to acknowledge them. The author recognizes that the battle to clarify is never won; a technical jargon constantly grows and picks up bad habits.

Developing this new dictionary and improving the existing one are unspectacular but very real contributions. As the blessings—and complexities—of electronics spread to the remoter suburbs of the free world, this project can well be followed elsewhere. — SPERRY LEA, *American Mission to Greece*

National Electronics Conference, 8th Annual Proceedings

Available from NEC headquarters, 852 East 83rd St., Chicago 19, Ill., 835 pages, $5.00.

IN THIS printed proceedings of the 1952 Conference, held in Chicago September 29, 30 and October 1, will be found the complete text of all technical papers and luncheon speeches with but one exception. In all there are not quite 100 papers which cut across all aspects of the wide electronics field. The contents are listed below by general divisions with the numbers of individual papers in each.

General (non-technical) papers, two; Servomechanism Theory, four; High-frequency Electron Tubes, four; Audio, five; Industrial Measurements, four; Magnetic Amplifiers and Servo Applications, four; Television, five; Equipment and Components Reliability, five; Waveguides, five; Transistors, five; Radio Navigation, Radar and UHF Transmitters, four; Circuits, ten; Components, Assembly and Measurements, five; Semiconductors, four; Memory Tubes and Tube Reliability, five; Computers, five; Antennas, four; Electronic Instrumentation, five; Engineering Management, four; Coding and Recording Equipment, five; Delay-line and High-frequency Test Equipment, five.

At the end of the book are appendices giving the list of exhibitors at the conference and the tables of contents of the seven previous proceedings volumes.

Radio Operating Questions and Answers

BY J. L. HORNUNG AND ALEXANDER A. MCKENZIE, *McGraw-Hill Book Co. Inc., New York*, 1952, 557 *pages*, $6.00.

AGAIN it is possible for FCC license candidates to "know all the answers" when taking commercial radio operator examinations. This eleventh edition of "Q and A" maintains the high standard of technical accuracy and clarity that has made previous editions so justly popular.

The book gives direct and to-the-point answers to over 1,900 questions taken from the latest FCC "Study Guide and Reference Material for Commercial Radio Operator Examinations." If pertinent sections of the material are absorbed by the reader, he is qualified to pass the written parts of exams for all classes of radiotelegraph and radiotelephone operators, plus aircraft radiotelegraph and ship radar endorsements.

Many of the questions are answered in single-word or single-sentence statements. Where an answer requires elaboration for complete understanding, however, extra material—including many excellent drawings—is provided.

The answers reflect a great deal of careful planning on the part of the authors. It is difficult to answer certain types of questions with positive unqualified statements. The answers provided in this book are virtually free of uncertainty. The information provided in each case is sufficient, but not excessive.

The book is a must for any aspiring commercial radio operator. The experienced operator can derive a great amount of benefit by skimming through its pages for a quick review.—JF

THUMBNAIL REVIEWS

Bibliography and Abstracts on Electrical Contacts. ASTM, 1916 Race St., Philadelphia 3, Pa. 1952, 257 pages, $5.50. Over 1,500 references, hundreds of abstracts, many special articles, the result of extensive work by Committee B-4, Electrical Heating, Resistance and Related Alloys to develop standards for contact materials. The articles covered go up through most of 1951 and the digests and listing are a most valuable contribution to the subject.

Synchros, Self-synchronous Devices and Electrical Servo-mechanisms. By Leonard R. Crow, Universal Scientific Company. The Scientific Book Publishing Company, Vincennes, Ind., 1953, 222 pages, $4.20. Non-mathematical, elementary text for technical schools, training courses and individuals. Well illustrated, easy to understand.

Vacuum-Tube Oscillators. By William A. Edson, Stanford University. John Wiley & Sons, Inc., New York; Chapman & Hall, Ltd., London, 1953, 476 pages, $7.50. First text on the subject; presents excellent treatment of all oscillator types plus chapters on frequency multiplication and division, modulation, automatic frequency control, noise, and long-line and multiple-resonance effects.

Tungsten—Its Metallurgy, Properties and Applications. By Colin J. Smithells. The Chemical Publishing Co., Inc., New York, 1953, 400 pages, $8.50. Comprehensive book on the metallurgy, chemical and physical properties, and industrial applications of tungsten. Topics discussed are the primary and secondary raw materials, their step-by-step treatment for production of metallic tungsten, working of tungsten for obtaining various ductile products, metallographic structure of the pure metal, influence of manufacturing operations on the physical properties of tungsten, tungsten alloys and their industrial applications, chemical and spectrographic methods for the determination of impurities. Should be of considerable assistance to students or specialists.

BACKTALK

Transistors

DEAR SIRS:

JUST A NOTE to express my appreciation for your series of articles beginning in the March 1953 issue of ELECTRONICS, "TRANSISTORS: Theory and Application", by Abraham Coblenz and Harry L. Owens (p 98). You are zero beat on my natural resonant frequency. Please keep up the good work.

ROY E. BRANN
South Pasadena, California

Mor(e)on Ads

DEAR SIRS:

I CONCUR in the remarks made by W9KQX in the March 1953 issue of ELECTRONICS (p 492). There is a vast field in advertising in which much improvement can and should be made. When a company comes out with a new set of tubes it would be wonderful if they would recommend and display circuitry that would be of immediate use in utilizing the product.

In so-called "institutional" advertising perhaps this is not useful, but in most ads which are directed to the *users*—the engineers, hams, etc.—it would be good to see useful data, such as circuits.

I have been with commercial manufacturers of gear, both amateur and commercial, and know that in most cases the ads are written and directed by nontechnical people, or if there are engineers behind the ads, their wishes are overridden by the "art" director who is more concerned with a pretty ad than a useful one. I deplore this attitude on the part of management that permits the "art" department or some "advertising counsellor" to tell the engineer what an ad shall say.

I also concur with W9KQX that many hams are readers of electronic magazines, and of ELECTRONICS in particular. I know that it reads well, and that it is well-read at Sandia Laboratory where I work—not only by engineers, but amateur-engineers as well. They all like its direct style and excellent presentation of the electronics art.

This letter is just another voice crying for honesty and forthrightness in advertising—and less useless malarky.

A. DAVID MIDDELTON (W5CA)
Director, ARRL West Gulf Division
Tijeras, New Mexico

Better SOS's

DEAR SIRS:

THE FACT that in this day of advanced art and science in air transportation and communication, it is a frequent occurrence for aircraft to crash or seacraft to meet disaster without a dependable automatic means of communication of identity and position, has been a personal concern to the writer.

There is a constant trickle of news over our nation, regarding a plane lost or overdue, but infrequently requiring days to locate, and occasionally personnel are lost through loss of time in bringing required aid or medical attention.

The state of the art on the form of telemetering, radiosondes and direction-finding techniques, contains the necessary applied science to justify investigation and development of proper equipment. I believe the need and suggested solutions should be publicized to encourage development. In the interest of public safety, this might best be accomplished through some agency that would assure an open license to anyone for general use, if there proved to be a patent application.

I have prepared and enclosed some general specifications.

JOHN E. TILLMAN
Albuquerque, New Mexico

(Editor's note: We have always been concious of the possibilities that exist for improvement in public safety through the intelligent use of electronics. Mr. Tillman's proposal is printed below.)

Emergency Device

GENERAL SPECIFICATIONS of means to provide aircraft and small seacraft with an automatic disaster warning device are as follows:

Basically the unit should be a small radio transmitter with a suitable antenna and small balloon packaged in an aluminum sleeve or boxed in a container that would be ejected from the craft either by the jar of impact or by manual release. The unit would be thrown clear of immediate area to prevent damage by resulting fire.

When ejected into the air, the balloon would release, holding one end of the antenna and the transmitter would form an anchor for the other end. The transmitter would be sealed and float in water when necessary. The transmitter would provide a radio signal of distress, giving craft identity type, and provide the signal necessary for homing devices.

Specifications

The transmitter itself should have the following features:

(1) It should be capable of automatic, possibly periodic, transmission for a minimum of 100 or 200 hours.

(2) Carrier frequencies should be selected by assignment from or agreement with FCC, CAA, USAF and USCG, making use of present monitoring systems to assure positive reception.

(3) Carrier frequency, modulation frequency and periodic transmission should be coded to reveal craft type and identity.

(4) Test provisions of operation when installed without ejection should be provided.

(5) The case must be sealed to water and air.

The balloon should have sufficient lifting power to support a small antenna. It should be able to withstand large changes in altitude, and it should be capable of being inflated by automatic storage devices employing suitable gas such as helium.

The actual location should be determined by past experience in vulnerability of specific parts of craft to afford best protection while still available for manual operation and maintenance checks. A study of ejection means, such as springs, CO_2 bombs and compressed air would be required—probably for each type of craft.

The purpose of the above proposal is to stimulate interest of members of the aviation and electronics profession who have the tools for studying the problem mentioned.

JOHN E. TILLMAN
Albuquerque, New Mexico

Cathode Impedance

DEAR SIRS:

HAVING seen no comments in either the January or February issue of ELECTRONICS regarding the article "Effective Cathode Impedance", by W. Chater and N. Golden (p 184, Dec. 1952) I am writing this in case no criticism has been submitted by others.

Using the nomenclature of the article, it is proved that for good bypassing

$$(\omega C_k R_{eq})^2 >> 1$$
or
$$[\omega C_k (R_k \,||\, R_m)]^2 >> 1$$

where || stands for "in parallel with".

This means that if R_k is made small or zero, C_k must be large or infinite, which is incorrect. In Fig. 1

$$i_1 = \frac{\mu e_s}{(r_p + R_L) \dot{+} (\mu + 1) Z}$$

where $\dot{+}$ stands for vector sum. Therefore the ratio

$$\frac{\text{Gain for } Z = Z}{\text{Gain for } Z = 0} = \frac{r_p + R_L}{(r_p + R_L) \dot{+} (\mu + 1) Z} = \frac{R_m}{R_m \dot{+} Z}$$

For values of this ratio approaching unity, Z must be much smaller than R_m; that is, R_k must be bypassed to a value much less than R_m. Taking two simple cases, (a) If $R_k << R_m$, C_k is not required. (b) If $X_{ck} << R_k$, R_k can be neg-

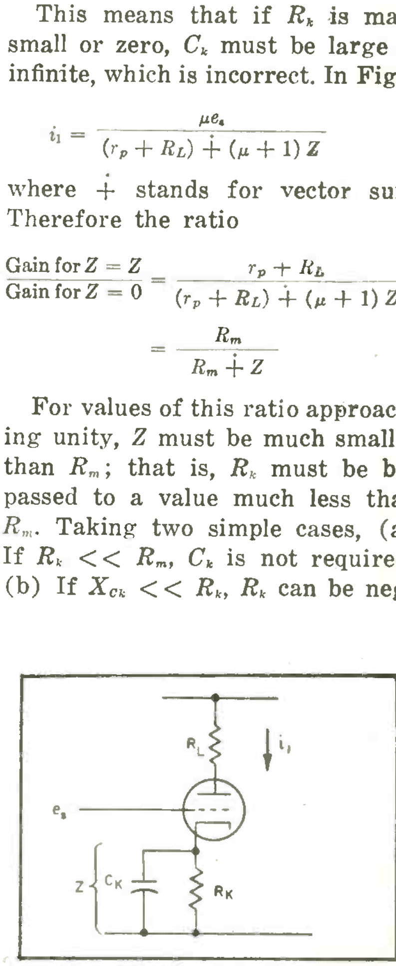

FIG. 1—Simple amplifier circuit illustrates bypassing situation discussed in letter

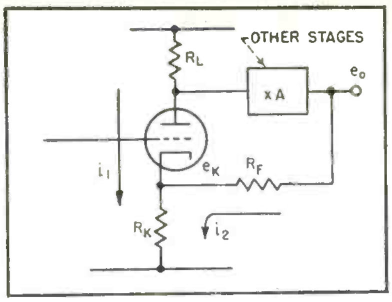

FIG. 2—Circuit with feedback current adding to normal tube cathode current

lected. Then

$$\left(\frac{1}{\omega C_k}\right)^2$$

must be much less than R_m or $(\omega C_k R_m)^2 >> 1$; not $(\omega C_k R_{eq})^2$ as above.

In the second part of the article it is stated that the feedback ratio

$$\frac{e_k}{e_o} = \frac{R_{eq}}{R_F + R_{eq}}$$

where $R_{eq} = R_k$ paralleled by R_m and is therefore less than R_k indicating that less current flows through R_k than through R_F, whereas actually i_1 and i_2 flow in the same direction through R_k.

In Fig. 2

$$i_2 = \frac{e_o - e_k}{R_F}$$

$$e_k = (i_1 + i_2)\, R_k$$
$$e_o = i_1 R_L A$$

Substituting

$$e_k = \left(\frac{e_o}{R_L A} + \frac{e_o - e_k}{R_F}\right) R_k$$

whence the feedback ratio equals

$$\frac{e_k}{e_s} = \left(\frac{R_k}{R_F + R_k}\right)\left(1 + \frac{R_F}{R_L A}\right)$$

and hence the R_{eq} should be greater than R_k, but only slightly if $R_F/R_L A$ is much less than unity. Also, its value depends on A.

It seems likely that the authors used the circuit shown in Fig. 3

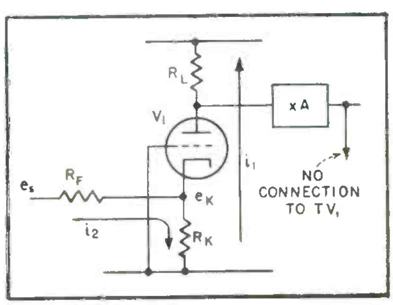

FIG. 3—Circuit in which feedback and cathode current subtract

for their tests. Here i_1 and i_2 flow in opposite directions in R_k.

$$i_1 = \frac{(\mu + 1)\, e_k}{r_p + R_L} = \frac{e_k}{R_m}$$

$$i_2 = \frac{e_s - e_k}{R_F}$$

$$e_k = (i_2 - i_1)\, R_k$$

Substituting

$$e_k = \left(\frac{e_s - e_k}{R_F} - \frac{e_k}{R_m} \right) R_k$$

$$\frac{e_k}{e_s} = \frac{R_k/R_F}{1 + \frac{R_k}{R_F} + \frac{R_k}{R_m}}$$

$$= \frac{R_F \,||\, R_K \,||\, R_m}{R_F} = \frac{R_{eq}}{R_F + R_{eq}}$$

The result stated by the authors for Fig. 2 is not applicable owing to the reverse direction of i_1.

D. L. CLAY
Birmingham Sound Reproducers, Staffs, England
Chief Electronic Design

Cheerio

DEAR SIRS:

I LIKE the cheerful tone of your November issue. It is good to know that a slacking-off in military contracts is not causing despondency among manufacturers, but is merely a spur to them to open up new fields of application for their products and to design and produce improved forms of existing equipment.

The information that Canada's contribution to the electronic equipment field is growing at a rapid rate is good news too, for I believe that a healthy and virile electronics industry is a sign of better times ahead. Once the United Nations have completed their rearmament programs consideration can and should be given to lightening the daily trend and increasing the benefits of leisure, and here the electronics industry can play a very big part.

Recruitment to the industry must be kept at a high level, and here again the prospects are cheerful.

Altogether the world prospects for this expanding industry are excellent and provided we all put our backs into it there should be no trade recession.

Your editorial comments in this respect have heartened us all.

SAMUEL WARRINER
Gloucester, England

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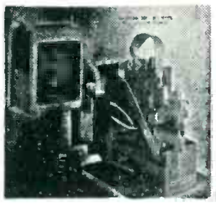

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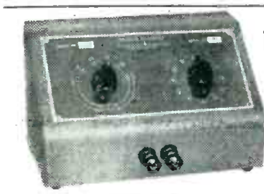

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Sensitive, rugged, non-shocking for unmounted coils; $150. f.o.b. HUNTINGTON BEACH, CALIF.

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A PRIVATE TECHNICAL PLATING SERVICE

offering . . . . PALLADIUM RHODIUM . . . . in flash, intermediate and heavy electrodeposits. Information regarding electroplated thicknesses upon request.

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Brown's Lane Fairfield, Connecticut

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SERIAL NUMBERS, TRADE MARKS
etc.
Cheaper—Easier to apply
Durable-Multi-Colored
Made to your specifications
Send sketch or sample for prompt quotation

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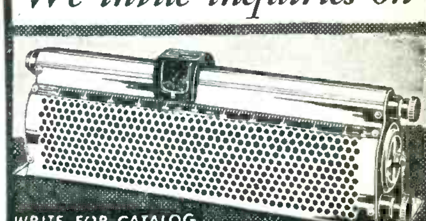
21 ATHERTON STREET, YONKERS 1, N. Y.

We invite inquiries on



WRITE FOR CATALOG

REX RHEOSTAT CO.
BALDWIN, L. I., N. Y.

This CONTACTS Section

supplements other advertising in this issue with these additional announcements of products essential to efficient and economical production and maintenance. Make a habit of checking this page, each issue.

PROFESSIONAL SERVICES

REPLIES (Box No.): Address to office nearest you
NEW YORK: 330 W. 42nd St. (36)
CHICAGO: 520 N. Michigan Ave. (11)
SAN FRANCISCO: 68 Post St. (4)

POSITIONS WANTED

ELECTRONIC ENGINEER (non-degree) with 13 years experience in communication, radar, control and instrumentation desires a responsible place with an organization with electronic problems and planning. Good theoretical and practical background in maintenance, design, system planning, sales and instruction. PW-7567, Electronics.

ELECTRONIC ENGINEER 31 yrs. M.S. in Electronics. 5 yrs. Industrial experience, Special Instrumentation and Analogue computers. Desires senior engineer or project engineer. PW-7429, Electronics.

TECHNICAL WRITER desires writing assignments which can be handled through mails: instructional material, tech manuals, ad copy, manuscripts. Experience includes ten years technical writing, five years teaching, radio, television, radar, industrial electronics, medical electronics. Inquiries invited. PW-7318, Electronics.

BSEE, 32, radar and counter measures WW2. 10 years design, installation, maintenance radio and microwave communication and control systems for power utilities and pipelines. Desire relocate southwest. PW-7492, Electronics.

SELLING OPPORTUNITIES WANTED

MILITARY & Industry Sales manufacturer's representative selling USAF, Signal Corps, Navy and Industry (Phila, Washington, Dayton, Rome, N. Y.) seeks additional lines and plants. RA-6821, Electronics.

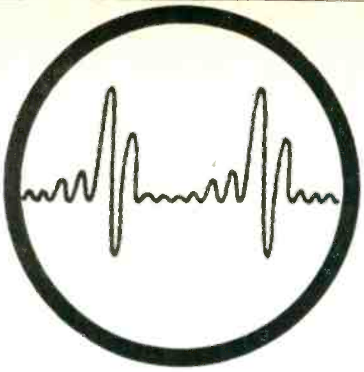
TECHNICAL SALES Representative. Aggressive new organization, headed by man with 25 years of Sales and Production Engineering experience, offers active selling and technical help to a few good products used by manufacturers in the Electronic and Metal Working industries from New Jersey to Washington, D. C. RA-7276, Electronics.

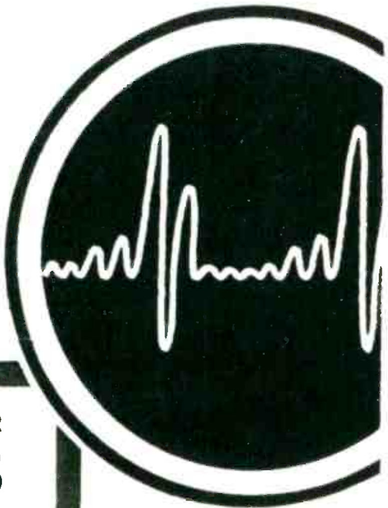
WORK WANTED

Wanted:
Development or assembly work by small electronic engineering and manufacturing group, specialists in top quality on complex equipment. WW-7269, Electronics.

Don't Forget the Box Number

WHEN answering the classified advertisments in this magazine, don't forget to put the box number on your envelope. It's our only means of identifying the advertisement you are answering.





SPECIAL OPPORTUNITIES FOR

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Convair in beautiful, sunshiny San Diego invites you to join an "engineers" engineering department. Interesting, challenging, essential long-range projects in commercial aircraft, military aircraft, missiles, engineering research and electronics development. Positions open in these specialized fields:

Electrical Design	Servo-mechanisms
Mechanical Design	Aerodynamics
Structural Design	Thermodynamics
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Weights	System Analysis

Generous travel allowances to those accepted. For free brochure, write Mr. H. T. Brooks, Engineering Dept. 900

CONVAIR

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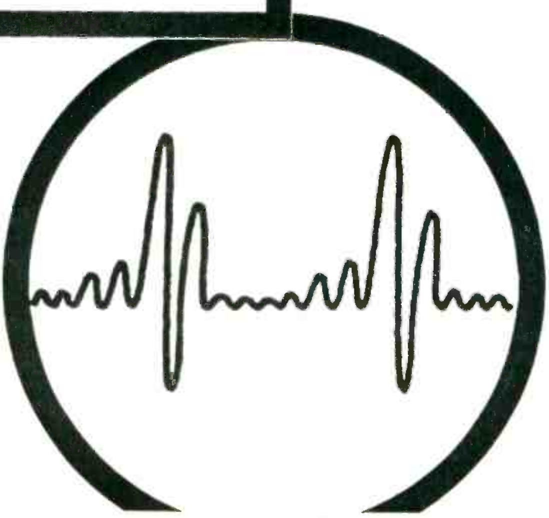
SAN DIEGO

3302 PACIFIC HIWAY
SAN DIEGO 12, CALIFORNIA



DEPARTMENT HEAD MISSILE ELECTRONICS

Prominent well-established aircraft and missile manufacturer offers an outstanding opportunity to a person qualified to head an expanding electronics organization. Salary commensurate with responsibility. Must have at least ten years experience in airborne electronics, five of which should be in missile or radar design and development. Advanced degree preferred. Position reports to chief engineer. Send detailed resume of background. Recent photograph optional.

P-6690, Electronics
520 N. Michigan Ave., Chicago 11, Ill.

WANTED • electrical • engineer

To supervise the operations and maintenance of Microwave Communications and Cathodic Protection Systems for large pipe line company. Location—Detroit, Michigan. Salary open. Include resume of experience and education, snapshot optional. All applications treated as confidential.

P-7328, Electronics
520 N. Michigan Ave., Chicago 11, Ill.

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.

SOUTHWESTERN
INDUSTRIAL ELECTRONICS CO.
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key words to your employment opportunities at GOODYEAR AIRCRAFT . . . pioneer and leader in lighter-than-air craft . . . an established and growing company building an outstanding technical reputation

DESIGN ENGINEERING opportunities exist in the fields of airships, airplanes, and components, airframes, power-plant installations, controls, hydraulics, electronics systems, fuel cells, canopies, and wheels and brakes

DEVELOPMENT of missiles, jet aircraft, and helicopters, electric and electronics system, servomechanisms, fiber resin laminates, and many other projects present an urgent need for capable engineers

WELDING ENGINEERS, civil engineers, mechanical engineers with ability in metals fabrication, and industrial engineers experienced in time study are needed. Job opportunities also exist for technical editors and illustrators

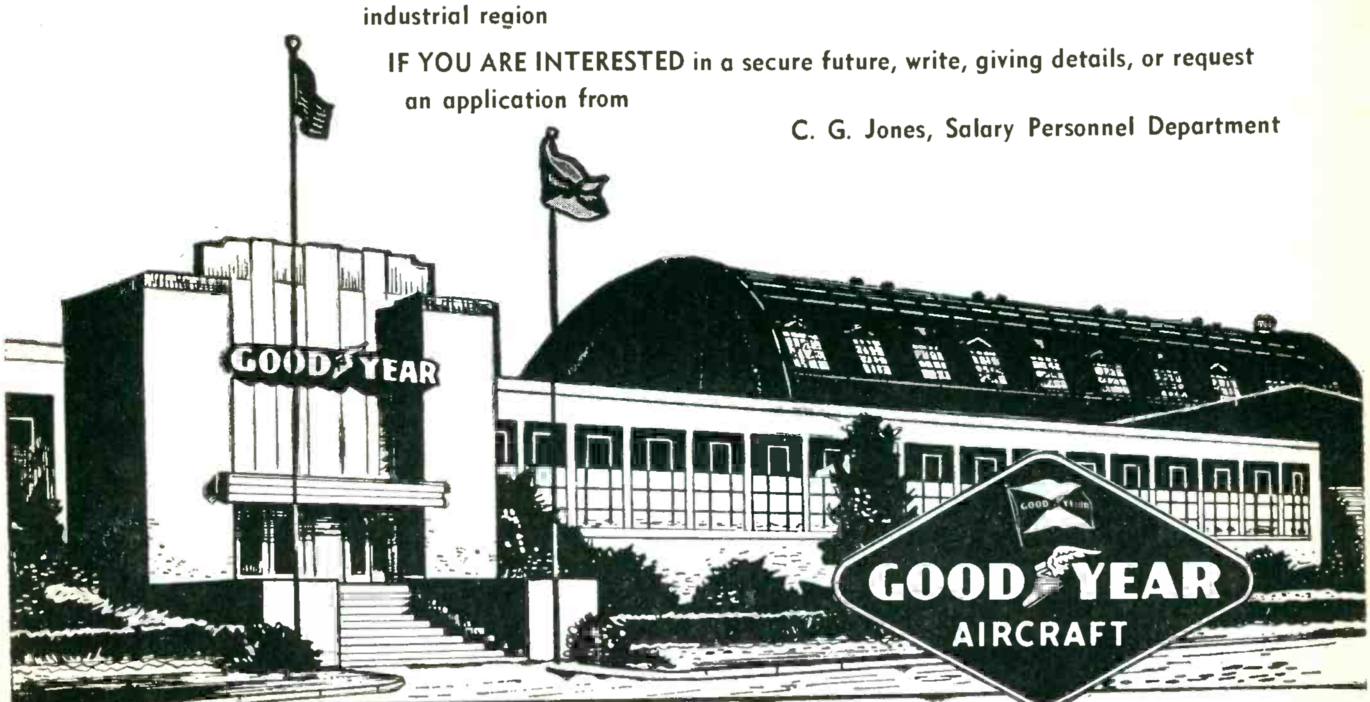
POSITIONS are open at several levels, and inquiries are also invited from recent graduates. Salaries are based on education, ability, and experience

PAID VACATIONS, free group life insurance, a good hospitalization plan, paid sick leave, company-sponsored pension plan, planned recreation, and free parking are among the facilities at the plant

A FRIENDLY CITY, Akron, Ohio, is located in the center of the midwestern industrial region

IF YOU ARE INTERESTED in a secure future, write, giving details, or request an application from

C. G. Jones, Salary Personnel Department



GOODYEAR AIRCRAFT CORPORATION, 1210 Massillon Road, Akron 15, Ohio

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FOR ATOMIC WEAPONS INSTALLATION

Mechanical Engineers, Electronics and Electrical Engineers, Physicists, Aerodynamicists, and Mathematicians. A variety of positions in research and development open for men with Bachelors or advanced degrees with or without applicable experience.

These are permanent positions with Sandia Corporation, a subsidiary of the Western Electric Company, which operates the Laboratory under contract with the Atomic Energy Commission. The Laboratory offers excellent working conditions and liberal employee benefits, including paid vacations, sickness benefits, group life insurance and a contributory retirement plan.

LOCATE IN THE

Healthful Southwest

Albuquerque, center of a metropolitan area of 150,000, is located in the Rio Grande Valley, one mile above sea level. Albuquerque lies at the foot of the Sandia Mountains which rise to 11,000 feet. Cosmopolitan shopping centers, scenic beauty, historic interest, year 'round sports, and sunny, mild, dry climate make Albuquerque an ideal home. New residents experience little difficulty in obtaining adequate housing in the Albuquerque area.

APPLICATIONS NOW BEING ACCEPTED FOR TECHNICAL WRITERS

These are not Civil Service Appointments

Make Application to the

PROFESSIONAL EMPLOYMENT DIVISION

SANDIA *Corporation*

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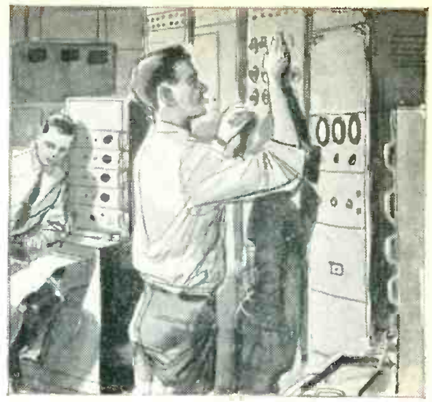
ALBUQUERQUE, N. M.



DESIGN, DEVELOPMENT ENGINEERS . . .

Looking for the *right* change?

Many men are—and the *right* job is often mighty hard to find.

But we've got some interesting openings now at Honeywell that might represent the right change for you.

If you're an experienced engineer it would pay you to look into the openings we now have in six areas:

- Servomechanisms
- Gyros
- Relays
- Vacuum Tubes
- Electromechanics
- Control Systems

Duties of the jobs. Take on complex design work requiring analysis and decision to bring into design form the requirements for a new or modified instrument, device or control system.

Requirements. B.S. or M.S. in Electrical, Mechanical or Aeronautical Engineering.

Atmosphere. A company that understands engineering—where one out of every ten employees is actively engaged in engineering or research.

Openings. In Minneapolis, Philadelphia and Freeport, Illinois.

For details write Mr. Ross Wagner, Personnel Dept., EL-5-87, Honeywell, Minneapolis 8, Minn. Ask for our book, "Emphasis on Research."

MINNEAPOLIS **Honeywell**

H HONEYWELL *First in Controls*

ENGINEERS

OPPORTUNITIES

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Where Product Development Is The Key To Continuing Growth

Product development has always played a major role in Sylvania's operations and is largely responsible for the company's growth to 40 plants throughout the nation. Similarly, Sylvania's Electronics Division is continuing its expansion program to accommodate increased development engineeering and manufacturing activities.

To engineers this means increasing opportunity with this 51 year old leader in the important field of electronics. At the Electronics plants in Woburn, Newton and Ipswich, Massachusetts you will enjoy the unique advantages of small plant operations in suburban areas minutes from the cultural and social activities of Boston. And — with Sylvania's assistance, you may continue your graduate studies at near-by world-famous universities.

Positions available for engineers with the following backgrounds:

MICROWAVE — with graduate work or experience in microwave theory. Positions will involve applications, measurements, or design of electronic test equipment for semi-conductor devices.

MECHANICAL — with experience in the following fields: 1. Design of small parts, tools, and jigs and fixtures. 2. Design of automatic production equipment.

SOLID STATE PHYSICISTS — Ph.D. or equivalent in experience in physics with a specialty in solid states work preferred. Will study electrical and optical behavior of semi-conducting materials.

METALLURGISTS — advanced degree or experience required. Will work on metallurgical preparations of semi-conducting devices.

ELECTRONIC — with graduate work or experience in product or circuit design and development.

Send complete resume to:

Mr. Robert L. Koller

SYLVANIA ELECTRIC

Electronics Division
WOBURN, MASS.

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We are expanding our permanent staff of engineers and scientists working in research and development on such problems as:

ELECTRONIC INSTRUMENTATION, MISSILE GUIDANCE, MICROWAVE APPLICATIONS, DESIGN OF SPECIAL PURPOSE ELECTRONIC COMPUTERS, TELEMETERING AND COMPLEX CONTROL SYSTEMS

While experience is important, general knowledge and breadth are more important than particular specialties.

If you would like to work in the stimulating atmosphere of an applied research and development laboratory where ideas are important, initiative is encouraged and associates are competent, we would be pleased to discuss employment with you. Descriptive material available upon request.

CORNELL AERONAUTICAL LABORATORY, INC.

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SYSTEMS RADAR SERVO COMPUTER

BACKGROUND:

Responsible positions open for top level development and project engineers with practical and research experience in

Advanced Electronic Circuits and Systems
Microwave Radar
Microwave Receivers and Transmitters

Also Engineering Design and Analysis relating to fields such as:—

Analogue and Digital Computers
Servomechanisms
Communications
Navigation
Fire Control
Optical

MAXSON

Requirements emphasize advanced analytical and/or management experience on highly complex electronic and electro-mechanical systems.

Kindly send resume and salary requirements to

The W. L. MAXSON Corp.
460 W. 34th ST., NEW YORK 1, N.Y.

ELECTRONIC SYSTEMS ENGINEERS

Experienced in:

Development and Design of Electronic Systems including experience in

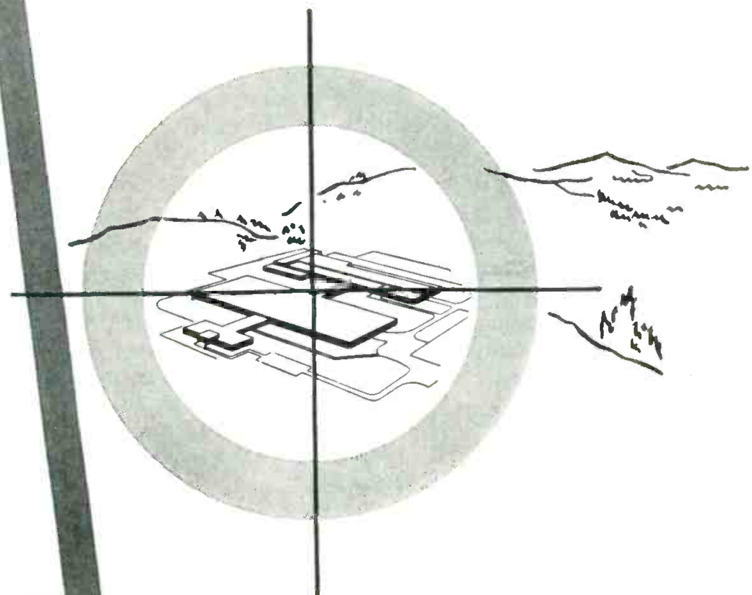
- SERVO DRIVES
- RADAR MICRO WAVE TECHNIQUES
- PRECISION TIME MEASUREMENTS
- COMPUTERS
- GYROS
- SYNCHROS
- UHF CIRCUITORY

MECHANICAL ENGINEERS

Experienced in:

Design and Development of Mechanical Systems including experience in

- MACHINE DESIGN
- STRESS ANALYSIS
- MECHANISMS
- CAM DESIGN
- GEAR AND GEAR TRAINS



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a great new division of an old established company...offers challenging assignments and splendid facilities in a magnificent new plant.

Enjoy ideal working and living conditions within 30 minutes driving distance of world-famous winter and summer resorts ...only three hours from New York or Philadelphia.

Salary in line with ability. Modern benefits program. Interview and moving expenses paid.

Contact PERSONNEL DEPARTMENT

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Affiliated Companies: American Type Founders, Inc. • Daystrom Electric Corporation • Daystrom Furniture Division

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Unusual Opportunities for Men with Long-Range Plans

• We are one of the leading Electronics firms in the Chicago area and require Design and Development Engineers with from 3 to 5 years' experience. Positions also available at Project Engineer, Engineer and Junior Engineer levels.

We will consider men with the necessary experience and ability who are ready to take on the responsibilities of these openings. The men selected will be given intermediate and advanced level assignments in our well- equipped Television, Radio, and Government Equipment Laboratories.

We are located in the northwest section of Chicago where living and working facilities are second to none. We are within easy access of all shopping centers with convenient city transportation. Close by are many suburbs where one can live and commute back and forth in a short time—adjacent to all great centers of learning.

Our company has a long-range program of design and development in which you may participate . . . all positions are permanent.

• Our requirements concern experience in all phases of the development of monochrome and color TV receivers • color generating equipment • UHF systems • radio receivers (broadcast or military) • radar systems • and laboratory test equipment

We suggest you write Mr. Walter Wecker, Personnel Division, giving educational qualifications and related experience. Interviews will be arranged at your convenience.

Admiral Corporation 3800 W. Cortland St. Chicago 47, Illinois

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UHF and MICROWAVE ENGINEERS

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.

For more information concerning the positions that are open we invite you to write to Personnel Director, Department A.

GIBBS MANUFACTURING & RESEARCH CORPORATION
Janesville, Wisconsin

ELECTRONIC DESIGNERS

Design of mechanical and electrical components and chassis in UHF and microwave systems.

RADIO ENGINEERS

Development of radio and radar components and systems.

ENGINEERS

Design of components for magnetic deflection of Cathode Ray Tubes.

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TO MEN WHO WANT THE BEST

Kollsman provides excellent facilities for the design and development of America's finest aircraft instruments. In our modern radio communications group you'll find a congenial atmosphere in which you can do your best work. You'll be encouraged to advance as our progressive organization continues to grow. And you'll receive liberal benefits including paid life, hospitalization, surgical, accident and health insurance.

KOLLSMAN INSTRUMENT CORP.
80-08 45th Avenue Elmhurst, Long Island, N. Y.

ENGINEERS
AND
PHYSICISTS
BS–MS–Ph.D:

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
Research & Development Dept.

PHILLIPS PETROLEUM COMPANY
Bartlesville • Oklahoma

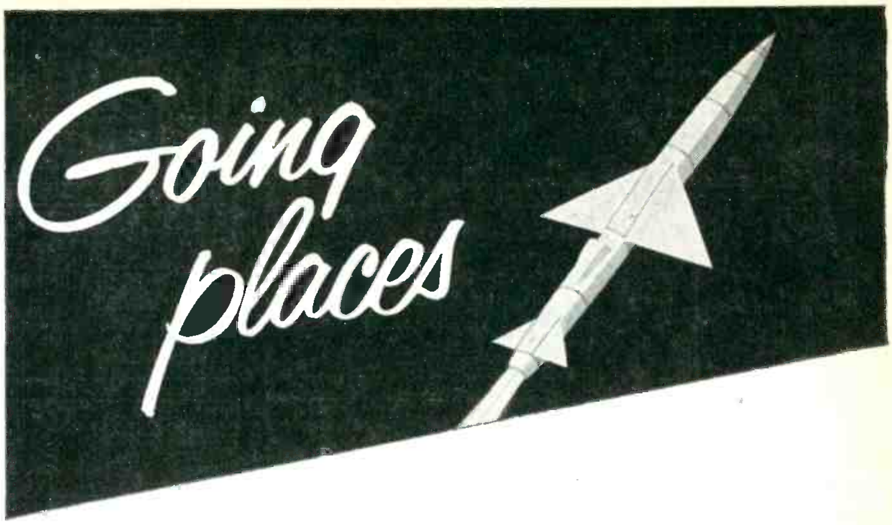
WANTED
ENGINEER WITH EXPERIENCE IN
VHF OR UHF

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.

BLONDER-TONGUE LABORATORIES
526-536 NORTH AVENUE
WESTFIELD, NEW JERSEY



Engineers, physicists, designers, technicians—

Investigate the challenging new opportunities in the guided missile industry

BENDIX OFFERS EXCELLENT POSITIONS IN ITS WELL-ESTABLISHED GUIDED MISSILE PROGRAM

To men interested in the rapidly growing guided missile industry, an association with Bendix offers unusual advantages. For here at Bendix, guided missile work is not a side line, but a well-established program with over seven years of successful development and research backing up today's operations.

No finer engineering and production facilities are found anywhere in the industry, and the men responsible for the Bendix guided missile program are recognized leaders in their field. Job opportunities range from theoretical systems analysis, through product and test equipment design and development, to field test and flight evaluation.

OPENINGS IN:

Aerodynamics	Hydraulics
Electronics	Mechanics
Microwaves	Servo Mechanisms
Dynamics	Structures

LET'S DISCUSS OUR MUTUAL INTERESTS

Write:

Employment Dept. Bendix Products Division
Bendix Aviation Corporation, 401 Bendix Drive
South Bend 20, Indiana

We desire personnel of the highest caliber—experienced in the field of airborne automatic electro-mechanical control equipment.

ENGINEERS

MECHANICAL DESIGN
ELECTRONIC
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DESIGNERS-LAYOUT MEN

ELECTRONIC
MECHANICAL

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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. . . all inquiries answered—write or apply . . .

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Salary dependent upon experience and ability.

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The Research Laboratory of Westinghouse Air Brake Co. and its subsidiaries

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or 10 Potter St., Cambridge, Mass.

MELPAR INC.

MAJOR AUTOMOBILE MANUFACTURER

REQUIRES

individual to evaluate present electronic computing devices and program for their future use. Thorough mathematics background and experience in design testing or programming of computers required. Position is permanent in Detroit. Salary open.

P-7519, Electronics
520 N. Michigan Ave., Chicago 11, Ill.

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The Physics Department of Southwest Research Institute, San Antonio, Texas, has several permanent staff positions for physicists and research engineers with B.S. or advanced degrees, and 2 to 10 years of experience in acoustics, antenna design, electromechanical transducers, geophysics, nuclear physics, optical instruments, pulse circuits, or servomechanisms.

P-7331, Electronics
520 N. Michigan Ave., Chicago 11, Ill.

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Needed immediately for supervisory position with rapidly expanding firm. Experience in Product Design of Electronic Units to military specifications or closely related field necessary.

VARO MFG. CO.
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MOTOROLA INC. NEEDS

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Experienced engineers for television receiver and circuit design. Experienced men also needed in U.H.F. and V.H.F. tuner design.

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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.

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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

ELECTRICAL and ELECTRONIC ENGINEERS

Excellent opportunities in the field of

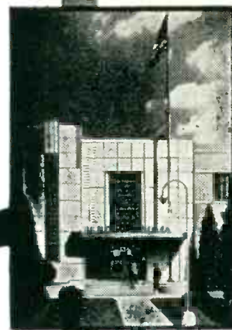
AUDIO AMPLIFIER DESIGN
SERVO AMPLIFIER DESIGN
COMPONENT DEVELOPMENT
EQUIPMENT DESIGN

Senior and Junior Engineers

Write, giving full details to:

Personnel Director, Dept. A,
GIBBS MANUFACTURING AND RESEARCH CORPORATION
Janesville, Wisconsin

MAKE THIS YOUR HOME FOR IMPORTANT WORK UNDER IDEAL CONDITIONS!



- TV RECEIVER DESIGN ENGINEERS
- ELECTRONICS ENGINEERS
- FIELD ENGINEERS
- TEST & INSPECTION ENGINEERS
- LAB. TECHNICIANS

NEEDED TO WORK ON: Radar, G.C.A., Mobile Radio, Auto Radio, Airborne Communication & Navigation Equipment, Television, Antennas, Microwave Equipment, Servo Mechanisms, Guided Missiles and Test Equipment Design.

YOU BENEFIT AT BENDIX RADIO: from high wages, a modern, air-conditioned plant, paid vacations and holidays, group insurance and a good chance for advancement.

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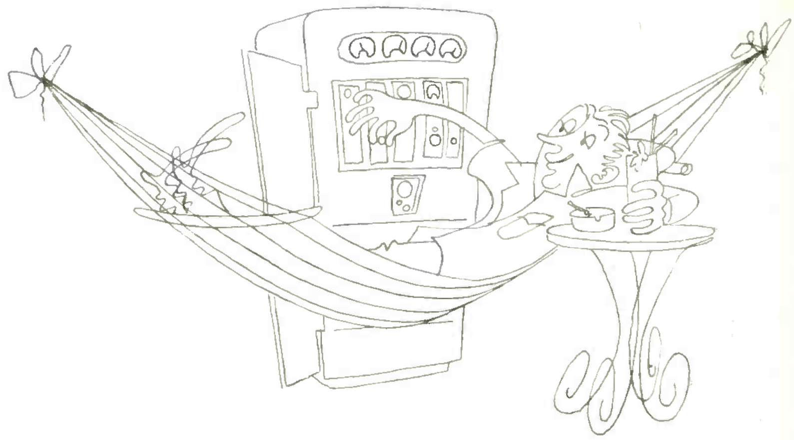
DIVISION OF BENDIX AVIATION CORPORATION
BALTIMORE-4, MD. Phone: TOWSON 2200
Makers of the World's Finest Electronic Equipment



Pleasant Working Conditions

So we're exaggerating a little! If you want to get technical about it (and you probably do) your life at our company won't be quite this cushy. We can promise this though—even the sky's not the limit for future opportunity. You work with a congenial group of engineers. People will listen to your ideas. The boss's door is always open. *Who you are*—You're an Electronic or Mechanical Engineer. You're experienced in air communication and navigation circuitry and development. You have worked with low or high frequency circuits, instrumentation, component utilization or associated problems. *What you do now*—Simple! Just contact:

Arthur E. Harrison, Vice President, Engineering
wilcox Electric Company, Inc.
Fourteenth & Chestnut, Kansas City 27, Mo.

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.

What You Can Expect at General Precision Laboratory

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
63 BEDFORD ROAD, PLEASANTVILLE, NEW YORK

CHICAGO MIDWAY LABORATORIES

THE UNIVERSITY OF CHICAGO

NEEDS

ELECTRONICS ENGINEERS and PHYSICISTS

for work on a long-range research and development program in air armament for the Air Force. Openings on both senior and junior levels in

INFRARED	INSTRUMENTATION
RADAR	AIRBORNE ORDNANCE
COMPUTERS	ELECTRONIC COMPONENTS

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Complete modern laboratory and shop facilities are available. This is a new and expanding program with excellent opportunities for advancement. Advanced study encouraged in nearby facilities.

We offer salaries equivalent to industry, as well as a one-month paid vacation. Applicants must be U. S. citizens.

Write or call:

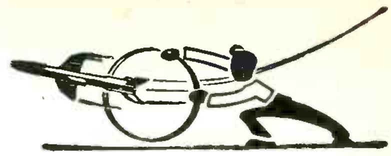
Director of Scientific Personnel

CHICAGO MIDWAY LABORATORIES
6040 South Greenwood Avenue Chicago 37, Illinois
BUtterfield 8-6611

CHIEF ENGINEER

Established electronics company located in the metropolitan New York area is expanding its electronic, nucleonic and industrial control departments and requires the services of a mature engineer and strong administrator to head up design and development of radio, radar and television transmitters, receivers and test equipment; servos, telemetering, scalers and associated equipment. Must be capable of planning and directing mechanical, electrical and electronic engineers; must be familiar with military specifications; able to examine and analyze specifications and prepare technical proposals. Excellent opportunity. Our staff knows of this ad. Submit resume to "President",

P-7502, Electronics
330 W. 42 St., New York 36, N. Y.



. . . An invitation to

Experienced

ELECTRONIC ENGINEERS *and* PHYSICISTS

We have several positions of technical leadership available in our growing Guided Missile Division. Applicants must have over four years experience and/or advanced degrees in either missile guidance systems, radar, servomechanisms, fire control computers, or U. H. F. techniques.

Our plant is located in beautiful suburban St. Louis, where you can enjoy the comforts of "county" living with easy access to "big city" shopping, entertaining, medical and educational facilities. Moving allowance for qualified applicants. Our Housing Representative will assist you in relocating.

Address replies to:

Technical Placement Supervisor
Box 516, St. Louis 3, Mo.

McDONNELL Aircraft Corporation
ST. LOUIS 3, MO.

ELECTRONIC ENGINEERS

FOR DESIGN & DEVELOPMENT WORK IN
RADAR
COMPUTERS
DIGITAL TECHNIQUES

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LECTRONIC TUBE

Receiving Tubes		1S4	.71	6AG7	1.45	6F6	.99	6SN7WGT	2.10	7W7	1.11	14C7	.93	50C5	.69	1B29	2.75
		1S5	.69	6AH6	1.29	6F6G	.87	6SQ7	.65	7Y4	.73	14E6	.99	50L6GT	.63	1B32	3.75
		1T4	.71	6AJ5	1.95	6F7	1.05	6SQ7GT	.65	7Z4	.79	14E7	1.09	50Y6GT	.92	1B35	11.00
		1T5GT	.71	6AK5	.84	6F8G	.91	6SR7	.63	10	.39	14F7	.89	53	.95	1B36	12.50
OOA	$1.50	1U4	.73	WE-6AK5	1.85	6G6G	.99	6SS7	.99	12A	.65	14H7	.89	55	.99	1B38	32.50
O1A	.67	1U5	.77	6AK5W	2.95	6H6	.66	6ST7	1.05	12A6	.64	14J7	.89	L55B	.32	1B40	4.95
OZ4	.59	1V	.65	6AK6	.99	6H6GT	.66	6T7G	1.09	12A6GT	.64	14N7	.89	56	.69	1B41	47.50
OZ4A	.63	1X2	.93	6AL5	.59	6J5	.59	6T8	.98	12A7	1.16	14R7	.89	57	.69	1B42	9.80
1A3	.71	2A3	1.28	6AL5W	2.65	6J5G	.64	6U5	.98	12A8GT	.77	14S7	.89	58	.69	1B54	32.50
1A5GT	.72	2A5	.79	6AQ5	.72	6J5GT	.55	6U7G	.65	12AH7GT	1.32	14W7	.89	59	1.24	1H20	.88
1A6	.72	2A7	.79	6AQ6	.79	6J6	.95	6V6	1.49	12AL5	.79	14X7	.89	70L7GT	1.29	1P21	35.00
1A7GT	.79	2B7	.79	6AR5	.79	6J7	.99	6V6G	.89	12AT6	.55	19	.89	71A	.79	1P23	4.10
1B3GT	.99	2E5	.94	6AS5	.99	6J7GT	.79	6V6GT	.67	12AT7	.99	19T8	.99	75	.85	1P24	1.27
1B4P	.79	2X2	.50	6AS6	2.25	6J8G	1.28	6W4GT	.64	12AU6	.71	22	1.16	76	.69	1S21	9.50
1B5	.74	2X2A	1.85	6AS7G	4.25	6K5GT	.99	6W6GT	.88	12AU7	.86	24A	.89	77	.69	1Z2	3.75
1C5GT	.85	3A4	.65	6AT6	.63	6K6GT	.65	6X4	.59	12AV6	.54	25A6	1.16	78	.79	2A4G	1.22
1C6	.69	3A5	.95	6AU5GT	1.21	6K7	.79	6X5GT	.59	12AV7	.99	25L6GT	.69	79	.89	2AP1	8.95
1C7G	.69	3A8GT	1.50	6AU6	.65	6K7G	.86	6Y6G	.89	12AW6	1.20	25Z5	.79	80	.59	2AP5	8.95
1D5GP	.69	3B7	.57	6AV6	.55	6L5G	1.06	6ZY5G	.89	12AX7	.99	26	.79	81	1.41	2B4	2.10
1D7G	.69	3C6	1.15	6B4G	1.25	6L6	1.87	7A4	.76	12BA6	.69	27	.69	82	1.19	2B22	2.20
1D8GT	.71	3D6	.57	6B5	1.20	6L6G	1.49	7A5	.79	12BA7	.95	28D7	1.95	83	1.11	2C21	.65
1E5GP	.71	3LF4	.91	6B7	.95	6L6GA	1.39	7A6	.75	12BD6	.99	30	.70	83V	1.25	2C22	.45
1F4	.69	3Q4	.77	6B8	.75	6L7	.99	7A7	.76	12BE6	.66	30 Spec	.45	84/6Z4	.75	2C26	.39
1F5G	.69	3Q5GT	.83	6B8G	.75	6L7G	.85	7A8	.78	12C8	.65	31	.54	85	.79	2C26A	.49
1F6	.71	3S4	.77	6BA6	.65	6N7	.99	7AD7	1.44	12F5GT	.79	32	.69	89Y	.55	2C33	4.95
1G4GT	.69	3V4	.79	6BA7	1.20	6N7GT	.89	7AH7	1.08	12H6	.69	32L7GT	.87	117N7GT	1.89	2C34	.49
1G5G	.69	5AZ4	.54	6BC5	.88	6P5GT	.96	7B4	.79	12J5GT	.55	33	.69	117P7GT	1.89	2C39	22.00
1G6GT	.69	5R4GY	1.59	6BC7	1.10	6Q7	.89	7B5	.79	12K8	.70	34	.69	117Z3	.65	2C39A	29.00
1H4G	.89	5T4	1.91	6BD5GT	1.60	6R7	.79	7B6	.79	12Q7GT	.67	35/51	.59	117Z6GT	.97	2C40	12.00
1H5GT	.69	5U4G	.59	6BD6	.85	6S4	.72	7B7	.79	12SA7GT	.69	35A5	.72	FM-1000	1.59	2C42	23.75
1H6G	.75	5V4G	.98	6BE6	.65	6S7	1.06	7B8	.78	12SF5	.79	35B5	.75	Transmitting and Special Purpose Tubes		2C43	17.75
1H6GT	.79	5W4	.82	6BF5	1.10	6S7G	.99	7C4	.45	12SF5GT	.79	35L6GT	.67			2C44	1.20
1J5G	.74	5X4G	.79	6BF6	.83	6SA7	.71	7C5	.79	12SF7	.85	35W4	.55			2C46	21.50
1J6G	.69	5Y3GT	.47	6BG6G	1.89	6SA7GT	.67	7C6	.79	12SG7	.85	35Y4	.72			2C51	5.75
1L4	.69	5Y4G	.71	6BH6	.95	6SB7Y	1.05	7C7	.79	12SH7	.73	35Z4GT	.69			2C53	11.75
1LA4	.87	5Z3	.87	6BJ6	.95	6SC7	.93	7E5	.79	12SJ7	.71	35Z5GT	.55	OA2	.95	2D21	1.55
1LA6	.99	5Z4	1.40	6BK7	1.60	6SD7GT	.94	7E6	.58	12SJ7GT	.65	36	.64	OA3	1.15	2E22	1.85
1LB4	1.01	6A6	.82	6BL7GT	1.45	6SF5	.83	7E7	.83	12SK7	.69	37	.69	OA4G	1.25	2E24	4.10
1LC5	.81	6A7	1.05	6BN6	1.59	6SF5GT	.80	7F7	.99	12SL7GT	.93	38	.69	OB2	1.10	2E26	2.85
1LC6	.93	6A8	.95	6BQ6GT	1.26	6SF7	.75	7F8	1.35	12SN7GT	.89	39/44	.59	OB3	1.19	2J21	8.75
1LD5	.93	6AB4	.83	6C4	.55	6SG7	.75	7G7	.89	12SQ7GT	.68	41	.71	OC3	1.10	2J22	8.95
1LE3	.93	6AB7	.98	6C5	.70	6SH7	.75	7H7	.79	12SR7	.79	42	.79	OD3	.95	2J26	24.75
1LH4	.82	6AC5GT	1.19	6C6	.73	6SH7GT	.75	7J7	1.10	12SR7GT	.89	43	.79	1B21A	2.65	2J27	22.95
1LN5	.74	6AC7	.85	6C8G	.96	6SJ7	.71	7K7	1.10	12X3	.89	45	.79	1B22	2.50	2J31	27.00
1N5GT	.83	6AC7W	3.25	6CB6	.79	6SJ7GT	.69	7L7	.97	12Z3	.89	45Z5GT	.89	1B23	9.60	2J32	36.50
1N6G	.75	6AD6G	.98	6CD6G	2.21	6SJ7Y	.85	7N7	.97	14A4	.97	46	.81	1B24 West	12.95	2J33	39.50
1P5GT	.69	6AD7G	1.29	6D6	.88	6SK7	.72	7Q7	.79	14A7	.74	47	.99	1B24SYLV	18.95	2J34	27.00
1Q5GT	.99	6AE6G	.89	6D8G	.83	6SK7GT	.72	7R7	.94	14B6	.74	50	1.09	1B24A	39.50	2J37	13.70
1R4	.69	6AF6G	.89	6E5	1.10	6SL7GT	.81	7S7	1.11	14B8	.89	50A5	.89	1B26	3.73	2J38	17.50
1R5	.79	6AG5	.79	6F5GT	.83	6SN7GT	.73	7V7	1.11	14C5	1.10	50B5	.69	1B27	14.95	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	.85
		83-22J	1.40		

FULL LINE OF JAN APPROVED COAXIAL CONNECTORS IN STOCK UHF—N—PULSE—BN—BNC

UG-7/AP	$6.30	UG-23B/U	$1.50	UG-58/U	$.70	UG-104/U	$1.40	UG-185/U	$.95	UG-261/U	$1.10
UG-12/U	.95	UG-23C/U	1.10	UG-58A/U	.90	UG-106/U	.15	UG-191/AP	.80	UG-262/U	1.10
UG-15/U	1.25	UG-24/U	1.30	UG-59A/U	2.15	UG-107B/U	2.75	MX-195/U	.75	UG-273/U	1.45
UG-18/U	1.25	UG-25/U	1.35	UG-60A/U	1.75	UG-108/U	2.60	UG-197/U	2.80	UG-274/U	2.30
UG-18B/U	1.05	UG-27/U	1.25	UG-61A/U	2.10	UG-109/U	2.60	UG-201/U	1.95	UG-275/U	5.50
UG-19/U	1.60	UG-27A/U	2.25	UG-83/U	1.75	CW-123A/U	.45	UG-203/U	.65	UG-276/U	2.75
UG-20B/U	1.60	UG-28A/U	2.95	UG-85/U	1.60	UG-146/U	1.95	UG-206/U	1.80	UG-290/U	.90
UG-21/U	.85	UG-29/U	.95	UG-86/U	2.25	CW-159/U	.60	UG-224/U	1.15	UG-291/U	.95
UG-21A/U	1.50	UG-29A/U	1.85	UG-87/U	1.40	UG-166/U	32.50	UG-236/U	3.85	UG-306/U	2.65
UG-21B/U	1.00	UG-29B/U	1.75	UG-88/U	.90	UG-167/U	3.75	UG-245/U	2.25	UG-349/U	2.65
UG-21C/U	1.05	UG-30/U	2.30	UG-89/U	1.10	UG-171/U	2.25	UG-246/U	2.35	MX-367/U	.85
UG-22/U	1.30	UG-34/U	9.75	UG-90/U	1.15	UG-173/U	.35			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-498/U	1.80
UG-22C/U	1.20	UG-37/U	17.50	UG-102/U	.80	UG-176/U	.12	UG-255/U	1.95	UG-536/U	1.65
UG-23/U	1.20	UG-57B/U	1.85	UG-103/U	.68	UG-177/U	.24	UG-260/U	.85	UG-625/U	1.35

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-57/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
2	400	$ .55
5-5	400	1.65
1	600	.55
2	600	.69
2-2	600 R'd	1.65
3	600	.95
4	600	1.65
4	600 R'd	1.65
5	600	1.75
6	600	1.85
8	600 R'd	1.85
8-8	600	1.95
4-4-4	600	2.50
4 x 3	600	2.50
10	600	3.25
50	600	7.95
1	1000	.65
2	1000	.90
2	1000 R'd	.95
3.5-.5	1000	1.85
4	1000	1.95
6	1000	2.50
8	1000	3.25
1	1200	.85

MFD	VDC	Price
1-1-1	1200	$1.85
.1	1500	.69
3	1500	2.50
4	1500	2.95
.1-.5	2000	.95
.25	2000	1.50
.3	2000	1.30
1	2000	1.95
3	2000	3.75
12	2000	8.95
1	2500	2.75
1-1	2500	3.85
32	2500	15.80
.5	3000	2.40
1	3000	3.40
.03	4000	1.25
3 x .2	4000	2.95
2	4000	6.95
.2	5000	2.50
1	5000	4.88
2	5000	18.50
5	5000	29.50
.01-.03	6KV	1.65

MFD	VDC	Price
1	6000	$9.95
.1	7000 R'd	1.79
.1-.1	7000	5.95
.1	7500	2.85
.5	7500	7.95
.075-.075	8KV	6.50
1	10KV	29.50
.1	12KV	8.95
1	15KV	45.00
.045	16KV	4.70
.05	16KV	4.95
.25	20KV	19.95
1	20KV	54.00
1	25KV	85.00

MFD	VDC	Price
.001	50KV	$24.50
.025	50KV	42.50
.2	50KV	85.00
.25	50KV	95.00
7.5	220VAC	1.95
1-3	330VAC	1.95
12.75	330VAC	4.10
15	330VAC	4.50
5	440VAC	3.10
2.9	660VAC	3.50
7	660VAC	4.25
8	660VAC	4.50

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

In Stock—Immediate Delivery

UTAH 0A-18 X124T-2 9262 9278 9280 9318 9340 9341 9350 UTAH

G.E.—K2464	AN/APN-9 (352-7250)
G.E.—K2468	AN/APN-9 (352-7251)
G.E.—K2469	AN/APN-9 (901756-501)
G.E.—K2744B	AN/APN-9 (901756-502)
G.E.—68G627	Westinghouse—132AW2
G.E.—68G828	Westinghouse—139DW2F
G.E.—68G929G1	Westinghouse—166AW2F
G.E.—80G13	Westinghouse—176AW2F
G.E.—80G152	Westinghouse—187AW2F
Philco—352-7071	Raytheon—UX-7350
Philco—352-7149	Raytheon—UX-10066
Philco—352-7150	W.E.—D-161310
Philco—352-7178	W.E.—D-163247
Philco—352-7190	W.E.—D-163325
Philco—352-7224	W.E.—D-164661

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	59.98
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-4	AN/ARC-5	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

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STANDARD BRANDS ONLY

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Type	Price
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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
2K41	145.00
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
3C22	89.50
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/EL-5B	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
4X150A	36.00
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
13T4	.85
15E	1.95
15R	.65
FG-17/5557	4.95
REL-21	1.95
23D4	1.15
24G	1.85
HK-24	4.95
RK-25	3.82
FG-27A	8.25
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-245A	2.35
WE-249B	3.50
WE-249C	3.50
250R	17.50
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
410R	185.00
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	5.75
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
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	2.25
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
5670	4.10
5687	4.80
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
8014A	55.00
8016	1.05
8020	1.25
8025	6.95
8025A	4.75
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

Type	Price
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	1.45
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"	250K	SS
500	SS	10K	1/2"	250K	3/4"
500	1/2"	15K	SS	250K	3/8"
500	5/8"	15K	1/2"	500K	SS
650	1/2"	20K	SS	500K	1/4"
1K	SS	25K	SS	500K	7/16"
1K	1/2"	30K	1 1/8"	1 Meg	SS
2K	3/8"	40K	SS	2.5 Meg	SS
2500	SS	50K	SS	5 Meg	SS
4K	SS	50K	1/4"		
5K	SS				

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 ⅝"

TRIPLE "JJJ" POTS—$3.95 ea.

100K/100K/100K ⅝"   20K/150K/15K ⅜"

ANTENNAS

AN-74BX .... $ 3.75
AT-38A/APT (70 to 400 MC) 13.70
AT-49/APR-4 (300 to 3300 MC) 13.70
AN-65A(P/OSCR-521) 1.50
AN-66A(P/OSCR-521) 1.75
AIA 3CM conical scan 125.00
ASB Yagi—5 element 450 to 560 MC 9.00
ASB Yagi—Double stacked 6 element 14.70
ASA Yagi—Double stacked 370 to 430 MC 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.

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.

CABLE ADDRESS • "LECTRONIC PHILADELPHIA"

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—SPDT 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
Weston 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 (New) $85.00
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.

CERAMIC-CASED TYPE G MICA CONDENSERS

.09 MFD 1500 VDC G1 .... ea. $9.25
.02 MFD 3000 VDC G1 .... ea. 9.25
.004 MFD 6000 VDC G1 .... ea. 18.10
.00015 MFD 20000 VDC G3 .... ea. 24.50

LECTRONIC RESEARCH LABORATORIES

715-19 ARCH ST.   PHILA. 6, PA.

Telephones - MARKET 7-6771-2-3

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. 5AS1315511A. 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. 5AM21J7. 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 8.8 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

MISCELLANEOUS

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

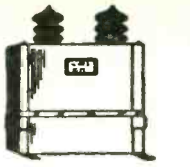
Instruction Manual for SCR 193A, B, C, D, E.......................... $2.00

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	.0000[illegible]	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)

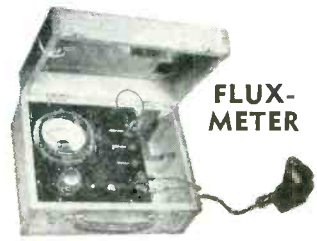
SO-1 (6AGE) Antenna Waveguide Resonance Chamber Assemblies (RF515)

SO-1 RF Coupling Waveguide to Transmitter (Z304)

SO-1 RF System and duplexing cavity (RF301 with V309)

FLUX-METER

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**

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 $149.50

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, 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.

CONSTANT OUTPUT AMPLIFIER

Constant Output Amplifier BC-730-C is a speech amplifier for operation between 600 ohm lines. It raises any level as low as —35db up to zero db and compresses 10db peaks into 1db. A peak of 10db causes no appreciable change of output. Frequency response uniform within 1db from 100 to 4000 cycles. With inputs of —35db to —60db the gain is bet. 35db and 38db. Relay rack panel with dust cover. Milliameter and db meter on front panel. 115V AC operated. Includes 5 tubes. New, limited quantity. $59.50

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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

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KS-161310—50kc to 4MC.......... $3.95

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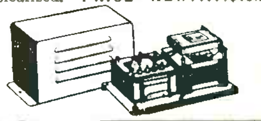
Adj. input taps 95-130V., 60 cy. 1 Ph. Output: 115V. 60 Watts, ½ of 1% Reg. Wt. 20 lbs. 6½" H x 8¾" L x 4⅝" W. Overload protected. Sturdily constructed. Tropicalized. PRICE—NEW..... $16.75



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Fil. IN: 0/75/80/85/105/115/125. Out: 5V3A/5V3A/5V3A/5V6A/6.3VO.5A No. 7249010 .... $1.95

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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

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#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 7⅛ x 6⅝ x 3¾....... $6.95

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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

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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 9⅛ x 13. Weight 143 lbs. Type 900777-502. Price, new..... $97.50

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Sylvania 1N21B. Individually boxed and packed in leaded foil............ $3.00

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1B22	3.95
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1B26	2.95
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1B32	4.10
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1B42	19.95
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1B60	69.95
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1N21A	1.75
1N21B	4.25
1N22	1.75
1N23	2.00
1N23A	2.75
1N23B	4.25
1N34A	.96
1N43	2.50
2B22	1.95
2B26	3.75
2C34	.35
2C40	10.00
2C43	15.00
2C44	.90
2D21	1.75
2E22	2.75
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805	5.95

TYPE	PRICE
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807	1.69
808	3.50
810	11.00
811A	3.95
813	9.95
814	3.95
815	3.50
816	1.45
829	12.95
829A	13.95
829B	15.95
830B	2.50
832	7.95
832A	9.95
833A	49.95
834	7.95
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TYPE	PRICE
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956	.69
957	.29
958A	.69
991	.65
F1148	.35
1280	1.25
1611	1.95
1613	1.38
1616	2.95
1619	.89
1622	2.75
1624	2.00
1625	.45
1851	1.85
5J26	50 00
2050	1.85
2051	1.80
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8012	4.25
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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.

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Other test equipment, used checked out, surplus.

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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
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TS33/AP X Band Power and Frequency Meter
TS/34AP Western El Synchroscope
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TS35/AP X Band Signal Generator
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APA10 Oscilloscope and panoramic receiver
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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.

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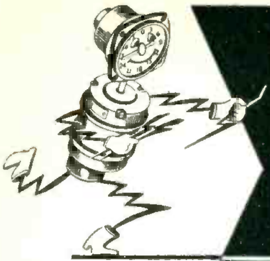

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SERVO MOTORS • ACTUATORS • GEAR MOTORS • GENERATORS

Guaranteed to Meet Original Manufacturers' Specifications

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Brown Instrument Co. "Elec-tronik Recorder." 12" circular chart revolves at one revolution per 10 minutes. Center zero, 200 microvolts d-c for full scale. Operates from 110 volts 60 cycles. Contains d-c chopper and a-c amplifier which drives a servo motor, plus recording mechanism. 5-0-5 scale for direct reading. Complete with charts. Only 3 available. Makes excellent recording galvometer. SA-261 .... $195.

HIGH PRECISION AUTOSYN

Pioneer Type AY-201-3-B Transmitter or Control Transformer, for controlled servo circuits. Same as AY-200-3 and AY-202-3 except for shaft detail. 26 volts 400 cycles single phase. Maximum error 15 minutes. Shipped with individual calibration curve. Eclipse-Pioneer specification sheet available on request. Weight 5 oz. maximum
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1 HP. VARIABLE SPEED DRIVE MOTOR

Louis-Allis "Adjusto-Spede" Squirrel cage a-c motor, electro-magnetic clutch and pilot governor. Speed range 0 to 1050 rpm. 208 volt 3 phase 60 cycles. Control excitation 0 to 10 volts d-c. Only small quantity available. SA-133 .... $125

HIGH CURRENT D-C POWER SUPPLY

Hammett Electric Model SPS-100B. Input 220 volts 3 phase 50-60 cycles. Output 12/24 volts d-c at 130/65 amps. continuous. The output voltage and current are both metered separately. Fan cooled. Only 4 available. .... $195.

DELCO 250 RPM. MOTOR NO. 5071895

27.5 volts d-c. Reversible two lead permanent magnet motor, 45 in.-oz stall torque. 8 in.-oz operating torque. 1⅜" diam. x 3¼" long. ¼" shaft extends ⅜". Also in stock similar PM motors with output speeds of 120, 145, 190 rpm. Weighs 7 oz.
SA-342 .... $29.50

U.S. NAVY SYNCHROS

We have in stock large quantities of Navy Ordnance Synchros guaranteed to meet original manufacturers' specifications. The following are a few of the most popular types: 1F, 1DG, 5F, 5G, 5 CT, 5 DG, 5D, 5HCT, 5 SF, 5SG, 6G, 6CT, 6DG, 7DG. Our stock also includes Army Ordnance, G-E, Bendix, Henschel, & Diehl types. Write for quotations.

PU7/AP AIRCRAFT INVERTER

Manuf. Windcharger. Input 28 volts d-c. Output 115 volts 400 cycles single phase — 2500 va. Voltage & frequency regulated. New original boxes. Special price. SA-164 .. $99.50

Other inverters in stock include:
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I-82-F RADIO COMPASS INDICATOR

Fairchild Instrument. 5 inch 0 to 360 degree dial. 26 volts-400 cycles single phase. May be operated on 10 to 15 volts 60 cycles. Kollsman design.
SA-284 .... $6.50 ea.

400 CYCLE TRANSTAT

Input 115 volts, 400 cycles single phase. Output 75 to 120 volts at 6.0 amp. Completely enclosed with AN connector for input and output. Locking device for permanent setting.
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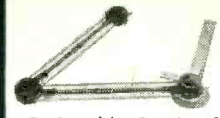
Standard Type FQ. 6 in. push-pull cylinder. Operates with any air pressure up to 350 pounds. Control valve is electrically operated with 24 volts d-c. Ideal for remote or automatic control.
SA-370 .... $12.50

DRAFTING MACHINE



Will save many hours of labor on plans, schematic drawings, etc. Each arm 18 inches long with full ball bearing construction. Designed by Bruning for the Navy and modified by Servo-Tek to be equal to their standard machine, with chucks to hold standard vertical and horizontal scales. Supplied with one 18 inch duraluminum Bruning scale.
SA-375 .... $39.50
Additional 12" aluminum scale for above
SA-376 .... $4.85

AIRCRAFT GENERATORS
$29.50 any type

SA-378 — Eclipse 310-27A — 15 volts d-c @ 50 amp.
SA-377 — Eclipse 703-3 — 15 volts d-c @ 25 amp.
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SA-412 — Army Type P-1 — 28 volts d-c @ 200 amp.
SA-306 — Eclipse 716-3A — NAVY NEA3 115 volts a-c @ 10.4 amps. and 30 volts d-c @ 60 amp.

1.8 KVA 400 CYCLE MG SET

Louis-Allis Type LA. Input 115 volts d-c. Output 115 volts single phase 400 cycles. Unit consists of 4 hp. d-c motor, 1.8 kva generator, and d-c excitor for generator. Motor speed 3450 rpm. Only 1 available .... $295.

SYNCHRO TRANSMITTER

C-78411 (Type V111) 50 volts 50 cycles. Torque grad. .22 in.-oz per degree. May be used on 60 cycles. Special price.
SA-221 .... $19.50

TORQUE UNIT-PIONEER NO. 12602-1-A

Consists of a CK-5 Motor and AY-43 Autosyn. The motor is coupled to the output shaft through a 125:1 gear reduction and the Autosyn through a 30:1 reduction. Similar to Pioneer Type 12606 except has base mounting. Leads brought out with lugs to attach to terminal strip. Other Pioneer Torque Units in stock. SA-89 .... $89.50

MOTORIZED MODULATING TEMPERATURE CONTROL

White - Rodgers Type 6203X. 24 volts d-c at .4 amp. Adjustable temperature range of 340 to 550 degrees F with a differential of 30 degrees. 30 seconds for 90 degree rotation. ¼" ouptut shaft extends ½". 10¾" x 2¾" x 3½". SA-393 .... $59.50

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Exhibit Supply Co. — Range 80-160 psi. Pressure activates normally open Micro Switch. 2¼" x 1¼" x 4¾".
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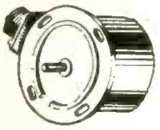

Continuous rotation, 100 ohm. res. 2 take-off brushes set at 180 deg. to provide sawtooth output. May be used with milliammeter circuit as 0-360 deg. direction indicator. Brand new, original packing

WE 15038 ..... **$5.75**

SPARES FOR APN-9

Power Trans., Pt. No. 352-7295-2.........$4.95 each
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I. F. Trans: T107-T110 Pt. #352-1554S...$1.00 each
Resistor: R150, R157, R162 84,000 OHMS.. .50 each
Resistor: R130, 220,000 ohms.............. .50 each
Resistor: R159 120,000 ohms............... .50 each
Resistor: R152, R164, 17,000 ohms......... .35 each
Resistor: R142, 4300 ohms.................. .35 each

APN-4 COILS

352-1585........ .49 352-1549........ $1.00
352-1269........ .49 352-1550........ $1.00

EE-89 REPEATER

Extends range of EE-8 field phone up to 20 miles of dry or wet wire operation. Extremely rugged, portable and lightweight. Uses hybrid coils and V. T. Amplifier, with extreme long-life characteristics.
Brand New, Complete With Tube & Tech. Manual, only........... **$12.75 each**

HELMHOLTZ PHASE-SHIFTER

Stator consists of 4 loops oriented at 90 degrees to each other. Total stator inductance is 40 MH. rotor: 10MH. total phase shift 0-360 deg. Designed for range unit of SCR-268...... **$3.95 each**

BIRTHER TUBE CLAMPS

926B-16 926C-19 926C-24
926B-15 926C-15 926K-2

PRICE: 18¢ EACH OR $16.50/100

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	......	......

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 II
			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 375
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"x5⅛"x10⅛". Bew............$22.50
LELAND No. 10536: IN: 28 VDC, 12A. OUT: 115V, 115VA. 400 CY 3 PHASE. EXC. COND.....................$70.00

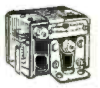
IN STOCK

- APN-3*
- APN-4*
- APN-7
- APN-9*
- APS-2
- APS-3*
- APS-4
- APS-6*
- APS-10*
- APS-15*
- SE
- SG
- SN
- SO
- SQ
- TAJ
- TBK
- BG (iff)

* Major Components and/or Spare Parts

D.C. RELAYS*

CR2792B116A3

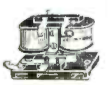


SPST—50 Amp Contacts. Operates from 22-30 VDC. Coil Res. 200 Ohms. Completely enclosed in transparent plastic case, which may be removed for adjustments.. **$1.59**

GE#CR2791B116W3

Same as above, except additional terminal brought out from contact arm.................... **$1.74**

GE#CR2791-F100D3

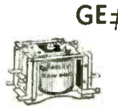


Differential: DPST, Norm. open. Dual coil, 1500 ohms per coil—25 Ma. Operating Current. Contacts: 20 Amp. **$2.25**

GE#CR2791F100G3

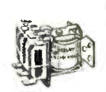
Same as above, except has extra 1A contact. Rated 5 Amp........ **$2.35**

GE#CR2791D101F3



All Ceramic Insulation, DPDT, Coil—12VDC, 100 Ohms DCR. Contacts designed for fast operation. Rated at 5 Amps... **$1.25**

GE#CR2791B106J3



3PDT, 5 Amp contacts. Coil rated 22-30VDC. 150 Ohms DCR. Contacts are designed for fast operation, and enclosed by clear plastic cover **$1.35**

GE#CR2791B106C3

SPDT, Dual Contacts will handle 20 Amps. Coil: 18-28VDC 125 Ohms DCR **$1.25**

***THESE RELAYS AVAILABLE IN MFRS. QUANTITIES**

W. E. PRECISION RESISTORS

1% TOL. 1 WATT

D-164886A	2.65 ohms
D-164886AA	3.83 ohms
D-167026*	13,500/ 10,000 ohms
D-162025AT*	1400/135/ 270 ohms
D-164285*	40,600/1500 ohms
D166860FL	1155 ohms
D-162707CY	2500 ohms
D-171862	279 ohms
D-171863	591 ohms
D-164286*	10,000/ 15,000/ 62,000 ohms
D-164284*	100,000/ 50,000 ohms
D-172241*	400/600/700/ 750 ohms

SPOOL-WOUND, NON-INDUCTIVE **85¢ EA.**
* TAPPED AT VALUES SHOWN

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: 20 V @ 10A 3.95
Pri: 115V 60 Cy. Sec: 8.1V @ 1.5A 1.39
Pri: 115V 60 CY. Sec: 18.5V @ 5A......... 4.25

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, 5 VCT/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 .050 A 5VCT/3A	2.25
CT-403	350VCT .026 A 5V/3A	2.75
CT-931	585VCT .086 A 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	4.95
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-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-824	2x26V/2.5A, 16V/1A, 7.2V/7A, 6.4V/10A, 6.4V/2A	8.95
FT-463	6.3VCT/1A, 5VCT/3A, 5VCT/3A	5.49
FT-55-2	7.2V/21.5A, 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, 16 KV TEST	18.95
FT-608	6.3V/3A/750V Test	1.79
FT-873	4.5AV/.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

ELECTROLYTIC CAPACITORS

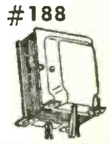
TWIST PRONG

Cap. Mfd	WVDC	Price
8	450	$0.16
30	300	.18
40	450	.38
50	400	.36
60	300	.21
80	150	.29
8 8	450	.24
30-20	25	.16
20-20	150	.23
80-80	300	.21
90-10	350	.21
80-10	450	.49
150-50-25	150	.49
80-10-10-10	300	.21
40-40-20-20	150	.28
30-15-15-15	300	.28
80-10-10-10	350	.32
40/10	450/350	.55
40/20	150/25	.21
40/50	400/300	.28
80/50	450/50	.65
250/1000	10/6	.30
8-8-10	450/25	.26
10-10/10	150/25	.23
10-10/20	450/25	.26
10-15/20	350/25	.18
15-15/10	450/350	.23
80-40/150	400/50	.45
120-60/20	150/25	.45
30-30-15/30	300/50	.39
40-40-20/20	350/15	.28
60-40-20/50	300/25	.28
60-40-20/200	150/10	.39
80-40-30/20	150/25	.36
80-40-30/100	150/25	.36
8/8/8	475/100/100	.23
10/50/100	350/100/50	.23
10/50/100	450/100/50	.27
20/20/10/20	350/300/300/25	.35

UPRIGHT OIL CAP.

MFD	Each
220VAC/600VDC	
6.2	$1.29
15	3.49
330VAC/1000VDC	
15	3.79
1000VDC	
.5	.69
.5-.5	1.19
1	1.49
4-1.5	2.19
1.5	1.39
1500 WVDC	
1	1.59
1.5	1.59
2	1.79
2000 WVDC	
1	1.79
2500 WVDC	
.5	2.98
4000 WVDC	
.15	6.95
4800 WVDC	
.1-.1	4.79
6000 WVDC	
.1	3.69
.15-.15	3.89
1.5	10.98
7000 WVDC	
.1-.1	3.79
1	9.95
8000 WVDC	
.075-.075	3.79
10K VDC	
.1	8.95
15K VDC	
.0016	7.95
16K VDC	
.015	9.50
20K VDC	
.25	17.50
25K VDC	
1	85.00
.5	65.00

TRANSFORMER SPECIAL #188



For amplifiers, transmitters, exciters, receivers, etc. ratings: Primary 115V, 50-60 cycles. Secondary delivery 750 VCT at 250 MA. Filaments: 5V @ 3A, 6.3V @ 2A and 6.3V @ 8A. Electrostatic shield bet. Primary & secondary.
A Great Buy At Only..... $5.75 each

ALL MERCHANDISE IN NEW CONDITION AND FULLY GUARANTEED, EXCEPT WHERE NOTED OTHERWISE.

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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COMMUNICATIONS EQUIPMENT CO.

MICROWAVE COMPONENTS

S BAND—RG 48/U W.G. 10 CM.

POWER SPLITTER for use with Type 726 or any 10 CM Shepherd Klystron. Energy is fed from Klystron Antenna thru dual pick-up system to 2 Type "N" connectors as shown. EACH $22.50

DIRECTIONAL COUPLER, Broadband, 20 db. Coupling. Type "N" Takeoff. Complete with all Hardware. Navy # CABY-47AAN-2 .... $37.50

LHTR LIGHTHOUSE ASSEMBLY. Part of RT39 APG 5 & APG 15. Receiver and Trans. Cavities w/assoc. Tr. Cavity and Type N CPLG. To Recvr. Uses 2C40, 2C43, 1B27. Tunable APX 2400-2700 MCS. Silver Plated $49.50

BEACON LIGHTHOUSE cavity 10 cm. Mfg. Bernard Rice, each $47.50

MAGNETRON TO WAVEGUIDE Coupler with 721A Duplexer Cavity, gold plated $45.00

RT-39/APG-5 10 cm. lighthouse RF head c/o Xmtr.-Recvr.-TR cavity, compl. recvr. & 30 MC IF strip using 6AK5 (2040, 2C43 1B27 lineup) w/Tubes.

721A TR BOX complete with tube and tuning plungers $12.50

McNALLY KLYSTRON CAVITIES for 707B or 2K28 .... $4.00

F 29/SPR-2 FILTERS, type "N" input and output Hi-Pass Over 1000 MC $12.50

WAVEGUIDE TO 7/8" RIGID COAX "DOORKNOB" adapter choke flange. Silver plated broad band $32.50

AS14A/AP-10 CM Pick up Dipole with "N" Cables $4.50

OAJ ECHO BOX, 10 CM TUNABLE $22.50

HOMEDELL-TO-TYPE "N" Male Adapters, W.E. #D167284 .... $2.75

I. F. AMP STRIP: 30 MC 120 d.b. gain, 2 MC Bandwidth, uses 6AC7's—with video detector. Less tubes $24.50

POLYROD ANTENNA, AS31/APN-7 in Lucite Ball. Type "N" feed $22.50

ANTENNA. AT49A/APR: Broadband Conical, 300-3300 MC Type "N" Feed $12.50

"E" or "H" PLANE BENDS, 90 Deg. less flanges $7.50

COAXIAL FILTER, F3/APR-2, LO-PASS, BELOW 400 MC $32.50

7/8" RIGID COAX—3/8" I. C.

ROTARY JOINT, Stub-supported, UG 46/UG 45 fittings $27.50

10 CM STABILIZER Cavity, tunable, standard UG46/UP 45 fittings $45.00

RG 44/U RIGID COAX, stub support, 5 ft. sections, with UG46/UG45 connectors $12.50

RT. ANGLES for above $4.50

RIGHT ANGLE BEND, with flexible coax output pick-up loop $8.00

SHORT RIGHT ANGLE BEND, with pressurizing nipple $3.00

RIGID COAX to flex coax connector $3.50

RT. ANGLE BEND 15" L. OA $3.50

FLEXIBLE SECTION. 15 L. Male to female .. $4.25

7/8" RIGID COAX. BULKHEAD FEED-THRU .. $14.00

X BAND—RG 52/U W.G. 3 CM.

CROSS-GUIDE COUPLER. Main Section 7" long with 90 deg. bend (E-Plane). 2½" radius. Broadbanded coupling figure is 20 db. individually calibrated .. $22.50

1" x ½" waveguide in 5' lengths, UG 39 flange to UG40 cover $7.50

Rotating joints supplied either with or without deck mounting. With UG40 flanges .... each $17.50

Bulkhead Feed-thru Assembly (As Shown) $15.00

Pressure Gauge Section 15 lb. gauge and press nipple $10.00

Pressure Gauge, 15 lbs $2.50

Waveguide Section 12" long choke to cover 45 deg. twist & 2½" radius, 90 deg. bend $4.50

Twist 90 deg. 5" choke to cover w/pres nipple .. $6.50

Waveguide Section 2½ ft. long silver plated with choke flange $5.75

Rotary Joint choke to choke with deck mounting .. $17.50

3 cm. mitered elbow "E" plane $12.00

UG 39 Flanges $1.10

UG40A/U Choke Flanges $1.50

90 degree elbows. "E" or "H" plane 2½" radius $12.50

45 degree twist $8.00

APS-4 Under Belly Assembly, less tubes $375.00

BEACON/PREAMP CONSISTS OF 2 KLYSTRON (723A) OSCILLATORS, WAVEGUIDE ASSEMBLY. 30 MC. Preamp Mixer and TR/ATR Tubes. Designed as front end assy. For receiver section of X-Band Radar Transmitter-Receiver. Ideal for schools, labs. and experimental gear. Brand New, complete with tubes $99.50

K BAND—RG 53/U W.G. 1.25CM

APS-34 Rotating joint $49.50

Right Angle Bend E or H Plane, specify combination of couplings desired $12.00

45° Bend E or H Plane, choke to cover $12.00

Mitered Elbow, cover to cover $4.00

TR-ATR-Section. Choke to cover $4.00

Flexible Section 1" choke to choke $5.00

"S" Curve Choke to cover $4.50

Adapter, round to square cover $5.00

Feedback to Parabola Horn with pressurized window $27.50

90° Twist $10.00

PULSE TRANSFORMERS

UTAH X-151T-1: Dual Transformer, 2 Wdgs. per section 1:1 Ratio per sec. 13 MH inductance 30 ohms DCR $7.50

UTAH X-150T-1: Two sections, 3 Wdgs. per section, 1:1:1 Ratio, 3 MH, 6 ohms DCR perWdg $7.50

68G711: Ratio. 4:1, 6.7 Ohms, Pri: 0.23 Ohms sec. $4.50

TR1049: Ratio: 2:1, Pri. 220 MH, 50 Ohms, sec. 0.75H, DCR 100 Ohms $6.75

K-901695-501: Ratio 1:1, Pri. Imp. 40 Ohm, Sec. Imp. 40 Ohms. Passes pulse 0.6 usec with 0.05 usec. rise $8.95

D-166173: Video. Ratio = 50:900 Ohms 10KC—2MC $12.50

G.E.K.-2745 .... $39.50

G.E.K.-2744-A. 11.5 KV High voltage. 3.2 KV Low voltage @ 200 KW oper. (270 KW max.) 1 microsec. or 1 microsec. @ 600 PPS $39.50

W.E. D169271 Hi Volt input pulse Transformer .. $27.50

G.E. K2450A. Will receive 13KV, 4 micro-second pulse on pri. secondary delivers 14KV. Peak power out 100 KW G. E. $34.50

Ray UX 7896—Pulse Output Pri. 5v. sec. 41v .. $7.50

Ray UX 8442—Pulse inversion—40v + 40v $7.50

RAY UX7361 .... $5.00

PHILCO 352-7250, 352-7251, 352-7287

UTAH 9332, 9278, 9341.

RAYTHEON: UX8693, UX5986 .... $5 ea.

W.E.: D-166310, D-16638, KS 9800, KS9948.

UTAH # 9262, with Cracked Beads, but will operate at full rated capacity $5.00

WANTED
ANY AND ALL

- Radar Eqpt.
- Test Sets
- Microwave
- Telephone Eqpt.
- Electron Tubes
- Comm. Eqpt.

Etc. Etc. Etc.

Quote Lowest Prices in First Letter

VACUUM TUBES

3B28	228A	504R	892R
3X2500A3	232C	508	893A
3X2500F3	233	575A	893AR
4B32	237A	673	FG17/17
4C35	241B	750TL	HF-3000
4X150A	242G	805	ZB-3200
5G22	249B	807	5604
AX4-125A/6155	249C	810	5619
AX4-250A/6156	HF250	813	5658
HF-60	250TL	828	5666
HF-100	250TH	832A	5667
FG105/AX105	251A	833A	5771
111H	255B	834	8002
ZB120	266B	838	8002R
HF-125	270A	845	8008
HF-130	279A	846	AX-9900/5866
HF-140	284D	849	AX-9901/5867
HF-150	HF300	849A	AX-9902/5868
HF-175	308B	849H	AX-9903/5894
HF-200	5559	851	AX-9904/5923
HF201A	2021	857B	AX-9904R/5924
203A	311CH	858	AX-9905/5895
203H	315AW	859	AX-9906/6077
204A	332A	866A	AX-9906R/6078
207	342A	866AX	AX-9907/6075
211	343A	869B	AX-9907R/6076
211C	343AA	872A	AX-9908/6079
211D	450TL	880	AX-9909/6083
211H	450TH	889A	AGR-9950/5869
212E	498	889RA	AGR-9951/5870
212F	501R	891	
220C	502	891R	
222A	502R	892	

GEIGER MULLER

75N	120NB
75NB3	150N
90NB	150NB
100C	153C
100CB	200C
100N	200CB
100NB	200N
120C	200NB
120CB	230N
120N	240C
	240N

VACUUM CONDENSERS

VC6/20	VC50/20
VC6/32	VC50/32
VC12/32	VC100/20
VC12/20	VC100/32
VC25/20	VC100A/20
VC25/32	VC100A/32

SPECIAL TYPES

6008/5911	85A1/OE3
EC 5	85A2
EFP-60	6047

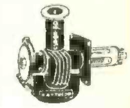
THERMISTORS

D167018	$1.50
D167332	1.50
D167613	1.50
D166228	1.50
D164699	2.50
D166792	2.15

VARISTORS

D171812	$1.50
D172155	1.50
D167176	1.50
D168687	1.50
D167208E, D171858	1.50
308A, 27-B	1.50
D168403	2.15

MAGNETRONS



Type	Price	Type	Price
2J21	$8.75	2J39	$24.50
2J22	7.50	2J49	59.50
2J27	19.95	2J61	34.50
2J31	24.50	2J62	34.50
2J32	28.50	2J31	85.00
2J37	12.50	725-A	Write
2J38	16.50	730 A	24.50

QK 60, 61, 62—$85 ea.

PULSE NETWORKS

15A—1-400-50: 15 KV. "A" CKT. 1 microsec. 400 PPS. 50 ohms imp $37.50

G.E. #3E (3-84-810) (8-2-24-405) 50P4T: 3KV "E" CKT Dual Unit: Unit 1, 3 sections, 0.84 Microsec. 810 PPS. 50 ohms imp: Unit 2, 8 sections, 2.24 microsec. 405 PPS. 50 ohms imp $6.50

7-5E3-1-200-67P. 7.5 KV. "E" Circuit. 1 microsec. 200 PPS. 67 ohms impedance 3 sections $7.50

7.5E3-3-200-6FT. 7.5 KV. "E" Circuit, 3 microsec. 200 PPS. 6 ohms imp. 3 sections $12.50

#755: 10KV. 2.2usec. 375 PPS. 50 ohms imp .. $27.50

#754: 10KV. 0.85usec. 750 PPS. 50 ohms imp .. $27.50

KS8865 Charging Choke: 115-150H @ .02A, 32-40H @ .080A, 30,700V Corona, 21KV Test $37.50

G.E. 25E5-1-350-50 P2T. "E" CKT, 1 Microsec. Pulse @ 350 PPS. 50 ohms 2, 25KV $69.50

DELAY LINES

KS9623 CHARGING CHOKE: 16H @ 75 MA, 380 OHMS DCR, 9000 VAC TEST $14.95

D-168184: 0.5 microsec. up to 2000 PPS 1800 ohm term $4.00

D-170499: 25/.50/.75 microsec. 8 KV 50 ohms imp $16.50

D-165997: 1¼ microsec. $7.50

RCA 255686-502, 2.2μ sec. 1400 ohms $2.00

MICROWAVE ANTENNA EQUIPMENT

AT49A/APR—Broadband Conical, 300-3300 MC. Type N Feed. (AS SHOWN) $12.50

AS-31/APN-7: 10 cm Polyrod in Lucite Ball. Type N Fitting Coax Feed. $22.50

Relay System Parabolic reflectors approx. range 2000 to 6000 Mc. Dimensions 4½" x 3'. New $100.00

Dipole for above $12.00

TDY "JAM" Radar rotating antenna. 10 cm. 30 deg. beam. 115 V AC drive. New $150.00

Parabolic Peel. Radiation pattern approx. 25 deg. in horizontal 33 deg. in vertical planes $35.00

Cone Antenna. AS 125 APR. 1000-3200 mc. Stub supported with type "N" connector $14.50

AS14A/AP, 10 CM pick up dipole assy. complete w/length of coax and "N" connectors $3.50

AS46A/APG-4 Yagi Antenna, 5 element array .. $22.50

30" Parabolic Reflector Spun Aluminum dish $4.85

RADAR ANTENNAS

AS-12/APS-3	AS-125/APR
AS-17/APS-2	AS-217/APG-15
AS-13/APG-2	AT49/APR
AS69/APT	AS-14/AP

30' SIGNAL CORPS RADIO MASTS

Complete set for erection of a full flat top antenna. Of rugged plymold construction telescoping into 3 ten-foot sections for easy storage and transportation. A perfect set-up for getting out. Supplied complete: 2 complete masts, hardware, shipping crate. Shipping wt. approx. 300 lbs. Sig. Corps No. 2A289-223-A. New .... $49.50 per set

400 CYCLE TRANSFORMERS

(All Primaries 115V, 400 Cycles)

80G198	6VCT/.00006 KVA	1.75
302433A	6.3V/9.1A, 6.3VCT/6.5A, 2.5V/3.5A, 2.5V/3.5A	4.85
KS 9445	592VCT/118MA, 6.3V/8.1A, 5V/2A	5.39
KS 9685	6.4/7.5A, 6.4V/3.8A, 6.4V/2.5A ALL CT	4.79
70G30G1	600VCT/36MA	2.65
M-7474318	2100V/.027A	4.95
95-G-45	2000V/.002A, 465V/.6A, 44V/10A, 6.3V/23.5A, 6.3V/1.8A, 5V/9A, 2X2.5V/1.75	17.95
TRANSTAT	IN: 115V, 400 CY. OUT: 75-120V, 6.0 Amps	12.95
M-7467886	2X140V/.014A, 120V/.012A, 1200VRMS Test, P/O MX-8/APG-2	4.95
352-7102	6.3V/2.5A	1.45
M-7472426	1450V/1 MA, 2.5V/1.75A, 6.4V/3.9A, 5V/2A, 6.5V/.3A P/O ID-39/APG-13	4.95

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RELAYS

RELAYS

RELAYS

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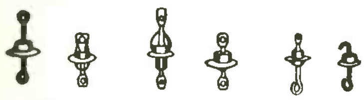
Universal general corp.

TERMS:—All Prices F.O.B. Our Plant. Rated Firms Net 10 Days. All others Remittance with Order. Orders Under $10 Remittance With Order, Plus Approximate Shipping Charges (overage will be returned.)

KOVAR GLASS TO METAL SEALS HIGH-VOLTAGE FEED THRU



Many types and sizes. Send us your blueprint or sample for our quote. Our prices are a fraction of original factory cost.

SAMPLE KIT 96 Seals (8 ea. 12 types) **5.00** postpaid in USA

LAB KIT 300 Seals (20 types) **15.00** postpaid in USA

H-F TIE POST

Low-loss Melamine Insulation, pictured actual size (4-40 Thread).....7.50/C. $67.50/M

AMPERITE THERMOSTATIC DELAY RELAY

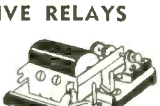
Amperite Thermostatic Delay Relays are actuated by a heater . . . can therefore be used on AC, DC, or pulsating current. Being hermetically sealed, Amperite Relays are not affected by altitude, moisture, or other atmospheric conditions. At the present time only SPST is available — normally open or normally closed.

NET 2.40 each

Available in voltage ratings of 2.5, 5, 6.3, 12, 26 and 115 volts. Delays in seconds are available as follows: 2, 3, 5, 10, 15, 20, 30, 45, 60, 75, 90 and 120 seconds. Most types from stock. When ordering specify: Voltage—Delay in Seconds—Open or Closed.

ULTRA SENSITIVE RELAYS

KURMAN BK35 — Nominal Operating Characteristics, 11,000 Ohms. 0.4 Ma. 4V DC SPDT. Adjustable contacts and armature. #R277. 10 for $55.00 100 for $475.00.



5.95 each

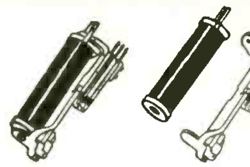
WESTERN ELECTRIC MERCURY RELAY 275C: Hermetically sealed; 2 coils: 700 & 3300 ohm. With coils in series, makes at 6.6 ma, breaks at 5.2; SPDT; High current capacity; High speed; #R464....................$17.50

HAYDON 5901-2: 220V 60 cyc, Adjustable Reset Timing Relay; SPDT (10 amp); #R466 $7.95

GUARDIAN 110: 220VAC; 2As, 2Bs; #R465 $2.95

SEE OUR PREVIOUS ELECTRONICS ADS FOR LISTINGS OR WRITE FOR CIRCULARS

TELEPHONE TYPE RELAYS



These relays have been standardized so that coils and frames of most manufacturers can be interchanged without affecting adjustments. A wide variety of applicable combinations are thus possible from a comparatively small number of relays.

Listed below are frames and coils from our stock. They may be purchased separately. However, a complete relay consists of coil and frame. In ordering complete relays specify which coil with which frame, i.e.: F101 with K117.

Representative completed relays are also listed with voltage and current ratings. Values are indicative of sensitivity that may be expected from similar combinations.

107 COOK, 3-6VDC, 6 make, 1 break (5As, 1C). 12 ohm. Part of BC654, #R407........$ 3.95
CLARE, 6500 ohm, 8maDC, 3 makes (3As) R276 .... 4.25
5035A7 AUTOMATIC, 1300 ohm, 8maDC, SPST n.o. (1A), #103.................... 1.75
CLARE K101, 6500 ohm, SPDT, 2 ma DC. Fast Action #175.................... 4.25
A18258 BENDIX (Cook 102) 8-12 VDC, Copper Slug, Slow Release, SPDT, 200 ohm, Part of SCR 522, #R365.................... 2.49
R5229A1 AUTOMATIC 6VDC, 3PST n.o. (3As), 75 ohms, Slow Release, #412........ 2.50
R5021A1 AUTOMATIC 1300 ohm, 20maDC, SPST n.c. (1B), #R413.................... 2.95

FRAMES

(For Cost of Relay Add Price of Frame to Price of Coil)

Stock No.	Contacts	Price each	Stock No.	Contacts	Price each
F101	1A	1.25	F111	1B, 2A	1.75
F102	2A	1.50	F114	1B, 3A	2.00
F103	3A	1.75	F108	1B, 1A, 1C	2.00
F104	4A	2.00	F107	2B, 1A	1.75
F105	5A	2.25	F112	2B, 2A, 2C	3.00
F106	1A, 1B	1.50	F118	2B, 5A 1C	3.25
F107	1A, 2B	1.75	F113	5B, 2A	2.75
F108	1A, 1B, 1C	2.00	F121	5B, 1C	2.75
F109	1A, 1C	1.75	F122	1C	1.50
F110	1A, 2C	2.25	F123	2C	2.00
F111	2A, 1B	1.75	F109	1C, 1A	1.75
F112	2A, 2B, 2C	3.00	F116	1C, 4A	2.50
F113	2A, 5B	2.75	F117	1C, 5A	2.75
F114	3A, 1B	2.00	F121	1C, 5B	2.75
F115	3A, 2C	2.75	F110	2C, 1A	2.25
F116	4A, 1C	2.50	F115	2C, 3A	2.75
F117	5A, 1C	2.75	F108	1C, 1A, 1B	2.00
F118	5A, 2B, 1C	3.25	F118	1C, 5A, 2B	3.25
F120	1B	1.25	F112	2C, 2A, 2B	3.00
F106	1B, 1A	1.50			

COILS

(For Cost of Relay Add Price of Coil to Price of Frame)

Stock No.	Ohms	Price each	Stock No.	Ohms	Price each
K101	0.75	1.25	K109	1000	1.75
K131	5.0	1.25	K136	1200	2.00
K102	12	1.25	K111	1300	1.75
K132	175	1.25	K137	1425	2.25
K103	250	1.25	K138	1500	2.25
K104	450	1.50	K139	1600	2.25
K105	500	1.50	K112	2000	2.25
K133	600	1.50	K140	2300	2.50
K134	700	1.50	K113	3000	2.50
K107	750	1.50	K115	4600	2.75
K135	800	1.75	K116	6500	2.75
K108	900	1.75	K118	40,000	3.25

SLOW-ACTION COILS

SLOW-MAKE			SLOW-RELEASE		
Stock No.	Ohms	Price each	Stock No.	Ohms	Price each
K122	33	1.50	K149	3.9	1.50
K146	125/1300	2.50	K123	75	1.50
K125	300	1.75	K124	200	1.50
K147	500/1500	2.50	K150	800	2.00
K148	1300	2.00	K151	1000	2.00
K146	1300/125	2.50	K152	1300	2.25
K147	1500/500	2.50	K127	2500	2.50
K126	2000	2.00			

DUAL COILS

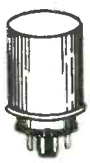
Stock No.	Ohms	Price each	Stock No.	Ohms	Price each
K141	50/2000	2.25	K145	1000/1000	2.25
K142	125/1300	2.25	K106	1100/500	2.00
K143	200/1000	2.00	K142	1300/125	2.25
K106	500/1100	2.00	K144	1800/500	2.50
K144	500/1800	2.50	K141	2000/50	2.25
K143	1000/200	2.00			

A-C COILS

Stock No.	Voltage	Price each
K119	6VAC	1.75
K120	24VAC	1.75
K121	110VAC	2.50

A = Normally Open; B = Normally Closed; C = Double Throw.

HERMETICALLY SEALED RELAYS



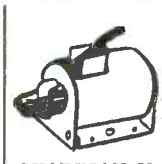
CLARE SERIES 5000: Clare SK Relay enclosed in hermetically sealed cylindrical can 1½" di. x 2½" h. All relays in this series are provided with a standard RMA octal plug base.

Stock No.	Type	Volts D.C.	MA	Contacts	Ohms	Price each
R438	5018	24	80	3A	300	5.95
R439	5025	30	15	2C	2000	6.95
R440	5036	36	15	2A, 1C	2450	6.95
R441	5094	36	12	2A, 1C	2850	6.95
R442	5167	75	20	1C(5amp)	2500	6.95

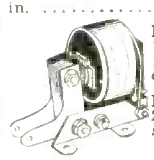
CLARE 15001; 115VAC. 60–400 cyc; DPST (2A); #R453.................... 6.95
CLARE 15006; 115VAC, 60–400 cyc; SPDT (1C); #R454.................... 6.95
ALLIED & PRICE 5709-27HPX; 24VDC; DPDT; 625 ohm; Octal Plug Base; #R449.......... 6.95
ALLIED PRHX; 24VDC; 2A, 1B, (10 amp); 300 ohm; #R450.................... 6.95
ALLIED LKHX54; 24VDC; 2A, 1B, 4C; 425 ohm; #R452.................... 9.95
ALLIED BOHRX20; 24VDC; DPDT (5 amp); 425 ohm; #R455.................... 6.95
ALLIED BOHRX; 115VAC; DPDT (5 amp); #R451 6.95
ADVANCE A8774-1Y; 6VDC; SPST (1A); 36 ohm; Solder Lug Terminals; #R443.......... 4.95

SIGMA 949; 115VAC; SPST, n.c. (1B); #R445.................... 4.95
SIGMA 71257; 6VDC; SPDT; 47 ohm; #R448.................... 5.95
SIGMA 5RJ-5000G; 1.4 ma; 5000 ohm; SPDT; #R281.................... 6.95
SIGMA 4AH; 4 ma pull-in, 2.5 ma hold; 2000 ohm; SPDT; #R444.... 3.95
STRUTHERS DUNN 181CXC100; 12VDC; 3As; 3Bs; 150 ohm; #R679 6.95
STRUTHERS DUNN 181BBX100; 6VDC; 2As; 2Cs; 36 ohm; #R447.. 6.95
4PDT SEALED AN TYPE; 24VDC; 425 ohm; (4Cs); Standard Makes; #R446.................... 5.95

A.C. SOLENOIDS



GUARDIAN No. 1: 24 VAC, 6 ohms ⅛ to ½" stroke, 6 oz.-in. #R 804..........$1.95
GUARDIAN No. 4: 115 VAC, 133 ohms ⅛ to 1⅛" stroke, 14 oz.-in. #R 805......$3.95
GUARDIAN No. 4: 115 VAC, Intermittent Duty, 49 ohms ⅛" to 1⅛" Stroke, 2 lb.-in. $3.95

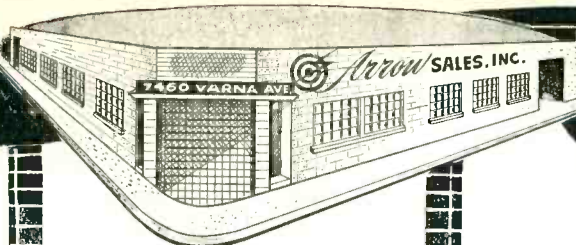


D. W. DAVIS MINIATURE 110V AC, Intermittent duty, 1⅜x1⅜x1½", ¾" stroke, 12 oz-in pull, #R178......$1.95
D. W. DAVIS MINIATURE 24V AC, 1⅜x1⅜x1½". ¾" stroke, 12 oz-in pull, #R179 $1.79
LEACH 980, 110V AC Intermittent duty, 1⅝x3⅛x2¼" Hinged type, #R180.....$2.25
UNIVERSAL 110V AC, 6-lb. pull, 2x2x2½", 1" thrust, #R176....................$2.95

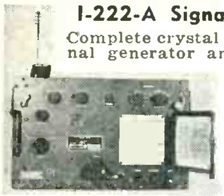
115-VOLT AC RELAYS

POTTER BRUMFIELD KL17A; 115VAC; 4PDT (5 amp); #R456....................$4.95
GUARDIAN 200; 115VAC; 3PDT (5 amp); #R458 ....$3.95
ALLIED BOR6A115; 115VAC; DPDT (5 amp); #R457 ....$3.95
A, H & H; DPDT (10 amp); #R459....$5.95
RBM 42600; DPST (2As) (20 amp); #R460 $3.25
SIGMA 41FZS7; SPDT, 10,000 ohm; #R909 $2.95
EDISON 501, Delay Relay; 115VAC/DC, SPST (1A); 30 sec. delay; #R461......$2.40
C-H N619, Contactor; 115VAC; 4PST (50 amp) with holding contacts; #R462..$15.00
G.E. CR5181-1A6, Contactor; 115VAC 4PST (30 amp) with holding contacts; #R463 $12.00

FOLLOW ARROW



FOR MILITARY ELECTRONICS



I-222-A Signal Generator

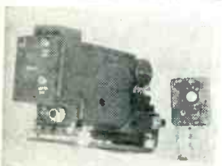
Complete crystal controlled signal generator and wavemeter. Frequency range: 8-15 MC. 135-230 MC. With 110 V. 60 cps. power supply and service manual. Like new **$97.50**

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	
	MD38/APQ13	

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.



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. **$245.00**

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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

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
I-77 Hickok Tube Checker		TS-159/TPX
I-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	I-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		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	
HEWLETT-PACKARD #205		

SUPREME TEST EQUIPMENT

Model 600 Tube and Set Tester..........$89.50
Model 616 Tube and Battery Tester..... 69.50

AN/ART-13 PARTS

Part #	Item
Transmitter	T-47A/ART-13
564916	Barometric Switch
565027	4-Pile Ceramic, Variable Cap.
K7890443	6-Pie Ceramic, Variable Cap.
564605	4 Centralab-Type 843-003 Cap Assembly
Antenna Loading	CU-25

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
BC-640	BC-639	RM-25
RM-26	SCR-284	SCR-536
SCR-540	MN-26 Complete Installation	

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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 bakelite 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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The Searchlight Section

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TA-2G Transmitters 12V HF 75.00
RA-2 Receivers 12V HF.... 75.00
MP10E Power Supply for above 30.00
MR44A Shock Mount for RA-2 4.00
MT56B Shock Mount for TA2 10.00

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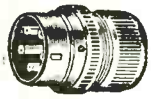
1 C 6	Boxed	.10
2 C 26 A	"	.10
19	"	.17
954	"	.12
250 TH	"	6.00
3 B 29	"	6.00
3 E 29	"	6.00
100 TS	"	2.50
1642	"	.10
10 Y (VT25)	"	.12
1B32/532A	"	.50

PLUGS

PLQ 169............................1.00
PLQ 171............................1.00
PLQ 172............................1.00
PL 172............................1.00

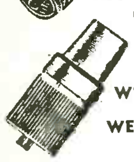
Teletypewriters M8D1 NEW.......$150.00
Bias Meters 1-97A................ 6.50
P 4 Computers..................150.00
E 78 Signal Generator............ 60.00
Antenna AT5/ARR-1................ .50
Tuning Units for BC-610 NEW........12.50

PLUGS • CONNECTORS
CLAMPS • AMPHENOLS
CANNONS • MELAMINE



80% OFF

WE HAVE ALL TYPES WITH CORDS AND CABLES, OR WITHOUT



WE HAVE SERIES OF
3100 3106
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!!

Get Our Low, Low Prices . . .
WIRE, WRITE, PHONE!!

MELAMINE BLOCKS

in 1/8"—3/16"—1/4"—5/16" Thicknesses
4000 pounds
Available at
50¢ per pound

Recorder for underwater sound equipment 60.00
Transmitter—Aircraft T9/APQ-2, 115v. 400 cy. 26 VDC 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.

CONTACTOR
BC 608 A NEW 7.50

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
Vibrators 6V. for Auto Radios...New .25
MC125 Remote Tuner..........New .50
MC124 Cable................New 1.50
MC215 Cable ....New .60

60,000 Used Headsets on sale 1.00 each
HS 18—HS 30—HS 33—HS 38

Oxygen Gas Masks............New .25
Control Boxes BC434...........New 3.50
Antennas 37-50 MC 72 inch........ 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

MOTORS

1/40 H.P. 115V. 60 Cy. 3400 RPM Mfg. Delco Diehl
Good for fans **2.50**

CRYSTALS

25,000 Pieces in FT. 241 Holders
New @ $.10 each

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

ARC-1 SALE

10 Channel Checked Out $850.00
20 Channel Checked Out 1050.00
50 Channel Checked Out 1250.00

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 1FF with Cables, Mounts—Plugs 35.00
Pilot balloon targets ML 350/AP..... .25

WANTED

ARC-1 or Component Parts
ARC-3 or Component Parts
ART-13 or Component Parts
BC348 or Component Parts
AN/TRC-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 508 and SCR 608

We buy all types of electronic materials.
We pay cash in advance.
What do you have to sell?

This is only a partial listing. We have a quantity inventory on our shelves consisting of Coils—Relays—Condensers—Transformers—Radio Receivers and Transmitters—Handsets—Headsets—Microphones etc. etc. All are ready for IMMEDIATE DELIVERY.

TALLEN CO. INC.

TALLEN CO., INC.

159 CARLTON AVE,. BROOKLYN 5,N.Y. TRiangle 5-8241

CONDENSERS

New JAN-C-25 Capacitors CP53 - 54 - 55 - 61 - 63 - 65 - 67 - 69 & CP70. Quotations upon request.

GUARANTEED—OIL CONDENSER SPECIALS—GUARANTEED

1 mfd.—1500 .... $1.05
GE #26F537-G2

16 mfd.—600 v $1.75
Dual 8 mfd oil filled cond. hermetically sealed and packed. Tobe type PT-SC-11 measuring 3¾"x2⅝"x2⅝". Stud mntg. centers 2". Plugs into standard four prong socket.

.25 mfd.—600 v ...... $.53
OM-625 with bckts.

OVER 15,000 SOLD

10 mfd.—600 v .... $.98
Three term, bal. mtg. channel type. Dims. 3¾" x 3½" x 2". Two 5 mfd. sections rated 400 V at 72 deg. "C". 1800 V test. Meets commercial specs. for 600 V. operation up to 40 degs. "C". Ideal for filter or power factor application. Repeat sales prove this rugged high quality condenser to be of outstanding value. Carton of 24. Weight 42 lbs. Large qua. available.. **$.89**

1—1 mfd.—600 v ..... $.85
3 ST. Bathtub. Lots of 100 10% Disc. Same Type but with 2 Terms. Case common. $.70
Lots of 100 10% Disc.

.5 mfd.—400 v .... $.21
CP63B1AE504 KK 416 MCT Disc. 100 10%, 500 25%—New.

8 mfd.—600 v $1.69
4½" H. x 2" Dia. Bkt.

Mfd	Volts	Price	Mfd	Volts	Price
			1	25KV	85.00
.005-.005-			2	600V	.59-.79
.01	10KV	4.75	2	600V TLAD	.85
.012	25KV	22.50	2	1000V	.85
.02	20KV	17.90	2	1000VTLA	1.29
.025-.025-			2	1500V	1.79
	50KV	55.00	2	2200V	2.80
.03	8000	3.95	2	2500V	3.95
.03	16KV	15.95	2	5000V	14.95
.05	5KV	2.98	2	4000V	7.95
.08	12.5KV	15.95	2	6000V	19.95
.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	65.50	8	600VAC	3.50
1	400V	.45	8	100V	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	1500	6.25
1	5000V	5.25	10	6000V	P.U.R.
1	6000V	8.98	12	1000V	4.95
1	7000V	12.00	15	600V	3.25
1	10KV	P.U.R.	15	1000V	5.35
1	16KV	P.U.R.	15	2000	9.25
1	20KV	P.U.R.	17	25V	.69

BATHTUB CONDS.

Mfd	Volts	Price	Mfd	Volts	Price
.01-.01	600	$.25	.25	600	.41
.02-.02	600	.25	.25	1000	.48
.04-.04	600	.25	.3	400	.15
.05	600	.20	.5	400	.37
.05-.05	600	.25	.5	600	.47
.08-.08	600	.25	.5	1000	.52
.1	600	.39	2x.5	600	.59
.1	1000	.42	1	200	.25
.1	1200	.45	1	300	.30
.1-.1	400	.29	1	400	.45
.1-.1	600	.39	1	600	.59
.1-.1	1000	.51	2	400	.60
3x.1	600	.40	2	600	.91
.2	1000	.21	4	100	.40
.25	300	.19			
.25	400	.30			

Sp. Bathtube Kit 15 @ 1.00

CHANNEL CONDS.

Mfd	Wvdc	Price	Mfd	Wvdc	Price
.025	600	$.19	.4	600	.30
.05	1000*	.22	.5-.1	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.

METAL TUBULAR OIL CONDS.

Mfd	Wvdc	Price	Mfd	Wvdc	Price
.0025	400	$.10	.05	1000V	.19
.005	600	.14	.1	400V	.17
.01	300	.09	.1	600V	.20
.01	600	.15	.25	600V	.18
.01	2000	.19	.5	600V	.19
.02	400	.14			
.03	400V	.15			
.05	200V	.07			

Quas. of 100. 10% disc.

TRANS. MICA CONDS.

Mfd	Wvdc	Price	Mfd	Wvdc	Price
.000024	2500	.19	.0025	1200	.42
.00003	2000	.75	.003	6000	5.95
.000047	2500	.21	.0035	2500	.55
.00005	2500	.29	.004	2500	.65
.00008	1200	.21	.0043	2500	.79
.00009	3000	.75	.0045	600	.24
.0001	600	.22	.005	1200	.43
.0001	1200	.32	.006	600	.29
.0001	3000	.85	.006	1200	.45
.0001	5000	1.95	.01	600	.40
.00015	5000	1.95	.01	1200	.69
.0002	15KV	Quote	.01	15KV	Quoted
.00025	1200	.35	.015	2500	.95
.00025	5000	2.05	.0125	6000	Quote
.00027	2500	.35	.02	600	.27
.001	600	.23	.02	600	.39
.001	1200	.32	.02	1200	.85
.001	2500	.48	.02	2000	1.25
.001	4500	1.45	.03	600	.49
.001	8000	3.95	.033	600	.59
.0015	5000	2.25			
.002	1200	.40			
.002	2500	.50			
0024	5000	2.35			

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 5c
1000 to 1500 mmfd 6c
2000 to 5100 mmfd 10c
6000 to 8000 mmfd 16c
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
100 to 800 mmfd 9c
1000 to 1700 mmfd 14c
2500 mmfd 16c

Special S. Mica Kit—100 @ $6.50

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

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.

25 W. POWER RHEOS.

Ohms	Shaft	Price	Ohms	Shaft	Price
1.3-1.3	1/8S	$.98	200	1/2	.69
15	1/2	.69	225	1/8LS	.69
20	1/2	.69	225	1/4S	.69
25	1/2	.69	300	1/2	.69
37.5	1/2	.69	350	1/2	.69
50	1/8S	.69	375	1/2	.69
50-50	1/2	1.25	500	1/4S	.69
75	1	.69	2500	1/2	1.20
100	1/2	.69	5000	1/2 & 1/8S	1.20
125	1/2	.69			
150	1/2	.69			
175	1/2	.89			
185	1/2	.69			

100 ohm Lots of 100 .... $.54

MAGNATRON

2J39 .... $8.95

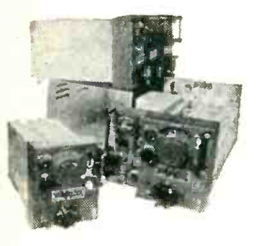
—TRANSTAT—

115 V, 1 phase, 100 amps., Kva. 115, Range 0-115 V. Amertran #29145. Specially priced.

WANTED

Condensers of all types in any quantity. Also other standard components. Top prices.

MONMOUTH RADIO LABORATORIES
BOX 159 Long Branch 6-5192 OAKHURST, N. J.



AN/APR-4 LABORATORY RECEIVERS

Complete with all five Tuning Units, covering the range 38 to 4,000 Mc.; wideband discone and other antennas, wavetraps, mobile accessories, 100 page technical manual, etc. Versatile, accurate, compact—the aristocrat of lab receivers in this range. Write for data sheet and quotations.

We have a large variety of other hard-to-get equipment, including microwave, aircraft, communications, radar; and laboratory electronics of all kinds. Quality standards maintained. Get our quotations!

We will buy any Electronic Material at top prices. SCHOOLS—unload your dusty surplus for cash or credit.

ENGINEERING ASSOCIATES
434 PATTERSON ROAD DAYTON 9, OHIO

TELEPHONE EQUIPMENT & PARTS

New TS9 handsets with switch in handle .... $ 7.00 Each
New TS 15 & TS 13 handsets .... $10.50 Each
New TS9 receiver & transmitter elements .... $ 1.25 Each
New WECO F1W handsets W/cord & PL47 plug .... $ 7.00 Each
RE8 field telephones reconditioned & tested .... $20.00 Each
New ATR inverter INPUT 110V. D.C. OUTPUT 110V. A.C. ...... $35.00 Each
Upright desk telephones (For extensions, intercoms, etc.) ...... $ 2.95 Each
Telephone Ringer boxes with induction coil, bell, capacitor .... $ 1.00 Each
New WECO T30Q throat mike .... 2 for $1.50
Operator head & chest sets reconditioned HS19 .... $ 4.00 Each
Sound power field telephones like new tested .... $25.00 Each
New SW 141 W/cords & PL68 plug $ 2.00 Each
New WECO F1 Transmitters & HA1 receivers .... $ 1.50 Each
New RAYTHEON Rectifilters Cat #1044 Inp. 125 A.C. Output 24 V.D.C. 1.0 Amps .... $40.00 each
WECO switchboards training with 60 jacks & 26 cords with PL47 plugs .... $25.00 Each

Terms: Check with order F.O.B. Brooklyn 5, N. Y.

EASTERN TELEPHONE COMPANY
323 VANDERBILT AVENUE
BROOKLYN 5, N. Y. MA 2-3753

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WORLD'S MOST COMPLETE STOCK

Types in stock: AF, AN, AP, ARC, BN, BNC, C, CLT, CN, CUF, D, DPB, DPD, E, F, FK, FM, FT, FW, GK, HN, IOH, IK, JJ, JK, LC, LF, LK, LN, M, MC, N, NK, P, PJ, PL, PM, PYE, RF, RFK, RGK, RNK, RTC, RWK, S, SF, SK, SKL, SO, U, UG, UHF, WK, XL, ZA.

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Philadelphia 3, Pa.

TUBES

All receiving and special purpose types. Real values that will save you 10 to 70%. Call or write today for special price list. State type & quantity for additional discount.

METROPOLITAN SUPPLY CORP.
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X-RAY

All types for industrial and experimental application. Tubes, cables and components.

MEDICAL SALVAGE CO., INC.
217 E. 23rd St., New York 10, N. Y.
Murray Hill 4-4267

COAXIAL CABLES:

RG-8/U Coaxial Cable: 1—100 Ft. 9¢ per ft.; 100—500 ft., 8½¢ per ft.; 500 ft. or more, 8¢ per ft.

RG-34/U Coaxial Cable: 71 ohm—125 ft. $15.00

ANTENNA EQUIPMENT

MAST BASES—INSULATED:

MP-132 BASE—(As illustrated at left) 1" heavy coil spring, 2" insulator. Overall length: 11-½". Weight: 2-¾ lbs. Price $3.95

MP-S-33 BASE—Insulated type with heavy coil spring and 5" dia. insulator. Requires 2" hole for mounting. Weight: 9 lbs. $5.95

MAST SECTIONS For ABOVE BASES

Tubular steel, copper coated, painted, in 3 ft. sections, screw-in type. MS-53 can be used to make any length with MS-52-51-50-49 for taper. Any section ....50¢ Each

Larger Diameter Section: MS-54....$1.25

AN-104B Antenna—100-156 MC.—Steel.... 3.95

AN-104B Antenna—100-156 MC.—Copper.... 3.00

AN-117 Whip Steel—6 Ft. Length.... 1.50

AN-109A Whip Steel—5 Ft. w/Base.... 1.50

TELEPHONE WIRE—3 Conductor, copper and steel. 525 feet....$4.75

BLOWERS

115 Volt 60 cycle BLOWER (pictured), approx. 100 CFM Dis. 2¼" intake; 2" outlet. Quiet running Motor size: 2½"x3¼". NEW — not Gov't surplus. Order No. 1C939 **$8.95**

DUAL BLOWER—Same as RN-520 above, except has blower assembly in each side of motor. Order No. 1C880 ....$13.95

COMPACT TYPE—108 CFM. motor built inside squirrel cage. 4-½" Intake: 3-⅜" x 3" Dis. Complete size: 4-¼" W. x 9-⅜" H x 8-⅛" D. Order No. 2C067 ....$14.50

FLANGE TYPE—140 CFM, 3-½" Intake: 2-½" Dis. Complete size: 8-½" W x 7-¼" H x 6-¾" D. Order No. 1C807 ....$13.95

FLANGE TWIN—275 CFM, 4-½" Intake: 3-¼" x 3" Dis. Complete size: 11-¾" W x 9-⅜" H x 8-1/16" D. No. 2C069 ....$21.95

AIRCRAFT CONTROL CABLE—3/32"—7 x 7 Strand. Weatherproofed, Galvanized, Preformed. 920 lb. test. Ideal for Television Guying and many other uses. Prices: 4½¢ per Ft.—1000 Ft. or more at 4¢ per Ft.

SELSYN

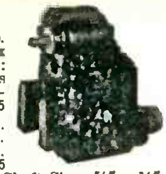
2J1G1 CONTROL TRANSFORMER WITH CAPS. 57.5 VOLT; 400 CYCLE. NEW; $5.95 Ea.

BATTERY CHARGING RESISTOR PANEL

115 VDC—6.67 ohms 30 Amps. Max. Switching High-Low & Off. Charging rate: 6-2 Volt Cells; High 30 A.; Low 15 A.—12.2 Volt Cells: 25.8 High: Low 12.7—15.2 Volt Cells; High 23.7; Low 11.6. Complete with Cable. Panel size: 21" x 22" x 10". Mfg. by Ward Leonard—NEW....Price: $29.95

DC SMALL MOTORS

24 VDC REVERSIBLE



MOTOR—3.7 RPM. 40 lb. Torque Motor Size: 5-⅛" x 4-1/32" x 3-5/16". Shaft Size: 21/32" x 5/16". Also operates 24 VAC. Philco No. 441-1008 ....$5.95

27.5 VDC—6000 RPM. 1.5 oz. in. Shaft Size: 1-⅛" x ¼". Motor Size: 2-½" x 1-¼". No. 5069-267 ....$6.95

27VDC—1/10 HP—3500 RPM. Shaft Size: ⅝" x ¼". Motor Size: 4" x 3-½", Air Assoc. No. EE-763 ....$6.95

80 VDC—1/50 HP—3000 RPM. Shaft Size: ⅜" x ¼". Motor Size: 5" x 3". G. E. No. 5 BN38HA10..$8.95

28.5 VDC—1/35 HP—2200 RPM. Shaft Size: 1-⅛" x ¼". Motor Size: 4-½" x 3-¾". Electrolux No. 16876 ....$5.95

RADIO FREQUENCY AMPLIFIERS:

RADIO FREQUENCY AMPLIFIER AM-14/APT 100 W. Used to increase output Transmitting Equipment AN/APT-1. Input 80 or 115 V. AC 400 to 2600 Cycle 600 W....$59.50

RADIO FREQUENCY AMPLIFIER AM-18/APT 140 to 210 MC.; Power Output 110 W. @ .5 Amps. Used to amplify output Radar Trans. T-28/APT-1; Power Input 80 or 115 V. AC 400 to 2600 cycle 600 W. $59.50

RADIO FREQUENCY AMPLIFIER AM-33/ART Freq. Range 35 to 105 MC. Band width 3.5 ± 0.5 MC. Used to increase power output AN/ARQ-8 to 150 Watts. Input 80 or 115 V. AC 400 to 2600 Cycle 600 W. $59.50

DYNAMOTORS

DYNAMOTOR and BLOWER: 9 Volts DC input: output 450 volts 60 MA. 4500 RPM. At 6 Volts DC input: output 260 Volts 65 MA. 3000 RPM....$4.95

Input	Output	Stock No.	Price
14 V. DC	600 V. 300 MA.	BD-36	$9.95
12 V. DC	220 V. 70 MA.		6.95
12 or 24 V. DC	440 V. 200 MA. & 220 V. 100 MA.	D-104	14.95
14 V. DC	375 V. 150 MA.	DM-375	8.95
14 V. DC	330 V. 135 MA.	DM-330	7.95
14 V. DC	500 V 500 MA.	PE-59	14.95

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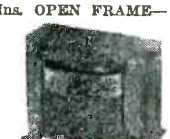

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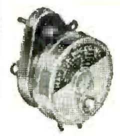

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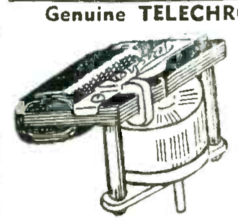

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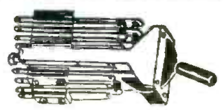

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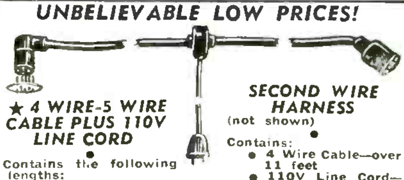

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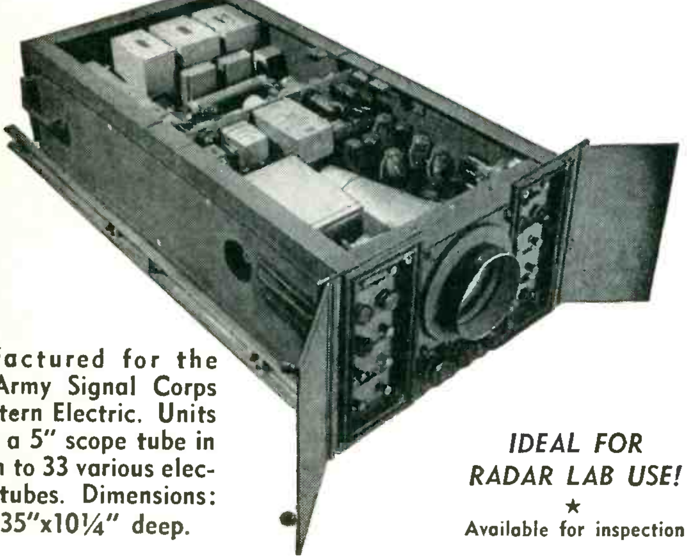

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ALSO IN STOCK FOR IMMEDIATE DELIVERY CAPACITORS...OILS, MICAS, CERAMICS ETC. CHOKES-TRANSFORMERS, AUDIO, POWER, SPECIALS, CONNECTORS...WIRE...COILS ...HARDWARE TRANSFORMER LAMINATIONS, MU-METAL, 4750 GRADES. IN FACT ...YOU NAME IT, WE HAVE IT AT SENSIBLE PRICES...YOUR INQUIRIES ARE INVITED.

BEST TV BUY YOU HAVE EVER SEEN

235 Sq. In. Projection (Schmidt) System manufactured by world famous North American Philips. Housed in neat mahogany cabinet. 24 tube circuit . . . Standard coil tuner. Eye strain free big big picture. Original list price...$399.95, our price...$169.95

For Fast, Intelligent, Friendly Service
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ELECTRONIC SPECIALTY SUPPLY CO.
58 Walker St. WA 5-8187 NYC 13, N. Y.

SELSYN SYNCHROS

5CT-5SCT—5DG $45.00
5F & 5G...........................$49.00

TELECHRON Synchronous Timing Motor—Type B 3

24 V AC .6 rpm
115 V 60 cy 1 rpm
220 V 60 cy 1 rpm $3.50 each
Signal Generator 1—138A.........$165.00
BC 342-C and BC 348-C, each......$123.00

Bodine Motor Type KC1-22

115 VAC 18, 6 rpm torque 32-O, new.$12.50
Bodine motor 115 V 1/75 hp, 1800 rpm type NYC-12. New $16.50

TRANSFORMERS

Power & Filament, Freed—Style D

500 V CT 120MA
Sec. 6, 3V 5 amp
5 V 3 amp $2.68 each
UG Connectors UG 9/U..............$1.25
UG 352/U $6.50
UG 234/U $15.00

LEONARD GREENE
Electronic Distributors
381 Tremont St. Boston, Mass.
HA 6-4794

SPECIAL PURPOSE TUBES AT CLOSE-OUT PRICES!!

All tubes listed below are available in quantity from stock. They are new, in original cartons, and fully guaranteed!

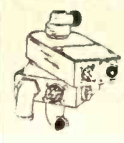
1B24 JAN	$ 7.95	2K46 SPERRY	295.00
1B27 JAN	9.95	3022 JAN GE	59.95
1B36 JAN	4.49	3K22 SPERRY	289.95
1B38 JAN	24.95	3K23 SPERRY	349.50
1B41 JAN	39.95	5C22 SYLV	39.95
1B42 JAN	12.95	5D21 JAN WE	14.95
1B60 JAN	58.95	5R4-GY RCA	1.29
1B63-A JAN	39.95	C6J	5.75
1N21 JAN	.75	6J4	5.95
1N21-A JAN	1.19	6K4	2.50
1N21-B JAN	2.22	6L6-M RCA JAN	1.75
1N23 JAN	.99	6SU7-GTY JAN	1.99
1N23-A JAN	1.95	12SJ7-M JAN	.59
1N23-B JAN	2.99	FG-172 GE JAN	24.95
1N26 WE JAN	6.49	300-B W.E.	9.95
1N32 SYLV	18.95	350-B JAN	4.29
1N34	.57	394-A	3.95
1N40 SYLV	6.95	434-A GE JAN	9.95
1N41 SYLV	8.95	715-B JAN WE	4.95
1N42 SYLV	15.95	715-C JAN WE	14.95
1P21 RCA	27.50	723 A/B W.E. JAN	14.95
1Q26 GE JAN	52.95	726-C WE JAN	54.95
2C40 JAN	5.95	804 JAN	10.95
2021 RCA	.99	807 RCA	.99
2E24 RCA JAN	3.25	864 JAN	.29
2E30 JAN	1.59	1614 RCA JAN	1.74
2K22 JAN	29.50	2050 RCA	1.29
2K25/723A/B		5654 G.E.	1.99
W.E. sld/ctns	18.95	5670	2.75
2K29	19.95	5687 TUNG-SOL	3.75
2K34 SPERRY	215.00	CK-5687	2.49
2K35 SPERRY	349.50	CK-5702	1.99
2K39 SPERRY	119.50	5829	2.99
2K41 SPERRY	118.50	9002 JAN	.75
2K42 SPERRY	119.95	9004 JAN	.37
2K43 SPERRY	124.95	9006 JAN	.29
2K44 SPERRY	114.95		

Above listing is only partial, write, if your requirements are not listed. Terms: Net 15 days to rated firms. All prices subject to change without notice.

NOTE OUR NEW ADDRESS:

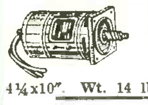
MICROWAVE EQUIPMENT SUPPLY CO.
255 East 78th St. New York City 21
TRafalgar-9-3776

SLIP RING ASSEMBLY




Emerson Electric—Part ET35300 (shown with and without housing). Used to transfer voltages between stationary and moving parts as in turrets or revolving displays. Full 360° rotation up to 15 RPM. Rating 12 conductors—ten 10 amp and two 100 amp at 28 VDC. Adaptable to higher voltages. Also has swivel plumbing designed to transfer oxygen at 15 P.S.I. Size 9x6x10". Wt. 10 lbs. Price complete NEW........................$8.50

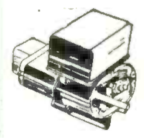
DC MOTOR SPECIALS



EMERSON ELECTRIC — Type D44FZ-454-0417. 1 H.P. 5800 RPM, 27v-40a armature and 27v-2.5a field, reversible. Shaft extends 2¼" in front and ⅝" in back. 24" leads. Size 4¼x4¼x10". Wt. 14 lb. Price NEW ONLY.....$8.75

GENERAL ELECTRIC — ½ H.P. #5BA50LJ2A. 4000 RPM. 60v-8.3a armature and 27v-2.3a field, reversible. Wt. 9 lbs. Price NEW $12.50

DC SERVO ACTUATOR



WHITE-ROGERS — #6904-43. 24 volts DC, 1.3 amp. Torque 150 in.-lbs., 3.5 RPM, reversible. Has limit switches and relays which make possible intermediate stop positions between extreme limit settings (25 to 360° arc). Also has centering switch. All controlled by remote switching. 5x4x6½". Wt. 4½ lbs. Price NEW ONLY........$9.50

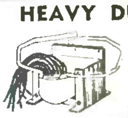
WHITE-ROGERS—Stk. #6904-6. 24 VDC 1.4 amp. Torque 150 in.-lbs., 6 RPM, reversible. No limit switches. Continuous rotation in either direction controlled by remote switching. 5x4x6". Wt. 4½ lbs. Price NEW ONLY.................$7.50

SYNCHRO - DIFFERENTIAL. — Bendix #C78249. 115V 60 cycle. Used as a dampener between two C78248 Synchros. Easily converted to 3600 RPM motor (instructions included). Size 3-⅜x5-⅜". Price Brand New in original containers............$5.50

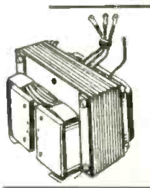
STEP BY STEP MOTOR

Bendix—Type CAL 14810 (MK1 Mod 0). 70 Volts DC input. Max. static torque 19.2 and 18.5 oz.-in. for one and two pair of coils energized respectively. Max. dynamic torque 8.47 and 4.9 oz.-in. for motor driven at 100 and 360 RPM respectively. 3x3x4½". Wt. 4 lbs. Price NEW......................$8.50

HEAVY DUTY TRANSFORMERS



#1221.—1.8 KVA. Input 120 volts 60 cycle. Output: 12.0, 14.5, 16.0, 17.0, 17.2, 17.8, 18.0 volts at 100 amps. Pri. leads 28" long. Sec. leads 17" long. Size 7x7x7". Wt. 26½ lbs. Price Brand NEW $23.50



GENERAL ELECTRIC. — #79G907. 2 KVA Intermittent duty. Input: 100/110/120 volts 60 cycle. Output 0.8 (eight-tenths) volt at 2,500 amps. Can be used for quick-heat applications, spot welders, testing, etc. Size 5¾ x 6¾ x 5". Wt. 27 lbs. Price NEW............$12.50

PROMPT DELIVERIES ON ALL ORDERS
ALL MERCHANDISE FULLY GUARANTEED

Terms: Prices FOB St. Louis. Cash or 25% with orders. Balance COD. Rated Concerns (D&B) Net 10 days cash. Prices subject to change without notice.

McNEAL ELECTRIC & EQUIPMENT CO.
4736 Olive St. St. Louis 8, Mo.

B-B ELECTRONICS

JEFFERSONTOWN, KY.

1L4	.45	1T4	.45	6SN7GT	.50
1LC6	.65	2X2	.45	6V6GT	.45
1LH4	.65	3A4	.50	328A	4.00
1LN5	.65	3S4	.45	394A	2.50
1N21	.65	6B8	.75	717A	.75
1R4	.45	6C21	17.50	CK1005	.35
1R5	.45	6SJ7	.50	1619	.30
1S5	.45	6SL7GT	.50	1626	.30

All tubes tested and guaranteed.

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BULBS & CYLINDERS
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HOUDE SUPPLY COMPANY
PHONE KEYPORT 7-1286
M. R. #1 Box 86X Keyport, N. J.

T-47A/ART-13 Aircraft Transmitters
DY-12 Dynamotors, BC-639 Receivers
SCR-694-C Portable Trans. & Recvrs.
BC-610-E Transmitters, (SCR-499)

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Box 19, Boston, 1, Mass
TEL: RICHMOND 2-0916

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Molded Bakelite case 7" x 4½" x 3"

D.C. MICROAMMETERS
5..10..50 microamperes

THERMOCOUPLE MILLIAMMETERS
1, 5..5..10 milliamperes

THERMOCOUPLE VOLTMETERS
5 to 500 volts

Available in multiple range combinations

Precision Electrical Instrument Co.
146 Grand Street New York 13, N. Y.

INDEX
SEARCHLIGHT
MAY, 1953

This index is published as a convenience to the readers. Care is taken to make it accurate but ELECTRONICS assumes no responsibility for errors or omissions.

ADVERTISERS INDEX

TO THE ADVERTISERS

MAY, 1953

SEARCHLIGHT SECTION
(*Classified Advertising*)
H. E. Hilty, Mgr.

CONDENSERS → CONDENSERS → CONDENSERS *Priced Right!*

CP-70 Style Condensers

VDC

MFD	VDC	TYPE	PRICE
.00365	15 K	14F162	22.50
.0091	15 K	14F222	27.50
.005	25 K	25020	29.50
.025	10 K	Y-3605	9.90
.035	400 K	P6756	1.25
.045	16 K	D-4495	10.25
.05	3 K	CP70E1EL254-K	2.90
.05/.05	2 K	P720555-9	1.40
.075	16 K	572	19.75
.1	1.5 K	K-34J222-3	1.70
.1	2 K	23F378	2.50
.1	3 K	TJU 30001	3.10
.1	4 K	TJU 40001	4.25
.1	6 K	6009	6.90
.1	7.5 K	25F175	7.50
.1	12 K	26F628	10.25
.1	15 K	14F63	9.75
.1/.1	2.5 K	26F709	5.25
.1/.1	7 K	25F774	6.75
.1/.1	7.5 K	7520	7.25
.15	8 K	8020	7.50
.15	65 K	14F72	92.50
.15/.15	5 K/8 K	Vitamin "Q"	37.50
.2	4 K	XLMSW40-.2	5.10
.2	50 K	14F126	67.50
.25	2 K	TJU 200025	1.95
.25	3 K	CP70E1EL254-K	4.50
.25	6 K	25F659	5.00
.25	15 K	26F359	27.50
.25	20 K	TK 20002-2	42.50
.25	25 K	D-91281	57.50
.25	50 K	14F97	72.50
.33	8.5 K	26F267	22.50
.35	30 K		62.50
.49	10 K	LD	42.50
.5	600	CP70B1EF504-V	1.25
.5	1 K	TJ	1.75
.5	1.5 K	TJU 15005	1.95
.5	2 K	XLNJW20-.5	2.25
.5	2.5 K	2509	3.50
.5	3 K	22F242-G2	4.75
.5	4 K	23F409	7.25
.5	5 K	TJH 50005	9.25
.5	25 K	14F103	62.50
.5/.5	1 K	9107	5.25
.5/.5	2 K	26F861	6.25
.5/.5	3 K	25F526	7.25
.5/.5	9 K	PC 2151	35.50
.51	10 K	LD	42.50
1	600	TJ 6010	1.15
1	1200	7870691	2.25
1	1.5 K	CP70	2.65
1	2 K	TRS 2001	3.10
1	2.5 K	2509	4.25
1	3 K	TJU 30010	4.75
1	5 K	5009	8.00
1	6 K	TK60020	12.50
1	7.5 K	26F213	22.50
1	10 K	14F267	42.50
1	13 K	25F313	45.00
1	15 K	14F63	47.50
1	25 K	TJ	82.50
1.5	1500	TJH 15080	2.25
1.5	25 K	8487	87.50
1.25/1.25	7.5 K	26F360	31.00
2	200	TRS 202	1.25
2	600	26F167	1.75
2	750	D-4430	1.95
2	1 K	CP70B1FG205-X	2.25
2	1500	TRS 1502	3.95
2	2 K	23F119	4.95
2	2.5 K	2509	5.90
2	3 K	3009	10.50
2	4 K	23F47	9.95

MFD	VDC	TYPE	PRICE
2	5 K	23F188	11.50
2	7.5 K	56	27.50
2	32 K	43J861-Z30	110.00
3/3	600	PC 2400	4.25
4	400	25F664	2.75
4	600	TJU 6040	2.70
4	1000	CP-70	3.75
4	1500	TRS 1504	5.25
4	2000	23F119	8.50
4	2500	TRS 2504	9.90
4	3000	CP70E1EL405-V	19.50
4	4000	22F221	27.50
4	5000	TJ 50040	42.50
5	600	CAY 48733	4.50
5	1000	XLMW10-5	7.26
5/5	400	RAL 300	1.25
6	600	22F136-G2	3.90
6	1000	CP70B1EG605-K	10.50
6	1500	CAY 48731-10	14.90
6	2000	CAY 48730	17.25
6/6	400	RO2	22.90
7	4000	T40C	42.50
8	200	TRS 208	4.25
8	600	26911-2	4.25
8	1000	TJH 10080	6.10
8	1500	TJH 15080	5.75
8	3000	Vitamin "Q"	12.50
8/8	600	PC 2400	5.75
8/8/8	500	CSF 481337-20	7.50
8.5/8.5	1000	46DO48	6.50
10	400	25F471	5.95
10	600	26F524	6.25
10	1000	RO-2	5.75
10	2500	23F397	10.90
12	600	TJ 6120	7.50
12	1000	0115	10.50
12	4000 p ak	7318	10.50

CP-70 STYLE CONDENSERS

VAC TYPE

MFD	VAC	TYPE	PRICE
.25	115	Hi-pass	.90
.6/.6/.6	90	1C	2.75
1	330	67X1X	.95
1	1200	PRF 1201	1.75
1.25	1000	26F556	.95
2	330	26F406-G2	1.65
3	330	67X3B	2.70
3.75	330	KG 3037	3.25
3.5	220	21F319	1.15
4	150	CD48880-5	2.10
4	440	67X23	2.90
5	440	67X24	4.50
6	330	KGM 3060	4.75
6	440	67X23	4.65
6	460	67X38	5.10
6	553	PO5	5.50
7	660	26F306	5.25
8	660	21F50-G3	5.25
10	220	ALMJW2.2-10	5.50
10	330	PRF 3310	5.75
10	660	26F495	7.75
12	220	MC 787	5.50
12	330	21F130	6.25
12	660	21F53	8.50
15	220	ALMW2.2-15	8.50
15	330	25F801	9.50
15	660	26F495	10.25
16.5	236	P 7369	7.25
28	440	67X23	12.10
30	90	26F571-G3	2.75
30/30/30	90	9C	9.50
50	330	26F447	27.50

TYPE G MICA CONDENSERS

MFD	VOLTAGE	TYPE	PRICE
.04	L KV	G-1	12.50
.09	1.5 KV	G-1	16.30
.08	1.5 KV	G-1	16.30
.0008	3 KV	UC-2509K	13.75
.02	3 KV	G-1	19.50
.00095	5 KV	C-D48274	14.50
.0015	5 KV	CRV-48416	15.50
.006	5 KV	CRV-48415	19.50
.00025	6 KV	PL-586-59	15.90
.00024	6 KV	G-1	15.90
.0006	6 KV	G-1	16.40
.0004	6 KV	G-1	16.25
.0002	6 KV	1960-207	19.90
.004	6 KV	G-1	19.50
.001	6 KV	G-1	17.50
.0012	7 KV	CRV-48157	15.00
.003	7 KV	UC 3048	17.50
.002	8 KV	UC 2371	27.50
.000375	10 KV	CRV-48418	28.50
.00068	10 KV	MX-61	28.50
.00057	10 KV	CD-38879-2	28.50
.00025	10 KV	CRV-48155	28.50
.00015	10 KV	UC-3123	28.50
.00002	10 KV	UC-3292	25.50
.0008	10 KV	CRV-48417	28.50
.005	10 KV	UC-2617	28.50
.0002	10 KV	48270-B5	28.50
.001	10 KV	UC-3296	28.50
.02	10 KV	PL-133-52	87.50
.0025	12 KV	XPXW	57.50
.008	12 KV	G-4	62.40
.00532	15 KV	1980-318	60.40
.00002	15 KV	MX-60	49.50
.002	15 KV	G-3	52.90
.0025	15 KV	1970-218	54.10
.00035	20 KV	PL-289-51	52.40
.00025	20 KV	G-3	52.40
.00015	20 KV	1970-404	53.50
.0066	20 KV	PL-1391-97B	59.50
.0005	20 KV	G-3	54.70
.0003	20 KV	UC-3112K	54.70
.0002	20 KV	G-3	52.50
.0001	20 KV	G-3	49.90
.004	20 KV	G-3	99.50
.0025	25 KV	G-4	190.00
.002	30 KV	1940-217	210.00
.0005	35 KV	G-4	210.00
.001	35 KV	1940-214	225.00
.001	75 KV	PL 49-728	360.00

CONDENSERS

TYPE F MICA

MFD	VDC	PRICE
.00055	5000	6.90
.00051	5000	6.90
.0009	3000	5.10
.0001	3000	5.25
.056	1000	3.90
.025	2500	5.10
.02	2000	4.90

CONDENSERS

TYPE 9

MFD	VDC	PRICE
.0005	1200	.69
.024	1500	2.50
.005	2500	1.50
.003	2500	1.90
.01	2500	2.05

CONDENSERS

TYPE 4

MFD	VDC	PRICE
.00005	1200	.69
.0022	1200	.69
.025	600	1.49
.022	600	1.25
.004	1200	.79
.001	600	.49
.01	500	.89
.01	600	.69
.01	1100	1.25
.01	1200	1.35
.01	2500	2.36

BATHTUB CONDENSERS

MFD	VOLTAGE—DC	TERMINAL	PRICE
.75	600	Side	1.25
.67	115 VAC	End	.95
.25	400	Side	.61
.25	600	Side and Top	.69
.25	1000	Side	.95
.25/.25	400	Side	.75
.25/.25	600	Bottom	.87
.25/.25/.25	600	Side	1.40
.14/.14	115 VAC	End	1.49
.05	600	Side	.39
.05/.05	1500	Top	1.45
.5	300	Top	.50
.5	400	Side	.59
.5	600	Bottom and Side	.69
.5	1000	Side	.89
.5/.1	100	Bottom	.49
.5/.5	600	Bottom and Side	.91
.3	600	Top and Side	.62
.2	600	Top and Side	.49
.2	1000	Side	.79
.1	100	Side	.36
.1	600	Top and Bottom	.58
.1	1000	Side and Top	.69
.1	1500	Top	1.05
.1/.1	600	Side	1.10

VACUUM CONDENSERS

MFD	VDC	TYPE	PRICE
50 MMFD	5 K	8047	5.50
12 MFD	20 K	VC-12	7.50
50 MFD	20 K	VC-50	12.50
50 MFD	20 K	W-50	11.50
100 MFD	7.5 K	1L33	14.50

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MOTOR STARTING CONDENSERS

110 Volts 60 Cycles

POPULAR BRANDS

3276	145-175 mfd	1.02
95758	161-180 mfd	1.12
3292	162-198 mfd	1.14
3289	180-220 mfd	1.37
3928	200-240 mfd	1.42
3251	218-262 mfd	1.22
3915	234-286 mfd	1.64
3825	243-270 mfd	1.64
3275	243-292 mfd	1.68
3242	324-389 mfd	1.83
3225	400-480 mfd	2.12
3224	485-580 mfd	2.86

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Electronics, INCORPORATED

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Wellesley 5-5210-1

METER SPECIALS

0-5 MA DC Tuning: Aircraft Mtg. "AN" Type..........$1.29
0-30 VDC "AN" ..1.98; 4 for $7.
0-60 ADC "AN" Type Mtg Less Shunt.....$3.25; 3 for 9.00
0-15 VAC GE 2½ Rnd 800cy 1.2°
0-150 VAC/Wstghs/2½ Rnd/60 cy.......... 3.49
0-150 VAC/25-125cy/3½" Sq/RA35/Wstgh. 5.98
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 Triplett 221T...... 4.98
VU-20 +3 Weston 301 3" Sq L.P. $41....14.98
0-120 MA RF 3½" Rnd Weston 301.......14.98

★ 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, Special..........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/¼ Tip/12" Lng/.75 Lbs.......... 3.17

ESICO INDUSTRIAL CONST. USE IRONS 120VAC/DC
Similar to American Beauty types as shown
01A60/60W/1/8 Tip/7" Lng/2 5 oz.......... 3.20
#38/Am. Beauty 3138/100W/3/8 Tip....... 5.29
#58/Am. Beauty 3158/200W/5/8 Tip....... 6.30
#78/Am. Beauty 3178/300W/7/8 Tip....... 8.18
#98/Am. Beauty 3198/550W/1⅛ Tip.......10.08
Esico Temp Regulating Stand............ 4.20

JACKSON VULCAN IRONS

#230/25W/¼ Tip/7" Lng/3 Ozs............ 1.30
#231/40W/¼ Tip/8" Lng/4 Ozs............ 1.90
#230C/Craftsman/25W/5 Tips/7" Lng...... 2.20
#85P/85W/5/16 Tip/12" Lng/.5 Lbs........ 1.49
Kester Solder one Lb. .062 Roll Reg...... 1.29
With any soldering iron. Special.......... 90c
MFGRS WRITE FOR QUANTITY PRICES

MICA CAPACITORS

Brand NEW Made to Rigid Gov't Specs.

CHECK THESE REDUCED, LOW PRICES

Mfd.	Each	Mfd.	Each
600 WV		600 WV	
.0001	$0.24	.03	1.10
.001	.37	1200 WV	
.002	.40	.002	.61
.004	.48	.004	.63
.005	.50	.005	.66
.006	.54	.01	.73
.008	.58	2500 WV	
.01	.61		
.02	.71	.00047	.54

Fig. D. Screw Term & Mtg.

Mfd.	Each	Mfd.	Each
600 WV		1200 WV	
.0001	$0.24	.01	$0.69
.00055	.32	.013	.79
.00085	.37	.033	2.05
.0012	.39	2500 WV	
.003	.44	.0004	.59
.005	.49	.002	.98
.015	.66	.0022	.98
.02	.73	.0024	1.03
.03	1.10	.0035	1.09
.033	1.20	.0036	1.09
.039	1.80	.0043	1.19
.04	1.98	.005	1.25
.05	2.20	.006	1.40
1200 WV		.01	1.75
.001	.50	.015	2.05
.002	.56	3000 WV	
.0051	.62		
.0068	.66	.005	1.65

Fig. E. Upright Xmtg. Micas

Mfd.	Each	Mfd.	Each
250 VDC		3000 VDC	
.05	$0.47	.00005	.78
.2	2.59	.0001	$1.08
1500 VDC		.0003	1.15
.04	.89	.0007	1.19
.05	1.08	.0055	1.35
2000 VDC		.008	1.79
.003	1.08	3500 VDC	
.005	1.19	.000033	.78
.006	1.25	5000 VDC	
.01	1.39	.0001	1.79
.015	1.68	.00015	2.29
.02	1.98	.0003	2.75
.03	2.35	.0006	3.59
2500 VDC		.001	3.89
.0025	1.08		
.006	1.65	.01	4.79

TYPE G HIGH CURRENT MICAS

.01MFD	10KV	30 AMP	$49.50
.0012MFD	20KV	16 AMP	35.00
.001 MFD	30KV	30 AMP	60.00
.0025MFD	25KV	22 AMP	49.00
.0005MFD	20KV	12 AMP	22.00

PLIERS KIT

6" Long Nose & Side Cutters $.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/case......$1.79

STEP UP TRANSFORMER

Primary 7.5KW. W/110V Inpt, Two Secondaries Dlvr 220V at 7.5 Amp Each, or One 440V at 7.5A. Same but 220V Pri. Will Deliver 2X440 at 7.5A Each, or 880V at 7.5A..................$110.00

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 Oner......$6.98

AUDIO AMPLIFIERS READY TO GO

Model 305MP 5 Watt Ampl. as Pictured Above Features Mike & Phono Inpts. W/Sep. Gain Cntrls. Latest Compensated Tone Cntrl Design With tubes......$14.98
Model 200MO Mike OSC. Broadcasts Through Your Radio with No. Direct Connection. W/Tubes... $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 110VAC..........$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/Altec-Pierless Output..........$51.00
"Techmaster" TM-15P Pre Amp Kit....$19.95
Meissner Hi-Fi Radio FM/AM & Phono. Complete All Built System. Incld 10 Watt Hi-Fi Amp, 7 Tube AM/FM Tuner, 12" Hi-Fi Electrovoice Tweeter Woofer 12B Speaker & 3 Speed Webster Changer. Special Prepaid.$199.95

"TAB"
THAT'S A BUY

SELSYNS

2J1H1 GE Selsyns..................2 for $6.98
2J1F3 GE Brand New 115V/400 cy, ea..... 9.75
C78248 Sync. Trans. 115/60 cy $39.95; 2 for 75.00
C78249 Sync. Diff. 115V/60 cy 17.95..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

OTHER TYPES IN STOCK

DYNAMOTORS

INPT 6VDC, Output 200V/100ma. or 12/24V Output 500V/50ma P' Magnt. As Illustrated.. 6.95
Inpt 28VDC/1.4A Output 250V/60ma.......... 3.69
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

★ TEST EQUIPMENT ★

MODEL 206P real mutual conductance tube tester. Checks all latest tubes, Industrial, radio and TV types. Tests all elements for gas, shorts, opens and leakage. Meter 4½" reads micromhos, and English scales, reject and good—roll chart. Gtd includes factory warranty and new test information as available. Post Paid..........$80.00
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. 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. Post Paid..$33.49
MODEL HVP 30,000 volt probe for Model 106. Display model **"TAB"** GTD. Post Paid.. $8.25
WRITE FOR TEST EQUIP. PAMPHLET

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.

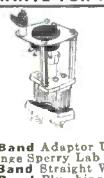
AUDIO COMPONENTS

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** Good Tone............ 1.49
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

ELECTROLYTIC CONDENSERS

2X 20MFD/450VDC..........79c; 4 for $3.00
3X 15MFD/450VDC..........1.25; 4 for 4.50
3X 20MFD/400VDC..........98c; 2 for 1.79
80MFD/450VDC..........98c; 2 for 1.79
25MFD/450VDC..........79c; 4 for 3.00
45MFD/450VDC..........89c; 5 for 4.00
2X20MFD/450 & 25VDC..........79c; 3 for 2.00
WRITE FOR ADDITIONAL LISTINGS

MICROWAVE



Klystron Mts Assy (723AB) & Coupling to 2 Type "N" Co-Ax Fittings. As Shown $9.98; 2 for $18.00
1 Microsecond Delay Line "Millen" $2.95; 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
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 32¾" 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-766 3911-G1, Includes 2J42 & Magnet, 3C45 & (2) 3B24..........$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 D-163247........$12.00
Pulse Blocking Osc. 3 wndgs, 1:1:1 ratio 1 mh wndgs GE H'Sld, HiVins..........$2.98
PULSE SHAPING Xfm: 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

TABOGRAM
WRITE FOR IT
WE STOCK LARGE VARIETY OF COMPONENTS. TELL US YOUR NEEDS
SELL US YOUR TUBES & EQUIPMENT

TELEVISION ANTENNAS

Delta Beam Adjustable indoor antenna. Powerful, for fringe areas. No more snow, ghosts, static, lines. Uses best principles of specialized antennas..........$4.95
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..........85c; 2 for $1.49
300 Ohm Twinex 100 ft $1.49; 1000 ft $12.49
RG59U TV Cable......100 ft $5.00; 500 ft $22.

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/.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
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
680VCT/200MA, 5V/3.5A, 6.3V/4A, 78V/1A $4.39; 3 for $12.
500VCT/60MA, 6.3V/4A HSLD..........$2.98
480VCT/80MA, 6.3VCT/4A, 5V/3A..........$2.69
420VCT/90MA, 6.3V/1.9A W/INPUTS 6, 12, 24, 115VDC & 115 230 VAC @..........$1.98

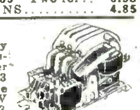
FILTER CHOKES

15Hy/40ma AC/DC sets, 3 for .98
12Hy/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 2 Hy/300ma USN..$1.25; 2 for...... 1.98
6Hy 175ma 250 Ohm..........$1.49; 2 for 2.49
10Hy 100ma Freed.......... 1.49

FILAMENT TRANS.

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/12KV INSUL G.E.......... 8.25
5V/115A CSD KENYON HVINS.......... 16.95
7.5VCT/12A CSD KENYON 15 KVINS.. 10.95
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

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

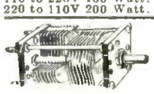
400 CYCLE XFMRS

WE KS9608 1233vct/350Ma, 1140vct/70Ma. 3.98
G-E M7472443P1 788V/200Ma, 210V/15Ma, 5V/2A.......... 2.95
G-E M7472469 6.3V/7A, 6.7V/.9A, 6.3V/.3A 2.95
WE KS9604 6.3V/4.65A, 6.3V/.3A.......... 2.25
WE KS9603 6.3V/3A, 5V/2A.......... 2.10
LANGEVIN 702556 6.3V/.6A.......... 1.49
FREED 11686 5V/10A.......... 2.98
WE KS9602 5V/4A.......... 1.98
FREED 11685 2.5vct/10A CSD.......... 2.98
LANGEVIN 702720 5V/6A, 13 KVINS... 3.49
WED164533 6.3V/1.25A, 6.3V/1.25A...... 1.98
Write for Quantity Price

STEP UP OR DOWN XFMR

110 to 220V 50 Watt..........$2.95
110 to 220V 100 Watt.......... 3.95
220 to 110V 200 Watt.......... 4.95

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 369mmf, each....... 59c
Midget 3 to 15 mmf, Midline, each....... 29c
2½ Meter Butterfly Cndsr 30mmf w/RF Tank & Choke..........59c; 2 for 98c

OIL CAPACITORS

Mfd	Each
50wvdc	
4	$0.40
150wvdc	
1-1-3-5	.98
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
8	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
12000wvdc	
.02	4.98

Mfd	Each
12500wvdc	
2	95.00
15000wvdc	
.0016	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

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	18390	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	12.89
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

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
353GTQ	FT 503	5000	49.98
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
26MFD/330VAC/1.5KVDC Int. **29W. Sec.**.. 6.98

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

100 WATT SEC 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

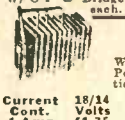
THAT'S A BUY **"TAB"** THAT'S A BUY

Dept. 5E 111 Liberty Street, New York 6, N. Y., U. S. A. PH. RECTOR 2-6245

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.

FEDERAL RECTIFIER KIT

"FEDERALS" all purpose selenium rectifier kit. You can make 24 different rectifiers ½ WAVE/W/CT & Bridge. 8 plates rated 18V/12AMP each. All Hardware & lugs..$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	$1.35	$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
C "TAB" fast delivery SPECIALS

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
36VCT—24V—18V/24 Amp.... 35.75
18V/2A....$1.98;18V/4AMP.... 3.95

"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

BATTERY CHARGER RECTIFIER

10-0-10 Volts (CT) 100 Amp (Fan Cooled). Replace Your Old inefficient Sulphide Rect. with the New Selenium Types. **SPECIAL**..$11.98

"TAB" THAT'S A BUY

PARTS CABINET

50 Draw Hvy Steel 84⅝"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 15⅝W/8⅝H/6⅛D Draws 2⅞"W/2"H/6"D & Two moveable Dividers each draw
"TAB" SPECIAL....$7.35 or 3 for $20

866A KIT AND XFORMER

2 Tubes, Sckts, xmf 115v 60cyc Inpt outpt. 5VCT, 10A/H,vinsul. SPECIAL....$5.49

DIODE PROBE TUBE

Unexcelled for **No-Loss VHF** testing. Ultra-sensitive subminiature-envelope. New, w/data VR92....25c; 5 for $1.

★ 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

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

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.... 3.59
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

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; 2 for $5.00
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

AUDIO COMPONENTS

Western Electric Push-Pull Pentode Output Transformer 197A. Rated 10 Watt 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

"GR" VARIAC

"GR" 200CU/O-130V/1KW/7.5A Reconditioned, Tested & Gtd....$15.98
General Radio 100R/O-230V/2KW/9A....$30.00
General Radio 50B/O-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

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

TUBES

GUARANTEED "TAB" TESTED

PRICES SUBJECT TO CHANGE

OA2	50.95	2E31	1.49	6A3	.90
OA3/VR75	1.04	2E32	1.49	6A4	1.89
OA4G	1.05	2E36	1.49	6A5G	2.07
OB2	1.37	2E41	1.54	6A6	.80
OB3/VR90	1.09	2E42	1.49	6A7	.85
OC3/VR105	1.15	2E43	1.49	6A8GT	.90
OD3/VR150	.90	2G21	1.49	6AB4	.79
OY4	2.53	2J21	8.75	6AB5/6N5	1.33
OZ4	.60	2J21A	8.90	6AB7/1853	.98
C1A/ELC1A	9.75	2J22	7.69	6AC5GT	1.00
O1A	.69	2J30	69.00	6AC6G	.95
VS-1	12.49	2J31	27.00	6AC7	.80
1A3	1.10	2J31A	79.95	6AD7G	1.29
1A4P	.79	2J32	37.00	6AG5	.79
1A5GT	.79	2J33	27.00	6AG7	1.39
1A6	1.49	2J34	27.00	6AH5G	1.49
1A7GT	.95	2J36	108.00	6AH6	1.22
1AD4	1.49	2J37	12.70	6AJ5	1.40
1AE4	1.80	2J38	11.75	6AK5	.74
ELC1B/3C31	3.45	2J39	44.00	6AK5W	2.98
1B3/8016	.81	2J42	187.00	6AK6	1.05
1B4P	.89	2J48	24.25	6AL5	.54
1B5/25S	.99	2J49	67.25	6AL7GT	1.29
1B7GT	.99	2J50	21.25	6AN5	2.99
1B21/471A	2.85	2J52	249.50	6AQ5	.55
1B22	2.20	2J55	85.00	6AQ5W	3.98
1B23	9.90	2J56	149.00	6AQ6	.81
1B24	9.45	2J61	49.95	6AQ7GT	1.29
1B26	2.45	2J62	49.45	6AR5	.79
1B27	12.75	2K22	39.45	6AR6	2.98
1B32/532A	3.90	2K23	39.45	6AS5	.79
1B35	9.15	2K25	28.49	6AS6	2.43
1B37	16.98	2K25/723AB	24.90	6AS6W	3.20
1B38	29.95	2K28	29.00	6AS7G	4.65
1B40	4.95	2K33	259.00	6AT6	.63
1B41	49.95	2K34	225.00	6AU5GT	1.10
1B42	18.00	2K35	389.95	6AU6	.59
1B46	1.98	2K39	130.00	6AV5GT	1.29
1B53	49.95	2K41	126.00	6AV6	.49
1B56	38.50	2K43	136.00	6AW6	1.89
1B58	175.00	2K44	130.00	6AX4/6U4	.79
1B60	69.75	2K45	110.00	6AX5GT	.79
1B63	50.00	2K48	120.00	6B4G	1.23
1B63A	75.00	2K50	459.00	6B5	1.19
EL1C	2.70	2V3G	.98	6B6G	1.05
1C5GT	.89	2W3GT	.98	6B7	.95
1C6	.79	2X2	.49	6B8G	.60
1C7G	.89	2X2A	1.53	6BA6	.63
1D5GP	.99	3A4	.99	6BA7	1.27
1D7G	.89	3A5	.81	6BC5	.63
1D8GT	.89	3A8GT	1.59	6BC7	1.23
1D21/631P1	3.89	3B4	2.69	6BD5GT	1.65
1E5	.99	3B5	.98	6BD6	.83
1E7G	.99	3B7/1291	.69	6BE6	.59
1F4	.69	3B22	2.70	6BF5	.98
1F5G	.79	3B23/RK22	4.95	6BF6	.65
1F6	.89	3B24	5.40	6BF7	2.55
1F7G	.89	3B25	4.50	6BG6G	1.39
1G4GT	.89	3B26	3.70	6BG7	1.98
1G5G	.89	3B28	7.90	6BH6	.63
1G6GT	.79	3C22	89.00	6BJ6	.69
1H4G	.89	3C23	9.90	6BK7	2.15
1H5GT	.72	3C31/C1B	3.45	6BL7GT	1.45
1H6GT	.79	3C33	14.98	6BN6	1.49
1J5G	1.20	3C34/HK24	5.49	6BN7	1.69
1J6GT	.79	3C45	12.89	6BQ6GT	1.20
1L4	.69	3D6/1299	.69	6BQ7	1.65
1L6	.98	3D21A	4.98	6BY5G	1.45
1LA4	1.19	3D22	13.95	EL6C/6C	16.98
1LA6	.99	3D23	4.90	6C4	.50
1LB4	1.29	3E29	14.95	6C5GT	.55
1LC5	.79	3J31	300.00	6C6	.57
1LC6	1.39	3K22	275.00	6C7	1.26
1LD5	.99	3K23	405.00	6C8G	.80
1LE3	.99	3K30	300.00	6C21	29.45
1LH4	.89	3Q4	.79	6CB6	.69
1LN5	.79	3Q5GT	1.29	6CD6G	1.69
1N5GT	.72	3S4	.85	6D4	2.70
1P5GT	.79	3V4	.79	6D6	.89
1P21	33.00	4-125A	29.00	6D7G	.89
1P42	5.60	4-250A	40.00	6D8G	.85
1Q5GT	.70	4-400A	57.50	6E5	.79
1Q26	69.00	4-1000A	108.50	6E7	1.39
1R4/1294	1.29	4B23	16.98	6F4	6.20
1R5	.79	4B27	4.98	6F5	.95
1S4	1.19	4B32	9.50	6F6	.79
1S5	.79	4C25/HK54	5.98	6F6GT	.79
1S21	9.50	4C33	59.00	6F7	.85
1T4	.79	4C35	22.25	6F7G	1.29
1T5GT	.99	4C36	15.98	6F8G	.85
1U4/5910	.73	4E27/257	14.50	6G6G	.90
1U5	.79	4J22	148.50	6H6	.60
1V	.79	4J31	98.00	C6J/5C21	6.95
1V2	.70	4J34	194.00	6J4	6.66
1X2	.95	4J42/700	27.00	6J5GT	.47
1Z2	3.98	4J47/720CY	300.00	6J6	.63
2A3	1.78	4J47	485.00	6J7	.72
2A4G	1.19	4J52	350.00	6J8G	1.19
2A5	.69	4J56	498.00	6K4	5.15
2A6	.69	4X-150A	45.00	6K4A	6.45
2A7	.69	4X-500F	85.00	6K5GT	1.09
2AC15	4.98	5AX4GT	.54	6K6GT	.59
2AS15	4.98	5AZ4	1.35	6K7	.75
2B22	3.90	C5B/5C30	3.95	6K8GT	1.08
2C21/1642	.67	EL5BHD	16.98	6L5G	.75
2C22/7193	.33	5C21/C6J	6.95	6L6	2.09
2C26	.19	5C22	42.05	6L6G	1.35
2C33/RX233A	3.49	5C30/C5B	3.95	6L6GA	1.35
2C34/RK34	.69	5D21	19.50	6L6GAY	2.29
2C36	27.00	5D23/RK65	36.50	6L7	.80
2C39	21.00	5J29	12.40	6N4	2.39
2C39A	29.50	5J23	59.00	6N6G	1.69
2C40	7.29	5R4GY	1.55	6N7GT	.80
2C43	17.75	5R4GYW	1.75	6P5GT	.89
2C43/464A	9.49	5T4	2.49	6Q7	.89
2C44	1.20	5U4G	.69	6R7	.77
2C50	3.69	5V4G	1.10	6R8	1.39
2C51	5.49	5W4	.89	6S4	.85
2C52	5.98	5X4G	.79	6S7G	.83
2021	1.26	5Y3GT	.43	6S8GT	.92
2E5	1.19	5Y4G	.79	6SA7GT	.63
2E22	1.95	5Z3	.99	6SA7GTY	3.37
2E24	4.69	5Z4	1.49	6SB7Y	1.19
2E25/HY65	5.15	C6A	6.75	6SC7	.90
2E26	2.88			6SD7GT	.80
2E30	1.95				

6SF5	.77	12BA6	.59	35C5	.69	F123A	7.90	CK536AX	.99
6SF7	.73	12BA7	.79	35L6GT	.79	T125	12.49	CK537AX	3.04
6SG7	.72	12BD6	1.23	35T	6.95	F127A	19.98	CK538DX	.98
6SH7	.61	12BE6	.59	35TG	5.45	VT127A	3.90	CK539DX	2.19
6SJ7	.70	12BF6	.85	35W4	.59	CV148	4.98	CK541DX	1.99
6SK7GT	.69	12BH7	1.29	35Y4	.69	150T	14.50	CK542DX	.99
6SL7GT	.69	12BY7	1.35	35Z3	.79	FG166	49.00	CK543DX	.99
6SN7GT	.70	12BZ7	1.25	35Z4GT	.69	FG172	29.00	CK544DX	.99
6SN7WGT	2.25	12C8	.65	35Z5GT	.59	182B	1.20	CK546DX	1.99
6SQ7GT	.63	12F5GT	.65	REL36/6J4	.49	FG190	12.80	CK547DX	1.98
6SR7	.63	12H6	.65	36	.65	HF200	21.00	550P1	19.95
6SS7	.75	12J5GT	.49	37	.69	T200	22.98	CK571AX/	
6ST7	.98	12J7GT	.75	38	.59	201A/CX301A	.98	5886	2.49
6SU7GTY	2.69	12K7GT	.89	RK39	2.89	203A	5.98	CK573AX/	
6SZ7	1.05	12K8	.69	39/44	.59	205B/VT2	1.69	6029	3.49
6T7G	.85	12Q7GT	.55	CRC40	.59	CE206	3.15	575A/975	15.95
6T8	.98	12S8GT	.98	T40	4.29	211/VT4C	1.25	WL579	10.49
6U5/6G5	.99	12SA7GT	.69	TZ40	3.98	CE215	8.98	WL579B	12.98
6U6GT	.83	12SC7	.80	40	1.09	RX215	9.95	601B	.19
6U7G	.55	12SF5GT	.72	HY40Z	3.75	WE215A	.18	HY615	.25
6V3	1.89	12SF7GT	.49	41	.79	217C	8.75	616	37.00
6V6	1.39	12SG7	.83	42	.69	227A	4.98	KU627	18.00
6V6GT	.57	12SH7	.63	43	.85	231	1.20	WL652	65.00
6V8	1.99	12SJ7GT	.59	45	.69	242C	3.95	WL670A	11.98
6W4GT	.57	12SK7	.72	45S/VT52	.65	244A	4.15	WL673	117.00
6W6GT	.89	12SL7GT	.65	45Z3	.69	247A	9.95	WL676	39.95
6W7G	.85	12SN7GT	.75	45Z5GT	.89	250R	18.95	WL686	35.00
6X4	.59	12SQ7GT	.63	46	.89	250TH	22.25	701A	5.95
6X5GT	.59	12SR7	.63	47	.99	250TL	17.75	702A	3.29
6Y6G	.89	12X3	.90	48	1.17	HK254	14.49	702B	5.98
6Y7G	.89	12Z3	.89	RK48A	6.85	262B	3.98	703A	4.75
6Z7G	.89	14A4	.87	RK49	7.50	274B	3.45	704A	.98
6ZY5G	.89			49	.83	276A	9.89	705A/8021	1.98
7A4/XXL	.73	14A7/12B7	.75	50	1.19	300B	11.50	707A	7.90
7A5	.73	14AF7/XXD	.83	50A5	1.19	T300	26.98	707B	13.50
7A6	.73	14B6	.65	50B5	.79			710A/8011	.95

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7A7	.69	14B8	.89	50C5	.69	HF300	24.30	713A	.98
7A8	.69	14C5	1.07	50C6	1.49	304TH	8.90	NL714	5.95
7AD7	1.49	14C7	.95	50L6GT	.69	304TL	8.90	714AY	5.90
7AF7	.89	14E6	.99	50X6	.89	307A/RK75	4.20	715A	6.00
7AG7	1.00	14E7	1.09	50Y6GT	.79	310A	6.25	715B	11.90
7AH7	1.19	14F7	.95	50Z7G	.98	311CH	10.95	715C	24.00
7B4	.69	14F8	.83	52	.99	311CT	10.50	717A	.90
7B5	.73	14H7	.83	53	.69	311T	10.50	718BY	48.45
7B6	.73	14J7	.83	T55	8.79	313C	2.98	718CY	48.45
7B7	.73	14N7	.87	55	1.06	316A	1.49	719A	28.50
7B8	.83	14Q7	.73	56	.85	323A	24.25	721A	2.49
7C4	.73	14R7	.80	57	.79	327A	4.95	721B	12.50
7C5	.69	14S7	.98	58	.79	5340	[illegible]	722A/287	2.45
7C6	.69	14W7	1.09	RK59	1.45	350A	6.50	723A	11.95
7C7	.69	14X7	1.23	59	1.78	350B	4.95	723A/B	25.00
7C23	72.00	15E	1.98	RK60/1641	1.95	353A	4.65	724A	3.95
7C29	69.95	15R	.89	RK61/XFG1	3.05	HK354	24.98	724B	3.45
7E5/1201	.65	FG17	3.95	T60	10.49	355A	14.15	725A	8.49
7E6	.53	18	.98	HY69	4.98	368AS	7.49	726A	14.25
7E7	.73	19	.69	70A7	1.59	371B	1.85	726B	45.00
7F7	.73	19BG6G	1.79	70L7GT	1.59	380A	.79	726C	79.95
7F8	1.25	19T8	1.09	71A	.79	388A	1.49	730A	24.50
7G7/1232	.89	19V8	1.62	CRP72	1.20	393A	8.90	800	1.85
7H7	.73	T20/1623	3.79	CRP73	1.49			801A	.45
7J7	.89	TUF20	5.19	73	1.67	394A	4.90	803	3.89
7K7	1.10	TZ20	3.79	NR74	.29	FP400	15.98	805	3.90
7L7	.83	20	1.17	HY75	4.59	WE417/5842	18.50	807	1.65
7N7	.79	RK20A	8.95	75	.99	WL417A	8.95	808	2.59
7Q7	.69	RX21	3.75					809	2.43
7R7	.83	22	.99	76	.79	GL434A	12.69	810	9.95
7S7	.92	24	.85	77	.69	446A	1.05	811	2.90

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7T7	1.03	24A	1.10	78	1.05	446B	3.89	811A	3.50
7V7	.79	24G/3C24	1.90	79	.89	450TH	45.00	812	2.70
7W7	.95	25A6	1.09	80	.69	450TL	52.00	813	12.49
7X7/XXFM	.89	25A7	2.98	81	1.69	460/HF200	15.95	814	2.97
7Y4	.49	25AC5GT	1.59	FG81A	5.95	WL468	13.95	815	2.98
7Z4	.65	25AV5GT	1.29	82	1.19	GL471A	2.69	816/866Jr	1.07
8DC-15	4.98	25BQ6GT	1.19	82V	1.39	CK501X	1.26	826	.95
10Y	.35	25C6	1.18	83	1.45	CK501AX	2.20	828	11.29
CV11	5.25	25L6GT	.69	83V	1.79	GL502A	1.79	829	11.49
12A	.57	25W4GT	.89	84/6Z4	.99	CK502AX	1.49	829B	12.45
12A5	1.39	25Y5	.79	85	.79	CK503AX	1.49	830B	3.49
12A6	.59	25Z5	.79	89	.75	CK505AX	1.79	832	7.65
12A7	.90	25Z6GT	.99	VR92	.25	CK506AX	1.49	832A	9.65
12A8GT	.65	26	.79	FG95/5560	24.85	RH507	9.98	833A	39.45
12AC7	1.19	27	.69	FG98	19.95	CK509AX	1.79	834	5.95
12AH7GT	1.45	FG27A	8.70	100TH	7.83	CK510AX	2.49	836	4.75
12AK5	1.98	HV27	10.95	102D	2.98	CK512AX	1.45	837	1.45
12AK5W	2.98	RK28A	4.89	102G	2.98	CK522AX	1.29	838	3.98
12AL5	.75	28D7	1.95	FG104	37.98	CK525AX	1.29	843	.39
12AT6	.52	30	.70	FG105	17.64	CK526AX	1.49	845	5.95
12AT7	.81	31	.59	VU111	1.45	CK527AX	2.84	849	29.45
12AU6	.72	HY31Z	2.75	HY114B	.75	CK528AX	1.49	852	19.98
12AU7	.63	32	.49	HY115/145	.79	CK529AX	1.79	860	4.90
12AV6	.49	FG32/5558	13.85	117L/M7GT	1.59	GL530	22.00	861	23.95
12AV7	.98	32L7GT	1.49	117N7GT	2.15	CK531DX	1.89	864	.39
12AW6	1.79	33	.59	117P7GT	1.39	531	6.98	865	1.29
12AX4GT	1.20	34	.69	117Z3	.59	CK532DX	1.89	866A	1.50
12AX7	.79	35/51	.89	117Z4GT	1.39	WL532	3.98	868/CE1C	3.49
12AY7	2.95	35A5	.79	117Z6GT	1.19	CK533AX	1.29	869	36.95
12AZ7	1.49	35B5	.79	117Z7GT	1.49	CK534AX	.99	872A	3.29

874	1.39	9003	1.50
878	1.95	9004	.42
884/6Q5G	1.80	9005	2.25
885	1.45	9006	.39
893A	250.00	**C'Ray Tubes**	
917	2.59	2AP1	9.70
922	1.85	3AP1	9.75
919	2.75	3AP1A	14.25
923	1.00	3AP5	18.00
925	1.69	3BP1	5.75
927/CE25	1.49	3BP1A	14.98
930	1.65	3BP5	18.00
931A	6.25	3DP1	4.75
954	.18	3EP1/1806P1	4.85
955	.39	3FP7	.98
956	.36	3FP7A	14.98
957	.65	3GP1	4.20
958A	1.45	3GP4	16.50
967/FG17	3.95	3HP7	1.40
973	16.95	3GP5	18.00
991	.45	3HP14	14.98
FM1000	1.50	3GP7	18.00
CK1005	.85	3JP7	12.50
CK1006	3.49	3JP12	19.95
CK1007	.89	3JP14	16.95
CK1027	2.98	4AP10	4.40
CK1028	15.98	5AP1	3.45
CK1089	2.99	5BP1	4.89
CK1090	2.98	5BP4	4.25
R1100	5.00	5CP1	4.50
R1130	12.00	5CP1A	18.49
E1148	1.35	5CP7	11.75
HY1231Z	5.39	5CP5	30.00
1612	1.90	5FP4	40.00
1613	.89	5FP7	2.00
1616	2.45	5HP1	5.70
1619	.25	5HP4	5.70
1620	4.70	5JP2	19.25
1622	2.69	5JP4	26.75
1624	1.90	5JP5	35.00
1625	.33	5JP7A	39.00
1626	.33	5LP1	22.25
1629	.29	5LP2	27.50
1630	.97	5LP7	29.95
1631	1.95	5LP4A	33.00
1632	.77	5MP1	10.50
1633	.73	5SP7	100.00
1634	.73	5RP7A	89.50
1635	1.89	7BP1	8.65
1636	3.19	7BP7	6.50
1644	.95	7EP4	17.98
2000T	149.50	7JP4	18.39
2050	1.47	9GP7	12.75
2051	1.15	9LP7	2.98
5516	5.98	12DP7	16.89
5517	3.39	12DP7A	49.50
5594	6.65	12GP1	49.98
5608A	5.95	12GP7	14.75
5618	3.50	12HP7	14.75
5637	6.99	905	3.49
5638	12.64	912	89.98
5647	8.35	913	9.98
5651	2.35	914A	45.00
5654	2.79	**Xtal Diodes**	
5656	6.90	1N21	.93
RK5657	350.00	1N21A	1.55
5663	1.85	1N21B	2.89
5670	5.30	1N21C	21.50
CK5672	1.29	1N22	1.25
CK5676	1.29	1N23	1.35
CK5678	1.89	1N23A	2.20
5684	14.98	1N23B	3.49
5686	3.90	1N25	4.98
5687	5.49	1N26	8.75
5691	7.85	1N27	1.56
5692	7.85	1N29	3.50
5693	6.75	1N34	.64
5694	3.65	1N34A	.90
CK5697	3.49	1N35	1.68
CK5702	3.49	1N38	1.43
CK5703	1.29	1N38A	1.25
CK5704	1.89	1N39	4.15
5718	10.15	1N41	8.95
5719	12.25	1N42	16.95
5726	1.79	1N43	1.73
GL5727	4.49	1N44	1.24
5744/CK619CX	1.69	1N45	1.45
5749	1.98	1N46	.69
5751	5.45	1N47	4.00
5763	1.70	1N48	.55
CK5783	6.69	1N51	.45
CK5784	6.98	1N52	1.62
5812	2.99	1N54	.89
5814	3.64	1N54A	1.17
CK5829	4.39	1N55	2.35
5840	12.34	1N56	.89
5842/WE417	18.50	1N57	.89
CK5851	8.65	1N58	1.19
CK5875	1.69	1N58A	1.26
5881	2.69	1N60	.60
8002R	99.50	1N61	2.10
8005	7.25	1N63/K63	2.49
8008	6.49	1N64	.69
8012	2.89	1N69	1.19
8013	2.75	1N86	1.25
8013A	6.45	1N87	1.25
8014A	28.95	1N88	1.25
8020	1.25	K34	1.35
8025A	4.75	CK705	.77
9001	1.55	CK706	.54
9002	.95	CK707	1.80

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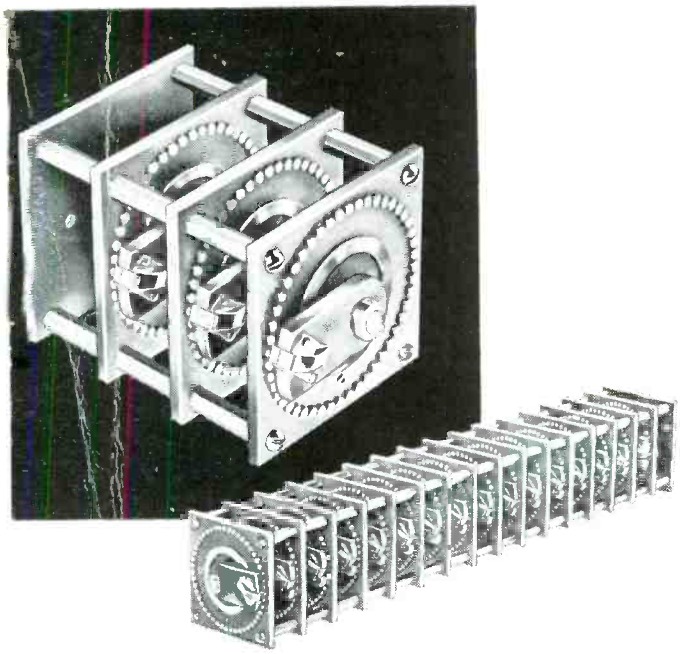

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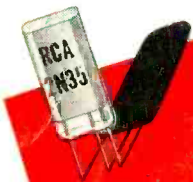

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