NOVEMBER · 1955
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electronics

A McGRAW-HILL PUBLICATION

SLURRYING PHOSPHOR ON COLOR TUBE

for the HIGHEST in RELIABILITY

UTC products are the most copied in the world. This is only natural, since we maintain the largest laboratories and engineering staff in our field. However, copying alone cannot provide the measure of uniformity and reliability inherent in UTC units. To provide for the maximum in quality and reliability, continuing programs of quality control and quality improvement are constantly maintained in our laboratories.

WHAT MAKES A TRANSFORMER FAIL?

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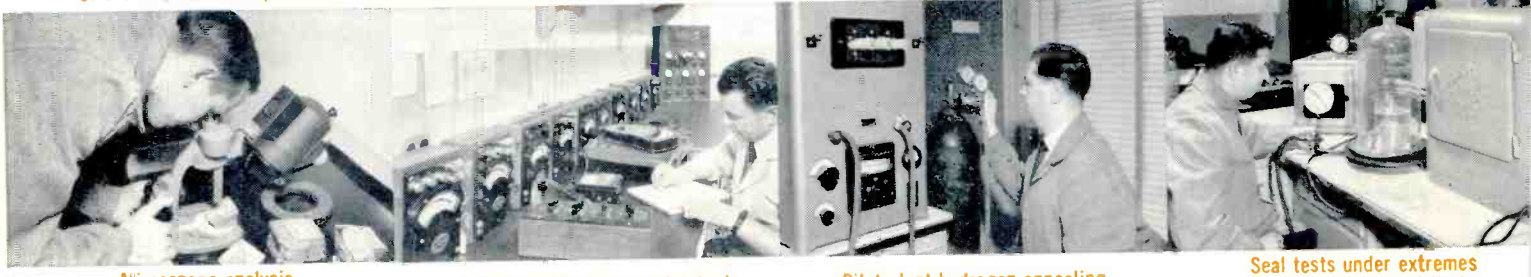
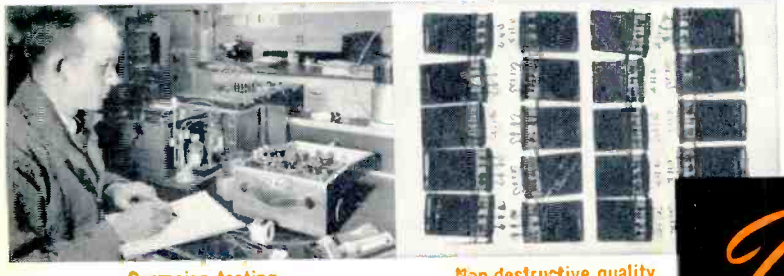


Microscope analysis of dissected units. Calibration to primary standards. Pilot plant hydrogen annealing. Seal tests under extremes of cold, heat, and altitude.

Abrasion and mercury tests on magnet wire. Pilot plant run on encapsulating material.



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electronics

A McGRAW-HILL PUBLICATION

NOVEMBER • 1955

SLURRYING PHOSPHOR ON COLOR TUBE—Production method used for RCA color kinescopes employs centrifuge to spread phosphor, supplanting the slower method of suspension deposition (see page 180) ..... COVER

FEATURES

CONTINUED ON NEXT PAGE

contents

continued

SHOP

► **THANKS** . . . Another firm in our industry now puts out for its employees a periodic dope sheet containing digests of important articles appearing in current magazines.

We note with great interest that most of them (and the best, we hope) are from a certain magazine that modesty forbids our mentioning.

► **POESY** . . . We are indebted to George Tillman of Syracuse for the following:

'Twas the day ELECTRONICS
October is here;
Engineers are unhappy
There's brine in their beer.

On page 16 there's a low-flying blimp
Photo quite lovely, but caption quite limp;
The reason is painful, as we all can see
One of your boys had left out GE.

We apologize.

► **BUNDLING** . . . Not a revival of an early American custom, but a simple method of grouping components between wiring boards is described in Industry Report this month, page 12. It allows change of circuit without involving high tool cost.

As developed so far, certain operations are done manually but in the final design an automatic insertion head would take a component and cut, bend and insert the leads.

PSYCHOLOGY OF A WORD— Having watched the development of microwave plumbing from the rain pipe days to the high-precision fabrication of modern equipment, we nevertheless have had a

electronics

NOVEMBER, 1955 Vol. 28, No. 11

Member ABC and ABP

TALK

feeling of awe whenever we saw fancy new gear.

It took a slight mistranslation to rid us of that feeling forever.

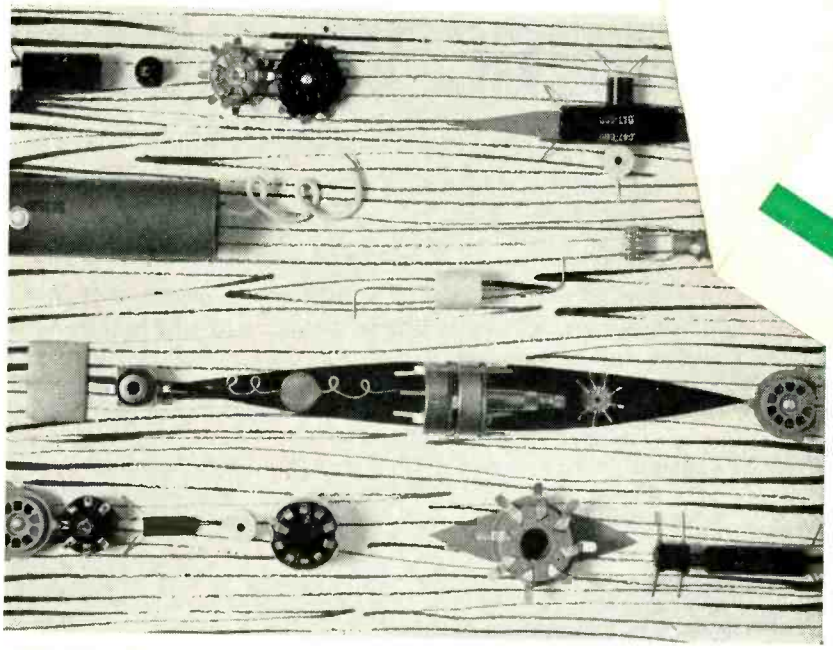
Editorial material sent in by a Japanese engineer from overseas includes photographs of disassembled sections of waveguides. His caption reads "*decomposed* sections of waveguide."

► **UTILECTART** . . . While collecting material on automatic production techniques, we collected components of various shapes and sizes. As the pile grew, it caught the artistic eye of Everett Hoffman, who deals with graphic aspects of the advertising art. By arranging the various components esthetically on boards he came up with some interesting patterns that aroused our curiosity.

Hoffman calls the technique "utilectart," for utility, electronics and art. Before we could stop him he went on:

"The idea of spatial organization in a picture has been an artistic challenge to painters and designers alike throughout the history of art. The problem is simply one of combining visual elements within a picture plane for the purpose of treating the eye . . .

"The subjective or story-telling virtues of a picture are quite separate and distinct from the artistic or esthetic problems solved . . . Not that the subjective can be ignored, for though picture-making is a highly debatable art, we do not presume to be dogmatic . . .

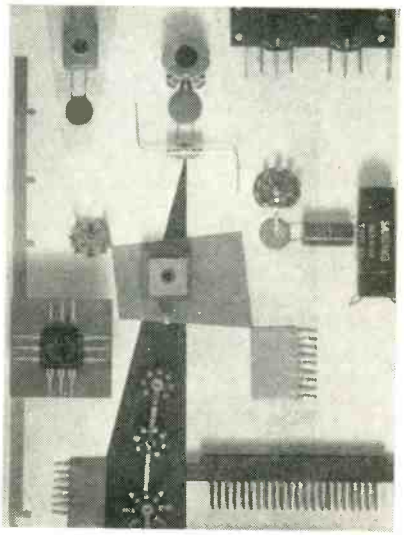


UTILITY, electronics and art are combined in these Hoffman abstractions based on newly designed components for automatic production

"It was the European artists who made the first real break with tradition, the Fauves and the Cubists who provided the intellectual ammunition for these two-dimensional constructions. The early twentieth century French artists who developed a new way of looking at things are the artistic fathers of these pieces . . .

"What I wish to show is that some of the most beautiful of the objects of our Machine Age are conceived of as functional, useful objects respecting strict laws of physics."

We like the patterns, anyhow.



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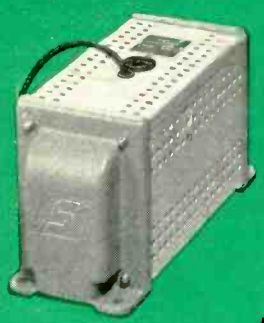
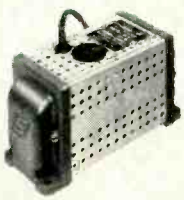
MVR60


MVR250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FEATURES

- No internal oscillator—eliminates drift
- R/C-tuned circuits—reduces hum and noise pickup
- Choice of 4 bandwidth characteristics: In-tune High, In-tune Medium, Narrow Band and ⅓ Octave.
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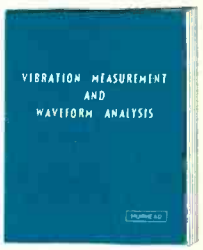
- Weight—55 pounds



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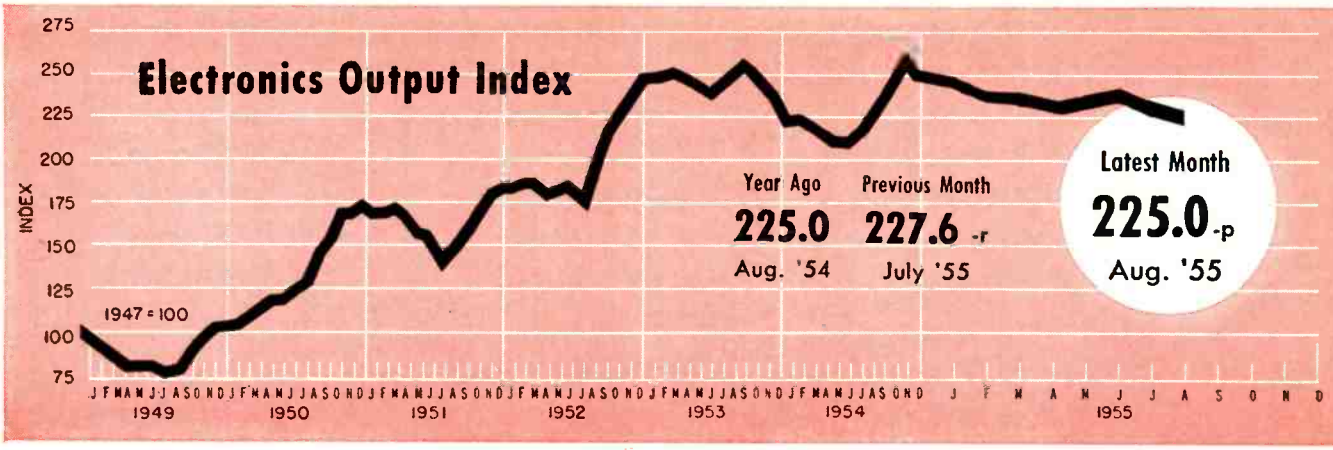


FIGURES OF THE MONTH

RECEIVER PRODUCTION

(Source: RETMA)	Latest Month Aug. '55	Previous Month July '55	Year Ago Aug. '54
Television sets, total	647,903	344,295	633,387
With UHF	105,673	63,466	93,404
Color sets	nr	nr	nr
Radio sets, total	947,634	718,489	785,499
With F-M	13,172	2,385	15,936
Home sets	300,513	141,119	280,607
Clock radios	137,604	93,517	155,171
Portable sets	106,197	79,410	74,713
Auto sets	403,320	404,443	275,008

RECEIVER SALES

(Source: RETMA)	Aug. '55	July '55	Aug. '54
Television sets, units	586,577	381,567	484,533
Radio sets (except auto)	456,625	303,965	447,025

RECEIVING TUBE SALES

(Source: RETMA)	Aug. '55	July '55	Aug. '54
Receiv. tubes, total units	45,238,000	28,340,000	35,167,272
Receiv. tubes, value	$33,099,000	$21,167,000	$24,002,391
Picture tubes, total units	1,048,534	515,793	855,191
Picture tubes, value	$19,812,567	$9,498,169	$17,941,034

SEMICONDUCTOR SALES

	May '55	Apr. '55	May '54
Germanium diodes, units Silicon diodes, units	1,493,211	1,419,245	1,001,905

INDUSTRIAL TUBE SALES

(Source: NEMA)	Quarterly Figures: Latest Quarter 2nd '55	Previous Quarter 1st '55	Year Ago 2nd '54
Vacuum (non-receiving)	$8,933,453	$8,784,478	$9,851,020
Gas or vapor	$3,365,008	$3,747,490	$3,987,036
Phototubes	nr	nr	nr
Magnetrons and velocity modulation tubes	$13,193,395	$14,229,442	$16,429,553
Gaps and T/R boxes	$1,677,574	$1,434,683	$1,914,313

TV SETS INSTALLED

(Source: NBC Research Dept.)	Latest Month July '55	Previous Month June '55	Year Ago July '54
Total sets	36,477,000	36,100,000	30,717,000

BROADCAST STATIONS

(Source: FCC)	Aug. '55	July '55	Aug. '54
TV stations on air	469	461	413
TV stations CPs—not on air	111	123	165
TV stations—new requests	24	17	175
A-M stations on air	2,758	2,748	2,603
A-M stations CPs—not on air	115	125	113
A-M stations—new requests	215	201	133
F-M stations on air	540	538	561
F-M stations CPs—not on air	16	17	10
F-M stations—new requests	6	4	3

COMMUNICATION AUTHORIZATIONS

(Source: FCC)	Aug. '55	July '55	Aug. '54
Aeronautical	45,203	44,435	40,695
Marine	52,440	51,528	47,360
Police, fire, etc.	18,877	18,593	16,109
Industrial	25,189	25,189	22,132
Land transportation	7,804	7,792	6,982
Amateur	138,852	137,682	121,762
Citizens radio	13,189	12,801	8,143
Disaster	319	317	305
Experimental	652	639	600
Common carrier	1,988	1,964	1,699

EMPLOYMENT AND PAYROLLS

(Source: Bur. Labor Statistics)	July '55	June '55	July '54
Prod. workers, comm. equip.	355,600-p	356,500-r	331,900
Av. wkly. earnings, comm.	$68.50-p	$71.96-r	$67.64
Av. wkly. earnings, radio	$67.30-p	$69.43-r	$67.20
Av. wkly. hours, comm.	38.7 -p	40.2 -r	39.1
Av. wkly. hours, radio	38.8 -p	39.9 -r	39.3

STOCK PRICE AVERAGES

(Source: Standard and Poor's)	Aug. '55	July '55	Aug. '54
Radio-tv & electronics	462.1	484.8	354.8
Radio broadcasters	533.9	560.4	381.3

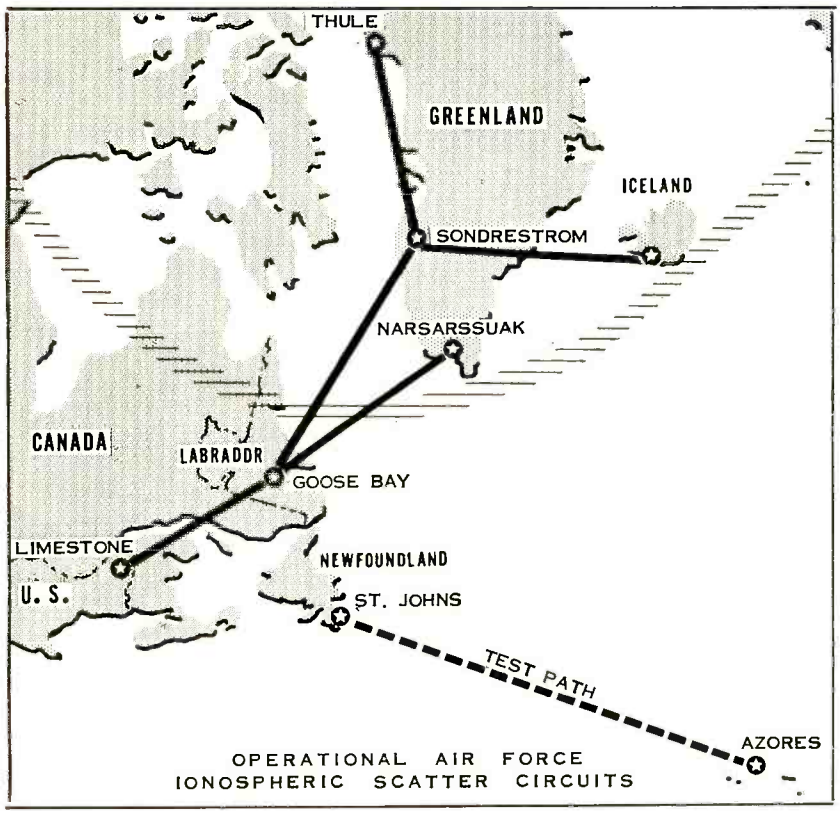
p—provisional; r—revised
nr—not reported

FIGURES OF THE YEAR

	TOTALS FOR FIRST EIGHT MONTHS 1955	1954	Percent Change	1954 Total
Television set production	4,820,991	3,785,519	+27.4	7,346,715
Radio set production	8,725,012	6,110,119	+42.8	10,400,530
Television set sales	4,171,139	3,658,927	+14.0	7,317,034
Radio set sales (except auto)	3,189,608	3,269,115	— 2.4	6,430,743
Receiving tube sales	300,080,000	225,085,000	+33.3	385,089,458
Cathode-ray tube sales	6,478,351	5,326,775	+21.6	9,913,504

INDUSTRY REPORT

Air Force Long-Distance Circuits Use VHF



Forward scatter insures reliability of teleprinter communications in radio blackouts

PATIENT COMMUNICATORS have so far failed to establish reliable radio service in the arctic using conventional high-frequency techniques. Very low frequencies require large antennas and have insufficient bandwith to accommodate multiplex circuits.

Fortunately, a phenomenon of the ionosphere (ELECTRONICS, p 102, June 1952) permits reception of directional signals over distances between about 500 and 1,500 miles. The phenomenon is often known as FPIS (forward propagation by ionospheric scatter). With increased habitation of the far north by defense forces, use of the new technique becomes a necessity.

► **Bitter Sweet**—A three-channel duplex system called Bitter Sweet links Loring Air Force Base at Limestone, Me. with Thule AFB in Greenland. This joint project of the Air Force, National Bureau of Standards and Page Communications Engineers, Inc. of Washington, D. C., requires relay stations at Goose Bay, Labrador and Sondrestrom, Greenland.

► **Future Circuits**—Engineers feel that the potentialities of FPIS have not been anywhere near fully exploited. Besides solving problems of erratic radio signals in the arctic, the technique is less expensive when compared with the amount of high or low-frequency equipment required to do an equivalent job.

Recently declassified are two new circuits linking Goose Bay—Narsarssuak and Sondrestrom—Iceland. This project is called Fat Girl and may include voice.

Europeans To Study U.S. Color-TV Standards

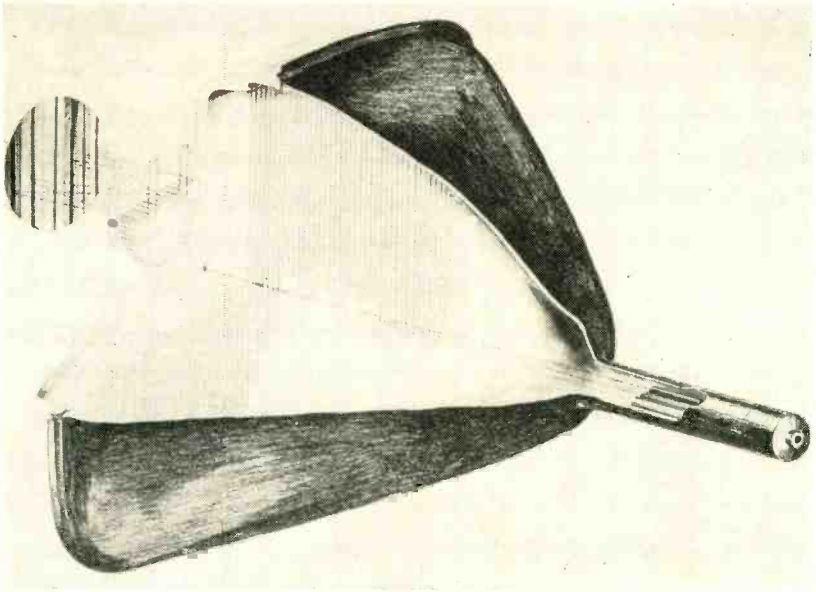
Large CCIR delegation coming to America in March. NTSC making arrangements

SOME 100 delegates of the Committee Consultatif International Radio (CCIR) will study American color-television standards, in the United States, in March. Arrangements for demonstrations, technical papers and plant visits are being made by the National Television Systems Committee (NTSC) of the Radio-Electronics-Television Manufacturers Association (RETMA) at the request of the State Department.

► **Two Weeks**—Recalling NTSC for

the purpose October 11, chairman W. R. G. Baker announced that CCIR delegates would participate in a program extending from March 5 through March 16. The first day will be devoted primarily to demonstrations at the United Nations building in New York, the balance of the first week to network, laboratory and plant visits in and near the New York metropolitan area. The second week will take delegates to other cities.

Many delegates plan to remain in the United States for a third week, in order to attend the Institute of Radio Engineers' national convention.



SKETCH of GE's post-acceleration tube shows how . . .

Color-Tube Design Progresses

Electron optical masking is done by grille wires that aid focusing also

PREVIEW of the post-acceleration tube was given by General Electric tube department in September. The company emphasized that the tube is still in the developmental stage and may not be ready for production until 1957.

▶ **Construction**—The post-acceleration tube has three electron guns. It uses direction selection near the screen to cause each of the three beams to strike the proper phosphor. The three guns lie in a horizontal plane.

The direction selection mechanism is an array of parallel 3-mil wires, spaced 28 to the inch, which form the color-selection electrode or grille. Close to the grille is the screen bearing a pattern of red, blue and green phosphor lines.

The grille permits more than 90 percent of the electrons from the guns to strike the phosphor screen compared to 12-14 percent for the shadow-mask tube. The new tube is theoretically more than six times as bright as the mask type. GE demonstrated how the tube's extra brightness stands up under lighting conditions up to 275 foot-lamberts.

▶ **Voltage Saving**—In normal operation, the final gun-electrode and cone potentials of the new tube are held at about 6.5 kv. The grille is held at a potential approximately 200 volts lower than 6.5 kv and the phosphor screen is run at about 25 kv.

▶ **Disadvantages** — Because post acceleration is used along with only one grille, secondary electrons hit the screen in a random manner and cause a white background. As a result, there is some loss of contrast. In a lighted room, however, the loss seems negligible.

▶ **Advantages**—The post-acceleration tube is expected to allow smaller, less complex deflection components, less driving power and fewer convergence adjustments. All of these would result in cost savings.

The yoke of the new tube, for example, uses 60 percent less copper than shadow-mask yokes. Savings are expected on 11 other items. Possible savings to set manufacturers range from 25 to 30 percent.

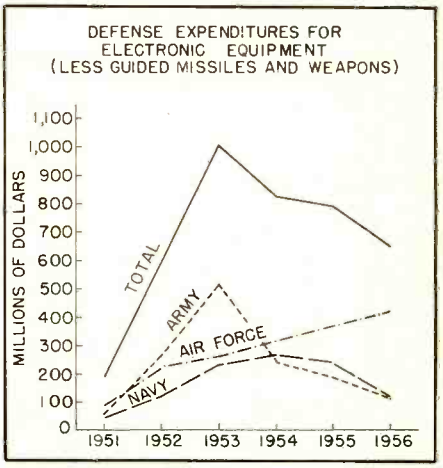
Industry Holds Share Of Defense Buying

Air Force becomes largest buyer of electronic and communications equipment

ELECTRONIC and communications equipment has accounted for 5 to 6 percent of total defense procurement for each fiscal year since 1951. It will retain about the same share during this year and next.

Total Defense Department expenditure for major procurement and production was about $16 billion in 1954—5 percent below the 1953 peak. A drop to about $12 billion is anticipated for 1955 with a slight upturn in 1956.

▶ **Breakdown**—Army electronics procurement peaked sharply in 1953. But the Army cut its ex-

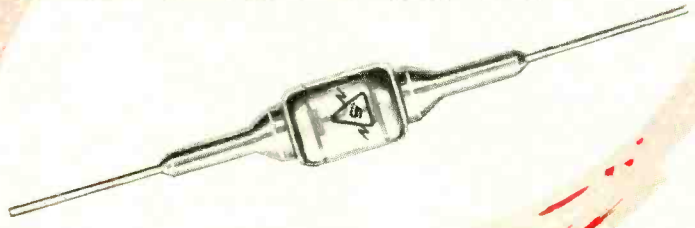


(Continued on page 10)

NEW V.L.I

(VERY LOW IMPEDANCE)

DIODE



up to 300 ma at 1 volt with excellent stability and fast recovery time

V.L.I. DIODE CHARACTERISTICS @ 25° C

	Forward Current @ + IV	Reverse Current Microamps Max.					Max. Reverse Working Voltage	Max. Average Anode Current
	ma min.	-10V	-30V	-50V	-100V	-150V		ma
1N447	25	20	60				30	60
1N448	25		30		100		100	60
1N449	50	10	30				30	60
1N450	50		30		100		100	60
1N451	50					150	150	60
1N452	100		30				30	80
1N453	100		30		100		100	80
1N454	200			50			50	100
1N455	300		30				30	100

The new Sylvania V.L.I. Diode is a significant development for electronic equipment designers with applications for high current carrying diodes. For the first time, you can expect high forward conductance combined with stable, drift-free performance, and fast recovery time.

The new Very Low Impedance diode is the result of recent technological advances in the diode field by Sylvania research engineers. It's the ideal diode for demanding computer applications in clipper, clamper, and logical circuits. In fact, it's the only diode wherever you want high forward conductance with high back resistance—high current carrying capacity with fast recovery time—and high rectification efficiency. The V.L.I. diode is designed into the Sylvania sealed-in-glass package and is 100% inspected for a positive, protective seal.

There's a full line of V.L.I. Diodes in a range of current-carrying capacity. Write for complete information or samples. Address Dept. L20R.

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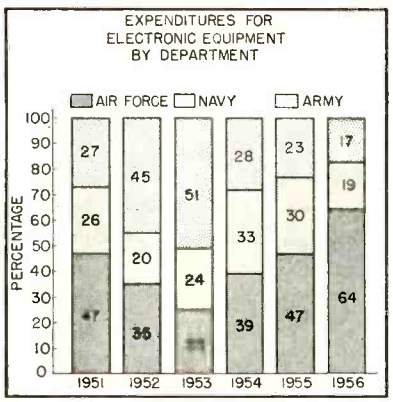
penditures in half during 1954.

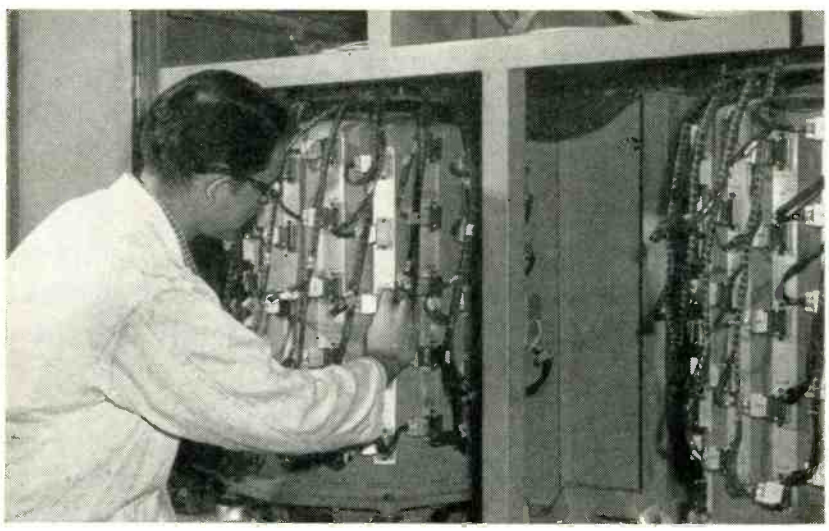
The Navy showed no drop through last year. But some leveling off is expected in 1955 and 1956.

The Air Force has upped its buying every year, expects no cut.

▶ **Future**—The Air Force's spending will boost its proportionate share of defense electronic expenditures from 39 percent in 1954 to close to two-thirds in 1956.

This is a partial picture of military electronic procurement since equipment installed as integral components in aircraft, ships, combat vehicles, guided missiles, ammunition and weapons is excluded.





MAGNETIC drums service 50,000 checking accounts as . . .

Digital Computers Seek New Fields

Special-purpose machines vary in size. Jobs range from banking to bombing

ELECTRONIC digital computers, tailored to specific jobs, are making news in banking, atomic energy, rail transportation and national defense.

▶ **Overdrafts**—Electronic Recording Machine, Accounting, developed for the Bank of America by Stanford Research Institute, can service 50,000 checking accounts. Banks' friend ERMA identifies accounts by bars printed in magnetic ink on the backs of checks.

The bank plans to acquire 37 of the machines. ERMA credits deposits, debits withdrawals, maintains balances, accepts stop payments and prevents overdrafts. It prints statements at 600 lines per minute.

The computer uses 12 reels of magnetic tape besides the two drums shown. Nine operators are needed. The machine incorporates 34,000 diodes, 8,000 electron tubes, weighs 25 tons and consumes 80 kw.

▶ **Bombs Away**—A quarter-ton baby computer developed by IBM will be used by the Air Force to translate reconnaissance information into bombing data. The computer will undergo tests at Wright Air Development Center with a view to placing small computers in the field at the squadron level.

▶ **King Sized**—Sperry Rand recently contracted with the Atomic Energy Commission's Livermore research laboratory for a computer known as the Univac-LARC. Priced at $2,895,000, the machine will use only 120 electron tubes. A ferrite-core memory will provide storage capacity for 20,000 ten-digit numbers with read-write time of two microseconds per word. The king-sized Univac will be used in scientific computation.

▶ **Railroads**—The Santa Fe railroad will soon install reservation equipment manufactured by Teleregister to keep track of passenger space reservations in Chicago, Kansas City, San Francisco and Fort Worth. The machine uses magnetic drum storage. The Santa Fe is the third railroad to adopt electronic computers for reservation accounting.

FCC Asks Military To Give VHF Channels

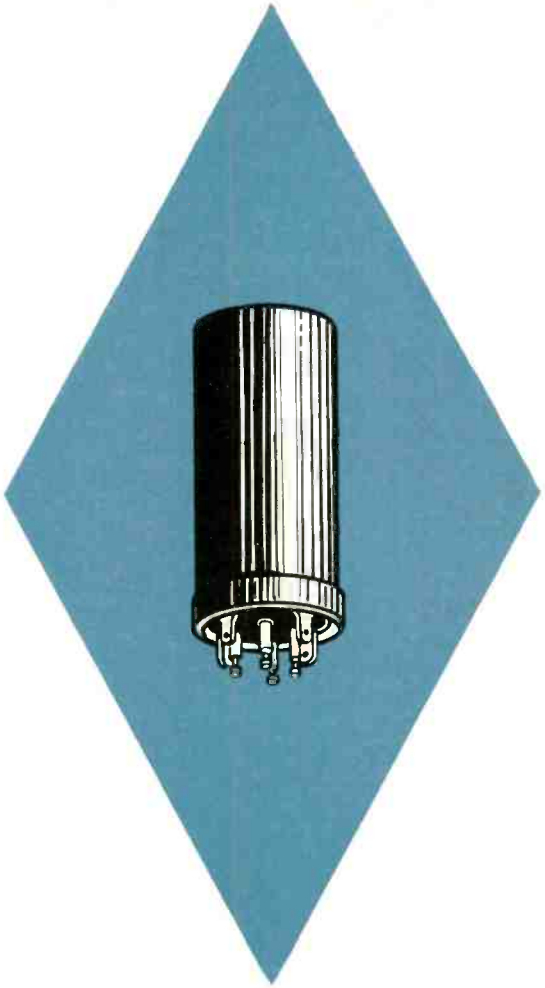
Broadcasters and engineers submit plans to help economically floundering uhf-tv

UNPRECEDENTED action by Federal Communications Commission was a forthright request to Arthur Flemming, director of Office of Defense Mobilization, asking that he explore the possibility of releasing government channels for more vhf television.

Action was taken because the broadcasting industry has been unable to utilize more than a fraction of its television allocations potential. Lack of transmitter power and lack of receivers for uhf have brought with them lack of advertiser interest—particularly in markets served adequately by more powerful vhf tranmitters.

▶ **Alternate Suggestions** — The Commissioners are united in seeking a solution but differ as to methods. Deintermixture, or allocations in one city of either vhf or uhf ex-

(Continued on page 12)



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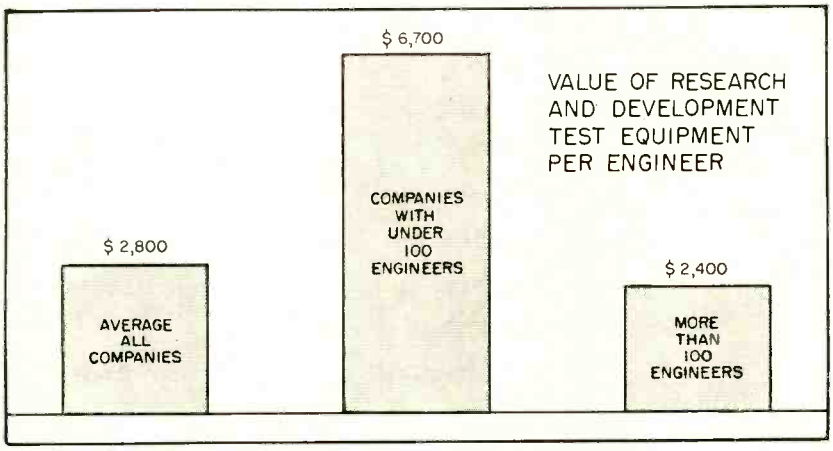
clusively, is not generally popular but could be handled by FCC alone.

CBS has suggested vhf drop-ins (departures from present allocations) to give 100 top markets at least three equal facilities and some deintermixing. Also suggested is a plan to eliminate uhf.

ABC proposes deintermixture plus drop-ins. Other petitions are already pending. It has also been suggested that geographical spacing of stations be reduced, although some engineers feel that interference will result.

A new allocations committee, headed by W. R. G. Baker, has been set up by RETMA to study the whole problem, while the Senate Commerce Committee has appointed Edward Bowles to work at a separate solution.



Research Buys Testing Gear

Spending averages $2,800 per engineer. Small companies spend 2½ times as much

ENGINEERS and their company purchasing agents take a lively interest in how much test equipment is desirable or necessary to carry out a research and development program. A recent survey by the editors of ELECTRONICS indicates that the engineer has access, on the average, to $2,800 worth of test instruments.

If he works for a large company employing more than 100 engineers, the average dollar value of his gear may be lower, about $2,400. Overall, however, there is likely to be a greater range and quantity available in a big lab. Companies with less than 100 engineers have an average investment of $6,700 per engineer.

► **Government Equipment**—Of the companies replying to questionnaires, several indicated that they possessed no government-owned equipment. On the average, however, there was more than half again as much of Uncle Sam's test gear that can be used only on the specific government project for which it was furnished. Government equipment has not been included in any of the averages shown on the chart.

Inventories of test equipment are generally made once a year, although some companies prefer six-month checks. A few indicate that they inventory either every month or continuously.

Depreciation is generally figured on the basis of 20 percent a year. Some equipment with long life is depreciated as low as 3 to 5 percent whereas a few rapidly obsolescing items are written off at 33⅓ percent a year.

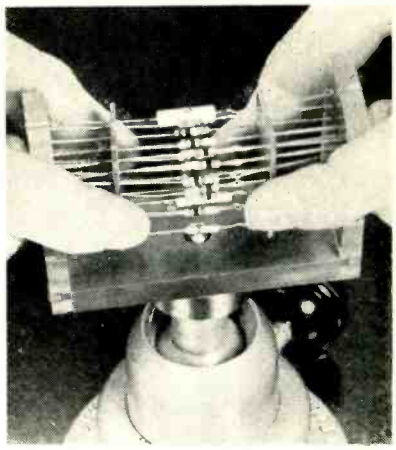
► **Home Grown**—Most research and development test equipment is purchased, although as high as 20 percent (in dollar value) may be made by a company itself for special use. In striking contrast are a few companies who buy only 20 percent and make 80 percent themselves.

Bundling Cuts Cost Of Short-Run Assemblies

New module permits frequent changes in product design with minimum tool cost

ELECTRONICS assembly technique, announced by Eastman Kodak Co., involves arranging axial-lead components in compact bundles located between pairs of etched wiring boards. Advantages include ruggedness and reliability, minimum restriction on electronic and mechanical package design and inherent flexibility that holds production costs down even when product designs must be changed frequently.

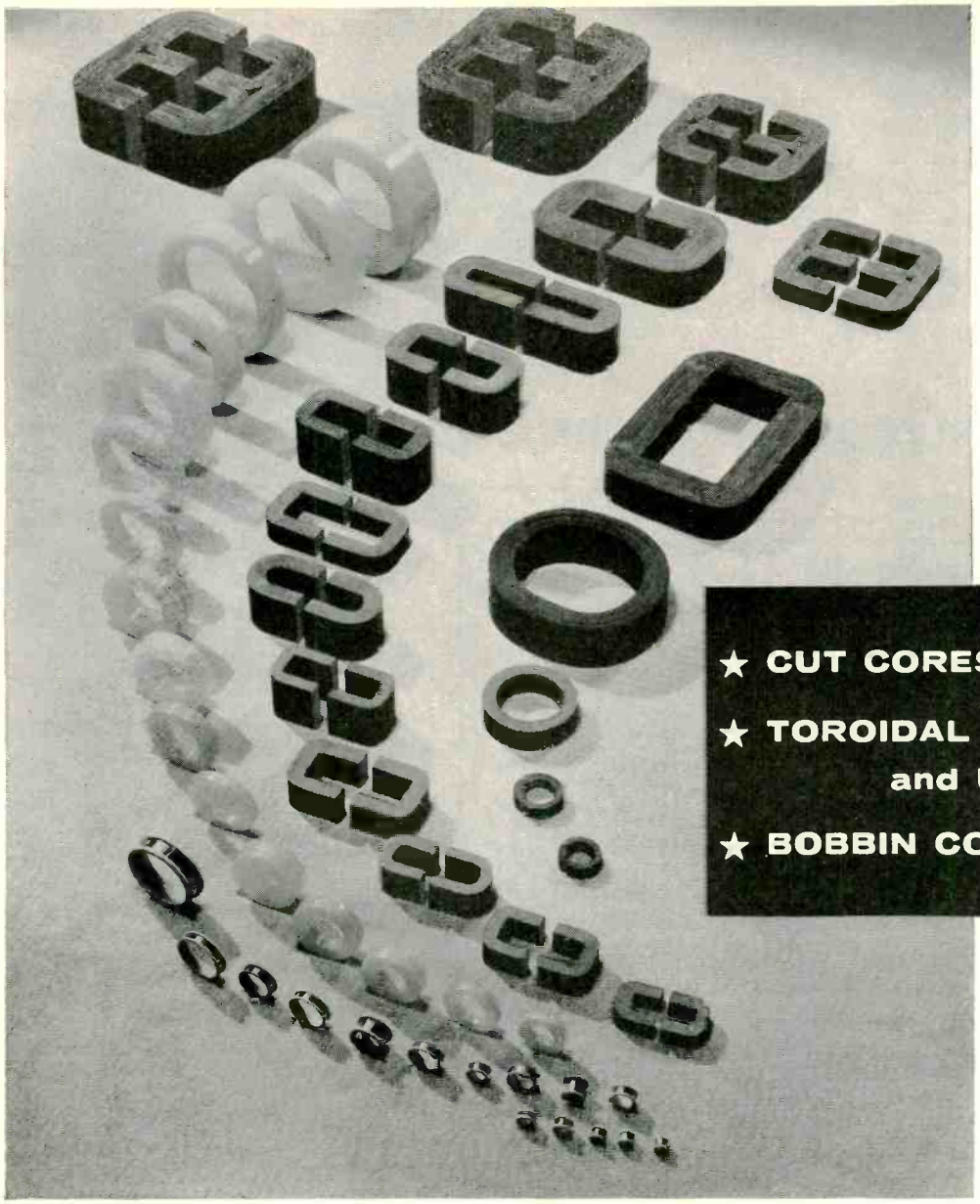
► **Manual Assembly**—The operator places two etched wiring boards for a Paraplate bundle in a bench-type holding fixture. Leads of components are cut slightly longer than the distance between boards, then bent to permit insertion of one lead in each board. Straightening leads after insertion prevents the component from falling out while others are inserted.



Pushing boards together after installation of components

When all parts have been installed, the boards are pushed up to the components and inserted in a tool that dips first one board and then the other in molten solder. Trimming projecting leads completes the assembly. Leads needed as external terminals can be left longer than the others.

(Continued on page 14)



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MATERIALS: Deltamax, 4-79 Mo-Permalloy, Supermalloy, Mumetal, 4750, Monimax, Silectron, Permendur: all are available for tape wound core applications. The choice of material will depend upon the specific properties required.

GAUGES: The following standard tape thicknesses are available for Arnold tape wound cores in most of the magnetic materials mentioned above: .012", .004", .002", .001", .0005", or .00025". Bobbin cores are made from tape .001" to .000125" thick.

SIZES: Cores weighing from a fraction of a gram to many hundreds of pounds can be supplied. Toroidal cores are made in 27 standard sizes with nylon cases. Types "C" and "E" cut cores are made in a total of 530 standard sizes. Many special sizes and shapes of both gapless and cut cores are manufactured for unusual requirements. ● *Let us work with you.*

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▶**Mechanized Assembly**—As now planned, an automatic insertion head would duplicate the steps in manual assembly. A four-jaw head would pick up a component, cut, bend, insert and unbend. The boards in their cradles would be carried from station to station of the in-line assembly machine, stopping at each head to receive a component.

Assembled bundles would be transferred automatically to the dip-soldering machine. It is estimated that a 40-head machine equipped with suitable short-run component programming could be completely changed over for a new design in less than 15 minutes.

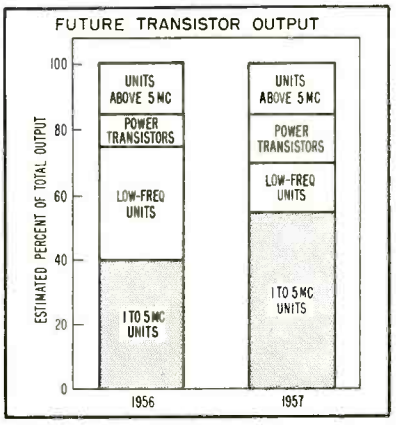
Transistor's Future Looks Bright

Manufacturer sees unit volume exceeding 15 million in 1957 with 1 to 5-mc units important

PICTURE of what may come in the transistor field was reported recently by one manufacturer.

▶**Volume**—The company feels that in 1955 about 1.5 million transistors will be sold. For 1956 it expects volume almost to double, going to 2.5 or 3 million units. It sees 1957 as the first mass volume year for the business and predicts that over 15 million units will be sold.

▶**Markets**—In 1956, about 1.5 million transistors are expected to go into portable radios, a half million into computers and 750,000 into hearing aids. Although transistor auto sets will be available in 1956, this market may not become substantial until 1957 when a number of hybrid auto sets, using both transistors and tubes, will bow.



▶**Types**—The firm expects both power transistors and the 1 to 5-mc units to garner a bigger share of the total market in 1957 than in 1956. It expects units of 5-mc and above to maintain a fair share of total output but sees low-frequency units dropping sharply. As for silicon transistors, the company expects that it may be 1958 before annual output exceeds a million.

Machine Makers Go Electronic

Tool companies enter field to design their own control systems

MACHINE TOOL manufacturers are going into the electronics business and a few electronics companies are invading the machine-tool field. Thirteen companies are offering machine tools equipped with computer-type electronic controls. Five are machine-tool manufacturers who have set up their own electronics sections to develop the equipment.

Two of the thirteen companies are primarily in the electronics and instrumentation field and have stepped into the tool field to market their drill-positioning equipment. The remaining companies have combined their production equipment with controls supplied by electronics firms.

▶**Methods**—Automatic positioning of the workpiece and selection of tool speed and cutting rate are the major control applications. Dimensional data taken from blueprints is supplied on tape or punch cards to a computer. The computer output then drives servos.

Radio Replaces Cables

Changes in timing of traffic signals during rush hours will speed Chicago vehicles with greater safety. First step in the new program will be installation of radio-controlled intersection units like the one under test by GE engineers. Cost of sufficient interconnecting cables would be prohibitive. Coded radio signals are used instead

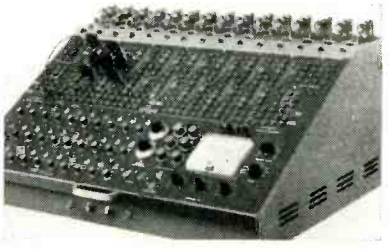
Build-It-Yourself Computer Appears

Other analogs simulate lightning and assist utilities to plan networks

DO-IT-YOURSELF has caught up with the computer business or vice versa.

The Heath Co., a Daystrom subsidiary, is selling an analog computer in kit form aimed at industry and the universities. The computer includes d-c operational amplifiers, power supply, initial-condition power supplies and function generator. The d-c amplifier contains three tubes.

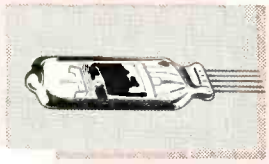
▶**Network Analyzer**—At the opposite pole pricewise is a half-mil-

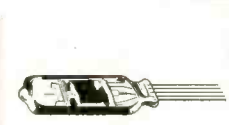


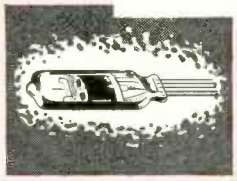
Heath computer made from kit

(Continued on page 16)

KĀHLE automatic machines

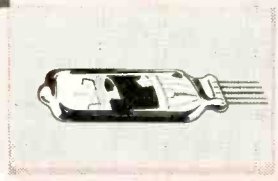






ARE PRODUCING

subminiature tubes



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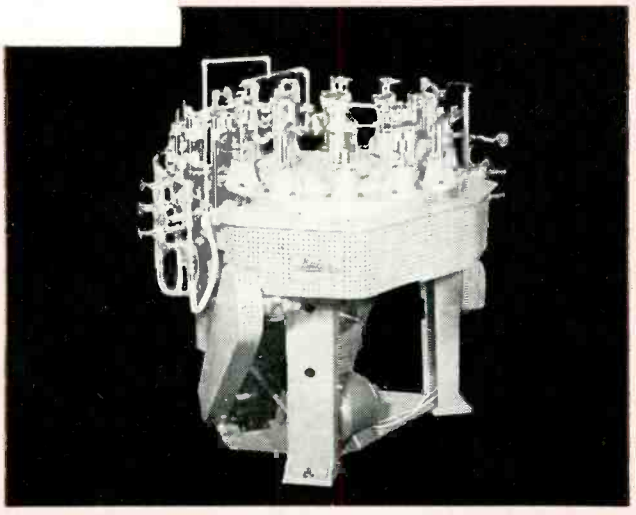

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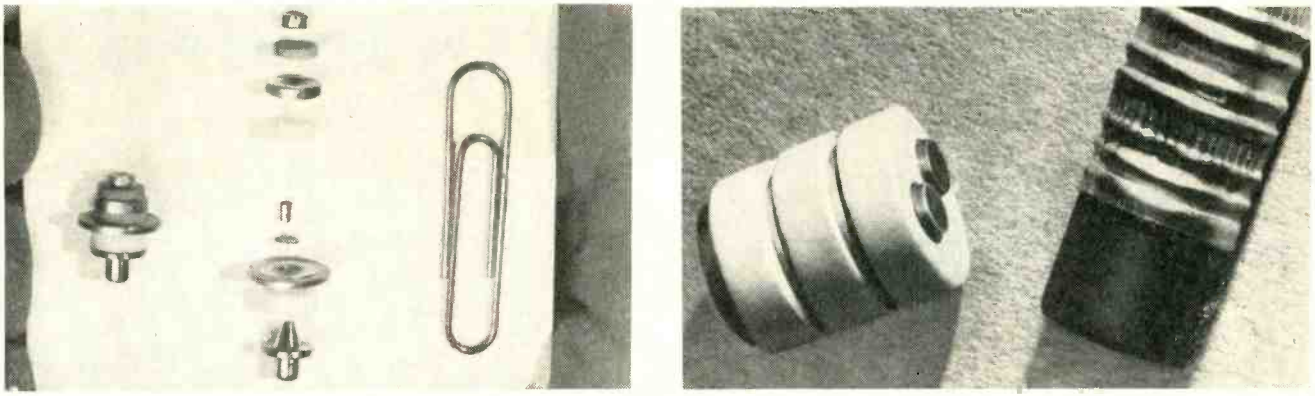
lion-dollar network analyzer presented to Syracuse University by Niagara Mohawk Power Co., New York State Electric and Gas Co. and GE. The computer solves problems relating to power transmision and electrical distribution.

▶ **Lightning**—A desk-size analog computer installed at Westinghouse's transformer division, Sharon, Pa. will permit studying effects of lightning surges on electrical apparatus. This will permit design of transformers so as to avoid costly damage to their innards when lightning strikes the equipment.



EXPLODED view of the developmental L-54 triode announced at Syracuse (left) and magnified commercial version of the 6BY4 triode (right) show what happens when . . .

New Materials Evolve New UHF Amplifier Tubes

Titanium and ceramic used for uhf-tv triode amplifier to speed automatic assembly

LATEST HOPE for an inexpensive uhf television radio-frequency amplifier stage resides in General Electric's microminiature ceramic type 6BY4 triode. Looking more like a bracelet charm than a serious electronic device, the new tube is about ⅜ inch long and ⅛ inch in diameter.

Besides its favorable technical qualifications (see p 176) it is interesting because of its constituent materials. All metal parts are titanium—a metal that absorbs gases rather than liberating them. New ceramics used as insulators can also be heated to high temperature without releasing enough gas to poison the tube's operating characteristics.

▶ **Military Applications**—With its component parts all in the form of circles, the new tube should be a natural for automatic assembly. Engineers say that it may take them another year and a half, however, to make a production-line item of the military version.

J. E. Beggs described to RETMA engineers meeting in Syracuse the development of a similar tube known as the L-54. Used as an oscillator, it has operated up to 10,700 mc. Tubes of this type have functioned at temperatures as high as 700 C. Such behavior qualifies them for difficult roles in guided-missile and similar tasks.

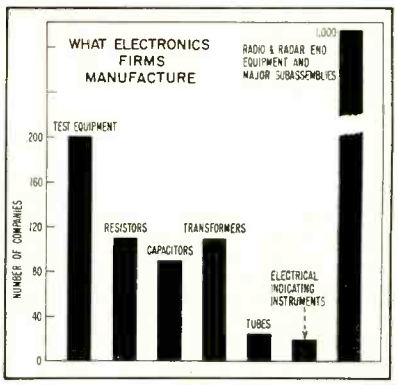
Industry Continues to Grow

Most segments of the electronics industry have grown in number of firms

MANUFACTURERS of electronic equipment, components and hardware totaled 3,600 at the beginning of 1955 according to the Electronics Production Resources Agency. Of these firms, 1,000 produced end equipment or major subassemblies. Component manufacturers totaled 2,000 while the remaining 600 companies produced hardware such as antennas and wiring harnesses.

▶ **Growth**—Since 1939, the number of firms producing equipment in the seven categories listed in the chart has increased fivefold. In 1939, there was a total of 373 firms; in 1944, 559; 1952, 1,254 and in 1955, 1,555.

Since 1952, the manufacturers of



test equipment have grown by 20 firms, transformer manufacturers have increased by 5 companies, capacitor makers by 30 companies, tube firms by 6 and radio and radar equipment and major subassemblies manufacturers by 150 firms. The only one of the seven categories to show no growth was the electrical-indicating-instruments field

(Continued on page 20)

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Type P-579 Fuel Gauge Tester ... Supplied with wide variety of connecting cables for calibrating modern aircraft fuel-indicating systems.

The Type P-579 Fuel Gauge Tester meets the need for an accurate system for calibrating modern-day, capacitance-type aircraft fuel gauges. The vital importance of reliable readings by fuel gauges for aircraft is self-evident. Every fuel gauge must be carefully adjusted in each new airplane, and checks for reliability must be made at routine intervals afterwards.

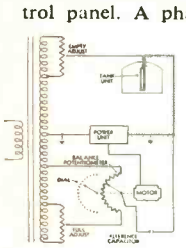
For use with jet aircraft, the test equipment must make provision for calibrating both the main sensing capacitor and the compensating capacitor in the fuel gauge system. The latter capacitor compensates for variations existing in the composition of jet fuel and also reduces the error introduced by changes in the temperature of the fuel. The composition of aviation gasoline does not vary appreciably and as a result compensation is not required.

The Type P-579 Fuel-Gauge Tester offered by the General Radio Company takes all the above needs into account. It is currently the only self-contained equipment suitable for calibrating fuel gauge systems installed in both jet and reciprocating-engine aircraft.

The Type P-579 Fuel-Gauge Tester is the commercial version of the Military Type MD-1 Calibrator manufactured by G-R. Specifications for the MD-1 were established by the Wright Air Development Center of the Air Research and Development Command. The heart of the instrument is the well-known General Radio precision-variable air capacitor.

The Air Force wanted the utmost accuracy built into this important test equipment. G-R was a logical supplier because this Company's trademark is synonymous with the best in precision electrical standards.

Today's high-grade fuel gauges employ capacitance sensing elements located in the airplane fuel tanks. The actuating means is the variation in capacitance occurring as a result of the replacement of air dielectric between the capacitor plates by aircraft fuel. In common practice, a 400-cycle transformer bridge (see typical aircraft fuel-gauge circuit below) is used to transform the change in capacitance to a reading on the fuel indicator located on the aircraft control panel. A phase-sensitive motor drives the fuel gauge needle. The motor also adjusts the position of a balancing potentiometer across one arm of the bridge making this a self-balancing device.



The Type P-579 Fuel Gauge Tester consists essentially of two G-R Precision Variable Capacitors which can be accurately set to simulate the capacitance existing across the fuel gauge sensing elements. By adjusting the Tester's precision capacitor to the same value of capacitance known to exist across the sensing element when fuel tanks are full, and noting whether the control-panel indicator reads "full", one has an accurate and convenient means for checking performance of the fuel gauge (similar procedure for checking "empty" readings). If readings are incorrect, the "full adjust" and "empty adjust" potentiometers can be repositioned until the dial indicates correctly.

Please send complete information on the G-R Fuel Quantity Gauge Tester

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

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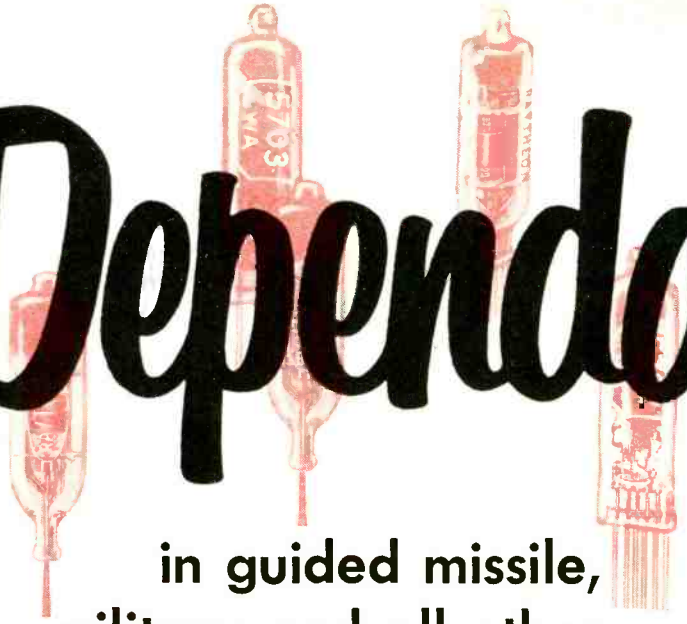

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TYPE	DESCRIPTION	Vibration Output mVac* (max.)	TYPICAL CHARACTERISTICS								
			Heater		Plate		Grid Volts	Screen		Amp. Factor	Mut. Cond.
			Volts	mA.	Volts	mA.	or R_k	Volts	mA.		
CK5639	Video Amplifier Pentode	100	6.3	450	150	21	100 ohms	100	4	—	9000
CK5702WA	RF Amplifier Pentode	50	6.3	200	120	7.5	200 ohms	120	2.6	—	5000
CK5703WA	High Frequency Triode	10	6.3	200	120	9.4	220 ohms	—	—	25.5	5000
CK5744WA	High Mu Triode	25	6.3	200	250	4.2	500 ohms	—	—	70	4000
CK5783WA CK5783WB	Voltage Reference	50	Operating voltage approximately 86 volts between 1.5 and 3.5 ma.								
CK5784WA	RF Mixer Pentode	100	6.3	200	120	5.2	−2	120	3.5	—	3200
CK5787WA	Voltage Regulator	50	Operating voltage approximately 98 volts between 5 and 25 ma.								
CK5829WA	Dual Diode	—	6.3	150			Max. I_o = 5.5 ma. per plate				
CK6021	Medium Mu Dual Triode	50	6.3	300	100	6.5	150 ohms	—	—	35	5400
CK6111	Medium Mu Dual Triode	50	6.3	300	100	8.5	220 ohms	—	—	20	5000
CK6112	High Mu Dual Triode	25	6.3	300	100	0.8	1500 ohms	—	—	70	1800
CK6152	Low Mu Triode	25	6.3	200	100	10.0	270 ohms	—	—	17.5	5100
CK6247	Low Microphonic Triode	2.5	6.3	200	250	4.2	500 ohms	—	—	60	2650
CK6533	Low Microphonic Triode	1.0	6.3	200	120	0.9	1500 ohms	—	—	54	1750

*At 40 cycles, 15 g.

Note: All dual section tube ratings (except heater) are for each section.

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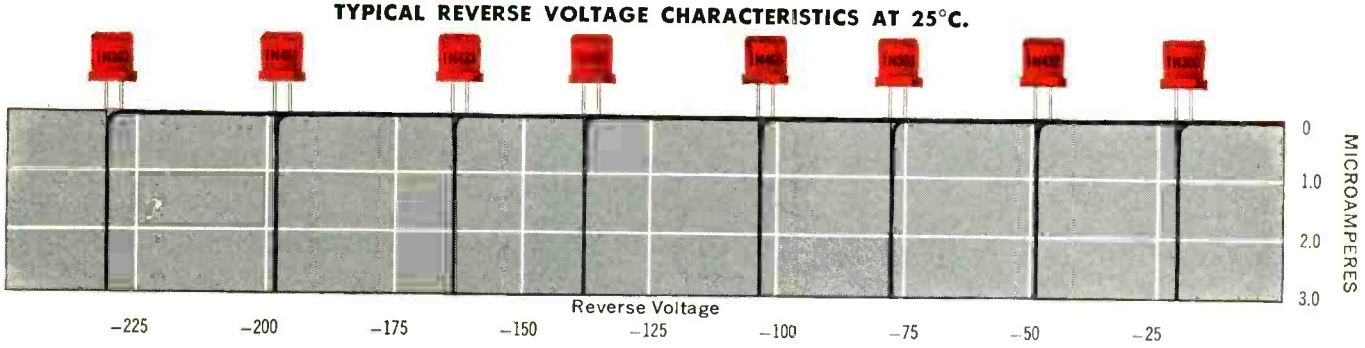
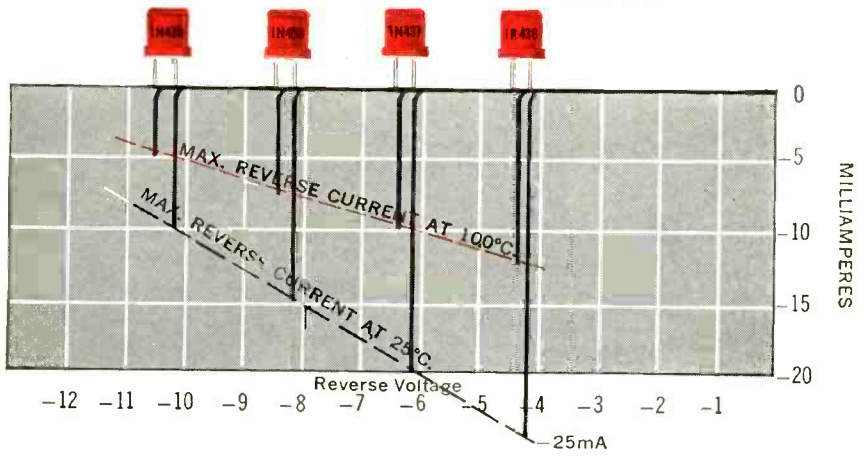


TYPICAL REFERENCE DIODE CHARACTERISTICS



Raytheon Bonded Silicon Diodes with reverse voltage ratings from 3.0 to 225 volts are just what you are looking for whenever the application calls for low reverse current and good stability at high temperature. Every diode receives four temperature cycles of one hour at −55°C and one hour at +150°C, followed by thirty-six hours at 95% relative humidity and 70°C. Exact characteristics are maintained after temperature cycling and stability remains excellent over long periods.

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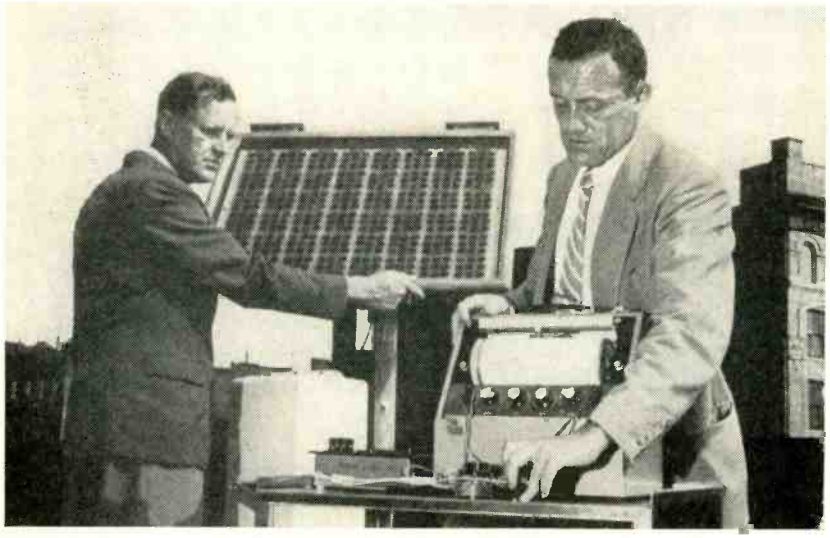
which has stabilized at 20 companies.

► **Dollars**—According to EPRA, about 50 manufacturers account for over 80 percent of the dollar volume of end-equipment production. The major producers of components number between 150 and 200 firms. Although about 200 firms manufacture test equipment, 20 firms produce over 80 percent of the dollar value.

For other components, the number of firms estimated by EPRA to have predominated in production at the start of 1955 were: resistors, 23; capacitors, 25; transformers, 18; tubes, 10; meters and indicating instruments, 10. EPRA figures are made available through RETMA.



SOLAR battery developed by Bell Laboratories gets final tests before . . .

Sun Powers Telephone Line

Silicon cells and transistors team up with the sun to power rural telephones

SUNLIGHT is furnishing power to a rural telephone system near Americus, Georgia as part of experiments being conducted by Bell Laboratories. The solar battery being used for the trial is encased in an aluminum housing less than a yard square. It contains 432 silicon cells. Technical details are given on p 178.

► **Charges Battery**—The silicon cells used in the battery are wafer-thin disks about the size of quarters. Excess current from the solar unit, not needed for immediate telephone use, is fed into a storage battery that powers the phones at night or in bad weather. Since the system under trial uses transistors instead of vacuum tubes, only small amounts of power are required to operate it.

► **How Made**—The silicon cells used in the sun battery are produced by introducing impurities into thin slices of high-purity silicon at high temperatures under gas.

This is done at a precise rate to reach a depth of less than one ten thousandth of an inch.

► **Use**—The new rural system being used allows several conversations to be sent simultaneously over a single pair of wires. Each conversation is sent at a different frequency as has been done for years on longer distance calls. The system on trial at Americus, however, operates economically over shorter distances than have previously been used.

Defense Is Big Business In Canada

THE following contracts were awarded by the Canadian Department of Defense Production, to the electronics industry in Canada during July, 1955 according to RETMA of Canada. The list includes only those contracts in excess of $10,000 and does not include contracts classified for security reasons or amendments to contracts:

Company	Amount
Collins Radio	$2,105,812
Computing Devices	98,607
Hallicrafters	16,129
Measurement Engineering	33,275
Northern Electric	252,160
Canadian GE	25,581
Electromechanical Products	48,955
Electronic Labs	10,690
Muirhead Instruments	60,986
Northern Electric	79,003
Standard Telephones & Cables	16,348

Electronics Grows In Massachusetts

Number of companies in the state increases almost 50 percent in three years

SURVEY completed in September by Associated Industries of Massachusetts counted over 450 electronics firms compared to about 300 firms accounted for in its 1952 survey. Less than four percent of the companies surveyed in 1952 have gone out of business since then and their number has been augmented manyfold by new firms started since 1952.

► **Location**—The industry is concentrated in the greater Boston area with an estimated 90 percent of the plants located from Worcester eastward. However, nearly every section of the state has some part of the industry.

One thriving center is along highway route 128. Following is a list of most of the electronics firms located along the route: CBS-Hytron, Bomac Laboratories, Sylvania, Vectron, Sylvania electronics systems division labs, Electralab and Polaroid Corp. Under construction are plants for Tracerlab, Tran-

(Continued on page 22)

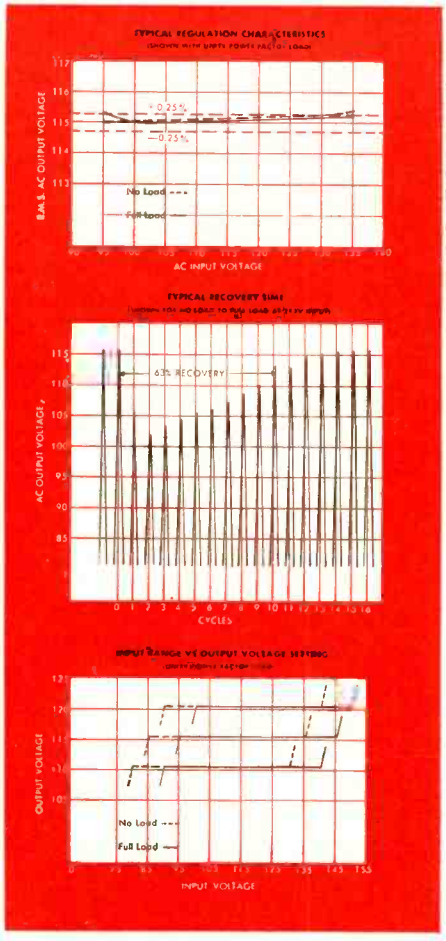
PERKIN ANNOUNCES

IMMEDIATE DELIVERY

on a NEW TUBELESS!

MAGNETIC AMPLIFIER

AC LINE VOLTAGE REGULATOR



MODEL MLR - 1000

1 KVA

- ☆ NO TUBES TO REPLACE
- ☆ NO MOVING PARTS
- ☆ NO VIBRATING CONTACTS
- ☆ REGULATES RMS VALUE
- ☆ IDEAL FOR UNATTENDED INSTALLATIONS

Specifications...

- Input Voltage Range: 95 to 135 volts
- Output Voltage: Nominal 115 volts, can be adjusted from 110 to 120 volts.
- Output Current: 8.5 amperes
- Regulation Accuracy: ±0.25% for any combination of line or load
- Frequency Range: 60 cycles ±10%
- Wave Form Distortion: 3% maximum
- Power Factor Range: 0.5 lagging to 0.9 leading
- Response Time: 0.2 sec.
- Maximum Load: 1.0 KVA
- Ambient Temperature Range: Up to 45° C.
- Dimensions: 19½" wide x 11" high x 11½" deep (cabinet) 19" wide x 10½" high x 11½" deep (rack panel)
- Mounting: Cabinet or 19" Rack Panel
- Finish: Gray Hammertone
- Weight: 85 lbs.

PERKIN power supplies

Write for Bulletin MLR 1000

For PROMPT REPLY, wire the factory collect or phone our nearest sales office.

New York City:	HUnter 2-7784
Philadelphia:	NOrristown 5-2600
Chicago:	DIversey 8-6885
St. Louis:	DElmar 7701
Kansas City, Mo.:	Jefferson 7221
Dallas:	FOrrest 8-8306
Denver:	MAin 3-0343
San Francisco:	ULmar 1-7129
Syracuse:	2-1167
Pittsburgh:	WAlnut 1-2959
Minneapolis:	MIdway 4-7884
Seattle:	MOhawk 4895
Albuquerque:	5-9632
Los Angeles:	Sycamore 8-5790

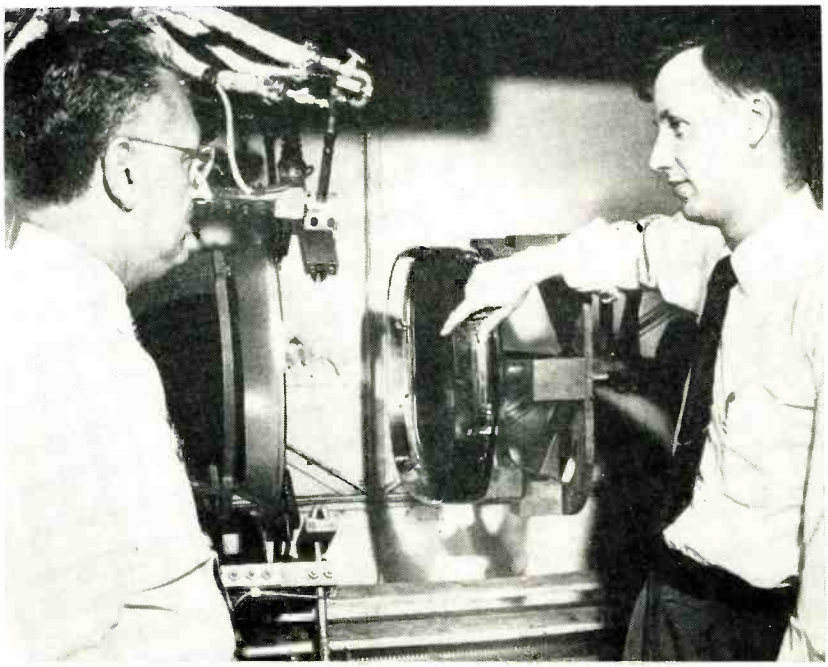
PERKIN ENGINEERING CORP.

345 KANSAS ST. EL SEGUNDO, CALIF. PHONE: OREGON 8-7215

sonics, Donnelly Division of the Indian Company and Mason-Neilan Regulator Co. Planning to build are: High Voltage Engineering, United-Carr Fastener and Kendall Controls Corp. In the state as a whole, some 50 companies have built new plants or have them under construction.

► **High-Gear**—Pace of electronic product development in Massachusetts was also indicated in the survey. Total of 102 companies reported the introduction of 1,742 new products in last three years.

► **Why**—To learn why New England is attractive to the industry, the Federal Reserve Bank of Boston surveyed firms in the area in 1953. Most of the companies, 51, listed the supply of skilled labor as the chief advantage while 28 listed accessibility of materials and supplies; 24, availability of research and engineering; 22, nearness to customers and markets; 15, center of electronics business; 15, climate, living and working conditions; 12, high quality of labor and 12, nearness of residences of personnel.



FACEPLATE with mask can be sealed directly to glass cone as . . .

Color Bulbs Go Conventional

All-glass 22-inch rectangular bulb uses solder-glass seal instead of metal joiner

SHADOW MASK color picture tube that uses an all-glass 22-inch rectangular envelope has been produced by the Westinghouse tube division. The bulb, since it uses no metal flanges, requires only the usual insulation of a black and white tube and high-voltage contact buttons.

► **Method**—With the new envelope, the phospor is deposited on the faceplate which is then aluminized. The shadow mask is attached to the faceplate by a simple technique. A low-temperature solder-glass seal is used to seal the face plate to the funnel after insertion of the components. It replaces the metal joiner.

By applying heat to the glass seal, the cone may be separated from the face plate at any time so that working parts can be removed for repair. Mass commercial production of the color television tube envelope is expected in the first quarter of 1956.

Electronic Headlight Dimmers Make Gains

Although the field is still small, indications are that sales will move ahead

AUTOMATIC electronic headlight dimmers have been on the market for a number of years now but have yet to become a fast-selling automobile accessory. However, the extra push for safety that the auto industry is now emphasizing, plus new developments in dimmers themselves may help push the business ahead.

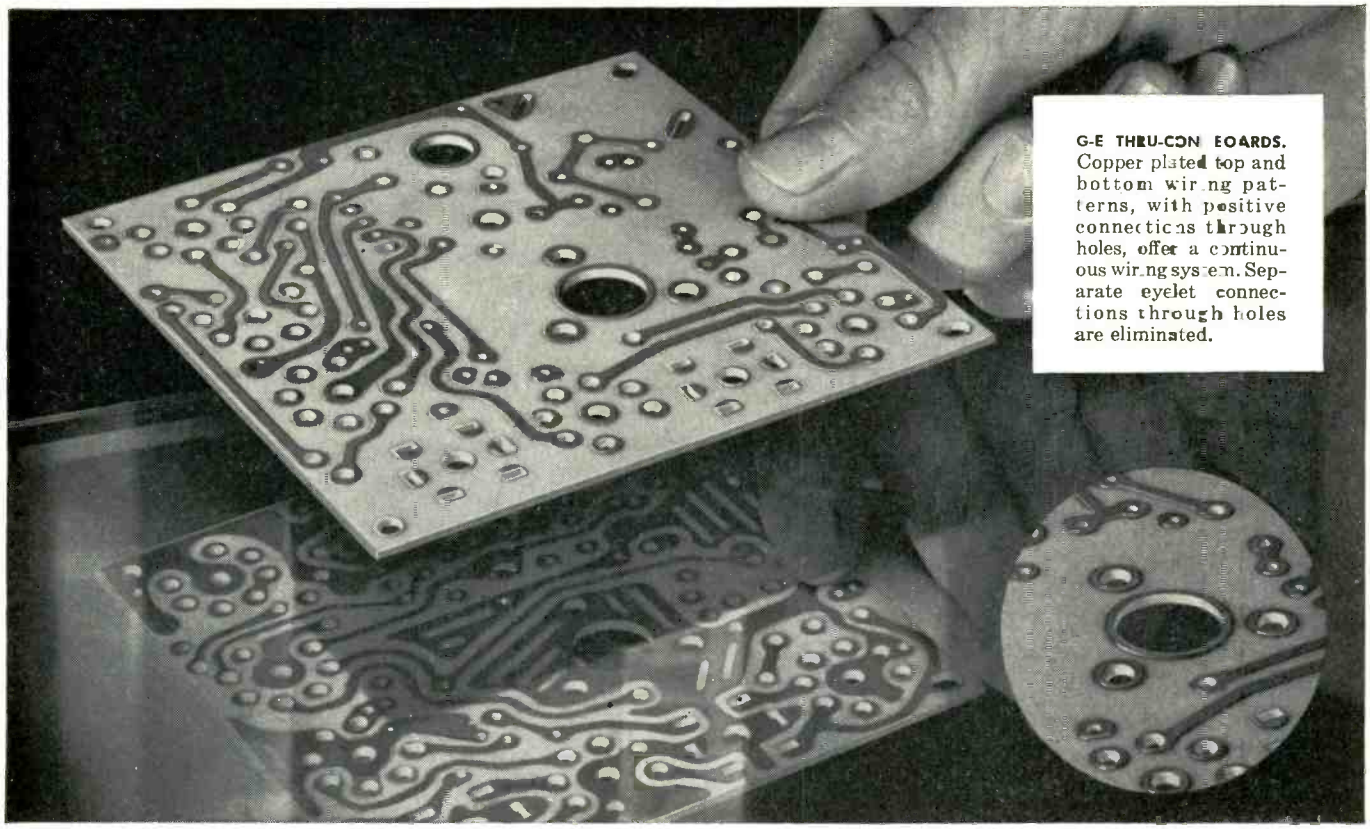
► **Users**—Installations of General Motors' Autronic eye in the first nine months of 1953 ranged from 26 percent of total auto production for one division to lesser amounts for the others. Although figures have not been revealed it is believed that the percentage has increased.

Studebaker-Packard may have dimmers available for its 1956 models. Other car manufacturers are considering dimmers as accessory units for 1956. Some dimmer manufacturers feel that the units will not be sold as original equipment on any large scale until 1957.

► **Unit**—Dynotron Corp. of Cleveland, Ohio, associated with Dickey Industries, makes the unit shown

Self-contained dimmer with pickup, amplifier and power supply in one package for both 6 and 12-volt car systems made by Dynotron

(Continued on page 24)



G-E THRU-CON BOARDS. Copper plated top and bottom wiring patterns, with positive connections through holes, offer a continuous wiring system. Separate eyelet connections through holes are eliminated.

G.E.'s Thru-Con Printed Circuit Boards have wiring patterns on two sides, positive connection through the board

Thru-Con Boards for printed circuitry lead to cost reductions, and product improvement in many industries

General Electric Thru-Con Printed Circuit Boards offer manufacturers of radio, television, and electronic equipment new opportunities to reduce production cost and substantially improve quality and performance.

G.E.'s Additive Method of Construction

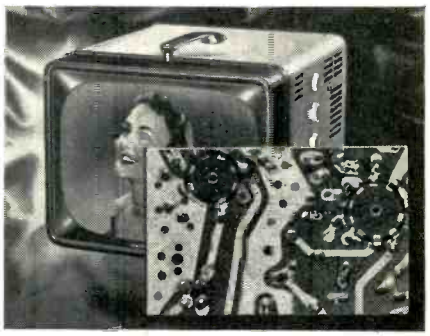
Production techniques developed by G.E. provide two patterns on a single board with a positive through connection—*without staking pins.* Continuous copper plating through the holes insures positive solder filleting top and bottom, extreme strength, and trouble-free assembly.

Thru-Con In Many Industries

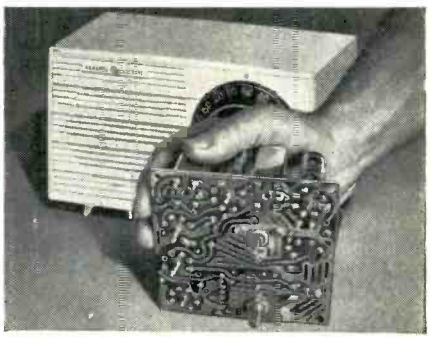
Widening usage in radio and TV receivers and street lighting controls has proven the advantages of printed circuits. G-E Thru-Con Boards not only offer manufacturing savings, they also make it possible to reduce parts inventories, shorten assembly and inspection time, and save in weight and product size.

Investigate G-E Thru-Con Boards

Your company may be able to profit by using printed circuitry and G.E.'s Thru-Con Boards. The combination of wiring patterns, circuit designs, sizes or shapes, is virtually limitless. Experienced G-E printed circuit engineers and technicians are ready to aid you in developing a printed circuit program. For a discussion of your problem and a sample G-E Thru-Con Board, just call or write today to: *General Electric Company, Electronic Components Department, Section X4115, Auburn, New York.*



PORTABLE TELEVISION. Printed circuit board in this new receiver contains more than 50% of the wiring. Smaller chassis, yet full size screen. G-E Thru-Con Boards reduce assembly costs, slash receiver weight.



COMPACT, LOW COST RADIO. G-E Thru-Con Board permits compact chassis which slips into cabinet and plugs into speaker. Printed circuitry permits savings—cuts retail cost.

Progress Is Our Most Important Product

GENERAL ELECTRIC

which is manufactured for both 6 and 12-volt electrical systems. It incorporates a photoelectric circuit with an electronic delay to eliminate flickering and improper return to upper beam after dimming.

The unit also operates from the tail lights of a car close ahead to prevent blinding its driver through the rear-view mirror. A small headlight relay mounts under the hood near the terminal block.

The firm plans to produce an additional model. Dynotron estimates that 1,000 of its electronic dimmers are now in use. The firm estimates potential sales for 1956 at 150,000 units with possibly a 300,000-unit volume in 1957.

► **Future**—A new automobile electronic headlighting system being developed at Battelle Institute in Columbus, Ohio casts a shadow over that portion of the road occupied by oncoming cars. This leaves normal, long-range light on the lane in which the equipped car is driving.

Transistor Transmitter Runs On Decibels

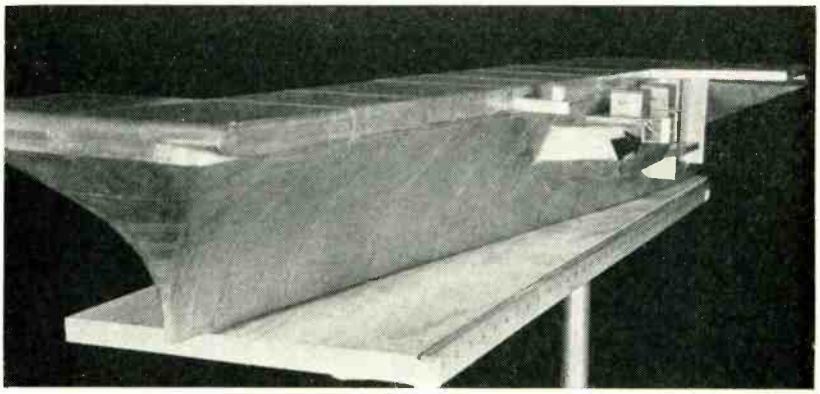
ENGINEERS of the Signal Corps Engineering Laboratories at Fort Monmouth, N. J. have come up with an experimental radio transmitter powered by the human voice. Present range of the unit is about 600 feet.

Further development is expected to increase this range to a mile and will likewise include construction of a companion receiver. This will be powered by stored energy from the voice and will be about the size of a matchbox.

► **Costs**—It is estimated that the new transmitter can be produced for $20. It uses a single transistor. After the speech energy strikes the microphone, part of it is rectified to provide power while the rest modulates the signal output.

Technician tests output of voice-powered radio transmitter by watching waveforms of his voice on cathode-ray oscilloscope

Flat-Top Sounds Off With Tubes



METAL scale model of aircraft carrier, constructed by Federal Telecommunication Laboratories, tests proposed antenna installations (one mounted on gun tub, arrow). Illuminated by microwave transmitter, the model is rotated to find how well the antenna picks up signals from different directions

U. S. S. Forrestal uses sound power and dial phones; speaking tubes are out

MODERN as any warship can be, the recently commissioned carrier Forrestal thinks, talks, listens and shouts with the latest electronic devices. Gone is the ancient and honorable speaking tube. Sound-powered and dial telephone circuits connect various centers together. A general announcing system, larger than any known commercial p-a, is driven by six 1,000-watt amplifiers.

► **Eyes and Ears**—To find where she is going and what lurks about, the Forrestal is equipped with air-search radar, loran, direction finders and underwater echo sounders.

To guide her planes home to the flight deck there are accurate 200-mile beams from Tacan equipment. Close in, GCA brings aircraft to touchdown in any kind of weather.

Balloon-borne sounding devices can be sent up to help track wind velocity and direction high above, besides reporting temperature and humidity. Fire-control radar protects the carrier from enemy action.

► **Communications** — Morse code, voice and teleprinter communications are available in quantity. Communications to aircraft using uhf has been made effective by four pairs of antennas (to insure 360-deg coverage) mounted below the flight deck.

Defense Department Wants More Reliability

Effort is made to set up basic policies and guides to improve miltronic equipment

IMPORTANCE of engineering for equipment reliability was emphasized by J. M. Bridges, Director of Electronics, Office of the Assistant Secretary of Defense, at a recent conference on reliability at Aberdeen Proving Ground, Md.

► **Plans**—The Office of Electronics, Assistant Secretary of Defense (Applications Engineering) is attempting to improve the reliability and producibility of military elec-

(Continued on page 26)

Performance

New PRO-310

is TOPS!

When you buy communications receivers, you buy performance above all else. And, performance is what you get when you buy the NEW PRO-310. It's the receiver designed with performance in mind. And, the PRO-310 outperforms all other receivers in its class. Here's why—

Took 3 years engineering and design time to develop, including 1½ years to iron out the 'bugs'.
Hammarlund has the receiver know-how gained by making thousands of sets for gov't service.

The "Heart" of the PRO-310

Newly developed front-end with three tuned circuits but only one RF tube amplifier provides remarkable selectivity and ultra-high signal-to-noise-ratio.

These features:

Frequency readings to 1 part in 5000
Continuous calibrated bandspread *over the entire range*
Exceptional stability
High Image Rejection – *on all 6 bands*
Sectionalized construction
Etched and plated circuits in the RF section
Many others

Check on the *NEW* PRO-310—it's made to order for your "tough-spot" service. Write for specs and other details to The Hammarlund Manufacturing Co., Inc., 460 West 34th Street, New York 1, N. Y. Ask for Bulletin E-11.

HAMMARLUND *Since 1910*

tronic equipment and parts. A specific program, covering contractual methods, engineering policies, test procedures and design specifications underlying equipment reliability is now being formulated.

▶**Reason**—The greatest cause of unreliability, according to Bridges, is the lack of maturity of product design, and failure to evaluate reliability of design through tests, service and material evaluation before production is undertaken.

Planning officers want early production of advanced new weapons, while research and development people seek to attain basic technological goals, often neglecting production engineering.

▶**Circuit**—Circuit design must be accomplished so that tubes and components will work well within their ratings, and so that a change in operating characteristics will not cause failure. If this design philosophy is not reflected in breadboard circuitry, it is unlikely that it can be introduced as design progresses. Reliability of much existing equipment suffers from critical circuits which will work only with selected tubes or special parts.

Financial Roundup

Profit reports in fiscal 1955 continue to show up well for electronics firms

COMPANIES in the electronics field continued active on the financial front during the past month. Three companies announced securities transactions and the following firms reported net profits for the fiscal periods indicated:

Company	Net Profit 1955	1954
Am. Cable & Radio 6m	$404,732	$906,970
American Electronics 6m	144,161	138,325
ACF Industries 3m	2,062,132	1,557,541
Beckman Instruments 12m	1,322,050	920,280
Electronics Engineering 6m	33,464	27,142
Garrett Corp. 12m	3,732,035	2,847,907
IT&T 6m	11,411,701	10,112,810
Magnavox 12m	2,426,087	2,102,530
Olympic Radio 6m	158,722	76,993
Precision Radiation Inst. 9m	496,658	122,835
Pyramid Electric 6m	235,080	313,567
Raytheon 3m	764,000	1,102,000
Westinghouse Air Brake 6m	3,227,911	2,317,916

FUTURE MEETINGS

OCT. 31-Nov. 1: 1955 East Coast Conference on Aeronautical and Navigational Electronics, IRE, Lord Baltimore Hotel, Baltimore, Md.

OCT. 31-Nov. 1: International Conference on Scientific Basis of Applied Solar Energy, University of Arizona, Tucson.

Nov. 1-5: World Symposium On Applied Solar Energy sponsored by AASE, Stanford Research Institute and University of Arizona, Phoenix, Ariz.

Nov. 3-4: Eighth Annual Electronics Conference, Kansas City IRE, Town House, Kansas City, Kan.

Nov. 3-4: Unclassified Symposium On The Technical And Operational Characteristics Of Tacan, Air Navigation Development Board, Hotel Statler, Washington, D. C.

Nov. 7-9: IRE, AIEE, ACM Eastern Joint Computer Conference, Hotel Statler, Boston, Mass.

Nov. 10-11: Electronic Business Systems Conference, National Machine Accountants Association, Statler Hotel, Los Angeles.

Nov. 11: Centennial Symposium on Modern Engineering, University of Pennsylvania, Philadelphia, Pa.

Nov. 14-15: IRE Symposium on Communication by Scatter Techniques, Lisner Hall of George Washington University, Washington, D. C.

Nov. 14-16: IRE, AIEE, ISA Electrical Technology in Biology & Medicine, Shoreham Hotel, Washington, D. C.

Nov. 15-17: Second International Automation Exposition, Navy Pier, Chicago, Ill.

Nov. 21-22: IRE Aeronautical Communications Symposium, Hotel Utica, Utica, N. Y.

Nov. 28-30: IRE Instrument Conference & Exhibit, Hotel Biltmore, Atlanta, Georgia.

DEC. 12-16: Nuclear Engineering and Science Congress, coordinated by Engineers Joint Council, Cleveland, Ohio.

DEC. 15-17: URSI Fall Meeting, University of Florida, Gainesville, Fla.

JAN. 9-10, 1956: Second National Symposium On Reliability And Quality Control In Electronics, ASQC and RETMA, Hotel Statler Washington, D. C.

FEB. 2-3, 1956: IRE National Symposium On Microwave Techniques, University of Pennsylvania, Philadelphia.

FEB. 15-17: 1956 Conference On High-Speed Computers, Louisiana State University, Baton Rouge, La.

FEB. 16-17 IRE, AIEE, Univ. of Pa. Conference On Transistor Circuits, University of Pennsylvania, Philadelphia, Pa.

MAR. 19-22: IRE National Convention, Waldorf-Astoria Hotel, Kingsbridge Armory, New York, N. Y.

APRIL 11-13: 1956 IRE 7th Region Technical Conference, Hotel Utah, Salt Lake City.

APRIL 25-27: Symposium On Nonlinear Circuit Analysis, II, Polytechnic Institute of Brooklyn, New York, N. Y.

Industry Shorts

▶**Production** of one million sq ft of printed wiring boards in 1956, representing between 5 and 6 million individual boards, is planned by GE.

▶**Since** 1947, the electronics industry on the West Coast has produced one new company each week according to P.S. Fogg of Consolidated Engineering.

▶**Definite** development program looking toward the substitution of aluminum for copper in telephone cable, was announced by Western Electric.

▶**Diffused base** transistors are being made at Motorola by impregnating pure germanium slices with arsenic or bismuth gas.

▶**Air Force** ordered $2.3 million worth of magnetrons from Westinghouse.

▶**Transistor** firm in Germany, Intermetal G. m.b. H., has been acquired by Clevite Corp.

KAY

NOISE FIGURE MEASUREMENT 10-3000 MC

SPECIFICATIONS

Frequency Range:
10 mc to 3,000 mc

Output Impedance:
50 ohms unbalanced into Type N Connector

Noise Figure Range:
0 to 20 db

Filament Voltage Supply:
From regulated supply

Meter Calibration:
Linear in db noise figure; logarithmic in D.C.M.A.

Fuse Protection:
One Type 3AG, 2 amps

Tubes:
1 Eclipse Pioneer TTI Diode

Power Supply Source:
117 Watts ±10%. 60 cps AC
Available for 50 cps.

Power Consumption:
130 Watts

Price:
$995. FOB plant

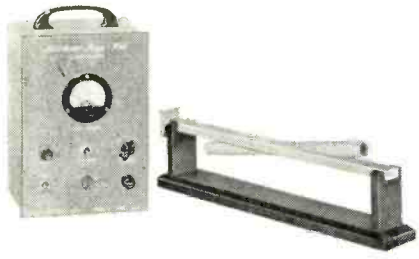
KAY *Mega-Node-Sr.*

A calibrated random noise source providing an output from 10—3,000 mc, the Megan-Node Sr. may be used to measure noise figure and receiver gain and for the indirect calibration of standard signal sources.

At the lower end of the frequency range noise figure may be obtained directly from the meter. For greater accuracy at higher frequencies, corrections for diode transit time and termination mismatch are available from charts supplied with each instrument.

KAY *Rada-Node* ▶

Complete radar noise figure measuring set for IF and RF, including attenuators, detector and noise sources. Complete with power supplies. Frequency range: 5 to 26,500 mc; noise figure: range, up to 21 db, in lower part of spectrum Prices on request.



KAY *Microwave Mega-Nodes*

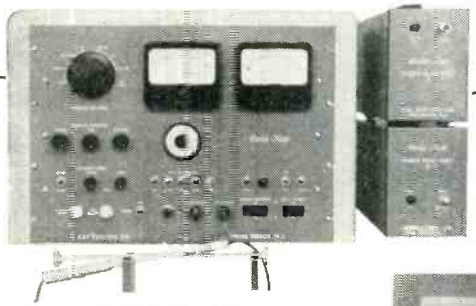
Calibrated random noise sources in the microwave range, used to measure noise figure, and receiver gain and calibrate standard signal sources in radar and other microwave systems.

Available in following waveguide sizes to cover range of 960—26,500 mc.

RG-69/U	..$400.	Available with fluorescent or inert gas (argon or neon) tubes. Noise output fluorescent tubes, 15.8 db ±.25 db; argon gas tubes, 15.2 db ±.1 db*; neon tubes, 18.0 db ±.5 db*.
†RG-48/U	.. 195.	
†RG-49/U	.. 195.	
†RG-50/U	.. 195.	
†RG-51/U	.. 195.	*Noise output of inert gas tubes indepedent of operating temperature.
†RG-52/U	.. 195.	
RG-91/U	.. 250.	Universal Power supply for both fluorescent or argon gas and all waveguide sizes: $100.
RG-53/U	.. 250.	

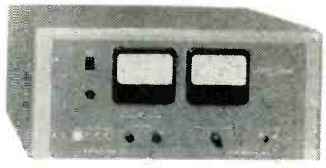
†$167. per Guide when 3 or more are purchased with $100. Power Supply

NEW! WR-770; WR-650—$595.00 each; WR-510; WR-430; WR-340—$495.00 each. All WR numbers fluorescent only.



KAY *Mega-Node*

Calibrated random noise source reading direct in db, for measurement of noise figure, receiver gain and for indirect calibration of standard signal sources. Frequency range, 5 to 220 mc; Output impedances, unbalanced—50, 75, 150, 300, Infinity; balanced—100, 150, 300, 600, Infinity; noise figure range, 0—16 db at 50 ohms 0—23.8 db at 300 ohms. Price: $295. FOB plant.



KAY *Auto-Node*

Designed for production-line noise figure measurement from 5 to 26,500 mc., the Auto-Node provides continuous interpolation over VHF, UHF and microwave frequencies. Two models are available:

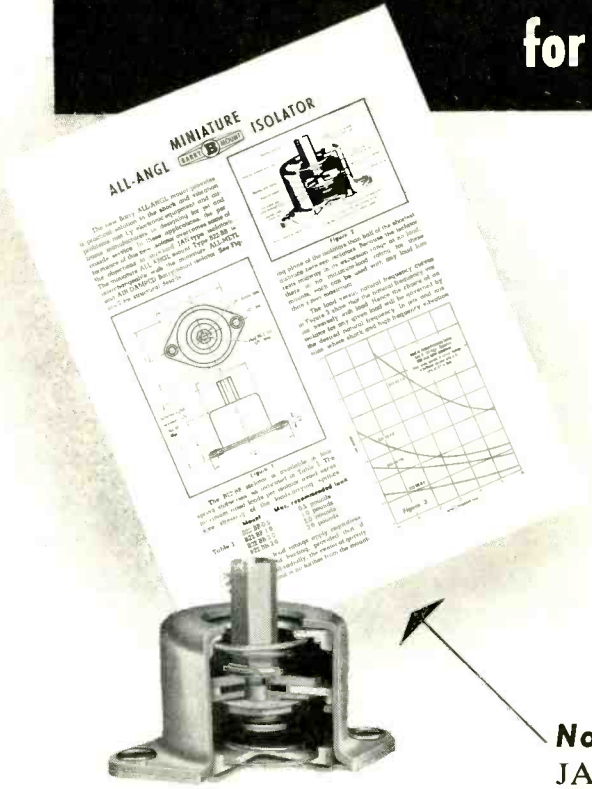
MODEL TV	MODEL RADAR
Freq. Range: 5—220 mc.	Freq. Range: 2 IF Strips 30 and 60 mc; other IF's available.
IF Strips: 20 or 40 mc. extra IF Strips available.	IF Noise Figure: 0—7 db
Noise Figure Range: 0—24 db	Price: $950. with 2 IF strips. FOB plant
Price: $795 FOB plant. Additional IF Strips, $125.00	

For Complete Information Regarding these, and other Kay Instruments, Write:

KAY ELECTRIC COMPANY

Dept. E-11, 14 Maple Avenue **Pine Brook, N. J.**

NOW! ALL-ANGL Barry Mounts *IN ALL JAN SIZES* for Jet and Missile Service



Built to handle the new jobs — too tough for MIL-standard mounts — the complete ALL-ANGL line lets you choose the JAN size best suited to your needs — for sure protection against shock and high-frequency vibration *in all directions.*

Complete information about ALL-ANGL Barry Mounts is given in our free engineering data sheets. You'll find load-deflection curves, transmissibility curves, load-versus-natural-frequency curves, and tables of load ranges — for practical solutions to the shock and vibration problems you meet in designing for jets and missiles.

Now Available — Miniature ALL-ANGL mounts, JAN-size 0, for loads up to 3 pounds per isolator. Data Sheet #455 gives dimensions and performance curves that show how you can use these Barry Mounts.

Ready December 1, 1955 — JAN-size 1 ALL-ANGL mounts for loads from 1 to 10 pounds per isolator. Data Sheet #1255 giving details of load ratings, dimensions, and performance curves also available December 1.

Ready February 1, 1956 — JAN-size 2 ALL-ANGL mounts for loads from 2½ to 40 pounds per isolator. Data Sheet #256 will be available Feb. 1 with load, dimension, and performance data.

Write us today — we'll send the first data sheet at once and the others as soon as they are printed. And if you have an immediate problem, our engineers are ready to answer your questions from their experience gained in years of pioneering the development of shock and vibration isolators for military, naval, aircraft, missile, and industrial uses.

New engineering opportunities are open in Barry's expansion program, at all levels in all departments. Send resumé.

When your problem is protection thru all flight attitudes, your answer is the ALL-ANGL.
For recommendations, call your Barry Sales Representative.

BARRY CONTROLS incorporated 707 Pleasant St. Watertown 72, Mass.

AT MACH 1+

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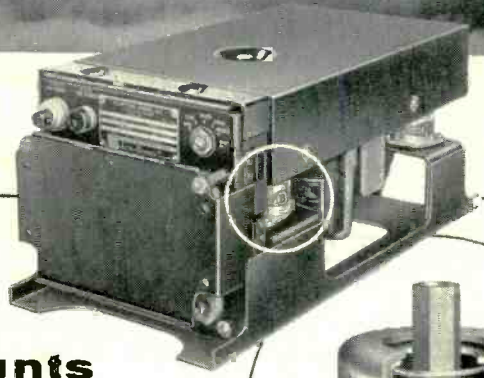
CONVAIR AND JACK & HEINTZ.



JACK & HEINTZ
MODEL 50127-000
CONTROL PANEL

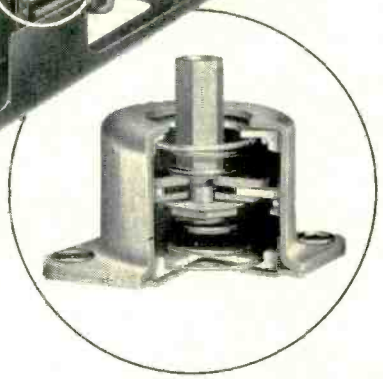
ALL-ANGL Barry Mounts give sure protection

Jack & Heintz proved this in testing mounts to protect their Hi-Phase voltage regulators and control panels for Convair's supersonic F-102A interceptor.

No other miniature isolator tested could meet Procedure I of MIL-E-5272A. ALL-ANGL Barry mounts exceeded life-test requirements.

And the ALL-ANGL works in any position—to give sure protection for vital controls through every twist, turn, and dive in the aircraft's most violent maneuvers.

Write for Data Sheet J-11. And for your airborne requirements to meet standard MIL specifications, ask about All-Metl, Air-damped, and special Barry mounts.



Here's the mount that meets the new needs of today's jet aircraft and missiles — where equipment must have greater protection against shock and high-frequency vibrations—and where MIL-standard mounts prove inadequate.

BARRY CONTROLS incorporated 707 Pleasant St. Watertown 72, Mass.

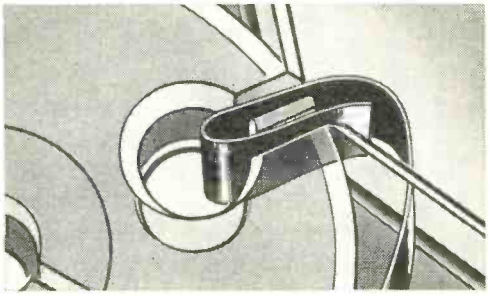
New engineering opportunities are open in Barry's expansion program, at all levels in all departments. Send resumé.

Now! Take your

Famous acetate-backed "Extra Play" Tape 190—new economy price saves you 28%

Here's your chance to buy the magnetic tape everyone's talking about—at a special *new economy price!* It's popular "SCOTCH" Brand "Extra Play" Magnetic Tape 190, first long play tape on the market and *still* the best seller. With 50% more recording time on every reel . . . higher fidelity . . . strength to spare . . . high potency oxide . . . "SCOTCH" "Extra Play" Magnetic Tape 190 has been making recording history. Buy now and save 28% on every reel!

Both these SCOTCH® BRAND *Magnetic Tapes*



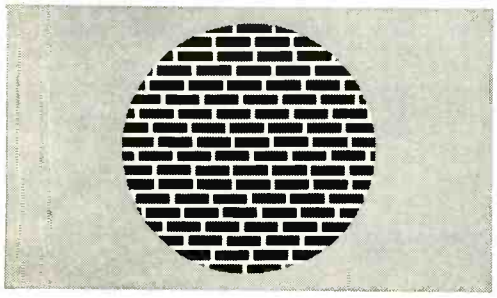
EASIER THREADING with new "Loop-Lok" reel! Saves time... saves tape! It's "SCOTCH" Brand's exclusive "Loop-Lok" reel. Just loop tape around the new-design center pin for instant threading. Tape locks tight without necessity of troublesome wrap-around, yet releases fast at end of reel.

choice of backings

New polyester-backed (Made from DuPont's "Mylar"*) "Extra Play" Tape 150 for extra strength

Years ago "SCOTCH" Brand pioneered tough polyester-backed magnetic tape for experimental government orders. Now *you* can enjoy the *same* benefits of "SCOTCH" Brand research and development with new "Extra Play" Magnetic Tape 150. "SCOTCH" Brand's extra-strength polyester backing assures you long-lasting recordings . . . perfect tape performance in all weather, all climates—(It's "Weather-Balanced"!)

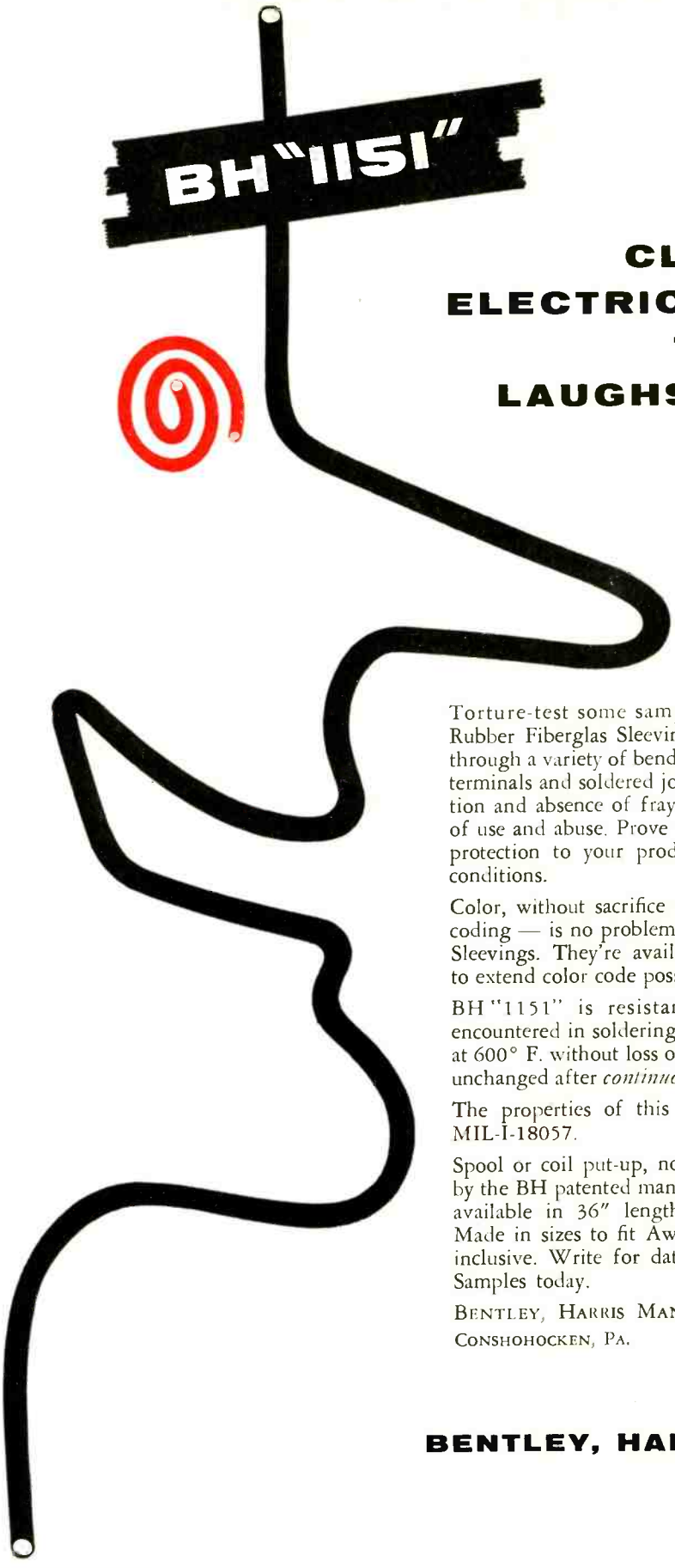
feature "Loop-Lok" reel and high-potency oxide!



CRISP, BRILLIANT SOUND thanks to newest oxide coating! By laying fine-grain oxide particles in a neat, orderly pattern (as shown here), "SCOTCH" Brand is able to pack in thousands more particles than standard long play tapes —to produce a super-sensitive magnetic recording surface.

**"Mylar" is a registered Du Pont trade-mark.*

REG. U.S. PAT. OFF.
SCOTCH BRAND *Extra Play* **Magnetic Tapes**



CLASS H ELECTRICAL SLEEVING THAT LAUGHS AT BENDS

Torture-test some sample lengths of BH "1151" Silicone Rubber Fiberglas Sleevings for electrical insulation. Put them through a variety of bends and twists. Use them to cover bumps, terminals and soldered joints. Then check the insulating protection and absence of fray of BH "1151" even under that kind of use and abuse. Prove to yourself its ability to give complete protection to your product, even under the most strenuous conditions.

Color, without sacrifice of strength — for circuit tracing and coding — is no problem when you standardize on BH "1151" Sleevings. They're available in 8 basic colors. Tracer stripes to extend color code possibilities are available on special order.

BH "1151" is resistant to the high spot temperatures encountered in soldering. It will sustain 15 consecutive minutes at 600° F. without loss of flexibility or strength. And it remains unchanged after *continuous* operation from —90° F. to 400° F.

The properties of this outstanding product are covered by MIL-I-18057.

Spool or coil put-up, now widely preferred, is made possible by the BH patented manufacturing method. BH "1151" is also available in 36" lengths, or short pieces on special order. Made in sizes to fit Awg or B&S bare wires from 24 to 5/8" inclusive. Write for data sheets and free Production Testing Samples today.

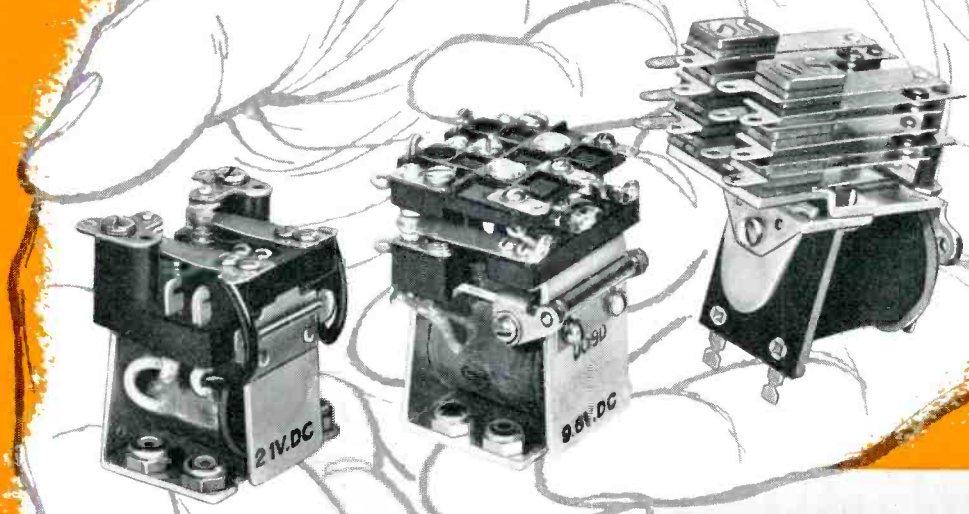
BENTLEY, HARRIS MANUFACTURING CO. 1311 BARCLAY ST.
CONSHOHOCKEN, PA. TELEPHONE: CONSHOHOCKEN 6-0634

BENTLEY, HARRIS Fiberglas* **SLEEVINGS**

*BH Non-Fraying Fiberglas Sleevings are made by an exclusive Bentley, Harris process (U.S. Pat. Nos. 2393530; 2647296 and 2647288). "Fiberglas" is Reg. TM of Owens-Corning Fiberglas Corp.

OHMITE®

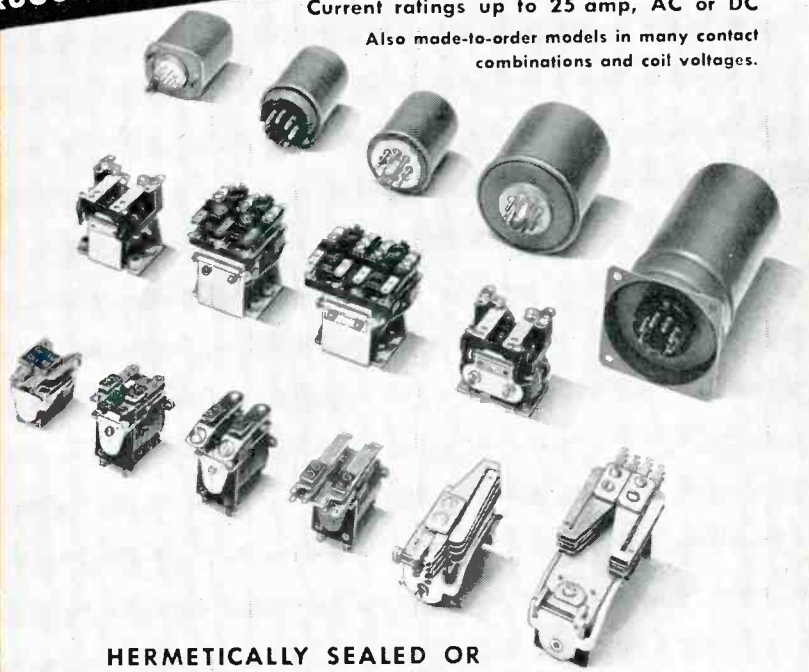
AMRECON® *Relays*



HIGH QUALITY, ALL-PURPOSE RELAYS . . . RUGGED, DEPENDABLE FOR LONG LIFE!

Current ratings up to 25 amp, AC or DC

Also made-to-order models in many contact combinations and coil voltages.

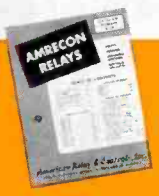


61 types in three stock models

Ohmite Amrecon relays have proven their exceptional ruggedness and long life in years of service. Now, three popular stock models—DOS, DO, and CRU, in 61 different types—are available from stock.

Models DO and DOS fill many industrial needs for a compact, lightweight relay that handles power loads usually requiring much larger, heavier units. They are particularly adaptable to aircraft and mobile equipment where severe shock and vibration are encountered. At 115 VAC or 32 VDC, noninductive load, Model DOS has a contact rating of 15 amp; Model DO, 10 amp; and Model CRU, 5 amp. Available in a wide range of coil operating voltages and contact combinations.

HERMETICALLY SEALED OR DUST-PROTECTIVE ENCLOSURES



SEND FOR CATALOG R-10

OHMITE MANUFACTURING COMPANY
3610 Howard Street, Skokie, Illinois
(Suburb of Chicago)

Be Right with
OHMITE®
RHEOSTATS • RESISTORS • RELAYS • TAP SWITCHES

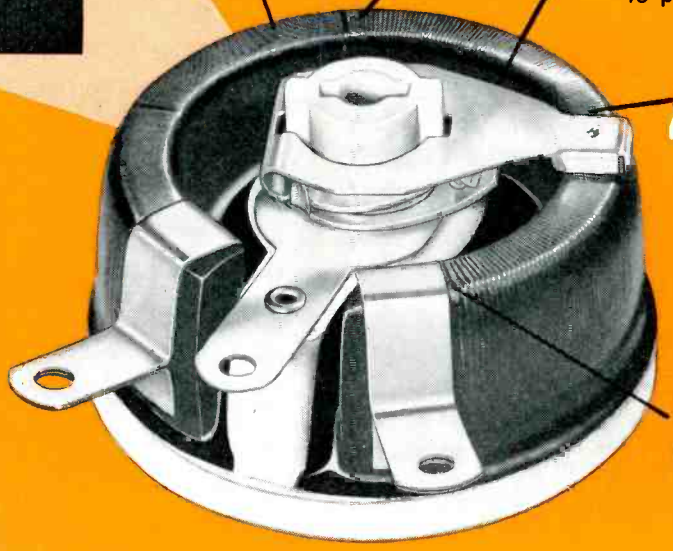
OHMITE® RHEOSTATS HAVE Smoother Windings!

5 REASONS WHY—

1. PRECISION GROUND CORE . . . Cores for fine wire, high resistance units are ground to give a smooth, flat contour for the contact brush.

2. SMOOTH JUNCTIONS where wire sizes change between sections of tapered windings . . . less differential between wire sizes.

3. PERMANENTLY LOCKED WINDINGS . . . Core and windings are bonded together with vitreous enamel to prevent shifting of wire.



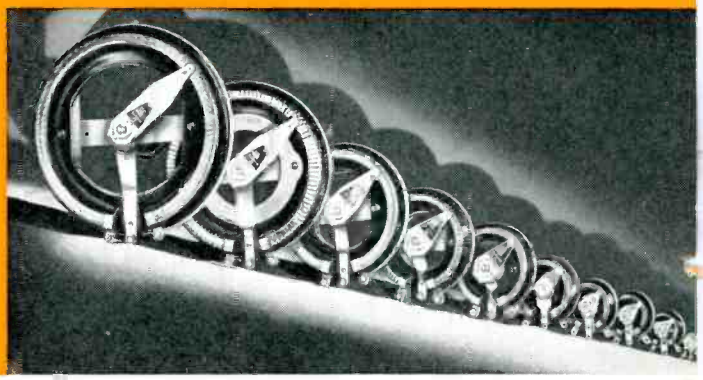
4. UNIFORM WIRE SPACING . . . Ohmite has developed special winding machines to insure uniform spacing and eliminate crossover of adjacent turns on fine wire units.

5. FLUSH TERMINALS . . . Terminals are flush with windings . . . brush glides smoothly from windings to terminal.

See for yourself! Examine an Ohmite Rheostat first hand. Compare its smoother resistance windings. Turn the knob and note how easily and smoothly the contact brush glides over the rheostat windings.

There's less wear on the resistance wire and on the contact brush. The brush makes contact with all of the turns and the resistance varies smoothly and uniformly as the shaft is turned. Every Ohmite Rheostat is *individually tested* on ultrasensitive electronic instruments to assure perfect contact between the winding and the contact brush.

Standardize on Ohmite Rheostats for unsurpassed dependability, smoothness of operation, and long life.



A COMPLETE LINE OF RHEOSTATS

from 25 to 1000 watts. Also available to meet MIL-R-22A requirements in *each* of the 26 type designations.

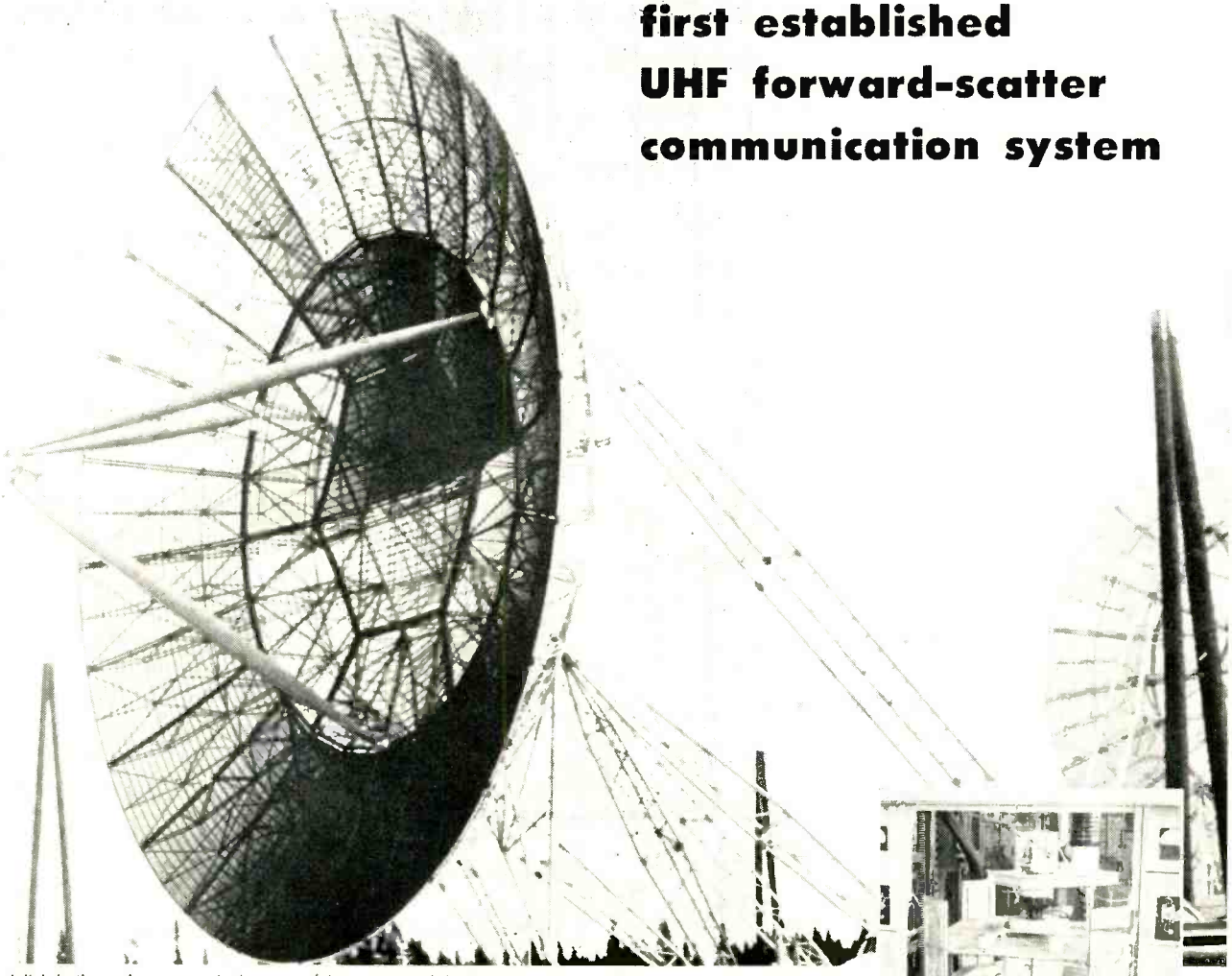
Write on company letterhead for Catalog and Engineering Manual No. 40.

Be Right with OHMITE®

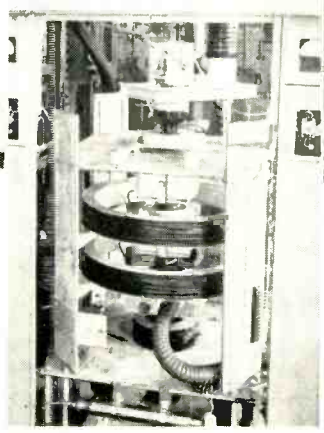
OHMITE MANUFACTURING COMPANY, 3610 Howard Street, Skokie, Illinois (Suburb of Chicago)

RHEOSTATS • RESISTORS • RELAYS • TAP SWITCHES

EIMAC klystrons are used in first established UHF forward-scatter communication system



A link in the northern communication system (photo courtesy of Bell Telephone Company of Canada).



Eimac high power klystron and Eimac-developed circuit components in final amplifier stage of forward-scatter transmitter (photo courtesy of Radio Engineering Laboratories).

In the forward-scatter communication system installed by the Bell Telephone Company of Canada over the rugged terrain of the north, Eimac amplifier klystrons are used exclusively. Eimac amplifier klystrons generate the high power necessary for revolutionary beyond-the-horizon scatter techniques. Their reliability and performance assure outstanding operation and minimize maintenance problems. Their simple, straightforward design, plus high power gain, make transmitter construction easy. All these features contributed to the selection of Eimac klystrons for the vital communication systems of the north. Now in operation for thousands of hours in these communication systems, Eimac klystrons have justified the early faith put in them and have aided substantially in making UHF forward-scatter a reliable method of distant communication.

Eimac

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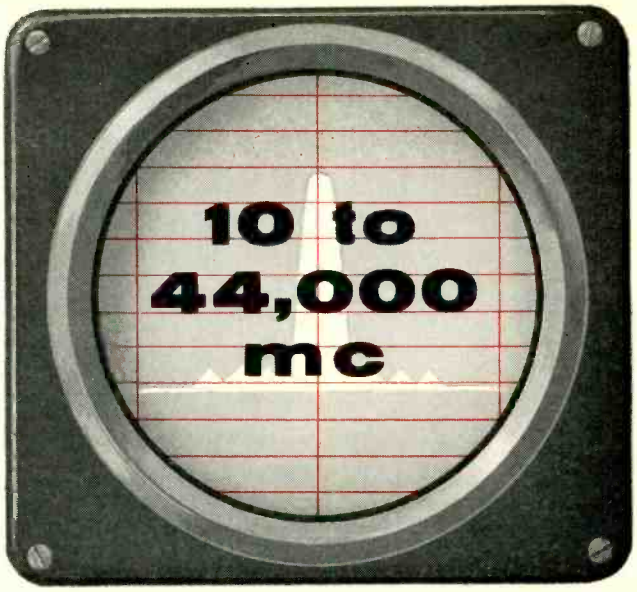
The World's Largest Manufacturer of Transmitting Tubes

POLARAD
PROVEN RELIABILITY



DIRECT READING SPECTRUM ANALYZER

UNI-DIAL CONTROL

Years of day-in, day-out field operation by most exacting users, have proven the Polarad Model TSA Spectrum Analyzer to be a versatile test instrument of highest reliability and accuracy for both laboratory and production applications.

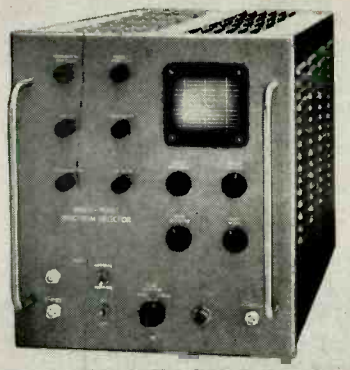
It is a broadband instrument with greatest pulse sensitivity over the band—10 to 44,000 mc. And each of its five interchangeable RF tuning heads operate with utmost simplicity and frequency stability. All tuning is by Uni-Dial control. Frequencies are read with 1% accuracy right on the linear dial as the set is tuned. No mode charts or interpolations necessary.

The Polarad Model TSA has been designed to save engineering manhours. Its 5 inch CRT display of the RF spectrum is bright and easily defined. And its 1 cycle sweep speed makes for fine resolution. For detailed specifications, contact your nearest Polarad Representative, or write directly to the factory.

APPLICATIONS

- Transmitter characteristics tests
- Broadband receiver for AM, FM, CW, MCW, and pulse modulated signals
- Component tests
- Frequency measurements
- Leakage, interference and radiation measurements
- Bandwidth measurements
- Modulation tests
- Adjacent signal channel tests
- Attenuation measurements
- Filter measurements
- Standing wave measurements

MULTI-PULSE SPECTRUM SELECTOR



MODEL SD-1

Increases the versatility of Polarad Spectrum Analyzers. It displays and allows selection for analysis of a specific train of microwave pulses, as well as any one pulse in the train; selects and gates a group of pulses up to 180 μsec. in length; and is designed to work with fast, narrow pulses; can be adjusted to gate any pulse including the first at zero time. Special circuitry discriminates automatically once pulses have been selected. Operates at any of the frequencies accepted by Polarad Spectrum Analyzers.

FEATURES:

Continuously variable sweep widths; 15 to 180 μsec. • Continuously variable gate widths for pulse selection; 0.4 to 10 μsec. • Continuously variable gate delays for pulse selection; .3 to 180 μsec. • Automatic gating of spectrum analyzer during time of pulse consideration. • Intensified gate (brightening) to facilitate manual pulse selection. • Triggered sweep on first pulse in any train. • No sweep in absence of signal.

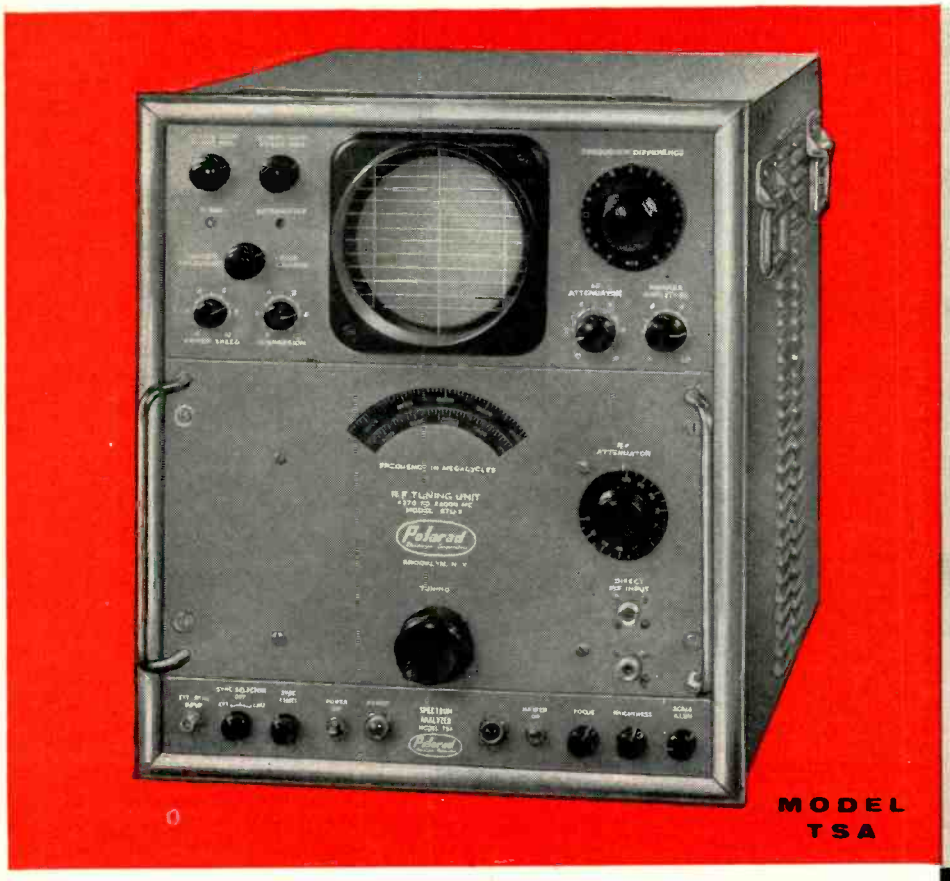
SPECIFICATIONS:

Maximum Pulse Train Time 180 μsec. • Pulse Rise Time .05 μsec. Minimum • Minimum Pulse Separation .2 μsec. • Repetition Rate 10—10,000 pps. • Minimum Pulse Width .1 μsec. • Input Power 95 to 130 volts, 50/60 cps., 325 watts. • Input Impedance 50 ohms. • Output Impedance 50 ohms (to match TSA Spectrum Analyzer).

BROADBAND SPECTRUM ANALYZER

FEATURES

- Greatest signal sensitivity over entire frequency band.
- Single frequency control with direct-reading dial accurate to ±1%.
- Complete frequency coverage from 10 mc to 44,000 mc.
- Internal RF attenuator (RF Tuning Unit Models STU-1, STU-2A, STU-3A).
- Adjustable frequency display from 400 kc to 25 mc.
- Frequency differences as small as 40 kc measurable by means of adjustable frequency marker with variable amplitude.
- 25-kc resolution for all bands.
- Stable klystron oscillators using non-contacting plungers to insure longer life.
- No klystron modes to set.
- 5-inch CRT display.
- Portable and completely self-contained.



MODEL TSA

SPECIFICATIONS

Model No.	Equipment
Model Du.....	Spectrum Display and Power Unit
Model STU-1...	RF Tunning Unit 10-1,000 mc.
Model STU-2A.	RF Tuning Unit 910-4, 560 mc.
Model STU-3A.	RF Tuning Unit 4,370-22,000 mc.
Model STU-4	RF Tuning Unit 21,000-33,000 mc.
Model STU-5...	RF Tuning Unit 33,000-44,000 mc.

SPECIFICATIONS:

Frequency Range: 10 mc to 44,000 mc.
Frequency Accuracy: ±1%
Resolution: 25 kc.
Frequency Dispersion: Electronically controlled, continually adjustable from 400 kc to 25 mc per one screen diameter (horizontal expansion to 20 kc per inch)
Input Impedance: 50 ohms—nominal
Sensitivity:*
STU-1 10-400 mcs—89 dbm
400-1000 mcs—84dbm
STU-2A 910-2,200 mcs—87 dbm
1,980-4,560 mcs—77 dbm
STU-3A 4,370-10,920 mcs—75 dbm
8,900-22,000 mcs—60 dbm
STU-4 21,000-33,000 mcs—55 dbm
STU-5 33,000-44,000 mcs—45 dbm
Overall Gain: 120 db
Attenuation:
**RF Internal 100 db continuously variable, IF 60 db continuously variable
Input Power: 400 Watts
*Minimum Discernible Signal
**STU-1, STU-2A, STU-3A

AVAILABLE ON EQUIPMENT LEASE PLAN

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Consult us on your Spectrum Analysis Problems

Write for your copy of the Polarad "Handbook of Spectrum Analyzer Techniques". 50c per copy. Includes discussion of Spectrum Analyzer operation, applications and formulae for analysis techniques.

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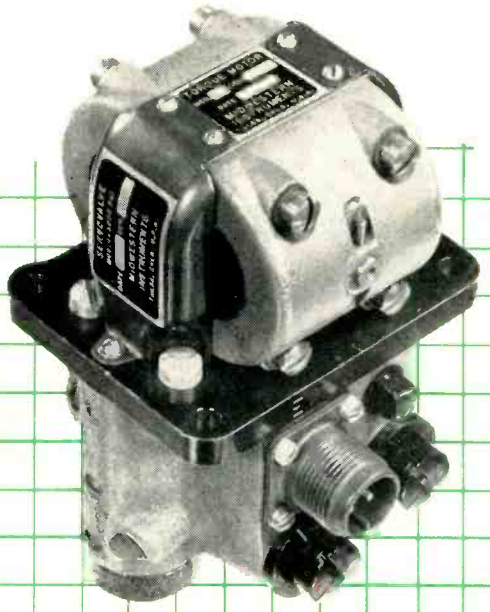

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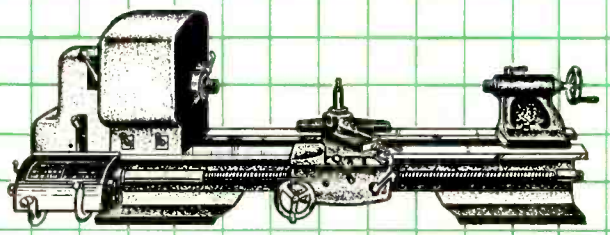

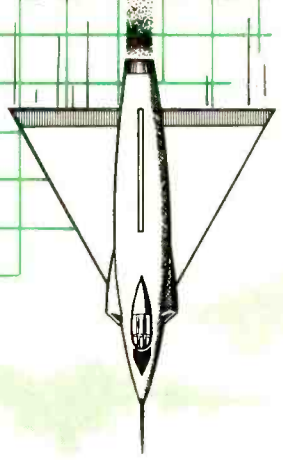

products

- OSCILLOGRAPHS (LABORATORY AND FLIGHT TEST)
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- AMPLIFIERS
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For servovalves—components, or complete systems for control or automation in ANY industry . . . Midwestern production facilities can help you solve your problems.

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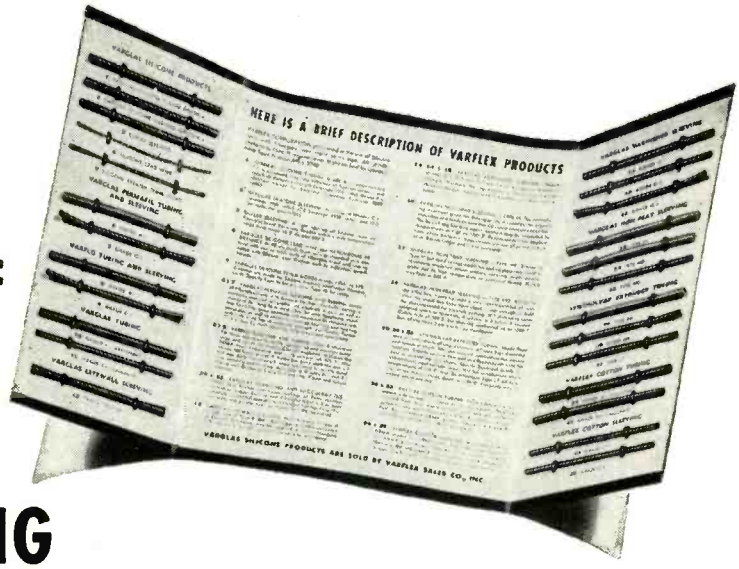

INCLUDES SAMPLES AND DESCRIPTIONS OF THE FOLLOWING...

VARGLAS SILICONE Class H insulating materials were pioneered by our Laboratory. Retain flexibility, electrical properties and mechanical strength in temperatures ranging from —85°F. to 500°F. Available in tubing, sleeving, lead wire, tying cord.

PERMAFIL-IMPREGNATED VARGLAS TUBING Fiberglas braid coated with General Electric's Permafil resin. Extremely tough, resistant to solvents and elevated temperatures, highly flexible. Can be bent or twisted with little or no loss of dielectric strength. Coils and standard 36" lengths.

VARGLAS SLEEVING AND TUBING Numerous types and grades—including synthetic-treated, varnished, lacquered, saturated, litewall and others.

VARGLAS NON-FRAY SLEEVING Fiberglas braid normalized to remove all organic impurities. It will withstand temperatures up to 1200°F. Recommended where dielectric properties are not paramount. Three types available.

VARFLO TUBING AND SLEEVING Vinyl-coated Fiberglas in full range of sizes, colors and grades. Extremely flexible with excellent heat aging qualities. Low priced.

VARFLEX COTTON TUBING AND SLEEVING Varnish or lacquer impregnated — for applications where MIL-I-3190 Class A materials are specified. All NEMA grades.

SYNTHOLVAR EXTRUDED TUBING Made in various standard formulations of vinyl polymers. Has high dielectric and tensile strength—will not support combustion nor absorb moisture. Type EG Approved under MIL-I-631A. Several others to meet special requirements.

NEW! VARGLAS SILICONE RUBBER SLEEVING AND TUBING—the culmination of 5 years of research—for applications requiring extraordinary flexibility. Details on request.

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Makers of Electrical Insulating Tubing and Sleeving

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Please send me free folder containing samples of your electrical sleeving and tubing.

I am particularly interested in insulation for:

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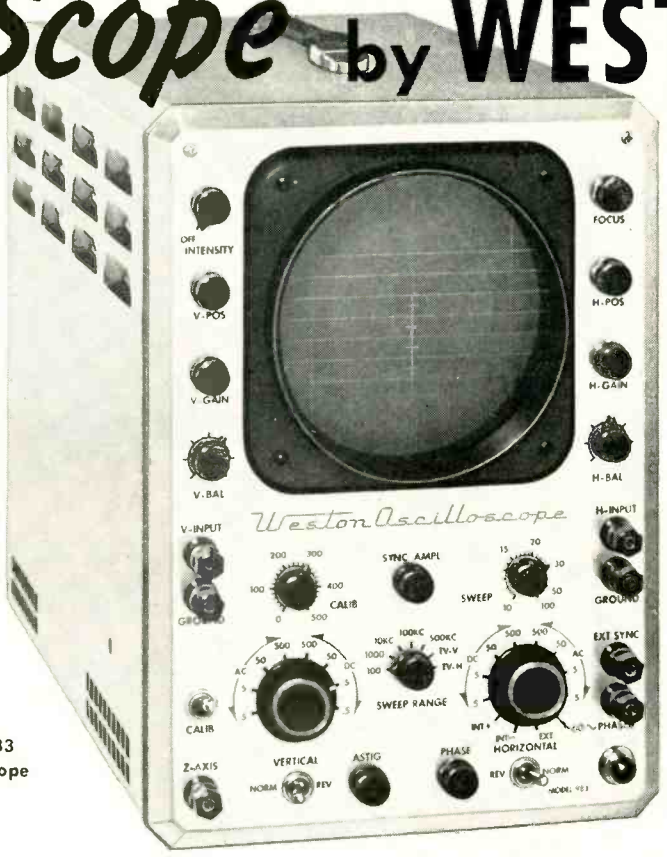
NOW...the All-purpose 'Scope by WESTON



Weston
Model 983
Oscilloscope

Model 983 is a high gain, wideband Oscilloscope designed to accurately reproduce waveforms comprising a wide band of frequencies. High sensitivity of 15 millivolts per inch RMS makes this "scope ideal for—SETTING RESONANT TRAPS...SIGNAL TRACING IN LOW LEVEL STAGES...AS A GENERAL NULL INDICATOR...for PHASE CHARACTERISTIC MEASUREMENT IN INDUSTRIAL APPLICATIONS...and for SWEEP FREQUENCY VISUAL ANALYSIS.

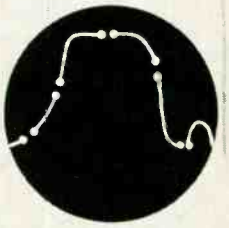
The 'scope contains identical vertical and horizontal push-pull amplifiers with a choice of AC or DC coupling without affecting either sensitivity or band width. Both amplifiers have compensated step attenuators and cathode follower input. *It has excellent square wave reproduction with overshoot of only 2 to 5%, with a rise time of 0.1 microsecond. The 'scope response is essentially flat throughout the specified range of 4.5 mc and is usable to 6 mc.*

The unit has provisions for internal calibration, internal phased sine wave, and Z-axis intensity modulation. Reversal of polarity of both horizontal and vertical signals is easily accomplished by means of toggle switching. *Tube replacements are non critical, and etched circuitry facilitates quick and rapid maintenance.*

The Model 983 Oscilloscope is now available through local distributors. For complete literature write WESTON Electrical Instrument Corporation, 614 Frelinghuysen Avenue, Newark 5, New Jersey.

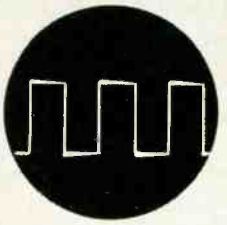
WESTON *Instruments*

WAVEFORM ANALYSIS



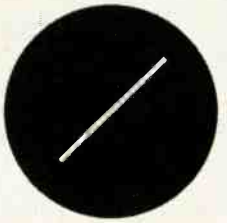
Response curves accurately displayed. Ideal for use with Weston intensity marker display. A fast, retrace sweep circuit with cathode follower output prevents pattern distortion.

SQUARE WAVE RESPONSE



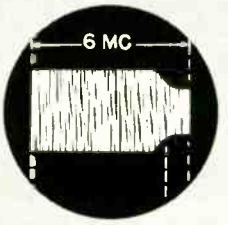
Overshoot is only 2 to 5%. Rise Time is 0.1 Microsecond. Square wave depicted 250 kc.

PHASE MEASUREMENTS



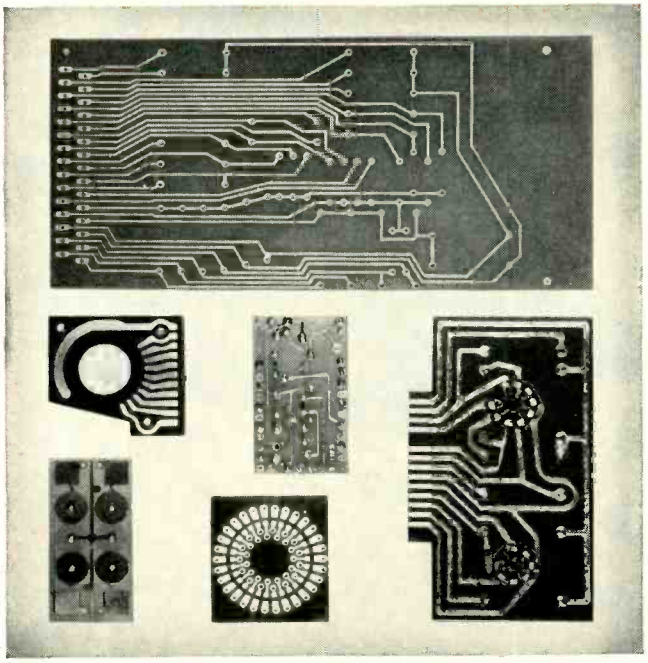
Phase shift between horizontal-vertical amplifiers, 0-500 kc-0°, to 1 mc within 2°; by internal adjustment with gain controls at max 0° phase shift possible on any specific frequency to 6 mc.

RESPONSE CHARACTERISTIC



Note flatness throughout specified range; to 3.6 mc down 1.5 db, at 4.5 mc down 3 db, at 6 mc down 6 db.

For the most dependable printed circuits, you need the high bond strength, workability, heat-resistance of C-D-F DILECTO® METAL-CLAD LAMINATES



Printed circuits based on C-D-F materials are being used with great success in military electronic equipment, commercial television and radio sets, telephone switchboards—even sub-miniature radiosonde equipment and hearing aids.
Photos courtesy of Photocircuits, Inc., Glen Cove, N. Y.

HIGH BOND STRENGTH—C-D-F's special adhesive for metal-clad Dilecto bonds the copper foil to the plastic without affecting the laminate's superior electrical properties. Heat-resistance, dissipation factor, dielectric constant, dielectric strength, and insulation resistance of the Dilecto base remain unaffected. The closely-bonded foil can be etched cleanly and dipped in hot solder to 220°C. (428°F.) for ten seconds with a guarantee of no blistering or separating. Metal-Clad Dilecto can be punched or machined either before or after etching.

EXCELLENT WORKABILITY—On all five Dilecto metal-clad grades, you can solder, punch, saw, and assemble components either by hand or automatically. Thanks to the inherently superior workability of the plastics laminate over that of ceramic-type materials, Dilecto can be dropped, jammed into tight chassis, and otherwise treated roughly on the assembly line and in service.

HIGH HEAT-RESISTANCE—Metal-Clad Dilecto Laminates are made of phenolic, epoxy, or Teflon* resin for various conditions of service and assembly, and have either cellulosic paper or woven glass-fabric base. All are ideally suited to printed-circuit applications in which heat-dissipation is a major problem. Continuous exposure to high ambient operating temperatures in enclosed electronic equipment has no significant effects on Dilecto's electrical and physical properties.

UNLOAD YOUR HEADACHE HERE! C-D-F, a big, reliable source of supply, can help you get the most for your printed-circuit money by reducing rejects, lowering fabrication costs, assuring dependable quality every time. Send us your print or problem, and we'll gladly supply appropriate test samples free. See our catalog in the Product Design File (Sweet's) or send for the new 20-page Dilecto catalog. Let your nearby C-D-F sales engineer (listed in Sweet's) help you right from the design stage!

TYPICAL PROPERTY VALUES

	Copper-Clad PHENOLIC (Grade XXXP-26)	Copper-Clad PHENOLIC (Grade XXXP-24)	Copper-Clad EPOXY (Grade GB-116E)	Copper-Clad EPOXY (Grade GB-181E)	Copper-Clad TEFLON* (Grade GB-116T)
BOND STRENGTH—0.0014" foil (Lbs. reqd. to separate 1" width of foil from laminate)	5 to 8	5 to 8	8 to 12	8 to 12	5 to 8
MAXIMUM CONTINUOUS OPERATING TEMP. (Deg. C.)	120	120	150	150	200
DIELECTRIC STRENGTH (Maximum voltage per mil.)	800	800	700	650	700
INSULATION RESISTANCE (Megohms) 96 hrs. at 35°C. & 90¾ RH	50,000	50,000	30,000	20,000	Over 10^6 megohms
DIELECTRIC CONSTANT 10^6 Cycles	4.20	4.20	4.90	4.95	2.85
DISSIPATION FACTOR 10^6 Cycles	0.026	0.026	0.019	0.018	0.0006
ARC-RESISTANCE (Seconds)	10	10	60	80	180
TENSILE STRENGTH (psi.)	16,000 x 13,000	14,000 x 11,000	46,000 x 42,000	48,000 x 44,000	23,000 x 21,000
FLEXURAL STRENGTH (psi.)	21,000 x 18,000	19,000 x 16,000	60,000 x 55,000	75,000 x 65,000	13,000 x 11,000
IZOD IMPACT STRENGTH edgewise (ft. lbs. per inch of notch)	0.40 x 0.35	0.40 x 0.35	6.5 x 6.0	13.5 x 11.5	6.0 x 5.0
COMPRESSIVE STRENGTH flatwise (psi.)	28,000	27,000	60,000	62,000	20,000
BASE MATERIAL OF LAMINATE	Cotton rag paper	Cotton rag paper	Fine-weave, medium-weight glass cloth	Medium-weave, medium-weight glass cloth	Fine-weave, medium-weight glass cloth
COLOR OF UNCLAD LAMINATE	Natural greenish	Natural Brown	Natural	Natural	Natural

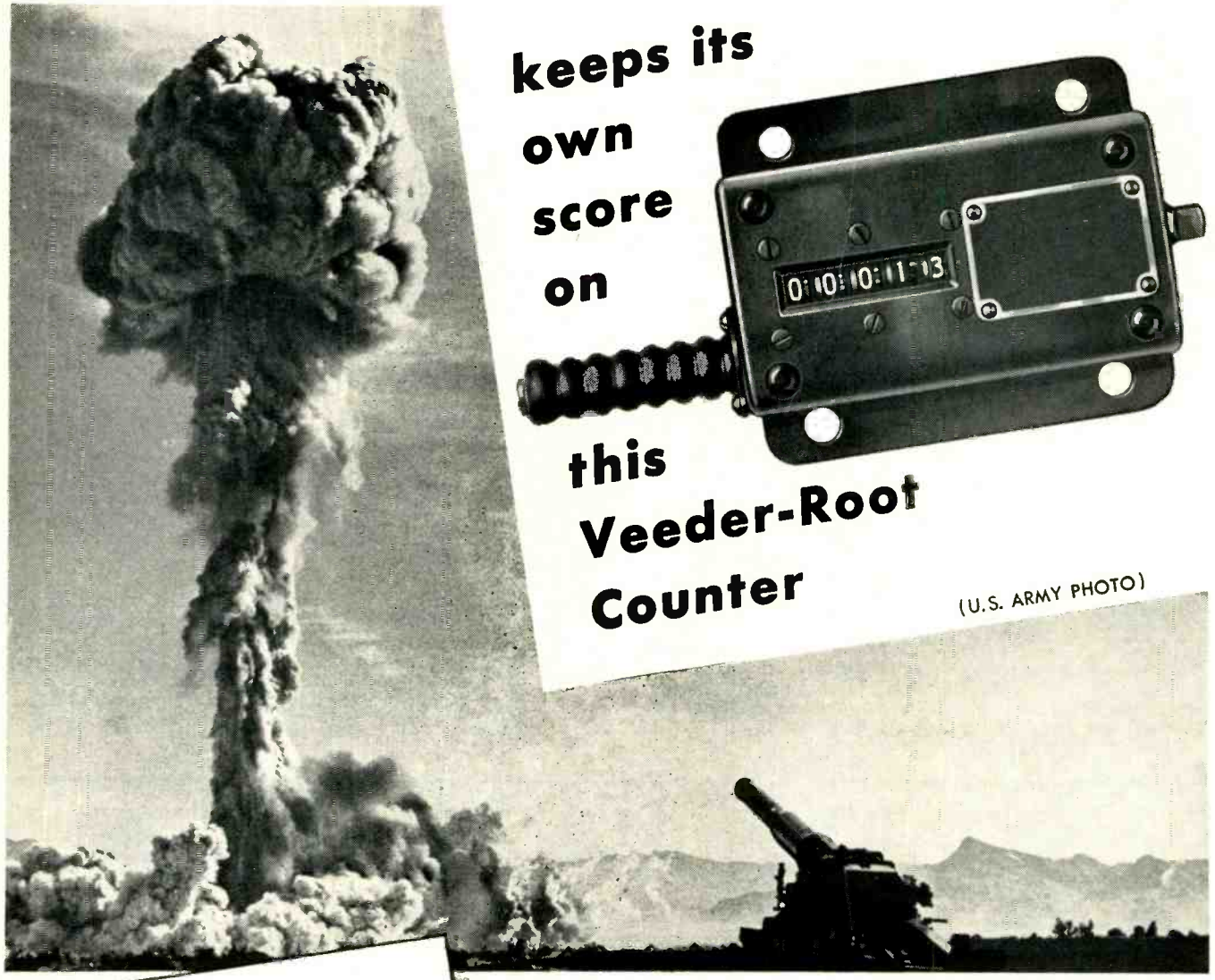
All these standard grades are available with 0.0014", 0.0028", 0.0042", or thicker electrolytic or rolled copper foil on one or both surfaces. Other metal foils and other resin-and-base combinations can be supplied on special order.

*duPont Trademark

CDF Continental-Diamond Fibre
CONTINENTAL-DIAMOND FIBRE DIVISION OF THE BUDD COMPANY, INC.
NEWARK 16, DELAWARE

Want more information? Use post card on last page.

NEW ATOMIC CANNON



Added Evidence that—

Everyone Can Count on VEEDER-ROOT

This mobile 280 mm. atomic cannon has *two* recoil motions. The primary recoil absorbs the cannon's "kick". The secondary recoil (something new in artillery) absorbs the forces created by the primary recoil. And each recoil motion is recorded by this special Veeder-Root Counter designed with a plunger-action shaft . . . which keeps the score on the cannon's use and indicates approaching need for maintenance.

This again points up the fact that "Anything Worth Making — or Worth Doing — *Is Worth Counting*." And Veeder-Root has the experience and resources *you* can count on, to give you any counter you need . . . for any mechanical or electrical application . . . in any field from Atomics to Automation. Write:

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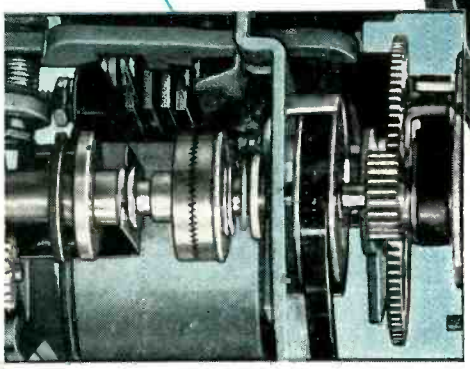
NEW

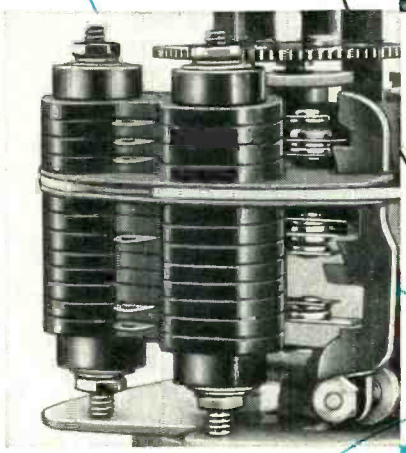
from face to terminal block

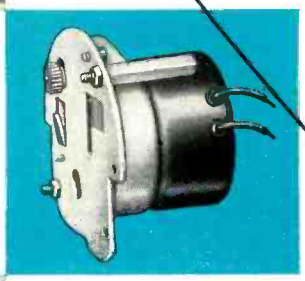
Cramer

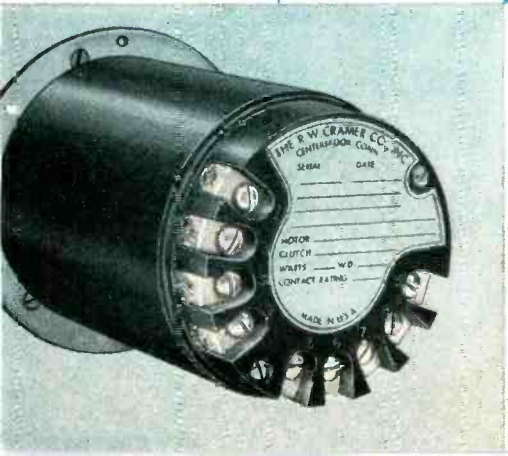
type 412

TIME DELAY RELAY









NEW—Repeat Accuracy within ± ¼ of 1% of full scale (30 sec. and longer ranges); ± ½ of 1% on faster timers.

NEW—Full Vision Dial. 300 degree scale assures precise settings and fast, accurate readings. Dial and pointers protected by transparent cover.

NEW Contacts, rated 15 amps., give positive quick-make, quick-break operation. Contacts are of silver cadmium oxide with ability to handle high inrush currents.

NEW Flexibility in wiring. Nine-position terminal block offers side or rear connection, presents a variety of wiring possibilities.

NEW Reset Shock Spring Design laboratory tested for more than a million operations.

NEW Friction Setting Mechanism allows adjustment even while timer is operating.

NEW—Ratchet Clutch operated by powerful relay, provides instant action, no slip.

NEW O-Ring Retainer permits quick removal of bakelite housing, exposing entire timer mechanism.

Timer driven by high torque (30 in. oz. at 1 r.p.m.) Cramer Type 112 Synchronous Motor.

Cramer TIMING DEVICES

The R. W. CRAMER CO., Inc.

SPECIALISTS IN TIME CONTROL
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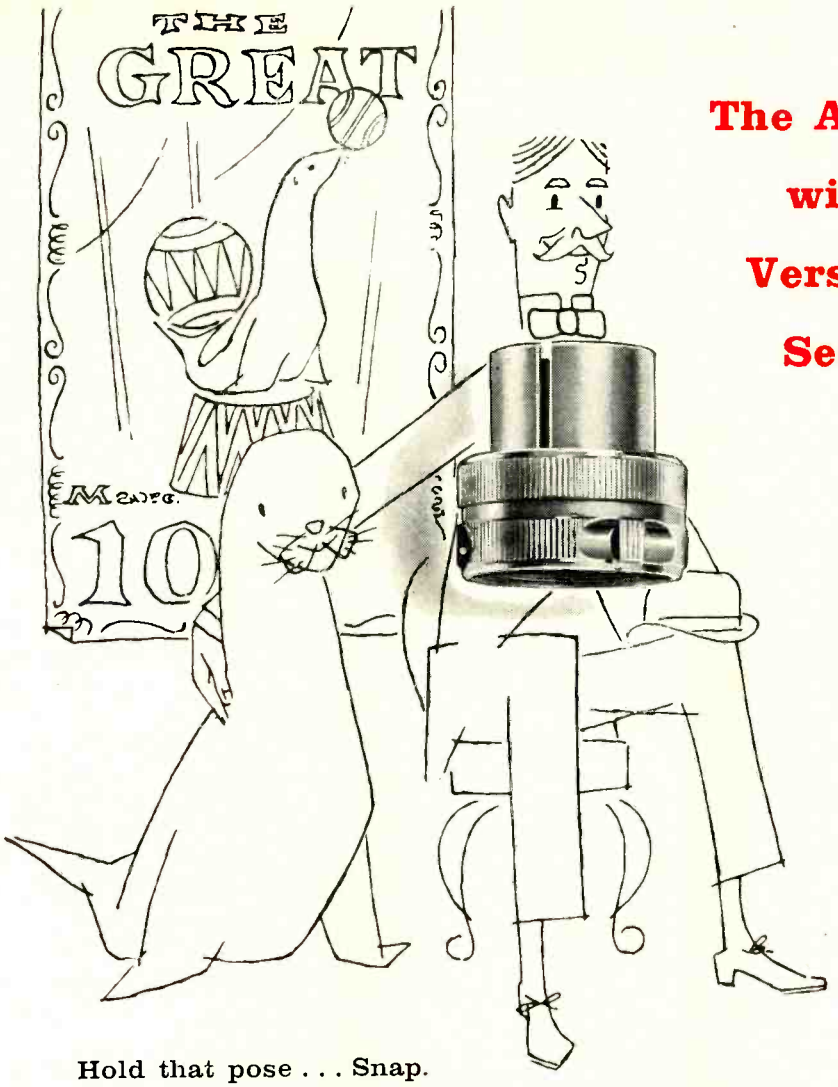
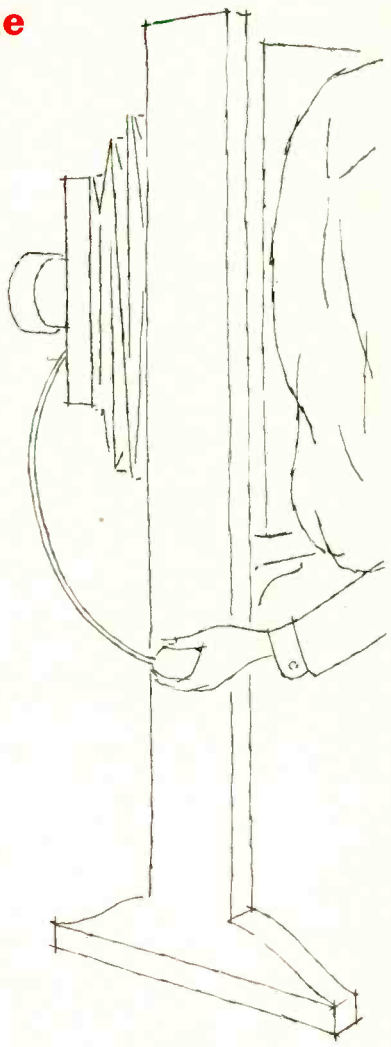


The A-N Connector with the Versatile Seal



Hold that pose . . . Snap.

Truly a wonderful portrait of a long-lasting, beneficial association. The versatile seal around each pin in Hermetic HS 2 and HS 6 Connectors is of Vac-Tite, glass-to-metal construction. It assures superior, leak-proof performance.

By hermetically sealing the A-N Connector pins, Hermetic can offer as the solution to difficult instrumentation problems, these vitally important characteristics:

- *Vacuum tightness (mass spectrometer proven)*
- *Arc-resistance of glass*
- *High-temperature operation*
- *Corrosion resistance*
- *100% moisture and pressure resistance*
- *Shock and vibration proof*
- *Equivalent to MIL-C-5015*

Yes, it's truly a wonderful portrait...a remarkable A-N Connector.

If your needs, however, require specially designed units with particular plating requirements, varied flange styles and extra-high pressure resistance, you will be pleased to learn of their availability. *Why not request drawings, engineering data and your copy of "Encyclopedia Hermetica" for the complete story.*

Hermetic Seal Products Company

31 South 6th Street, Newark 7, New Jersey

California Associate: Glass-Solder Engineering, Pasadena

FIRST AND FOREMOST IN MINIATURIZATION

TYPICAL LABORATORY BENCH SETUP shows how simple it is to hook up the input and load connections of the Solavolt for testing a fluorescent ballast at several different input voltages. It has attached input cord and plug, line on-off switch, and three sinusoidal ac voltage outputs, all regulated within ±1%: (1) a standard receptacle for fixed 115 volts (2) a standard receptacle for a variable output of 0-130 volts and (3) a pair of jacks for variable output of 0-130 volts.

±1% Regulated AC Voltage Supply Adjustable from 0 to 130 Volts

When an adjustable source of regulated ac voltage is required for the accurate performance of a variety of electrical or electronic equipment, a Solavolt is often the simple, practical solution. It provides the close regulating action of a Sola Constant Voltage Transformer (a static-magnetic stabilizer) with less than 3% harmonic distortion of the output voltage wave.

Two of the Solavolt's three outputs are adjustable from 0 to 130 volts. The third provides a fixed 115 volts. All three outputs are regulated ±1% regardless of input changes from 95 to 125 volts, and may be used simultaneously within total maximum va rating.

Regulation is completely automatic and continuous with response time of 1.5 cycles or less. Except for the rotor of the autotransformer, there are no moving parts, and no manual adjustments are required. There are no tubes or other expendable parts.

The Solavolt is an ideal package unit, with carrying handle, where portability and compactness is a factor. It is particularly useful for general laboratory work, instrument calibration, testing, general shop use, or other similar applications. Solavolts are available from your electronic distributor in either 250va or 500va capacities.

SOLA *Constant Voltage* **TRANSFORMERS**

Write for Bulletin 7K-CVL193 for full electrical and mechanical specifications of the Solavolt.

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CONSTANT VOLTAGE TRANSFORMERS for Regulation of Electronic and Electrical Equipment • **LIGHTING TRANSFORMERS** for All Types of Fluorescent and Mercury Vapor Lamps. • **SOLA ELECTRIC CO., 4633 West 16th Street, Chicago 50, Illinois, Bishop 2-1414** • *NEW YORK 35: 103 E. 125th St., TRafalgar 6-6464* • *PHILADELPHIA: Commercial Trust Bldg., Rittenhouse 6-4988* • *BOSTON: 272 Centre Street, Newton 58, Mass., Bigelow 4-3354* • *CLEVELAND 15: 1836 Euclid Ave., PRospect 1-6400* • *KANSAS CITY 2, MO.: 406 W. 34th St., Jefferson 4382* • *LOS ANGELES 23: 3138 E. Olympic Blvd., ANgelus 9-9431* • *TORONTO 9, ONTARIO: 617 Runnymede Rd., Lyndhurst 1654* • *Representatives in Other Principal Cities*

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Complete Audio Connector Bulletin is yours for the asking . . . D Series in separate bulletin coded D-4.

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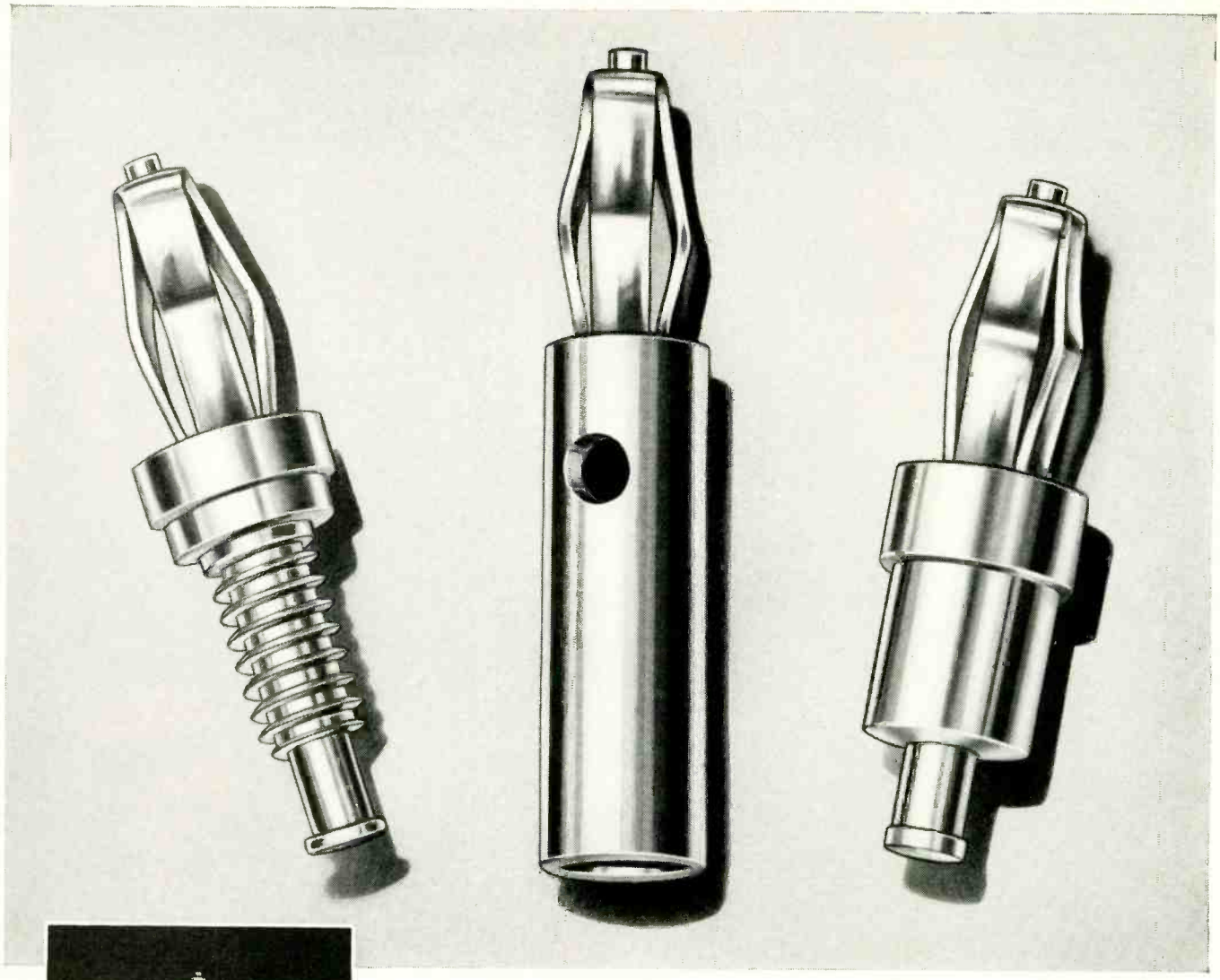
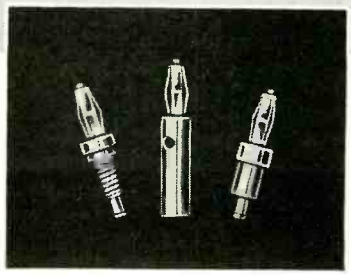


6 times enlargement



Actual size

Ucinite Miniature Banana Pins

Heavy resistance to torque is a big feature of Ucinite miniature banana pins. The springs are mechanically riveted over and the large area around the tip of the pin is bonded by solder.

Pins are available in a variety of types, for assembly by staking . . . with nuts and washers . . . with soldered tails . . . with multiple plug-in features. Springs are designed to fit .093 sockets.

Built to withstand rough usage, Ucinite miniature banana pins are available in cadmium, silver or gold plate.

For further information, call your nearest United-Carr representative or write directly to us.

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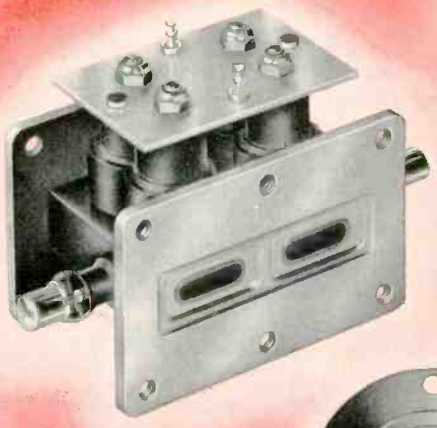
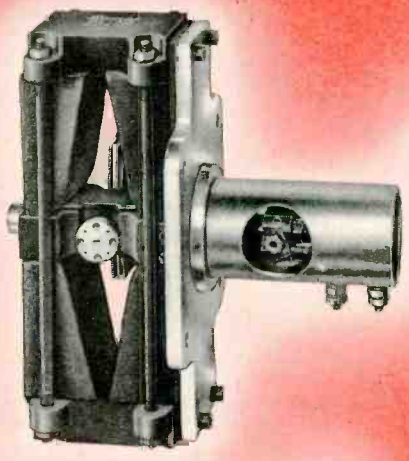
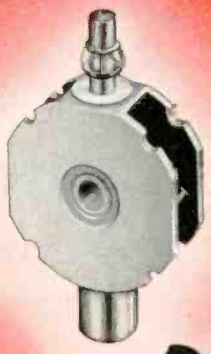
...THE MOST COMPLETE LINE...







microwave tubes and components

GAS SWITCHING TUBES — Bomac produces the most extensive line of TR, ATR, Pre-TR, attenuator tubes, duplexers and shutter tubes available, for all frequency bands and power levels.

HYDROGEN THYRATRONS — Bomac offers a complete line for use as switch tubes in line type modulators for pulsing magnetrons in radar equipment. Also used for precise triggering at high power levels.

PRESSURIZING WINDOWS — Bomac has windows available for all wave guide sizes, broad band characteristics with low insertion loss, temperature range —55°C to 100°C and 30 lb./sq. in. pressure differential either direction.

SILICON DIODES — Bomac diodes are manufactured to high standards to assure electrical uniformity, high burnout and humidity resistance.

MAGNETRONS — Bomac has available tunable and fixed tuned magnetrons with high peak RF powers for pulsed service in the higher frequency bands.

REFLEX KLYSTRONS — Bomac now offers X band klystrons having improved local oscillator performance and dependability.

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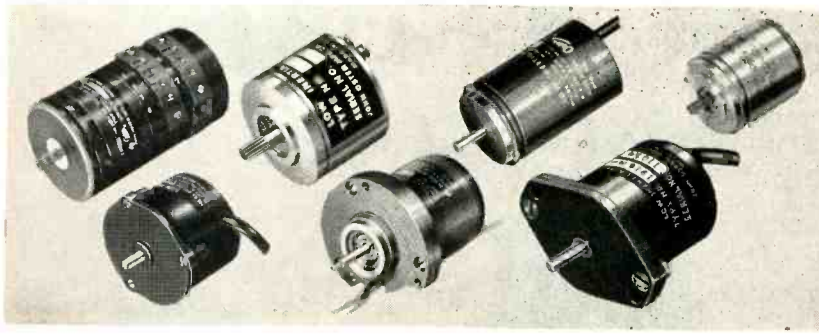
CHOOSE YOUR 2Ø SERVO



Oster®

These high performance 400 cycle servos conform dimensionally with Bu Ord specs in many models. Greater efficiency, minimum air gaps and extremely high torque-to-inertia ratio is attained by precision manufacturing. 60 cycle units can be made available.

Type Number	Size	Length	Mounting	Minimum Stall Torque In Oz.	No Load Speed Minimum	Power Input at Stall Total Watts	Rated Voltage Fixed Phase	Rated Voltage Control Phase	Special Features
1916	10	1 3/16"	Flange	15	9,000	3.	28	28	
2409	10	1 3/16"	Flange	.13	9,000	2.3	18	18	HI Temp application
2155	10	31/32"	Synchro	24	4,800	4.5	52	52	
2162	10	31/32"	Synchro	.24	4,800	5.5	26	26	
2201	10	/32"	Synchro	.24	5,000	5.2	26	52	
2442	10	1.156"	Synchro	.13	10,000	3.2	18	18	
3009	10	1.156"	Synchro	3	10,000	2.5	18	54	1400 OHM cont. ph. Z
3040	10	.975"	Synchro	.149	10,000	2.6	18	54	1400 OHM cont. ph. Z
3053	10	.975"	Synchro	.15	10,000	2.8	18	18	
3185	10	.968"	Synchro	.3	6,000	6.2	26	26	avail. up to 125°C
2156	.980" OD	.956"	Synchro	15	6,000	5.	27.5	14	125°C
2307	1" OD	1.5"	Synchro	.25	10,000	10.	115	115	
3188	1" OD	1.511"	Flat	35	10,000	12.6	115	115	
3199	11	1.703"	Synchro	.63	6,200	7.	115	115	Mark 14 Mod O
3161	15	1.512"	Flange	.45	000	5.8	26	50	
3148	15	1.640"	Synchro	1.45	4,800	12.2	115	115	Mark 7 Mod O
2287	15	1.640"	Synchro	1.45	4,800	12.2	115	115	avail. up to 150°C
3159	15	1.640"	Synchro	1.45	4,800	12.2	115	230	
3271	15	1.640"	Synchro	.0	10,000		115	115	
3272	15	1.640"	Synchro	1.0	10,000		115	230	
3273	18	2."	Synchro	2.35	4,800	18.4	115	115	
3217	18	2."	Synchro	2.35	4,800	18.5	115	282	
3270	18	2.	Synchro	1.4	9,800	18.0	115	115	
2094	2" OD	2.718"	Flange	3.5	7,200	40.	115	115	Damping Generator
2237	2 1/8" OD	4.750"	Synchro	23.	10,000	130.	115	115	

Many of the above units can be supplied with gear train to your specifications.
Other servos to your requirements.

Write for further details, giving type number.

Other products include Actuators, AC Drive Motors, DC Motors, Motor-Gear-Trains, Fast Response Resolvers, Servo Torque Units, Synchros, Reference Generators, Tachometer Generators, and Motor Driven Blower and Fan Assemblies.

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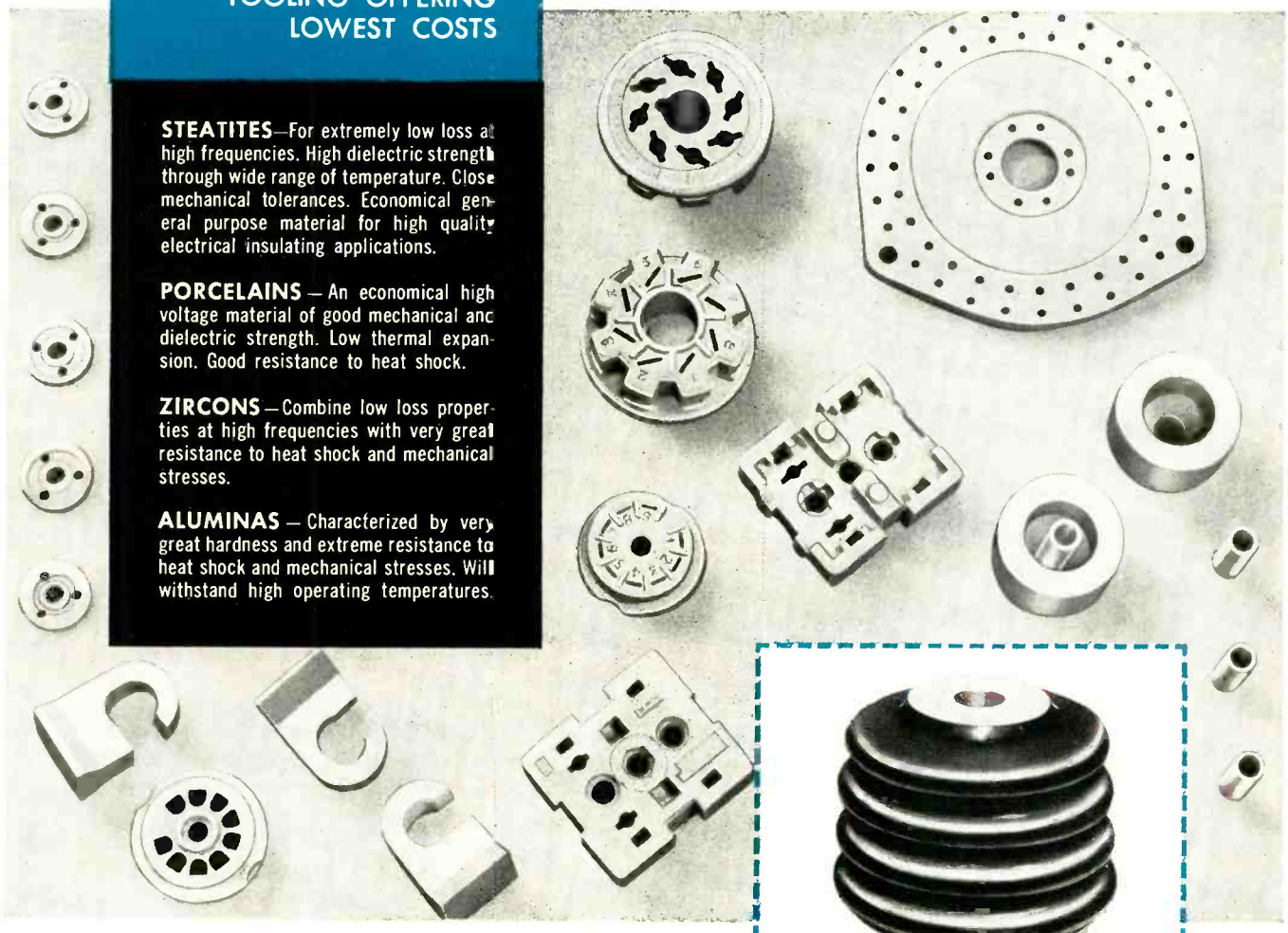
STEATITES—For extremely low loss at high frequencies. High dielectric strength through wide range of temperature. Close mechanical tolerances. Economical general purpose material for high quality electrical insulating applications.

PORCELAINS—An economical high voltage material of good mechanical and dielectric strength. Low thermal expansion. Good resistance to heat shock.

ZIRCONS—Combine low loss properties at high frequencies with very great resistance to heat shock and mechanical stresses.

ALUMINAS—Characterized by very great hardness and extreme resistance to heat shock and mechanical stresses. Will withstand high operating temperatures.



ONE source of supply for ALL electrical ceramics—

For dependable quality and "on time" deliveries, General Ceramics can meet your requirements for electrical ceramics that conform to your assembly line schedules. Standardized designs, lowest tooling costs and modern method of manufacture assure lowest possible cost per unit. Close adherence to specifications and strict final inspection minimize rejects, speed your assembly. When specifications call for ceramics, consult ceramics headquarters! Call, wire or write for estimates.

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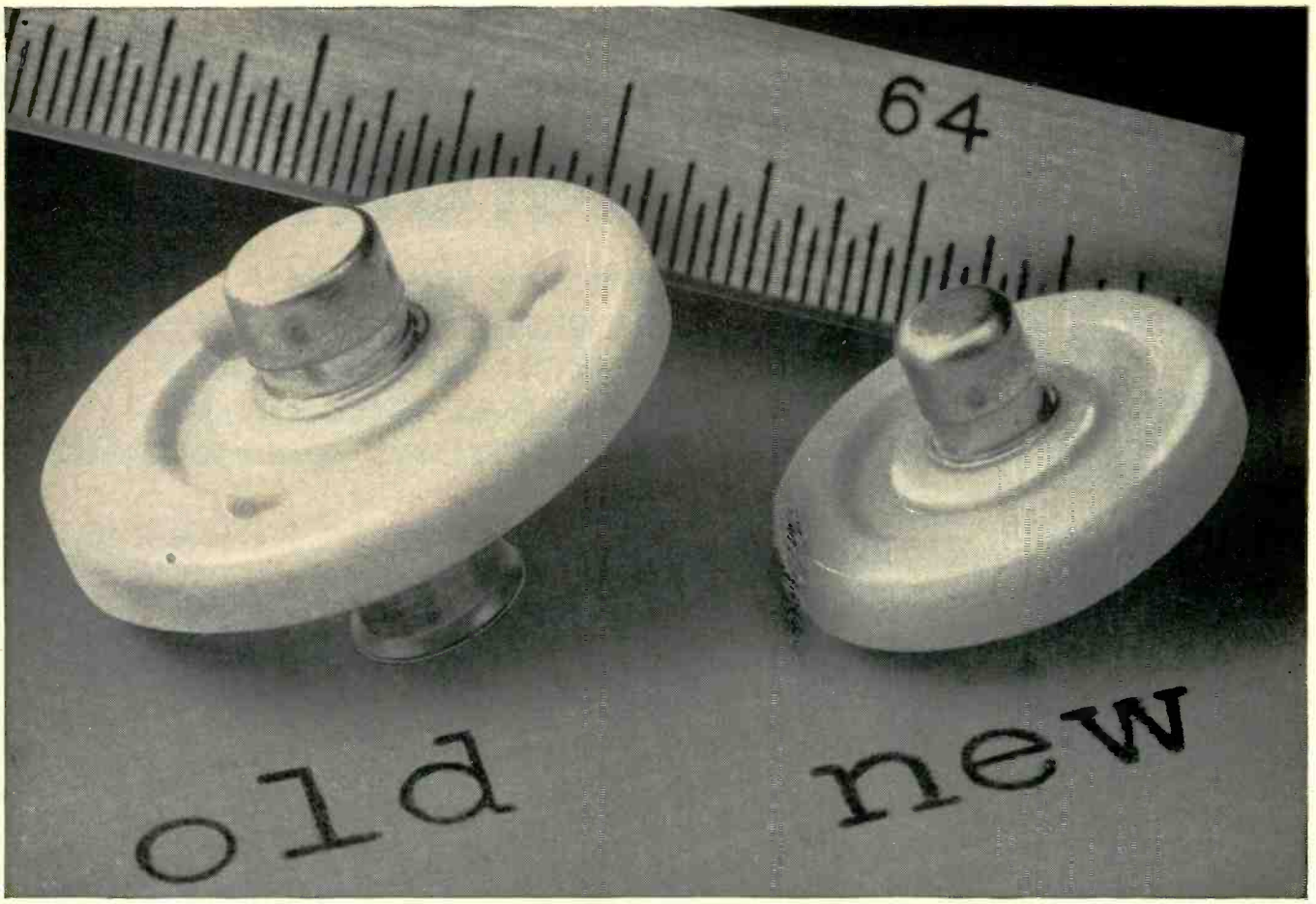


New miniature disc cathode shank diameter and length are reduced by approximately 25% from the previous model. Ceramic also is about 25% smaller. Concentric groove in ceramic inhibits leakage from sublimation deposits. Magnification 8x.

NEW SUPERIOR TUBE MINIATURE DISC CATHODE SAVES 25% SPACE, UP TO 50% HEATER POWER

Up to now, practically all cathode ray tubes were equipped with disc cathodes as large as the one shown on the left in the above picture. But since the aperture in the first grid of most cathode ray tubes is normally so much smaller than the cap of the cathode, Superior Tube engineers reasoned that the cathode could be smaller and still give as good emission. They were right. The new cathode is shown above.

Think what this means: Tri-gun color TV tubes can have more slender necks. So also can multi-gun special purpose cathode ray tubes. Cost can be saved in the glass, the base, and the socket. Even single gun tubes can benefit. Less metal and ceramic means a lower heater power requirement.

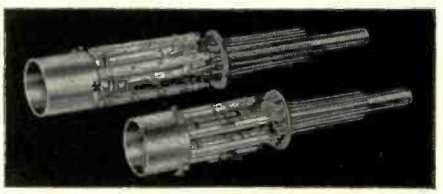
These miniature disc cathodes are available in all regular Superior Tube cathode alloys. Ceramics can be either 0.365″ or 0.490″ dia., with or without breather holes. Cap to ceramic dimensional tolerance (the "E" dimension) guaranteed within ±.0005″.

Ask for a sample quantity of these new cathodes and try them for performance. Write for engineering information. Superior Tube Company, 2500 Germantown Ave., Norristown, Pa.

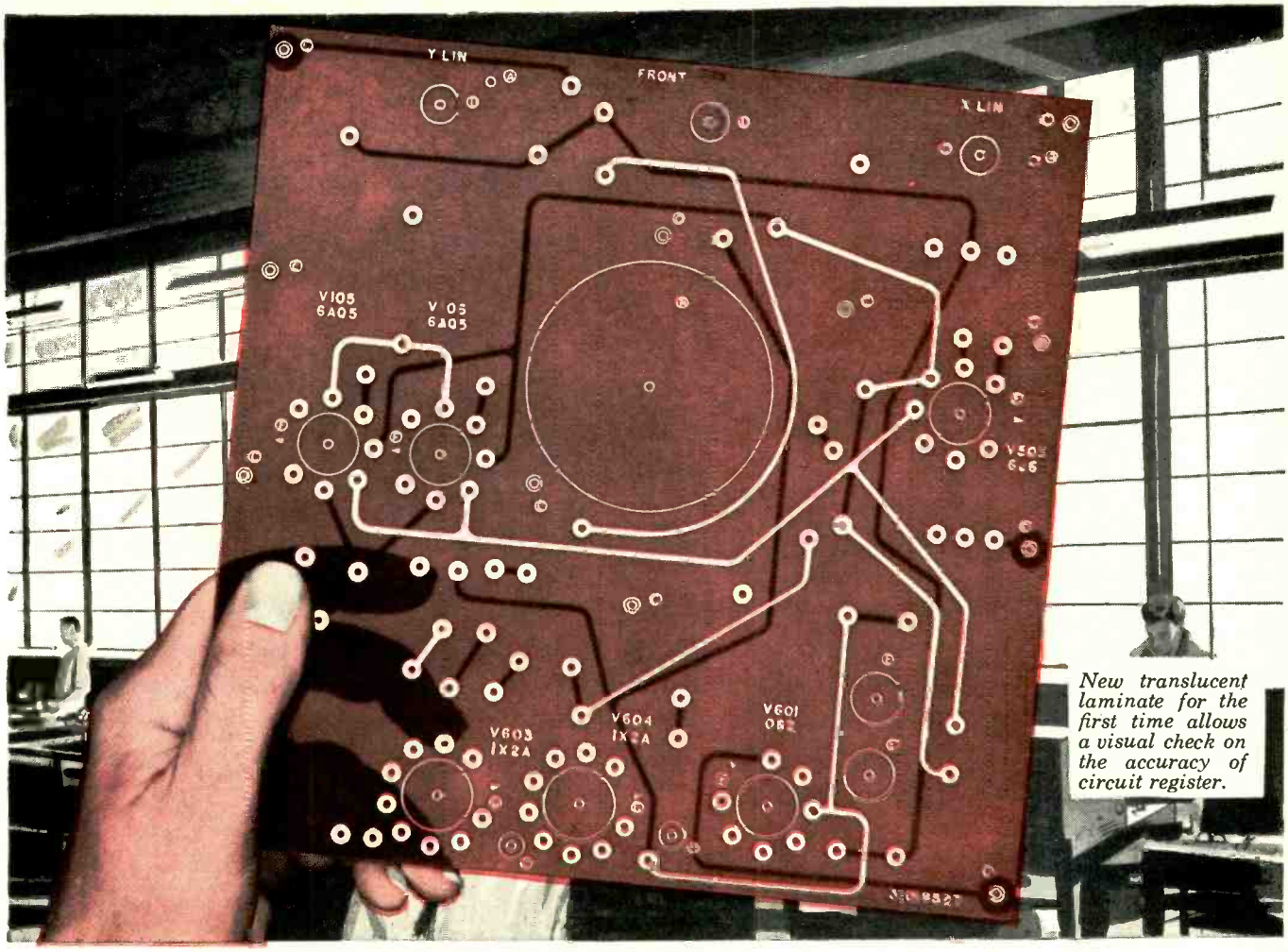
All analyses .010″ to ⅝″ O.D. Certain analyses in light walls up to 2½″ O.D.

Superior Tube
The big name in small tubing

Radius of Curvature of edge of cap lessens the danger of high temperature "dishing" frequently experienced with large area, sharp edge cathodes. "Dishing" would affect cut-off voltage of tube, require use of more expensive variable resistor in grid circuit. A small flat surface is retained to provide a satisfactory source of emission current.



Size Comparison of Color TV Guns. Note how much more compact gun can be with miniature disc cathodes. Permits more slender tube neck.



New translucent laminate for the first time allows a visual check on the accuracy of circuit register.

Formica Research perfects sensational new cold punching laminate

Brings 1,000,000 megohms resistance value, precision and translucency to printed circuitry . . . . .

Research, an important part of the exclusive new Formica 4-point service, has just perfected a new cold punching paper base laminate offering 1,000,000 megohms insulation resistance and valuable new translucent properties.

Known as XXXP-36, the new grade brings greater accuracy to printed circuitry. Because of its cold punching qualities, XXXP-36 requires no heat cycle. Therefore, the base laminate is not subject to dimensional change as in grades which must be heated before punching. This means that with Formica XXXP-36, you can now produce printed circuits with new and higher standards of accuracy.

XXXP-36 translucency can be doubly useful. Make this simple test: hold it to the light. You can see (1) the smooth, homogenous structure, the total absence of resin pockets, voids and imperfections that dissipate the insulating properties of ordinary paper base laminates . . . and (2) how perfectly the circuit on one side registers with that on the other. New XXXP-36 is ideal for terminal boards and tv insulators requiring high I. R. Formica's engineering skill can help you find new materials for new products and processes. For complete information on the new XXXP-36, or on the new "Formica-4" service, use coupon below.

The Formica Co., 4640 Spring Grove Ave., Cincinnati 32, Ohio.

Industrial
FORMICA®
Laminated Plastic
Pays in Performance

FORMICA®—*the most famous name in laminated plastics—Engineered for industry, Beauty Bonded for the home.*

Make the Formica Translucency Test. Send for a sample XXXP-36 printed circuit. Fill out and mail coupon today.

Gentlemen:

☐ *I'd like a sample XXXP-36 printed circuit and complete information on this new grade.*

☐ *Send bulletin showing how I can take advantage of the new "Formica-4" laminated plastics service.*

Name_____

Company_____ Title_____

Address_____

City_____ Zone___ State_____

Want more information? Use post card on last page.

Up where the

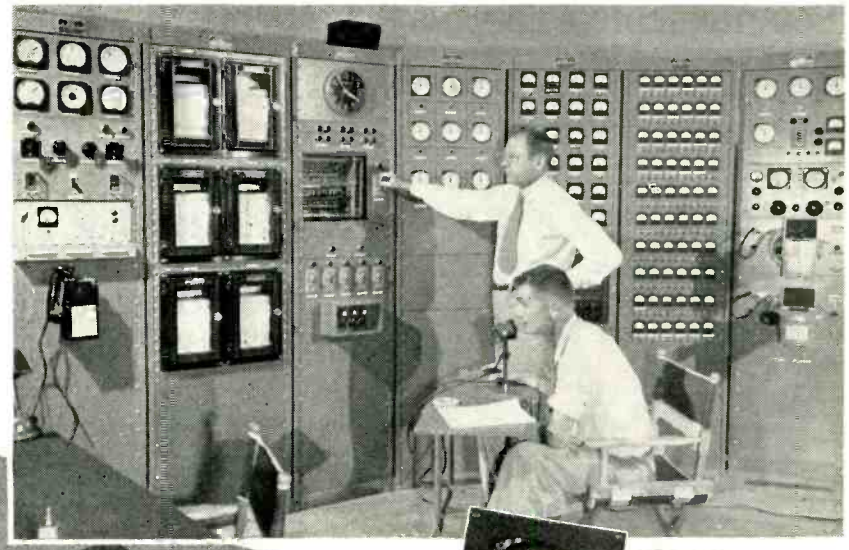
ATOMIC BOMB LETS GO

Split Seconds Seem Like Eternity

...ic ... ...e nuclear
device itself must be armed and fired.
These and hundreds of similar details must be
taken care of without fail in proper order
and at predetermined times in order that the
desired information be obtained. This control
is provided by a device known as a "sequence
timer" located in the control room. The ...
...t electric signals which acti...

THIS EXCERPT from the "Guide for Observers' Tour of the Control Point and Forward Area, Nevada Proving Grounds" highlights the importance of equipment capable of accurately measuring elapsed time down to unbelievably short intervals.

The first section of the panel shown below is used only for air bursts. The second and third sections contain the frequency control equipment for the motor-generator set which supplies power to the timing equipment, with voltage recorders connected to various points in the target area – thus assuring accurate timing – and recorders for wind velocity and direction. In order to activate test equipment at the exact time, very precise control of the frequency for the timer is required... The precision timers on the fourth and seventh sections are by STANDARD.



Complex instrument panel in Control room of Control Point, Yucca Pass, Nevada Proving Grounds

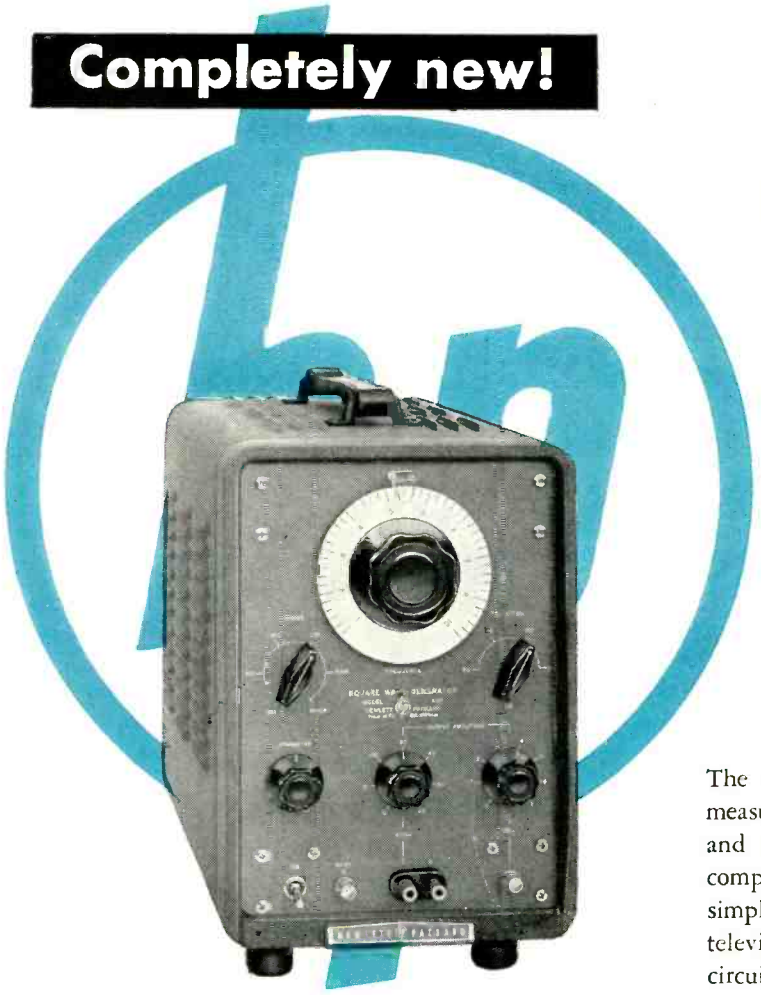
The STANDARD ELECTRIC TIME COMPANY

STANDARD
Since 1884

97 LOGAN STREET · SPRINGFIELD 2, MASSACHUSETTS

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

Completely new!



1 cps to 1 MC Square Wave Generator

with 0.02 μsec rise time

Other Unusual Features

7 volt 75 ohm TV circuit

55 volt 600 ohm high level circuit

Full amplitude variation

External synchronization

The new *-hp-* 211A Square Wave Generator permits fast measurement of audio and video amplifier frequency phase and transient characteristics up to several megacycles. In computer, pulse code and telemetering work, it materially simplifies triggering and switching. It is excellent for testing television circuitry, and ideal for modulating high frequency circuits, testing attenuators, filters and delay lines. In general laboratory use it is an excellent means of measuring time constants, indicating phase shift, frequency response and transient response.

Model 211A has many unique features. Besides the 0.02 μsec rise time and two separate outputs (with full amplitude variation on both), the generator can be operated either free-running or externally synchronized. External synchronizing can be either with a positive going pulse or a sine wave signal of 3 volts amplitude. Much of the instrument's circuitry is etched to provide clean, trouble-free layout, compact size, freedom from stray capacity variations, and thus, a highly uniform product. The generator is of quality construction throughout and is housed in a streamlined, lightweight metal cabinet.

SPECIFICATIONS

Frequency Range: 1 cps to 1 MC, continuous coverage.

Low Impedance Output: 7.0 v peak-to-peak across 75 ohm internal impedance. Rise time less than 0.02 μsec. BNC Connector.

High Impedance Output: 55 v peak-to-peak across 600 ohm internal impedance. Rise time less than 0.1 μsec. Dual banana jacks —¾" centers.

Amplitude Control: Low Impedance Output — Potentiometer and 60 db attenuator, variable in 20 db steps. High Impedance Output—Potentiometer.

Frequency Control: Dial calibrated "1 to 10" and decade multiplier switch. Six bands.

Symmetry Control: Allows exact square-wave balance.

Sync Input: Positive-going pulse or sine wave signal, minimum amplitude 5 volts peak. BNC connector.

Power: 115/230 v ±10%, 50/60 cps, 195 watts.

Size: 9¾" wide, 13⅞" high, 13⅜" deep.

Weight: Net 22 lbs.; Shipping 44 lbs.

Price: $265.00.

Data subject to change without notice. Prices f.o.b. factory.

SEND FOR OPERATING TECHNIQUES, CAPABILITIES, COMPLETE DATA

HEWLETT-PACKARD COMPANY
3331A PAGE MILL ROAD., PALO ALTO, CALIFORNIA

Please send complete data on *-hp-* 211A Square Wave Generator

Name_____

Company_____

Street_____

City_____ Zone_____ State_____

Complete Coverage, Highest Quality

Want more information? Use post card on last page.

24-hour service on SINTERED ALNICO MAGNETS ..from stock

Indiana Sintered Permanent Magnets are available for your development work in dozens of *standard* sizes and shapes.

Fast, 24-hour shipment on Sintered Alnico II Magnets can be made *from stock*. Sintered permanent magnets are also available, on special order, in Alnico grades IV, V, and VI.

For a complete assortment of sizes and shapes to choose from, write for 12-page Sintered Catalog No.12-A11. Or, if you're not sure what type of magnet or grade of material to use, consult Indiana's engineers for their recommendations, without obligation, of course. Their 47 years of experience in designing magnets for some 40,000 designs is your assurance that the most efficient and economical magnet is chosen for your product.

INDIANA PERMANENT MAGNETS

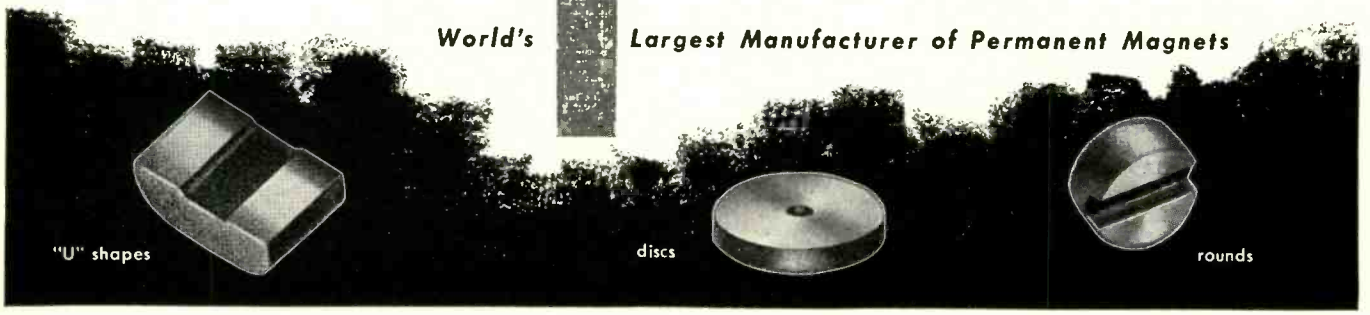
THE INDIANA STEEL PRODUCTS COMPANY
VALPARAISO, INDIANA

World's Largest Manufacturer of Permanent Magnets

Sintered Alnico

PROPERTIES	ALNICO II*	ALNICO IV	ALNICO V	ALNICO VI
Residual induction (minimum) Br Gausses	6900	5200	10500	8800
Coercive force (minimum) Hc Oersteds	520	700	600	780
Energy product (minimum) BdHd max x 10°	1.45	1.2	3.5	3.0
Peak magnetizing force—Oersteds	2000	3000	3000	3000
Weight—lb/cu. in. Mechanical properties	.249 Hard	.250 Hard	.260 Hard-brittle	.260 Hard-brittle

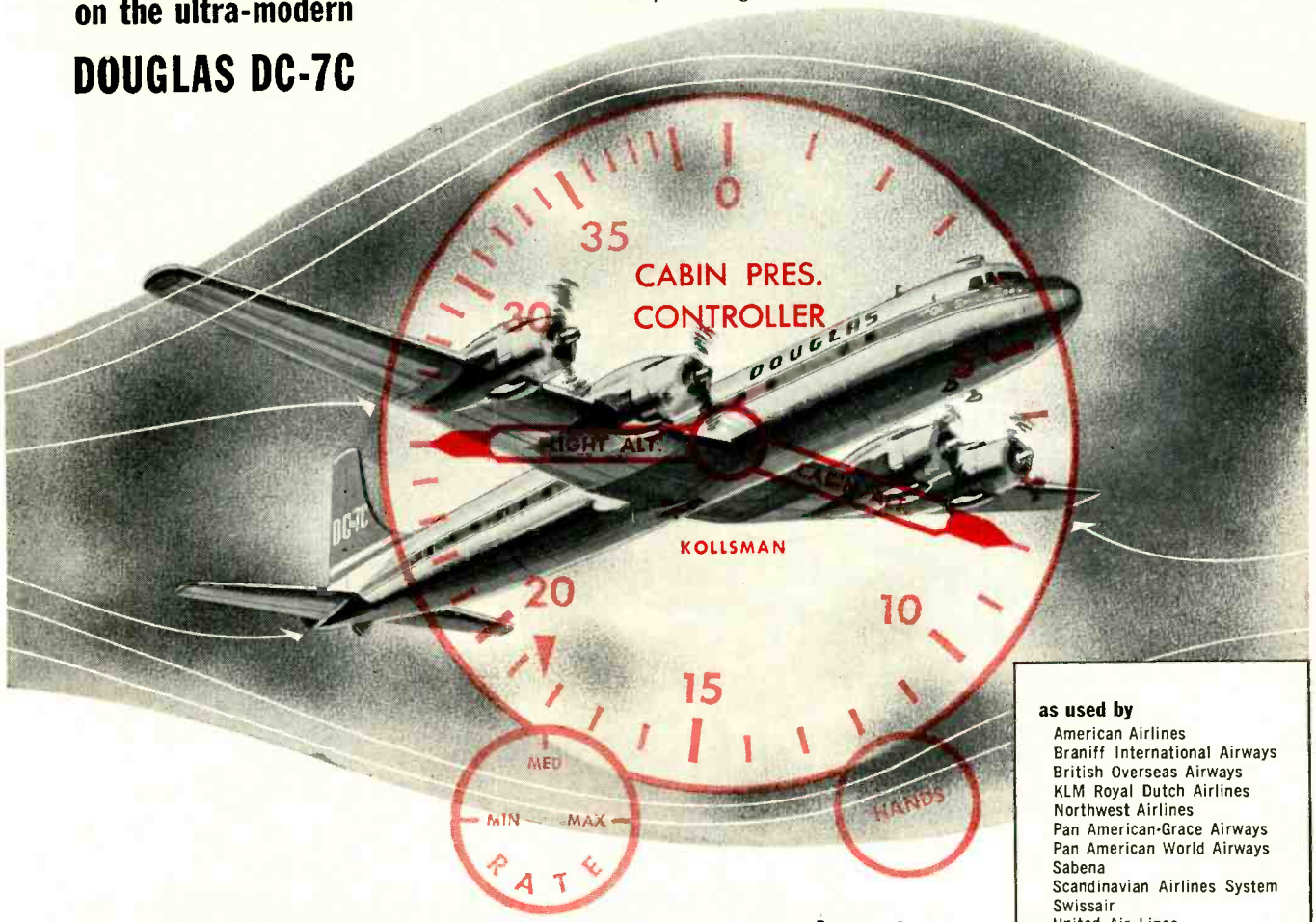
*Alnico II only, available from stock.



BENEFITS NEVER BEFORE POSSIBLE

- **no annoying ear-popping**
- **simple controls — automatic, reliable**
- **far less maintenance**
  No sensor contacts or filters to clean.
- **completely electrical**
  No complex tubing.
- **lower cost**
- **lighter weight**
  As much as 60% lighter!
- **easily retrofitted in any existing aircraft**
- **particularly adaptable to future high performance air transports**

STANDARD... on the ultra-modern DOUGLAS DC-7C



as used by
American Airlines
Braniff International Airways
British Overseas Airways
KLM Royal Dutch Airlines
Northwest Airlines
Pan American-Grace Airways
Pan American World Airways
Sabena
Scandinavian Airlines System
Swissair
United Air Lines
Western Air Lines

new KOLLSMAN KS-54 cabin pressure control system

DOUGLAS chose the new Kollsman KS-54 Cabin Pressure Control System for their new DC-7C's because of the many decided advantages it offers over the other existing systems.

LIVING-ROOM COMFORT IN THE CABIN . . . There is no annoying ear-popping because cabin pressure is held practically constant under cruising conditions. Even when cabin pressure is changing, the rate of change is so smoothly controlled that the actual change of pressure is unnoticable.

PEACE OF MIND IN THE COCKPIT . . . When the controls are set, the system is fully automatic and thoroughly reliable — especially so because of the simplicity of the Kollsman design.

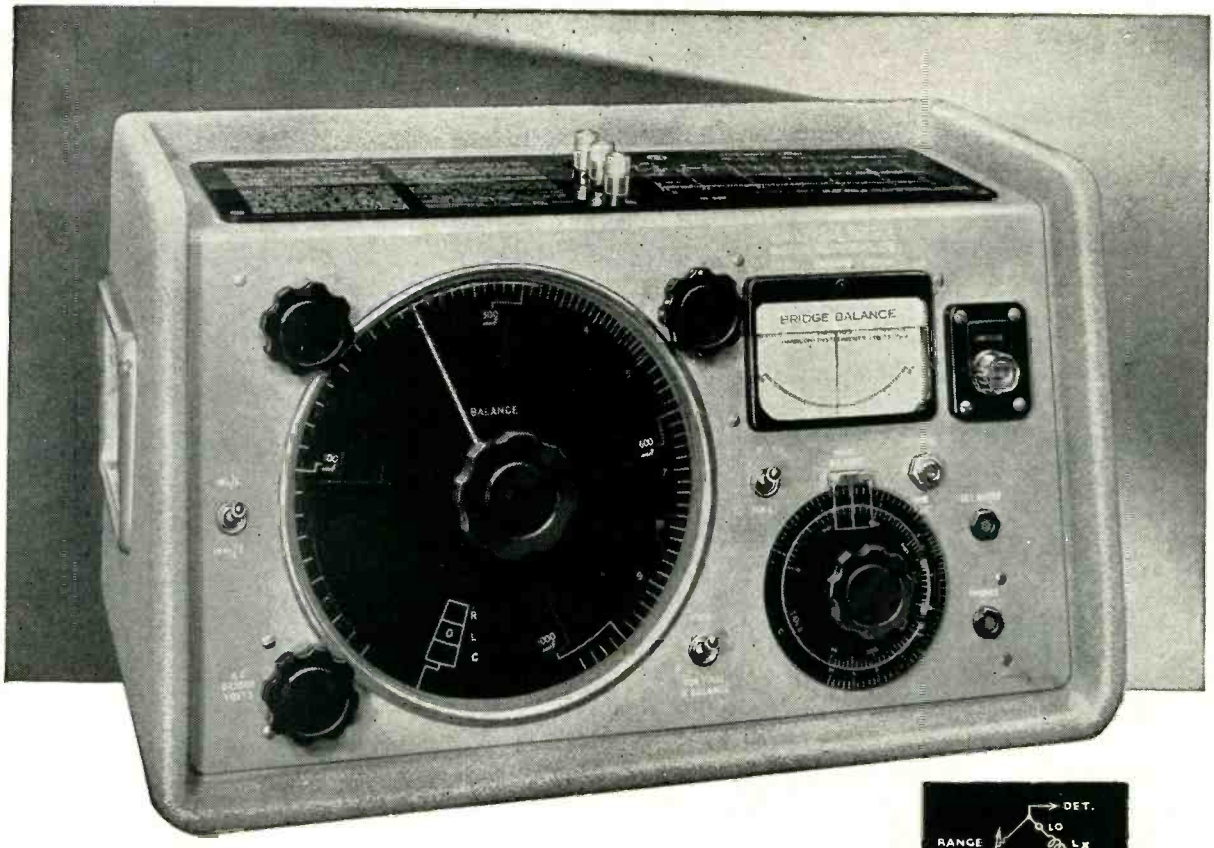
NO WORRY IN THE MAINTENANCE SHOP . . . The components are simple and rugged, proven dependable and require a minimum of maintenance. There are no sensor contacts or filters to clean, no complex tubing to worry about.

WRITE for special folder giving full technical details on the new Kollsman KS-54 System, or ask to have a sales engineer visit you.

kollsman INSTRUMENT CORPORATION

80-10A 45th AVE., ELMHURST, NEW YORK • GLENDALE, CALIFORNIA • SUBSIDIARY OF *Standard* COIL PRODUCTS CO. INC.

Want more information? Use post card on last page.

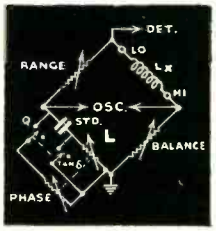


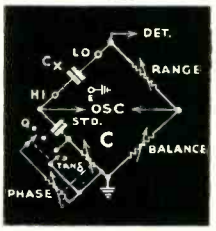
ACCURATELY MEASURED

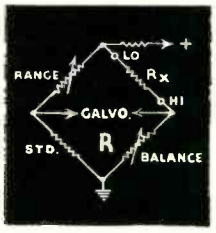
L - AT 1 OR 10 kc

C - AT 1 OR 10 kc

R - AT D.C.







INDUCTANCE, CAPACITANCE, RESISTANCE and power factor measured quickly and accurately on this self-contained and robust instrument. Its industrial-designed appearance fits well in modern surroundings and partners its outstanding electrical performance.

UNIVERSAL BRIDGE TYPE TF 868/1

Inductance from 1 μH to 100H, Capacitance from 1 $\mu\mu$F to 100 μF, and Resistance from 0.1 Ω to 10MΩ.

Single direct reading L.C.R. dial — no multiplying factors involved.

Continuously variable a.c. bridge voltage and automatic detector sensitivity control.

MARCONI INSTRUMENTS

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CANADA: CANADIAN MARCONI CO., MARCONI BUILDING, 2442 TRENTON AVENUE, MONTREAL

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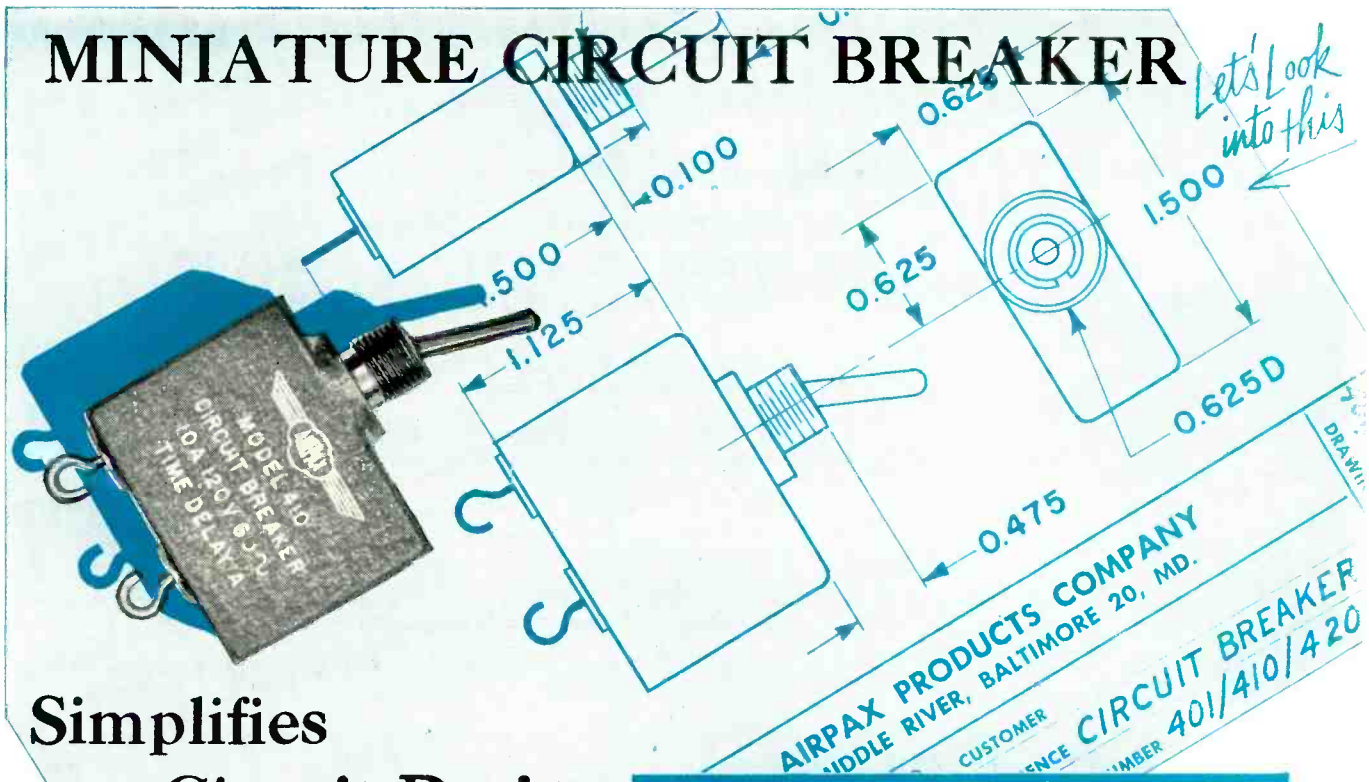
Managing Agents in Export: MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED, MARCONI HOUSE, STRAND, LONDON, W.C.2

MINIATURE CIRCUIT BREAKER



Simplifies Circuit Design

You can now perform the *two* functions of power ON-OFF control and circuit protection with *one* miniature fully magnetic time-delay trip-free circuit breaker. Save space (see diagram above); save weight (weighs less than 2 oz). The characteristics (tabulated at right) of this new Airpax component show it to be a significant advance in power control; just what you need.

Handle has ON and OFF positions; it moves to OFF position when breaker trips, yet breaker cannot be prevented from tripping by holding handle in ON position. Stable tripping mechanism assures reliable operation even under adverse temperature and vibration. Give your equipment the protection it deserves.

To restore service after fault has been removed, simply reset the breaker. A breaker having a 30-sec time delay recovers full delay in about 20 sec.

To receive complete engineering data, simply write to

CHARACTERISTICS

RATINGS: 0.05 amp to 10 amp at 50 V DC or 1.0 to 10 amp at 120 V AC

MINIMUM TRIP: 125% of rated load

INSTANTANEOUS TRIP: 1,000% of rated load

INTERRUPTING CAPACITY: a typical value is 500 amp at 30 V DC

POWER CONSUMPTION: 0.6 watt in lower current ratings, rising to about 2 watts at 10 amp rating

SHOCK: resists 50 g in all directions

VIBRATION: 10 to 55 CPS at 0.06 in. total excursion in all directions

TEMPERATURE: −40 C to +100 C

LIFE: 10,000 operations at rated current into resistive load

ENCLOSURE: hermetically sealed

AIRPAX

ENGINEERS DESIGNERS

MIDDLE RIVER BALTIMORE 20, MD

Completely Insulated for stability under long, hard operating conditions

There's nothing else like

ISO-KAP*

Centralab's New Molded Disc Ceramic Capacitor

Actual Size

Only one of its kind! The only molded, *completely* insulated, ceramic disc capacitor. Breakdown to ground in excess of 3000 V.D.C.

Strong! Unaffected by extremes of vibration; by ozone, salt water, or any known acid or solvent at room temperature.

Accurate! Thickness, diameter, and lead spacing are always exact. And leads are always on perfect center line—never offset. The answer for automatic assembly.

Dependable! New basic ceramic body. Capacitance characteristics are virtually flat over a wide temperature range.

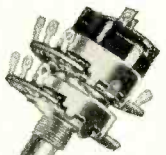
Leads can't pull out! Lead strength is greater than the tensile strength of No. 22 wire.

Clearly labeled! Stamped with capacity, voltage rating, and tolerance.

Write for engineering bulletin EP-48, for facts and figures on Iso-Kap.

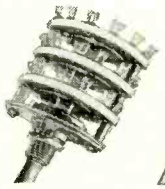
More proof that if it's a job for electronic components, it's a job for Centralab

Centralab's advanced engineering continues to create the prototypes of the components industry

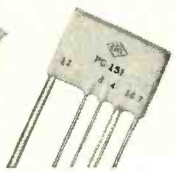


CONTROLS

CERAMIC CAPACITORS

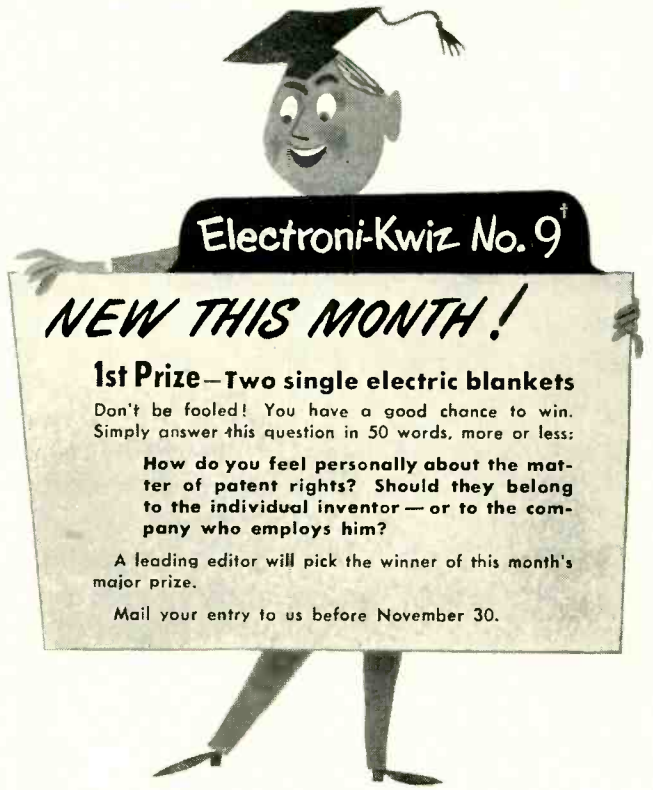


SWITCHES



PACKAGED ELECTRONIC CIRCUITS

STEATITE INSULATORS



†Nothing to buy. Employees of Centralab and their advertising agency not eligible. Duplicate prizes awarded in case of tie. Entries become the property of Centralab—none can be returned.

D-5512

Centralab

A DIVISION OF GLOBE-UNION INC.

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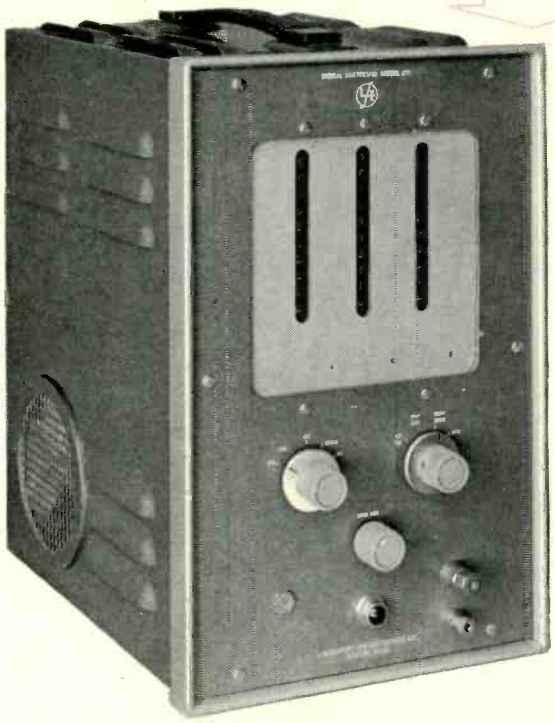
In Canada: 804 Mt. Pleasant Road, Toronto, Ontario

*Trademark

SINCE 1922, INDUSTRY'S GREATEST SOURCE OF STANDARD AND SPECIAL ELECTRONIC COMPONENTS

2 TWO NEW PRODUCTS JOIN THE LFE FAMILY!

503



LFE MODEL 503

ELECTRONIC DIGITAL MULTITESTER

The 503 — a new type of electronic Multitester — presents display digitally — uses electronic counters.

Unique Model 503 uses three decade columns of neon lights for the indication — gives *absolute* readings — *eliminates* problems of parallax and ambiguity.

Rugged Model 503 is precise — dependable — lightweight.

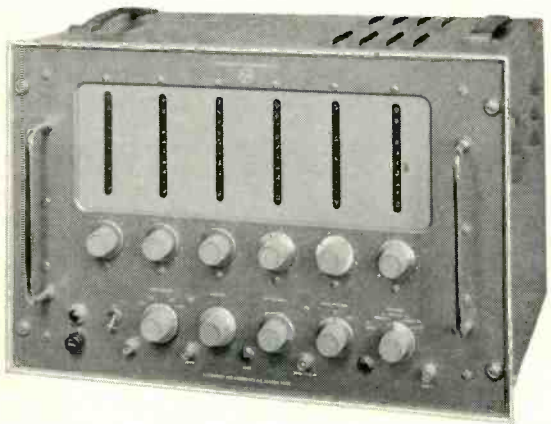
And—the skill is in the instrument—so almost anyone can use it—confidently—efficiently—in shop or laboratory!

A PREDETERMINED

COUNTER OF HIGH-SPEED VERSATILITY!

The "genius" of the LFE 502 lies in its ability not only to count a predetermined number of impulses, but also to use these pulses for control. So, when you buy the 502, you're buying both a Predetermined Counter and a control device in one compact instrumen. Automatic sorting and packaging, control of motor speeds or machine tools, generation of precision delays, interval measurements — whatever counting and controlling task you assign the LFE 502, you can depend on this accurate, dependable, high-speed instrument to give you perfect satisfaction.

For specifications and more details about these new instruments, write for our free informative bulletins and the name of the LFE Engineering Representative nearest you. Inquiries on export sales should be addressed to: Andrew S. Szucs, Inc., 50 Broad St., New York 4, N. Y.



502

L/E

LABORATORY FOR ELECTRONICS, INC.

75 Pitts Street, Boston 14, Mass.

Dr. R. G. Hutter, manager of Sylvania's Physics Research Laboratories, under whose direction basic research in traveling wave tubes is carried on, discussing problems with engineer R. I. Harrison. Dr. Hutter is holding a Sylvania low level 2000-4000 mc amplifier tube in his hands.

When Sylvania started out on a traveling wave tube program, their research engineers specified PRD test equipment. High quality was an important factor in their choice. In addition, they wanted a line of test equipment covering a wide frequency range to take care of future developments in higher frequencies.

If you, like Sylvania, are pushing to higher frequencies, you will be interested in PRD's full coverage and especally in the –

PRD MILLIMETER WAVEGUIDE TEST EQUIPMENT

Why? Because: 1. Precision really counts with millimeter equipment
2. PRD has pioneering experience in this field
3. The equipment is available *now*.

Write for Complete Catalog A

Polytechnic RESEARCH & DEVELOPMENT CO., INC.

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Telephone: ULster 2-6800

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737-41, SUITE 7, NO. SEWARD STREET, HOLLYWOOD 38, CAL. – HO 5-5287

versatile

Multi-channel -- telegraph A1 or telephone A3.

FROM GROUND TO AIR OR POINT TO POINT

STABLE

High stability (.003%) under normal operating conditions.

RUGGED

Components conservatively rated. Completely tropicalized.

Model 446 transmitter operates on 4 crystal-controlled frequencies (plus 2 closely spaced frequencies) in the band 2.5-24.0 Mcs (1.6-2.5 Mcs available). Operates on one frequency at a time; channeling time 2 seconds. Carrier power 350 watts, A1 or A3. Stability .003%. Operates in ambient –35° to 45°C. Nominal 220 volt, 50/60 cycle supply. Conservatively rated, sturdily constructed. Complete technical data on request.

Here's the ideal general-purpose high-frequency transmitter! Model 446... 4-channel, 6-frequency, medium power, high stability. Suitable for point-to-point or ground-to-air communication. Can be remotely located from operating position. Co-axial fitting to accept frequency shift signals.

AER -O- COM

3090 DOUGLAS ROAD MIAMI 33, FLA.

speaking of TV Quality...
HERE'S HOW TO GET MORE
at LESS COST!

A Stackpole Ceramagnet ring 3⅛" in diameter by ½" thick forms the "heart" of this efficient, magnetic focusing unit produced by Glaser-Steers Corporation, Belleville, N. J. The entire unit weighs less than 13 ounces. Quick, accurate focusing is obtained with simplified gear arrangement.

FROM A COST STANDPOINT, magnetic focusing of television picture tubes paves the way to important cost savings by comparison with electrostatic tube focusing methods. In actual instances, material savings alone have run from 50c to $1.

FROM A DESIGN STANDPOINT, magnetic focusing lends itself well to the trend toward increased second anode voltages.

FROM A PRODUCTION STANDPOINT, the predictable higher quality of magnetic tubes reduces incoming inspection costs. Factory focusing of sets is done in less time with less skilled labor.

FROM A PERFORMANCE STANDPOINT, magnetic focusing quality is generally superior, more stable, and more effective over the entire face of large tubes. Focusing is less affected by voltage changes. When tube replacement becomes necessary, servicing adjustment is a relatively simple matter.

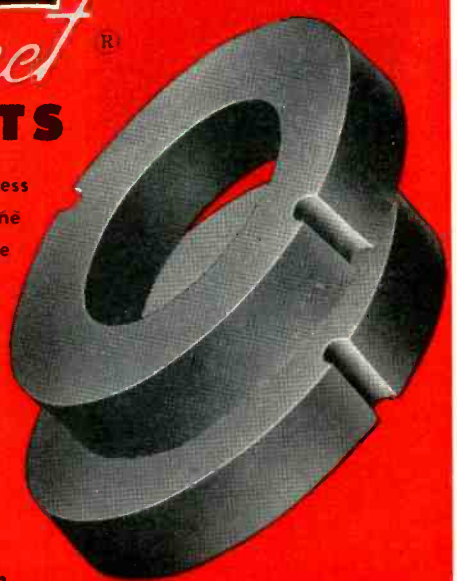
STACKPOLE Ceramagnet®

CERAMIC MAGNETS

Magnetic picture tube focusing is but one of countless jobs, both electrical and mechanical, that can be done better and at less cost with this unique new Stackpole ceramic magnetic material.

Ceramagnet is highly uniform, powerful and permanent. Available in almost any shape or size, it opens important new engineering horizons wherever dependable, low cost magnetic attraction, repelling or even "cushioning" may be utilized.

Send details of your application for recommendations and Ceramagnet samples.

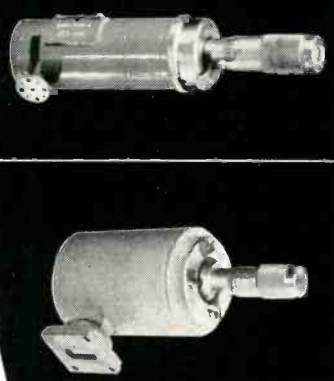


Electronic Components Division

STACKPOLE CARBON COMPANY, St. Marys, Pa.

new D-B broad band precision cavity wavemeters

—*solve 3 measuring problems*



Fewer Instruments Needed. Each DE MORNAY-BONARDI instrument covers an unusually wide segment of the total range, and measures the entire frequency band within that range. Only eleven sizes serve from 2.6 KMC to 90 KMC. You save capital outlay on the number of sizes needed.

Extremely High Accuracy. These are high Q units, built with such precision that they may be used as secondary standards to calibrate all other laboratory cavities. Micrometer readings are plotted on a multi-page, high resolution calibration chart for maximum accuracy. DE MORNAY-BONARDI units are temperature compensated, and unaffected by changes in humidity or atmospheric pressure.

Sustained Accuracy. Sturdy, sealed construction, use of ball bearings, and inert gas pressurization assure permanence of calibration... Q values maintained for many years without service. Write for complete data.

SPECIFICATIONS

Temperature Range	−30°C. to +70°C.
Correction Factor	Temperature correction over range in the order of 10^{-6} f/deg.C.
Temperature Compensation	Bi-metallic mechanism
Constant Dielectric	Nitrogen – not affected by environment
Hermetic Waveguide Seal	Metal – glass – mica window
Tuning Plunger Seal	Bellows type
Spurious Mode Suppression	Thru use of Microllon absorbing material
High Resolution Micrometer	Resolves plunger travel into 0.0001".

REACTION* TYPE CAVITY WAVEMETERS

Calibrated Freq. Band KMC	Calibration Accuracy Min ± MC	Cat. No.	Price
60-90	40	DBA-715-1	$460
50-75	30	DBB-715-1	460
33-50	10	DBC-715-1	460
26.5-40	6	DBD-715-1	460
18-26.5	3	DBE-715-1	460
12.4-18	1.5	DBF-715-1	430
8.2-12.4	0.75	DBG-715-1	415
7.05-10	0.60	DBH-715-1	450
5.85-8.2	0.35	DBJ-715-1	485
3.95-5.85	0.15	DBK-715-1	530
2.6-3.95	0.075	DBL-715-1	735

**Note: Absorption and Transmission types also in stock*

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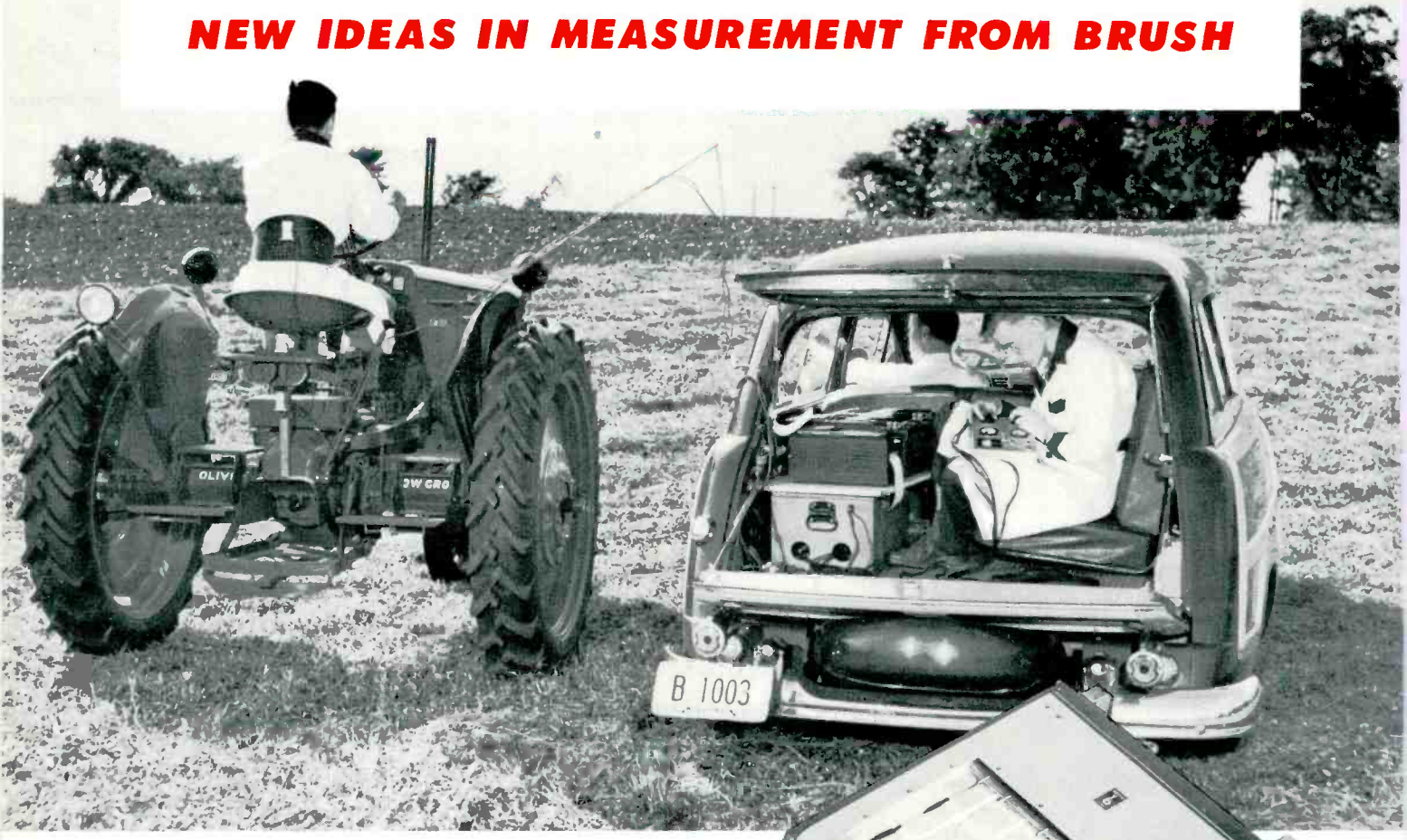
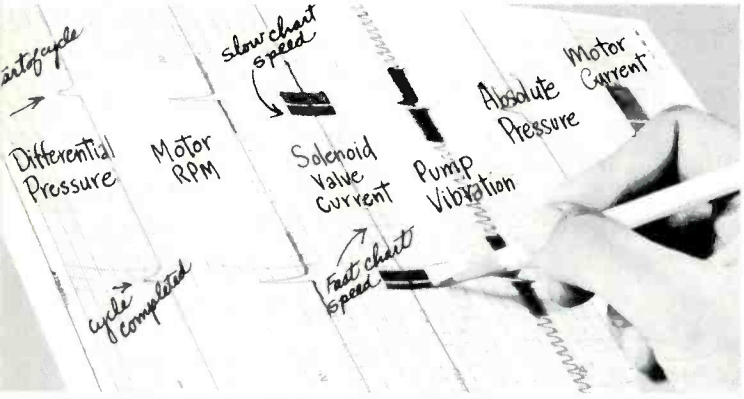


More and More Engineers are checking performance of equipment in the field thanks to new portable instruments by Brush. Here operating data is recorded from vibration pickups on a tractor and on a driver's back. Brush Portable Instruments are lightweight, easy to use and designed for rugged use. Ideal for recording stress, strain, force, vibration, torque, pressure, electrical variables and other physical characteristics.



Gets more answers. Typical chart recording from a test on a pump system shows the wealth of information obtained by Brush Systems. Charts can be driven at many different speeds to obtain optimum clarity and economy. Chart drive is electrically controlled, thus speed can be changed instantaneously from local or remote locations.

Helps in "sound" design. Where sound or vibration is a problem you can obtain complete vital data with the new Brush Third-Octave Spectrum Recorder, coupled with either the measurement microphone or broad band accelerometer. This system provides a complete frequency and noise level analysis in third-octave bands from 35 cycles to 18,000 cycles per second and automatically plots entire analysis data.

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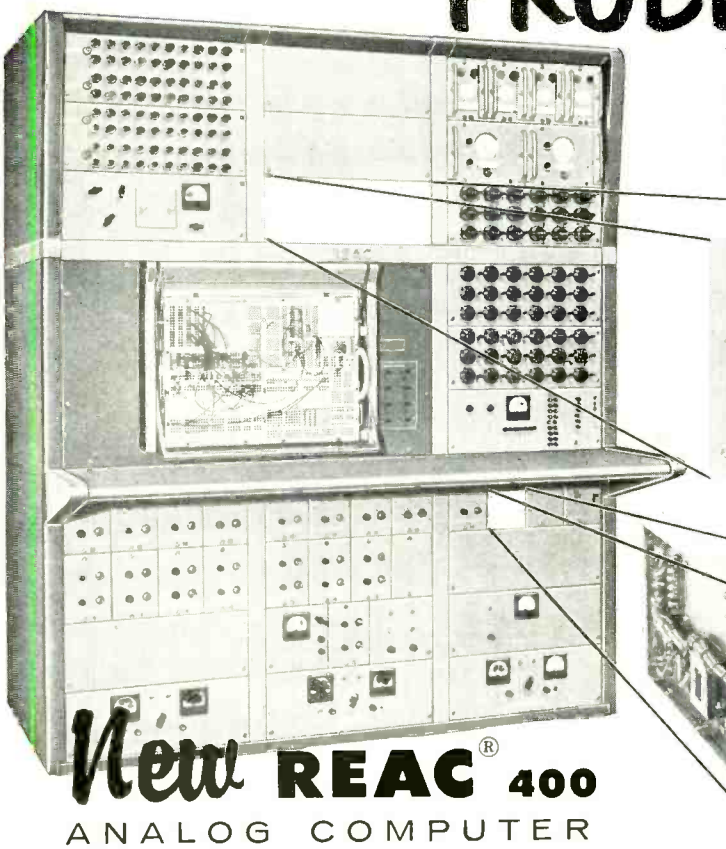
Call BRUSH for the answer!

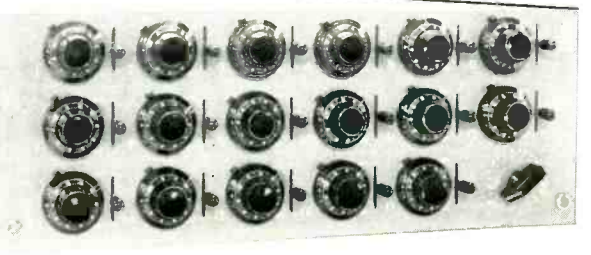
For help in your measurement problems, call your nearby Brush representative, or write Brush Electronics Company, Department 8, 3405 Perkins Avenue, Cleveland 14, Ohio. Your request will receive prompt attention!

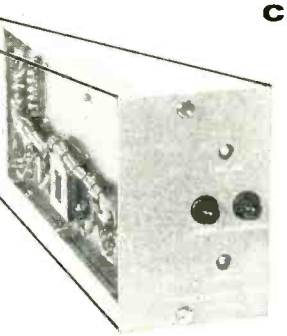
PROBLEM CHECK*

*Patent Pending

new REEVES development permits verification of problem set-up before a problem is run







New REAC® 400
ANALOG COMPUTER

CHECKS:

- ★ Diagramming of the problem from the equation.
- ★ Patching of the problem from the diagram.
- ★ Operation of all computer components to be used.

It's the only economical way...

Prepatch boards are, of course, prepared away from the machine. "Problem Check" means that only an absolute minimum of time is required on the machine to check the problem set-up in its entirety. A great deal of expensive checking and cross-checking while the problem is on the machine is thereby eliminated.

"Problem Check" is a new method developed by Reeves to verify analog computer circuits **without disturbing the problem set-up.** Checking is done directly from the equation **before** the problem is run, and the operation of every computing element is checked. Further, if the output of any computing element is not correct, the location of the difficulty is indicated, and the trouble can be quickly and easily found. After "Problem Check," runs may be taken on the machine with assurance that the set-up is correct and that the machine is functioning properly.

REVIEW THESE OUTSTANDING REAC® 400 FEATURES

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Servo multipliers have bandwidth over 50 cps. Velocity 1500 v/sec. Six gang pots; two tapped with front panel plug-in turrets for function generation.

New HIGH SPEED RESOLVERS
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New BUILDING-BLOCK CONSTRUCTION
Permits assembly of computer elements in any desired combination to do particular job or expand existing installation. Completely adaptable to your specific requirements.

New CONVENIENT PATCHBAY
Available in units of 1632, 3264 or 4896 holes for maximum flexibility. Color-coded mask aids in patching. Patchboard changes possible during operation.

New POWERFUL AMPLIFIERS
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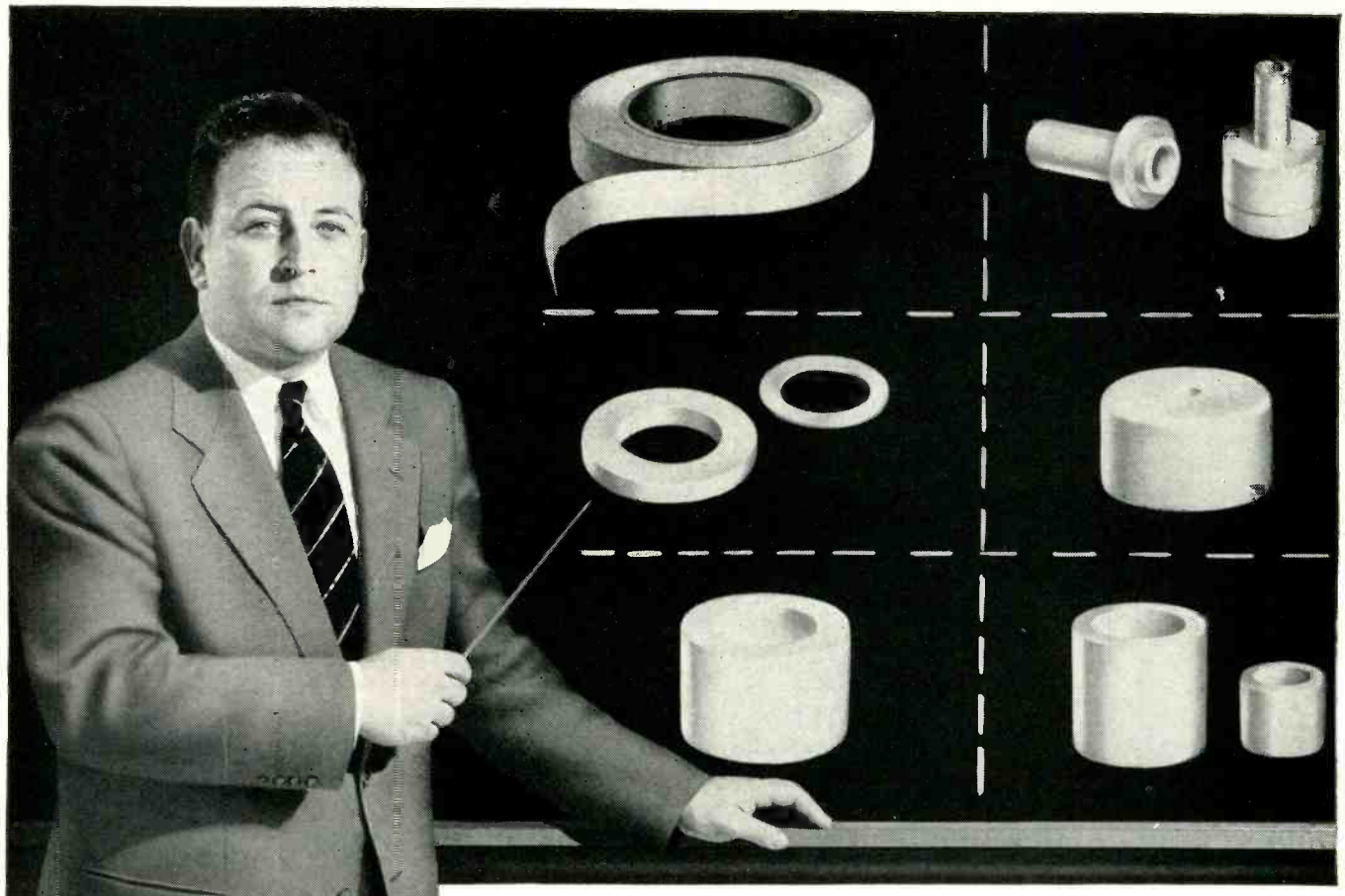

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R/M "TEFLON" is blazing many trails that few people thought would ever open up. Daily it is instrumental in improving old products and processes, in developing new ones, and in effecting unheard-of economies. In the form of tape and other component parts, R/M "TEFLON" has already licked many electrical and electronics problems once thought unsolvable. So turn to R/M if you have a problem that "TEFLON" might possibly solve. We can fabricate to your specifications or supply you with "TEFLON" in the form of rods, sheets, tubes or tape. For complete information, write today.

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NATVAR 400 means this Stator is SET FOR *LONG* LIFE

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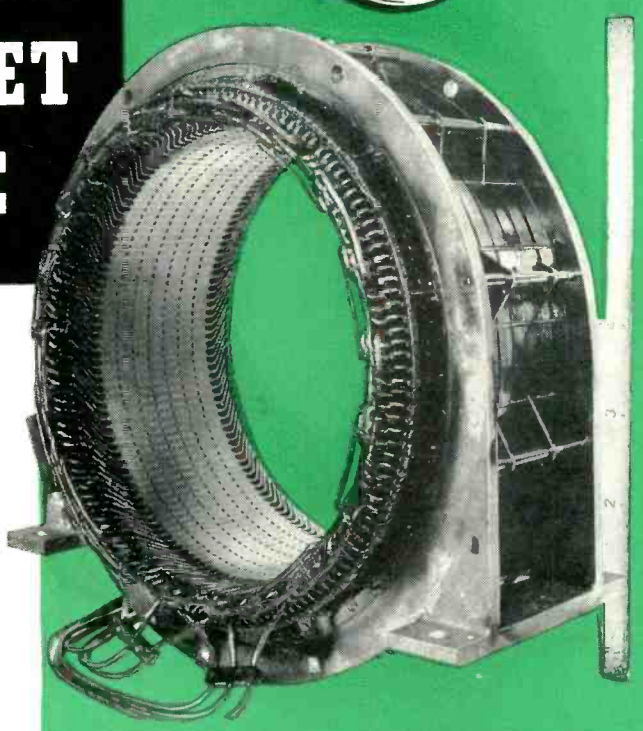
If reliability is important to you, it will pay you to use Natvar flexible insulations. They are dependably uniform no matter when or where purchased, and are immediately available either from your wholesaler's stock or direct from our own.



Stator showing open slot construction of the Fairbanks-Morse Type TGZO Alternator, 1405 kva — 300 r.p.m. — 3 phase —60 cycle — 2400/4160 volts — 80% p.f. — for direct connection to a diesel or dual-fuel engine, for utility, municipal and industrial power generation. Since they are frequently subjected to prolonged overloads in this type of service, they are designed for 50°C temperature rise above 40°C ambient. Coils, insulated and protected with "Natvar 400" extruded tape are tested at 9320 volts for one minute.

Two form wound coils for a Fairbanks-Morse 4160 volt Alternator. Lower coil has end sections insulated with "Natvar 400" extruded tape. Slot section is wound with a sacrifice tape, which is later removed and entire coil is wound with linen tape. Upper view of coil shows completed form, after final varnish dip and bake, ready for insertion in stator.

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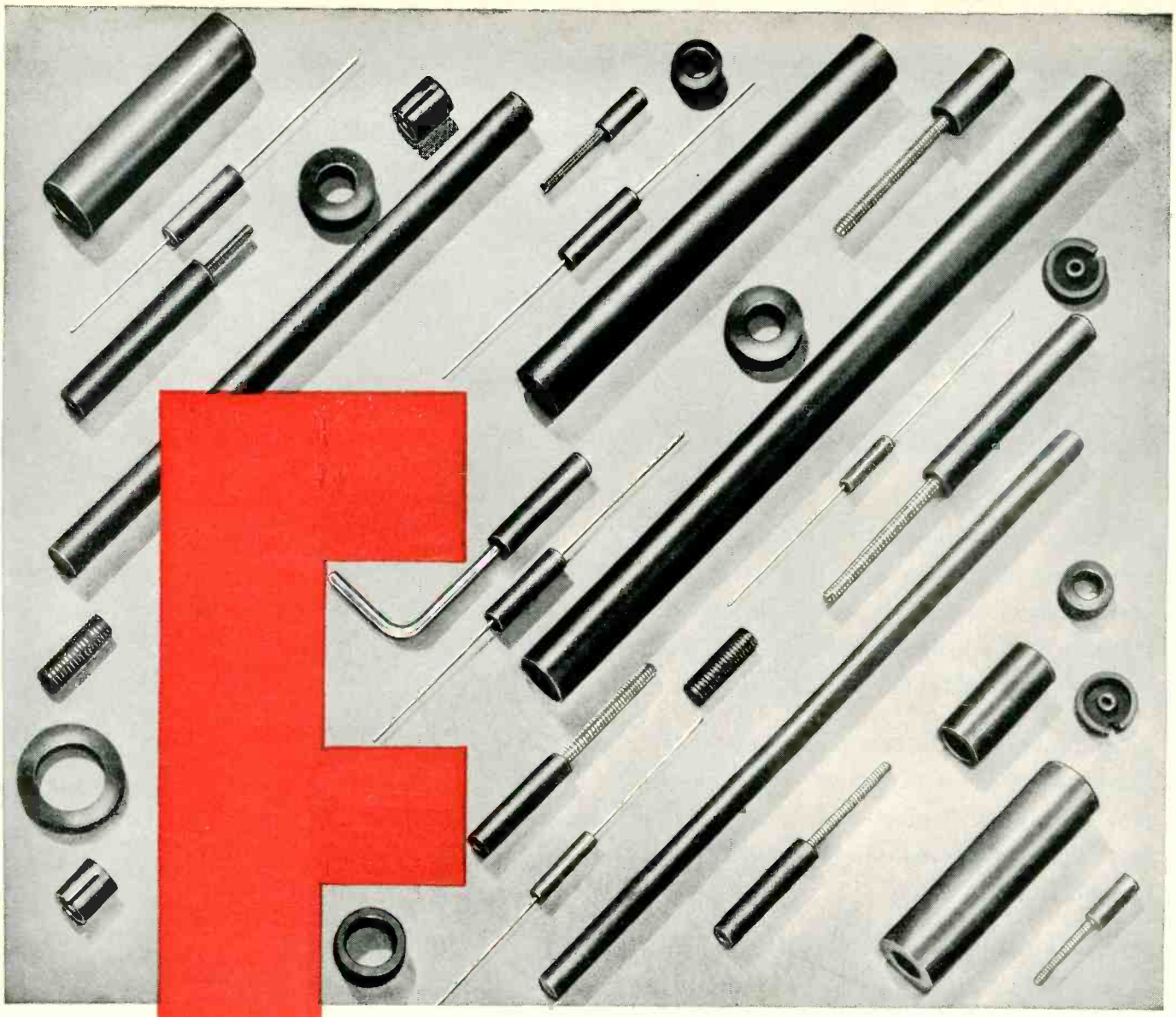

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Automation Creates Jobs For Workers With Skills

There is new and reassuring information for those who fear that "automation" — the control of machines by machines — will mean fewer job opportunities. It comes from a special survey of 1,574 companies in metalworking industries recently completed by AMERICAN MACHINIST, a McGraw-Hill publication. More than one-fifth of the companies reported that they already have automatic loading, transfer or assembly machinery in operation. In these companies as a whole there has been a net increase in total employment since this machinery was installed.

According to the AMERICAN MACHINIST survey, of these companies with actual experience in automation

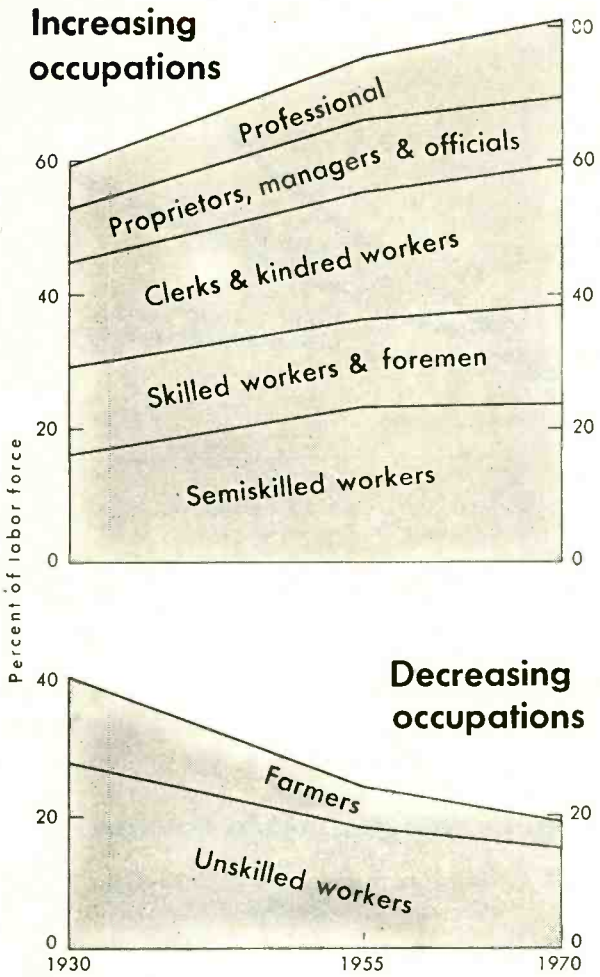
- 26% reported increases in employment averaging 21%
- 51% reported no change in total employment
- 23% reported decreases in employment averaging 16%

More Jobs for the Skilled

Of greater significance, however, is the response by 40% of these companies that they required more skilled maintenance men and by 21% of the companies that they had increased their engineering staffs. This indicates that automation is strengthening a trend already evident in the United States, a trend of expanding opportunity for those with industrial and professional skills and, relatively, of contracting opportunity for the unskilled.

The following chart shows how strong this trend has been over the past 25 years and how strong it may be expected to be over the next 15 years.

There has been a sharp decline in the percentage of unskilled workers in the nation's labor force and a corresponding increase in the percentage of those with varying degrees of skill.

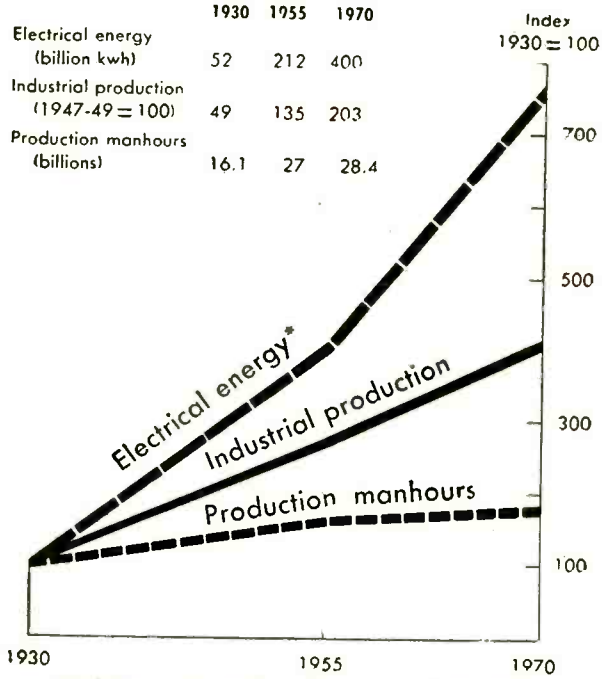


It is possible, of course, to cite cases of individuals and groups that do not conform to the charted trends. Farmers, for example, are becoming at the same time more skilled and less numerous. But this does not upset the broad proposition that opportunities are increasing for those who have skills.

Power and Production

Much of the basic explanation for the relative expansion of opportunities for those with industrial and professional skills lies in the increasing use of power-driven machinery. This has made possible a vastly greater increase in manufacturing production than in the manhours of human labor devoted to it. The following chart shows the relative increases in electrical energy and manhours of labor used in manufacturing since 1930 and the rise in industrial production.

	1930	1955	1970
Electrical energy (billion kwh)	52	212	400
Industrial production (1947-49 = 100)	49	135	203
Production manhours (billions)	16.1	27	28.4

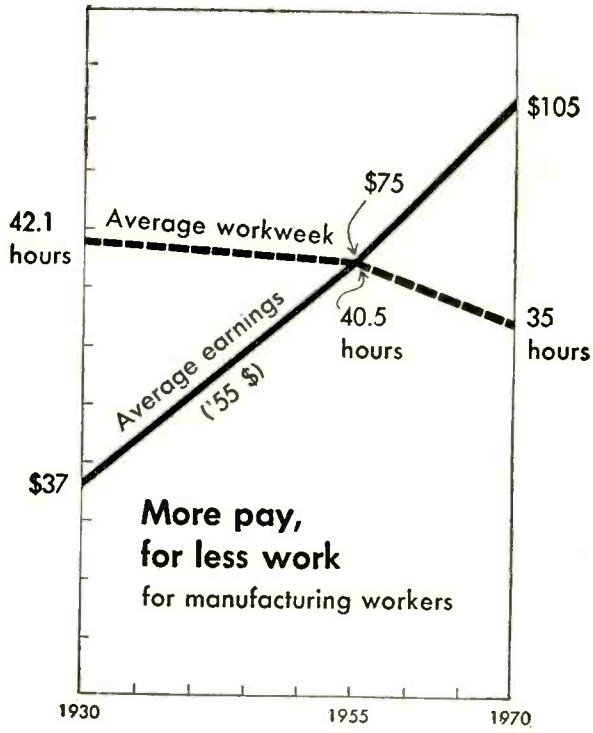


*Excludes power used in aluminum and magnesium reduction, both very heavy power users.

Power-driven machines have reduced the amount of human energy required for physical labor, but they have increased the need for skillful handling and maintenance. As the AMERICAN MACHINIST survey demonstrates, the same is true of automatically controlled machinery.

Higher Wages, More Leisure

The rising average wage of American industrial workers and the decline in hours per week that they must work reflect directly the extent to which the increase in industrial production has outstripped the manhours devoted to it. The final chart shows the increase in weekly wages (in dollars of constant purchasing power) and the decrease in the average workweek in manufacturing since 1930. It also shows the changes that may come in the next 15 years if present trends continue.



There are some who would slow what an earlier editorial in this series characterized as "the continuing process of taking dull and laborious work off the backs and minds of men and transferring it to machines operating in large batteries under automatic control." In doing so, they might make the world safer for those with no skill. The far more constructive course is to welcome the expanding opportunities now being provided and be sure that the nation's young people, who are now starting another school year, are prepared to take advantage of them.

This message is one of a series prepared by the McGraw-Hill Department of Economics to help increase public knowledge and understanding of important nationwide developments that are of particular concern to the business and professional community served by our industrial and technical publications.

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Donald C. McGraw

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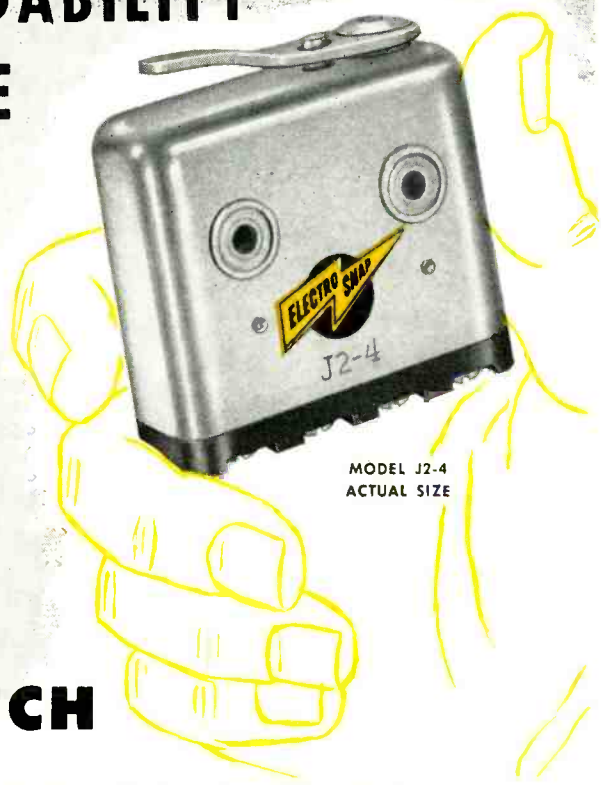

MODEL J2-4
ACTUAL SIZE

New ELECTRO SNAP

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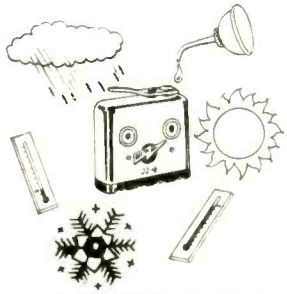
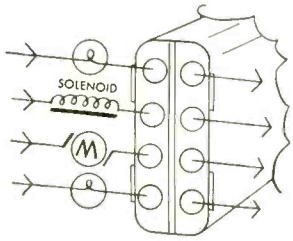
Seals Out Moisture, Dirt, Oil, Corrosion, Condensation from Temperature Cycling



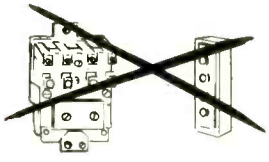
With switch mechanism hermetically-sealed in a dry, inert gas, switch is dependable at any altitude, moisture or temperature condition. Use it on aircraft, machines where oil is a problem, in areas subject to freezing or extreme heat or corrosive atmospheres.

Controls FOUR Circuits with ONE Snap



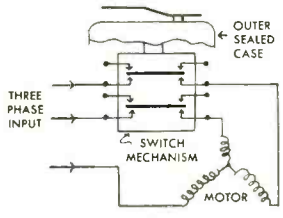
Eight separate contacts and terminals permit many unusual circuit combinations. May be wired externally for D.P.D.T., 2 circuit; D.P.S.T., normally open; D.P.S.T., normally closed. Movable poles may also be wired externally in series to increase current capacity of switch or number of contact breaks for high voltage switching.

Eliminates Expensive and Bulky Relays, Extra Switches



J2-4 can control circuit combinations that were formerly possible only with complicated relays or a number of separate switches. Saves money, weight and space.

Starts, Stops or Reverses Three-Phase Motors



Simultaneous action of two movable poles permits switch to break or reverse current flow through two windings of a three-phase motor. Movable poles are interlocked by unique design of switching mechanism, eliminating need of adjustment.

SPECIFICATIONS

Electrical Rating—10 amps @ 125/250v AC/ 30v DC Ind.

Operating Force—2½ lbs.

Weight—2½ oz. (4 oz. with actuator)

TOGGLE ACTUATOR

(constant or momentary contact) can be furnished on switch. Fits AN-type toggle switch mountings.

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Attention HJN-11 • 4220 Lake Street, Chicago 24

Please send full information on new J2-4 Hermetically-Sealed Simultaneous Double-Pole Switch.

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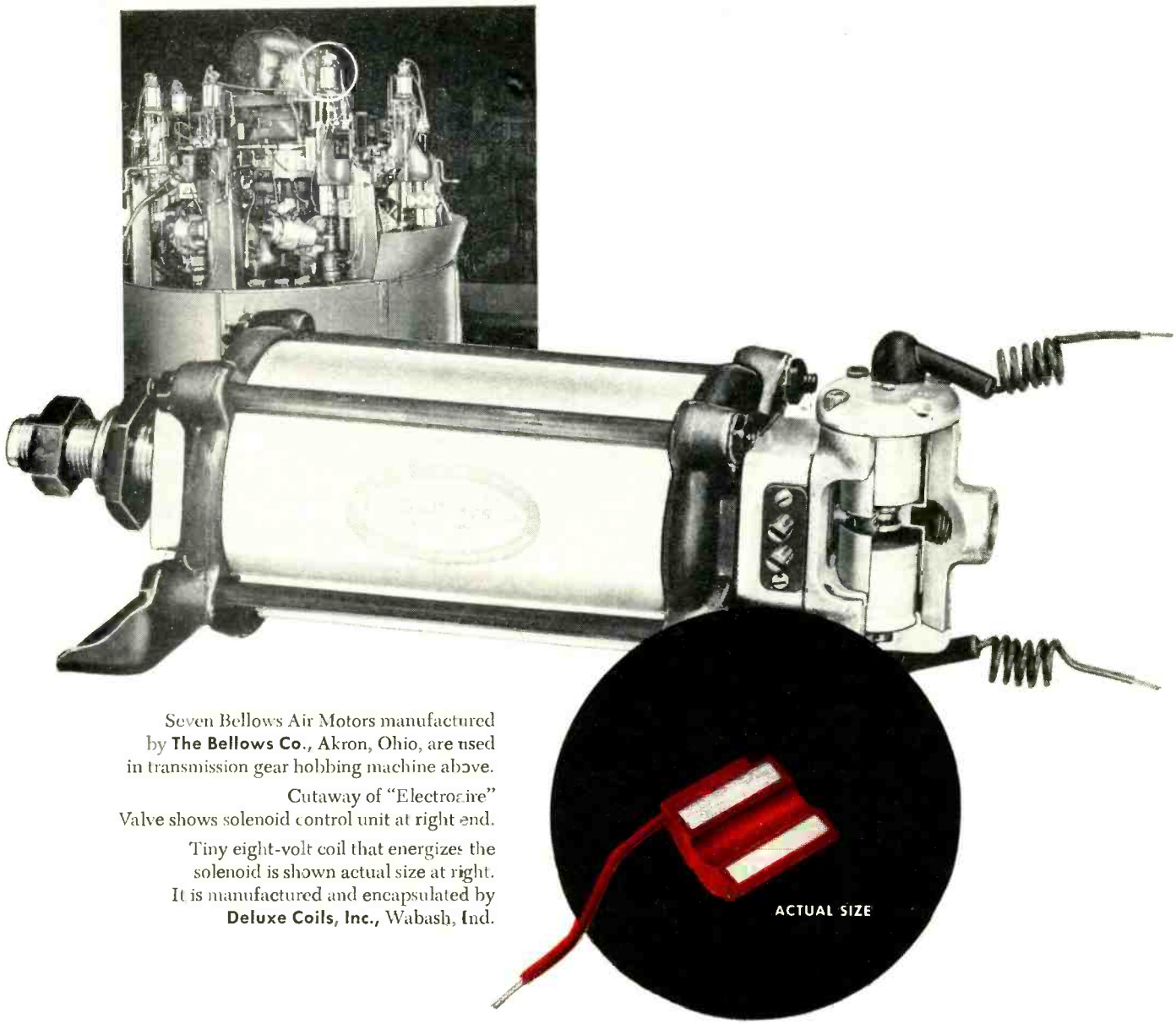

Seven Bellows Air Motors manufactured by **The Bellows Co.**, Akron, Ohio, are used in transmission gear hobbing machine above.

Cutaway of "Electrofire" Valve shows solenoid control unit at right end.

Tiny eight-volt coil that energizes the solenoid is shown actual size at right. It is manufactured and encapsulated by **Deluxe Coils, Inc.**, Wabash, Ind.

Solenoid coils encased in BAKELITE Epoxy Resin rack up 50,000,000 cycle service record!

Heart of this Bellows Air Motor is a unique 4-way directional valve which is air-powered but electrically controlled. Two built-in solenoid control units act as "triggers" to release and direct the air pressure.

Completely enclosing and sealing these solenoid coils in BAKELITE Brand Epoxy Resin makes them durable and trouble-free. The manufacturer guarantees them against burnout, states that operating records of 50,000,000 cycles or more without maintenance are quite common!

BAKELITE Epoxy Resins—available in many different types—are widely used for potting and encapsulating. They resist moisture, oils, grease, chemicals, and most acids and alkalies. Easily poured as a liquid, they cure at room or moderately elevated temperatures. Their dielectric and adhesive properties are excellent. For more specific information and a list of suppliers, write today to Department KN-50.

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BY Greenleaf

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HIG-4 GYRO

DATA

1. Spin Motor: 12 Volts A.C., 400 cps, 2 phase
2. Power Required: Running 1.5 Watts—Start 2.2 Watts
3. Run-up Time: 15 Seconds Maximum
4. Angular Momentum: 10^4 Gram-Centimeter^2/second
5. Gimbal Travel: ± 5° Maximum
6. Signal Generator Sensitivity: 10 mv/mr, with 55 m/a, 400 cps
7. Signal Generator Linearity Deviation: ± 1%
8. Torque Generator Linearity Deviation: Less than 1%
9. Input Rate: 4 Radians/second Maximum
10. Drift Rate: 1° per hour maximum
11. Weight: 1.5 pounds

NOTE: *This Gyro can be readily modified to meet your requirements. We invite inquiries listing specifications.*

The Greenleaf Line of Gyros and associated devices is being steadily expanded. It now includes a wide selection of Free and Rate Gyros, and the HIG-3 and HIG-4 Gyros.

Write, wire or phone for further information.

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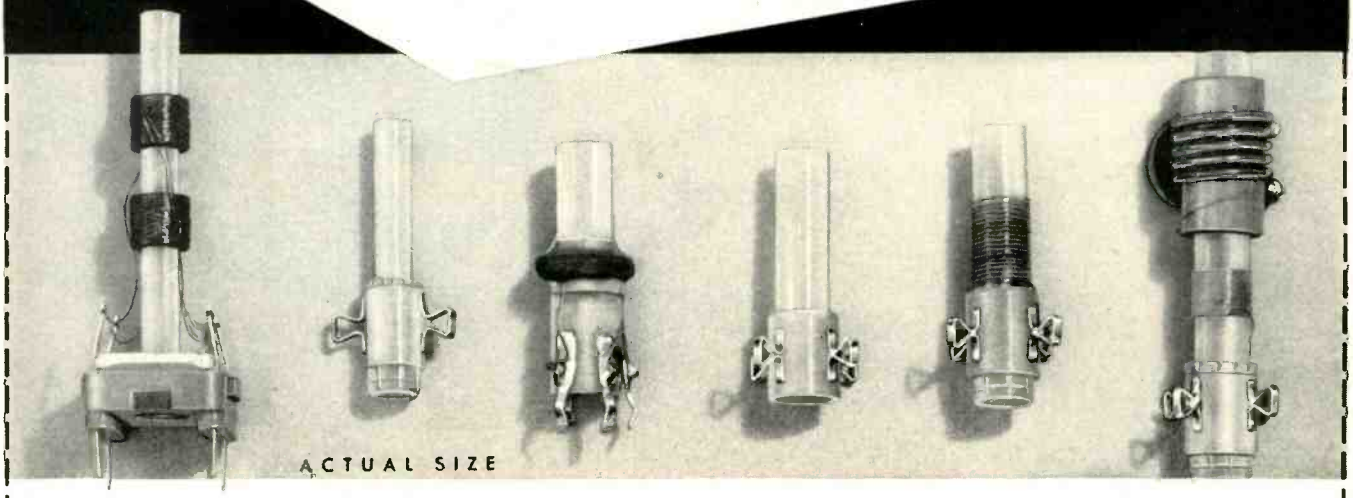
(patents pending)



LOW COST because they are ONE-PIECE precision molded forms of high temperature plastic, eliminating the usual high cost assembly operations in conventional phenolic forms. No mounting clips are required with RI-lon SNAP-IN keyed design! (Interchangeable with present clip-mounting methods.)

PLUS these superior electrical and mechanical features!

1. Resists electrolysis indefinitely.
2. Has uniform mechanical characteristics.
3. Simplifies components for automatic insertion in printed circuit-type applications.

AVAILABLE for conventional or printed circuit lug-type applications in countless R.F. applications, including all varieties of RI-trans. (RI-trans are available in 8-32 or ¼-28 RI-lon tube construction.) RI-lon forms are available in a wide variety of colors for easy identification.

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* *Only a few of the firms Volkert serves can be shown here.*

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1. Arrange for a group showing in your plant of the color film, *Stampings for Electronics.*

2. Ask to be placed on the mailing list to receive *The Volkert View.*

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Want more information? Use post card on last page.

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Getting information the hard way!

Finding out what's going on inside an atomic mushroom is not a job for amateurs.

In some tests, a pilotless, ground-controlled U. S. Air Force drone plane has been the investigator that entered the radio-active cloud and took a reading—then returned to base where instruments were read for the vital story they had to tell . . . electronic instruments developed and produced, in part, by Webster-Chicago.

This is another example of how Webster-Chicago's Government Division serves the Services. For research, development and production that solve tomorrow's problems today, our engineers and facilities are at your call.

. . . from an idea to a prototype
. . . from a prototype to production

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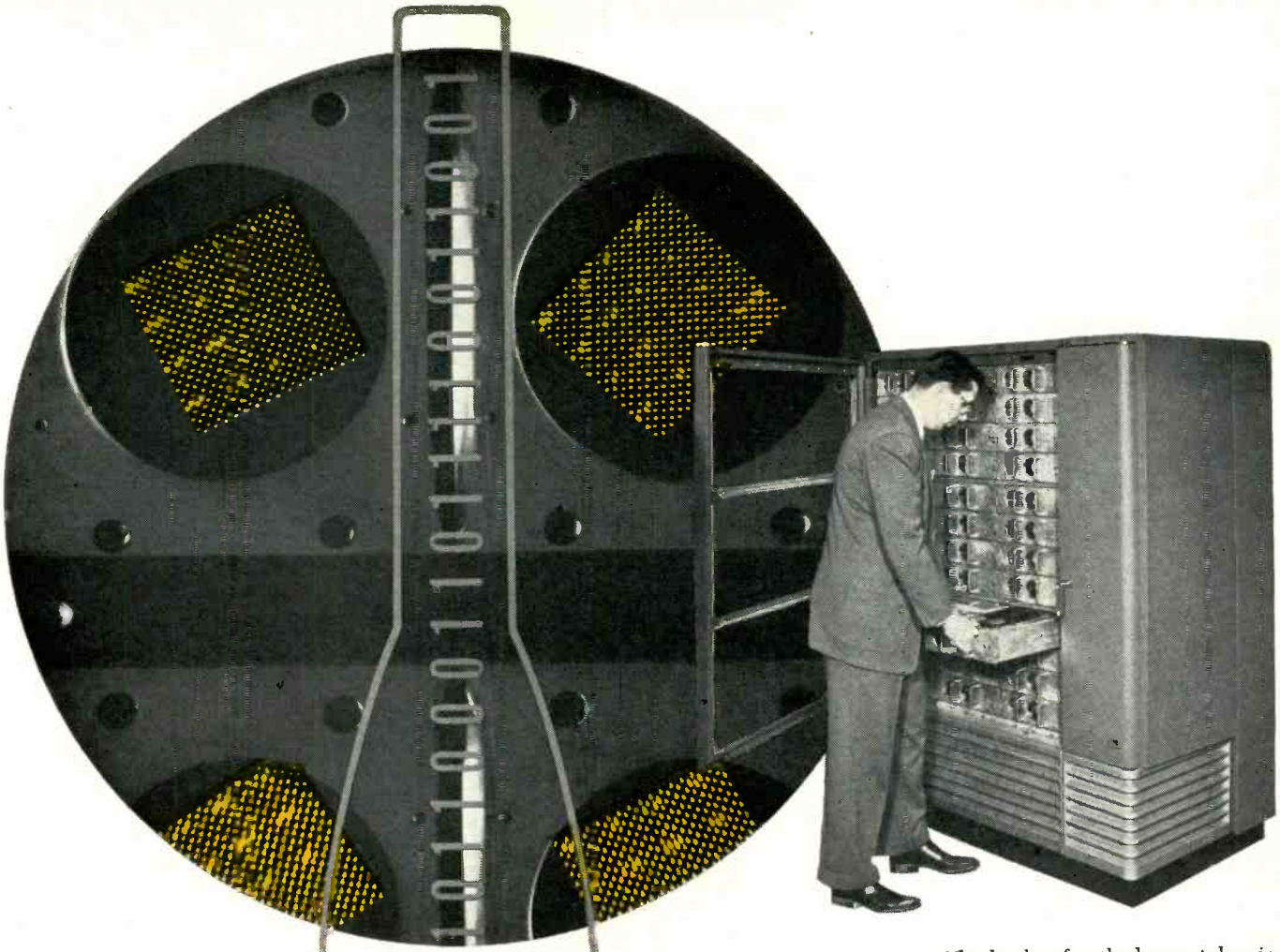


The banks of cathode ray tubes in the IBM Electronic Data Processing Machines are known as Electrostatic Storage Units, one of three "memory" devices.

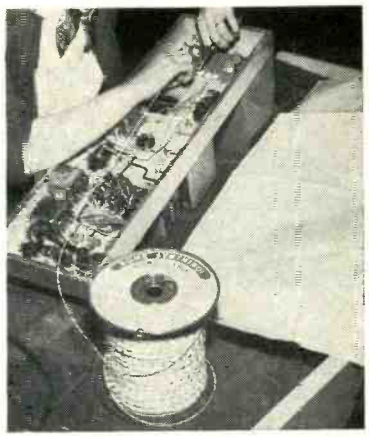
you can't risk wiring trouble in an electronic **brain**

Out goes your favorite reading lamp, leaving you mumbling in annoyance—even so, it's hardly a calamity. But in the International Business Machines Corporation's incredible electronic calculator, the "701," wiring trouble is simply out of the question. It cannot be allowed to happen.

One of the "701's" three "memory" devices is the Electrostatic Storage Unit. All information to and from other components of this powerful electronic "brain" passes through the Electrostatic Storage Unit which stores data or releases it in 12/1,000,000 of a second. Obviously, this kind of performance demands consistently dependable performance from *all* machine elements.

For users of hook-up wire there is, then, significance in the fact that Rome Synthinol® Hook-up Wire is used in wiring the power supply for this electrostatic storage unit. Rome Synthinol's characteristics of high resistance to heat, flame, acids, oils, plus consistent quality control during production, are what make it dependable.

It will pay *you* to investigate the advantages of this quality Hook-up Wire, Rome Synthinol.



Rome Synthinol Hook-up Wire is used in wiring the power supply for the IBM Electrostatic Storage Unit. The unit shown here is part of the deflection gate and supplies the necessary voltage to it.

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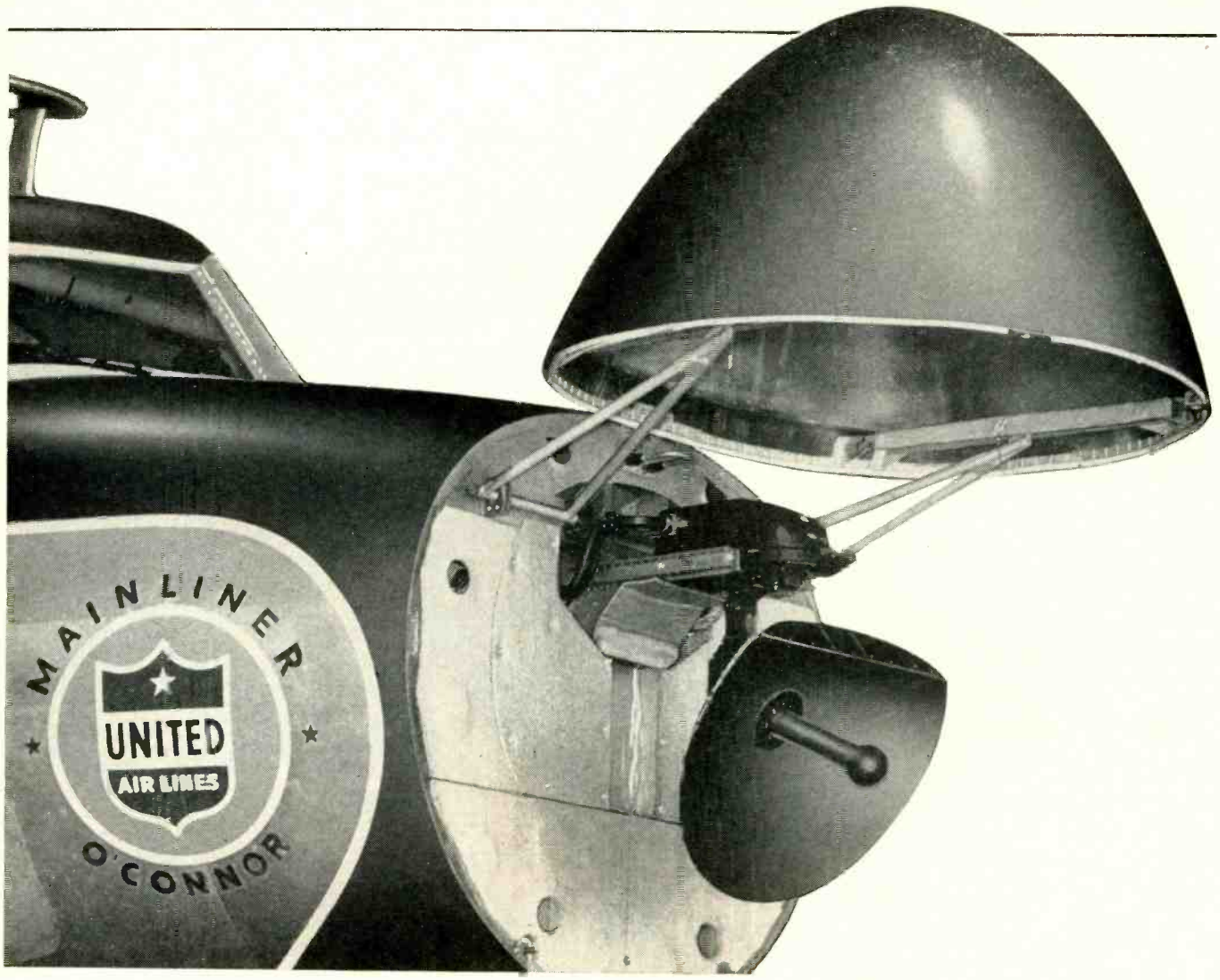

How Convair 340's Solve a Housing Problem for United Air Lines' All-Weather Radar

The nose knows when and where bad flight weather threatens! Radar weather-spotting equipment in the nose of United's Convair 340 now sees through a Koch Fiberglas Radome.

When Convair received United's order for radar-equipped 340's, they naturally turned to Koch, world's largest fabricator of moulded Fiberglas, for domes to house the radar.

The life expectancy of the Koch Radome is many, many times that of any other Radome. This Radome is made possible only by Koch's own exclusive method of moulding.

W. J. Flanagan, Convair Purchasing Agent, wrote Koch upon completion, "You have made substantial contributions to this industry by proposing and successfully applying new departures and moulding technique."

If you are a plane manufacturer, or if you install airborne radar, investigate Koch's Moulded Fiberglas Radome. If you manufacture any equipment that needs special protection, ask the people who know the most about Fiberglas fabrication. We will be glad to confer with you about your project. Address Dept. EKD.

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Pioneer in industrial products of moulded Fiberglas

CORTE MADERA, CALIFORNIA

Is this versatile new CBS tube the answer to your HIGH-VOLTAGE CONTROL problems?

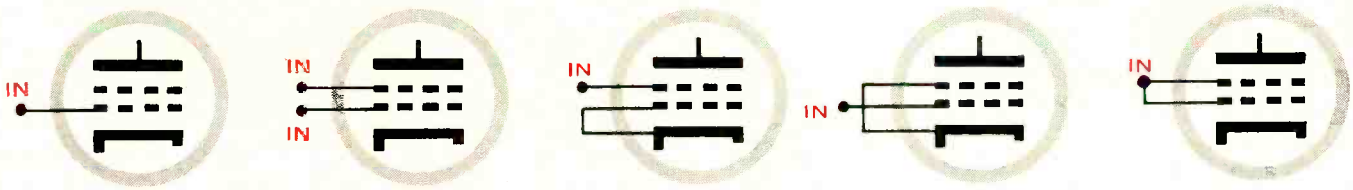
The 6792 is a CBS-Hytron advanced-engineering accomplishment that can solve high-voltage control problems in:

Nucleonics
Photronics
Radar
Industrial Electronics
Computers
Color TV
or Research.

Here is the first multipurpose, high-voltage control tube rated for operation from 3 to 25 kilovolts. An outgrowth of CBS-Hytron's long experience in designing transmitting and pulse tubes, this new tetrode will perform as a:

h-v regulator
h-v gating tube
h-v variable resistor
or h-v amplifier

Note the wide range of input connections to vary the operating characteristics



The versatile CBS 6792 may well be the answer to *your* high-voltage control problem. Check it. Write for data sheet E-258.

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CBS-HYTRON, Danvers, Massachusetts . . . A DIVISION OF COLUMBIA BROADCASTING SYSTEM, INC.

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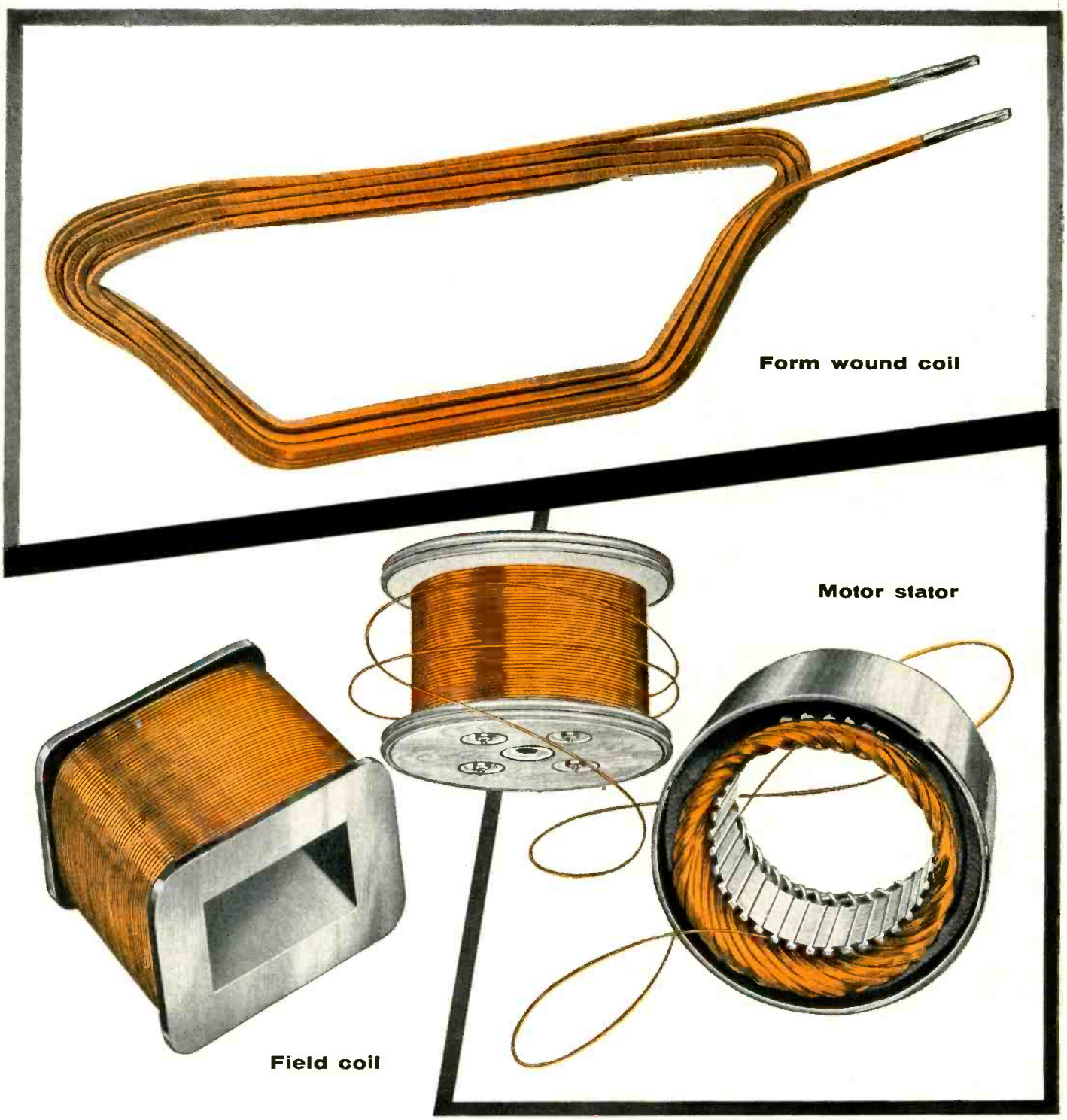

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4. Greater safety factor—positive inorganic spacing between turns provides reliability, protection against overloads.

5. Excellent uniformity—reel to reel—end to end.

6. Over-all savings in winding—no loss of performance.

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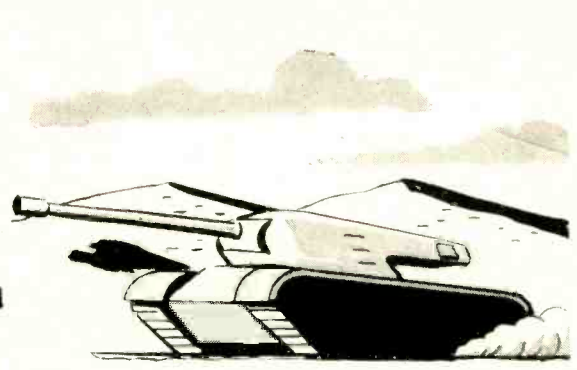
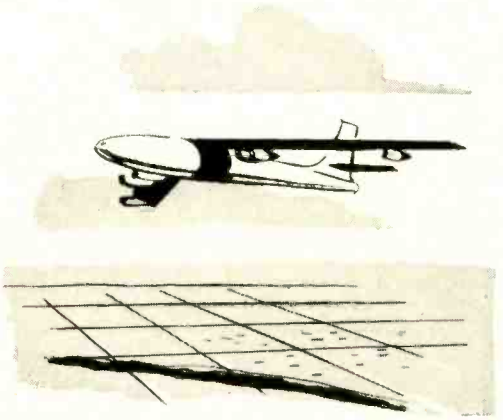
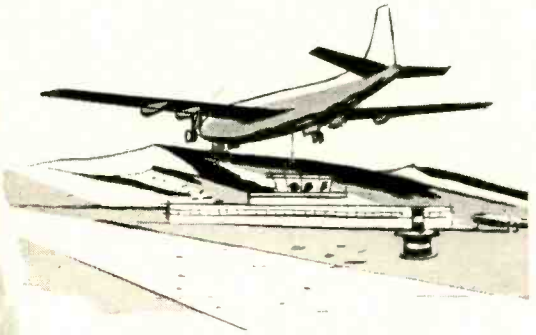


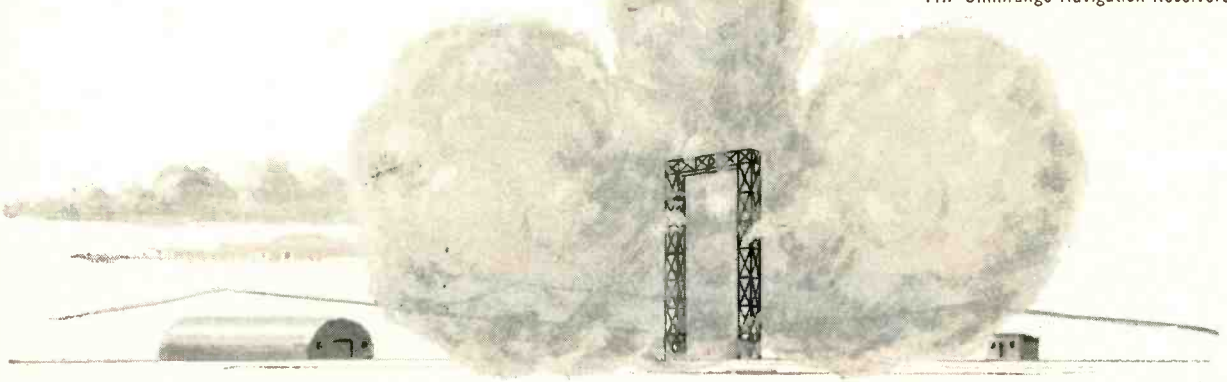
Vehicular HF Communication Transmitters



Airborne UHF and HF Communications Transceivers



VHF Omnirange Navigation Receivers



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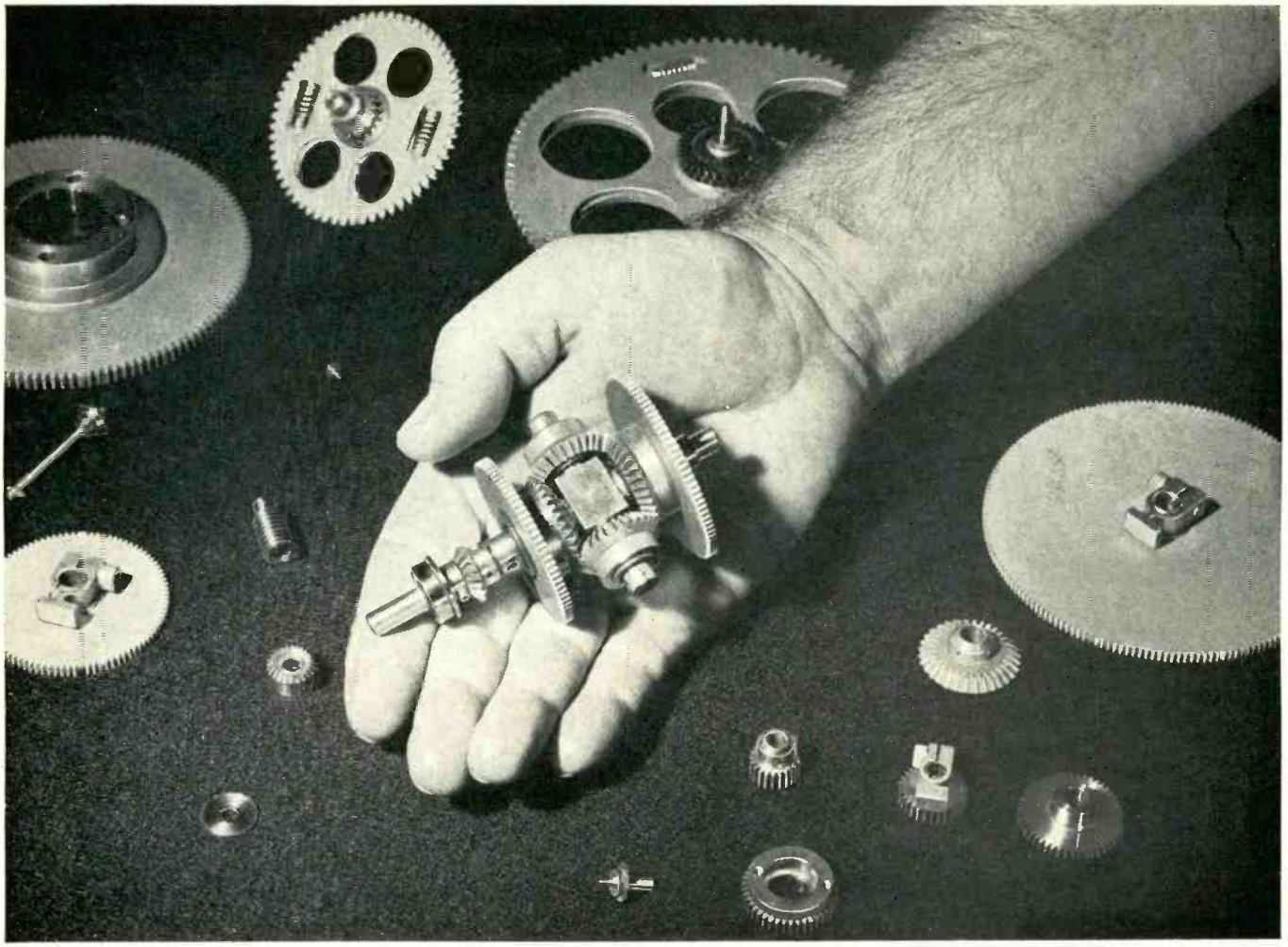

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TYPE X-80
CLIPPER DIODE-RECTIFIER

High peak power capabilities of type X-80 in relation to its physical size have been accomplished through an unusually forceful combination of design features.

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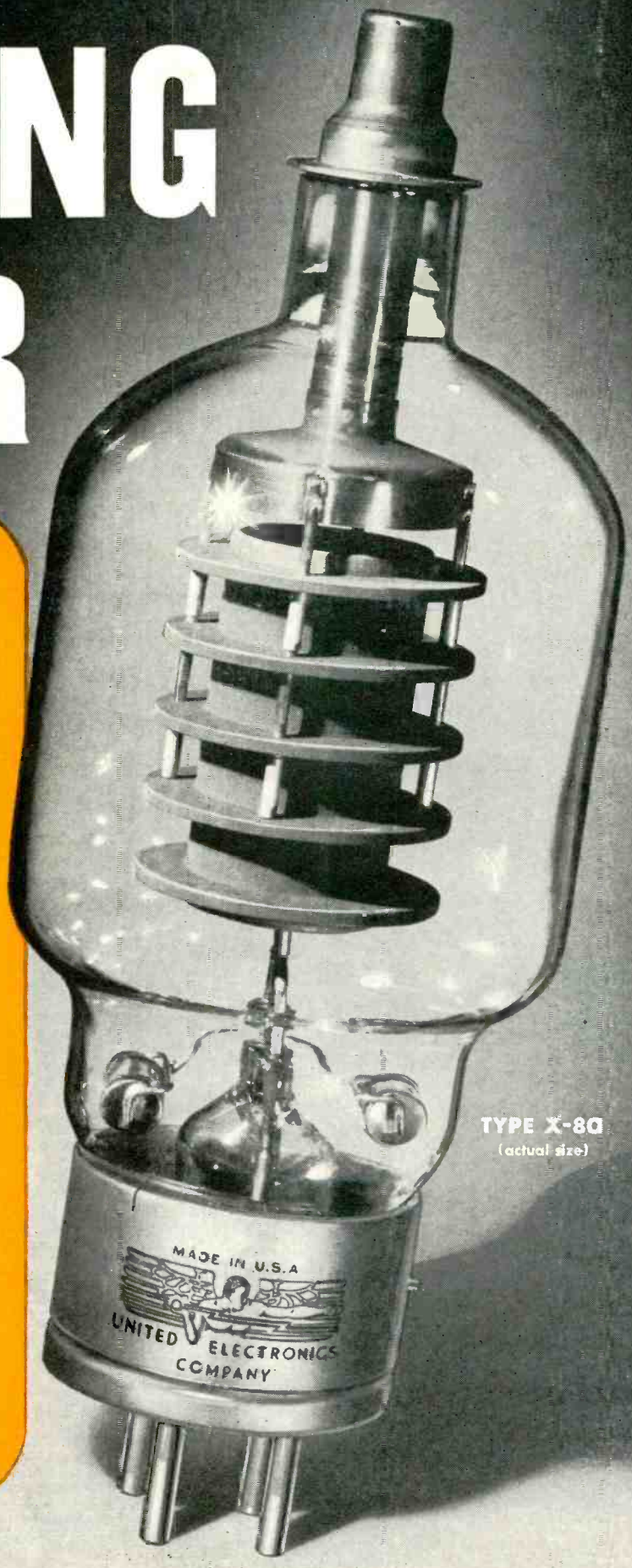
3. Exclusive UNITED *isolcted getter traps* for retention of hard vacuum and high voltage internal insulation.

Type X-80 is serving importantly as a high current clipper tube in radar equipment employing the large hydrogen thyratrons, as well as in power supply rectifier applications.

Write for detailed specifications.

40 Kilovolts Inverse Peak	**80 Amperes** Peak Plate Current as shunt diode
800 mAdc (average) as a rectifier	**Filament Ratings** 11.5 Volts Nominal 15.5 Amperes



TYPE X-80
(actual size)

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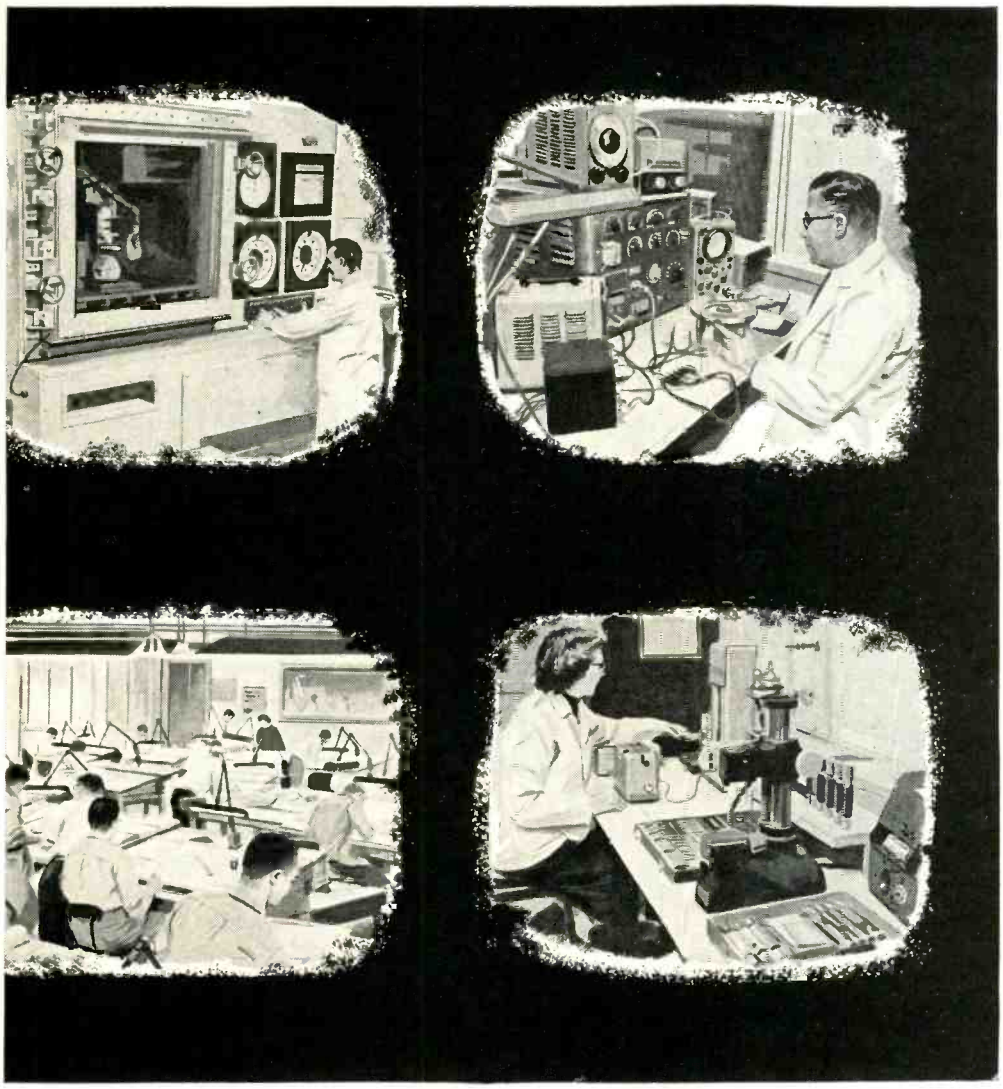

A...Jet Engine Pressure Ratio Systems. Noted for low weight, small size, accuracy, stability, sensitivity. Refer to Bulletin #361.

B...Digital Converter. Possible rate of 25,000 counts per minute, an unambiguous output of 13 binary digits in natural binary code. Refer to Bulletin #360.

C...Magnetic and Electronic Amplifiers. Open, dust-proof or hermetically sealed units. Either standard or to customer specifications. Write for specific data.

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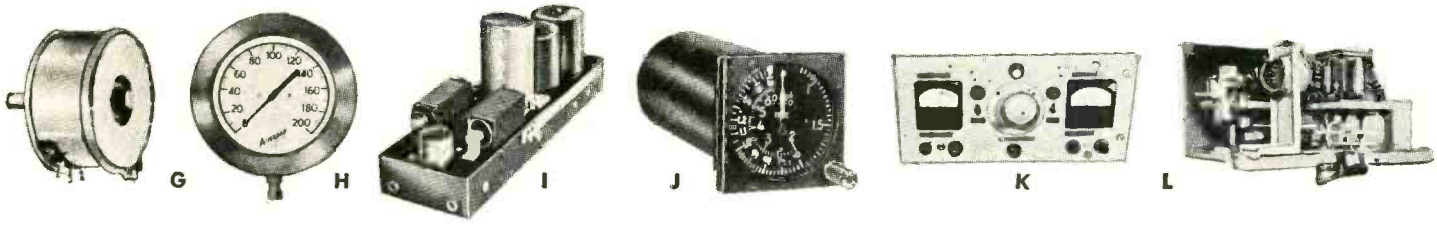
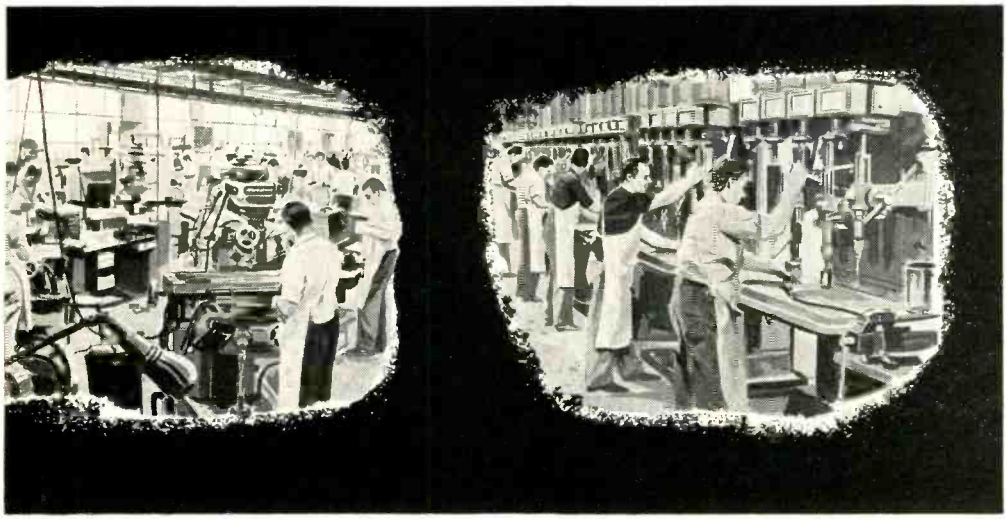
H...Acragage Bourdon Tube Gauges. Pressure, vacuum and compound for the petroleum, chemical, and industrial field. AN types for aircraft. Refer to Bulletin #364.





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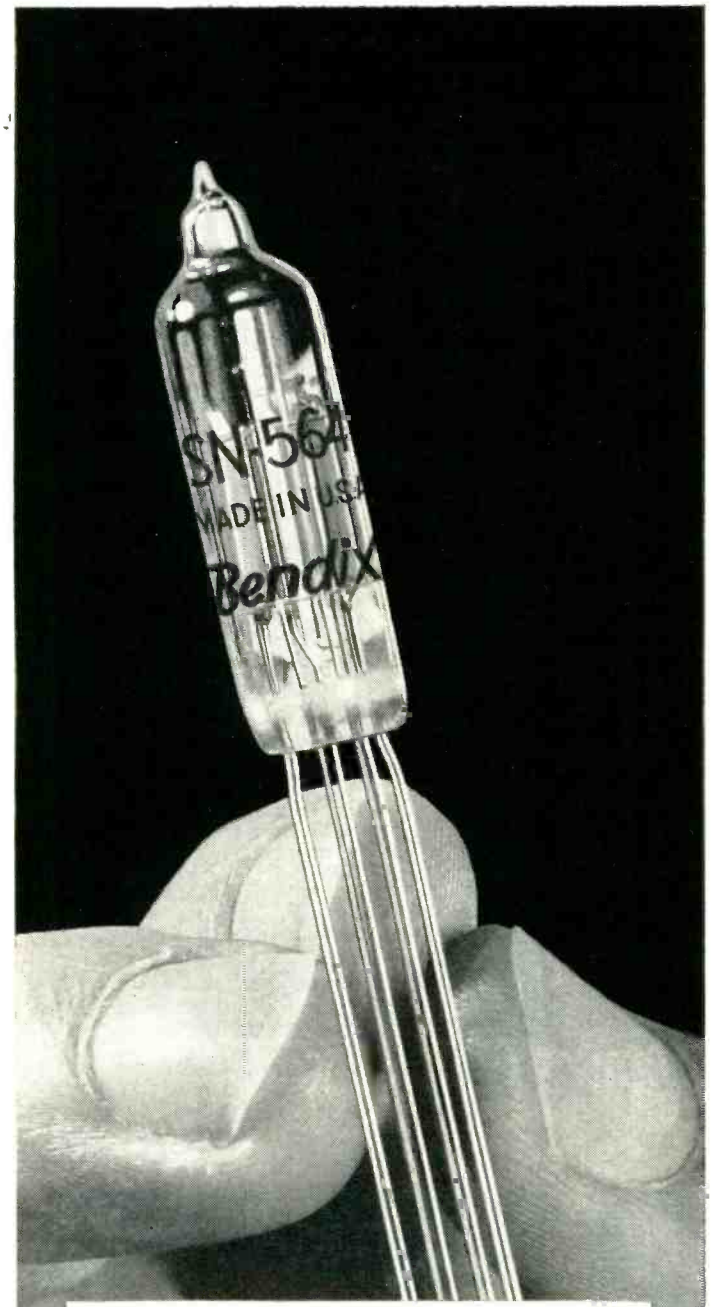

MECHANICAL DATA

Base	Button: Subminiature 8-pin long or short leads
Envelope	T-3 (8-1)
Bulb Length (Max.)	1.375 in.
Diameter (Max.)	0.400 in.
Mounting Position	Any
Altitude Rating (Max.)	60,000 ft.
Bulb Temperature (Max.)	125°C.
Ambient Temperature (Min.)	—55°C.
Cathode	Coated Unipotential

ELECTRICAL RATINGS

Heater Voltage	6.3 Volts
Heater Current	0.15 Amperes
Peak Plate Inverse Voltage	500 Volts
Peak Forward Plate Voltage	500 Volts
Maximum Negative Grid 1 Voltage	—200 Volts
Maximum Negative Grid 2 Voltage	—100 Volts
Maximum Average Cathode Current	16 mAdc
Maximum Peak Cathode Current	100 mA
Heater-Cathode Voltage: Maximum	+25 Vdc
	—100 Vdc
Cathode Warmup Time	10 sec.

Now available— subminiature xenon tetrode thyratron

RETMA 5643

Bendix Red Bank

Improved Type TD-17

APPLICATIONS: Counters, grid control rectifiers, gyro erection systems, missile systems, automatic flight control systems, and other control circuits requiring utmost degree of reliability.

ADVANTAGES: Freedom from early failure . . . long service life . . . uniform operating characteristics . . . ability to withstand severe shock and vibration.

FEATURES: Advanced mechanical and electrical design plus 100% microscopic inspection during manufacture . . . special heater-cathode construction minimizes shorts . . . 24-hour run-in tests under typical overload conditions.

The TD-17 is but one of many electron tubes designed and built by Bendix Red Bank for special-purpose applications. For full information on the TD-17, or on other tubes for other uses, write RED BANK DIVISION, BENDIX AVIATION CORPORATION, EATONTOWN, NEW JERSEY.

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Canadian Distributor:
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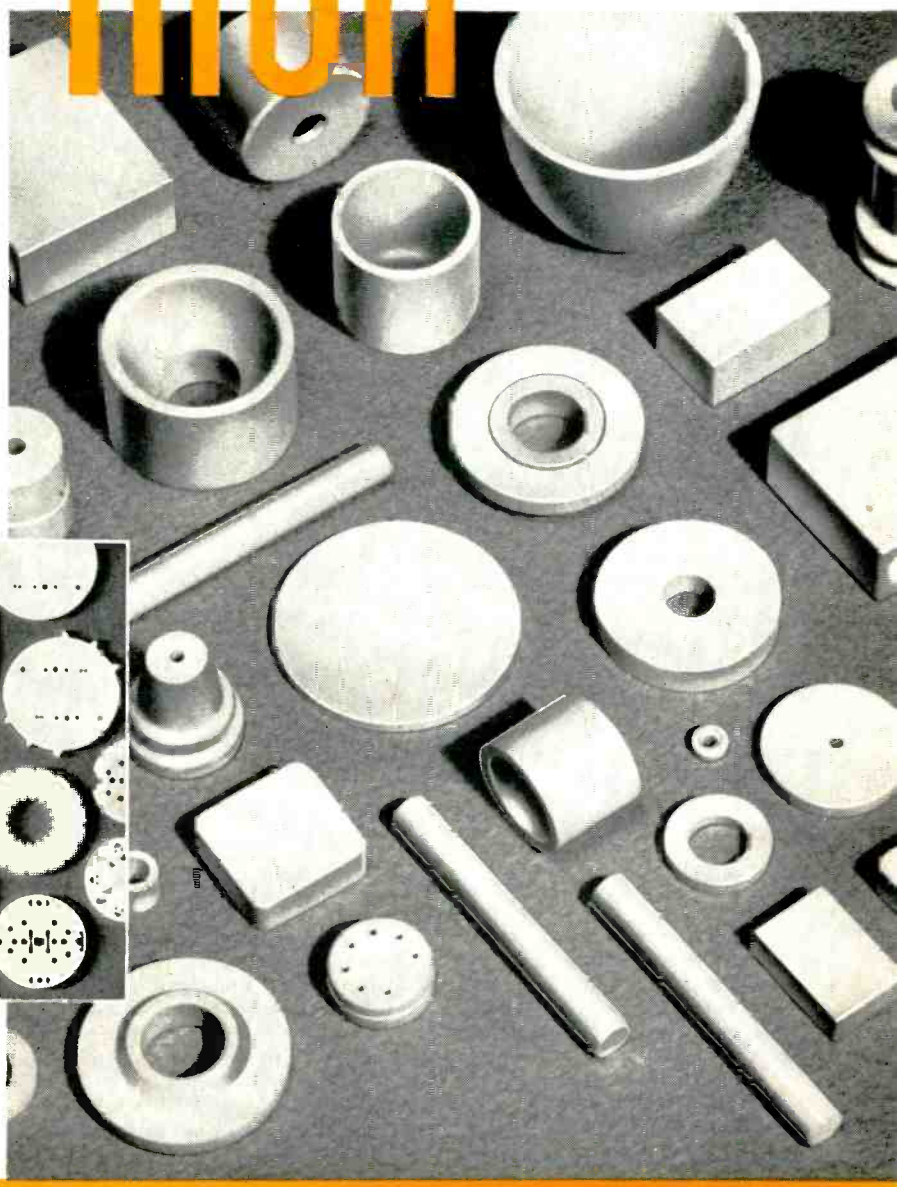

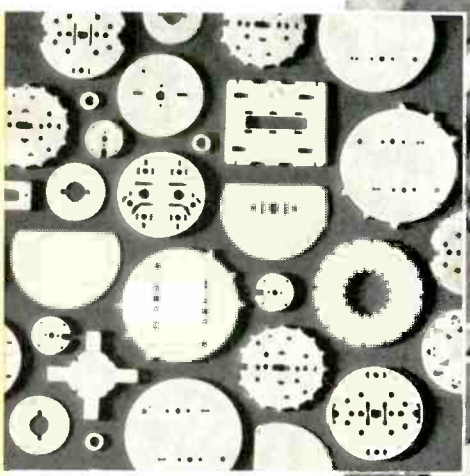

Volume production in a complete range of precision parts, including electron tube shapes processed to be highly porous, readily degassed, thicknesses as low as .009".

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When present flight ceilings of military aircraft are again elevated, the fire control radar apparatus will be ready to rise with the planes. Admiral's development work on the basic unit has eliminated the need for pressurization to prevent voltage break-downs at extremely high altitudes. In solving this central problem, a host of vexing collateral problems have been eliminated. As developed and built by Admiral, the unit is compact, lightweight, and needs no bulky, expensive cooling system to dissipate internal heat.

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NOTE: NEW COLOR SOUND FILM on Admiral Automation available for showing to technical or business groups. Address requests to Public Relations Director, Admiral Corporation, Chicago 47, Ill.

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FACILITIES BROCHURE describing Admiral plants, equipment and experience sent on request.

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Government model TS-148/UP Frequency-meter Range - 8470 to 9630 MC/S ±5 MC/S max. error.
Sensitivity to CW - Spectrum Amplified Pos. - 80 db. below 1 watt for 1 inch deflection.

SPECTRUM ANALYZER

Spectrum Position - 55db. below 1 watt for 1 inch deflection. Maximum dispersion of spectra.
Attenuation - uncalibrated. Variable 3 to 70 db. 1.5 MC/S per inch.

GOVT. MODEL

TS-148/UP

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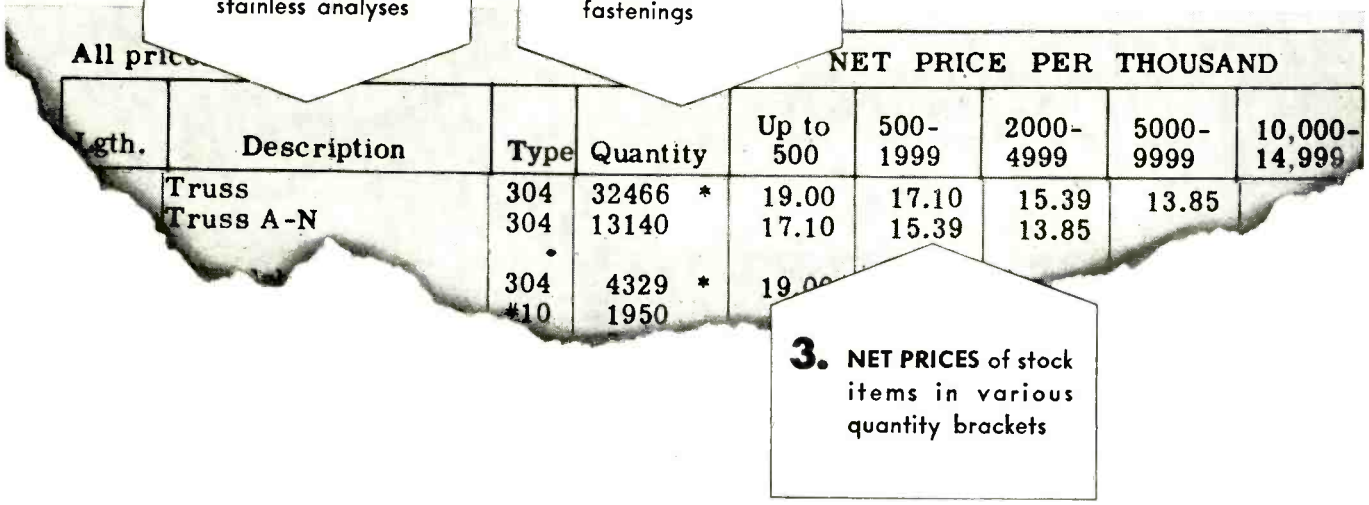

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	Truss A-N	304	13140	17.10	15.39	13.85		
		304	4329 *	19.00				
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3. **NET PRICES** of stock items in various quantity brackets

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12AB5

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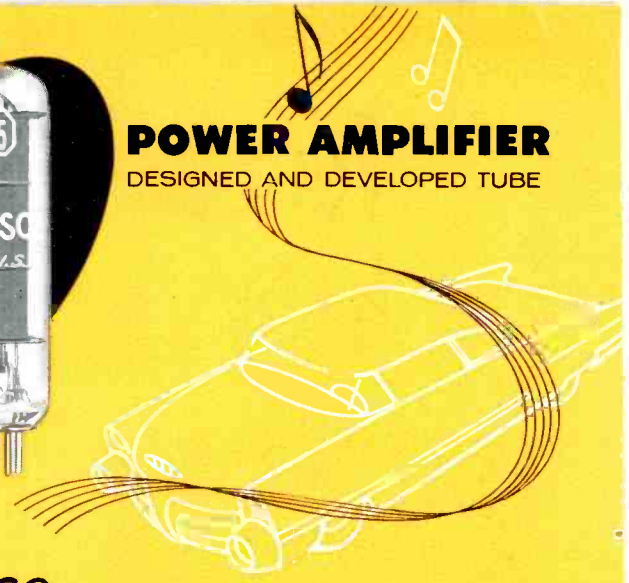
see other side for additional information

TUNG-SOL AUDIO POWER AMPLIFIER

A TUNG-SOL DESIGNED AND DEVELOPED TUBE

12AB5



Greater Factor of Safety Assures Continuity of Service

12AB5 is the first audio power amplifier designed specifically for automotive radio service. In both design and ratings, this tube is specifically intended for the 12-volt systems adopted by leading car manufacturers.

There has been no compromise with household radio or TV needs in engineering the 12AB5. The design recognizes the wide range of operating voltage to which an automotive receiver is subjected during idling and full charge conditions of the storage battery.

This new tube is intended to be used either singly or in push-pull for power output stage use. Its nine-pin construction in an all-glass miniature envelope, provides a wider margin of safety than the previous smaller seven-pin 6AQ5 and 12AQ5.

The 12AB5 is in full production under the rigid quality control procedures that keep Tung-Sol tube performance at the top of the industry.

MECHANICAL DATA

Coated unipotential cathode			
Outline drawing	RETMA 6—3	Bulb	T—6½
Base	RETMA E9—1	Miniature button	9 pin
Maximum diameter			⅞"
Maximum overall length			2⅝"
Maximum seated height			2⅜"
Base pin connections:		Basing	9 CK
Pin 1—grid #2		Pin 6—grid #1	
Pin 2—no connection		Pin 7—grid #3, cathode	
Pin 3—grid #1		Pin 8—grid #2	
Pin 4—heater		Pin 9—plate	
Pin 5—heater			
Mounting position			Any

ELECTRICAL DATA

Heater Characteristics*		
Heater voltage—nominal	12.6	VOLTS
Heater current—nominal	0.2	AMP.
Direct Interelectrode Capacitances—APPROX.		
Grid to plate: G to P	0.7	μμf
Input: G1 to (H+K+G2&G3)	8.0	μμf
Output: P to (H+K+G2&G3)	8.5	μμf
Bulb Temperature—MAXIMUM	250	°C.
Ratings—Interpreted According to Design Center System		

ELECTRICAL DATA

Maximum plate voltage	315	VOLTS
Maximum grid #2 voltage	285	VOLTS
Maximum plate dissipation	12	WATTS
Maximum grid #2 dissipation	2	WATTS
Maximum grid #1 circuit resistance		
Fixed bias	0.1	MEG.
Cathode bias	0.5	MEG.
Maximum heater—cathode voltage		
Negative (DC)	200	VOLTS
Positive (DC)	100	VOLTS

Operating Conditions and Characteristics*

Class A1 Amplifier—single tube			
Heater voltage*	12.6	12.6	VOLTS
Plate voltage	250	250	VOLTS
Grid #2 voltage	200	250	VOLTS
Grid #1 voltage	...	—12.5	VOLTS
Cathode bias resistor	270	...	OHMS
Peak AF grid #1 voltage	10.5	12.5	VOLTS
Zero-signal plate current	33.5	45	MA.
Maximum signal plate current	36.0	47	MA.
Zero-signal grid #2 current	1.6	4.5	MA.
Maximum signal grid #2 current	3.2	7.0	MA.
Plate resistance	...	50	KIL.
Transconductance	4000	4100	μMHOS
Load resistance	6000	5000	OHMS
Power output (maximum signal)	3.3	4.5	WATTS
Total harmonic distortion	12	8	%

*This tube is intended to be used in automotive service from a nominal 12 volt battery source. The heater is therefore designed to operate over the 10.0 to 15.9 voltage range encountered in this service. The maximum ratings of the tube provide for an adequate safety factor such that the tube will withstand the wide variation in supply voltages.

TUNG-SOL ELECTRON TUBES

The TUNG-SOL engineering which has produced the 12AB5 is constantly at work on a multitude of special electron tube developments for industry. Many exceptionally efficient general and special purpose tubes have resulted. Information about these and other types is available on request to Tung-Sol Commercial Engineering Department.

TUNG-SOL ELECTRIC INC., NEWARK 4, NEW JERSEY

SALES OFFICES: ATLANTA, CHICAGO, COLUMBUS, CULVER CITY, DALLAS, DENVER, DETROIT, NEWARK, SEATTLE.

NOVEMBER, 1955


MINIATURE LAMPS


SEALED BEAM HEADLAMPS


SIGNAL FLASHERS

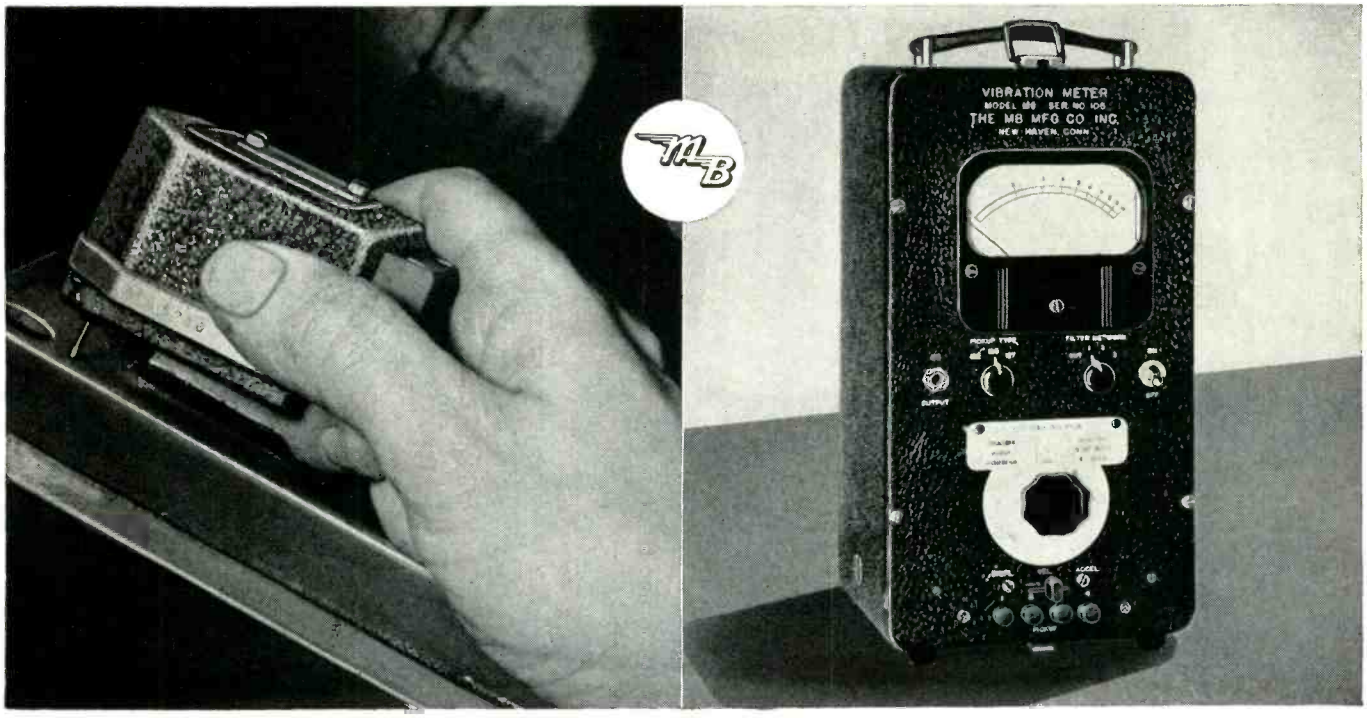

RADIO AND TV TUBES


ALUMINIZED PICTURE TUBES


SPECIAL PURPOSE TUBES


SEMICONDUCTORS

Two new "tools" to help you pin point vibration



MB Probe-type Pickup and Portable Meter

simplify reliable vibration detection and measurement

Here's the pickup that really searches out vibration. It combines the extreme sensitivity of electromagnetic operation with the wide usefulness of a hand-held probing instrument.

With this new MB Type 115 Pickup, you can explore large panels . . . bearings, housing, structural members, bodies large and small. Since the light probe adds negligible loading or weight to the vibrating object, it translates any vibration into voltage with great accuracy for measurement. It lets you pin-point the trouble . . . determine quickly any need for corrective design.

The improved Model M6 MB Vibration Meter teams up with the pickup to give you the facts on vibration. With it, you measure the voltage generated in the pickup directly . . . in useful terms of amplitude, velocity, or acceleration of the vibratory motions.

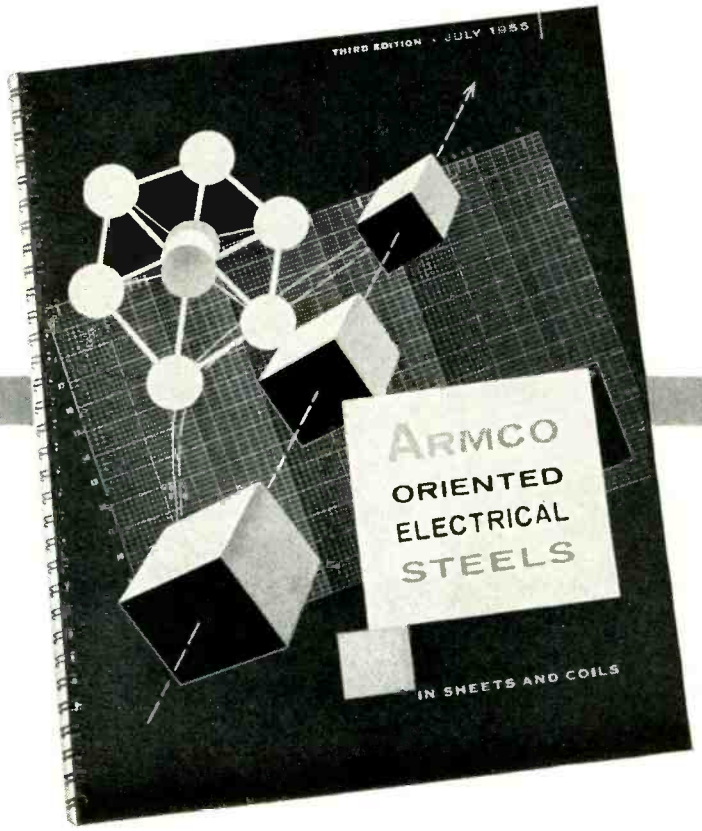
You can connect as many as four MB Pick-ups to this meter . . . a selector switch enabling you to read any one at a time. The meter is portable, compact, ruggedized and operates on standard AC.

To lick vibration, you've got to locate it first. You'll find this pair a big help for that job. Write for more data.

MB *manufacturing company*
A division of Textron American, Inc.
1060 State Street,
New Haven 11, Conn.

PRODUCTS TO ISOLATE VIBRATION . . . TO EXCITE VIBRATION . . . TO MEASURE VIBRATION

New Oriented Silicon Steels for LIGHTER-WEIGHT Transformers



Armco Oriented Electrical Steels have spearheaded revolutionary changes in transformer design for the last 15 years because of these principal advantages:

Lower Core Loss

These electrical steels give the designer silicon steels with much lower core loss in the rolling direction than any conventional cold-reduced or hot-rolled grades.

Higher Permeability

The Armco oriented grades have another unique advantage over conventional electrical steels—higher permeability at high inductions combined with lower core loss. Before the introduction of oriented silicon steel, lowered core loss was obtained only at the expense of permeability at high transformer inductions. As core loss improved, the exciting current became the limiting factor in design. The oriented grades overcame this handicap.

Other Advantages

In addition to lower core loss and higher permeability in the rolling direction, Armco Oriented Electrical Steels have excellent lamination factors and surface insulations. They are supplied with magnetic properties fully developed at the mill. Only a low-temperature (1475 F) anneal is required for stress-relieving.

New Information Available

Original grades of Armco Oriented Electrical Steel are long obsolete, replaced by lower core loss grades. Magnetic data now available are more complete.

Write us on your company letterhead for a copy of "Armco Oriented Electrical Steels—Third Edition, July, 1955." This 56-page catalog gives extensive information on the present Armco Oriented grades, M-6W, M-7W, M-6X and M-7X.

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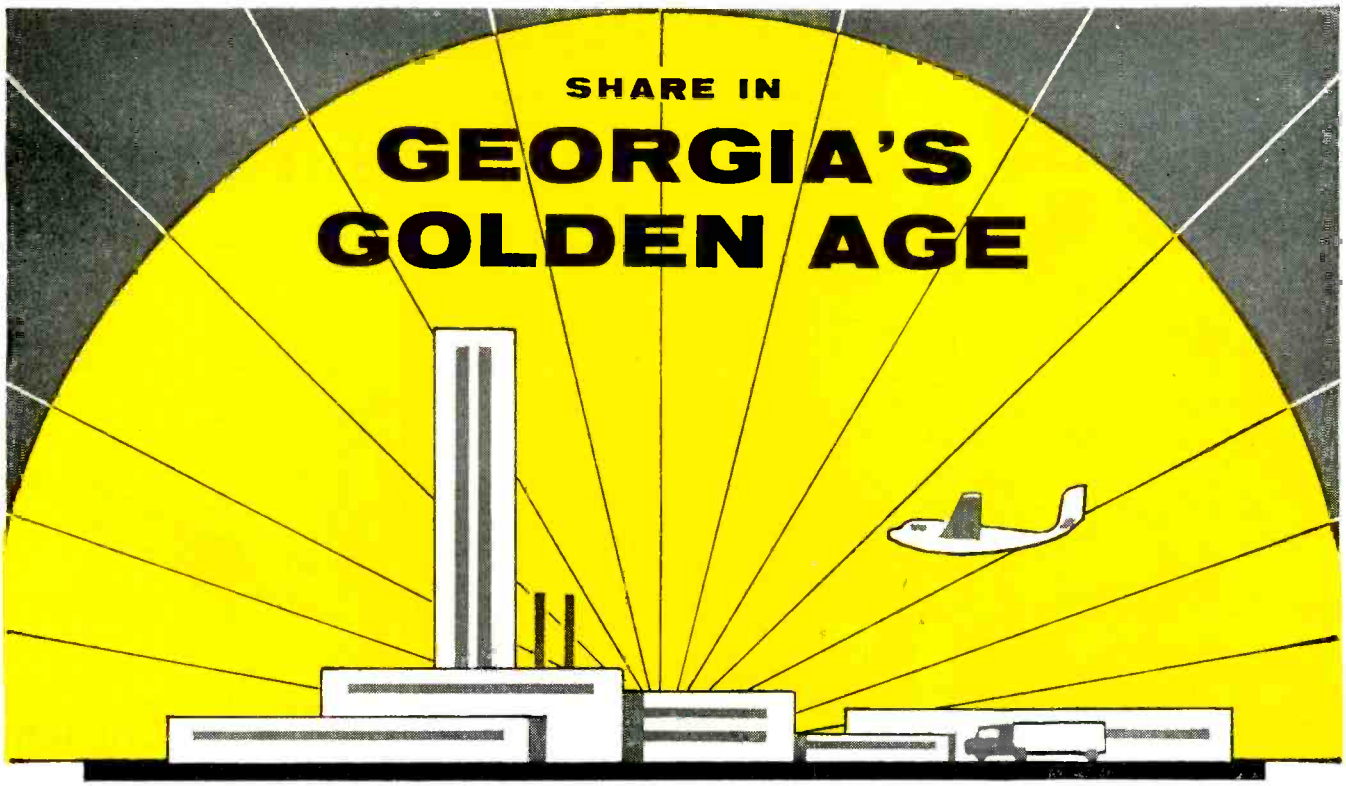
SHEFFIELD STEEL DIVISION • ARMCO DRAINAGE & METAL PRODUCTS, INC. • THE ARMCO INTERNATIONAL CORPORATION



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... you, too, will find that it's good business to produce in Georgia. Over 7100 manufacturers, including many of America's greatest industrial names, have already staked their claims to share in Georgia's Golden Age. Georgia—scene of America's first gold rush in 1828, today offers many nearby, growing consumer markets to sales-minded industries ...

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IRC OFFERS MORE TYPES OF 1%

Deposited Carbon

Here's 1% accuracy in an extremely stable non-wire wound resistor at a price low enough to permit its use wherever the characteristics of composition carbon resistors are not fully suited. IRC's unmatched experience in producing film type resistors has led directly to the superior reliability and stability of IRC Deposited Carbons. Outstanding characteristics include load, environmental and age stability and ability to operate at higher temperatures than MIL specification requirements, low wattage coefficient, and low capacitive and inductive reactance in high frequency applications.

3 SMALL SIZES—DCC ½ WATT
DCF 1 WATT and DCH 2 WATTS

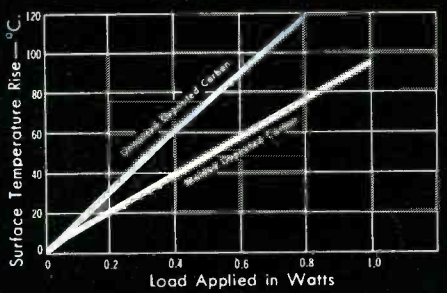
MEET ALL REQUIREMENTS OF MIL-R-10509A SPECIFICATION

Wherever the Circuit Says

Molded Deposited Carbon

Molded **Deposited Carbon resistors are now available from IRC in 3 sizes: Types MDA—⅛ watt, MDB—¼ watt and MDC—½ watt. The *molded* plastic housing provides complete mechanical protection, minimizes the effect of moisture and improves load life characteristics. These 1% precision film type units exceed MIL-R-10509A specifications.**

COMPARISON SURFACE TEMPERATURE RISE VS. LOAD
Molded vs. Unmolded Deposited Carbon Resistors



Boron Carbon

Where a high degree of accuracy under widely varying temperatures is required, IRC Boron Carbons offer an ideal combination of characteristics. Their superior temperature stability is provided in 3 sizes: Types BOC—½ watt, BOF—1 watt and BOH—2 watts—all 1% accuracy. Considering weight, size and cost factors, plus lower capacitive and inductive reactance, these film type precision resistors can satisfactorily replace wire wounds.

IRC TYPE	BOC	BOF	BOH
Equivalent MIL Style	RN 20R	RN 25R	RN 30R
Wattage (40°C. Ambient)	½	1	2
Max. Continuous Voltage	350 V.	500 V.	750 V.
Minimum Ohms	10	20	30
Maximum Ohms (IRC)	0.5 meg	2.0 meg	5.0 meg

makes them all . . . can recommend without bias . . .

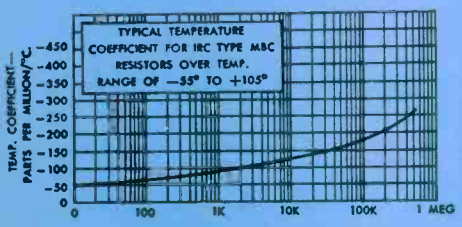
Subsidiaries :
Circuit Instruments Inc., St. Petersburg, Fla. • Hycor Company, Los Angeles, Calif. and Vega Baja, Puerto Rico • IRCAL Industries, Los Angeles, Calif.

TOLERANCE RESISTORS than any supplier in the industry

Molded Boron Carbon

Only from IRC can you obtain Boron Carbon resistors with the protection of a *molded* plastic housing. Any risk of mechanical damage to the coating or of insulation breakdown is overcome. Any need for special handling is eliminated, and moisture and load life characteristics are improved. 3 sizes—Types MBA ⅛ watt, MBB ¼ watt and MBC ½ watt—all exceed MIL-R-10509A specifications.

TYPICAL TEMPERATURE COEFFICIENT



Wire Wound

IRC's winding skills and automatic assembly equipment provide precision windings to exacting standards. Continuous inspections at every stage of manufacture assure maximum reliability in each finished resistor. IRC Mil Type precision wire wounds meet all requirements of MIL-R-93A specification. In addition to 6 Mil sizes, IRC supplies tiny Type WW10J—13/32 x 9/32". Standard tolerance ±1%; minimum tolerances are shown below.

Minimum Tolerances

Resistance	IRC MIL TYPES	TYPE WW10J
10 ohms & up	0.1%	
5 ohms & up	1.25%	
1 ohm & up	0.5%	
1500 ohms & up		0.1%
200 ohms & up		0.25%
65 ohms & up		0.5%

Encapsulated Wire Wound

Tru-Mite encapsulated wire wound precision resistors are produced to IRC's high standards by its West Coast subsidiary, IRCAL INDUSTRIES. Available in 11 sizes and axial lead or lug types. Standard tolerance ±1%; also ±½, ¼, 1/10 and 1/20% tolerances can be supplied. Tru-Mite core material is the same epoxy resin as is used for the embediment. This eliminates the normal effects of temperature and moisture. Tru-Mite resistors exceed MIL-R-93A specifications.

MANY COMBINATIONS OF CHARACTERISTICS AND OPPORTUNITIES FOR COST REDUCTION ARE INVOLVED WHEN SPECIFYING CLOSE TOLERANCE RESISTORS. NO OTHER SINGLE SOURCE CAN OFFER YOU THE SCOPE OF TECHNICAL GUIDANCE AVAILABLE FROM IRC.

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Name_____

Company_____

Address_____

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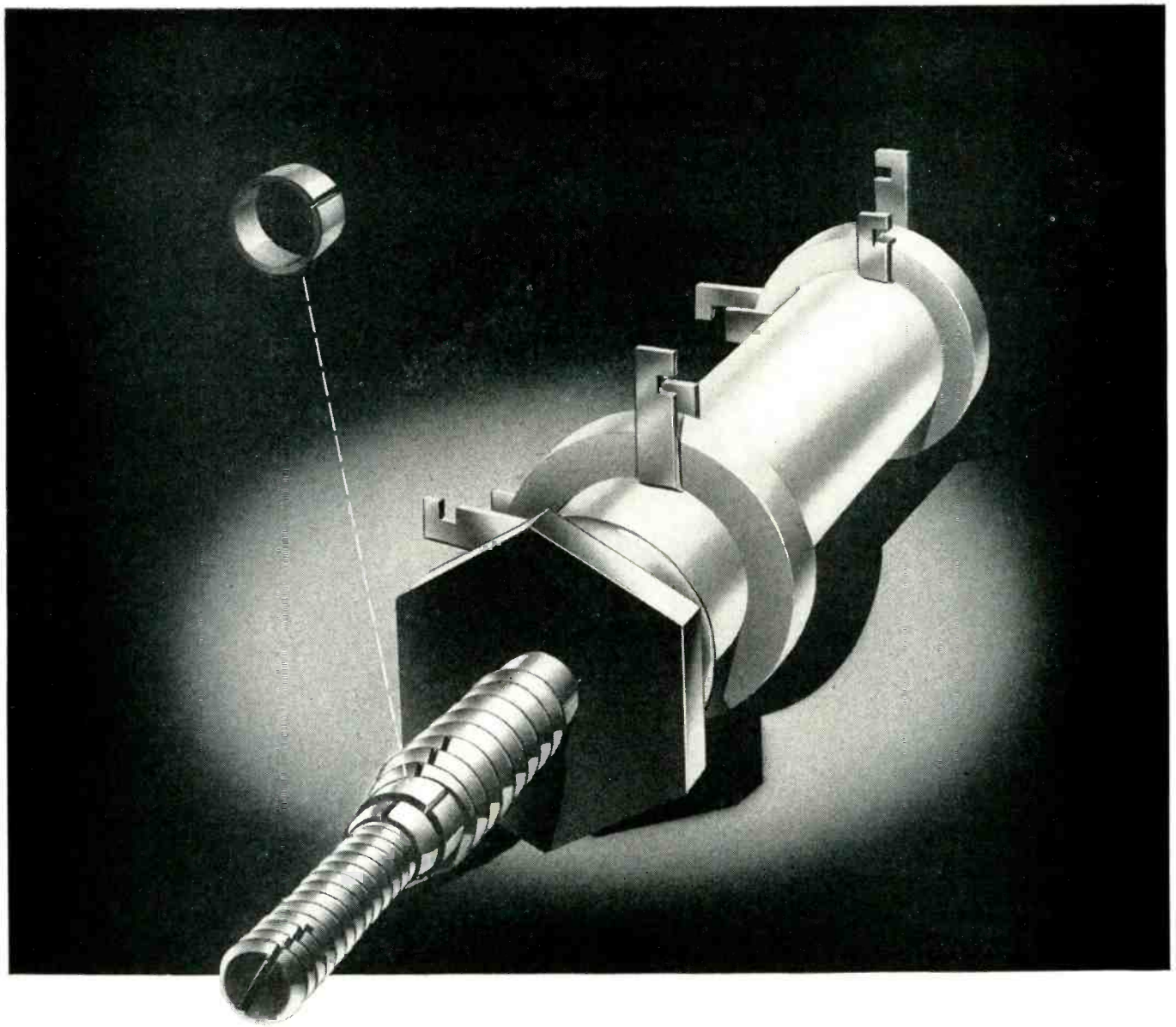


Always tense but never tired

Again CTC comes up with an advancement for more secure, more effective electronic assemblies. It's the new Perma-Torq* constant tensioning device for tuning cores of standard CTC ceramic coil forms.

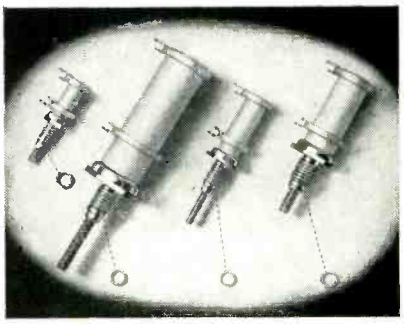
CTC's Perma-Torq, a compression spring of heat treated beryllium copper, has very high resistance to fatigue and keeps coils tuned as set, under extreme shock and vibration. It allows for immediate readjustment without removal or loosening of any mounting nut or locking spring. But most important of all — Perma-Torq like all CTC components is *quality controlled*.

CTC's *quality-control* means you get consistent top quality components. Each step of production is checked, each component part — even though already certified — is checked again. And finally CTC's finished product is checked. That's why CTC can offer you a guaranteed electronic component — standard or custom — whose performance you can depend upon.

CTC researchers and practical experts are always available to help solve your components problems. For samples, specifications and prices write to Sales Engineering Dept., Cambridge Thermionic Corporation, 437 Concord Ave., Cambridge 38, Mass. On the West Coast contact E. V. Roberts, 5068 West Washington Blvd., Los Angeles 16 or 988 Market St., San Francisco, Cal.

NEW PERMA-TORQ UNITS come completely factory assembled to mounting studs, eliminating the bother of assembling and adjusting separate locking springs. CTC coil forms with Perma-Torq Tensioning Device are designated PLST, PLS5, PLS6 and PLS7, are completely interchangeable with the LST, LS5, LS6 and LS7 series, and are available at no increase in price.

*Patent pending



CTC

CAMBRIDGE THERMIONIC CORPORATION

makers of guaranteed electronic components
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1. POTENT POWER + **2. SMALL SIZE**

Up to 5100 mmf at 300 vDCw
Up to 3900 mmf at 500 vDCw

(size) Length 3/4", average Width 7/16", average Thickness 3/16" DM-20 shown actual size

El-Menco Dur-Mica DM-20

DIPPED MICA CAPACITOR WITH PARALLEL LEADS

3. PEAK PERFORMANCE

ideal for new miniatured designs and printed wiring circuits

MEETS ALL HUMIDITY, TEMPERATURE AND ELECTRICAL REQUIREMENTS OF MIL-C-5 Specifications!

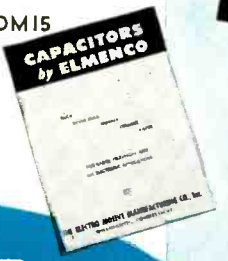
TEST IT AND COMPARE!

- El-Menco's Dur-Mica DM20 costs even less than our famous molded mica capacitors.
- Provides greater versatility — wider applications.
- Tougher phenolic casing assures *longer-life* and *greater stability* through wide ranges in temperature.
- Parallel leads simplify application in transistor and sub-miniature electronic equipment including printed circuits for military and civilian use.

For Extreme Miniaturization Use Our DM15

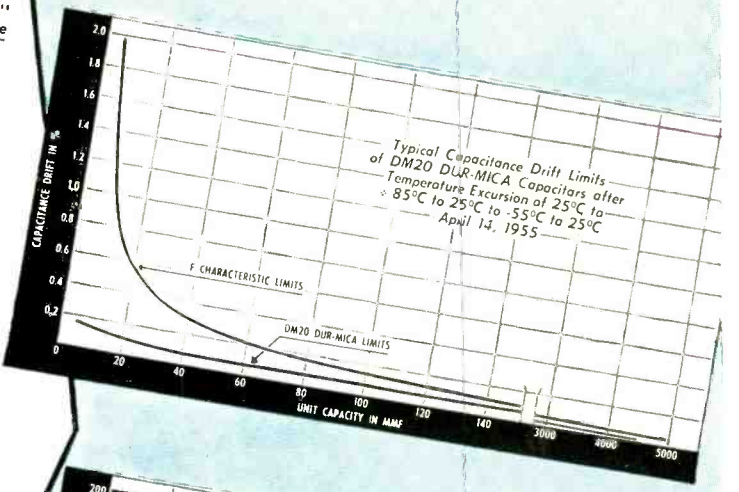
DM15 — Up to 510 mmf at 300 vDCw
Up to 400 mmf at 500 vDCw

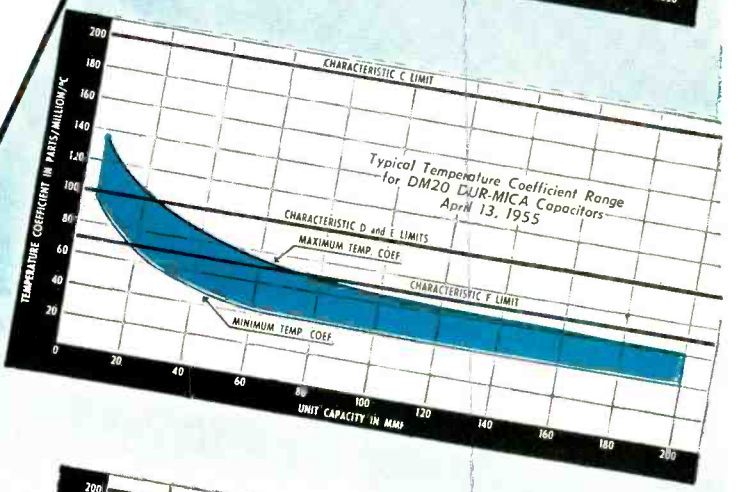
Available in 125°C operating temperature. Minimum capacity tolerance available ±½% or 0.5 mmf (whichever is greater).

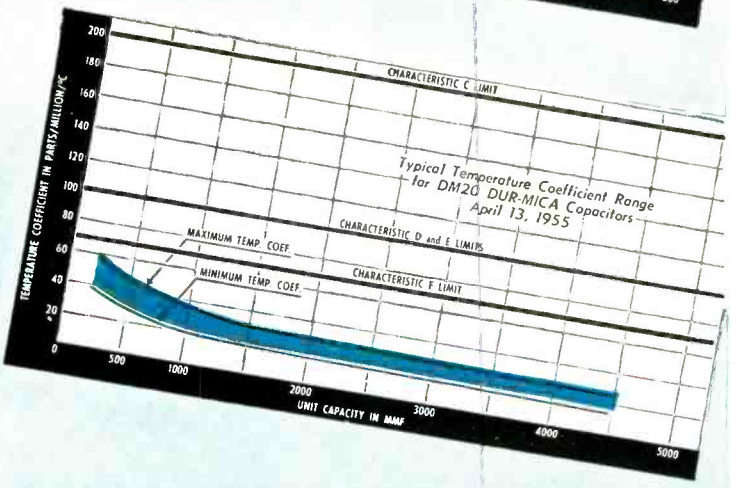


El-Menco Capacitors

to meet modern miniature requirements







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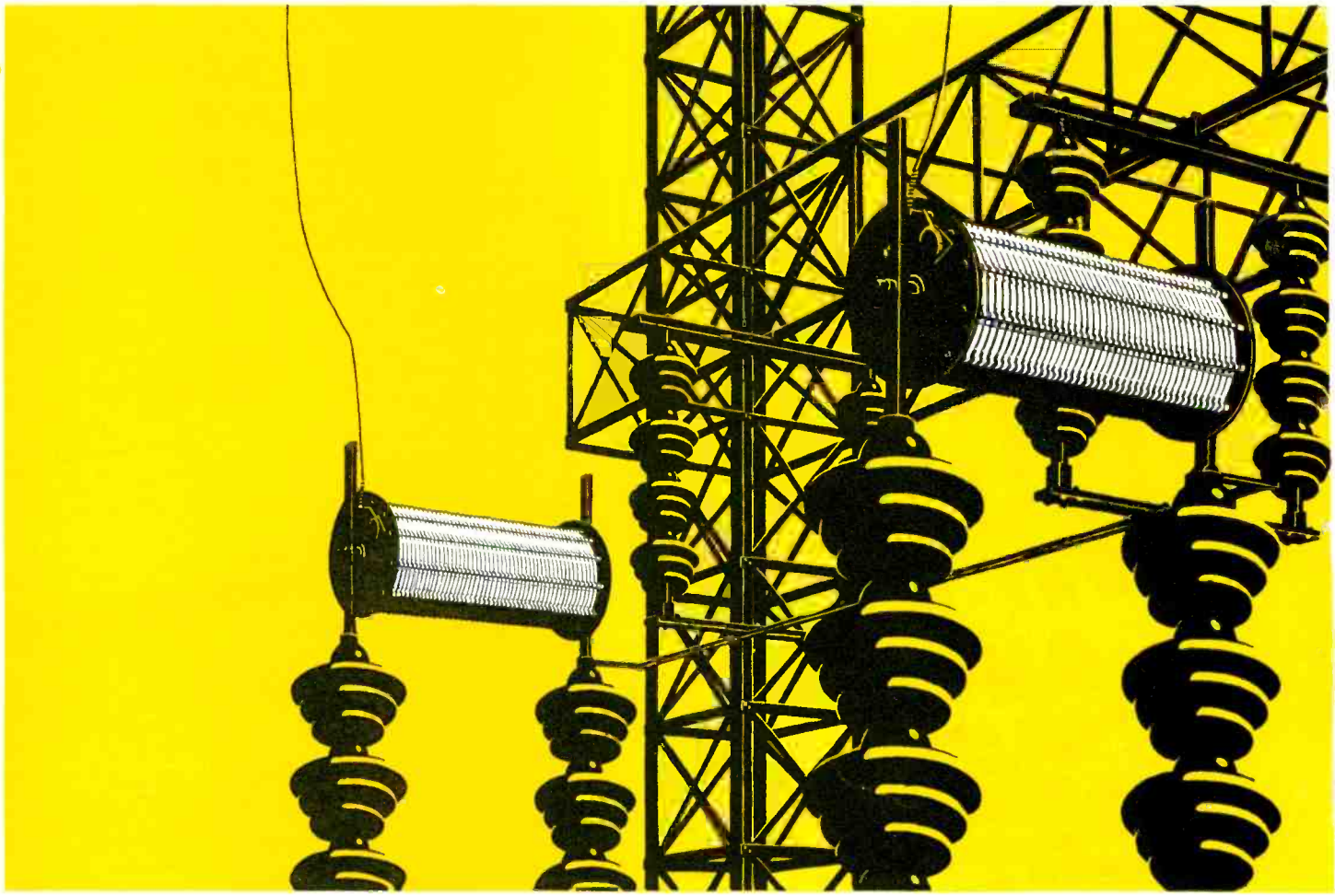
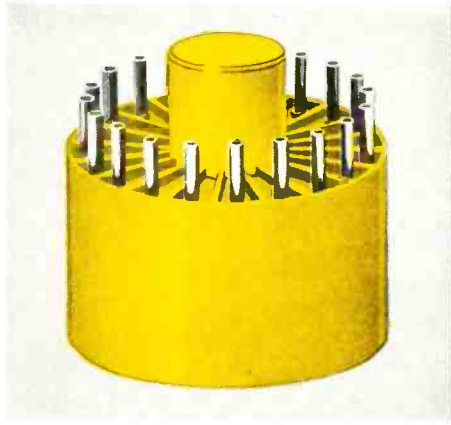
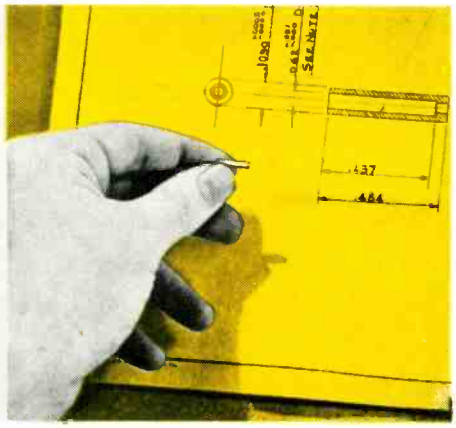


General Electric solves a tough insulating

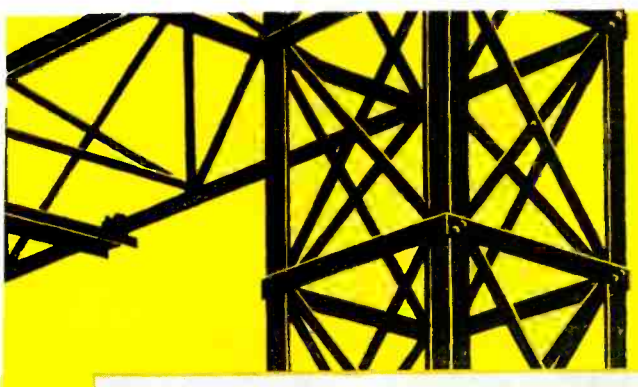


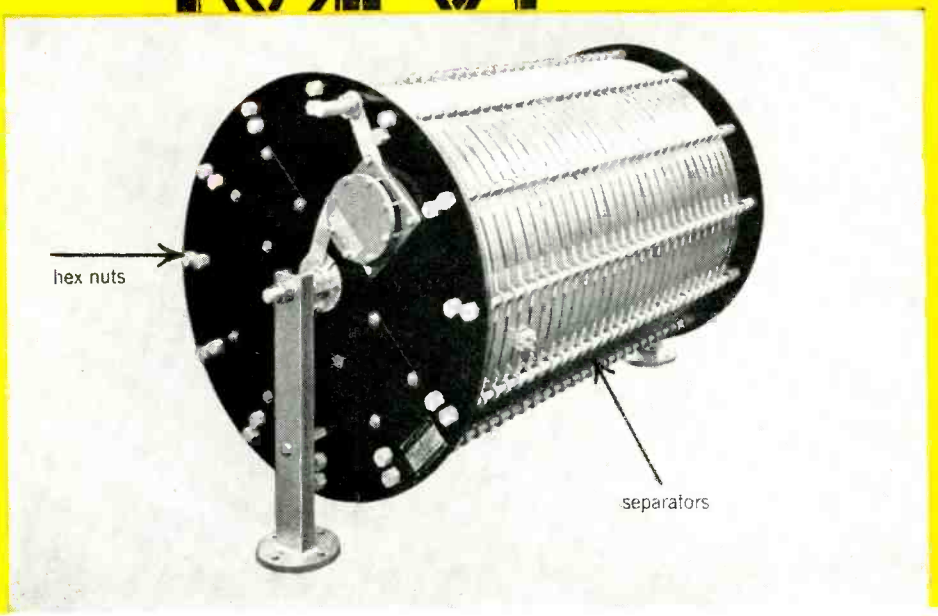
1 Because of its outstanding dielectric strength and arc resistance, mineral-filled PLASKON Alkyd was selected by R.C.A. for television picture tube bases. Under a test potential of 12,000 volts, electrical leakage between the pins is so low as to be negligible.

2 Rapid molding characteristics, plus excellent dimensional stability and electrical properties, are the reasons why mineral-filled PLASKON Alkyd continues to be used by Standard Coil Products Co., Inc. for TV tuner segments.



3 This precision spring holder by Mason, Shaver & Rhoades is molded to extremely close tolerances, (as little as .0005") through the use of glass-reinforced PLASKON Alkyd. Only this material had sufficient strength in thin sections to meet their requirements.





problem with **PLASKON**® alkyd

Here is another instance where PLASKON Alkyd was given a difficult . . . and highly specialized job to do, and succeeded with flying colors. General Electric needed a versatile, insulating material for separators between turns of carrier current line trap coils, and for nuts to bolt the line traps together.

Glass-reinforced PLASKON Alkyd Molding Compound was selected for both because it met all the specifications of physical and electrical endurance required. Alkyd has great resistance to arcing and leaking under high voltage, and when reinforced with glass, has extraordinary compressive, flexural and impact strength as well. It is self-extinguishing, has exceptional dimensional stability and is resistant to weathering.

The demand by industry and the military for a plastic to meet exacting requirements and offer mass production economies has made PLASKON Alkyd an obvious essential in today's specialized and highly advanced end-products. Have you investigated the unlimited possibilities of alkyd for your products? Why not call your local Plaskon man for complete information.

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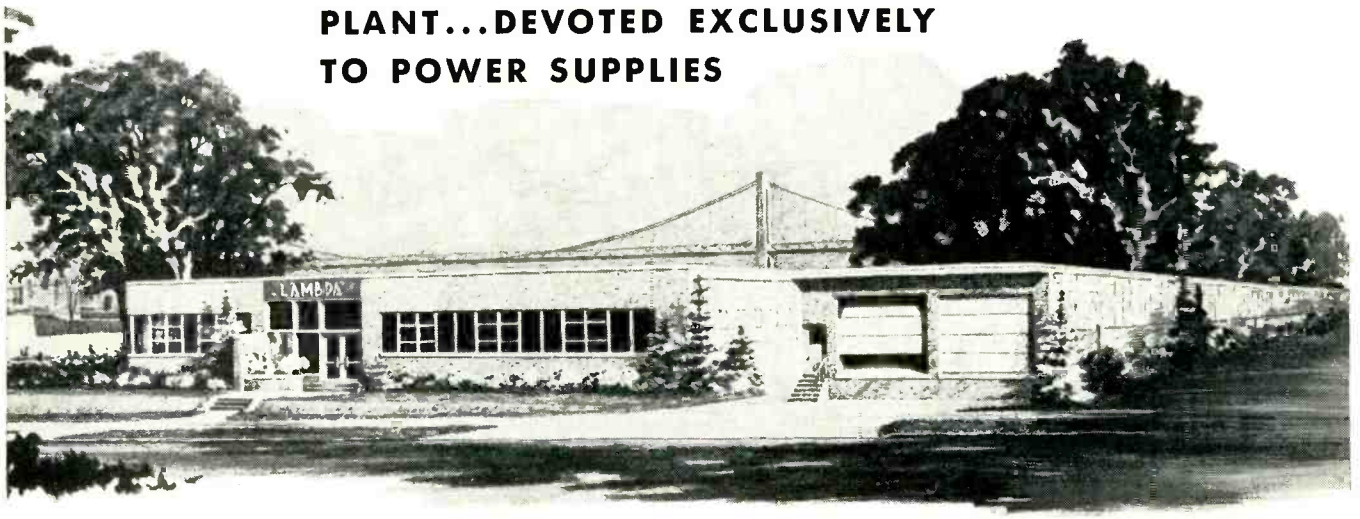
Send for your copy of the comprehensive *Lambda Catalog of Power Supplies for Laboratory and Industry.* If you have a special power supply problem, we will be glad to make recommendations.

LAMBDA OPENS MOST MODERN PLANT...DEVOTED EXCLUSIVELY TO POWER SUPPLIES



To meet the record demand for precision-engineered, factory-assembled power supplies, Lambda has constructed this new manufacturing plant at College Point, New York. The substantial increase in production capacity permits Lambda to ship models from stock under ordinary conditions; assures you of quick delivery.

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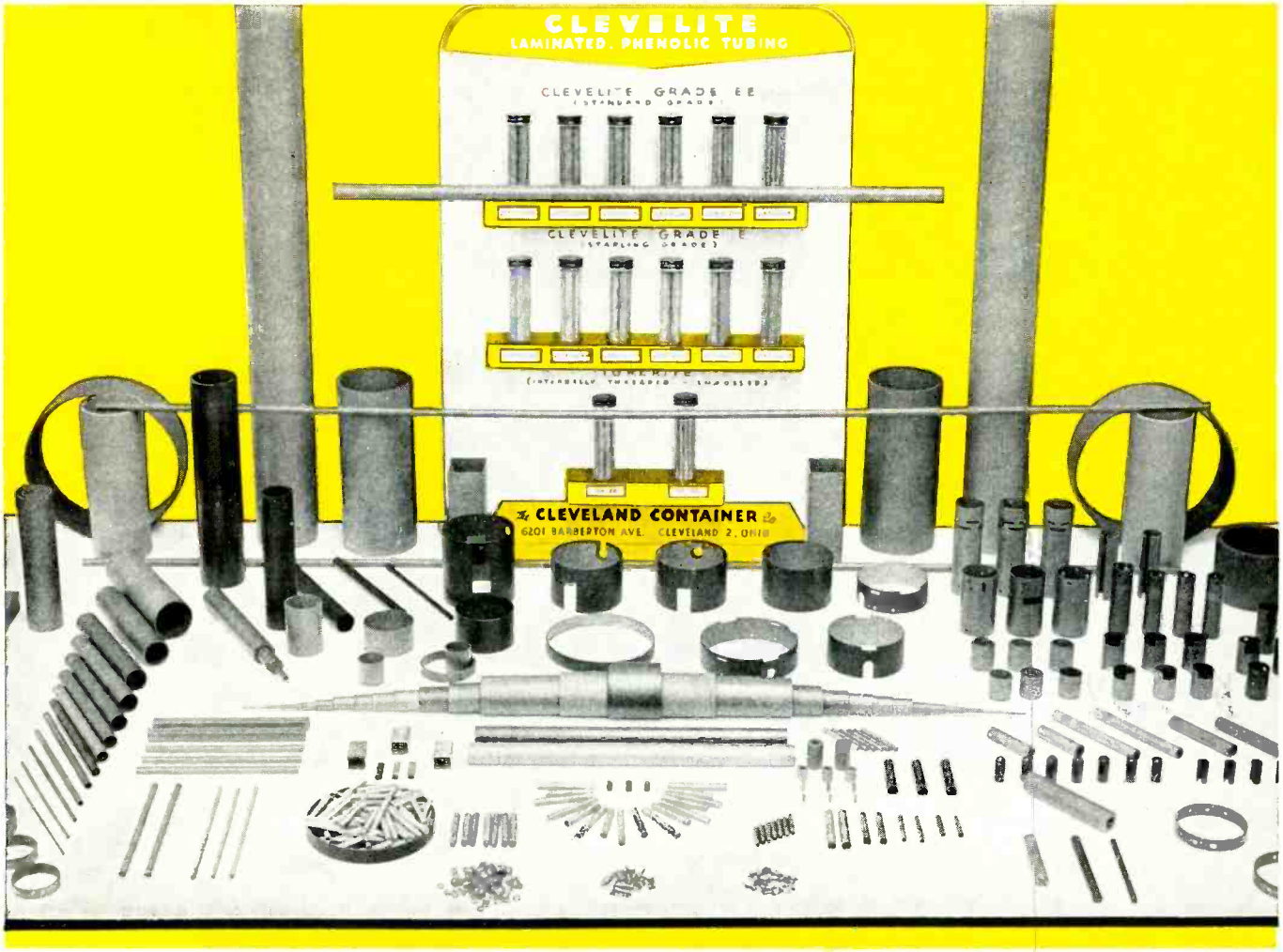

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★ ★ ★

INVESTIGATE this outstanding coil form!

★ ★ ★

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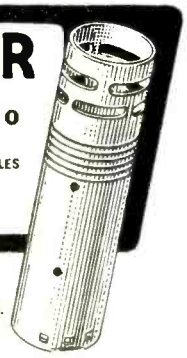

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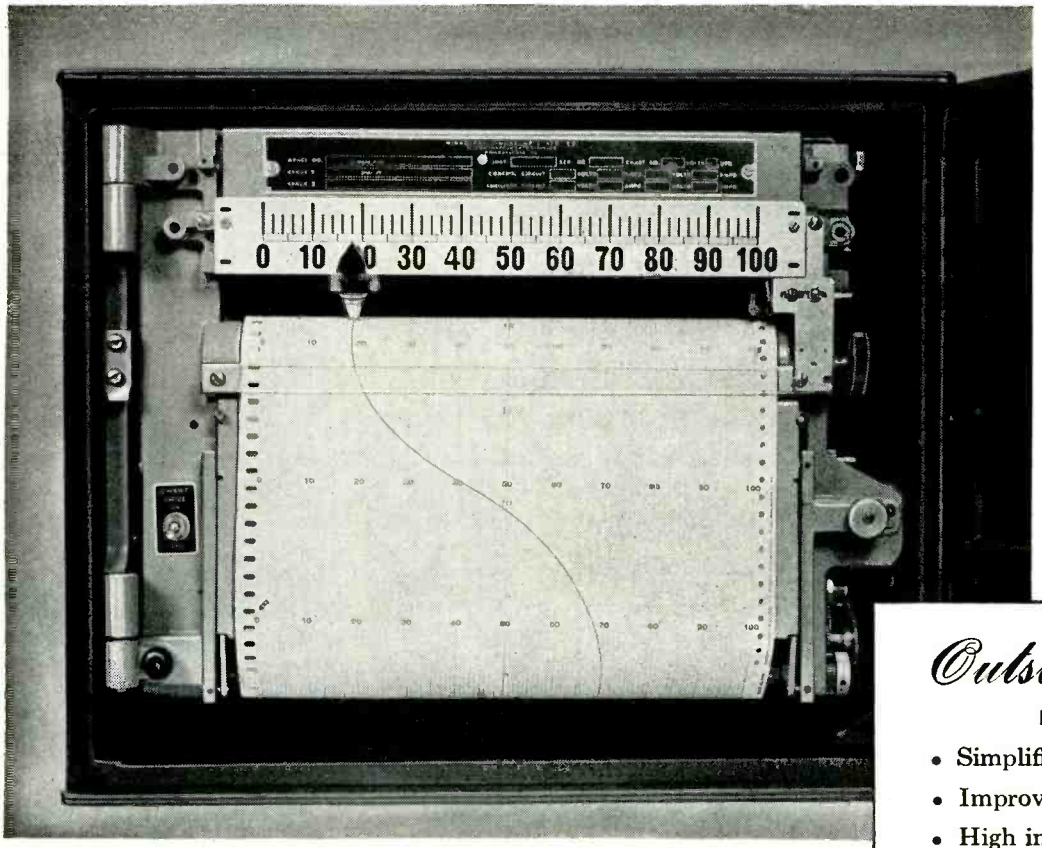

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NEW FEATURES

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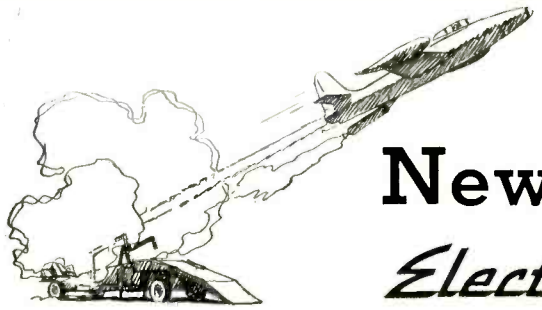

New 1/4-second *ElectroniK* recorder

follows fast-changing variables with split-second response

Designed to meet the special data-recording requirements of experimental stations, laboratories, and research centers, the new ¼-Second Pen Speed *ElectroniK* Recorder fills an important gap between conventional large-chart recorders and oscillographic instruments.

This new *ElectroniK* Recorder is the *fastest* large-chart instrument available today . . . the perfect solution for high-speed plotting of any function that can be reduced to a d-c millivolt signal. It offers the investigator extreme sensitivity, complete flexibility, laboratory precision . . . plus many *new* features the research man will appreciate:

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New slidewire and contacts—Designed for long life under high speed operation.

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● **REFERENCE DATA:**
Write for Instrument Data Sheet No. 10.0-21 "¼-Second Pen Speed *ElectroniK* Recorder."

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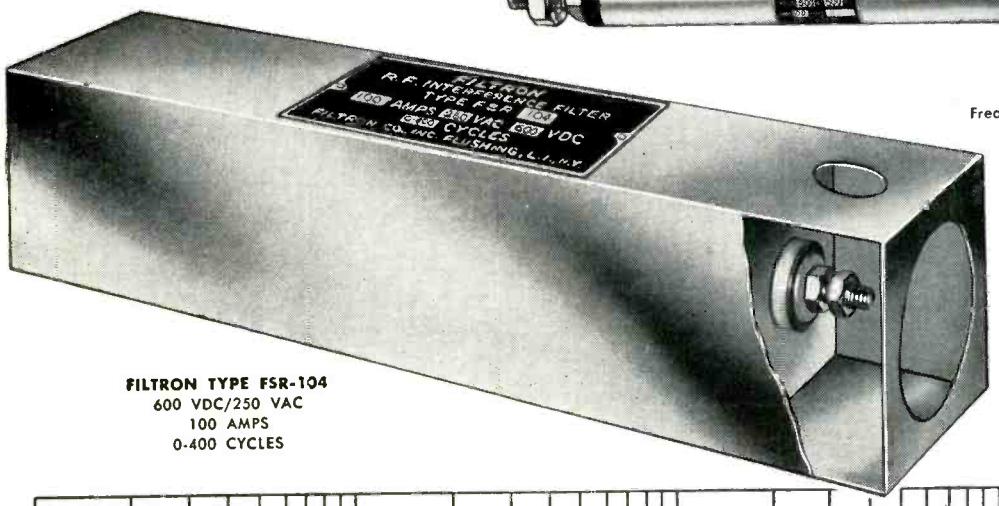
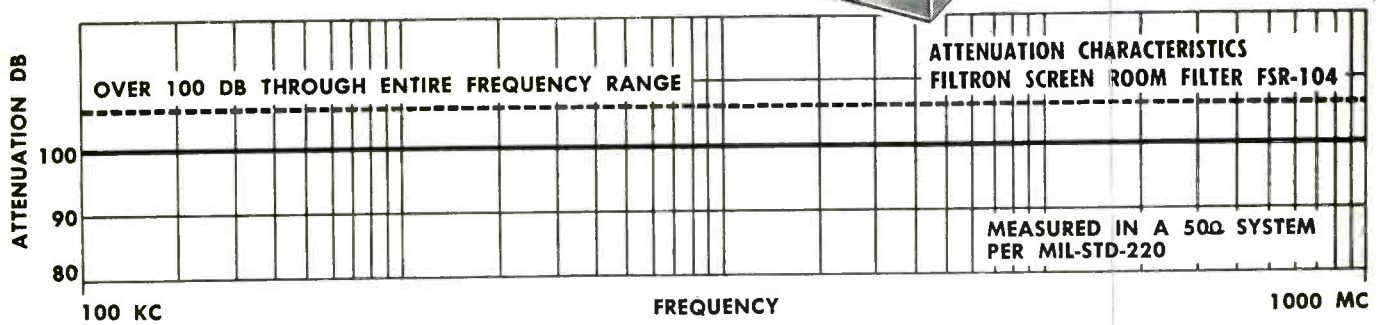


FILTRON TYPE FSR-104
600 VDC/250 VAC
100 AMPS
0-400 CYCLES



JUST OFF THE PRESS—Write for your copy

RADIO INTERFERENCE FILTER CATALOG

This 20 page catalog contains valuable data on FILTRON RADIO INTERFERENCE FILTERS for SCREEN ROOMS, INDUCTION HEATING EQUIPMENT, DIATHERMY SETS, X-RAY UNITS and other electrical interference-producing equipment. Included are illustrated installation recommendations, essential information on applications, attenuation characteristics and mechanical dimensions . . . Your copy gladly sent free upon request.

Screen room manufacturers specify and install FILTRON Screen Room Filters as standard equipment.

FILTRON Screen Room Filters are used in the majority of industrial, government and military screen rooms, to meet the requirements of specification MIL-S-4957, and wherever critical RF measurements are required.

FILTRON has over 40 types of Screen Room Filters available, ranging from 1 Amp to 1000 Amps, 28 VDC to 500 Volt AC/DC, 0 to 1000 cycles. Complete technical information available.

FILTRON RF Interference Filters are also specified in the latest types of Radar, Radio Transmitters, Receivers, Motor Generator Sets, Inverters, Aircraft, Electronic Systems, and numerous other "restricted" equipments.

When you have an RF Interference Filter problem, consult FILTRON—the most dependable name in RF Interference Filters.

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Redwood City, Cal.
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S. Sterling Company, Detroit, Mich.
R-O-R Associates, Ltd., Toronto, Can.
Montreal, Can.
Holliday-Hathaway Co., Inc., *Sales Offices at:* Canaan, Conn., Cambridge, Mass., New York, N. Y., Great Neck, N. Y., Rochester, N. Y., Binghamton, N. Y., Wood-Ridge, N. J., Winston-Salem, N. C.

An inquiry on your Company letterhead will receive prompt attention

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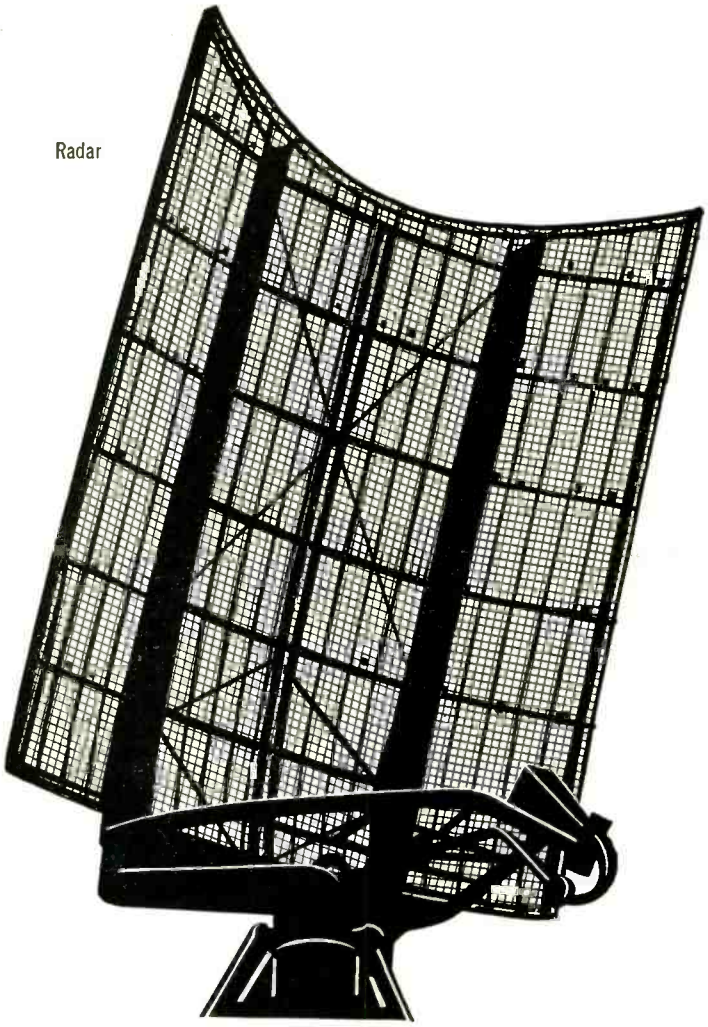
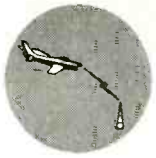
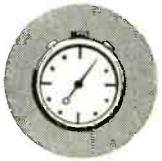


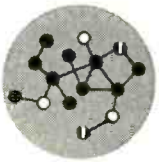
Radar



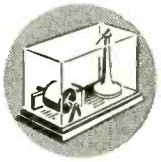
Navigation



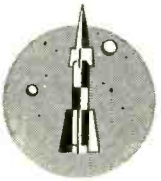
Timing



Nucleonics



Geophysics



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FOR GENERAL-PURPOSE LABORATORY USE

Generates pulses accurately spaced in time with respect to an internally generated reference pulse—range 0 to 100,000 microseconds

Complete generality permits numerous and varied uses such as radar range calibration, target simulation, generation of secondary frequency standards, elapsed time measurements, phase measurements, etc. Fields of application include Radar, Navigation, Telemetry, Nuclear Studies, Computor Research, Geophysics, Ordnance, and any other fields in which timing is significant.

The ability to generate a specific delay at accurate variable repetition rates sets this instrument apart from any other pulse or delay generator in the field today. Write for full details.

Pulses can be supplied under either one-shot conditions or at variable repetition rates. Both pulse delay and repetition period can be established in increments as small as 1 microsecond.

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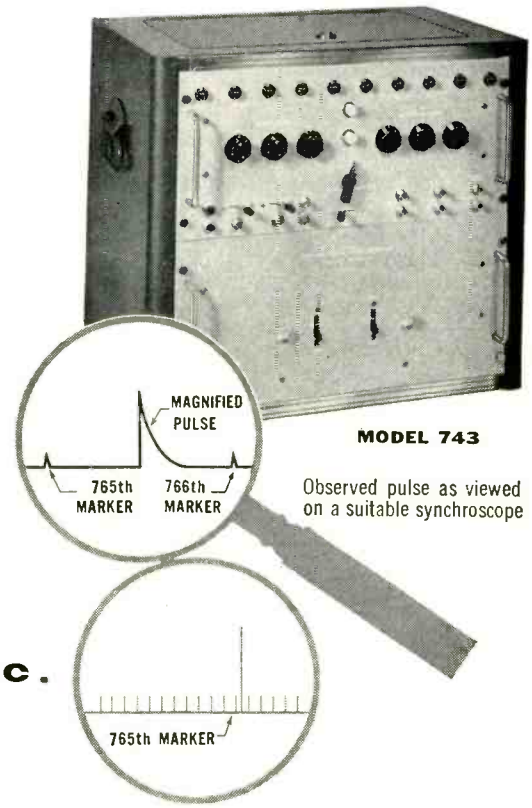

MODEL 743

Observed pulse as viewed on a suitable synchroscope

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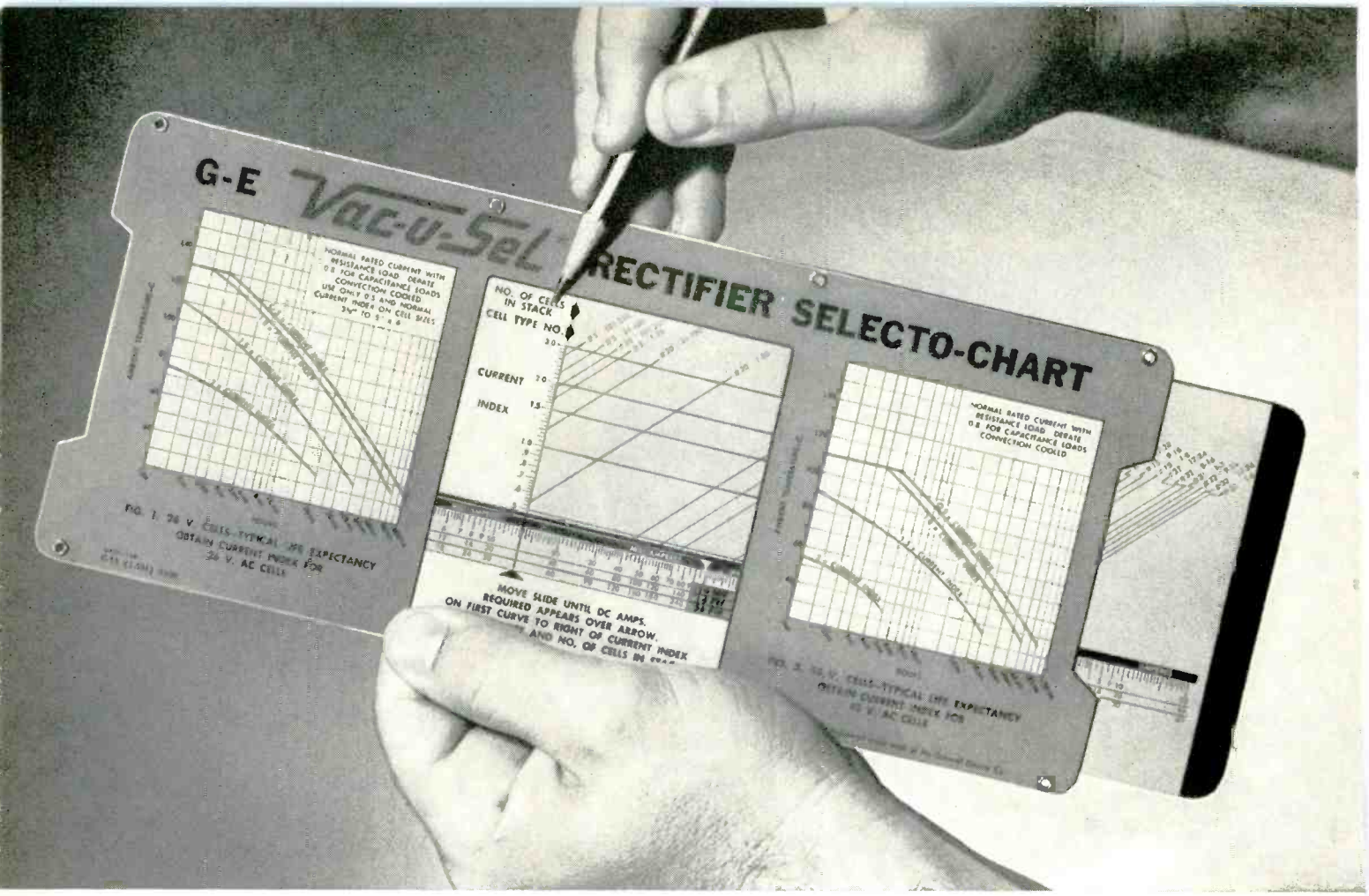

THIS G-E DESIGNED SELECTO-CHART, KEY TO THE NEW APPLICATION APPROACH, COMPUTES EXACT VAC-U-SEL RECTIFIER STACK YOU NEED.

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FOR MORE INFORMATION on this new application approach, or the outstanding Vac-u-Sel line of rectifiers, contact your nearest G-E Apparatus Sales Office, or write Section 461-38, General Electric Co., Schenectady 5, N. Y.

G-E SALES ENGINEERS are able to determine, on the spot, the exact Vac-u-Sel stack to suit your particular application.

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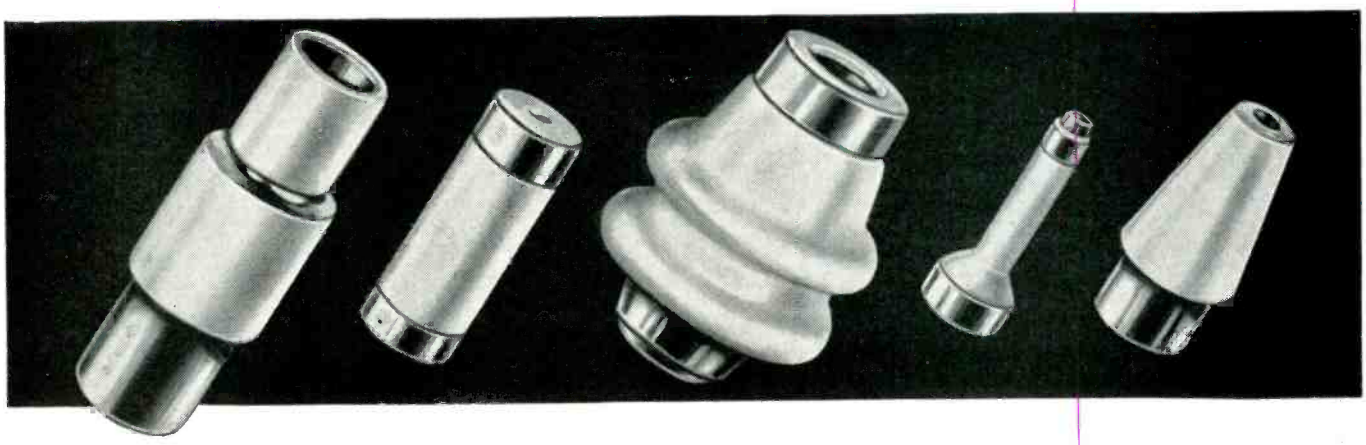
Want more information? Use post card on last page.

Here's an exciting new development in metallized ceramics!



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for use with both hard and soft solders!

Here is Frenchtown's revolutionary answer to a problem that has baffled industry for years . . . a satisfactory *single* metallic coating for refractory ceramic bodies which provides a surface for applying solders with melting points between 275° and 1600°.

NICOTE, applied to refractory ceramic bodies by high temperature firing, in most applications requires no expensive preliminary processing such as buffing, electroplating, or tinning to form a strong, firmly-adhering bond with either *hard* or *soft* solders.

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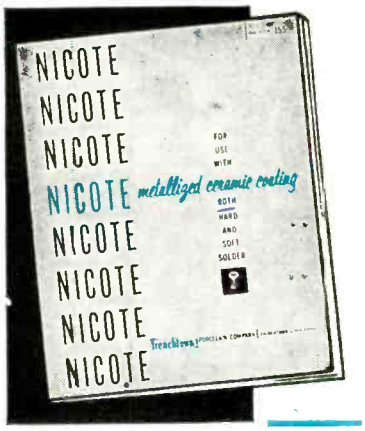
NICOTE'S mechanical bond to the refractory ceramic body approximates ceramic strength, making it ideal for hermetic seals, high strength mechanical seals, and vacuum type applications.

Like to know more about the amazing possibilities of NICOTE Metallized Ceramic Coating for your product? Bulletin 155 contains complete engineering details. Write for a free copy today. There's no obligation, of course.



This idea starter is free for the asking . . . contains complete facts and details about NICOTE . . . Frenchtown's new **single metallic coating** for use with both hard and soft solders. Ask for Bulletin 155.

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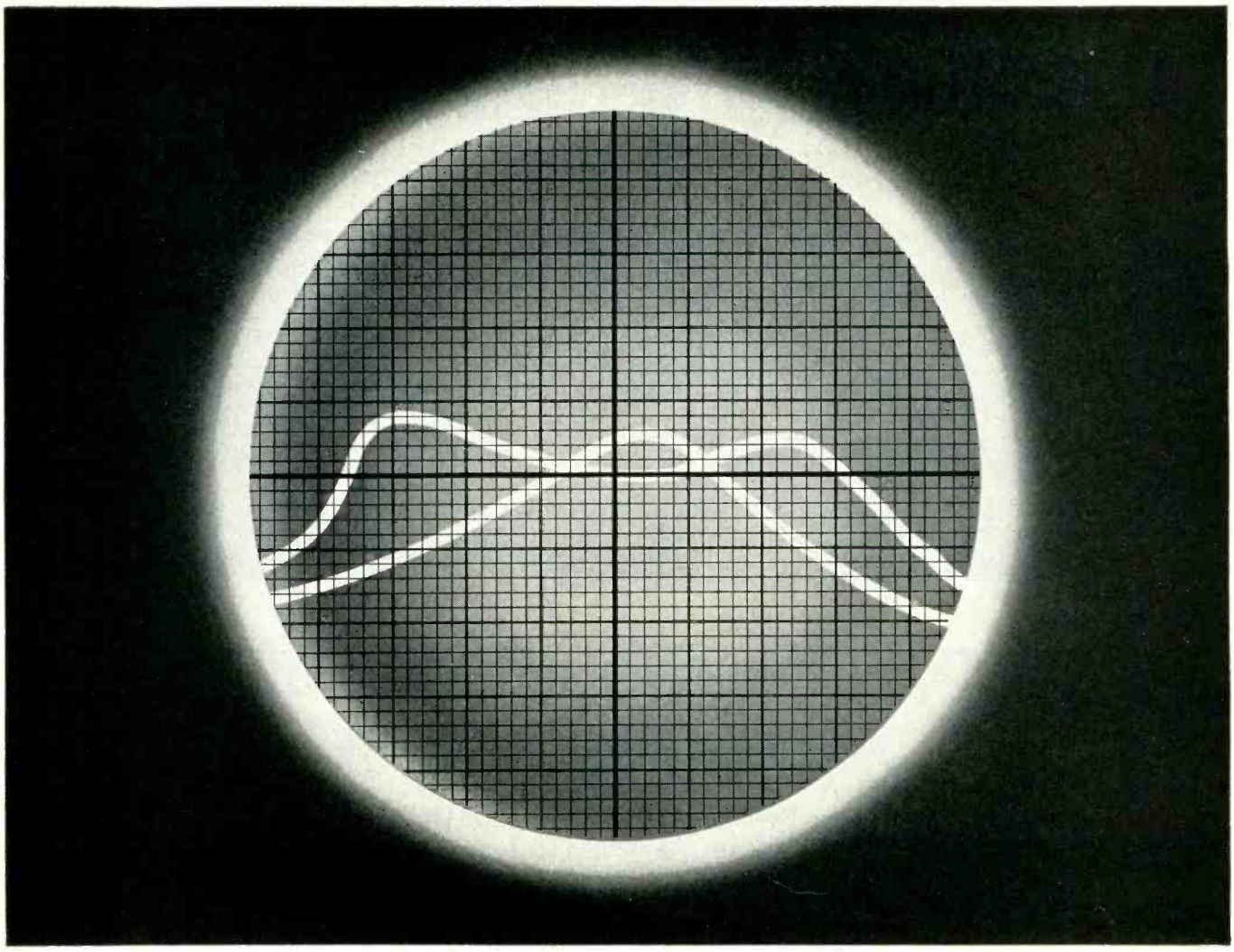

how can vacuum-melted metals help the electronics industry?

When a metal is melted and cast in a vacuum, the gaseous impurities are literally sucked out. The result is an important improvement in many critical properties.

For example, cathode nickel alloys, iron, and alloys for metal-glass seals — are all produced to extremely close standards of composition and uniformity. Soft magnetic alloys exhibit improved permeability, both initial and saturation. Copper shows marked increase in purity and soundness.

Vacuum-melted components greatly increase vacuum tube life and reliability. That's because the vacuum-melting process degasses these metals *before they are placed in the tube.*

Vacuum Metals Corporation, pioneer in development and leading producer of vacuum-melted metals and alloys, can now offer you a wide range of metals for electrical or electronic applications. If you would like to see how these remarkable new materials can fit into your own production, write on your company letterhead, describing the application in which you are interested. *Vacuum Metals Corporation, P.O. Box 977, Syracuse 1, New York.*

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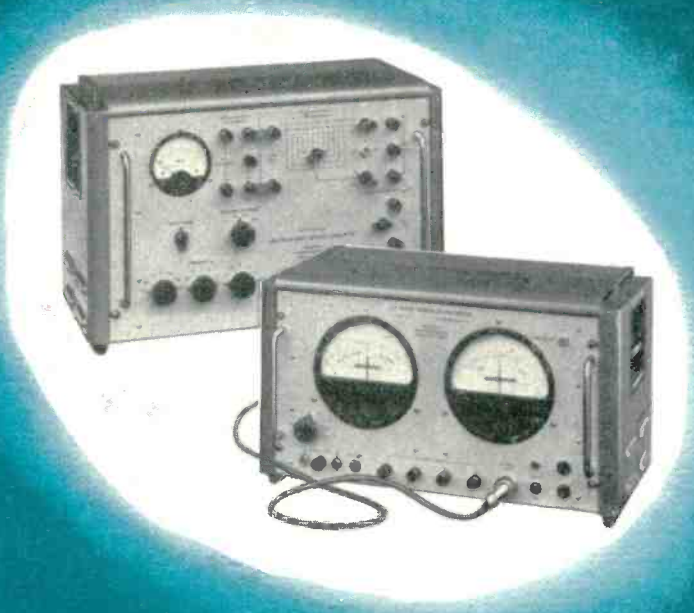

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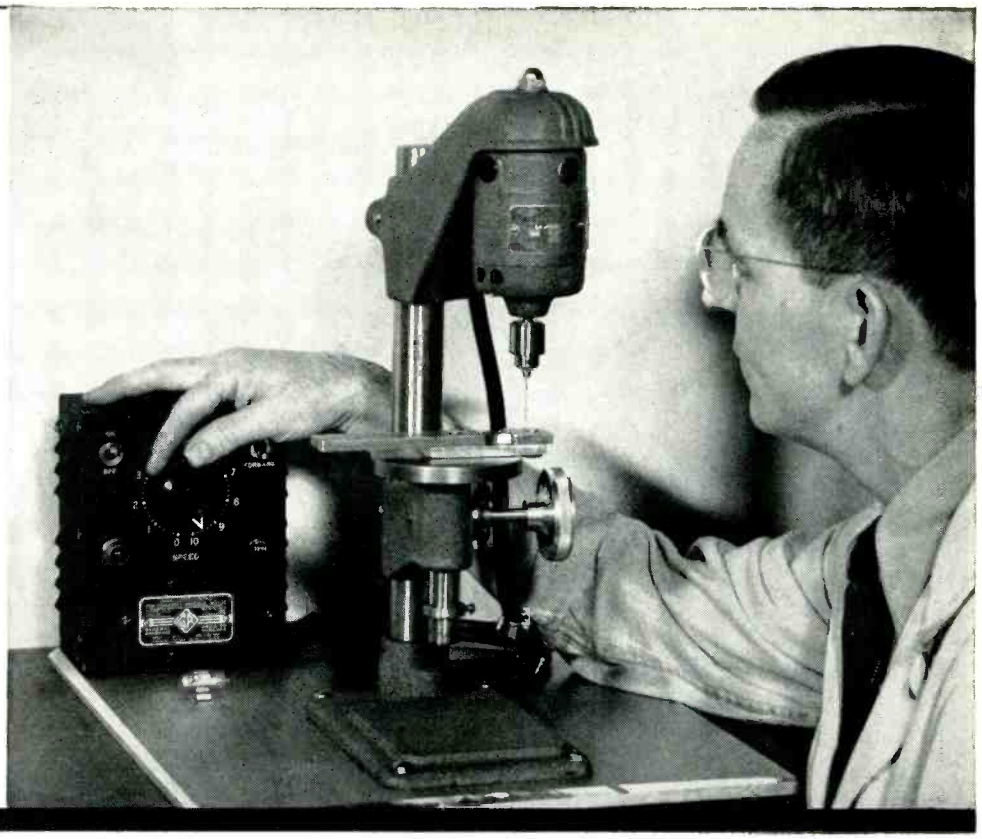
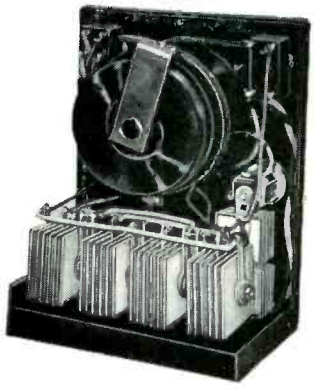
Radio Receptor Selenium Rectifiers



....Deliver Top Performance in Variac Motor Speed Controls

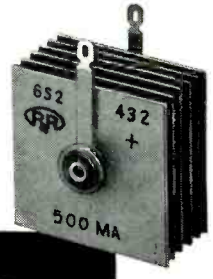


One of General Radio's Variac Motor Speed Controls showing a typical application of Radio Receptor Selenium Rectifiers. Six RRco. units are employed here.

Back in 1948, General Radio Co. of Cambridge, Mass. posed tough rectification problems to us involving their compact new Variac Motor Speed Controls. Working closely with their engineers then and since we have come up with the answers. As a result, Radio Receptor rectifiers have successfully been used in units rated at 1/15, 1/6 and 1/3 hp for field and armature supplies.

General Radio tells us that year after year *for seven years* the service record of these Radio Receptor rectifiers has proved they are worthy components of a fine product – that they are long lived and really reliable in constant use in many diversified applications.

You see, it pays to talk to Radio Receptor specialists when the circuit calls for rectifiers. We'll gladly offer practical suggestions concerning *your* problem, too. Write us now!



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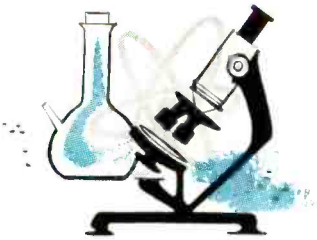
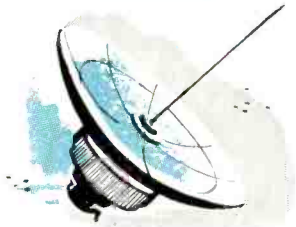
In Defense and Industry

RESEARCH



Applied Physics, Circuit Research, Solid State Physics, Low Temperature Physics.

RADAR



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Photomultipliers, Storage Tubes, Image Tubes, Infrared Tubes.

MISSILE

Guidance and Control System, Test Equipment.

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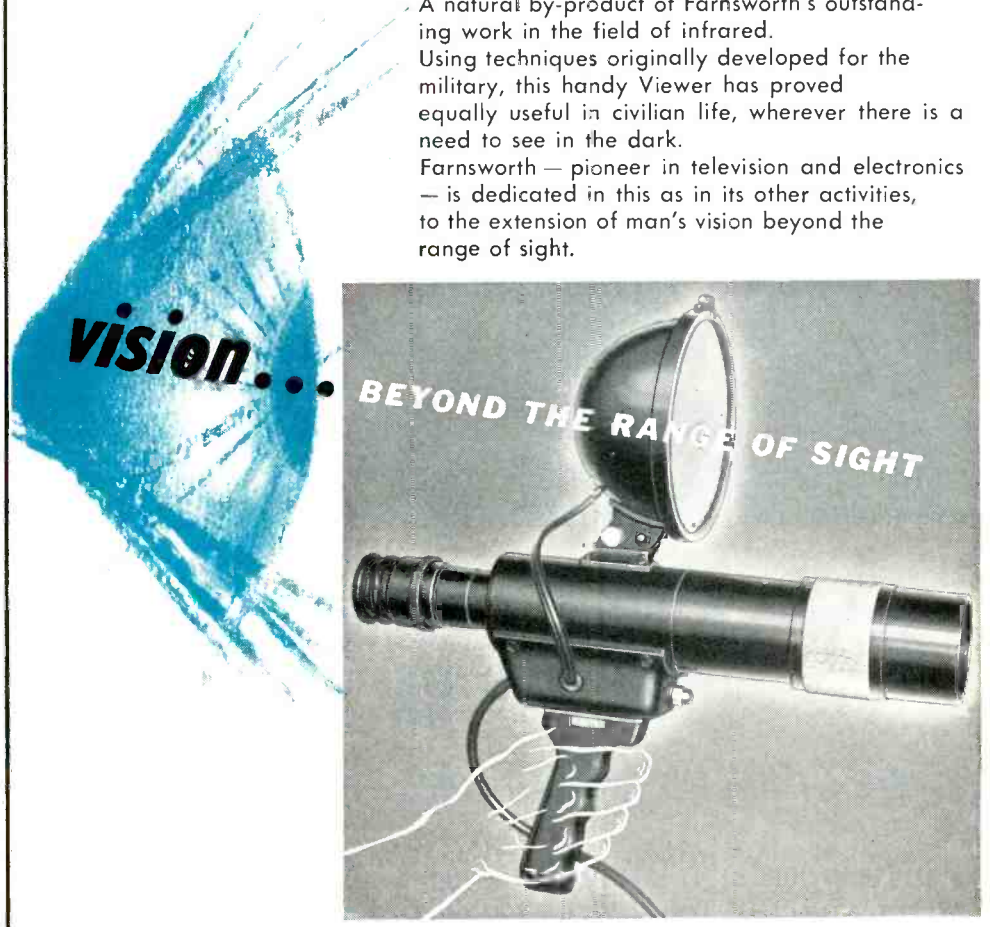
Lets you see in the dark!

Another Farnsworth Achievement!

A natural by-product of Farnsworth's outstanding work in the field of infrared.
Using techniques originally developed for the military, this handy Viewer has proved equally useful in civilian life, wherever there is a need to see in the dark.
Farnsworth — pioneer in television and electronics — is dedicated in this as in its other activities, to the extension of man's vision beyond the range of sight.



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For more information on the Infrared Viewer and other outstanding Farnsworth achievements write Dept. V-105.

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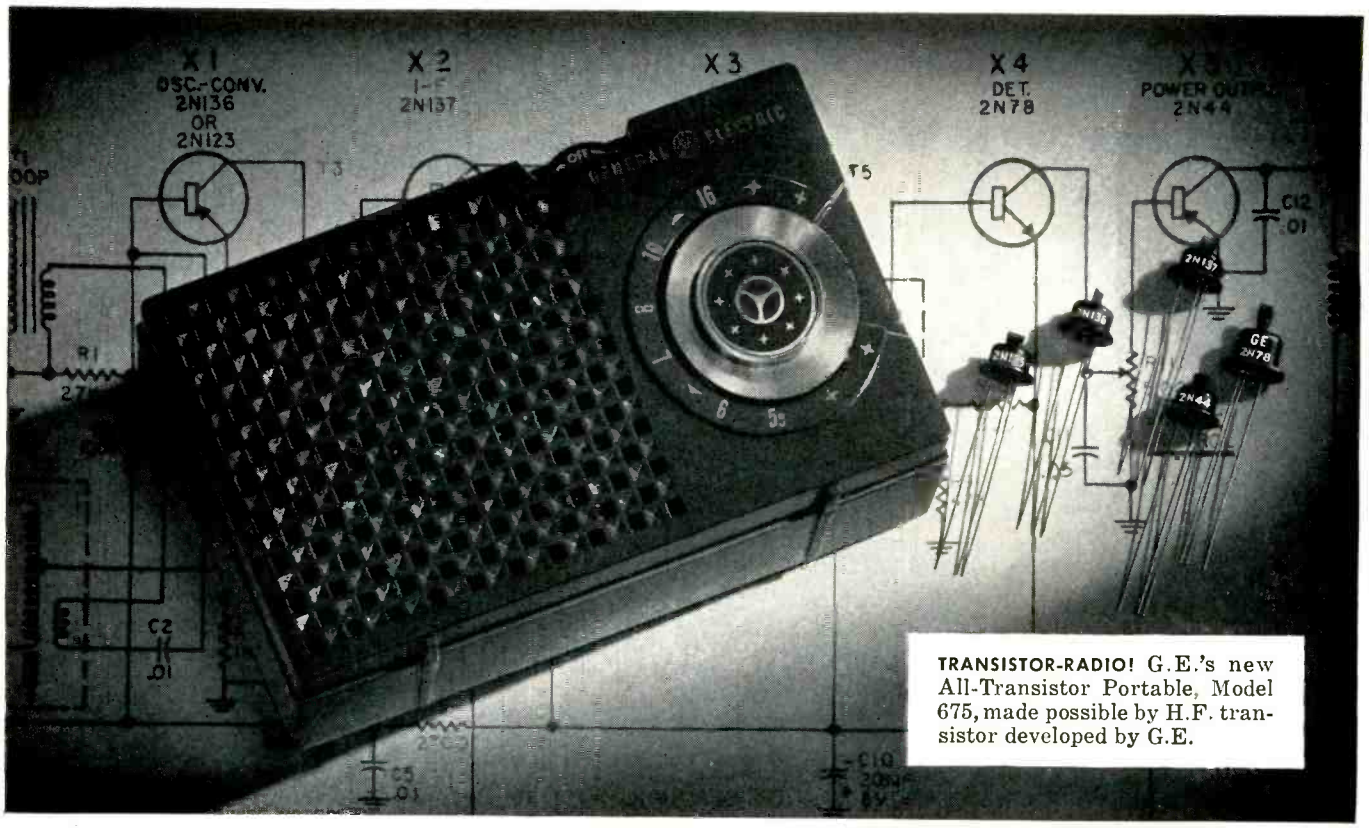


TRANSISTOR-RADIO! G.E.'s new All-Transistor Portable, Model 675, made possible by H.F. transistor developed by G.E.

NOW—A FULL LINE OF G-E H.F. TRANSISTORS FOR ALL RADIO APPLICATIONS

New G-E H.F. PNP Transistors, 2N135, 2N136, 2N137, Complement the G-E 2N78 NPN

THIS new line of G-E High Frequency PNP Transistors offers immediate benefits to electronics manufacturers for use in RF and IF amplifier circuits. The new High Frequency designs, now in full production, were created specifically for use in radio circuits. The line provides minimum alpha cut-offs of 3 MC, 5 MC and 7 MC—coupled with a 5 ua maximum collector cut-off current. The result: all the high-gain and high-power advantages of other General Electric transistors, *plus* operating ranges extending from 3 to 15 MC depending on the transistor selected.

NOW IN COMMERCIAL RADIO CIRCUITS

In the circuit above, the 2N136 is used as a converter—its 5 MC minimum alpha cut-off assures stable oscillator performance and high conversion gain. The 2N137 —with 7 MC minimum alpha cut-off—provides 33 db gain at 455 KC. The high frequency 2N135 offers a higher collector voltage rating for the second IF where it is needed. The 2N78 NPN transistor—originally designed for computer and RF circuitry—proved ideal as a power detector and audio amplifier to drive a 2N44 power output transistor with direct coupling.

PRODUCTION QUANTITIES AVAILABLE

General Electric's new high frequency line is in mass production now. Detailed characteristics and specifications of the G-E 2N135, 2N136, and 2N137 transistors may be obtained upon request. Your G-E Semiconductor specialist and our factory application engineers have the answers to your transistor radio circuit questions. Call them in, or write: *General Electric Co., Semiconductor Products, Section X4115, Electronics Park, Syracuse, N. Y.*

Progress Is Our Most Important Product

GENERAL ELECTRIC

MEMO

FROM: THE ENGINEERING STAFF AT NJE

TO: DESIGNERS WHO USE HIGH-CURRENT REGULATED POWER SUPPLIES (for computers, aircraft electromechanics, mobile electronics, etc.)

SUBJECT: **What is Zero-Lag?**

We got tired of defining response time...so we got rid of it. Here's how:

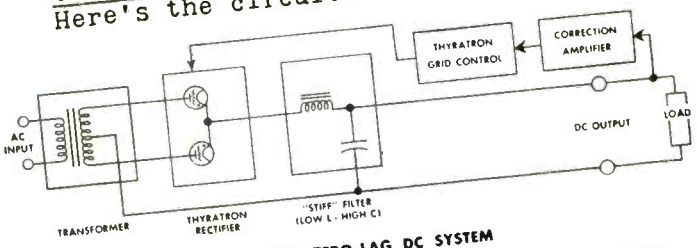
Response time is rarely a problem if vacuum-tube "series regulator" techniques can be used. Correction for rapid load or line fluctuations is fast, and a small capacitor across the power supply output will "soak up" the small transient which occurs.

Above an ampere or two, however, the series regulator is pretty sad. Too hot. Inefficient. Expensive. Too many tubes. Too much maintenance. It is especially sad at low output voltages.

We say this without prejudice...for we build all seven types of electronic power supplies, including dozens of special series-regulator units every month.

But, when a customer comes to us for a recommendation on, say, a 10-40 volt, 20-ampere unit to actuate a high-speed jet-engine valve...or a 150 volt, 60-ampere unit for a computer plate supply...if he needs freedom from transient lags, we recommend the only system we know that will meet his requirement economically -- **NJE Zero-Lag**

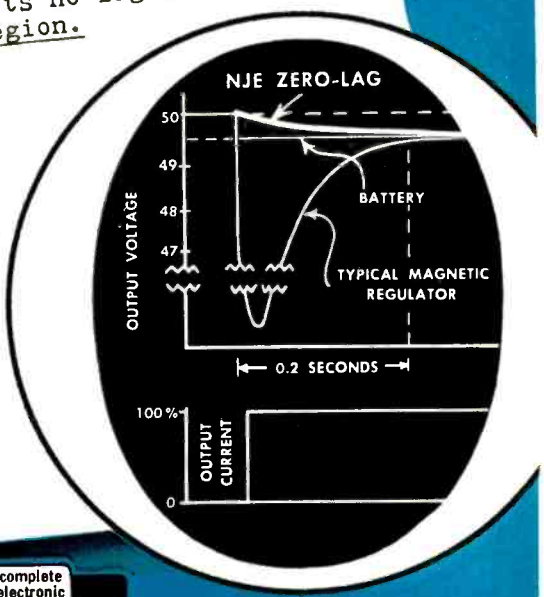
Basically, our zero-lag system exhibits no lag because the voltage never leaves the regulated region. Here's the circuit:



THE ZERO-LAG DC SYSTEM

The trick is in the thyratron response speed, and in the value of "C" — which is often as much as a farad. (Don't let anyone ever tell you the farad isn't a practical unit — we have over 80 farads working in the field right now.)

If you have transient problems in the 0-500 volt, 0-100 ampere range—call or write us. The "lag" in our custom quotation department is about one week — but the lag in our power supplies is zero . . . absolutely zero.



For our complete line of electronic power supplies See electronics Pp. 113-120 BUYERS' GUIDE

Write for Catalog Z-5

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POWER SUPPLIES UNLIMITED

New Mallory Cardboard Tubular Capacitors

. . . premium performance at no increase in cost

Never before has quality like this been built into cardboard tubular electrolytics. At no increase in price, this new series developed by Mallory offers you a combination of features unique in this type of capacitor:

Minimum size, high ripple current ratings, low RF impedance . . . obtained through use of genuine fabricated plate anodes.

Long life, high stability temperature rating up to 75°C . . . due to fabricated anode and etched cathode.

Low leakage current.

Low-resistance tab-to-lead wire connections . . . welding ends danger of intermittent or high resistance connection.

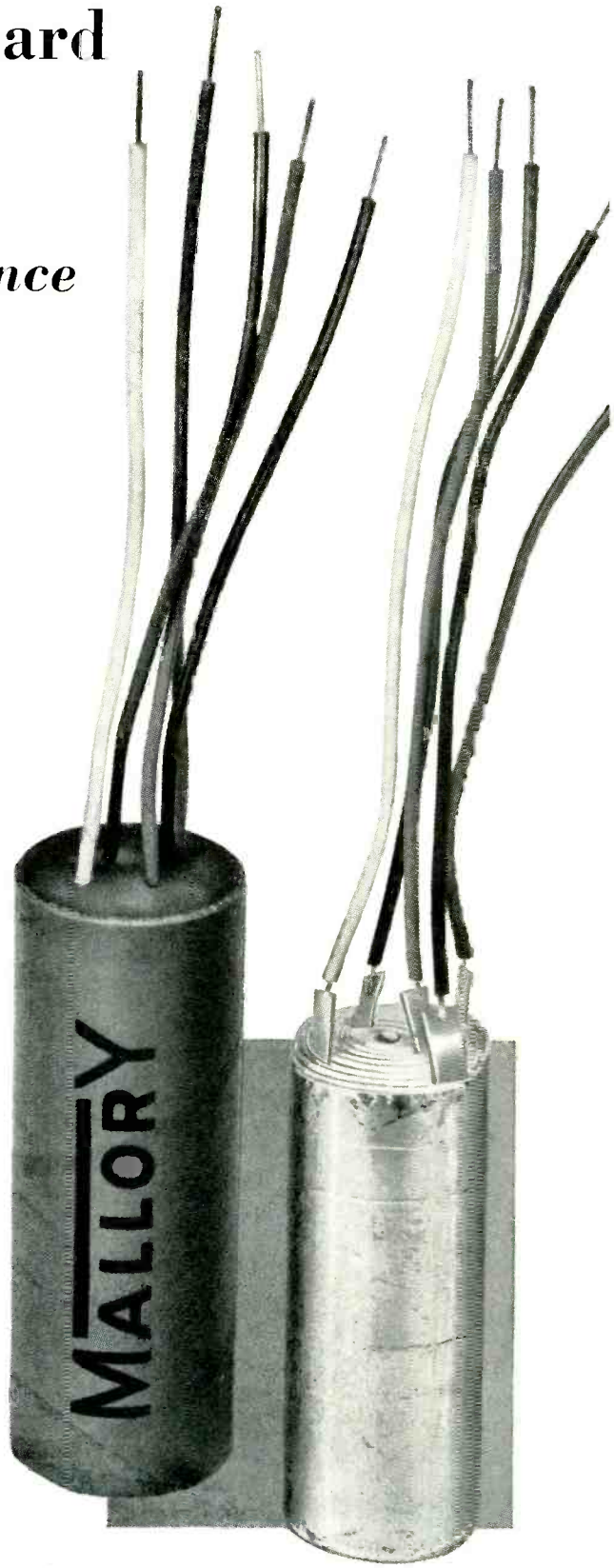
Low moisture loss . . . cartridge is foil wrapped; wax impregnated cardboard tube is sealed with wax at both ends.

High dielectric strength, exceeds U.L. requirements, due to improved low-moisture absorbent separators.

Rugged, flexible leads . . . covered with plastic insulation rated for 105° C, have U.L. approval.

The new series comes in single, dual, triple and quad sections, with leads all coming from one end or from opposite ends of the cartridge. A complete choice of voltage and capacity ratings is available.

For technical data, write or call Mallory today. A Mallory capacitor engineer will be glad to consult on your circuit requirements, to suggest possible cost-cutting simplifications based on Mallory's long experience in all types of applications for electronic components.



Inside of the case is this foil-wrapped cartridge. Tabs are welded to the leads, to prevent intermittent connections.

Parts distributors in all major cities stock
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Serving Industry with These Products:
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electronics

W. W. MacDONALD, Editor

NOVEMBER • 1955

CROSS TALK

► **D.O.A.** . . . At the risk of shoveling sand against the tide, we wonder if right now would be too soon for manufacturers to pay more attention to the way their products work when they reach the ultimate consumer.

Some of the stuff reaching the home, in particular, was skimped in design, left the production line even closer to the ragged edge, and proved to be dead-on-arrival at the final doorstep. And in this day of deals and discount houses, more salesmen than servicemen, the baby more than ever before is at the tender mercy of its parents. Even if this were not so it would be difficult for middlemen to fix what wasn't there in the first place, and if they could fix it it wouldn't stay fixed long.

Now, we bought the idea of mass-production-to-reach-more-people at cribside, and still think it is the best basis for the American economy. But just how far can a good thing be carried? Certainly not to the point where merchandise fails to satisfy, even if it is cheap.

There should be more design margin . . . *and men with a conscience*. More rugged assembly . . . *and men with a conscience*. More careful adjustment . . . *and men with a conscience*. More critical testing . . . *and men with a conscience*.

Or there will soon be more manufacturing reputations marked dead-on-arrival.

► **LOCK AND KEY** . . . If technical manpower is the key to the future, then one of the locks that will open the door is represented by guided missiles.

Important in itself, the guided missile program involves advances in just about every known application of electronics. Among these are remote control, navigation, telemetering and television. Then there are less conventional refinements, already in use but currently classified. And, what is more important, an inkling of completely unconventional things to come gleaned from research in the upper atmosphere.

► **COMPUTER CAROLS** . . . With Christmas not far off, we are reminded that last year at least two labs set up their computers to play yuletide melodies at employee parties.

Don't know just how it was done because our informants want no publicity about how they set up electronic giants to do the work of a small boy.

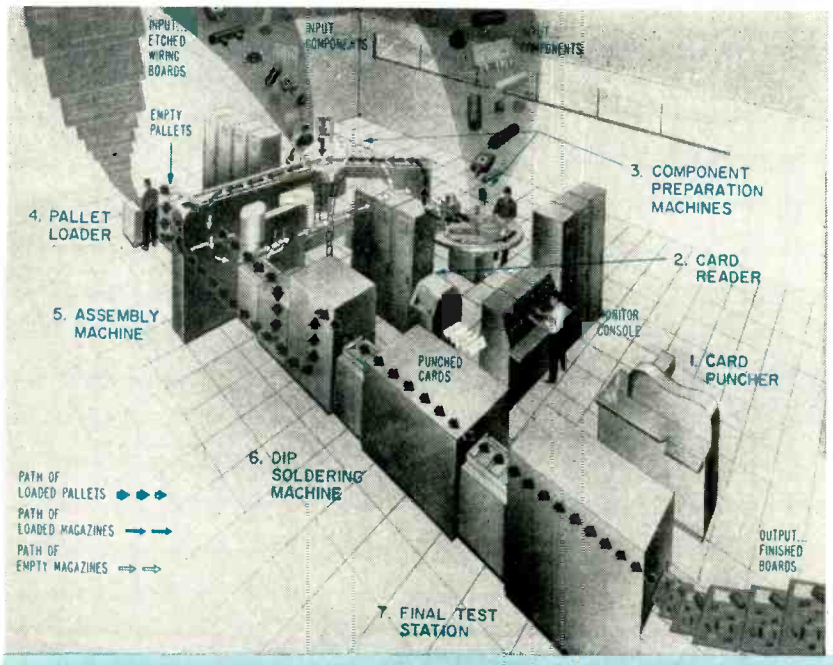
LOOKING AHEAD . . .

Flashlight-battery-operated transistorized radios can eventually compete successfully in initial cost and operating cost with power-line-operated sets, and we don't mean just portables

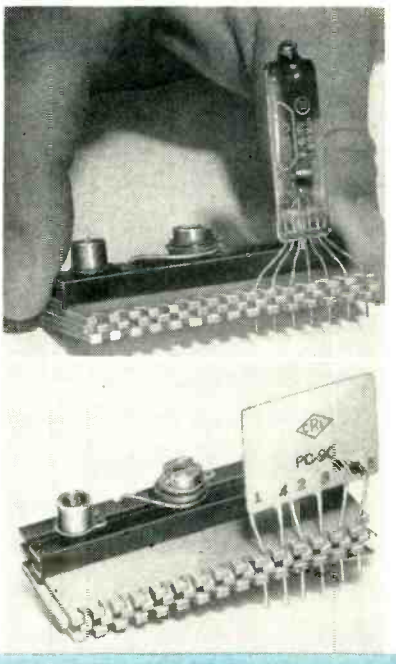
Ultrasonic shaker-uppers are quietly being bought by doctors, may supersede diathermy for many therapeutic uses

Long-playing phonograph records are not necessarily forever wedded to present speeds, could someday turn slower. Also, monogroove binaural disks using a vertical cut for one channel and a horizontal for the other are a commercial possibility

The speed with which manufacturers push color-tv probably depends more than anything else upon the extent to which the public does or does not buy up monochrome stocks by Christmas



COMPLETE SYSTEM—Individual machines, now being tested, will be arranged as in this artist's sketch, requiring only 1,200 sq ft of floor space. Four operators can keep system running at full output of up to 120 boards per hour



CARRIERS—Leads of each component are held accurately in position by three-comb spring-loaded carrier

Punched Cards Control

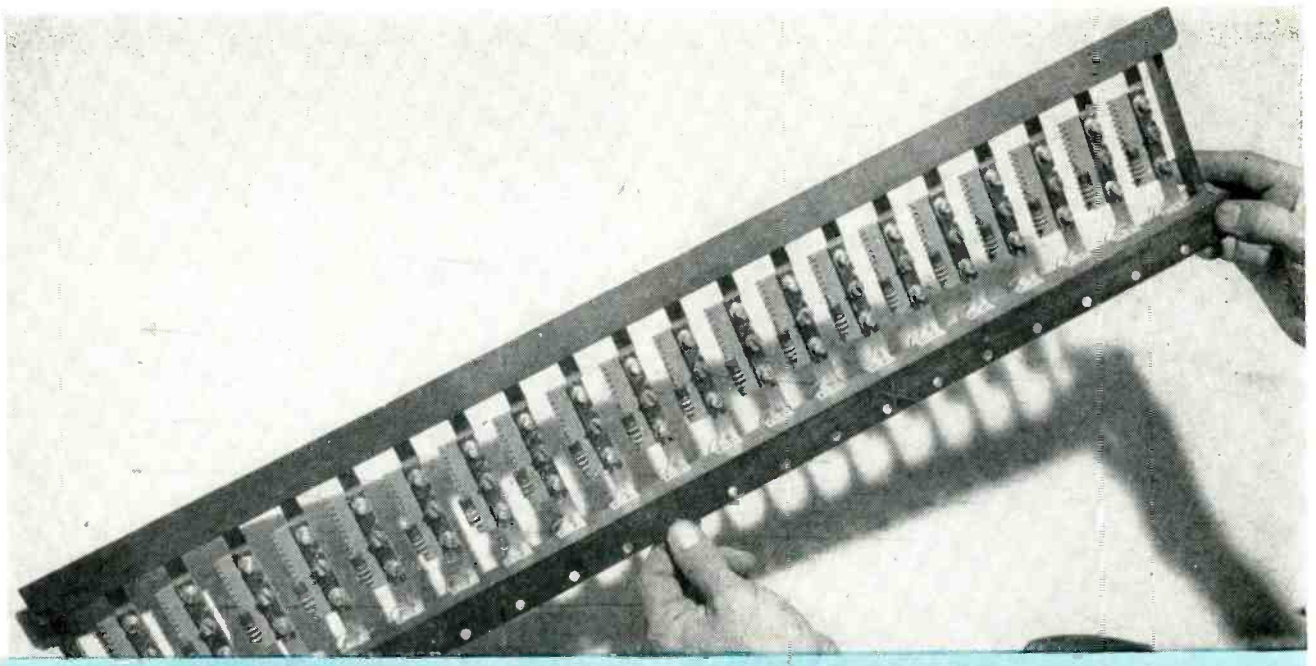
SUMMARY —— Programmed single-station automatic assembly machine turns out completely soldered etched-wiring boards in batches of up to 20, as required for many types of military electronic production. Components are inserted at rate of 1,600 per hour as boards on pallets recirculate under single placement head

MANUFACTURE of electronic subassemblies in job-lot quantities of 10 to 50 is a common requirement in the production of complex military electronic systems. Use of etched wiring and dip soldering in conjunction with a memory-controlled automatic assembly system provides the flexibility and ease of changeover desirable for this type of production, along with a means for stockpiling production know-how stored in punched cards or other data storage mediums. Such data can then be used in time of emergency to produce electronic equipment with a minimum of delay in machine setup and human operator training time.

The Signal Corps automatic component assembly system, as built by GE for job-lot electronic production, uses one operator to load etched and punched wiring boards into empty pallets at the pallet loader, two operators to feed components into the two component preparation machines and a fourth to supervise the entire operation at the monitor console. The cards required for control can be prepared at any time beforehand by an operator familiar with a standard card puncher.

The card reader automatically supplies punched-card data for controlling the component preparation machines. These prepare components, load them into individual carriers, test the components, then load the carriers into magazines.

The assembly machine takes components from the carriers one by one and inserts them in the etched wiring boards that circulate on pallets in batches through the machine.



MAGAZINE—All components go through assembly machine in magazines like this, each holding 20 carriers. The one-watt resistors shown here in the carriers have leads already cut and formed, ready for insertion and clinching. Transfer head in placement machine removes a carrier for unloading, then puts empty carrier back in magazine

Job-Lot Assembly System

By GEORGE W. GAMBLE, CHARLES J. GODWIN

General Electric Advanced Electronics Center
Cornell University, Ithaca, N. Y.

and FREDERICK S. FELDHEIM

Signal Corps Supply Agency
Philadelphia, Pa.

When all components have been inserted, each assembly automatically passes through the dip soldering machine and the final test station.

All operations, from the initial preparation of the components to the final testing of the completed equipment, are automatic and are controlled by a central program set up by Remington Rand punched cards. The entire setup requires a floor area of only 30 by 40 feet. To change from one type of product to another, it is merely necessary to change the program cards and the raw components being fed to the machines.

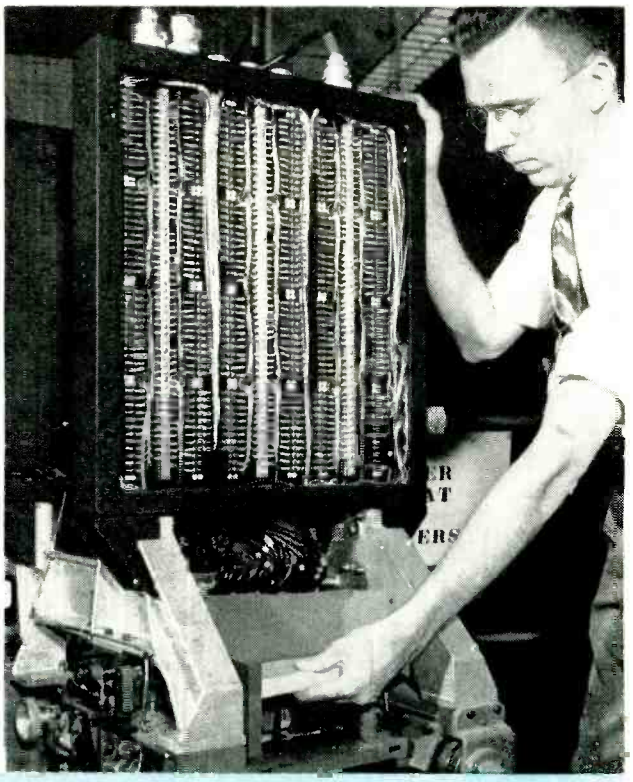
The component placement rate of this system is 16,600 per hour on wiring boards having a usable area of from 1 by 1 inches to 8 by 12 inches. The number of components per assembly is limited only by the usable board area. Completed assemblies are soldered at the rate of 120 boards per hour and tested at the rate of 5 tests per second.

Operation of System

Components as received from the supplier are fed into the two component preparation machines by the operators. Here the leads are automatically straightened and formed, the components are placed in comb-like component carriers and tested and the carriers are loaded in magazines. Each magazine holds 20 like components. Prepared components are held in magazine hold areas until called for by the punched cards. A conveyor system then transports the magazines to the placement head.

The batch concept of board and component handling has been adopted in the design of this sys-

CARD PUNCHER—Keyboard of commercial model has been modified to punch binary members for programming the various machines of the Automatic Component Assembly System

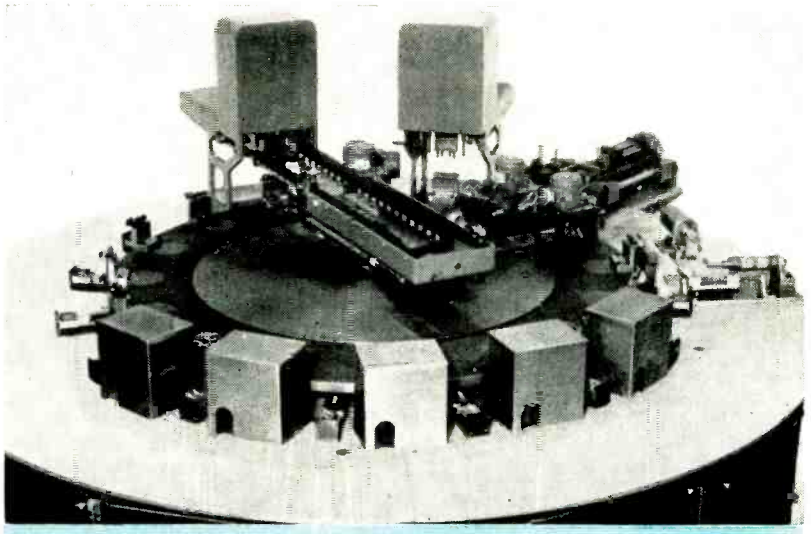


CARD READER—Minor modifications and addition of terminal boxes permitted use of standard reader, connected into control circuits of machines. Operator is loading pack of cards

tem. Up to 20 boards on pallets are fed to the placement head of the component assembly machine, along with magazines containing the required components. The board and the placement head are then servoed to their proper positions to place the first component in its position on the board and clinch its leads under the board. All boards pass under the placement head and receive this component. The exhausted magazine is then ejected from the placement head, a fresh magazine is inserted and the placement cycle repeats. The process continues until all components are placed on all boards in the batch, after which the batch is passed on to the dip soldering machine. Boards are circulated through the placement cycles by a conveyor system and two elevators.

Empty magazines are automatically returned to the component preparation machines for reuse. Empty pallets are likewise returned to the pallet loader. A wide variety of lead-mounted components can be handled, including resistors, capacitors, subminiature tubes and resistor-capacitor couplates.

Indicator lamps on the monitor console, which give warning of system failure, are illuminated only when a fault occurs. Indicator lamps connected purely with maintenance, such as those used to assist in locating relay failures in event of system breakdown or to check correct operation of relay trees, are located elsewhere and are switched in only when needed. Lamps at the component preparation machine are lighted to convey



COMPONENT PREPARATION MACHINE—Components loaded manually into hoppers of this machine are automatically inserted in carriers for cutting of leads and testing, after which carriers are loaded in magazine above turntable

command, otherwise remaining unlit. Lamps on the final test machine come on only to indicate the nature of a defect in an assembled board. After test, the boards are stamped to signify acceptance or rejection, then discharged from the system at the unloading station.

Component-Handling Methods

Axial-lead components retained in corrugated cardboard strips are loaded in batches into the axial-lead component preparation machine. Here the leads are straightened and formed, then loaded into component carriers. The carriers in turn are passed through lead-trimming and test positions, then loaded into magazines.

Radial-lead and multiple-lead components are fed manually one by one through straightening dies into the carriers, then passed through lead-trimming and test positions the same as for axial-lead components.

Each component preparation machine has a 16-head indexing turntable 44 inches in diameter, having a maximum indexing speed of 1,800 indices per hour and a dwell time of 1.5 seconds.

To facilitate the entry of leads into the holes of the circuit board, all leads are trimmed after being loaded into the component carrier. This is done by a pair of rotating cutters having gear teeth to facilitate rotation from a common drive. After trimming, the cutting wheels are lowered to clear the leads so the component carrier can be indexed to the next position.

The first four index positions of the turntable are for loading and lead-trimming. The next ten are for testing the components, as follows: 5—small capacitor tests; 6—resistor, diode forward resistance and inductor continuity tests; 7,8—spares; 9,10—transistor tests (not instrumented); 11—capacitor leakage tests and diode back resistance tests; 12—large capacitor test; 13—vacuum tube shorted-element test; 14—vacuum tube gas and heater tests.

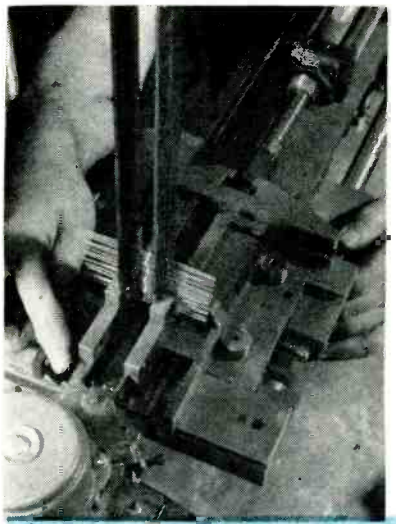
The leads of the component are contacted at the proper station by a contact assembly, the spring fingers of which have been automatically switched to the programmed test equipment under command of the punched-card reader. For resistor testing, only one station is activated, whereas for vacuum-tube testing seven stations are activated to furnish the necessary filament preheating and test voltages.

After being tested, satisfactory components in carriers are indexed to station 15 where they are loaded into transport magazines. Rejected components are not picked up, but are indexed to station 16 where they are ejected from the carrier, and the empty carrier is indexed to the loading station for reuse.

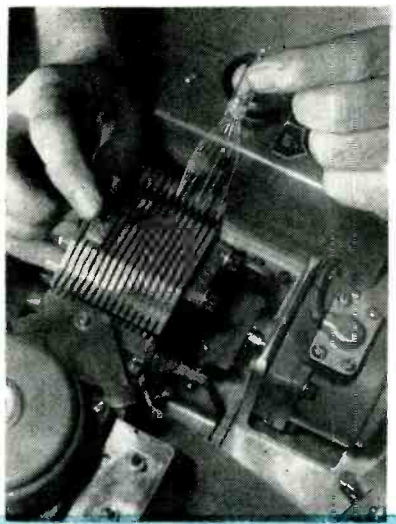
Emptied carrier magazines go to a transfer station where the empty carriers are taken out. A pneumatic actuator pushes down spring-loaded pins that engage the bushings in the first carrier to establish alignment, then pushes open the carrier retaining springs. Other parts of the actuator then disengage the carrier from the magazine and deposit it in the nesting block on the turntable of a component preparation machine.

As the carrier-unloading assembly goes back up, an indexing mechanism is acuated to step the magazine forward to the next unloading position, for removing another carrier. When an empty carrier, already on the turret, is indexed beneath the unloading head, the unloading motion is disabled for that dwell period. When the magazine is empty, it is moved into position for receiving newly loaded carriers.

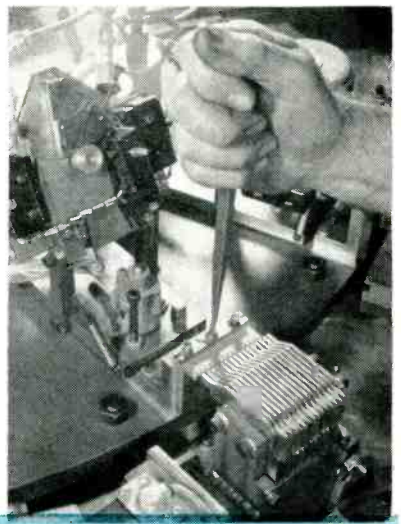
To place a loaded component carrier back in a magazine, the spring-loaded pin-and-collet assembly of the transfer head travels downward and presses the spring-loaded pins of the carrier nesting block out of the carrier bushings. The carrier is then retained on the transfer head and is loaded into the magazine on the upward stroke. Upon completion of the upward



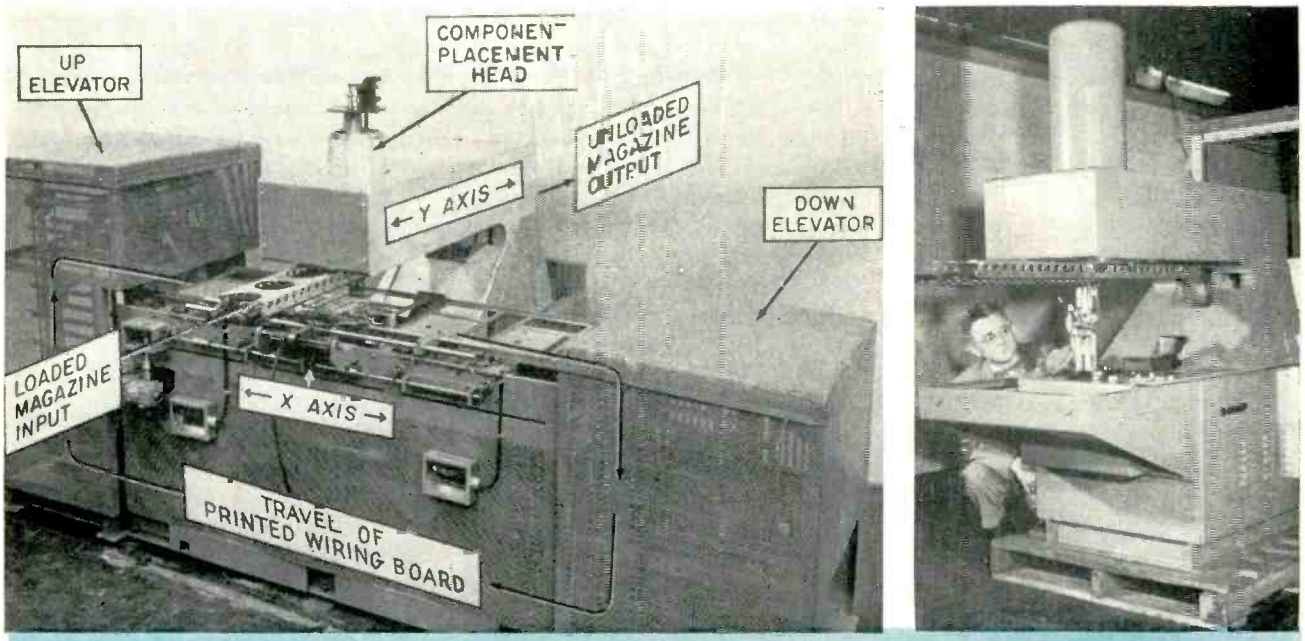
LOADER—Axial-lead components are loaded into vertical feed rack for forming and insertion in carrier



LOADER—Multiple-lead components such as subminiature tubes are manually loaded one by one



OPENING CARRIER—Screwdriver here illustrates how screw of carrier is rotated by servo to open combs



ASSEMBLY MACHINE—Servo-positioned insertion head (right) fits into center of elevator and conveyor mechanism that recirculates 20 wiring boards under head until all required components have been inserted one by one. Elevators also provide required storage space at each end to accommodate adjacent machines having different operating times

stroke the magazine is indexed one position as the turret indexes for loading the next carrier.

Upon completion of the magazine loading cycle, the magazine moves to the loaded magazine hold elevator (not yet built) to await action by the sequence control.

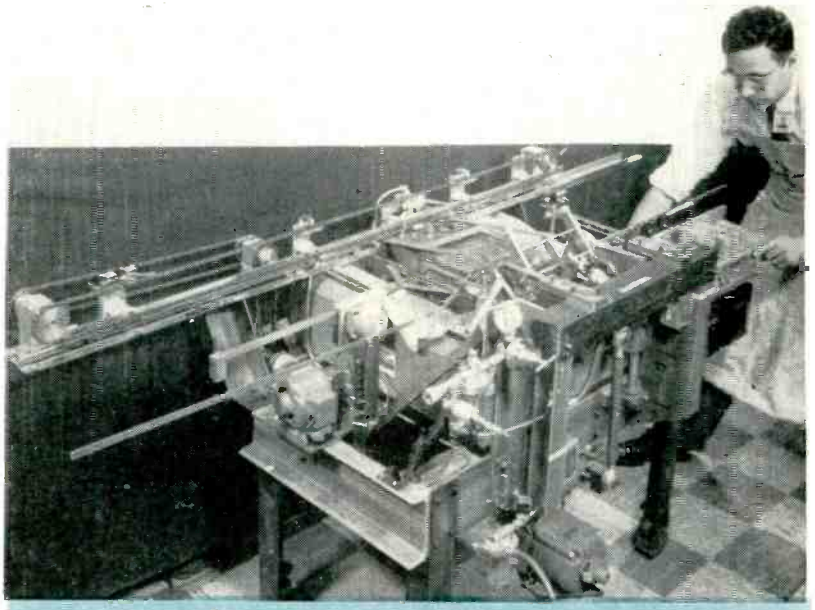
Magazines loaded with tested components move from either component preparation machine into magazine hold elevators. If a magazine is in the program order of placement, as remembered by the magazine sequence control from punched card data, the hold elevator elevates the magazine and moves in directly to the storage elevator at the placement head. If the magazine is out of order because of longer component preparation time required by a magazine on the other preparation machine, the loaded magazine is held in the hold elevator until the sequence control passes the other magazine to the placement head. In this way loded magazines stored at the placement head are always in the program order of placement.

The order of flow of magazines from which components have been removed by the placement head has no significance. The order of flow becomes important after a magazine is loaded and enters the hold elevators of the placement head.

The component placement head is positioned over the 12-inch dimension of the printed wiring board on what is termed the Y axis and may also be rotated through a maximum of 157.5 degrees.

Loaded magazines are inserted in the placement head at the Y=0 position upon demand of the head control circuits. The board-holding pallet is programmed in the 8-inch dimension of the board, called the X axis. The head and board are positioned at the beginning of the placement cycle for each batch of components.

Component placement is achieved by stripping a loaded carrier from its magazine and bringing the car-



DIP SOLDERER—Hood is removed to show mechanism that receives board carrying steel pellets at right end, moves them over spray fluxing station first, then brings them over solder pot and slowly moves solder ladle up to bottom of board

rier down to the board. The component leads are pushed through the board and grasped by a lead-anchoring mechanism while the carrier is moved away from the component and returned to the magazine. The gripping jaws then draw the component leads down through the board and cut and bend the leads to secure the component mechanically. The magazine is then indexed one carrier position, the next board is brought up and the cycle repeated.

Components can be placed within 0.090 inch of each other if their size permits. However, mounting holes must be staggered for such close placement. The maximum component size which can be handled is 2.35 inches long, 2 inches high and 0.75 inch wide. The system will handle components having up to eight leads. All leads are placed in line. Components can be placed in angular positions of up to 157.5 degrees in 22.5-degree steps.

When all components in the batch have been placed, the unloaded magazine is ejected through the back of the head frame and conveyed to the unloaded magazine storage elevator.

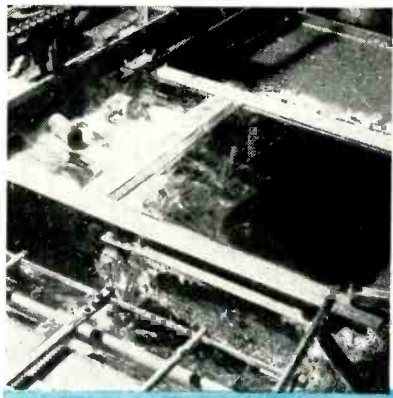
Pallet-Circulating Conveyor

Input information consisting of the number of component boards, the number of components per board and the X-axis servo information is supplied by the punched-card reader at the beginning of a new batch. The board pallets are then automatically loaded into the bottom of the up elevator of the pallet-circulating conveyor. The control indexes the up elevator a step at a time, filling all slides in the elevator. The pusher at the top of the elevator ejects the pallet onto the upper pallet drive and index mechanism.

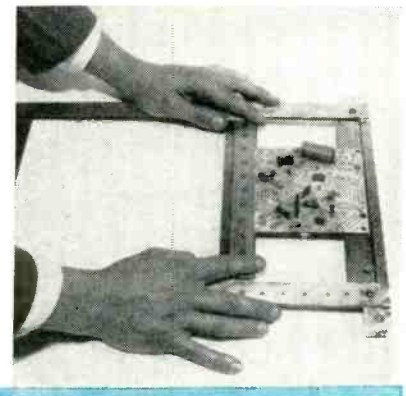
When the first pallet reaches the active work station, it is slowed and stopped, taper pins are pushed into the holes in the pallet, and an interlock is closed to the head circuit which allows the head to place a component. When the head has placed a component and is sufficiently clear of the board to allow pallet motion, a signal is given to the controller which retracts the taper pins and allows the board to be driven away, and the next pallet is indexed into position. The pallet being driven away will be placed in the top of the down elevator and the elevator will index one step down and wait for the next pallet. As the pallet reaches the bottom on the down elevator it is ejected into the lower pallet drive, as are all subsequent pallets.

When the desired number of pallets have entered the circulating system, the control transfers from load to cycle and pallets enter the up elevator from the lower pallet drive unit, operating on a demand signal from the head. The same is true for the down elevator.

At the dip soldering machine the boards are first passed over a fluxing spray of rosin and alcohol, then positioned over the solder pot. The solder ladle, immersed in the solder pot, is brought up to the board as the board is rotated into its solder suface. The board is vibrated while it is in the solder bath to clean it and bring solder into intimate contact with the joints. A time-delay relay controls immersion time. The board is then rotated away from the solder bath and again vibrated to remove excess solder while the solder is still molten. A short dwell period then permits the solder to solidify before the board is transferred to the storage elevator for the final test station.



SOLDERING—Assembled wiring board and pallet rest on solder ladle, which comes up out of solder pot here



PALLET—Universal design can be easily set to take boards up to 12 inches long and 8 inches wide

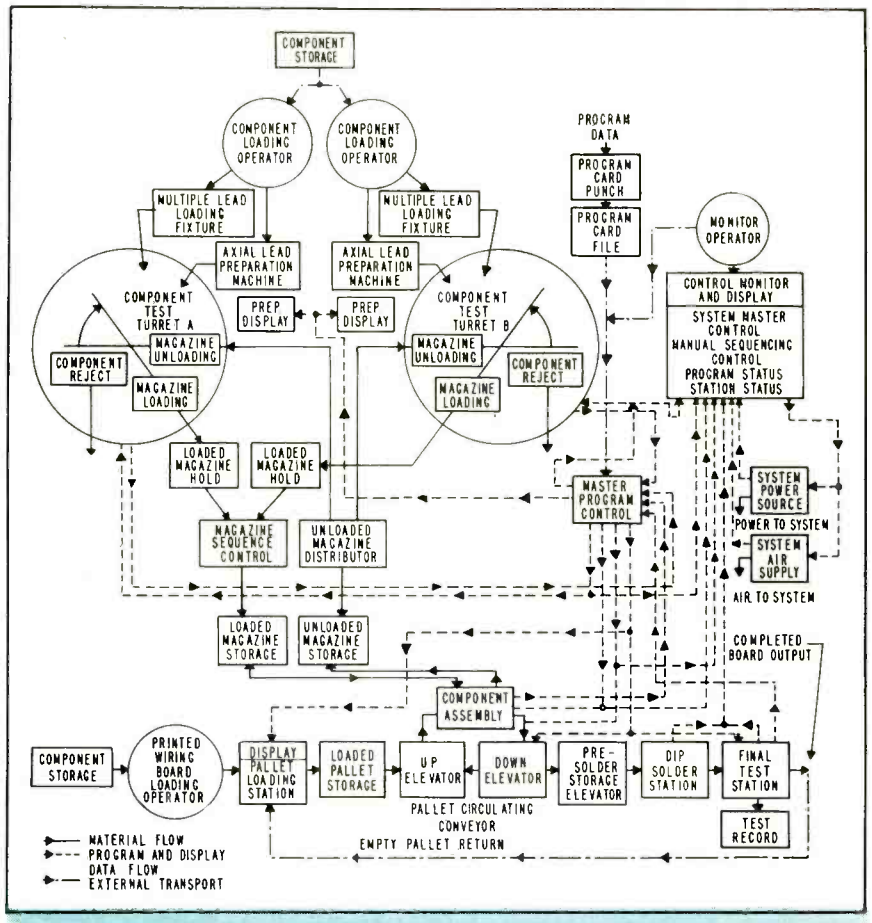
When the last pallet of any batch is ejected from under the head, the programming control stops the pallet circulation until the X-axis positioner has been reset for the next component. The system circulates pallets in this manner until the first pallet has had all the components placed and has appeared at the bottom of the down elevator. The control will then actuate the pusher on the bottom of this elevator to eject the pallets from the loop. When all the pallets in the batch have been ejected from the loop the control automatically requests new data for the next cycle.

The loaded pallets are ejected from the pallet circulating conveyor into the presolder storage elevator, from which they are drawn on demand of the dip soldering machine.

Final Testing

Since all components are tested before assembly and the component transport system is interlocked to prevent misalignment of components during their placement cycle, there are only three conditions which could cause failure of the printed circuit assembly: (1) component leads not going into their holes; (2) component leads not soldered; (3) solder shorting out etched wires on the board.

Two types of tests are used to determine acceptability of a finished circuit board: the shorts test, which measures an extremely low impedance between any one etched wire and the others; and the continuity test, which measures a low impedance between one lead



FLOW DIAGRAM—Dashed lines show how punched cards in master program control serve to actuate and monitor all machines, thus assuring proper assembly sequence. Paths of wiring boards are represented by solid arrow lines between boxes

FINAL TEST—Pallets with boards will enter at top right on conveyor now under construction

MONITOR CONSOLE—Main lamps come on only to indicate malfunctions. Emergency button stops all machines

of a component through a solder joint, along the etched wire, and through the lead of another component soldered to the same etched wire. Thus, the first test detects shorted conductors. The second detects whether or not a lead has gone into a hole and if it has been soldered, but not the quality of the solder bond. A paper tape printer automatically records the number and type of failure on each board as the test is made.

Punched-Card Equipment

The function of the card punching machine is the transformation of all necessary system control data into punched-card coded form. The data consists primarily of five types: (1) complete specifications of the components to be prepared and assembled, including data on the various preassembly tests to be performed; (2) data to control the order of preparation and assembly of each circuit element; (3) data specifying the number of printed circuit boards to be assembled in the particular batch; (4) data specifying the accurate location of each circuit element on the printed circuit board; (5) data specifying the tests to be performed on the completed circuit board assemblies.

The card reader senses the recorded data and transmits it in appropriate form to the various machines.

A single stack of punched cards is made up for each board design. Each card contains program data for one or more of the individual stations within the system.

The automatic component assembly system program has been carried out under Signal Corps Contract DA-36-039-sc-30250 as an industrial preparedness measure. The contract is between the Signal Corps Supply Agency, Philadelphia, Pa. and the General Electric Light Military Electronic Equipment Department, Utica, N. Y. The work has been carried out by the GE Advanced Electronics Center, Cornell University, Ithaca, N. Y., with some work being subcontracted to the GE Equipment Development Plant and the GE General Engineering Laboratory at Schenectady. The project is being monitored for the Signal Corps by the Supply Agency at Philadelphia and by the Signal Corps Engineering Laboratories at Ft Monmouth, N. J.

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Temperature Indicator for Aircraft Engines

SUMMARY —— Precision potentiometer type device in which the thermocouple output is compared with a reference voltage gives precise temperature indication in aircraft jet engines. System accuracy is better than ±5 C

By HAROLD KOLETSKY *Project Engineer, Avien, Inc., Woodside, N. Y.*

JET ENGINE use in military aircraft has brought with it severe requirements in engine temperature instrumentation.

To obtain maximum thrust from these engines and yet avoid damage to turbine buckets through overheating, requires precise indication of operating temperatures under all extremes of flight and environmental conditions.

The temperature-indication system to be described was developed for the U. S. Air Force. It replaces the galvanometer type of instrument for the measurement of exhaust-gas and turbine-inlet temperatures over the range of 200 C to 1,200 C.

Temperature indication system is used in Lockheed's C-130-A Hercules. Gages measure turbine-inlet temperature of the plane's four turbo-prop engines

The basic system is shown in Fig. 1. The principle used is similar to that of the laboratory type potentiometer commonly employed for high-precision temperature measurements, in which the output of a thermocouple is measured against an accurate reference voltage. A servo-driven self-balancing bridge is utilized to provide automatic, continuous comparison of these voltages and their translation into corresponding temperature indications.

In applying this principle to aircraft use, there are four major design problems. Foremost is the requirement for a precise d-c reference voltage. A nonlinear potentiometer is required to produce linear rotation versus temperature, compensating for the nonlinear characteristics of the standard aircraft thermocouple. A null modulator capable of detecting d-c error signals as low as 40 microvolts, corresponding to a temperature change of 1 C, and a cold-junction compensator are also needed.

The problem of the thermocouple probe was not considered, since a requirement of the system is that it be designed for use with the standard aircraft thermocouple.

D-C Reference Voltage

To obtain an accurate d-c reference voltage, the K-Volt Standard was developed. This unit, which plugs into a standard noval tube socket on the amplifier chassis, employes three double-anode silicon diodes which have been selected for their stability of characteristics with time and with variations of ambient temperature.

These diodes are connected as shown in Fig. 2.

Operation of the circuit can be understood by considering the dynamic diode characteristics shown in Fig. 3. For any double-anode diode, once the breakdown voltage has been achieved, the dynamic resistance is of the order of 10 ohms. The device behaves like a voltage regulator. Regulators are cascaded to provide a voltage output that it constant within ±0.05 percent, for a 10-percent line-voltage variation.

The silicon junction diodes used in this application are of the low

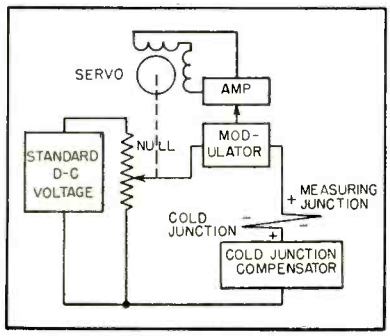


FIG. 1—Basic temperature-indication system for jet-engine use

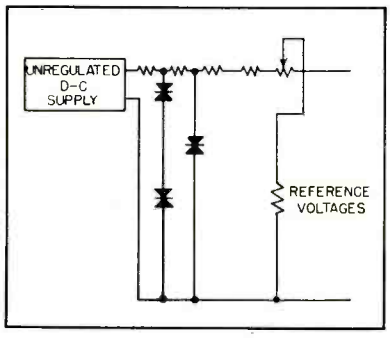


FIG. 2—Double-anode diode voltage-regulating circuit

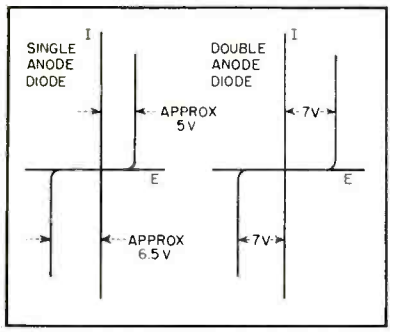


FIG. 3—Dynamic characteristics of reference diodes

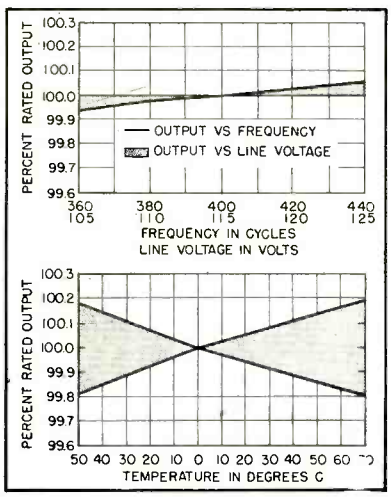


FIG. 4—Curves show output of voltage standard with variation of temperature, line voltage and frequency

Zener voltage type. The most interesting property of these diodes is their behavior over wide ranges of ambient temperature (−65 C to +100 C). Temperature induced changes of their forward-conduction characteristics are almost exactly equal and opposite to the changes of their reverse-conduction characteristics. By combining two diodes into a double-anode diode, a reference-voltage device virtually independent of temperature is achieved.

Theoretical life of these units is in excess of 10,000 hours of operation. Laboratory tests, including temperature cycling, for more than 1,000 hours show stability of better than 0.1 percent.

Stability of the voltage standard over the entire range of line voltage, frequency and temperature variations encountered in aircraft service are shown in the curves of Fig. 4.

For line-voltage variations from 105 volts to 125 volts and temperature variations from −55 C to +70 C, the reference voltage is maintained within 0.25 percent of rated output. However, this figure represents the worst conditions that might arise from these variations. As seen from curves, voltage and temperature effects are random within the envelopes plotted. Under actual service conditions stability may be better than specified.

A nonlinear potentiometer produces linear shaft rotation by locating taps on a linear potentiometer and loading it to produce the desired function. This technique brings with it the added feature of making each loaded potentiometer equal in resistance within ±0.05 percent. This provides for complete interchangeability of indicators.

Temperature

Temperature compensation of the thermocouple cold junction is accomplished by using a pair of resistors, one sensitive, the other stable to temperature change. The stable element provides an essentially constant current to the other resistor. Thus the voltage across the temperature-sensitive resistor is determined by its temperature coefficient of resistance which has been selected for close similarity to the output-versus-temperature curve of the thermocouple.

In this case an iron-nickel alloy was chosen for the temperature-sensitive resistor and a nickel-chromium alloy for the temperature-stable resistor. Both compensating resistors are wound on the same bobbin, with the cold-junction thermocouple embedded under the wire that is compensating it.

Throughout the system precautions are taken to insure against the presence of secondary thermojunctions. At the amplifier input, thermocouple leads are brought to terminal studs made of the respective thermocouple materials. Within the amplifier the compensating resistors, along with all thermocouple junctions and the voltage standard, are housed in a hermetically sealed, silicon-oil thermal sink, which maintains all components at the same temperature.

Complete System

The schematic of the complete system is shown in Fig. 5. Note that the potentials of the thermocouple measuring circuit, the cold junction and the cold-junction compensator are in series with the voltages developed across the zero-adjustment potentiometer and the rebalance potentiometer.

In calibrating the system, the resultant of cold junction and cold-junction compensator voltages is cancelled out by the zero adjustment. Accordingly, balance is achieved when the voltage across the rebalance potentiometer equals that of the thermocouple measuring junction.

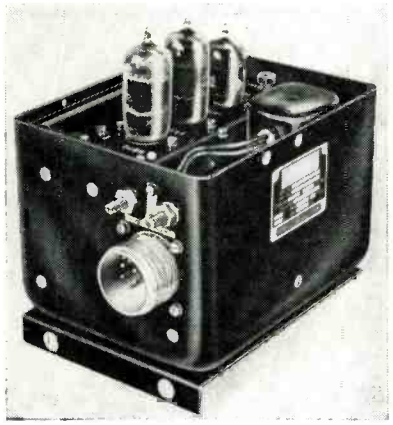
Any change in the temperature of the measurement junction will unbalance the system, producing a corresponding d-c error signal. This error signal is applied to the input of the signal modulator and is converted into a 400-cycle a-c signal which is amplified to actuate the servo-motor. The rebalance potentiometer is then driven to a new balance position corresponding to the new temperature of the thermocouple measurement junction.

The input to the amplifier is through a transformer. This is necessitated by the requirement

that operation of the system be undisturbed with either of the thermocouple leads shorted to ground. Since the system is required to be sensitive to changes in temperature of 1 C, (which represents a d-c error signal of only 40 microvolts, the chopper has been selected primarily for low-noise operation with 400-cycle excitation. A full-wave configuration of chopper and input transformer is used to achieve maximum gain.

The amplifier consists of three stages of voltage amplification and employs a low-noise input tube, a 6072, which is a ruggedized version of the 12AY7. Because of the high gain developed, precautions are taken to eliminate ground loops by bringing all grounds to a single chassis connection at the input grid.

In keeping with the requirements of aircraft service, the system is designed to provide a full-scale response of only 5 seconds. To assure system stability along with high-speed response, velocity feedback is used in the form of a bridge which utilizes the induced emf of the running servo-motor



Amplifier with cover removed to show tubes and adjustments

to provide a damping signal for the amplifier. This bridge consists of two resistors, the servo motor and an inductor having a Q identical to that of the motor. Resistors and inductor have been selected so that the ratio of motor impedance at stall to that of the inductor is duplicated by the resistors, thus making the damping circuit operative only while the motor is running.

Because of the self-balancing bridge design employed, no current is drawn through the thermocouple leads at null. Consequently, the resistance of the lead wires themselves need not be held to any specified low value, as is the case with galvanometer-type gages.

The performance and accuracy of the system are not affected by thermocouple lead resistance up to 200 ohms. A considerable weight saving can usually be effected by the reduction of the thermocouple lead wire to a much lighter gage.

The indicator is helium filled and hermetically sealed in keeping with moisture-proofing practices for military equipment. To prevent ambiguity during engine shut down or at preflight inspection under subzero conditions, the indicator includes a pointer stop which prevents downscale travel below the low end of the scale. Design of this stop is such that the servo-motor is stalled to prevent unnecessary gear action and wear.

In both laboratory and aircraft evaluation tests the accuracy of the system has been found to be at least ±5 C (or 0.5 percent of scale range) over 1,000 hours of operating service.

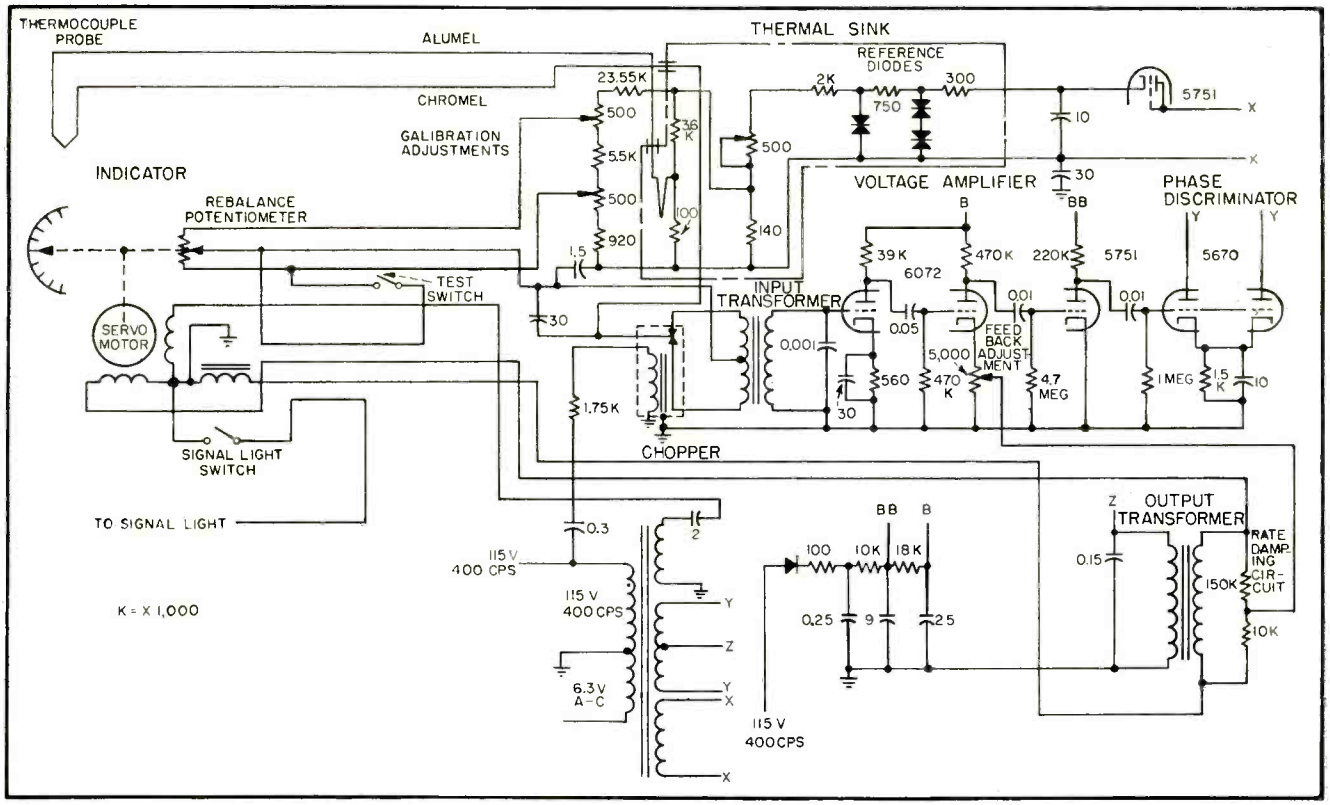
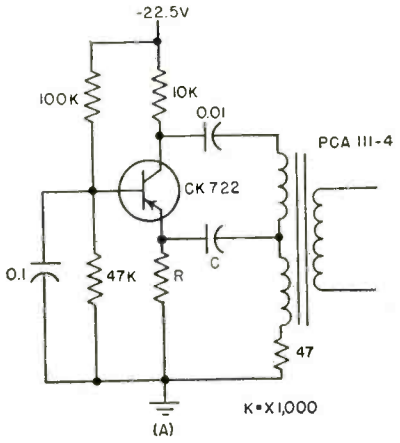


FIG. 5—System schematic shows temperature-indication system. Phase discriminator operates without B+ supply, eliminating need for a high current rectifier and bulky filter capacitor



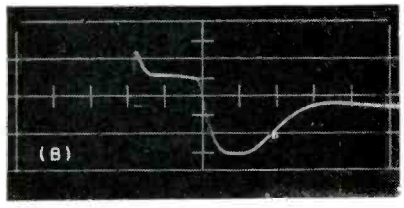
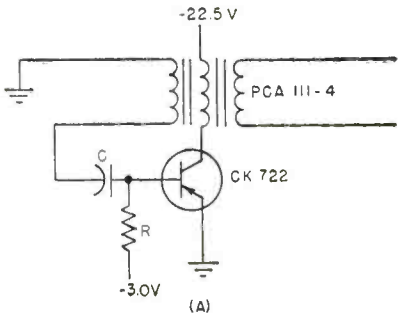


FIG. 1—Grounded-base blocking oscillator (A) provides output pulse (B) of 3.5 μsec duration



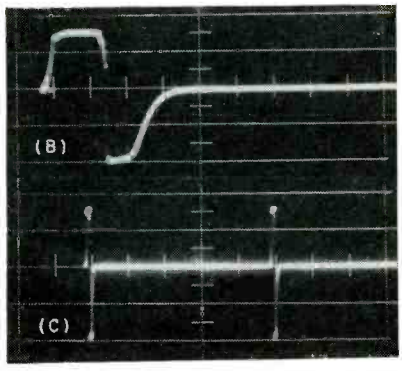
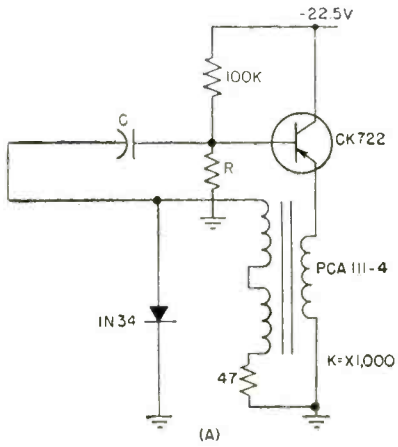


FIG. 2—Grounded-emitter oscillator (A) output pulse width (B and C) can be varied by changing value of C and R



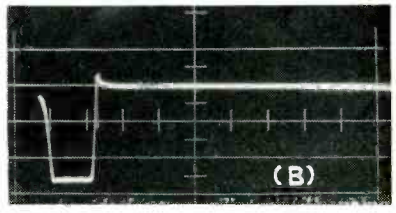


FIG. 3—Blocking oscillator (A) using grounded-collector arrangement produces flat-topped pulse (B)

Transistor Pulse Generators

SUMMARY —— Five pulse-forming circuits using germanium and silicon transistors have pulse rise times as fast as 0.1 microsecond at repetition frequencies to 50,000 pps. Pulse widths are variable 0.4 to 9 microseconds

MISSILE telemetering and supersonic aircraft require rugged compact components. The five transistor circuits described here meet these requirements and provide a wide choice of pulse characteristics.

The grounded-base blocking-oscillator circuit is given in Figure 1A. Feedback has been added from collector to emitter. This circuit employs a CK 722 junction transistor and a PCA 111-4 pulse transformer. For oscillation to occur, the voltage at the collector must be stepped down to drive the lower impedance emitter. The pulse duration using this transformer should be 4 μsec.

The pulse-repetition frequency may be varied from 60 to 50,000 cps by varying R and C. At frequencies above 50,000 cps there is considerable jitter in the output. By letting $C = 0.01$ μf and $R = 10{,}000$ ohms the prf is approximately 12,500 cps.

The rise time of the voltage pulse measured at the collector is approximately 0.5 μsec and the pulse duration is 3.5 μsec. By using different values of C the pulse width may be varied slightly. The amplitude of the collector pulse is +17 volts. The waveform of the collector pulse is shown in Fig. 1B.

A 47-ohm resistor was placed in series with the transformer winding to give an indication of the peak current drawn during the conduction period. The amplitude of the peak current is approximately 50 ma. This circuit has been operated continuously in excess of 1,000 hours without any degrdation in performance.

Another blocking-oscillator circuit tested is shown in Figure 2A. This circuit is a grounded-emitter configuration with the feedback from the collector to base.

The prf may be varied by changing C, R or the bias-supply voltage to the base. With $C = 0.01$ μf and $R = 10{,}000$ ohms the prf is 2,000 cps. The collector pulse is given in Fig. 2B and Fig. 2C. Care should be taken in the selection of C since

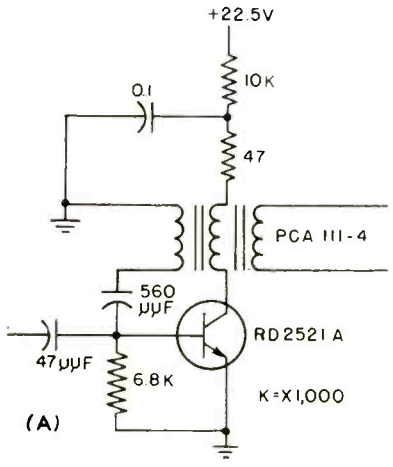


FIG. 4—Oscillator circuit (A) triggered by 2.0 volt pulse provides a 0.5 μsec output (B)

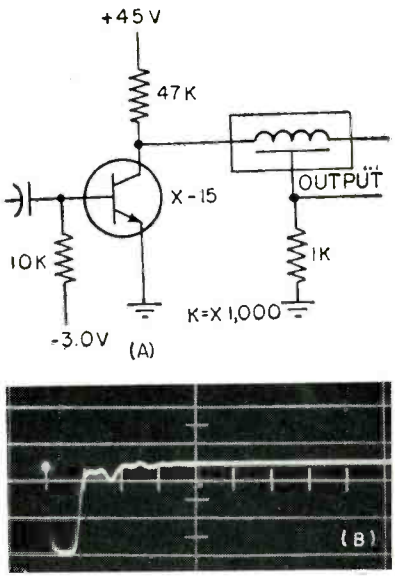


FIG. 5—Pulse-forming network (A) gives an output pulse (B) of 0.55 μsec with a rise time of 0.1 μsec

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it has a considerable effect on the pulse width.

With $C = 0.01$ μf the pulse width was 9.0 μsec. When the value of C was decreased to 0.001 μf, the pulse width was decreased to 5.0 μsec. The wide variation in pulse width is due to the low base-to-emitter resistance. The rise time measured at the collector was about 0.8 μsec for both pulse widths. The amplitude of the collector voltage pulse was 20 volts.

The grounded-collector blocking oscillator in Fig. 3A uses the emitter-to-base circuit for the required feedback. For this circuit to oscillate, the voltage fed back to the base must be larger than the emitter voltage. The polarity of the transformer is such that the base is driven negative as the emitter potential decreases. The diode is used to clip the overshoot.

The rise time of the emitter pulse, shown in Fig. 3B, was approximately 0.5 μsec and the pulse width was 7.5 μsec for C equal to 0.005 μf and R equal to 50,000 ohms. Pulse width is again a function of capacitance. An extremely flat-topped pulse is obtained from the emitter of this circuit. Pulse amplitude is equal to supply voltage. For the values of R and C given, prf is 3,600 cps.

The circuit shown in Fig. 4A uses an RD2521A, *npn* junction transistor and a PCA 111-4 pulse transformer in a triggered blocking-oscillator circuit. This transistor has a rated $f_{\alpha o}$ of 2.5 mc compared to the rated $f_{\alpha o}$ of 0.8 mc for the CK722. The $f_{\alpha o}$ is the frequency at which the α of the transistor is 3-db lower than the low-frequency α. Pulse width should be in the neighborhood of 0.4 μsec.

Since no bias has been supplied to the emitter-to-base diode this circuit cannot run free. When a positive pulse is applied to the base, the diode is biased properly for transistor action to occur. The positive trigger voltage required to start blocking action is approximately 2.0 volts.

Figure 4B gives the waveforms measured at the collector of this circuit. Pulse width of the collector pulse was measured to be 0.5 μsec with a rise time of 0.2 μsec. The amplitude of the collector pulse is 17 volts. Current pulse measured at point A is about 2.5 volts in amplitude which indicates that a peak current of 50 ma flows through the circuit during conduction.

Pulse-Forming Circuit

The pulse-forming circuit, shown in Fig. 5A, employs an X-15 medium-power silicon transistor and a Technitrol Eng. Corp. Type D delay line.

Initially, the pulse-forming network is charged to a positive voltage by the supply voltage. When the transistor conducts, the line is discharged through the output resistor generating a negative pulse having a duration of twice the delay time of the delay line. The amplitude of the pulse is one-half the supply voltage if the line is terminated in the characteristic impedance of the pulse-forming network.

An X-15 transistor has been used because it has a higher collector voltage rating than most transistors. Other types of transistors have been tested in this circuit with good results. The delay line used has a delay of 0.3 μsec and a characteristic impedance of 1,000 ohms. The response of this line is about 2.2 mc for 3-db attenuation.

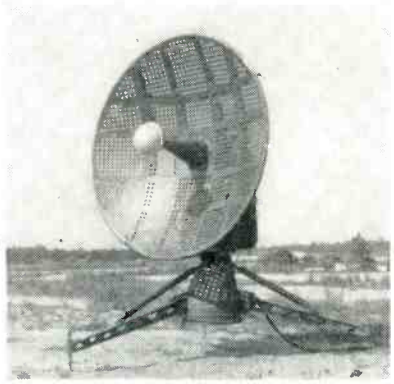
The input pulse applied to the base of the transistor was generated by the grounded-base blocking oscillator discussed earlier. The input trigger has a prf of 2,000 cps, an amplitude of +8 volts, rise time of 0.5 μsec with a pulse duration of 3.5 μsec.

Figure 5B is a reproduction of the output pulse generated by this circuit. This pulse has a rise time of 0.1 μsec and a width of 0.55 μsec with an amplitude of approximately 22 volts. Rise time is determined by the speed at which the transistor starts to conduct and the characteristics of the delay line.

Helicopter Measures

By HELMUT BRUECKMANN

Signal Corps Engineering Laboratories
Fort Monmouth, New Jersey



Tracking device of Rawin set used in radiation pattern measurements

THE SPACE radiation pattern of a large antenna is usually measured by constructing a scale model of small enough size and testing this model on an antenna pattern range.

The better solution is to measure the space pattern directly by means of an aircraft. Aircraft pattern measurements have seldom been made in the past. They have a reputation of being costly, unreliable or inaccurate.

Delicate measuring equipment was operated under cramped space conditions in a strongly vibrating aircraft. The limitations of the aircraft and of the pilot in maneuvering it were not properly taken into account. The method for positioning of the aircraft was slow and necessitated a long flying time. Finally, the problem of the reference or illuminating antenna was not always solved satisfactorily.

Recent tests resulting in successful pattern measurements of a large antenna have shown that accuracy can be improved and cost reduced.

Improved Method

The instrumentation used is shown in Fig. 1. Both horizontal and vertical polarization patterns can be measured. A small, self-contained signal-source is located in the center of a dipole antenna suspended from an aircraft by means of a nylon string. A c-w signal of constant intensity is transmitted, at the test frequency.

Depending upon the kind of polarization desired, the dipole is arranged either in a horizontal position, as shown in Fig. 1, or in a vertical position. For vertical polarization, the wind sock is replaced by a weight of small wind drag. This permits large separation between the signal source and aircraft.

Orientation of the dipole axis, which is the direction of minimum radiation, is in the direction of the aircraft. Therefore, the effect of the body of the aircraft on the pattern of the dipole is negligible.

A slow-flying light aircraft with a ceiling altitude of about 10,000 feet is required. The aircraft actually used was the Army type H19 helicopter. It is assigned to fly in circles of prescribed radii about the antenna at set altitudes, as illustrated in Fig. 2. The altitude is held constant for the duration of each circle. The radius of each circle is also held constant. For this purpose ground markers are laid out on the circle. The pilot is also aided by information given to him through voice communication equipment from the ground. Any deviation from the prescribed radius is determined and accounted for in the evaluation so that it does not affect the accuracy of the pattern.

The signal transmitted from the aircraft is received on the ground by means of the antenna under test, and a highly stable and selective receiver. Its strength is recorded continuously versus elapsed time with a fast moving recorder. The time scale is linear and the signal strength scale is logarithmic extending over a range of about 40 db.

The reference level is calibrated in terms of receiver input voltage every time the gain is changed by means of a signal generator. The signal recorder is equipped with an events marker.

Tracking

Special tracking equipment is positioned on the ground close to the antenna under test. It automatically records the azimuth and elevation angle of the aircraft by means of a position recorder. This tracking equipment prints the angles as numbers every 6 seconds on tape. The angles are accurate to 0.01 deg. Each time the position recorder prints, it closes a circuit which operates the events marker attached to the signal recorder. This permits exact coordination between signal and position recording.

The increase in range with altitude resulting from the prescribed flying path and the variations in range due to deviations of the aircraft from the prescribed flying path are taken into account. Signal strength is corrected prior to transferring it onto the pattern plot or onto a contour map. These corrections, however, are usually small enough to be neglected. If the actual range deviates as much as 20 percent from the assumed range, for example, this deviation amounts to an error in signal strength of only 1.6 db. The actual range R is computed from the measured alti-

Antenna Patterns

SUMMARY —— Space radiation patterns of large and complex antennas are measured by using a helicopter towing a small self-contained signal source and dipole antenna attached to a windsock. Pattern plotted in less than 3 hours flying time is accurate within 20 percent

tude H above ground level and elevation angle ψ by means of

$$R = \frac{H}{\sin \psi} \qquad (1)$$

In measurements of horizontal polarization the dipole is always essentially at a right angle to the radius of the antenna and therefore no corrections accounting for the dipole pattern are necessary. In measurements of vertical polarization, however, corrections accounting for the difference of the dipole pattern (which is a sin θ function) and the pattern of an isotropic radiator have to be made.

These dipole correction patterns can usually be neglected if elevation angles below 33 degrees only, corresponding to an error smaller than 20 percent, are considered. If higher angles are considered, these corrections can be determined easily since the angle θ between the dipole axis and the direction to the antenna under test equals $(90 - \psi)$ deg and the elevation angle ψ is known.

For measuring the radiation at high elevation angles, above 45 deg, a somewhat different flight path is indicated. It is usually sufficient to measure the radiation at these high elevation angles in the principal plane only. The procedure outlined in Fig. 3 then applies, in the case of horizontal polarization. The corresponding flight path for vertical polarization would be a horizontal line in the principal plane.

The airborne signal source consists of a battery-operated crystal-controlled transmitter of about 0.1-watt output power. Its circuit diagram is shown in Fig. 4. It is encased in an aluminum shell.

The shell consists of two halves insulated from each other by a teflon ring and connected to opposite ends of the amplifier tank coil as shown in the photograph. All components are designed to withstand shocks of 30 g.

A 5-foot length of wire is connected to each of the halves of the shell, thus providing for an antenna of 10 feet fed in the center. A metal ball or double-cone is attached to each end of the wire.

For measuring vertical polarization, the antenna is suspended at the end of 150 feet of nonconducting line, preferably nylon string. The lower end of the dipole is attached to an 18-lb metal ball, the

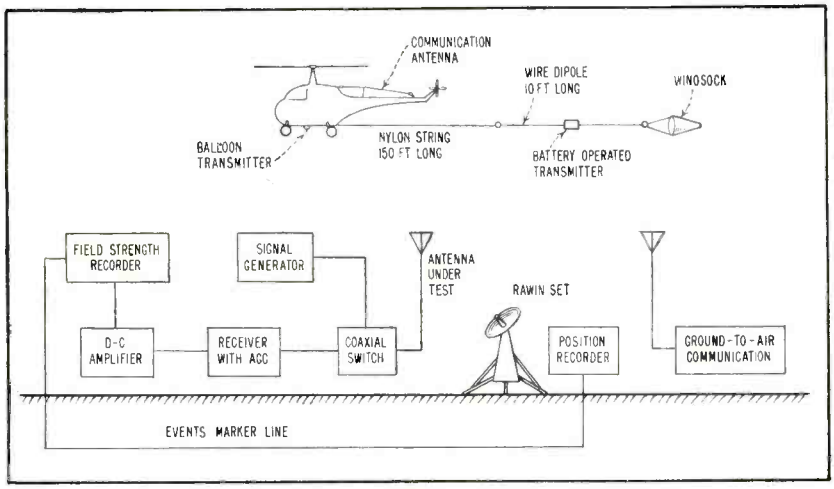


FIG. 1—Instrumentation for antenna radiation-pattern measurements

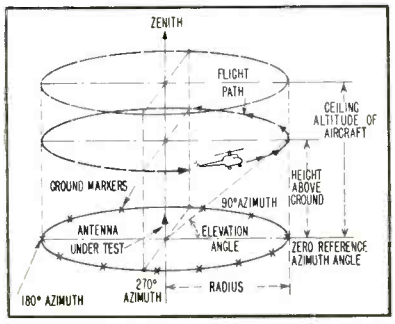


FIG. 2—Flight path of aircraft for radiation-pattern measurement at elevation angles below about 45 degrees

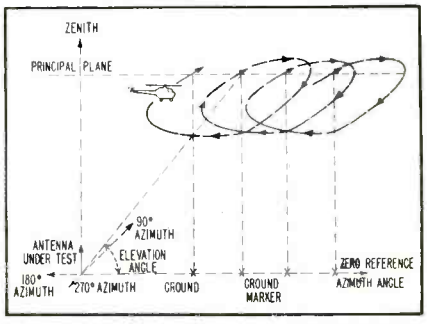
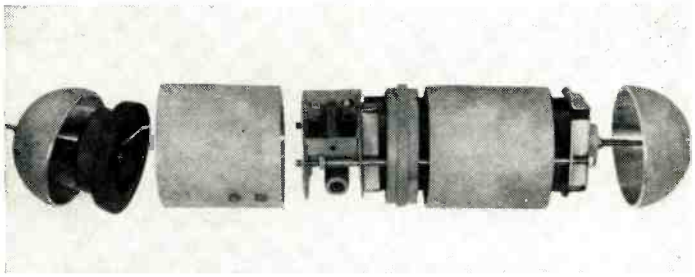


FIG. 3—Aircraft flight path for radiation pattern measurement at elevation angles above about 45 degrees



Exploded view of airborne signal source used for radiation pattern measurements of both vertical and horizontal polarization

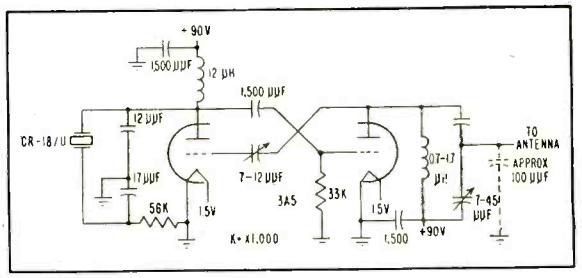


FIG. 4—Battery-operated crystal-controlled transmitter is used as airborne signal source

upper end to a light-weight metal ball. The metal ball at the lower end keeps the dipole as nearly vertical as possible and increases the effective height of the dipole. The metal ball at the other end is added to balance the antenna electrically to provide for a well-defined reference.

For measuring horizontal polarization the weight is replaced by a light-weight ball and a wind sock. The wind sock is of conical shape made of nylon cloth and is similar to the ones commonly used for indicating wind direction at airfields.

The wind sock is 27 inches in diameter at the inlet, 6-feet long and tapered down toward the end to a diameter of 6 inches. Its precise diameter and length were determined from the requirement that it exert a wind drag of 40 lb at an air velocity of 70 miles per hour.

The metal balls in the case of horizontal polarization are utilized mainly to make retuning of the transmitter unnecessary when switching polarization.

The tracking equipment consists of Rawin set AN/GMD-1A. This set is normally used for tracking meteorological balloons equipped with radiosonde. It operates at a frequency near 1,600 mc.

Sources of Error

The error in signal strength caused by a deviation of the angle between the dipole axis and the direction to the antenna from 90 degrees is less than 20 percent or 1.6 db if the deviation is smaller than 33 degrees (since cos 33 deg = 1/1.2). This kind of error may occur during measurement of horizontal polarization if strong winds prevail because of the large drift angle. It can be neglected for most practical purposes if the wind velocity is less than 55 percent of the velocity of the aircraft relative to the air, assuming the aircraft flies a circle about the antenna (since sin 33 deg = 0.55). Under wind conditions of 20 miles per hour or less and an aircraft velocity of 70 mph, no serious errors of this kind can possibly occur.

The specified drag of 40 lb exerted by the wind sock in the case of horizontal polarization, together with the weight of the transmitter of 6 lb, result in an angle of the front half of the dipole against the horizontal of less than 10 degrees. This angle is tolerable because the resulting unwanted vertical component is then more than 22 db lower than the desired horizontal component.

In the case of vertical polarization, the wind drag of the metal ball at the lower dipole end and that of the signal source cause a certain deviation of the upper dipole half from the vertical. Since the total wind drag is less than 4 lb at a speed of 70 mph compared to a total weight of 24 lb this deviation is less than 10 degrees. This corresponds to a horizontally polarized component more than 20 db down from the vertically polarized component.

The deviation of the actual range from the prescribed range is likely to decrease percentagewise with increasing distance under otherwise similar conditions. It is desirable, therefore, to make the range as large as is compatible with height limitations of the aircraft and tolerable signal-to-noise ratio. The so-called Fresnel-zone condition requires the range to be greater than $2D^2/\lambda$, where D is the lateral dimension of the antenna under test and λ the wavelength. A range of 2 to 3 miles appears to be in order.

It can be shown that the error $\Delta\psi$ in measuring ψ and the resulting error ΔR in computing R from Eq. 1 are related for small elevation angles by

$$\frac{\Delta R}{R} = -\frac{R}{H}\Delta\psi \qquad (2)$$

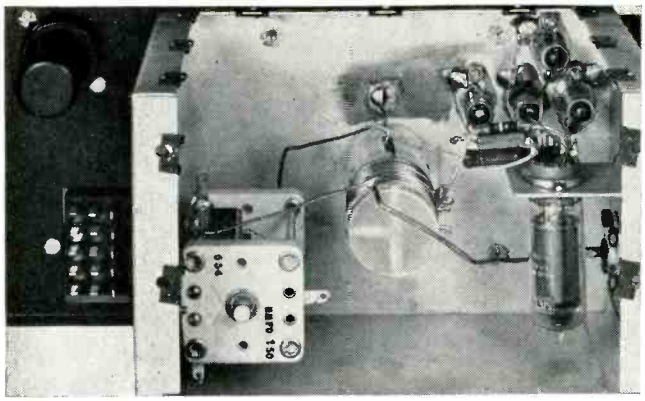
If, for example, $\psi = 4.8$ deg corresponding to $R/H = 12$, and $\Delta\psi = 1$ deg or 1/57 radian, then $\Delta R/R$ is 21 percent, corresponding to an error in field strength of 1.6 db.

Height Variation

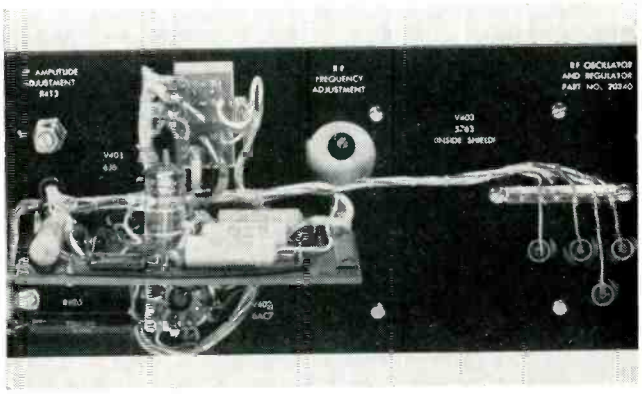
The effect of an error in measuring or adjusting the height of the aircraft is greatest at low elevation angles, as can be seen from Eq. 1. At an elevation angle of 4.8 degrees, for example, an error in H of 1 foot corresponds to an error of 12 feet in range. Assuming an actual height of 1,330 feet corresponding to a radius of the path flown of 3 miles, an error of 60 feet in height causes an error in range of 5 percent, equivalent to an error in field strength of 0.4 db. This is about the maximum error from this source under favorable conditions.

Approximately six circles, each flown at a different altitude, corresponding to the elevation angles 5, 10, 17, 25, 35 and 45 degrees, for example, are usually sufficient to check the actual pattern against the theoretical pattern. It takes an aircraft flying 70 miles per hour 11 to 16 minutes to complete one circle of from 2 to 3 miles radius, respectively. This amounts to a total flying time, including ascend and descend, of about 3 hours for a complete pattern of one polarization component.

The author thanks W. Todd of Evans Signal Laboratory, the numerous personnel at Coles Signal Laboratory involved in this development, the helicopter crew and the crew operating the tracking equipment for their contributions.



Rear view of r-f oscillator and regulator



Front view showing adjustments through openings

Spectrometer Regulator Stabilizes R-F

SUMMARY — Constancy of radio-frequency voltage amplitude for linear accelerator used in r-f mass spectrometers must be held to 0.01 percent over a wide frequency range. An electrometer tube technique can be employed that insures pure waveform from 2 to 6 mc. Output voltage of 125 volts peak r-f drives a 250-$\mu\mu$f capacitive load

By WALTER DONNER

Chief Project Engineer
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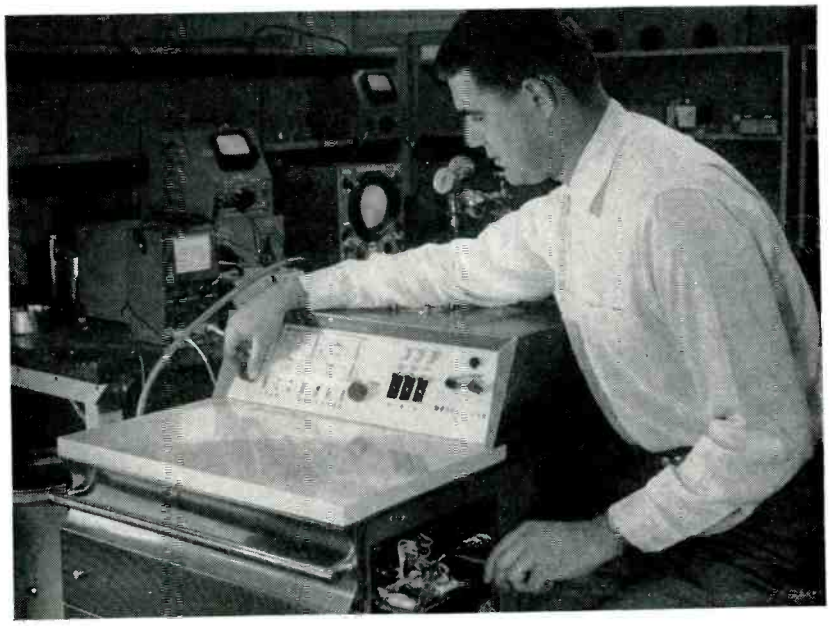
Fullerton, Calif.

FOR SEPARATING charged particles as a function of their mass-to-charge-ratio (m/e) a mass spectrometer may be used. In conventional instruments positively charged ions are formed by bombardment with an electron beam in an ion chamber to which the sample gas has been admitted. The particles are then accelerated, collimated and allowed to pass through a magnetic field at right angles to their trajectories. The ion trajectories will be bent into an arc.

With a given accelerating voltage and magnetic field, ion trajectories will be a function of mass. By plac-



Engineer makes final adjustment to leak detector that uses mass spectrometer technique of determining minuscule amounts of gas

ing a collector plate behind a resolving slit at a suitable location, only a particular mass will be collected.

R-F Spectrometer

Another method of separating masses utilizes a linear accelerator instead of a magnetic field for mass separation. As shown in Fig. 1, ions are formed by electron bombardment within an ion chamber and accelerated by a voltage V. The particles then pass successive gaps upon which an r-f voltage is applied.

If the particles arrive at the first gap at the proper time of the r-f cycle and if they are traveling at the proper velocity so that they can just traverse the gap in a half-cycle of r-f, they will be accelerated and will gain the energy of the r-f. The velocity v of a particle of charge e is

$$v = (2eV/m)^{1/2}$$

so it is seen that for a given frequency and gap length only a particular mass can traverse the gap and pick up the maximum energy. A greater separation in mass can be resolved by utilizing more gaps in cascade, each gap being successively longer by the increase in velocity predicted by the system.

Once the particles are separated in kinetic energy by the r-f analyzer, a pair of deflection plates can serve as a kinetic energy selector. The amount of deflection is inversely proportional to the kinetic energy, the particle paths being independent of mass in an electrostatic field. If the particles are injected at an angle of 45 deg into the electrostatic field, a first order focusing is achieved (Fig. 2). For a parallel beam, the ratio of beam widths at the top of the parabolas with respect to the entrant width is $\Delta h^2/2d$, where $2\Delta h$ is the entrant beam width and d is the distance between the deflecting plates.

Oscillator Design

An output voltage of 125 volts peak r-f is required on the accelerator. Since the accelerating structure within its case looks like 250 $\mu\mu$f, it is necessary to use a capacitive voltage divider across the oscillator tank to vary frequency over a range of 3 to 1. It is desirable to vary the capacitance of the LC tank in changing frequency since this produces a linear mass scan if a linear capacitance change is used.

A variable air capacitor with a maximum-to-minimum capacitance of 25 to 1 was selected for tuning. With the capacitive load of the tube lumped on the tank through a 10-to-1 capacitive divider shown in Fig. 3, a frequency range of 3 to 1 is obtained (capacitance range of 9 to 1).

To produce 125-volt signal at the tube requires a 1,250-volt signal across the tank, owing to the capacitive divider. This is achieved using a Lampkin oscillator circuit with a coil whose Q is over 350. An effective step-up transformer is thus produced, requiring less than 300 volts plate and screen voltages. Since no power is required from the oscillator, a pair of 5763 tubes is sufficient for conservative operation, the output voltage being proportional to the g_m.

The screen voltage is used as the variable element for maintaining the amplitude constant as the frequency is varied. The screen voltage change for change in frequency is inversely proportional to the Q of the tuned circuit as a function of frequency. The frequency range used is from 2 to 6 mc.

R-F Regulator

The problem of measuring the r-f amplitude to 0.01 percent is indeed difficult. No diode rectifier is free enough from variable contact potentials to make a 125-volt measurement to 12.5-mv accuracy. Germanium diodes, although having less contact potential, are temperature sensitive and therefore also useless.

An electrometer tube circuit shown in Fig. 4 provides a reasonable way to achieve the measurement. A type CK5886 tube was selected because the large grid-to-cathode spacing allows the application of 120 volts bias on the tube. The stage is used as a plate detector, the r-f signal being applied at the grid on top of a 120-volt bias voltage.

The tube conducts for only a small portion of the r-f cycle and the filtered d-c plate voltage is a

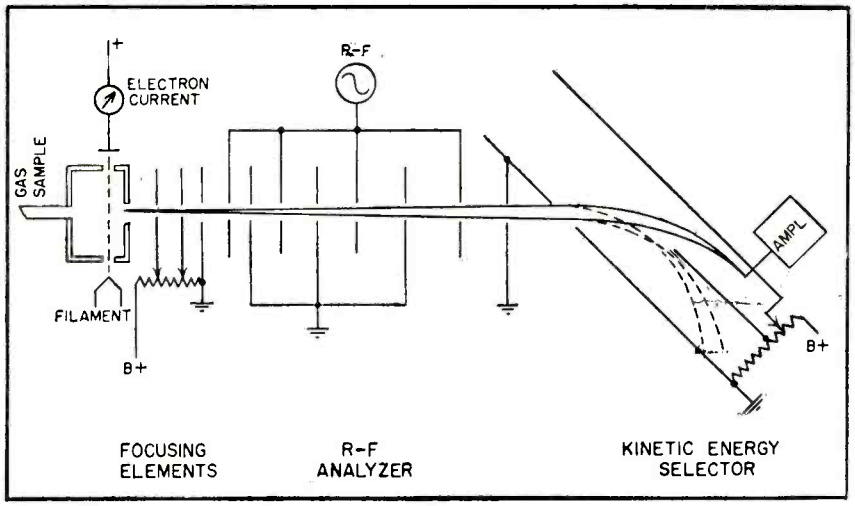


FIG. 1—Six-gap i-f accelerator mass spectrometer

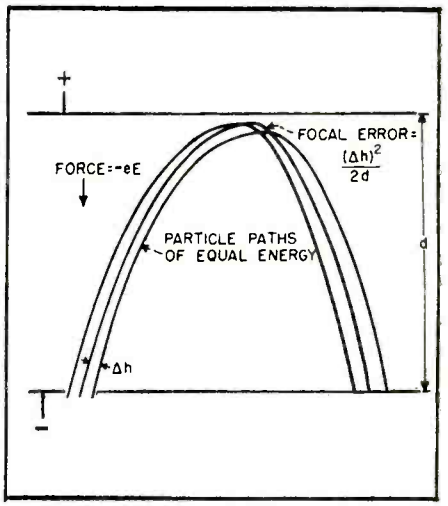


FIG. 2—Charged particle paths

function of the r-f amplitude. Plate and screen voltage are operated at 10 volts with respect to cathode to reduce grid current and ion currents. The bias stability can be kept to better than 2 mv a day, a factor of 10 below the required 12.5 mv bias stability required for the system.

The plate load is returned to ground potential to reduce d-c variations and the grid and cathode are both common to a well-regulated −250 volt supply. To stay within peak plate current ratings on the CK5886, a 15-megohm plate load is used. Since this represents the grid resistor of the following 6J6 stage, the second stage shown in Fig. 5 must also be designed with low plate voltage to reduce grid current. A 6J6 was selected since it can operate with low plate voltages and still have a suitable bias for the application.

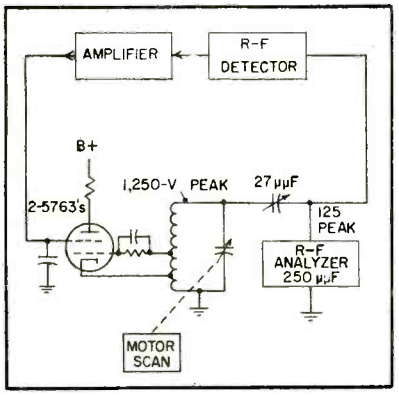


FIG. 3—Oscillator with regulator

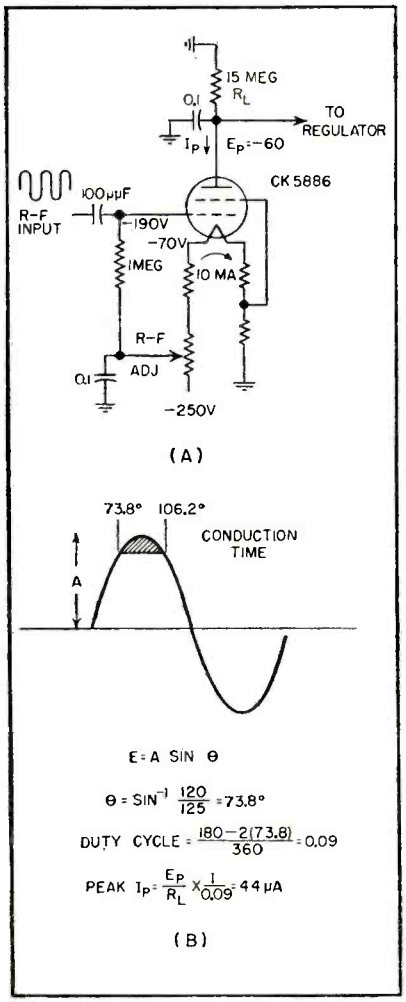


FIG. 4—Radio-frequency detector (A) and operating characteristics (B)

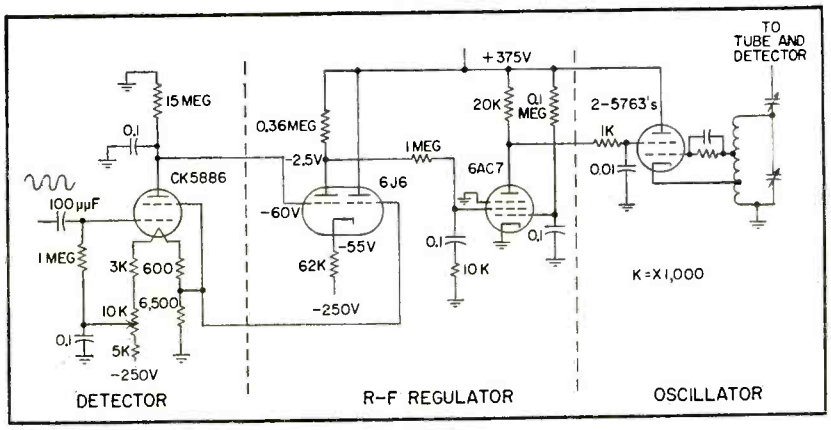


FIG. 5—Assembled circuits showing detector, r-f regulator and oscillator

The loop gain required can be computed on the basis of the number of stages used and an arbitrary figure of ±12 percent variation in gain per stage. For 0.01-percent stability, half the difference between the extreme values of $1/AB$ corresponding to the ±36-percent variation of A about A_o for three stages must be 0.0001 or less. Therefore

$$0.0001 = \frac{1}{AB} \times \frac{1}{2}\left(\frac{1}{0.64} - \frac{1}{1.36}\right)$$

AB = 4,130 where AB is the loop gain

For commercial equipment this value is arbitrarily multiplied by 10 to give a good safety factor. With three stages, the second stage must be a differential amplifier for the loop to maintain correct phase relationship so that an increase in r-f amplitude will decrease screen voltage and so that a good voltage gain at d-c can be achieved without cathode degeneration.

The third stage is used as a shunt regulator with its cathode grounded. A large variation in plate current will therefore not upset the bias characteristics. Phase-compensating networks have been added to prevent oscillation and yet maintain response of the amplifier to several hundred cycles.

The performance of the r-f regulator is good, maintaining amplitude stability to 0.001 percent as the frequency varies from 2 to 6 mc. The long term stability is 0.01 percent. Since the linear accelerator is in a sense an r-f voltmeter, the final energy being equal to $V_o + nE$, it makes an excellent means of checking the amplitude stability of the r-f applied to its plates.

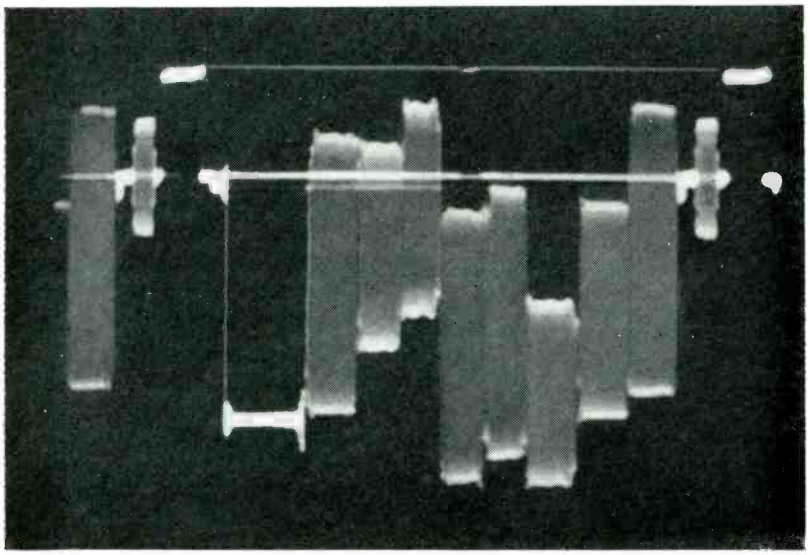
Argon Check

For example, if an argon sample is admitted to the spectrometer, peaks will occur at masses 40, 38 and 36, corresponding to the argon isotopes. The ratio of the peak heights of the isotopes is known to better than 0.01 percent and since the peak heights on the r-f accelerator instrument are also a function of the amplitude stablity of the r-f, a good check on the operation of the regulator can be made as a function of frequency.

In making measurements of an r-f voltage of variable frequency to 0.01 percent, it is necessary that the detector be mounted with as short a lead as possible to the analyzer, since the inductance of even a short piece of wire combined with the capacitance of the analyzer forms a resonant circuit at several hundred megacycles. Thus, the transfer characteristic will be a function of frequency.

Matrixing and Encoding

SUMMARY — Single encoded composite video signal appears at the output terminals of unit that combines color television signals under the NTSC system and feeds tv transmitter without distortion of any signal element



Signal at output of matrix and encoder unit in response to color-bar generator signal input

THE NTSC SYSTEM of color television transmission specifies that a composite video signal shall contain in separable form: a luminance signal which can be utilized by existing monochrome receivers to give a normal black and white picture and a two-component chrominance signal, which together with the luminance signal, conveys the complete color information.

Each of these signals is normally composed of a linear combination of the gamma-corrected red, green and blue signal outputs of a color camera, slide scanner or color-bar generator. Since the luminance and two components of the chrominance signal must be transmitted over a common communication channel, these signals must be distinguished from one another. The chrominance signal is superimposed as a modulation on a subcarrier signal. The individual chrominance components are in turn disinguishable because their respective subcarrier signals are in phase quadrature.

The subcarrier must be transmitted at periodic intervals to provide the reference against which the phase of the chrominance signal may be compared. Modulation is accomplished in a balanced modulator to secure the advantages of a disappearance of the subcarrier in the absence of color. To minimize crosstalk between luminance and chrominance signals and between the components of the chrominance signals bandwidth limiting is required of the chrominance components before modulation.

The unit to be described accepts as inputs a blanking signal, a sync signal, a subcarrier signal, a burst-key signal and the red, green and blue color signals. The unit performs the necessary operations of matrixing, modulation, bandwidth limiting, subcarrier reference-signal insertion and addition of blanking and sync signals.

Operational Stability

Feedback is used in all amplifier stages of this matrix and encoder unit to assure stability of gain and linearity of operation. In the modulator stages feedback is not easily achieved. Here the problem of stability is met by operating these stages at a high signal level. The drive signals, sync and blanking, are amplified and passed through limiting stages. This insures that the waveform and amplitude of these signals, as they appear at the output, are insensitive to amplitude and waveshape at the inputs.

NTSC Specifications

The NTSC specifications, that are relevant in the present discussion are given in Table I, Eq. 1 through 4. The symbols R, G and B represent respectively the gamma-corrected amplitudes of the signals furnished by the red, green and blue cameras and have a maximum amplitude of unity. The symbol Y represents the luminance signal, while I and Q represent the amplitudes of the two quadrature subcarrier voltages that convey color information. Finally, the symbol E represents the total video signal.

In the absence of color, $I = Q = 0$, the subcarrier amplitude is required to be zero. This feature requires that the modulators operate

Color for Telecasting

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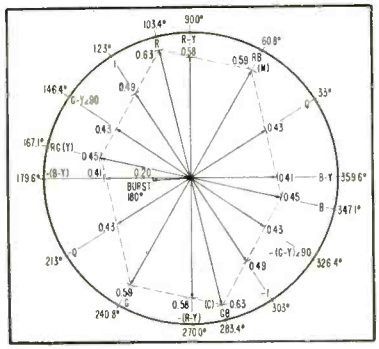


FIG. 1—Subcarrier signal for each of the colors listed in the color-bar chart

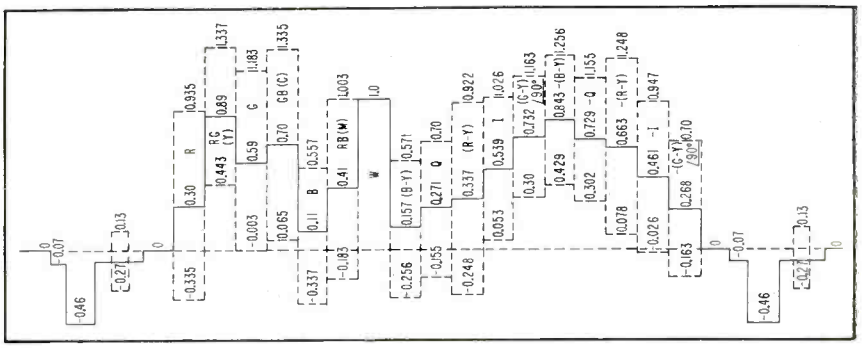


FIG. 2—A composite video signal from one horizontal sync pulse to the next. The solid line represents the luminance signal

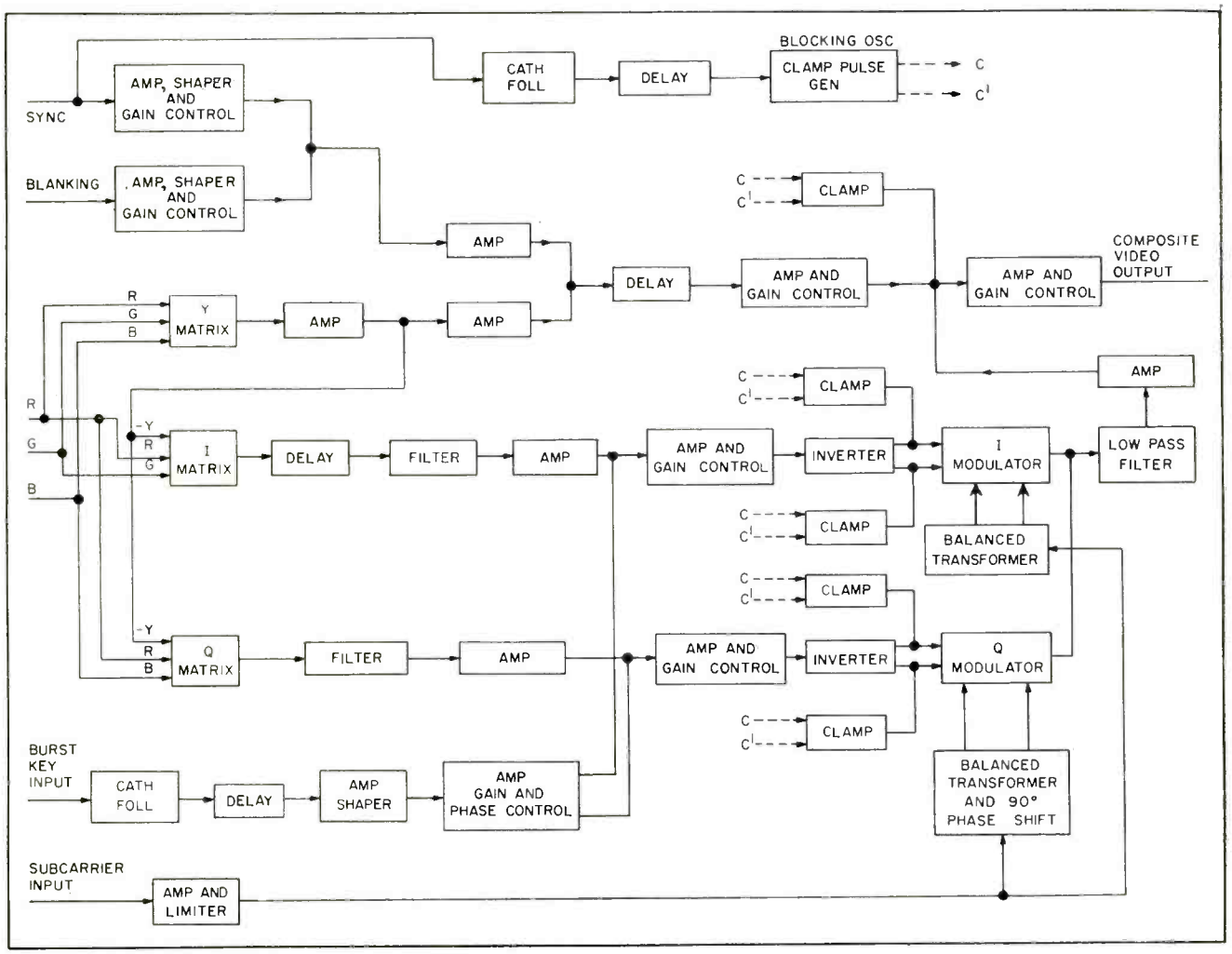


FIG. 3—Block diagram of the matrix and encoder unit. All amplifier stages employ feedback to assure stability of gain

as balanced modulators and hence furnish zero output in the absence of modulation. A pure luminance signal results when the R, G and B camera signals are of equal amplitude. Note in the derived relationships in Table I, Eq. 5 through Eq. 8 that $I = Q = 0$ when $R = G = B$.

The Y signal bandwidth is limited only by channel space allotted, while, as noted in Table I, the I and Q signals are restricted to bandwidths of 1.3 mc and 0.5 mc respectively.

The color-bar signal chart of Table II specifies the amplitudes of camera signals that give rise to maximum amplitude of the color signals listed in the column labeled signal. The subcarrier phase is specified with respect to the phase of the reference burst whose phase is arbitrarily specified to be 180 deg. The information in the last two columns of the chart is also given as a sinor diagram in Fig. 1.

In Fig. 2 the appearance of the composite video signal on a line basis, that is, from one horizontal sync pulse to the next is shown. The solid line represents the luminance signal which serves as the pedestal upon which the subcarrier signal is superimposed. The dotted lines represent the peak positive and negative excursions of the subcarrier signal. The reference phase burst is nominally eight cycles in duration and sits on the back porch of the horizontal blanking pulse. For convenience, black level has been set arbitrarily at zero. The small separation between blanking level and black level is referred to as set-up.

Matrixer and Encoder

Each of the camera input signals is fed directly to the Y-matrix as shown in Fig. 3. The Y-matrix, composed purely of resistors, provides at its output a linear combination of the R, G and B signal, which is proportional to the signal Y as given in Table I. From Eq. 5 and 6 note that it is possible to form I and Q signals in a matrix, the input signals to which are the R, G and B signals. Such an arrangement would require the use of two inverting amplifiers to provide the signals $-G$ and $-B$.

These inverting amplifiers would then be required to have a high degree of gain stability and freedom from distortion. The gain stability is needed to assure accuracy in the matrixing. Freedom from distortion is required so that $I = Q = 0$ when $R = G = B$. If either of the inverting amplifiers produces some harmonic components of the input signals, these harmonic components will constitute a residual in the I and Q channels when, in principle, no chrominance signal should be present. Thus the I and Q signals are formed on the basis of the alternative formulations given by Eq. 7 and 8. Now only the Y signal need be inverted.

The Q signal from the Q-matrix is passed through a bandwidth-limiting filter and then into the Q amplifier. The signal is amplified and converted finally into the symmetrical signal required for the push-pull operation of the Q modulator. The I signal from the I-matrix is treated in an identical fashion with the single exception that the I signal passes additionally through a length of delay cable. This delay is required because the delay in the Q filter is appreciably larger than the delay through the I filter. The NTSC specifications require that all components that contribute to the final video signal must be delayed by an equal amount to a tolerance of ± 0.05 μsec. This requirement also accounts for the delay introduced into the sync, blanking and burst-key channels.

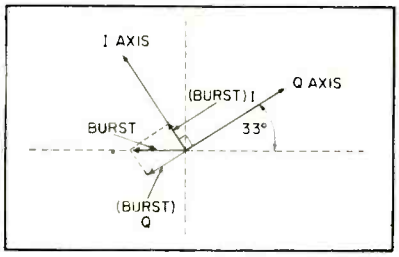


FIG. 4—Burst signal generated by simultaneous unbalance of the I and Q modulators

In addition to the I and Q video signals, which are fed to their respective modulators, each modulator also receives a push-pull 3.58-mc subcarrier signal. This subcarrier signal, provided by a color sync generator, is amplified and limited in a two-stage tuned amplifier so its amplitude at the modulators is independent of variations at the subcarrier input jack. The subcarrier is applied directly to the I modulator and phase shifted by 90 deg before application to the Q modulator.

The output of each modulator is a balanced, a-m signal. The amplitude in one case is proportional to the I signal; the amplitude in the other case is proportional to the Q signal. The two outputs are added in a common plate load. Since the two outputs are in quadrature, the resultant signal is one that is modulated in both amplitude and phase. The phase indicates the relative amounts of I and Q while the amplitude, $(I^2 + Q^2)^{1/2}$ is related to the amount of chrominance signal. For a purely black and white scene there would be no output from the modulators and a signal would appear only in the luminance channel.

Owing to the slight but inevitable nonlinearity of operation of the modulators, second and higher harmonics of the subcarrier are generated, which must be eliminated. For this purpose, the modulated subcarrier is passed through a low-pass filter. The frequency response from the plates of the modulators to the composite video output jack is uniform to within 1 db up to 5 mc and negligible at 7.16 mc ($2 \times$ subcarrier) and thereafter.

The color burst constitutes the phase reference for the chromi-

Table I—NTSC Specifications Relevant to Matrixing and Encoding Unit and Derived Relations

NTSC SPECIFICATIONS

(1) $E = Y + [Q \sin(\omega t + 33°) + I \cos(\omega t + 33°)]$
(2) $Y = 0.30R + 0.59G + 0.11B$
(3) $I = -0.27(B - Y) + 0.74(R - Y)$
(4) $Q = 0.41(B - Y) + 0.48(R - Y)$

DERIVED

(5) $I = 0.599R - 0.2773G - 0.3217B$
(6) $Q = 0.213R - 0.5251G + 0.3121B$
(7) $I = 1.472R + 1.449G - 2.925Y$
(8) $Q = 0.480R + 0.410B - 0.890Y$

Q-Channel Bandwidth

At 400 kc less than 2-db down
At 500 kc less than 6-db down
At 600 kc at least 6-db down

I-Channel Bandwidth

At 1.3 mc less than 2-db down
At 3.6 mc at least 20-db down

Table II—Color Bar Signal Chart

SIGNAL	R	G	B	Y	SUBCARRIER Amplitude	SUBCARRIER Phase
R	1	0	0	0.30	0.635	103.42°
RG (Yellow)	1	1	0	0.89	0.447	167.13°
G	0	1	0	0.59	0.593	240.83°
GB (Cyan)	0	1	1	0.70	0.635	283.42°
B	0	0	1	0.11	0.447	347.13°
BR (Magenta)	1	0	1	0.41	0.593	60.33°
RGB (White)	1	1	1	1	0	.....
B − Y (R − Y = 0)	0.1571	0	1	0.1571	0.4135	359.63°
Q (I = 0)	0.5371	0	1	0.2711	0.4265	33°
R − Y (B − Y = 0)	1	0	0.3371	0.3371	0.5848	90.03°
I (Q = 0)	1	0.4056	0	0.5393	0.4865	123°
(G − Y) | 90° (G − Y = 0)	1	0.7317	0	0.7317	0.4313	146.38°
Color Burst	.....	.....	.....	.....	0.20	180°
−(B − Y) (R − Y = 0)	0.8429	1	0	0.8429	0.4135	179.63°
−Q (I = 0)	0.4629	1	0	0.7289	0.4265	213°
−(R − Y) (B − Y = 0)	0	1	0.6629	0.6629	0.5848	270.03°
−I (Q = 0)	0	0.5944	1	0.4607	0.4865	303°
−(G − Y) | 90° (G − Y = 0)	0	0.2683	1	0.2683	0.4313	326.38°

nance signal. The NTSC specifications require that on a sinor diagram on which the phase of the burst is 180 deg, that the phase of a pure Q signal shall be 33 deg while the phase of a pure I signal shall be (33 deg + 90 deg) = 123 deg. These phase relations are indicated in Fig. 4. A color burst of proper phase can be generated by unbalancing simultaneously the I and Q modulators so that the relative amplitudes of the modulator outputs are related by the equation

$$\frac{(\text{Burst})I}{(\text{Burst})Q} = -\tan 33 \text{ deg}$$

The burst-key pulse is furnished by a color sync generator and has a duration of nominally eight cycles of the subcarrier signal. This color pulse is passed through an impedance-matching cathode follower into a delay cable and then through a shaping amplifier. The signal then proceeds through a gain-and-phase-control amplifier. This amplifier provides two burst-pulse outputs and has provision for adjusting independently the relative amplitudes and overall amplitudes of the burst-pulse outputs. The burst pulses are then injected into the I and Q amplifiers through a pair of buffer amplifiers.

Sync and blanking signals are passed through shaping amplifiers to make them independent of the input amplitudes, then mixed together and added to the Y signal. This composite Y signal is delayed, further amplified and added to the chrominance signal. This forms a composite video signal that is delivered to the output jack through an output amplifier. This output amplifier is adjustable in gain, has excellent linearity and will furnish a 1.4-volt peak-to-peak signal across a 75-ohm load. The output impedance is 75 ohms.

Synchronous clamping circuits are employed at the input to the output amplifier and at the video inputs to the modulators.

Video Amplifiers

Long-time stability results in large measure from use of negative feedback in all video amplifiers. With the exception of the output stage all are of the form shown in Fig. 5A. The merits of this stage with respect to stability and linearity are apparent through a comparison of the characteristics of this stage with a conventional stage of video amplification as shown in Fig. 5B. The conventional stage has a nominal gain, $A = -g_m R_L$ and an upper 3-db frequency, $f_2 = (2\pi R_L C_o)^{-1}$, C_o being the total capacitive loading of the stage. The cathode compensated stage of Fig. 5A when adjusted so that $R_k C_k = R_L' C_o$ has a gain and 3-db frequency given respectively by

$$A_c = \frac{g_m R_L'}{1 + g_m R_k} \quad \text{and} \quad f_{2c} = \frac{1 + g_m R_k}{2\pi R_L' C_o} \qquad (9)$$

Note from Eq. 9 that in both cases the gain-bandwidth product is the same, $Af_2 = A_c f_{2c}$.

If R_L' in the cathode compensated amplifier is selected to be $R_L' = kR_L$ and R_k is selected so $g_m R_k = k - 1$, then, from Eq. 9, the gain and bandwidth of the compensated stage will individually be equal to the gain and bandwidth of the conventional stage. In the conventional stage a given percentage variation in g_m will produce an equal percentage variation in gain. In the compensated stage however the fractional change $\Delta A_c/_c$ in gain resulting from a fractional change $\Delta g_m/g_m$ in transconductance is given by

$$\frac{\Delta A_c}{A_c} = \frac{1}{k} \frac{\Delta g_m}{g_m} \qquad (10)$$

This result follows from the gain

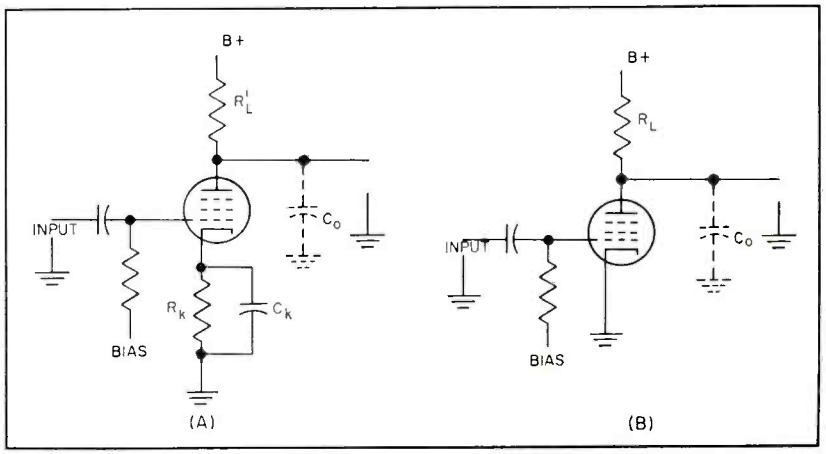


FIG. 5—Cathode-compensated amplifier stage (A) and conventional stage (B)

expression in Eq. 9. The principal source of gain instability in a video amplifier is the variation of g_m resulting from tube aging. Equation 10 indicates that the modification of a conventional amplifier in accordance with the procedure given above will preserve gain and bandwidth and reduce gain drift by the factor k.

Another advantage of the use of cathode compensation is a reduction of the nonlinearity of the amplifier. In a conventional amplifier nonlinearity of operation results essentially from the fact that the transconductance is a function of tube current and that, as a consequence, the amplifier gain varies over the range of the signal excursion.

Reduction of distortion may also be seen from the following considerations. Suppose that a peak-to-peak output signal E is required. In a conventional amplifier the tube must swing through a current range ΔI such that $R_L \Delta I = E$. In the compensated amplifier, since $R_L' = kR_L$ the tube is only required to swing through a current range $\Delta I/k$ and hence through a correspondingly smaller range of transconductance.

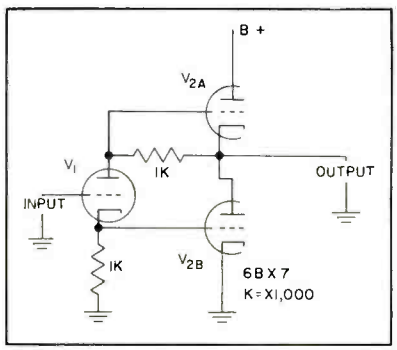


FIG. 6—Composite video output amplifier circuit

The output amplifier is of the type developed by Peterson and Sinclair and is illustrated in Fig. 6. Tube V_1 serves as a phase inverter to provide push-pull signals to the grids of V_2. In the quiescent condition the currents through V_{2A} and V_{2B} are equal and the load current is zero. A signal excursion at the grids of V_2 causes a current change, say ΔI, in V_{2A} and a current change $-\Delta I$ in V_{2B}. The difference current $2\Delta I$ flows through the load. Thus, the output tubes operate effectively in push-pull with a consequent reduction in even harmonic distortion. At the same time the circuit provides the convenience of a single ended output.

Shaper Amplifiers

Shaper amplifiers are used in this unit to standardize certain signals: blanking; sync; and the burst-key signal. The shaper chain shown in Fig. 7 is typical. Composite blanking is fed to the triode section of the 6U8 tube whose output is sufficient to drive the pentode section from clamp to beyond cutoff. The positive peaks of the output of the pentode are clean, free of overshoots and yet sharply rising owing to the rapidity with which the tube was driven to cutoff. The final stage of this chain, V_2, is driven from zero bias to beyond cutoff. Direct coupling to the grid of this stage insures that no overshoots will be generated due to grid-current charging of coupling capacitors. The output of this stage is clean on both ends, independent of the amplitude of the input blanking signal and suitable for mixing into the luminance channel. Gain control of the signal is accomplished by varying the screen voltage of V_2 which controls the plate-current swing for a given grid-voltage swing.

The balanced modulator provides an output subcarrier signal whose amplitude is proportional to the video input signal and is zero when the video signal is zero. The basic modulator circuit is shown in Fig. 8.

If the two tubes are operating identically, and if the input signals are perfectly balanced, there will be zero output in the common plate load. If, due to asymmetries of circuit components or tubes or unbalance of subcarrier signals, output is obtained for zero video input, control R_2 may be adjusted to give zero output. If an unbalance exists that results in a video signal appearing at the output the video gains of the two sides may be equalized by adjusting R_1.

Varying the bias on grid 1 affects sharply the total space current. Grid 3 controls the partition of this current between plate and screen. For a given voltage swing on grid 3 the plate-current swing will be greater if the total space current is greater and smaller if the space current is smaller. Hence R_2, which controls the grid-1 biases, may be used to control the subcarrier output of each side. Changing the bias on grid 1 also changes the video gain of the tube and this appears as a secondary effect.

Adjusting R_1 varies the amount of cathode degeneration of the video gain of each side and there-

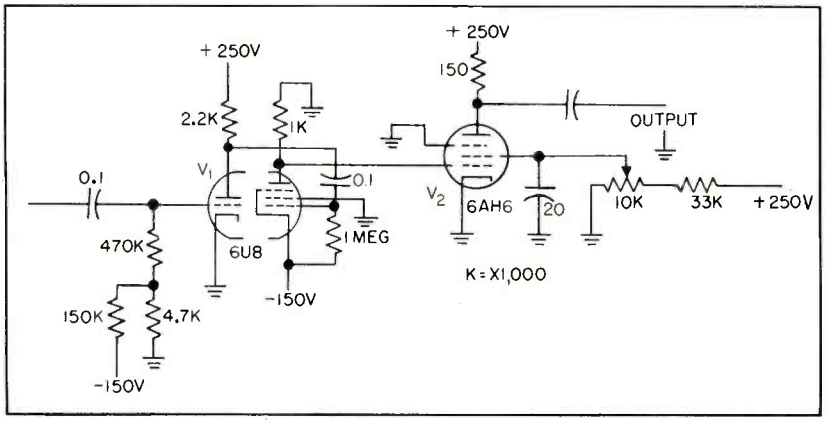


FIG. 7—Composite blanking is fed to the grid of V_1 of the shaper-amplifier chain

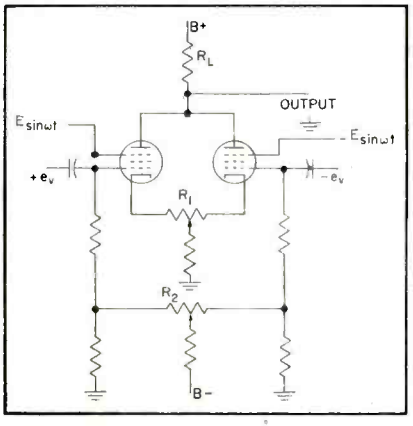


FIG. 8—Basic balanced modulator

fore acts as a video balance. However, it also affects the net grid-1 bias and therefore has the secondary effect of influencing the subcarrier balance.

Synchronous Clamping

A modulator must provide zero subcarrier output during the blanking interval of its video input. Hence, during this blanking interval the two first grids of a modulator must return to the same voltage level. However, the chroma amplifiers are a-c coupled and the absolute voltage level at the modulator grids individually will be a function of the chrominance-signal duty cycle.

Provision is therefore required for resetting both modulator grids to some common reference voltage during the blanking interval. The problem may not be solved through the use of d-c coupled amplifiers, since the R, G and B camera-input signals are a-c coupled. An examination of Eq. 7 and 8 in Table I shows that the I and Q signals may make either positive or negative excursions with respect to the zero voltage blanking level and therefore conventional d-c restoration is not suitable. The synchronous clamping circuit of Fig. 9 provides a satisfactory system of d-c restoration.

During the unblanked portion of the line, the diodes are held nonconducting by voltages developed across capacitors C_1 and C_2. During the blanking interval, pulses are applied to the diodes that force them into conduction and thereby connect the modulator grid through the conducting diodes and resistors R to the reference voltage.

If the two clamp signals are alike (but opposite in polarity) there will be no net clamp signal appearing at the modulator grid. Any difference in rise and fall times between the pulses will result in spikes appearing at the modulator grid. Any difference in shape of pulse tops will appear as signal at the modulator grid. Significant differences in pulse amplitude are tolerable.

To obtain pulses as nearly alike as possible, a special pulse transformer has been designed having a pair of bifilar-wound output windings. Two other windings in the transformer are used in a conventional synchronized blocking-oscillator circuit. The synchronizing signal for the blocking oscillator is obtained from composite sync, which has been suitably delayed to match the delays in the chrominance and luminance channels. The blocking-oscillator timing has been so adjusted that, while it is easily synchronized by pulses occurring at line rate, it behaves as a 2-to-1 divider during the interval of the equalizing and serrated vertical pulses. The advantage of this 2-to-1 division is that it avoids a 60-cycle component in the clamping signal.

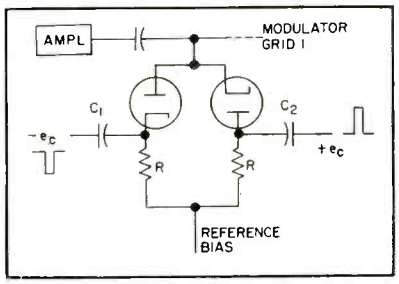


FIG. 9—Synchronous-clamp circuit

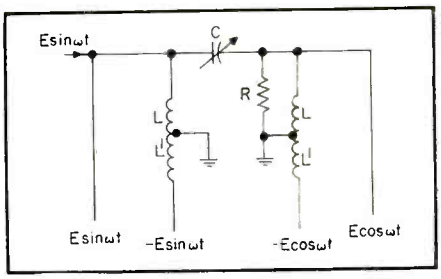


FIG. 10—Ninety-degree phase shift circuit

A synchronous clamp is also used at the grid of the output stage to minimize the required dynamic range of the output amplifier. If the signal applied to this amplifier were a-c coupled in conventional fashion, the average voltage level at the amplifier input would always be zero. As the duty cycle of the signal varies from one extreme to the other, the signal excursion with respect to zero goes positive or negative by an amount equal to the peak-to-peak voltage of the signal. Hence the amplifier is required to handle linearly a signal that is nominally twice the peak-to-peak input amplitude. Where linearity is at a premium, such operation is wasteful. The situation is corrected through the use of a synchronous clamp that restores the voltage at the output amplifier grid to a fixed reference at the end of each line.

The phase-shift circuit is shown in Fig. 10. A signal $E \sin \omega t$ is converted to a pair of push-pull signals by means of a bifilar-wound transformer LL'. To obtain a signal 90-deg out of phase, the original signal is fed to a series resonant circuit LC. The voltage across coil L will lead the input signal by 90 deg. The voltage across L will equal

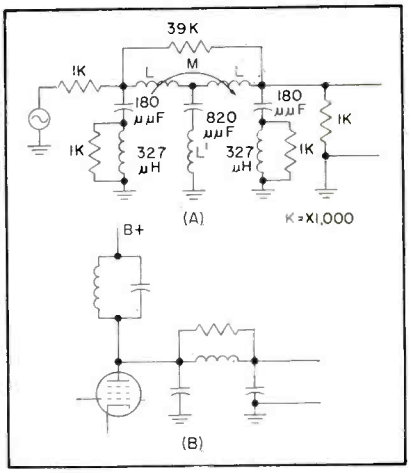


FIG. 11—Q-channel filter has Z_0 of 1,000 ohms (A) and I-channel filter (B)

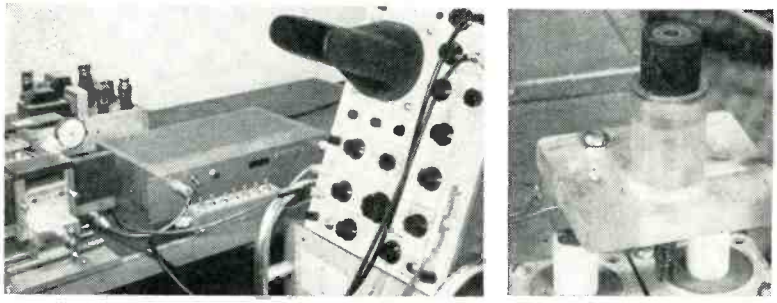
Q times the input voltage. To make the output equal to the input we make $Q = 1$, that is, $R = X_L$. The actual calculation of R, L and C is complicated by the presence of stray capacitance across C, L and L' and the reflected impedance of L' into L.

I and Q Filters

The filter in the Q channel is shown in Fig. 11A. It consists of a single m-derived section and has a characteristic impedance of 1,000 ohms. The resistors shunted directly across the coils are employed for damping purposes to minimize ringing. An m-derived section ($m \simeq 1.27$) is employed rather than a prototype section since the former provides a more nearly linear phase characteristic. This improved phase characteristic serves further to reduce ringing.

The I filter is of the form shown in Fig. 11B. It consists of a combination of tuned shunt peaking and series peaking. Both I and Q filters meet the NTSC specifications with a comfortable margin of safety. In both filters the residual ringing and overshoot is small enough to be negligible.

Pulsed Eddy Currents



Experimental setup using crt oscilloscope, left; and closeup of probe, right

Table I—Values of T in Microseconds

Coating Metal	Distance 5 mils	25 mils
Aluminum	0.75	18.8
Zirconium	0.045	1.12
347 Stainless Steel	28.1	702.0

SEVERAL methods may be used to measure the thickness of metal coating on a base metal such as: ultrasonics, back-scattering of beta or gamma rays and eddy currents. Eddy currents appear to offer the best chance of success.

If one of the metals is ferromagnetic the problem is simple, but for two nonmagnetic metals the problem is more difficult. Several investigators[1] have used sinusoidal eddy currents of a single frequency but this method presents difficulties such as low sensitivity and high harmonic content. Echo sounding by pulsed eddy currents[2] seems to have promise.

Theory

An electromagnetic field is applied to the surface of the coated metal and echoes from the metallic layers received. These echoes are caused by reflection from the metal-to-metal interface separating metals of different electrical properties.

A small single-layer probe coil with its axis perpendicular to the surface of the metal projects the electromagnetic field into the metal and receives the echoes. This helps make point-by-point depth measurements.

The input pulse is shaped like the positive loop of a sinusoidal wave. The path of the waves in the metal is shown in Fig. 1A. The first reflected wave contains information about the surface metal but nothing about the thickness of the coating. If the primary object is to measure the thickness of the coating, the first reflected wave will not be useful and must be balanced out by a bridge circuit. The second reflected wave contains information about the thickness of the coating and it will be the strongest of the remaining waves.

Pulse Width

The length of the pulses needed is directly related to the basic time

$$T = d^2\mu_1\sigma_1$$

where d is the thickness of the coating. Representative values of T in microseconds are given in Table I.

For best results, the input pulse should be approximately five times T. From Table I this would necessitate an extreme range of length of pulses. Some compromise on pulse length is necessary unless only one coating metal and thickness d is to be used. A pulse length of 3 microseconds was used.

The rate generator of an oscilloscope (Tektronix Model 517) is used to trigger a thyratron which sends identical pulses through both the standard and the test probes. The circuit is shown in Fig. 1B. The responses of the probes are balanced against each other and the difference voltage amplified and reproduced by the oscilloscope. Proper interpretation of the oscilloscope trace will yield the depth of the coating thickness.

When the input pulse from the oscilloscope triggers the thyratron the 1,000-$\mu\mu$f capacitor discharges through the thyratron and the primary of the transformer. The resistor in series with the thyratron and the capacitor and resistor shunting the primary of the transformer aid in shaping the pulse. The secondary of the transformer is loosely coupled to the primary and shielded from the primary. The secondary is balanced to ground and the output voltage applied to a bridge. Two of the arms of the bridge are the two probes. The probes are shunted by variable capacitors and resistors which permit

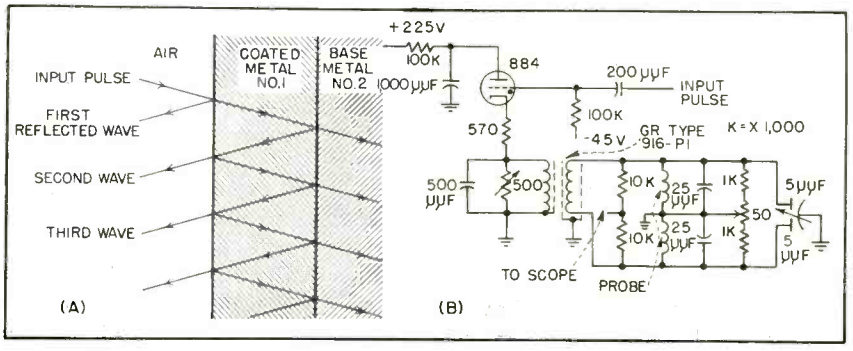


FIG. 1—Wave reflection at metallic interface (A) and pulsing circuit (B)

Gage Plating Thickness

SUMMARY — Echo-sounding technique making use of pulsed eddy currents determines thickness of one metal coated on a base metal. System takes advantage of electrical dissimilarities and is effective even when both metals are nonmagnetic

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a closer balance. The other two arms of the bridge are 10,000-ohm resistors whose midconnection serves as the output terminal to the oscilloscope.

Operation

If the bridge were perfectly balanced, when the ungrounded end of one probe is driven positively in voltage, the corresponding end of the other probe is driven negatively to the same extent and the output voltage to the oscilloscope would be zero. If a slight unbalance is present, an unbalanced voltage will exist at the terminals of the oscilloscope.

For adequate deflection of the oscilloscope under less sensitive conditions, an additional wide-band amplifier employing distributed amplification is useful.

The probes, shown in the photograph, are about ½ inch in diameter and have a core and outside shell of ferrite (Croloy 70). A single-layer coil of wire is wound on an insulating tube encasing the core. The resulting coil has an inductance of approximately 250 μh. Part of the core is movable so that a variable air gap can be introduced in the core to help in balancing the probes. If sufficient sensitivity were available, only the inner core would be used. This would materially reduce the effective area of the probe. The probe is held in plastic and a screw at the bottom adjusts the length of the air gap. An insulating spacer centers the core.

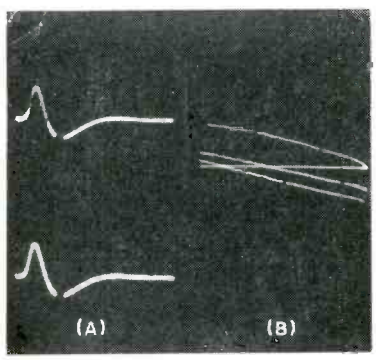
Measurement

The standard sample of metal is placed on the standard probe while another sample of metal is placed on the test probe. The balancing adjustments on the bridge and the probe are made so that the pulse output is nearly zero. A slight unbalance is added by changing the test probe air gap. The result is a wave similar to that of Fig. 2A, left. The gap in the wave is caused by a marker on the oscilloscope screen. The crossing point of the pulse wave is singled out and the time axis about this point expanded. The resulting wave is shown in Fig. 2B. As the thickness of the coating increases the crossing point moves toward the left. The position of the crossing point may be calibrated in thickness of coating.

One difficulty was the variation of the crossing point with the probe spacing. It was found experimentally that the slope of the oscilloscope trace varied also with this probe spacing. If the distance between the probe and the plate were varied until the slope of the trace had some fixed value, then the probe spacing would always be the same and the crossing point would measure coating thickness.

The results are shown in Fig. 2, right. The solid line is the calibration curve of the oscilloscope. The two encircled points are those of standard samples used for calibration.

The test sample was tested by the oscilloscope method and then was sectioned for optical measurements. The crosses are the results of optical measurements. They indicate good agreement between the nondestructive and destructive tests.



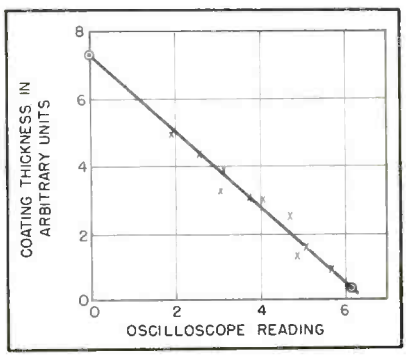


FIG. 2—Output waveform on crt (A), expanded trace (B) and coating thickness as a function of crt reading, right. Crosses indicate optical measurements

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(1) R. Hochschild, Eddy Current Testing by Impedance Analysis, *Nondestructive Testing*, 12, p 35, May-June 1954.
(2) D. L. Waidelich, Coating Thickness Measurements Using Pulsed Eddy Currents, *Proc NEC*, 12, Feb. 1955.

*Now at University of Missouri, Columbia, Mo.

Table I—Linearity Measurements, Resistor R_c Adjusted for Zero Frequency Error at Dial Setting of 9

Correct Dial Reading	Frequency with Respect to Highest Frequency of Each Range	Actual Dial Reading with No Compensation: 5 to 50 pps, R_c = 10.5K	50 to 500 pps, R_c = 10.5K	500 to 5,000 pps, R_c = 11.5K	Actual Dial Reading with Compensating Resistor (R_K = 1 Meg): 5 to 50 pps, R_c = 10.5K	50 to 500 pps, R_c = 10.5K	500 to 5,000 pps, R_c = 11.5K
0	$f/10$	0	0	0	0	0	0
1	$f/9$	1.02	1.0	1.0	0.99	0.995	0.995
2	$f/8$	2.02	2.0	2.0	1.99	1.99	1.99
3	$f/7$	3.02	3.01	3.01	2.99	2.99	2.99
4	$f/6$	4.03	4.01	4.01	3.99	4.0	4.0
5	$f/5$	5.02	5.02	5.01	5.0	5.0	5.0
6	$f/4$	6.02	6.01	6.01	6.0	6.0	6.0
7	$f/3$	7.01	7.01	7.0	7.0	7.0	7.0
8	$f/2$	8.01	8.0	8.0	8.0	8.0	8.0
9	f	9.0	9.0	9.0	9.0	9.0	9.0

Repetition-Rate Generator

SUMMARY — Free-running double screen-coupled phantastron covers range of 5 to 5,000 pps in three ranges with 2-percent accuracy. Compensating circuits improve basically linear operation of phantastron and ten-turn potentiometer frequency control assures reproducible indication

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ALTHOUGH in many instances a free-running multivibrator can be used to control the repetition rate of a pulse generator, accurate settings can not be made easily because the timing of the multivibrator period is determined by an exponential rather a linear waveform.

The phantastron repetition-rate generator to be described covers the range of 5 to 5,000 pps in three ranges with 2-percent accuracy. Timing is determined by the linear plate voltage rundown waveform.

Circuit Operation

Use of a double screen-coupled phantastron, in which two single screen-coupled monostable phantastrons are cross coupled, results in linear operation and thereby accurate timing over the complete period, which consists of two linear rundown waveforms.[1]

In the circuit of Fig. 1, V_1 and V_4 are pentodes with suppressor-grid control. Both halves of the circuit, if considered independently, are conventional monostable screen-coupled phantastrons. Both suppressors are biased substantially below cutoff and either a positive trigger on the suppressor or a negative trigger on the plate is required to initiate the action for each rundown. Considering both halves as operating together, however, the cross coupling between the two circuits will maintain free-running operation once started. When the circuit is turned on, some slight disturbance is enough to start a rundown in one of the two sections. During this rundown period, screen current in the tube of that section is very low and the screen voltage is high.

At the end of the rundown, the plate current decreases and the screen current increases rapidly, causing the screen voltage to fall. Since each screen waveform is differentiated and coupled to the plate of the other 6AS6, a negative trigger will be coupled to the opposite plate at the end of the first rundown and another linear rundown will be initiated maintaining free-running operation.

Tubes V_2 and V_5 are cathode-follower low-resistance recharging paths for the grid-to-plate coupling capacitors. Without the cathode follower, the plate coupling capacitors would have to recharge through the large plate resistor R_L, resulting in

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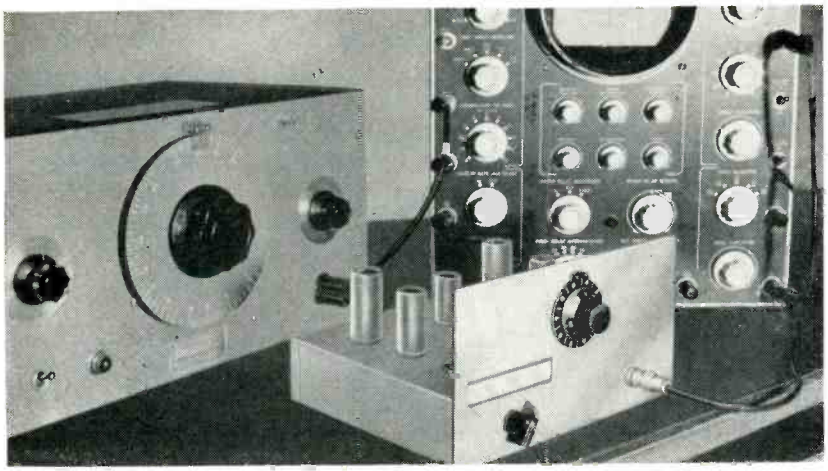


Setup for testing repetition-rate generator uses a-f generator and oscilloscope

Has High Accuracy

a long recovery time determined by the time constant $R_L C$. Using the cathode-follower recharge path, however, the recovery time constant becomes approximately $(1/g_m)\ C$, which is completely adequate in most cases.

Tubes V_3 and V_6 clamp the plates at a voltage level of 200 to 20 volts, as determined by the helical potentiometer. As the rundown in either of the sections begins, its own clamping diode disconnects allowing that plate potential to go down.

Frequency Ranges

There are three frequency ranges: 5 to 50 pps; 50 to 500 pps; 500 to 5,000 pps. Since frequency is inversely proportional to period and period is proportional to clamping level, for a particular grid-circuit time constant $R_g C$, a setting of a 200-volt clamping level will correspond to the lowest frequency of each range and a setting of a 20-volt clamping level will correspond to the highest frequency of each range.

The V_1 suppressor waveform (Fig. 2A) is differentiated and applied to V_5, a heavily conducting amplifier stage. Thus, a positive trigger output at the plate of V_5 is obtained for each cycle of operation of the phantastron circuit. By using a 6AH6 sharp cutoff pentode as V_5, a 70-volt trigger with a 0.4-μsec rise time can be obtained.

Typical rundown plate waveforms for V_1, Fig. 2, show that the plate rundown waveforms are essentially linear. These plate waveforms also show the initial step which is characteristic of this type of circuit. In Fig. 2B, the step is only a small fraction of the total rundown amplitude so that the ratio of T_2 (actual period) to T_1 (sawtooth period) is close to unity.

In the plate waveform of Fig. 2C, obtained at low clamping levels, the initial step becomes an appreciable part of the rundown and the ratio of T_2 to T_1 becomes noticeably less than unity. Thus a linear control of clamping level with a precision helical potentiometer does not linearly control period.

Compensating Circuits

One method of compensating for this nonlinearity is to introduce another nonlinearity elsewhere. An inherent nonlinearity exists in the actual clamping level since the trigger-isolating resistor R_c shown in Fig. 3 introduces a voltage which is in series with the desired clamping voltage. At first, it seemed desirable to make R_c as small as possible to reduce this source of nonlinearity. However, voltage drop e_c shown in Fig. 3 increases as the clamping level decreases. The step in the waveform introduces one nonlinearity which tends to decrease the period and the voltage

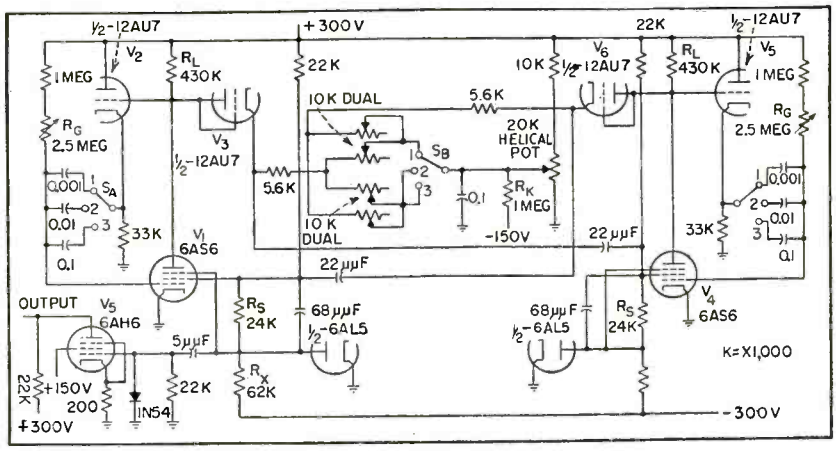


FIG. 1—Frequency ranges for switch positions 1, 2 and 3 are 500 to 5,000, 50 to 500 and 5 to 50 pps. Two R_g controls are mounted on common shaft

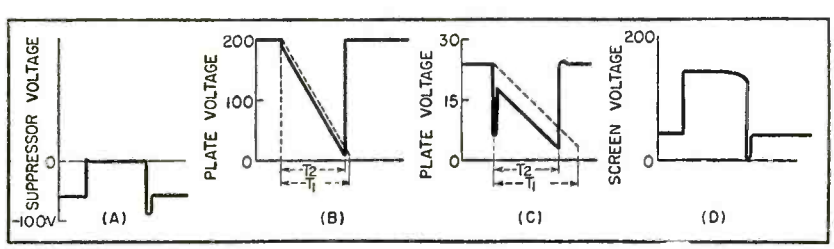


FIG. 2—Typical waveforms for V_1 in Fig. 1. Rundown waveform (B) is obtained with a 500-pps repetition rate and (C) with a 5,000 pps rate

Table II—Linearity Measurements for Two Highest Frequency Ranges of Circuit of Fig. 1

Repetition Frequency (pps)	Period (μ sec)	Correct Dial Reading for All Ranges	Actual Dial Reading (50 to 500 pps)	Actual Dial Reading (500 to 5,000 pps)
50	20,000	0	0	0
100	10,000	5.00	5.0	5.0
150	6,670	6.67	6.66	6.67
200	5,000	7.50	7.49	7.50
250	4,000	8.00	8.0	8.01
300	3,330	8.33	8.33	8.34
350	2,860	8.57	8.57	8.58
400	2,500	8.75	8.75	8.76
450	2,220	8.90	8.89	8.90
500	2,000	9.00	9.0	9.00

drop across R_c introduces a nonlinearity which tends to cancel the former by tending to increase the period.

By proper adjustment of R_c (combination of 5,600-ohm fixed resistor and 10,000-ohm dual potentiometer), reasonably good compensation can be achieved. This compensation is not perfect, but in combination with another compensation to be described excellent results can be obtained. One adjustment for R_c suffices for the two lowest frequency ranges. A separate adjustment and therefore a separate dual potentiometer is required for the 500 to 5,000 pps range.

Leakage Conduction

In addition to the error introduced in the clamping level by the voltage drop across R_c there is an error introduced in the clamping level by conduction from B+ to ground through plate resistor R_L, the catching diode and helical potentiometer. This error is minimized by making the value of resistance of the helical potentiometer small enough so that much more current flows through the potentiometer from the clamping divider than flows through the potentiometer from the catching diode. In Fig. 3 this error is listed both as an absolute error and a percentage error for several settings of the potentiometer.

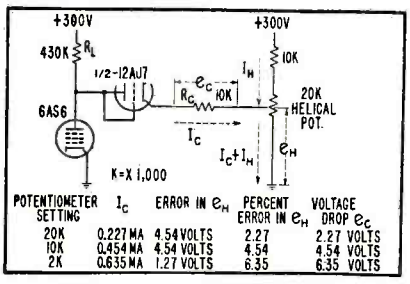


FIG. 3—Section of circuit of Fig. 1 used to introduce nonlinearity compensation

Percentage error in clamping level from this source is plotted against helical-potentiometer setting as the uncorrected curve in Fig. 4.

By introducing R_k as shown in Fig. 4, the value $(I_c - I_k)$ can be made to equal zero at some setting of the potentiometer, depending upon the value of R_k. Correction curves are shown in Fig. 4 for two values of R_k. The curves indicate that more complete compensation for the error in e_H is obtained with R_k = 560,000 ohms than with R_k = 1 megohm, but better overall circuit results are obtained with R_k = 1 megohm. This can be explained by the fact that the nonlinearity introduced by the step in the rundown waveform is not completely compensated for by proper selection of R_c alone. Therefore, the circuit requires an introduction of just the right amount of compensation which would tend to increase the period at low clamping levels and thereby complement the compensation introduced by R_c.

A value of R_k = 1 megohm serves to limit the percentage error introduced in the clamping level at high clamping levels, while introducing the proper amount of compensation tending to increase the period at low clamping levels. The initial step in the waveform and the error in the clamping voltage e_H together with the voltage drop across R_c could introduce errors of as much as 10 percent if care were not taken in selection of R_c, R_k and the clamping potentiometer.

A comparison of linearity measurements made with and without the R_k compensation is shown in Table I. The R_k compensation tends to decrease the maximum error by shifting the zero-error point, splitting the error about that new point. A Helipot Duodial with one dial reading 0 to 10 turns and the other dial a vernier which has a resolution of a hundredth of a turn was used with the helical potentiometer to obtain the readings listed in Tables I and II.

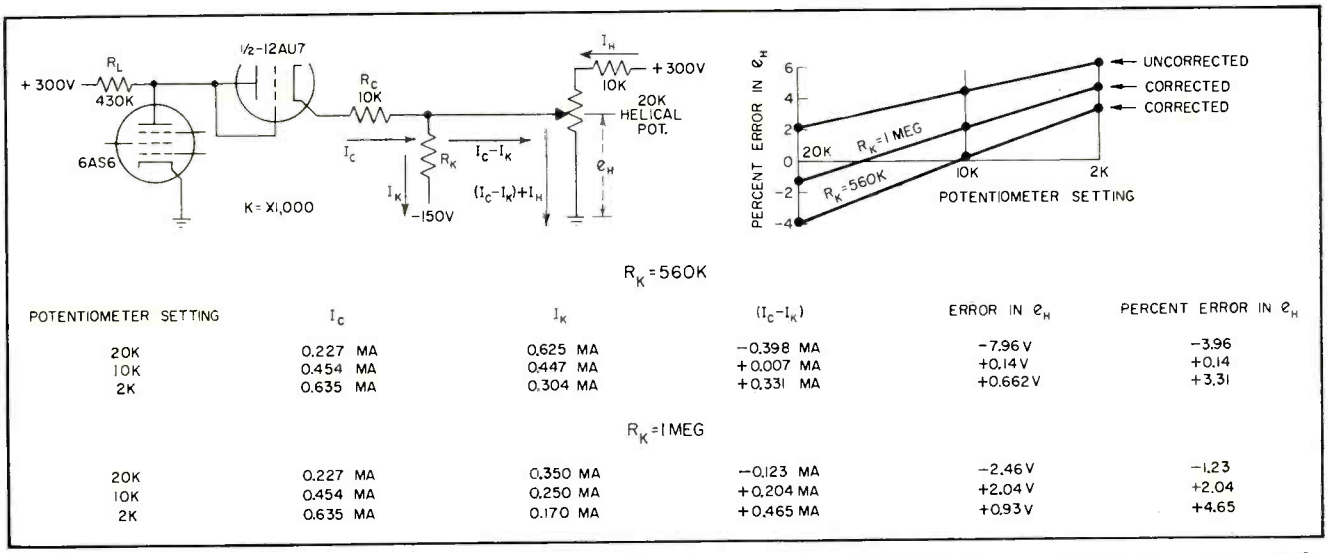
Linearity Measurements

Linearity measurements were made by a method which did not depend upon the absolute accuracy of the equipment used.

An audio oscillator output was connected directly to the vertical input of an oscilloscope and to the horizontal input of the oscilloscope through a 90-deg R-C phase-shifting network, resulting in a circular trace. The positive trigger output obtained from V_5 was coupled to the grid of the cathode-ray tube of the oscilloscope through a high-voltage capacitor.

The audio oscillator was set to correspond to the highest frequency of each range of the repetition rate generator shown in Fig. 1. The three plate-coupling capacitors were chosen on a capacitance bridge as exact multiples so that the setting of R_g would establish the 5 to 5,000 pps range. The helical potentiometer was connected so that its maximum value (20,000 ohms or zero turns) corresponded to minimum frequency. In obtaining a 10-to-1 clamping-level ratio with the helical potentiometer, the ninth turn would correspond to the maximum frequency (a setting of 2,000 ohms).

With the audio-oscillator frequency set exactly to the highest frequency of each range of the repetition-rate generator, an intensified dot would become stationary on the circular pattern on the oscilloscope. As the frequency of the repetition-rate generator is varied throughout its range with the audio-oscillator frequency fixed at the highest fre-



R_K=560K

POTENTIOMETER SETTING	I_C	I_K	(I_C-I_K)	ERROR IN e_H	PERCENT ERROR IN e_H
20K	0.227 MA	0.625 MA	−0.398 MA	−7.96 V	−3.96
10K	0.454 MA	0.447 MA	+0.007 MA	+0.14 V	+0.14
2K	0.635 MA	0.304 MA	+0.331 MA	+0.662 V	+3.31

R_K=1 MEG

20K	0.227 MA	0.350 MA	−0.123 MA	−2.46 V	−1.23
10K	0.454 MA	0.250 MA	+0.204 MA	+2.04 V	+2.04
2K	0.635 MA	0.170 MA	+0.465 MA	+0.93 V	+4.65

FIG. 4—Equivalent circuit for developing compensation for nonlinearity produced by conduction from B+ through R_L, catching diode and potentiometer to ground. Graph shows error in clamping level due to this source of nonlinearity

quency of that particular range, the frequency of the repetition-rate generator will pass through each submultiple of the audio-oscillator frequency from $f/2$ to $f/10$, and at each one of these points the intensified dot would again become stationary.

The measurements obtained are listed in Table I. A very accurate linearity check can be made without the absolute accuracy of the test equipment entering into the measurement.

This assumes that the audio oscillator will remain stable throughout the measurement. Most oscillators have good short-term stability at these low frequencies. If at a particular setting of the phantastron frequency control, the dot on the circular pattern on the oscilloscope remains stationary over a fairly long period of time, it can be assumed that the oscillator is stable, since it is highly unlikely that the oscillator and the phantastron would drift together.

Additional tracking of the circuit is obtained by setting the audio oscillator to the lowest frequency of each range, so that at each successive multiple of this lowest frequency, an additional intensified dot appears, the pattern becoming stationary at the exact multiple. Listed in Table II are linearity measurements for the two highest frequency ranges. A 5-cps sinusoidal waveform was not available so that the 5 to 50 pps range could not be checked with this type of measurement.

These two sets of linearity measurements differ primarily in the frequency points that are checked.

Performance

In general, linearity measurements shown in Tables I and II indicate that by using the methods of compensation discussed, the circuit can be made to operate linearily to within 2 percent. Electronically regulated power supplies were used and as a result the long-term stability of the circuit was found to be excellent.

Since frequency is inversely proportional to the period of any waveform, a linear control of period in this circuit results in a dial with a nonlinear frequency calibration. Table II shows that on the 50 to 500 pps range it takes five complete turns to cover the range 50 to 100 pps. The range 200 to 400 pps takes one-and-a-quarter turns while the range from 450 to 500 pps takes only a tenth of a turn. Even at the crowded end of the scale where frequency changes rapidly, 2-percent accuracy is maintained.

Tables I and II show that nowhere is the error greater than one one-hundredth of a turn. A sample calculation shows that if there is an error of one division in the setting within the 450 to 500 pps range, the error would not be greater than 5 pps out of 450 pps, the equivalent of a maximum of 1.1-percent error. Another sample calculation shows that if there is an error of one division in the setting within the 100 to 150 pps range, the error would not be greater than 0.3 pps out of 100 pps which is the equivalent of a 0.3-percent error.

Dial Calibration

A chart can be drawn up to convert frequencies not listed in Table II to the proper dial reading on the helical potentiometer, but a more practical arrangement would be to have a larger calibrated dial geared to the helipot so that this large dial would make one complete revolution for ten turns of the helical potentiometer.

Allowing for possible errors in reading the dial, it is fair to state that a 2-percent accuracy can be maintained using this circuit.

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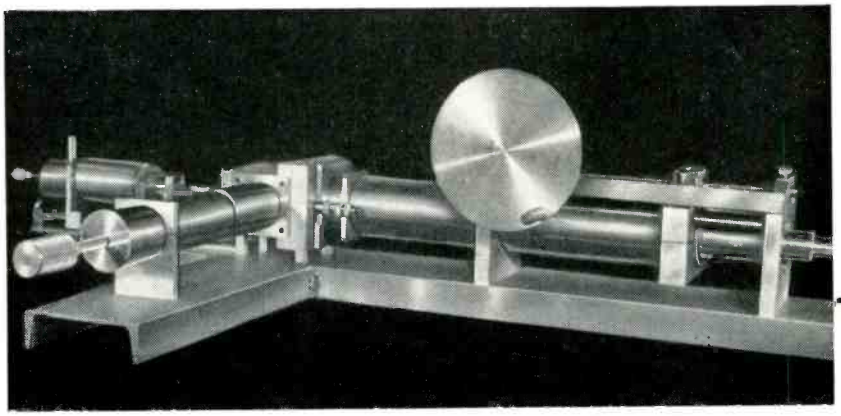
The author acknowledges the helpful suggestions contributed by John Collins.

REFERENCE

(1) "Waveforms", Vol. 19, *MIT Rad Lab Series*, p 199, McGraw-Hill Book Co., Inc., New York, N. Y., 1949.

UHF Multiplexer Uses



Multicoupler as constructed in coaxial form. Large wheel at right center tunes resonant cavity

By HERBERT J. CARLIN

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SEVERAL transmitters and receivers can be operated on a single antenna in the frequency band from 225 to 400 mc.

The multiplexer designed for this purpose achieves high isolation and low insertion loss at unusually close frequency spacings between transmitters and receivers. When the multicouplers are used with a frequency separation of 3 mc between equipments, the average insertion loss in a 4-coupler system is approximately 1 db per coupler, and the isolation between equipments located at adjacent couplers is approximately 60 db.

Decoupling

Each antenna coupler making up the passive multiplexing system sets up two paths of transmission from a single antenna as shown in Fig. 1. The coupler provides a channel between the antenna A and a piece of transmitting or receiving gear located at one of the coupler terminals T. Signals not intended for this path are routed from the antenna past the coupler to some other directional coupler[1].

An n number of couplers can provide multiplexing of $n + 1$ equipments on a single antenna. The coupler achieves its duplexing action by combining the properties of a directional coupler and a filter permitting simultaneous use of multiplexed signals which are very closely spaced in frequency.

The design of the coupler is, in first approximation, the coaxial realization of an impedance-bridge equivalent circuit shown in Fig. 2. This bridge is balanced when the product of the impedance in opposite arms are equal. That is $Z_a Z_b = R_0^2 = 1$ or $Z_a = 1/Z_b$.

Impedance Z_a is inverse to Z_b. Under these conditions power at port T is entirely decoupled from arm N. At the same time port A is also decoupled from port L. This decoupling is theoretically independent of frequency though parasitic effects in the coaxial coupler prevent the full realization of this frequency invariant performance. The decoupling is related to the directivity of directional couplers and, the actual device is a coaxial directional coupler.[1].

The on-resonance insertion loss from a transmitter to an antenna (T to A) or the off-resonance loss of a coupler (A to N) can be made small providing a high enough value of Q for the resonant circuits of Fig. 2 is used, and provided that the resonant impedances of these tank circuits are suitably chosen.

Ideally, Z_b should be low at resonance and Z_a high at that point. This permits coupling of T to A via path cda. Off resonance, Z_b must increase rapidly and Z_a decrease so that power from A bypasses the coupler and goes to N via path dbc.

With finite Q, the resonance level of Z_b should not be set too low for the impedance level would then never reach high enough values off resonance to produce sufficiently low insertion loss. Similarly, the resonant level of Z_a must not be permitted to be too high at resonance. A further problem is the loss of effective directivity when the coupler is operated with a mismatched antenna. This is taken into account by the use of a variable impedance as a balancing network at arm L.

The schematic diagram of the coaxial resonant cavity used to

Table I—Losses in a Four-Coupler System

Frequency	On Resonance insertion loss for single coupler	Average loss per coupler	
		3-mc spacing	5-mc spacing
225 mc	1.5 db	0.68 db	0.61 db
300 mc	0.5 db	0.78 db	0.55 db
400 mc	2.0 db	2.06 db	1.30 db

Selective Couplers

SUMMARY —— Frequency selective passive coupler system gives 60-db isolation with an average insertion loss of 1-db per coupler in a 4-coupler multiplexing system having a frequency separation of approximately 1 percent between transmitters

realize the series tank circuit of arm ab of the bridge is shown in Fig. 3A. The length l is approximately a quarter wavelength at resonance.

Resonant Impedance

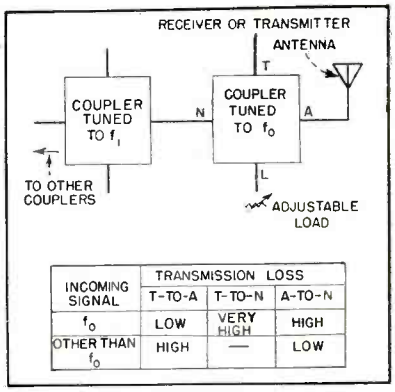
Control of the resonant impedance level is achieved by coupling to the circuit at a suitable distance d from the open-circuited end of the cavity. The required value of resonant impedance is approximately 50 ohms so that it is necessary to make d small by coupling to the region where the electric field is near a maximum so as to get a relatively high resonant impedance level.

An approximate equivalent circuit of the coaxial cavity is shown in Fig. 3B. The resistance R_o, which is the resonant impedance, is directly proportional to l/d and inversely proportional to the cavity Q. Thus, the adjustment of distance d is equivalent to a variable turns-ratio transformer coupling at resonance.

To cover the frequency band the distance d has two positions in the actual coupler, one for the low frequency part of the band and the other for the high end. The impedance variation of the cavity at the coupling point is no longer that of a simple resonant cavity. Neglecting resonances outside the band at the $l = n\lambda/4$ points ($n > 1$), the impedance is shown plotted in Fig. 3C. The series resonant point occurs at $\lambda/4 = l$, corresponding to ω_o. At a slightly higher frequency ω_1 the impedance becomes antiresonant. This is desirable since this minimizes the coupling from arm A to arm T of the coupler and hence reduces the off-resonance insertion loss even when close frequency spacing is used. On the low-frequency side of resonance ω_o the impedance increases at a slower rate, so that the off-resonance insertion loss is not as small below ω_o as above.

Above ω_1 the impedance begins to go down but never reaches a sufficiently low point inside the operating frequency band to adversely affect coupler operation. Even when $f_o = 235$ mc, the next higher zero of impedance is at 450 mc, 50 mc beyond the highest operating frequency.

The construction of the antiresonant coaxial cavity, arm bc of Fig. 2 is shown schematically in Fig. 4A. Whereas the resonant arm operates



INCOMING SIGNAL	TRANSMISSION LOSS		
	T-TO-A	T-TO-N	A-TO-N
f_o	LOW	VERY HIGH	HIGH
OTHER THAN f_o	HIGH	—	LOW

FIG. 1—Table gives impedances presented between various ports of antenna coupler shown in block form

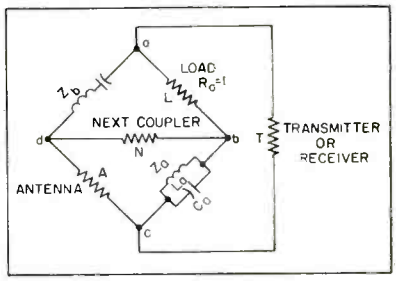
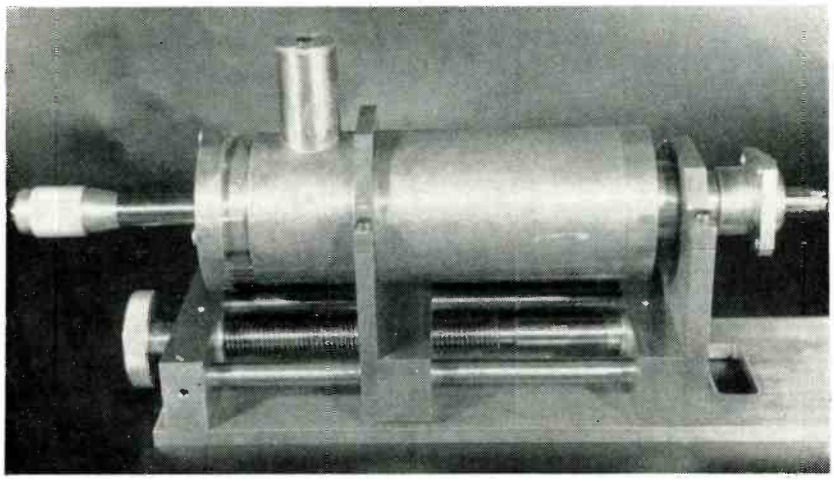


FIG. 2—Equivalent bridge circuits for paths between transmitter or receiver and antenna



Upper knob at left of antenna-matching section adjusts inductance. Lower knob is capacitance control

like a ¼λ series-resonant cavity with series coupling at the high-field end, the antiresonant tank is the dual of this. Thus, it is a ¼λ parallel-resonant cavity with shunt coupling to the low-field region to achieve relatively low resonant impedance levels on the order of 50 ohms.

The total length of the antiresonant cavity includes the height d of the stub structure $l + d$ shown in Fig. 4A, and adjustment of this dimension is analogous to the action of an autotransformer. The equivalent circuit is shown in Fig. 4B and the admittance plot in Fig. 4C. The low admittance point at antiresonance is at ω_o, and above this point the admittance increases rapidly benefiting the off-resonance insertion loss above ω_o.

In all respects the operation of this cavity is approximately the dual of the series cavity of Fig. 3. However, it was not found necessary to make the impedance-level adjustable in the actual coupler.

A realization of the coupler in coaxial line is shown in the photograph and in Fig. 5. A bridged-T equivalent obtained by redrawing the bridge circuits of Fig. 2, with the more complex representations of the cavity given in Fig. 3 and Fig. 4 is also shown in Fig. 5.

The two cavities are tunable for frequencies from 225 to 400 mc, and the impedance-level control which sets the resonant impedance level of the series cavity is also shown.

The series-resonant cavity is located in the inner conductor but is made externally tunable.

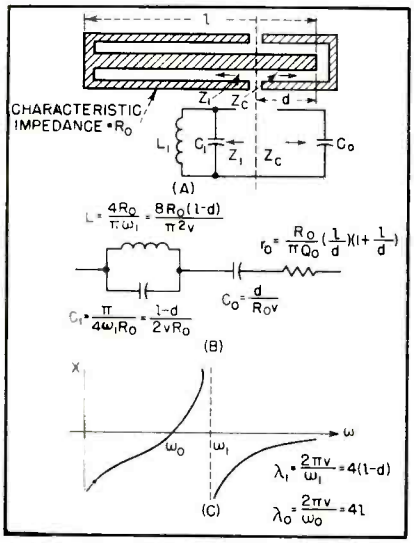


FIG. 3—Basic physical form for resonant leg of bridge (A) with equivalent circuit (B) and reactance-versus-frequency plot (C)

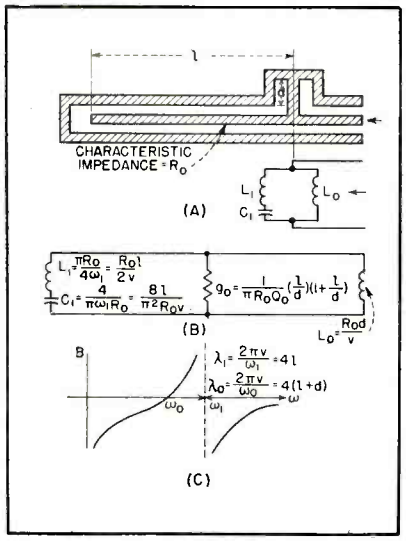


FIG. 4—Physical configuration of antiresonant leg of bridge (A) with equivalent circuit (B) and diagram of susceptance plotted against frequency.

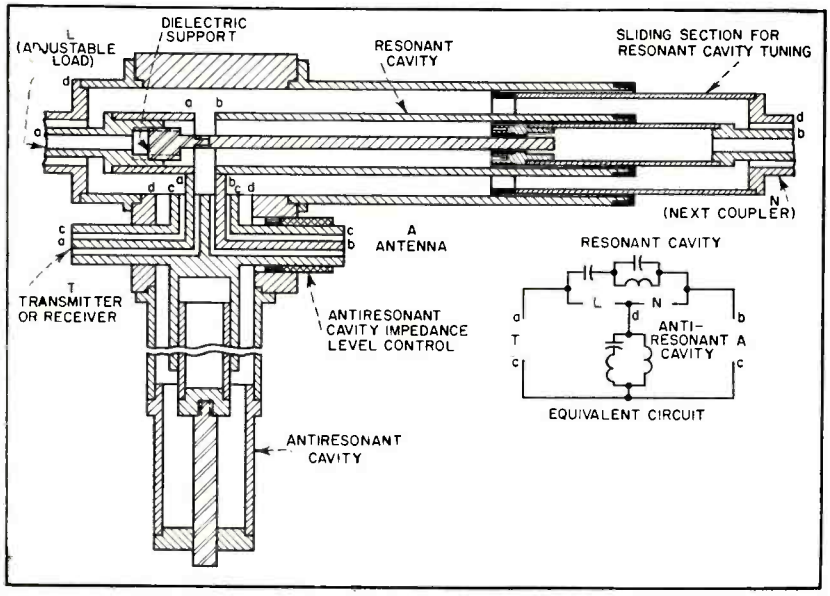


FIG. 5—Cross-section of uhf multicoupler. Letters on diagram refer to points on equivalent circuit

Antenna Balancing

The antenna balancing network functions as a variable impedance and is located in arm L of Fig. 2. By adjusting this, it is possible to balance the bridge circuit even when antenna arm A is not matched to R_o. The balance condition for a null in arm N, $Z_a Z_b = Z_A Z_L$, is achieved by appropriate adjustment of Z_L.

The construction of the balancing network is shown schematically in Fig. 6A. The equivalent circuit of the network is shown in Fig. 6B and its impedance locus in Fig. 6C.

The locus of the parallel R-C circuit is a semi-circle as the capacitor is varied. At any setting of the capacitor, adjustment of the inductance moves the impedance along paths typified by the vertical dashed lines. The extent of the impedance plane covered is limited by the minimum and maximum capacitance and inductance in the physical circuit.

The actual design covers all impedances with maximum vswr of 3.0 in 50-ohm coaxial line. The adjustable sleeve C at the back end provides the variable capacitor, and the helical line L, whose turns may be progressively short circuited by the variable coaxial inner conductor gives the variable inductance.

The stub line R is a glass metallized-film resistor capable of handling 10 watts continuously. This is isolated by about 20 db from the transmitter arm by virtue of the coupler characteristics and hence is easily able to operate with a transmitter powered at 100 watts.

The balancing network permits the attainment of high isolation even when the coupler arms are not exactly inverse. That is, it compensates for intrinsic coupler deviations from the ideal bridge circuit as well as for a mismatched antenna. In the photograph of the antenna balancing network, the upper micrometer adjustment controls the

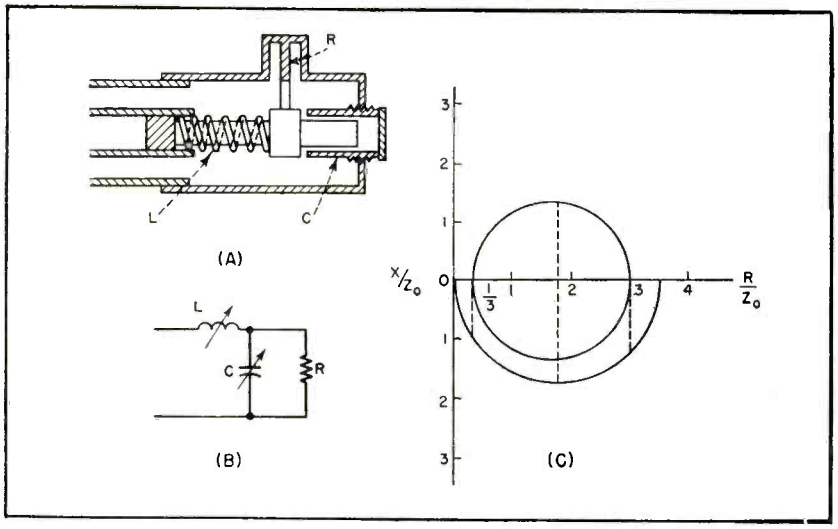


FIG. 6—Antenna balancing network (A) has equivalent circuit shown at (B). Adjustment varies impedance along dashed lines in impedance plot (C)

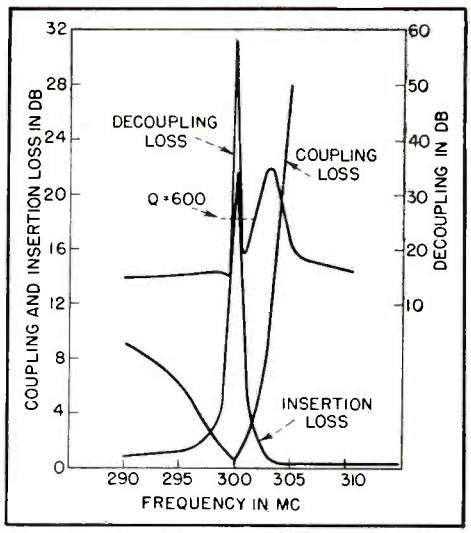


FIG. 7—Measured performance curves for a typical coupler unit

capacitance, and the lower thumb screw moves the coaxial structure in and out to vary the inductance.

Typical performance curves of a coupler tuned at 300 mc and operating with a balancing network are shown in Fig. 7. Insertion loss I is the coupling from A to N (values of I at other than the resonant frequency are the off-resonance insertion losses). The coupling loss is the loss measured from A to T (the resonant value of C is the on-resonance loss), and the decoupling loss is that measured from T to N.

Performance data of a 4-coupler system (a total of 4 equipments-transmitters and/or receivers with a matched load on port N of the last coupler) are given in the table.

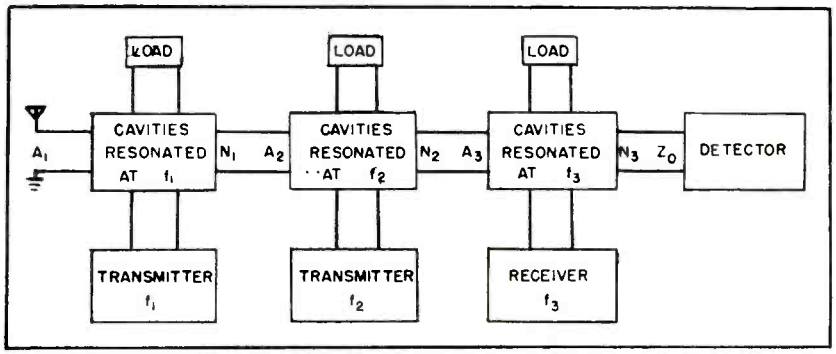


FIG. 8—Arrangement of equipment in three-coupler system. Detector is used for elignment of couplers

Alignment Technique

A typical 3-coupler system is shown in Fig. 8. To operate this system the first transmitting coupler has its cavities set at the desired transmitter frequency f_1.

A tuning screw permits adjustment of the resonant-impedance level of the resonant cavity. There are only two positions for this adjustment: one for the range of 225-to-320 mc the other for the range 310-to-400 mc. In general, only the frequency tuning of the two cavities need be adjusted for various transmitter frequencies.

The final adjustment of the coupler is made with the antenna balancing network. A tunable detector at the end of the coupler chain is set for the transmitter frequency and the balancing network is then tuned for a null indication.

The null indicator would first be tuned for f_1, and then the balancing network of the transmitting coupler set for a null. The detector would then be set for f_2, and the balancing network of the f_2 coupler (presuming its cavities have already been set at the precalibrated scale indication for f_2) adjusted for a null.

Since the next-coupler port of coupler f_1 has been decoupled from the transmitter port T_1, the adjustment of coupler 2 has no effect whatever on the previously tuned setting of coupler 1.

Freedom from interaction effects between units of the coupler system is almost independent of the closeness of frequency spacing of adjacent equipments. If a uhf receiver of 10-kc bandwidth is used, it can operate even closer than 1 mc to an adjacent high-power transmitter and the residual transmitter signal will still be low enough in level to be adequately discriminated against by the receiver selectivity.

The main limitation on closeness of frequency spacing is a matter of tolerable insertion losses, and if these are to be of the order of 1-db, then a minimum spacing of about 3 mc is required. If higher losses are permissible (of the order of 3 db per coupler), 1-mc separations are feasible.

The author acknowledges the valuable suggestions of J. W. E. Griemsmann, A. D. Bresler and M. Cohen. The experimental measurements were carried out by P. Paterno and C. Bollinger.

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REFERENCE

(1) H. J. Carlin, A. D. Bresler and M. Cohen, "A New UHF Antenna Multicoupler System", Report R-397-54, PIB-330, Microwave Research Institute, Polytechnic Institute of Brooklyn, Oct. 1954.

Cathode Compensation

SUMMARY —— Increased bandwidth, gain stability and linearity, with lower plate current, are accomplished by compensating cathode circuit. Design of 500-volt output, 3.7-mc amplifier for an oscilloscope is detailed

USE of cathode compensation in a pulse amplifier increases bandwidth and decreases gain by the same factor causing the gain-bandwidth product to remain unaltered.

The same result may be achieved more simply by reducing the value of the plate load resistor. However, cathode compensation improves gain stability, linearity of operation, requires less current for a given output voltage and has other advantages which are given below.

Circuit Theory

To calculate the effect of the cathode impedance on gain and bandwidth the circuit of Fig. 1A is replaced by its equivalent, Fig. 1B. The impedance seen looking toward the tube between plate and ground is equal to $r_p + (1 + \mu)\ Z_k$ where r_p is the plate resistance and Z_k the impedance in the cathode circuit. If R_kC_k is made equal to R_LC, the four elements between points A and B constitute a compensated attenuator. The circuit may therefore be redrawn as in Fig. 1C where

$$e_i' = \frac{\mu e_i[(\mu + 1)R_k + R_L]}{r_p + (\mu + 1)R_k + R_L} \qquad (1)$$

$$R' = \frac{r_p[(\mu + 1)R_k + R_L]}{r_p + (\mu + 1)R_k + R_L} \qquad (2)$$

and the total capacitance is

$$C' = \frac{R_LC}{[(\mu + 1)R_k + R_L]} \qquad (3)$$

The time constant of the circuit is

$$\tau_c = R'C' \leqq \frac{R_LC}{(1 + g_mR_k)} \qquad (4)$$

if $(R_k + R_L) << r_p$. Thus the time constant has been reduced and the bandwidth extended by the factor $1/(1 + g_mR_k)$.

The nominal gain of the amplifier, at a frequency where the capacitors may be neglected, is computed to be $A = -(g_mR_L)/(1 + g_mR_k)$. If the input e_i consists of a unit step of amplitude $-E$ the corresponding output is

$$e_o = \frac{g_mR_LE}{1 + g_mR_k}\ (1 - e^{-t/\tau_c}) \qquad (5)$$

With the cathode connected directly to ground, the output would be

$$e_o = g_mR_LE\ (1 - e^{-t/\tau_o}) \qquad (6)$$

where $\tau_o = R_LC$. In either case the ratio of gain to rise time is the same.

If the screen supply voltage is returned to ground instead of the cathode, the above results are slightly uncertain because the plate current is less than the cathode current, the difference going to the screen, and a signal voltage will appear between screen and cathode. The first of these effects causes the nominal gain to be reduced slightly, but since the compensation depends only on the time constant of the cathode impedance and not its magnitude, the compensation condition remains $R_kC_k = R_LC$.

The signal on the screen grid will be amplified, just as is the control-grid signal, but to a much smaller extent. The screen-grid signal is of opposite polarity to the control-grid signal and as a result the overall gain will be decreased. The cathode impedance will provide the same type of degeneration for the screen-grid signal as for the control-grid signal. It is the cathode time constant that is of importance and hence the cathode compensation condition is unaltered.

Comparative Merits

To show some of the useful features of cathode compensation, two amplifiers, one with and one without cathode compensation will be compared.

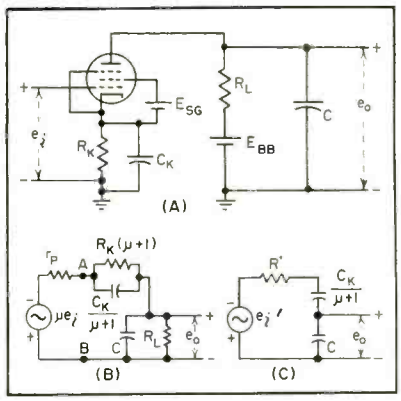

FIG. 1—Cathode compensated amplifier (A) is represented by equivalent circuits (B) and (C)

The first amplifier, without compensation, has a plate resistor R_L and carries a quiescent current I_o. The second amplifier has a plate resistor aR_L and a cathode resistor selected to make $1 + g_mR_k = a$. The quiescent tube current and voltage remain as before, which means plate resistor aR_L must be returned to a higher supply voltage. It may happen that the cathode resistor selected will furnish the bias required for optimum linearity of tube operation. Generally, however, some additional external bias will be required. The capacitance, C, shunting the plate to ground is to be the same in both cases. These two amplifiers now have the same gain and the same bandwidth.

One advantage of the compensated amplifier is its greater stability of nominal gain with respect to variation of tube parameters. In the case where the nominal gain is given by $-g_m\ (aR_L)/(1 + g_mR_k)$ the gain will be a less sensitive function of g_m than in the case where the gain is given by $-g_mR_L$. In the limiting case in which $g_mR_k >> 1$, compensated-case gain is $-aR_L/R_k$, independently of g_m.

Linearizes Video Stage

By JACOB MILLMAN and HERBERT TAUB

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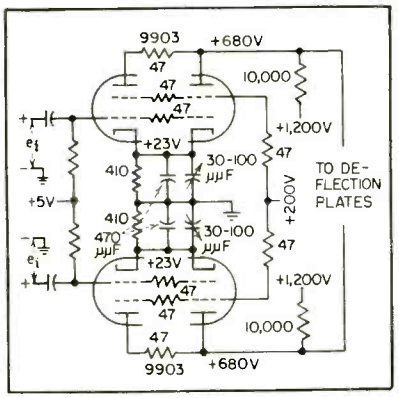

FIG. 2—Detection amplifier for 5-in. crt gives 500-v p-to-p output with current swing of only 25 ma at each tube

A second advantage may be appreciated by considering a problem that arises in the design of the last stage of an amplifier for a cathode-ray oscillograph. Such an amplifier is required not only to meet certain specifications with respect to frequency response, but must additionally be able to provide an undistorted output signal of sufficient amplitude to produce a substantial deflection of the beam.

If the quiescent current of a tube is I_o it may be estimated roughly that the tube will operate fairly linearly over a current range $0.25I_o$ to $1.75I_o$ so that the total plate voltage change is $(\Delta I)\ R_L = 1.5I_oR_L$. If this output swing is inadequate, it may be increased by increasing the plate resistor, but such a procedure has an adverse effect on frequency response.

One solution to the problem is to change the tube to one whose current can be made large enough to supply the required output voltage across whatever plate resistance must be used to meet the bandwidth specifications. In so doing, the drain of the power supply will have been increased and the additional tube capacitances of the larger tube may in part undo the advantage gained in not having to increase the plate resistor. In such a case and other similar circumstances where the plate circuit resistor must satisfy certain requirements which are inconsistent with the band-pass or distortion specifications, cathode compensation may be used to advantage.

The compensated amplifier will give a times as much output, for fixed bandwidth, as will the uncompensated amplifier for the same current swing. Because of the way the gain depends on g_m in the two cases and, since g_m is essentially a function of tube current, this larger output signal in the compensated amplifier will have less distortion than the smaller signal available from the uncompensated amplifier. Since the gain of the two amplifiers is the same, the input signal to the compensated circuit must be a times the input to the uncompensated amplifier.

Deflection Amplifier

The amplifier stage of Fig. 2 was used as the deflection amplifier for a 5RP1 cathode-ray tube operating at an overall accelerating voltage of 12 kilovolts. Deflection sensitivity of the cathode-ray tube is about 100 volts per inch and 5 inches of deflection was required.

A first step in relieving the burden on the amplifier is the use of a symmetrical amplifier so that each tube supplies only half the required signal.

Each half of the amplifier uses both sections of the Amperex 9903 dual beam tetrode. The 47-ohm resistors minimize the possibility of high-frequency parasitic oscillations.

The voltage developed across the cathode resistor is different from the bias required so some additional bias is applied directly at the grids. The total shunt capacitance at each plate load is about 22 $\mu\mu$f. For the value of R_k = 410 ohms, the value of C_k needed is 535 $\mu\mu$f.

The quiescent cathode current is about 56 ma and the quiescent plate current is 52 ma. At these currents the g_m of both sections together of the 9903 is about 10 millimhos. The gain, calculated from $|A| = g_mR_L/(1 + g_mR_k)$, is 19.6, while the 3-db frequency is 3.7 mc.

The 250-volt output signal required at each plate is achieved with a plate current change of only 25 ma. The required input swing is about 13 volts and the factor $(1 + g_mR_k)$ is about 5.

If cathode compensation were not employed the plate resistor would have to be reduced to about 2,000 ohms and for comparable linearity of output, a tube would have to be selected which could furnish a quiescent current of about 250 ma.

Another application for cathode compensation exists in connection with direct-coupled amplifiers. If a plate load is used that is small enough to give good high-frequency response then the d-c voltage drop across this load may be so small that a rather high voltage exists at the plate. Hence, a direct connection from this plate to the grid of a succeeding tube may be inconvenient. This d-c plate voltage may be reduced and a direct connection possibly used if the plate load is increased. The frequency response may be restored through cathode compensation.

The authors wish to express their appreciation to M. Star and J. Rabinowitz of the Tel-Instrument Co. for their contributions to development of the circuit of Fig. 2.

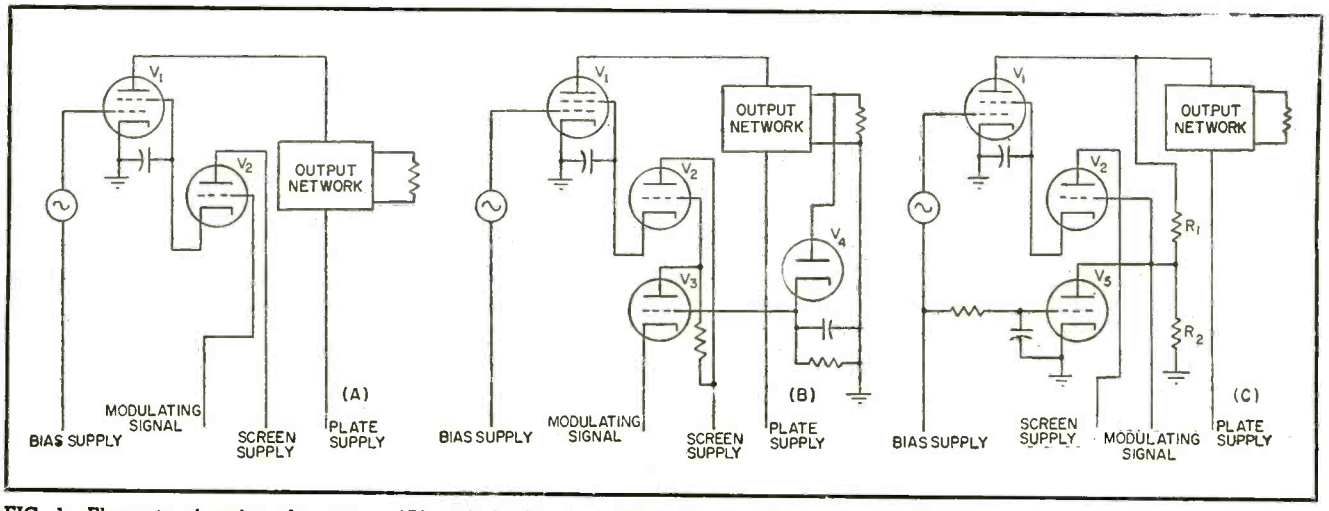

FIG. 1—Elements of series-tube system (A) with feedback rectifier (B) and tube protection (C)

Series Tube Modulates

SUMMARY —— Low-level system can be employed for any service requiring high information rate, light weight, simplicity of adjustment, easy variation of output power or controlled-carrier operation

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ADVANTAGES and disadvantages of the various methods of high-level and low-level amplitude modulation of radio-frequency transmitters are generally known to radio engineers.

In addition to better known and more conventional methods it is possible to modulate the output of a transmitter by inserting a tube in series with the screen supply of the modulated amplifier.

System Advantages

Such a system has several advantages over most other low-level systems. Since even high-power screen-grid transmitting tubes operate with relatively low screen-grid voltages and currents, this series tube may in many cases be a receiving-type tube.

Frequency of the modulating signal may be allowed to vary from d-c to a very high frequency since the output of the modulator is derived from the cathode of the series tube, which has a low-output impedance like a cathode follower. The modulating system operates at relatively high efficiency.

Inverse feedback can be applied easily over a wide frequency range. The transmitter is easy to adjust. In the simpler version, power output can be adjusted with a single control without disturbing loading or modulation adjustments.

Since the modulation system is directly coupled it is possible to operate under controlled-carrier conditions without complicated circuits; it is only necessary to form the modulating voltage so the screen-grid voltage is zero during periods of no modulation.

Figure 1A shows the most elementary form of the series-tube screen-grid modulation system. The r-f amplifier V_1 is adjusted like a c-w amplifier with maximum rated

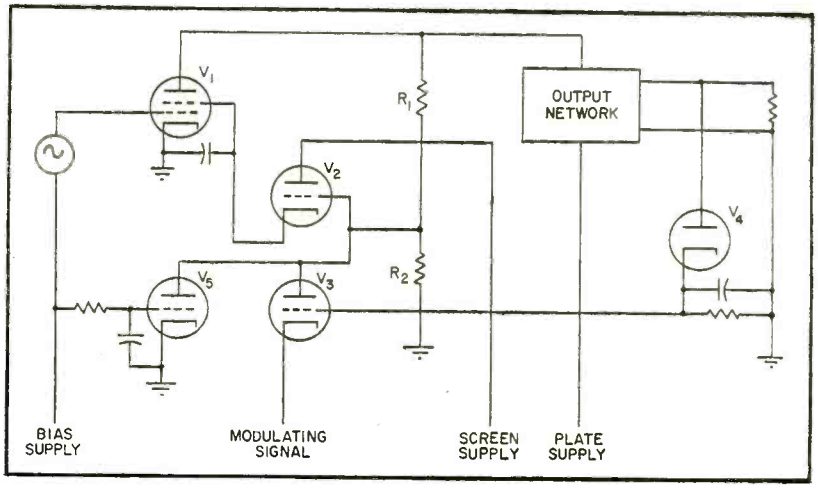


FIG. 2—Intermediate stage in development of practical circuit

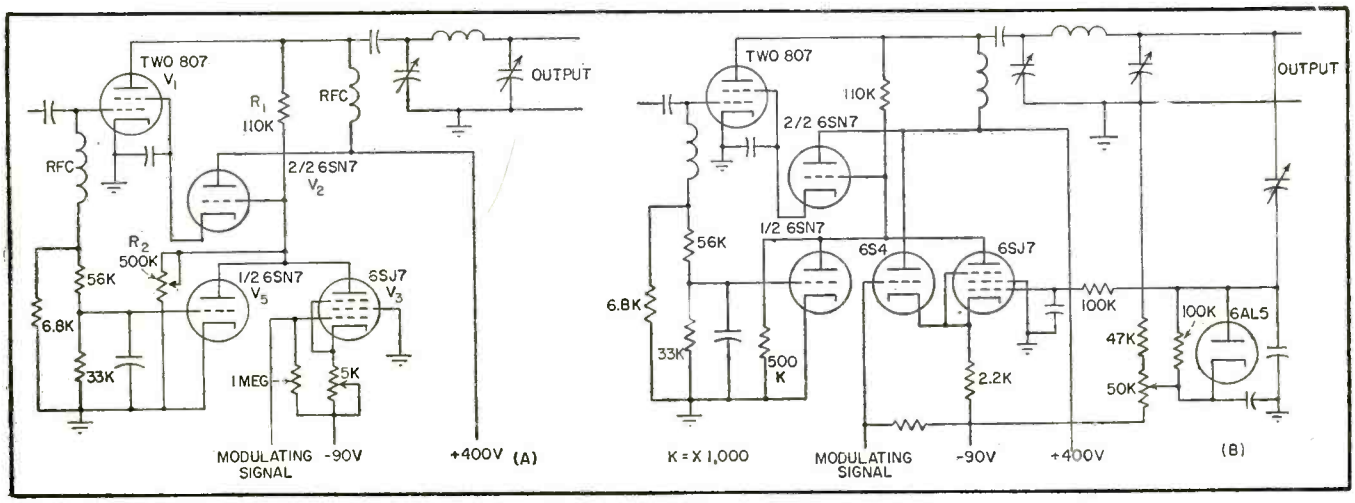


FIG. 3—Version of final circuit (A) with inverse feedback added (B)

Amplifier Screen-Grid

screen voltage. After this adjustment the output power of the stage may be varied from zero to maximum by varying the potential on the grid of V_2. Because of the mode of operation, V_1 may be operated continuously at any output level from zero to maximum without exceeding its ratings. Such operation permits maximum flexibility in the use of the transmitter.

Certain screen-grid transmitting tubes have a nonlinear relation between screen-grid voltage and power output. Such nonlinearity and any nonlinearity contributed by other parts of the system can be reduced by rectifying a portion of the transmitter output and applying this rectified signal as inverse feedback. Figure 1B shows the basic circuit with the feedback rectifier V_4 and an amplifier V_3 added.

Tube V_3 is used to amplify the feedback signal and also to permit the application of the feedback and modulating-signal voltages to separate tube electrodes. It should be noted that the whole system is still directly coupled. Controlled-carrier operation is therefore still possible and the inverse feedback will stabilize the power output of V_1 as well as contribute to the linearity of the modulation process.

Figures 1C and 2 show the addition of the tube protection feature to the circuits of Fig. 1. Resistors R_1 and R_2 are selected such that the potential at their junction is slightly below the desired maximum operating screen-grid voltage of V_1. In most cases R_1 can be selected high enough in value to prevent excessive dissipation from applied r-f power.

Should this prove impossible a radio-frequency choke can be connected in series with R_1 to remove the r-f voltage from it. Resistor R_1 could be connected to a point below the output network. However, this would not protect V_1 against damage in case some component within the network open-circuited. Under normal operation the grid-bias supply to V_1 cuts off the plate current of V_5 so that it has no effect on the operation of the circuit.

Safety Feature

If grid bias is lost, V_5 conducts and brings the grid of V_2 to a low potential. The cathode of V_2 follows the grid to a relatively low potential thus greatly reducing the screen voltage of the tube. Sampling of the bias voltage should properly be done at the grid of V_1, if fixed bias is used, to guard against damage resulting from an open circuit in the grid network. With grid-leak bias any difficulty in the input circuit will remove the bias from the grid of V_5, which will provide the necessary protection.

Failure of the plate-supply voltage or an open circuit in the d-c portions of the output network will cause the voltage at the junction of R_1 and R_2 to fall to zero, thus bringing the grid of V_2 to zero potential. The potential at the cathode of V_2 and the screen of V_1 will be reduced to low value, preventing damage to V_1. In the circuit shown in Fig. 1C the output power of the transmitter may be varied by making R_2 variable.

For a practical check on design factors a transmitter was constructed and tests conducted. The transmitter was first wired as shown in Fig. 3A. A 6SJ7 pentode was chosen as V_3 to realize a large stage gain. It was necessary to return the cathode of V_3 to −90 v to bring the cathode voltage of V_3 down to zero potential. The transmitter was set up with V_3 disconnected from the circuit.

The screen-grid voltage of V_1 was set to 250 volts by adjusting R_2, then V_3 was connected and the 6SJ7 cathode resistor was varied until the screen voltage of V_1 was reduced to 125 volts. Oscillograms in Fig. 4 were taken with these settings. Figure 4A is a trapezoidal pattern showing the modulation characteristics of the transmitter under normal modulation.

Operating conditions were such that at the most negative modulation point the carrier was not com-

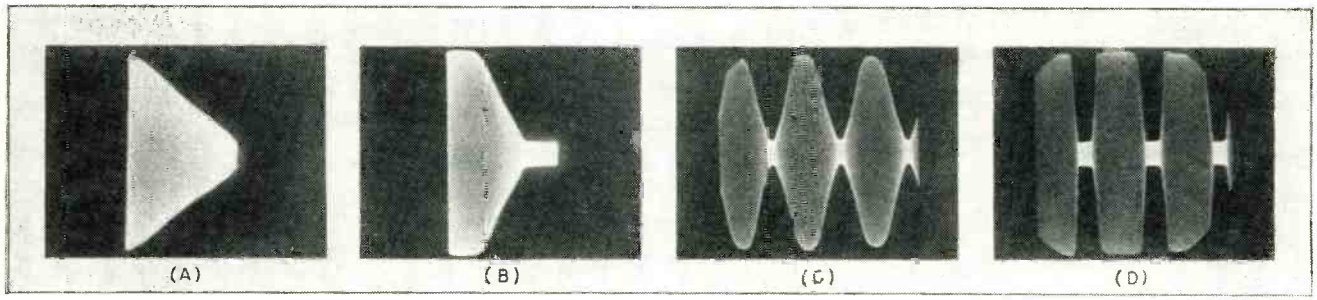


FIG. 4—Oscillograms taken from early version of final circuit are described in text

pletely cut off. Figure 4B is a trapezoidal pattern showing the effects of heavy overmodulation. The transmitter saturates smoothly at the maximum positive peaks and does not go to zero output at the negative peaks. This oscillogram shows that a transmitter using this modulation system may be overmodulated without the splatter caused by abruptly cut carrier.

If desired, a change in operating voltages and better shielding would permit the carrier to be reduced more nearly to zero output at negative modulation peaks. Envelope oscillograms Fig. 4C and 4D correspond to (A) and (B) respectively, Fig. 4C being a normally modulated envelope and that at (D) being a heavily overmodulated envelope.

With the transmitter normally modulated as shown by Fig. 4C, the value of R_3, in Fig. 3A, was reduced to reduce the output power of the transmitter. Since R_3 is also a part of the plate load of V_3 a reduction of its value reduces the gain of V_3.

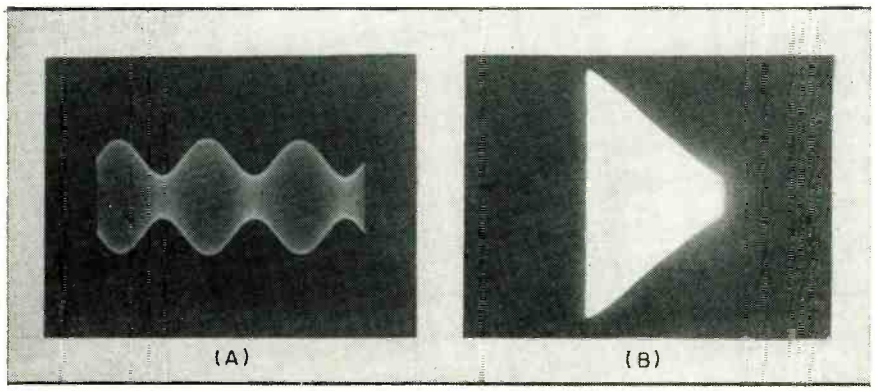
This results in an automatic reduction in the level of the modulating signal along with the reduction of the output power. Figure 5A is in an envelope oscillogram showing the effect of reducing R_3. No other controls were adjusted between the taking of oscillograms Fig. 4C and Fig. 5A.

In Fig. 3B inverse feedback is added to the transmitter. Output of the carrier rectifier is returned to the grid of the 6SJ7 and the modulating signal introduced into the cathode of the 6SJ7 by a 6S4 cathode follower. Cathode of the 6SJ7 is returned to −90 volts.

Using this circuit connection the amount of gain reduction caused by inverse feedback is controlled by the capacitor that couples the 6AL5 diode to the output circuit. Once a satisfactory amount of gain reduction is set, the proper carrier operating point can be established by adjusting 6AL5 cathode voltage.

Modulation Patterns

Trapezoidal patterns show normal modulation, Fig. 5B and considerable overmodulation, Fig. 5C. These are similar to Fig. 4A and 4B except that the modulation characteristic is somewhat more linear as might be expected from the use of inverse feedback. Figure 5D is an envelope pattern showing the transmitter set with the quiescent carrier at the maximum output level with negative pulses modulated upon the carrier. Figure 5E shows the quiescent carrier set for minimum level with positive pulses modulated upon the carrier. These oscillograms indicate the great flexibility and utility of series-tube screen-grid modulation.



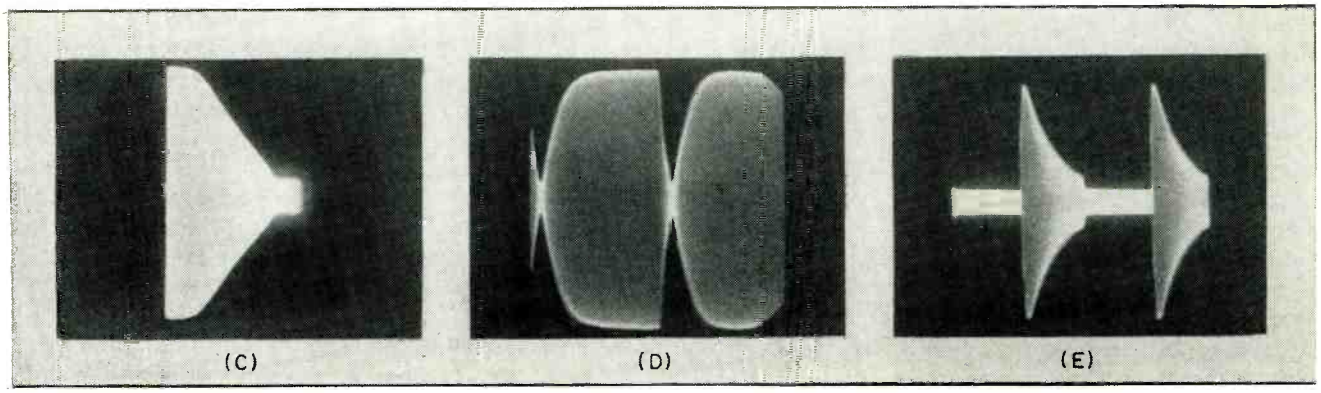


FIG. 5—Power reduction automatically reduces modulation (A). Other waveforms show versatility of modulation system

Direct-Reading Noise-Figure Indicator

SUMMARY —— Useful in evaluating performance of traveling-wave tubes and other microwave components, instrument has a linear output on a decibel scale. Absolute accuracy is better than ±0.3 db. Relative accuracy, when used as a null-reading device, is better than ±0.1 db

By C. E. CHASE

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AN IMPORTANT aspect of the evaluation of microwave components and systems is the measurement of noise figure.

Conventional measurement techniques become tedious when there is a large number of parameters to be varied, and it would therefore be desirable to have an instrument capable of reading noise figure directly and with a minimum of adjustments.

Such a device has been constructed and has proved valuable in evaluating the performance of a number of RCA type 1038 low-noise traveling-wave amplifiers.

Various devices of a similar nature have been constructed in the past.[1] All of these employ some sort of gas-discharge device such as an ordinary fluorescent tube as a standard noise source. This noise source is square-wave modulated at a frequency of the order of 30-80 cps and the resultant modulated noise-signal fed into the input of the device to be studied. The ratio of this modulated component of noise to the unmodulated component may be used to determine the noise figure.

In particular, if all amplifiers are linear and a quadratic detector is used, the output voltage is proportional to the noise power and the noise figure is equal to the noise-source power minus the ratio of the modulated to unmodulated output voltages in db.

The present noise indicator differs from earlier designs chiefly in the use of simple circuits to take the logarithms of these two voltages and subtract them giving an output which is linear on a db scale. The output meter has a scale covering a range of ±3 db about a zero which may be set at any value by varying the r-f power from the noise source and may be read reproducibly within ±0.1 db.

Front panel of noise indicator

Principles of Operation

The noise figure F of a receiver may be defined as[2]

$$F = P_a/4KT_oR_a df$$

where P_a is the total noise power of the receiver referred to the input, K is Boltzmann's constant, $T_o = 290$ K, R_a is the resistance of a matched load or dummy antenna at the input to the amplifier and df is the effective amplifier bandwidth. If the amplifier input is connected first to a matched load at room temperature and then to a noise source which may be considered as a matched load at some elevated temperature T_2, F may be defined by

$$F = [(T_2/290) - 1]/(Y - 1)$$

where Y is the ratio of the noise powers at the output of the amplifier under these two conditions.

Consider a noise source at a temperature T_2 and define the excess noise n in db by $n = 10 \log [(T_2/290) - 1]$. If P_1 is the noise power at the output terminals of the amplifier when its input is connected to a matched load at room temperature and P_2 is the increase in output noise power when the input is connected to the noise source, the noise figure in db is given by

$$F(\text{db}) = n - 10 \log P_2/P_1$$

A device which has an output proportional to $\log P_2/P_1$ reads noise figure directly in db, apart from the constant term n which may be set at any desired value either by varying the noise ratio of the noise source in the case of a hot load or saturated noise diode or by inserting a known amount of r-f attenuation between the noise source and the amplifier in the case of a fluorescent-tube noise source.

Description of Noise Meter

The complete apparatus for direct noise measurement of an r-f ampli-

fier is shown in Fig. 1. The noise source, a Kay Microwave Mega-Node type RG48/U, is modulated with a 60-cps square wave. The far end is terminated in a matched load. A calibrated r-f attenuator makes it possible to set the noise power from the noise tube at any desired value below its full output of 15.84 db excess noise.[3] This modulated noise signal is fed into the input of the amplifier being tested, then through a balanced mixer, 30-mc i-f amplifier and into the direct-reading noise indicator.

A complete circuit diagram of the noise indicator is shown in Fig. 2. The first tube is a 404A i-f amplifier designed to extend the linear range of i-f amplification so that a bolometer detector may be used. The bolometer bridge consists of two 5-milliampere Littelfuses and has a square-law characteristic up to about 100 millivolts output. The time constant of the detector is chosen to pass the 60-cycle modulation with little distortion while removing most of the higher-frequency noise components. The d-c amplifier has a gain of about 500 and is linear up to about 50 volts.

Circuit Details

The output waveform of the d-c amplifier is shown at the bottom of

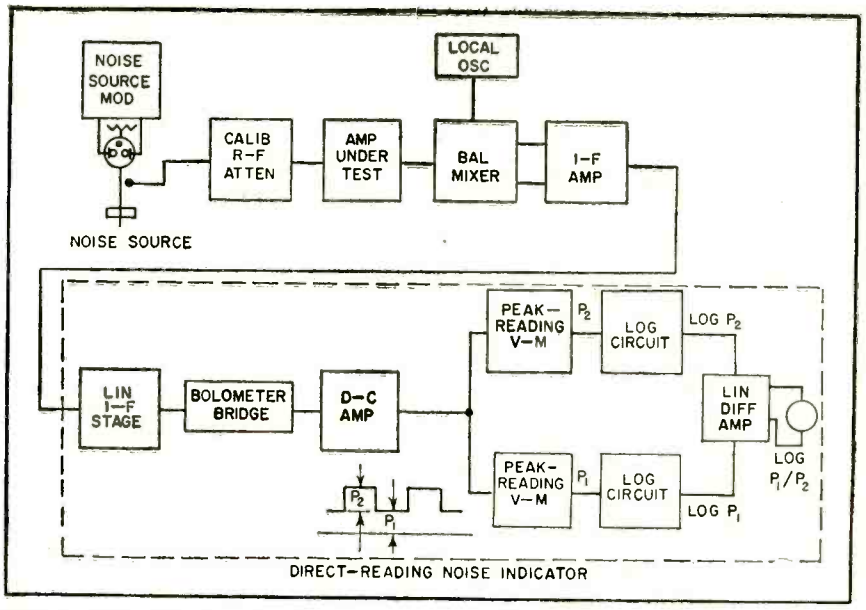

FIG. 1—Test setup for noise-figure measurement. Dashed lines enclose direct-reading noise indicator

Fig. 1. Level P_1 is proportional to the noise power at the output of the amplifier under test when its input is terminated in a matched load. Level P_2 is similarly proportional to the increase in this noise power when the noise source is turned on. The two peak-reading voltmeters develop d-c output voltages equal to P_1 and P_2 with an error no greater than 5 percent over the operating range of the instrument, which corresponds to a range of 5 to 20 volts out of each peak-reading voltmeter.

These voltages are applied to two logarithmic circuits consisting of R_2-D_1 and R_3-D_2. Diodes D_1 and D_2 are type 6S5K84 selenium rectifiers, which obey a logarithmic current-voltage relationship for small currents.[4] The voltages appearing at the grids of the differential amplifier V_5 are thus proportional to log P_1 and log P_2.

A 100-μamp zero-center meter M_1

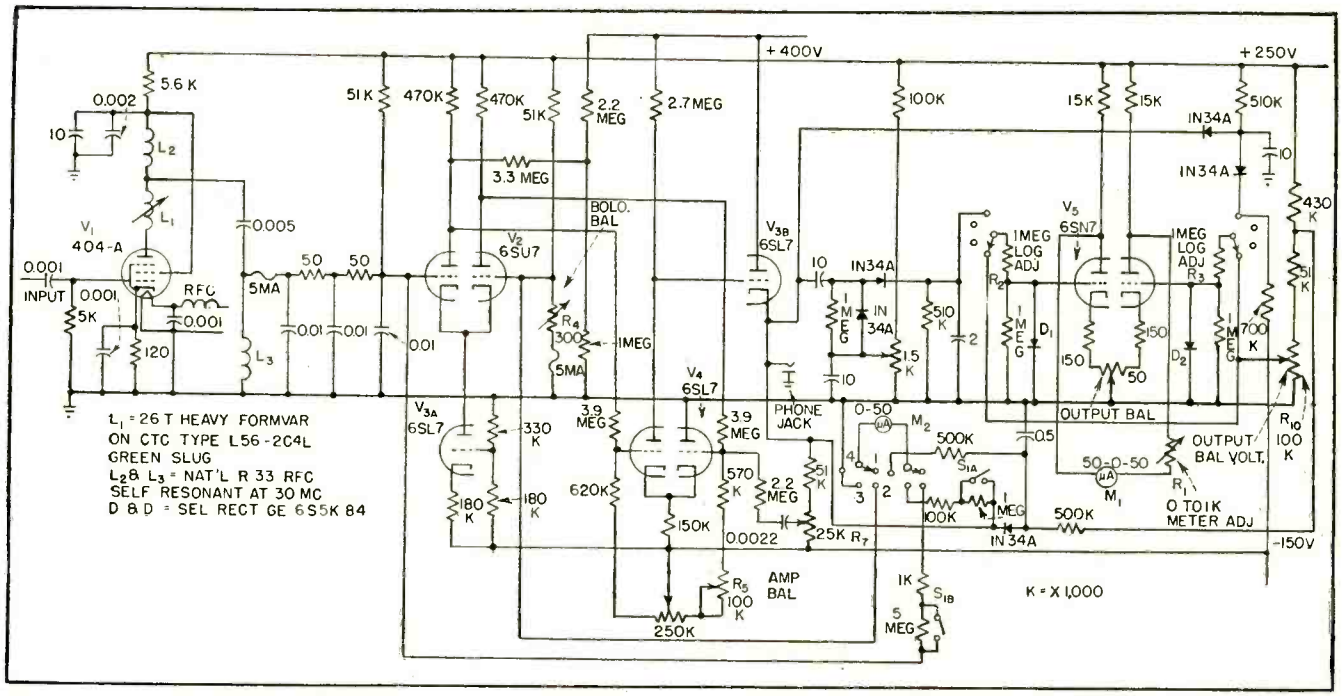

FIG. 2—Bolometer bridge, dual peak-reading voltmeters and logarithmic circuits combine to provide linear output reading on decibel scale

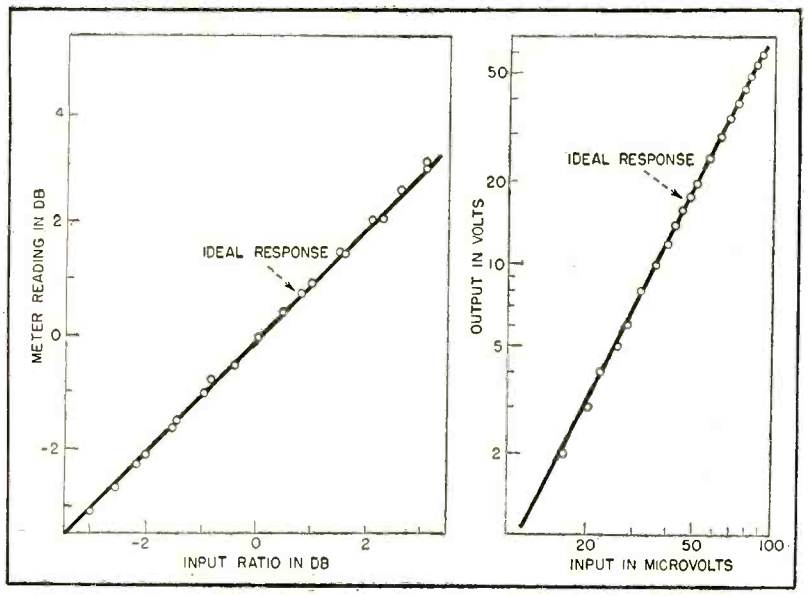

FIG. 3—Response of logarithmic circuits, left, and of amplifiers and detector, right. Solid lines show ideal response

connected between the anodes of V_5 reads a quantity proportional to log P_2/P_1. Resistor R_1 may be adjusted to calibrate this meter over a convenient range. The present instrument has a range of ±3 db.

The four-position rotary switch together with the 0-50-μamp meter M_2 permits easy balancing of the bolometer bridge, d-c amplifier and output tube. After the first half hour of operation only occasional readjustment is necessary. With the switch in the operate (4) position M_2 reads voltage P_1. This must be set in the range 5-20 volts by adjustment of the i-f gain.

Potentiometer R_{10} allows a variable d-c voltage to be applied simultaneously to the two logarithmic circuits when the rotary switch is in position 1 (balance output). When R_2 and R_3 are adjusted to compensate for the slight differences in the characteristics of D_1 and D_2, the output meter should read 0 ± 0.1 db when this voltage is varied from 5 to 20 volts. After the initial adjustment of R_2 and R_3, this voltage is left in the neighborhood of 10 volts and is applied to the two logarithmic circuits when the output is being balanced.

Potentiometer R_7 provides an adjustable amount of positive feedback through the 0.0022-μf capacitor to V_4. This gives the d-c amplifier an increased high-frequency response to compensate for the relatively poor frequency response of the bolometer detector.

Since the characteristics of Littelfuses vary widely the output waveform at the cathode of V_{3B} should be observed on an oscilloscope whenever bolometers are changed and R_7 should be adjusted until the top and bottom of the square wave appear flat and the base line does not move when the noise source is switched on and off. A phone jack is provided for this purpose. This adjustment will make the absolute value of noise figure accurate within ±0.3 db. For more accurate results R_7 should be adjusted by direct calibration against a device of known noise figure, since this is a somewhat more critical test than observation of the waveform.

Potentiometers R_4 and R_5 are front-panel controls. Pushbutton S_1 increases the sensitivity of M_2 during the balancing operations. This is necessary to prevent damage to the meter under initial conditions of extreme unbalance or should a bolometer burn out.

Performance

The logarithmic circuits and differential amplifier were tested by applying a fixed d-c voltage of 10 volts to one logarithmic circuit and a variable voltage of 5 to 20 volts to the other, corresponding to a range of ±3 db at the input to the instrument. This was done with first one logarithmic element and then the other held constant so that both could be checked over the operating range. The results are shown in Fig. 3, left. The errors are within 0.1 db over the entire range.

The linearity of the amplifiers and power law of the detector were determined by feeding a 30-mc signal into the input of the i-f amplifier and measuring the output of the d-c amplifier at the cathode of V_{3B} as a function of input signal voltage. The results are shown in Fig. 3, right, where d-c output voltage in volts is plotted against input voltage. It can be seen that the output voltage is accurately proportional to the input power up to at least 60 volts output. The characteristic is independent of the gain of the i-f amplifier and holds equally well for each of several different bolometers which were tried.

The performance of the peak-reading voltmeters was tested by applying a 60-cycle square wave of variable amplitude superimposed upon a variable d-c voltage. The errors were less than 1 percent at 10 volts input and not over 5 percent at the limits of the range of operation, 5 and 20 volts.

The absolute value of noise figure is accurate to ±0.3 db, or somewhat better if a direct calibration is made against a standard noise-measuring apparatus. If the instrument is used as a null-reading device by varying the r-f attenuator until the output meter reads zero, measured differences in noise figure are accurate and reproducible within ±0.1 db. When the r-f attenuator is fixed and the noise figure read from the ouput meter, errors in relative values do not exceed ±0.2 db.

The author expresses appreciation to L. D. Smullin for his encouragement of this work and for many helpful suggestions and to E. Maxwell for many useful discussions and assistance.

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(2) A. van der Ziel, "Noise", Prentice-Hall, New York, 1954.
(3) W. W. Mumford, *BSTJ*, 28, p 608, 1949.
(4) N. M. Schaeffer and G. W. Wood, *Proc IRE*, 42, p 1,113, 1954.

Low-Ripple Adjustable

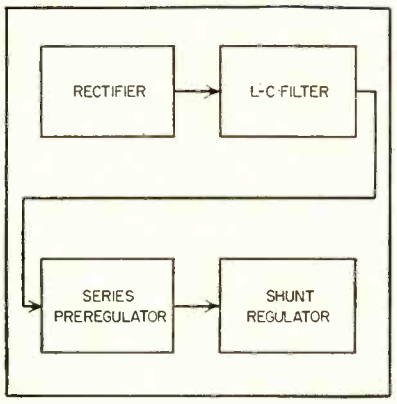

FIG. 1—Complete power supply

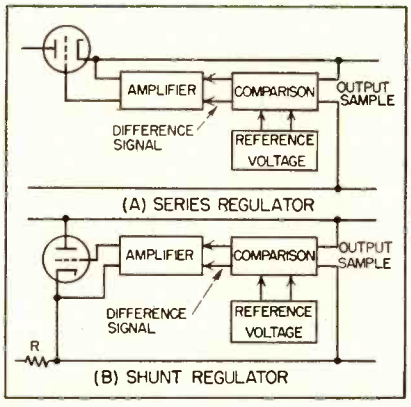

FIG. 2—Basic regulator circuits

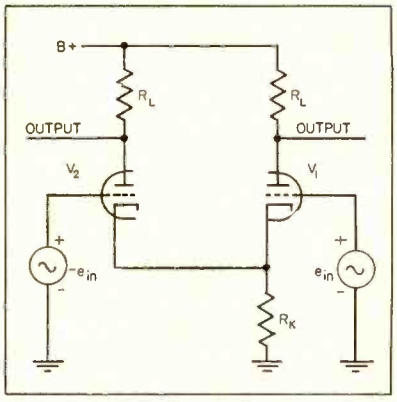

FIG. 3—Basic balance amplifier

AN ELECTRONIC power supply meeting ripple requirements for critical circuits consists of a rectifier, filter and two-stage regulator, as in Fig. 1. At 1,000 v output, there is less than 20 μv peak of random signal and no discernible ripple. The output voltage can be set to any value between 350 and 1,000 v, and output impedance is 10 ohms or less.

Degenerative voltage regulators can use either a series regulator tube or a shunt regulator tube, as shown in Fig. 2. Basically, however, the operation is the same: The output is compared with a reference voltage, usually a battery or a v-r tube, and the amplified difference signal is applied to the regulator tube in such a way as to reduce the difference signal. In the series regulator of Fig. 2A, this is accomplished by changing the plate voltage drop of the series or gate tube; in the shunt regulator of Fig. 2B, it is accomplished by changing the current drawn by the regulator tube. This current, in addition to the load current, flows through R and any power supply impedance.

A regulator of either type using two twin triodes as amplifiers can easily be built to give a ripple reduction of 1,000. When such a regulator is used to regulate the output of a moderately good rectifier-filter system with ripple output in the order of a few volts, it provides an output ripple in the order of a few millivolts.

The effect of transformer magnetic fields has been made negligibly small by the use of only one ground point in the regulator chassis so as to eliminate possible loops, and by removal of transformers from the regulator chassis. Transformers placed in the vicinity of the preregulator amplifier tube cause ripple in the output, which apparently results from a modulation of the tube electron beam by the transformer field.

Rectifier voltages to ground are caused by coupling from all parts of the rectifier circuit to ground and to the power transformer primary. Commonly these voltages are in the order of tens of millivolts, acting on impedances in the order of megohms. This condition can give rise to a large amount of output ripple if the proper choice of series or shunt regulator is not made.

Regulator output ripple can be reduced to an acceptable amplitude by selecting the preregulator and regulator so that one terminal of the rectifier is grounded. For positive output terminal grounded, one terminal of the rectifier can be grounded by using a shunt preregulator and a shunt regulator.

Similarly, the series preregulator and series regulator are effective when the negative output terminal must be grounded.

In practice, for positive output terminal grounded the series preregulator and shunt regulator are nearly as effective as the shunt system. Similarly, for negative output terminal grounded, a shunt preregulator followed by a series regulator would be satisfactory.

Amplifier

The balanced amplifier shown in Fig. 3 is employed throughout the preregulator and regulator. It is quite suitable for such applications because gain is not seriously reduced no matter how large the cathode resistance R_k may be, and the sum of the currents through the two triodes is nearly constant.

Freedom from gain dependence on R_k is desirable because it allows use of as large a cathode resistance as may be required to adjust tube operating voltages. With other circuits there is serious loss of gain because the cathode resistance cannot be bypassed at zero and very low frequencies.

The foregoing considerations make the problem of supplying plate voltages to the required high-gain d-c amplifier relatively simple. The gain of each half of the circuit is exactly the gain that each half would have with a perfectly

Regulated Power Supply

SUMMARY —— Two stages of degenerative regulation reduce power supply ripple to a fraction of a millivolt while giving relatively low output impedance as required for critical electronic equipment. Output is adjustable over range of 350 to 1,000 volts

By GEORGE HETLAND, JR. and ROBERT R. BUSS

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bypassed cathode resistor connected from cathode to B minus.

In some cases the grid of V_2 must be operated with no input signal. An example of such operation is the circuit of V_1 in Fig. 4. Since operation with one grid grounded halves the input signal, the output signal is also halved, assuming that the cathode resistor is moderately large.

Operation

The complete circuit is shown in Fig. 4. In the shunt regulator, V_4 acts as a constant-current tube; V_8 in the preregulator serves a similar function. Since in the regulator the current drawn by V_1 and V_2 is almost constant, there is a fairly constant 300-v plate supply which appears between the cathode of V_4 and the negative output lead. The plate-cathode voltage of V_4 changes with changes in output voltage caused by output control R_1 or the fine output adjustment R_2. With 1,000 v output, the plate-cathode voltage of V_4 is 700 v, which somewhat exceeds the voltage rating but not the power rating. From the standpoint of tube life, a high-voltage tube would have been preferable, but minimum tube drop would have been greater, making it difficult to regulate output down to 350 v.

The removal of C_1 and, in the preregulator, C_2, will allow oscillations around the high-gain amplifier loop. Since it is desirable to have an output capacitor, this method of preventing oscillations was chosen.

In operation R_1 and R_3 are adjusted to give 5 ma through V_3 with the given load and desired output, and the rectifier voltage is then adjusted to give 250 v drop across gate tube V_7. In use, the system has been operated at fixed voltages for long periods of time and this adjustment procedure, when necessary, has not been found to be burdensome. If a great many changes in output voltage setting were contemplated, it would be possible to gang these controls.

An output current limitation is set on the system by the 12.5-watt allowable plate dissipation of V_7. Thus a maximum of 50 ma may safely be passed with 250 gate voltage, leaving about 35 ma for the load.

The work reported in this paper was supported by a joint Army-Navy-Air Force contract held by the Electronics Research Laboratory, Stanford University.

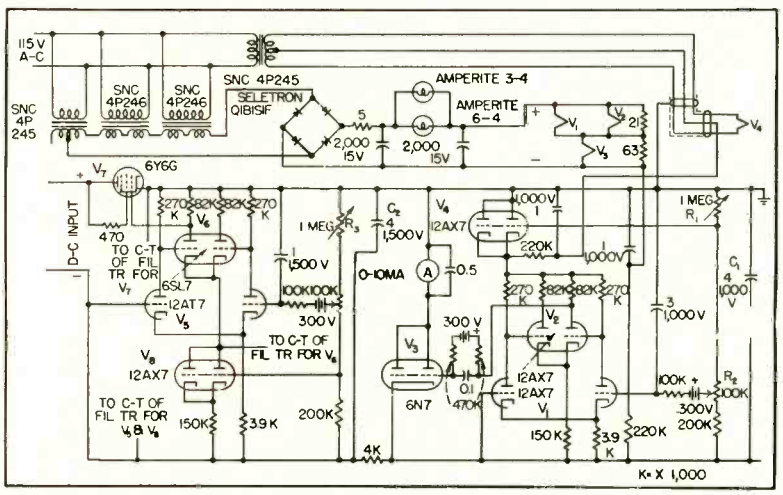

FIG. 4—Complete circuit of preregulator, regulator and d-c filament supply. Adjust rectifier input for hot spot on regulator tubes. The 12AX7 was selected as first amplifier tube in regulator because of its comparatively low noise output. Dry-cell batteries serve as voltage references. Use of d-c heater supply eliminates 60-cps signal modulation

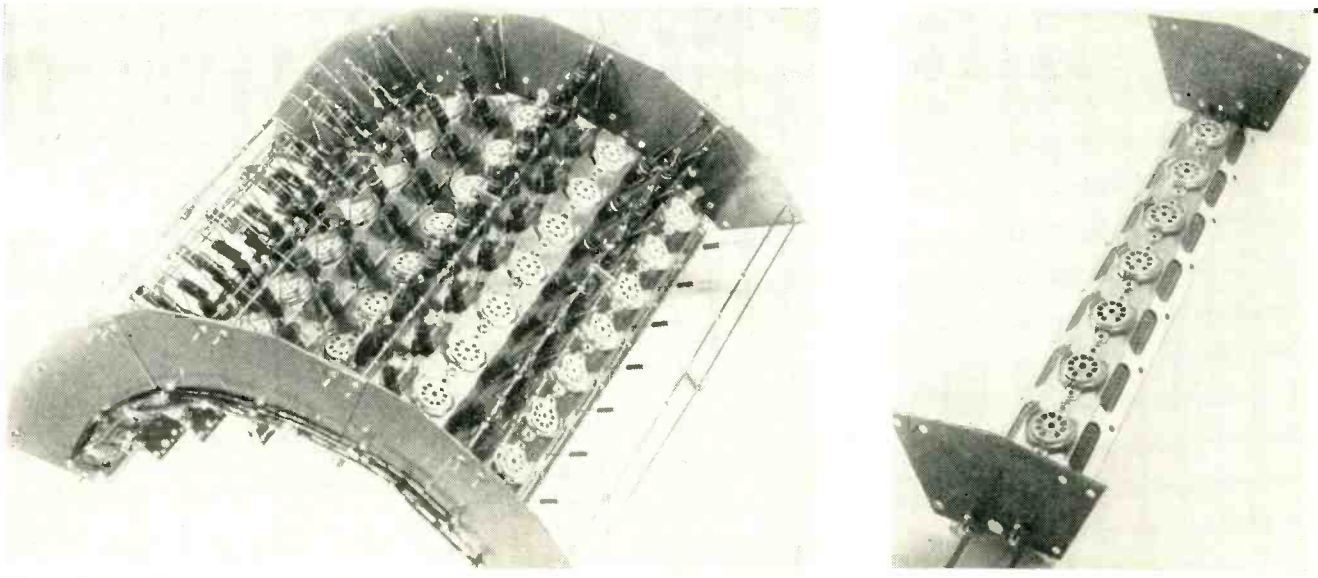

FIG. 1—Top view of six-gang chassis using basic chassis shown at right. Closeups of assembly are shown in Fig. 5 and 6

Basic Chassis for

EQUIPMENT DESIGNERS are faced with the necessity of producing small quantities of assemblies or families of units that can be basically similar but must be individually flexible. This situation is particularly true in research and development fields where each assembly usually must be special and unique.

Standard Chassis

Figure 1 illustrates a major assembly of six standard chassis, of which an individual unit is pictured in detail. Using these units as a basic chassis, adders, registers, digit resolvers, pulsers, amplifiers and various control units incorporated in the IAS computer have been produced. They provide an inexpensive and versatile basis for wiring experimental circuits in a minimum of time.

Design and subsequent modification of this basic chassis were based on a variety of requirements. The nature of the research decreed that any standard chassis adopted be: adaptable for serial, parallel and combined operation with other units; capable of accepting most, if not all, tube types commonly used in computer work; small; light; rugged; easily wired and serviced and capable of being produced in reasonable quantity without recourse to expensive equipment. The wiring technique dictated that resistor leads be left a minimum of $\frac{3}{8}$ inch long and that they be laid in place without bending leads wherever possible. Elimination of hookup wire, adequate ventilation and minimum interconnection distances between adjacent tubes and units were also given weight.

Statistical analysis of the program established that 7 and 9-pin miniature tubes would be used in most circuit applications and any chassis accepting both sockets, in common and in combination, would satisfy this requirement.

Composition resistors, mica and ceramic capacitors and crystal diodes emerged as supplementary components whose comparative size and application posed no real problems. This information completed the component picture and there remained only the determination of size and choice of shape. It was chosen to incorporate eight stages in the basic chassis since this number seemed to be a maximum as well as common size. The trapezoidal shape was chosen for its semichannel shape, which imparts rigidity to the unit and lends itself to a curved assembly (Fig. 1) that vastly simplifies parallel wiring. Finally, a few well-placed holes in the main insulator permitted transfer of some of the components to the upper side of the chassis thus relieving congestion around the tube socket.

Chassis Construction

The basic chassis assembly evolved from the above criteria is shown assembled and disassembled in Fig. 2. The chassis proper is formed from 0.032-inch aluminum alloy (52S half hard) and the spacer and insulators are formed from nylon-base Bakelite. All of these parts are produced from dies made in the model shop. An estimated 150 man-hours of shop time were required to fabricate the entire set of dies.

Starting with an aluminum blank $2\frac{5}{16}$ in. wide by 12 in. long, eight $\frac{3}{4}$-in. socket body holes are punched with one stroke of a 4-ton press. The die assembly contains eight punches staggered vertically so no more than two punches are shearing the metal at any one time. This was done to avoid overloading the press.

A second die punches all of the socket mounting lug holes, center insulator mounting holes and edge holes in one pass. Oblong slots on either side are piloted on the $\frac{3}{4}$-in. holes and punched progressively. These slots serve as clearance holes

SUMMARY —— Universal unit is used as basic chassis for computer adders, registers, digit resolvers, pulsers, amplifiers and other control units. Design of chassis and details of fabrication permit small production runs of complex electronic equipment with minimum mechanical work by engineer

By N. M. EMSLIE

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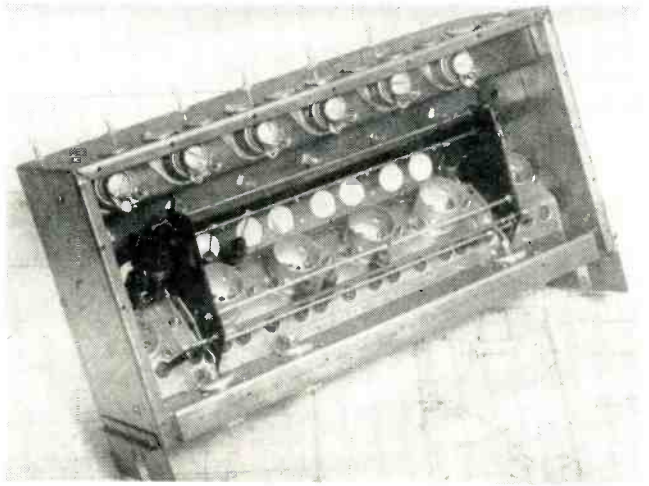
Experimental Work



Prototype model of basic chassis installed in shielded assembly

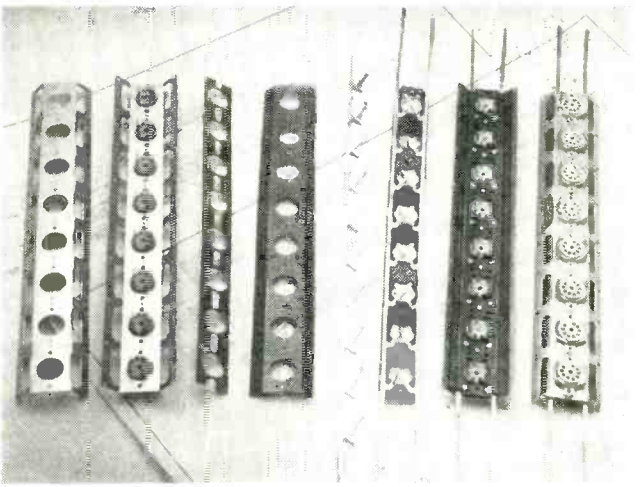


FIG. 2—Exploded view of basic chassis shows components

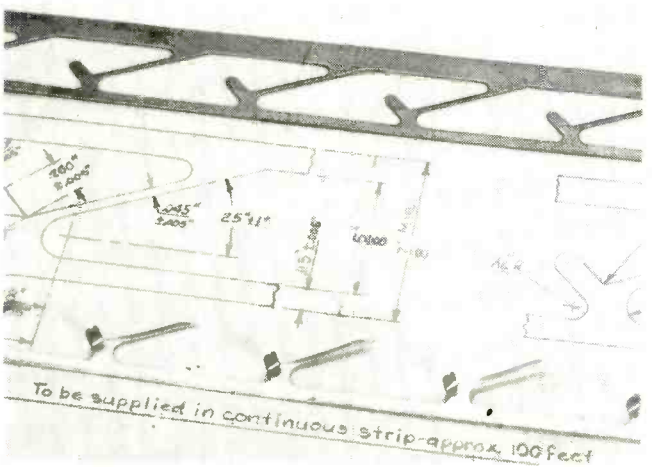


FIG. 3—Filament bus strips as blanked (top) and trimmed for use

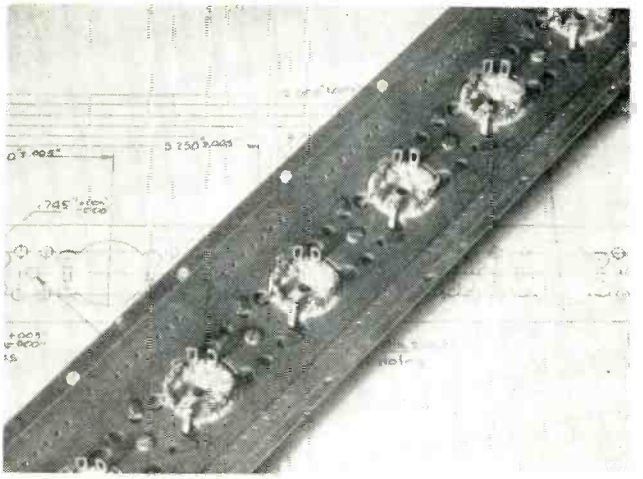


FIG. 4—Closeup of filament-bus connections to 9-pin sockets

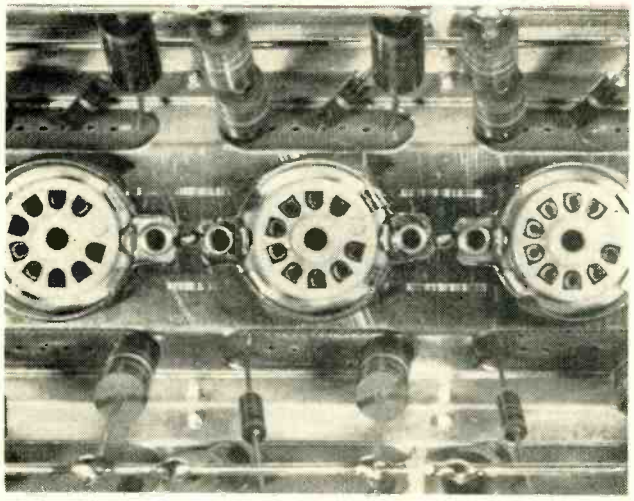


FIG. 5—Top-view closeup of multigang assembly of basic chassis

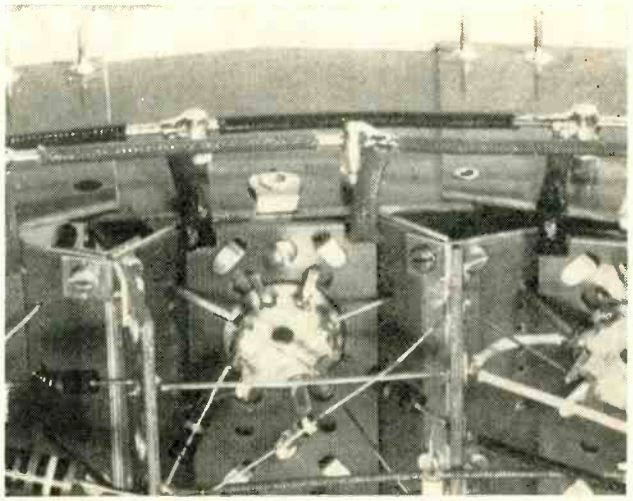


FIG. 6—Bottom-view of multigang assembly of basic chassis

for resistor leads brought to the upper side of the chassis through holes in the main insulator. Forming to the trapezoidal shape is also done on the punch press.

Socket Mounting

One manufacturer makes a 7-pin socket with the same mounting hole dimensions as their 9-pin socket. It was found practical to mount the 7-pin socket in the hole punched for a 9-pin socket. The only objection to this procedure is the gap left between the $\frac{5}{8}$-inch diameter socket body and the $\frac{3}{4}$-inch diameter hole in the chassis, which was a possible solder and dirt trap. The 0.016-inch bakelite spacer was designed to overcome this condition and to serve another function besides.

This spacer is punched in two variations, the first with eight $\frac{3}{4}$-inch holes punched in the same die used to punch the metal chassis and the second with eight $\frac{5}{8}$-inch holes. Both variations have the oblong slots which span and clear the two eyelets on adjacent sockets. The spacer then serves as a shim to prevent the main and filament insulators from being distorted by the eyelet heads when they are drawn up against the metal chassis.

In the assembly of a chassis with 7-pin sockets, the spacer with the $\frac{5}{8}$-inch hole is used, not only as a shim but also to close the gap between the $\frac{3}{4}$-inch hole in the chassis and the smaller body of the socket. Where 7 and 9-pin sockets are mixed on one chassis, a hand-operated punch can be used to enlarge the necessary number of $\frac{5}{8}$-inch holes to $\frac{3}{4}$-inch diameter in a minimum of time.

The main insulator is first punched to fit 9-pin socket bodies. In the second operation, seven 0.050-inch diameter holes are punched in the skirt on each side of every socket hole. When this insulator is bent and assembled each of these groups of holes centers in an oblong slot in the metal chassis. The holes are so located that a resistor lead can be wired from the upper side of the chassis directly to any tube pin without bending the lead.

Folds in this 0.015-inch nylon-Bakelite insulator are postformed in a crude aluminum die. Although nylon-base Bakelite is not normally regarded as a suitable postforming material no difficulty is encountered with the thin sheet used. Ordinary soldering irons inserted in holes in the male and female die blocks provide sufficient heat to do the forming.

Filament-Bus Strip

Figure 3 shows the ladderlike shape of the copper filament-bus strip as it comes from the press and the finished strip with the excess metal sheared off and the round-nosed clinching tabs bent for insertion into the insulator. An 0.015-inch by $\frac{7}{8}$-inch continuous copper coil is fed into the die and blanked, one hole at a time, cut into 14-inch lengths and the excess trimmed on a shear. As yet, a use has not been found for the unusually shaped slugs that are left.

Figure 4 illustrates the method of clinching the bus strips to the insulator and the ease with which they can be connected to the socket pins. This completes the basic chassis, the parts of which are produced in quantities of 200 in 3 days.

The basic chassis can be tied to adjacent units by an aluminum angle tie strip, visible in Fig. 5, to form an assembly of up to eight chassis. In any such assembly the shaped-end bulkheads (Fig. 1) are eyeletted together where they overlap to supporting cathode and plate busses and stiffen the assembly. Initially, end bulkheads were fabricated in one piece, there being a different type of bulkhead for each type of assembly (single chassis bulkhead, two-gang bulkhead, etc.). This practice was inefficient and four-gang and larger units were difficult to assemble due to tolerance buildups. The present end bulkhead is easy to make, economical of material and can be assembled easily, regardless of chassis bend tolerances. Figures 5 and 6 are closeups of wiring on the top and bottom of a multigang assembly that illustrate the simplicity of wiring and ease of accessibility. Note the eyeletted terminal boards erected at the intersection of the chassis (Fig. 6). This greatly facilitates neat wiring and guides and supports interstage wiring.

During the past few years about 1,000 of these basic units have been fabricated. Three other laboratories have built computers based on the IAS computer and have used the same design successfully, not only in the machines but for experimental and breadboard circuitry.

Ultrasonic Switch Aids Diversity Reception

SUMMARY —— Adapter that can be used with two conventional receivers, either a-m or f-m, requires little or no modification to existing equipment. Crosstalk from rejected channel is down 40 db

By G. FRANKLIN MONTGOMERY

National Bureau of Standards
Washington, D. C.

CONNECTION of two existing a-m or f-m receivers to operate effectively in dual diversity without extensive modification of the receivers themselves is possible with the adapter shown.

The local oscillator generates two out-of-phase square-wave voltages at ultrasonic frequency. Each voltage is used to key two modulators. The first modulator accepts the d-c output of one of the two receivers, and the second accepts the audio output.

The output of each d-c modulator is a square wave whose amplitude varies linearly with the d-c input. The two modulator outputs are out of phase. When they are added, therefore, a square wave is obtained whose amplitude is proportional to the difference of the two d-c inputs and whose phase indicates the sign of the difference. This difference square wave is amplified by the difference amplifier.

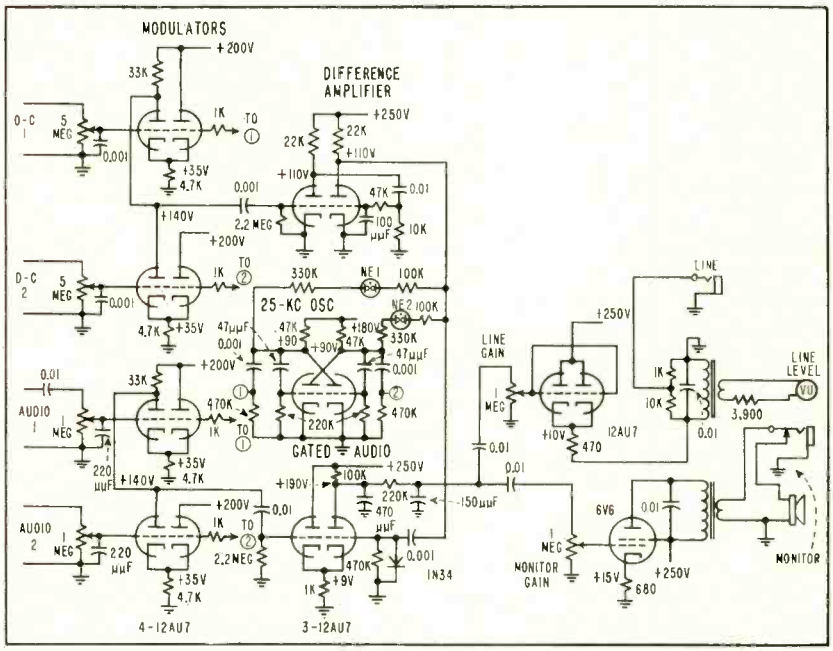
The output of each audio modulator is a square wave, clamped to a fixed potential during its positive half-cycle, whose amplitude is proportional to the instantaneous value of the audio signal from one receiver. The two audio modulator outputs are out of phase. When they are added, an alternating sequence of samples of the audio signals from the two receivers is obtained. This sequence is fed to an audio amplifier that is gated on by the amplified square-wave difference voltage.

Output of the gated audio amplifier is thus a sequence of samples, at the ultrasonic frequency, of the audio signal from either one receiver or the other. The selected receiver output depends upon the phase of the square-wave difference voltage and the circuit is arranged so that the selected audio output is that from the receiver having the greater d-c output. The filtered output of the gated audio amplifier is used to drive a power output stage.

Narrow Crossover

In any diversity system, there is a crossover range of signal amplitudes in which the audio outputs of both receivers are present simultaneously. In the adapter discussed here, this crossover range may be made as small as desired by providing sufficient gain in the difference amplifier. Maximum switching rate can be half the local oscillator frequency.

In this model, selection occurs for a range of direct input voltages from 0 to 15 volts, and the crossover range is less than 0.25 volt, at full gain settings. The required sinusoidal audio input (full gain) is 0.5 volt rms. Crosstalk from the rejected audio input is 40 db below the selected input.



Circuit diagram shows simplicity of method used to obtain optimum signal from two receivers with good rejection of weaker signal. Neon lamps show which receiver has stronger signal

Square-Law Detector

By JAMES W. SAUBER

Project Engineer
Ballantine Laboratories, Inc.
Boonton, New Jersey

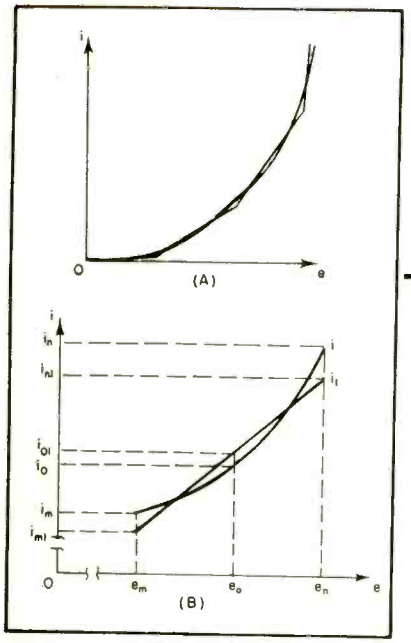


FIG. 1—Square-law characteristic showing segmented approximation (A) and isolated segment (B)

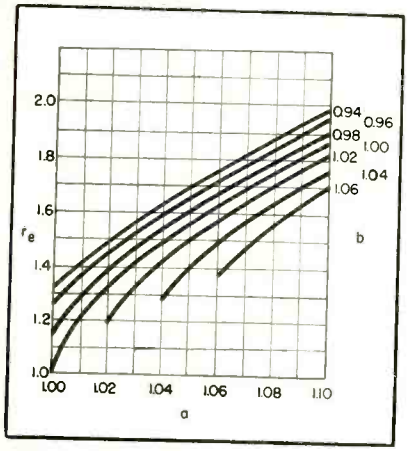


FIG. 2—Detector design chart plot of error functions vs. segment voltage ratio r_e. Curves are plot of Eq. 6

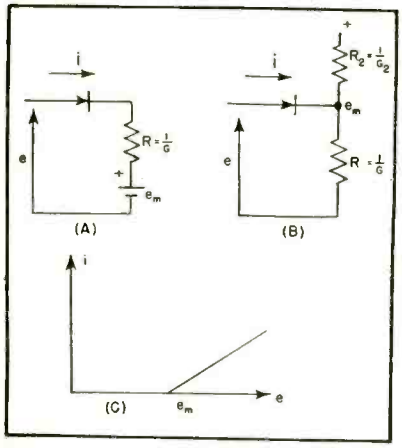


FIG. 3—Typical biased-diode circuits (A) and (B) and their response (C)

THE REALIZATION of a true root-mean-square voltmeter for sensitive wide-band measurements of nonsinusoidal waveforms is made difficult by the detector requirements.

Some means of achieving a square-law response must be provided. As an electrical network the detector may have two or more terminals, with input and response as voltages or currents. Response may be proportional to the square, the mean-square or the root-mean-square of the input. The detector may be unilateral or bilateral, but in any case a squaring characteristic is essential.

A square-law characteristic can be synthesized from linear resistors in combination with voltage-biased diodes. The parabolic characteristic is thus approximated by a continuous sequence of linear segments. The degree of approximation may be made as high as desired through the use of more segments.

Dynamic amplitude range is limited only by the quality of the diodes. The diodes act only as voltage-actuated switches, their own nonlinear characteristic having a second-order effect on the synthesized square-law characteristic.

Crystal diodes have finite back resistance and may be somewhat temperature sensitive. Nevertheless, the synthesized square-law detector incorporating crystal diodes is affected by temperature to a much lesser extent than thermocouples.

The detector used in this true-rms voltmeter is of the segmented- approximation type using high back-resistance germanium diodes in a circuit wherein the effects of crystal imperfections are minimized and for which there is no zero-signal current to be balanced out.

This squarer accepts positive voltage signals from a full-wave rectifier and responds in a current instantly proportional to the square of the input voltage. This current is

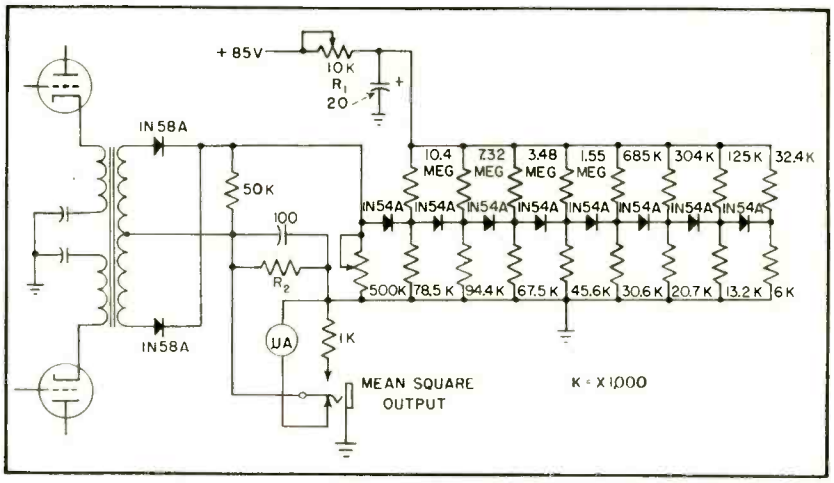


FIG. 4—Square-law detector providing a total of nine line segments with the first segment variable to allow adjustment of the square-law characteristic

for RMS Voltages

SUMMARY —— Voltmeter uses series string of biased diodes to maintain operation on square-law segment of operating curve. Instrument covers range from μ volts to 320 volts at frequencies from 5 cycles to 500 kilocycles

passed through a sensitive d-c microammeter which is bypassed to the alternating component of the response.

Square Law Approximation

A current-versus-voltage square-law characteristic, with its segmented approximation, is shown in Fig. 1A. A typical isolated segment is shown in Fig. 1B. Ideally, the characteristic equation is

$$i = Ke^2 \qquad (1)$$

where K is a proportionality constant. Therefore, at the points e_m, e_o and e_n, representing the voltages for which the approximation errors are to be greatest

$$i_m = Ke_m^2, \quad i_o = Ke_o^2, \quad i_n = Ke_n^2 \qquad (2)$$

Let p_m, p_o and p_n be these maximum errors and let the added subscript l stand for the linear approximation. In terms of the square-law points the approximation points are

$$\begin{aligned} i_{ml} &= (1 - p_m)\, i_m \\ i_{ol} &= (1 + p_o)\, i_o \\ i_{nl} &= (1 - p_n)\, i_n \end{aligned} \qquad (3)$$

It is convenient to use the segment voltage ratio r_e and the error functions a and b where

$$\begin{aligned} r_e &= e_n/e_m \\ a &= (1 + p_o)/(1 - p_n) \\ b &= (1 - p_m)/(1 - p_n) \end{aligned} \qquad (4)$$

Substitute Eq. 2 into Eq. 3 and then into the standard equation for a straight line. The linear approximation can be expressed as

$$i_l = K(1 - p_m)e_m^2 \left[\frac{\left(\frac{r_e^2}{b} - 1\right)}{r_e - 1} \times \left(\frac{e}{e_m} - 1\right) + 1 \right] \qquad (5)$$

The maximum errors and the segment voltage ratio r_e are related by

$$r_e^4 - 4ar_e^3 + [4a + b(4a - 2)]r_e^2 - 4abr_e + b^2 = 0 \qquad (6)$$

Equation 6, plotted in Fig. 2, is an important design equation, for upon specification of the desired maximum errors the segment voltage ratio is determined.

For the important special case where it is desired that the maximum positive error to be equal to the maximum negative errors, $a = 1 + p_o/1 - p_o$ and $b = 1$. For $p_o = 0.02$, corresponding to a maximum root-mean-square error of 1 percent, $r_e = 1.494$, and ten such symmetrical segments end to end span an overall voltage-ratio range of $(1.494)^{10} = 55$. The corresponding current-ratio range is approximately 3,000.

In some cases it may prove advisable to specify a restricted amplitude range of small errors and permit progressively larger errors for the adjacent amplitude ranges above and below the restricted range. It is only necessary to see that the end point errors p_m and p_n are matched between adjacent segments. The total voltage-ratio range is the product of the individual r_e's.

In general, the detector-response error will be less than the maximum design errors, since the response to a sine wave, for example, will include a succession of alternating positive and negative errors tending to cancel each other. The most severe test is the response to a square wave or other flat-topped pulse.

Detector Network Design

Assuming that the diode in Fig. 3A has zero forward resistance and infinite reverse resistance, current will not flow until the signal voltage e exceeds the bias voltage e_m. Thereafter, the current response is $G\ (e - e_m)$, G being the conductance of the resistance R, as shown in Fig. 3C.

In Fig. 3B the bias voltage is de-

Voltmeter allows 100-μv signal to be detected with a noise level of 12 μvolts

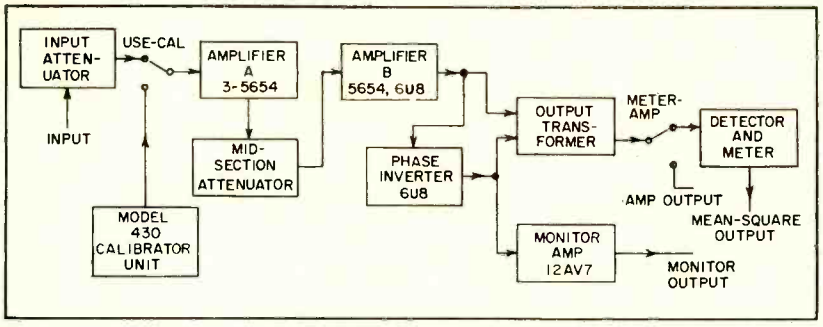


FIG. 5—Block diagram of root-mean-square voltmeter. The instrument is essentially an amplifier-detector

termined by the ratio $G_2/(G_1 + G_2)$, and the current response by the combination $G_1 + G_2$. By connecting many such circuits in parallel and adding their current responses it is possible to approximate any first quadrant monotonically increasing function.

To derive the circuit values required for the square-law approximation it is necessary to determine the number of linear segments, each segment corresponding to a biased-diode circuit, on the basis of the desired overall voltage-ratio range and the amount and distribution of maximum errors.

Use Fig. 2 for finding r_e for each segment. Operating limits of voltage and current are then chosen, permitting specification of the proportionality constant K and the various segment biases e_m.

The slope of the approximation, from Eq. 5, is

$$\text{slope} = \Sigma G = K(1 - p_m)e_m \frac{\frac{r_e^2}{b} - 1}{r_e - 1} \qquad (7)$$

$$\Sigma G = K(1 - p_n)\frac{e_n}{r_e}\frac{r_e^2 - b}{r_e - 1}$$

ΣG is the sum of all circuit conductances up to and including the one under consideration, and by taking the difference between successive values of these sums the individual circuit conductances are obtained. For the initial segment, which in the usual design is not biased

$$G = K(1 - p_n)e_n \qquad (8)$$

Finally, the values of G_1 and G_2 as in Fig. 3B may be calculated for each circuit from G, e_m, and the voltage of the bias source.

The effect of linear series resistance R_s, such as resistance of the signal source, is to require modification of each conductance sum by the factor $1/1\text{-}R_s\Sigma G$, and in the subsequent calculation of G_1 and G_2 e_m must be modified by the factor $1 - K(1 - p_m)e_m R_s$.

To permit the use of semiconductor diodes a circuit similar to Fig. 4 was developed. Here the diode circuits are connected in tandem in the order of increasing bias voltages. The diodes are in series and each circuit receives its signal from the circuit immediately preceding it. Capacitances to ground are minimized.

If high back resistance and high forward-conductance germanium or silicon diodes are used, temperature effects will be small at worst, since the tandem arrangement is to a large extent self compensating.

To achieve wide-band response extending to as high a frequency as possible, control must be exercised over circuit capacitances since at the highest frequencies the circuit tends to peak detection.

Instrument Details

Figure 5 shows a block diagram of the complete instrument. Essentially, the voltmeter is an amplifier-detector type instrument; input signals are changed in voltage level by suitable amplifier-attenuator combinations before detection. The lowest measurable voltage is determined by the inherent noise of the instrument referred to its input. Noise of 12 μv is typical, and therefore a 100-μv signal may be detected by a square-law detector, after amplification, with less than 1 percent error from this source.

The upper limit of voltage measurements is 320-v rms. A signal of this amplitude and with a crest factor of 5 has a peak of 1,600 v, which is considered the voltage limit for the components and specific techniques employed.

The instrument therefore spans a voltage range of 130 db. Two separate compensated attenuators provide the requisite 120-db attenuation in 10-db steps.

The two amplifiers combined provide a total of 84-db gain with flat frequency response from 5 cps to 500 kc. Each amplifier is stabilized by negative feedback and power-supply regulation. In combination with a separately stabilized unity-gain phase inverter a balanced cathode-follower output is provided.

To effect complete d-c isolation between amplifier and detector circuits without impairing low-frequency response an output transformer is used, allowing the common point between detector and meter to be grounded.

The detector shown in detail in Fig. 4, is designed to provide controlled square-law performance over a 50-to-1 range of voltage amplitudes, corresponding to a current variation of 2,500 to 1. Full-scale meter current of 200 μa is obtained with a detector input of 5-volts rms.

Squaring is controlled up to 25-v peak, thereby allowing a signal with a crest factor of 5 to be measured at full scale, and larger crest-factor signals at down-scale points.

The effective bandwidth of the instrument for wide-band noise and pulse measurements is about 1 mc.

Note that total of nine segments are used, the initial segment being variable to permit exact adjustment of the square-law characteristic. The detector bias-supply control R_1 provides an effective variation of about 20 percent of the proportionality constant K. A thermistor shunt R_2 across the meter provides temperature compensation for the entire instrument.

Instrument error for sine-wave measurements is within 3 percent between 15 cps and 150 kc, and 5 percent between 5 cps and 500 kc. For complex waveforms within the crest-factor specifications the error depends only upon the distribution of harmonic frequencies within and without these frequency ranges.

The writer acknowledges the invaluable assistance of Walter Kram and J. R. Hansell of Ballantine Laboratories in the development of this instrument.

SHORTEST ELECTRICAL PATH TO THE GROUND···SIMPLIFIES WIRING ···REDUCES SPACE REQUIRED BY CIRCUIT COMPONENTS—

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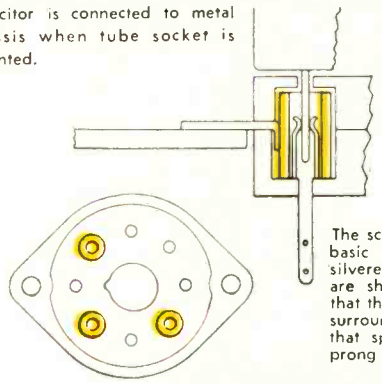
Capacitors built into socket may be either by-passed to ground directly, or left open for coupling applications. On by-pass applications, ground strap contacting outer plate of capacitor is connected to metal chassis when tube socket is mounted.



The schematic diagram shows basic design principle. The silvered ceramic condensers are shown in yellow. Note that the condenser completely surrounds the tube pin, and that specially designed tube prong terminals are used.

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With built-in ceramic condensers, Plexicon Tube Sockets, no larger than standard receiver socket, provide the most effective method of by-passing . . . with condenser close to tube element providing shortest path to the ground. . . . capacity up to 1,000 MMF—the tube element may be coupled or by-passed as desired.

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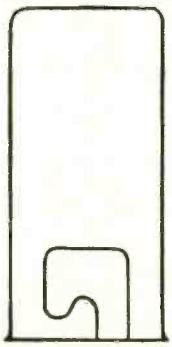
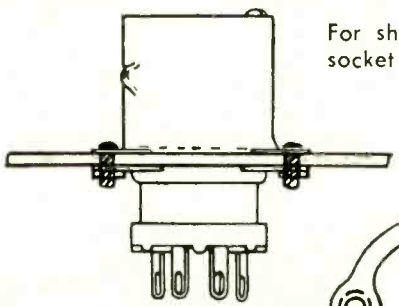
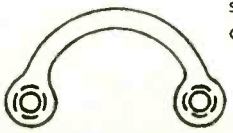


SHIELD



BAYONET SHIELD BASE

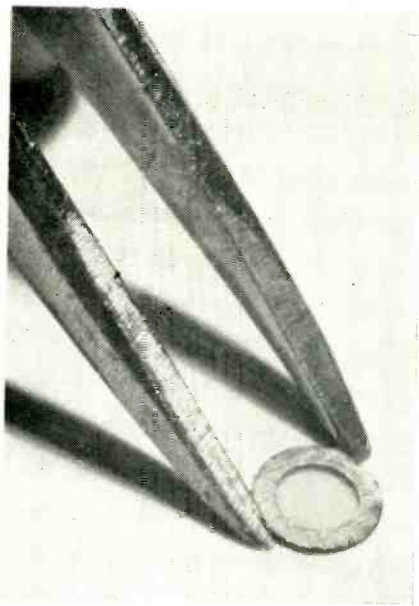


MOUNTING STRAP

For shielding tube, two types are available for miniature socket as shown, Bayonet with three lengths of shield cans available and Snap-on, two lengths of shields available. Bayonet type shown here.

The Mounting strap is a CINCH development for ease and simplicity in mounting miniature sockets. One strap nut takes the place of two conventional type nuts and is generally used in assembling sockets having attached base.

Write for detailed information



Machine-wound grid structure has 1,000 turns per inch

while reduced interelectrode capacitance and minimum lead inductance enhance use of the tube at uhf. The new ceramic is said to minimize r-f losses.

AEW Planes Keep Continuous Watch

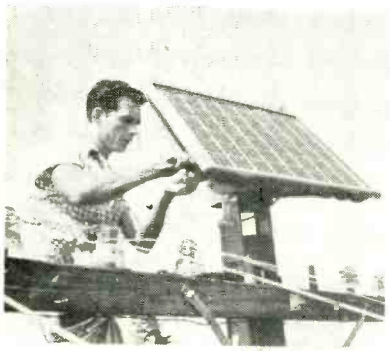
Radar sentry plane picks up information on location of unidentified planes and surface craft

Early warning aircraft fly radar equipment as they patrol east and west coastal areas. Combat Information Officer (below) co-ordinates search work

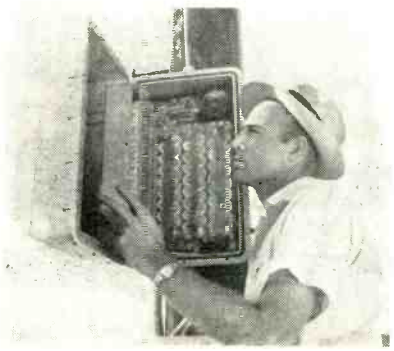
RADAR watch, limited generally to line-of-sight distance, can be extended by pushing lookout stations beyond the perimeter of the protected area and by increasing the effective horizon. Both these steps can be resolved by use of high-flying aircraft.

The U. S. Navy and Air Force use Lockheed Super Constellations carrying 6 tons of radar equipment. Crews of 31 men man the aircraft for round-the-clock operations. The project is known as airborne early warning (AEW).

Solar Battery Powers Telephone Carrier



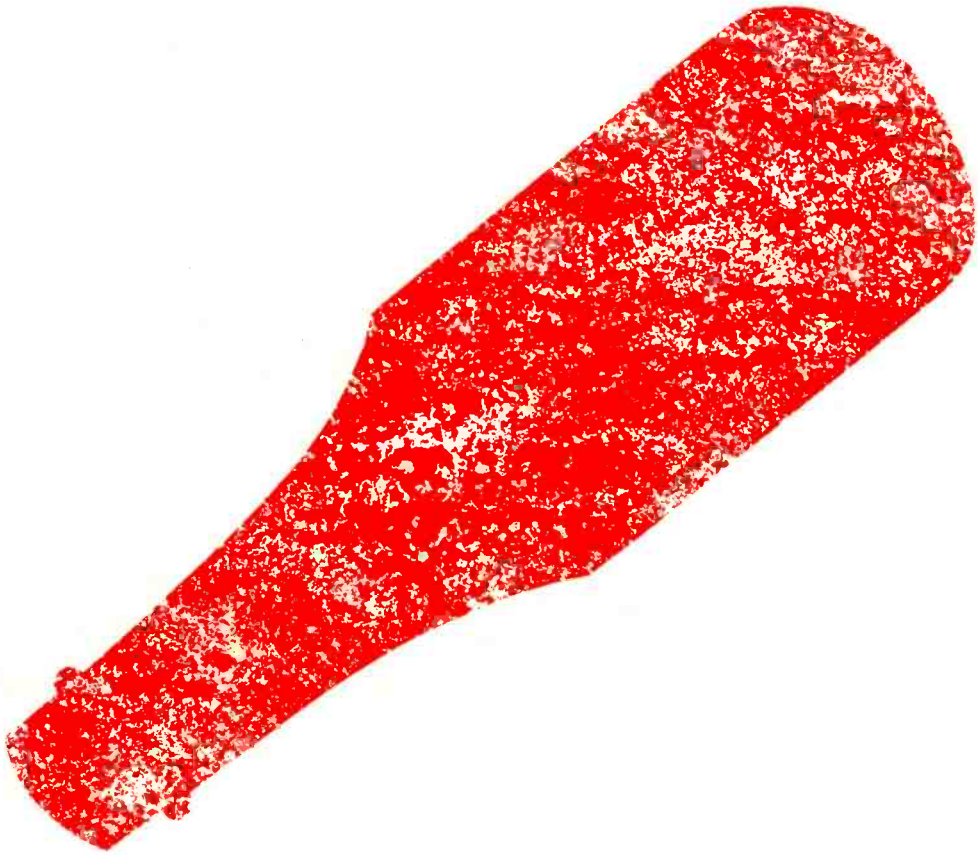
Rural telephone line now carries several circuits using transistor amplifiers powered by solar generator atop pole



Storage battery operates low-current transistor equipment during night. It is charged by solar battery that powers equipment during day

IMPROVED rural telephone service using carrier currents on so-called thin or skinny routes has been made posible through the development of transistor equipment. With current drain reduced as compared with electron tube equipment, it is possible to power remote amplifiers from the recently developed Bell Labs solar battery.

When the solar charger is backed up by storage cells, periods of bad weather or darkness, during which



no ketchup needed

When a predestined steer meets a dedicated chef ... man, that's steak!

If steer or chef is bad (and double trouble if both) ... ketchup can't help.

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Take the best available materials (sifted by unrelenting research). Season with the same inventiveness used by Dr. A. O. Beckman to develop the precision potentiometer in 1940 (we've never switched brands). Add assembly-line economies without compromising quality. Test and retest in the industry's most complete lab. Inspect a dozen times (too many cooks can't spoil *this* broth). Pack well. Ship on schedule.

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Helipot makes precision potentiometers ... linear and non-linear ... in the widest choice of sizes, mounting styles and resistances. Many models are stocked for immediate shipment ... our engineers will gladly adapt standard models to your requirements ... or design entirely new HELIPOT* *precision potentiometers for you.*

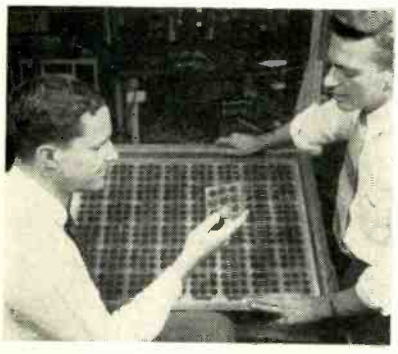
For information and specifications ... write for data file 1101.

THE FRONT COVER

MANUFACTURE of color kinescopes of the shadow-mask type requires that three phosphors be laid onto the screen in a dot pattern. The process used for black-and-white kinescopes provides for suspension deposition of the phosphor over a period of time. To speed up the process for color tubes, RCA uses three color-producing phosphors combined with polyvinyl alcohol, deionized water and a photosensitizing agent.

Applied centrifugally as a slurry to the cap of the color kinescope, each solution is distributed as shown on the cover and the photograph at the left.

When the glass cap is taken out of the slurrying machine, it is affixed to is its individual shadow mask and placed on a so-called lighthouse as shown at the right. The light dots expose the phosphor and fix it photographically. Excess phosphor is washed off and the glass plate is then put through two more similar steps to obtain the other two sets of dots. Colors are red, green and blue.



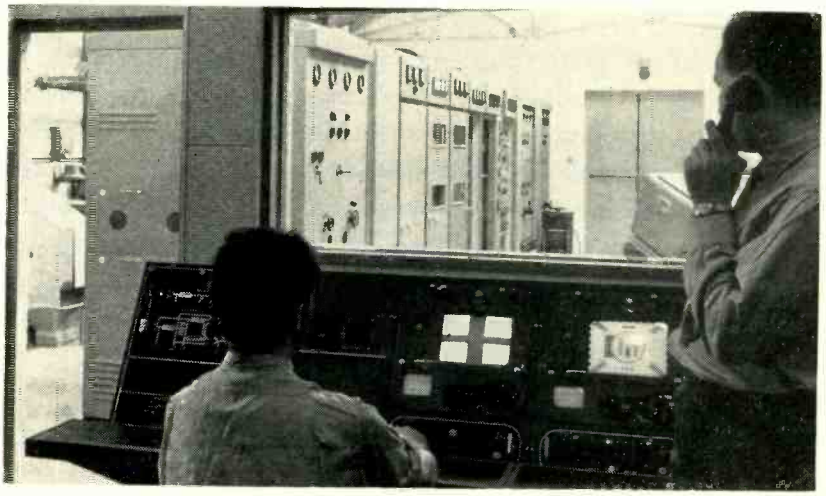
Silicon disks assembled in modules of nine deliver power at the rate of 100 watts per square yard of effective surface area

the solar battery is weak or inoperative, offer no problem.

Such an installation is now furnishing rural multicarrier telephone service near Americus, Ga., for Southern Bell Telephone Co.

The Bell solar battery comprising 432 silicon cells cushioned in

Albion Tries Commercial TV



London station of the Independent Television Authority (ITA) began full-scale commercial television on Sept. 22, 1955. Such programming is effectively in competition with that of government-sponsored British Broadcasting Corp., until recently a monopoly. Control desk, with transmitter beyond, was built in Croydon by Marconi's Wireless Telegraph Co., Ltd. ERP of station is about 60 kw

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oil and covered by glass is about 15 times more efficient than previous solar converters. The cells convert as much as 11 percent of the energy they receive, a performance comparable to that of the best gasoline and steam engines.

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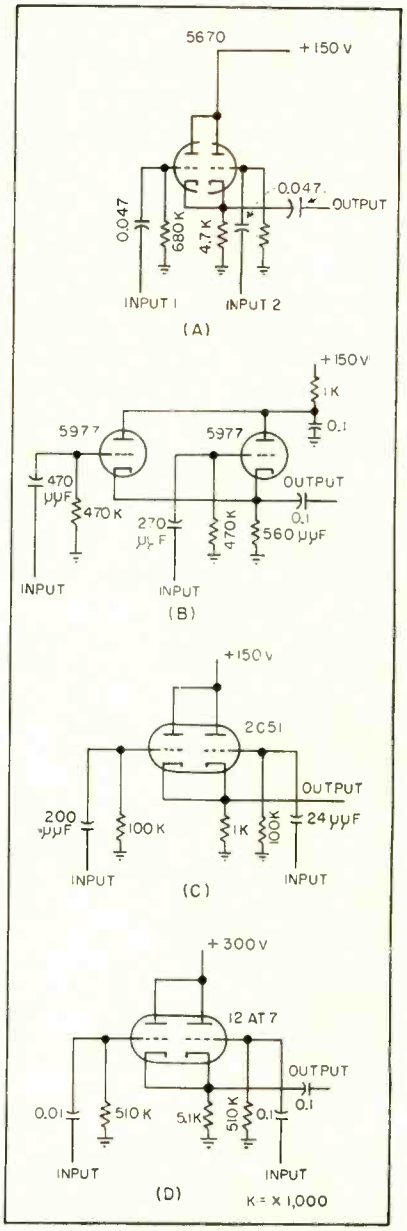

FIG. 1—Example of preferred circuit for mixing radar video signal with marker pulses (A). Three examples (B), (C) and (D) of the 22 video mixers found in radar sets

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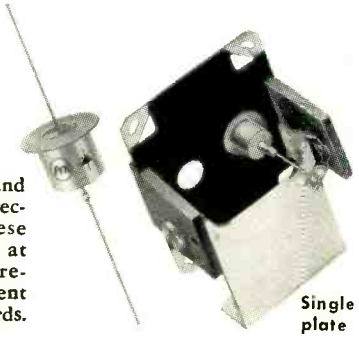

Single plate

The 1N91, 1N92, and 1N93 germanium rectifiers used in these new stacks assure at least 20% lower reverse leakage current than RETMA standards.

Once in a while a new design is so good that it sets entirely new standards for an electronic component. The *new* Federal germanium stacks are like that. Here are seven of their most important advantages over existing types . . . advantages that mean a *better* rectifier for *your* equipment:

- **SPACE-SAVING**—The stacks average one-third shorter in length.
- **LIGHTWEIGHT**—Light, strong plastic side strips are used instead of heavy axial assembly bolts and insulators.
- **RIGID CONSTRUCTION**—Interlocking of fins and strips builds a "tight" structure unaffected by vibration.
- **BETTER HEAT DISSIPATION**—Full area of the fin is available for cooling.
- **TERMINAL LUGS ELIMINATED**—Terminals are stamped out as part of the fin corners, so that wires may be soldered directly to the fin.
- **NO PROTRUDING BUS BARS**—Corners of fins are clipped out for passage of bus bars connecting non-adjacent plates.
- **FULLY INTERCHANGEABLE**—Electrically and mechanically interchangeable with types now on the market.

For detailed information, ask for "Federal Germanium Power Stacks" booklet. Phone NUtley 2-3600 or write to Dept. F-213.

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to be gained by standardization of electronic circuits.

A program undertaken by National Bureau of Standards and Navy Bureau of Aeronautics seeks to determine well-known circuit configurations common to a wide variety of equipment. The purpose is to weed out unnecessary differences in detail. A full technical report will be available in November from the Government Printing Office. It will be titled "Preferred Circuits Manual, Navy Aeronautical Electronics Equipment" and identified as NAVAER 16-1-19.

FIG. 2—Five i-f strips produced for Navy aeronautical equipment perform the same electrical functions

Some circuits are unique and specially designed for a purpose. Most circuits, however, are widely used in many equipments. Such widely used circuits become essential building blocks, like the elements of a block diagram. While it is not always advantageous to freeze circuit design, economies often result thereby in price, delivery time and reduction of spare parts.

Junior engineers who are often assigned the routine of designing well-known circuits will have their work facilitated, reducing, in turn, the supervisory burden of senior engineers.

Studies of 22 equipments showed essentially 60 circuit types. Although circuits within a type were not necessarily identical, in many cases they were similar enough for standardization. For example, certain range-marker generator circuits could well be identical for many radars and for other time-scale generators.

Power supply circuits were found capable of standardization. As a first step, studies were made of the large number of power supply voltages. It was discovered that voltages used in 20 equipments showed 20 different nominal values that could readily be reduced to four.

A typical preferred circuit for a

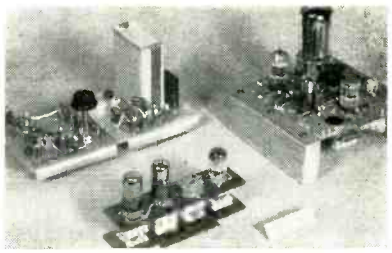


FIG. 3—NBS-BuAer preferred circuits are adaptable to different methods of construction as shown in different fabrication techniques

radar video mixer is shown in Fig. 1A. That at (B) is a common-cathode mixer combining pulses representing range markers and heading markers. In Fig. 1C a common-cathode mixer combines two positive polarity range strobe triggers. The circuit in (D) combines 9-v positive polarity range markers with 2-v to 10-v positive iff signals.

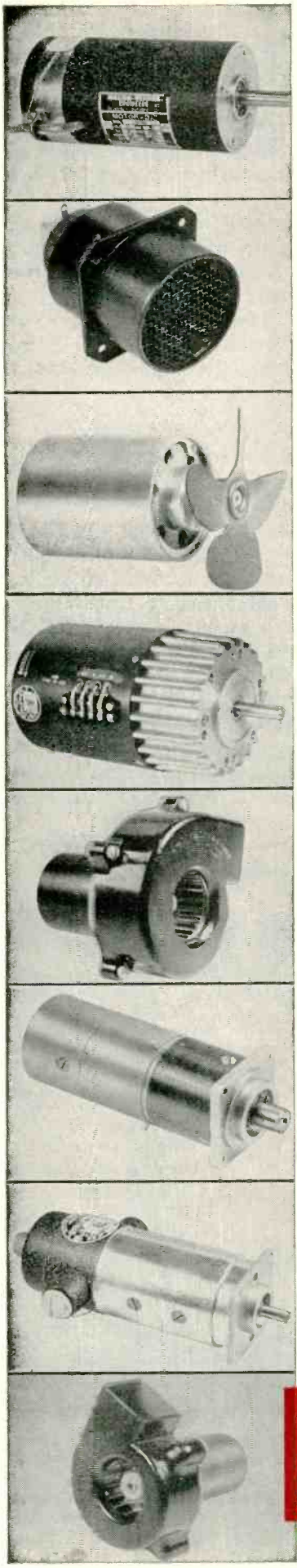
Flat Cathode-Ray Tubes

DISPLAYS using cathode-ray tubes of unusual design have been described previously (ELECTRONICS, p 7, Feb. 1955 and p 214, Mar. 1955). Technical information recently made available from Kaiser Aircraft and Electronics Corp. summarizes some aspects of function and design.

In its simplest form, the tube comprises a phosphor screen, a set of horizontally disposed deflection plates and an electron gun placed below them. The electron beam from the gun is deflected in a plane parallel to the phosphor screen and slightly behind it.

Under the condition that the deflection plates are at the same voltage as the phosphor screen, the beam will sweep the entire area between the phosphor screen and the vertical deflection plates. The deflected beam will pass behind the phosphor screen until it reaches a field created by one of the vertical deflection plates being at voltage lower than the phosphor screen. The beam will be deflected into the phosphor screen at that point.

Owing to its horizontal deflection at the gun the beam will describe a horizontal line on the phosphor screen. If the voltage on each of the several vertical deflection plates behind the phosphor screen is varied, a negative field, created by these de-



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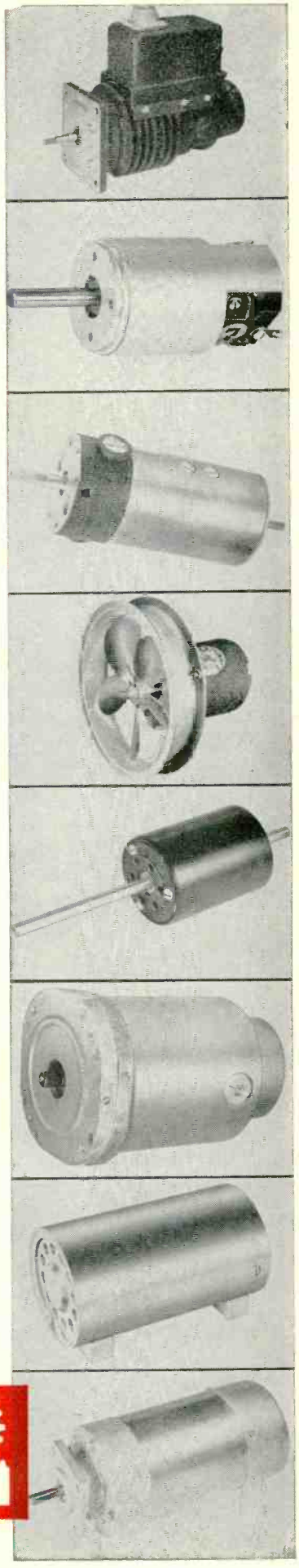

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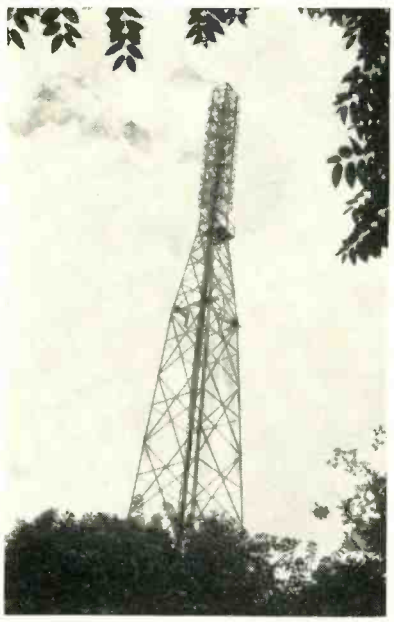
flection plates, will move smoothly from the top of the tube to the bottom. It is necessary that the voltage on each plate be dropped uniformly and that the voltage on the next lower plate start to drop just as the voltage on the previous plate reaches a minimum so that a noninterrupted flow of the negative field will occur. Seven to ten plates are normally enough for adequate control. The focusing action of this field brings the beam to a small horizontal line at the surface of the screen with great power.

Two-Bend System

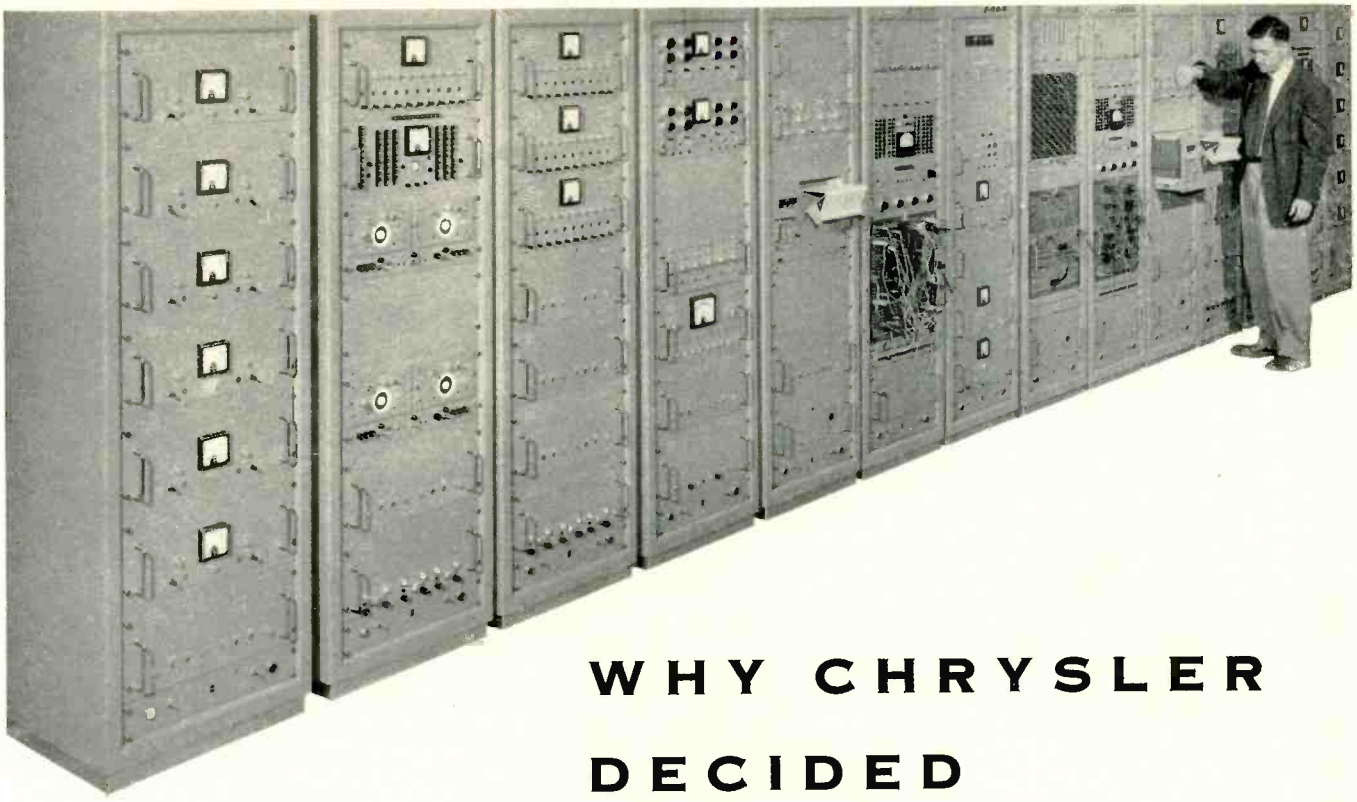
In a two-bend model of the new tube, the electron gun is placed to inject a beam below the tube and midway between the extension of both the phosphor screen and the bottom vertical deflection plate. In this arrangement, transverse deflection plates on the bottom side of the beam deflect the beam upward into the area behind the phosphor screen. This lower portion of the tube is normally operated at set voltage or slightly above.

An isolating electrode is needed. Voltages on the horizontal deflec-

British TV Tower



Eight-stack aerial array atop fabricated tower has gain of about sixfold in power when used by England's first commercial television broadcast station. It is located at Croydon and was built for Independent Television Authority by Marconi



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tion plates now are varied from plate to plate in a sequential manner, each plate varying gradually from B+ to approximately zero. The vertical deflection plates make the second bend and bring the beam into contact with the phosphor.

The two bends occur at right angles to each other. Focusing action in each bend may be likened to the collapsing of a copper pipe when bent sharply. The beam is squeezed in one dimension during each bend and since these bends are at right angles, the result is a small spot on the screen. Deflection defocusing is normally a problem in conventional tubes, as is beam blowup. This is a condition in which the charges within the beam tend to force the beam apart and therefore deteriorate focusing. They are of little hindrance in the new tube, as deflection defocusing is turned to advantage and beam blowup is of little consequence, owing to the fact that a dense beam is not created until the last convergence at the phosphor screen.

The display arrangement of the single-bend model results in a keystone-shaped display. This keystoning may be corrected by electronic, electrostatic or electromagnetic means. The two-bend model is not subject to keystoning.

Controlling Means

Each deflection plate varies between B+ and approximately zero in turn so the resultant negative field moves down the tube in a smooth manner. This action is reversible and can be used to create backward sweeps. There are many ways of accomplishing this voltage control, but only two will be described.

The simplest arrangement uses an electron gun, driven from the normal sawtooth voltage source, to sweep a row of target plates that are electrically connected to one set of deflection plates in the cathode-ray tube. The resistors serve to return the plates to B+ after the beam has passed. This setup will cause the voltage on each plate to be varied in a linear manner for sequential operation.

The desired result may also be accomplished by the use of a variable-μ or remote-cutoff grid in a tube

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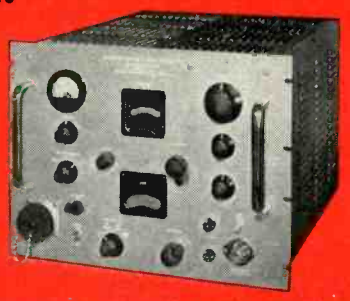

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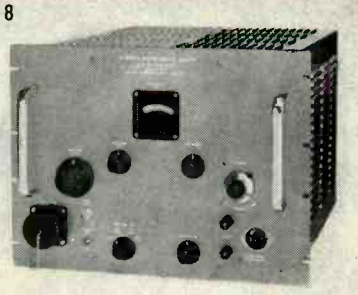
12.4 TO 39.7 KMC

SS-1218



POLARAD MICROWAVE SIGNAL SOURCES
12.4 TO 50.0 KMC

	SIGNAL GENERATORS		SIGNAL SOURCES	
Frequency Range	Model Number	Output Power	Model Number	Power Output (Average)
12.4 to 17.5 KMC	SG 1218*	—10 DBM	SS 1218	15 mw
18.0 to 22.0 KMC	SG 1822	—10 DBM	SS 1822	10 mw
22.0 to 25.0 KMC	SG 2225	—10 DBM	SS 2225	10 mw
24.7 to 27.5 KMC	SG 2427	—10 DBM	SS 2427	10 mw
27.27 to 30.0 KMC	SG 2730	—10 DBM	SS 2730	10 mw
29.7 to 33.52 KMC	SG 3033	—10 DBM	SS 3033	10 mw
33.52 to 36.25 KMC	SG 3336	—10 DBM	SS 3336	9 mw
35.1 to 39.7 KMC	SG 3540	—10 DBM	SS 3540	5 mw
37.1 to 42.6 KMC	* External Source Power Measurement Range +10 to +30 DBM Accuracy with Correction: ±2 DB		SS 3742	Approx. 3 mw
41.7 to 50.0 KMC			SS 4150	Approx. 3 mw

Modulation:
1. Internal
   1000 CPS Square Wave
2. External
   a. Pulse
      Pulse Width: 0.5 to 10 Microseconds
      PRF: 50 to 10,000 PPS
      Pulse Amplitude: 10 volts Pk to Pk Min.
      Polarity: Positive
   b. Sawtooth or Sinusoidal
      Frequency: 50 to 10,000 CPS
      Amplitude: 15 Volts RMS Min.

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employing a series of anodes arranged in a row. The end of the grid that has the larger spacing requires more voltage to be cut off and so will pass electrons while the grid is too negative for the lower end of the tube to conduct. Therefore, a positive-going sawtooth voltage applied to the grid will cause the tube to conduct in a progressive manner from the top downward so that the voltage on the various deflection plates will be varied as desired to create a raster or other scan.

High Voltage

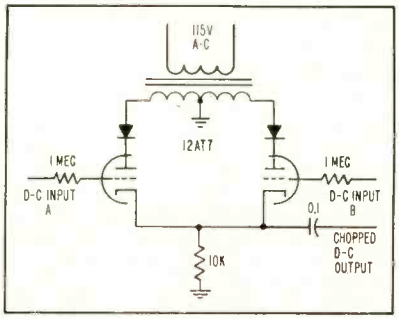
Since the vertical deflection plates are behind the phosphor screen and the beam must pass between these plates and the screen to reach the top portions of the tube, these plates must normally be at full screen voltage. This places severe requirements on components used in the vertical-deflection portion of the controlling circuits. It is common to operate these vertical plates at 15,000 volts.

Control tubes have been especially developed to handle this high voltage and one type, normally employed in groups to handle a set of deflection plates, employs an electrostatic ion-trap to protect the oxide cathode from high-voltage ion bombardment. This tube has an operating range from a few hundred volts to over 20,000 volts.

Electronic Chopper for D-C Amplifiers

By Irving Barditch
Baltimore, Md.

Commercially available vibrator-type choppers have voltage limitations depending both upon their contact material and physical con-



Vacuum-tube d-c chopper is useful at high voltages where arcing may reduce life of vibrator type units

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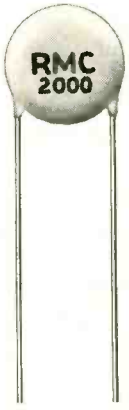

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struction. In applications where d-c potentials of greater than 300 volts must be converted to a-c voltages, their use is not indicated.

A simple vacuum-tube circuit of good stability and long life can be used. This circuit consists of two triodes connected as cathode followers with a common cathode being fed alternate half waves of the chopping frequency through selenum rectifiers to their respective plates. The unit exhibits in large measure cathode-follower stability, while the series grid resistors limit loading on the d-c sources.

The transformer center tap and the cathode resistor may be returned to either ground or positive and negative potentials respectively to allow both positive and negative inputs to the grids.

Nonlinear Time-Delay Generator Uses Diodes

By BRUCE A. KAUFMAN
Frankford Arsenal
Philadelphia, Pa.

A DELAYED TRIGGER can be produced whose delay from the initiating trigger is proportional to a known nonlinear function of the height of a control pedestal containing system information. In addition, this pedestal varies in amplitude throughout its duration and the delay must be determined by its height at the instant of initiating trigger.

These requirements were met by a time-delay generator of the phantastron type. In a phantastron,

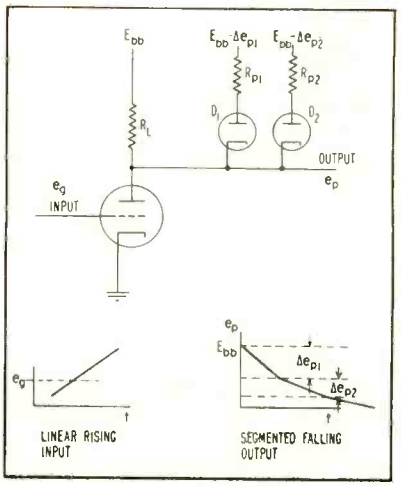

FIG. 1—Nonlinear function generator uses biased diodes to shape waveform

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A series of new High Forward Conductance types has been added to the comprehensive line of Hughes subminiature germanium point-contact diodes. The sturdy internal construction of these point-contact devices *ensures* electrical and mechanical stability—even under severe operating conditions.

With the addition of this new series, Hughes now offers an even greater selection of RETMA, JAN, and Special diode types, embracing the complete range of germanium diode specifications. This means that you can be sure of obtaining the particular Hughes diode best suited to meet the specific requirements of your circuit. That's because you can choose from among varying combinations of such electrical characteristics as: High Conductance . . . High Back Resistance . . . Quick Recovery . . . High Temperature Operation.

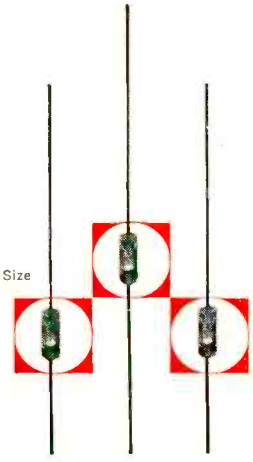
Listed here are a few of the more popular Hughes diode types, arranged according to forward and reverse characteristics. More than 150 additional special types are available.

At Hughes, intensive research is devoted to the *continuing* development of existing products. This effort progressively provides you with the finest semiconductor devices available. It is one reason why Hughes diodes are *first of all* . . . for RELIABILITY. It's one more reason why you should come to Hughes for your diode requirements!

WORKING INVERSE VOLTAGE		FORWARD CURRENT at +1V (Milliamperes)							
		3-5	5	10	20	50	100	150	200
30	200μA @ − 20V						HD 2152		
40	10μA @ − 10V	1N128*							
60	50μA @ − 50V 100μA @ − 50V 500μA @ − 50V 850μA @ − 50V		1N116 1N90 1N126*	1N117 1N95	1N118 1N96	HD 2167 HD 2166 HD 2155	HD 2173 HD 2174 HD 2162		HD 2160 HD 2171 HD 2172
80	50μA @ − 50V 100μA @ − 50V 125μA @ − 50V** 250μA @ − 50V** 250μA @ − 50V 500μA @ − 50V	1N67A 1N89	1N191** 1N192** 1N198*	1N99 1N97	1N100 1N98	HD 2151 HD 2168 HD 2169	HD 2150 HD 2163 HD 2175		HD 2158 HD 2157 HD 2159
100	180μA @ − 90V 500μA @ − 100V 625μA @ − 100V 300μA @ − 50V 50μA @ − 50V	1N68A 1N127* HD 2051				HD 2170	HD 2165	HD 2154	HD 2161
150	500μA @ − 150V		1N55B						

*JAN Types. 1N198 only high-temperature tested at 75°C.
**Computer Types. Special recovery tests. 1N191 and 1N192 tested for back current at 55°C.

New High Conductance types listed in red.



Actual Size

Like all Hughes diodes, High Forward Conductance types are packaged in the famous one-piece, fusion-sealed glass envelope, impervious to moisture and to external contamination. Maximum dimensions, glass envelope: Length: 0.265 inch. Diameter: 0.105 inch.

HUGHES SEMICONDUCTOR DIVISION

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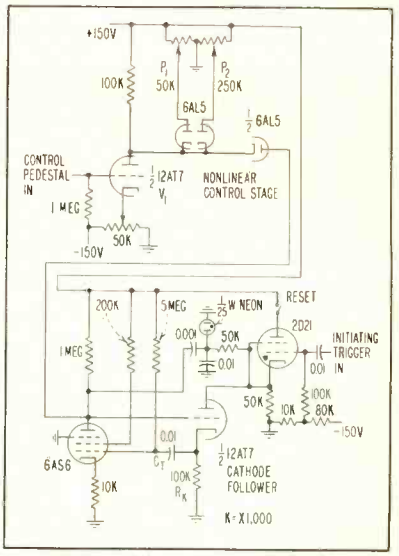


FIG. 2—Time-delay generator produces pulse delayed in time as a function of nonlinear waveform generated by V_1

plate-rundown and hence screen pulse duration is a highly linear function of the plate-control voltage existing at trigger and is independent of it afterwards. The trailing edge of this screen waveform may be differentiated to produce a spike delayed in time from that which triggers the phantastron.

To produce a delay that is the given nonlinear function of the pedestal magnitude, a special stage was provided to feed the pedestal to the phantastron. This stage shown in Fig. 1 is essentially a nonlinear d-c amplifier, whose output is a requisite function of input voltage.

As the input voltage rises the plate voltage falls and when it falls a given increment Δe_p, diode D_1 con-

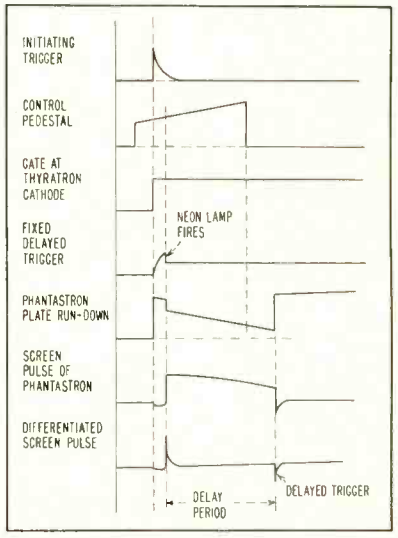
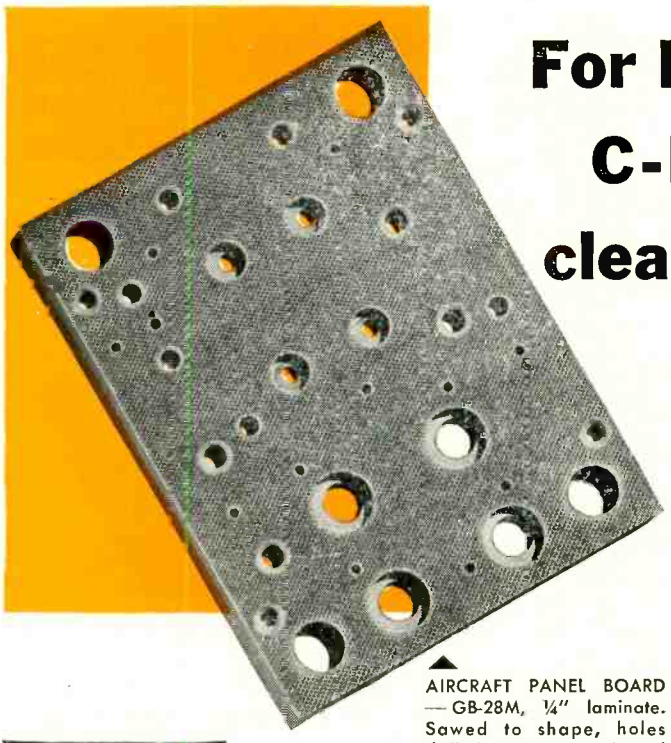
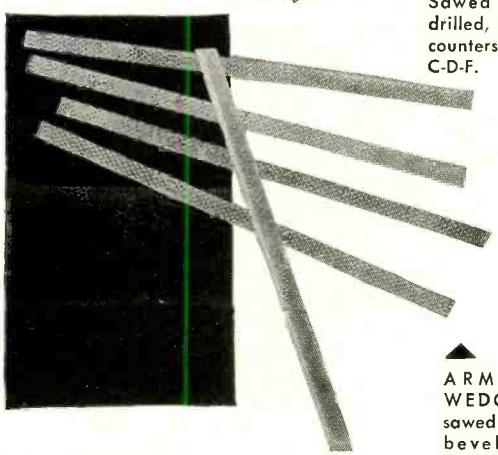


FIG. 3—Waveforms at various points in nonlinear time delay generator circuit

For high heat applications C-D-F Melamine Dilecto cleanly machined by C-D-F



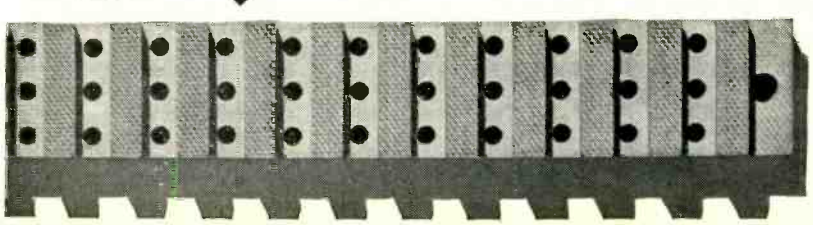
AIRCRAFT PANEL BOARD — GB-28M, ¼" laminate. Sawed to shape, holes drilled, counterbored and countersunk. Machined by C-D-F.



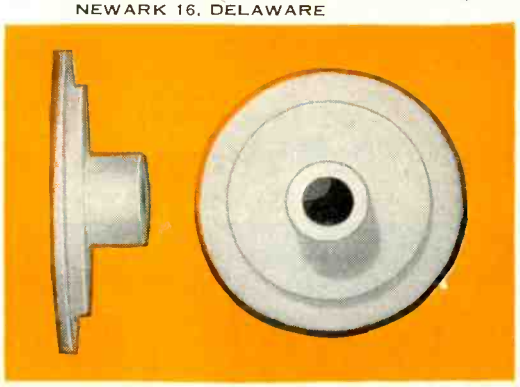
ARMATURE SLOT WEDGES — GB-28M, sawed into strips, then beveled edges were broached to angle of 21° 23', and strips were cut to exact length. Machined by C-D-F.

RF COIL FORM — Natural GB-112M Dilecto rolled tubing, smooth edged. Sawed to length; drilled and burred by C-D-F.

TERMINAL BLOCK—GB-28M. Sawed to shape, grooves milled, corners sanded round. Holes were drilled, counterbored, characters stamped. Machined by C-D-F.



INSULATOR — ML rod. Turned on automatic screw machine by C-D-F. Grade ML is a fine weave cotton fabric base laminate bonded with a melamine resin. Easy to machine.



As operating temperatures rise, melamine laminated plastics can satisfy many requirements for component parts. Glass base melamine grades of Dilecto resist elevated temperatures —up to 300° F. continuously, 350° F. intermittently. They have extremely high impact strength; excellent arc resistance and self-extinguishing properties. C-D-F melamine Dilecto grades are usually specified for many electrical applications requiring high arc resistance, mechanical strength, flame and heat resistance.

C-D-F can supply melamine Dilecto in sheets, tubes and rods in the following grades:

GB-28M—Medium weight glass base laminate with melamine resin. Highest mechanical strength; excellent arc resistance, high heat and flame resistance; self-extinguishing. Dimensionally stable—little affected by temperature and humidity.

GB-112M—Lightweight glass fabric with melamine resin. Substantially same characteristics as GB-28M. Usually produced in thickness less than $\frac{1}{32}$".

GM-1—Glass mat base melamine resin bonded laminate. A lower cost product suitable for many applications requiring arc resistance along with good mechanical strength and flame resistance.

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See our general catalog in Sweet's Design File for more data, the address and telephone number of your nearest C-D-F sales engineer. Also write for technical bulletin and specific catalog, free test samples, or send us your print for quotation.

CDF *Continental-Diamond Fibre*

CONTINENTAL-DIAMOND FIBRE DIVISION OF THE BUDD COMPANY, INC.
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ducts shunting R_{p1} across R_L and reduces the gain of the stage. As the plate voltage continues to fall, D_2 will conduct and further reduce the gain of the stage in a like manner. A segmented voltage transfer characteristic is thus obtained.

The diode switched load resistors and Δe_p can be varied to produce a variety of control functions. Any number of diodes and shunting resistors may be used to obtain the desired degree of approximation to a given function.

When the control pedestal, which is positive-going, appears at the grid of the control tube, a negative-going pedestal of controlled amplitude appears at the plate.

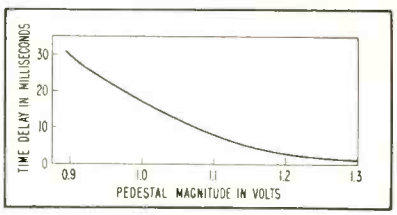


FIG. 4—Time delay as a function of pedestal magnitude

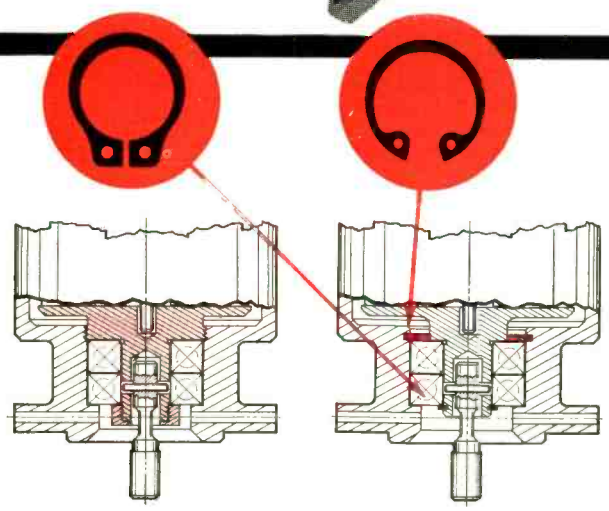
At some instant during the duration of the control pedestal a trigger is supplied to the phantastron, which must then generate another trigger, delayed in time by an amount directly proportional to the voltage level existing at the plate of the control tube at the instant of trigger. Since the pedestal has been passed through the control stage whose output is the requisite function of its input, the desired time-delay versus pedestal magnitude is obtained.

Since a phantastron will trigger on a negative pulse applied to the plate or grid, the leading edge of the control pedestal will trigger the phantastron and all control is lost. Means for preventing this action must be provided. A successful scheme used here was to return the plate of the cathode follower of the phantastron circuit to the cathode of a thyratron. Feedback action of the phantastron is prevented until the cathode follower is gated on. The thyratron is fired by the same trigger that starts the phantastron. However, this results in a system limitation. Owing to the finite time necessary to charge C_T to the increased cathode voltage of the gated

10 Waldes Truarc rings speed assembly— Eliminate parts and machining in precision control

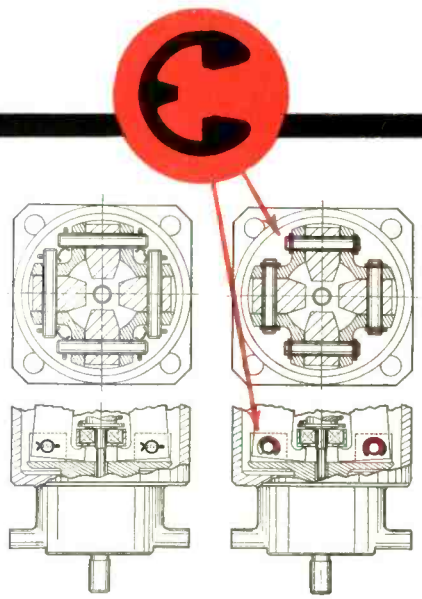
Kahn Rotary Speed Control

Kahn and Company, Inc., of Hartford, Conn., use a total of 10 Waldes Truarc Retaining Rings in this new mechanical-electric translator for automatic control of rotary speed. Truarc rings act as positioners and retainers to eliminate parts, simplify operations, save labor, and speed assembly.



Rotor Installation. In the old way, ball bearing was retained by a threaded shoulder and threaded bearing cup retainer.

New way, using two Truarc Rings (Series 5100 and 5000) eliminates 4 threading operations, bearing shoulder and threaded bearing cup. Assembly is quicker and easier, two ounces lighter.



Flyweight Assembly. Formerly, 2 holes had to be drilled in each of the 4 pivots, and 8 cotter pins were required.

The new way, using 8 Truarc E-Rings (Series 5133), replaces holes with grooves, reduces pivot size, leaves no projecting parts. Rings snap into place, speed assembly time by three minutes per unit.

Whatever you make, there's a Waldes Truarc Retaining Ring designed to improve your product... to save you material, machining and labor costs. They're quick and easy to assemble and disassemble, and they do a better job of holding parts together. Truarc rings are precision engineered and precision made, quality controlled from raw material to finished ring.

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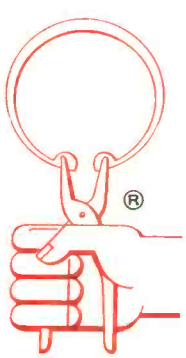

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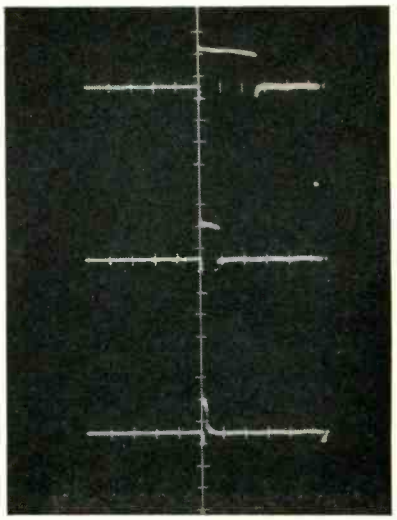

FIG. 5—Waveforms at screen of phantastron

cathode follower, the phantastron is not ready to start until about R_kC_T seconds after the gate. The phantastron must be supplied with a trigger delayed at least R_kC_T seconds from the initial starting trigger.

Since this time is not highly critical, a simple RC neon-lamp fixed-delay generator is provided. It is initiated by the positive step at the cathode of the thyratron. Theoretically speaking, if the level of the control pedestal varies significantly during this trigger delay period a system error results.

For the particular system under consideration the time rate of change of level is not so great as to cause this source of error to be

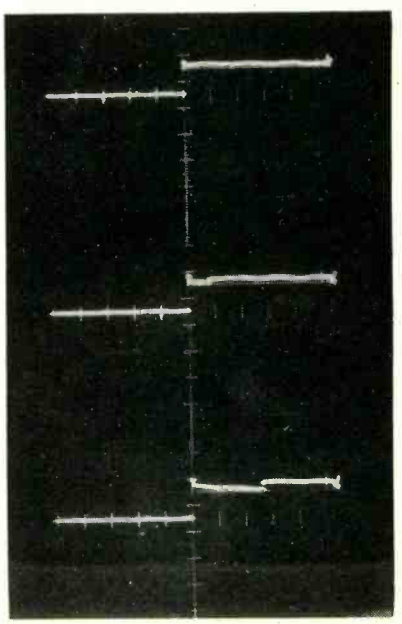

FIG. 6—Phantastron plate waveforms

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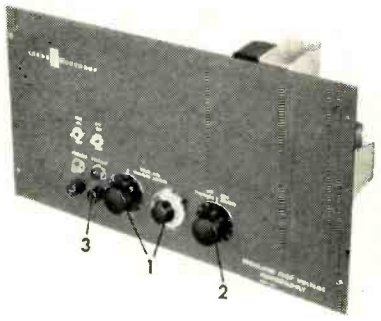

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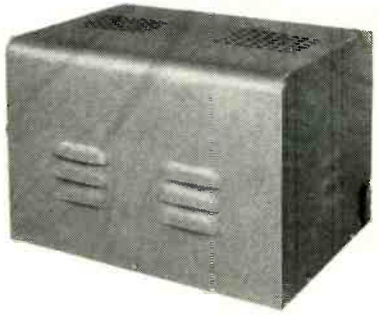

Catalog Number—101-2-0-1, same as above except includes chassis only without metal case and has a constant voltage output of 105 volts.

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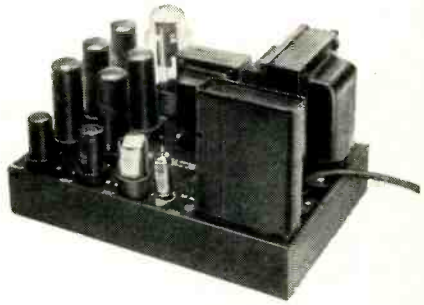

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required delay versus pedestal magnitude. Figures 5 and 6 also show typical waveforms at the screen and plate of the phantastron.

Precise Measurement of Sawtooth Linearity

By Robert L. Richardson
Syracuse University
Syracuse, N. Y.

In many circuit applications a linear sawtooth waveform of voltage is required. Frequently a departure from perfect linearity of less than ±0.5 percent is necessary. There are circuits capable of generating waveforms of this sort but some way of measuring their departure from linearity is usually needed. One way of making these measurements is presented here.

The linearity of the waveform is determined by measuring its amplitude at many closely spaced points. Using these measurements the waveform may be plotted. This plot is then compared to a perfectly linear sawtooth to determine its departure from linearity. The problem is therefore to measure precisely the ordinates and abscissas of a large number of points along the waveform so that an accurate plot may be obtained. The circuit of Fig. 1 is used to perform these functions.

The operation of this circuit is as follows. The sawtooth voltage is applied to the input terminals. The waveform at the grid of V_1 is a sawtooth whose d-c level can be varied by changing the bias voltage. This grid voltage is amplified

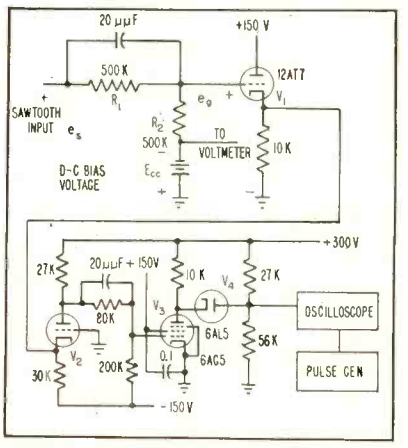

FIG. 1—Circuit for measuring linearity of sawtooth waveforms

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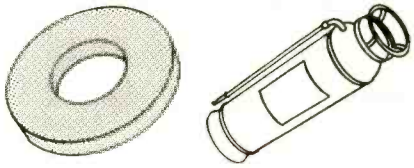
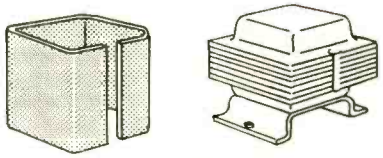


Washers for fire extinguishers are punched from Taylor Vulcanized Fibre . . . a versatile material that resists many chemicals, provides a long-wearing seal.



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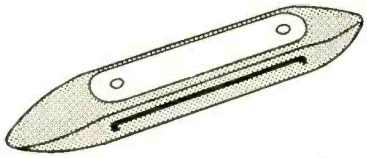

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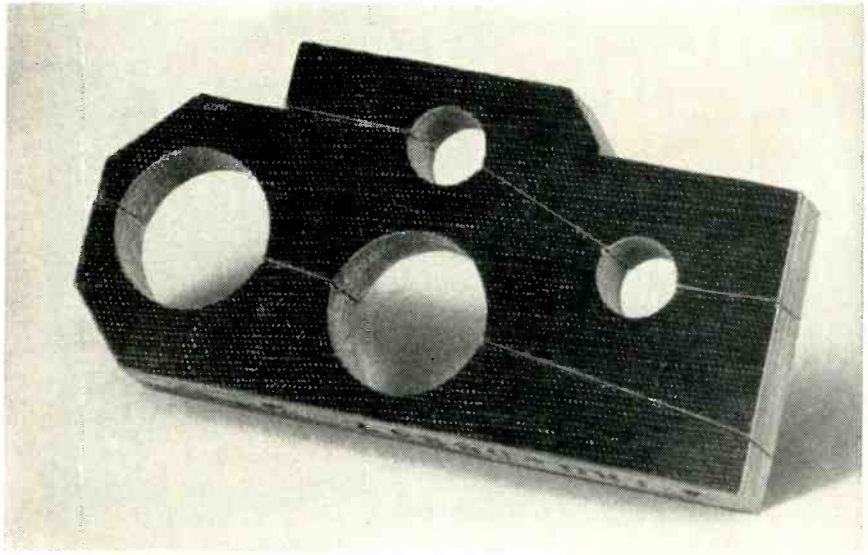

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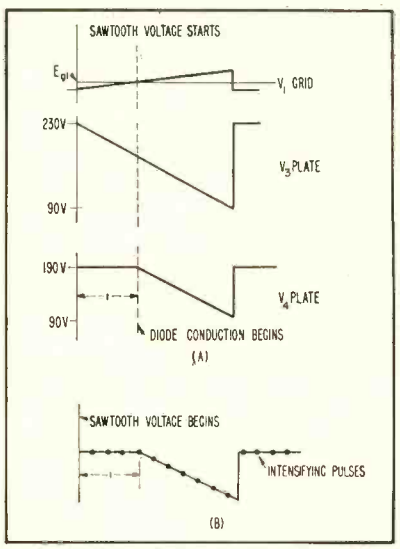

FIG. 2—Waveforms at various points in measuring circuit (A) and typical oscilloscope pattern with timing markers (B)

by the succeeding stages such that the waveform at the plate of pentode V_3 is an amplified and inverted replica of it.

When the diode is conducting its plate waveform will be essentially the same as that at the plate of the pentode.

When the diode is not conducting, however, its plate is held at 190 volts by the voltage divider. Since the diode does not start to conduct until its cathode becomes negative with respect to its plate, the plate waveform of the diode will be essentially that part of the plate waveform of the pentode that is below 190 volts. The plate waveforms of the pentode and diode are shown in Fig. 2A.

The plate voltage of the pentode at the time when the diode begins to conduct (190 volts) corresponds to a definite voltage E_{g1} on the grid of V_1. When this grid voltage is more positive than E_{g1}, the pentode plate voltage will be less than 190 volts and the diode will conduct. From Fig. 2A it can be seen that there is a sharp break in the diode plate voltage as the grid voltage of V_1 becomes more positive than E_{g1}.

The waveform at the diode plate is applied to an oscilloscope used to measure the time interval between the start of the sawtooth and the instant that the grid voltage of V_1 reaches E_{g1} (the point where diode conduction begins). To make this time measurement, a pulse gener-

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Fluctuating voltage killed these electronic tubes off young. Overvoltage murdered most . . . a five percent overvoltage cuts tube life by almost 50 percent (see chart below). Undervoltage, which resulted in cathode bombardment of gas or mercury-filled types, ruined more. Even while in use, poor voltage regulation made these tubes perform erratically. And when they died, downtime costs and replacement costs ran high.

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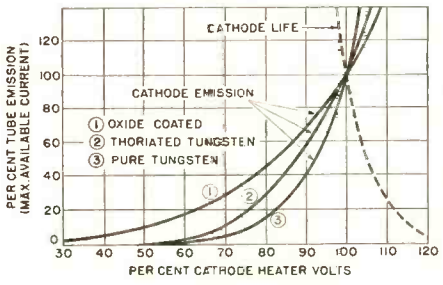

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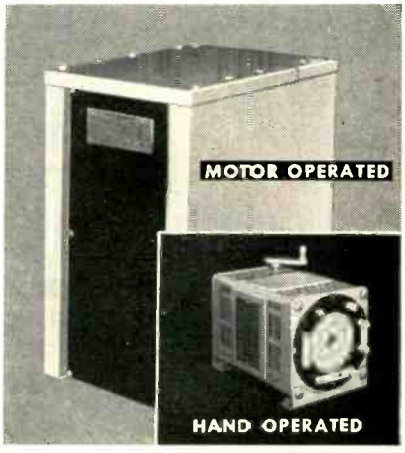

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ator with precisely spaced pulses is needed. The pulses are used to intensity modulate the oscilloscope trace at equal intervals of time and are synchronized to start at the instant that the test sawtooth begins.

If the time interval between the pulses is accurately known, the time between the start of the sawtooth and the instant that the grid voltage of V_1 reaches E_{g1} can be measured by counting the number of pulse intervals between the beginning of the test sawtooth and the break in the diode plate waveform. A typical oscilloscope waveform is shown in Fig. 2B.

The above discussion describes a method of determining the time between the start of the sweep and the instant the grid voltage of V_1 reaches E_{g1}. This time interval will be the abcissa of a point on the sawtooth. It is now desired to find a way of obtaining the ordinate of this point. In other words, the amplitude of the input waveform at the instant that the grid voltage of V_1 reaches E_{g1} must be determined. This is done by considering the input circuit of Fig. 1, where e_s is the instantaneous input sawtooth voltage, e_g is the instantaneous grid voltage of V_1, E_{g1} is the grid voltage of V_1 at the instant that the diode begins conduction (E_{g1} is a constant in any given circuit), and E_{cc} is the d-c bias voltage. The following equation can be written for the input circuit

$$e_g = \frac{E_{cc} + e_s}{R_1 + R_2} R_2 - E_{cc} \qquad (1)$$

when $e_g = E_{g1}$ the equations can be rewritten as

$$E_{g1} = \frac{E_{cc} + e_s}{R_1 + R_2} R_2 - E_{cc}$$

$$E_{g1} = \frac{R_2}{R_1 + R_2} e_s + E_{cc}\left(\frac{R_2}{R_1 + R_2} - 1\right)$$

$$= \frac{R_2}{R_1 + R_2} e_s - \frac{R_1}{R_1 + R_2} E_{cc}$$

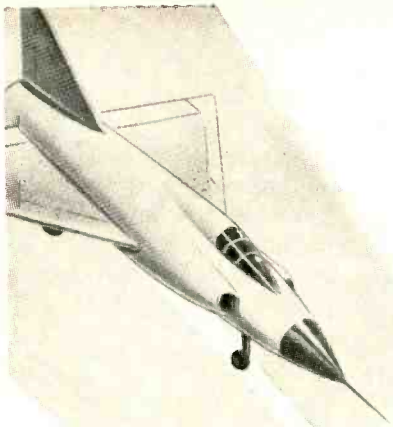
or

$$e_s = \frac{R_1 + R_2}{R_2} E_{g1} + \frac{R_1}{R_2} E_{cc} \qquad (2)$$

If $R_1 = R_2$, then

$$e_s = 2E_{g1} + E_{cc} \qquad (3)$$

Therefore, the amplitude of the



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input sawtooth at the instant that e_g reaches E_{g1} is equal to E_{cc} plus a constant. Voltage E_{cc} can be measured accurately. The value E_{g1} is a constant of the circuit, which can be evaluated by letting $e_s = 0$ (grounding the input) and varying E_{cc} until the diode just begins to conduct. In this case

$$\frac{R_1 + R_2}{R_2} E_{g1} = -\frac{R_1}{R_2} E_{cc}$$

$$E_{g1} = -\frac{R_2}{R_1 + R_2} E_{cc} \qquad (4)$$

This provides a way of measuring the amplitude of the input sawtooth at the instant that the pentode grid voltage reaches E_{g1}. Since the bias voltage E_{cc} is variable, the instant that e_g reaches E_{g1} can be varied from the beginning to the end of the sawtooth. This makes it possible to measure the amplitude and timing of any point on the input waveform.

The most convenient way of obtaining a set of these measurements is to vary the bias potential so that the break in the diode plate waveform occurs at successive intensifier pulses. In this way the amplitude of the input sawtooth can be measured at equal time intervals. These measurements can be used to make a plot of the actual input sawtooth voltage. This graph can then be compared to an ideal sawtooth to determine the departure from linearity. If the departure is small, however, ordinary graphical comparison may be difficult. In this case a plot of the difference between corresponding ordinates of the actual and ideal sawtooth waveforms can be made. This graph is then a plot of the deviation of the input sawtooth from perfect linearity.

This system places no requirements on the linearity of the pentode or the triodes. As long as these tubes are operating in a reasonably linear region at the instant the diode begins to conduct, the accuracy of this method will be in-

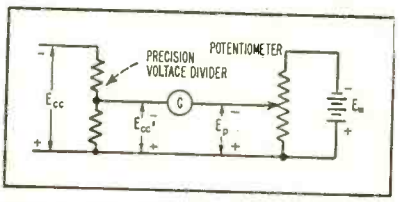

FIG. 3—Potentiometer circuit for measuring sawtooth voltage level

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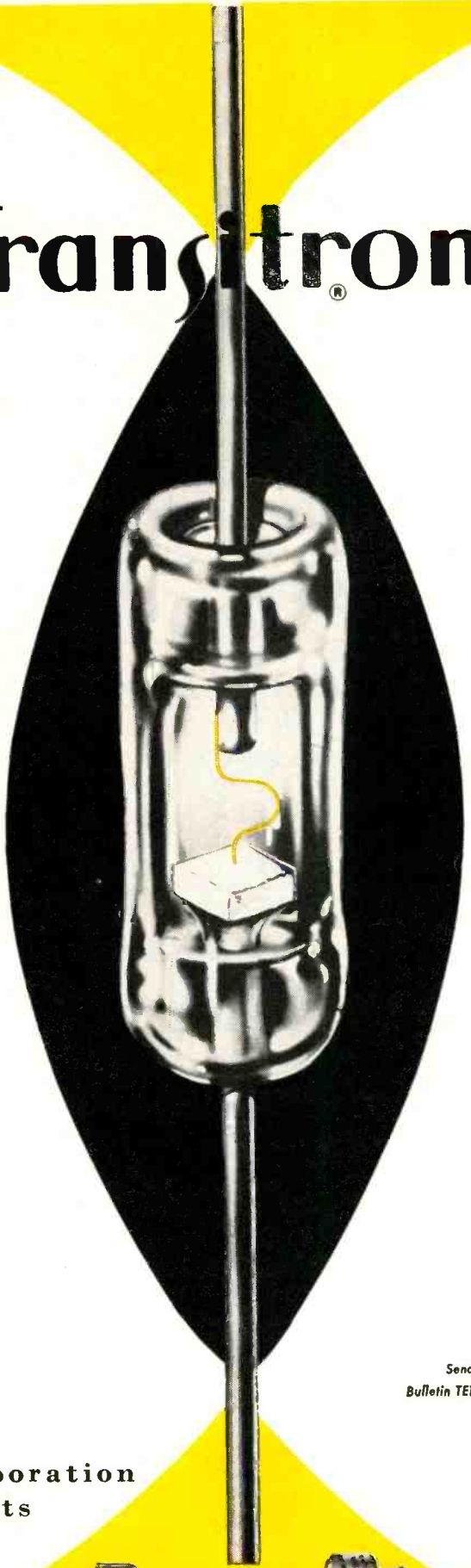
TYPE	Current at +1V. (ma)	Inverse Current (μa Max.)	Cont. Inverse Voltage	DESCRIPTION
T15G	125	500K between -20 and -90V	90	Inverse Recovery Time Tested.
T16G	40	500K between -10 and -50V	60	Forward & Inverse Recovery Time Tested.
1N191	5	400K between -10 and -50V @ 55°C	60	Inverse Recovery Time Tested.
1N192	5	200K between -10 and -50V @ 55°C	60	Inverse Recovery Time Tested.
1N270	200	100 @ -50V	60	LOW IMPEDANCE FAST
1N283	200	20 @ -10V	20	FORWARD SWITCHING TIME.
1N273	100	20 @ -20V	30	(useful for magnetic
1N279	100	200 @ -20V	30	core switching)
T5G	40	100 @ -100V	100	Hi Res.-Hi Cond.
1N67A	5	50 @ -50V 5 @ -5V	80	Hi Resistance
T3G	20	50 @ -50V	60	Hi Res.-Hi Cond.
T2G	40	300 @ -50V	60	Hi Conductance



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dependent of any distortion introduced by them. The accuracy of the system, however, does depend on the precision with which the time and voltage measurements can be made.

Time measurements will be considered first. The intensifying pulses must be both of constant time interval and synchronized with the beginning of the sawtooth. This is easily accomplished by gating the pulse generator to start at the instant that the sawtooth starts or vice-versa.

It has been assumed that the break in the diode plate waveform is very sharp. If the slope of the input waveform is small, however, the break may not be sharp because the diode does not go from cutoff to full conduction instantaneously. This results since an increase in plate voltage of a few tenths of a volt is required to make a diode, which is just beyond cutoff, conduct heavily. The time required for this change to take place is inversely proportional to the slope of the amplified sawtooth that is applied to the cathode of the diode. A sharp break may thus be obtained by increasing the slope of this wave-

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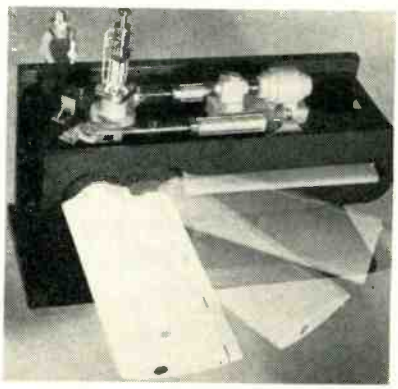

Consistently cutting 20-degree rolls to less than 2 degrees, the new Sperry Gyrofin ship stabilizer uses electronic techniques. The photograph shows how the fin can be swung out into the slip stream of the ship's hull where its tilting action develops roll-countering forces. Although moved into desired position hydraulically, computer techniques operate through magnetic amplifiers in response to strain-gage signals to tilt fins. Two fins are used for merchant vessels, each one exerting up to 3,000 foot-tons of lift. Model shows retracted fin being moved out into slip stream of ship's hull

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OPERATING DATA, 6333

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	MAXIMUM RATING per tube	TYPICAL OPERATION one tube	
AC Filament Voltage	—	22	volts
DC Plate Voltage	15000	12000	volts
DC Grid Voltage	3000	1600	volts
Plate Load Resistance	—	3500	ohms
Peak RF Grid Voltage	—	2600	volts
DC Plate Current	2	1.55	amps
Plate Input	30	18.60	kw
Plate Dissipation	10	4.35	kw
DC Grid Current (approx.)	400	165	ma
Driving Power (approx.)	—	420	watts
Plate Power Output	—	14.25	kw
Tube Power Output	—	745	BTU/min.

OPERATING DATA, 6446

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Plate Volts and Input—Max.	100	75	50%
For Frequencies Indicated	5	12.5	20(mc.)

	MAXIMUM RATING per tube	TYPICAL OPERATION one tube	
AC Filament Voltage	—	21.8	volts
DC Plate Voltage	15000	1200	volts
DC Grid Voltage	— 3000	— 500	volts
Peak RF Grid Voltage	—	1460	volts
Plate Current	2	2	amps
Plate Input	30	24	kw
Plate Dissipation	20	6.5	kw
DC Grid Current	400	230	ma
Drive Power (approx.)	—	300	watts
Plate Power Output	—	17.5	kw
Tube Output	—	996	BTU/min.

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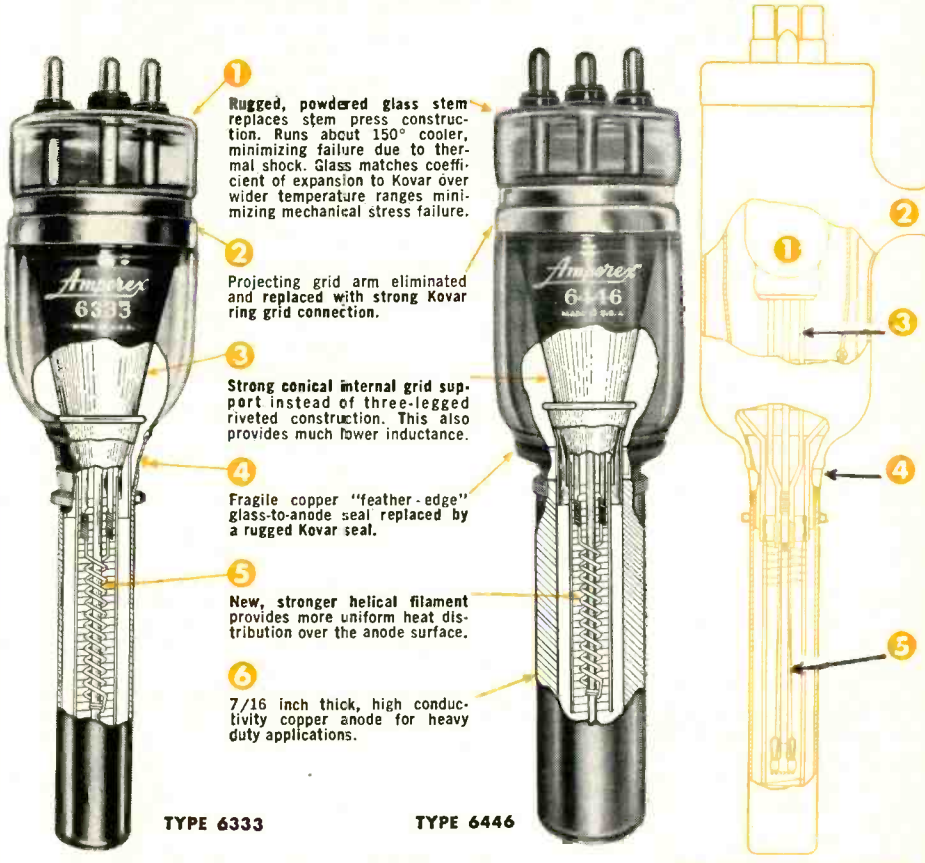

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form. This can be accomplished by adding more stages of gain between V_2 and V_3.

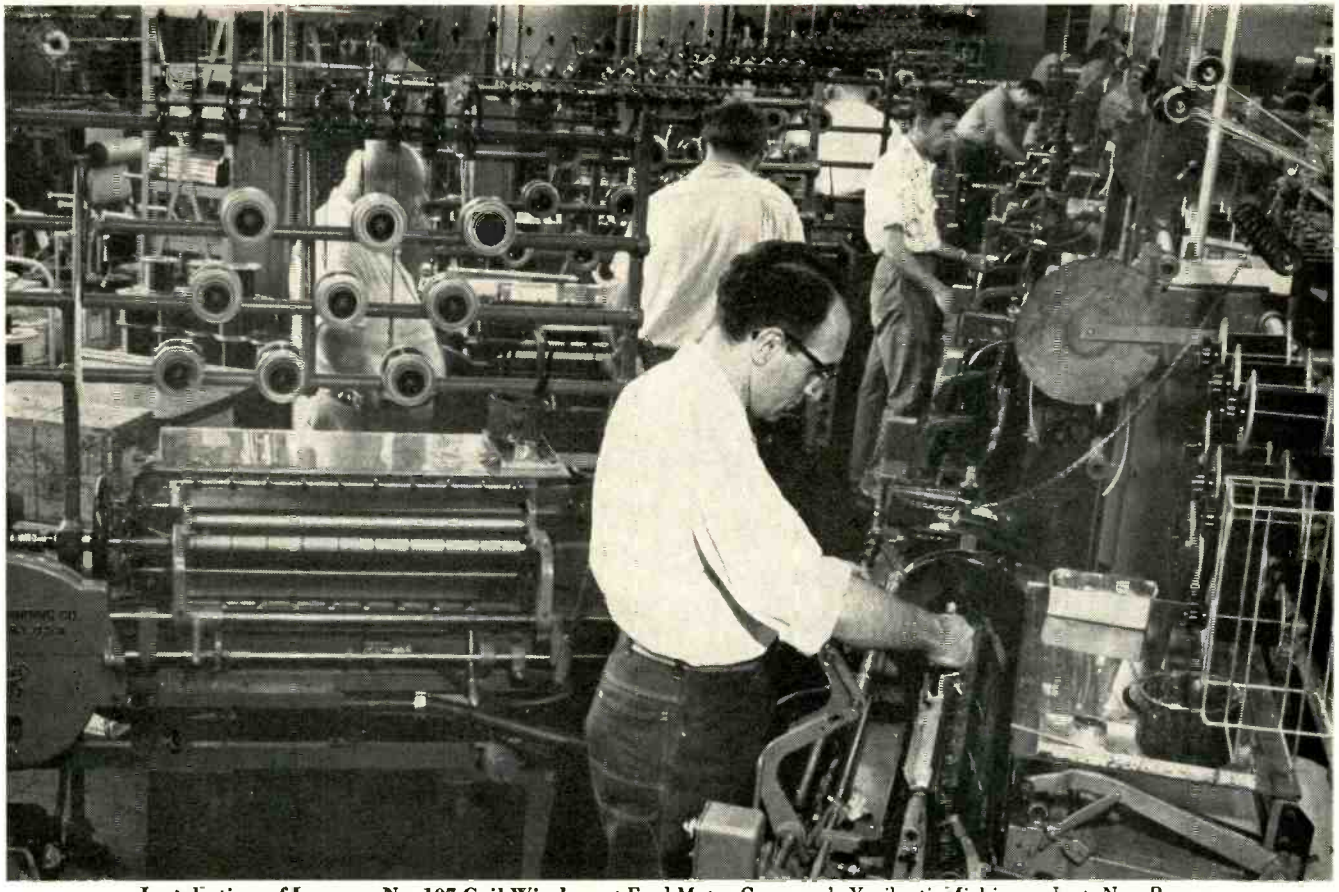
The voltage E_{cc} is most accurately measured by using a precision voltage divider, galvanometer and precision potentiometer as shown in Fig. 3. The precision voltage divider is used to obtain a voltage small enough to measure using the precision potentiometer. The potential is measured by varying the potentiometer setting until no current flows through the galvanometer.

When this occurs E_p is equal to E_{cc}'. If a potentiometer such as the Leeds and Northrup Type K is used, E_p can be read directly from the potentiometer dials. The potentiometer also can be conveniently calibrated with a standard cell so the voltage measurements will be accurate to better than 0.1 percent. Once E_{cc}' is known, E_{cc} can be calculated by dividing E_{cc}' by the ratio of the volt box. The amplitude of the input sawtooth at the point of measurement can then be calculated using Eq. 2 or Eq. 3.

Accuracy

The above discussion assumes that E_{cc} is a pure d-c voltage and that no sawtooth appears at its output. This will be true only if the output impedance of the bias voltage source is negligible compared with R_2. A feedback amplifier was used in this case to obtain a variable voltage source with an extremely low output impedance. A multiturn potentiometer was used to control the output of this source to make fine adjustment of E_{cc} possible.

The overall accuracy of this method would be seriously affected by any drift in any of the potentials of the circuit. Therefore, the circuit should always be allowed to warm up long enough to become stabilized, before any measurements are made. Several other precautions are also necessary if drift is to be minimized. The +300, +150 and −300 supply voltages should be obtained from well-regulated and essentially drift-free sources. The heater voltages of all of the tubes should be extremely stable. This can be accomplished either by using a constant voltage transformer or by feeding



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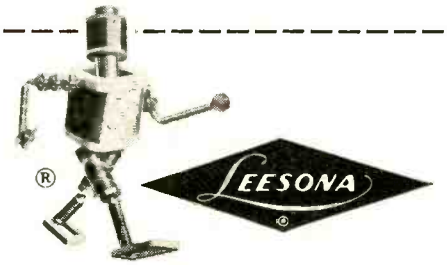
B.5.2



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the heaters from a regulated d-c source. All resistors should be types that are known to be very stable. It is also recommended that no resistor ever be required to dissipate more than approximately one-fourth rated power.

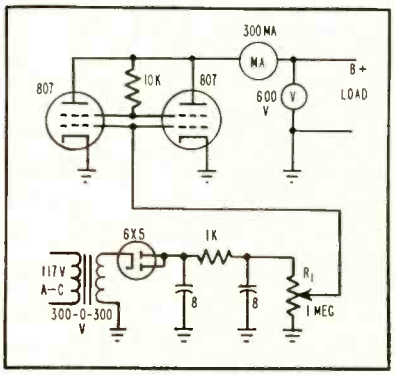
The system described in this paper has been used to determine the departure from linearity of sawtooth waveforms of amplitudes from 2 to 50 volts and durations up to 2,500 microseconds. From the measurements that were made it was found that the amplitude of the sweep at a particular point could be determined with an accuracy of better than 0.2 percent and that the timing could be measured to better than 3 microseconds. The accuracy can be increased by further refinements in the actual measurement procedures.

The work described here was carried out as part of Air Force Contract AF 30 (602)-300 with the Rome Air Development Center.

Electronic Load

By Donald Froemke
and V. Ronald Nelson
Department of Physics
Augustana College
Sioux Falls, S. D.

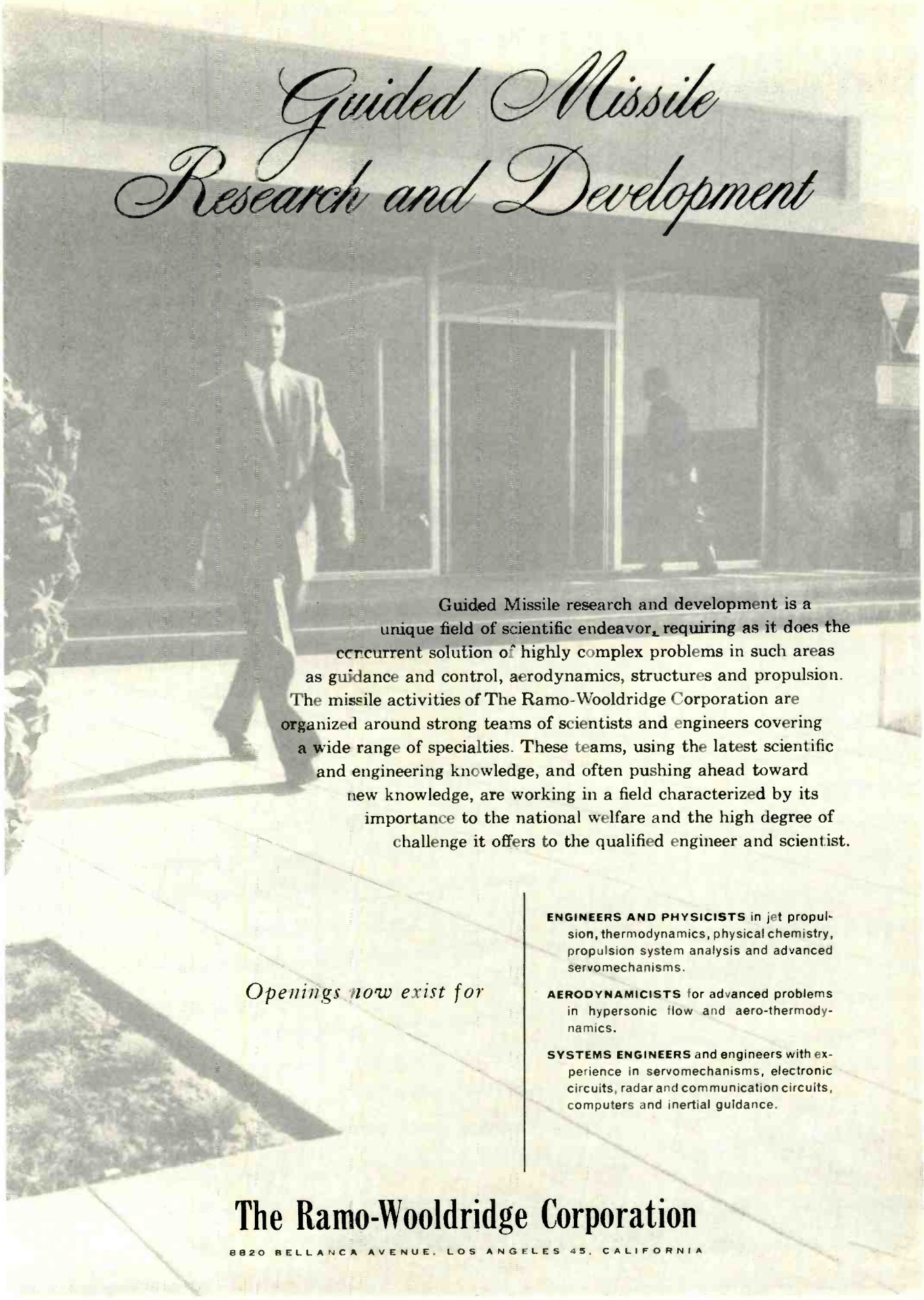
Testing performance and regulation of electronic power supplies, generators and dynamotors is generally performed with a resistive



Variable load useful in testing dynamotors or power supplies

load. Such a load is likely to be bulky and does not usually lend itself to fine adjustment of load current.

The device described below provides a variable load without these



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disadvantages listed above.

Two 807 beam power amplifier tubes are paralleled across the voltage source under test. A conventional bias power supply furnishes their grid voltage, which may be controlled by potentiometer R_1. Thus the drain on the test power supply may be varied from zero at cutoff to the maximum rated plate current. For 807 tubes, maximum plate current is about 200 ma each or a total of 400 ma.

The voltmeter indicates the test supply voltage, making it convenient to collect data for a voltage-current curve on the power supply. Successive readings may be taken close together by fine adjustment of the grid voltage of the 807 tubes.

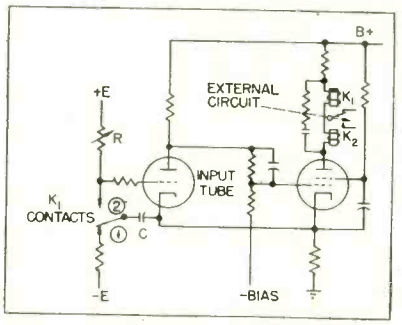
Maximum recommended plate voltage on these tubes is about 600 volts. In applications involving voltages above 600 volts and currents above 400 ma, tubes with higher ratings should be substituted. Paralleling more tubes will increase the current capacity.

Precision Time-Delay

By Warren C. Struven

Radiation Laboratory
Dept. of Physics
University of California
Berkeley, California

A PRECISION TIME-DELAY circuit has been developed for use with the bevatron magnet-timing equipment. The operating conditions required a circuit with a stability of at least 1 part in 1,000 over a delay range of 150 milliseconds to 2.5 seconds. This circuit has a lower limit of 3 milliseconds and an up-



Time-delay unit has additional relay K_2 to provide control of external circuit

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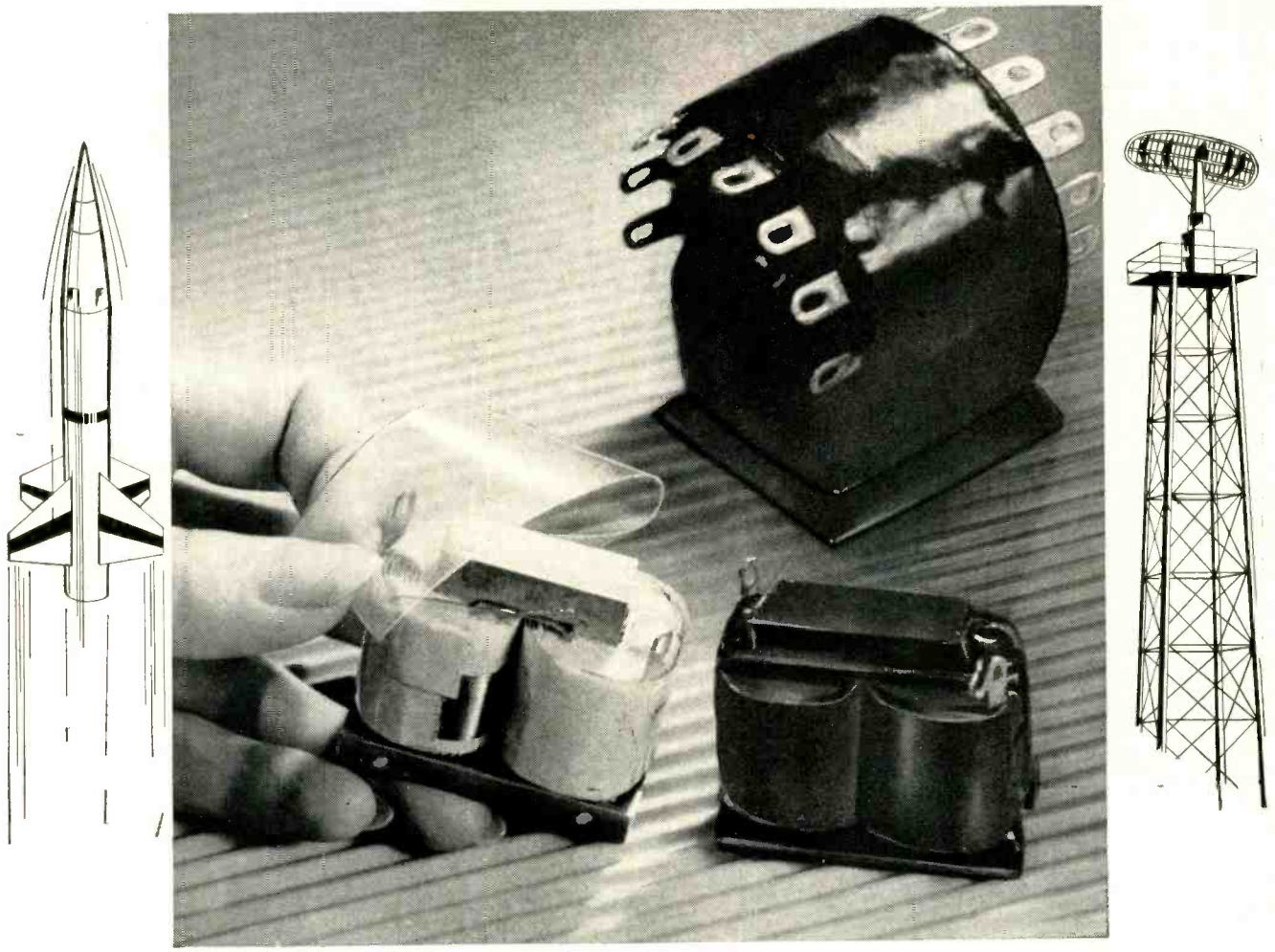

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per limit restricted only by the maximum value of timing capacitor used. Relay contacts are provided for external use if desired.

The circuit shown in the diagram is a modified form of Schmitt trigger where the hysteresis usually associated with the Schmitt circuit is determined mainly by the operation time of the relay. The hysteresis of the usual Schmitt trigger is determined mainly by the value of cathode resistance. The cathode resistance is determined by input-tube gain, the transconductances, plate resistances and the plate load resistances.[1]

Operation

In the rest state, capacitor C is charged to $-E$ (relay position 1). When a positive gate is applied to the pentode grid, the pentode is caused to conduct, energizing the relay and moving the contact arm to relay position 2. The triode is immediately cut off and remains cut off until the grid voltage just passes the cutoff voltage, at which time positive feedback cuts off the pentode and restores the circuit to its rest position. The capacitor charges toward $+E$. In the operation, the end of the timing cycle occurs when the capacitor voltage is just slightly more positive than the cathode.

Both $+E$ and $-E$ are of equal value. Therefore, if $+E$ and $-E$ vary, timing accuracy is not materially affected.[2] This voltage is most easily obtained by grounding the center tap of a regulated supply. The bevatron magnet pulse-timing equipment uses two such circuits. One has a variable range of 0.15 sec to 2.5 sec (time of rectification cycle) and a 2.5-sec lockout circuit to insure that a particular repetition rate is not exceeded. Both circuits have operated for 1½ years with a long-term stability of better than 1 part in 1,000. Jitter from cycle to cycle is less than 1 part in 2,000.

This work was performed under the auspices of the U. S. Atomic Energy Commission.

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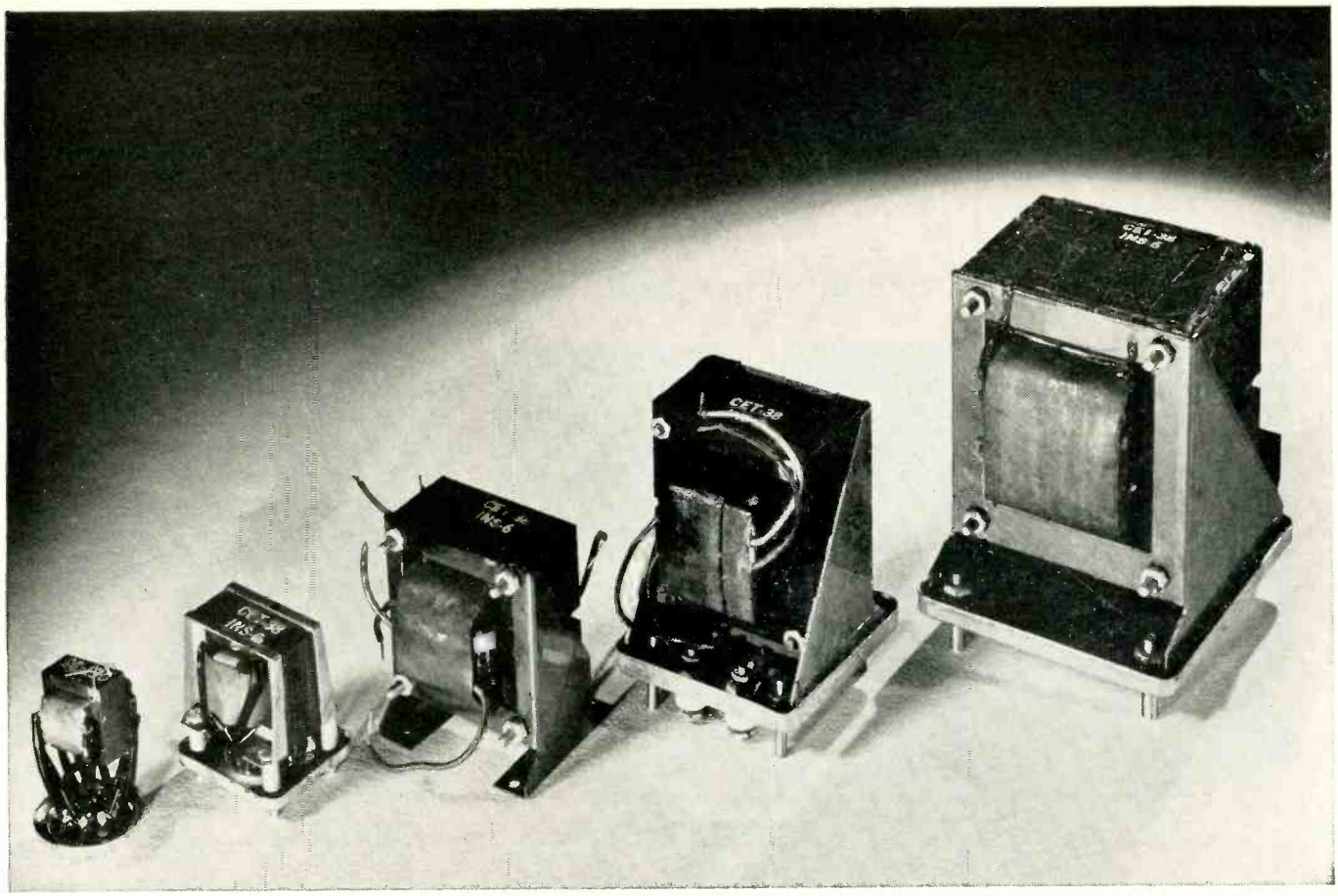
(1) O. Schmitt, A Thermionic Trigger, *Jour Sci Inst*, 15, p 24, Jan. 1938.
(2) S. Wald, Precision Interval Timer, ELECTRONICS, p 88, Dec. 1948.



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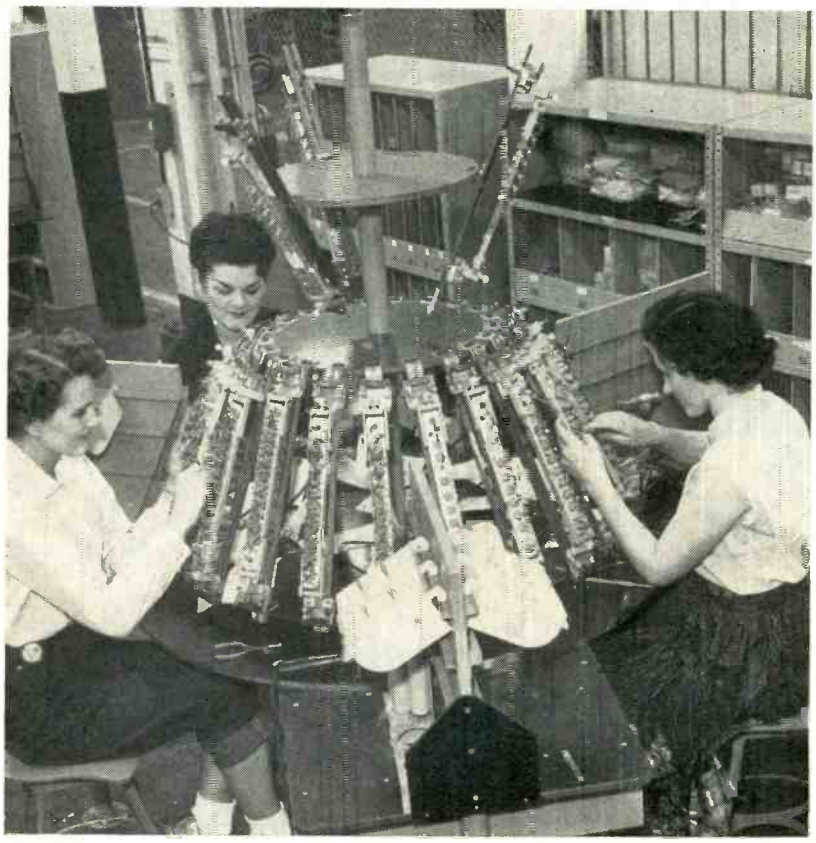
Edited by JOHN MARKUS

Three-Operator Assembly-Turntable Boosts Production Rates



Fixture holding 21 chassis strips rotates freely on pipe going through center of table, to give equivalent of pass-along assembly line in minimum floor space. Table is rotated manually when operators complete assigned work

A ROTATING holding fixture for assembling resistor boards and other flat electronic units used in aircraft electronic equipment has been developed by Martin. The resistor boards are held in a convenient position in front of the operator. As she completes a specified series of operations, the wheel is turned so the next operator can add another series. Sample boards, showing exactly the operations each operator is to complete, are mounted directly above the work. The samples eliminate time lost in checking work diagrams or shop sketches. Each operator is flanked by a table with bins which keep a supply of all the wire, resistors, or other parts required. A shelf for tools is immediately in front of her.

These new fixtures have contributed much to the ease and convenience of doing a difficult, exacting job and have shown positive results in higher production rates and greater accuracy of work.

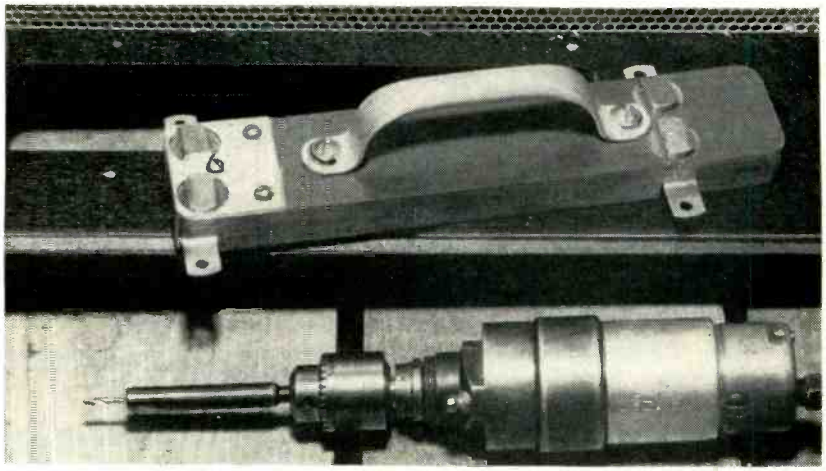
With three work positions, the assembly can be done in three steps or in multiples of three steps.

Magnetic Holding Tool Makes Parts Serve as Drilling Gage

A SIMPLE magnetic gage expedites the drilling of holes and mounting of two strap metal brackets across a slotted opening in the front of a color-tv receiver cabinet in RCA's Bloomington, Ind. plant. These brackets are required to hold the box that encloses the controls later mounted on the front of the cabinet.

The gage consists of a piece of ¾-inch laminated plastic material having four drilled holes in which are set round permanent magnets. A metal handle is attached for convenience in handling the gage.

The operator places the two mounting brackets in position against the pairs of permanent



Magnetic gage used for holding two metal straps in correct positions for mounting across slot in front of cabinet, during drilling and driving of mounting screws

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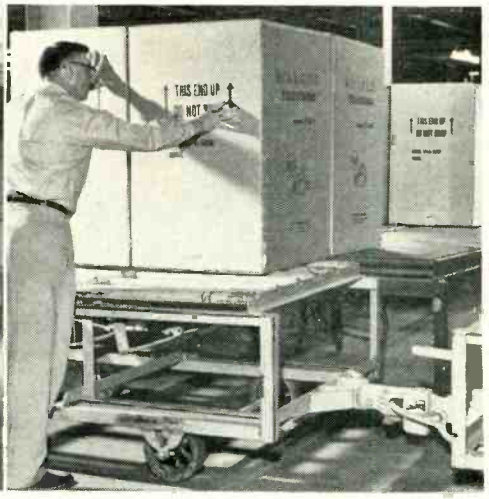
magnets, then lowers the gage into the slot. With a drill chuck in an air gun and an appropriate size drill set into a depth stop, he reaches down into the cabinet to drill the four holes. With another air gun he then drives in the four mounting screws to anchor the brackets, then lifts out the gage.

Midget Train Delivers Cabinets to TV Assembly Line

Pulling train-load of cabinets for 21-inch television receivers up to the ends of roller conveyor lines. Cars have double-layer loads of eight cabinets each



Pushing single-layer load of four cabinets off car onto two parallel roller conveyors

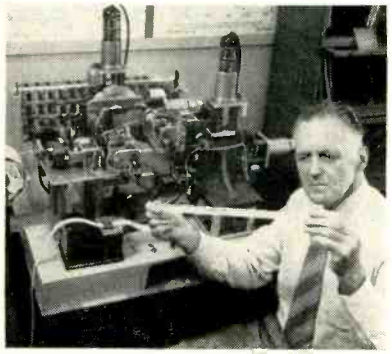
HIGH-SPEED assembly lines in RCA's Bloomington, Ind. plant are kept supplied with empty cabinets by a Mercury industrial truck hauling special roller-top cars that unload directly on the roller conveyors of the cabinet assembly lines. The cars are each large enough to hold four cabinets directly on the rollers. Four more can be placed on top of these while still clearing the overhead piping in the plant. A train of six cars can thus bring 48 cabinets at a time.

To unload, the truck driver stops the train with the first car directly opposite the ends of a pair of conveyors. An assistant then releases the roller-locking lever on the car and pushes the entire load all at once onto the conveyor lines. The train is then advanced until the next car is in line and the process is repeated.

Braking of rollers on cars is achieved with two rubber-covered metal bars supported by levers that bring it up under the rollers on the car when the braking handle is pushed down.

The front wheels on the cars are pivoted, so they follow the tracks of the truck precisely even around sharp corners. The rolling equipment is made by Mercury Mfg. Co., 4044 South Halsted St., Chicago.

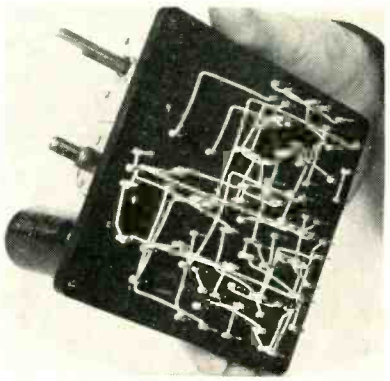
Card-Controlled Machine Makes Wrapped Joints Automatically



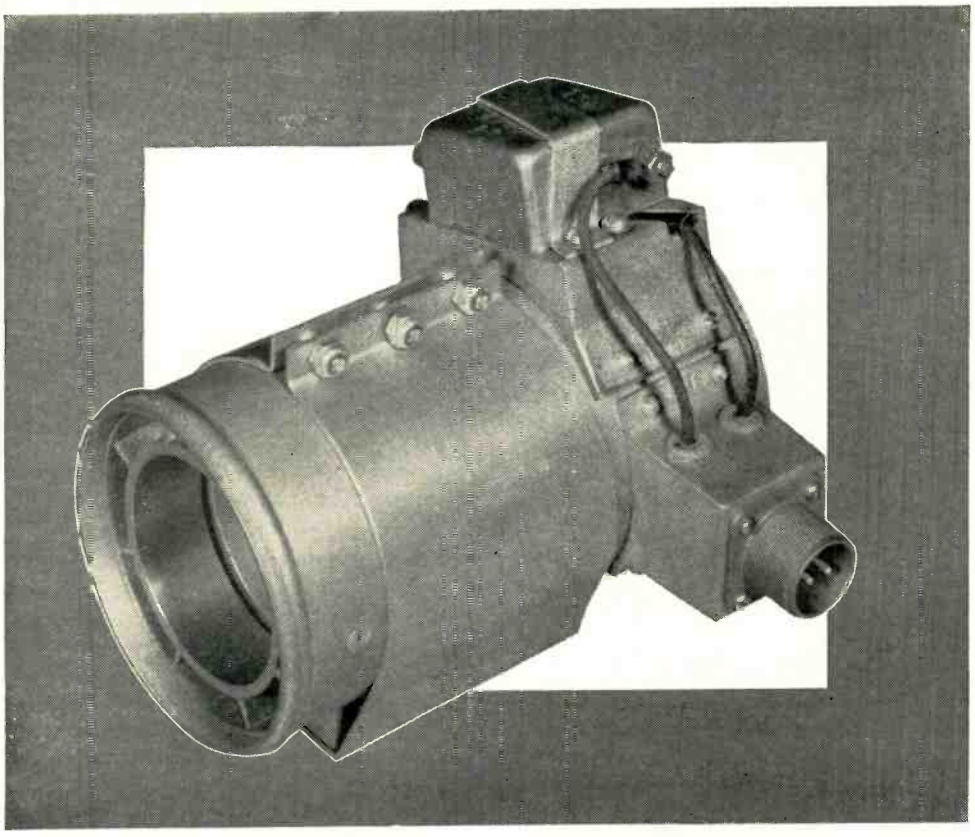
Examining punched tape used to control automatic wiring machine in background. Motor-driven wire-wrapping tool makes wrapped joints on terminals

A MACHINE that can automatically wire complex electrical apparatus by using solderless wrapped connections has been developed by R. F. Mallina of Bell Telephone Laboratories. Instructions are fed to the machine from a punched tape. Relays translate this information into electrical signals that control the cams and gears of the machine.

▶**How It Works**—The experimental machine uses two rotating spindles. The wire is fed directly from a large spool. One spindle



Bottom view of plastic panel for five-tube radio, showing solderless wiring put on by machine



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An extensive series of tests were recently initiated in an attempt to determine an effective cooling process. The tubes and sockets were mounted in pairs in a special cabinet designed to equalize the air distribution for each tube. The problem was to discover a method of heat dissipation that would hold the temperature of the glass-to-metal seals below the design operating level.

Of all the blowers tested, only this Joy AXIVANE fan was able to meet the rigid specifications. The tubes were cooled with 25°C air at an elevation of 50,000 feet, easily surpassing all requirements.

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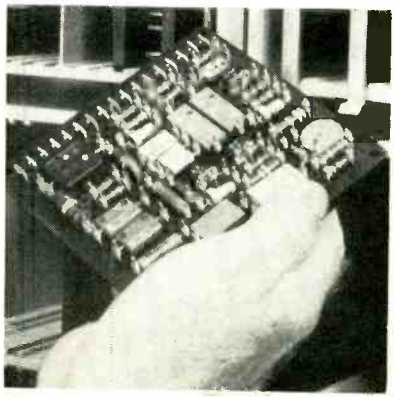


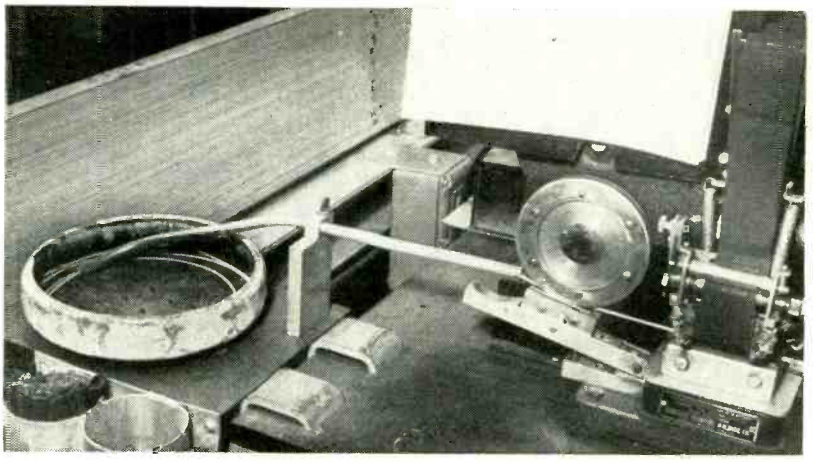
Top view of plastic panel, showing how leads of components are first anchored to solderless terminal pins

pulls the wire, in an inverted L-shaped movement, to a connecting terminal. At the same time the wire is cut to the correct length at the second spindle. The spindles remove a bit of insulation from each end of the wire as they whip the bare wire ends around the terminals. This produces a pressure of about 15,000 pounds per square inch at each contacting area.

Following their punched tape instructions, the spindles then pick up the supply wire from the spool and move to the next electrical connection where the process is repeated. Machine wiring eliminates the need for preparing, storing and handling the many short pieces of wire.

The machine can be used in conjunction with plastic panels, all alike, on which are mounted different groups of electrical parts such as tubes, transistors, resistors and capacitors. The terminals of the parts protrude through holes in the panels spaced at regular (modular) intervals.

Wire-Coiling Dish for Cable Leads



Wire coming from Kingsley printer is automatically coiled inside freely-rotating dish at left

INSULATED wire is automatically coiled as it speeds from an electronic wire measuring and stamping machine, by running the wire into a plastic laminate dish that is mounted on a bearing which permits it to rotate freely. This eliminates a time-consuming operation from the plug-assembly line. Copper tubing guides the wire into the dish at the right angle to give smooth rotation without kinking the wire. The inside of the dish has straight sides so the wire can easily be lifted out after coiling. Wire-reinforced paper strips are then used for tying the coil, in the plant of The Glenn L. Martin Co.

Tote Rack for I-F Strips Loads Easily

TO MINIMIZE the need for reaching beyond a comfortable working position while transferring finished television i-f strips from a slide-along line to a caster-mounted tote rack, only half the rack is loaded from one side. The operator then spins the entire rack around for loading

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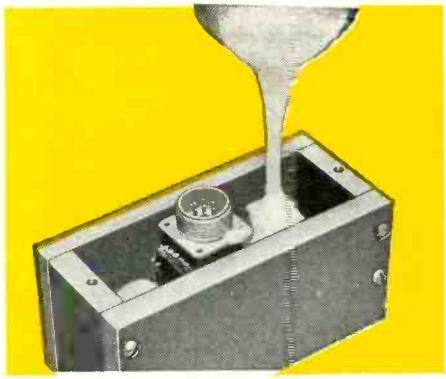
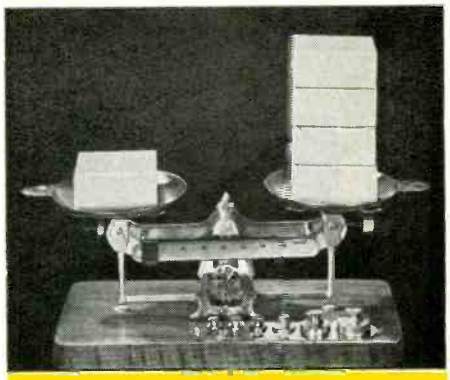
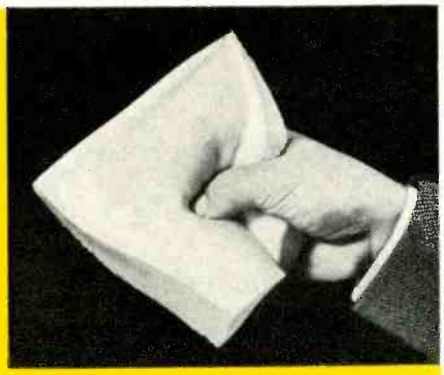




Choose your density



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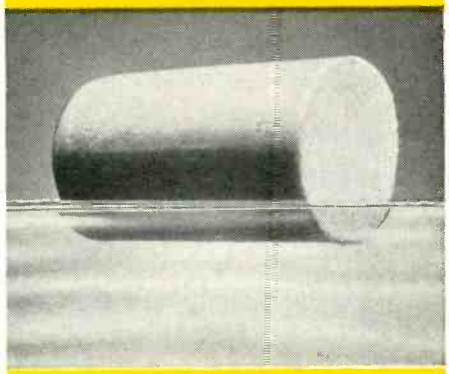

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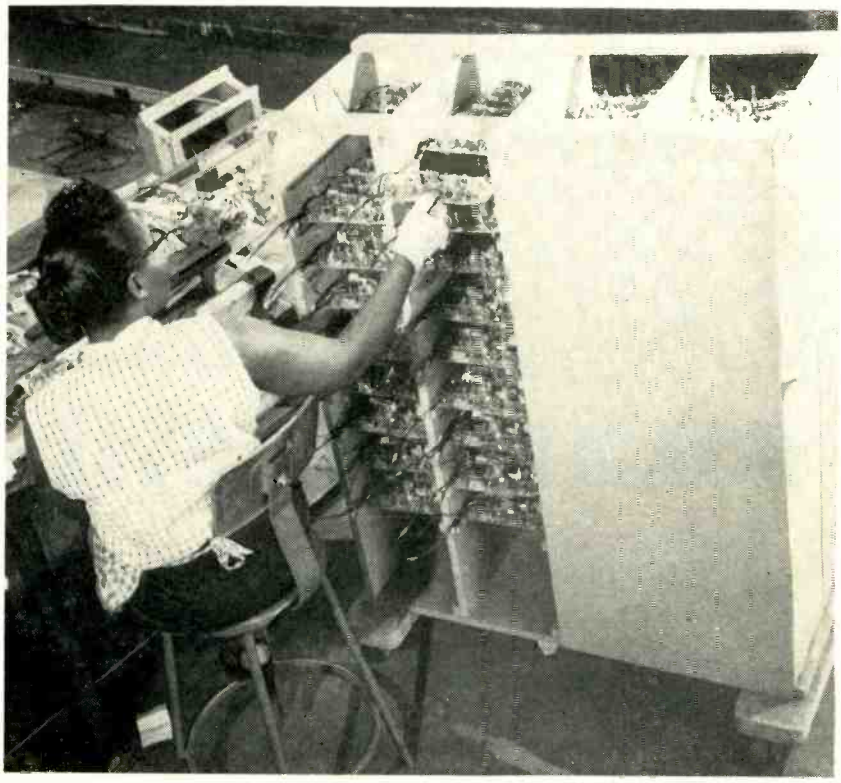


Method of loading tote rack with i-f strips for transport to main assembly line

the remaining half of the units.

The i-f strips are supported by wood cleats nailed to the vertical partitions, with each pair of cleats holding four strips. The two bottom pairs of cleats are omitted, again to minimize operator strain and reduce fatigue.

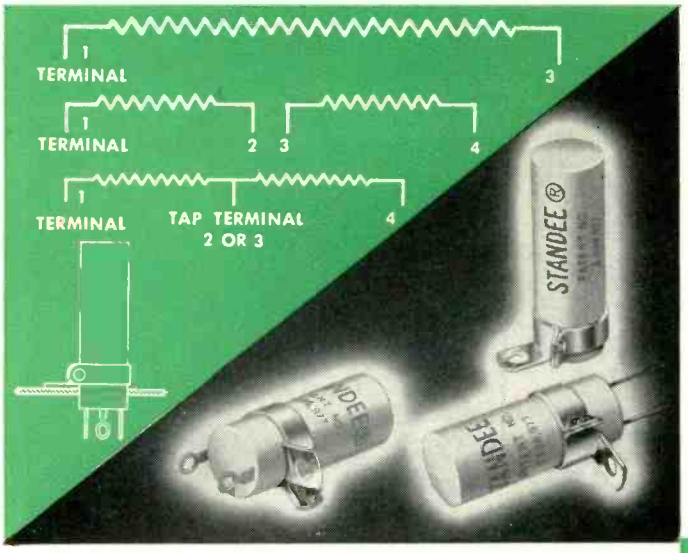
Applying Varnish to Coil with Pressurized Hypo

AFTER assembly of ten-turn precision potentiometer windings on helical forms, a fillet of varnish is applied to one side of the element with high accuracy by means of a special setup in the Hicksville, N. Y. plant of Fairchild Controls Corp.

While observing the operation with the aid of a 20-power binocular microscope, the operator positions the varnish-applying hypodermic syringe at the start of the first turn, then rotates the potentiometer-holding arbor on a lead screw having the same pitch as the helix. An air line having a pressure of 5 lb per sq in. is attached to the end of the syringe, with the exact pressure being controlled by a foot-pedal throttle. The operator varies the pressure as required to get the varnish down between the coil and the form without having any varnish reach the top part over which the contact wiper rides. The fillet varnish is mixed with a blue dye for added visibility during this

Anchoring turns of precision pot in core with varnish applied by hypo under air pressure

Take that HEAT out of the CHASSIS, by either of these methods...



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Clarostat Series KS above-chassis-mounted power resistors. Handy terminals (lug, standard; or pigtail, at extra cost) for easy wiring. These unique components solve the problem of safe heat dissipation, yet terminals are below chassis, to fulfill UL requirements. Wire winding on glass fiber core, permanently sealed in smooth ceramic casing. Available in single, dual and tapped-section types as shown in wiring diagrams. Adjustable mounting ring provides for any protrusion above or below chassis. In 1½, 2, 2½ and 3″ h. sizes. 10, 15, 20 and 25 watt ratings, respectively. Wide range of resistance values.

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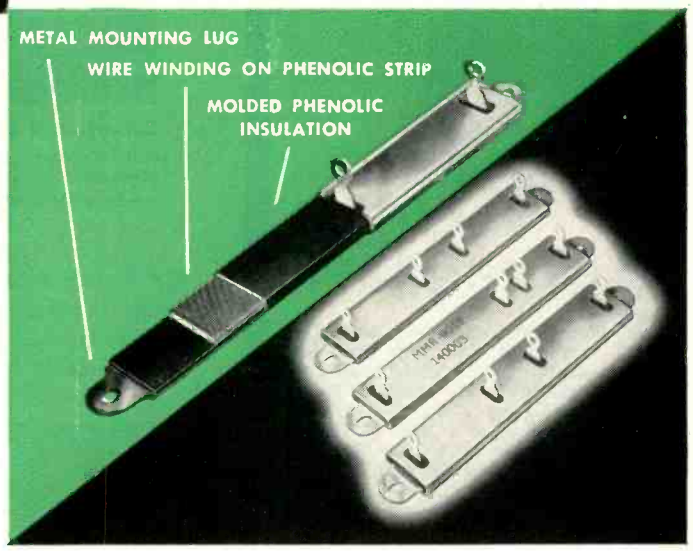
Clarostat Series MMR metal-clad resistors. Resistance winding sealed in molded phenolic and further protected by metal casing, for electrical and mechanical ruggedness. Adequate, but not excessive, phenolic insulation seals against moisture without hampering heat transfer to outer metal casing. No hot-spot troubles. Mounted flush against metal surface for maximum heat dissipation, unit is rated at 5 watts per winding inch, as against 2½ watts in free air. Sizes from 2″ to 6″ mounting centers. 1 to 10 sections. Breakdown strength over 1000 V.A.C.



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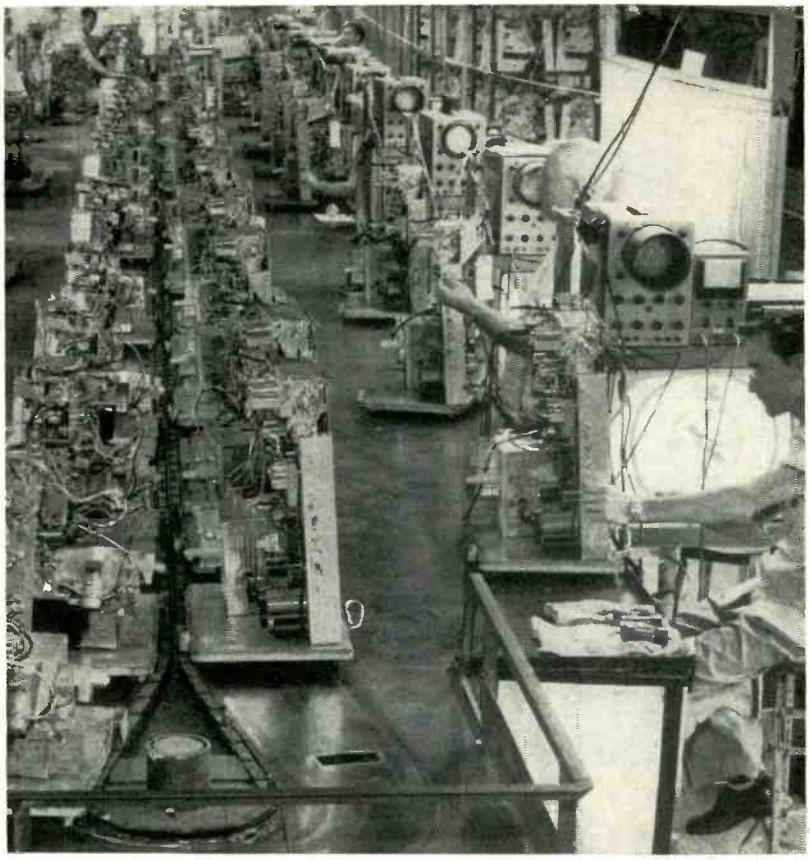
critical procedure.

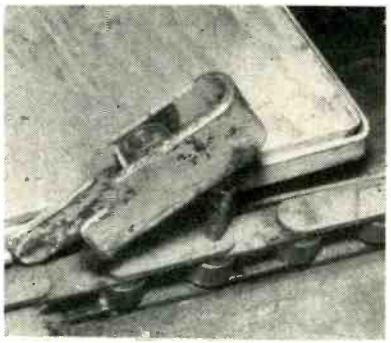
The potentiometer arbor has a notch in which the attached leads fit, to keep them out of the way and thereby prevent breakage of leads as the core is rotated.

Quick-Release Clamps Pull Chassis Dollies



Conveyorized color-tv test line. Dollies travel clockwise around bend in foreground. Brushes under one dolly sweep the table continuously and push scraps down through rectangular hole in table at right foreground. On this line, tests are made with black-and-white Indian-head test pattern

AN ENDLESS horizontal chain conveyor running down the middle of a wide metal-top table keeps RCA 26-tube color tv receivers circulating on dollies past test positions on both sides of the table, in the firm's Bloomington, Ind. plant.

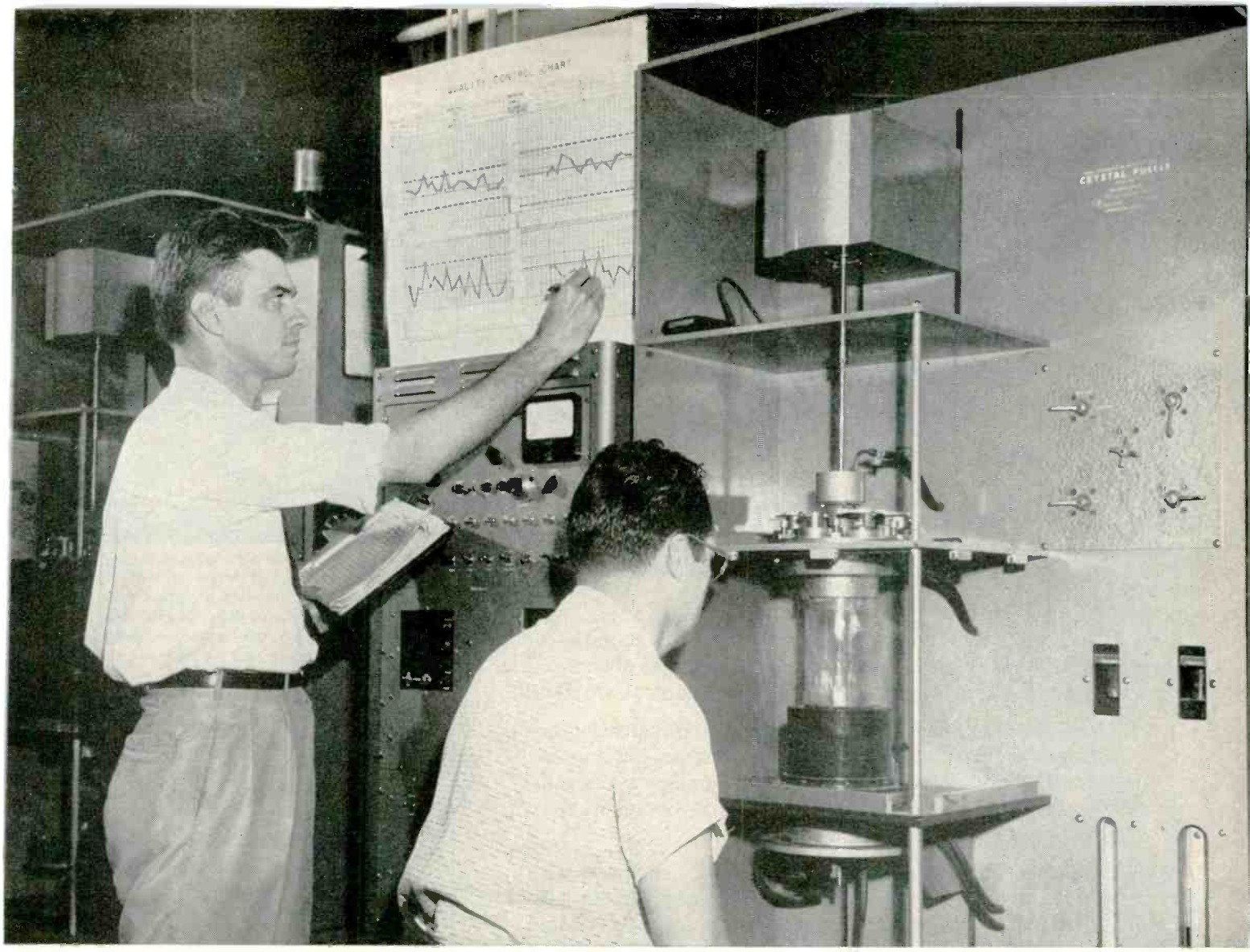


U-shaped clamp on dolly is here in raised position for pulling dolly off stud of chain conveyor. Metal band inside clamp prevents dolly from coasting past stud under its own momentum when conveyor is stopped

When work on a chassis is finished at one of the test positions, the operator pushes its dolly up into an empty space on the conveyor. A U-shaped metal clamp on the dolly automatically engages with the next pin on the conveyor chain.

A loosely mounted metal ring and transverse pin on the clamp act together to prevent the dolly from rolling past the pin under its own momentum when the conveyor is stopped for any reason. Any operator can stop the conveyor simply by standing up to tug the plastic clothesline strung over the test positions on both sides and anchored to the conveyor stop switch.

To take a dolly off the line, the



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Method of mounting table-sweeping brooms under one of dollies on color-tv test line. Wood handles of broom project up above top of dolly through cut-out slots, hence the sweeping dolly does not normally carry a chassis

operator presses down the handle projecting from the front of the dolly. This raises the U-shaped clamp from the conveyor stud so that the dolly can be pulled into the test position. The color chassis is heavy enough to rest directly on the ball-bearing dolly, without need for hold-down clamps.

Plastic clothespins are used to indicate the test status of each chassis. A clothespin at the upper left side of the chassis signifies that it is ready for test, having been just

Test position on color-tv alignment line, showing special test plug used for feeding picture carrier and r-f sweep signals into elevator coil at input of tuner, for aligning tuner to i-f strip

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Typical of the types of projects Hoffman Field Engineers are working on, one group is presently engaged in conducting field evaluation studies at remote air bases on TACAN, the most advanced airborne navigation equipment yet produced. This field study is being coordinated with Hoffman's production of TACAN equipment.

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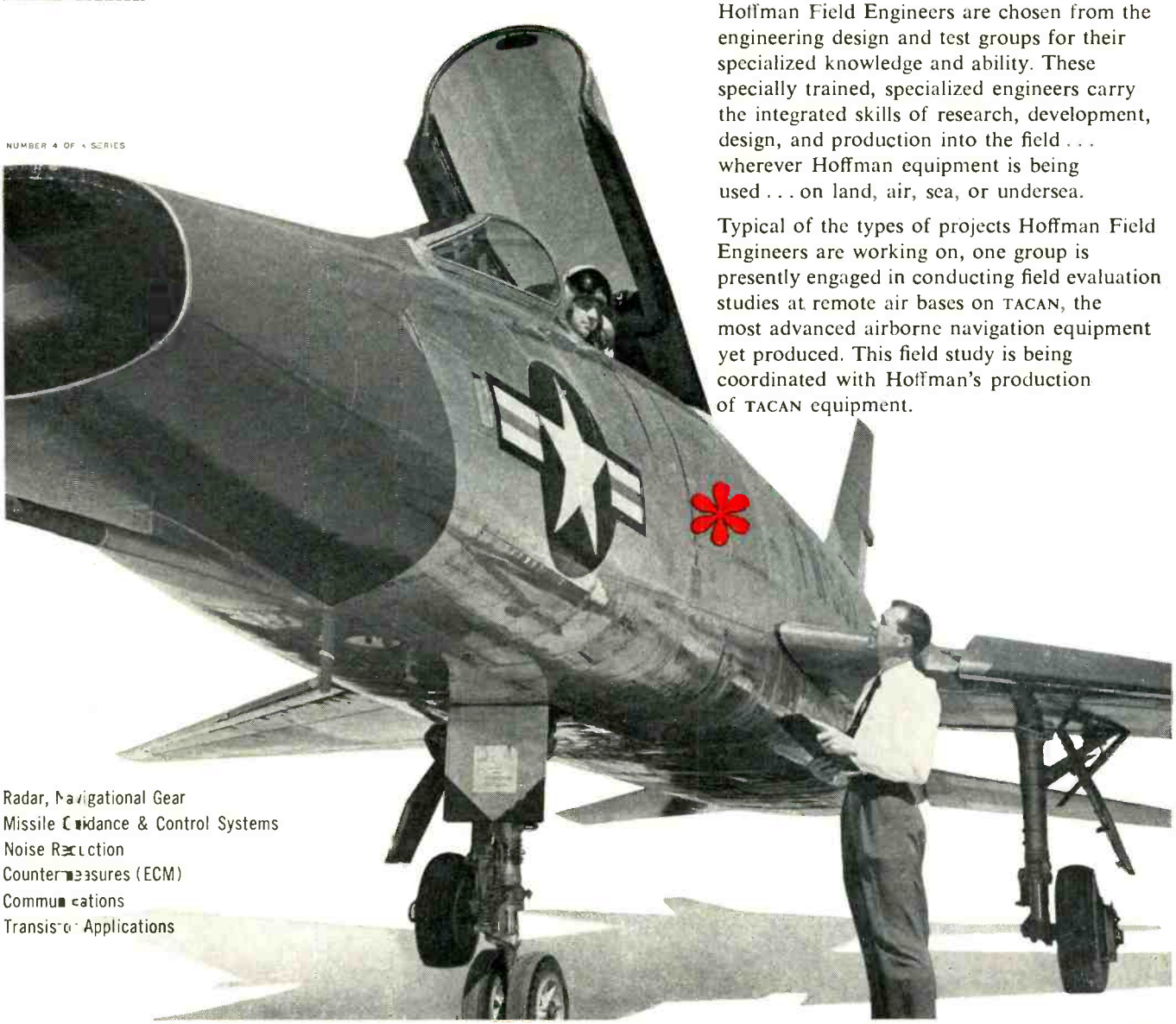

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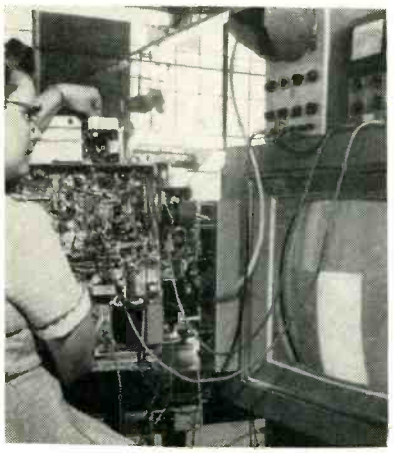


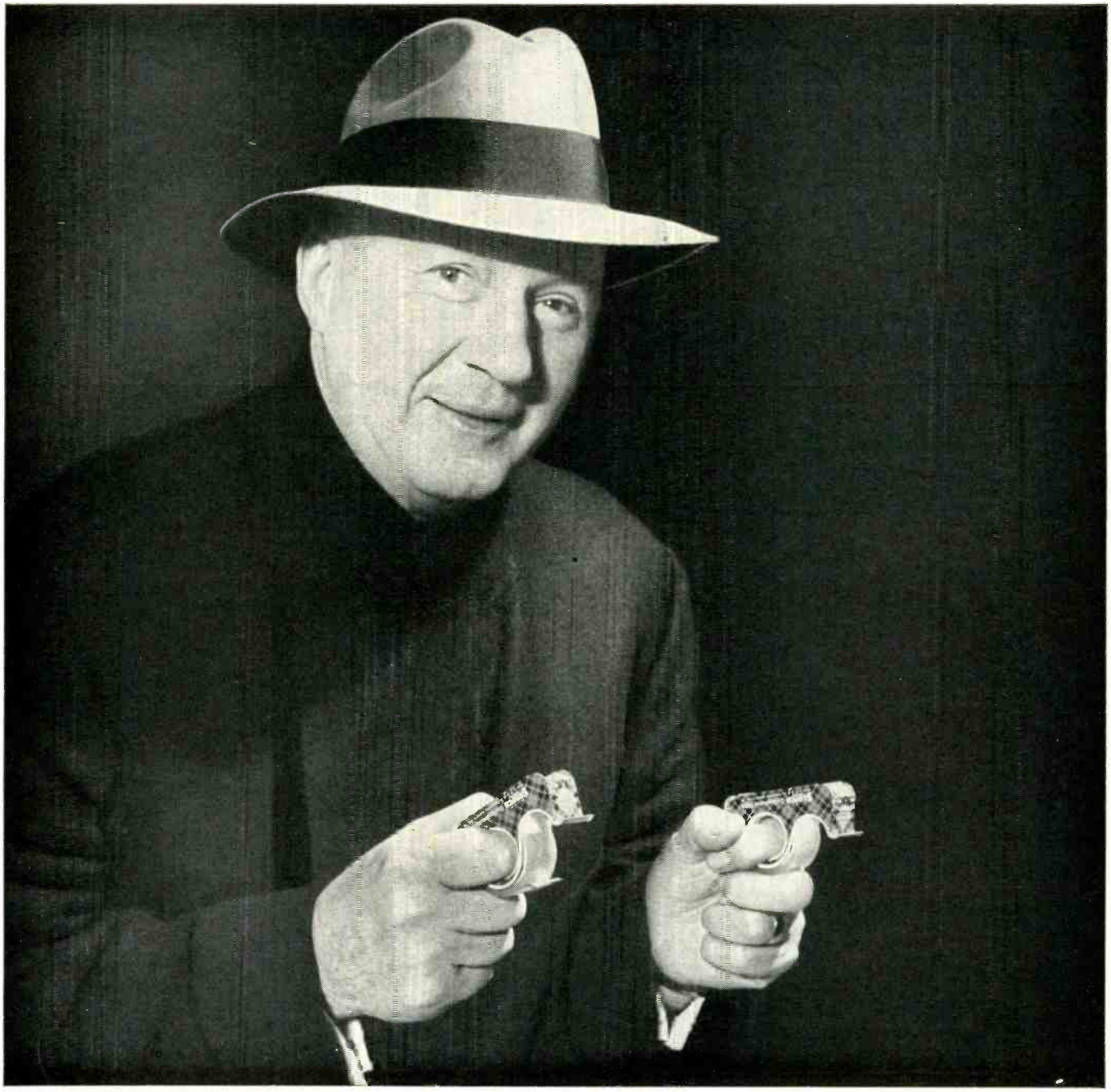
Video test position, utilizing color-bar-generator pattern on 21-inch round color tube in test cabinet at right. Operator here makes seven connections to chassis on dolly: 1—plug kinescope cap of set into top socket of vertical box at left of picture tube; 2—plug convergence leads of set into next lower socket; 3—plug in yoke leads; 4—attach lead of regulator current meter (above picture tube) to under-chassis terminal and attach other meter lead to chassis, then attach another lead to run B plus back to set from yoke so as to jump around fuse; 5—plug in line cord; 6—feed color-bar signal into elevator coil of tuner through plug; 7—connect heavy braided metal ground strap to chassis

put on the conveyor or having gone through a troubleshooting and repair position on the line. A clothespin at the lower left on the chassis means it has tested OK and is ready to be placed on an overhead conveyor for transfer to the i-f test and alignment line. A clothespin at the upper right signifies the need for troubleshooting.

This recirculating conveyor system has proved particularly successful during the early stages of bringing a new color television line up to speed. The sets can be run around the conveyor line and in and out of test and repair positions as often as necessary without interfering with the flow of production, as long as the average output of the test lines approximately matches that of the assembly lines.

Life Test Setup

PRECISION potentiometers are run through millions of operating cycles on a unique universal test stand in the Hicksville plant of Fairchild Controls Corporation. A special



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heavy metal grille serves as the base, on which are mounted the support brackets for the potentiometers and the supports for the drive shafts. The shafts are linked together by gears which in turn are driven through a reduction drive by a small electric motor.

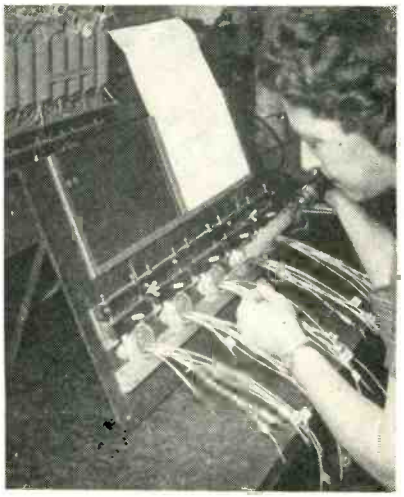
Switches give the option of continuous rotation or back-and-forth oscillation. A strip of sheet metal is fastened over the gear chain to prevent objects from falling in and jamming, since the unit runs unattended for many days.

Linotype Slugs Identify Wires

MARTIN has added a Linotype machine to its aircraft manufacturing equipment. In today's aircraft, electrical and electronic systems use thousands of wires of many different types, each of which must be coded by a printed number every few inches of its length. Linotype identifies these wires with sharp, clear characters. New slugs are cast for printing each specific lot of wires. This replaces movable type, which required hand setting and constant replacement due to wear.

Terminal Plug Holder

PLUGS for the connecting cables of the Matador guided missile are wired five at a time with the aid of a holding fixture in the Baltimore plant of The Glenn L. Martin

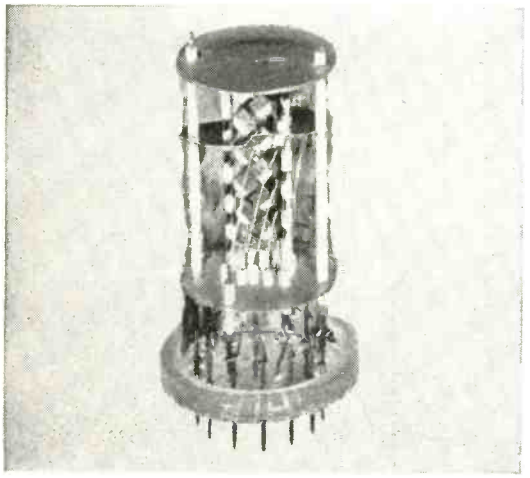


Assembling plugs with aid of universal holding fixture

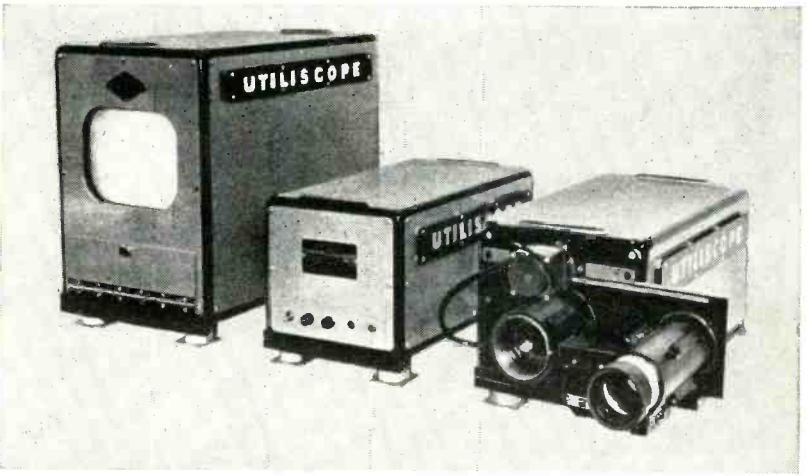
1. The SEEING EYE of industry. This simple Image Dissector tube is used in the Utiliscope, a closed circuit industrial TV, made by Diamond Power Specialty Corp., Lancaster, Ohio. It eliminates filament and electron gun. For dependability and assurance of long life, most of the internal components are Inconel, a high nickel-chromium alloy.

Why "Diamond" *uses* Inconel *parts in*

Simplified Industrial TV Pick-Up Tube



2. This electron multiplier increases the signal of the Image Dissector tube two to six million times through a series of eleven silver-magnesium cups on Inconel holders. Diamond designers found that Inconel is the only satisfactory metal for all but a few of the electron multiplier's 150 parts.



3. When an engineer says, "Let's look into it," he may mean this "Utiliscope" industrial TV. It takes a steady look at places the eye can't reach . . . places too hot or highly radio-active for people to watch. Light falling on the face of the Image Dissector tube liberates electrons from the special surface of the photocathode. Some of these tubes are still being used after more than four years of service.

Here's why most of the internal parts of Diamond's dependable, long life Image Dissector tube are made of Inconel:

Inconel is non-magnetic, even after being cold-worked. It is easy drawing. Spot welds excellently. Can be easily cleaned and kept clean to avoid gas formation. It remains strong and stiff when heated for degasification. *And, when all costs are considered, it's less expensive.*

Inco Nickel Alloys for Electronic Uses is the title of a booklet that may suggest where the useful properties of Inconel or one of the other Inco Nickel Alloys can solve a design or fabrication problem for you. Write for it, today.

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Details of holding fixture. Wing nut can be loosened to slide under strip up or down to accommodate different sizes

Co. Adjustable legs hold the fixture at the optimum angle for assembly. Aluminum channels and transparent sheet plastic windows form pockets on the upper half of the fixture for supporting standard 8½ × 11-inch assembly prints.

Controlling Sludge in Etched Wiring Bath

By L. J. MARTIN and M. J. VAVRA
Weapon Systems Development Laboratories
Hughes Aircraft Co.
Culver City, Calif.

ELECTROLYTIC conduction is the chief source of leakage in etched circuits. Electrolytic leakage results from the combined presence of moisture and ionizable contaminants.

Scattered evidence suggested that ferric-chloride contamination varied during the life of an etching bath. Consequently, modified ASTM patterns of Fig. 1 were etched in batches of four on boards cut from a single sheet at intervals until the etchant was considered to be exhausted. Samples of the etchant were taken as each batch was etched. All etched boards were cleaned as uniformly as possible by hand-scrubbing with hot water and detergent. When dry, the average surface and volume resistivities of each batch were high and reason-

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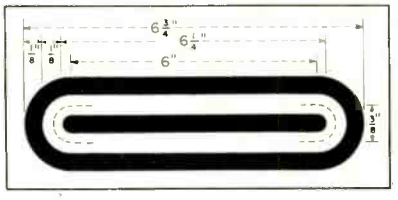

FIG. 1—Modified ASTM guard ring pattern used in troubleshooting the production of etched wiring boards

ably uniform, as shown in Fig. 2.

Tremendous resistivity variations showed up following humidity exposure. These variations followed a systematic trend from batch to batch, as indicated by the dashed lines in Fig. 2. The fact that resistivities deteriorated, then improved and deteriorated again was puzzling until these results were correlated with the history of this etching bath. Batch 10, the first to show this improvement, followed a rest period while batch 12 was etched at the start of work the following day. These improvements following rest suggested sludge as the important contaminant, since sludge settled when the bath was not used.

Examination of the etchant samples corresponding to each batch of boards showed a yellowish-brown precipitate, the amount of which varied inversely with the wet resistivities of each batch. Analysis of the sediment showed it to be primarily a complex mixture of filterable copper and iron oxides. The particles seemed to be porous and to be saturated with copper and iron salts in all stages of oxidation.

►Sludge-Preventing Procedure—Further correlation of sludge formation and etchant exhaustion with specific gravity and hydrogen-ion tests caused the following picture to take shape. Initially, there is no sludge and hence no sludge contamination. With continued use of a bath, sludge is formed and contamination of the board increases. A fresh bath with 23 deg Baume has a pH of about 0.5 which increases as the bath is used. When a pH of approximately 0.85 to 0.90 is reached, sludge formation becomes noticeable and results in contamination of the board. If the ferric-chloride bath is operated be-

SIZE
1-1/16 OD
1/2 H
6-32 MTG.

TYPES	Q max.	Freq.
MP206	140	14 KC
MP848	185	35 KC
MP608	170	60 KC
MP073	265	250 KC

SIZE
1-5/16 OD
23/32 H
6-32 MTG.

TYPES	Q max.	Freq.
MP930	160	8 KC
MP395	225	25 KC

SIZE
2 OD
1 H
8-32 MTG.

TYPE	Q max.	Freq.
MP254	210	6 KC

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IND.	PART. No.	IND.	PART. No.	IND.	PART. No.	IND.	PART. No.	IND.	PART No.
5.0 MH	MP-206-1 —	2.0 MH	MP-848-1 —	5.0 MH	MP-930-1 —	5.0 MH	MP-395-1 —	20 MH	MP-254-1 —
6.0 MH	MP-206-2 —	2.4 MH	MP-848-2 —	6.0 MH	MP-930-2 —	6.0 MH	MP-395-2 —	24 MH	MP-254-2 —
7.2 MH	MP-206-3 —	3.0 MH	MP-848-3 —	7.2 MH	MP-930-3 —	7.2 MH	MP-395-3 —	30 MH	MP-254-3 —
8.6 MH	MP-206-4 —	3.6 MH	MP-848-4 —	8.6 MH	MP-930-4 —	8.6 MH	MP-395-4 —	36 MH	MP-254-4 —
10 MH	MP-206-5 —	4.3 MH	MP-848-5 —	10 MH	MP-930-5 —	10 MH	MP-395-5 —	43 MH	MP-254-5 —
12 MH	MP-206-6 —	5.0 MH	MP-848-6 —	12 MH	MP-930-6 —	12 MH	MP-395-6 —	50 MH	MP-254-6 —
15 MH	MP-206-7 —	6.0 MH	MP-848-7 —	15 MH	MP-930-7 —	15 MH	MP-395-7 —	60 MH	MP-254-7 —
17.5 MH	MP-206-8 —	7.2 MH	MP-848-8 —	17.5 MH	MP-930-8 —	17.5 MH	MP-395-8 —	72 MH	MP-254-8 —
20 MH	MP-206-9 —	8.6 MH	MP-848-9 —	20 MH	MP-930-9 —	20 MH	MP-395-9 —	86 MH	MP-254-9 —
24 MH	MP-206-10 —	10 MH	MP-848-10 —	24 MH	MP-930-10 —	24 MH	MP-395-10 —	100 MH	MP-254-10 —
30 MH	MP-206-11 —	12 MH	MP-848-11 —	30 MH	MP-930-11 —	30 MH	MP-395-11 —	120 MH	MP-254-11 —
36 MH	MP-206-12 —	15 MH	MP-848-12 —	36 MH	MP-930-12 —	36 MH	MP-395-12 —	150 MH	MP-254-12 —
43 MH	MP-206-13 —	17.5 MH	MP-848-13 —	43 MH	MP-930-13 —	43 MH	MP-395-13 —	175 MH	MP-254-13 —
50 MH	MP-206-14 —	20 MH	MP-848-14 —	50 MH	MP-930-14 —	50 MH	MP-395-14 —	200 MH	MP-254-14 —
60 MH	MP-206-15 —	24 MH	MP-848-15 —	60 MH	MP-930-15 —	60 MH	MP-395-15 —	240 MH	MP-254-15 —
72 MH	MP-206-16 —	30 MH	MP-848-16 —	72 MH	MP-930-16 —	72 MH	MP-395-16 —	300 MH	MP-254-16 —
86 MH	MP-206-17 —	36 MH	MP-848-17 —	86 MH	MP-930-17 —	86 MH	MP-395-17 —	360 MH	MP-254-17 —
100 MH	MP-206-18 —	43 MH	MP-848-18 —	100 MH	MP-930-18 —	100 MH	MP-395-18 —	430 MH	MP-254-18 —
120 MH	MP-206-19 —	50 MH	MP-848-19 —	120 MH	MP-930-19 —	120 MH	MP-395-19 —	500 MH	MP-254-19 —
150 MH	MP-206-20 —	60 MH	MP-848-20 —	150 MH	MP-930-20 —	150 MH	MP-395-20 —	600 MH	MP-254-20 —
175 MH	MP-206-21 —	72 MH	MP-848-21 —	175 MH	MP-930-21 —	175 MH	MP-395-21 —	720 MH	MP-254-21 —
200 MH	MP-206-22 —	86 MH	MP-848-22 —	200 MH	MP-930-22 —	200 MH	MP-395-22 —	860 MH	MP-254-22 —
240 MH	MP-206-23 —	100 MH	MP-848-23 —	240 MH	MP-930-23 —	240 MH	MP-395-23 —	1.00 HY	MP-254-23 —
300 MH	MP-206-24 —	120 MH	MP-848-24 —	300 MH	MP-930-24 —	300 MH	MP-395-24 —	1.20 HY	MP-254-24 —
360 MH	MP-206-25 —	150 MH	MP-848-25 —	360 MH	MP-930-25 —	360 MH	MP-395-25 —	1.50 HY	MP-254-25 —
430 MH	MP-206-26 —	175 MH	MP-848-26 —	430 MH	MP-930-26 —	430 MH	MP-395-26 —	1.75 HY	MP-254-26 —
500 MH	MP-206-27 —	200 MH	MP-848-27 —	500 MH	MP-930-27 —	500 MH	MP-395-27 —	2.00 HY	MP-254-27 —
600 MH	MP-206-28 —	240 MH	MP-848-28 —	600 MH	MP-930-28 —			2.40 HY	MP-254-28 —
720 MH	MP-206-29 —	300 MH	MP-848-29 —	720 MH	MP-930-29 —			3.00 HY	MP-254-29 —
860 MH	MP-206-30 —	360 MH	MP-848-30 —	860 MH	MP-930-30 —			3.60 HY	MP-254-30 —
1.00 HY	MP-206-31 —	430 MH	MP-848-31 —	1.00 HY	MP-930-31 —			4.30 HY	MP-254-31 —
1.20 HY	MP-206-32 —	500 MH	MP-848-32 —	1.20 HY	MP-930-32 —			5.00 HY	MP-254-32 —
1.50 HY	MP-206-33 —			1.50 HY	MP-930-33 —			6.00 HY	MP-254-33 —
1.75 HY	MP-206-34 —			1.75 HY	MP-930-34 —			7.20 HY	MP-254-34 —
2.00 HY	MP-206-35 —			2.00 HY	MP-930-35 —			8.60 HY	MP-254-35 —
2.40 HY	MP-206-36 —			2.40 HY	MP-930-36 —			10.0 HY	MP-254-36 —
3.00 HY	MP-206-37 —			3.00 HY	MP-930-37 —			12.0 HY	MP-254-37 —
				3.60 HY	MP-930-38 —			15.0 HY	MP-254-38 —
				4.30 HY	MP-930-39 —			17.5 HY	MP-254-39 —
				5.00 HY	MP-930-40 —			20.0 HY	MP-254-40 —
				6.00 HY	MP-930-41 —			24.0 HY	MP-254-41 —
				7.20 HY	MP-930-42 —			30.0 HY	MP-254-42 —
				8.6 HY	MP-930-43 —			36.0 HY	MP-254-43 —
				10.0 HY	MP-930-44 —				
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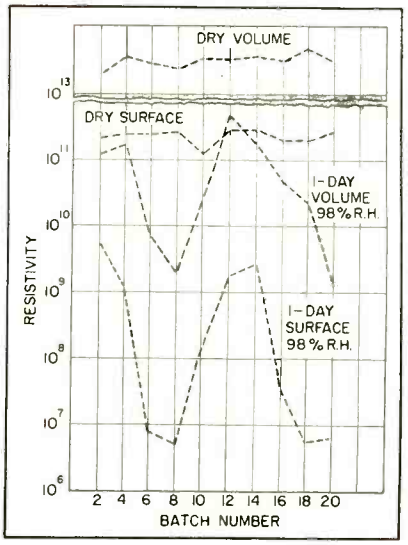


FIG. 2—Volume and surface resistivities of etched wiring boards

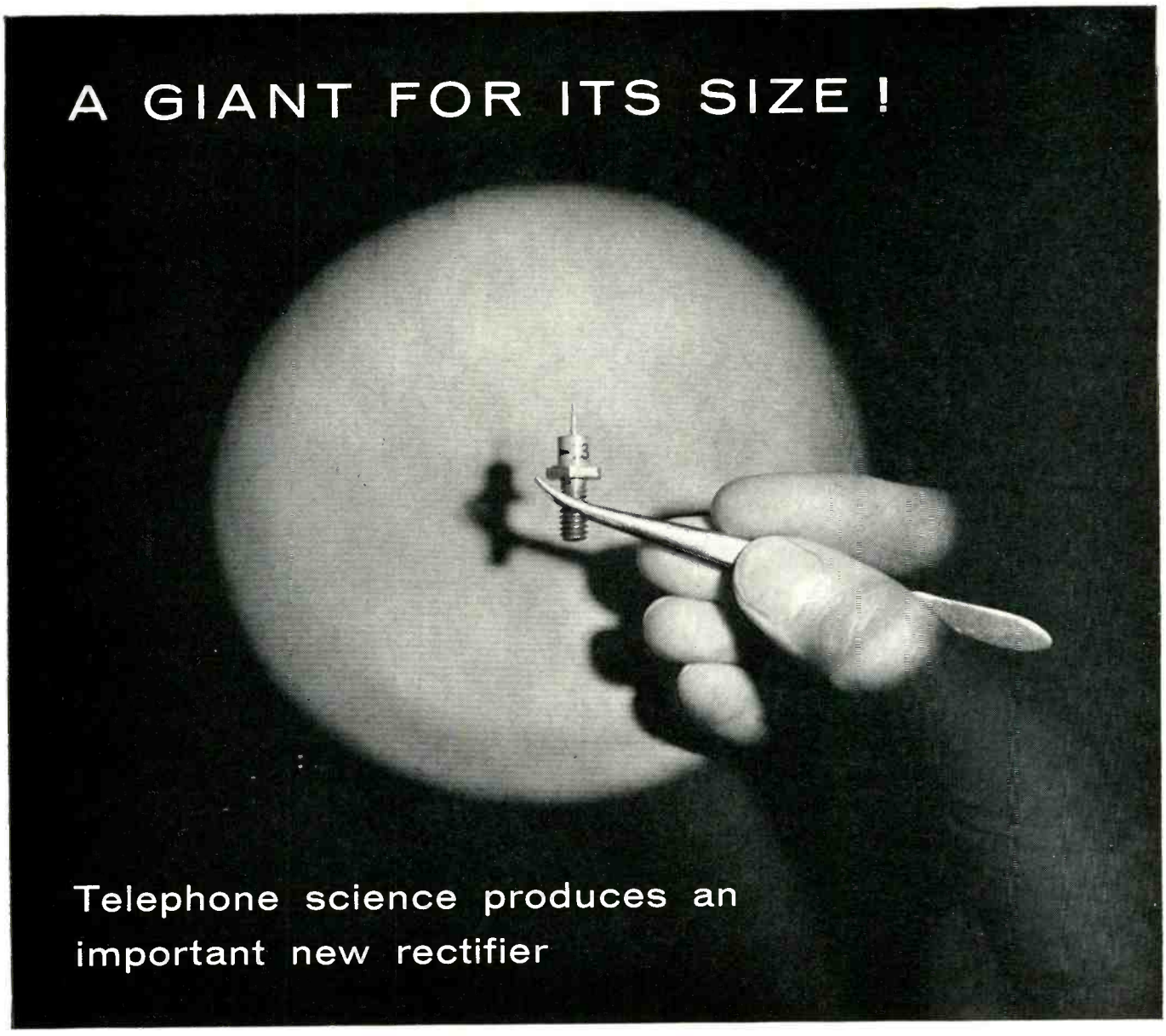
low a pH of 0.8, the boards can be cleaned by simple water washing with minimum contamination.

▶**Cleaning Procedure**—Though a satisfactory means of preventing sludge contamination had been found, it was recognized that one should be able to salvage contaminated boards by some better cleaning method which would dislodge or dissolve the sludge deposit. Many mechanical cleaning procedures were tried, with unsatisfactory results. Abrasives capable of dislodging this tenacious deposit damaged the phenolic surface. After trying many chemical cleaning techniques it was found that the sludge scum was soluble in a 10-percent solution of oxalic acid. The cleaning procedure consisted of soaking the etched board in a 180F—10-percent oxalic-acid solution with subsequent thorough rinsing in hot water. This process produced etched boards relatively free of contamination.

Tin Reflowing Cuts Wire-Stripping Costs

WIRE preparation costs have been reduced by over 50 percent in the Grand Rapids, Mich. plant of Lear, Inc., by eliminating wire retwisting and retinning operations after cutting and stripping stranded wire. This is accomplished by a tin reflow method that uses an induc-

A GIANT FOR ITS SIZE !



Telephone science produces an important new rectifier

At Bell Laboratories one line of research is often fruitful in many fields. Latest example is the silicon power rectifier shown above.

Product of original work with semiconductors—which earlier created the transistor and the Bell Solar Battery—the new rectifier greatly reduces the size of equipment needed to produce large direct currents. It is much smaller than a tube rectifier of equal performance and it does not require the bulky cooling equipment of other metallic rectifiers.

In the Bell System the new rectifier will supply direct current more economically for telephone calls. It can also be adapted to important uses in television, computers, industrial machines, and military equipment. Thus, Bell Telephone Laboratories research continues to improve telephony—while it helps other fields vital to the nation.

Above, new rectifier (held in pliers) is contrasted with comparable tube rectifier and its filament transformer, rear. Mounted on a cooling plate, lower center, the new rectifier can easily supply 10 amperes of direct current at 100 volts, that is 1000 watts—enough to power 350 telephones.

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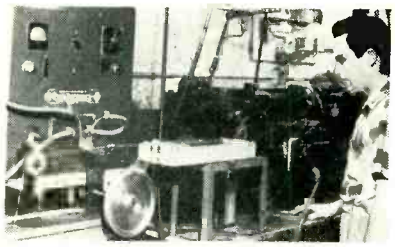
IMPROVING TELEPHONE SERVICE FOR AMERICA PROVIDES CAREERS FOR CREATIVE MEN IN SCIENTIFIC AND TECHNICAL FIELDS

tion heating generator and special measuring devices developed by Reeve Electronics, Inc., 609 W. Lake St., Chicago.

This equipment, which is placed between the roll of wire and any wire stripper, automatically senses the points along the wire where cutting and stripping will occur. It applies a short pulse of r-f heating energy to these points as the wire travels into the wire-stripping machine to melt the tin



Installation of Reevelec induction heating generator mounted ahead of wire-stripping machine. After fusing of tinned strands by work coil, wire passes through pan of cooling water

on the individual strands. This effectively solders them into a solid bundle that will not fray under the strain of cutting and stripping. The wires can then be fitted into tight terminal lugs or other small orifices without retwisting.

A precision electronic timer, triggered by the wire stripper, controls the heat cycle with great accuracy, so that no overheating discoloration of wire or deformation of even low-temperature plastic jackets occurs. The equipment is being used successfully with various MIL spec wires, Teflon-jacketed wire and with Teflon-jacketed silver-plated wire.

Recorder Checks Linearity of Precision Pots

PAPER tracings showing actual performance of precision linear potentiometers are produced automatically by a motor-driven linearity checker in Fairchild's Hicksville, N. Y. plant. The potentiometer is inserted in a fixture on the motor-driven turntable and tightened to hold the housing stationary. The beginning of the winding is then

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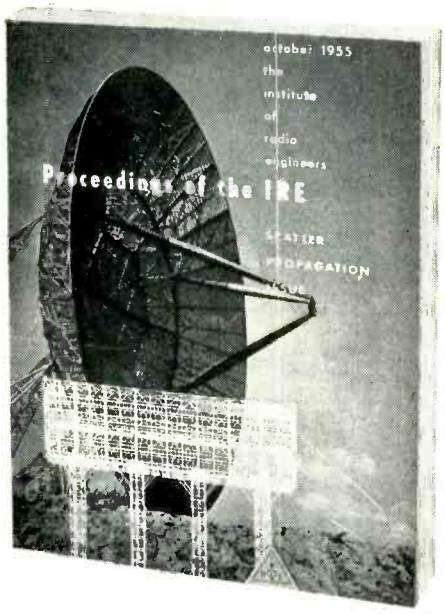

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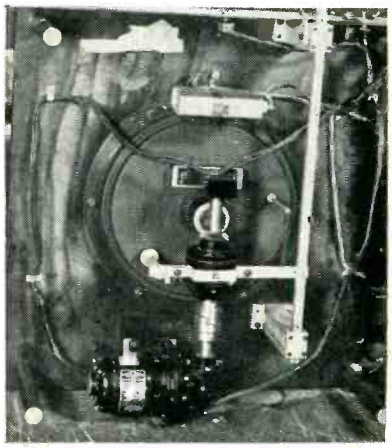
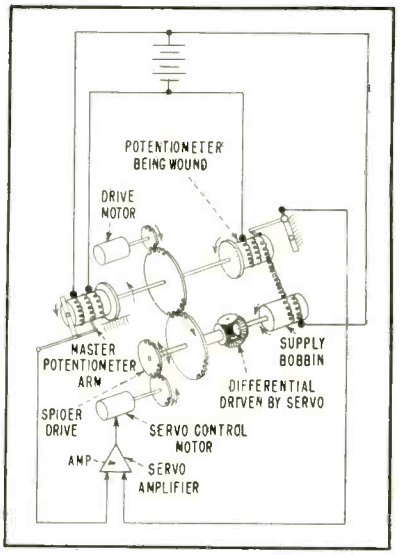


Bottom view of motor-driven turntable on which potentiometer is mounted

zeroed with the aid of a scope and a split collet is tightened over the potentiometer shaft.

The potentiometer connections made for this initial setup also serve for connecting to the checking cir-



Circuit of linearity checker

NEW HUDSON STANDARD CASES

Available From Stock!

STANDARD RECTANGULAR SIZES

HU—688:
DIMEN. A—5/8"
DIMEN. B—1 5/16"
LENGTH—5/8"

HU—734:
DIMEN. A—11/16"
DIMEN. B—1 9/32"
LENGTH—1 27/64"

HU—736:
DIMEN. A—3/4"
DIMEN. B—15/16"
LENGTH—7/8"

HU—745:
DIMEN: A—3/4"
DIMEN. B—15/16"
LENGTH—1 3/8"

HU—750:
DIMEN. A—7/8"
DIMEN. B—1 1/16"
LENGTH—1 3/8"

HU—796:
DIMEN. A—5/8"
DIMEN. B—1 5/16"
LENGTH—2 1/2"

HU—826:
DIMEN. A—11/16"
DIMEN. B—1 9/32"
LENGTH—1 5/8"

HU—844:
DIMEN. A—11/16"
DIMEN. B—1 9/32"
LENGTH—1 1/4"

STANDARD ROUND SIZES

HU—727:
OUTSIDE DIA.—1 1/4"
LENGTH—1/2"

HU—728:
OUTSIDE DIA.—1 1/16"
LENGTH—2 1/4"

HU—737:
OUTSIDE DIA.—1 15/64"
LENGTH—1 13/32"

HU—760:
OUTSIDE DIA.—21/32"
LENGTH—5/16"

HU—771:
OUTSIDE DIA.—.742"
LENGTH—3/4"

HU—773:
OUTSIDE DIA.—1 1/16"
LENGTH—1"

HU—806:
OUTSIDE DIA.—1 9/64"
LENGTH—1 7/8"

HU—819:
OUTSIDE DIA.—49/64"
LENGTH—2 1/64"

STANDARD SQUARE SIZES

HU—709:
DIMEN. A—1"
LENGTH—2 1/8"

HU—789:
DIMEN. A—1"
LENGTH—1 1/2"

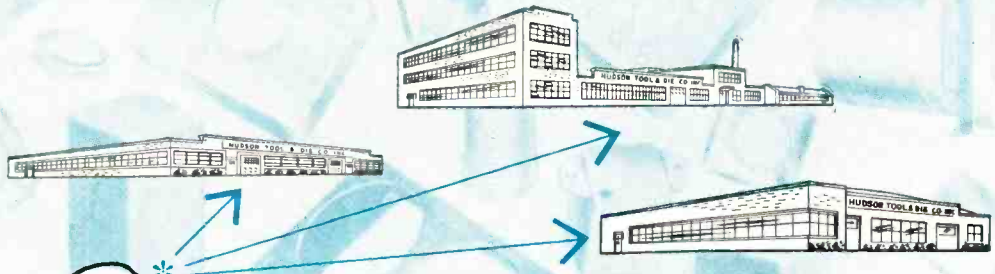
HU—793:
DIMEN. A—1"
LENGTH—1 19/32"

HU—808:
DIMEN. A—1 1/64"
LENGTH—1 25/32"

HU—810:
DIMEN. A—4 5/64"
LENGTH—7/16"

HU—847:
DIMEN. A—1"
LENGTH—2 1/4"

File This Page for Future Reference



3* FULLY-EQUIPPED PLANTS

Offering the Most Complete Line of Precision Drawn Cases and Covers in the Industry!

...THREE COMPLETE SERVICES!*

Hudson Standard Metal Closures

Over 1000 economical standard types mean HUDSON can supply precision components at commercial prices. A wide variety of optional features make it possible to solve all but the most unusual closure requirements with standard types selected from HUDSON stocks.

Hudson Quality Metal Stampings

Metal parts produced to your exact specifications at prices that reflect the economies of mass production methods. Hudson can work to close tolerances and maintain uniformity throughout production runs. Quotations supplied promptly on receipt of drawings.

Hudson Sheet Metal Facilities

Depend on HUDSON for expert fabrication of simple or complex sub-assemblies. Facilities include certified welding of alloys, silver soldering, brazing and chrome plating.

NEW CATALOG READY, NOW!

The Hudson story is contained in one handy catalog. Full descriptions of all standard items and complete information on Hudson metal working facilities. Call or write for your copy, now!

Precision Components of Steel, Aluminum, Copper, Brass, Mu Metal

HUDSON TOOL & DIE COMPANY • INC

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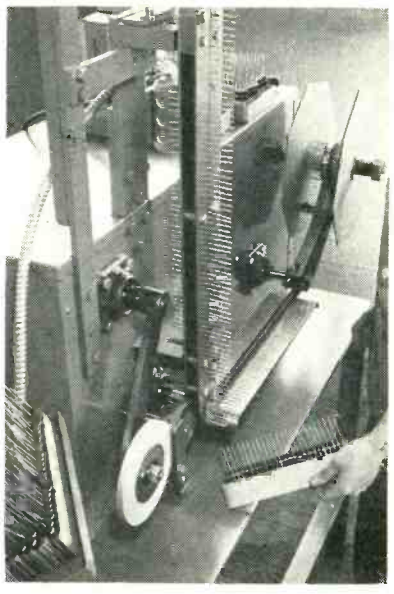
cuit that includes a 10-inch-diameter 150,000-ohm master potentiometer. This provides different loading arrangements to permit checking zero-base, terminal or independent linearity as required. A Brush Magnetic Penmotor with special amplifiers serves as the recorder.

After a pattern has been run off, an appropriate template is placed over it to check at a glance whether the unit is within the established tolerance limits. The trace also reveals shorted turns at taps.

Automatic Belting for Machine-Fed Components

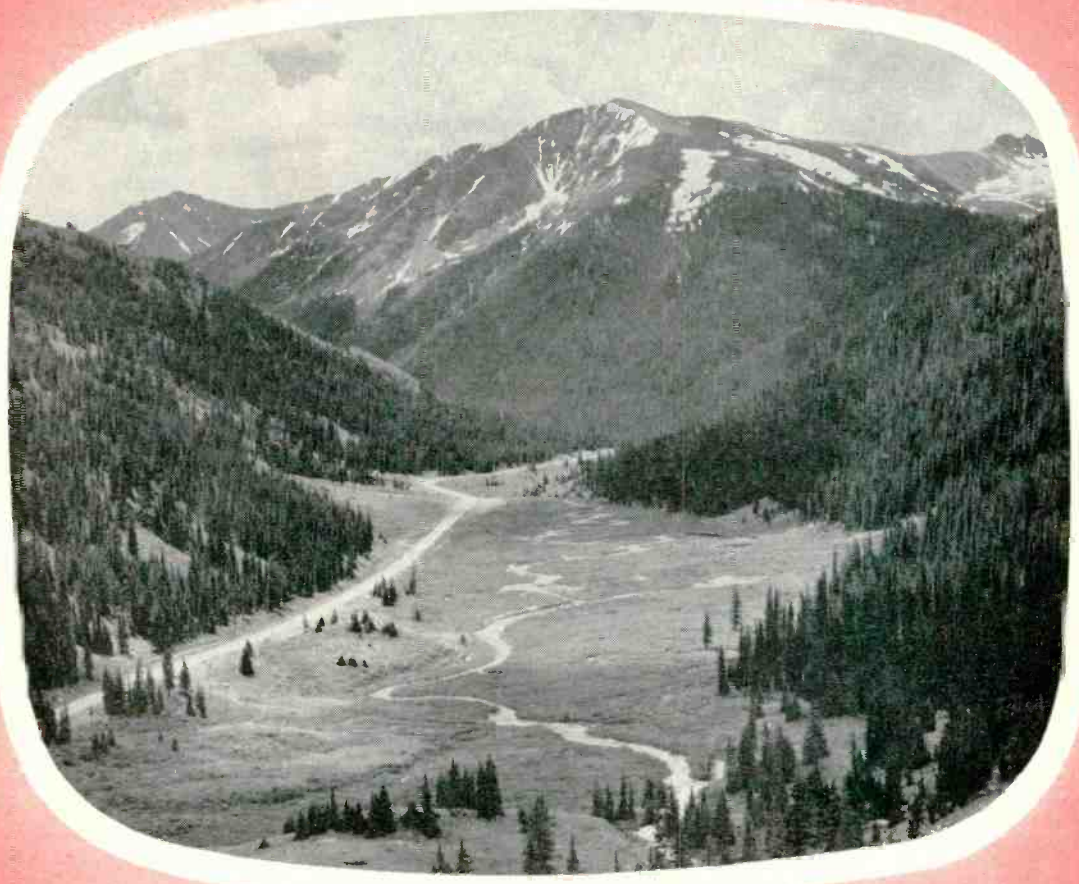
AUTOMATIC belting machines that place fixed resistors and capacitors on narrow belts of pressure-sensitive tape have been developed and constructed by Allen-Bradley Co., Milwaukee, Wis. to meet the growing demand for reel packaging by users of automatic assembly machines.

The machines each weigh about 350 lb and are about 4 feet high, 3½ feet long and 26 inches wide. A 1/20-hp electric motor inside each unit runs a simple chain-drive mechanism that operates the indexer (a sprocket type wheel that uniformly feeds the individual re-



Machine in operation. Operator loads vertical slide from prefilled corrugated paper sleeves holding resistors or capacitors

Picture Quality Is Our Business Too!



Set designers assure their customers steady, clear pictures by careful component selection. Good-All backs that selection with reliable capacitors at economical cost. The enthusiastic acceptance of **GOOD-ALL MARBELITE** and **SERAMELITE** tubulars is a measure of the confidence designers have in these capacitors. Tens of millions are in use today in TV and Radio Sets of leading manufacturers.

Good-ALL capacitors

MARBELITE

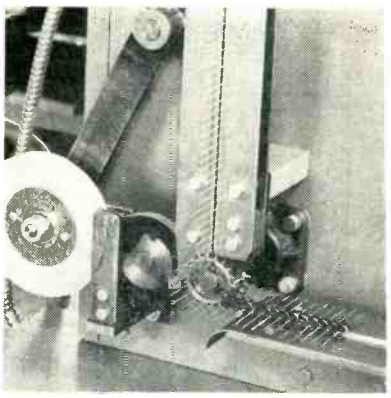
Marbelite capacitors are best known for their physical and electrical ruggedness. Good-All type 503-M provides solid plastic construction at surprisingly low cost. A miniature series is also available for applications in which space is limited.

SERAMELITE

The seramelite family of capacitors is housed in ceramic tubes with end-seals of a tough, dense plastic. Their performance under conditions of high temperature and humidity is outstanding. Various impregnants are available and Seramelite types with "MYLAR" dielectric are becoming increasingly popular.

Get full information by writing GOOD-ALL direct or contacting our nearest sales representative.

GOOD-ALL ELECTRIC MFG. CO. • GOODALL BLDG. • OGALLALA, NEBRASKA



After 12-inch leader has been run out, resistors are gravity-fed onto the tape, which is pulled from bottom of white roll at left and runs over top of black rubber buffing roller

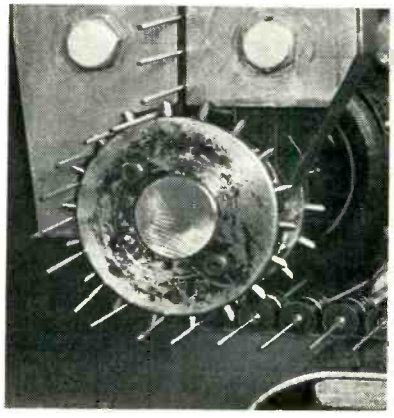
sistors or capacitors to the tape) and the rewind reel.

Each machine—manned by a single woman operator—has a production capacity of between 10 and 20 filled reels (better than 20,000 individual units) per hour. To maintain this production the operator's only duties are to replenish the supply of tape, reels and units being belted, and to control the flow of tape-belting with a stop-start foot pedal.

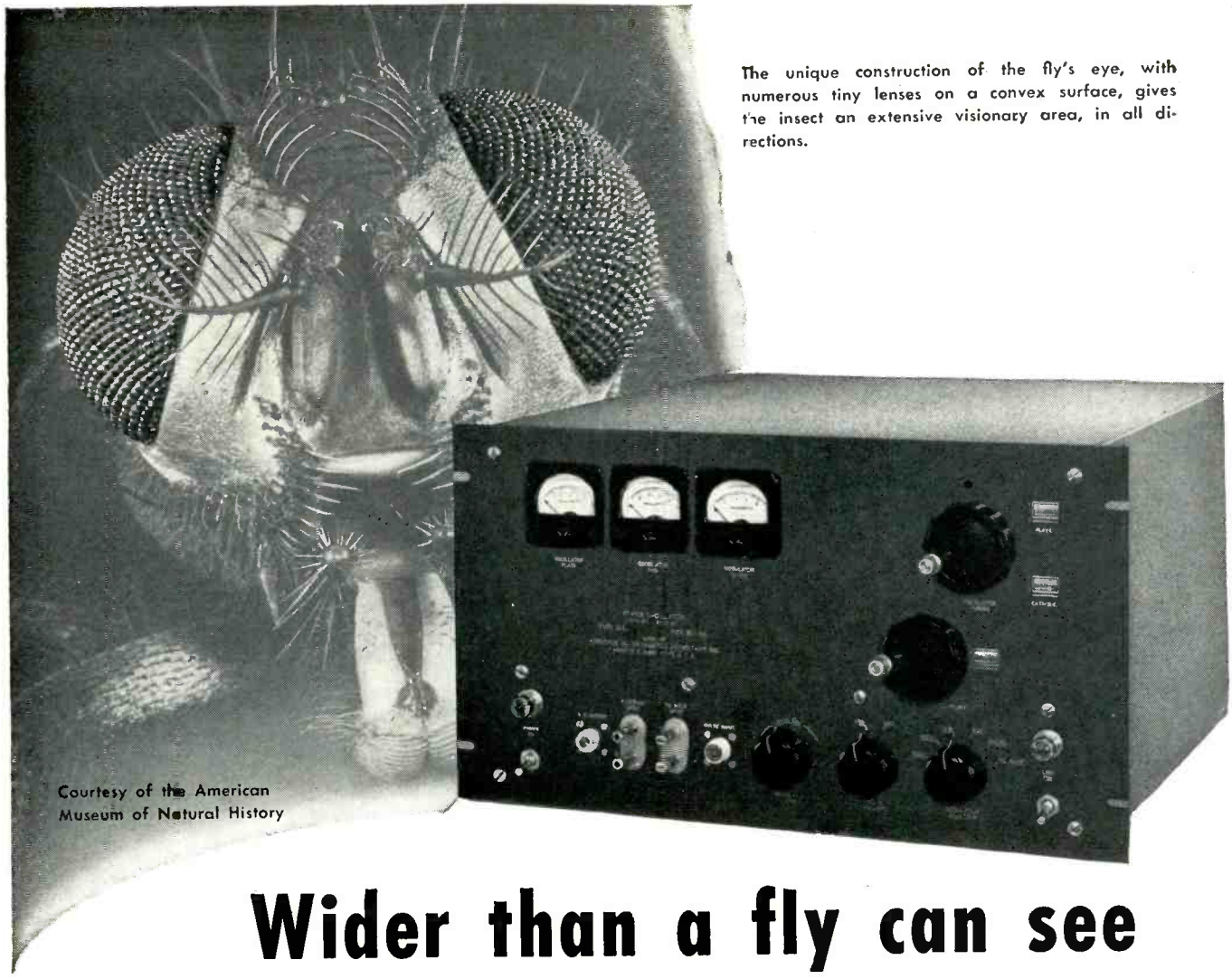
▶**Getting Started**—Readying a machine for use takes the operator only about a minute and calls for the following steps:

(1) Mounting a 60-yard roll of the Minnesota Mining and Manufacturing Co.'s Scotch brand No. 898 filament tape (either ¼ or ⅜ inch wide depending on the size of the resistors or capacitors to be belted.)

(2) Threading the tape—adhesive side up—between a rubber pressure roller and the indexer and



Closeup of indexer that controls spacing of units on tape belt



The unique construction of the fly's eye, with numerous tiny lenses on a convex surface, gives the insect an extensive visionary area, in all directions.

Courtesy of the American Museum of Natural History

Wider than a fly can see

Unlike most of nature's children, man's endeavors have carried him far beyond the use of his natural endowments. Spurred on by mental development, human efforts have created a dynamic way of life, demanding the most versatile mechanisms man is able to devise.

Scientists at Airborne Instruments Laboratory are constantly at work, creating electronic devices to aid industrial progress. In the Wide Range Power Oscillator, they have achieved an instrument, excellent in performance and quality, for testing over the wide frequency range of 300 to 2500 mc.

Equipped with a self-contained rectifier power supply and a single tuning control for grid-cathode and grid-plate lines, the Wide Range Power Oscillator is representative of Airborne's high standard of achievement in research, development and production. Here is another example of individual design, resulting in the universal appeal of AIL products.

Write for descriptive literature.

AIRBORNE INSTRUMENTS LABORATORY INC.

160 OLD COUNTRY ROAD • MINEOLA, NEW YORK

pulling out about a foot of tape to act as a leader.

(3) Loading the vertical feeder slide with ½-watt, 1-watt or 2-watt units from prefilled corrugated paper sleeves holding from 25 to 50 units each.

(4) Starting the machine, which in turn automatically begins applying the units to the tape and feeding the leader end of the tape out until it can be attached to the rewind reel.

Attaching tape leader to core of reel

(5) Attaching the tape-leader to the reel's core completes the operation.

► **Reel Specifications**—During production the number of reels that can be completed with one 60-yard roll of tape depends entirely on the size of the units being belted. For example, it takes about 52 feet of tape (allowing one foot on each end as a leader) to complete one 2,500-capacity reel of ½-watt units and about 42 feet to fill a 1,000-capacity reel with 2-watt units. In the former case about 3½ reels can be done with one roll of tape, while in the latter instance about 4⅓ reels is tops. The 12-inch leaders that precede the first unit and trail off from the last unit on the belt are designed to facilitate loading into customer machines and for splicing the new belt to the belt of an emptying reel.

The expendable 9- and 12-inch

New Resistor Stands Higher Overloads... Without Crazing!

The "Blue Ribbon", resistor with a higher wattage rating per unit space requirement. Made by Hardwick, Hindle, Inc., Newark, N. J.

because of DRIVER-HARRIS 146 ALLOY

Here is a resistor really new and different . . . the compact Hardwick, Hindle "Blue Ribbon," which stands remarkably high overloads and excessive heat without crazing.

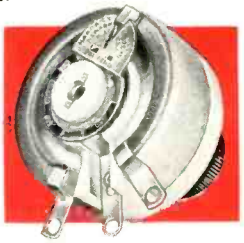
Special design features which make this possible are: an aluminum thru-bar extending through the center of the elliptical ceramic core, which insures a more even distribution of heat to prevent "hot-spots;" and a thermo-shock-proof enamel coating which eliminates crazing.

Heretofore, crazing, which occurred mostly at *terminal* areas, shortened resistor life and limited the safety factor. To prevent this, an alloy with three hard-to-find qualities was needed: (1) It had to have a coefficient of expansion to match all integral parts; (2) it had to be free of gas; (3) it had to form a perfect bond with the enamel.

A large order, indeed. But Driver-Harris filled it by developing #146, a glass-to-metal sealing Alloy. This alloy now makes it possible to operate resistors and rheostats at hitherto dangerous overloads, with no risk of breakdowns in the enamel coatings.

146 Alloy is one of 4 Driver-Harris Alloys which cover most glass-to-metal sealing needs—available as rod, wire, strip, sheet foil, and in special shapes. Today the makers of the "Blue Ribbon" use 146 Alloy for the terminals in all of their resistors and rheostats as well. They also use Nichrome*, Advance*, and other gas-free resistance alloys made by Driver-Harris in winding the cores.

What you can learn from this is clear. If you also need a special purpose alloy, send us your specifications. Our engineers with 48 years of experience are at your service.



One of a new line of "H" Series high wattage rheostats made by Hardwick, Hindle, using Driver-Harris Alloys.

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

Nichrome and Nichrome V are made only by

SPECIAL PURPOSE ALLOYS SINCE 1879 — D H — TRADE MARK REG. U. S. PAT. OFF.

Driver-Harris Company HARRISON, NEW JERSEY

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

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

MAKERS OF THE MOST COMPLETE LINE OF ELECTRIC HEATING, RESISTANCE, AND ELECTRONIC ALLOYS IN THE WORLD

Securing filled reel by pressing down 12-inch trailing leader

reels now being used by Allen-Bradley have a 1-inch diameter core upon which the tape-belt is started and octagon-shaped side shields of fiberboard construction. Their width varies from $3\frac{3}{4}$ inches for belted $\frac{1}{2}$-watt units to $4\frac{1}{32}$ inches for 2-watt units.

To ready the filled reels for shipment, the packaging department merely tapes a cardboard retainer ring around the circumference of the belted units and packs the reels in individual cartons. Six such cartons are then placed in a master carton for shipment.

Water-Dip Solution Keeps Terminals Clean

CLEAN metal is kept clean for later soldering, welding or finishing operations by immersion in Water Dip No. 33, made by Maas and Waldstein Co., Newark, N. J. The resulting coating does not interfere with any electrical contacts, wiring or parts that must be attached to the chassis. The soldering operation is actually improved and speeded up by this treatment, as it keeps the plated surface chemically clean.

The coating is best applied by dipping the plated or chemically cleaned parts directly from the last hot water rinse, while the parts are still wet. This insures maintenance of a chemically clean surface free from water spots and runs. The protective coating prevents fingerprinting or staining of plated parts during assembly, storage and use.

In one test, 5,000 radio chassis units were copperplated and water-

CLIFTON PRECISION'S NEW 8 SIZE SYNCHROS

Available in all Types!

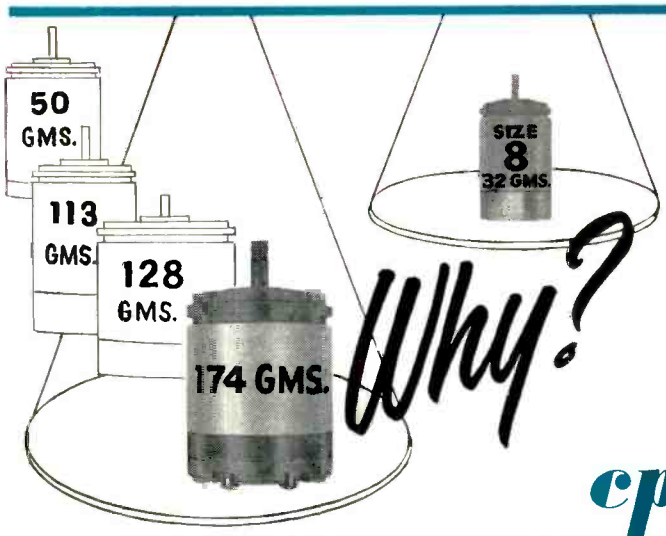
ACCURACY 7 MINUTES · WEIGHT 32 GMS.

Function	Type Number	Primary Element	Excitation Voltage 400 cy.	Input Current (ma.)	Input Power (Watts)	Primary Impedance Secondary Open (Phase)	Primary Resistance (line)	Secondary Element	Output Voltage	Secondary Impedance Primary Open (Phase)	Secondary Impedance Primary Shorted	Secondary Resistance (line)	Phase Shift Degrees	Sensitivity mv./deg.	Accuracy Minutes Max.
Transmitter	CGC-8-A-7	Rotor 1 Phase	26	100	.50	54+ j260	37.0	Stator 3 Phase	11.8	12+ j45	15+ j3.5	11.8	8	200	7
Control Transformer	CTC-8-A-1	Stator 3 Phase	11.8	90	.230	28+ j110	24.7	Rotor 1 Phase	23.6	220+ j740	246+ j60	143	8.5	400	7
Control Transformer	CTC-8-A-4	Stator 3 Phase	11.8	37	.091	67+ j270	59.5	Rotor 1 Phase	24	508+ j1680	640+ j190	381	9.2	400	7
Resolver	CSC-8-A-1	Stator 2 Phase	11.8	84	.268	38+ j136	27.0	Rotor 2 Phase	23.2	280+ j600	344+ j75	230	11	400	7
		Rotor 2 Phase	26	39	.430	280+ j600	230.	Stator 2 Phase	10.6	38+ j136	70+ j29	27.0	20	180	7
Repeater	CRC-8-A-1	Rotor 1 Phase	26	100	.50	54+ j260	37.0	Stator 3 Phase	11.8	12+ j45	15+ j3.5	11.8	8	200	30' *
Differential	CDC-8-A-1	Stator 3 Phase	11.8	85	.21	27+ j120	25.0	Rotor 3 Phase	11.8	38+ j122	47+ j14	36	9	200	7 Rotor 7 Stator

Total Null max. 20mv for each unit

*Torque 2600 mg.-mm./degree from CGC-8-A-7

Also available in 115v 400 cy. primary, 90v secondary Transmitters, C.T.'s, Receivers



WHY USE 1945 SYNCHROS IN 1956 DESIGNS?

Clifton's new Size 8's can take the place of larger units at very significant saving in bulk and *weight*.

These new Size 8's are now in use in some of the latest and *lightest* avionic equipment. In equipment which must be flown, why load on extra weight?

Samples are available from stock, quantities from the production line.

LOOK TO CPPC FOR SYNCHRO PROGRESS

cppc

CLIFTON PRECISION PRODUCTS COMPANY INC.

CLIFTON HEIGHTS **PENNSYLVANIA**

dipped. The results were: no rejects; sets looked good when shipped; good electrical contacts obtained at all riveted and soldered joints.

Television parts were nickelplated and water-dipped resulting in good electrical contact even though high currents were used between parts in mechanical contact. Television transmitter panels and racks looked good in spite of handling received during assembly. Little retouching of the finish was needed.

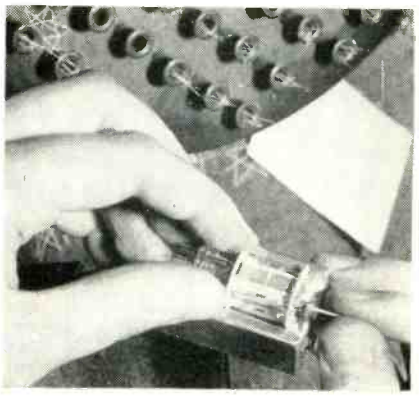
In another test, terminals on coils and terminal boards were plated and dipped, with a dye added for identification. This permitted easy soldering, speeded-up assembly work and reduced checking and testing time. A glance showed the inspector and operator if the correct wire was on the correct terminal. Various dye solutions are available for this use.

Electronic pianos have springs which are identical except for wire diameter. Here again, use of dyes in the dip gives easy identification along with protection.

Filament-Inserting Funnel

A SIMPLE mount assembly jig with a tiny built-in funnel is used to position parts precisely while inserting multi-leg folded filaments into the cathode sleeves of miniature tubes in the Bloomfield, N. J. tube plant of Tung-Sol Electric Inc.

The jig is rigidly mounted on the workbench, to leave both hands of the operator free for assembly. With her left hand she picks up tube mount and places it in the lower part of the jig. With her



First step in inserting filament

RATED AT:
8 AMPERES
115 volts — 60 cycles
non-inductive load
Contact Combinations up to
3 POLE • DOUBLE THROW

The GUARDIAN® *Multi-Purpose* SERIES 1200 RELAY
. . . a Mighty Midget!

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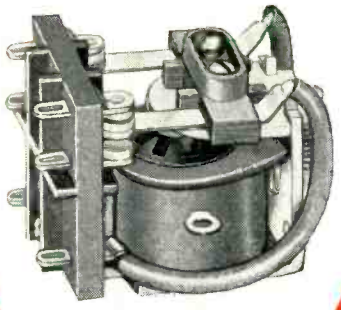
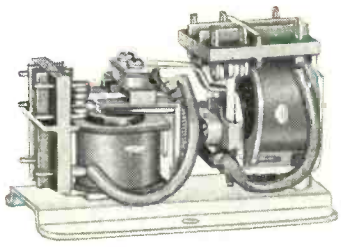
- **Versatile**
- **Flexible**
- **Rugged**



ACTUAL SIZE



GUARDIAN
Series 1200/1200 Interlock
Standard Series 1200 is also available as an Interlocking Relay, in any A.C./A.C., D.C./D.C. or A.C./D.C. combination.

APPLICATIONS:
- Automation
- Computers
- Communications
- Circuitry Projects
- Remote Control Units
- Automatic Selectors
- Electronic Controls
- Switching Devices

CHARACTERISTICS:

COIL

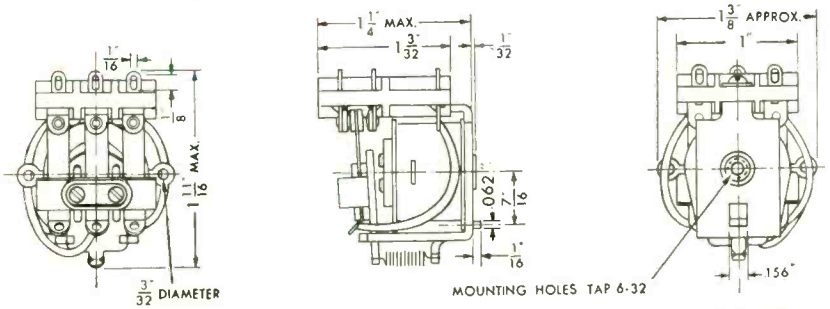
Standard voltages. 6 to 230 volts, 60 cycles, A.C., non-inductive; 6 to 110 volts, D.C.
Terminals. Solder lug type.

CONTACTS

Rating. Available for 1½ amperes or 8 amperes, 115 volts, 60 cycles, non-inductive load.
Combination. Available in any standard combination up to 3 P.D.T.
Material. Fine silver is standard; other materials to specification.

MOUNTING

Standard. Single hole 6-32 tapped. Bottom mounting.



TOP SIDE BOTTOM

● **Ultra-small . . . but packed with power!** This compact, efficient relay is RATED AT 8 AMPERES, 115 volts, 60 cycles non-inductive load! Contact combinations up to 3 pole, double throw. Never before has so much power capacity been combined with so many possible contact combinations within such midget proportions. Unit measures approximately 1⅝″ long, 1″ wide, by 1¼″ high. Weighs only 1.9 ounces.

Solder Terminals molded in phenolic block, with barriers for over-surface insulation meet Underwriters' Laboratories specifications. It is extremely rugged. Series 1200 has already achieved extraordinary success in the applications listed to the left. It promises to become the most popular of all midget relays in every industry, yours included.

write **today to arrange for a production sample.**
Include blue print or circuit diagram if possible.

Telephone CHesapeake 3-1100

GUARDIAN ELECTRIC
1625-MW. WALNUT STREET CHICAGO 12, ILLINOIS
A COMPLETE LINE OF RELAYS SERVING AMERICAN INDUSTRY

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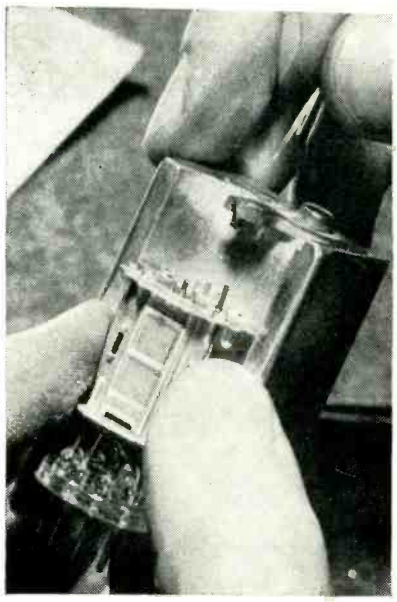


Pushing filament through funnel into cathode of tube mount

right hand she removes a folded filament from the carrying tray and inserts it in the funnel-shaped hole at the top of the jig. The final operation involves bringing the tube mount up to the funnel, which places the cathode sleeve directly under the funnel so that the filament can be pushed in easily and without damage.

Vacuum Metallizing of Selenium Rectifiers

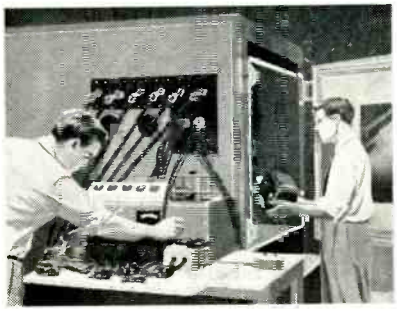
By J. Gordon Seiter
Manager, High-Vacuum Division
F. J. Stokes Machine Company
Philadelphia, Pennsylvania

In the manufacture of selenium rectifiers in the Buffalo plant of Westinghouse Electric Corp., vacuum metallizing provides accurate control over the thickness of metal deposited and produces the desired crystal structure to give the required performance characteristics.

Aluminum sheets approximately 25 inches square are nickel-plated conventionally, then placed inside a stainless-steel drum and held in place against the inner surface by small spring-steel clips. This drum is then rolled into the vacuum chamber of the large metallizer made by F. J. Stokes Machine Co. of Philadelphia. The chamber is evacuated to a low pressure and selenium is evaporated onto the plates from a heat source where the temperature is precisely con-

For accuracy in flight...

...you need accuracy in manufacturing



With 400-cycle equipment, you just can't take chances . . . the very lives of both plane and crew depend on its accurate operation. And to get accurate *output*, you need accurate *input* . . . during engineering and manufacturing as well as in flight. That's why makers of aircraft systems and components everywhere depend on Leach for the *precise* power needed during design and testing of 400-cycle equipment.

Now, Leach offers a new 400-cycle power supply for laboratory or in-plant use . . . a complete package ready to "plug-in." Characteristics equal those of Leach's widely used mobile ground-power packages—the units trusted for supplying precise power during vital pre-flight checkout— and ratings from 3 to 125 KVA are available.

Send today for the latest brochure on Leach's broad line of 400-cycle power supplies.

PRECISE 400 CYCLE POWER

RATING	3 phase—5 to 125 KVA at .8 P.F. 1 phase—3 to 85 KVA at .8 P.F.
OVERLOAD RATING	150% for 5 minutes; 200% for 5 seconds
REGULATION:	
Frequency	400 cps ± 0 cps with 60 ± 0 cps input
Voltage	± 1%
RECOVERY TIME	100 milliseconds
VOLTAGE MODULATION	less than .25%
FREQUENCY MODULATION	less than .25%
PHASE BALANCE	per MIL-E-7894A
WAVE FORM	3% rms total harmonic content (2% rms available on special order)

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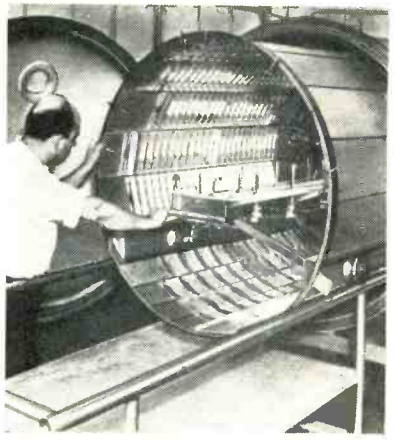
trolled to produce the proper type of crystal structure. The drum is rotated within the chamber while the selenium is being evaporated so that as the vapor rises, it will coat the surface of all the sheets. The drum with the plates attached is then rolled into another evaporator for deposition of the barrier film over the selenium.

After the barrier film has been deposited, the sheets are removed from the drum and broken into small plates along scored lines, to give squares ranging up to 5 in., depending on the rectifier capacity desired. A mask is placed over the coated side of the sheets, protecting a narrow strip around the edges of the plate and a narrow band around a central hole in the plate. The unmasked portion is then sprayed with cadmium or zinc to provide a contact layer on the plate.



Type of metallizing unit used for depositing selenium. Drum rolls out on pipe rails for loading

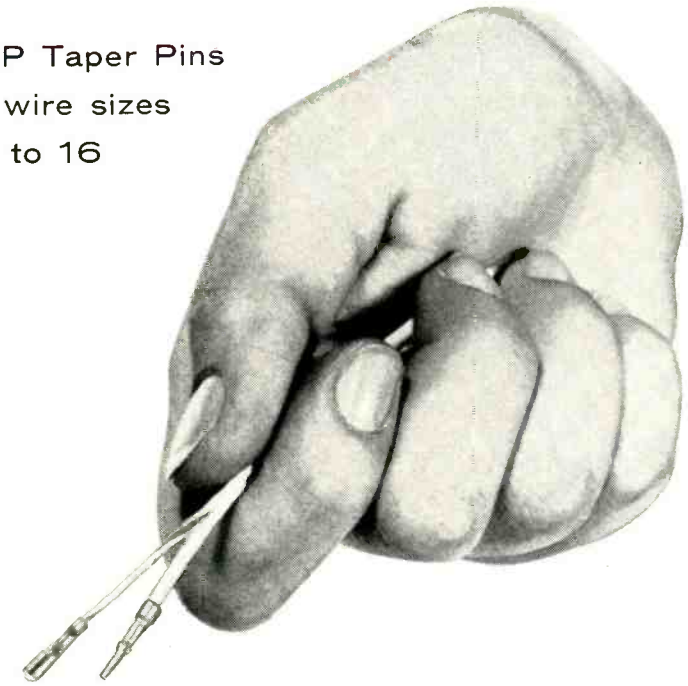
After this contact layer has been sprayed on, the plates go into a Stokes vacuum shelf-dryer where they are again heated, under vacuum conditions, to refine still further the crystal structure of the selenium and the barrier layers. The plates are then ready for assembling into complete rectifiers.

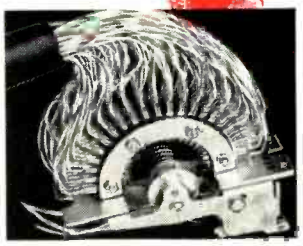
Resistor Lead Cutter

SIDE LEADS of flat wire-wound resistors are cut to length on an ordinary paper cutter in Emerson's Jersey City plant. Though started as an emergency procedure for small lots of resistors, the simple tech-

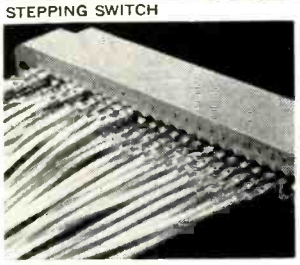
AMP Taper Tab
receptacles for wire
sizes 26 to 18

AMP Taper Pins
for wire sizes
26 to 16

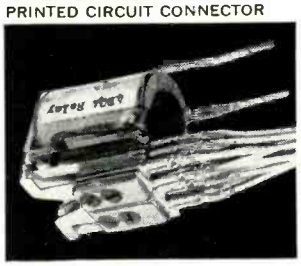




STEPPING SWITCH

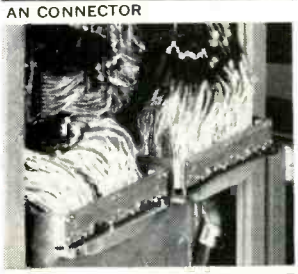


PRINTED CIRCUIT CONNECTOR

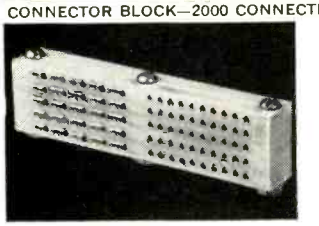


TAPER TAB RELAYS

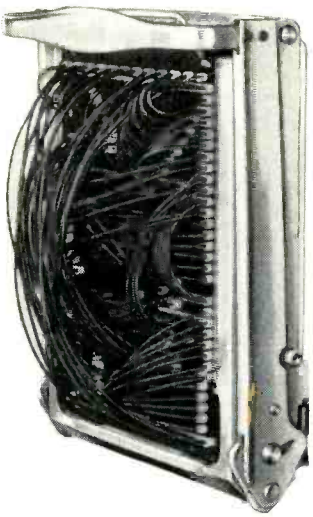
AN CONNECTOR



CONNECTOR BLOCK—2000 CONNECTIONS



A-MP TAPER BLOK



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AIRCRAFT-MARINE PRODUCTS, INC., 2100 Paxton Street, Harrisburg, Pa.
In Canada: AIRCRAFT-MARINE PRODUCTS OF CANADA, LTD., 1764 Avenue Road, Toronto 12, Ontario, Canada

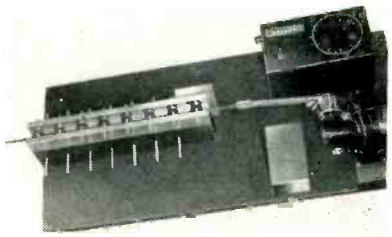
nique proved surprisingly effective.

The regular paper stop on the 15-inch-square board of the cutter is set to serve as a guide against which the resistors are held to give the desired lead length. The operator can easily hold two resistors against this at a time with her left hand while bringing down the cutter with her right hand.

Rotational Life-Tester

By L. KLEIST
The Magnavox Co.
Fort Wayne, Indiana

BASIC requirement for a rotational life-testing machine is a cyclic rotational motion variable both in magnitude of arc and speed of cycling. In the simple machine shown, this is achieved by converting the rotational motion of the motor to cyclic rotation through the reciprocating action of a rack



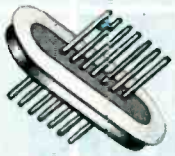
Rack-and-gear drive for fourteen components, with drive motor at lower right and Variac speed control at upper right

and gear train. The degrees of rotation are controlled by varying the distance of travel of the rack by a variable eccentric arm connected to the motor shaft.

Limits on the degree of travel are from approximately 0 to 500 degrees. The smallest arc is limited by the precision of the fit of the rack and spur gears, while the largest arc is limited by the throw allowed in the eccentric arm and rack.

Arcs larger than 360 degrees are useful when checking assemblies having a rotating component, which is connected through some type of gear train to a control knob. An example of this is the tuning assembly of a radio tuner, which is usually geared down for the purpose of finer tuning adjustments. To facilitate adjustment, a pointer and calibrated circle are attached to one

When specifications call for—



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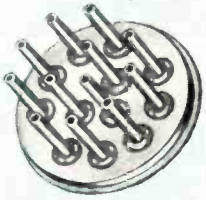

Check your requirements with sealed terminal specialists! Electrical Industries *specializes* in the design and manufacture of sealed terminations for all types of electronic and electrical components. Both standard and custom terminals can be supplied quickly to meet every design specification and the severest environmental condition. In most cases, specifications can be met with standard types that offer maximum economy and fast delivery!

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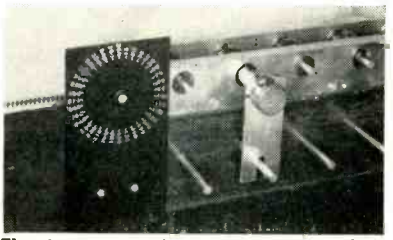
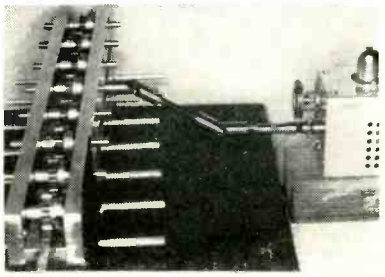


Floating mount for potentiometer eliminates side thrust



Universal joints eliminate side thrust when life-testing TV tubes

shaft to indicate degrees of rotation.

Speed of cycling is varied by controlling the voltage on a 1/25-hp, 5,000-rpm series motor with a 3-amp Variac. A 120:1 speed reducer is mounted on the motor. The speed range on this particular equipment is between 10 and 100 full cycles per minute. The number of elapsed cycles is measured on an impulse counter connected to a snap-action switch actuated by a cam on the motor shaft. Total count available is 999,999 cycles.

The entire unit is mounted on a plywood base ¾ × 15 × 32 inches, with fourteen shafts readily available for attaching components to be tested. The motor will develop enough torque to swing fourteen light components such as potentiometers and variable capacitors.

For light components normally supported by their shafts, the component is held only by the shaft and is free of any side thrusts, except for the weight of the component and bracket, which is negligible. With larger components or assemblies, too large to be supported by this shaft, two ¼-inch universal joints are used to eliminate side thrusts.

If a component under test freezes and refuses to turn, the sleeve connecting the component to the machine will slip on the machine shaft or the additional load will stall the machine.

Sometimes it may be desirable

electronic engineers:

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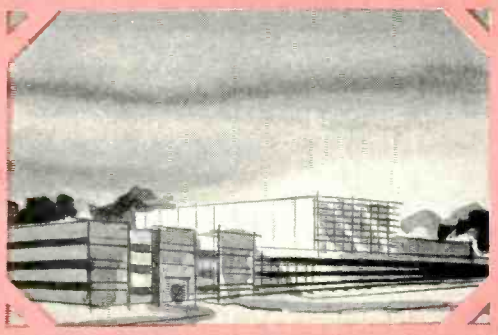

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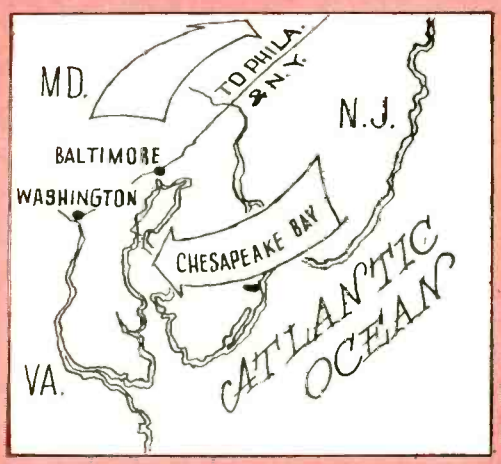

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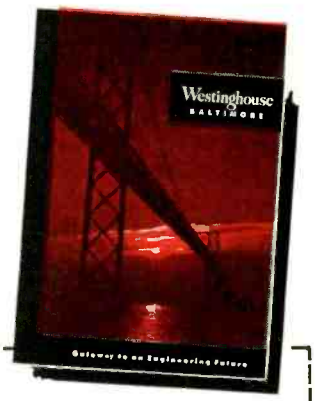

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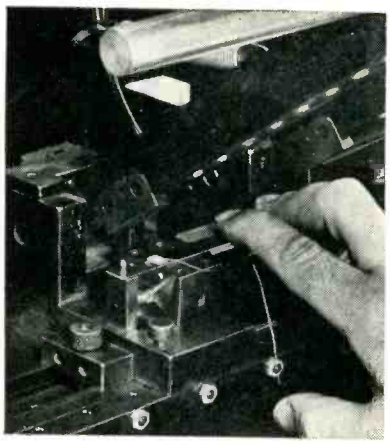
to place weights on the mounting bracket to simulate a side thrust placed on a control by a belt-and-pulley arrangement. Nearly always it is necessary to supply rated electrical conditions to the unit under test to evaluate fully the expected life.

Cutting Tapered Cards for Precision Potentiometers



Placing resistor card in position on cutting anvils. Hole in left end of card, fitting over positioning peg, is cut off along with surplus length at other end of card

A BENCH tool developed in the Hicksville, N. Y. plant of Fairchild Controls Corp. accurately cuts wound cards to specified length within a tolerance of five thousandths of an inch, yet can be quickly reset to a new value. The operator merely places the wound card over a positioning peg on the cutting anvil, then brings down a spring-loaded overhead lever to shear off the ends of the card so it will fit precisely when bent into a circle for insertion in the housing of a precision potentiometer.

The setup procedure involves removing a positioning pin and sliding the left-hand anvil and blade assembly along the ways to a hole marked within the integral inch of the desired length value. The pin is then pushed through the anvil into the drill bushing set into that hole.

A micrometer on the right-hand side of the tool is then set to the exact decimal-inch value desired, moving the other anvil and blade. This section is spring-loaded

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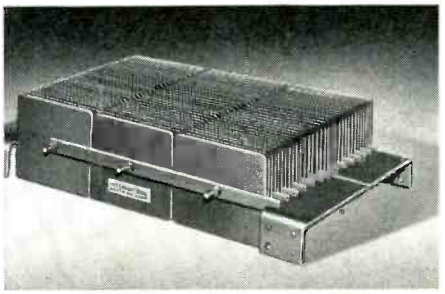

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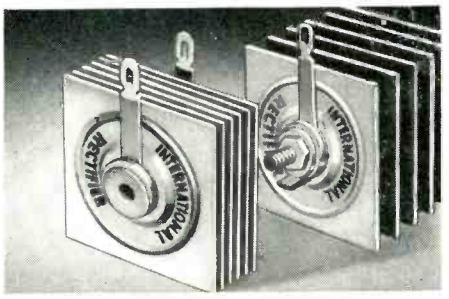

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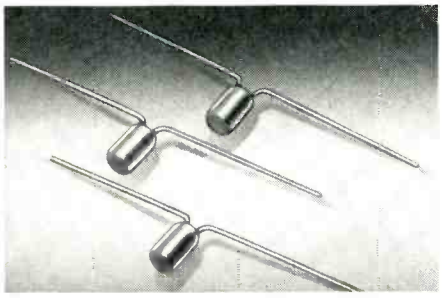
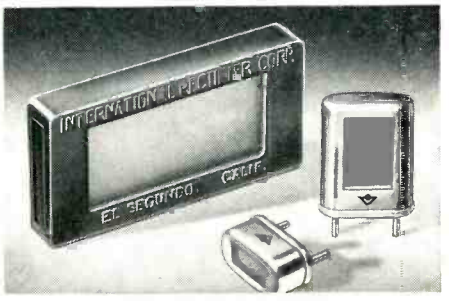


SUB-MINIATURE SELENIUM DIODES

Developed for use in limited space at ambient temperatures ranging from −50°C to +100°C. Encapsulated to resist adverse environmental conditions. Output voltages from 20 to 160 volts; output currents of 100 microamperes to 11 MA. **Bulletin SD-1B**



PHOTOELECTRIC CELLS

Self-generating photocells available in standard or custom sizes, mounted or unmounted. Optimum load resistance range: 10 to 10,000 ohms. Output from .2 MA to 60 MA in ave. sunlight. Ambient temperature range: −65°C to +100°C. **Bulletin PC 649**

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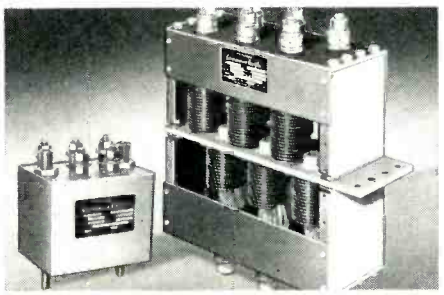

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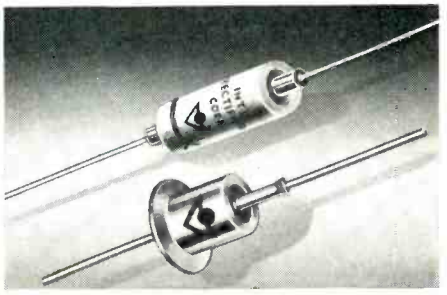

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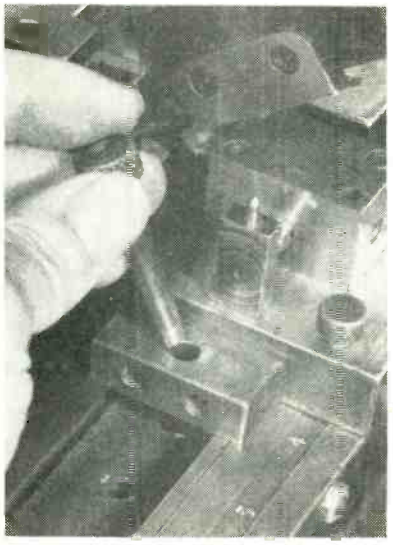


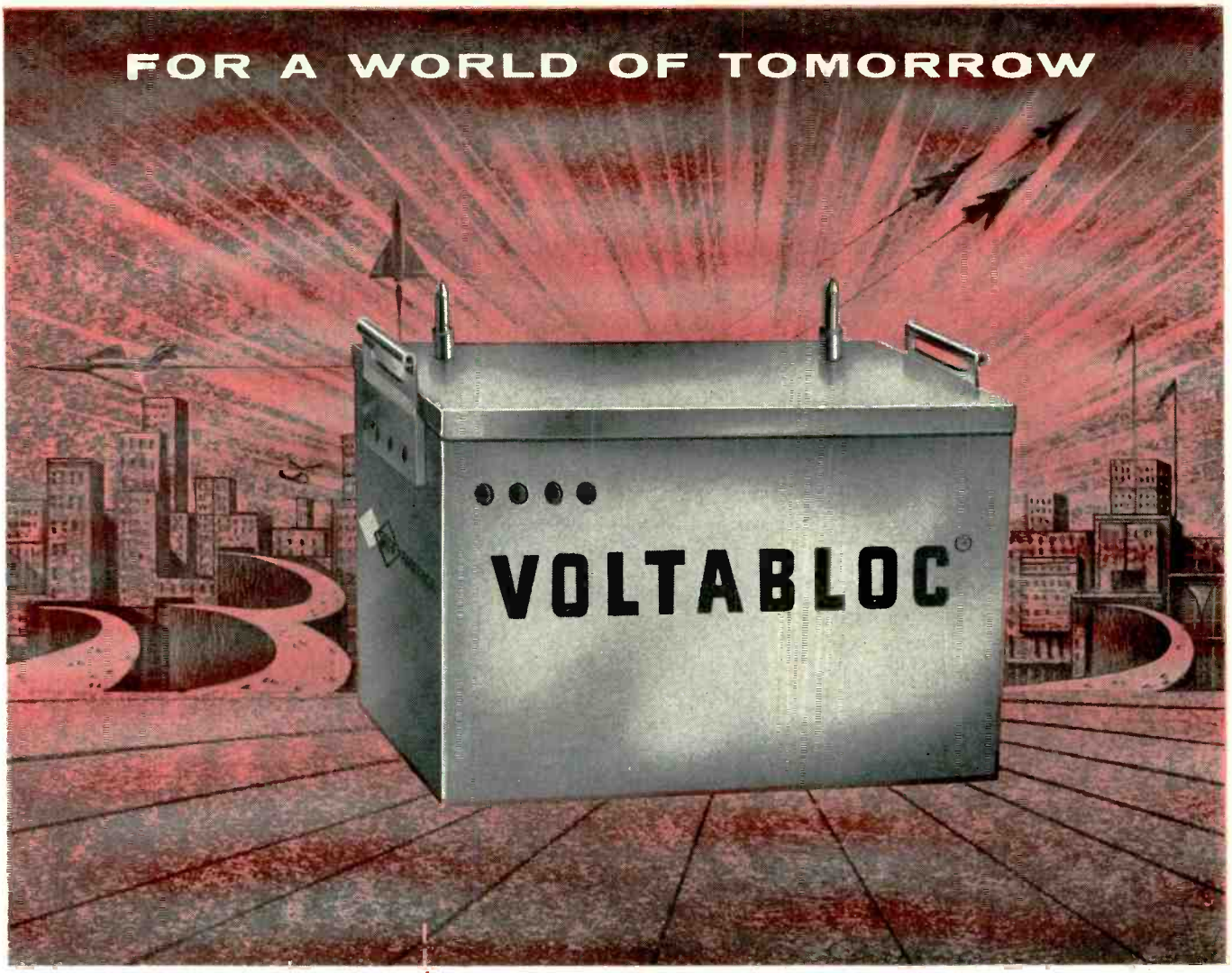
Placing positioning pin of left-hand anvil-blade unit in 4-inch position hole on bed of tool, as initial step in setting cutting blades for desired length of cut

against the micrometer to give the required accuracy.

The third setup step involves placing a card on the positioning peg, then loosening a set-screw and sliding this peg to locate the two cuts where they will give maximum strength to the card. The steel crossbar on the handle slides freely in the left-hand blade arm, to permit this change in cutting length.

The cutting blades are of hardened steel, ground razor-sharp. This gives a smoothly sheared edge on the paper-base phenolic that serves as the winding card for a linear or nonlinear unit.

Adjusting micrometer to set right-hand anvil-blade combination to desired thousandth of inch



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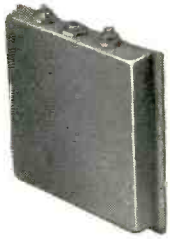

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New Products

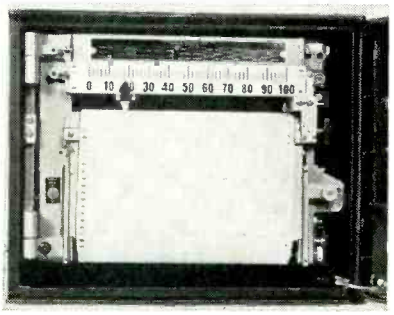
Edited by WILLIAM P. O'BRIEN

86 New Products and 51 Manufacturers' Bulletins Are Reviewed . . . Control, Testing and Measuring Equipment Described and Illustrated . . . Recent Tubes and Components Are Covered

HIGH-SPEED RECORDER

logs any changing variable

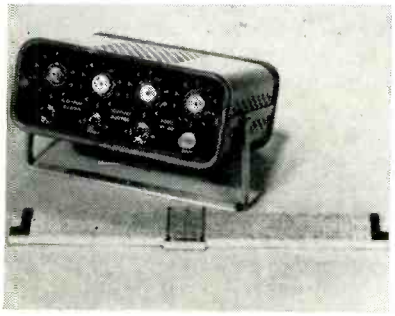
MINNEAPOLIS-HONEYWELL REGULATOR CO., Industrial Division 4428 Wayne Ave., Philadelphia 44, Pa. A high-speed electronic recorder, capable of logging any changing variable literally within a split second, has been developed. The strip chart instrument requires only ¼ sec for its pen to cover the full 11-in. chart width. It was designed primarily for research



centers, laboratories and experimental stations where emphasis is on high-speed measurement and charting of changing conditions which can be measured by d-c output transducers. The amplifier of the new recorder has a high input impedance and increased output power. It is of plug-in construction. A manual pen lifter prevents ink clogging or tearing of chart paper. Accelerated chart speeds, appropriate to the split-second pen speed, are available.

ELECTRONIC COUNTER

features small size



WESTPORT ELECTRIC, 149 Lomita St., El Segundo, Calif. Model WE-610 is a portable, 4-decade, electronic counter featuring small size (3 models can be mounted side-by-side in a 3½ by 19-in. panel) and light-weight construction (6 lb complete, 12 oz without power supply). Combination of glow transfer tubes and simplified circuitry results in an attractive unit which is reliable and long lived despite its small size and relatively low cost. When using 60-cycle power frequency as a time base this unit can be used to calibrate timing devices such as x-ray timers, relays and actuators. Because of its high counting rate it makes an excellent radiation counter, and in conjunction with an external timer, an ideal radiation rate meter. Response is 0 to 5,000 pps; maximum indicated count, 10,000 units; sensitivity, 50 mv rms.

SWEEP GENERATOR

operates automatically

CHADWICK-HELMUTH CO., P.O. Box 321, Monrovia, Calif. The new Sweep-Sync, model 201, produces linear horizontal sweep on oscilloscopes for the display of a selected number of cycles on the vertical axis signal. This number, once set by a front panel control, remains constant over the sweep rates 5 cps to 100 kc automatically, and no adjustments are required for changes in signal amplitude or frequency. The instrument is designed to be used in sine wave or pulse testing

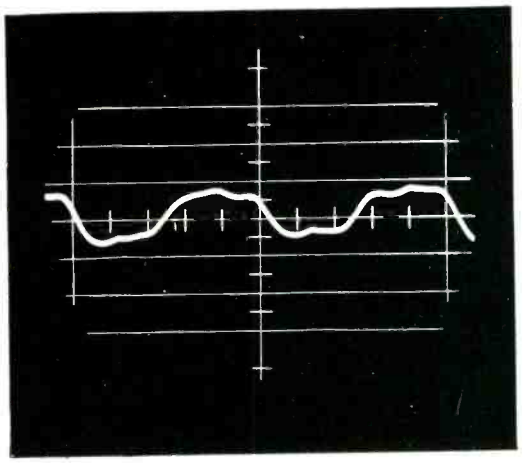
where frequency or prr variations make conventional procedures inadequate. Features include complete printed wiring and miniaturization, small size occupying only 4 in. of front panel width, and cabinet design allowing access to all parts with no disassembly.

CAPACITORS

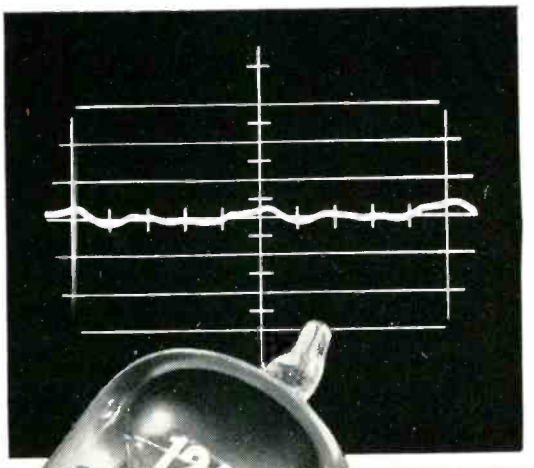
of the flat Mylar type

SANDERS ASSOCIATES, INC., Nashua, N. H. Type KFM series of flat Mylar capacitors can readily be used

Closest thing yet to zero hum level



Standard audio preamp tube



The new 12AD7

Unretouched oscillograms show relative hum levels taken under identical conditions in a typical cascaded preamp circuit. Low hum level in the oscillogram on the right was achieved simply by substituting the new Sylvania type 12AD7 for a standard audio preamp tube.

Now...

Sylvania 12AD7...the low-hum, low-micro preamp tube you've been waiting for

Sylvania has been working two full years to bring you an audio preamp tube with exceptionally low hum and micro characteristics. It is a 9-pin miniature, high mu (100) double triode.

You can incorporate the new 12AD7 into both existing and new audio equipment designs . . . with improved performance.

The 12AD7 reduces cost of incoming inspection for low hum. That's because the 12AD7 has been circuit designed, and circuit tested for minimum hum and microphonism.

Write for complete details on the new 12AD7 plus these other important Sylvania audio tube types

6SN7GTA 6L6GB
6V6GT
12AU7A 12AX7

SYLVANIA®

Sylvania Electric Products Inc.
1740 Broadway, New York 19, N. Y.
In Canada: Sylvania Electric (Canada) Ltd.
University Tower Bldg., Montreal

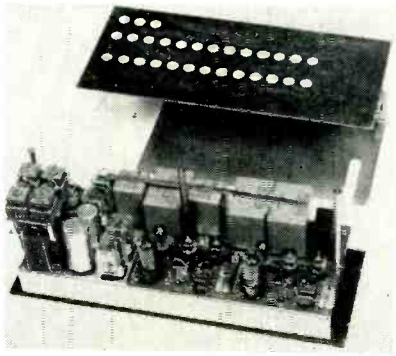
LIGHTING · RADIO · ELECTRONICS · TELEVISION · ATOMIC ENERGY

with printed circuits and automatic assembly processes. All sizes are supplied with 2 sets of parallel leads for convenient mounting. They are made of Mylar polyester film dielectric material and are encapsulated in high quality Kel-F. This construction provides a moisture seal, and stable operating characteristics over a wide temperature range. Multiple lead wires, securely attached to capacitor foils and held rigidly in place by a Kel-F seal, permit varied arrangements of lead connections and reliable attachment to printed circuit baseplates and modular wafers. Standard sizes are rated at 150 and 250 v d-c working at 125 C. For use at 85 C and below, these ratings are increased to 250 and 350 v d-cw respectively.

TERMINAL EQUIPMENT

for control signals

RADIO FREQUENCY LABORATORIES INC., Powerville Rd., Boonton, N. J. Model 983 Voicon terminal is used for the transmission and reception of control signals over an in-use telephone channel without impairing the quality of the speech. Primarily designed for use by airlines to control unattended slave radio stations, it is equally useful for many industrial applications. Two tone channels are placed above 2,400 cps and are isolated with respect to the voice circuit by voice bandpass filters. Model 983 is applicable to microwave and power line carrier voice channels as well as those derived on physical pairs.

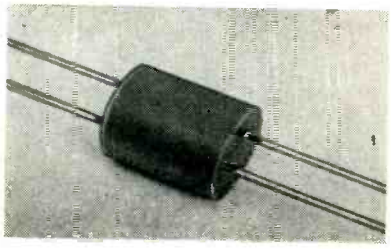


The equipment consists of a 2-channel frequency shift tone transmitter and a 2-channel frequency shift tone receiver, each with power supply, voice band-pass filters and isolation transformers. Each receiver channel is provided with a dpdt relay in its output circuit. Relay contacts are rated at 2 amperes for direct connection to the controlled function, stepping switches, or power relays. Design of the equipment provides fail-safe operation in the event of signal or equipment failure. The basic terminal provides for 2 control channels with center frequencies of 2,800 and 3,000 cps.

RESISTOR ASSEMBLY

thermally similar

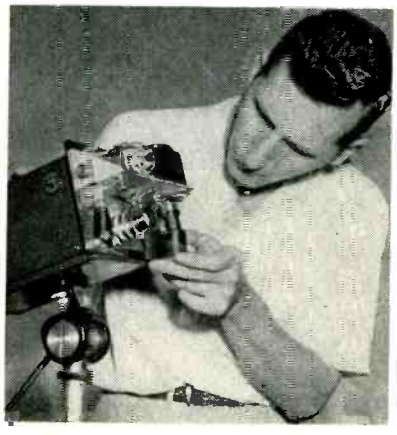
CLAROSTAT MFG. CO., INC., Dover, N. H., has announced a method of encapsulating two precision deposited carbon resistors with nearly identical temperature coefficients in a single enclosure to provide highly similar thermal conditions within the capsule as the ambient temperatures vary. The newly developed thermally similar resistor assembly has been designed to meet the needs of those applications requiring identical resistance change characteristics, such as in color tv, electronic computers, specialized test equipment and guided missile controls, where accurate balancing of circuitry is required.



AUTOMATIC IRIS

for industrial tv camera

RADIO CORP. OF AMERICA, Camden, N. J. Developed for use with the ITV-6 closed-circuit system, the iris illustrated automatically provides constant lighting for the camera's Vidicon pickup tube regardless of external light levels. The iris mechanism automatically masks the lens with the proper filter for any given external light condition. In much the same manner that a phototube responds to light, the camera's Vidicon pickup tube responds to the intensity of external light striking it. With corresponding intensity, the Vidicon activates the iris control mechanism which, in turn, triggers the motor regulators on the camera. The motors automatically unreel the film between the lens and the Vidicon tube until the filter of proper density is in place.



R-F FITTINGS

made of magnesium

MODEL ENGINEERING AND MFG., INC., 65 Frederick St., Huntington, Ind., has developed and produced magnesium fittings fabricated

Now available the revolutionary ELECTRO TEC process* for your LARGE SLIP RING ASSEMBLIES

featuring

- LOWER COST
- CLOSER TOLERANCES
- ONE-PIECE CONSTRUCTION
- JEWEL-LIKE FINISH
- UNIFORM RING HARDNESS
- REDUCED WEIGHT

An assembly with 14 concentric, hard silver rings electro deposited into machined plastic blank. Dovetail locks rings in place. Machined blank insures accuracy. Diameter approx. 11", thickness approx. 5/16".

Cylindrical assembly with 25 rings. Three wide rings accommodate large contact area brushes for high current capacity. Length 4", O.D. approx. 5 3/8".

Now a Complete Service in all sizes of Slip Ring Assemblies

An assembly with 30 rings of various widths to accommodate various current requirements. Unit is approx. 4-5/16" long, designed for flange mounting.

Cylinder type assembly approx. 3 3/4" long with 24 hard silver rings. 1 5/8" O.D. with wall thickness less than 1/4".

*PAT. NO. 2,696,570

ELECTRO TEC is now tooled up, with new expanded facilities for production of large Slip Ring Assemblies to exact customer specification. Sizes range up to 36" in diameter, either cylindrical or disc type.

The exclusive ELECTRO TEC PROCESS*—the electro-deposition of hard silver rings into an accurately machined plastic blank—consistently yields a high degree of dimensional accuracy, excellent concentricity, and a jewel-like ring finish. This process also eliminates expensive tooling and mold charges, frequently lowers costs to 30% of other methods of manufacture. The silver rings are uniformly hard for long life—70-95 Brinell.

ELECTRO TEC one-piece construction precludes dimensional variation due to accumulated errors. The plastic base is fully cured before rings are plated into it, thus preventing separation of base material from the rings.

ELECTRO TEC LARGE SLIP RING Assemblies are widely used in Radar Equipment, Fire Control Systems, Test Tables and many other critical applications. Light weight combined with rugged durability recommends their use in airborne applications.

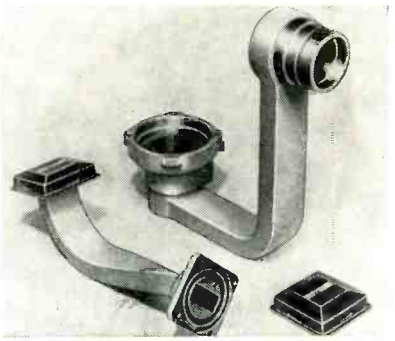
Every user knows the ELECTRIC TEC reputation for quality and superiority in miniature and sub-miniature slip ring assemblies.

Our Engineering Department is available for consultation on any of your slip ring problems without obligation.

ELECTRO TEC CORPORATION

SOUTH HACKENSACK • NEW JERSEY

Want more information? Use post card on last page.



from RG-170/U, RG-171/U and RG-172/U waveguides, and equivalent respectively to RG-68/U and RG-67/U (both aluminum), and RG-91/U (brass). Besides these three standard sizes, the firm is also making special Tru-Guide magnesium waveguides for nonstandard or custom applications. The magnesium components, which are ⅔ as heavy as aluminum and ¼ as heavy as brass, possess higher strength-to-weight ratios than the heavier metals. They conform to military specification MIL-T-85C. A special approved coating process imparts maximum resistance to corrosion and electrolytic action, without impairing physical or electrical performance. Standard sizes are available in any configurations of E and H bends, twists, and lengths up to 10 ft, mounted to any type flange.

POWER SUPPLIES are semiregulated

NJE CORP., 345 Carnegie Ave., Kenilworth, N. J. The ELG line of semiregulated power supplies employ germanium power rectifiers in conjunction with automatic line-regulating transformers and extremely stiff transformers and filters. In most models efficiency is of the order of 94 percent. Average temperature rise is 5 C. Circuitry is extremely simple, and no component is rated at less than 30,000 hr of continuous duty. A typical unit delivers 100 v at 2

DEVELOPED FOR APPLICATIONS . . .

. . . beyond today's horizons

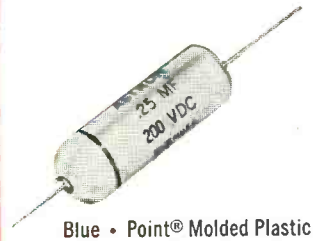
Today's design requirements foreshadow tomorrow's revolutionary applications . . . imposing critical new areas of performance on electronic components.

The vexing problem of efficient capacitor and R. F. filter operation under these ultra-severe conditions of extreme heat, cold, moisture and vibration challenges the imagination of the component manufacturer . . . truly he must create "something completely new under the sun"!

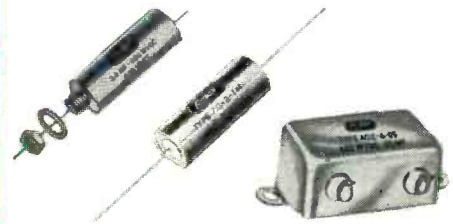
A foremost pioneer in the exacting development of advance-design components, to cope with these requirements, is Astron . . . leader in miniaturization, manufacturer of industry's widest variety of types, whose experience, ability and creative far-reaching point of view produces the significant, highly-engineered designs pictured here . . . proof of a dedication to progress.

The types and styles illustrated are but a few of the many available . . . for complete technical and application information on all Astron products, please request catalog AC-4.

New HEIGHTS OF PERFORMANCE Achieved by advance-design **ASTRON CAPACITORS AND R.F. FILTERS**

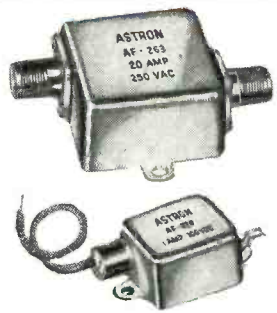


Blue • Point® Molded Plastic Paper Capacitors

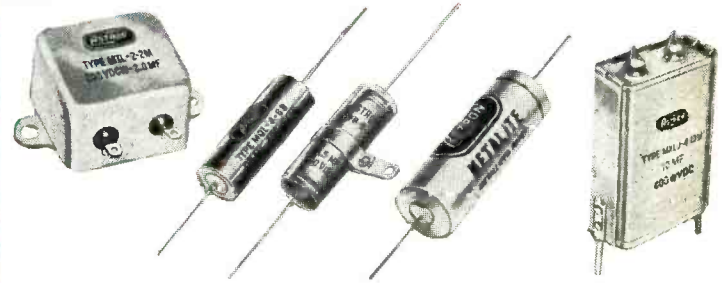


Meteor® High Temperature Miniaturized Capacitors

Series "X"* Mylar† - Plus Capacitors

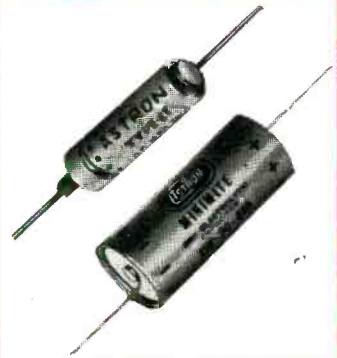


Comet* Molded Plastic Metallized Paper Capacitors



Metalite® and Hy-Met* Sub-Miniature Metallized Paper Capacitors

R. F. Noise Suppression Filters. Complete noise suppression "Packaged" service—Definition of requirements • Engineering analysis • Efficient solutions • Advance-type components • Quality production.



Safety Margin "SM"* Miniature Electrolytic Capacitors

Safety Margin "SM"* Twist-Prong and Cardboard Cased Electrolytic Capacitors

MIL-Type Hermetically Sealed Paper Capacitors

Attention: West Coast Buyers

Astron now maintains a complete West Coast Stock of all standard items . . . see your local Astron distributor.

ASTRON CORPORATION
255 GRANT AVENUE EAST NEWARK, N. J.

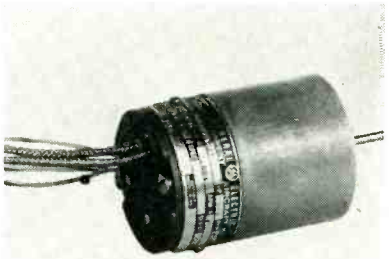
Export Division: Rocke International Corp., 13 E. 40th St., N. Y. C. In Canada: Charles W. Pointon, 6 Alcina Ave., Toronto 10.

*Reg. Du Pont Trademark
†Trademark

amperes, regulated to better than 1 percent against line and load changes, and has less than 0.1 percent rms ripple. Transient response is excellent, and most units can be economically designed for zero-lag response, so as to exhibit no transient deviation outside the regulated zone.

RADIO RECEIVER is all-transistorized

TOKYO TSUSHIN KOGYO, LTD., Shinagawa, Tokyo, Japan. The Sony TR-55 portable superheterodyne radio receiver uses 5 transistors and 4 penlight 6-v batteries. It is equipped with a 2.5-in. dynamic loud speaker. Weight of the unit is 560 grams; frequency range, 535 to 1,605 kc; practical field strength, 1 to 2 mv per meter; electrical maximum output, 20 mw; undistorted maximum output, 10 mw; and selectivity, approximately 15 decibels.

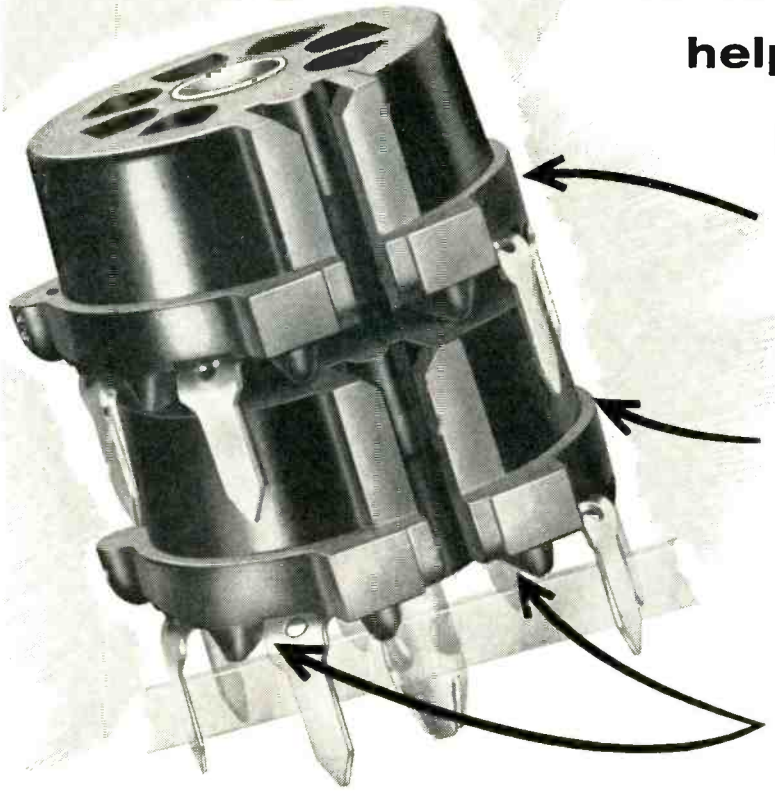


D-C SERVO MOTOR for aircraft applications

GENERAL ELECTRIC CO., Schenectady 5, N. Y., has announced a new miniature d-c servo motor capable of withstanding a high potential of 1,500 v and of responding to field currents of 0.0075 ampere. Suited for aircraft applications on blowers, actuators, tuners and

3 ways better...

One look tells you 3 ways this new Sylvania socket can help you produce a better printed circuit chassis



1. "It supports"

new collar design supports the metal tube shield isolating it from the printed circuit board and contact tails. Short circuits are eliminated.

2. "It stacks"

designed for foolproof nesting to accommodate automatic assembly techniques. Ground-strap slot keys sockets for proper orientation.

3. "It sits up"

contact-tail barriers keep the socket perched higher off the printed circuit board for greater heat dissipation and freedom from flux contamination.

← Available in 7- and 9-pin types

Sylvania printed circuit sockets offer you all the important advantages you need for design efficiency. You get freedom of layout. Contacts fit through smaller holes in the circuit board. You can arrange your circuits for shortest conductor paths.

Sylvania sockets are all-molded. Moisture traps are eliminated; insulation qualities are higher. Contact characteristics are superior. Printed circuit production is more economical because Sylvania sockets are designed for automatic production methods.

Before you package your printed circuit design be sure you take a close look at these sockets. Write for data or samples. Address Dept. L20S.

SYLVANIA®

SYLVANIA ELECTRIC PRODUCTS INC.
1740 Broadway, New York 19, N. Y.
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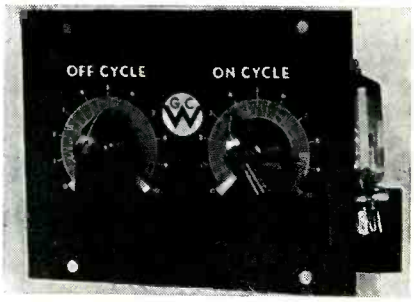
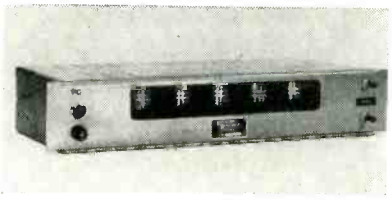
similar devices, the new motor will operate equally well at sea level or at 50,000-ft altitude and within temperature limits of −65 F to 165 F. It is also used as a prime mover in gun direction computer systems, electronic devices, and can be modified for other aircraft and missile applications. The new motor, designated 5BBY13DJ7, draws maximum armature current of 0.8 ampere from a 28-v line. It is rated at 0.002 hp at 6,500 rpm and can be geared to speeds as low as 130 rpm.



REPEAT CYCLE TIMER
uses minimum power

G. C. WILSON & Co., 1915 Eighth Ave., Huntington, West Virginia, has announced a new low cost electronic repeat cycle timer, suitable for design into automatic machines or for process control. Typical applications include sign flashing, life testing, bag filling, refluxing and automatic weighing. Design of the model No. 4 repeat cycle timer utilizes an electronic circuit with two cold-cathode triodes. No warmup is required and no filament power is consumed. Complete, independent adjustability of both ON and OFF cycles from 0.1 to 12 sec is provided. Output is a spdt relay with 5-ampere contacts.



ELECTRONIC COUNTER
features compactness

RANSOM RESEARCH, P. O. Box 382, San Pedro, Calif. Type 200 series

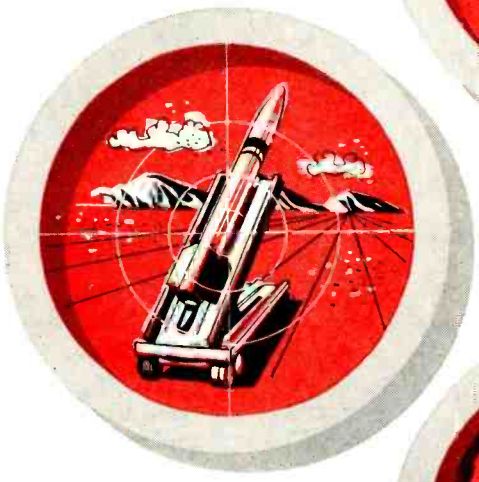
BENDIX-PACIFIC SPECIALIZES IN AIRBORNE RADAR

WHICH IS YOUR RADAR REQUIREMENT?

TERRAIN CLEARANCE RADAR

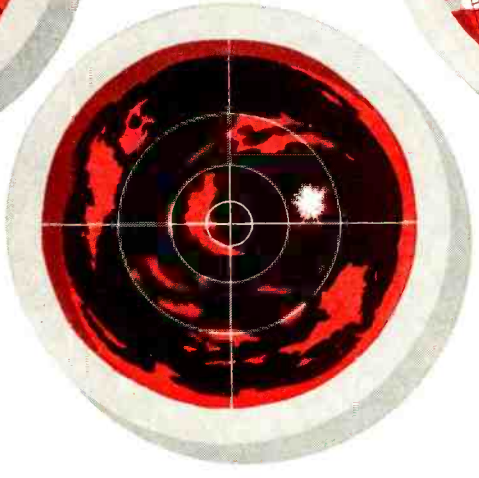
NAVIGATIONAL RADAR

TAIL-WARNING RADAR



MISSILE GUIDANCE

MAPPING RADAR



RADAR BEACONS

Bendix-Pacific specializes in airborne radar, having design experience and manufacturing ability to develop and produce systems radar to meet your requirements.

Let us send a qualified radar systems engineer to visit you at your convenience.

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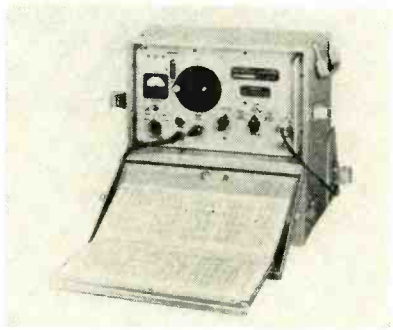
CANADIAN DISTRIBUTORS: AVIATION ELECTRIC, LTD., MONTREAL 9 • **EXPORT DIVISION:** BENDIX INTERNATIONAL, 205 E. 42nd ST., NEW YORK 17

high-speed digital electronic counter is capable of up to 250,000 counts per sec. Modular design of basic plug-in components and the employment of printed circuits make it unusually compact. The basic chassis mounts in only 3½ in. of standard relay rack space and may be mounted on drawer slides or in rugged cabinets. Uses include counting and frequency measurement in laboratory, industrial, military and maintenance applications as a separate instrument or as an integral part of a computer or other device.



FREQUENCY METER is 0.01 percent accurate

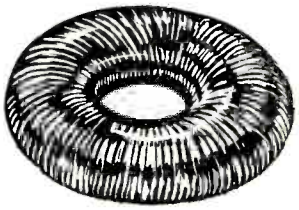
RADIO FREQUENCY LABORATORIES, INC., Powerville Road, Boonton 3, N. J. Model 591 heterodyne frequency meter (military type AN/URM-32) is a portable unit of 0.01-percent accuracy using three fundamental frequency ranges and their selected harmonics to measure frequencies between 10 kc and 1,000 mc. The instrument is used to generate a standard frequency voltage between 125 kc and 1,000 mc or to accept a signal from an external source of 10 kc to 1,000 mc and compare it with either a calibrated vfo or a quartz crystal oscillator. The vfo's cover the basic ranges of 125 to 250 kc, 2.5 to 5.0 mc and 65 to 130 mc. The vfo dials permit readings to one part in 50,000. Front panel controls on the unit consist of: (1) a function switch with position for on-off, operate-modulate, and crystal check conditions; (2) a 3-position range switch for selecting the frequency range of the vfo; (3) a single panel zero-beat corrector for standardizing the vfo against the internal crystal oscillators; (4) an agc; and (5) a voltage switch for measuring A and B bat-

FEATURING TEMPERATURE COEFFICIENTS AS LOW AS 10 PARTS PER MILLION PER °C. BETWEEN —55° AND +85°

NEW FREED HIGH FREQUENCY — HIGH "Q" TOROIDAL INDUCTORS

PRODUCTS OF QUALITY — DEPENDABILITY RESULTS OF EXTENSIVE ENGINEERING

HIGH FREQUENCY TOROIDAL INDUCTORS featuring very high Q, temperature stabilization and low pickup utilizing the latest materials and techniques.



	OD	H
TI-20	1"	9/16
TI-21	5/8	5/16
TI-22	7/8	3/8
TI-23	7/8	3/8

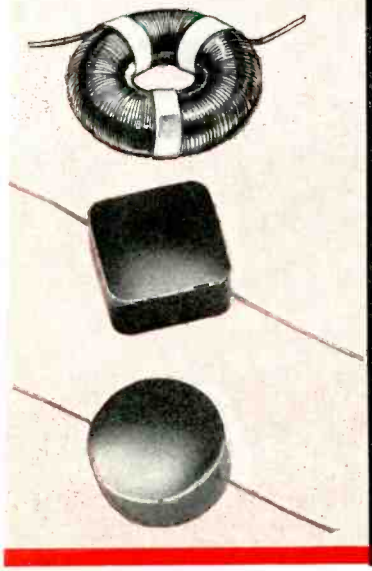
Can be supplied hermetically-sealed, encapsulated or in a metal can.

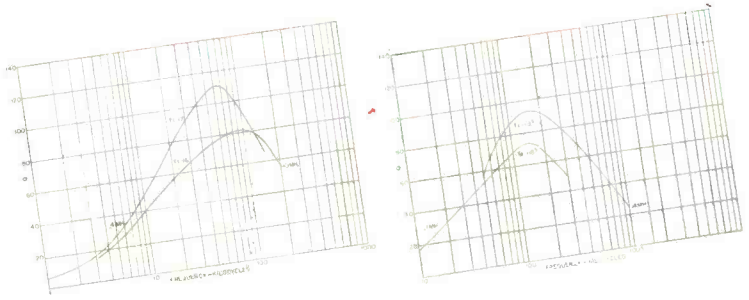
TI-20S
14 stock values from 0.05 Mhy. to 4.5 Mhy.

TI-23S
15 stock values from 10 Mhy. to 700 Mhy.

TI-21S
15 stock values from .01 Mhy. to 1 Mhy.

TI-22S
10 stock values from 10 Mhy. to 150 Mhy.





TI-16
20 stock values from .1 Mhy. to 100 Mhy.

TI-17
18 stock values from .1 Mhy. to 100 Mhy.

TI-18
18 stock values from .1 Mhy. to 100 Mhy.

TI-19
13 stock values from .1 Mhy. to 5 Mhy.

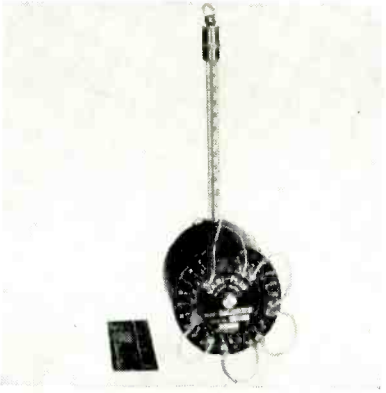
THESE TOROIDS ARE FEATURING HIGH Q AND SUBMINIATURE SIZE. Our unique winding and impregnation process insures very low distributed capacity and consequently self-resonant frequencies far removed from the operating range.

NOW AVAILABLE FROM STOCK FOR IMMEDIATE DELIVERY

FREED TRANSFORMER CO., INC.

1722 WEIRFIELD ST., BROOKLYN (Ridgewood) 27, NEW YORK
Phone: EVergreen 6-1300

tery voltages with the panel voltmeter.



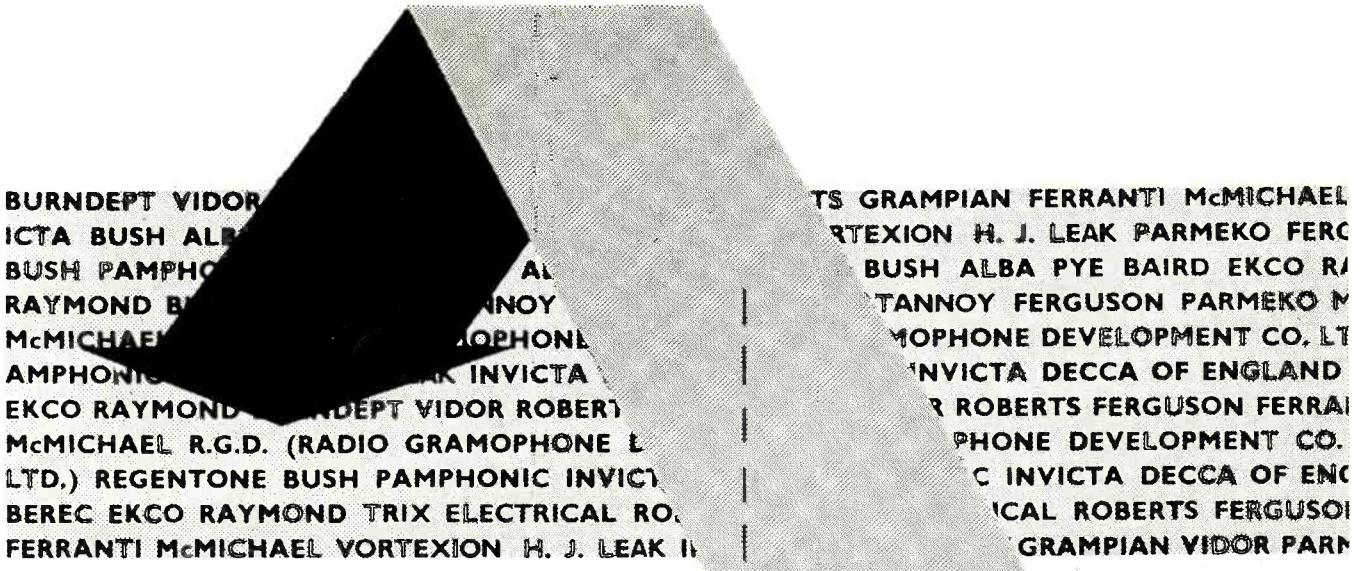
RESISTANCE DECADE
1 to 0.01 percent accurate

CONSOLIDATED RESISTANCE CO. OF AMERICA, INC., 44 Prospect St., Yonkers, N. Y. Series 1000 Vari-Plug resistance decade consists of extremely accurate (1 to 0.01 percent) resistances encapsulated in epoxy-resin, adjustable by interlocking, shock and vibration-proof plug-in connectors, instead of switches. Design permits the provision of a thermometer well for measurement of temperature rise of individual resistances. This enables accurate determination of minutest resistance changes due to current flow and also the selection of optimum wattage ratings to provide the maximum sensitivity without affecting the accuracy. The decade measures 2¾ in. diameter by 2½ in. depth, weighs barely 8 oz. Resistance adjustment can be made in 0.1 or in 1-ohm steps and takes only a few seconds. Nominal power rating of individual resistances is 0.5 w. Versatile application is possible.

SMALL TUBE SOCKET
for use in printed circuits

INDUSTRIAL HARDWARE MFG. CO., INC., 109 Prince St., New York 12, N. Y., has developed a new type miniature tube socket designed for use in printed circuitry. Made of laminated Bakelite, the product snaps and locks into place mechanically when pressure is applied, employing a principle similar to that of a snap fastener. By way

THE GREATEST NAMES IN BRITISH ELECTRONICS USE



British equipment manufacturers are making a vital contribution to the development of electronics in all fields of application.

Their products are being exported to every corner of the world, earning a universal reputation for advanced techniques and excellent performance.

The majority of these electronic equipment manufacturers consistently use Mullard tubes. This choice is decided upon because they prefer the greater assurance of efficiency and dependability, and because the vast manufacturing resources of the Mullard organisation guarantee ready availability of Mullard tubes wherever they are needed.

Supplies of Mullard tubes for replacement in British equipments are available from the companies mentioned below:—

In the U.S.A. International Electronics Corporation, Department E11. 81, Spring Street, N.Y. 12, New York, U.S.A.

In Canada Rogers Majestic Electronics Limited, Department IC. 11-19 Brentcliffe Road, Toronto 17, Ontario, Canada.

Mullard TUBES

Mullard

Electronic Tubes—used throughout the world

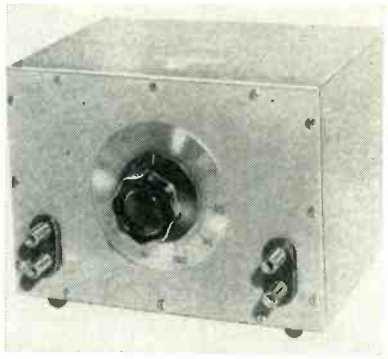
MULLARD OVERSEAS LTD., CENTURY HOUSE, SHAFTESBURY AVE., LONDON, ENGLAND

Mullard

Mullard is the Trade Mark of Mullard Ltd., and is registered in most of the principal countries of the world.

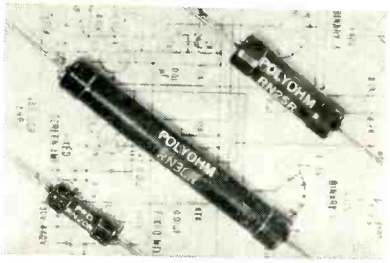
MEV 30

of this self-locking principle, the socket is kept securely in place in the chassis and cannot be jarred loose by vibration or handling, thus eliminating the need to replace parts that have fallen out prior to the final soldering. The contact tails of the product are rigid and therefore cannot flare outward, which permits easy and quick alignment with the chassis holes.



VARIABLE DELAY NETWORK
in ranges of 2 to 2,000 μsec

ESC CORP., 534 Bergen Blvd., Palisades Park, N. J. Unlike conventional tapped delay lines which must be terminated in a high impedance at the selected tap this new variable delay network provides a variable delay between matched impedances. Available in ranges of 2 μsec to 2,000 μsec, the No. 300 series illustrated afford flexibility in obtaining long delays, with time delay proportional to angular rotation of the control shaft.



POLYOHM RESISTOR
exceeds MIL-R-10509A specs

POLYTECHNIC RESEARCH AND DEVELOPMENT CO., INC., 202 Tillary St., Brooklyn 1, N. Y. The Polyohm 1-percent resistor exceeds all MIL-R-10509A specifications. Taking

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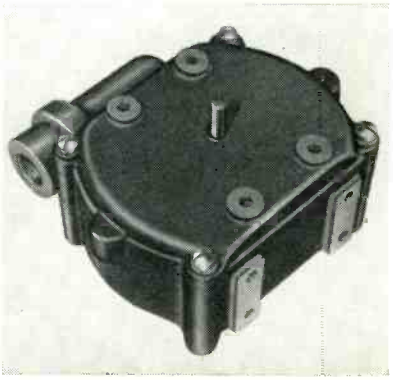
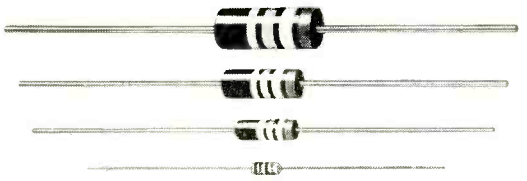
full power at ambient temperatures up to 120C, it is ideal for use in aircraft, guided missiles and other applications where high ambient temperatures rule out ordinary 1-percent resistors. Polyohms are also suited for applications where wire-wound resistors are too expensive or bulky or the effect of their inductive and capacitive reactance cannot be tolerated. Unlike usual film resistors, this resistor will remain well within its 1-percent tolerance even under conditions of high humidity. Its temperature coefficient is only —150 ppm per deg C, which is lower than both the R and X characteristics. The resistor is made in ½, 1 and 2-w sizes.



ROTARY SOLENOID
for 60-cycle operation

LECTRONICS, DIVISION OF LEE SPRING CO., 30 Main St., Brooklyn, N. Y. Designed basically for 60-cycle a-c- use, this solenoid can be operated by standard voltages without the use of rectifiers or transformers. The pure rotary movement produced at the shaft simplifies application by eliminating the need for counter-balancing the spiral action of some rotary devices. The torque developed by the solenoid provides all the desirable force characteristics of conventional linear type solenoids, but permits easy installation without levers and linkages. The solenoid is essentially a toroidal coil system wound on a stator and a shaft mounted rotor. When energized, the magnetic field causes the rotor and shaft to turn. The solenoid is unaffected by vibration and shock, and operates perfectly in any mounting position. Eight basic sizes provide a wide



Allen-Bradley molded fixed resistors are available in four sizes—Type TR 1/10 watt; Type EB ½ watt; Type GB 1 watt; and Type HB 2 watt. They meet RETMA, JAN-R-11 and MIL-R-11 specifications. Rated at 70C ambient, they require no derating if used on plastic board assemblies. When used according to published ratings, they will not open circuit nor have large erratic resistance changes. In cartons or on reels for automatic assembly.

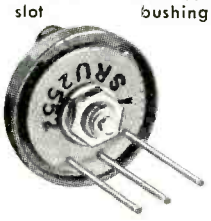
Allen-Bradley Type J molded variable resistors are made in single, dual, and triple unit construction in total resistance values from 50 ohms to 5 megohms. They are rated at 2 watts at 70C ambient. They are outstanding for their low noise characteristics, initially and after use. Metal parts are made of corrosion-resistant materials. Taps can be supplied at 40, 53, and 68% of effective rotation. A Quality product throughout.

ALLEN-BRADLEY QUALITY COMPONENTS for ELECTRONIC CIRCUITS

Type G molded variable resistors (1½ inch diam) are ideal for subminiature assemblies. Available with plain bushings or lock-type bushings with plain or screwdriver shafts. Rated at ½ watt. Total resistance from 100 ohms to 5 megohms.

Type T molded variable resistor (1 inch diam) are compact ½ watt rheostats or potentiometers for hearing aids and other compact applications. Rated at 70C ambient. Total resistance available from 100 ohms to 5 megohms.

Screwdriver slot — Lock-type bushing



Type T potentiometer

Type SO stand-off capacitors

Type FT feed-thru capacitors

Type FT feed-thru and Type SO stand-off discoidal capacitors exhibit no parallel resonance effects normally encountered with tubular capacitors in VHF and UHF frequency ranges.

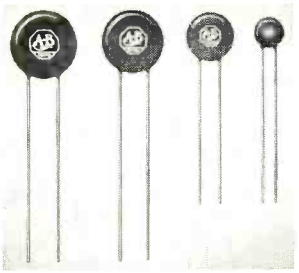
Type FT feed-thru capacitors are furnished with soldering tabs or with screw thread mountings.

Type SO stand-off capacitors have soldering tabs, screw thread mountings or self-tapping threads.

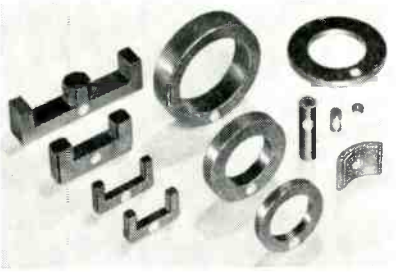
Both types are available from 5 mmf to 1000 mmf.

Ceramic dielectric capacitors Type GP—General purpose capacitors for by-pass and filtering at ambient temperatures up to 85C. In RETMA, JAN, and MIL values from 10 mmfd to .022 mfd in d-c voltage ratings of 500, 1000, 2500, and 5000 volts.

Other capacitors are Type TC temperature compensating; Type LB line by-pass; and Type DY deflection yoke capacitors for television scanning frequencies and voltages in standard nominal values from 5 mmf to 470 mmf.



Every step in the manufacture of these capacitors is performed in the Allen-Bradley plant.



Available in various shapes and sizes to fit black and white and color television circuits or for general electronic applications.

A-B ferrite cores are offered in 3 performance classifications—WO-1, WO-2, and WO-3. The WO-2 material has lower losses and higher permeability, making possible appreciable cost savings in designs of television receivers. Write for performance data on Allen-Bradley ferrite cores.

Allen-Bradley radio, electronic, and television components are a QUALITY line of basic units for all types of electronic equipment. Their stable performance characteristics and their conservative ratings make them ideal components for critical applications in military electronic devices. They are widely used in industry, and by manufacturers of radio and television receivers. There are many additional QUALITY items in the Allen-Bradley line, that are not shown here, which merit your consideration. Allen-Bradley sales engineers are located in principal cities from coast to coast. Call your nearest Allen-Bradley office for technical data, today.

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

ALLEN-BRADLEY
RADIO & TELEVISION COMPONENTS
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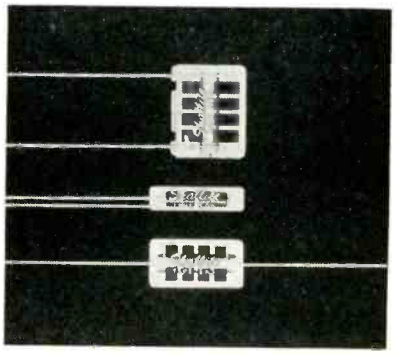
In Canada
Allen-Bradley Canada, Ltd.
Galt, Ont.

range of forms—offering a variety of torque values from fractional in.-lb to 62.5 in.-lb at maximum stroke on continuous duty models. Stock models give 20, 30 and 45-deg rotation.

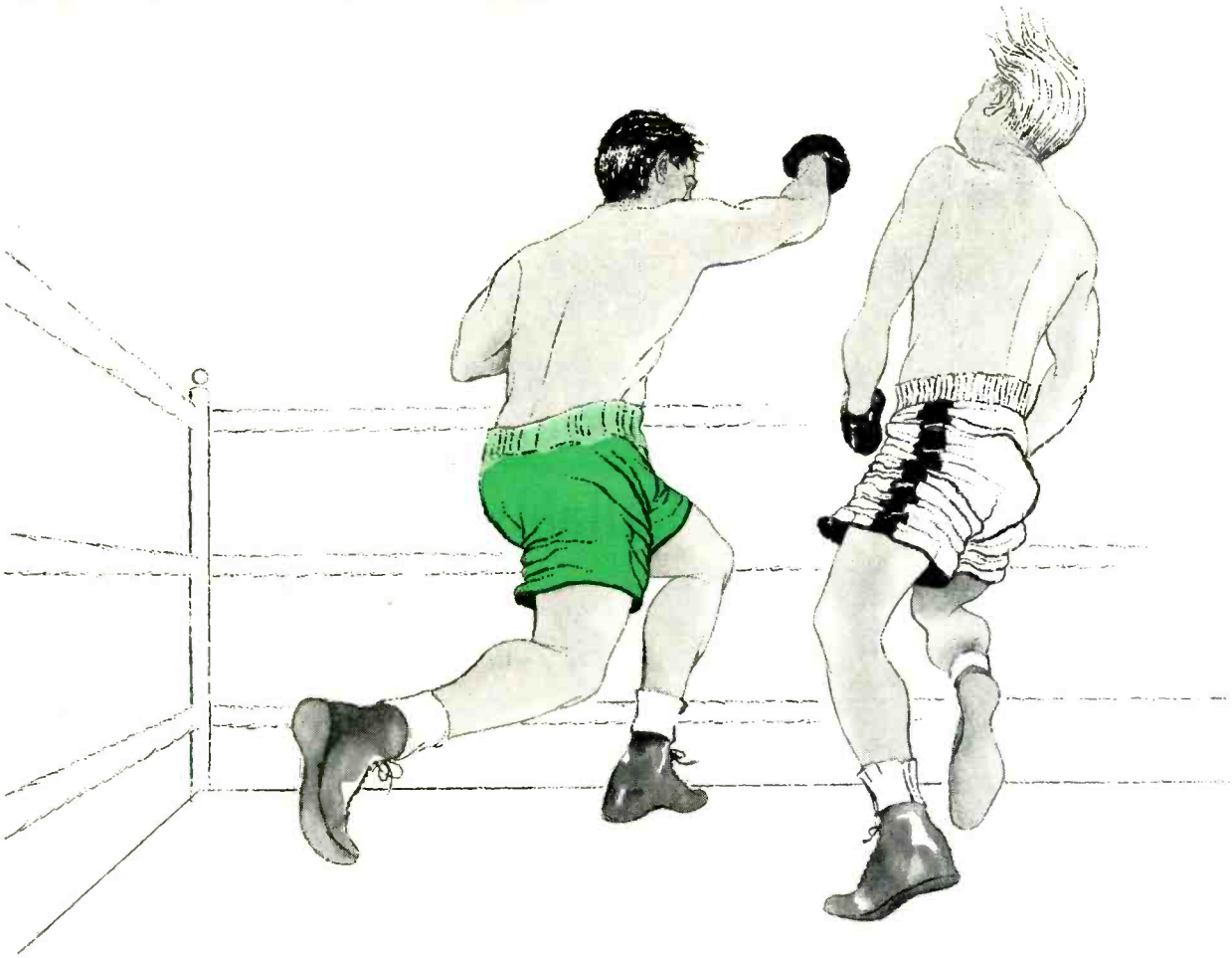


WIRE-WOUND RESISTORS
of the wire-lead type

SHALLITE, INC., 10 Mill St., Paterson 1, N. J., has developed a wire-lead precision wire-wound resistor based on transparent encapsulation. The visibility feature, resulting from the transparent encapsulation, assists materially in precluding service failures caused either by bubbles or strains. The new resistors include other outstanding improvements, such as the electric welding of wire to the phosphor bronze leads—all being completely visible through the transparent encapsulation and exceptional compactness. These wire-lead type resistors will exceed the requirements of Government Specification MIL-R-93A. A single-page bulletin now available contains a dimensional diagram, chief features and a table of specifications.

STROBO-SYNC
for vibration analysis

WINKLER LABORATORIES, 5225 North 20th St., Phoenix, Arizona. Model



Constantin K.O.'s your production problems with another modern, complete plant.

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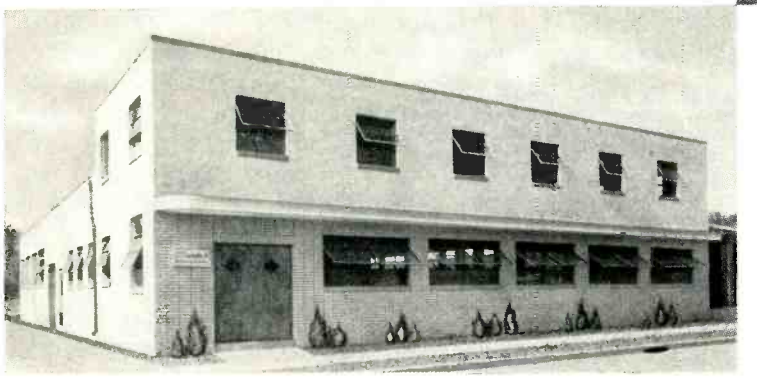
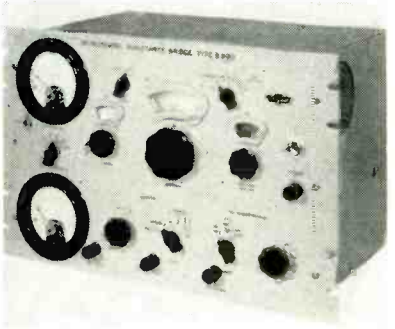


In order to meet the increased demands of the Electronic Industry, L. L. Constantin continues its expansion program by the opening of another, modern plant at 187 Sargeant Avenue, Clifton, New Jersey. Equipped with complete facilities for VOLUME PRODUCTION, the Clifton Plant will manufacture the full line of Constantin's high-quality, glass-to-metal vacuum seals.

L. L. Constantin & Co.
MANUFACTURING ENGINEERS

TRANSISTOR MOUNTS • SINGLE TERMINALS • COMPRESSION HEADERS • END SEALS • CRYSTAL BASES • AN CONNECTORS • MINIATURIZATION

201A Strobo-Sync automatically synchronizes commercial and existing stroboscopic light sources with electrically driven h-f shake machines so that objects may be observed in apparent slow motion. The visual frequency is adjustable from zero to over 2 cps and once adjusted remains constant over the entire range of shake frequencies from 20 to 2,000 cps. No adjustment of amplitude is required over a 40-db range. No other adjustments exist or are required. It eliminates the need for an operator normally required to constantly adjust the stroboscopic light frequency. A single-page bulletin giving specifications and price is available.



HAY BRIDGE
for reading inductance and Q

FURZEHILL LABORATORIES LTD., 57 Clarendon Road, Watford, Herts., England. Type B.800 incremental inductance bridge gives direct reading of inductance and Q of iron-cored inductors with or without d-c flowing. Both these parameters are dependent on the value of a-c exitation and accurate metering facilities are included to measure the a-c voltage across the choke under test. A particular feature of the bridge is that it is designed for operation of a range from 25 to 3,000 cps. This has been done to cope with the increasing demand for measurements at frequencies other than 50 cps, such as the checking of inductors for polyphase rectifiers, radar systems and aircraft equipment. Balance is indicated on a logarithmic meter having 5 ranges of sensitivity, fed from the bridge output through a selective amplifier which eliminates waveform errors. This results in a sharp null so that precise and repeatable readings are

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WITH THE NEW

EDO *Direct-Reading* LORAN

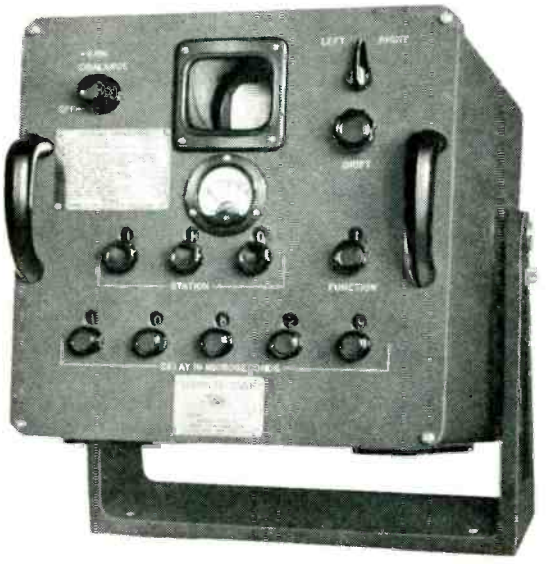
Now, Edo, a recognized leader in marine electronic development, announces a new Loran at a practical price. Built to the highest electronic standards, the Edo Loran gives quick, directly-read time difference readings for accurate plots in a matter of seconds. No calculations, no computations, no tables, no special training needed to operate.

Edo has achieved a practical low price for its new Loran with no compromise in quality by applying the most advanced electronics circuitry. For instance there are less than half the number of tubes in the Edo Loran (only 2[illegible]) than in any other currently available equipment. This at no sacrifice in accuracy and with the advantage of lower power requirements, easier maintenance, and greater dependability.

Features of the Edo ***Model 262 Loran***

- ★ Only 28 tubes including cathode-ray tube and rectifiers.
- ★ Single, compact, light-weight, self-contained unit.
- ★ Low power consumption, 200 watts, 117 volts @ 60 cycles.
- ★ The unit can be mounted on a table, suspended from overhead or bulkhead.
- ★ Large direct reading dials especially illuminated for night use. Recessed CRT requires no hood.
- ★ Delay is not stored and cannot drift.

SEND FOR THE NEW BROCHURE ON THE EDO MODEL 262 LORAN.



Edo CORPORATION College Point, L.I., N.Y. SINCE 1925

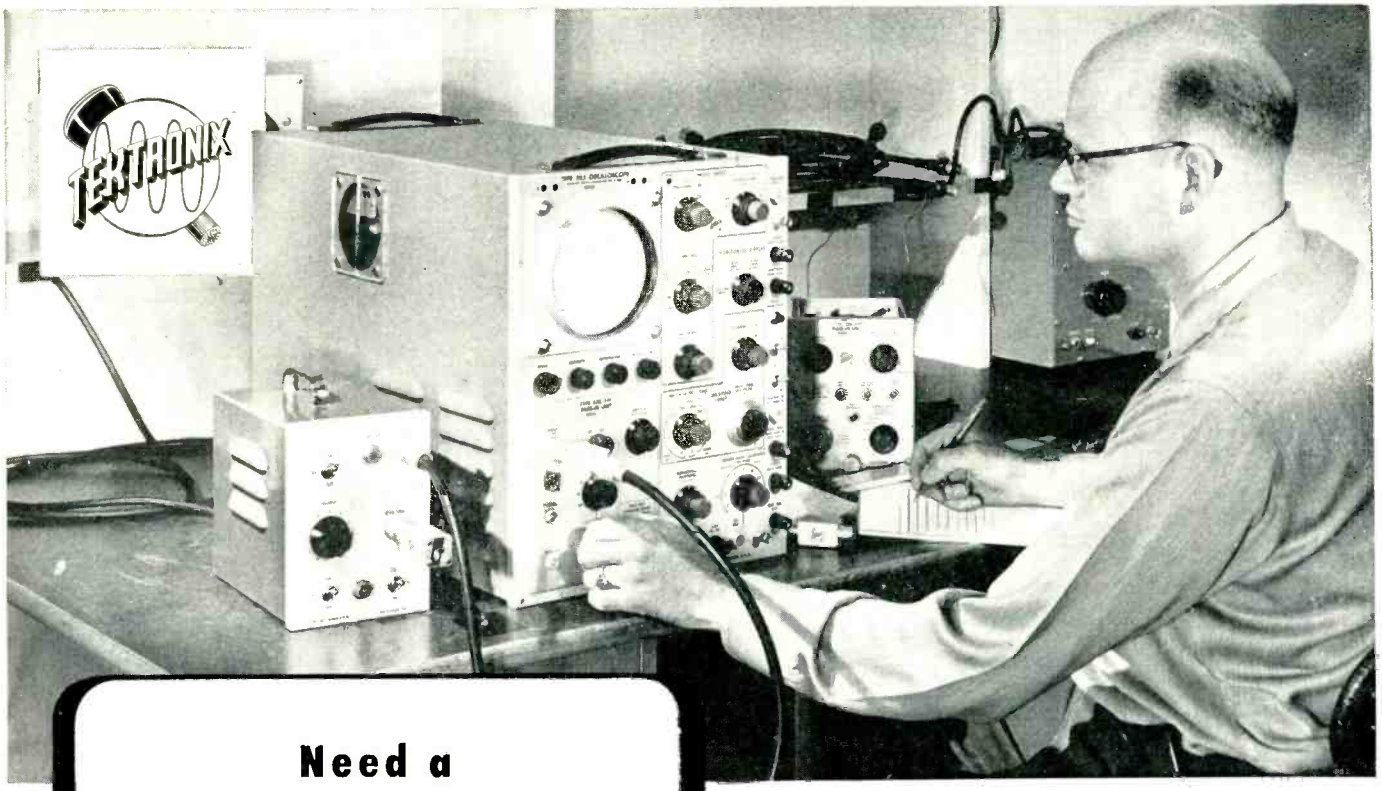
easily obtained. Leaflet B.1 gives circuit description and specifications.

POWER CONNECTORS
meet new military specs

AUTOMATIC AND PRECISION MFG. Co., 252 Hawthorne Ave., Yonkers, N. Y., has announced miniature armored connectors that meet the requirements of the recently amended military specification MIL-C-3767. Plugs are rated for 125 v 15 amperes up to 250 v 10 amperes, and will accommodate cables from 0.125 in. to 0.450 in. in diameter. Insert material is glass-filled melamine (under MIL-P-14). It withstands high impact and retains dielectric properties even after long exposure to moisture while under polarized voltages. Grounding blade on one type (the UP121M) is removable, making the connector serviceable where grounding receptacles have not been provided.

SENSITIVE RELAY
of the miniature type

MAGNADYNE Co., 84 S. Water St., Port Chester, N. Y. Model No. 10 miniature sensitive relay is suited for both commercial and military applications where either single or double-pole miniature sensitive relays meeting high standard shock, temperature, minimum space, and vibration requirements are needed. It has a 10-g standard vibration immunity and a 100-g nonoperating shock resistance. Units are hermetically sealed and conform to MIL-R-5757 specifications. Con-



Need a VERSATILE OSCILLOSCOPE?

Most of the oscilloscope applications you are likely to encounter can now be handled by a single instrument. Tektronix Oscilloscopes of the Type 540 and Type 530 Series have the wide sweep range, triggering flexibility, bright display, and accurate calibration essential to broad application coverage. With one of the wide-band vertical preamplifiers plugged in, the versatility of these oscilloscopes leaves few applications out of range.

Usefulness of these oscilloscopes is further increased by the availability of extra plug-in units for several specialized applications at small additional cost. Conversion is a simple mechanical operation that takes only a few seconds. For instance, if the next job requires sensitivity to a fraction of a millivolt, just remove the plug-in unit previously in use and insert the Type 53/54E unit. You change from one set of requirements to another without handling heavy, bulky equipment.

For complete specifications on these or other Tektronix oscilloscopes, please call or write your Tektronix Field Engineer or Representative, or write us at address below.

DC TO 30 MC OSCILLOSCOPES

Type 541 Oscilloscope, in combination with the Type 53/54K Plug-In Unit, has a dc-to-30 mc vertical passband, risetime of 12 millimicroseconds, and sensitivity to 0.05 v/cm; 600,000,000 to 1 sweep range is continuously variable from 0.02 μsec/cm to 12 sec/cm, with 24 calibrated steps from 0.1μsec/cm to 5 sec/div and accurate 5x magnifier. 10-kv accelerating potential on Tektronix precision C-R tube. **Type 541—$1145** plus price of desired plug-in units.

Type 545 Oscilloscope has same specifications plus accurate delayed-sweep circuitry. Sweep delay is continuously variable from 1 μsec to 0.1 sec; 12 calibrated ranges are accurate within 2%. Incremental accuracy is within 0.2% of full scale. Delayed sweep can be triggered by observed signal for jitter-free display. **Type 545—$1450** plus price of desired plug-in units.

DC TO 10 MC OSCILLOSCOPES

Type 531 Oscilloscope has dc-to-10 mc passband, 0.035-μsec risetime with wide-band plug-in units. Sweeps and accelerating potential same as Type 541. **Type 531—$995** plus price of desired plug-in units.

Type 535 Oscilloscope has same specifications as Type 531 plus delayed sweeps as described for Type 545.

Type 535 — $1300 plus price of desired plug-in units.

DC TO 5 MC OSCILLOSCOPE

Type 532 Oscilloscope has dc-to-5 mc passband, 0.07-μsec risetime. Sweep range is 0.2 μsec/cm to 12 sec/cm continuously variable, with 21 calibrated steps from 1 μsec/cm to 5 sec/cm and accurate 5x magnifier. 4-kv accelerating potential on Tektronix precision C-R tube.

Type 532 — $825 plus price of desired plug-in units.

PLUG-IN PREAMPLIFIERS

for Type 540-Series and Type 530-Series Oscilloscopes

Type 53A Wide-Band DC unit	$ 85
Type 53B Wide-Band High-Gain Unit	125
Type 53C Dual-Trace DC Unit	275
Type 53/54D Differential High-Gain DC Unit	145
Type 53/54E Low-Level Differential AC Unit	165
Type 53G Differential Wide-Band DC Unit	175
Type 53/54K Fast-Rise DC Unit	125

All prices f.o.b. Portland (Beaverton), Oregon

Tektronix, Inc.

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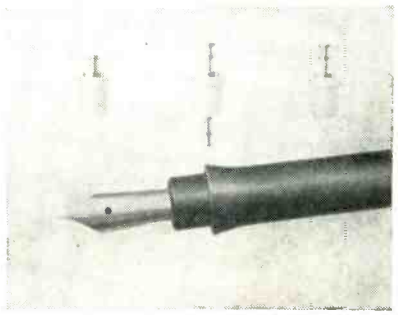
Want more information? Use post card on last page.

tacts are silver, rated 2 amperes, 28 v d-c and 115 v a-c. Life expectancy at rated resistive loads is 100,000 operations. Operating power is 40 mw for dpdt and 20 mw for spdt. The model No. 10 contains a high-efficiency double coil magnetic circuit with a resistance up to 12,000 ohms, with a maximum dissipation of 1 w. Size is approximately 1 in. by 1 in. square by 2 in. in overall length.

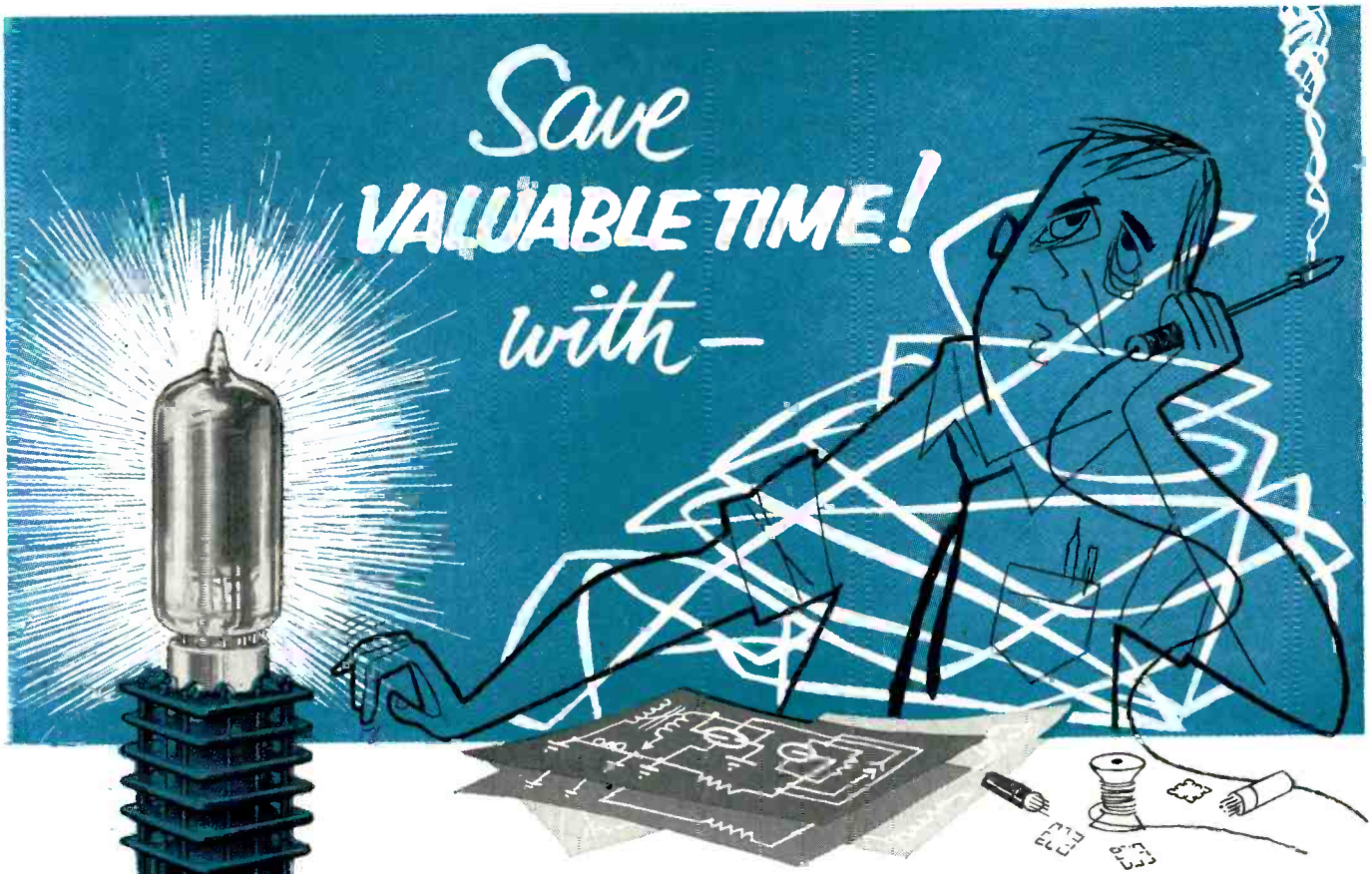


PUSH-IN TERMINALS
mount by a press fit

CAMBRIDGE THERMIONIC CORP., 445 Concord Ave., Cambridge 38, Mass., announces a new series of push-in insulated terminals, designated as X-2182, that mount by a press fit, using Teflon both as a holding material and as an insulator. The new terminals permit a press-fit into mounting panels of $\frac{1}{16}$ in. to $\frac{1}{8}$ in. in thickness, with secure seating that keeps terminals shake proof and firmly attached. These terminals feature high terminal pull strength in any direction. Complete specifications, information and prices are available from the manufacturer.

WIDE-BAND AMPLIFIER
is feedback stabilized

ELECTRICAL AND PHYSICAL INSTRUMENT CORP., 42-19 27th St., Long



MODULIZED
STANDARD CIRCUITS

Why fuss and fume over basic circuit details? That's the technician's, not the engineer's job, when dealing with standard circuitry. There's more important, more profitable, more rewarding work to do in **creative design.**

Which accounts for Aerovox Modulized Standard Circuits. Block diagrams are reduced to functional units that plug or otherwise connect into your designs and assemblies. Modules are complete, wired, tested sub-assemblies to save you untold time, effort, expense. They provide that firm foundation on which you can build up your creative talents. And especially vital in facing today's engineering shortage.

Seven standard circuits are now available in handy module form. Others to follow for both **standard** and **special** circuit requirements. These modules are but part of the Aerovox Automation Program. New type capacitors, resistors, sockets and other components, in conjunction with advanced printed wiring and ingenious automatic assembly techniques, are available to those interested in radio-electronic Automation.

WRITE FOR BROCHURE! ***Engineering details available to anyone writing on business stationery. Let our module specialists show you how to apply these basic circuit assemblies in gaining released time for your creative efforts.***

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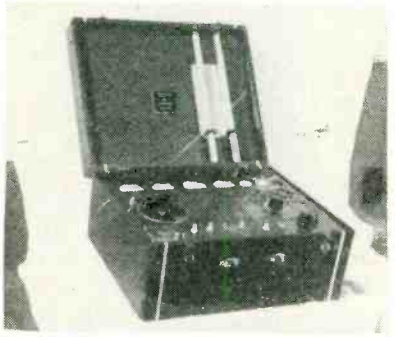
Want more information? Use post card on last page.

Island City 1, N. Y. Model 720 is a feedback stabilized wide-band amplifier designed for use in amplifying to a high output level the fast pulses encountered in nuclear research, tv, transient studies and other applications where a wide bandwidth and a faithful pulse reproduction are required. The bandwidth is from below 2,000 cycles to 10 mc. Gain is continuously variable by coarse and fine attenuators from 60 db to 20 db. The output stages deliver up to 50 v pulses into a 1,500 ohm load or 10 v into a 200 ohm load. An input polarity switch allows either positive or negative input pulses to appear as positive output pulses. A switch selects either high or low input impedance.



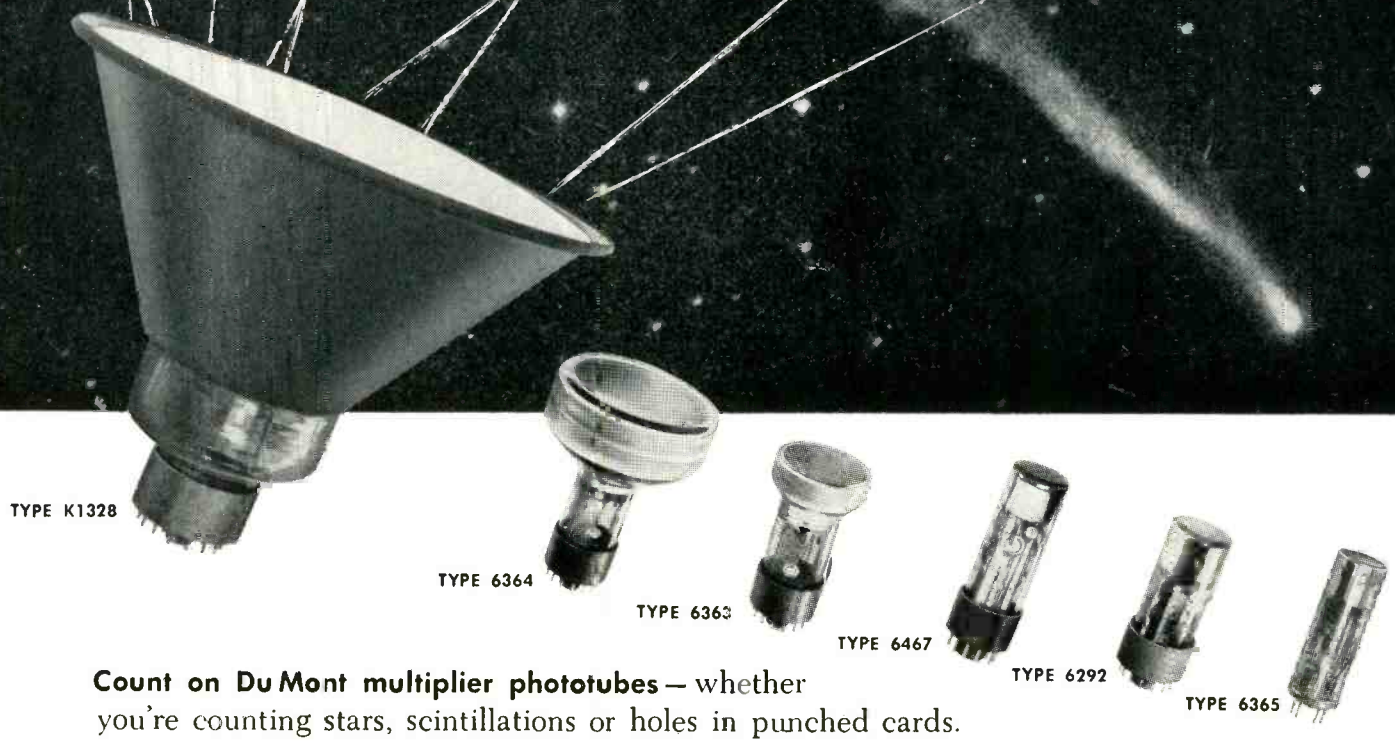
TUBE ANALYZER
tests thyratrons, phanotrons

ALECTRIC MFG. CO., 7842 39th Ave., Kenosha, Wisc. Model No. JB-16A tube analyzer tests tubes under actual circuit operating potentials. The thyratron actually functions in an operating circuit with meters indicating operating points, permitting quick comparison with tube manufacturers' specifications and curves, and automatic indication of critical grid volts. All common industrial tubes are accommodated, from 1 ampere upwards. Average arc-drop voltmeter provides direct indication. Input of the analyzer is 105 to 130 v a-c, 1 phase, 60 cycle. A bulletin on the unit is available.

TRANSISTOR
features low cost

GENERAL ELECTRIC CO., Syracuse, N. Y., has placed on the market a

IN COUNTING THE COUNTLESS...



Count on Du Mont multiplier phototubes — whether you're counting stars, scintillations or holes in punched cards.

Du Mont multiplier phototubes have become a *standard for comparison.* Their superior long-term stability, their high cathode sensitivity, their excellent signal to noise ratio and their very high amplification are all well known by critical users of multiplier phototubes.

From ¾" size used in oil-well exploration and medical research to the 16" giants used for large area counting in astronomy and critical radiation studies, Du Mont multiplier phototubes share the same fine characteristics.

If you aren't familiar with Du Mont multiplier phototubes and want the complete story, just write on your company letterhead to:

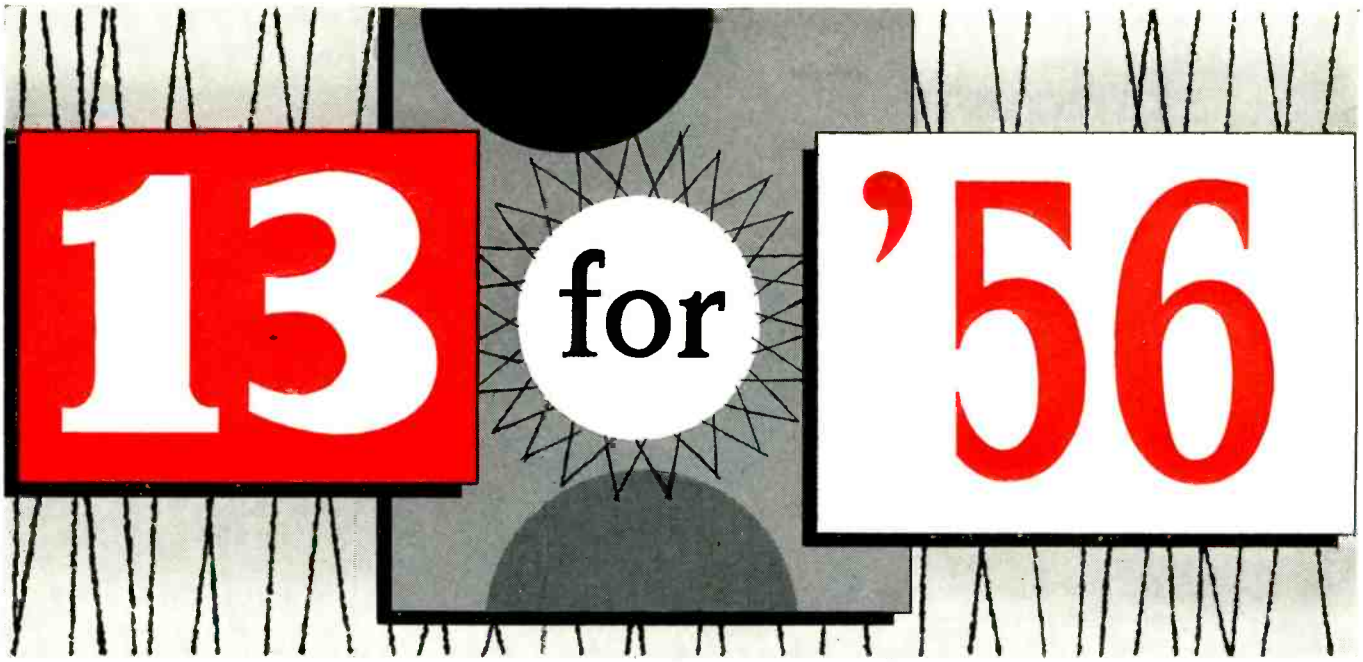
DU MONT

Technical Sales Dept. **ALLEN B. DU MONT LABORATORIES, Inc.** 760 Bloomfield Avenue, Clifton, N. J.

new stable, inexpensive transistor. The 2N107 is a *pnp* audio transistor produced by the company's fused junction process. It has an all-metal case and is hermetically sealed for the maximum in reliability. Hermetic sealing is accomplished by the use of glass-to-metal seals and resistance-welded seams. The 2N107 in a typical common emitter circuit has a power gain of 38 db. Maximum frequency cutoff is 2.5 mc with the design center at 1.0 mc. Alpha design center is 0.95. Maximum collector voltage is −12 v and the maximum junction temperature is specified at 60 C. The transistor is capable of dissipating 50 mw in 25 C free air.

TIME DELAY RELAY
is highly reliable

E.V. NAYBOR LABORATORIES, 30 Manorhaven Blvd., Port Washington, N. Y. Type TD6H time delay relay uses an air dashpot for the delay function which affords good stability under various environmental conditions. Resistance to high shock and to vibration at all frequencies is inherent in the design. Contacts provide direct control of equipment in most cases, thus eliminating the need for an auxiliary relay. The snap-action switch is operated by an efficient magnetic actuator. Relay operation is d-c at standard nominal voltages. Coil resistance values to 12,000 ohms can be supplied and relays for a-c operation are obtainable on special order. Contact arrangement is single or dpdt and contacts are rated at 5 amperes for 115 v a-c or 26.5 v d-c. Temperature range is



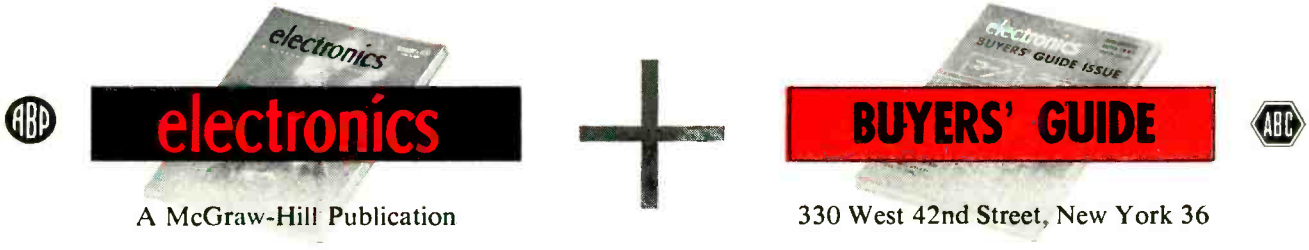
. . . what we mean is a promotion package of 12 REGULAR ISSUES OF ELECTRONICS plus the BUYERS' GUIDE

Whatever other dilemma the advertising budget planner may be in, he is in agreement on one salient point: *advertising, to develop maximum effectiveness, must be continuous.* Nothing, absolutely nothing, pays off on the long run more than getting potential buyers familiar with your product and trade name by way of consistent, all-the-year-'round advertising. Once ascertaining what your market is, the logical approach is to keep your product in view of this market through continuous, consistent advertising.

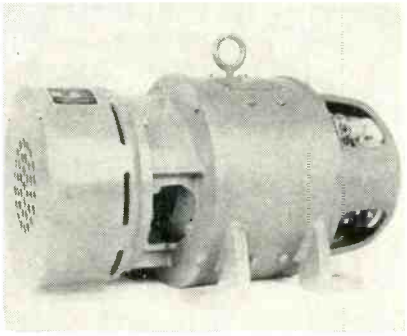
For instance, the value of continuity in advertising was demonstrated by a series of surveys conducted by McGraw-Hill's Research Department. It was found through the results of these surveys that continuity in advertising increased the recognition of an electronic firm's products 26% in nineteen months.

For the budget planner with an electronic account, there is a ready-made promotion package for the consistent, continuous year 'round advertising program. That program is 12 regular issues of ELECTRONICS plus the 1 issue of the ELECTRONICS BUYERS' GUIDE . . . 13 insertions for 1956! Here you will reach more than 40,000 subscribers who *pay* to get ELECTRONICS – owners, partners, corporate officers, managers, department heads, chief engineers and especially: electronic, electrical, design and research engineers; in brief, the people of the industry who are responsible for buying the products you promote in the sales pages of ELECTRONICS and the buying reference pages of the "Guide." With a consistent, continuous advertising program in 13 issues of ELECTRONICS (12 regular issues plus the "Guide") manufacturers have discovered that they get the greatest return from their advertising dollar investment because ELECTRONICS reaches the men who influence purchasing.

BUDGET NOW FOR 13 INSERTIONS IN '56!

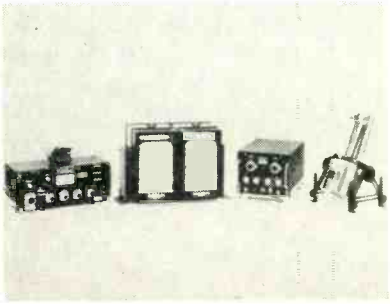


—65 C to 125 C with altitude to 70,000 ft.



CONVERTER
28 v d-c to 400 cycle a-c

GEORATOR CORP., Manassas, Va., has developed the unit illustrated to meet the need for a converter to supply 400 cycles where only 28 v d-c is available. It consists of a continuous duty, 28 v d-c motor, direct coupled to a Nobrush generator. The generator rotor is mounted directly on the motor shaft and the generator stator and its housing bolted directly to the motor housing. This eliminates couplings and results in an overall size little greater than that of the motor alone. The converter pictured delivers 1.5 kva single phase 400 cycles, 115 v. Other outputs are available. Two or three phase can also be supplied on the output. No brushes, slip rings or commutators are used in the generator. Thus there is no r-f interference originating there, and virtually no maintenance required for the generator portion.



SCINTILLATION COUNTER
for geophysical exploration

MT. SOPRIS INSTRUMENT CORP., 1320 Pearl St., Boulder, Colo., has announced the model SC188DA air-

Puts your business on a cash basis

If you are an electronics manufacturer or a wholesaler with annual or potential sales of $1,000,000 or more you can profitably use our kind of banking service to provide increased working capital without increased indebtedness or dilution of profits.

Why not investigate this modern approach to your money problems and learn how you can put your business on an all-cash basis, with wider opportunities for sales and profits.

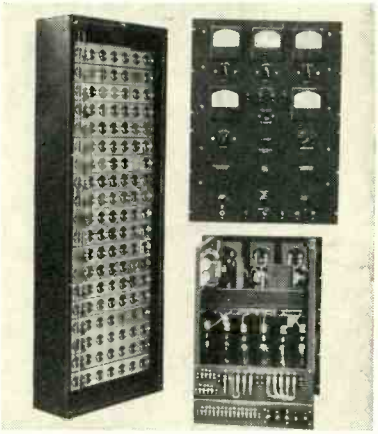
More than four hundred companies in various industries are now profitably using our banking services.

Textile Banking Co., Inc.

Providing operational financing for manufacturers and distributors of furniture, apparel, electronics, plastics and textiles.

55 Madison Avenue, New York 10, N. Y.

borne-carborne scintillation counter. Some of the features are: dual level discrimination against high and low energy radiation for limited spectral selection; range expanding at no sacrifice in sensitivity with a zero displacement control; synchronous logging of absolute altitude and counting rate with a dual recorder; and advanced circuitry for high pulse resolution, linearity and accuracy. The system is completely shock mounted and uses ruggedized vacuum tubes throughout. A 4-page folder contains illustrations and specifications.



POWER SUPPLIES
with 0.5 percent regulation

NJE CORP., 345 Carnegie Ave., Kenilworth, N. J. A new group of high-current regulated supplies exhibit the characteristic of zero recovery time from a line or load transient. Designed around a fast-response thyratron rectifier, a stiff filter, and a large output storage capacitance, these units have been successfully used in computers, telemetering systems and aircraft-control applications in which the power supply must simulate an ideal battery. Instead of the 200 to 500-millisecond time-lag between a step change in line or load and the correction for it, in the zero-lag system the voltage never leaves the regulated region. Standard regulation is 0.5 percent against static line changes of 20 percent, static load changes of 100 percent, dynamic line changes of 10 percent, and dynamic load changes of 25 percent. Standard ripple is less

Why take **"FISHERMAN'S LUCK"?** ...

trying to pick the correct resistors for your circuits from "stock" items or catalog pages? Specify GLOBAR® Resistors and be *sure* of getting *exactly* what you want.

Over ninety percent of the GLOBAR® Resistors made are "custom-engineered" in the correct sizes, shapes, resistance values and characteristics—to solve *specific* circuit problems. Try us and see!

It costs no more to use

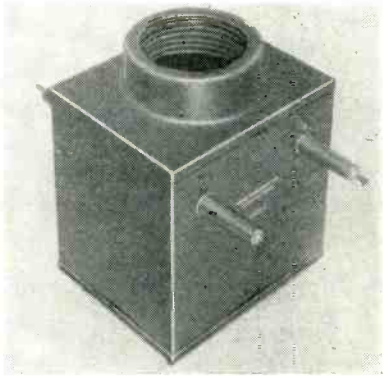
GLOBAR®

Ceramic Resistors

GLOBAR Division, The Carborundum Company, Niagara Falls, New York

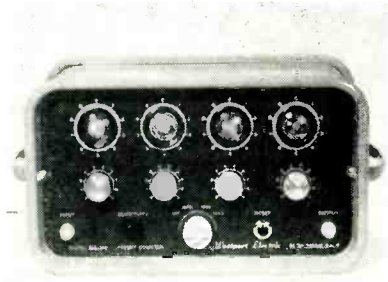
87-526

than 0.1 percent. Thirty stock models are described in catalog Z-5.



PULSE TRANSFORMER features high power rating

FISHER ENGINEERING, INC., Huntington, Ind. The D211C4B pulse transformer will handle 15,000 v. The transformer is designed to operate with pulse widths of 20 μsec and features a rise time of less than 1 μsec. Duty cycle is 4 milliseconds, continuous. Total maximum variation of output pulse from nominal peak value is less than 5 percent. Weighing 45 lb, the unit measures 8 by 6½ by 9 in., including four stud mounts on the base, but not four 3-in. feedthrough insulators on the primary and secondary sides. The transformer is hermetically sealed and oil filled, and has the bellows-type expansion drum.



PRESET COUNTER has 0 to 5,000 pps response

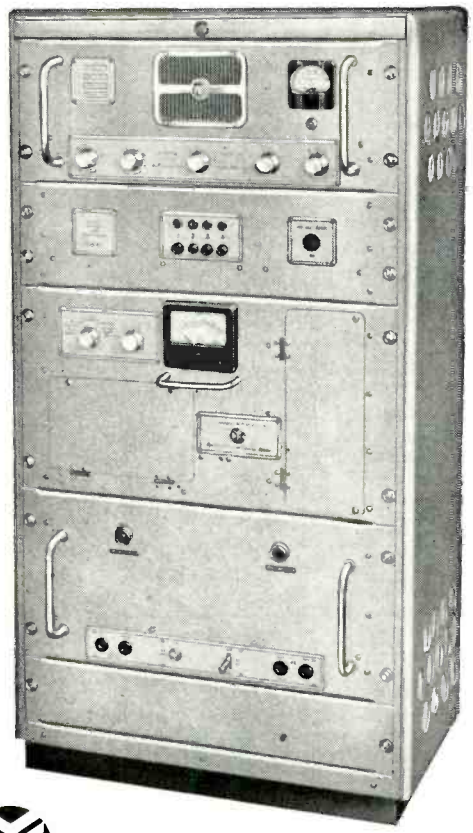
WESTPORT ELECTRIC, 149 Lomita St., El Segundo, Calif. Model WE-310 is a small, lightweight preset electronic counter featuring basic simplicity and long term dependability. An operator may set in any number from 1 to 9,999 by rotating each of the four decade

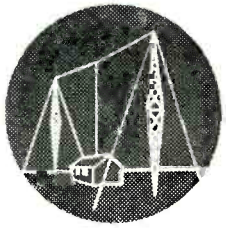
60 WATT H.F. FIXED STATION

This completely new Pye equipment has been specifically designed for point-to-point communication and will fulfil equally well a ground-to-air role in air traffic control systems.

Push button control brings any one of four preselected channels into immediate operation; this facility is also available when the equipment is installed for remote unattended operation. The 60 watt Fixed Station Transmitter offers R/T, C/W, or M.C.W. operation with 'break-in' facilities on telegraphy.

The equipment is suitable for unattended operation in the tropics.





Telecommunications

CAMBRIDGE ENGLAND

Pye (New Zealand) Ltd.
Auckland C.I., New Zealand

Pye Radio & Television (Pty.) Ltd.
Johannesburg
South Africa

Pye Canada Ltd.
Ajax, Canada

Pye Limited
Mexico City

Pye Pty Ltd.
Melbourne, Australia

Pye Limited
Tucuman 829
Buenos Aires

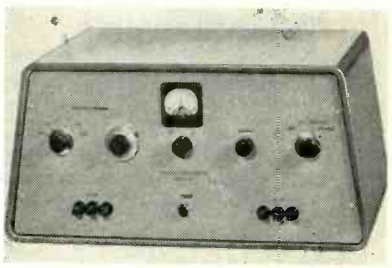
Pye (Ireland), Ltd.
Dublin, Eire

Pye Corporation of America
270 Park Avenue
New York

PYE LIMITED . . CAMBRIDGE . . ENGLAND

Telephone: Teversham 311

selector switches to the appropriate number. The unit will count until this total has occurred; then, coincident with the last input pulse, it provides an output pulse. Either of two modes of operation is selected by means of a front panel selector switch. On CYCLE, the WE-310 counts to the present number, produces an output pulse, resets itself automatically, and resumes counting. Thus, the instrument is ideal for grouping or batching any items which can be counted. In the MANUAL position of the selector, the instrument counts to the preset number and then opens or closes a pair of relay contacts which hold until the unit is manually reset. Response is 0 to 5,000 pps. Size is 6 by 6 by 11 in.; weight, 12 lb; price, $449.



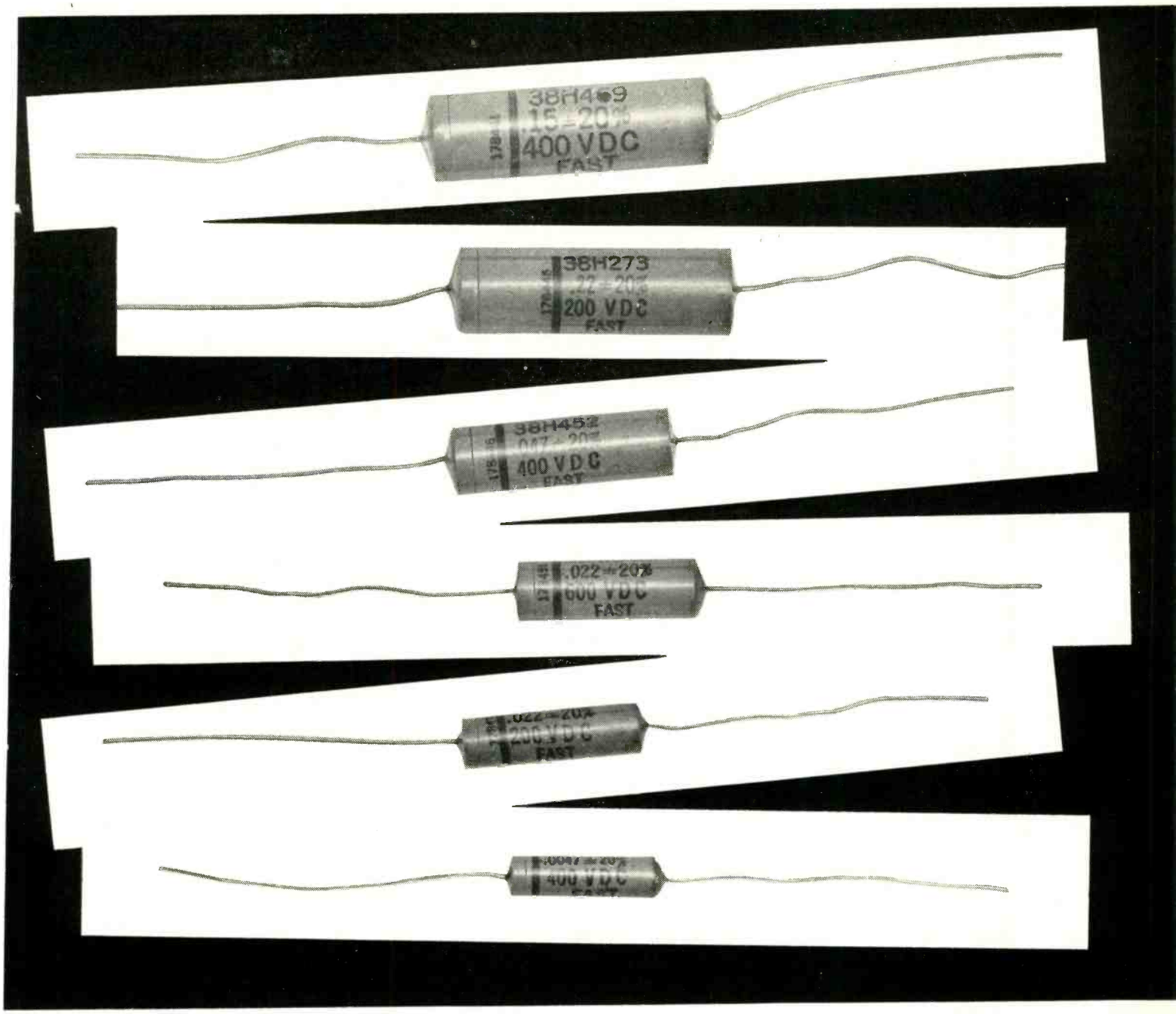
STABILIZED AMPLIFIER
is wide-band type

PHOTRON INSTRUMENT CO., 6516 Detroit Ave., Cleveland 2, Ohio. Model D4 d-c amplifier has a gain of 50,000 with drift referred to input of less than 25 μv per hr. Frequency response is d-c to 100 kc for gain up to 1,000. Gain is continuously adjustable from 0.001 to 50,000 by a 10-turn precision potentiometer and a 6-step decade attenuator. Accuracy of gain settings is $\pm$1.5 percent. Input impedance is 1 megohm. Either pen or string galvanometer can be driven directly from output. Adjustable frequency-compensation for the Photron pen galvanometer is provided.

MEGOHMMETER
is battery operated

FREED TRANSFORMER CO., INC., 1715 Weirfield St., Brooklyn 27, N. Y. Model 2030 battery-operated portable megohmmeter measures

Fixed paper capacitors are cased in low-loss **RESINOX*** **10900**



MONSANTO PHENOLIC SELECTED BY JOHN E. FAST & CO. BECAUSE OF OUTSTANDING ELECTRICAL PROPERTIES

For components requiring low electrical loss characteristics at high frequencies, it will pay you to consider Resinox 10900 Natural.

This thermosetting material has proved its outstanding dielectric strength in a wide variety of critical radio, television and electronic applications. Its water absorption (percentage by weight) is rated at 0.03.

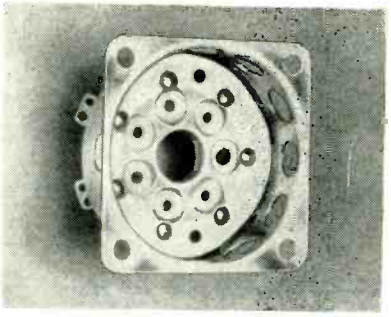
In addition to superior electrical loss properties, Resinox 10900 offers excellent moldability and fast cure, as well as low after-shrinkage.

Perhaps Resinox 10900 is exactly what you need to solve an electrical parts problem. Write today for full information. Monsanto Chemical Company, Plastics Division, Dept. E-11, Springfield 2, Mass.

MONSANTO

*Resinox: Reg. U. S. Pat. Off.

leakage resistance from 5 megohms to 10,000,000 megohms in 5 ranges with an accuracy of ± 3 percent. A regulated 500 v supply is incorporated in the instrument for supplying test potential. The instrument is entirely self contained, safe and rapid to use. Readings are obtained instantaneously on a large easy-to-read meter. Battery drain has been reduced to a minimum in order to insure long term reliable operation. A standard resistor is incorporated for fast checking of instrument accuracy and calibration. For further information on model 2030 and the complete Freed catalogs covering transformers and laboratory test instruments, write directly to the manufacturer.



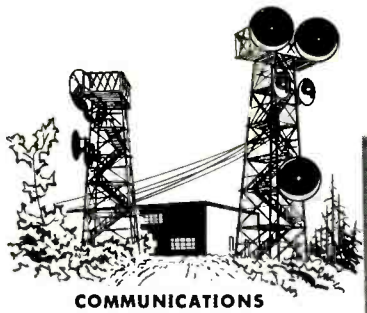
TUBE SOCKET
is 7-pin, steatite insulated

E. F. JOHNSON Co., Waseca, Minn. A compact new vhf septar steatite insulated tube socket requires ⅛ in. less chassis mounting space than previously available types. The socket has an integral ventilated aluminum shield base which submounts the tube for optimum input and output shielding. The socket will permit more compact equipment design in mobile, aircraft and other types of transmitting equipment.

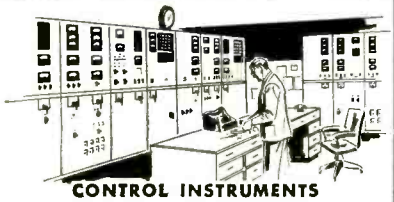
POTTING PLASTIC
is Teflon based

TOPPER MFG. CO., INC., 43 Roselle St., Mineola, L. I., N. Y. Electroplast is a new development in the field of potting plastics. It is a Teflon based general purpose encapsulating plastic, hardened through addition of an activated curing agent which permits the curing to proceed at room tem-

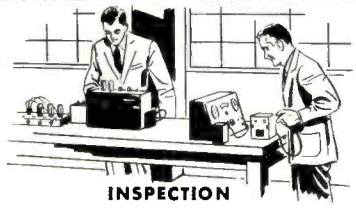
TESTING



COMMUNICATIONS

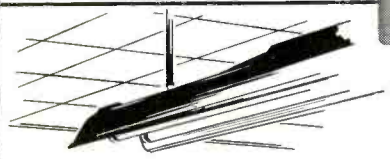


CONTROL INSTRUMENTS

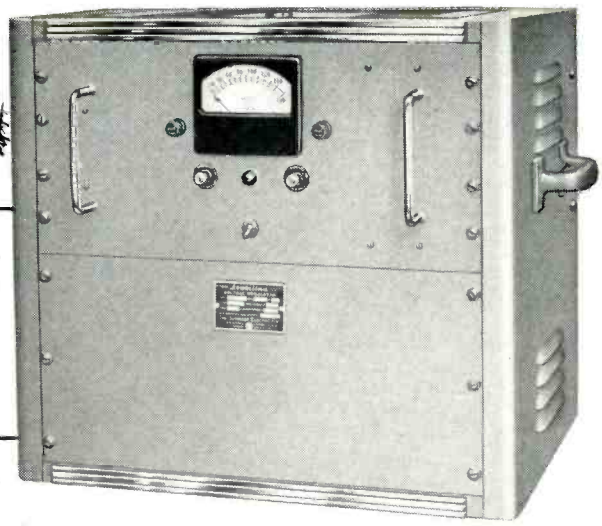


INSPECTION

MOTORS



LIGHTING



ELECTROMECHANICAL (TYPE EM)

For large industrial loads and for applications requiring zero wave form distortion or high efficiency.

STABILINE AUTOMATIC VOLTAGE REGULATORS TYPE EM

Get Zero Wave Form Distortion - with Precise Root Mean Square Voltage Control

When you use *heat, light, sound, power* or *electronic gear,* you need to control voltage to closer limits than it is available commercially.

In thousands of installations the STABILINE Automatic Voltage Regulator type EM has proved itself a rugged "work horse" and an accurate means of maintaining *root mean square* voltage — the rating for which all electrical equipment is designed. Its zero wave form distortion makes it a "must" for many types of electronic equipment. Its efficiency is comparable to fixed-ratio transformers.

STABILINES type EM are available in 115, 230 and 460 ratings for single and three phase duty in capacities up to 100 KVA with correction speeds from .075 to .32 seconds per volt. Send for bulletin for full details.

See Superior Electric's Mobile Display when it is in your area.

THE SUPERIOR ELECTRIC COMPANY

SALES OFFICES: The Superior Electric Company

1436 N. Serrano Avenue, Hollywood 27, California
P. O. Box 946, 2881 El Camino Real, Redwood City, Cal.
453-A Eglinton Ave., West, Rm. 202, Toronto 12, Ontario, Canada
P. O. Box 48, 721 So. Boulevard, Oak Park, Illinois
6716 Laurel Drive, Baltimore 7, Md.
250 Park Ave., Rooms 502, 503, 504, New York 17, New York
P. O. Box 132, 101 Public Square, Medina, Ohio
4515 Prentice St., Rm. 201, Dallas 6, Texas

REPRESENTATIVES

Burgl R. Hill Co., 19481 James Couzens H'wy, Detroit 35, Mich.
Fred H. Haight Co., 3212 Eastlake, Seattle 2, Wash.

THE SUPERIOR ELECTRIC COMPANY
211 Reynolds Avenue, Bristol, Conn.

Please send my copy of the STABILINE Bulletin.

Name .....

Position .....

Company Name .....

Company Address .....

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

Want more information? Use post card on last page.

perature with no health hazard. Electroplast is recommended for transformer encapsulation. Once activated the material may be vacuum cycled, applied as a brush or dip coat or poured into position. It cures at straight room temperature in 12 hr to form a Teflon finish impervious to extreme humidity temperature and chemical action. The cured material is characterized by a low-loss, high-dielectric surface. Electroplast is available in stock sizes of one and five gallon containers. Write for "Design of Potted Circuits."

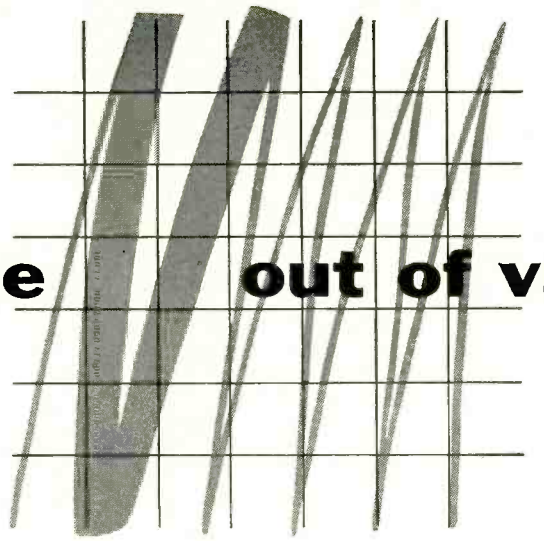
AIRCRAFT INVERTER
is a high-output unit

LELAND ELECTRIC CO., division of American Machine & Foundry Co., 1501 Webster St., Dayton 1, Ohio. A new 41-lb aircraft inverter, model SE-24-1, rated 2,250 v-a at 35,000 ft (44 C) is being produced. As the inverter has electronically controlled carbon piles which regulate power for shunt and exciter fields, both voltage and frequency modulation are a fraction of the allowable specification value resulting in a reduction in the noise level of the servo system. The unit measures 13¼ in. long by 9¼ in. high by 7⅛ in. wide.

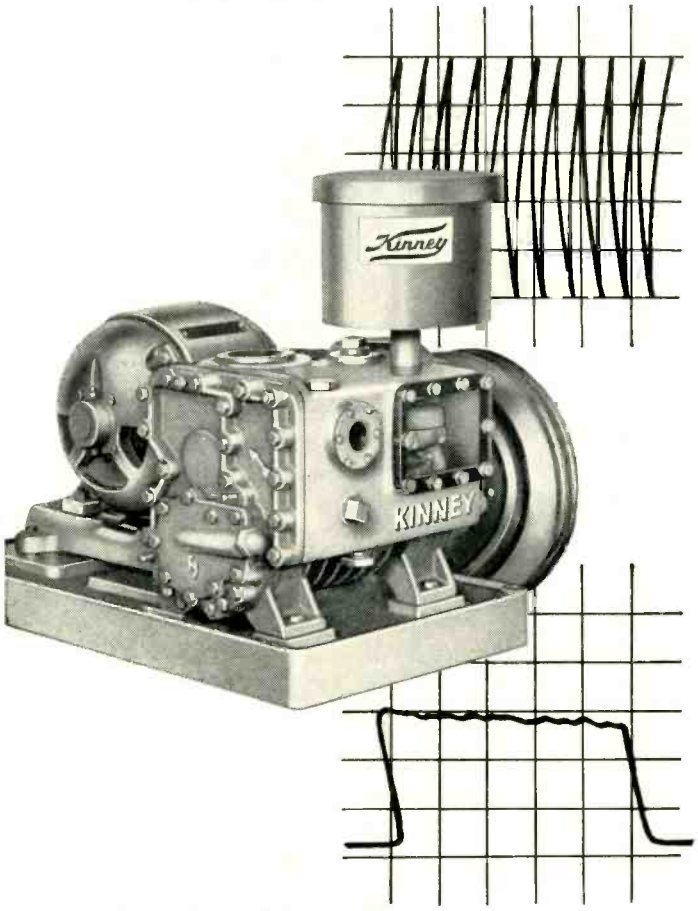
TWIN-TRIODE
for tv cascode use

GENERAL ELECTRIC CO., Schenectady 5, N. Y., has developed the 6CH7 twin-triode for tv cascode r-f amplifier circuits. It is designed to give considerably more gain and a better noise factor on the higher vhf channels than previous cascode tubes. The increased gain is achieved by a new basing connec-

We took the V out of vacuum!



Here's the kind of curve an ordinary vacuum pump plots on a vibragraph. This might be called "nerve-shattering" performance.



Kinney dynamically balanced Pumps plot a curve like this. If you need vacuum, balanced performance is another reason why you need Kinney.

Vibration, that is. Yes, the complete line of Kinney Compound High Vacuum Pumps, now dynamically balanced, is functionally vibration-free . . . another big plus for Kinney:

Ideal for Portable Jobs — Balanced performance is vitally important on light flowing vacuum jobs — and also on cabinet-enclosed installations.

Easier Installation, Less Maintenance — No need for flexible tubing to isolate pump from piping. Less vibration also means longer life for connecting piping, fittings, valves, etc.

Write us today for information of Kinney Balanced Compound Vacuum Pumps—and also about conversion kits for gaining vibration-free performance from Kinney Pumps now in use. Kinney Manufacturing Division, Boston 30, Mass. District offices in Boston, New York, Philadelphia, Cleveland, Chicago, and Los Angeles are all competently staffed to discuss vacuum with you. Los Angeles office carries complete stock and has full service facilities.

WRITE TODAY

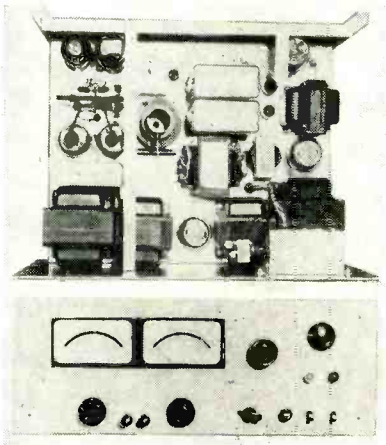
KINNEY MFG. DIVISION
THE NEW YORK AIR BRAKE COMPANY
3565 WASHINGTON STREET • BOSTON 30 • MASS.
INTERNATIONAL SALES OFFICE, 90 WEST ST., NEW YORK 6, N.Y.

Please send engineering information on Kinney Dynamically Balanced Vacuum Pumps.

Name .....
Company .....
Address .....
City ..... State .....

Want more information? Use post card on last page.

tion featuring two cathode leads for the driven-grid section, with the shield between sections internally connected to the grid of the grounded-grid section. Ratings in typical operation as a class A1 amplifier show that with 150 plate volts and a 220-ohm cathode bias resistor, each section has an amplification factor of 36, plate resistance of 5,300 ohms, and transconductance of 6,800 μmhos.

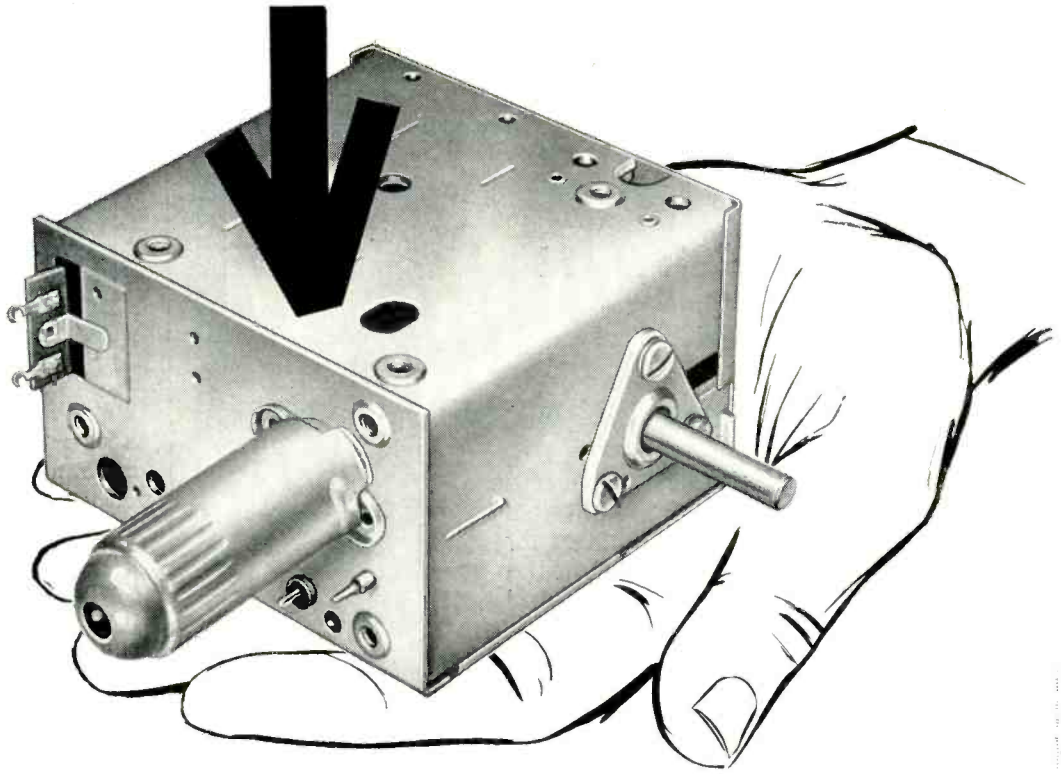


H-V POWER SUPPLY
has 8 ma output at 5,000 v

NEUTRONIC ASSOCIATES, 87-16 116th St., Richmond Hill 18, N. Y. Model R-500A high-voltage power supply is a precision type instrument designed for extra stable, well filtered and uniform operation. Voltage range is 100 v to 5,000 v d-c; current output, 8 ma at 5,000 v; output polarity, either positive or negative, is switch controlled on front panel; regulation, 0.5 percent or better, no load to full load, and with line voltage variation from 105 to 130 v; stability, 0.25 percent; ripple 0.05 percent; and response time, better than 5 milliseconds from 1 kv to 5 kv.

I-F AMPLIFIER
has 100-db gain

LINEAR EQUIPMENT LABORATORIES, 380 Oak St., Copiague, Long Island, N. Y., has announced a new addition to its line of miniature and subminiature i-f amplifiers. The model I.F. 30 is intended for direct incorporation into prototype radar equipments. It has 100-db gain,



NEW

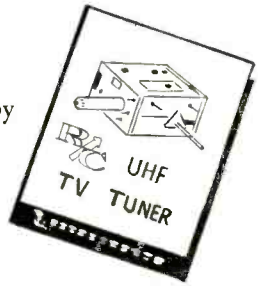
low cost UHF tuner

FEATURES OSCILLATOR RADIATION FIXES

Here's famous R/C quality at the lowest price ever! The new T-90 Series uhf t-v tuner meets all RETMA spurious radiation requirements. Yet it costs less than any previous Radio Condenser uhf tuner.

The double-circuit tuned T-90 Series has excellent i-f and image rejection, giving remarkably high selectivity. As indicated by R/C statistical quality control, the noise figure of the new tuner exceeds most requirements, and the drift characteristics are equally good. Field results to date have been uniformly excellent.

If you want information fast on the T-90 Series, we'll be happy to have one of our engineers call at your convenience.



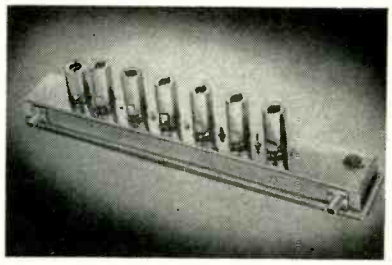
Get Complete Engineering and Performance Data.
Write Radio Condenser for your free copy of Bulletin T-90.

RADIO CONDENSER CO.

Davis & Copewood Streets • Camden 3, New Jersey

EXPORT: Radio Condenser Co., International Div., 15 Moore St., N.Y. 4, N.Y. *CABLE: MINTHORNE*
CANADA: Radio Condenser Co., Ltd., 6 Bermondsey Rd., Toronto, Ontario

Want more information? Use post card on last page.

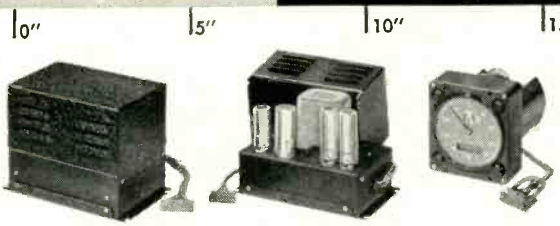


2-mc bandwidth and incorporates a low noise cascode input. The mechanical design permits ready modification of input and output circuitry and impedance for any particular application, thus greatly simplifying the engineering design problems of i-f portions of new equipments. Complete data on linear i-f strips is available on request.

FLYING TYPEWRITER

Uses ferrite-core memory

POTTER INSTRUMENT CO., INC., 115 Cutter Mill Road, Great Neck, N. Y., has put into production a magnetic core memory storage which reduces the number of tubes in the Flying Typewriter (high-speed electronic printer) to less than 300. Printing speeds have been stepped up considerably so that the printer can now print up to 36,000 characters per minute of alphanumerical data and 72,000 impressions per minute of strictly numerical characters. This is equivalent to 15 lines, 80 columns wide, per sec. A standard Flying Typewriter consists of the printer, magnetic storage and power supply cabinets and a type 902 magnetic tape handler. Data can be fed into



Equipment to indicate phase angle difference between two like frequency signals received over radio links. One chassis is a 400-cycle oscillator supply for two indicators. The other chassis combines impedance matching and a servo amplifier for one indicator. Complete system includes an oscillator, two indicators, two amplifiers.

servo problems stock units can't solve

This equipment "does the job right" because it was especially designed for a single application . . . by a company whose major function is solving individual servo control problems with complete, precisely engineered and manufactured servo assemblies.

Of course, if you just want servo *components*, Transicoil can provide them to the highest order of precision and accuracy. But it is in the "package" engineering of unique assemblies that Transicoil's experience and creative imagination offer the greatest value. And in most cases, these assemblies cost no more than the individual components would purchased separately.

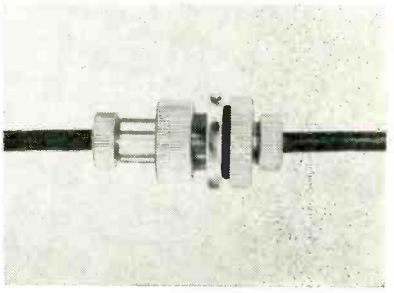
Check out your next servo problem with Transicoil first. Ask for the new gear-motor availability guide if you haven't yet received a copy.

Transicoil

CORPORATION

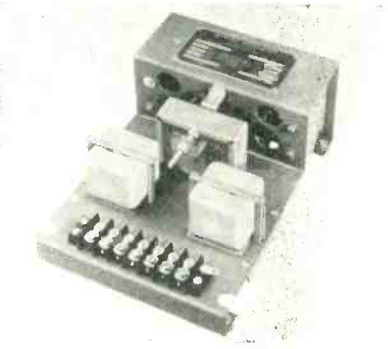
Worcester • Montgomery County • Pennsylvania

the printer from punched or perforated tape handlers or directly from a high-speed digital computer, however.



CONNECTORS
are pressure and water-proof

MIDWESTERN INSTRUMENTS, Indianapolis, Ind. The PW-51 pressure-proof and water-proof connectors are available in 5 sizes with AN-type inserts. All sizes are machined from Naval brass bar stock or aluminum bar stock. The standard finish on brass is polished chrome; however, they are obtained with or without plating. The aluminum connectors are clear anodized. These connectors were designed to be not only waterproof, but to also withstand pressure in excess of 200 lb per sq in. They will withstand the severe use which military requirements impose without breaking or leaking. Pressure-proof caps are available to fit both plugs and sockets.



V-F CONTROL
for motor alternator sets

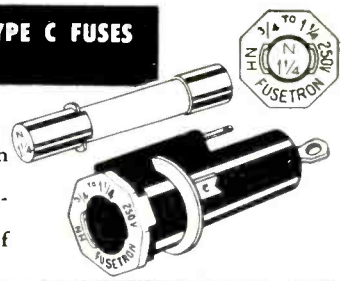
ELECTRIC REGULATOR CORP., 314 Pearl St., Norwalk, Conn. A new line of VF controls is made up of compact, inexpensive, integrated single packages for the precise regulation of both voltage and fre-

. . . You'll find the Type and Size Fuse you need

• • • IN THE COMPLETE LINE OF BUSS AND FUSETRON FUSES

The following is only a partial listing. The complete BUSS line of fuses includes dual-element (slow blowing), renewable and one time types — in sizes from 1/500 ampere up . . . plus a companion line of fuse clips, blocks and holders.

FUSETRON TYPE N and TYPE C FUSES and FUSEHOLDERS



Especially suitable for protection of TV

Ears on fuses match slots in holder.

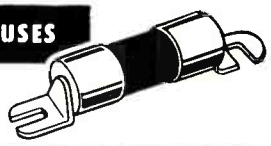
Marking on fuse and fuseholder in direct view.

Safeguard against use of wrong size and type of fuse.

BUSS KLM HIGH INTERRUPTING CAPACITY FUSES

$^{13}/_{32}$ x 1½ inch. Capable of safely interrupting 68,000 amps.

FUSETRON ACK CLAMP TYPE FUSES



20 to 300 amp., *Dual-element type.*

BUSS ACO AIRCRAFT FUSES

Mechanical Indicating — Limiter type 1 to 75 amp.

BUSS AGX FAST ACTING FUSES

¼ x 1 in. Glass tube 1/500 to 2 amp.

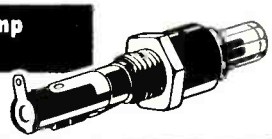
BUSS Series HJ and HK Non-Indicating FUSEHOLDERS

Panel mounted for ¼ x 1 inch and ¼ x 1¼ in. fuses.

BUSS IBM SIGNAL ACTIVATING FUSES

¼ x 1¼ inch. Silverplated pin pops out when fuse is blown and activates signal or alarm.

BUSS Series HJ and HK Lamp Indicating FUSEHOLDERS



Panel mounted for ¼ x 1 inch and ¼ x 1¼ inch fuses.

FUSETRON MDL FUSES

¼ x 1¼ inch. *Dual-element — slow blowing type 1/100 to 30 amp.*

BUSS No. 4051 ONE-PIECE CLIP and TERMINAL

Solder type terminal for ¼ inch fuses.

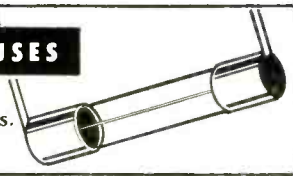
BUSS ABC CERAMIC TUBE FUSES

¼ x 1¼ inch. High interrupting capacity fuses ¼ to 30 amp

BUSS No. 4409 FUSE BLOCKS

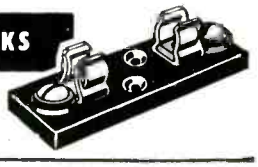
Small Base, solder type Side Terminals.

BUSS GJV PIG TAIL FUSES



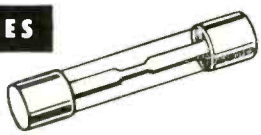
⅛ to 6 amp. Solder into circuit wires.

BUSS No. 4512 FUSE BLOCKS



Full Base, Screw type Terminals.

BUSS SFE STANDARD FUSES



Fuses of different amperages are different lengths — to make it impossible to insert too large a size.

FUSETRON FNM FIBRE TUBE FUSES

$^{13}/_{32}$ x 1½ inch. *Dual-element — slow blowing type.*

For more detailed information to help you select fuses and fuseholders to meet your electrical protection needs . . . Write for bulletin SFB.

Or tell us your problem and let our Fuse Engineers assist you in getting the protection you require.

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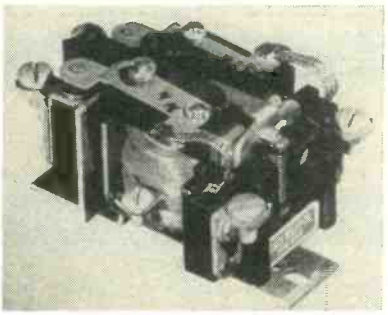
FUSETRON
TRUSTWORTHY NAMES IN ELECTRICAL PROTECTION
BUSS

Makers of a complete line of fuses for home, farm, commercial, electronic and industrial use.

ELRC 1155

quency of motor-alternator sets and inverters. Presently available in two models, VF-60 for 60-cycle outputs and VF-400 for 400 cycle, the control permits conversion from any d-c source voltage to any a-c output voltage, within the ratings of the controlled machine. Units can be built for any power frequency. Standard units regulate both output voltage and frequency to within ±2 percent. Special models which control voltage and frequency to within ±¼ percent, are available for military and other exacting applications. The control permits operation of a-c equipment on vehicles, airplanes, railroads, ships and in remote locations with the reliability that is expected from public utilities lines.

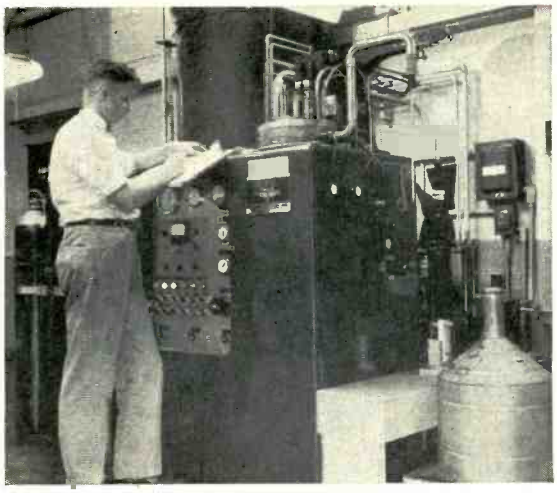


TWO-POLE RELAY
for industrial application

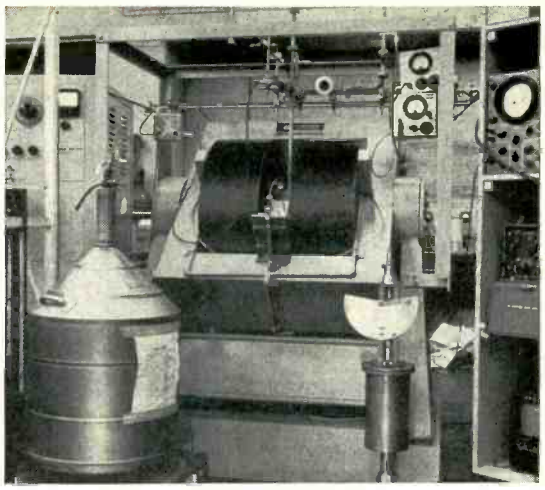
LEACH CORP., Leach Relay Division, 5915 Avalon Blvd., Los Angeles 3, Calif. Small size, quiet operation, low coil power and screw terminal connections for simple installation are the advantages of a new 2-pole single-throw relay for motor starting and industrial control of refrigeration and heating equipment. Designed for normally open operation, the new relay is designated the 9194. Motor load ratings are for 1½ hp at 115 v a-c and 3 hp at 230 v a-c. Maximum contact load ratings are for 20 amperes at either 115 or 230 v a-c, single phase and 114 amperes locked rotor at 230 v a-c.

SWEEP GENERATORS
display 845 to 1,950 mc

APPLIED RESEARCH, INC., 163-07 Depot Rd., Flushing, N. Y., has an-

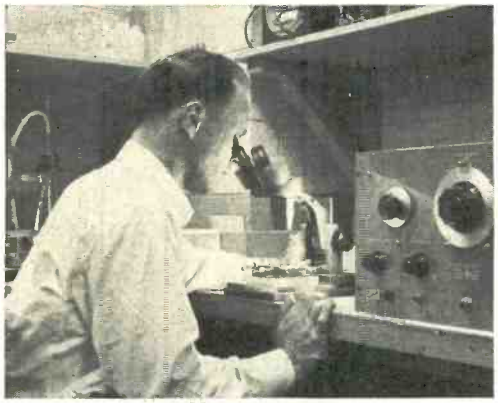


LOW TEMPERATURE



SPIN RESONANCE

ENGINEERS, PHYSICISTS, CHEMISTS



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- **Radio & TV Receiver Design**
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- **Ceramic Engineering (High Dielectric, Piezoelectric)**
- **Patents**
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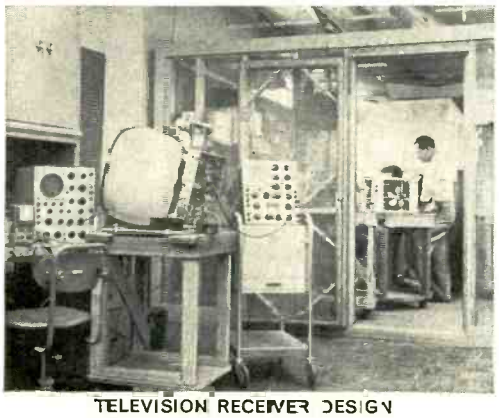
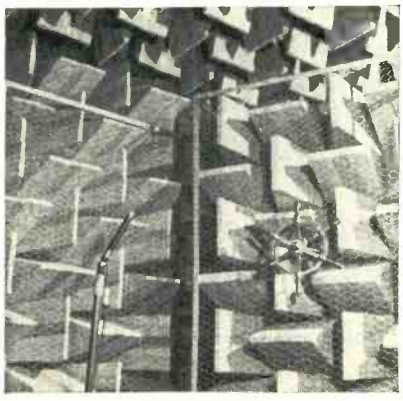
Since 1919 Zenith has manufactured radios for home use and is one of the country's oldest companies continuously in this field. It is today a leading manufacturer of quality television sets and hearing aids. Continuity of management, a record of pioneer technical developments and a reputation for quality products are important factors for you to consider. Zenith's consistent, steady growth and unusually low engineering turnover rate indicate a desirable combination of opportunity and stability.



TELEVISION RECEIVER DESIGN



ACOUSTICS

For an appointment, write to
G. E. GUSTAFSON
Vice President, Engineering
Zenith Radio Corporation
6001 Dickens Avenue, Chicago 39, Illinois

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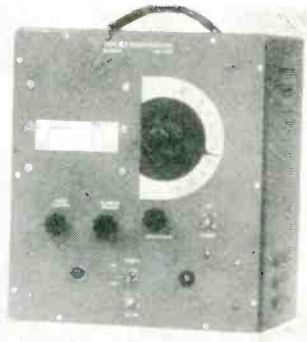
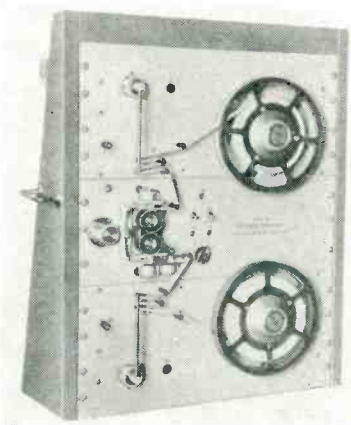


nounced the new type HFS broadband sweep generators. Model 1319 simultaneously displays the frequency range of 1,350 to 1,950 mc; and model 813, the range of 845 to 1,375 mc. This makes possible rapid design, alignment and test of systems and components within the L-band frequency. Through the use of these generators the development and use of broadband multiple-tuned resonant circuits are made possible. The selectivities which can only be obtained from quadruple, sextuple and even decatuple tuned circuits now become available.

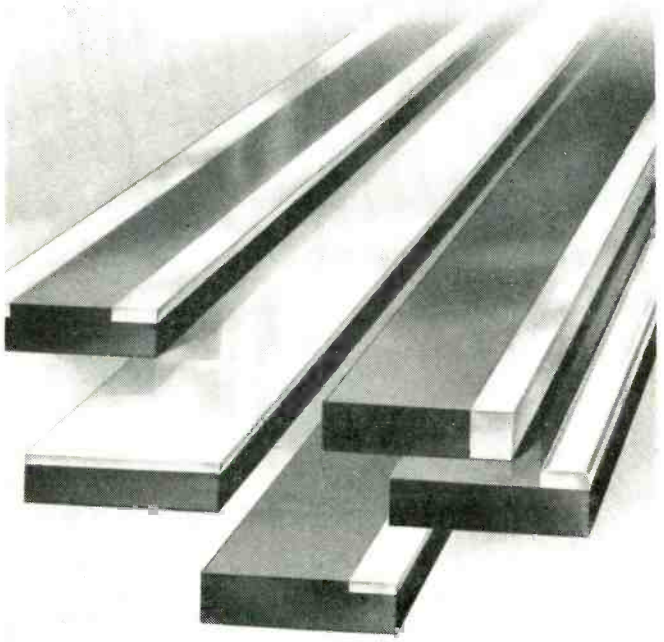


TAPE READER
is a high-speed machine

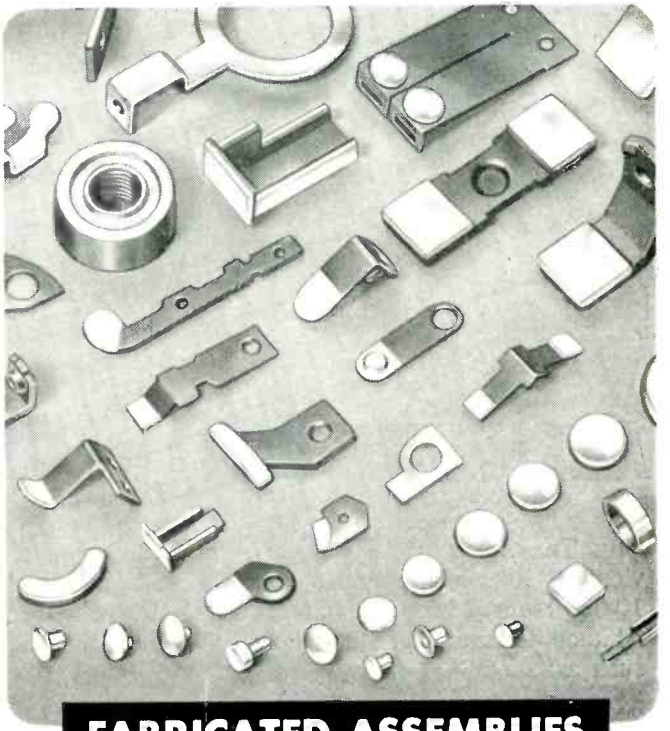
POTTER INSTRUMENT CO., INC., 115 Cutter Mill Road, Great Neck, N. Y. With start and stop times of 5 milliseconds and tape speeds up to 60 ips, the model 903 perforated tape handler offers character readout up to 600 per sec. It will actually stop on the stop character at speeds of 150 and 300 characters per sec and on the character following the stop character at rates of 600 characters per sec. This greatly increases the efficiency of the machine. Various models are avail-

General Plate

COMPOSITE CONTACTS



COMPOSITE STOCK



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Composite Contact Material
that meets your requirements
Composite Contact Assemblies
that cut your costs!

There are many advantages for using General Plate composite contact materials, processes and facilities. Among the more important are better performance, longer operating life and lower fabricating costs.

But that's not all — here at General Plate you have a single source that can supply your contact requirements be it composite raw stock, contacts or complete assemblies. General Plate stock and contacts are available in a wide range of alloys designed to meet your specific requirements.

General Plate Composite Contact Materials make it possible to manufacture complete contact assemblies to close tolerances by single blanking and forming operations. Compare this to other methods whereby the contacts and supporting members are fabricated separately and then assembled by brazing, welding or staking methods.

By letting General Plate fabricate your complete contact assemblies, you will save money, time and trouble . . . needless equipment cost and problems of scrap disposal are eliminated . . . contacts and/or contact assemblies made to your exact specifications are shipped to you ready for installation.

Write for complete information and Catalog PR700.

You can profit by using General Plate Composite Metals!

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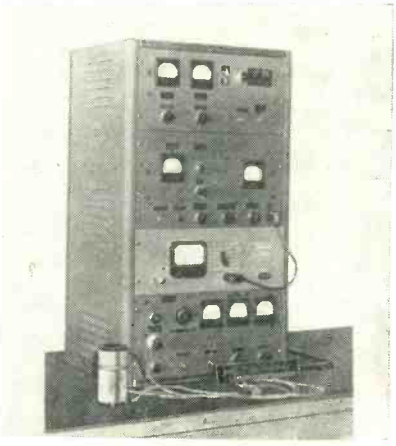
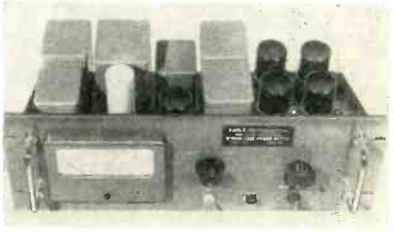
Want more information? Use post card on last page.

able to handle tape widths from ⅛ in. to 1 in. and 5 to 8 channel tape for nearly every conceivable tape handling operation. Readout head is of simple photo-diode construction. Reel size on the tape handler is 10½ in. and capacity is 1,000 ft.



GYRO TESTER
indicates drift rate fast

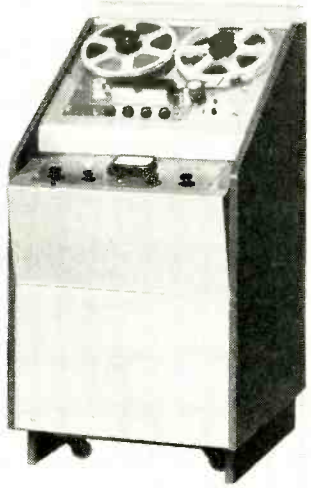
CEDAR ENGINEERING INC., 5806 W. 36th St., Minneapolis 16, Minn. The gyro tester is designed to speed up drift rate measurements of HIG-3, HIG-4, HIG-5, HIG-6 and similar devices employing a torque generator input and a signal generator output. The new circuit eliminates time-consuming rate-table techniques. The unit calibrates torques up to 100 dyne cm. It gives a continuous indication of drift rate that can be recorded for long term drift measurements. Tests can also be made for mass unbalance, reaction torque of torque generator, or signal generator, and earth rate measurements.



POWER SUPPLY
for strain gage systems

EAGLE INSTRUMENTS, INC., Van Nuys, Calif., has available a new power supply unit that is useful in most strain gage systems as a

an Ampex can keep your accountant happy too!



it can cost less per hour than any other recorder you can buy

A few cents per hour is all it costs in the long run . . . because year after year an Ampex continues to perform within original specifications (18,000 known hours of service in one actual instance). Inevitably it requires fewer adjustments and parts replacements than machines of lesser quality. And because an Ampex is the recorder that everyone wants, it maintains the highest percentage of its original value. For lasting economy, buy the best — buy Ampex.

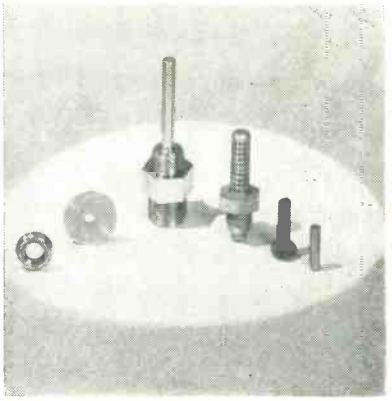
For further information, write Dept. E-2290

SIGNATURE OF PERFECTION IN SOUND

AMPEX CORPORATION

934 Charter Street, Redwood City, California

direct replacement of a battery. Drop-off of output voltage is eliminated as well as battery charging and maintenance. Complete isolation from the input line results in less than 1-mv ripple from either output side to ground. It features magnetic circuitry, resulting in maximum reliability and long life. All components are in hermetically sealed cans with only the interconnecting wiring exposed. Output of the strain gage power supply is 5 to 15 v in two ranges at 0 to 1 ampere, continuously adjustable within 0.1 percent. Ripple is less than 0.05 percent; regulation, ±0.1 percent.



TEMPERATURE PROBES
in varied configurations

ARNOUX CORP., Box 34628, Los Angeles, Calif. High resistance (20,000 ohms) temperature probes, when used with TME bridge network, provide 5-v output signals (without amplification) for as little as 150 deg temperature change. Probes are available in varied configurations for measuring fluid, surface, structure, air, hydraulic line, cylinder head and subminiature component temperatures.

H-V POWER SUPPLIES
in six compact models

MICROTIME LABORATORIES, 7247 Atoll Ave., N. Hollywood, Calif., announces two new series of 60, 100 and 200 kv power supplies in six compact models. Input is 115 v a-c; maximum continuous current output is 1 ma. The HV series units permit, through use of a suitable

Thermocouple Head Model 501
Heavier wire provides ruggedness. Higher operating temperature keeps filament clean . . . less subject to ambient temperature changes. Not damaged by exposure to atmosphere. Price **$9.50**

Thermocouple Control Model 701
Operates at 115 volts, 50/60 cycles, for use with 501. Range 10^{-3} to 1 mm Hg. Price **$110.50** (excluding head) Multi-point and recording units also available.

Pirani Gauge Model 516
Two scales — 0 to atmosphere and 0 to 20 microns — provide greater accuracy. Relatively unaffected by line voltage or temperature changes. Independent of cord length. Not damaged by exposure to atmosphere. Outgassing circuit provided. Price **$160.00**

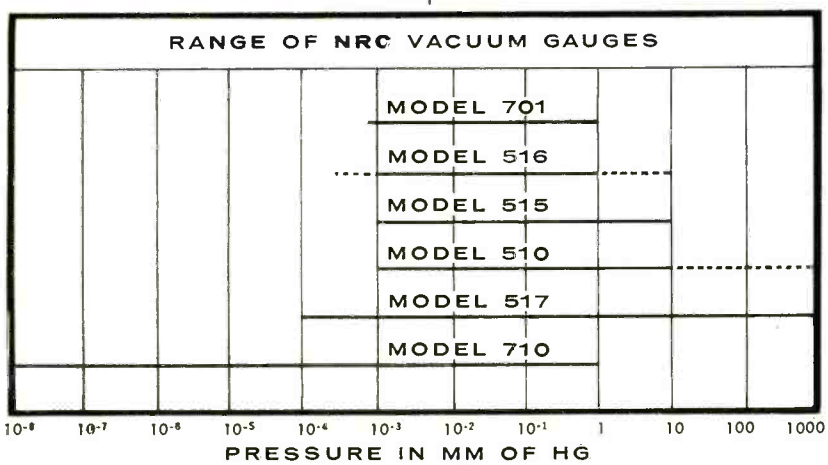
Alphatron® Ionization Gauge Model 515
All Alphatron® vacuum gauges have burn-out proof radium source ionization which provides emission stability, minimizes contamination, assures instantaneous response, high accuracy, long life. Model 515 has direct reading, single logarithmic scale covering the range 10^{-3} to 10 mm Hg. Price **$225.00**

Alphatron® Ionization Gauge Model 510
Has all the advantages of radium source ionization. Provides direct accurate readings with instantaneous linear response from 10^{-3} to 10 mm Hg in three ranges and nonlinear extended range to 760 mm Hg. Separate ionization chamber reduces effects of contamination. Recorder or controller connection can be added. Price **$520.00**

Alphatron® Ionization Gauge Model 517
Has all the advantages of radium source ionization. Provides accurate measurement over the widest range of any AC-operated vacuum gauge. Six ranges covering pressures from 10^{-4} to 1000 mm Hg. Linear response with high stability. Connection provided for recorder or controller. Price **$425.00**

Ionization Head Model 507
Widely spaced pins minimize leakage due to dirt, corrosion — retains accuracy. High sensitivity maintained. Dual filament system provides "double life." Price **$20.00**

Thermocouple-Ionization Control Model 710
Controls two 501 and one 507 heads. Range 2 x 10^{-6} to 1 mm Hg. Protective circuit guards ionization head against burn-out from excessive pressure bursts. Emission control circuit holds electronic variables constant, allows single meter, more reliable readings over all ranges. Price **$357.50** (excluding heads)



For years laboratory and production technicians at National Research have been pioneering new developments in high vacuum . . . designing, installing and operating high vacuum systems that are producing millions of dollars worth of product successfully year after year. In their determination to provide themselves with the finest instrumentation possible National's technicians have designed and built their own Vacuum Gauges. Here is the complete line.

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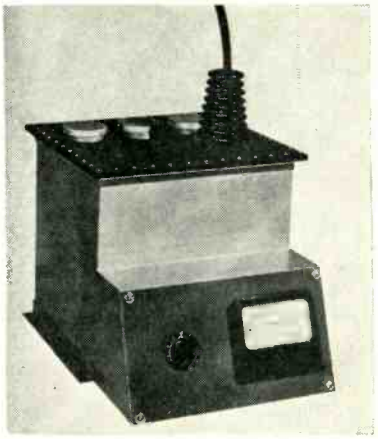
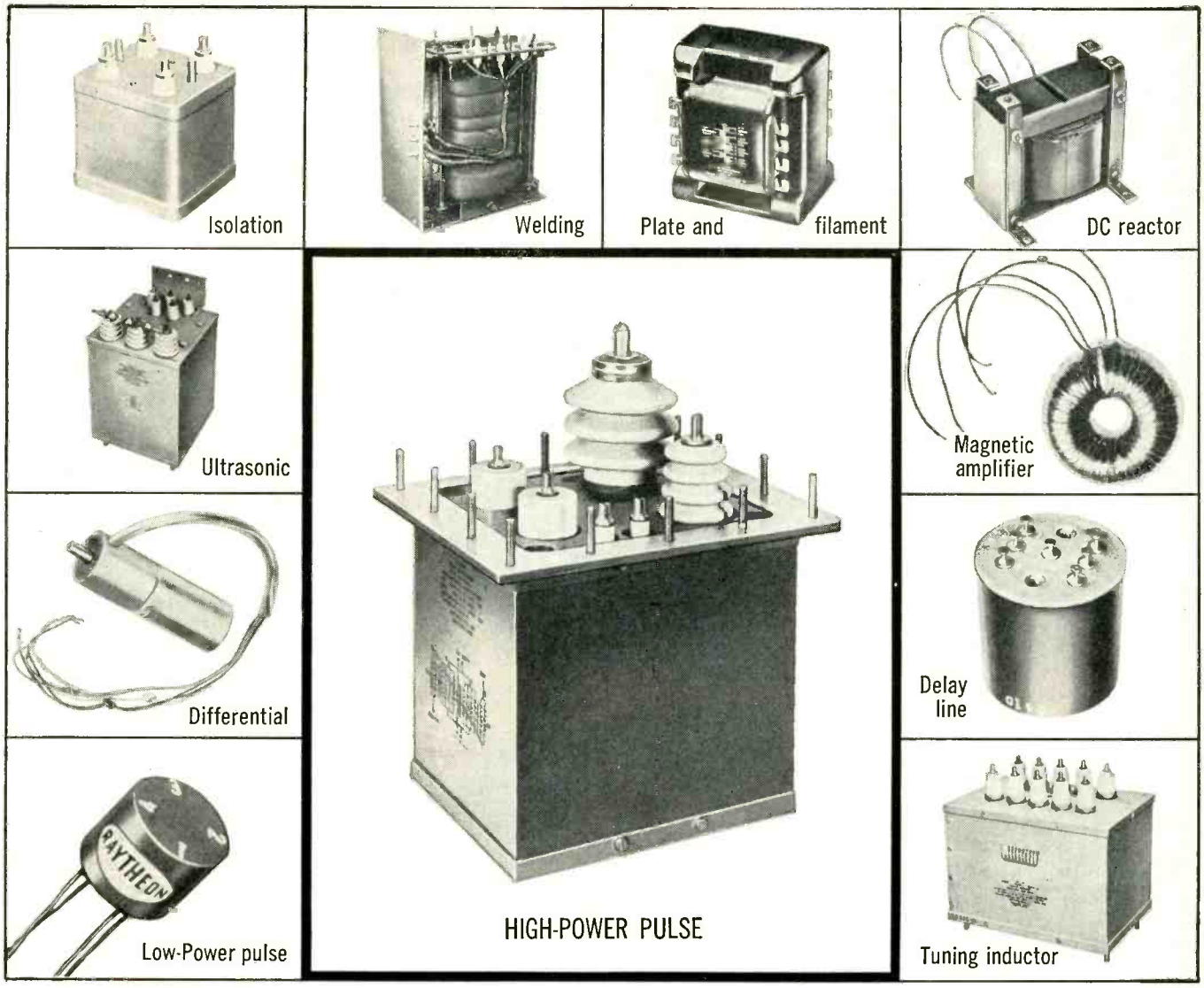


variable transformer, a-c primary voltage of the h-v transformer to be varied independently of the filament voltage. Powerstat and associated meter are available, mounted on the unit if desired. HVA series consist of a basic h-v supply and a separate a-c control, each housed in a completely enclosed cabinet. Reversible polarity, 0-230 v a-c, and additional current output are available on special units. Illustrated is the HV-60 with Powerstat.

SOLDER BRAZER
operates in small areas

TARTAK ELECTRONICS, 2979 No. Ontario St., Burbank, Calif. Model SP-102 Hi-Temp solder brazer has been designed for simple operation. The unit brazes Formvar or enamel-covered wire without costly prestripping or precleaning. The joints made by this brazer are stronger and will stand up longer than the wire itself. The crucible cannot crack even if allowed to cool without emptying the unit, thus increasing the operation life of the unit. The brazer has a crucible life in excess of 300 hr. The unit incorporates a switch for temperature control on the front panel



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Available to you are the resources of Raytheon's entire transformer engineering staff. Yet in order to best satisfy your needs, design, development and production of your transformers are turned over to an individual Raytheon engineer who sees your job through from start to finish.

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All types of winding, core processing, impregnation and baking equipment are available for model making or full production runs. Raytheon also offers complete facilities for testing.

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Raytheon has successfully custom engineered over 30,000 transformer designs and millions have been produced. Proof of Raytheon quality is this fact: *in 25 years less than ¼ of one percent of all Raytheon transformers have been returned from the field for any reason.*

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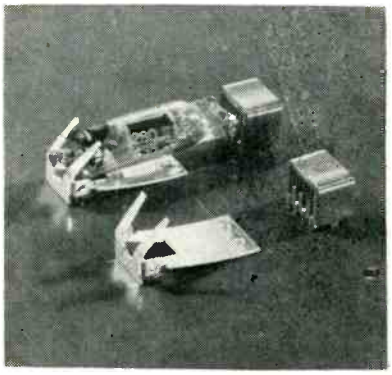
RAYTHEON

Excellence in Electronics

enabling the production lines to have four convenient ranges of heat: 1,200 F, 1,350 F, 1,500 F and 1,650 F. The brazer has been constructed to operate in small areas along the assembly lines, thus eliminating the need for multipots, which take up valuable production space.



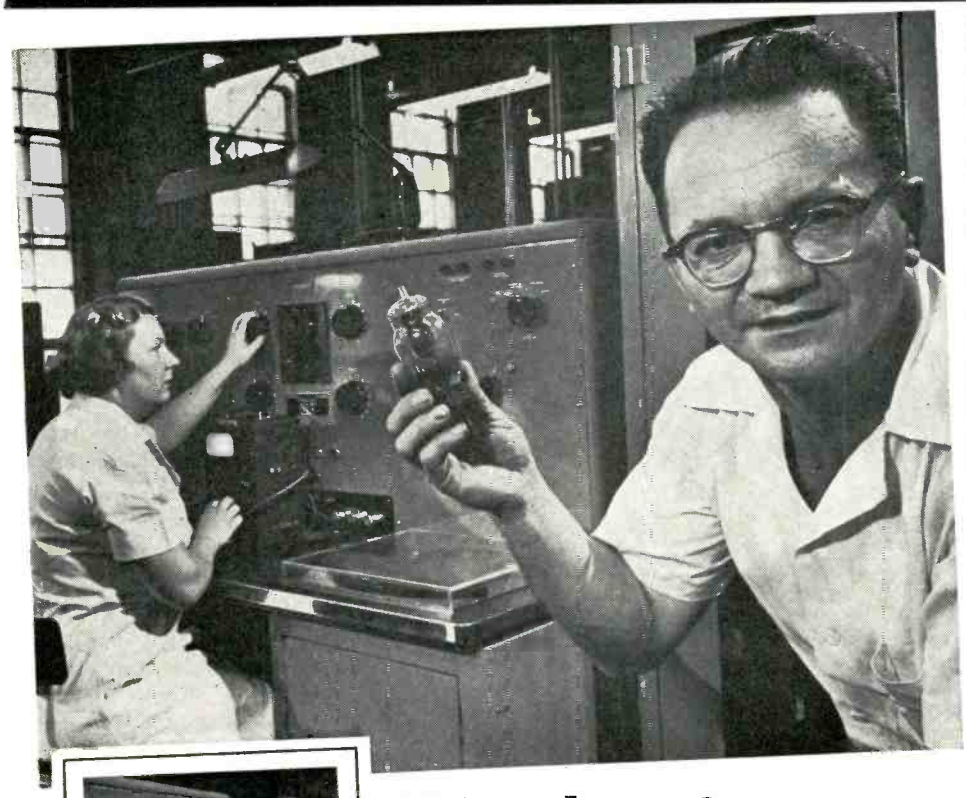
TUBE RETAINER
mounted to chassis by rivets

P. R. MALLORY & Co., INC., 3029 E. Washington St., Indianapolis 6, Ind., has designed a simple but effective tube retainer to prevent parallel-mounted flat-press or button base subminiature tubes from working loose from their sockets. The tube retainer, mounted to the chassis by rivets, has been silver-plated both to prevent corrosion and to insure good electrical contact with metallic coated tubes. The retainer has been designed for use in all military or civilian electronic equipment using miniaturized circuits where the circuits will be subjected to rugged conditions of shock and vibration. Technical specifications and supplemental data may be obtained by writing the company.

QUANTIZER
adaptable to any shaft

THE AUSTIN CO., 76 Ninth Ave., New York 11, N. Y. A new shaft position quantizer with its control unit provides a standard shaft-position-to-digital converter system. Essentially a simple induction device, the unit has no gears or digitizing commutators. The four standard models of the Quantizer, functioning with the standard control unit, divide one turn of the

America's Most Complete Line of Instrument Calibration Standards!



"Simple to Operate.. yet EXTREMELY ACCURATE"

FROM ACTUAL EXPERIENCE BY
Test Engineering Activity
RCA TUBE DIVISION
HARRISON, NEW JERSEY

For three years the life test laboratory of the Harrison plant of the RCA Tube Division has been using the RFL Models 262B and 454B Instrument Calibration Standards to periodically check the accuracy of over 2,000 meters employed to measure receiving tube characteristics prior to shipment. Element currents, amplification factor, plate resistance, transconductance, emission, etc.,are measured to fine tolerances.

According to Mr. Tomalesky, manager of the laboratory, "both Standards are in operation eight hours a day, five days a week. Only two maintenance calls have been necessary in three years. The 0.1% accuracy of Model 262B satisfies our requirement for DC meter standardizing. These two Standards have eliminated the problems associated with previous methods."

The advantage gained by in-plant calibration of electrical instruments using these console type Standards, which encompass the full range of testing instruments, under controlled laboratory conditions, goes beyond mere convenience. Their ease of operation, consistent calibration and high accuracy over wide current and voltage ranges are impossible to duplicate using individual testing equipment which must be moved from job to job throughout a manufacturing plant.

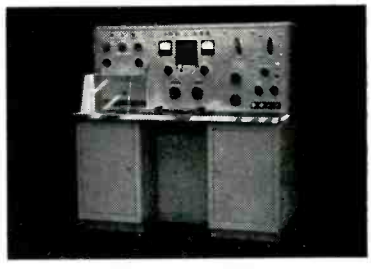
In addition to accuracy, each RFL Standard has many features which make rapid calibration procedure possible. Where many instruments must be tested, it can be demonstrated that an appreciable cost saving over older calibration methods will soon result.

Model 260C

Calibrates DC electrical measuring instruments to direct reading accuracies of 0.5% (0.25% using calibration charts) through voltages ranging from 1 millivolt to 1500 volts and currents ranging from 1 microampere to 150 amperes.
Net price $8,975.00 f.o.b. Boonton.

Model 261B

Calibrates all types of AC meters to direct reading accuracies of 0.5% (0.25% using calibration charts) over frequency range of 50 to 1600 cps. Current range from 1.5 milliamperes to 200 amperes; voltage range from 75 millivolts to 1500 volts. Output of electronic power oscillator has less than 5% total harmonic content at 60 cycles.
Net price $9,250.00 f.o.b. Boonton.



Model 262B

Calibrates DC electrical measuring instruments to direct reading accuracies of 0.1% (0.05% using calibration charts) through voltages ranging from 1 millivolt to 1500 volts and currents ranging from 1 microampere to 150 amperes.
Net price $14,300.00 f.o.b. Boonton.

Write for technical data and application information.

RFL

Radio Frequency
LABORATORIES, INC.
Boonton 3, New Jersey, U.S.A.

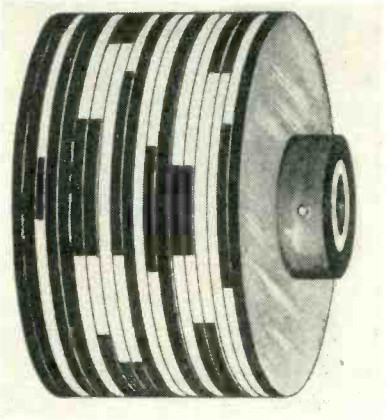
DESIGNERS AND MANUFACTURERS OF ELECTRICAL EQUIPMENT SINCE 1922

Radio Frequency Laboratories, Inc.
Boonton, New Jersey
Please send me complete information on all Instrument Calibration Standards.

Name_____ Title_____
Company_____ Phone_____
Address_____
City_____ State_____

Want more information? Use post card on last page.

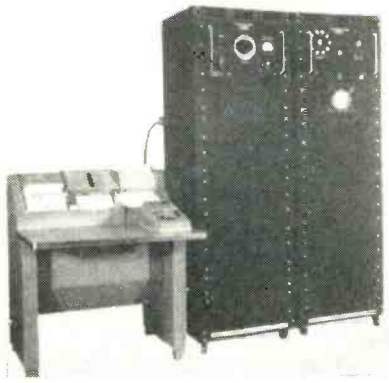
data shaft into any one of many possible divisions which range from 320 to 4,096 parts. The total count is accurate to ±1 count for any position of the shaft and is guaranteed whether the data shaft is stationary or turning at up to 240 rpm. An external command pulse initiates a shaft position reading. The output count is an exact measure of the shaft position at the instant of the command pulse. Electronic converter systems providing various output resolutions using the small size quantizer, and larger sized quantizers for resolutions above 4,096 parts per turn, are available.



COMMUTATOR
in drum form

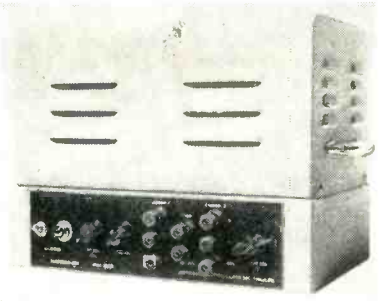
ELECTRO-MINIATURES CORP., 205 Lafayette St., New York 12, N. Y., has developed a new drum type switching commutator. It gives dependable trouble-free performance in the smallest possible space. All switching combinations are attainable. Other applications are frequency multiplication and division. These drums are particularly well suited to cascade operation. Solid, precision made, precious metal or alloy segments and a wide choice of plastics allow extensive ranges of operating temperature, insure long shelf life and give stable operation

in service. Simple registration techniques make possible highly accurate angular resolution as well as exceptionally small segments. Size and weight for airborne and military applications are minimal.



DATA RECORDER
for gyro rate tables

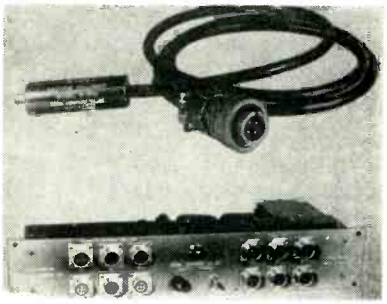
EPSCO, INC., 588 Commonwealth Ave., Boston 15, Mass. System No. 177 automatic data recorder for gyro rate tables makes use of magnetic techniques to punch automatically on IBM cards data arriving asynchronously from as many as 10 separate sources. Data consists of time interval measurements to an accuracy of 1/10,000 of a sidereal minute. In addition, dates, identification numbers, shaft positions and temperature are automatically recorded on the IBM cards. Special provision is made for measuring the average time interval between pairs of pulses in order to compensate for asymmetry in the rate table.



ELECTRONIC LOAD
measures internal impedance

AMERICAN ELECTRONIC LABORATORIES, INC., 641 Arch St., Philadelphia 6, Pa., has available an elec-

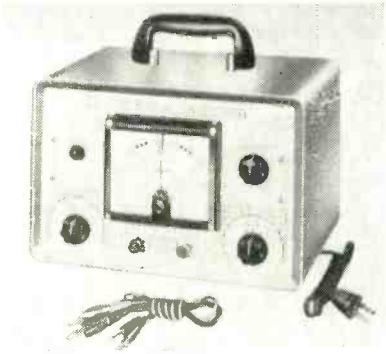
tronic load for both static and dynamic measurements on d-c power supplies. It provides a direct and convenient method of measuring the internal impedance of a regulated power supply as a function of frequency and determining the range of load over which the regulation is effective. The instrument contains 2 individual channels with independent static load adjustments. Channels may be interconnected for a total average power range of 150 w. A wide range of currents may be drawn at various applied voltages so long as the maximum ratings of tubes are not exceeded. Provision is made for both external and internal modulation of load tubes for dynamic regulation checks. Also provided is a 1-ohm resistor to allow a voltage output proportional to load current to be obtained for observing voltage current waveforms on an oscilloscope.



CATHODE FOLLOWER
for crystal transducer

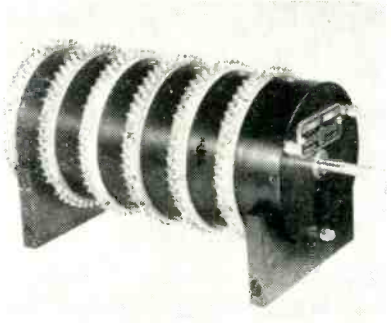
SIGNAL EQUIPMENT CO., INC., 2706 Third Ave., Seattle 1, Wash. The Sonic model S-650 is an impedance matching cathode follower with unusually high input impedance and resistance to most adverse environmental conditions. Its input impedance is over 200 megohms; gain is 0.95 ±1 percent from 2 to 20,000 cps; and its vibration sensitivity is less than 20 μv per g. The unit will withstand vibration of ±10 g and shock-excitation of 30 g of 12 milliseconds duration. The case is filled with casting resin to make the unit impervious to dust, moisture, altitude or mechanical failure. The S-650 was designed for use with barium-titanate accelerometers. A specially designed 6-channel power supply with low ripple and d-c heater source is

available in both rack and cabinet models for operation of these cathode followers or other devices with similar power requirements.



TESTING UNIT
shows capacitor leakage

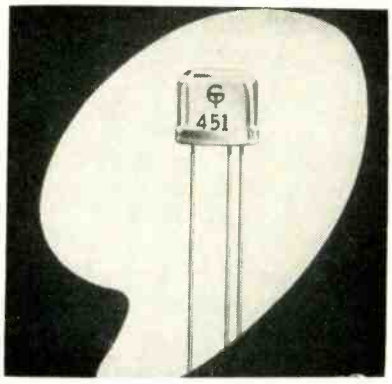
SIMPSON ELECTRIC CO., 5200 W. Kinzie St., Chicago 44, Ill., has developed the model 383 in-circuit capacitor leakage tester. It shows the presence or absence of leakage in virtually all paper, mica, or ceramic capacitors while connected in the circuit, eliminating disconnecting and resoldering. The tester checks capacitors ranging from 1 $\mu\mu$f to 0.25 μf for leakage from a few ohms to hundreds of megohms, and also detects breakdowns, shorts and intermittents. Checking is done at full rated working voltage, right in the circuit. Capacitors under test can be shunted by circuit resistance which is much lower (1 percent or less) than the value of the leakage resistance.



SAMPLING SWITCH
low-level type

GENERAL DEVICES, INC., P.O. Box 253, Princeton, N. J., has a new low level sampling switch, 6 pole, 540 contacts. Each contact plate has 90 contacts and employs semi-

molded construction for greater dimensional stability and superior performance. Constant force Perma-Brushes are utilized for more dependable and longer service free life. Convenient solder type terminals or wire leads with plugs are available on request. The switch features dynamic phasing and each pole can be individually adjusted in phase relative to the other poles, while the switch is operating with a special design adjustment wrench. Dynamic contact resistance is approximately 1 ohm average. Measurements are 7 1/16 in. long, 3 3/8 in. diameter.



H-F TRANSISTORS
are double sealed

GENERAL TRANSISTOR CORP., Jamaica, N. Y., is now delivering its new h-f GT-760 series of transistors. The new series is designed for h-f operation as r-f and i-f amplifiers in broadcast receivers and as switches for high-speed computer application. The GT-760, GT-761 and GT-762 with respective alpha cutoff frequencies of 5 mc, 10 mc and 20 mc are doubled sealed—encapsulated in plastic and hermetically sealed in a can.

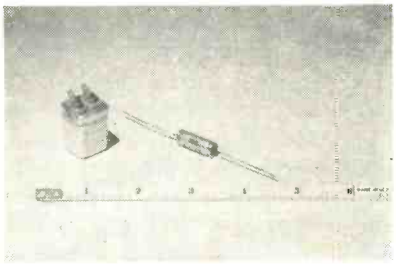
FILLER MATERIAL
used in casting resins

FERRO CORP., Cleveland, Ohio, is producing an inorganic filler material known as Kanamite. It is being used in casting resins in some classified electronic equipment as a core filler in plastic dies and as a strength additive in foamed plastics. In addition to being an inorganic displacement filler in plastics, it also ads considerably to the

flowability. In proper percentage usage can contribute additional strength, and shrinkage in curing can also be reduced. Kanamite is the trade mark for unicellular, spheridized clay particles fired at around 3,000 F in a process developed several years ago by the Kanium Corp. at the Armour Research Foundation.

TOLERANCE INDICATOR
for testing components

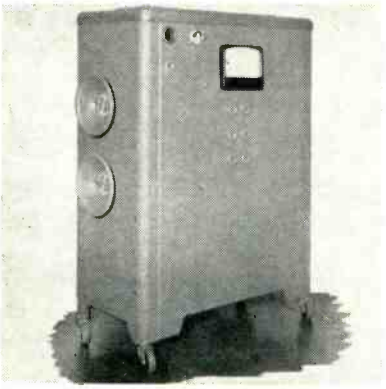
FEDERAL TELEPHONE AND RADIO CO., 100 Kingsland Road, Clifton, N. J., has introduced a tolerance indicator designed for rapid production testing of resistors, capacitors and inductors by comparison with an external standard. Direct readings in percent are given on a 4-in. meter with four tolerance ranges providing sensitivities as high as 2.5 percent full scale. The wide range of measurements include 10 ohm to 1 megohm, 10 $\mu\mu$f to 1 μf, and 100 μh to 2 mh with an accuracy of $\pm$ 5 percent of full scale. With a separate accessory meter, sensitivity of 0.01 percent per division is available, equivalent to 0.5 percent full scale.



TANTALYTICS
in 2 high-temperture lines

GENERAL ELECTRIC CO., Schenectady 5, N. Y. Two new types of 125 C

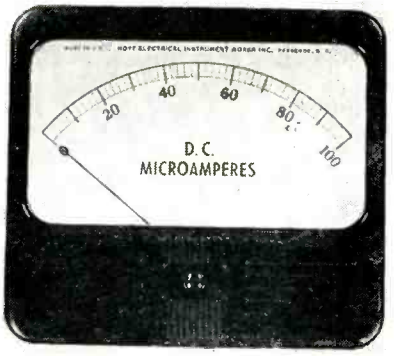
tantalytic capacitors have been announced. The rectangular case types range in rating from 36 μf at 100 v d-c to 220 μf at 25 v. The cylindrical case types range from 36 μf at 100 v to 160 μf at 10 v. Designed to operate in the high ambient temperatures produced in jet engines and guided missiles, the new units will perform for 1,000 hr at 125 C without losing more than 20 percent of initial 25 C capacitance. The rectangular units may be mounted in the same chassis space as the cylindrical, slung-type units. Construction features tantalum foil and a nonacid electrolyte in both polar and nonpolar types. The cylindrical units feature a double casing and a double bushing seal, to check the evaporation of the electrolyte. The cylindrical units are similar in shape to the 85 C line, but slightly larger, and can be mounted with the same type of clamps. The rectangular units are best for bus-bar wiring applications, and the cylindrical for point-to-point wiring.



LAB POWER SUPPLY is a portable unit

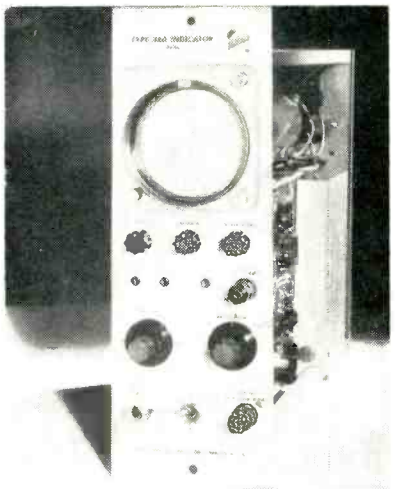
THE STRONG ELECTRIC CORP., 142 City Park Ave., Toledo 2, Ohio, has developed a portable laboratory power supply transformer unit for convenient, on-the-spot availability of any desired output voltage. With 3-phase, 230-250 v, 60-cycle a-c input, the unit has two output ranges: 211-640 v, 31 amperes, in 10-v steps; and 100-295 v, 66 amperes in 4-v steps. Adjustment is by 8 fine steps and 8 coarse steps with overlap. Taps are changed on 3 phases simultaneously. It is designed for continuous duty at the

rated output, and includes a heavy duty 115-v cooling fan. Parallel 100-ampere capacity output jacks are provided.



MICROAMMETERS
with 4-in. dial scale

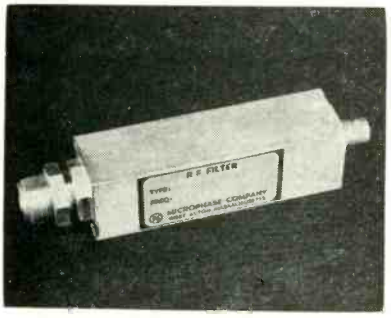
BURTON-ROGER CO., 42 Carleton St., Cambridge 42, Mass. The new Hoyt No. 647 d-c and No. 648 a-c microammeters for industrial panel installations feature smoothly finished black Bakelite cases which are not affected by industrial fumes or high temperatures. Meters are available with provision for bottom illumination and have standard 4 in. by $3\frac{9}{16}$ in. mounting stud dimensions. The No. 647 d-c meter has the standard Hoyt high-torque, D'Arsonval movement; the No. 648 a-c meter, an air damped, jeweled movement with cross arm balance.



INDICATOR
replaces bulkier scopes

TEKTRONIX, INC., P. O. Box 831, Portland 7, Oregon. Type 360 indicator contains a 3-in. flat-faced crt,

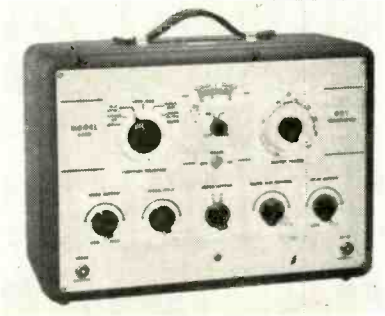
accelerating-voltage supply, vertical amplifier with a sensitivity of 0.05 v per division, and a calibrated vertical attenuator. It can take the place of a bulkier oscilloscope in single monitoring applications, or several can be used along with other instruments as building blocks in complex sequence-control and monitoring systems. Features include: d-c to 500 kc vertical-amplifier passband; four calibrated sensitivities from 50 mv per division to 50 v per division with 10-to-1 attenuator for continuously variable sensitivities from 50 mv per division to 500 mv per division. Horizontal gain control permits sweep calibration. Weight is 9 lb; price, $195.



COAXIAL FILTERS
for uhf and microwave use

MICROPHASE CORP., Box 1166, West Acton, Mass., has announced compact, low-pass coaxial filters for use in the uhf and microwave region from 100 to 2,000 mc. Featuring insertion loss less than 1 db, the attenuation of series LS rises to 60 db within 25 percent, and that of series LF within 13 percent of the cutoff frequency. These filters are useful for suppression of harmonics and spurious radiation from transmitters and receivers, and for laboratory measurements. The filters, rated at 100 w, are 3 to 8 in. long, and weigh 5 to 9 oz, dependent upon cutoff frequency. They are resistant to vibration and shock, and can meet the requirements of MIL-E-5400 and MIL-E-5422C. Type N connectors, one male and one female, are normally furnished; other connectors, including types BNC, C, and UHF, can be provided. Standard cutoff frequencies available are 100, 200, 400, 700, 1,000 and 2,000 mc. Other low-pass, as

well as high-pass and band-pass filters, are available with cutoff frequencies from 10 to 10,000 mc.



DOT GENERATOR
for circuit checking

TRIPLETT ELECTRICAL INSTRUMENT Co., Bluffton, Ohio. Model 3438 dot generator checks video, r-f, i-f, sync and color circuits with modulated r-f (channels 2 to 6) and i-f (20 to 55 mc) outputs available. Horizontal syn pulses (15,750 cycles) and vertical sync pulses (60 cycles) are available for checking sync circuits. Other features include: horizontal bars (480 to 600 cycles) and vertical bars (crystal controlled at 189 kc) for checking linearity on black-and-white and color sets; and cross hatch used to check overall linearity with 11 vertical bars and 8 horizontal bars. A square block will be produced for the cross-hatch pattern. On the equipment white dots of proper size are used to check convergence of color tv sets.

PRESS-FIT TERMINALS
simplify assemblies

SEALECTRO CORP., 186 Union Ave., New Rochelle, N. Y., has developed and manufactured terminals featur-

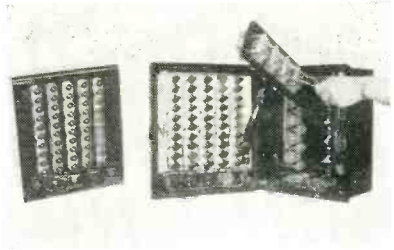
ing Teflon insulation for excellent electrical properties particularly at high frequencies. Because of the resiliency of this material, the terminals are simply press-fitted into the chassis or component hole with an inexpensive insertion tool, for a snug, rigid, permanent installation. Press-Fit terminals are especially suited to applications requiring high shock and vibration resistance. Dielectric constant and loss factor are extremely low. Insulating properties favor miniaturization and subminiaturization programs. Sealectro offers standoffs, feedthroughs and handy connectors for breakaway connections.

PREAMPLIFIER
converts into d-c voltages

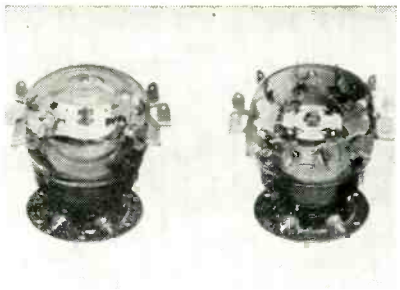
SANBORN CO., 195 Massachusetts Ave., Cambridge, Mass. Model 150 Preamplifier converts rms values of a-c and voltage into proportional d-c voltages. Typical performance specifications when used with associated company equipment, are as follows: type of reading, true rms; voltage ranges: 25, 125, 250 v; current ranges: 50, 100, 250, 500 ma, 1 ampere; full-scale deflection: 5 cm; overall tolerance, ± 3 percent of full scale, for frequencies between 50 cycles and 2 kc. It is usable to 4 kc. Rise time is 0.15 sec. Complete specifications and data are available on request.

SCANNING INSTRUMENT
for easy operation

ROBERTSHAW-FULTON CONTROLS CO. 2920 North Fourth St., Philadelphia 33, Pa. Checking and controlling various steps in production processes are simplified through the use of the new Fielden electronic scanner, capable of monitor-



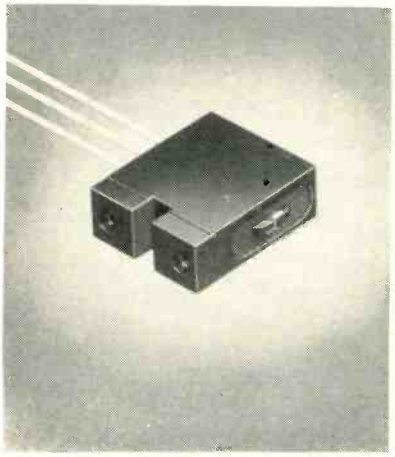
ing up to 25 production points. The scanner may be used in any industrial or lab process to monitor variables including temperature level, flow and pressure. It is designed to check processes at a speed of either 1 point or 5 points a second, and maintains a continuous check on its own accuracy and operation. Further information on the scanner is available without obligation from the Fielden Instrument Division of the company.



VACUUM RELAYS
multiple pole type

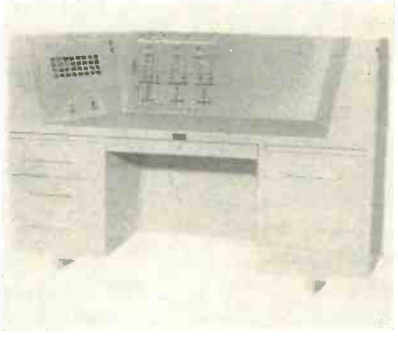
JENNINGS RADIO MFG. CORP., P. O. Box 1278, San Jose, Calif. Multipole vacuum transfer relays are available for switching antennas, pulse networks, and many d-c circuits. Types RM2 (2 pdt) and RM4 (4 pdt) models are provided with removable 24 v d-c actuating coils built into the flanged bases. An efficient magnetic circuit penetrates the vacuum seal by utilizing the different magnetic properties of copper and steel. Vacuum enclosed contacts are rated at 12 kv peak and are capable of continuously carrying 30 mc currents of 10 amperes rms. They can withstand test voltages of 18 kv peak between contact terminals and from the terminals to the base. Contact resistance is only 0.005 ohm and it remains low even when broken under load due to the complete absence of any contaminating materials within the

vacuum enclosure. Switch capacitance between contacts is 0.33 μf, and operate time is less than 30 milliseconds. Size is 4½ in. long and 4 in. in diameter.



READ-RECORD HEADS
dust and moisture proof

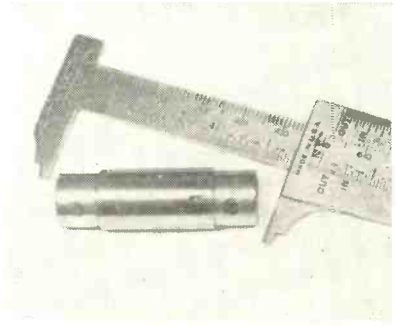
LIBRASCOPE, INC., 808 Western Ave., Glendale, Calif. Model MH-10-A was specifically designed for low-cost recording or reading on magnetic drums in memory systems of digital computers. Simplicity of design, flexibility of operation, high readback signal, low noise and h-v insulation are features. The writing or record current is usually low—less than 20 ma, while the readback voltage obtained is greater than 0.5 v peak-to-peak across 500 turns. Radial adjustment is 0.030 in. The unit is completely encapsulated in a die-cast aluminum case for moisture resistance, and has a 2-piece sintered core.



LAMP ANNUNCIATOR
the graphic panel type

THE H. R. KIRKLAND CO., Morristown, N. J., announces the new

graphic panel type of lamp annunciator, designed to supervise automatic processes, flow patterns and the like. It is generally constructed in one of two ways: either nonlighted diagrams, with raised strips in various colors, with indicating lights at the desired positions; or using strips of translucent material, with light source behind front panel, producing a light spot at the desired point on the diagram. The annunciators can be supplied for mounting in a surface or flush cabinet, or on a slanting console, with or without the desk.

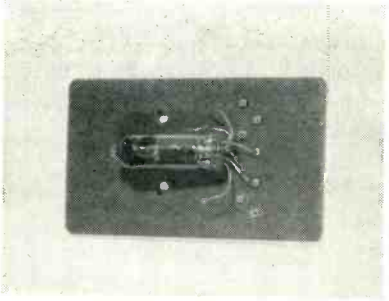


PRECISION CLUTCHES
in four basic types

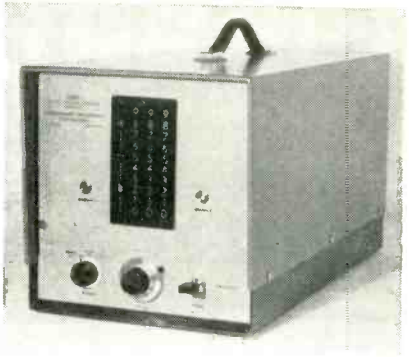
PRECISION SPECIALTIES, 1342 E. 58th St., Kansas City 10, Mo., has introduced a line of miniature precision clutches featuring a positive displacement drive that will transmit up to 10 in. lb of torque at speeds up to 1,800 rpm. They are available in 4 basic types: single revolution, over-running, nonreversing and indexing. Both sleeve-end and through-shaft mounts are available. Small compact design and high torque capacity make the units ideal for use in business equipment, servomechanisms and computer devices.

SLIP SOCKETS
for solderless connection

TECHRON, INC., 254 Friend St., Boston, Mass. The Micro-Pin socket makes possible solderless connecting of diodes, transistors and other components into a circuit, particularly a printed circuit. Especially adaptable for subminiature assemblies, it has numerous applications in computers, guided



missiles, telemetering, small radio receivers and hearing aids. The unit is a spring-backed, plug-in socket made of copper alloy. Its outer shell is approximately 0.2 in. long and 0.08 in. in diameter. It is press-fitted and dip-soldered into the circuit board. Diameter of the socket is such that the receiving hole in the circuit board can be either punched or drilled. The sockets are currently available from stock to fit leads of 0.016 in. diameter and will soon be available for lead sizes of 0.175 in. and 0.022 in.



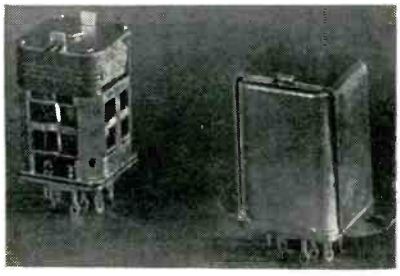
DIGITAL VOLTMETER designed for bench-top use

CONSOLIDATED ENGINEERING CORP., 300 N. Sierra Madre Villa, Pasadena 15, Calif. Type 33-110 Sadic digital voltmeter has a sensitivity such that 10 mv provides full-scale digital output (999). Controls permit selection of any voltage in either of two ranges (10 to 25 and 20 to 50 mv) for full-scale readout. Output may be used for operation of automatic typewriters, card punches and tape punches. Designed for bench-top use, the instrument requires no external power supply other than 115-v, 60-cycle a-c. Input signals must remain constant long enough for the Sadic to attain balance. Strain

gages, pressure pickups, load cells, position-measuring potentiometers, thermocouples, analog computers, and mass spectrometers are a few of the devices which may provide this type of signal. This analog-to-digital converter operates on the self-balancing Thomson-Varley potentiometer principle and has 1,000 discrete balance positions. It attains balance in a maximum of 0.8 sec. The converter measures approximately 9½ by 10 by 18½ in. Additional details are contained in CEC bulletin 3002.

HOT TUBE PULLER
built in two models

HUNTER TOOL CO., 6608 S. Gretna Ave., Whittier, Calif., has added a hot tube puller to its line. Built in two models—one straight and one bent at a 90-deg angle (illustrated)—the tube puller is designed to remove hot tubes in a jiffy. It is easy to operate. Just clamp over the desired tube and pull up and out.



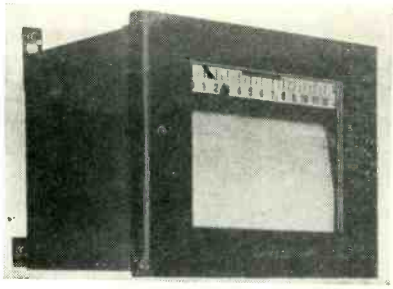
RELAY
withstands vibration, shock

BARTH ENGINEERING AND MFG. CO., Milldale, Conn., announces completion of the development of a premium relay specifically aimed

at extreme vibration and shock environments. The company is now producing a four-pole double-throw version of the relay.

SERVO MOTOR
in high temperature unit

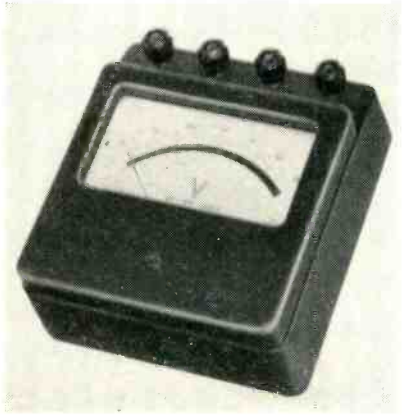
JOHN OSTER MFG. CO., 1 Main St., Racine, Wisc., now offers a new high temperature size 15, 400-cycle servo motor which also meets Mark 7 specifications. Operating temperatures up to 150 C continuous 1,000 hour ambients have been attained. Extremely small air gap results in top performance for a high torque-to-inertia ratio. Humidity protection is given by encapsulating the entire stator in a thermosetting resin to meet MIL-E-5272A. Series 2287 has stainless steel ball bearings and meets MIL-S-17087 specifications. Dimensions are 1.437 in. o-d by 1.640 in. long. Weight is 8 oz, minimum stall torque 1.45 in. oz, no load speed 4,800 rpm minimum and power input at stall is 12.2 w total.



STRIP CHART RECORDER
of the multiple-range type

APPLIED PHYSICS CORP., 362 W. Colorado St., Pasadena, Calif., is now producing a multiple-range strip chart recorder, which automatically switches between a series

of full-scale ranges of 0 to 110, 100 to 210 and on up to 900 to 1,010 mv. Model 39 recorder is particularly useful for applications, such as measuring small voltages or currents with an electrometer, where emf values must be recorded with high accuracy over a wide range of values. Range switching is performed by limit switches at the ends of the recorder slidewire, so that a higher or lower range is automatically selected when the recorder pen reaches either end of the scale.

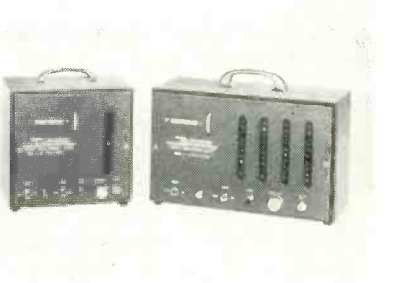


METERS
in a wide variety of types

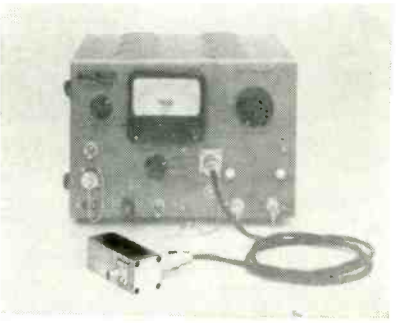
PHYSICS RESEARCH LABORATORIES, INC., 507 Hempstead Turnpike, West Hempstead, N. Y., announces the new C. P. Goerz (Vienna) precision (± 0.5 percent) moving coil ammeters, milliammeters, microammeters, galvanometers, voltmeters and high sensitivity millivoltmeters and electrodynamometer single and three phase (both three and four wire) wattmeters. Most models are available for a-c and d-c. With the aid of accessories currents as high as 300 amperes may be measured. The millivoltmeters can be converted to h-f ammeters (ranging from 50 amperes at 800 kc to 200 ma at 50 mc) by separate thermotransformers. All units have mirror scales, knife-edge pointers, are light and compact. Catalogs are available.

BATCH COUNTERS
for industrial application

THE COMPUTER-MEASUREMENTS CORP., 5457 Cleon Ave., North Hol-



lywood, Calif. The Detectron DS-700 series batch counters are dependable, direct-reading totalizing electronic counters especially designed for such applications as: industrial batch counting, measuring characteristics of jet engines, turbines, electric motors, and counting total revolutions of high-speed shafts. Available in four models the series will operate with absolute accuracy from 0 to 100,000 counts per second, depending on the number of decades. Relay contact closure and negative output pulse of approximately 100 v is provided each time the electronic decade section reaches maximum count. Relay contacts are rated at 5 amperes, 115 v, 60 cycles. Net weight ranges from 8½ lb on the 1-decade unit to 13½ lb on the 4-decade unit. Complete specifications are available on request.



NOISE DIODE PROBE
for very high frequencies

RS ELECTRONICS CORP., 435 Portage Ave., Palo Alto, Calif., announces production of an accessory noise diode probe which may be used with the company's noise generators for very high frequencies, or when low output capacitance is required. The probe contains a separate noise diode which places the noise source directly at the amplifier input (or other apparatus) under test. Lead length problems at

very high frequencies are thereby minimized. The capacitance and resistance of the noise source is adjusted by changing the resistor or variable shunt capacitor within the probe. The probe cord plugs into the front panel of the noise generator; a front panel switch on all RS noise generators selects either the internal noise diode or the probe.

Literature

High-Stability Resistors. Pyrofilm Resistor Co., 8 Whippany St., Morristown, N. J., has available bulletin PT1000 on new glass-sealed carbon film resistors. The resistor described offers particular advantages in high-precision networks. Described in the literature is the stability characteristic of the resistor which is ±0.03 percent per year at 0.5 w rating and derating to zero power at 140 C. With a 1-w rating, derating to 160 C, stability is better than ±0.1 percent in 1,000 hr. Resistance values indicated in the literature range from 1 ohm to 30 megohms. Leads can withstand up to 15-lb pull. Actual size is $\frac{3}{16}$ in. diameter by $\frac{15}{16}$ in. measured the length of the resistor body.

Coaxial Terminations and Directional Couplers. The Narda Corp., 160 Herricks Road, Mineola, L. I., N. Y. Four models of coaxial directional couplers offering complete power measurement over the most widely used frequency ranges from 225 to 4,000 mc, are described in catalog sheet 282. A new line of fixed and sliding coaxial terminations, covering the entire frequency range from S to X bands (2,400 to 12,400 mc), are described in catalog sheet 302. Photographs, applications, features, specifications and prices are included in both catalog sheets.

Radio Interference Suppression. Metal Textile Corp., Roselle, N. J., has available a booklet discussing the suppression of radio interference with Metex electronic

weatherstrips and r-f gaskets. Types, shapes and sizes of shielding products are illustrated and described. The booklet tells how to specify and lists normal tolerances.

Capacitor Literature. General Electric Co., 1 River Road, Schenectady 5, N. Y., has published the following new pamphlets on capacitors: (1) GED-2620, describing the basic characteristics of specialty capacitors for use in electronic systems. (2) GET-2417, giving a complete listing of GE capacitors for the electronic industry with basic applications, ratings, tolerances and temperature ratings. (3) GEA-4996B, an explanatory bulletin on the functions of networks and methods of determining the suitable unit for each application. A capacitor network application data sheet, essential for all radar and missile applications, is included. (4) GET-2333G, giving specifications for Tantalytic capacitors. (5) Two bulletins on the 125 C Tantalytic capacitors. Bulletin GET-2502 describes the rectangular case units; GET-2513, the cylindrical, double case units. (6) GEA-6258 gives general information on the company's new lines of tantalum foil capacitors for high temperature applications.

Production Facilities. Telectro Industries Corp., 35-16 37th St., Long Island City 1, N. Y., has published a 24-page booklet describing facilities and typical products. Sections of the booklet describe in text and illustration the corporation's facilities for designing and engineering service, production personnel, and testing. A list of available machine tools and electronic test equipment is included. Typical products are illustrated with line drawings and photographs showing assemblies and subassemblies; aircraft industry equipment; recording and audio equipment; electronic test equipment; interphone and control equipment; electronic industry equipment, and special products and facilities.

Wire-Wound Resistors. Precision, Inc., 730 Lyndale Ave. North,

Minneapolis, Minn. An 8-page brochure describes various types of wire-wound resistors now available. It also contains valuable information in the form of an alloy characteristics chart listing symbols, alloys, trade names, nominal temperature coefficients, thermal emf on copper, and a guide to proper selection. The bulletin covers fixed, adjustable, tapped multisection, pigtail terminal, and ferrule terminal vitreous enamel, as well as wire-wound precision resistors, and includes photographs of each available type.

Explosive-Driven Cutters. Beckman & Whitley, Inc., 915 E. San Carlos Ave., San Carlos, Calif. Three designs of guillotine-type explosive-actuated cable cutters (covering a wide range of destruct requirements in most of the major missiles in production and under development) are described in a new leaflet, Form EDC-555. Similar in overall arrangement, the three types illustrated vary primarily in the diameter of the cables they are able to cut. These include 9/16 in. and 1⅛ in. diameters, and 2¼ in. by 1½ in. maximum packs. Besides being illustrated photographically, the units are detailed with scaled dimensional drawings and specifications.

Rectifier Power Supplies. Opad Electric Co., 69 Murray St., New York 7, N. Y. To facilitate quotation on special and custom-built rectifier power supplies, the company offers a 2-page power equipment questionnaire form as a convenience in specifying power supply requirements. The form is designed to reduce the many variables down to a simple selection arrangement and eliminates the possibility of overlooking any important features or requirements. Copies of form PEQ are available on request.

Toroidal Coil Winding Machine. Arnold Magnetics Co., 5962 Smiley Drive, Culver City, Calif. A new 4-page folder describes a portable toroidal coil winding machine used for both laboratory and pro-

duction requirements. The literature explains how the machine sets up quickly, is easy to operate, accommodates a range of wire sizes from Awg 26 to 44, and winds at speeds up to 1,500 turns per minute.

Connectors. Whitney Blake Co., New Haven 14, Conn., has available a 4-page folder entitled "A New Approach to Connector Problems". The illustrated folder shows the company's new electrical connectors and explains how many types of AN connectors can be built up from a few basic components, thereby reducing greatly the number of parts that must be stocked. The connectors described give weight and space savings, are built to Army-Navy Specification MIL-C-5015B, and are waterproof, vibration proof and environmental resistant. The folder also illustrates new types of termination provided and describes the new enclosed type socket contact developed for these connectors to provide protection against test prods and abnormal abuse.

Pulse Signal Simulator. Haller, Raymond and Brown, Inc., State College, Pa. A single sheet illustrates and describes the model 60.3-01 pulse signal simulator which is designed to simulate typical radar signals and other signals as training aids, or for use as a piece of test equipment. Power supply requirements, mechanical specifications and electrical characteristics are given.

Switch Brochure. General Devices Inc., P. O. box 253, Princeton, N. J., has published a 4-page, 2-color brochure on high-speed multicontact sampling switches. It illustrates the company's three basic proven switch designs which are available with a wide variety of contact arrangements and integrated motor drives for use in military, scientific and commercial purposes. Detailed photos show the variety of applications. Also illustrated is a performance chart showing the extended service-free life of a typical 60-contact 300-rpm switch, covering one year's continuous operation and over 50,-

000,000 revolutions. Featured in the brochure is the new Perma-Brush. The constant force characteristics of this design results in minimum wear and enables maximum performance.

Radiation Measuring Equipment. Nuclear Instrument and Chemical Corp., 229 W. Erie St., Chicago 10, Ill. A 48-page, 2-color catalog describes a complete line of radiation measuring equipment for medical, industrial and research applications. Included are photographs and descriptions of individual instruments as well as suggested groupings of units for specific applications. Scalers, count-rate meters, portable instruments, Geiger, proportional and scintillation counters are described.

Magnetic Null Indicator. Doelcam, a division of Minneapolis-Honeywell Regulator Co., 1400 Soldiers Field Road, Boston 35, Mass. A new 2-page bulletin covers the Magnetik null indicator, a portable temperature measuring instrument. The bulletin provides complete engineering data on the low-level, linear-deflection d-c null indicator. Included is a technical description of the engineering concept of the division's second harmonic magnetic converter covering such features as isolated input, immunity to 60-cycle pickup, and rugged design.

Analog-To-Digital Converter. J. B. Rea Co., Inc., 1723 Cloverfield Blvd., Santa Monica, Calif., is offering an 8-page illustrated brochure describing the company's anlog-to-digital converter and systems in which it operates. Illustrated with photographs and block diagrams, the brochure describes the high-speed, accurate operation (0.1 percent accuracy) of the REA-Converter. Also described is a typical system, incorporating a new high-speed input commutation switch, digital output magnetic recorders and programming circuits.

Potting Connectors. Cannon Electric Co., 422 W. Avenue 33, Los Angeles 31, Calif. Numerous il-

lustrations coupled with concise instruction material on the method of potting connectors for the purpose of sealing against moisture are included in the 12-page, 2-color bulletin PM-1. Such items as ways to mix the sealant, potting forms, types of guns and various required time intervals are discussed in detail. Also included are both the resilient and plastic insert potting connector types with complete dimensional data to latest BuAer specifications.

Microminiature Relay. General Electric Co., Schenectady 5, N. Y. The 4-page bulletin, GEA-6346, covers a new microminiature relay and lists specifications for both the standard and the current-sensitive models. The hermetically sealed relay described weighs 0.35 oz in the standard model and 0.4 oz in the current-sensitive model.

Electrical Tachometers. Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J. Catalog D9A gives complete details on the new, simplified bearingless tachometer generators, as well as complete information on all Weston a-c and d-c voltage responsive and frequency responsive tachometer systems. It also illustrates and describes the types and sizes of indicators, recorders and tachometer generators available, together with dimensional diagrams and helpful mounting information.

Regulated D-C Power Supply. Lambda Electronics Corp., 103-02 Northern Blvd., Corona 68, N. Y. A recent folder illustrates and describes a 1.5-ampere regulated d-c power supply series. Included are a models and price list, specifications and a check list of the company's other power supplies.

Servomechanism Components. Norden-Ketay Corp., 555 Broadway, New York 12, N. Y. Bulletin No. 362 is an 18-page pocket-size manual of rotating servomechanism components, and adjustment and setting tools. Dimensional drawings and specifications are included.

Environmental Testing Facilities. American Electronic Laboratories, Inc., 641 Arch St., Philadelphia 6, Pa. A 4-page brochure outlining

services supplied is now available. Complete facilities are described including tables of parameters measured, range of measurement and accuracy of measurement.

Ceramic Capacitors. Solar Mfg. Corp., East 46th St. and Seville Ave., Los Angles, Calif. A new catalog gives application data, capacitance-per-size designations, specifications and curves for a complete line of ceramic capacitors. The line described includes disk types in by-pass, h-v, temperature-compensating and special styles; feedthrough and trimmer types, and tubular types in bypass and temperature-compensating styles. An extensive line of printed networks is catalogued, together with data on piezoelectric elements. Also included is a simplified style designation system for use in ordering. Requests for the catalog should be sent on company letterhead.

Flexibility of Temperature Controls. Minneapolis-Honeywell Regulator Co., 2753 Fourth Ave. South, Minneapolis 8, Minn. How the flexibility of electronic temperature controls makes them useful in a wide range of commercial heating and air conditioning installations is explained in a new booklet. The four basic features that give electronic control its flexibility and application to a wide variety of installations are described and illustrated. Included are (1) a wide choice of methods of thermostat operation including remote adjustment from a single central panel; (2) convenient, efficient and economical sequencing of heating and air conditioning equipment operation to meet varied requirements; (3) easy location of control components for maximum efficiency regardless of shape, size and number of zones in the system and (4) speedy and efficient compensation of thermostats to meet the rapid and widely fluctuating load changes characteristic of most commercial buildings.

Glass Sealing Alloys. Superior Tube Co., 1523 Germantown Ave., Norristown, Pa. Glass sealing tubing made from constant or uniform expansion alloys is described in data memorandum No. 15. The

data cover 6 glass sealing alloys in standard production. Included in the data are production limits, nominal chemical analysis, temper ranges, mechanical properties, thermal properties and tolerances. A chart shows approximate expansion curves for the 6 standard alloys for temperatures from 0 to 1,000 F. The seals described are used increasingly to protect electronic components such as transistors, capacitors, voltage regulators and meters from humidity, industrial atmospheres or to pressurize these components for high-altitude service.

Testing Instruments. Amthor Testing Instrument Co., 45 Van Sinderen Ave., Brooklyn 7, N. Y., has available a catalog illustrating and describing tensile testers, pressure gage testers, tachometers, thickness gages, speed indicators, mercury column pressure and vacuum gages, bursting strength testers, cordage and paper scales.

Boron Carbon Precistors. International Resistance Co., 401 North Broad St., Philadelphia 8, Pa. A 4-page bulletin (B-6a) contains comprehensive data on types, construction, applications, performance, temperature coefficient, tolerance, insulation, and terminations of ½, 1 and 2-watt boron carbon precistors. Detailed charts and graphs are included.

Encapsulated Resistors. Cinema Engineering Co., Division of Aerovox Corp., Burbank, Calif., has issued a 20-page catalog, insert size, covering its encapsulated resistor line. Illustrated are both the CE100 and CE 200 series for axial wire terminals, radial wire terminals and radial lug terminals. The PW100 series and PW200 series are for printed circuitry. Dimensional detail, wattage ratings, maximum resistance and military equivalents are stated. Ask for bulletin LC-1030-A.

Tape Resistors. Hansen Electronics Co., 7117 Santa Monica Blvd., Los Angeles 46, Calif. "Tape Resistors and their Application to Miniaturization" is the title of bulletin HEC-1. The brochure describes tape resistors, gives their char-

acteristics and discusses design considerations affecting printed circuitry and miniaturization.

Tube Curve Work Sheets. Technical Publishing House, P.O. Box 61, Waltham 54, Mass. Vacuum-tube circuit design is made easier and faster by use of new large tube curve work sheets. The curves, on 8½ by 11 in. pads, show plate characteristics, positive-grid characteristics, plus screen characteristics for pentodes. For ease of reading numerical data, all graph scales have been standardized at 1, 2 or 5 units per scale division. Reliable design is assured by limits of maximum voltage, current, and dissipation being clearly marked on the curves. A sample sheet of any of the 15 tube types available will be sent upon request.

Magnetic Servo Amplifiers. Feedback Controls, Inc., 1332 North Henry St., Alexandria, Va. Six magnetic servo amplifiers and output stages are illustrated and described in an 8-page booklet, 101 8/55. Features, applications, specifications and dimensional diagrams are included.

Ceramic Magnets. The Indiana Steel Products Co., Valparaiso, Ind. The characteristics, design and application of Indox I—a lightweight, low-cost nonmetallic ceramic permanent magnet—are described in a new, 4-page catalog. Catalog 15 shows how the light weight and high coercive force of the magnet make it especially suitable for indicating gages, magnetic couplings, magnetic filters, special instrumentation and miscellaneous holding applications. The high coercive force described also makes it well adapted for generators, motors, tv focusing units, polarized relays, and in applications where the magnetic length is limited or magnetization prior to assembly is necessary. The catalog also describes the manufacturing processes involved and lists the types of Index magnets available for experimental purposes.

Potentiometer and Variable Autotransformer. The Perkin-Elmer Corp., Norwalk, Conn. A 4-page brochure describes features, design principle and specifications of the

400-cycle Vernistat for use in servo systems and analog computers. The device discussed (combining the best features of an a-c potentiometer and a variable autotransformer) relates mechanical shaft rotation to electrical voltage. It is designed to the BuOrd specifications for a size 18 synchro.

Precision Mechanical Springs. The Reliable Spring and Wire Forms Co., 3167 Fulton Rd., Cleveland 9, Ohio. A 24-page 2-color, profusely illustrated brochure, contains facts on manufacturing methods, facilities, processes, ranges and applications of springs in modern manufacturing. It describes methods for specifying correctly and offers suggestions on the selection of spring sources. The brochure illustrates the method for integrating spring manufacturing with the users' own production. It describes quality control procedures, and explains research and development activities.

Thermocouple Connectors. Minneapolis-Honeywell Regulator Co., Wayne and Windrim Aves., Philadelphia 44, Pa. Specification sheet 56 describes A-N thermocouple connectors. The connectors described provide a quick and easily detachable connection for one or more thermocouple circuits. They consist of mating plug and receptacle assemblies, keyed to prevent incorrect assemblies. Their particular usefulness is in test assemblies and for panel boards which are set up for semipermanent use.

Crystal Diode Manual. CBS-Hytron, a division of Columbia Broadcasting System, Inc., Danvers, Mass. Bulletin E-217 is the second edition of the company's crystal diode manual. Revised and brought up to date, the new edition includes germanium and silicon diodes, glass encased and plastic encased. The profusely illustrated manual contains 3 parts: (1) Construction and advantages; (2) electrical and mechanical data; (3) selection and application.

Products and Facilities. Inland Testing Laboratories, 1457 W. Diversey Parkway, Chicago, Ill., has issued a new 40-page brochure. It describes in detail the qualifications, personnel, equipment and

facilities available at Inland for a wide range of products and systems testing and evaluation and other testing services available to industry and government agencies.

Induction Heater. Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh 30, Pa. Bulletin 85-875 describes the 30-kw induction heater for the metal-working industry. Applications of the induction heater are suggested. In addition to complete control and output facilities, a description of the work station housing for all components such as output transformers, capacitors, contactors and timers is presented.

Servoscope. Servo Corp.. of America, 20-20 Jericho Turnpike, New Hyde Park, L. I., N. Y. A 6-page folder describes industrial applications, outstanding features, advantages and specifications for a multiple signal generator with various signal outputs. The Servoscope described provides the user with a direct method of comparing the gain and phase shifts of a servo system, component or l-f network; and is applicable to a-c carrier and d-c servo systems. The four models discussed offer frequency ranges from 0.001 to 60 cps. Each generates three types of signals: sine-wave modulated carrier, l-f sine waves and l-f square waves.

Sensitive Relays. Hedin Tele-Technical Corp., 87 Dorsa Ave., Livingston, N. J., has published literature featuring three new sensitive relays incorporating sensitivity with a thorough wiping effect. The relay 100 operates 25 million times with no fatigue or deterioration. The relays described are designed particularly for chassis with space limitations. The literature points out that drop-out can be adjusted to 65 percent of pickup; contact combinations are from spst to dpdt; and pure silver contacts are used. Complete technical specifications may be found in the literature discussed.

Industrial Enclosed Switches. Micro Switch, a division of Minneapolis-Honeywell Regulator Co., Freeport, Ill. Published as an aid to the plant engineer and maintenance man, as well as the de-

signer of original equipment, the 28-page catalog 83 describes in detail the wide variety of enclosed switches which are designed for use on either a-c or d-c industrial applications. Included are general purpose switches, sealed switches, heavy-duty limit switches, hand operated switches and maintained-contact switches, all of which are available in a variety of actuator designs, contact arrangements and electrical ratings. Catalog 83 is complete with photographs, dimension drawings, circuit diagrams, electrical data and technical information. In all, 90 different switches are covered.

High-Voltage Resistors. International Resistance Co., 401 North Broad St., Philadelphia 8, Pa. Bulletin G-1a contains 8 pages of comprehensive data on construction, specifications, installation, tolerance, voltage coefficient, temperature coefficient, ratings, insulation and terminations for the type MV high-voltage resistors. Detailed charts and graphs are included.

Kits & Complete Instruments. General Electronic Equipment Co., P.O. Box 347, Easton, Pa., has announced a new two-color brochure describing the new line of kits and complete instruments that are available. The bulletin includes oscilloscopes, tube testers, Geiger counters and multitesters.

Insulating and Jacketing Materials. E. I. DuPont deNemours & Co., Inc., Wilmington 98, Delaware. Number WC-1, first of a series of bulletins covering insulating and jacketing materials for wire and cable, deals with the properties of the products of the Polychemicals Department. The second bulletin will be concerned with wire coating techniques as they apply to these materials. Subsequent bulletins will deal with the other aspects of the field of wire coating and utilization.

Infrared Spectroscopy. Beckman Division, Beckman Instruments, Inc., Fullerton, Calif. Reprints of an informative article surveying the usefulness of infrared spectroscopy as a research and development tool in the industrial labora-

tory are now available. The authors touch on the behavior of compounds absorbing infrared energy, present a number of infrared spectra showing characteristic absorption bands of various compounds and outline the many possible infrared applications.

Strip-Chart Recorders. The Bristol Co., Waterbury 20, Conn., has released a bulletin describing a line of 6-in. strip-chart recorders for pressure, liquid level, temperature, flow and mechanical motion. The 12-page, 2-color bulletin contains installation drawings showing methods of applying the instruments to the different variables, as well as photographs of the various models and their features. Use of the recorder as a receiver for remotely generated signals is also described.

Direct - Reading Spectrometers. Baird Associates, Inc., 33 University Road, Cambridge 38, Mass. Bulletin No. 44 provides a detailed description of improved model direct-reading spectrometers featuring the automatic servo monitor. Operation and construction of direct readers are outlined in an 8-page bulletin with diagrams and photographs. The completely automatically operated monitor described keeps the optical system in alignment at all times. Another feature is the logarithmic calibration of clock indicators directly in percent concentration. The bulletin gives an engineering treatment of the instrument and is accompanied by a file folder which describes economic advantages.

Silicon Junction Diodes. Hughes Aircraft Co., Culver City, Calif., has available an illustrated 8-page bulletin S P-4, which lists and describes silicon junction diodes types HD6001, HD6002, HD6003, HD6005, HD6006, HD6007, HD-6008, and HD6009. The bulletin contains specifications and characteristics of these subminiature devices, which are fusion-sealed in glass, and have an ambient operating temperature range of from −80 to +200 C.

D-C Temperature Bridges. Leeds & Northrup Co., 4934 Stenton Ave.,

Philadelphia 44, Pa. Complete information about bench-type and portable d-c temperature bridges for temperature and temperature difference measurements of moderate accuracy by the resistance thermometer method is now available in an illustrated 2-page data sheet. Data sheet E-33(2) describes the construction of each bridge, diagrams the circuit, and lists specifications and accessory equipment.

Miniature Ball Bearings. Miniature Precision Bearings, Inc., Keene, N. H. A 24-page booklet covers a line of 513 standard miniature precision radial bearings tabulated according to bore size. The relatively high load capacity and resistance to shock of the bearings described make them particularly suitable for applications in which jewel pivots cannot be used because of low physical strength. Information on special bearings and their applications, as well as the company's services, is included.

Airborne Assemblies. Electronic Specialty Co., 5121 San Fernando Road, Los Angeles 39, Calif. A new engineering design catalog lists voltage sensing devices, timers and time delay relays, flashers, and special aircraft devices, test equipment and miniature components. The airborne assemblies described are for use where precision and dependability are essential. Forty-eight installation drawings are provided, plus specifications for each item.

Receiving-Type Tubes. Radio Corp. of America, Harrison, N. J. A 20-page booklet (Form No. RIT-104) contains technical data on 130 small industrial tubes including Special Red tubes, premium tubes, pencil-type tubes, computer tubes, glow-discharge tubes, small thyratrons, low-microphonic amplifier tubes, and other special types. In addition, a chart is included listing RCA types intended for government end use only. Each tube type except those in the latter group is covered by a text description, tabular data, and a base or envelope connection diagram. Representative tube types are illustrated. The booklet is priced at $0.20 per copy.

Plants and People

Edited by WILLIAM G. ARNOLD

Technical societies select electronic engineers to receive honors and awards. More manufacturers plan facility expansions by acquisitions or new construction. Top engineers move to new positions of responsibility in the industry

Sylvania Makes Ten Millionth TV Tube, Plans English Plant

SYLVANIA Electric Products has produced a total of 10 million tv picture tubes.

The ten millionth tube—a 24-inch aluminized tube—was produced at the firm's Seneca Falls, N. Y. plant.

The company recently expanded its total domestic manufacturing space for picture tubes to 800,000 sq ft. Last fall it built a West Coast tube plant.

Don G. Mitchell, president and board chairman of Sylvania, announced that the company plans to form a picture tube firm in England in conjunction with Thorn Electrical Industries.

The new company, which would make only black-and-white tubes, is to be jointly financed by Thorn and Sylvania. A capital investment of several million dollars is planned. Probable name for the firm will be Sylvania-Thorn Cathode Ray Tubes, Ltd.

Watching production of 10,000,000th tv picture tube at Sylvania are, left to right: W. C. Toner, plant manager; M. D. Burns, vice-president of operations; D. G. Mitchell, chairman and president and W. H. Lamb, divisional general manager

Initial output is estimated at more than one-half million tubes a year.

The tubes will be used for Thorn's own make of television set, as well as for consumers in England and for export to other European and South American countries.

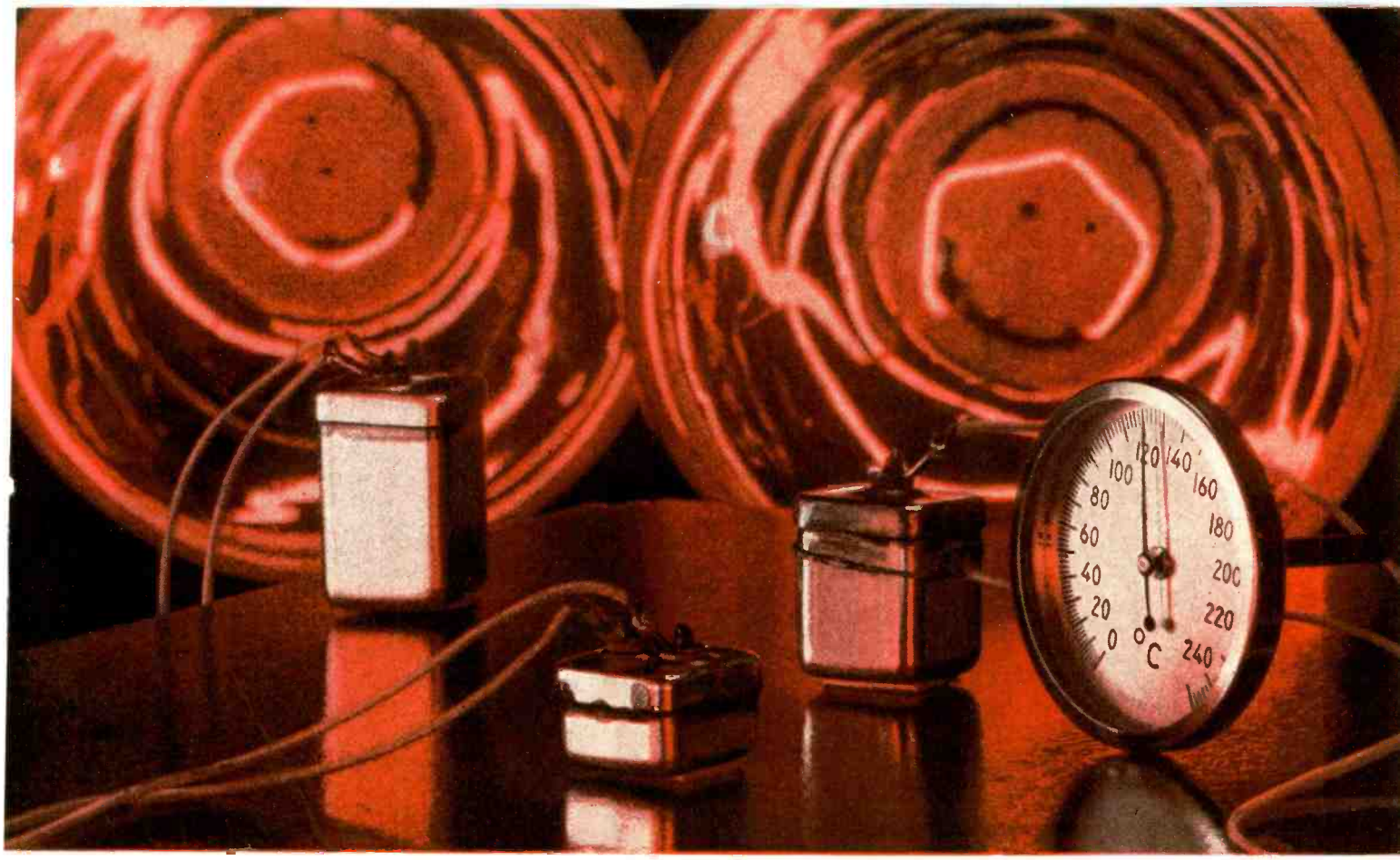
IRE Selects Hogan, Bullington, Hinman For Top Awards

JOHN V. L. HOGAN, president of Hogan Laboratories and founder of station WQXR, will be the recipient of the IRE Medal of Honor. The award is to be made "For his contributions to the electronic field as a founder and builder of the IRE, for the long sequence of his inventions, and for his continuing activity in the development of devices and systems useful in the communications art." It will be presented during the IRE National Convention in New York City next March.

He began his career in radio in 1906 as a laboratory assistant to Lee De Forest. From 1910 to 1921 he held posts with the National Electric Signaling Co. and the International Radio Telegraph Company. He then became a consulting engineer in New York City. He is responsible for inventions in radio, television and facsimile fields. He was founder and owner of station WQXR, until it was acquired by The New York Times. He is president of Hogan Laboratories of New York City.

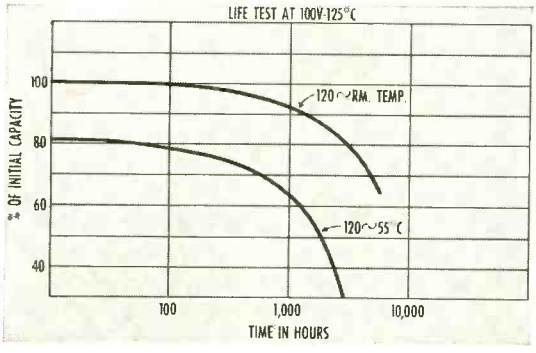
John V. L. Hogan

In 1912 he helped found the Institute of Radio Engineers, which has since grown to an international membership of over 43,000. He served as vice-president of the IRE from 1916 to 1919 and president in 1920. He has also served frequently as a member of the board of directors and on many committees of the

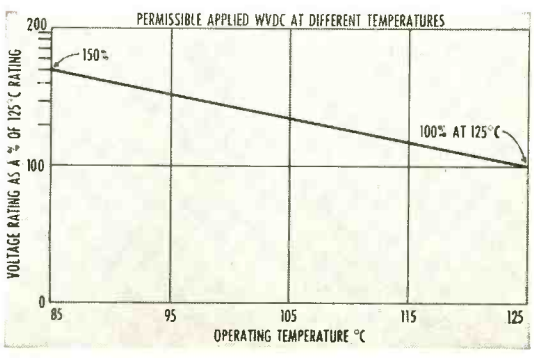


INFRA-RED LAMPS RAISE AMBIENT TEMPERATURE TO +125 C.

NEW G-E TANTALYTIC* CAPACITORS OPERATE AT +125°C AMBIENT



LONG LIFE of G-E high temperature Tantalytic capacitors is shown by this graph of life vs loss of capacitance for typical 100 volt d-c unit.



HIGHER VOLTAGES than 100 VDC can be applied . . . with no loss of life . . . at ambient temperatures below rated +125 C as shown above.

Available in ratings from 36 uf at 100 VDC to 180 uf at 30 VDC

Designed to operate at +125 C for 1000 hours with not more than 20% loss in initial +25 C capacitance, General Electric's new high-temperature Tantalytic capacitors meet the tough requirements of miniaturized military equipment.

FOIL CONSTRUCTION assures the same long life, high quality, and stable operating characteristics provided by +85 C Tantalytics. Unlike other types of Tantalytic capacitors, the foil construction also offers:

- **Both polar and nonpolar construction.**
- **Chemically neutral electrolyte . . . minimizes corrosion danger.**
- **Excellent mechanical stability . . . freedom from electrical noise under shock and vibration.**
- **Excellent reliability at rated temperatures . . . extended life at temperatures below +125 C.**

AVAILABILITY: G-E high-temperature Tantalytic capacitors can be obtained now in sample quantities for evaluation and prototype use. Production lots will be available by September in the following standard ratings:

Voltage	uf Case 1 ¾" x ¾" x 1 ⅛"	uf Case 2 ¾" x ¾" x ⅞"	uf Case 3 ¾" x ¾" x ½"
30	180	110	55
50	100	60	30
75	60	36	18
100	36	24	12

For more information, see your G-E Apparatus Sales Representative or write for Bulletin GEA-6258, General Electric Company, Section 442-27, Schenectady 5, New York.

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industry's technical organization.

The Morris Liebmann Memorial Prize, awarded annually to an IRE member who has made a recent important contribution to the radio engineering art, is to be given to Kenneth Bullington of Bell Telephone Laboratories, New York, N. Y. "For his contributions to the knowledge of tropospheric transmission beyond the horizon, and to the application of the principles of such transmission to practical communications systems."

He joined Bell Laboratories in 1937 and since that time has been engaged almost entirely in studies relating to the propagation of radio waves. His work on scatter propagation during the last three years has been a major factor in extending communications.

Kenneth Bullington

Wilbur S. Hinmann, Jr.

Wilbur S. Hinman, Jr., director of the Diamond Ordnance Fuze Laboratories of Washington, D. C., will receive the Harry Diamond Memorial Award, which is given to persons in government service for outstanding work in radio and electronics. The award will be given "For his contributions to the electronic art in the fields of meteorology and proximity fuzes."

He has been an important contributor to the development of aircraft navigation aids, radiosondes for obtaining information on upper-air weather, and in the development of the proximity fuze during World War II. He became director of the Fuze Laboratories which took over work on the proximity fuze from the National Bureau of Standards after the war.

William Shockley Joins Beckman Instruments

DR. WILLIAM SHOCKLEY has joined Beckman Instruments of Fullerton, Calif.

He comes to the firm from the Bell Telephone Laboratories, where he has been director of transistor physics research since 1954. He has been a member of Bell's research activity in various capacities since 1936.

He will build a new research group for Beckman, composed of scientists in the field, to work broadly toward the further development of semi-conductors.

Concerning his new position, Dr. Shockley said, "Beckman Instruments offers an unusual opportunity for attracting outstanding scientific personnel with the objective of building a compact group of men who are interested in the most rapid progress possible of transistor and other semi-conductor research and development. This field is still in its infancy. In Arnold Beckman I have found an industrial leader with a viewpoint thoroughly sympathetic to the kind of program which I wish to carry out. I feel, as does Dr. Beckman, that the contribution of transistors and other semi-conductor devices to automation will open a new era in which man is further freed from the limitations imposed on him by nature and many of the tedious necessities of this industrial age."

William Shockley

The transistor originally was developed during a program of solid state physics research at Bell Telephone Laboratories, which was carried out under Dr. Shockley's direction. In the course of this research program, Bell made an announcement in 1948 of the first transistor.

IT&T Builds $2.5 Million Plant In California

IT&T will construct a new plant in Los Angeles, Calif. for its Federal Telephone and Radio Co. Representing an initial investment of over $600,000 for land, building and equipment, the new plant will be constructed in five parts, at an ultimate cost of nearly $2.5 million.

A line of electronic products, including power supplies and other devices particularly useful in aircraft manufacture, will be produced at the new plant.

All manufacturing will be on one floor with the office, laboratory and production areas occupying 36,000 sq ft of floor space in the initial section. It is situated on 13 acres.

It is IT&T's first factory on the West Coast. It was conceived with the purpose of enabling Federal to serve better the aircraft and other manufacturing industries.

(Continued on page 368)

Byron Jackson Joins Borg-Warner

BYRON JACKSON, west coast manufacturer of pumps, oil tools and electronic equipment, has become the Byron Jackson division of Borg-Warner Corp.

Present management and policies will be continued. E. S. Dulin, president of Byron Jackson, has been named president of the new division.

Packard-Bell Elects Leng

RICHARD B. LENG has been elected to the newly created position of vice-president in charge of the technical products division of Packard-Bell Co.

He has had 20 years engineering and management experience in the electronics industry with Sylvania Electric, RCA and Raytheon. He joins Packard-Bell after resigning his post of manager of California operations for Sylvania Electric.

RCA Plans New Transistor Plant

A $3 MILLION plant will be built by RCA's tube division in Bridgewater Township, near Somerville, N. J.

The new plant, which will be erected on an 83-acre plot beginning this fall, is expected to be ready for

operation by late 1956. It will serve as engineering and manufacturing headquarters for the semi-conductor activities of the division, providing facilities in addition to those in Harrison, N. J., for handling the demand for transistors and diodes.

The Bridgewater plant will have approximately 126,000 sq ft of floor space.

Loughlin And Olson Receive SMPTE Awards

THE SOCIETY of Motion Picture and Television Engineers named Bernard D. Loughlin as recipient of its 1955 David Sarnoff Gold Medal Award for his outstanding contributions to the field of color television. He is a consulting engineer with the Hazeltine Corp. in Little Neck, New York.

The award was established to give recognition to technical contributions to the art of television and is awarded primarily for achievements within the last five years. In 1954 it was presented to Ray D. Kell of RCA.

Loughlin has been with Hazeltine since 1939 in research and development. Two of his outstanding contributions noted by SMPTE are the understanding that the optimum method of transmitting a compatible color picture is by the transmission, by normal standards, of a black-and-white picture to which the color information is added; and the "constant luminance" principle, by which monochrome signal carries all of the luminance and the added color signals contribute only to chromaticity.

He is the holder of 36 patents, with 31 pending applications, and is the author of many technical articles. In 1952 he was awarded the Vladimir K. Zworykin Television Prize by the IRE.

The Society also selected Harry F. Olson of RCA as the recipient of its Samuel L. Warner Memorial Award for 1955.

The Warner Award is given to "a candidate who has done outstanding work in the field of sound motion-picture engineering and in the development of new and improved methods or apparatus de-

signed for sound motion pictures." Dr. Olson was selected for the results of his productive career in audio engineering, including his work on the velocity microphone, the duo-cone speaker for high fidelity sound reproduction, and his contributions to the development and improvement of phonograph pickup and recording equipment, underwater sound equipment, and sound motion picture and public address systems.

Dr. Olson, who is today director of the RCA Acoustical and Electromechanical Research Laboratory, Princeton, New Jersey, joined that company in 1928. He holds more than 60 patents on devices and systems in the acoustical field and is also the author of more than 70 articles and papers in professional journals, as well as several books.

Audio Engineers Elect Officers

COLONEL Richard H. Ranger, president of Rangertone of Newark, N. J., has been elected president of the Audio Engineering Society. He succeeds Albert A. Pulley, manager of general recording for RCA Victor records.

A pioneer in the development of transoceanic radio, ship-to-shore telephony, facsimile and electronic organs and chimes, Colonel Ranger has headed his own company since 1930. Rangertone manufactures magnetic tape recorders, primarily

Col. Richard H. Ranger

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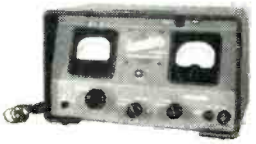

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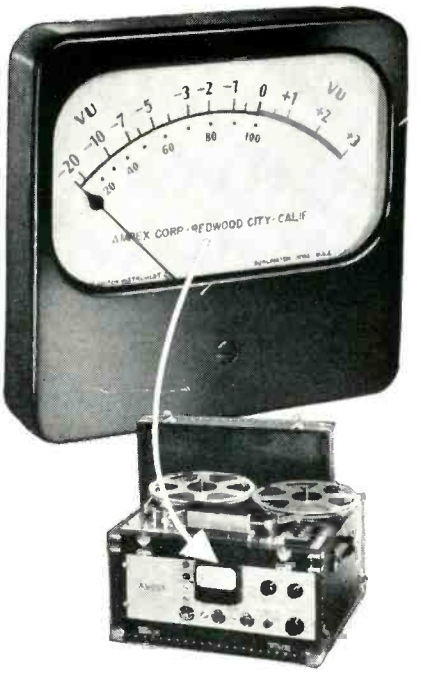

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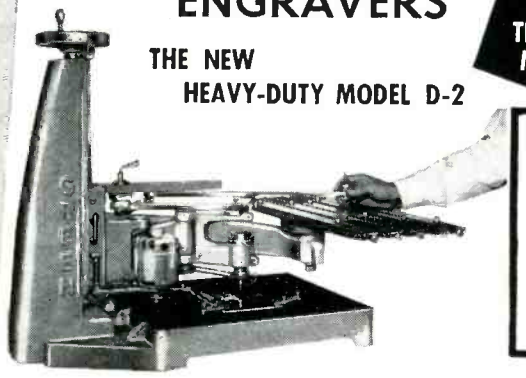

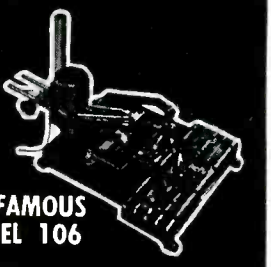

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for motion picture sound and for use on television programs.

He is a fellow of the Society, which elected him executive vice president last year.

Walter O. Stanton, president of Pickering and Co. of Oceanside, N. Y., was elected executive vice-president of the Society. Two vice-presidents were chosen: Ewing D. Nunn, owner of Audiophile Records, Saukville, Wisconsin, who is central vice-president, and Roy A. Long, research engineer of the Stanford Research Institute, Stanford, California, who was chosen western vice-president.

C. J. LeBel, chief engineer, Audio Instrument Co. of New York, a founder and first president of the Society, was reelected secretary for his fifth consecutive term. The treasurer, Ralph A. Schlegel, technical facilities supervisor, WOR-General Teleradio, New York, was also renamed.

Elected as governors were: Victor Brociner, president, Brociner Electronics Corporation, New York: C. Robert Fine, president, Fine Sound, New York, and Donald J. Plunkett, New York studio manager, Capitol Records, New York.

NARTB Selects Engineering Group

THE ENGINEERING advisory committee for the National Association of Radio and Television Broadcasters has been named for the 1955-56 fiscal year.

Raymond F. Guy, National Broadcasting Co., New York, will serve as chairman. Other committee members are:

Glenn G. Boundy, Storer Broadcasting Co., Miami Beach; Ralph N. Harmon, Westinghouse Broadcasting Co., New York; Phillip B. Laeser, WTMJ, WTMJ-TV, Milwaukee; John G. Leitch, WCAU, WCAU-TV, Philadelphia; J. E. Mathiot, WGAL, WGAL-TV, Lancaster, Pa.; James D. Russell, KKTV, Colorado Springs, Colo.

Network representatives on the Engineering Advisory Committee are: Rodney D. Chipp, DuMont-TV, New York; Earl M. Johnson, Mutual Broadcasting System, New

York; William B. Lodge, Columbia Broadcasting System, New York; Frank Marx, American Broadcasting Co., New York.

Honeywell Names Transistor Head

Jerre Manning

JERRE MANNING has been named manager of Minneapolis-Honeywell's transistor division in Minneapolis. Manning was formerly general manager of the company's marine equipment division in Seattle, Wash.

Honeywell specializes in the production and sale of power-type transistors.

Manning will head the division's production, engineering and sales activities. Prior to becoming manager of the marine equipment division in 1954, he was divisional manager at Chicago for Honeywell's Micro Switch division.

Varian Enlarges Palo Alto Plant

VARIAN Associates of Palo Alto, Calif., has started a major enlargement of its Palo Alto plant.

Construction will add 25,000 sq ft of work space and bring the Palo Alto plant area to 63,000 sq ft. The company also occupies about 50,000 sq ft in nearby San Carlos, where klystron tube manufacturing activities are centered.

Additional space will be used for the firm's work in the field of nuclear magnetic resonance, microwave engineering and radar trans-

mitters and other electronic subsystems, as well as klystrons and other specialized vacuum tubes.

Working facilities of Varian will total about 123,000 sq ft on completion of the new additions, including about 10,000 sq ft for the subsidiary firm, Varian Associates of Canada, which will open in Georgetown, Ontario.

Admiral Builds Research Lab In West

ADMIRAL CORP. is building a new electronic research laboratory located on a 3 acre site in Stanford Industrial Park. The land has been leased for 99 years from Leland Stanford Junior University.

The new laboratory will provide facilities for the expansion of the firm's advanced development section which has been housed for the past 4½ years in Palo Alto. Research and development engineers, headed by Robert M. Jones, will staff the laboratory upon its completion late this year.

The building will house precision equipment and other scientific apparatus required in research and development work on military projects in the fields of guided missiles, radar systems, air navigation, nuclear radiation measurement, direction finding and communications, as well as on the company's civilian products.

Brush Electronics Promotes Two

DAVID B. PARKINSON and John H. Harris have been promoted as vice-presidents of Brush Electronics Co., a unit of Clevite Corp. Harris will be vice-president and general works manager, and Parkinson will be vice-president and general engineering manager.

Dr. Parkinson has done developmental work during a 10-year association with the Bell Telephone Laboratories. He is a recipient of the Presidential Medal for Merit and the Potts Medal of the Franklin Institute for outstanding work in the development of fire-control equipment during the war. He joined Brush Electronics in 1948, and is

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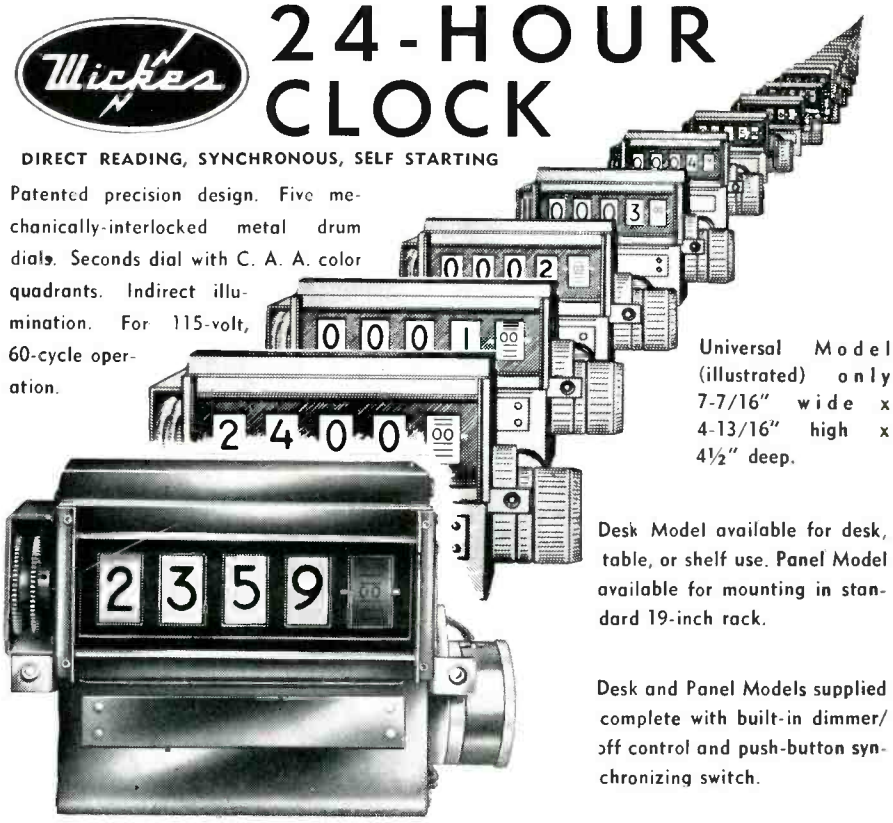

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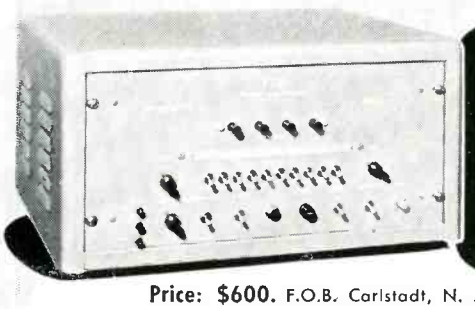

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Expressly designed for testing Video equipment requiring a high level signal, the Tel-Instrument Type 1105 provides a 2.0 V. Max. p-p signal from a 75-ohm source into a 75-ohm load, with a sweep range from 50 KC to 10 MC. Features include: Ten selectable crystal controlled pulse-type markers supplied at either integral megacyle point, or as desired; flat output within ±0.2 db over entire range, attenuated over 60 db; and external markers.

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responsible for all design and production engineering at the company.

Harris joined Brush Electronics in 1944 after holding management and manufacturing positions with Minneapolis - Honeywell Regulator Co. and with Lear. He is responsible for the company's direct manufacturing, production control, maintenance and materials procurement.

Du Mont Labs Elevates Ruiter

JACOB H. RUITER has been promoted to manager of advertising and promotion of the technical products division of DuMont Laboratories. He was previously public relations manager.

He joined the firm in 1943, and has served as an engineer in a number of departments, headed the instruction book section of engineering, and managed technical publications and technical advertising.

He is the author of a number of books and articles dealing with cathode-ray instruments and with television.

United-Carr Acquires Two Companies

UNITED-CARR Fastener Corp. of Cambridge, Mass., has acquired two California companies which will operate as divisions of United-Carr subsidiary companies.

Graphik-Circuits of Pasadena, Cal., has become a division of Cinch Manufacturing Corp., United-Carr's Chicago subsidiary. The division designs and manufactures

printed electrical circuit boards.

Plastic Process Company, Los Angeles, Cal., will be operated as a division of Monadnock Mills, a United-Carr subsidiary in San Leandro, Cal. The new division will produce plastic components.

IRC Builds New Plant In California

A NEW electronics plant is being built in California for International Resistance Co.

The plant, which will employ some 300 persons for an annual payroll of $1million, is for Hycor and Ircal Companies, IRC subsidiaries.

The plant will manufacture resistors, transformers, magnetic amplifiers and other special parts.

The completion date is set for December, 1955.

The land, with improvements and equipment, will represent an investment of more than $1 million.

The building will contain 26,000 sq ft of floor space.

Bendix Appoints Weapons Director

RUSSELL D. O'Neal has been named director of weapons systems planning of Bendix Aviation Corp. He will head an expanded program of development and production of modern weapons systems.

In 1941, Dr. O'Neal became a staff member of MIT where he engaged in the development of radar. In 1949, he became assistant director of the Willow Run research center of the University of Michigan and, in 1951, was made director of the center in charge of electronic and guided missile work.

In 1953, he became assistant division manager of Consolidated Vultee Aircraft Corp.

Baird Names Transistor Head

WALTER G. DRISCOLL has been appointed assistant director of research at Baird Associates in Cambridge, Mass., manufacturers of precision instuments. He will be in charge of the company's transistor-

ized electronics department.

A one-time special agent of the Federal Bureau of Investigation, Dr. Driscoll joined the Baird staff from the Department of Defense.

Norden-Ketay Appoints Roehm

PERRY R. ROEHM has been appointed executive vice-president of Norden-Ketay Corp. He was, prior to this appointment, vice-president of the company in charge of engineering and sales.

He served as chief production engineer of Norden's New York City plants, and later became production superintendent at the U. S. Navy bombsight plant in Elmira, New York, which was operated by Norden.

In 1944, Roehm joined the Barden Corp., where he was a vice-president and director. He joined Norden-Ketay in March, 1955, following the integration of Norden Laboratories and Ketay Instrument.

Borg-Warner Builds For Research

CONSTRUCTION in Des Plaines, Ill., of a multi-million-dollar Borg-Warner research center is planned by the company.

Construction of the first unit of the research center has been started.

The new laboratory will contain

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facilities for metallurgical, electronic, electrical, chemical, acoustical, hydraulic, applied mechanical, physics and nuclear research. The laboratory also will house a complete machine and model shop, a modern computation center and a large technical reference library. About 100 scientists and engineers will be engaged at the start of the operation. Building of the initial unit is expected to be completed next spring.

Sperry Products Acquires Western Inspection

WESTERN Inspection of Midland, Texas has been acquired by Sperry Products of Danbury, Conn. Western Inspection will become Sperry Western. James H. Binford continues as president, with Sperry's R. B. Manning named vice-president and treasurer and D. W. Gordon secretary and assistant treasurer.

Western provides a service for the non-destructive testing of tubular goods in the oil industry.

Raytheon Sets Up Lab, Names Nichols, Spencer

RAYTHEON Manufacturing Co. has established a laboratory at the White Sands Proving Grounds in Las Cruces, N. M. The laboratory will conduct tests and evaluation of equipment which the firm, as prime contractor, is developing for Army Ordnance.

A large building on the base has been allocated to the company, and the tools and equipment necessary to equip the facility are being furnished by the firm and the U. S.

The lab's functions are being integrated with the firm's guided missile test facilities at Point Mugu, Calif. Robert Skidmore has been transferred from Pt. Mugu to coordinate the work at the White Sands laboratory.

Nathaniel B. Nichols has been named manager of Raytheon's commercial equipment engineering activities. He was formerly manager of the firm's research division.

During World War II, he was associated with MIT where he head-

ed the servo group of the fire control division. Subsequently, he became research director of the Taylor Instrument Companies, leaving in 1950 to accept a professorship in electrical engineering at the University of Minnesota.

Percy L. Spencer, vice-president of Raytheon and general manager of its microwave and power tube operations, has been elected a director of the firm.

He joined the firm in 1925 and his technical contributions include the strapping and tuning of magnetrons, applications of microwaves to industrial and medical fields, innovations in the photocell and gas rectifier arts and new techniques of manufacturing. He came to the company from Submarine Signal Co. of Boston.

Cook Forms New Electronics Firm

Frank R. Cook

THE FRANK R. COOK CO., a new research and manufacturing organization, has been formed by a group of Denver and New York industrialists in Colorado. The company will engage in the development of equipment for aeronautical and electronic industries. It will be

headed by Frank R. Cook.

The company has completed negotiations for the purchase of laboratory and manufacturing facilities in Denver and in Colorado Springs.

Prior to forming the new organization, Cook served for five years as director, aeronautical engineering, and director of research and planning of the Minneapolis-Honeywell Regulator Co. in Minneapolis, Minn.

Gabriel Selects Electronics Head

STEVEN GALAGAN has been appointed director of engineering for Gabriel Laboratories and the Gabriel Electronics Division in Needham Heights, Mass.

In 1946 he was appointed section head of the antenna division at the U. S. Navy underwater sound laboratory in New London, Conn. He was also an instructor at Mitchell College, New London in mathematics and physics.

In 1952 he was associated with the General Electronics Laboratories of Cambridge, Mass., as chief engineer. Here he devoted his time to research and development in the fields of telemetering, countermeasures, computers, and special electronic instrumentation and circuitry. He was elected to the board of directors of General Electronics in 1953.

Galagan came to Gabriel in early 1955. Prior to his appointment as director, he held the position of general sales manager.

Los Angeles Sets Up AEC Committee

THE ELECTRONICS Committee of the Los Angeles Chamber of Commerce has inaugurated a new information service to aid local firms in dealing with the Atomic Energy Commission.

The new service will provide data on procedures for submitting research proposals directly to AEC divisions of research, biological, medical, and reactor development in Washington, as well as for subcontract work for major research institutions.

In addition, the service will sup-

ply information on procedures for selling equipment to independent contractors handling equipment procurement for the AEC. According to the C of C, the AEC used 5 to 15 percent of the $5.5 billion spent in 1954 on plants and equipment for the purchase of electronics supplies.

Beckman Purchases Ceramics Firm

BECKMAN Instruments of Fullerton, Calif. has purchased Place Industrial Ceramics Corp. of El Segundo, Calif., developers of a film-type resistance element, applicable to a number of the firm's instrument products.

The plant will be under the management of the company's Helipot division of Pasadena. First project for the ceramics firm will be the manufacture of trim-type potentiometers.

Thomas Place Sr. and Thomas Place Jr. will continue to supervise plant operations.

Norden-Ketay Buys Frohman Manufacturing

NORDEN-KETAY Corp. purchased all the outstanding stock of The Frohman Manufacturing Co. of Miami, Florida in exchange for approximately 50,000 of its shares.

The purchase includes the total goods and assets of Frohman, its Miami plant and its turbine products division at Boca Raton, Fla.

Frohman is engaged in manufacturing precision and high speed shafts, gears and gear trains. The firm is expected to gross over $1.5 million a year. Its present backlog is $1.5 million.

I. D. E. A., Acquires Radio Apparatus Corporation

RADIO APPARATUS Corp. of Indianapolis, Indiana, has been acquired by I. D. E. A. through an exchange of common stock.

Radio Apparatus will continue to operate under the name Monitoradio Division of I.D.E.A. The firm produces vhf receivers for moni-

toring emergency communication broadcasts. No change in personnel or policy is anticipated as a result of the merger.

Admiral Born Joins Collins Radio

REAR ADMIRAL Arthur S. Born, USN (Ret.), has joined Collins Radio Co. of Cedar Rapids, Iowa, as assistant to the vice-president of research & development.

He has served in various capacities in the Navy, including command of the USS Badoeng Straits and head of the electronics division of the Bureau of Aeronautics. His latest assignment has been in the Office of the assistant secretary of defense, applications engineering.

EICO Appoints Vice-President

PHILIP A. PORTNOY has been appointed a vice-president of EICO, Electronic Instrument Co., kit and instrument manufacturers.

He has been with EICO since 1951 as executive assistant to H. R. Ashley, president. Prior to that, he was a practicing attorney and during World War II, taught radar and radio electronics and repair for the Signal Corps.

Burrough Selects Control Manager

CARL BECKMAN has been appointed manager of the newly organized automation and process control division of the Burroughs Corp. re-

Carl Beckman

search center in Paoli, Pa. He will direct the design and development of industrial automation equipment using digital computer techniques. Beckman formerly was manager of the center's electromechanisms department, development division.

Motorola Establishes New Department

Robert F. Schulz

MOTOROLA has consolidated its microwave and power utility products department. Robert F. Schulz has been made manager of the new department which will be called the microwave and industrial products department. Commercial sales activities will be directed by Leonard G. Walker and James Stewart will be in charge of export and special accounts sales.

Since joining Motorola in 1953, Schulz has directed the engineering, production and sale of the Motorola line of microwave equipment. His 25 years of previous experience in the electronic industry include 13 years in various positions in the broadcast industry, three years as a consulting radio engineer and nine years as supervising engineer and deputy director for Airborne Instrument Laboratory.

Photon Inventors To Be Honored

RENE A. HIGONNET and Louis M. Moyroud, of Cambridge, Mass. will be awarded John Price Wetherill Medals of The Franklin Institute of the State of Pennsylvania, "for

America has homework to do!

THERE'S PROBABLY a lot about your town that makes you want to brag a bit about it.

But there's one thing you *can't* be proud of. And it's a shame you share with just about every other community in America.

The homes where far too many people live are a disgrace. Slums, semi-slums, housing blight are with you. Fixing them up is the homework to be done.

If your town is like most in the U. S., here's what the figures show: 1 out of every 10 homes are rock-bottom slums. Nearly one-half urgently need basic repairs.

But slums are something that is happening on the other side of town, you may say. The problem isn't mine.

Slums are YOUR homework

Distance is no barrier against the threat and cost of housing blight.

Your taxes go up because it takes more money for your town to fight the diseases and delinquency and poverty spawned in the slums. The security of your family goes down because the slum is the natural parent of crime.

Where your business comes in

Every firm has a responsibility toward the town where it's located. Part of it is to support community improvements as any other good citizen would.

Some slums are beyond repair. They must be torn down and a fresh start made. Others can be made to conform to accepted living standards. So it is up to you to get behind every sound program which seeks to provide adequate housing for all our people.

Civic and individual groups must have business backing . . . *your* firm's backing if they are to succeed.

Follow the course of Action!

A group of Americans from every walk of life has joined together in a non-profit organization to combat home and community deterioration, A.C.T.I.O.N., the American Council To Improve Our Neighborhoods.

Send today for a free copy of "ACTION." It explains what A.C.T.I.O.N. is and proposes to do. It lists booklets, research, check-lists, and other material which can help you. Address P. O. Box 500, Radio City Station, New York 20, N. Y.

ACTION

American Council To Improve Our Neighborhoods

their conception and development of the Photon type-composing machine."

The Photon, a photographic type composing machine, utilizes photographic processes along with applied communication network theory, numerical counting processes and control mechanisms to produce a wide variety of type styles and sizes into justified lines of characters on photographic film.

Much of the early work on photocomposition was conducted in Paris under the difficulties and shortages of the German occupation. The Lithomat Corp. and a group of scientists were interested, and the Graphic Arts Research Foundation of Cambridge, Mass., was founded to perfect the device and provide a research facility capable of undertaking fundamental problems in the field of graphic arts. The organization, financed by the printing and publishing industry, developed the machine and licensed Photon of Cambridge, Mass., to commercialize the finished machines.

Ten of these machines have been built in the United States. Five are at the Photon plant in Cambridge and five on contract with publishing and printing houses. Several published books have been set on the Photon. The first was The Wonderful World of Insects released in 1953. Also, in November 1954, The New Testament in Cadenced Form was published.

The Graphic Arts Research Foundation, under contract from the United States Government, is designing and building a machine for the compositon of Chinese.

Airborne Instruments Selects Horvath

AIRBORNE Instruments Laboratory has added William J. Horvath to the staff of its medical physics group. Dr. Horvath will assist in the continuing development of the cytoanalyzer—an electronic instrument designed for extensive testing for early cancer—and on other problems of medical physics.

In 1945, he helped organize the Navy's Operations Evaluation Group, and later was deputy director of the group for two years. In

1949, he joined the newly organized Weapons System Evaluation Group of the Joint Chiefs of Staff, in which he served for three years as a project leader and in an advisory capacity to the director. Although he resigned from full-time service with the group in 1952, he continued as consultant. He also served as consultant to the National Research Council Committee on Undersea Warfare.

Phaostron Changes Its Name

THE PHAOSTRON Company of South Pasadena, Calif., makers of electrical measuring apparatus, is changing its name to Phaostron Instrument & Electronics Co.

The firm plans to minimize its output of products for military use, and is converting to consumer items.

It plans to add 13,000 sq ft of factory space to its present facilities.

Logistics Research Promotes Two

W. V. NEISIUS, formerly director of applications, has been appointed vice-president of applications and sales, and A. Y. Baker, formerly chief engineer, is appointed vice-president, development and production, of Logistics Research.

Both Neisius and Baker have been with Logistics since before the first production ALWAC computer was delivered in February, 1954. Neisius is former assistant professor of mathematics at Georgia Institute of Technology, and statistical and engineering consultant to the Georgia Power Co. Baker held various positions in radar engineering with aircraft manufacturing firms before entering the electronic computer field.

General Devices Appoints Engineering Head

EVERETT B. GARRETSON has been appointed to the newly created position of director of engineering of General Devices of Princeton, N. J. General manufactures high speed

multi-contact, sampling switches.

For the past five years, Garretson has been president of his own consulting engineering firm.

Previously, he had been a staff member of the Princeton University plastics laboratory developing apparatus for measuring the dielectric constant and loss factor of plastics and oils at microwave frequencies.

Navy Needs More Engineers

AT THE Naval Air Material Center in Philadelphia, engineering vacancies exist in the following options: electrical, electronics, general, industrial, mechanical, structural and aeronautical. Starting salaries range from $3670 to $8990 per annum.

Canadian IRE Sets Show Plan

PLANS are under way for the Canadian I.R.E. Convention which will be held in Toronto on October 1, 2 and 3, 1956.

In addition to the technical sessions at which papers on subjects in the electronics field will be presented, an engineering exhibition will feature upwards of 200 exhibits.

The convention which is expected to draw engineers from all parts of Canada and the adjacent States, will be held in a new building to be erected at the Canadian National Exhibition.

Armco Steel Names Three

G. H. COLE, former associate director of research, has been named consulting engineer for magnetic materials at Armco Steel Corp.

Cole joined the firm's research organization in 1929. He had been an associate director of research for the company since 1931.

V. W. Carpenter succeeds Cole and will direct Armco's future research work in the field of magnetic materials. He joined the company in 1930. In 1940, he became supervising metallurgist and held that position until his recent advance-

Let's face it!

HAVE YOU A DISASTER PLAN FOR YOUR PLANT?

BOMBS...OR FIRE...OR FLOOD...OR TORNADO ...you can handle them if you act now.

Let's face it... the threat of war and the atomic bomb has become a real part of our life—and will be with us for years. Fires, tornadoes and other disasters, too, can strike without warning.

Whatever the emergency is, everybody's going to want help at the same time. It may be hours before outside help reaches you. The best chance of survival for you and your workers—and the fastest way to get back into production—is to know what to do and be ready to do it. Disaster may happen TOMORROW. Take these simple precautions TODAY:

☐ **Call your local** Civil Defense Director. He'll help you set up a plan for your offices and plant—a plan that's safer, because it's integrated with community Civil Defense action.

☐ **Check contents** and locations of first-aid kits. Be sure they're adequate and up to date. Here, again, your CD Director can help. He'll advise you on supplies needed for injuries due to blast, radiation, etc.

☐ **Encourage personnel** to attend Red Cross First-Aid Training Courses. They may save your life.

☐ **Encourage your staff** and your community to have their homes prepared. Run ads in your plant paper, in local newspapers, over TV and radio, on bulletin boards. Your CD Director can show you ads and official CD films or literature that you can sponsor locally. Set the standard of preparedness in your plant city. There's no better way of building prestige and good community relations—and no greater way of helping America.

Act now . . . check off these four simple points . . . before it's too late.

ment in research.

D. C. Dieterly has been appointed supervisor of the firm's magnetic research laboratory.

Anderson Leaves Panellit

RALPH A. ANDERSON has resigned as vice-president in charge of design and development engineering of Panellit of Skokie, Ill.

Budd Enters Radiography Field

THE BUDD CO. of Philadelphia will manufacture, sell and service the gamma radiography equipment and sources previously produced by The Gamma Corp. of Mansfield, Mass.

A. J. Stevens, formerly president, C. F. Thompson, formerly vice-president and T. W. Healy, formerly treasurer of the Gamma Corp., have joined Budd and will continue their activities in connection with isotope radiography equipment, as well as other applications of nuclear radiation.

Chassis Company Enlarges Quarters

CALIFORNIA Chassis Co. of Lynwood, Calif., has added approximately 10,000 sq ft to the floor area of its main plant.

The annex will be used mainly for research facilities and warehousing. It will release space in the original building for additional production line operations.

Fua Heads ETL's Expanded Lab

ELECTRICAL Testing Laboratories, independent testing organization, has expanded its facilities and personnel for testing in the field of electronics. Its electronic laboratory now occupies approximately 5,000 sq ft of the 100,000 sq ft, 8-story building owned by E. T. L., and has a staff of fifteen.

Dr. Frederic Fua is director of the electronics lab. He is also president and research director of Stand-

Waldman Named By Telectro

EDWARD WALDMAN, formerly director of purchases, has been named plant manager for the Telectro Industries Corp., of Long Island City, N. Y., manufacturers of tape recorders and precision electronic devices.

Waldman joined Telectro Industries as an engineer in 1949. Later he was transferred to the purchasing department where he served as director of purchase prior to his new appointment.

American Buys R-C Instrument

AMERICAN Electronics of Los Angeles, manufacturers of equipment for the electronics industry, will enter the nuclear instrumentation market with the purchase of R-C Scientific Instrument Co. of Playa Del Ray, Calif.

An exchange of 13,500 common shares of American Electronics for the total assets of R-C Scientific will be made. R-C sales for 1954 were about $300,000. American Electronic sales, for the first six months of this year, netted over $3 million.

The R-C Scientific Instruments Company designs and manufacturers nuclear instruments.

The firm will be operated as a wholly-owned subsidiary under the name of Reed-Curtis Nuclear Industries.

Appoint Staff for Geophysical Year

SECRETARIAT of the U. S. national committee for the International Geophysical Year now includes: executive secretary, Hugh Odishaw; administrative officer, R. C. Peavey; program officer, G. F. Schilling. Dr. Joseph Kaplan is chairman of the committee.

The International Geophysical Year program, a study of man's physical environment, will take place in 1957-58. More than forty

nations are participating in the coordinated, simultaneous geophysical investigations. The program of the United States includes the following fields: aurora and airglow, cosmic rays, geomagnetism, glaciology, gravity measurements, ionospheric physics, latitude and longitude, meteorology, oceanography, seismology, solar activity, rocket exploration of the upper atmosphere, and the earth satellite program.

The U. S. national committee for the IGY, established by the National Academy of Sciences, is responsible for the formulation, direction, and execution of the U. S. program. Federal sponsorship and funds have been obtained by the Academy's committee through the National Science Foundation, the government agency responsible for federally supported basic research. To date, the Congress has appropriated $12 million for the program.

Television Committee Officers Named by AIEE

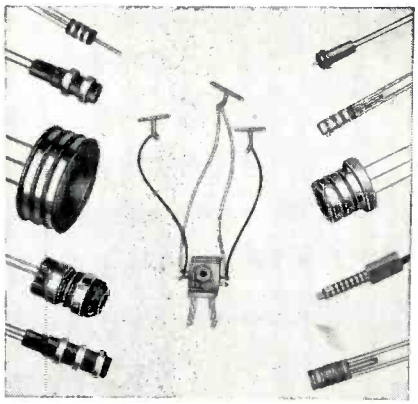
THE AIEE has named new officers for the committee on television and aural broadcasting systems for the 1955-56 term. They are: chairman: J. B. Epperson, chief engineer of Scripps-Howard Radio & TV., reappointed. Vice-chairman: C. M. Braum, consultant to the Joint Committee on Educational Television, Washington, re-appointed. Secretary: Carl E. Smith of Carl E. Smith Consulting Radio Engineers in Cleveland. He replaces R. K. Hellmann of Hazeltine Electronics who has resigned to handle another AIEE appointment.

Consolidated Selects Transducer Director

KENNETT W. PATRICK has been appointed director of the transducer division of Consolidated Engineering Corp.

He formerly was director of the firm's systems division. Succeeding him in that post is Harry E. Burke, Jr., who has been assistant director of the division since February, 1954.

Walter B. Claus, who has directed activities of the transducer division the past two years, was assigned to



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

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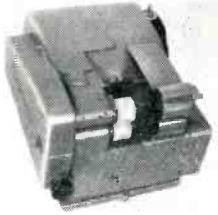
TI-CO WIRE STRIPPER



The TI-CO Wire Stripper completely strips single or multiple leads of fine magnet wire in sizes No. 18 to No. 48; removes all types of insulation, formvar, nyclad, glass, etc., without damage to wire; exceptionally fast, clean stripping with minimum rejects. Speeds up production; guarded machine, safe for operator. Wire diameter kept to within .0002". Machine compact, portable and relatively quiet; rugged; stands up under steady use; precision ball bearings throughout. General-purpose brushes are of fibreglass. Machine can be adapted to strip any coil form. Machine can be adapted to strip wire outside 18-48 range.

PRICE: $225.00

For additional information write or phone:

THOMAS INSTRUMENT COMPANY

Telephone 5134 PHOENIX, NEW YORK

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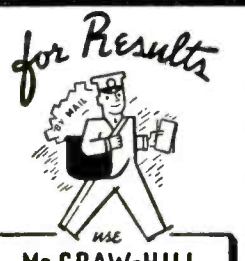

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- Build up weak territories
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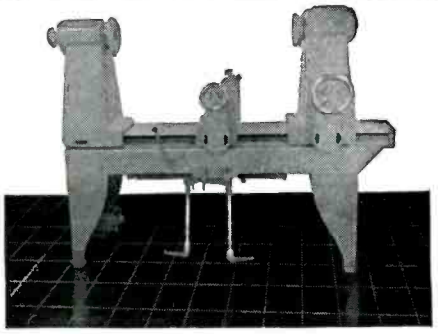
Direct Mail is a necessary supplement to a well rounded Business Paper advertising program.

Most progressive companies allocate a portion of their ad budgets to this second medium at the same time as they concentrate on the best business publications.

600,000 of the top buying influences in the fields covered by the McGraw-Hill publications make up our 150 mailing lists. Pick Your prospects out of our Industrial Direct Mail catalogue.

Write for your free copy of our Industrial Direct Mail catalogue with complete information.

GLASS WORKING LATHES



MODEL ME

$3135.00 f.o.b. Grass Valley, Calif.
Especially useful for handling large television Bulbs

GENERAL SPECIFICATIONS

Maximum length overall	84"
Maximum width overall	27"
Maximum length, spindle nose to spindle nose	47"
Height, floor to spindle	52⅝"
Radial clearance above apron	21¼"
Spindle hole diameter	⅜"
Approximate shipping weight	1800 lbs.
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STANDARD EQUIPMENT

Two face plates
One collet draw-in bar
Hand carburetion control
Foot pedal control of air or nitrogen supply and oxygen-gas volume
Main air valve controlling air in either or both spindles
Standard spindle speeds approx. 30-40-60 RPM. (With Adjusto Spede 17½-175 RPM.)
½ h.p. motor, 220 volt, 3-phase

DO YOU KNOW?

That a first class glassblowing job requires accurate alignment of rotational axes between the headstock and footstock?

That variable spindle speed gives another dimension to your technique?

That simple chucking attachments supply versatility for wide varieties of applications?

That special chucking for your industrial procedures, or laboratory practices are available?

That Litton jet-mix fires are universally used in glassblowing to prevent reducing conditions?

That Litton Lathes have been the standard of the vacuum tube industry for 22 years, and have been constantly improved?

That you can get these precision tools at reasonable cost, in eight sizes, with swing from 8" to 42", and working length from 20" to 75½"?

Let us send you complete specifications and prices on our line of equipment and tools for the Vacuum Tube industry and for general research and development laboratory use.

3238

Litton Engineering Laboratories

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undertake several special projects for the manufacturing division.

Rea Names Magnetic Head

FRANCIS A. OLIVER has been appointed as manager of the newly created data storage devices unit of the J. B. Rea Co. of Santa Monica, Calif.

The new unit will be responsible for the development and manufacture of magnetic storage components, including magnetic heads and drums, magnetic tape recording machines, magnetic core "matrix" memory systems and dialectric storage elements.

Oliver, designer of the new magnetic components, was formerly head of research and development of magnetic storage devices at National Cash Register's electronic division. Prior to that he headed a similar division at the computer division of the Bendix Aviation Corp.

Hall-Scott Buys Another Electronics Firm

HALL-SCOTT Motors Co. of Berkeley, Calif., has acquired its second electronics firm—Dynamic Analysis Co., of Los Angeles.

The Los Angeles firm has developed a desk model computer, for which Hall-Scott acquired manufacturing rights.

Dynamic Analysis will be integrated with Hall-Scott's electronics division in Burbank. This newly-acquired division, formerly known as Bardwell & McAllister, does electronics work for guided missiles and radar, and also has contracts with the Atomic Energy Commission.

The new firm was acquired through outright purchase.

Two Engineers Join Stanford Research

RICHARD K. THOMAS and Robert F. Trainer, both from Johns Hopkins University laboratories, have joined

the Mount Lee laboratory of Stanford Research Institute as electronics research engineers.

They will take part in the microwave testing program carried on at the research center.

Thomas was for three years a group leader in electronics countermeasures research and development at the University's radiation laboratory in Baltimore. He has previously supervised an antenna group with Bendix Radio, and developed vhf and microwave antennas at Airborne Instruments Laboratory in Mineola, N. Y.

Trainer was formerly a staff assistant in the John Hopkins Applied Physics Laboratory at Silver Springs, Md. He has conducted research in antennas and transmitters as well as electronic and pulse circuitry.

Army Ordnance Seeks Definitions

THE ARMY Ordnance Corps is preparing an ordnance engineering design handbook to summarize fundamental principles and basic design data. So as to avoid confusion as to the meaning of terms as used in ordnance engineering and as used in other fields that ordnance cuts across, aid is sought from all engineers with information on technology and nomenclature problems. Information should be sent to the Center for Documentation and Communication Research, School of Library Science, Western Reserve University, Cleveland 6, Ohio.

Sunstein Establishes New Company

A NEW company known as Sunstein Engineering Co. has been formed in Bala Cynwyd, Pa., to provide consulting services in the electronics field.

The firm is headed by David E. Sunstein, formerly assistant technical director of research for Philco Corp. His employment prior to the formation of this new company was entirely with Philco Corporation, the first five years of which were spent in the factory, and the last ten years in the research division. Prior to his position as assistant

technical director of research, he served as director of government research activities.

Wheeler Laboratories Promotes Williams

FRANK H. WILLIAMS has been appointed assistant chief engineer of Wheeler Laboratories in Great Neck, N. Y., and elected to the board of directors of the firm.

He has a background of experience in the field of radar, with previous employment of several years at Hazeltine Electronics Corp.

During the six years since he joined Wheeler Laboratories, Williams has been in charge of several radar projects. In his present capacity, he will participate in the direction and management of the staff of twenty engineers working on problems of radar, antennas and microwaves.

Washington Forms Electronics Division

A NEW division for the engineering and manufacture of electronic and electro-mechanical devices and systems has been formed in Minneapolis by Washington Machine and Tool Works.

The new division, General Components Co., will be under the direction of Ivan C. Pedersen and Karl Schurr. Precision rotary and linear-travel potentiometers are among the first products to be marketed.

Pedersen has most recently been at Minneapolis-Honeywell, aeronautical division, working on helicopter autopilots. Previously, he was with Zenith Radio Corp. in radar development and Amphenol in high frequency cable development.

Schurr has most recently worked as project engineer at Minneapolis-Honeywell on the E-10 autopilot. Previously, he was with Victor Adding Machine Corp. as senior technical representative.

Plans are proceeding for purchase or construction of a new building to house the expanded facilities of the company.

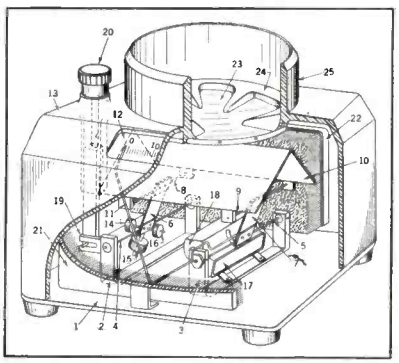
Want more information? Use post card on last page.

New Books

Sonics: Techniques for the Use of Sound and Ultrasound in Engineering and Science

By THEODOR F. HUETER AND RICHARD H. BOLT.
John Wiley & Sons, Inc., New York, 456 *p,* $10.00.

THIS BOOK, intended to bring the engineer up to date in the applications of sound energy to industrial processes, also contains



Ultrasonic power meter

enough fundamental information to serve as a college text in the subject.

The authors have attempted to deal with the field of acoustic vibration as a unit, without separating it into arbitrary catagories of subaudible, audible and ultrasonic. The title "Sonics" is defined as "the technology of sound as applied to problems of measurement, control and processing."

Chapter divisions include basic physical principles of sound, radiation of sound energy and design of transducers. In the practical-applications chapters the use of sonic energy for processing and testing of liquids and solids is discussed. Techniques of nondestructive testing are also discussed. In many of the applications, simplified design equations are summarized for practical use.—D.A.F.

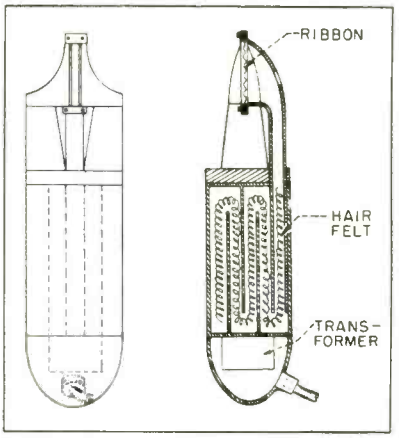
Practical Electroacoustics

By M. RETTINGER, *Chemical Publishing Co., Inc., New York,* 271 *p,* $10.00.

THE CONCERN of "Practical Electroacoustics", to quote from Mr.

Want more information? Use post card on last page.

Rettinger's foreword, is "chiefly a description and analysis of audio communication equipment—microphones, moving-coil loudspeakers, mixers, studios, magnetic recording devices, as well as related subjects, such as crossover networks, attenuators, magnets and vibration isolation". It is further stated that "little is said about amplifiers, a discussion of the various types of which would fill several volumes. Not much space has been devoted



Ribbon Microphone

to acoustic measurements either, as they are well described in the book by Leo L. Beranek of the same title. Architectural acoustics was covered in another book by the author."

Content

Topics are treated in eight chapters under the headings: microphones, loudspeakers, circuits, magnetic structures, public-address systems, vibrations, architectural acoustics and magnetic recording. Inclusion of the chapter on architectural acoustics seems strangely at variance with the intentions expressed in the preface.

The discussion of the characteristics of various types of attenuator networks in the chapter on circuits is a sincere attempt to give the reader at least a taste of the complex of muddled details so characteristic of this subject. The presence of a chapter on public-address systems is also somewhat of an innovation and includes, among other topics, an informal technical history of the Hollywood Bowl sound reinforcement system, which will undoubtedly give pleasure to those readers who enjoy the anecdotal approach, and a detailed exposition

of the electrical impedance matching of various loudspeaker combinations.

Inconsistencies

Although the reviewers cannot claim to have scrutinized the text with the scrupulous care of a proofreader, they encountered a number of inconsistencies. The most serious criticism of the reviewers is that the text attempts to cover far too much material in far too little space. The author could have devoted the entire text to field applications of eletroacoustical equipment and drawn on his extensive experience to discuss in greater detail the proper choice and use of microphones, speakers, magnetic recorders and their associated circuitry in studio recording, public address systems etc. A book restricted to such a choice of topics would have been of considerable value.—E. G. THURSTON, *Armour Research Foundation, Chicago, Illinois and* W. H. PEAKE, *Ohio State University, Columbus, Ohio.*

Color Television Fundamentals

By MILTON S. KIVER. *McGraw-Hill Book Company, Inc., New York,* 1955. 312 *p,* $6.00.

FOR those scientifically curious about color television, Mr. Kiver's book is fascinating. First, it attempts to explain colorimetry and second, it deals directly with the specific details of color receiver circuitry. On colorimetry alone the reader appeal is strong for little has been written on it in a popular vein.

This volume represents a fairly complete summary, at the lower engineering level, of the salient facts of current color television; circuitwise, it gives factually accurate descriptions on a great deal of material covering most current color television receiver designs. Although the explanations suffice to introduce the basic principles, the technician will find them generously sprinkled with broad engineering assumptions. Not until the last two chapters do the circuit descriptions and the adjustment procedures reach his industry level and use practical language. In these two

chapters the explanations have concrete significance to the fundamental facts and indeed, the text on troubleshooting in Chapter X most specifically reviews and crystallizes the explanations on basic phenomena that have gone before.

The treatment of three-gun color tubes is good. Their basic operation, their inherent characteristics when related to convergence, purity, brightness etc supply a background of information which would have been well located forward in the volume since there it might have contributed some clarity to the discussion on fundamentals. An excellent discussion is given in the chapter on deflection and convergence circuits.

Receiver Circuits

Descriptive color circuitry on current color receivers occupies four complete chapters and forms the basis of the text, using 100 pages of the 300-page total.

The book as a whole constitutes a text on color receiver circuitry at the technicians level; it is a complete compilation, including the engineering type explanations, from popular color television literature appearing over the last three years. It is complete in its coverage and for high level technical usage should prove a valuable source of information.—HARRY E. THOMAS, *Senior Project Engineer, Federal Telecommunication Laboratories, Nutley, N. J.*

Dielectric Materials And Applications

EDITED BY A. R. VON HIPPEL. *Technology Press and John Wiley, New York*, 1954, 438 *p*, $17.50.

THIS book is a companion volume to the one on "Dielectrics and Waves" and is concerned more with the engineering use of dielectric materials rather than the theoretical aspects that were considered in the companion volume. The book consists of a series of contributions from a number of authorities in the field under the editorship of Professor von Hippel who has done an extremely able job in integrating these various contributions into a

very useful book on dielectrics.

The first section of the book treats the theory of dielectrics. Following this, there is a section on dielectric measuring techniques.

The third section of the book which is concerned with dielectric materials and their applications, is a thorough survey of the various types of materials available.

Following this the fourth section deals briefly with the dielectric requirements of the armed forces.

Engineering Data

The fifth section of the book consists of the tables of dielectric materials which have been issued by the MIT Laboratory for Insulation Research.

All in all, this book is a must to those engineers who are concerned with the use of dielectrics, either in components or in equipments.—HENRY JASIK, *Consulting Enginer, Mineola, New York.*

Elektronische Halbleiter

BY E. SPENKE. *Springer-Verlag, Berlin*, 1955, 379 *p*, *DM* 34.50.

THIS BOOK is probably one of the most complete compilations of basic information on the physics of semiconductors ever written with the exception of Dr. W. Shockley's "Electrons and Holes in Semiconductors".

Prefaced by Dr. W. Schottley, a leading authority in this field, the book is divided into two portions. Tht first part (chapters I to V) is an accumulation of the author's lectures and is written for students or for those just entering the field of semiconductors.

The second half of the book (chapters VI to X) is intended for the basic study of the physics of semiconductors.

The author has handled his material with skill.

His organization and development of all the chapters is excellent. A bibliography is given at the end of each chapter and affords good references on the material treated. Illustrations are numerous, well chosen and finely reproduced, some in three colors. Treated very comprehensively, the book provides to

physicists as well as to electronics engineers the basic information necessary to become intelligently acquainted with the problems of semiconductors. In addition, it is an excellent source book for those in the fields of inorganic chemistry, crystallography, experimental physics and others where the problems of semiconductors might arise.

The book is worthy of the highest recommendation. — E. KEONJIAN, *General Electric Co., Syracuse, N. Y.*

Thumbnail Reviews

Proceedings of the Symposium on Printed Circuits, Sponsored by RETMA and IRE—PGPT. Engineering Publishers, New York, 1955, 122 p, $5 (paper). Presents twenty-five papers delivered at a symposium held in Philadelphia during January 1955. Subjects covered include product design, reliability, management considerations, production techniques and printed components used with printed wiring.

A Guide To Special Purchase Tubes. Graham Electronics Supply, Inc., Indianapolis, Indiana, 1955, 60 p, $4.50 (paper). Cross reference data useful as a guide in searching for proper special purpose and industrial tube substitutions. Each listing gives manufacturers and other designations for the given tube.

The ARRL Antenna Book. Headquarters Staff. American Radio Relay League, West Hartford, Connecticut, 1955, 344 p, $2 (paper). Contains information on antenna theory, design and construction. Subjects include fundamental transmission lines, long-wire antennas, multielement directive arrays, uhf and vhf systems, supports, receiving antennas, rotary beams and mobile antennas.

Transistor Applications. Raytheon Manufacturing Company, Newton, Massachusetts, 1955, 126 p, $.50 (paper). Describes constructional details on over fifty types of transistorized equipment as well as technical data on CK721, CK722, CK727 and other Raytheon transistors.

Convegno Di Elettronica e Televisione. Consiglio Nazionale Delle Ricerche, Rome, Italy, 1955, two volumes, 1,214 p. $16.10 (paper). Contains 77 papers delivered during the Science Days—fourth session symposium on electronics and television held in Milan, Italy during April 1954. Papers are printed in the language in which they were delivered. Includes English, Italian, French and German. Subjects covered include trends in television

developments, television equipment, broadcasting systems planning, international magnetic and dielectric material, transistors, electron optics, radar, industrial electronics, servo mechanisms and computers.

Techniques For Application of Electron Tubes and Military Equipment. Rex A. Whitlock. Wright Air Development Center, 1955, 100 p, available from Office of Technical Services, Washington, D. C., $2.50 (paper). Presented from point of view of equipment designer as a guide in application of electron tubes. Book discusses tube properties, circuit design and specific tube types, including the 5654, 6AK5W, 5670 and 5751.

Digital Differential Analyzers—Part I—The Elements. George F. Forbes. George F. Forbes Publisher, Pacoima, California, 1955, 48 p, $7.50 (paper). Intended to aid the mathematician and engineer in utilizing a digital differential analyzer in his work. The book tells how to code engineering problems in machine language and describes the operation and limitations of machines.

The Elements of the Theory of Real Functions. J. E. Littlewood. Dover Publications, Inc., New York, 1955, 71 p, $2.85 (cloth), $1.35 (paper). First American edition of a British book based upon lectures delivered by the author at Cambridge University.

F-M Limiters and Detectors. Alexander Schure. John F. Rider, Publisher, Inc., New York, 48 p. $.90 (paper). Fundamental theory and circuit design of f-m limiters and detectors including the 6BN6 gated-beam circuit.

Radio Interference Suppression Techniques. Coles Signal Laboratories, Available from Office of Technical Services, Washington, D. C., 256 p, $6.75 (paper). Several sources are discussed including rotating machinery, ignition systems, switches, contactors and electronic devices. Other subjects include measurements of testing procedures, theory of interference suppression, suppression components and applications.

Light Calculations and Measurements. H. A. E. Keitz. N. V. Philips' Gloeilampenfabrieken, Eindhoven, Holland, 413 p, $7.50. Written primarily from the viewpoint of the illumination engineer, this book contains material on electronic light measuring instruments and background information of potential interest to television engineers.

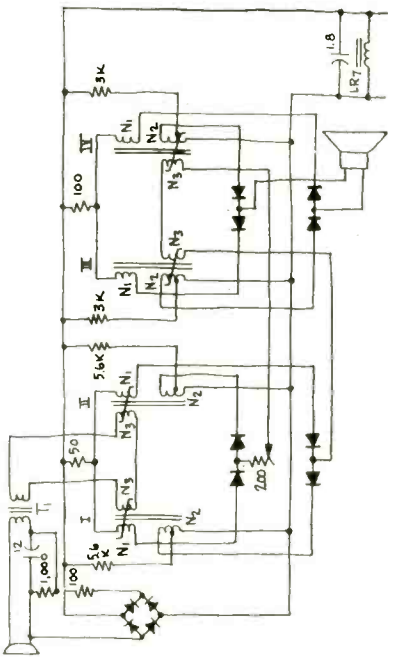
Handbuch der mikrochemischen Methoden. Zweiter Band—Verwendung der Radioaktivitaet in der Mikrochemie. By Friedrich Hect and Michael K. Zacherl. Springer-Verlag, Vienna, 1954, 423 p, $19.30. Second section of book, 179 pages, discusses radioactivity measurements and electronic equipment used therein.

Backtalk

All-Magnetic A-F Amplifier

DEAR SIRS:

CONCERNING the errors appearing in Fig. 6 on page 125 of the September issue of ELECTRONICS, the circuit diagram shown was apparently redrawn by your artist.



In the circuit as it was printed one set of rectifiers in each bridge has been reversed. This would make the circuit inoperable.

In addition, the winding notations as published in Fig. 6 do not agree with those in Table II to which it refers. The result of this is that the power winding and control winding values have been interchanged.

Corrections on the accompanying diagram conform to values published in Table II. If N_3 in the published diagram were made 10 turns as is indicated, instead of 130, our engineers are of the opinion that the set would burn up, destroying all the components.

These corrections have been made and noted on the diagram and the value placed on the capacitor in the frequency multiplier next to LR7, which was omitted in the published circuit.

MARY T. KANAGY
Technical Information Officer
By direction of the Commander
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Silver Spring, Maryland

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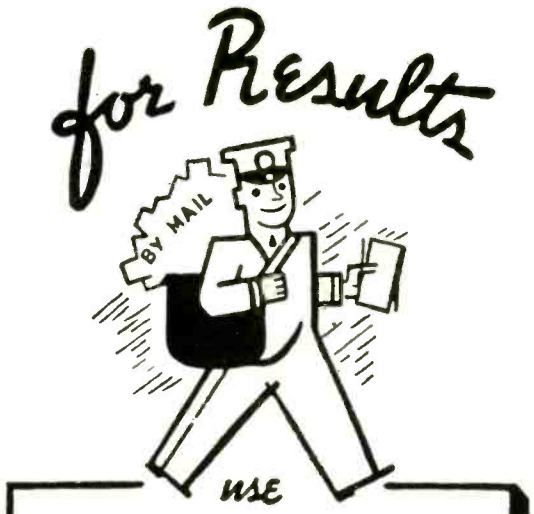

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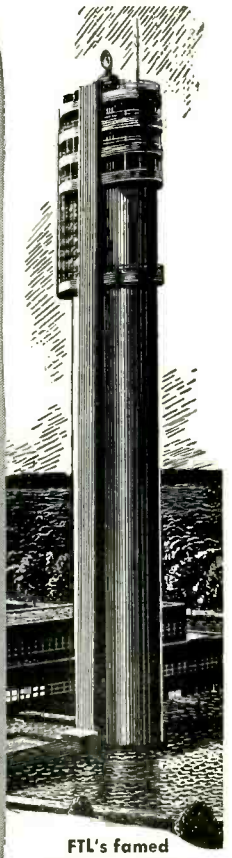

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These include rewarding work on missile guidance, servo analysis and design, expansion and further evolution of the Goodyear-built analog computing equipment, antenna design, radar, electromechanical systems, microwave, pulse techniques, electrical systems and power plant design.

Here is an opportunity to establish a long and fruitful relationship with a versatile and stable organization—to utilize one of the largest and most modern computer laboratories, explore new avenues, new concepts—*a place where creative sparks can be charged to arc brilliant new horizons!*

Resumé treated confidentially. Application forms on request: C. G. Jones, Personnel Department, Goodyear Aircraft Corporation, Akron 15, Ohio. Plants in Akron and Litchfield Park, Arizona.

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GOODYEAR AIRCRAFT

THE TEAM TO TEAM WITH in AERONAUTICS

ENGINEERS

— HERE'S THE COMPLETE STORY

CROSLEY

A recognized name in the field of Electronics. For more than a decade the carefully planned growth of the Crosley Government Products Division has been making Cincinnati the Electronics Center of the Midwest. Crosley's immediate expansion program offers numerous opportunities in many fields. Present plans call for continued expansion during the next ten year period.

The Crosley Government Products Division is a member of the AVCO Manufacturing Corporation — a family of famous names including Crosley Broadcasting, Crosley Appliances and Electronics, Bendix Home Appliances, Lycoming, American Kitchens, New Idea Farm Equipment and Horn Manufacturing Company.

WHAT IS CROSLEY DOING NOW?

Crosley's Engineering Staff has been engaged in the design and development of a selected diversity of electronics equipment; such as Radar, Sonar, Gunsights, Transmitters, and Receivers. During recent years Crosley has gone into new applications of electronics and is doing Research, Advanced Development and Product Engineering in Guided Missiles, Gyros, Magnetic Amplifiers, Servos, Computors, Radar, Infra-Red Radiation, Detection Nucleonics, Transistors and Human Engineering. In addition, Crosley is one of the largest producers of Fire Control and Air Navigational equipment. These programs enable Crosley to place engineers in positions which offer them responsibilities and challenging opportunities for unlimited growth.

OPPORTUNITIES FOR YOU

The people on Crosley's engineering staff have progressed because Crosley has been successful in its many fields of activity. This success also creates the need, today, for new members in our organization. There are openings at all levels of education and experience for individuals with backgrounds in any of the following: Electronics, Electro - Mechanics, Mechanics, Physics, Mathematics, Optics, Technical Writing, Packaging or Illustrating. These opportunities are in existing groups as well as in new groups now being formed.

WHAT YOU CAN EXPECT

The Crosley Engineerng organization is divided into small groups to give every employee individual consideration and the opportunity to secure the position for which he is best fitted. In evidence of Crosley's successful employee relations program, Engineering Personnel turnover is but a fraction of 1% per year. Crosley offers top salaries, substantial group insurance and retirement benefits, a subsidized education program and modern air conditioned work areas which boast the latest engineering equipment and facilities. Transportation expenses for you and your family and your household belongings will be paid by Crosley.

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Greater Cincinnati is located on a sweep of the Ohio River and is surrounded with charming residential sections on the hills overlooking the city. Our many modern shopping centers are distributed throughout the Greater Cincinnati area providing convenient lower cost shopping for Cincinnati residents without the inconvenience of metropolitan traffic.

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Address your resume to:

Desk E-2, Director of Engineering Government Products

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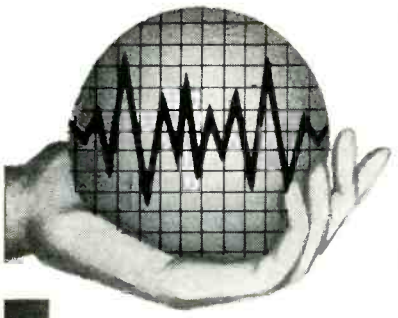

ENGINEERS

How Realistic Are You About Your Future In Electronics?

As the electronics industry grows from $9 billion to $20 billion in the next 10 years, will you be growing with it?

In answering, consider the extent to which your personal progress is dependent on the progress of the company you are with ... and the following facts about Sylvania:

- Sylvania has expanded to 45 plants and 16 laboratories in 11 states
- In 6 years, the electronics industry grew 24%; Sylvania grew 32%
- Since 1949, Sylvania has doubled its engineering staff and tripled its sales

Sylvania's success story is the story of its creative engineers. These men of talent are given wide latitude to experiment ... every facility to test original designs ... and are rapidly advanced in the company as is shown by the fact that the average age of high level officials at Sylvania is only 45.

If you are realistic about your future, look into the opportunity now open to join Sylvania ... and be high in your profession 10 years from now.

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Majors in E.E., M.E., Math, Physics. Research & Development experience in—

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For nearly 75 years, BURROUGHS has been a leading company in an expanding industry . . . the growing, highly diversified field of business equipment. As proof of its forward look, the RESEARCH LABORATORY in Paoli, Pa., was established to create the Data Processing machines of *tomorrow!*

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(San Francisco Bay Area—Near Palo Alto)

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ELECTRONIC DEFENSE LABORATORY

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ENGINEER

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Expansion in the guided missiles field has lead to the creation of a new opening with a major company, located in upper New York State which offers real technical challenge to an instrumentation system engineer. The job involves:

Establishing total instrumentation requirements; engineering systems to meet requirements and sub-dividing them to hardware units; establishing requirements on ground station equipment and environment standards for instrumentation equipment.

The engineer will be expected also to provide liaison with agencies providing ground stations. Approximately 10 years experience is desired.

An opening is also available to an engineer with a minimum of 5 years experience able to establish test plans and execute tests to prove hardware design, including installation and necessary service to test site.

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P-7986—Electronics

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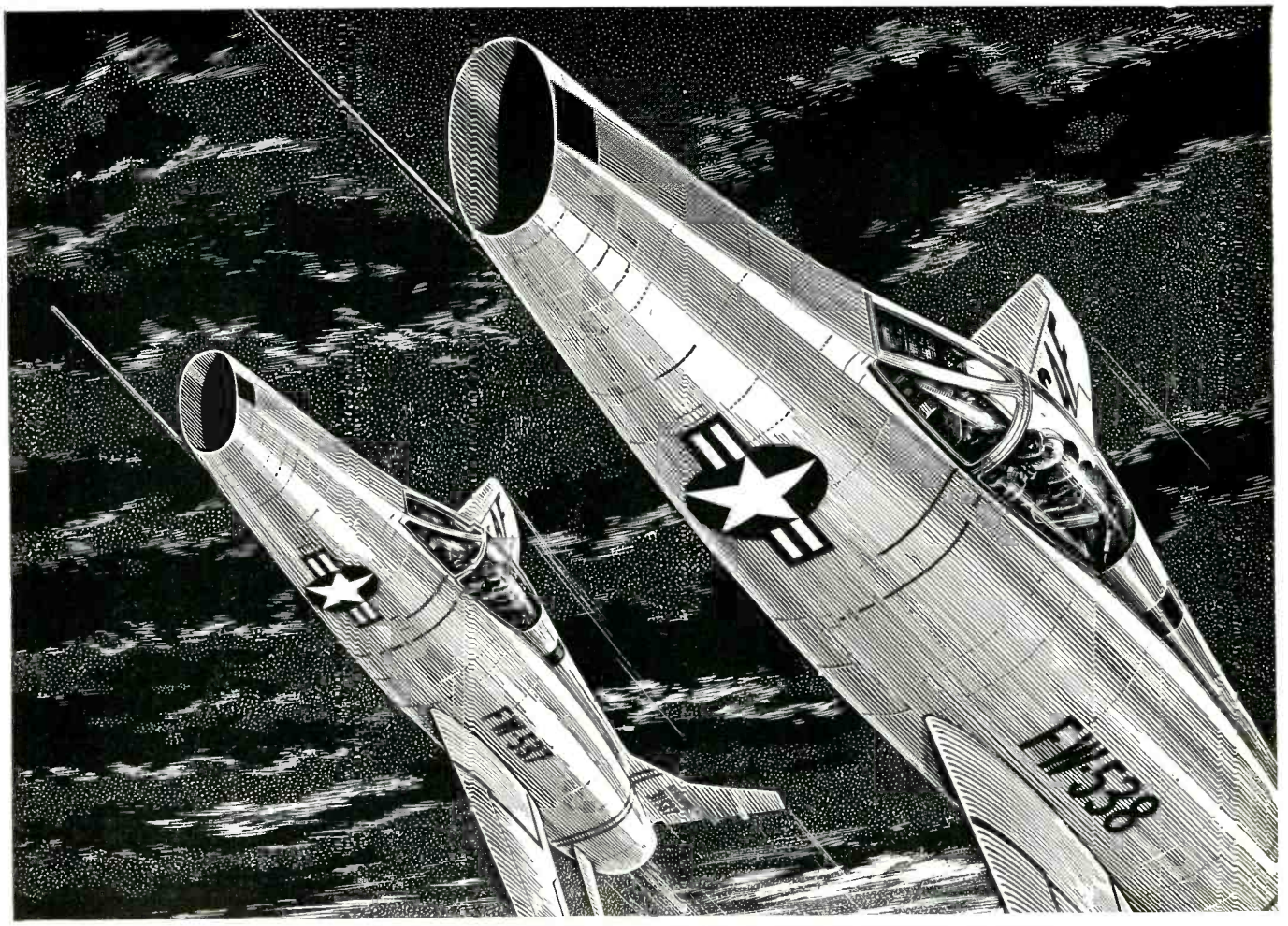

North American F-100 SUPER SABRE, America's first operational, supersonic jet fighter.*

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North American Aviation's supersonic F-100 SUPER SABRE* is only the beginning . . . AIRBORNE VEHICLES of the FUTURE are *now* daily design problems for North American Aviation engineers. *You* start where our research has led.

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ENGINEERING RESEARCH LABORATORY: New positions for all types of electrical and electronic engineers exist at all levels of experience in our Research Laboratory. These positions have been created by North American's leadership in research . . . you will take up where our research has led. You'll work closely with world-recognized engineers . . . on the team that's engineering ahead for a better tomorrow.

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Mr. L. Stevenson, Engineering Personnel Office, North American Aviation, Dept. 56-EL, L.A. 45, Calif.

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NORTH AMERICAN AVIATION, INC.

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WELL WORTH LOOKING INTO...

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6-10 years experience in missile or radar electronic system development. Ability to direct systems engineering at the project level.

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7-10 years experience in development and design of electronic test equipment for complete systems involving microwave and pulse techniques, adaptation of commercial instruments to special applications, preparation of proposals and the actual product design of electronic and electromechanical devices. Familiarity with problems of maintenance helpful. Supervisory experience and ability required.

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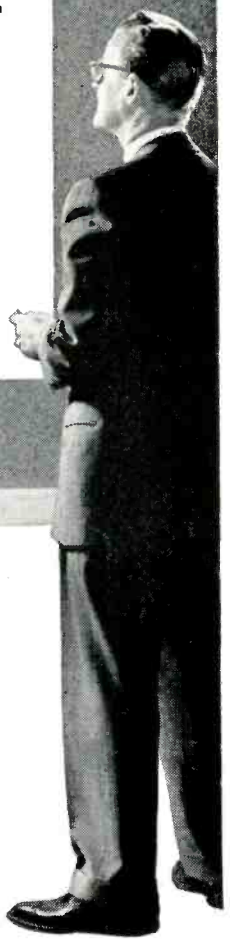
6-10 years experience in missile or aircraft electronic package design. Familiarity with vibration and other environmental problems essential.



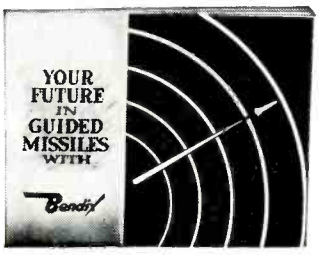
Here are three especially attractive job opportunities for engineers who want to get on the ground floor in the important, interesting, and challenging phase of a new industry—guided missiles.

Qualified men are given real job responsibilities with Bendix and grow with the development of what is not only the nation's most important weapon system, but a project that will undoubtedly lead to new and important long-range commercial application.

At Bendix you will be associated with top missile authorities and have at your command unexcelled engineering and manufacturing facilities. Salaries for these top jobs and other opportunities are open for discussion. Write today to: Mr. W. L. Webb, General Manager, Missile Section, Bendix Products Division, Bendix Aviation Corporation, 401 North Bendix Drive, South Bend, Ind.

23 OTHER ENGINEERING POSITIONS!

Bendix also offers unusual job opportunities for assistant engineers, junior engineers, and technicians, as well as a score of other assignments. A 30-page book describing in detail every phase of our guided missile operation will be sent to you on request. If you are interested in guided missiles, this book is bound to interest you. Write for it today.



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P-7461, Electronics
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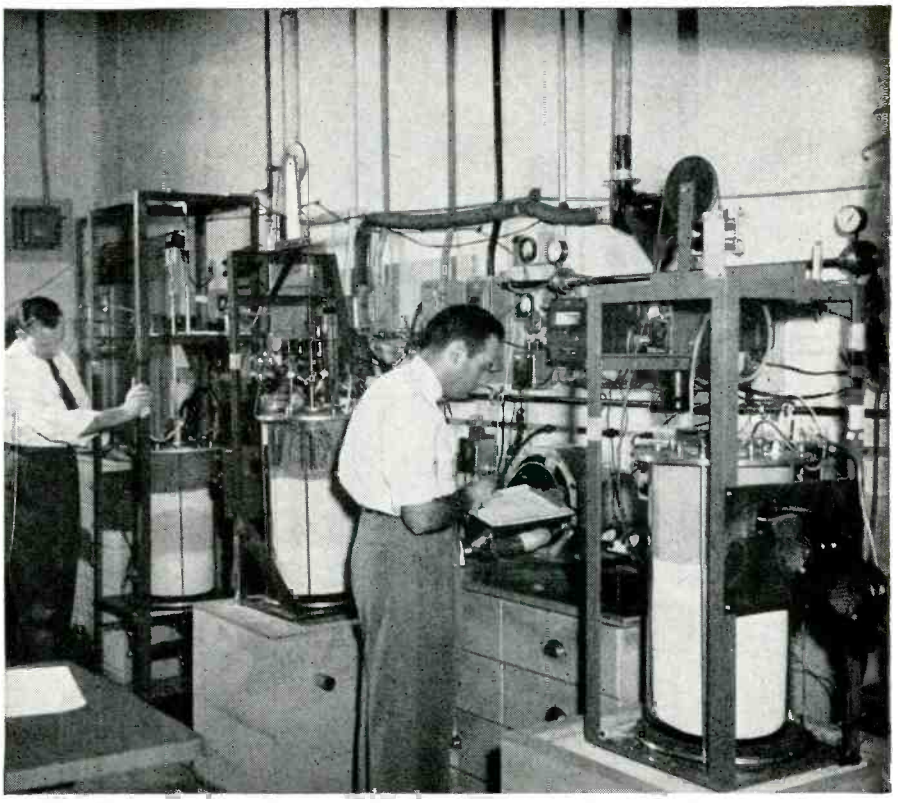

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P-7816, Electronics
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Research facilities that enable you to test out your most revolutionary ideas and encouragement to publish original work available to the engineer experienced in precision gyroscopic equipment.

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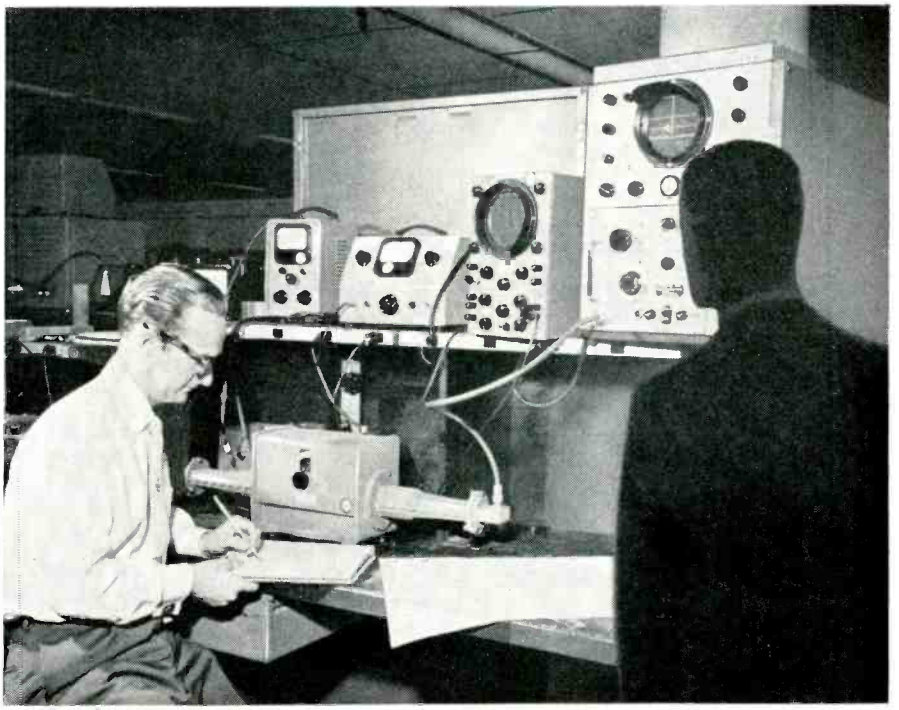
SEEKING THE CHALLENGING PROJECTS IN



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Convair, in beautiful San Diego, now earnestly needs skilled **MICROWAVE ENGINEERS AND PHYSICISTS**: to solve design problems of an advanced nature in microwave antennas and scanners. Must be experienced in pencil beam and shaped beam designs for guided missile and airborne radar applications. For analytical and experimental work in the design of microwave components for specialized microwave radar systems and test equipment. For experimental development of components in the fields of dielectric and metallic media including familiarity with radome and microwave lens design. Unusual opportunities for senior level engineers with advanced degrees or equivalent experience.

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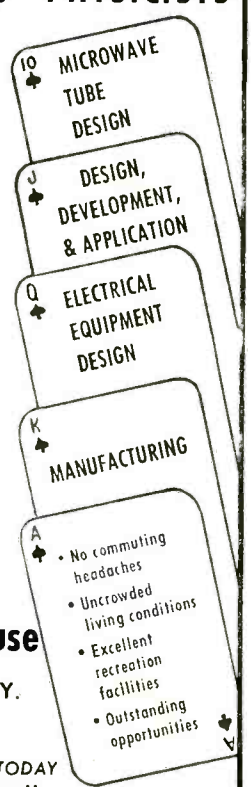

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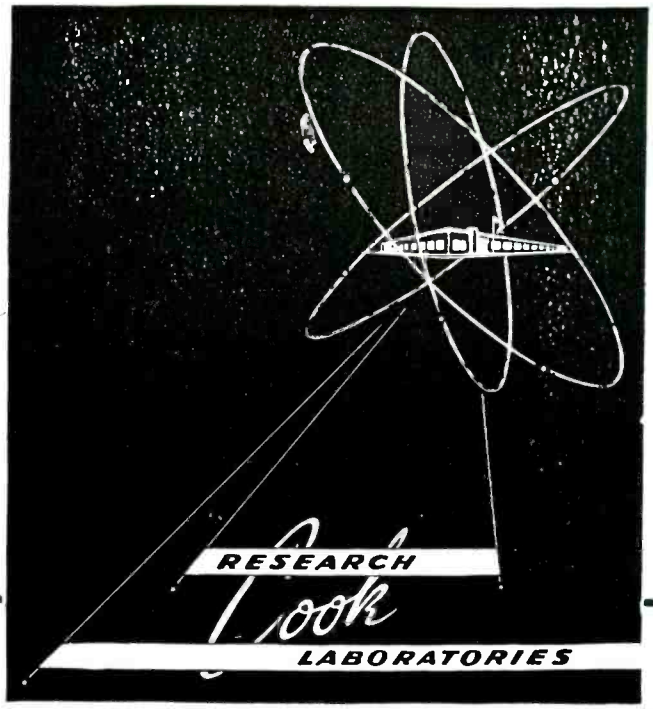

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Supervise development of Microwave Communications Systems. Establish requirements and coordinate design of receivers, transmitters and multiplex equipment.

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Wideband amplifiers for multiplex telephone, color television, timing and synchronizing circuits for vidicon camera units.

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Write to Edward W. Reed, Communications Engineering Department, 150 California Street, Newton, Massachusetts, to arrange for an interview and visit of our extensive laboratory facilities.

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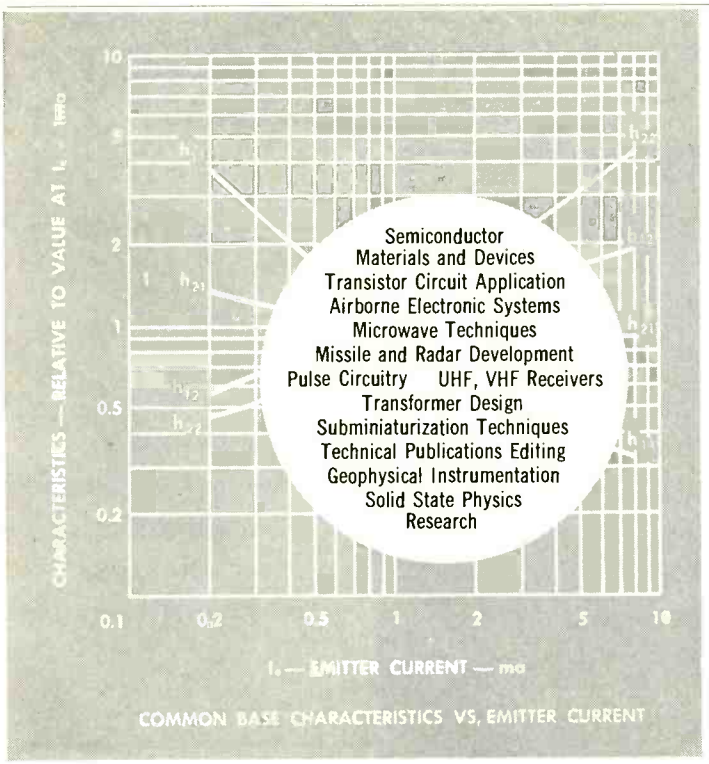

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to share in our rapidly expanding programs in

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Gun laying, IFF and beacons, navigational aids, air traffic control, video processing and distribution systems.

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Good Location: Modern, medium sized Southwestern community. Pleasant surroundings with excellent family recreation, religious and educational facilities.

Phillips 66

Reply by letter giving age, experience and other qualifications. All applications carefully considered and kept confidential. Write:

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PHILLIPS PETROLEUM COMPANY
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Excellent opportunities for several engineers with well established East Coast instrument manufacturer now expanding its line of aviation products which includes electronic and electro-mechanical components for jet engines and guided missiles.

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NEW TECHNIQUES IN
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Require installation adjustment and maintenance experience with communication receivers and associated terminal equipment. Also, men with similar experience with high-powered transmitters, antennas, transmission lines.

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We design and manufacture a variety of instruments and systems for analysis and control: infra-red spectrophotometers, and continuous analyzers, nuclear magnetic resonance equipment, and gas chromatography instruments... Also we design and manufacture precision optics and optical systems.

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Research & Development
Physicists - Engineers
(SENIORS)

Experienced in research and development of various radar systems including: beacons, missile guidance and counter measures. Advanced training in applied mathematics, noise theory and probability analysis desirable. EE degree or equivalent required.

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—Flight Simulators
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Specialists in TUBES

All Famous Name Brand Radio and TV Receiving Tubes, Transmitting tubes, Special Purpose Tubes

You get *immediate delivery* on these high quality, low priced tubes taken from one of the most extensive selection of tubes available. Order now!

We handle such brands as: Hallicrafters, National Union, Zenith, Admiral, Stewart-Warner, Raytheon, RCA, Philco, Sylvania, Crosley, G.E., Motorola, Testron.

SPECIALS: Transmitting Tubes

5654	$1.00	3B28	$2.00
5725	$2.24	2C46	$6.00
2D21	.81	6AS6	$1.75
6080	$2.00	HF200	$6.00

This is just a partial list of types available. Phone or mail your order. Send for our complete tube listing.

B & C DISTRIBUTORS COMPANY
180 Spring Street • Paterson, N. J.
MUlberry 4-4010

Surplus Industrial ELECTRONICS Components Equipment

TEST SET—MODEL OAP-1—Power source 115-V 50-4002. Complete with cables, calibration charts. Exc. cond. Ready to plug in and use..... $49.95

TEST SET—TS 173/UR—Power Source 115-v 602. Complete with calibration book, spare tubes, and crystal. This is the high frequency version of the LM and BC221 frequency meter. Excellent condition. $150.00

LORAN RECEIVER—MODEL DBE—Power Source. 115/230-v 50-60 cy. type C6-46265 indicator. Good cond. w/all tubes $75.00

STEP DOWN XFORMER—Available in production quantities—115-v—60 to 28-v 1.5 amps. Open frame constr. Lots of 100—$1.00 ea. Lesser quant. $1.59 ea. Write for large quant. price.

WESTERN ELECTRIC STEPPER SWITCH—Production quantities—Coil voltage from 4.5-v to 12 VDC—44 steps, 4 decks. D162768—ea. $7.95—50 @ $5.00—Quantities—write.

VIBRAPACK—PE-104—P.O. Ser 284—Exc. cond. $9.95 ea.

VIBRAPACK PE-204—New—Orig. pack..... $2.50

RADAR UNIT T42—UPT-T1—This is a complete installation—Power supply (115-v—60 cy.) radar unit, antenna, meter, all cables, instruction book—Br. new in wooden crate—$60.00 complete.

SQ RADAR—A complete radar unit. Ready to operate used, but operating cond. Low Price.

WESTERN ELECTRIC POWER SUPPLY—Input 115 VAC 602—output 115 VDC 600 MA. Regulated Filtered. Beautiful construction, all UF components. With diagram (Bell Labs) Brand new ±6S 800156. $29.95

LAE 516. Gen. Used. With calib. curves. 115-v-60v $79.95

1625 TUBES—Large lot—Individual boxed. Lots of 100—22c; Lots of 600—17c; Lots of 1200—15c.

REX RADIO SUPPLY CO.
88 CORTLANDT ST. N.Y. 7, N.Y.
Phone CO-7-1617—Prices F.O.B. N.Y.

★ ***MANUFACTURERS***
Let us handle technical sales representation of your products

★ ***INVENTORS***
We will share the cost of protecting your invention if accepted for commercialization

We Specialize in Electronics, Nucleonics, Instrumentation, Servomechanisms & Cybernetics.

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REpublic 2-2651

NOTICE
United States Patent No: 2,686,266
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Non-exclusive licenses upon royalties of 1% may be obtained by qualified manufacturers under the above United States Patent for all uses except in well bores.
Infringers will be rigorously prosecuted.
For further information contact:
FETHERSTONHAUGH & KENT,
Patent Attorneys,
505 GREAT WESTERN BUILDING,
WINNIPEG, MANITOBA, CANADA

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For Sale complete set of Electronics 1941-1955 very reasonable. R. B. Hall, 6431 Euclid Ave., Hammond, Indiana.

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WILL BUY ALL

ART-13 T47A Transmitters $200.00	BC-348 Rec'r Modified $25.00
ART-13 T47 Transmitters $150.00	BC-348 Rec'r Unmodified $50.00
BC-788C Altimeters $160.00	ARC-1 Radio Complete $250.00
ARC-3 Complete $185.00	
R5/ARN-7 Radio Compass $175.00	BC-312 Receiver $40.00
	BC-342 Receiver $50.00

Ship via Express C.O.D. Subject to Inspection to
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49 Washington Ave. Little Ferry, N. J.

MUST HAVE FOR CURRENT ORDERS
PHONE COLLECT

BC-312	BC-314	BC-610
BC-342	BC-344	T-47/ART-13
R-5/ARN-7		ATC/ART-13

SEMLER INDUSTRIES INC.
STanley 7-1554
6853 Lankershim Boulevard
North Hollywood, California

WANTED

ELECTRONIC TUBES, all types. Also want all types airborne electronic equipment: ART-13; BC-788; I-152; ARC-1; ARN/7, etc. Top dollar paid!

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Los Angeles 35, California

Employment Opportunities

ADVERTISERS INDEX

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POWER RHEOSTATS

Over 25,000 Rheostats for immediate shipment

25 WATT

Ohm	Shaft Length	Price
1.3	SS	69c
2	7/16"	79c
4	7/16"	79c
10	7/16"	79c
12	7/16"	79c
15	7/16"	79c
20	7/16"	79c
25	7/16"	79c
50	7/16"	45c
60	7/16"	79c
70	3/8"	79c
75	1 1/8"	79c
75	7/16"	79c
100	7/16"	79c
100	7/16"	79c
125	7/16"	79c
150	3/8"	79c
185	7/16"	79c
200	7/16"	79c
250	3/8"	79c
350	7/16"	79c
370	7/16"	79c
500	7/16"	79c
500	SS	69c
750	7/16"	69c
1000	SS	69c
2500	SS	79c
3000	1 1/8"	89c
3500	SS	79c
5000	7/16"	89c
5000	SS	79c

50 WATT

Ohm	Shaft Length	Price
.25	SS	5.99
1	7/16"	.99
2	7/16"	1.09
8	7/16"	1.09
10	7/16"	1.09
12	7/16"	1.09
15	7/16"	1.09
20	7/16"	1.09
22	7/16"	1.09
50	7/16"	1.09
55	7/16"	1.95
75	2 1/16"	1.09
80	7/16"	1.09
90	1"	1.09
123	7/16"	1.09
125	7/16"	1.09
150	9/16"	1.09
250	5/8"	1.09
380	7/16"	1.89
500	7/16"	1.09
1000	SS	.99
1800	7/16"	1.09
10000	7/16"	1.29

75 WATT

Ohm	Shaft Length	Price
380	1 3/16"	1.79

100 WATT

Ohm	Shaft Length	Price
10	7/16"	2.19
10	SS	2.09
25	7/16"	2.19
37	7/16"	2.19
100	7/16"	2.19
2500	SS	2.19
5000	SS	2.29
10000	SS	2.39

150 WATT

Ohm	Shaft Length	Price
35	7/16"	2.85
100	7/16"	2.85
400	7/16"	2.85
500	1/2"	2.85
8000	9/16"	3.19

300 WATT

2	2"	5.95

PRECISION WIREWOUND RESISTORS

¼ WATT - 30¢

OHMS	OHMS	OHMS	OHMS	OHMS	OHMS
.12	10.84	13.52	105.8	301.8	2.193
.627	11.25	13.89	123.8	366.6	2.850
2.5	11.74	14.98	125	414.3	3.500
6.68	12.32	16.37	147.5	705	36.000
10.48	13.02	62.54	220.4	723.1	59.148
	13.15	79.81			

½ WATT - 35¢

.25	46	270	4.300	14.825	36.000
.334	52	298.3	4.451	15.000	37.000
.444	55.1	400	5.000	15.750	43.000
.592	66.6	500	5.900	16.700	45.000
.557	75	855	6.500	17.000	50.000
.76	90	1.500	6.650	25.000	59.000
1	97	2.250	7.000	30.000	68.000
1.01	125	2.500	7.300	32.700	100.000
1.53	180	3.000	7.500	32.888	120.000
2.84	210	3.427	8.000	33.000	180.000
11.1	235	4.000	8.800	33.300	200.000
13.3	260		10.000	35.888	500.000
26			12.000		

1 WATT - 45¢

2	3.39	420	5.000	15.000	56.000
.725	5.21	425	8.250	20.000	60.000
.861	15	2.200	9.000	30.000	66.000
1.01	38	3.000	10.000	40.000	84.000
2.58	250	3.300	12.000	50.000	
2.86	270			55.000	

1 WATT - 60¢

100.000	130.000	220.000	270.000	320.000	590.000
105.000	132.000	240.000	296.000	448.000	645.000
120.000	150.000	250.000	297.000	390.000	680.000
128.000	175.000	260.000	300.000	520.000	700.000
				522.000	

Orders f.o.b. Philadelphia Minimum order $3.00

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ARCH ELECTRONICS CO.

634 ARCH STREET
PHILADELPHIA 6, PA.

Diehl Midget PM Motor $3.95

KS—15098—LO1 27 VDC

Utah Pulse Transformers

9262 . . . . $6.95 9280 . . . . $7.95

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Used—Excellent **$6.95**

BL-221 FREQUENCY METER $115.00

SELSYN C78248 ea. $6.95

Differential C78249 ea. . . $2.95

Mounting Brackets for Above 35¢ Pair

A B CARBON RESISTORS

Brand New—Fresh Stock

All Standard R.M.A. values available

EB ½ GB 1 HB 2

Price Schedule

	Tol.	1 to 99	100 of a value
½ Watt	10%	5.05 ea.	52.95
½ Watt	5%	.10 ea.	6.00
1 Watt	10%	.08 ea.	5.00
1 Watt	5%	.16 ea.	11.00
2 Watt	10%	.10 ea.	9.00
2 Watt	5%	.20 ea.	18.00

TYPE "J" POTS

- JLU Locking Bushing
- Shaft for Knob

Your choice—95¢ ea.

OHMS	OHMS	OHMS	OHMS	OHMS
50	1K	4K	50K	500K
100	1500	5K	75K	1 MEG
250	2K	10K	100K	2 MEG
500	2500	15K	150K	2.5 MEG
	3K	25K	250K	5 MEG

COAX CONNECTORS

SPECIAL: SO 239 / PL 259 } **35¢ ea.** Brand New

83-1AC	.42	83-22R	.68	UG-21B/U	1.00
-1AP	.30	-22SP	.80	27P/U	2.35
-1BC	.35	-22Y	1.95	58/U	.68
-1F	1.10	-168	.12	58A/U	.85
-1H	.12	-185	.12	260/U	.65
-1HP	.22			260A/U	.75
-1J	.70			260B/U	1.00
-1R	.35	M-358	1.30	261/U	.75
-1RTY	.65	M-359	.30	261A/U	1.00
-1SP	.35	M-359A	.65	262/U	.95
-1SPN	.35	PL-258	.75	262A/U	1.00
-1T	1.30	PL-259	.35	274/U	2.20
-22AP	1.40	PL-259A	.35	290/U	.60
-22F	2.10	PL-274	1.10	291/U	.70
-22J	1.40	SO-239	.35		

OIL CONDENSER SPECIALS

10 mfd.—600 v. . . . . $.89

Three term, bot. mtg. channel type. Dims. 3¾" x 2½" x 2". Two 5 mfd. sections rated 400 V at 72 deg "C". 1800 V test. Meets commercial specs. for 600 V operation up to 40 degs "C". Ideal for filter or power factor application. Repeat sales prove this rugged high quality condenser to be of outstanding value. Carton of 24, weight 42 lbs. Large qua. available . . . . . **$.79**

6 mfd.—150 v. . . . . $.29

Three term, dual 3 mfd. oil cond. complete with brackets, measuring 4¼"x1¾"x1". Ideal for audio crossover networks.

2 mfd.—7500 v. $21.95

Pyranol-Ind. Cartoned

Mfd	Volts	Price	Mfd	Volts	Price	Mfd	Volts	Price
.001	50KV	24.94	.5	25KV	45.95	5	1000	1.89
.0023	16KV	6.95	.65	12.5KV	13.95	5	1500	1.98
.01	5000	.79	1	500	.55	2x5	400	.89
.01	10KV	4.95	1	1000	.69	2x5	600	1.19
.012	25KV	12.95	1	1500	.99	3x5	400	1.29
.02	8000	4.75	1	2000	1.85	6	600	1.69
.02	10KV	5.25	1	2500	2.20	6	330AC	1.69
.02	20KV	10.95	1	3000	2.95	6	1000	2.30
.025	50KV	22.95	1	5000	6.25	6	1500	2.95
2x			1	6000	5.95	7	110AC	.79
.025	50KV	34.50	1	6000	6.50	7	600	.98
.03	7500	4.50	1	7500	8.95			
.035	10KV	5.95	1	7500	14.50	7	600	1.35
.05	7500	2.95	1	10KV	23.50	7	800	1.75
.08	12.5KV	8.95	1	15kV	26.95	7	5000	29.95
.1	1500	.39	1	20KV	45.95	8	500	.99
.1	2000	.45	1	25KV	49.50	8	600	1.49
.1	2000	.89	1	25KV	65.00	8	660AC	4.25
.1	2500	.98	1	25KV	75.00	8	800	1.89
.1	3000	.69	1.75	330AC	.69	8	1000	2.78
.1	3000	1.19	2	600	.55	8	1400	3.05
.1	7500	.85	2	600	.65	8	1500	3.65
.1	7500	4.25	2	1000	.79	9	2000	5.95
.1	10KV	6.35	2	1000TLA	1.29	8	2500	6.50
.1	12KV	6.95	2	1500	1.15	2x8	600	1.89
.1	2000	.89	2	2000	2.80	10	50AC	.65
2x.1	2000	.89	2	2500	3.45	10	600	1.19
2x.1	7000	3.50	2	3000	4.25	10	600	2.25
2x.1	6000	2.29	2	4000	7.50	10	1000	3.75
.2	10KV	8.50	2	5000	12.50	10	1500	4.25
.2	15KV	13.98	2	7500	21.95	10	2000	5.95
.2	50KV	39.50	2	10KV	35.95	10	6000	59.50
3x.2	4000	2.85	2	12.5KV	59.50	12	660AC	3.75
.25	1500	.88	2	20KV	89.75	14	50	.99
.25	2000	.98	2x2	600	.85	15	330AC	3.50
.25	3000	1.45	3	1000	.98	15	400	1.29
.25	4000	1.98	3	2000	2.50	15	440AC	3.85
.25	6000	.85	3	4000	8.99	15	1000	3.95
.25	20KV	18.95				15	1500	5.40
.25	25KV	40.00	2x3	150	.29	15	5000	63.50
.25	32KV	49.50	3x3	400	.68	20	330AC	3.50
.25	50KV	62.95				20	600	1.69
.3	2000	.59	½	500	.59	24	500	1.89
2x.25	2000	1.10	4	600	.79	28	1000	5.95
.4	10KV	10.90	4	600TLA	.98	30	330AC	5.25
2x.4	7500	5.25	4	1000	1.89	30	2500	12.95
.5	1500	.59	4	1500	2.65	50	330AC	6.50
.5	2000	1.19	4	2000	2.95	70	220AC	6.50
.5	2500	1.49	4	2500	4.95	80	4000	45.50
.5	3000	2.39	4	3000	6.99			
.5	5000	3.09	4	4000	13.95			
.5	7500	6.25	4	5000	24.95			
.5-.1	2000	.39	4	7500	39.95			
2x.5	600	.69	4	10KV	59.95			
2x.5	9000	12.95	5	220AC	1.19			
			5	330AC	1.39			
			5	600	1.19			

Other Items Available
Mica Conds.
Bathtub Conds.
Channel Conds.
Rheostats
Potentiometers

TRANS. MICA CONDENSERS

Mfd	Wvdc	Price	Mfd	Wvdc	Price	Mfd	Wvdc	Price
.00001	600	.20	.0004	1200	.29	.004	600	.29
.000024	2500	.35	.0004	2500	.29	.004	1200	.49
.000025	1200	.29	.0004	5000	1.95	.004	2500	.91
.00003	600	.24	.00047	2500	.40	.005	600	.35
.00003	1200	.28	.0005	600	.23	.005	1200	.45
.00003	2000	1.25	.0005	1200	.29	.005	2500	.98
.00003	2500	.35	.0005	2500	.39	.005	3000	1.65
.000047	2500	.30	.0005	3000	1.25	.006	600	.36
.00005	600	.23	.0005	5000	2.45	.006	1200	.55
.00005	1200	.29	.005	7500	2.95	.006	3500	1.65
.00005	2500	.33	.0062	3000	1.25	.0062	2500	.94
.00005	3000	1.25	.00068	2500	.28	.0075	3000	1.75
.000051	5000	1.75	.00089	1200	.28	.008	600	.35
.00007	2500	.26	.001	600	.23	.008	1200	.57
.000075	5000	1.45	.001	1200	.32	.01	600	.48
.0001	600	.24	.001	2500	.49	.01	1000	.50
.0001	1200	.27	.001	4500	1.65	.01	1200	.69
.0001	2500	.36	.001	5000	2.25	.01	1250	.69
.0001	5000	1.95	.001	8000	3.98	.01	2500	.94
.00015	600	.23	.0015	600	.23	.012	1200	.64
.00015	2500	.33	.0015	2500	.53	.014	600	.45
.00015	5000	1.95	.0015	5000	2.25	.014	1200	.64
.0002	600	.23	.002	600	.27	.015	600	.55
.0002	1200	.29	.002	1200	.39	.015	2000	1.75
.0002	2500	.34	.002	2500	.63	.02	600	.21
.0002	5000	1.95	.002	5000	2.25			
.00025	600		.002	6000	2.40	.02	1200	.99
.00025	1200	.19	.0024	5000	2.25	.02	2000	1.60
.00025	2500	.35	.0025	600	.28	.03	600	.55
.00025	5000	1.95	.0025	1200	.43	.03	1200	1.18
.00027	1200	.27	.0025	2500	.65	.039	600	.67
.00027	2500	.36	.003	600	.31	.25	250	1.95
.0003	600	.23	.003	1200	.52	.4	600	3.25
.0003	2500	.36	.003	2500	.73	2x.1	250	1.98
.0004	600	.23	.003	3000	1.65	.115	2000	4.65
			.003	5000	2.25			

MONMOUTH RADIO LABS.

BOX 150 OAKHURST, N. J.
Capitol 2-2776

LOW-VOLTAGE TRANSFORMERS

New Release of Government Surplus Material Model #S-9527. KENYON TRANSFORMER CO. — 2.2 KVA. Input 110/220 Volts 50/60 Cy. Output 11 Volts C-T (5.5-0-5.5) At 200 Amperes! Continuous Duty. Case Size 8½x10½x13".

Price BRAND NEW ONLY . . . . . $23.95 Ea.

#S-9527-WE.—WESTINGHOUSE.—Same Specs, But Single 115 V Input & Lighter Wt. NEW: $23.95

DOZENS OF USES FOR INDUSTRIALS, TESTING LABS, EXPERIMENTAL UNITS & SCHOOLS

★ Heavy-Duty Soldering ★ Dip-Soldering ★ Plating ★ Battery-Chargers ★ Spot-Welding ★ Welding ★ Magnetizers ★ Heat-Treating ★ Electromagnets ★ Testing - Tubes, Coils, Breakers & Relays.

Terms: Prices FOB St. Louis. Cash With Orders Well Rated Concerns (D&B) Net 10 Days Cash.

McNEAL ELECTRIC & EQUIPMENT CO.

4736 Olive St. Dept. E-11 St. Louis 8, Mo.

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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.

NEW TS-13/AP X-BAND SIGNAL GENERATORS with manual $575.00; T-47A/ART-13 Transmitters, $450.00; H-P, Boonton, G-R, Measurements, many others in stock.

ENGINEERING ASSOCIATES

434 PATTERSON ROAD DAYTON 9, OHIO

COMMUNICATIONS EQUIPMENT CO.

MICROWAVE MAGNETRONS

*2J21A	$2.25	3J31	$32.50	700B	$8.75
2J22	2.50	4J34	23.50	700D	8.75
2J26	2.50	4J42	47.50	706A	9.75
2J27	3.00	5J23	34.50	706D	14.75
2J29	18.50	5J30	14.50	706CY	9.75
2J31	13.95	5J33	4.75	706EY	9.75
2J32	14.50	QK 59	39.50	725A*	
2J37	9.50	QK 60	35.00	730A	8.75
2J39	8.25	QK 61	50.00		
2J62	6.75	QK 62	54.00	* Write	

X BAND – 1" x ½" WAVEGUIDE

AT-68/UP 3 Cm Horn with type N. feed for receiver measurements, etc. New (as shown) $7.45
ROTARY JOINT (APS-6) Sperry PT #658275, 180 deg. rotation, choke-to-choke. Has "Built-in" Di-Coupler, 20 DB., with "N" Takeoff 22.50
PARABOLOID DISH, 18" diam. Spun Aluminum, 8" Focus. For AN/APS-6 ..... $4.95
3 **CM. DIPOLE** and Feed Assembly. (May be used with above dish.) 8 inches long. $5.00
FLEXIBLE SECTION 9 in. long Cover-to-Cover. . $5.50
3CM. DIPOLE FEED, 15" L. for APS-15 10½" Focus $14.50
MITRED ELBOW. Cast aluminum, 1¼" x ⅝" W.G. W.E. Flanges, "E" Plane $3.50
3 **CM. ANTENNA ASSEMBLY**: Uses 17" paraboloid dish, operating from 24 vdc motor. Beam pattern: 5 deg. in both Azimuth and elevation. Sector Scan: over 160 deg. at 35 scans per minute. Elevation Scan: over 2 deg. Tilt: Over 24 deg. $35.00
Cross-Guide Directional Coupler, UG-40 output flange. Main Guide is 6" Long, with 90 Deg. "E" Plane bend at one end, and is fitted with Std. UG 39/UG 40 flanges. Coupling figure: 20 db Nominal. $22.50
RG52/U Waveguide in 5' lengths, fitted with UG 39 flanges to UG40. Silver plated ..... per length $5.00
Rotating-Joints supplied either with or without deck mountings. With UG40 flanges ..... each $17.50
Bulkhead Feed-thru Assembly $15.00
Pressure Gauge Section with 15 lb. gauge $10.00
Directional Coupler, UG-40/U Take off 20db. $17.50
MAGNET AND STABILIZER CAVITY For 2J41 Magnetron $24.50
90 degree elbows, "E" plane 2½" radius $8.50
ADAPTER, waveguide to type "N", UG 81-U, p/o TS 12, TS-13, Etc. $7.50
ADAPTER, UG-163/U round cover to special BTL Flange for TS-45, etc. ..... $2.50 ea.

I. F. AMPLIFIER STRIPS

Model 15: 30 Mc Center frequency. Bandwidth 2.5 Mc gain figure: 65 db. Uses 5 stages of 6AC7's. Has D. C. Restorer and Video Detector A.F.C. Strip included. Input impedance: 50 Ohms. Less tubes. $17.50
60 MC. Miniature IF strip, using 6AK5's 60 Mc center Freq. Gain: 95 db at Bandwidth of 2.7 Mc. New Complete with tubes $15.00

JAN WAVEGUIDE FLANGES

UG 39/U	$1.10	UG 51/U	$1.65
UG 40/U	$1.25	UG 52/U	$3.40
UG 40A/U	$1.85	UG 52A/U	$3.40

COAXIAL R.F. FILTERS

F-29/SPR-2, Hi-Pass., with 1000 mc Cut-off, Type "N" input and output. 50 Ohms Z. $9.50
F-41/SPR-1. Hi-Pass, with 300 mc cut-off, Type "N" input and output. 50 Ohms Z (As shown) $10.50

PULSE TRANSFORMERS

4P37 Primary, 50 Ohms 750V. .001 Duty. Sec. 15KV. 1000 Ohms Impedance. Bifilar 12.6V/2.5A. . . . $32.50
RAYTHEON WX 4298E: Primary 4KV., 1.0 USEC. SEC. 16KV-16 AMP DUTY RATIO: 001 400 CYCLE FIL. TRANS. "BUILT-IN" $42.50
WECO: D-163247 For Modulator of SCR 720. . . . $22.50
GE #K-2449A. Primary: 9.33 KV, 50 ohms Imp. Secondary: 28 KV, 450 ohms. Pulse length: 1.05/5 usec @ 635/120 PPS. PK Power Out: 1,740 KW. Bifilar: 1.5 amps (as shown) $62.50
GE #K-2748-A, 0.5 usec @ 2000 Pps. Pk. Pwr. out is 32 KW impedance 40:100 ohm output. Pri. volts 2.3 KV Pk. Sec. volts 11.5 KV Pk. Bifilar rated at 1.3 Amp. Fitted with magnetron well $24.50
K-2745 Primary: 3.1/2.8 KV. 50 ohms Z. Secondary: 14/12.6 KV. 1025 ohms Z. Pulse Length: 0.25/1.0 usec @ 600/600 PPS. Pk. Power 200/150 KW. Bifilar: 1.3 Amp. Has "built-in" magnetron well. $32.50
K-2461-A. Primary: 3.1/2.6 KV—50 ohms (line). Secondary 14/11.5 KV—1000 ohms Z. Pulse Length: 1 usec @ 600 PPS. Pk. Power Out: 200/130 KW. Bifilar 1.3 Amp. Fitted with magnetron well. $29.50
K35J45—Pulse Inversion: PRI: 5 KV PK. Pulse Negative. Sec: Pos. Pulse, 4 KV: 1 usec. and .001 DUTY RATIO $6.50
54J318-1—3 wdgs. Ratio: 1:1:1, 1.10 uh. /wdg., 2.5 ohms DCR $3.50

PULSE MODULATORS

MIT. MOD. 3 HARD TUBE PULSER: Output Pulse Power 144 KW (12 KV at 12 Amp.) Duty Ratio: .001 max. Pulse duration: 0.5, 1.0, 2.0 microsec. Input voltage: 115 v. 400 to 2400 cps. Uses 715B 1-829B 3-72's, 1-73. New ..... Less Cover—$135
ASD Modulator-Units, mfd. by Sperry. Hard tubes pulser delivers Pk. pulse of 144 kw. Similar to Mod 3 unit. Brand new, less tubes. $85.00

Airborne RF head, model ASD, delivers 50 Kw peak output at 9000 mc. at .001 duty, 1 usec./1000 PPS. Complete with pulser unit and all tubes. $210

3 CM. TEST SETS

TS 12/AP. For standing wave measurement of plumbing, TR/ATR boxes, crystal mixers, antennas, etc. The TS 12 consists of two basic units: Unit 1 is a high gain stable amplifier followed by a 3-inch meter which reads SWR directly. UNIT 2 consists of waveguide accessories, including a slotted line, probes, dummy load, adapters, etc. Either bolometer or crystal input may be used. Both units are portable, self contained. Operates from 115 v. 60-800 cps. New*
TS 13/AP. Signal source 9305-9445 mc, 50 microwatts. Comes with a wavemeter, thermistor-bridge power meter, and calibrated attenuator. Oscillator is a klystron type 723/a-b which may be internally (self-synch) or externally pulsed. Controls are provided for FM operation, variable pulse delay, pulse width and phasing. Operates from 115 v, 60-800 cps. New*
** Price on Request*

—IN STOCK—

AIA	ASH	SO-8
APA-9	BG	SG-1
APA-10	DAS†	SJ-1
APN-3	DBS†	TAJ
APN-7	APT-2	TBK
APN-9*	APT-4	TBL
APS-2	MKIV	SCR520*
APS-3	MKX	SCR521
APS-4	RC145	SCR518
APS-6	RC148	SCR545
ASD	SO-1	SCR584

* COMPONENTS. † LORAN EQUIPMENT

—TEST SETS—

TS-10	TS-12	TS-159
TS-36	TS-56	TS-90
TS-47	TS-34	TS-98

BARGAIN SPECIALS

Barry shock mounts: nos. 2045, C-2060, C-2070, C-2090. ..... 45c ea.
Trihedral radar reflector, MK-1, aluminum. $3.50
SPLICER, for 11/16 perforator tape. WEco = X-61859 list 20 SCS = 4TW 61859-20. Complete set, with number tape dispenser $8.50

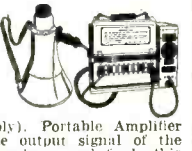
SPARES FOR PRC-10

3C1084H-67	3C1084H-71	2Z5822-488
3C1084H-68	3C1084Z-74-3	2Z5822-503
3C1084H-69	2Z9632.611	3DA1-304
3C1084H-70	2Z9631.407	3DA10-543

MN 28Y Control box, unit of MN 26 compass, New. $3.75
Noise filters, Mallory NF1-1, 100 amp/35 vdc. . . . $1.00
Power supply unit, navy type—EL-2. Input: 115 vac, 60 cy. Output: 135 vdc/10 ma. 90 vdc/5ma; 3 vdc/360 ma. New, complete with spare parts box. To be used with model TBX radio gear. $9.50
Coaxial switch, 12-position, with type "N" fittings. Type SA-14, SPR-1 ..... $17.50
Amplifier, Altec A-127. 18 Watts output with response from 20-20,000 cps. Operates from 115 v. 60 cps. Std. rack panel mtg. Used, excellent. $103
Pulse analyzer, type APA-6. With 3 in. scope. . . . $235
BC 602 Control box for SCR 522 (pushbutton). . . . $3.75
24-volt Transformer. Input 115 v/60 cy. Output 24 v/3A $1.79
Phase-shifter, Helmholtz type: 0-360 deg. $2.50
Capacitor, oil-filled, 0.25 mfd./25,000 volts dc. $15
Hydrophone, MODEL MI-2. A lattice of 3 crystals in a disk-like structure; 17-37 Kc. $27.50
AN/CRW-2A Remote control receiver, for operating target planes, etc. New, with soundproof mounting box $34.50
TEL. REPEATER, EE 89, complete with tubes and tech. manual $17.50
TEL. REPEATER, EE 99, with 12 vdc. vibrator power supply (PE 204) $49.50
F.T.&R. 101-A. Two-wire applique, contains equalizing devices, and balancing circuits. Used for adapting 2-wire military circuits to 4-wire systems. $47.50
RADAR TRAINER, Model 15-C. Brand new, complete with pulse generator, power supply, main unit, all cables and instruction book. $125
UNDERWATER MICROPHONES, Model JR—Consists of a mosaic of 7 crystals. May be used at 17-73 Kc. omnidirectional, 50 ohm output. $27.50
SAIA/APA-1 Motor Driven Coaxial Ant. Switch DPDT. Continuous Operation from 24VDC. Completely Enclosed $34.60
MP-22 MAST BASE Mobile Antenna Mount. . . . $4.59
SA-A/APN-1 Altitude Limit Switch for APN-1 Altimeter $7.95
ALTITUDE INDICATOR for APN-1 ..... $12.50
C-87D Final P.A. Coil for BC610 2-3.5 MC. Variable Link $4.89
RA-74 Power Supply for Super Pro. $69.50

ELECTRIC MEGAPHONE SYSTEM

For Rural Areas, Hotels, Commercial Steamers, Ball Parks, Etc.



U. S. NAVY type PAE-1 Electric Megaphone equipment is designed for voice reinforcement in much the same manner as, but to a greater degree than, the familiar acoustic megaphone. Consists of Megaphone Unit (which combines a microphone and reproducer in a single assembly). Portable Amplifier which electrically amplifies the output signal of the microphone section of the megaphone and feeds this amplified signal to the reproducer section. Charging Rack for recharging the self-contained storage battery of the portable amplifier. BRAND NEW. $129.50

DYNAMOTORS

TYPE	INPUT VOLTS	INPUT AMPS	OUTPUT‡ VOLTS	OUTPUT‡ AMPS	Price
BDAR83	14		375	.150	$6.50
35X-059	19	3.8	405	.095	4.35
POSX-15	14	2.8	220	.08	8.95
DM33A	28	7	540	.250	3.95
23350	27	1.75	285	.075	3.95
B-19	12	9.4	275	.110	6.95
			500	.050	
DA-3A*	28	10	300	.260	3.95
			150	.010	
			14.5	5.	
PE 73CM	28	19	1000	.350	10.50
BD 69†	14	2.8	220	.08	8.95
DAG-33A	18	3.2	450	.06	2.50
DM25†	12	2.3	250	.05	6.95
BDAR 93	28	3.25	375	.150	6.95

‡Less filter *Replacement for PE 94.
†Used, Excellent.
PE 94, Brand New 5.95

INVERTERS

800-1B Input 24 vdc, 62 A. Output: 115 V, 800 cy, 7A, 1 phase. Used, excellent $18.75
PE-218H: Input: 25/38 vdc, 92 amp. Output 115V 300/500 cy 1500 Volt-ampere. NEW. $32.50
PE206: Input: 28 vdc, 36 amps. Output: 80 V 800 cy, 500 volt-amp. Dim. 13 x 5½ x 10½. New. . . . $22.50
AN3187-1, Input: 13.75 V; 18.4A. Output: 115 V/400~, 3φ, 0.95 PF. New $59
PU 7/AP. Input: 28 vdc/160 A. Output: 115 VAC, 400~, 1φ, 500 VA., 21.6 Amp. Volt. and Freq. Reg. Used, Exec. $75

TS-56A/AP TEST EQUIPMENT

Slotted line test equipment designed for operation over a frequency of 500-675 MC. Has impedance of 51 ohms. Ideal test set for matching antennas, measurement of characteristics of transmission line. With instructions manual. New. Shipping wt.: 41 lbs. $120.00

TEST OSCILLATOR TS-47/APR, 40-2000 + Mc. Fundamental coverage 40-500 Mc in two ranges. Harmonics above 2000 Mc. Provides a calibrated (dial) accuracy ± 0.7 per cent) H.F. source for testing receiving equipment. Output 3MW or more up to 400 Mc. less on harmonics. C.W., mod. pulse or sine wave output. Operates on 115/230 60 Cy. or batteries Part of APR countermeasures equipment. New $165.00

VHF ANTENNA

Sig. Corps. AN154. 150-200 mc. Consists of 3 vertical dipoles working against a mesh reflector, 90 in. x 40 in. Spacing between elements is ½ wavelength. Unit comes complete with portable carrying chest and 1/12 HP lobing motor - (synchronous, 115 vac 60 cy.). Antenna folds up to 46 in. sq. x 18 in. height. Hhpg. wt. aprox. 200± (as shown) $22.50

400 CYCLE TRANSFORMERS

	(All Primaries 115V. 400 Cycles)	
KS13101	6.3V/15A, 6.3V/0.9A, 6.3V/0.4A, 6.3V/0.2A	$3.85
KS13104	1450VCT/0.283A, 1050VCT/0.217A	7.50
KS9615	6.3V/4A, 3V/1A	1.57
KS9608	1233/.35MA, 1140VCT/.07A	5.79
302433A	6.3V/9.1A, 6.3VCT/6.5A, 2.5V/3.5A, 2.5/3.5A	4.85
KS 9445	592VCT/118MA, 6.3V/8.1A, 5V/2A	5.39
KS 9685	6.4/7.5A, 6.4V/3.8A, 6.4/2.5A ALL CT	4.79
70G30G1	600VCT/36MA	2.65
M-7474318	2100V/.027A	4.95
352-7069	2-2.5V Wdgs at 2.5A, Each Lo-Cap., 22Kv Test	5.95
352-7096	2.5V/1.79A, 5V/3A, 6.5V/6A, 6.5V/1.2A, D/O BC800	4.95
352-7099	360VCT/20MA, 1500V/1MA, 2.5V/1.75A, 6.3V/2.5A, 6.3V/.6A, P/O BC-929	6.45
D1 63253	5200V/.002A, 2.5V/5A	5.35
M-7471957	2.5V/20A, 12KV Test	4.85
352-7179	250V/100MA, 6.5V/12ACT, 5V/2A	3.45

MAIL ORDERS PROMPTLY FILLED. ALL PRICES F.O.B. NEW YORK CITY. M.O. OR CHECK. ONLY SHIPPING SENT C.O.D. RATED CONCERNS SEND P. O. PARCELS IN EXCESS OF 20 POUNDS WILL BE SHIPPED VIA CHEAPEST TRUCK OR RAILEX.

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BC-788, T-47A/ART-13, BC-348R, R-5/ARN-7, RT-18/ARC-1

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AN/ASQ-1 and 1A MAGNETOMETERS

This is an airborne magnetometer used to measure the magnetic flux of the earth and to locate submarines and other metallic objects by their distortion of the magnetic field. Sensitivity 2-3 gamma or better. POR.

AN/GSQ1-A SPEECH SCRAMBLERS

Speech scrambler for use on any comm. channel to insure privacy. We can supply complete installations of this equipment 28v DC input. Also 110v 60 cyc.

SCR-291A DIRECTION FINDER

Automatic ground direction finder covering 1.5mc-30mc. Provides instant bearings on a C.R. indicator of any signal in its range. This equipment is transportable and can be set up quickly. 110v 60 cyc. POR.

P.P.I. REMOTE RADAR REPEATERS

We can supply the following types of remote Radar P.P.I. Repeaters. The main radar provides the Syncronizing, Syncro. and Video. Pulses to operate the Repeaters. These repeaters may be used with any marine ground or airbourne.

VC 7" P.P.I. Upright deck mount Repeater. 4 Ranges are provided from 4-200 miles. Input 110 Volt 60 Cyc.

VD 7" P.P.I. Deck mount Repeater. This unit is very similar to the VC but is completely Waterproof and may be used on deck. The ranges are the same as the VC. Input 110 Volt 60 Cyc.

VE 7" P.P.I. Table mount Repeater. This is a very compact set. 4 ranges are provided from 4-200 miles. Input 110 Volt 60 Cyc.

VF 9" P.P.I. Deck mount Repeater. This is a very late model Repeater enabling 20 radars to be fed into it. 4 Ranges from 4-200 miles are provided. Input 110 Volt 60 Cyc.

VG 12" P.P.I. Plotting Table Projection Repeater. This is a very elaborate Remote Indicator. For use in a plotting center. Up to 20 Radars may be fed into it. This set utilizes a Sklatron tube to provide data that can be retained on the screen and can be erased at will. Input 110 volt 60 Cyc.

Accessories are available such as repeater adaptors enabling the set to be used at a greater distance than normal. Input switches to select the radar to be viewed etc.

SCR-682-A RADAR

10CM high power long range harbor surveillance and early warning RADAR. This equipment is a 3000 mc mobile search radar that can be transported in a truck. The equipment incorporates a 7" PPI for operation up to 240,000 yards. Azimuth accuracy is ± 1%. Range accuracy is 100 yards at 10,000 yard range and 5000 yards at 240,000 yard range. Trans. output is approx. 225 KW. pulse width is one microsecond. Antenna beam width is 6°. Input is 110v 60 cyc. Can be supplied with or without operating shelter or antenna tower. POR.

We can supply many types of radars, test sets, communications equipments, manufactured after 1947. Write us if you cannot find it.

AN/APR-4 38-4000 MC RECEIVER

This is a precision receiver covering 38-4000 mc. The set utilizes 5 tuning units with direct reading dials in megacycles. The receiver has a wide and narrow band-width 30mc. I.F. strip which may be selected at will. An output meter is provided to measure signal strength. Outputs are provided for a pulse analyzer and pan adaptor. Each tuning unit has an automatic sweeping mechanism which enables any portion of the tuning range to be scanned automatically. Input 110v 60 cyc. POR.

500-1300 MC SIGNAL GENERATOR

This is a high precision signal generator covering 500-1300 mc. A precision attenuator is built in providing accurate determination of output from 0-100,000 microvolts. Either CW or pulsed carrier output with the following characteristics are provided. Pulse rate 60-2,500 CPS. Pulse length 2-30 microseconds. Output line 50 Ohm impedance. Accuracy better than one percent. Input 110 v 60 cyc. With calibration charts. Price $249.50

90-600 MC SIGNAL GENERATOR

This set covers 90-600 mc. with an accuracy of one percent or better. C.W. or pulse output with the following characteristics are provided. Output from 0-100,000 microvolts 2-30 microseconds long. Pulse rate 60-2500 cyc. Pulse delay 3-300 microseconds. Output 50 ohm line. Input 110v 60 cyc. Price.....$249.50

CF-3A CARRIER REPEATER

This is a transportable 4 wire carrier telephone repeater. This set amplifies all signals when used in an intermediate position on a carrier system to extend the range. DC signaling and telegraph communications can be performed to the terminal equipments or to other repeaters. Monitoring and transmission circuits are built in. Power input 110 or 220v or 12v DC. This set can be used with all CF terminals and commercial equipments. Brand New in original cases. POR.

AN/APA-17 DIRECTION FINDER

This is an automatic direction finder covering 300-1,000 mc to be used with the APR-1 and APR-4 radar search receivers. The bearing is presented on a cathode ray screen in a cardoid pattern. The set can be used in aircraft or on the ground. Input 110v 400 cyc and 28v DC. POR.

RADAR BEACONS
X and S Band High and Low Power Racons

We can supply the following Beacons in Portable and Stationary Models. The X-BAND models will operate with the new Weather Radars

AN/CNP-6 X-Band high power Radar Beacon. This is a 40 KW set for use at an Airport. This set will Interrogate X-BAND Radars up to 200 miles. Variable Coding is provided as well as monitoring facilities. Input is 110 V 60 CYC.

AN/CPN-8 S-BAND HIGH POWER Airport Beacon. This is a very compact set. This set will Interrogate S-BAND Radars up to 200 Miles. Variable Coding and monitoring facilities are provided. Input 110 Volt 60 Cyc.

AN/CPN-17 S-BAND High power version of the CPN-6 with all the latest improvements. Input 110 Volt 60 Cyc.

AN/UPN-4 X-BAND Very lightweight Portable Beacon. This set will interrogate X-BAND Radars up to 60 miles. Variable Coding is provided. Input 12 Volts D.C. Weight Approx. 40 Lbs.

AN/UPN-1 and 2 S-BAND Portable beacons. This set will interrogate a S-BAND Radar up to 60 Miles. Variable Coding is provided. Input is 12 Volts D.C. and 110 Volts 60 Cyc. Weight Approx 50 Lbs.

MOTORS:

24 VDC REVERSIBLE MOTOR — 3.7 RPM. 40 lb. Torque. Motor size: 5-½" 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: 1⅛" x ¼" Motor size: 2½" x 1⅝" No. 5069-267.....$4.95

26 VOLT 60 CYCLE—60 RPM Synchronous Cramer Motor #1147. Shaft size: 1" x ⅛".....$1.95

110 VDC 1/70 HP., 1550 RPM. Motor size: 4" x 2⅛". Shaft size: 1" x 3/16". Redmond #157.....$4.95

6 VDC 1/20 HP., 4000 RPM. Motor size: 5" x 3". Shaft size: ¾" x ¼". Redmond #E-50.....$4.95

12 VDC 1/30 HP., 4500 RPM. Motor size: 3" x 2⅛". Shaft size: 1" x 3/16". Delco #5047520.....$4.95

27 VDC 1/10 HP., 3500 RPM. Shaft size: ⅝" x ¼". Motor size: 4"x3-½". 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. #5-PN38HA10....$8.95

28.5 VDC 1/35 HP., 2200 RPM. Shaft size: 1½" x ¼". Motor size: 4½" x 3¾". Electrolux #16876...$5.95

27 VDC GEAR HEAD MOTOR—960 RPM; 1/75 HP; 1.75 A. Size: 5" x 3". Shaft ¼" x ⅝". Air Assoc. #EE120MJ.....Price: $7.95

27.5 VDC GEAR HEAD MOTOR—324-1 Ratio; 4050 RPM; Right Angle Drive Motor. Size: 5" x 3-½". Shaft: 5/16" x ¾". Bodine Type #V10R. Price $7.95

24 V. GENEVA LOC ACTUATOR MOTOR ASS'Y.—1/25 HP.; 15000 RPM, w/Gear Head & Limit witches. Motor Size: 5-½" x 3-⅛". Angle Drive Shaft: ¼" x ½". Bendix #IM-106524. Price: $7.95

24 VDC GEARED HEAD MOTOR—Heavy Duty. 8 Amp. 2-½ lb. Torque. 100/200 RPM. Shaft Size: 5/16" x 1". Right Angle Drive.....$8.95

27 VDC MOTOR—1.5 A.; 1/50 HP.; 3000 RPM Shunt Motor; Motor Size: 3" x 2-¼". Shaft: 5/16" x ¾". Oster #D8-1 or WEVS-5876.....Price: $2.95

27.5 VDC MOTOR—1/100 HP.; 7000 RPM; Motor Size: 3" x 1-¾"; Shaft: ¼" x ¾" L. Oster #C2BP-1A—Price.....$2.95

27.5 PERMANENT MAGNET ALNICO FIELD MOTOR—.03 Amp.; 10000 RPM; Size: 1" x 1-⅛" x 2". Shaft: ⅛" x ½". Delco #5068571.....Price: $7.95

NEW ITEM PM MOTORS AVAILABLE:

Write for prices today on the following: DELCO 5069625, DELCO 5068571, DELCO 5069370

115 Volt 60 cycle GEARED HEAD MOTOR—24 RPM. 1/100 HP. Right Angle Drive—Size: 7-½" x 4" x 1". Shaft Size: 3/16" x ⅜".....NEW: $9.95

115 VAC 60 Cycle INDUCTION MOTOR—1.9 RPM. 75 Torque oz. in.; 9 Watts—with variable Multi-Disc Coder Wheel & Micro Switch, mounted on bracket ass'y. Holtzer Cabot Motor. Type RWC 2505.....$9.95

INVERTERS & GENERATORS:

AC-DC GENERATOR—Output 115 VAC 800 cycle 10.5 A. & 28.5 VDC; 60 A. at 2400 RPM. ⅞" spline shaft. Bendix Eclipse No. NEA-3. ...NEW: $18.95

PE-218—Input 28 VDC 100 A.; output 115 V. 400 cycle 1 Phase, 1500 VA. Used: $14.95—New: $39.95

NEW ITEM 60 CYCLE TO 400 CYCLE MOTOR —

GENERATOR: Motor 3 HP. 115/230 60 cycle single phase; Generator 115 Volt 400 cycle single Phase 1400 Watt & 28.5 VDC 400 Watt. Belt Drive. Reconditioned.....$295.00

TYPE 800-1-D—Input 28 Volt 62 A.; output 115 Volt 7 Amp, 1 Phase 800 cycle.....NEW: $24.95

METERS:

WESTON AC AMMETER:
(Pictured) In portable leather case, with Test Leads, 2½". 0-15 AC and 0-3 AC Scale..... **$5.95**

DC AMMETER HOYT: In portable metal case with Test Leads, 4½". Fan. Mirrored scale 0-15 ADC.....$4.95

0-3 RF AMMETER 1S-128; 2½" Rd....NEW: $2.95
0-8 AMP RF w/Thermocouple IS-89: 2-½" Rd. 4.95
0-15 AC-DC—2-½" Rd., 1S-122.....4.95
0-500 MA DC—2-½" Rd., 1S-22.....4.95
0-1 MA DC Simpson—3-½" Rd.....3.95
0-2 MA DC Vestinghouse—3-½" Rd.....2.95
0-20 MA DC Westinghouse—3-½" Rd.....2.95
0-150 V. 60 cycle—Simpson—3-½" Rd.....3.95
0-250 MA DC—Delur—3" Sq.....3.95
AUDIO OUTPUT METER—Portable, Five Ranges: 0/1.5, 6, 15, 60, 150 Volts AC. Res.—4000 Ohms. Plastic Case P/O 1-56 Test.....NEW: $6.95
USED: $4.95

Receiver—Transmitter F M 20—28 M C.

BC-500 RECEIVER — TRANSMITTER: FM Crystal Control on 5 Channels. 100 KC separation 20-28 MC.
TRANSMITTER: 25 Watt output. 7 tubes: 1/1625, 1/12AG, 3/12SJ7; & 2/12SA7.
RECEIVER: 11 Tubes: 1/12SL7, 2/12A6, 3/12SA7, 3/12H6, 2/12U8, & 1/12SJ7.
DYNAMOTOR SUPPLY: Receiver 28 VDC 1.2 A. input; output 250 VDC 60 MA. Transmitter 28 VDC 4.1 A. input; output 550 V. 120 MA.
CONTROL PANEL: For Local Control and outlets for Remote also. Heavy duty 5" speaker. Size: 12" x 25" x 9½". Weight: 65 lbs.
Price: NEW: **$59.50**

BRAND NEW GUARANTEED

SAVINGS FROM **70-85%**

POWER RHEOSTATS

"Be Right with" Famous Make

MODELS H-J-G-K-L-N-P-R

Ohm	Watt	Each	Ohm	Watt	Each	Ohm	Watt	Each
.1	150(L)	5.54	25	25(H)	1.86	500	75(G)	3.15
.25	50	1.98	25	50	1.86	500	100(K)	3.55
.5	100(K)	2.34	25	75(G)	3.15	500	150(L)	5.05
.5	150(L)	5.34	25	100	3.25	500	150	4.25
.87	150(L)	5.34	25	100(K)	3.55	500	300(N)	8.42
1	25	1.75	50	25	1.49	585	150(L)	5.05
1	50	1.98	50	25(H)	1.86	750	25	1.49
1	50(J)	2.34	50	50	1.86	750	25(H)	1.86
1.1	50	1.98	50	25	1.49	750	150	4.25
2	25	1.75	75	25	1.49	780	100(K)	3.55
2	25(H)	1.86	75	25(H)	1.86	800	25	1.49
2	50(J)	2.10	75	50	1.86	858	100	3.71
2	100(K)	3.79	75	75(G)	3.15	1000	25	1.66
2.5	150	4.45	75	300	6.30	1000	25(H)	2.10
3	100(K)	3.79	80	500(R)	12.18	1000	50(J)	2.22
5	25	1.56	100	25	1.49	1200	225(P)	6.99
5	50(J)	2.10	100	25(H)	1.86	1200	300	6.95
5	100(K)	3.79	100	50	1.86	1250	50(J)	2.22
6	25(H)	1.86	100	100(K)	3.55	1250	150(L)	5.34
6	50(J)	2.10	100	150(L)	5.05	1500	25	1.66
6	75(G)	3.15	125	25	1.49	1500	25(H)	2.10
7	25	1.49	125	25(H)	1.86	1500	50(J)	2.22
7.5	75(G)	3.15	125	500(R)	12.18	1600	50(J)	2.22
7.5	225(P.	6.99	150	50(J)	2.10	1800	50(J)	2.22
8	25	1.49	175	25	1.49	1800	150(L)	5.62
8	25(H)	1.86	175	25(H)	1.86	2000	25(H)	2.10
8	50(J)	2.10	175	500(R)	12.18	2000	60	2.10
8	50	1.86	185	25	1.49	2250	150(L)	5.62
10	25	1.49	200	25	1.49	2500	25	1.66
10	25(H)	1.86	200	25(H)	1.86	2500	50(J)	2.22
10	50	1.86	200	100(K)	3.55	2500	100(K)	3.71
10	100	3.25	200	150(L)	5.05	2500	150	5.62
12	25(H)	1.86	250	25	1.49	2500	500(R)	12.18
12	50	1.86	250	25(H)	1.86	3000	25	1.66
12	500(R)	12.18	300	50	1.86	3000	100(K)	3.79
13	100(K)	3.55	300	50(J)	2.10	3500	25	1.66
15	25	1.49	300	75(G)	3.15	5000	25	1.66
15	25(H)	1.86	350	25	1.49	5000	25(H)	2.22
15	50	1.86	350	25(H)	1.86	5000	50(J)	2.45
15	50(J)	2.10	350	150(L)	5.05	5000	100(K)	4.04
15	75(G)	3.15	375	150(L)	5.05	7500	50(J)	2.45
15	100	3.25	400	25	1.49	7500	100(K)	4.30
15	150(L)	5.05	400	75(G)	3.15	10000	25	1.98
16	50	1.86	500	25	1.49	10000	50(J)	2.50
20	25(H)	1.86	500	25(H)	1.86	10000	50	1.98
20	50(J)	2.10	500	50	1.86	15000	25	1.98
25	25	1.49	500	50	1.86	20000	150(L)	6.95

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OA4	1N78	2J61,A	4J52	GT	258A	615	880	5651	5949
OA5	1N81	2J62A	4J58	6SN7W	259A	KU627	884	5651WA	5963
OB2	1N91	2K22	4PR60A	GT	266B	631-P	885	5654	5965
OB2WA	1N92	2K23	4X-150A	6S117	274B	648-P1	889RA	5657	5977
OB3/ VR90	1N93	2K25	4X-150G	GTY	QK284	HK654	891	5659	5987
OB4	1N126	2K26	4X-250B	6X4W	290A	700B	892	5660	5993
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OD3/ VR150	1N128	2K29	7BP7, A	300B	703A	898	902P1	5663	5998
OD3W	1N158	2K30	C5B	304B, L, TH, TL	704A	902P1	5667	6002	
OZ4	1N198	2K33A	EL5B	7UP7	705A	706	920	5670	6005
REL1	1P23	2K39	5AP1	7YP2	706	920	923	5672	6012
1A2D	1P24	2K41	5BP1	GG305	SERIES	923	929	5677	6021
BG1A4B	1P30	2K42	5BP4	8B21	CE306	707A, B	930	5684	6028
BG1A4C /1B67	1P31	2K43	5C22	9LP1	307A	708A	931A	5685	6044
	1P32	2K44	5CP1	9LP7	310A	710A	CW-931A	5686	6045
	1P36	2K45	5CP2A	10E/13	311CT	713A	954	5687	6050
	1P37	2K46	5CP7	10E/222	314A	714A, AY	955	5687WA	6072
	1P39	2K47	5D21	10KP7	316A	715A, B, C	956	5691	6073
	1P40	2K48	5FP7, A	10KP17	ML-322	717A	957	5692	6074
1AD4	1P42	2K50	5FP14A	A-11	T327A	719A	958A	5693	6080
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CIB/ IC31	2AC-15	2K55	5HP4	12AT7	3378	SERIES	991	5702	6082
	2AS-15	2K56	5J23	WA	342A	721A	1003	5702WA	6087
1B22	2A21	2X2A	5J26	15E	348A	CE-722A	CK1005	5703	6088
1B23	2AP1	3AP1	5J29	FG17	350A, B	CK-722	CK1009	5703WA	6096
1B24	2BP11	3B	5J30	RX21	354C, F	723A/B	TR 1032K	5704	6097
1B24A	2B22	3B4	5J32	HK24	359A	724B	VC-1258	5718	6100
1B27	2B23	3B24	5JP1	24G	371A, B	725A	DG-1295	5719	6101
1B35	2C4	3B24W, WA	5LP7	RK20A	ML-381	726A, B, C	CK-1301	5721	6110
1B35A	2C22		5NP1	RK25	388A	728	1603	5722	6111
1B36	2C34	3B25	5R4GY	25T	393A	SERIES	1611	5725	6112
1B37A	2C35	3B26	5R4WGY	25Z6W	395A	750TL	1613	5726	6136
1B38	2C36	3B28	5RP1A	GT	397A	800	1614	5727	6140
1B40	2C37	3B29	5Y3W	26Z5W	401A	801A	1616	5732	6141
1B42	2C39, A	3C22	GTA	28D7W	403A, B	802	1619	5734	6146
1B44	2C40	3C23	5ZP16	31Z	404A	803	162	5744	6147
1B46	2C42	3C33	6AP7W	RK-34	407A	804	1622	5749	6143
1B47	2C43	3C45	6AF4A	35T, TG	408A	805	1624	5750	6186
1B50	2C44	3D6	6AG7Y	RK-39	409A	806	1625	5751	6188
1B51	2C46	3D21A	6AH4	T-40	412A	807, W	1626	5763	6189
1B52	2C50	3D22	6AH6	TZ-40	415	808	1629	5764	6199
1B53	2C51	3D24	6AJ6/ 1A2D	RX-47	416A, B	809	1630	5765	6201
1B54	2C52	3DP1, S2		RK-49	417A/5842	810	1631	5783	6205
1B57	2C53	3E29	6AK5W	V-50	418A	811, A	1632	5783WA	6216
1B58	2D21	3EP1	6AL5W	52HAP7	419A	812, A	1633	5784	6246
1B59	2D21W	3FP7A	6AM5,WA	RK-65	420A	813	1634	5787	6247
1B60	2E22	3GP1A	6AN6	HY-65	421A	814	1635	5792	6249
1B63A	2E24	3J31	6AQ5W	HY-69	422A	815	1641	5793	6280
1B98	2E25A	3K21	6AR6	RK-72	423A	816	1642	5794	6293
1B100	2E26	3K23	6AS6W	RK-73	427A	825	1644	5797	6336
1C	2E30	3L54	6AS7G	RK-75	428A	826	1654	5798	8002
1C21	2E31	GA-4	6BA6W	75T, TL	429A	828	1754	5800	8005
1D	2E32	5N-4	6BA7	BR-90	431A	829B	1850A	5803	8008
C1K	2E35	4-65A	6BE6W	RV-92	438A	830B	1907	5812	8011
1N21, ABC	2E36	4-125A	6BF5	C-100A	446A, B	832A	1961	5814	8012, A
	2G21	4-250A	6BF7, W	HF100	ZP-449	833A	2050	5814A	8013, A
1N22	2H21	4-400A	6BL6	100TH, TL	450TH, TL	834	2051	5819	8014A
1N23, A, B,C,CR	2J21	4-1,000A	6BM6			836	4210	5820	8016
	2J22	4B22	6C	101D	451A	837	4330	5823	8020
1N25	2J23	4B23	6C4W	FG105	454H	838	4340	5825	8025A
1N26	2J24	4B24	6C21	WE121A	464A	841	4350	5829	9001
1N28	2J25	4B25	6D4	VT127, A	471A	843	5269	5840	9002
1N31	2J26	4B26	6F4	151N	502A	845	5516	5841	9003
1N32	2J27	4B27	6H6WGT	FG154	506AX	845W	5517	5842	9004
1N34,A	2J29	4B28	6J6	QK155	507AX	850	5527	5844	9005
1N35	2J30	4B31	C6J	183	508	851	5528	5845	9006
1N38A	2J31	4B32	6J4	QK202	510	852	5586	5847	AX9903
1N39	2J32	4B36	6J4WA	203A	511X	854	5588	5851	38111A
1N41	2J33	4C22	6J5WG1	204A	512AX	857B	5590	5853	D96475
1N42	2J34	4C27	6J6WA	207	526AX	858	5591	5876	D164696
1N43	2J36	4C28	6L6WGA, GB	211, D	527	860	5610	5879	D178461
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1N47	2J41	4C36	C6M	217C	522AX	864	5636	5886	8651860-G1
1N53	2J42	4D21	6SA7W GT	218	N-531	865	5637	5894	
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1N58	2J50	4J31	6SC7GTY	235A	535AX	869B	5641	5902	
1N60	2J51	4J33	6SG7Y	249A, B, C	551AXA	872A	5642	5915	
1N69	2J53	4J34	6SJ7Y	250TH, TL	559	874	5643	5931	
1N70	2J54	4J42			571AX	875	5644	5932	
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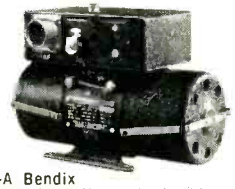

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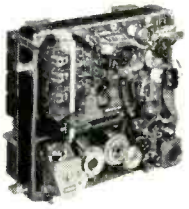

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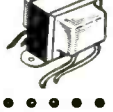

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OB2	.99	2J38	8.95	3J21	75.00	LM16	200.00	388A	1.80	802	3.95	1500T	135.00
OB3	1.10	2J39	8.59	4B26	5.40	15E	1.75	392A	7.50	803	5.95	HK1654	75.00
OC3	.96	2J40	29.00	4C27	10.00	15R	.75	394A	3.95	805	4.95	1603	5.00
OD3	.89	2J42	135.00	4C28	35.00	NE16	.59	MX408U	.50	807	1.25	1612	1.50
C1B	2.95	2J49	60.00	4E27	16.00	20A	.75	417A	15.00	808	1.95	1613	1.25
1B23	1.50	2J50	55.00	4J25	50.00	KY21A	8.25	434A	15.00	809	2.95	1616	1.25
1B24	6.95	2J55	150.00	4J26	50.00	RK21	2.50	446A	1.95	810	10.50	1619	.45
1B26	9.00	2J56	110.00	4J27	50.00	RX21	8.00	446B	3.95	811A	3.75	1622	1.50
1B29	1.75	2J61	20.00	4J28	50.00	KH24G	1.50	450TL	45.00	812A	3.95	1624	1.75
1B37	15.00	2J61A	25.00	4J29	50.00	25T	2.95	450TH	52.50	813	13.75	1625	.35
1B38	35.00	2J62	15.00	4J30	30.00	RK39	2.75	464A	7.50	814	3.75	1626	.25
1B50	23.00	2K22	29.00	4J31	150.00	HF50	1.75	471A	1.25	815	3.25	1851	1.80
1B51	7.50	2K23	15.00	4J32	150.00	HK54	4.50	527	18.00	816	1.45	2000T	150.00
1B58	35.00	2K25	11.50	4J33	150.00	RK72	1.00	WL530	23.00	829	11.00	2050	1.80
1B60	35.00	2K26	68.00	4J34	150.00	RK73	1.00	WL531	22.50	829A	12.00	2051	1.00
1N24	.55	2K28	35.00	4J35	150.00	FG95	19.95	WL533	15.00	829B	17.50		
1N21A	.95	2K29	35.00	4J36	150.00	100TH	7.95	HK654	35.00	830B	2.00		
1N21B	1.50	2K38A	75.00	4J37	150.00	FG105	20.00	700A/D	10.00	832A	9.95		
1N21C	12.50	2K39	140.00	4J38	150.00	122A	1.75	701A	4.50	833A	45.00		
1N22	.66	2K41	135.00	4J39	150.00	203A	7.50	703A	3.95	834	7.50		
1N23	.90	2K42	180.00	4J40	150.00	211	.95	704A	1.95	836	3.95		
1N23A	.90	2K43	199.00	4J41	150.00	217C	12.00	705A	2.75	837	2.75		
1N23B	.90	2K44	195.00	4J42	190.00	242C	10.90	706AY/ FY	25.00	838	5.95		
1N23C	7.50	2K45	80.00	4J51	190.00	244C	9.50	707A	5.75	849	35.00		
1N25	4.50	2K48	95.00	4J52	225.00	249C	4.25	707B	6.75	857B	125.00		
1N26	6.75	2K50	295.00	4J53	225.00	250TH	19.95	714AY	36.00	860	3.50		
1N27	3.50	2K54	35.00	5HP1	3.95	250TL	19.95	715A	4.50	861	25.00		
1N34A	.79	2K55	25.00	5HP2A	12.00	252A	3.00	715B	9.00	866A	1.50		
1N38	1.00	2K56	72.00	5HP4	3.95	275B	1.00	715C	15.00	869B	67.50		
1N43	2.25	3AP1A	10.00	6CP1	7.50	304TH	10.00	717A	1.50	869BX	58.00		
1P23	75.00	3HP1	7.20	6CP7	9.95	304TL	10.00	719A	15.00	872A	3.50		
2C39A	13.50	3HP4	5.50	5CP7A	18.00	307A	3.50	720AY/ GY	50.00	874	2.25		
2C40	12.00	3H25	5.50	6CP12	15.00	310A	4.50	721A	1.50	878	1.50		
2C43	14.50	3H26	5.00	5D21	10.00	310B	4.95	721B	7.50	879	.50		
2C44	.60	3H28	8.00	5JP1	27.50	311A	6.50	723A/B	18.00	884	1.50		
2C46	7.50	EL3C	5.50	5JP2	19.50	312A	3.50	724A	1.95	885	1.50		
2D29	.99	3C22	75.00	5JP4	27.50	328A	15.00	724B	2.25	931A	5.00		
2IA	12.00	3C24	1.75	5J23	25.00	327A	3.75	725A	18.00	954	.35		
2J22	9.00	3C31	2.95	5LP1A	25.00	326A	6.75	726B	45.00	955	.50		
2J26	15.00	3DP1	7.50	5SP7	96.00	350A	4.50	726C	45.00	956	.75		
2J27	15.00	3DP1A	10.00	C6J	11.00	350B	5.95	730A	22.50	957	.25		
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VARIOUS 5000 AND 6080 SERIES OF NEW PRODUCTION

5B20	475.00
5B26	450.00
8012	2.00
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8013	3.00
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8020	1.80
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9003	1.25
9004	.35
9005	2.75
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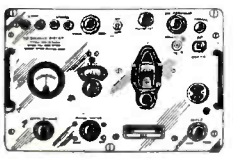
THOUSANDS OF OTHER TUBES

Special! TS45 X BAND GENERATOR—$99.00



NEW TS-147 B AND C/UP TEST SET SIGNAL GENERATOR

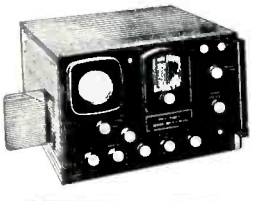
Hard-to-get X-Band Now Available

Test Set TS 147 UP is a portable Microwave Signal Generator designed for testing and adjusting beacon equipment and radar systems which operate within the frequency range of 8500 MC to 9600 MC.

NEW UNUSED SURPLUS TS 259 K BAND

23400-24500 MEGACYCLES SIGNAL GENERATOR

NEW 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.

SPECIAL! 5,000 V. POWER SUPPLY

For IP25 Infrared Image Converter from 3 V. Battery Source. NEW, Complete with RCA 1654 Tube..... **$990**

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TSKI/SE	T35/AP	TS108	TS226	*Surplus Equip.*
TS3A/AP	TS36/AP	TS110/AP	TS239A-TS239C	APA10
RF4/AP	1-96A	TS125/AP	TS251	APA38
TS12/AP	TS-45	TS126/AP	TS258	APS 3 APS 4
TS13/AP	TS47/APR	TS147	TS270	APR4
TS14/AP	TS69/AP	TS174/AP	TF890/1	APRSA
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Inbuilt network 2 wires needed for HF & LF Response. **Famous HI-FI mfg. 15" Coaxial** PM & 5" Tweeter. 25W/20–17500 cy Model **P25CO. $19.50**
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ALL 115V 60 CYC INPUT
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MICA CONDENSERS

MFD	WVDC	Price
.03	600	59c: 100/$50
.001	1200	49c: 100/$32
.001	1200	20c: 100/$15
.002	1200	25c: 100/$21
.015	2500	$1: 100/$80
.002	2500	75c: 110/$69

Fairchild Type 736 Five Gang Precision Potentiometer, 3 units 10,000 Ohm, one 25,000 Ohm one with 2 taps accy. ±0.5% 3.5 Watts, SERVO mtg. Reg $100.00—**"TAB" Special $12 ea; 3/$30**

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Heinmann Magn. Bkrs. Amps: 3, 5, 7, 9, 10, 12, 30, 40, 50, @ $1.98 ea; 12/$20; 50/$75
Sq. D & CH Toggle Sw. Bkrs. Amps: 5, 10, 15, 20, 25.....ea. .98
Klixon Therma Push Button Bkrs. Amps: 5, 10, 15, 30, 35 @ .85.....50/$34
10/$7.98
Asst'd One Each Twelve Types @ $9

$1.25 ea. *Lots of 24*
Lots of 12 @ $1.50 Ea. Sold Singly @ $1.79 Ea.
4 MFD 1200VDC or 10 MFD 600VDC *Any Assort'mt*

NEW!! HI SENSITIVITY

6KV DC & AC
27 Range
MULTITESTER
(Not a Kit)

"TAB" 60 $21.95 ea.
IN LOTS OF 3

A complete precision test instrument, **20,000 Ohms per Volt DC, 10,000 Ohms p/v AC.** 38 microampere movement. 8 easy to read scales—DC 0–6, 30, 120, 600, 1200, 6000 Volts. AC 0–6, 30, 120, 600, 1200, Volts. Current 0–60 ua, 6, 60, 600 ma. Resistance 0-8K, 80K, 800K, 8 megohms. Decibles Cal 1000 ohm —20 to +6, 20, 34, 46, 60 DBs. Capacity 250 uufd to 10mfd. Inductance 10 to 1000 millhys. Hi accuracy, versatile, 1% Precision Resistors, Scale 3", Plastic engraved panel, Rugged metal case. Lgth 4¾" x 6¾" x 2¾". Complete w/batteries & leads. RF Diode Probe included for signal measurement. Shpg. wt. 4lbs.
"TAB" SPECIAL.....@ $22.95 ea
HV PROBE, 30,000 Volts.....@ $5.95 ea

NEW MINIATURE PM MOTOR

MINIATURE DIEHL PM MOTOR Type FD6-21, RPM 10,000/27.5VDC Excellent mtr for Fan cooling. **"TAB" Special** @ $2.95; 12 for $30.00
HAMS, INDUSTRIALS-COOL THAT TUBE! Diehl Miniature mtr & Fan.....**$3.95; 12/$42**

SPECIAL "TAB" BUYS

Giannini Density Unit mfg. for Sperry part #672340, consists twin Altimeter Bellows actuating Precision Potentiometers. Temp Comp cost over $200—**"TAB" Special $20 ea:**.....2 for $30
Same except Sperry part #709632 only one bellows actuated resistor—**Special $12 ea:**.....2 for $20
Bourns Miniature Precision "Trimpot" 2000 Ohms—**Special @ $3:**.....4 for $10

NEW MINIATURE METER

O-1 Milliamp

Precision Jeweled D'Arsonval Mvt. Better than 2% accy. Readable long 1¾" scale, 20 divisions. Rugged, Well damped. Bakelite cased. Front Sq. or Rear Round Face mtg. Mounts 1½; hole. 4 screws 1¼" ctrs. Not surplus.

Data Sheet for shunt current ranges
"TAB" SPECIAL.....$3.85; 2 for.....$7.00

PLANETARY DRIVE

5:1 & 1 to 1 RATIO
Reg. $5.95 **"TAB" @ $2**
SPECIAL.....**3 for $5**

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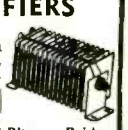
HEAVY GAUGE STEEL

50 Draw 34½H, 18W, 9"L Draw 3W 2½ H, 8"L, 65 lbs.....Spec. **$25**
100 Draw As Above 135 lbs.....**$59**
27 Draw 37H, 30¾W, 14"L Draw 3H, 9W, 12"L 120 lbs.....**"TAB" $34**

NEW "TABTRON" SELENIUM RECTIFIERS

ENGINEERED for INDUSTRY



"TAB" manufactures power rectifiers to your specifications. From one amp up to and above 1000 amps, convection or fan cooled, single or 3 phase. "NEMA" & JAN. Specs. Write for catalog.

FULL WAVE BRIDGE • DATED & ONE YEAR GTD

Max Amp	18VAC* 14VDC	36VAC* 28VDC	54VAC* 42VDC	72VAC* 56VDC	130VAC* 100VDC	266VAC* 217VDC	Ctr Tap AC*/DC 30/12	3 Phase 120VAC	Bridge 240VAC 150VDC	300VDC
1	$1.30	$2.30	$3.70	$4.45	$7.40	$22.25	$2.10	$14.90	$28.95	
2	1.95	2.70	5.30	5.85	9.10	28.85	2.35	15.90	30.90	
3	2.90	4.10	5.75	7.80	12.70	36.85	2.65	17.40	33.50	
4	3.45	6.40	11.10	14.30	21.70	38.85	2.95	18.90	36.95	
6	3.95	7.70	12.35	17.25	29.65	54.85	3.25	20.90	39.95	
10	5.85	11.35	19.20	24.65	41.10	84.85	4.75	36.90	71.95	
12	7.20	14.25	21.75	28.75	43.75	99.85	5.95	41.90	81.95	
20	12.95	24.85	36.85	47.25	77.00	160.85	7.95	50.90	97.95	
24	14.05	28.55	43.25	56.00	78.25	190.85	9.95	89.90	159.95	
30	17.75	33.50	55.50	69.00	106.50	235.85	Q	117.90	225.95	
36	22.10	41.50	64.75	84.25	131.00	295.85	14.95	134.90	269.95	
50	29.40	54.00	97.35	106.35	171.00	405.35	23.95	179.90	359.95	

RECTIFIER & XFMR COMBO, Up to 28VDC at 24 Amps Cont. Duty..$60

WRITE FOR OUR NEW RECTIFIER & POWER SUPPLY CATALOG PR655

"TABTRAN" Rectifier Xfmrs

Sec'd Volts (DUAL†) 18-15-9-0:0-9-15-18V

5 Amp†	$8.65; 2 for $15.75
12 Amp†	$15.50; 2 for $32
24 Amp†	$35.50; 2 for $70
*50 Amp	$58.50; 2 for $115
*100 Amp	$107; 2 for $210

18 Volt 2 Amp.....$1.98; 2 for $3.50
† Wndgs In Series at Ratings shown; Parallel 2xAmps; Voltage one half max.
* Dual Pri 115 & 220V 60cy; Tapped 36VCT

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6 or 12V DC Power Supply Full Wave Rectification 6000MFD Condenser Filter Ready to Operate Input 115V 60cy Output 6.3 or 12.6V.
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TPA075/75W.†	3.65
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TPA250/250W.†	6.75
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Model TPA1000 Watts/1 KW†	16.95
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Cased/0-135V/15A*	41.98
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Uncased/0-27V/7.5A†	54.67
Cased 0-270V/9A†	86.50
Cased 0-270V/12A†	103.00
Cased 0-270V/15A†	132.00
Cased/0-270V/30A	163.00
GR50A/0-135V/45A/LN	100.00
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(LN, Like New (*) New (†) 3 Phase New Industrials 6 or more 10% disc.

New! Quality VOLTAGE REGULATOR

$ $ Popularly Priced $ $
ONLY $16.98
Line Voltage Stabilizer

Stabilizes line voltage within plus or minus 3% regardless of **VOLTAGE & FREQ.** shifts. Ideal for **INDUSTRIAL LAB** or **TV & RADIO** use. Insures full size, strength, & sync of TV picture regardless of line voltage. Automatically operated regulator turns on & off with set or Equipment. **TROUBLE FREE, QUIET,** needs no adjustment. Universal Use—from 100 to 300 Watts. Input 100–125V/ Output 115V plus or minus 3% 50/60 cycles—. **Sold on "TAB" Money Back GUARANTEE. ORDER SIX ADDITIONAL 10% DISCOUNT**

New Variable 0 to 6 & 12 Volt/12 Amp

DC POWER SUPPLY
Battery Eliminator Charger Model RR Plater Aircraft Marine or any DC Req. Extra Hvy Duty Selenium Rectifier, 2 Meters V. & A. Ckt. Design for Cont. Service and up to 20 Amp intermittent overload. **New Model T612V12AC**
SPECIAL.....$29.95

High Current Power Supplies

ONE YEAR GTD

Variable 0–28VDC. Completely Built, Ready to Go. Full Wave Selenium Rectifier, Transformer, Variac, Volt & Amp Meters, Switch, Terminals & Fuse. Hvy Duty Steel Cabinet Std 115V/60 cy Input or 220V† (3 phase) to order.

Stock Number	Continuous Rating	With Meters
T28V5A	0–28 WVDC at 5 Amp	$50
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T28V5A2CC	5 Amp 0.01% Ripple	$145
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T28V12ACC	12 Amp (1% Ripple)	$160
T28V12A2CC	12 Amp 0.01% Ripple	$220
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T28V24ACC†	24 Amp (1% Ripple)	$225
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T28V50A†	0–28 VDC at 50 Amp	$285
T28V50ACC†	50 Amp (1% Ripple)	$410
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Variable 75 to 135 VDC Completely Built, Ready to go. Includes F. W. Selenium Bridge Rectifier 4" Rectangular Volt & Ammeter Over-Load output Dsgnd for cont. service. **Specify** for 115 or 230 VAC 1 phase, 60 cy Input		
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CE156M 6000MFD 15V.....$1.25; 2 for $2
CE603M 3000MFD 60V.....$3.98; 2 for $7

INFRARED SNOOPERSCOPE

SEE IN DARK TUBE

Image-Converter Tube Hi-Sensitivity simplified design 2" dia. Willemite screen—Resolution up to 350 lin/in. Tube & Data **"TAB" Special $6.98; 2 for $11**
Snooperscope Pwr Supply
1800VDC/35MA. Using Doubler Ckt, Transformer Rectifiers, Sockets, Resistors, Capacitors and Diagram 115V/60cy Oper.....**$6.98**

POCKET AC-DC Multitester

"TAB" 27C $9.45 ea
Lots of 3

Hi-accuracy precision VOM. 1000 Ohms per V. Reads AC & DC Volts 0, 5, 25, 250, 1000V. DCMA: 0, 1, 10, 100MA. Ohms 0, 10, 100K. Size 1¼D, 4½L 3¼W. Test Leads. **Sold Singly $9.95; (plus 40c ship in U. S. A.)**
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OA3	.98	4J47	485.00	703A	1.48	5670	2.24	5959	37.25
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OD3/V150	.78	5D21	9.48	715B	11.90	5687	3.59	6080	5.99
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1AG4	1.35	6AN5	1.60	721A	.98	5693	5.49	6101	1.55
1AX2	1.25	6AS6	1.60	723AB	9.98	CK5694	3.70	6110	6.55
1B3	.66	6AS7G	2.98	724A	2.94	CK5697	3.70	CK6111	8.95
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1B46	1.88	6SN7	.56	725A	4.49	5704	2.25	6121	9.00
1B63A	42.50	6V6GT	.56	807	1.19	5713	173.50	GL6136	1.89
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1Q23	150.00	7C25	125.00	814	2.48	5719	5.99	6164	64.95
1X2A	.62	8D21	99.00	815	3.98	5721	189.55	6199	49.99
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2D21	.75	FG17	3.01	864	.34	5732	3.94	6271	159.95
2E22	1.89	19BG6	1.38	927	1.36	5736	159.95	6273	199.95
2E24	2.48	24G	1.96	954	.15	5744	2.39	8005	4.97
2E26	3.78	HK24	4.90	955	.65	5749	1.72	8012	1.09
2E32	2.07	35Z5	.46	956	.32	5750	3.10	8013	4.91
2E43	1.49	75A	4.49	957	.51	5751	3.09	8014A	50.15
2J30	50.50	50L6	.60	CK1005	.56	5764	55.99	8020	2.95
2J42	99.50	71A	.74	1612	1.98	5765	55.99	8025A	2.95
2K25	23.88	HY69	5.49	1613	1.27	5769	298.00	9001	.88
2K28	29.50	HK155	699.95	1616	.79	CK5783	5.55	9002	.96
2K29	Q	QK202	99.99	1619	.34	CK5787	4.95	9003	.98
2K30	130.00	203A	7.38	1620	5.01	5794	5.99	9006	.15
2K33	219.48	215	10.35	1625	.44	5812	2.99	C'Ray Tubes	
2K39	Q	233A	2.92	1626	.16	5814	1.28		
2K41	175.00	250R	10.95	1629	.22	5819	49.99	3BP1A	5.55
2K42	149.55	HK254	18.00	1632	.63	5820	69.00	3CP1S1	5.98
2K43	130.00	250TH	35.00	1633	.98	5823	1.29	3DP1	4.81
2K44	Q	304TH	15.00	1642	.62	5825	11.99	3DP1A	6.80
2K48	110.00	304TL	15.00	1644	.99	5828	6.70	3EP1	4.71
2K50	315.00	316A	.48	1850A	99.00	5840	5.05	3FP7	1.91
2P23	298.00	388A	1.99	2050	.98	5841	7.98	3FP7A	6.91
3B24W	8.48	394A	1.96	2050W	2.48	5842	11.00	3GP1	1.91
3C22	72.50	434A	3.94	2051	.68	5814	1.00	5BP1	1.95
3C24	3.98	446B	2.98	5514	4.69	5852	7.57	5CP1A	14.49
3D21A	7.99	450TH	75.49	5516	5.51	5857	59.50	5CP5	3.55
3K23	325.00	520AX	2.05	5517	2.22	5863	49.94	5HP1	3.91
3X2500A		512AX	1.35	5586	150.25	CK5875	2.05	5JP1	14.95
	125.00	531DX	1.89	5588	119.99	5876	12.49	5JP2	7.94
4-65A	19.49	536AX	1.55	5634	7.50	5879	1.50	5LP1	5.91
4-125A	19.09	538DX	.98	5640	11.57	5881	2.70	5SP7	100.00
4B23	16.98	539DX	2.50	5641	6.59	5893	7.55	7BP7	6.50
4B27	4.98	544DX	2.50	5642	.99	5910	.74	AND OTHERS WRITE	
4C35	16.95	571AX	4.45	5654	1.72	5927	89.45		
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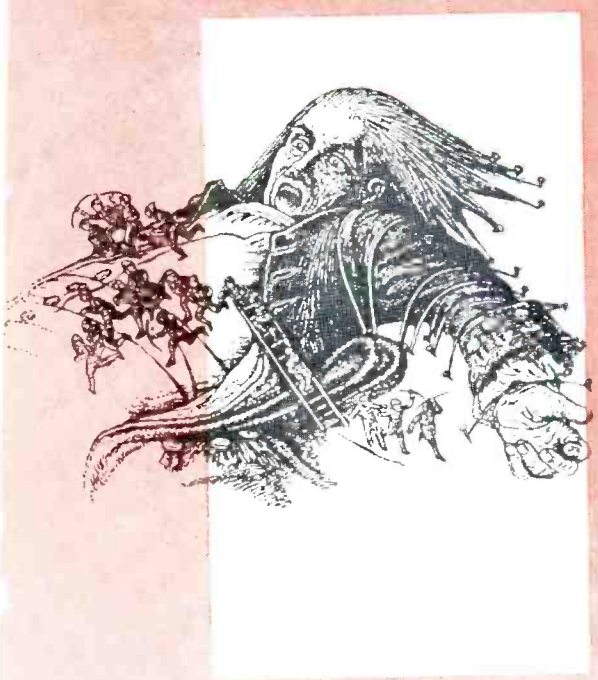

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Type	Dia.	Length	Max. Res.	Wattage Rating	Terminals
1273	1/4	5/16	400K	.1	One End #22 Gauge
1283	1/4	5/16	400K	.1	Axial #22 Gauge
1274	3/16	3/8	100K	.1	Axial #22 Gauge
1284	1/4	27/64	.5 Meg.	.25	One end #20 Gauge
1192	1/4	1	1.0 Meg.	.75	Axial #22 Gauge

- Fully encapsulated.
- Meet and exceed all humidity, salt water immersion and cycling tests as specified in MIL-R-93A, Amendment 3.
- Operate at 125°C continuous power without de-rating.
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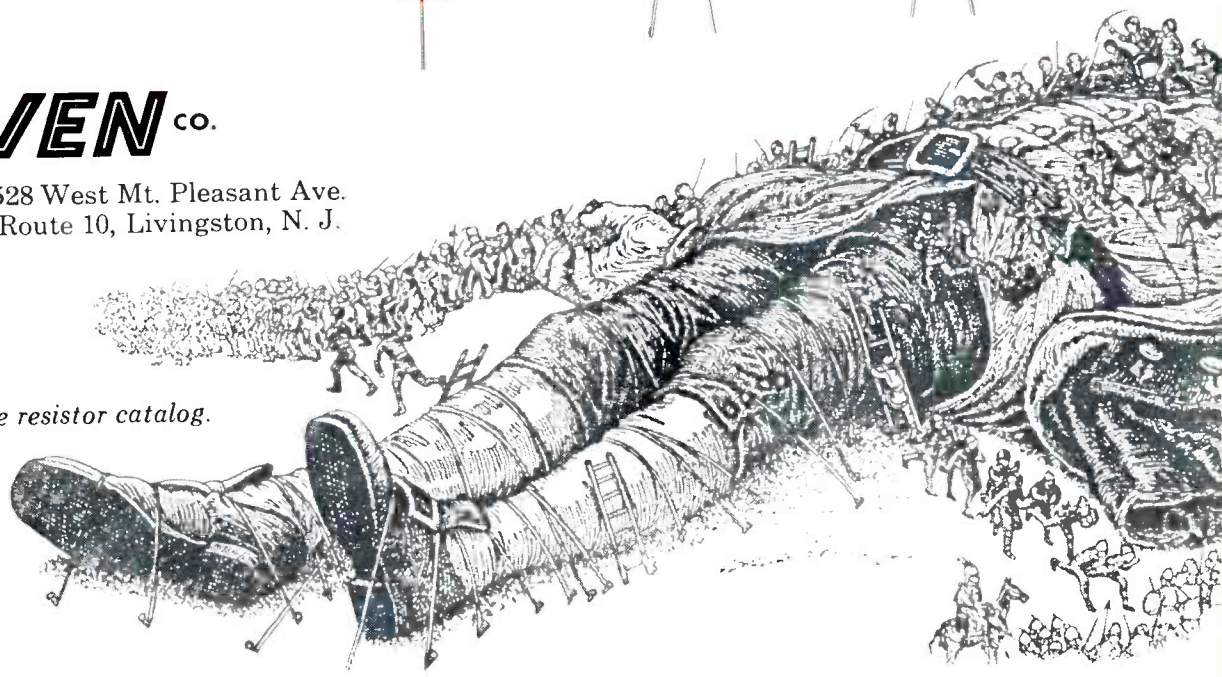

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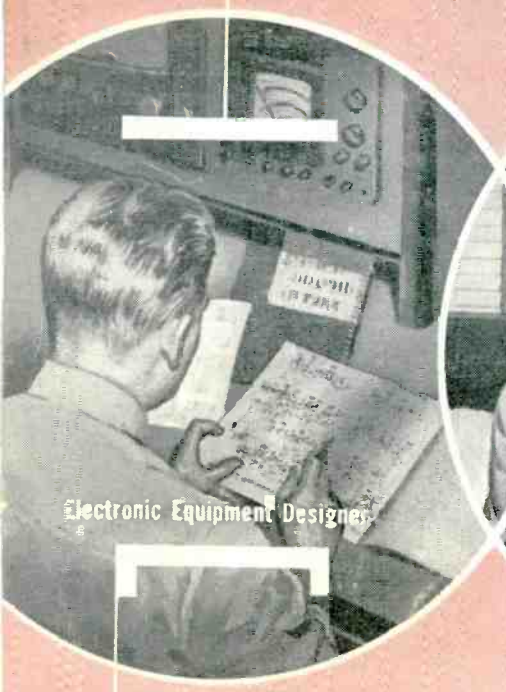
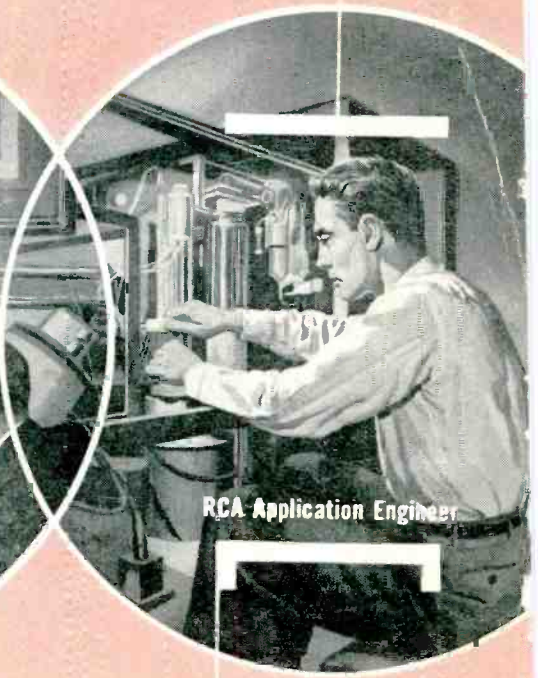
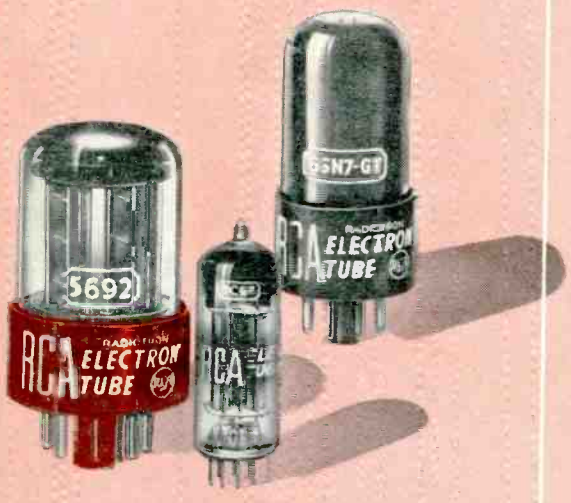




COMMON GROUND-WORK



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