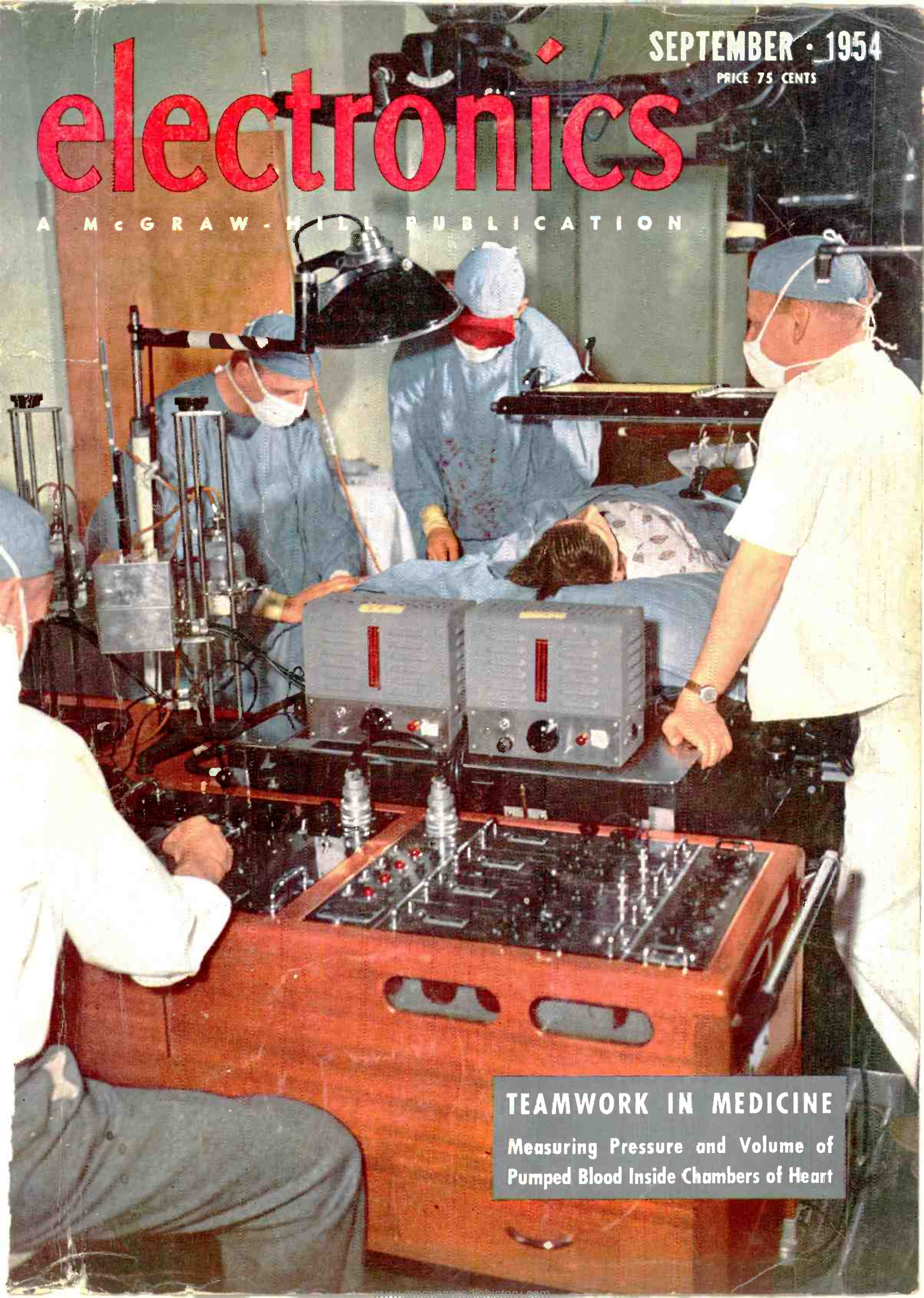
SEPTEMBER · 1954
PRICE 75 CENTS

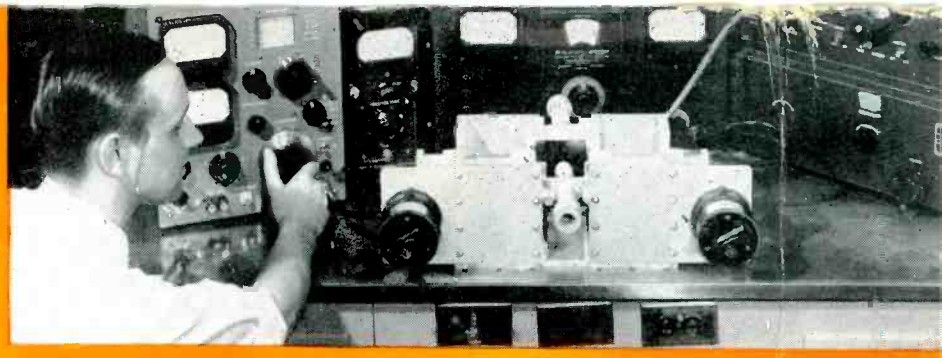
electronics

A McGRAW-HILL PUBLICATION



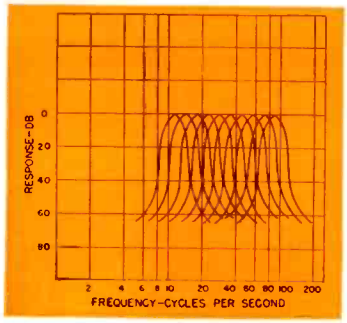
TEAMWORK IN MEDICINE

Measuring Pressure and Volume of Pumped Blood Inside Chambers of Heart

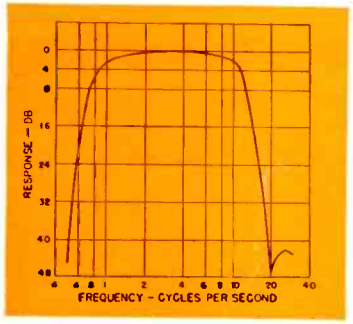


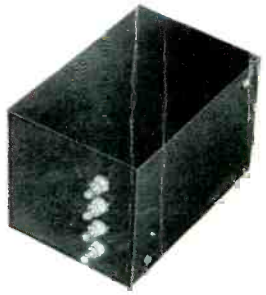
for SPECIALIZED FILTERS

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

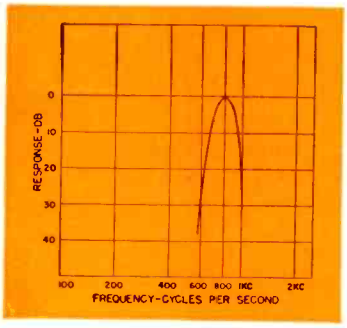


These low frequency band pass filters are held to 1 DB tolerance at the 3 DB crossover . . . 600 ohm . . . 4 filters per 7½" rack panel.

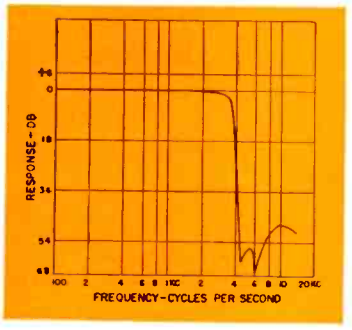




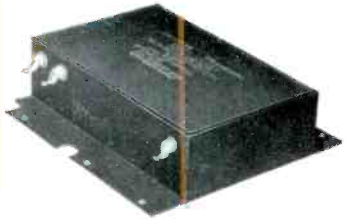
This ultra low frequency filter has a band pass range of one cycle to 10 cycles . . . 50,000 ohms . . . 700 cubic inches.

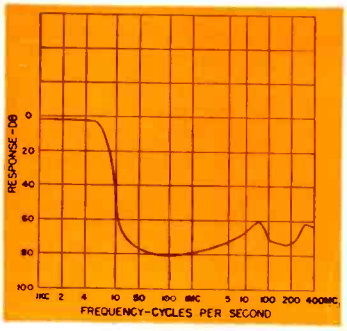


This 600 ohm miniaturized 1 KC band pass filter is housed in a case only 1" x 1¾" x 2½".

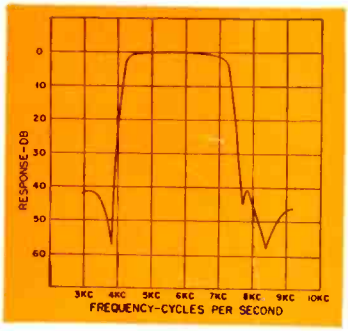


This 600 ohm miniaturized low pass filter is housed in a case only 1" x 1¾" x 2½".





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



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

United Transformer Co.
150 VARICK STREET NEW YORK 13, N. Y.
EXPORT DIVISION: 13 EAST 40th STREET, NEW YORK 16, N. Y. CABLES: "FRE..."

electronics

SEPTEMBER • 1954
A McGRAW-HILL PUBLICATION

TEAMWORK IN MEDICINE—Making cardiac catheterization test on patient with heart disease at Massachusetts General Hospital, Boston. Radiologist, surgeon, heart specialist and chemistry technician collaborate in using special x-ray equipment and electronic devices for obtaining pressure and flow rate recordings. Photo by Donald Withee. Details on p 184 ..... *COVER*

Tubeless Magnetic Amplifier DC Supplies

Latest additions to the SORENSEN *line!*

Sorensen Tubeless Magnetic Amplifier DC Supplies are designed for applications where utmost reliability is required. The four instruments described below cover a wide range of requirements; additional instruments are under development and will shortly be added to the line.

MODEL MA640 (illustrated above)

Input	105-125 VAC, 1Ø, 60∿
Output	4.5 - 7.7 VDC, adjustable
Load Range	0-40 amperes
Ripple	1% maximum
Regulation Accuracy	±1.0% for any combination of line and load conditions
Recovery Time	0.2 seconds under worst conditions
Size	17″ wide, 12¼″ high, 15″ deep. Can be furnished for relay rack mounting. Meters, as illustrated, optional at extra cost.

MODEL MA65

Input	105-125 VAC, 1Ø, 60∿
Output	6 VDC, adjustable ±10%
Load Range	0-5 amperes
Ripple	1% maximum
Regulation Accuracy	±1.0% for any combination of line and load conditions
Recovery Time	0.15 seconds under worst conditions
Size	For relay rack mounting — 19″ wide, 5¼″ high, 12″ deep. A cabinet is available for bench operation. This is an unmetered unit.

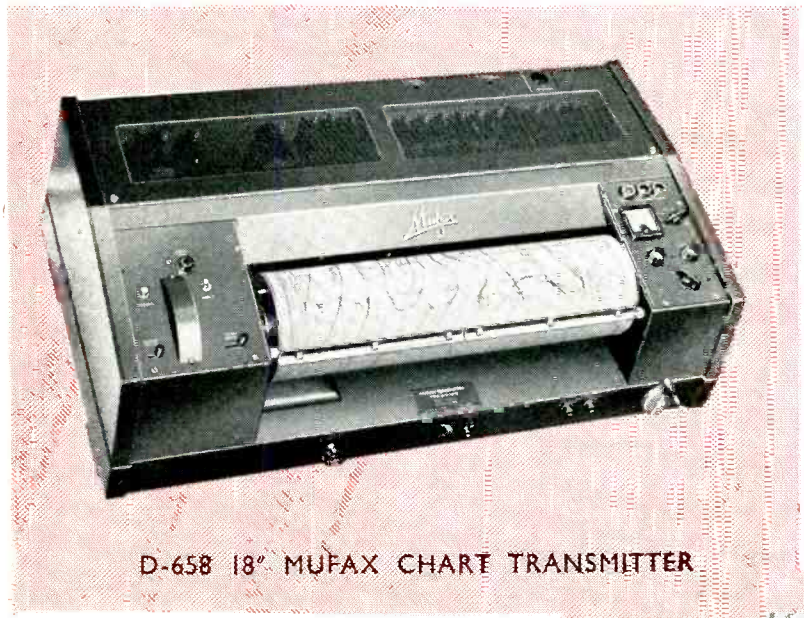
MODEL MA6/15

Input	190-230 on a 208 line, 1Ø, 60∿ 210-250 on a 230 line, 1Ø, 60∿
Output & Load Range	4.5 - 7.7 VDC at 0-100 amperes 8.5 - 15.4 VDC at 0-75 amperes
Ripple	1% maximum
Regulation Accuracy	±1.0% for any combination of line and load conditions
Recovery	0.2 seconds under worst conditions

MODEL MA2850

Input	190-230, 3Ø, 4-wire wye, 60∿
Output	23 - 32 VDC, adjustable
Load Range	0-50 amperes
Ripple	3% maximum
Regulation Accuracy	±1.0% for any combination of line and load conditions
Recovery Time	0.5 sec[illegible]ions

MUIRHEAD–*FIRST IN FACSIMILE*



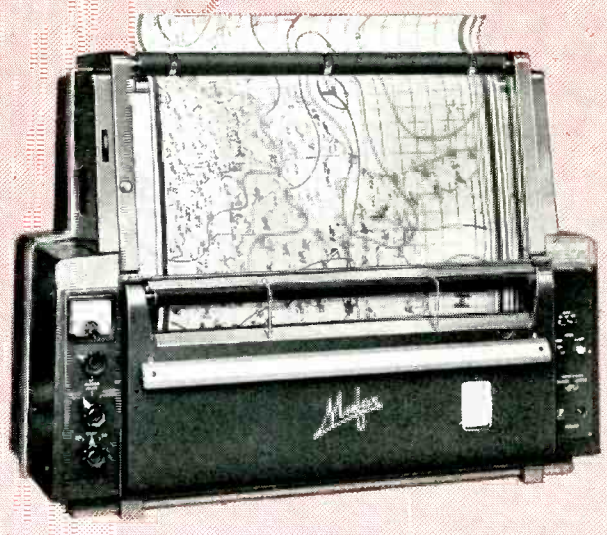
D-658 18″ MUFAX CHART TRANSMITTER

THE TRANSMITTER

A chart measuring 18″ x 22″ can be accommodated on the transmitter drum. Provision is made for automatic operation over a broadcast network including American recorders as well as Mufax machines. An additional high speed facility is provided for use with Mufax recorders only.

THE RECORDER

The operation of the recorder is entirely automatic, and recording is on Mufax electrosensitive paper supplied in rolls sufficient for over thirty hours continuous operation. The recorded chart is immediately visible, requires no processing, and can be examined while being received.



D-649-G 18″ MUFAX CHART RECORDER

MUFAX chart transmitters and recorders together provide the first completely automatic system for the transmission of facsimile weather maps. The new Canadian Weatherfax System uses this equipment exclusively.

WRITE UNDER YOUR BUSINESS LETTERHEAD
FOR PUBLICATIONS 8691 & 8696

MUIRHEAD

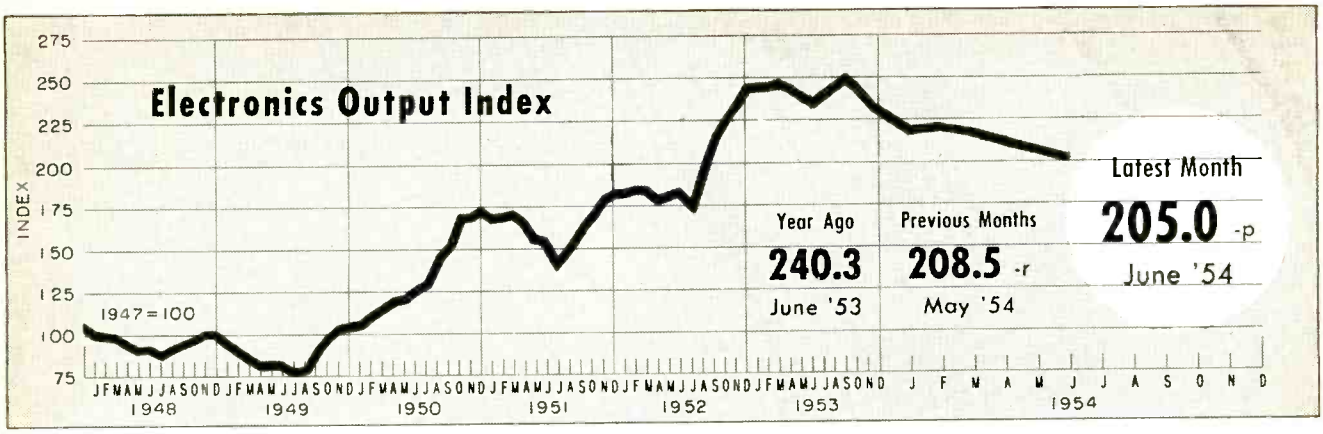
PRECISION ELECTRICAL INSTRUMENTS

TECHNICALITIES

Maximum chart size	18″ x 22″
Index of Co-operation	576
Helix and drum speed	1 or 2 r.p.s.
Scanning rate	96 lines/inch
Line signal	AM: 1500c/s carrier
Power supply	95-125V, 60c/s

93

MUIRHEAD & CO. LIMITED · BECKENHAM · KENT · ENGLAND



FIGURES OF THE MONTH

RECEIVER PRODUCTION

(Source: RETMA)	Year Ago June '53	Previous Month May '54	Latest Month June '54
Television sets, total	524,479	396,287	544,142
With UHF	.....	86,790	99,404
Color Sets	.....	2,982	347
Radio sets, total	1,163,831	722,104	837,655
With F-M	49,875	9,819	15,854
Home sets	287,724	173,480	226,350
Clock Radios	131,144	57,370	132,668
Portable sets	239,189	174,735	141,904
Auto sets	505,774	316,519	336,733

RECEIVER SALES

(Source: RETMA)	Year Ago June '53	Previous Month May '54	Latest Month June '54
Television sets, units	431,089	308,728	351,885
Radio sets (except auto)	449,116	386,152	537,494

RECEIVING TUBE SALES

(Source: RETMA)	Year Ago June '53	Previous Month May '54	Latest Month June '54
Receiv. tubes, total units	42,505,685	28,650,825	31,031,315
Receiv. tubes, value	$29,634,656	$20,465,451	$21,694,500
Pic. tubes, total units	746,822	584,782	681,937
Picture tubes, value	$17,480,475	$12,062,269	$13,933,845

SEMICONDUCTOR SALES

(Source: RETMA)	Year Ago May '53	Previous Month Apr. '54	Latest Month May '54
Germanium Diodes / Silicon Diodes	1,466,362	994,949-r	1,001,905

INDUSTRIAL TUBE SALES

Quarterly Figures

(Source: NEMA)	Year Ago 1st '53	Previous Quarter 4th '53	Latest Quarter 1st '54
Vacuum (non-receiving)	$10,400,000	$9,467,331	$8,971,335
Gas or vapor	$3,300,000	$4,854,222	$4,589,239
Phototubes	$700,000	$405,000	$405,000*
Magnetrons and velocity modulation tubes	$10,500,000	$13,073,095	$16,135,274
Gaps and T/R boxes	$1,700,000	$1,707,730	$1,517,426

*4th quarter 1953

TV AUDIENCE

(Source: NBC Research Dept.)	Year Ago July '53	Previous Month June '54	Latest Month July '54
TV Homes, total	24,519,000	30,411,000	30,717,000

BROADCAST STATIONS

(Source: FCC)	July '53	June '54	July '54
TV Stations on Air	224	402	409
TV Stns CPs—not on air	284	171	169
TV Stns—Applications	524	14	16
A-M Stations on Air	2,466	2,583	2,592
A-M Stns CPs—not on Air	122	114	121
A-M Stns—Applications	251	158	167
F-M Stations on Air	578	553	559
F-M Stns CPs—not on Air	21	16	12
F-M Stns—Applications	8	5	5

COMMUNICATION AUTHORIZATIONS

(Source: FCC)	June '53	May '54	June '54
Aeronautical	39,315	41,374	40,154
Marine	40,357	45,762	46,299
Police, fire, etc.	13,631	15,438	15,697
Industrial	17,378	21,313	21,598
Land Transportation	5,922	6,887	6,891
Amateur	111,289	122,283	123,287
Citizens Radio	3,829	5,706	7,054
Disaster	191	283	283
Experimental	414	567	586
Common carrier	1,214	1,613	1,635

EMPLOYMENT AND PAYROLLS

(Source: Bur. Labor Statistics)	May '53	Apr. '54	May '54
Prod. workers, comm. equip.	407,300	354,300-r	340,200-p
Av. wkly. earnings, comm.	$65.53	$66.30 -r	$67.60 -p
Av. wkly. earnings, radio	$63.36	$65.35 -r	$66.25 -p
Av. wkly. hours, comm.	40.2	39.0 -r	39.3 -p
Av. wkly. hours, radio	39.6	38.9 -r	39.2 -p

STOCK PRICE AVERAGES

(Source: Standard and Poor's)	July '53	June '54	July '54
Radio—TV & Electronics	272.4	308.7	351.2
Radio Broadcasters	269.3	325.9	377.3

p—provisional; r—revised

FIGURES OF THE YEAR

	1953 Total	TOTALS FOR FIRST SIX MONTHS 1953	1954	Percent Change
Television set production	7,214,787	3,834,236	2,845,147	—25.8
Radio set production	13,368,556	7,266,542	4,886,559	—32.8
Television set sales	6,375,279	2,775,900	2,805,760	+ 1.1
Radio set sales (except auto)	7,064,485	3,017,198	2,410,893	—20.1
Receiving tube sales	437,091,555	243,160,348-r	165,709,060	—31.8
Cathode-ray tube sales	7,582,835	5,197,071-r	3,957,238	—23.8

INDUSTRY REPORT

TRANSISTORIZED TV RECEIVER with inch-thick picture tube is here visualized as an ultimate result of . . .

New Design in Picture Tubes

THIN enough to hang on a wall like a picture or mount on the easel of a table model set, the television screen pictured above in mock-up with pasted-on picture has enough factual engineering foundation to be a portent of things to come. This concept of the television set of tomorrow stems from development work being done by scientists at the GE Electronics Laboratory at Syracuse, N. Y. on miniaturized components and radar display techniques.

▶ **How It Works**—Though technical details have not been released, it is likely that the new tube will make use of vertical and horizontal grid wires on opposite sides of the phosphor screen. Computer circuitry would feed voltages in turn to succeeding x and y grid wires, so that the phosphor glows where the energized grid wires intersect. Switching of voltages from wire to wire then gives scanning action. The intensity of illumination from each dot must be varied in accordance with the picture signal. With this design large screens are easiest to make, so that picture size is limited only by viewing distance at which the 525-line picture structure blends.

The receiver would in all probability employ transistors, subminiaturized components and printed circuits located in the base supporting the picture tube. Sound could originate from a low-frequency speaker in the base and from rows of high-frequency electrostatic speakers above and below the picture tube. The tweeters would thus beam the high notes directly at the viewer.

Although prominent manufacturers are known to be working on picture tubes without electron guns, none as yet claim to have solved the many engineering problems involved. Best predictions are that it will take ten years to convert this vision to reality.

UHF Satellites To Expand TV Service

LONG-STANDING PROPOSAL to use satellite stations for filling in shadowed areas has been accepted by the Federal Communications Commission and given a twist that may benefit uhf television.

A satellite as now legalized is an auxiliary station (it must be operated on a uhf channel) that picks up either a vhf or uhf program and relays it on a different frequency. It is not to be confused with a proposed booster that would use very low power on the mother station's frequency to fill in holes in viewer coverage. This policy, effective September 1, will also permit operation of small uhf stations that have no intention of originating programs but will use network or film material.

Broadcasters are not yet sure how the new system will work out. Still effective is the duopoly rule that says no one enterprise may have two stations with duplicating or overlapping coverage. However, the FCC indicates that upon showing of good cause it will waive this rule.

Nor is the multiple-ownership rule waived. Present regulations

limit one company to five tv stations. A satellite counts as one, just as a more powerful outlet, but here again FCC has proposed (but not yet acted) to allow additional uhf stations, bringing the total to seven.

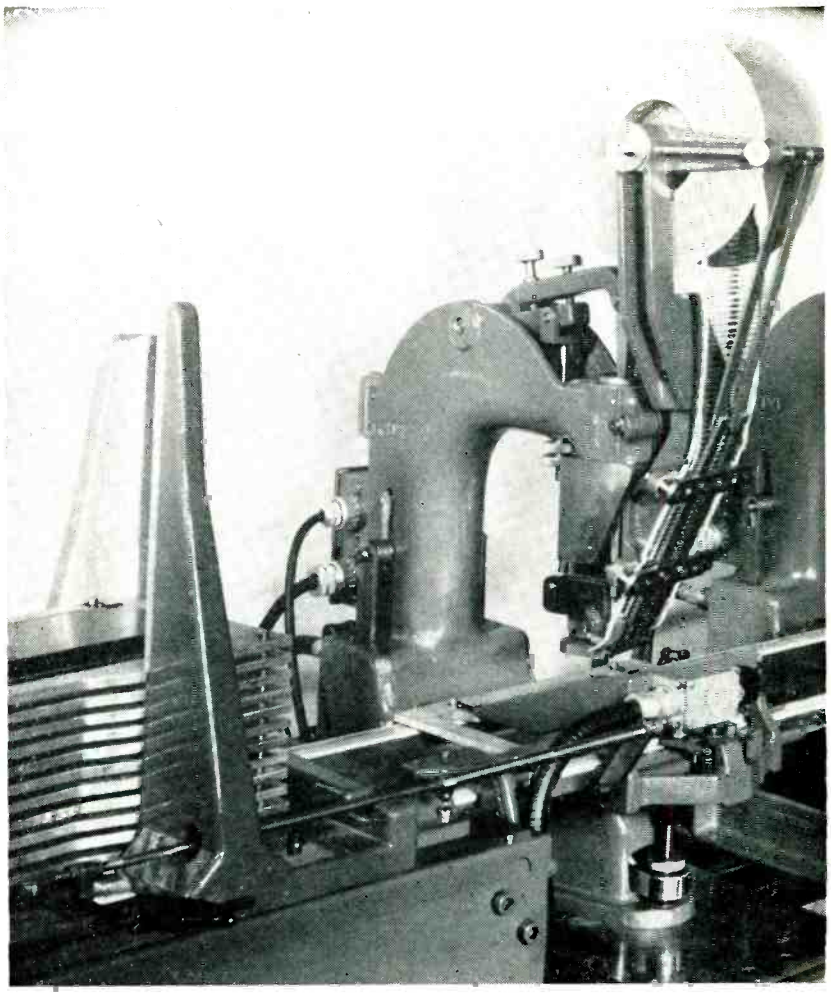
Army Uses Color TV In Front Lines

NATIONWIDE tv audience saw how color tv may be used by the Army in time of war to direct front-line operations when the Signal Corps in cooperation with RCA demonstrated it over NBC.

The first half of the telecast used current black-and-white combat tv equipment of the Signal Corps over closed-circuit hookup; the second half was broadcast in color over network tv through NBC's color mobile unit. A water-crossing operation and an assault on an "enemy-held" position were televised by portable and aerial tv cameras in the hands of Signal Corps personnel accompanying the advancing troops. A regimental commander post behind the lines saw the battle on a bank of 8 tv monitors and directed his troops.

► **Dollars**—Cost of a complete tactical tv unit has been estimated by the military at $12,000 to $100,000, depending on the tactical unit to which it is adapted. The present intermin tactical tv system consists of three vidicon cameras, each feeding back to a transmitter built into a ¾-ton truck and from there by microwave to a monitoring truck. Two cameras and a transmitter were airborne.

Camera at left covers mock assault on pillbox during demonstration



BELTED components fed to stapler-type heads are pushed into printed-circuit board as . . .

New Machine Assembles Circuits

AN AUTOMATIC ASSEMBLY LINE for mounting standard components on printed-circuit boards uses parts-placing heads operating much like stapling machines. The new system, demonstrated by the United Shoe Machinery Corp. of Boston, will turn out 1,200 completed boards per hour, ready for dip soldering.

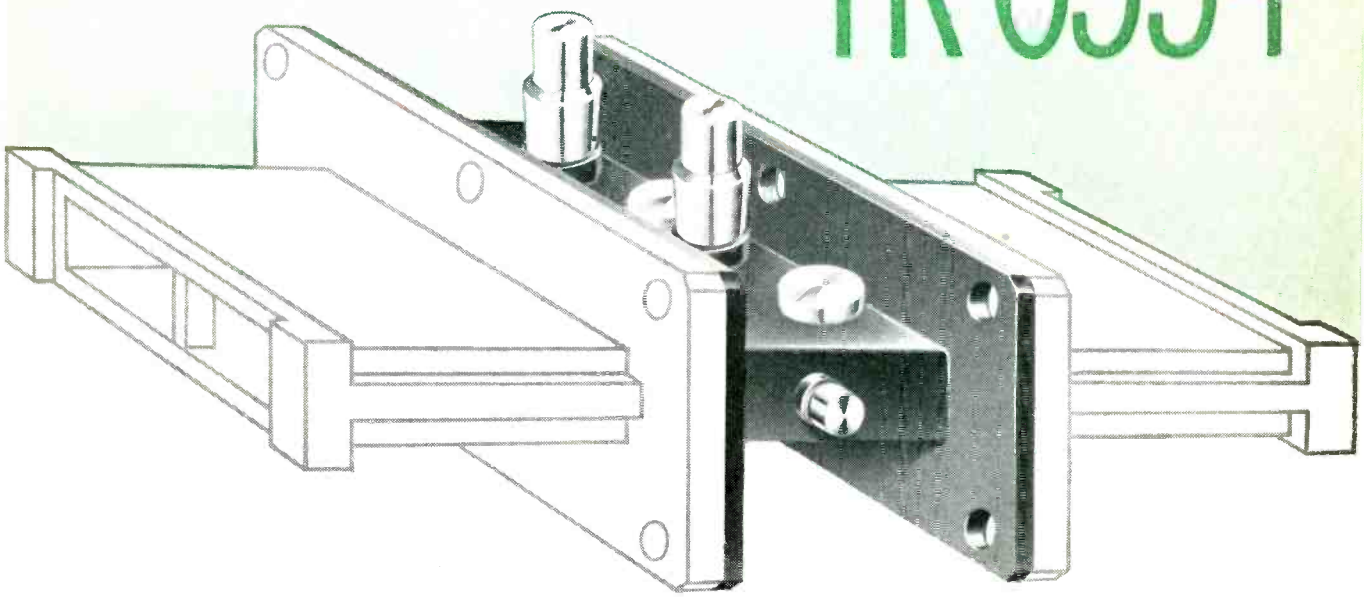
► **How**—The installing heads, one for each component to be mounted, clip leads to the proper length and insert them in holes drilled in the mounting boards. The boards, set into metal pallets, are moved by a conveyor belt to each installing position. Proper installation of each part is checked by electrical contact on the anvil of each installing unit. The components are fed to the installing heads on a taped strip from a reel mounted on the unit. (For more details, see the Production Techniques department of this issue.)

► **Future**—The first machines demonstrated will handle only resistors, capacitors, jumper wires and eyelets. These will be installed on assembly lines in three different manufacturing plants for evaluation of operation, versatility and operating costs. If industry reaction is favorable, units for installing tube sockets, transformers and other components will be designed. The first pilot operation is expected to be functioning by September 1, 1954 in an electronic manufacturing plant.

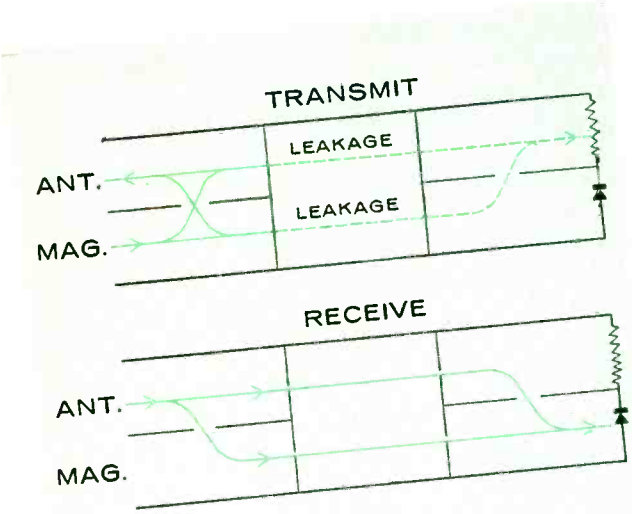
(Continued on page 8)

SYLVANIA NOW OFFERS

A NEW DUAL TR 6334



For X-Band Balanced Duplexers



SPECIFICATIONS

Leakage Power	10 mw max.
Spike Leakage Energy	0.1 erg max.
Recovery Time	7 μ sec. max.

Duplexer Loss (Including interaction) less than 1.2 db for any magnetron impedance or phase.

Here's Sylvania's answer to today's demand for a completely balanced duplexer for use in microwave system design.

Consider these advantages

This new tube is mounted between two readily obtainable short slot hybrid couplers and offers unusually broad band applications (12% band width).

In addition, its simplicity of design permits a reduction in both size and weight, and provides greater crystal protection. For complete information regarding this improved duplexer or other TR and ATR Tubes simply drop a line to Dept. 4E-1609, at Sylvania.

"Another reason why it pays to specify Sylvania."

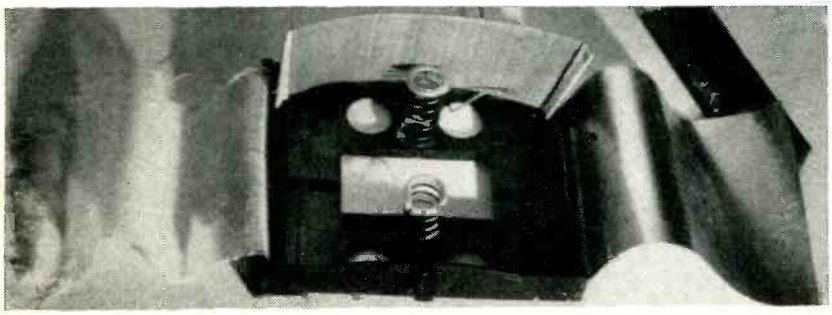
SYLVANIA

Sylvania Electric Products Inc., 1740 Broadway, New York 19, N. Y.

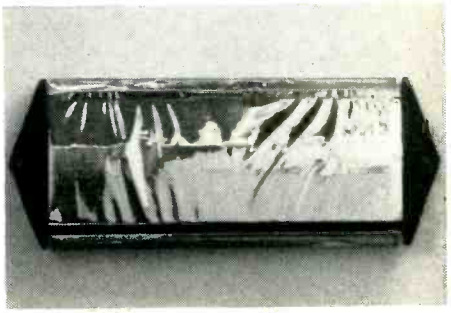
In Canada: Sylvania Electric (Canada) Ltd.
University Tower Building, St. Catherine Street, Montreal, P. Q.

LIGHTING • RADIO • ELECTRONICS • TELEVISION

Electrostatic Speakers Revived For Phonographs



Simplicity means low production cost in German version of electrostatic tweeter. Perforated brass plate (top center) is brought down over tension springs and plastic dielectric sheet backed with gold-foil electrode (right) is put over plate.



Example of American version of tweeter —the Columbia Records kilosphere speaker—which also uses stretched foil electrode.

High-fidelity boom creates market for low-cost tweeters in mass-produced units

TWO LARGE MANUFACTURERS of home phonographs—Philco and Columbia Records—are using electrostatic loudspeakers in their new models. Columbia also uses electrostatic tweeters in its tape recorders. These units, which are used in addition to standard cone loudspeakers, extend frequency response to over 20,000 cycles per second. Phonographs using these speakers have special appeal to the rapidly growing market of high-fidelity enthusiasts. Television sets and f-m radios constitute a still larger potential market for the low-cost tweeters.

▶ **Cost**—Both manufacturers are currently producing the electrostatic speakers in their own plants. Initial unit cost for one manufacturer is approximately $5.70, but production plans call for getting this down to $4.00 per unit. This manufacturer plans to produce at least 150,000 units this year.

A German-made unit is being imported by Harvey-Wells Electronics for approximately $1.25. With volume, this price can drop to $1.15 per unit.

▶ **Background**—The electrostatic speaker is by no means new. It was introduced in this country in the 1920's, though did not prove successful because it attempted to reproduce the entire audio range instead of just high frequencies as at present. The speaker was reintroduced here at last year's Audio Fair. In the meantime, the unit has been used as a high-frequency tweeter by at least four German radio manufacturers.

Transistor Production Increases in Volume

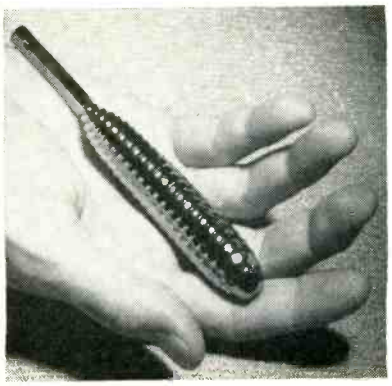
GE tools for mass output with new process; Raytheon makes millionth junction transistor

GLIMPSE of the present and future production picture for two transistor manufacturers was given last month when Raytheon produced its millionth germanium junction transistor and GE announced plans for quantity production of the units under its rate-grown process.

▶ **Plans**—Development work has been largely completed on the new GE process for growing transistor crystal material at high speed. The firm expects to begin sampling to manufacturers late this year. Production limited only by the volume of sales will begin in 1955 at the firm's Syracuse plant.

Prices of the transistors are expected to become competitive with vacuum tubes as soon as electronic manufacturers place orders for comparable quantities.

▶ **Production**—At present, GE is making a few hundred transistors a week on its pilot line in Syracuse. A rate-grown ingot is being produced each ten days, which is currently enough to keep the line supplied for about ten days. The firm is presently mechanizing the fabrication process of attaching leads to the transistor bars.



Quarter-pound germanium ingot, rate-grown by GE step technique in two hours, gives 2,000 transistors.

▶ **How**—The rate-grown process, first announced a year ago, involves varying the heat and withdrawal-rate controls cyclically during the crystal-growing process. As a result, as many as a hundred usable wafer-thin slices of germanium can be cut from a six-inch ingot. With other processes only one useful slice is formed per crystal. The disc-shaped slices are then diced into thousands of bars each several thousandths of an inch long, with a junction layer through the

(Continued on page 10)

IT'S SPRAGUE FOR
Ceramic Capacitors

EVERY TYPE AND RATING FOR SMALL OR LARGE PRODUCTION RUNS!

Sprague can provide you with the best capacitors for your requirements. And when it comes to ceramic capacitors, large plants with adequate production and tooling facilities offer prompt delivery for small or large production runs.

In the East, Sprague ceramic capacitors are made at North Adams, Mass., and Nashua, N. H. The Midwest is served by Sprague's wholly owned subsidiary, the Herlec Corporation of Grafton, Wis.

Some of Sprague's newest developments are shown at right. For future developments in ceramic capacitors, look to Sprague for the ultimate in performance, miniaturization, and reliability.

SPRAGUE ELECTRIC CO.
35 Marshall St., North Adams, Mass.

Sprague, on request, will provide you with complete application engineering service for optimum results in the use of ceramic capacitors, and printed resistor-capacitor networks.

NEW!

'RING' CERAMIC CAPACITORS to clean up chassis

Designed to fit around 7-pin miniature tube sockets, these capacitors may contain 2, 3, or 4 sections. They result in a neat physical layout while reducing space to a minimum. Positive positioning of the ultra short leads between the capacitor and socket terminals eliminates lead dress problems and, consequently, allows "hot" circuit designs. Voltage ratings from 100 to 500 d-c. Write for Engineering Bulletin 610.

NEW!

FLAT 'PAN' CERAMIC CAPACITORS simplify circuit design

Mounted flat against a chassis with a screw or rivet, these miniature capacitors provide a highly secure mounting. 1 to 4 sections in the shallow pan are insulated and moisture-protected by a phenolic resin. Ideal for military electronics. These units have an unusually high self resonant frequency, and eliminate lead dress problems when mounted adjacent to a miniature tube socket. Available in ratings from 100 to 500 volts d-c. Write for Engineering Bulletin 611.

WIDELY-USED CERAMIC CAPACITORS for electronics, radio, and TV

Shown at left are a few of the many other types of ceramic capacitors available from Sprague. These include:

- Buttons • Discs • Hi-Voltage Moldeds
- Precision Ceramic Trimmers • Plates
- Printed resistor-capacitor networks
- Hermetically sealed, metal cup and tubular precision capacitors

For complete details on any type of ceramic capacitor — it pays to ask Sprague. Write for catalog data on the types in which you are interested.

SPRAGUE

WORLD'S LARGEST CAPACITOR MANUFACTURER

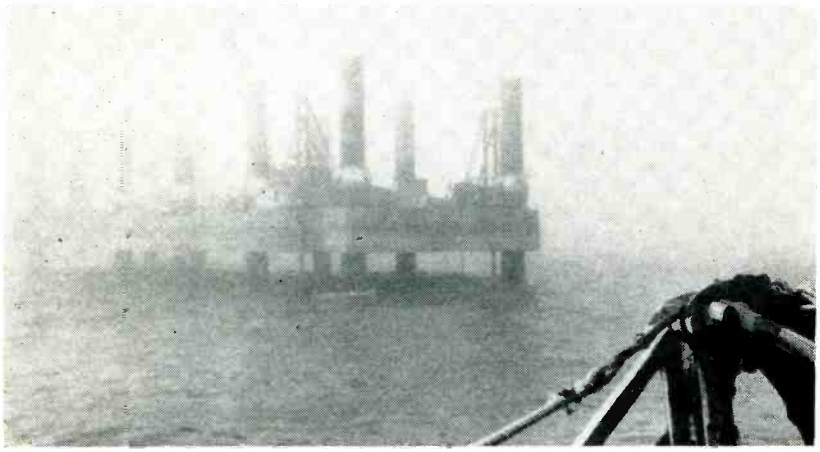
Export for the Americas: Sprague Electric International Ltd., North Adams, Mass. CABLE: SPREXINT

center of each. The more cycles there are in the crystal-growing process, the more layers there are for slicing and dicing.

▶**Raytheon**—In announcing the production of its millionth junction transistor, Raytheon pointed out that field failures in actual service are running at the rate of less than 2 percent per year, with well over one billion transistor operating hours to date.

So far the great majority of the firm's transistor output has gone to the hearing aid industry. Close to 300,000 of U. S. hearing aid wearers out of a total of 1.2 million have already converted from tube to transistor aids.

The company announced that its power and radio-frequency transistors were in the research stage in 1953 and are now in the production design stage, with a good chance of small commercial production before the end of 1954 for sampling to manufacturers.



MAN-MADE ISLANDS like this to appear in open Atlantic as . . .

U. S. Starts Sea Platforms For Radar

Off-shore radar bases to extend along Continental Shelf from Norfolk to Newfoundland

EAST-COAST leg of the nation's radar warning system began to take form as work started on a line of huge radar platforms to be built at sea for the Air Force as far off the Atlantic coast as 125 miles.

Each platform will have about 15,000 sq ft of area. Total construction cost, not including radar, is estimated at $20,000,000 for some 25 platforms.

▶**Facilities**—The platforms will operate as radio and radar aids to navigation and as weather stations, in addition to use as early warning stations. Each will generate its own electric power and will be connected by radio with shore-based radar stations.

The platforms will have living quarters for 20 to 30 operating personnel an sufficient space for a heliport. At the top of the lighthouse-like tower on each will be a small observatory for housing the radar and weather equipment.

▶**Land**—The Air Force also plans to improve facilities at 69 existing land radar installations and begin construction of some 485 new semi-fixed and small automatic radar aircraft warning stations, adding to hundreds of small permanent and semi-fixed stations already in operation. The new automatic stations will bridge gaps in coverage between larger semi-fixed stations.

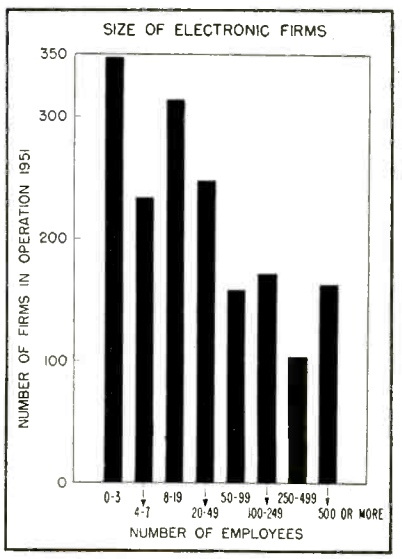
How Electronic Firms Size Up

Companies in the field cover all employment ranges but most firms are small

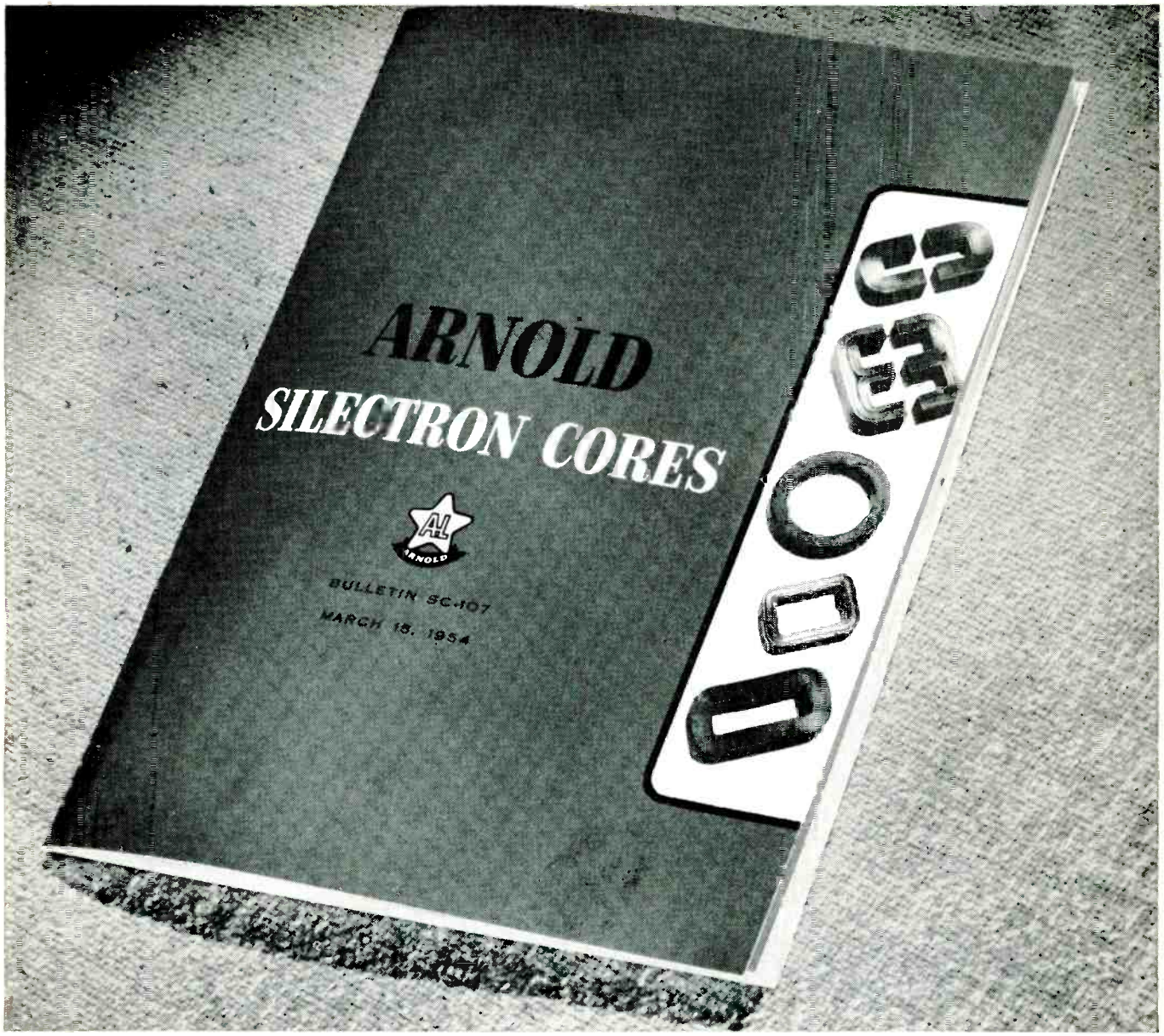
GIANTS of the electronics industry were recently sized up in a tabulation by the National City Bank of New York of the 100 largest U. S. manufacturing corporations in terms of total assets at the end of 1953.

Although most of the firms cover many industries, four can be classified as radio-tv-electrical equipment makers and four more have sizable interests in the field. The eight companies and their total assets in 1953 were as follows: Avco, $232 million; Bendix, $329 million; GE, $1.7 billion; IBM, $520 million; RCA, $494 million; Sperry, $259 million; Western Electric, $877 million and Westinghouse, $1.3 billion.

▶**Smalls**—Despite the importance that these large manufacturers have assumed in the electronics industry, it is the smaller manufacturers that account for the size of the industry in terms of number of firms. As is shown in the chart, over half of the manufacturers in the communication equipment field



(Continued on page 12)



Here's *New Technical Data*

on Silectron cores . . . all shapes and sizes

This new bulletin contains design information on Arnold cores wound from a grain-oriented silicon steel, Silectron. Curves showing the effect of impregnation on core material properties are published for the first time. This 52-page bulletin includes information on cut "C" and "E" cores, and uncut toroids and rectangular shapes. Sizes range from a fraction of an ounce to hundreds of pounds in standard tape thicknesses of 1, 2, 4 and 12 mils.

A new method of tabulating core sizes is introduced whereby cores are listed in the order of their power handling capacity. You'll find this Silectron core bulletin a valuable addition to your engineering files—*write for your copy.*

ADDRESS DEPT. E-9

W&D 5305

THE ARNOLD ENGINEERING COMPANY

SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION

General Office & Plant: Marengo, Illinois

DISTRICT SALES OFFICES . . . New York: 350 Fifth Ave.

Los Angeles: 3450 Wilshire Blvd. Boston: 200 Berkeley St.

are small companies that employ less than 20 workers and nearly two-thirds employ less than 50. Electrical equipment manufacturers that employ over 500 workers represent only 4.9 percent of the number of companies in the field.

Italian Government Seeks U. S. Licenses

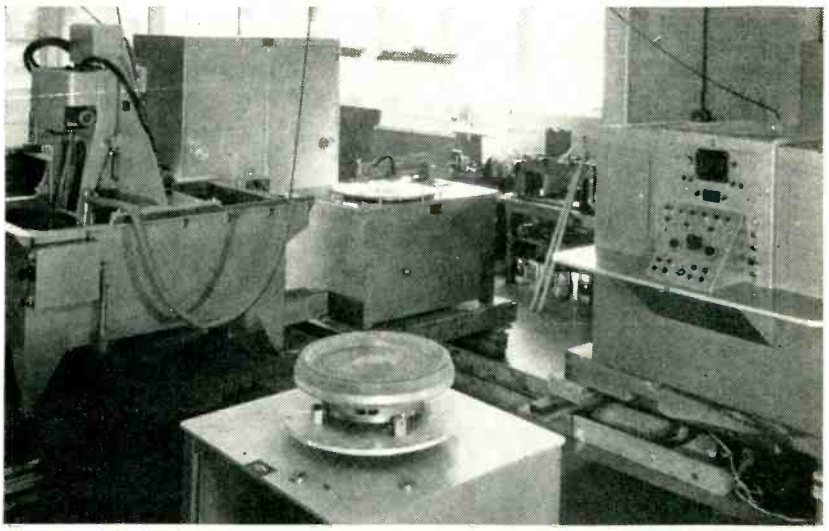
A MOVE to strengthen further its electronics industry was made by Italy with the establishment of an office in New York for Finmeccanica of Rome, a financial holding company controlled by the Italian government. Purpose of the U.S. headquarters is to improve the volume of business between Italy and the U.S. and Canada by entering into as many licensing agreements as possible with the U.S. firms. The agreements are to give the Italian company's plants the benefit of U. S. progress and at the same time allow U. S. firms to supply the Italian and other markets with products identical to those produced here at considerable dollar saving and a reasonable rate of return.

▶**Setup** — Finmeccanica controls close to 40 different corporations with about 50 plants and 75,000 workers. Exports for the company, not including offshore procurement sales, were $51 million in 1953 compared to $37 million in 1952.

Among the companies that the government-controlled holding company has under its wing are Microlambda of Naples which manufactures radar and other electronic equipment on license from Raytheon, the Marconi Company of Rome which makes radio equipment and tubes and Filotechnica Salmoiraghi of Milan which manufacturers some of its precision instruments under Sperry Corp. of London licenses.

Microlambda, which has concentrated mainly on the production of Raytheon radar for the offshore procurement program, employs about 400 workers in its plant in Naples. It has assets of about $3 million. The firm estimates that billings of about $400,000 were made on electronic products delivered in 1953.

▶**Government Assistance** — The U.S. Foreign Operations Administration has set up a plan to protect American business firms against losses from inability to transfer their foreign money earnings in dollar-short countries into U.S. currency. If a company should be unable to exchange its Italian lira or other currencies into dollars, the U.S. government would provide the dollar exchange up to the amount a company expects to obtain. Raytheon, for example, has obtained a guarantee from the U.S. to cover $93,500 under a German contract and $329,000 under an Italian agreement. The amounts represent fees and royalties the firm expects to receive during the lives of the contracts with the foreign companies involved.



ULTRASONICS and digital automation equipment are applied to auto parts inspection as . . .

Nondestructive Testing Cuts Costs

Industries install ultrasonic and industrial x-ray equipment for substantial dollar savings

INCREASING use of nondestructive testing throughout U.S. industry is resulting in substantial sales for some electronic manufacturers.

Ultrasonics and industrial x-ray are two of the methods that are being used extensively.

▶**Ultrasonics**—Digital computing and ultrasonics are being used for the inspection of Allison jet engine rotor forgings. Application of SIMAC (sonic inspection measurement and control), a device developed by Sperry Products, is one of the newest applications in nondestructive testing.

The device was developed at a cost of $300,000. It automatically and completely scans a circular part mounted on a rotating turntable immersed in water by beaming ultrasonic waves into it. Beams reflected by structural discontinuities, which may be defects, are logged on a circular chart for interpretation and filing.

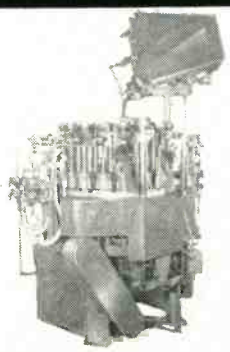
A scanning machine, recorder, control cabinet and an electronic console which is also a monitoring station comprise the complete installation. A quartz-crystal transducer in the scanning head transmits short bursts of sound at 5 million vibrations per second. The motion of the scanning head is controlled by a servo-motor which in turn is controlled by an array of holes punched in tape. In all, 60 holes are punched in the tape for each scan line. All operations of the apparatus are controlled

(Continued on page 14)

LARGEST PRODUCER

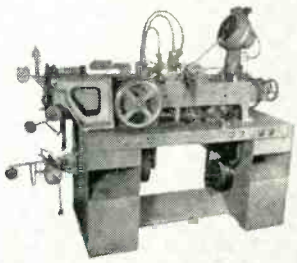
of custom machinery for electronics and allied industries

sealing . . . exhausting . . . bulb making . . . stem making . . . wire products

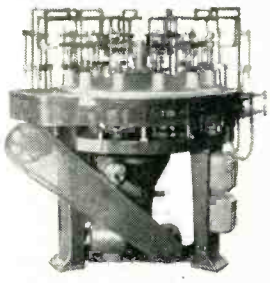


BULB MAKING MACHINE

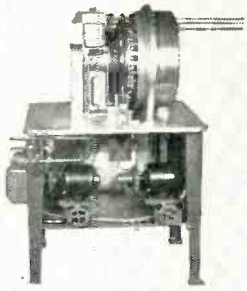
GLASS TUBING CUTTING MACHINE
VERTICAL TYPE



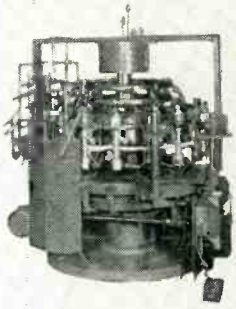
LEAD WIRE WELDING MACHINE



BUTTON STEM MACHINE



GLASS TUBING CUTTING MACHINE
HORIZONTAL TYPE



AUTOMATIC EXHAUST MACHINE

Built into the automatic machinery shown on this page is knowledge of every phase of electronic tube production...

Kahle's machines are engineered to manufacture electronic tubes and component parts so that the burden of "knowing how" to make the product falls upon the machinery itself instead of the manufacturer. Forty-six years of intimate contact with the design and construction of custom machinery together with a long history of pioneering successes in electronics and allied industries, produce the "know-how" in such combinations of machines as the models depicted above. Kahle executives have vast experience in the actual manufacturing of the end products which such machinery produces. This cumulative knowledge is built into the machinery to solve bottlenecks and gives a smooth uninterrupted flow of the finished products for all production requirements.

"Built-in know how" is what makes Kahle's name the password in the electronics and glass industries where production difficulties can be overcome with custom machinery.

ONTI

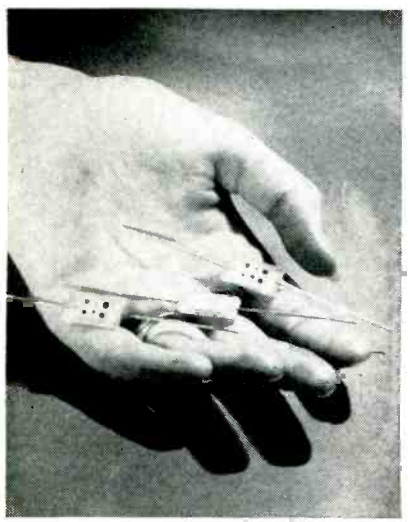
Call on Kahle and learn how you can benefit from the company which enjoys the respect of the industry's leaders.

Kahle ENGINEERING COMPANY
1353 SEVENTH STREET • NORTH BERGEN N J

in the electronic console. The ultrasonic echo signals are displayed on the face of a c-r tube for visual monitoring.

▶**Market**—Size of the potential market that nondestructive testing represents is seen in the estimate that at least $100 million annually is spent by U.S. industry for nondestructive testing. Some casting firms spend as much as $25,000 a month on x-ray inspections alone. In the petroleum field it is estimated that more than $42 million a year is spent in field inspections of tubes and pipes.

Non-destructive testing by electronic and other means has paid off for industry. For example, it has been estimated that x-ray inspection of castings up to 5 feet in diameter costs about $7.50 per casting while destructive testing averages $350 a piece.



CAPABLE of high-speed manufacture and independent of imported materials, these . . .

Glass Capacitors Rival Micas

NEW LOOK in fixed capacitors is promised by Corning Glass, now beginning automatic manufacture of small glass blocks for use in communications and industrial electronic circuits.

Quality capacitor units in the postage-stamp size are generally made from mica with conducting plates of silver vaporized directly onto the mica dielectric. Their capacitance varies little over wide temperature ranges. They require high-grade mica, most of which must be imported and they are expensive.

A few months ago, experimental glass capacitors, admittedly good, cost ten times as much as silver micas. Now, automatic production has dropped costs to as low as 2½ times as much. Corning expects to close the gap in the near future even further costwise.

▶**Replacement Market**—Glass capacitors will not replace silver micas overnight. Although the total range of variation for the glass-dielectric units is less than that of the best silver mica, the latter can be used at lower temperatures than the glass. However, in case of a mica shortage, circuit redesign would allow fuller use of the glass types. One glass unit is almost exactly like the next, making circuit design less tricky.

TV Manufacturers Unveil New Lines

Color set activity heightens; lower prices for monochrome and color tv are evident

MAJOR television receiver producers unveiled their new tv and radio lines for the fall selling season.

▶**Color**—Manufacturers made varied approaches in introducing color sets for the fall market. Motorola introduced three 19-inch color sets using the CBS tube at prices starting at $895. CBS-Columbia planned to show its 19-inch color sets this month.

Emerson announced plans to market a color set at $695 using RCA's 15-inch tube. This firm does not intend to produce 19-inch color sets but will make 21-inch sets when a tube is perfected.

RCA, which plans to show its new 21-inch color tube this month, reduced the price of its $1,000 15-inch color set to $495 and will refund $505 to customers who bought the set at $1,000. It is expected that Westinghouse will take similar action on its 15-inch sets. According to RCA, its action was taken to clear distributor and dealer inventories before the introduction of 21-inch color sets.

Philco, which has also developed a 21-inch color tube, announced that it does not intend to offer color tv receivers this year.

Magnavox indicated that it would not sell color sets until a 21-inch tube had proved itself. Other set manufacturers seemed to be staying on the color fence awaiting further color tube developments.

▶**Prices**—Lower-priced black-and-white models were shown with 17-inch table models as low as $129.95 and 21-inch table sets at $149.95. Price ranges of some lines are 20 percent below last season's. Bid for second-set markets by many manufacturers was evident in the resurgence of 17-inch table models now carried by most firms, though Philco has dropped them.

Slight divergence in tube-size trends was evident. One company dropped the 24-inch set from its b-w line while another, which was one of the last to bring out a 24-inch set, has expanded its 24-inch line. Greater use of aluminized tubes was noticeable in new fall lines. For many companies, all but their price leader sets used them.

Financial Roundup

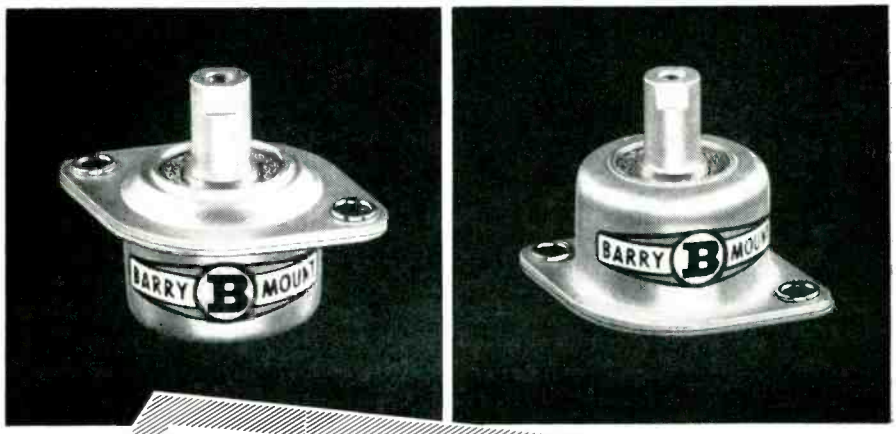
COMPANIES in the electronics field enjoyed, in general, better net profits during the first six months of 1954 than for the similar period in 1953. According to the survey by the National City Bank of New York, the combined net profits of 18 companies in the radio-tv-electrical equipment field for the first half of 1954 totalled $174.5 million, 17 percent over 1953's first

(Continued on page 16)

the **NEW** *miniature* ... ALL-METL

BARRY B MOUNT

UNITS SHOWN ACTUAL SIZE



for all-temperature vibration protection of airborne equipment

These new isolators are the latest addition to the famous Barry ALL-METL line.
They are specifically designed to help you meet miniaturization demands under toughest environmental conditions.

Temperature range — from −60°C to +175°C

Weight — only ½ ounce per unit isolator

Height — only 1¼ " free, 25/32" bottomed

Load ratings — 0.1 to 3.0 lbs. per unit isolator

Performance — meet all relevant requirements of JAN-C-172A/MIL-C-172B

Ruggedized — to meet shock tests under specifications AN-E-19, MIL-E-5272, MIL-T-5422B, and MIL-C-172B.

Mounting styles — available in plate and cup types, as illustrated, for 2-hole or 4-hole mounting.

For complete information, ask for your free copy of the new Barry Product Bulletin 542, containing full installation and performance data. And for greatest benefits with these new isolators, let our Field Engineering Service help in the early stages of your equipment design.

THE BARRY CORP.

707 PLEASANT STREET
WATERTOWN 72, MASS.

SALES REPRESENTATIVES IN ALL PRINCIPAL CITIES

British Licensee: Cementation (Muffelite), Ltd., London, England

six months profits of $149.4 million.

Combined net profits for these companies for the second quarter of this year, totalling $81.5 million, were 4 percent ahead of 1953's second quarter profits of $78.3 million. According to the survey which covered 19 manufacturing industry groups, only food, paper, office equipment and automotive manufacturers exceeded the 17 percent profit increase of radio-tv, electrical equipment firms. Following are the reports of 30 companies in the electronics field for the fiscal periods indicated:

Company	Net Profit 1954	1953
Aircraft Radio 6m	$316,000	.....
Am Bdcasting Paramount Theatres 6m	1,982,000	$2,587,000
American Machine & Foundry 6m	1,840,000	2,151,000
American Phenolic 6m	252,277	573,651
AT&T 12m	440,230,000	388,541,062
Ampex 12m	26,000	89,000
Bendix Aviation 6m	11,113,149	8,596,601
Clevite Corp 6m	1,646,758	2,015,419
Consolidated Engineering 6m	472,594	365,983
T. A. Edison 6m	459,603	513,165
Fairchild Camera & Instrument 6m	757,699	289,671
General Cable 6m	2,434,657	2,971,347
GE 6m	93,856,000	75,417,000
Hoffman Radio 6m	818,683	697,320
Lear 6m	1,379,558	793,615
W. L. Maxson 9m	1,009,786	646,194
Minn. Mining & Mfg. 6m	11,644,303	9,056,111
Motorola 6m	2,858,301	4,640,679
National Cash Register 6m	5,627,065	5,570,465
Philco 6m	1,735,000	12,216,000
RCA 6m	19,268,000	18,185,000
Raytheon 12m	3,523,000	3,859,000
Standard Coil 6m	1,358,996	2,736,431
Stewart-Warner 6m	1,511,560	2,143,064
Stromberg Carlson 6m	1,177,759	1,071,271
Sylvania 6m	3,522,785	5,169,092
Tempco Aircraft 6m	1,325,328	906,342
Thompson Products 6m	6,490,502	5,357,618
Tung-Sol 3m	1,001,537	1,015,355
Westinghouse 6m	45,359,000	35,660,000

▶**Securities** — Ultrasonic Corp. offered 200,000 shares of common stock (par $5) at $12.75 per share. Proceeds will be added to general funds for working capital and general corporate purposes.

American Electronics offered 160,000 shares of common stock (par $1). Proceeds will be used to repay loans and for general corporate purposes.

Master Television filed with SEC covering 1,000 shares of class A stock to be offered at par ($100 per share) and $199,000 of 10-year 6-percent debentures to be offered at 10 percent of principal amount. Proceeds are to be used for working capital.

Conventions Use Closed-Circuit TV

Promoters offer packaged facilities; trend renews interest in projection television

MULTI-CITY large-screen closed-circuit television is saving millions of dollars annually for companies with nationwide operations such as Ford, Chrysler, Pan American and IBM. For example, Westinghouse used a private telecast to introduce its new line of appliances, radios and tv sets to 2,000 distributors in 27 cities. Cost was $75,000 as against $450,000 necessary to bring the distributors to a central location and pay for their hotel accommodations and sundry expenses. A rule-of-thumb in gaging the cost of a private television hookup is $1,500 per hour per city.

▶**Producers**—Several companies, including Box Office Television and Theater Network Television (TNT) both of New York, specialize in handling closed-circuit television conferences. The Sheraton hotel chain is also interested in the business. Large-screen projection telesets are already installed in five hotels and jeeped-up receivers—that is, home receivers with an added video input—installed in 23 others. Closed-circuit tv is estimated to be a half-million-dollar business this year.

During 1953, the intercity facilities of AT&T were used about 20 times for closed-circuit telecasting service.

▶**Sales Meetings**—First intercity large-screen sales conference was put on in 1952 for Lees Carpets. This year about 10 such business meetings have been held. The companies using the service are among the biggest in the country. Their satisfaction with the plan seems evidenced by repeat meetings already on order.

▶**Theater TV**—Another form of closed-circuit television involves distributing concerts, operas, football games and prizefights to theaters. There are 93 theaters in 53 cities equipped with large-screen projection television sets. Their total seating capacity is 214,613.

Recently, plans have been announced for a million-dollar network to distribute floor shows to restaurants and night clubs.

▶**Equipment**—The large-screen theater sets are of the projection type and provide a 15 × 20 ft picture. When installed these sets cost $25,000 each. To provide coverage in cities where large-screen equipment is not installed, show promoters have their own portable projection tv sets. For example, Box Office uses 31 portable projection units that throw a 9 × 12 ft picture.

Closed-circuit show promotors indicate that a market exists for portable theater-quality projection equipment that will sell for under $2,500.

▶**Color**—Business and entertainment closed-circuit telecasts thus far have been in monochrome. Color has been used for medical purposes, however, such as when a group of doctors wish to watch an operation. The American Cancer Society has six color tv units for closed-circuit use; Smith, Kline and French have two.

Small Towns Attract Electronics Firms

SMALLER CITIES, many of them dependent on a single industry for employment, are looking to the electronics industry as a stable means of industrial diversification. In Lowell, Mass., a former textile-mill town, a development and industrial commission has been formed to attract industry to that area. Electronics manufacturers are high on their list of desirable types.

▶**Inducements**—Low labor and building costs are among the inducements that the Lowell commission offers. In addition, finan-

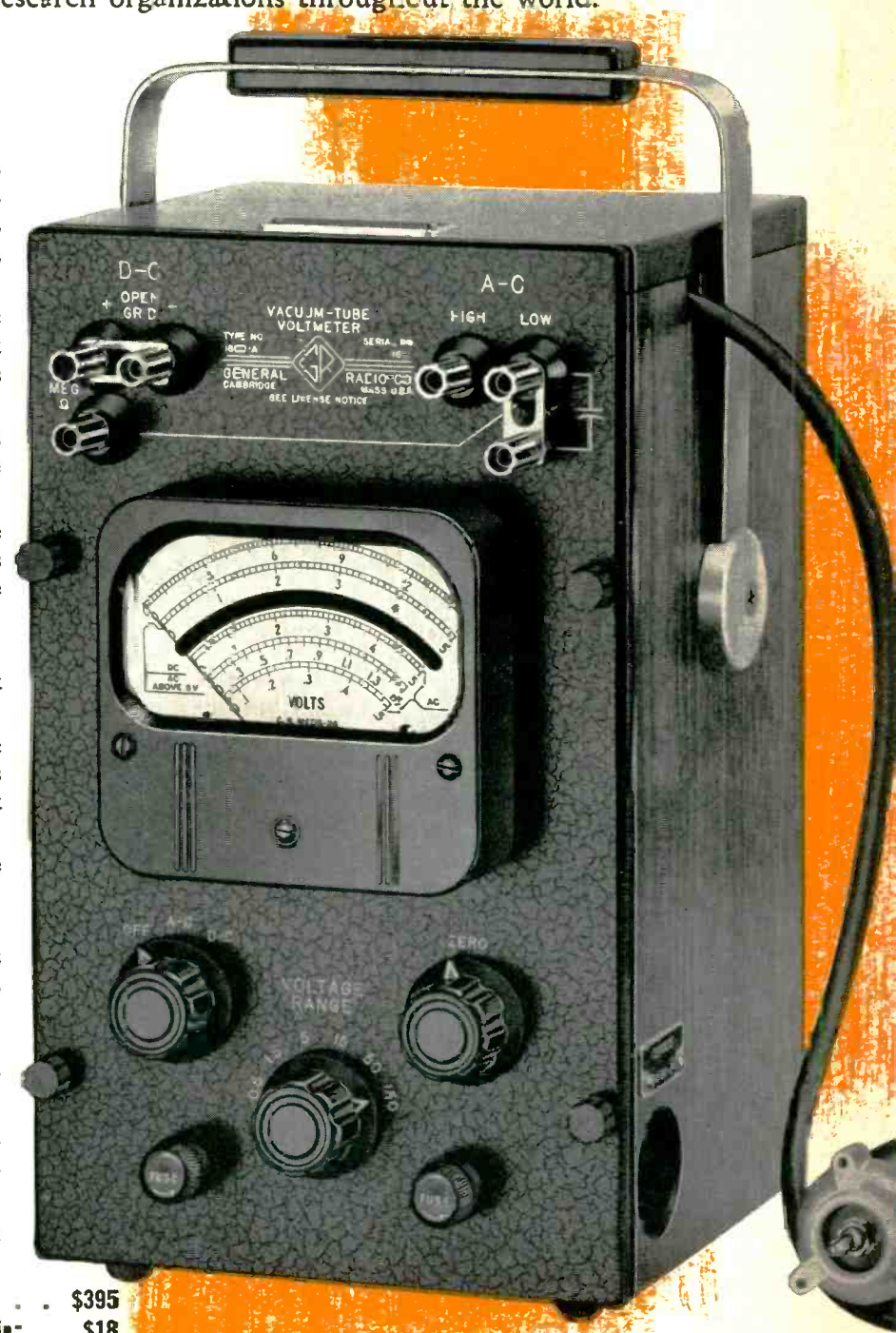
(Continued on page 18)

for Highest Accuracy

IN A-C/D-C VOLTAGE MEASUREMENTS

The GR® TYPE 1800-A VACUUM-TUBE VOLTMETER

Just consider the features and specifications for this popular measuring tool . . . unsurpassed in Accuracy, Stability, Ruggedness and Operating Conveniences. Thousands are in use in laboratories, schools and research organizations throughout the world.



★ The Type 1800-A VTVM is suited not only to accurate measurements at audio and radio frequencies, it in addition gives reliable d-c voltage indications.

★ Voltage range — 0.1 to 150 volts, a-c in six ranges and 0.01 to 150 volts, d-c — 0.5 volt range permits accurate low voltage readings — the Type 1800-P2 High-Frequency Multiplier, attached to the probe, extends the a-c voltage range to 1500 volts.

★ Basic accuracy is ±2% of full scale on all six a-c and d-c ranges — chart is supplied with instrument for frequency corrections on a-c measurements as high as 500 Mc.

★ High Stability — one zero control for all ranges — resetting not required when switching from one range to other.

★ Completely-shielded probe contains acorn-type diode rectifier connected to input capacitor — various terminations and fittings may be attached to probe to suit particular application at hand.

★ Illuminated meter scale elminates parrallax in readings — meter is protected from overloads; cannot be burned out.

★ High 25-megohm input impedance — 1050 Mc resonant frequency permits accurate measurements at hundreds of megacycles — on d-c ranges, two input resistances: 10 megohms and open grid.

★ Current and power measurements also can be made with the 50-ohm termination-unit (supplied) attached to the VTVM probe.

★ Low-frequency response is excellent — range is extended to 1500 volts at d-c and audio frequencies with the Type 1800-P3 Low-Frequency Multiplier.

★ Operation is from 105 to 125 or (210 to 250) volts, a-c, 50 to 60 cycles — internal voltage regulator eliminates meter fluctuations.

★ Line connector cord, Type 274 and 874 termination connectors, 50-ohm coaxial terminating resistor, and spare fuses are supplied with instrument.

★ Dimensions are 7⅜ x 7½ x 11⅛ inches — Net Weight, 13¾ lbs.

Type 1800-A Vacuum-Tube Voltmeter . .	**$395**
Type 1800-P2 High Frequency Multiplier .	**$18**
Type 1800-P3 Low-Frequency Multiplier . .	**$35**

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

Admittance Meters ☆ Amplifiers ☆ Coaxial Elements ☆ Distortion Meters ☆ Frequency Measuring Apparatus ☆ Frequency Standards ☆ Impedance Bridges ☆ Light Meters ☆ Megohmmeters ☆ Modulation Meters ☆ Polariscopes ☆ Precision Capacitors ☆ Oscillators ☆ U-H-F Measuring Equipment ☆ Parts & Accessories ☆ Signal Generators ☆ Wave Analyzers ☆ Variacs ☆ TV & Broadcast Monitors ☆ Pulse Generators ☆ R-L-C Decades ☆ R-L-C Standards ☆ Unit Instruments ☆ Sound & Vibration Meters ☆ Stroboscopes ☆ Null Detectors ☆ Motor Controls ☆ Wave Filters ☆ V-T Voltmeters

cial backing and aid in locating or building plants and in recruiting a labor force are available. In one area designated as an industrial park, a group of one-story buildings designed for horizontal manufacturing operations is being built. The landscaped area will have room for expansion, along with parking and recreation areas.

Electronics companies already building or operating in the area include Raytheon, CBS-Hytron and Cambridge Thermionic Corp. Projects for other firms in the field are planned.

Tubes Submerge With Submarine Cables

SUCCESS of engineers in developing submerged amplifiers with 20-year reliability has triggered an electronic revolution in the submarine cable field. In recent months two underwater cable jobs have been announced by the Bell System in which underwater repeaters will be used.

►**Projects**—Work is already in progress on a $35 million transoceanic telephone cable system which is to be laid across the Atlantic from Newfoundland to Scotland (ELECTRONICS, Jan. 1954, p 20). The cable will have over 100 vacuum-tube repeater amplifiers.

Bell has also proposed construction of an underwater telephone cable system which will stretch 800 nautical miles between Port Angeles, Wash. and Ketchikan, Alaska. Estimated cost is $14 million. This cable will contain built-in underwater repeaters spaced about 40 miles apart, to boost voice signals. Each employ three vacuum tubes and will be housed in a flexible copper tube about seven feet long and 1½ inches in diameter. The vacuum tubes, specially designed by Bell Labs, are expected to have a life of 20 years. The entire repeater is supported by steel rings to form a structure that is built into the cable and appears as a tapering bulge. The design permits the amplifier to pass through the cable ship's gear along with the cable.

Industry Grows Despite Failures

Business failures doubled last year, but number of firms in operation is higher

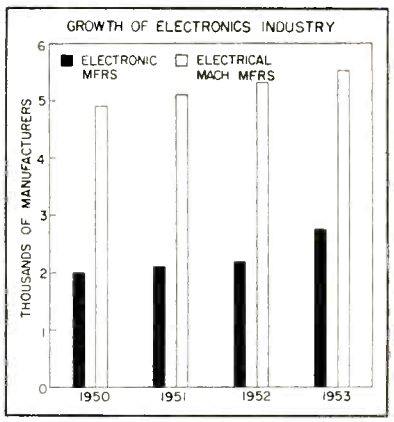
MANUFACTURERS in the electronics industry have continued to increase steadily in number despite a growing list of business failures. More than 2,700 manufacturers for the industry were listed in ELECTRONICS Buyers' Guide in 1953, about 300 more than in 1952. In the 1954 Guide more than 30,000 manufacturers are listed.

Trend of Commerce Department figures for firms in the electrical machinery classification which includes electronic companies indicates an increase of about 200 companies for 1953.

►**Failures**—According to RETMA, 33 electronic equipment and parts manufacturers failed in the year ending in May 1954 compared to 16 in the previous year. Since 1945, 170 electronic manufacturers have had serious financial difficulties although about 35 of these are still in operation.

The 33 companies that failed in the past year had liabilities of approximately $24.8 million. Twelve of the firms were radio and tv set producers, five produced components, five made military equipments, seven manufactured sound equipment and recorders, three made commercial communications equipment and one manufactured instruments. More than half of the companies seeking reorganization were less than seven years old.

►**Why** — Credit committee of RETMA indicated the circumstances causing the failures of the 33 firms. Lower sales were not seen as a fundamental reason. Most of the companies had been doing a volume out of proportion to working capital. They had high fixed expenses such as rent and interest, which could not be cut back and had accumulated inventory excessive in relation to sales.



Several had taken long-term contracts for the production of complex military or commercial communication equipment at too low a price.

►**Distributors** — According to RETMA, of more than 1,300 parts distributors only 8 experienced financial difficulties last year. Their liabilities totaled $1.3 million. More than 40 new distributors of the electronic parts entered business during the 12-month period. Many established wholesalers had to have larger quarters to handle heavier inventories for growing sales.

Industrial Instruments Give Few Headaches

THOUSANDS of noncommunications electronic instruments are giving satisfactory service to industrial users because manufacturers have learned the secrets of foolproof design and personalized service.

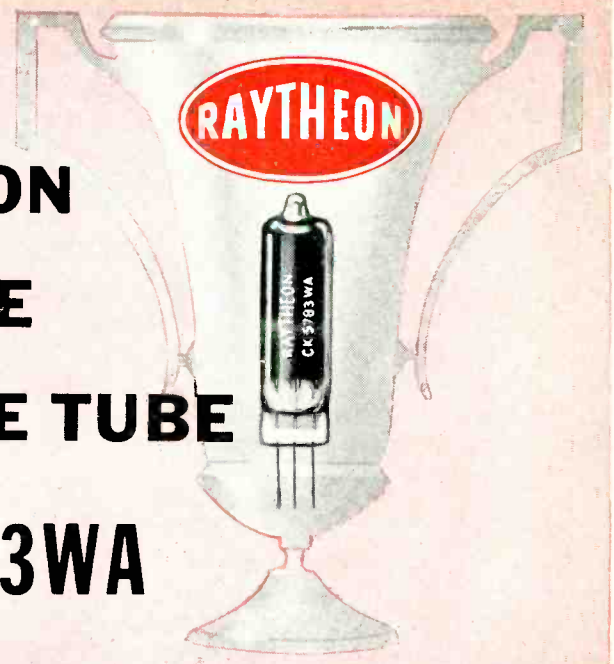
One long-established manufacturer says that a high percentage of the equipment sold is never heard from again. A logical conclusion is to assume the gear lives out its entire life without trouble, requiring only routine replacement of tubes.

Such experience may be a matter of environment, too. Where there are competent and interested engineers or technicians

(Continued on page 20)

A NEW CHAMPION SUBMINIATURE VOLTAGE REFERENCE TUBE

RAYTHEON CK5783WA



The Raytheon CK5651WA Miniature Voltage Reference Tube likewise possesses each and every one of these ten great performance features.

You now have your choice of Subminiature or Miniature for the most exacting Voltage Reference Tube applications.

LOOK AT ALL TEN of these important performance features of the Raytheon CK5783WA Subminiature Voltage Reference Tube.

1. Tightened Voltage Drop Range: 83-89 volts.
2. Low dark starting voltage — only 115 volts maximum — no higher than for light starting.
3. Wider Ambient Temperature Range: −55°C to 150°C.
4. Lower Temperature Coefficient only −5 mV/°C maximum, from 25°C to 75°C.
5. Reduced voltage jump*. Maximum value: 5 mV.
6. Reduced drift** (1 hour). Typical value: 50 mV change.
7. Improved repeatability***. Typical value: 20 mV change.
8. Improved stability over 500 hour period (150°C ambient). Typically less than one volt change.
9. Improved stability over 5000 hour period (30°C ambient). Typically less than one volt change.
10. Ability to meet every requirement for military reliable tubes, including shock and vibration.

Notes: *Voltage jump — Maximum sudden jump in operating voltage when operating current is varied slowly over specified range.
**Drift — Maximum operating voltage change during the period of operation.
***Repeatability — Maximum shift in operating voltage between successive firings of the tube.

RAYTHEON VOLTAGE REGULATOR AND REFERENCE TUBES
give you this complete range to choose from — each and every one a great performer

Type	Max. Dimensions Height (Inches)	Max. Dimensions Diam. (Inches)	Min. Starting Voltage Supply	Operating Voltage (Approx.)	Min. Operating Current Ma.	Max. Operating Current Ma.	Max. Regulation Volts
OA2	2.63	.75	180	150	5.	30.	6
OB2	2.63	.75	127	108	5.	30.	3.5
● OB2WA	2.63	.75	133	108	5.	30.	4
CK1022	2.69	.75	1100	1000	0.005	0.055	20
CK1037	1.75	.40	730	700	0.005	0.100	15
CK1038	1.75	.40	930	900	0.005	0.055	15
CK1039	1.75	.40	1230	1200	0.005	0.100	25
CK5651*	2.13	.75	115	87	1.5	3.5	3
CK5651WA*	2.13	.75	115	84.5	1.5	3.5	2
CK5783*	1.63	.40	125	87	1.5	3.5	3
CK5783WA*	1.63	.40	125	86	1.5	3.5	3
CK5787	2.06	.40	135	100	5.	30.	6
CK5787WA	2.06	.40	135	100	5.	25.	4
CK5962	2.69	.75	730	700	0.002	0.055	15
CK6213	1.38	.40	200	130	1.0	2.5	2

● NOTE: Type OB2WA now available to MIL specifications.

*Voltage Reference Tube

RAYTHEON

Excellence in Electronics

RAYTHEON MANUFACTURING COMPANY

Receiving Tube Division — Home Office: 55 Chapel St., Newton 58, Mass. Bigelow 4-7500
For Application Information Write Or Call The Home Office Or: 4935 West Fullerton Avenue, Chicago 39, Illinois, NAtional 2-2770
589 Fifth Avenue, New York 17, New York, Plaza 9-3900 ● 2419 South Grand Avenue, Los Angeles 7, California, Richmond 7-4321

RAYTHEON *MAKES* ALL THESE:

RELIABLE SUBMINIATURE AND MINIATURE TUBES · SEMICONDUCTOR DIODES AND TRANSISTORS · NUCLEONIC TUBES · MICROWAVE TUBES · RECEIVING AND PICTURE TUBES

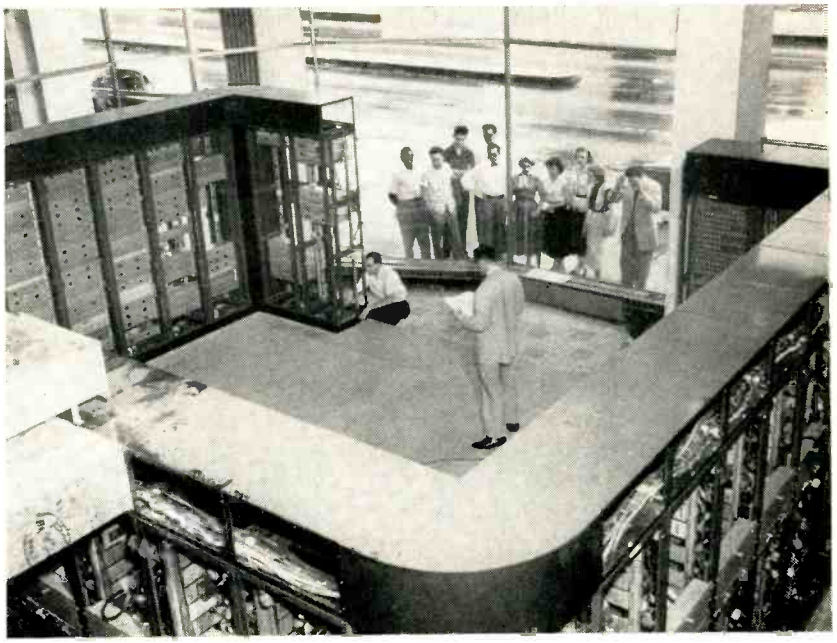
available, there is always less trouble reported than when an average electrician does the servicing.

► **Handling Breakdowns**—Besides building equipment well, there are two tricks for keeping customers satisfied and equipment working. Most manufacturers provide an adequate instruction manual complete with circuit diagrams, typical voltage readings and sometimes oscillograms. Most successful is the list of symptoms, their probable cause and where to look for faulty components. The other trick is getting a badly damaged instrument repaired fast.

Outfits like General Radio prefer to get the equipment into the factory or an authorized service organization where standards are quickly available. Such organizations usually have district engineering offices where customers can discuss ailments over the telephone or bring equipment for first aid by the resident engineer. One distressed visitor who had been making a hundred dollars a day on sound-level measurements got his meter repaired thus in an hour. Other equipment manufacturers may have eight or ten manufacturers' representatives throughout the country who can take care of almost all but the basket cases.

Straight industrial controls are another matter. Because they are more likely to be used under factory than research conditions, companies like Brown Instrument find it desirable to maintain some 50 offices throughout the country from which technicians can be dispatched. Plant people are eligible for a free training course.

► **Service Organizations**—In existence, but not noticeably on the increase, are independent service organizations. According to one manufacturer, growth of this service has not been appreciable during the last ten years. They are predominantly in metropolitan areas where business is plentiful. Some repairmen complain that manufacturers don't like them—want to hoard customer contacts to effect replacement sales.



MORE centers like this one at Burroughs Corp. are being set up as . . .

Computer Applications Multiply

Problems being solved range from Bible study to editorial space analysis

INDICATION of growing use of computers for all types of research is seen in the following list of some of the specific and general types of problems that the devices have worked on:

Automatic dictionary design for translating foreign languages into English
Ball bearing design involving determination of the components of stresses and deformation of two elastic bodies in contact
Adaptation of automatic digital computer to accounting and record keeping
Computation of mathematical tables
Determination of lens design
Bible study to determine which of several Greek manuscripts copies best represent the unknown original
Design of computers for inventory control
Factory control and utility customer billing
Engine life surveys
Airline scheduling
Pipe flange design
Management employment surveys
Matrix algebra
Editorial space analysis
Overhead cost allocation
Budgetary computations
Missile design
Auto traffic-light control
Punch press control
Toll road computations
Weather forecasting
Payroll computations
A-c network calculations
Census report computations

► **Cost**—One computer manufacturer, with a computer service center in operation about 15 months, has completed over 200 jobs for a wide variety of companies. Biggest customers for computer work have been aircraft manufacturers and designers. But electronic manufacturers, telephone companies, government agencies including the armed forces and the Department of Commerce have also been substantial users.

Actual computing time, not including setup, for the wide variety of problems done by centers has ranged from as little as 2 minutes to over 100 hours. At an average rental rate of $300 per hour, the cost per job has thus ranged widely.

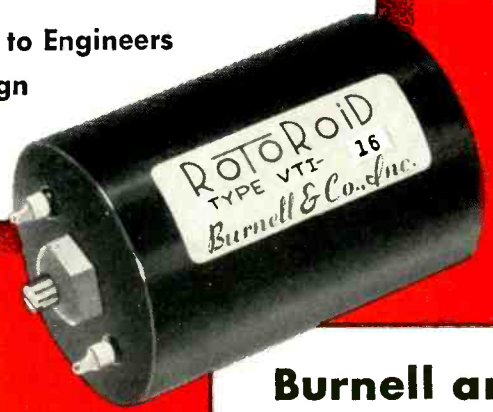
Set Manufacturers Gear Production To Sales

DESPITE higher retail tv set sales throughout the first half of this year, set makers have clamped down drastically on tv receiver output to get rid of inventory built up in 1953's last quarter. How overloaded the industry has been is indicated by the fact that while tv sales through June were 30,000 units above last year's volume for the six months, set production for

(Continued on page 22)

An Announcement

of the Utmost Importance to Engineers Doing Research and Design Work in the Entire Audio Frequency Range.



Burnell and Co., Inc.

is proud to announce the development of *an entirely new product*—

ROTOROID®

a Variable Toroidal Inductor (patent applied for)

ROTOROID will prove to be a valuable aid in the solution of many engineering problems—in research and design—and opens new possibilities for production which were previously impractical or impossible.

ROTOROID

- . . . is a continuously variable, stepless toroidal inductor which can provide a 3:1 range of maximum to minimum inductance in 180° rotation of a shaft.
- . . . employs no mechanical resistance contacts and is therefore free of noise and wear.
- . . . requires no DC saturating currents and thereby eliminates the need for circuitry.
- . . . is applicable over the entire audio range (from approximately 300 cps). ROTOROID is not limited to any stock value of nominal inductance. It is available in any value of inductance now available in regular toroids.
- . . . is hermetically sealed and is vibration and shock-proof, can be chassis or panel mounted.

Write Department C for further information.

Burnell & Co., Inc.
Yonkers 2, New York

PACIFIC DIVISION: 720 Mission Street, South Pasadena, California

An outstanding feature of ROTOROID is that, at maximum inductance, it provides the full Q of the toroid it contains. Thus, the user is at once able to take advantage of the high Q characteristics of toroids while at the same time having available a variable inductor not previously available in a toroid.

Applications: Virtually unlimited. Just a few of the many possible uses of ROTOROID are:

- **Tunable Audio Oscillators**
- **Variable Z Devices**
- **Servo Systems**
- **Telemetering**
- **Adjustable Selective Networks**
- **Variable Phase Shift Networks**
- **Variable Filters**
- **Electro-Mechanical Control Systems**

Availability: Immediately available: ROTOROIDS VTI-16 and VTI-3 which are equivalent in electrical characteristics to Burnell toroids TC-16 and TC-3 in cases 2¼" in diameter, 3-1/16" long. Soon to be available: two miniature types equivalent to Burnell toroids TCO and TC-6.

FIRST IN TOROIDS AND RELATED NETWORKS

the period was off 26 percent compared to last year.

► **Difference**—In the first six months of this year tv set output only exceeded tv retail sales by some 39,000 units. Last year for the same period, units produced surpassed units sold at retail by over 1 million.

The month-by-month comparison shows the picture in more detail. For January and February, retail sales exceeded production by over 400,000 sets. For the same months last year, however, production was ahead of sales by over 250,000 units. In March, April and May of this year production in each month stayed ahead of sales by some 85,000 units, compared to an excess of about 200,000 units in each of the months last year. Not until June of this year did tv set production pass output for the same month a year ago. It also exceeded sales by 192,257, by far the largest margin for the year.

Industry Shorts

► **Extension** of effective date for compliance by r-f arc welders to FCC rules on r-f radiation has been moved ahead one year, to July 31, 1954. Industry committee is working on methods to reduce interference from such machines.

► **Radio astronomy** research grant of $250,000 has been awarded to Australian scientists by Carnegie Corp. of New York, part of which will be used to construct a parobolic reflector 250 feet in diameter and some 60 feet deep.

► **Largest** percentage of tv set buying in 1953 was done by the $7,500 and over income group, which accounted for 21 percent of purchases. The $4,000 to $5,000 and $5,000 to $7,500 income groups each purchased 19 percent, according to Admiral.

► **Royal assent** was given in July to Britain's television bill setting up an Independent Television Authority to provide for 10 years of commercial tv broadcasting services.

MEETINGS

SEPT. 8–11: Symposium on Propagation, Standards and Problems of the Ionosphere, Laboratories of the National Bureau of Standards, Boulder, Col. sponsored by the NBS Central Radio Propagation Lab.

SEPT. 13–24: First International Instrument Congress And Exposition, Commercial Museum and Convention Hall, Philadelphia, Pa.

SEPT. 15–17: Symposium on Information Theory, MIT, Cambridge, Mass., Sponsors, IRE, AIEE, URSI, ONR, ARDC, SCEL.

SEPT. 16–18: Joint Electron Tube Engineering Council, General Conference, Chalfonte-Haddon Hall, Atlantic City, N. J.

SEPT. 17–18: IRE Conference on Communications, Cedar Rapids, Iowa.

SEPT. 29–30: IRE Symposium on Industrial Electronics, Mellon Institute, Pittsburgh Pa.

SEPT. 30–OCT. 1: Fifth Annual Meeting of the IRE Professional Group on Vehicular Communications, Rice Hotel, Houston, Texas.

SEPT. 30–OCT. 2: Second Annual International Sight and Sound Exposition, Palmer House Hotel, Chicago, Ill.

OCT. 4–6: National Electronics Conference, Hotel Sherman, Chicago.

OCT. 6–7: First National Annual Meeting of the IRE Professional Group on Nuclear Science. Hotel Sherman, Chicago.

OCT. 13–17: Annual Convention, Audio Engineering Society, Hotel New Yorker, New York, N. Y.

OCT. 14–17: Audio Fair, Hotel New Yorker, New York, N. Y.

OCT. 18–20: Radio Fall Meeting, Hotel Syracuse, Syracuse, N. Y.

OCT. 21–23: Eighth New England Conference of the American Society for Quality Control, Ten Eyck Hotel, Albany, N. Y.

OCT. 22–24: First Annual New England High Fidelity Music Show, Hotel Touraine, Boston.

OCT. 26–28: The Second National Conference on Tube Techniques, Western Union Auditorium, New York, N. Y. Sponsors, Department of Defense.

OCT. 27–30: Thirtieth Annual Convention, National Association of Educational Broadcasters, Hotel Biltmore, New York, N. Y.

NOV. 4–5: East Coast Conference on Airborne and Navigational Electronics. IRE, Sheraton-Belvedere Hotel Baltimore, Md.

NOV. 8–10: Symposium On Modern Advances In Microwave Techniques, Engineering Societies Bldg., New York City.

NOV. 10–11: Conference on Electronic Instrumentation and Nucleonics in Medicine, Morrison Hotel, Chicago, Ill.

NOV. 12–13: National Symposium on Quality Control Methods In Electronics, IRE and American Society for Quality Control, Hotel Statler, New York, N. Y.

NOV. 18–19: Sixth Annual Electronics Conference, Kansas City IRE, Hotel President, Kansas City, Mo.

NOV. 29–DEC. 2: First International Automation Exposition, 244th Coast Artillery Armory, New York, N. Y.

DEC. 8–10: Eastern Joint Computer Conference & Exhibition, Bellevue-Stratford Hotel, Philadelphia, Sponsors, IRE, AIEE, ACM.

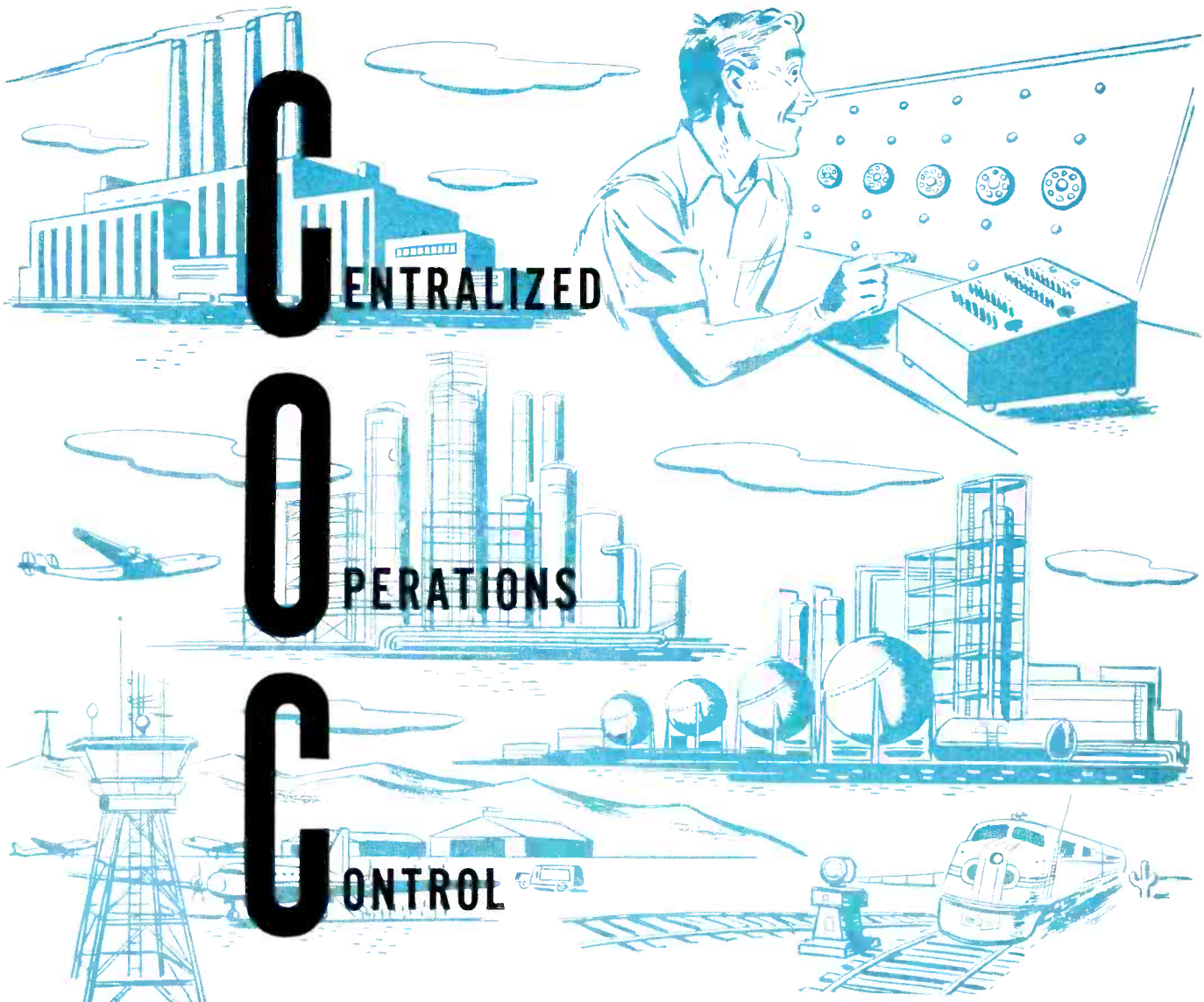
JAN. 17–19, 1955: Fourth Biennial Conference On High Frequency Measurements, IRE, AIEE, URSI, NBS, Washington, D. C.

► **Entertainment** tube type with largest factory sales volume for June was the 6CB6 with total sales of 1.9 million units, according to RETMA.

► **Comparison** of the number of radio listeners and tv viewers in Britain during hours when both services are on the air showed that tv claimed 44 percent of the audience and radio 56 percent. For the same period in 1953 the proportions were 34 percent tv and 66 percent radio.

► **CAA** will provide pilots in southwest U. S. with weather information obtained from civil and military radar on a 90-day trial basis. Almost 200 radars, worth an estimated $25 million, are being operated by the Air Force, Navy and Weather Bureau.

► **Americans** will own an estimated 7½ million color sets in 1957 and 37½ million in 1964, according to GE tube department research estimates.



THIS IS COC. If your operation is spread out across several acres, miles, counties or even states, and you need control from a single point, you need "COC"—Centralized Operations Control.

If your operation is confined to just one plant or area, but with many points where careful control must be exercised, you need "COC"—Centralized Operations Control.

COC can open a valve or start a pump 500 miles from the control point or it can indicate a liquid level in a tank in your plant yard.

There are varying degrees of COC.

Coming under this broad classification is the Hammarlund "Multi-Gate"® System which provides complete remote control and metering of such quantities as flow, temperature, pressure and voltages, as well as furnishing switching, warning alarms and various On-Off indications for pipelines, refineries, chemical plants, railroads, public utilities and many other industries. And these operations can be performed over radio, microwave, wire or carrier.

Other Hammarlund remote-control systems are used by airlines and commercial broadcast stations to control unattended transmitters located away from the tower or studio.

Hammarlund "Fleet Control" and Selective Calling Units control the movements of radio-equipped vehicles efficiently and dependably.

Hammarlund "COC" is so broad that it can be adapted to handle practically any problem of remote supervisory control. For more information on COC write The Hammarlund Manufacturing Co., Inc., 460 West 34th Street, New York 1, N. Y. Ask for Bulletin CC-1.

HAMMARLUND

SINCE 1910

How to keep informed on the "with what" part of your business

AT YOUR FINGER TIPS, issue after issue, is one of your richest veins of job information – advertising. You might call it the "with what" type – which dovetails the "how" of the editorial pages. Easy to read, talking your language, geared specifically to the betterment of your business, this is the kind of practical data which may well help you do a job quicker, better – save your company money.

Each advertiser is obviously doing his level best to give you helpful information. By showing, through the advertising pages, how his product or service can benefit *you* and *your* company, he is taking *his* most efficient way toward a sale.

Add up all the advertisers and you've got a gold mine of current, on-the-job information. Yours for the reading are a wealth of data and facts on the very latest in products, services, tools . . . product developments, materials, processes, methods.

You, too, have a big stake in the advertising pages. Read them regularly, carefully to keep job-informed on the "with what" part of your business.

McGRAW-HILL FOR BUSINESS

McGRAW-HILL PUBLICATIONS

Now Maintain 100% Modulation Without Danger Of Distortion With NEW PEER Regulated Output Amplifier

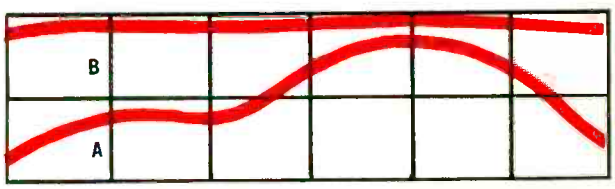
MANY USES

Hundreds of these amplifiers are now being used by the United States and other governments for critical applications in air navigational control.

Now available as a standard stock item at a production price for use by air lines, police radio, commercial communications systems, "professional" amateurs, and others. Suggested uses are:

Input to any voice radio transmitter
Input to recorder
Input to filter or landline
Input to PA system
Input to any equipment where it is desired to hold the modulating level close to, but not exceeding, a maximum.

The Peer Model CA-1503 Regulated Output Amplifier enables the utilization of maximum modulation (between 95% and 100%) without danger of over-modulation, distortion, hash, or radiation of interfering signals. In contrast most compression amplifiers offer at best only 75% modulation utilization, while non-regulating amplifiers require maintenance of modulation level at 25% to avoid over-modulation or distortion. The Peer Regulated Output Amplifier eliminates "riding the gain" and does an all-around much better job, especially for speech transmission, since it automatically compensates for normal variations in voice and speaking attitude.



Amplifier Modulation Output "A" shows average modulation level without regulated output amplifier (approx. 25% modulation utilization). "B" indicates average modulation level with the model CA-1503 amplifier (95% modulation utilization).

STANDARD FEATURES:

Gain 85 db which is adequate for all standard microphones (can be supplied with up to 100 db gain on special order).

Automatic regulating feature holds the output within less than 1 db with variations in input of 20 or more db. Instantaneous increase in input of 20 db causes only a 3 db transient in output which exists for only 1 millisecond. When input is suddenly decreased 20 db, 63% recovery will be obtained in .5 seconds. This is the most advantageous rate for normal speech service but other rates can be provided on special order.

Regulating level can be set for any output level over a 25 db range (normal factory setting is for regulation at 100 mw output).

Output level is nominally 100 mw, but can be increased to 200 mw or decreased to any value—suitable for most transmitting equipment, recorder, and landline applications. Output is brought out in two 150 ohm sections which may be used individually or connected in series for 600 ohm termination. Separate windings allow insertion of series balanced filter if desired (such as instances where the output line is also used for control or signalling purposes).

Automatic balancing circuit maintains balanced push-pull gain, even though tube unbalance may exceed 20 db, without increase in distortion.

Frequency response linear within ±½ db 200-5000 cps.

Precision step attenuators provided in both the input and output. Input attenuator provides maximum of 43.5 db in 1.5 db steps. Output attenuator adjustable in 6 steps over a 20 db range.

Hum and noise level below −50 db (can be made lower on special order).

Total harmonic and hum distortion less than 1%.

Input impedance 25 ohms (±2 ohms) over entire frequency range—matches most moving coil microphones. Also has built-in 600/25 ohm matching pad for connecting to a 600 ohm line (pad decreases total gain by 20 db). Input has reactive component of less than 10% allowing satisfactory use following critical filter circuits. Other input impedances available on special order. 25 ohm input available from front panel jack and rear terminal strip. 600 ohm input available only on rear terminal strip.

Front panel equipment includes accurate meter indicating the degree of regulation, and standard precision VU output meter. Internal switch allows connecting the monitor circuit to an external VU meter if desired, and terminals are provided for this on the rear terminal strip. The input attenuator and auxiliary microphone jack are also located on the front panel.

Constructed entirely of aluminum with chassis seams welded. Generous utilization of nickel alloy transformer cores allows weight reduction to under 15 lbs. Mounted on standard 19" equipment rack panel. Dimensions 19" W x 6--31/32" H x 10⅜" D.

Conservative Design for continuous unattended operation. Hermetically sealed transformers and condensors—construction and components meet MIL specifications. Uses miniature individually shielded tubes and all tubes operate well below maximum ratings for long life. All three stages are push-pull.

Standard finish of front panel is black wrinkle, with bright etched aluminum surfaces elsewhere. Other finishes available on special order. Furnished complete with one set of tubes and detailed instruction manual. Net weight 14.5 lbs, shipping weight 27.5 lbs. Standard voltage 115 volts, 60 cycles. Power requirement 24 watts.

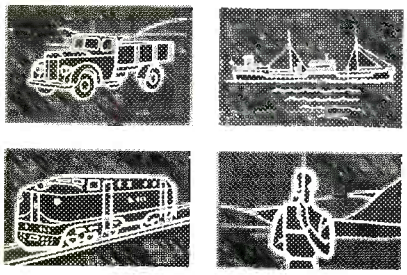
***Price F.O.B. Benton Harbor* $295.00** IMMEDIATE DELIVERY

PEER INCORPORATED BENTON HARBOR, MICHIGAN

REPORTER

MOBILE RADIO TELEPHONE

For Engineering Communications



● The "Reporter", a compact and economical equipment designed to fit neatly under vehicle dashboards. Also available in transportable form or for use as a fixed station.

In civil engineering, control of mobile vehicles and personnel is all important. The Pye "Reporter", by providing an ever-present link to administrative H.Q., is of inestimable value in speeding up all remote operations and achieving vast economies in plant and manpower. Reason enough that it should feature so prominently in over two thirds of the V.H.F. schemes in the United Kingdom.

Telecommunications

Pye (New Zealand), Ltd., P.O. Box 2839, Auckland C.1, New Zealand.

Pye Canada, Ltd., Ajax, Ontario, Canada.

Pye-Electronic Pty. Ltd., 65 Park Street, Abbotsford, Melbourne, Victoria, Australia.

Pye Ireland, Ltd., Manor Works, Dundrum, Dublin, Eire.

Pye Radio & Television (Pty.) Ltd., P.O. Box 10648, Johannesburg, South Africa.

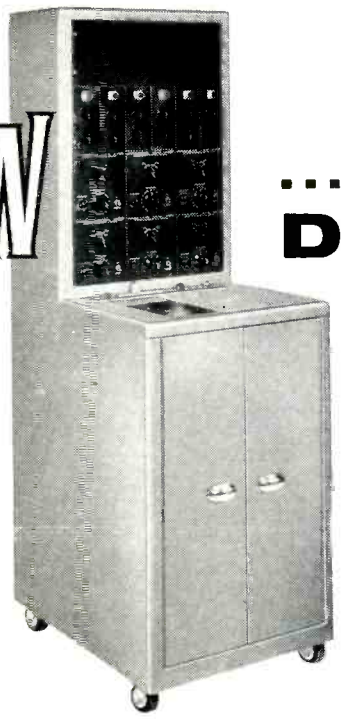
PYE LIMITED • • CAMBRIDGE • • ENGLAND

E.4

The new Type M Dynograph Recorder is a high speed direct writing oscillograph providing exceptionally high, absolutely stable, d-c or a-c amplification. It may be used with reluctance type pick-ups without auxiliary equipment. The exceptional stability, sensitivity, and versatility of the Dynograph allow simultaneous direct recordings of a very wide variety of transient variables such as temperature, speed, position, pressure, acceleration, vibration and strain.

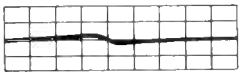
The Type M employs individual plug-in amplifiers; and input panels provide all connections for various types of signal pick-ups. It is the most advanced equipment for your direct-writing recording problems.

NEW ...OFFNER TYPE M DYNOGRAPH RECORDER

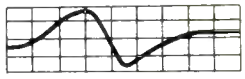


WHY THE DYNOGRAPH? For almost every application of direct writing oscillographs, those who have compared features of competitive instruments have chosen the Dynograph—because:

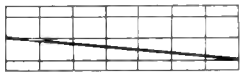
The Dynograph provides thirty times the d-c sensitivity of competitive instruments.* Instead of a barely readable record like this:



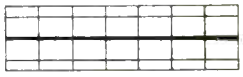
The Dynograph gives a large, easily read record like this:



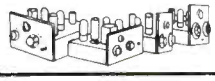
Yet while competitive recorders drift 1 mv per hour* or more



the Dynograph is absolutely non-drifting,

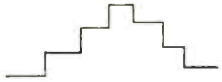


Other recorders require additional amplifiers or preamplifiers for moderate gain d-c; for high gain d-c; for carrier applications (strain gauges or reluctance bridges).

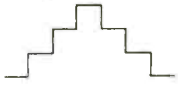


With the Dynograph, one amplifier covers all applications—and does a better job on each!

Pen friction and low torque gives hysteresis on many recorders.



There is no measurable hysteresis on the Dynograph.



Limited pen travel makes recording of large dynamic variations difficult.

Over 8 cm of pen excursion is available in the Dynograph.

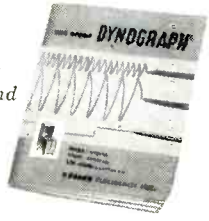
Even at moderate sensitivities, other assemblies require considerable warmup time for stabilization.

The Dynograph is stable as soon as it is working.

* Based on manufacturer's published claims.

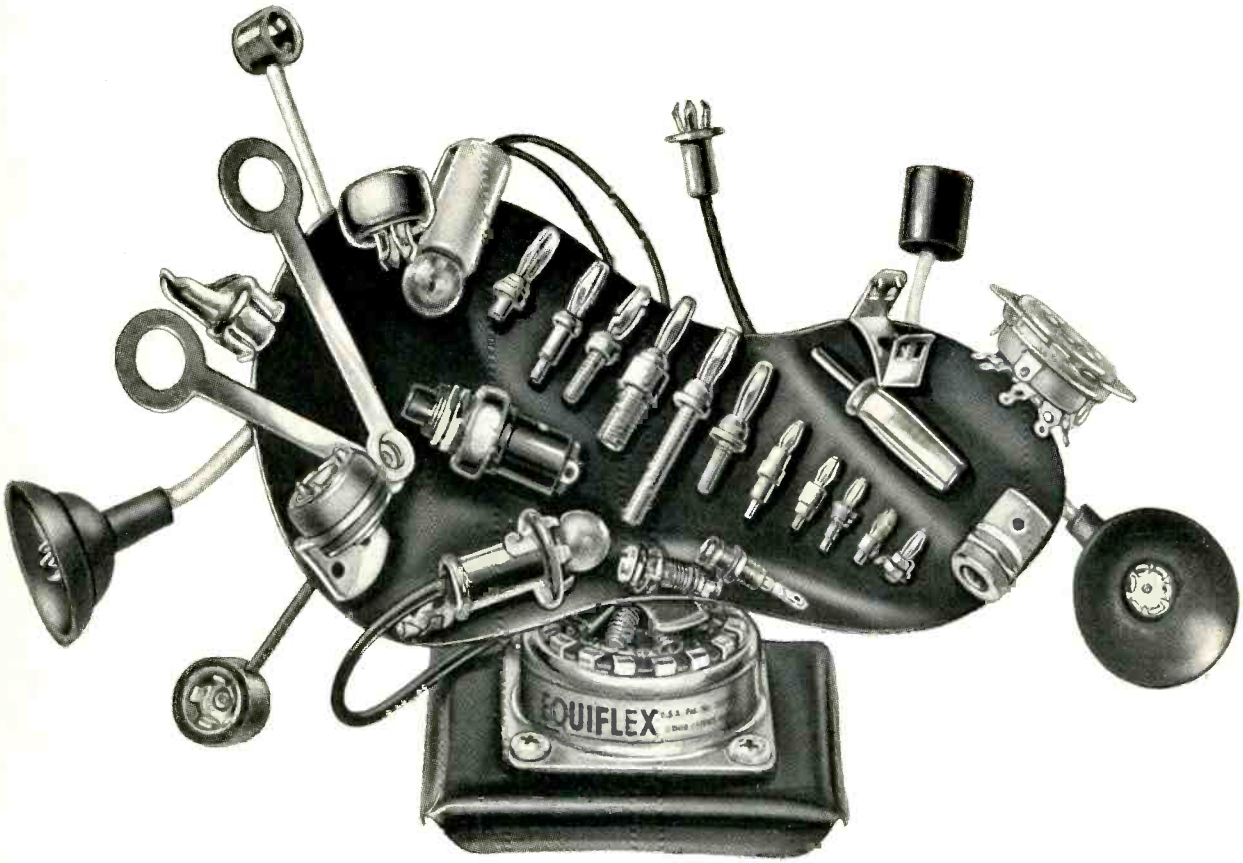
COMPARE AND YOU WILL SELECT THE DYNOGRAPH

Eight page, 2 color bulletin describes technical details and application information. Write for your copy of Bulletin L-742.



OFFNER ELECTRONICS INC.

5324 N. Kedzie Ave., Chicago 25, U.S.A.



Kinzoid Potentiometer

Secret of this formidable device is a built-in correlator which enables it to analyze cocktail conversation, measure the potential in any given situation, and answer the jackpot question. Table model, illustrated, requires higher voltages than are generally available. Battery powered portable models are under development. Component parts may be purchased in quantity from Ucinite, however, and can be wired to your specifications.

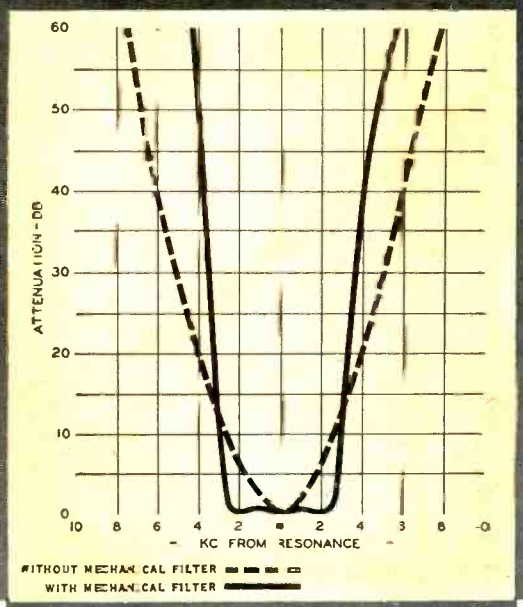
With an experienced staff of design engineers, plus complete facilities for volume production, Ucinite is capable of supplying practically any need for metal or metal-and-plastics assemblies... switches, connectors, shock mounts and small electrical parts of all kinds. Call your nearest Ucinite or United-Carr representative for full information or write directly to us.

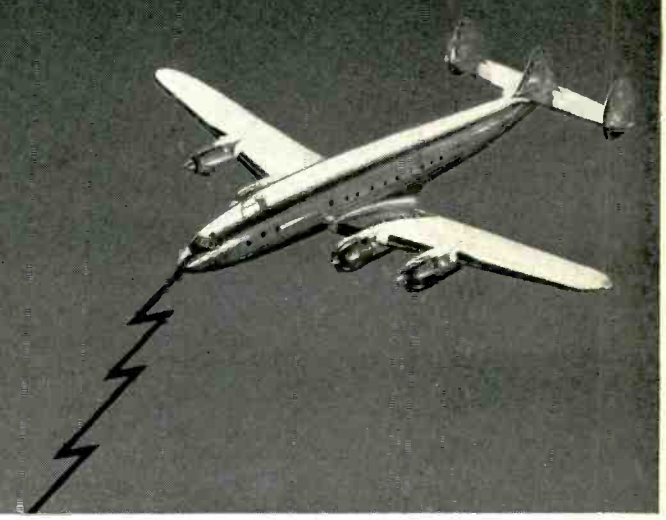
ELECTRICAL ASSEMBLIES
Ucinite
RADIO AND AUTOMOTIVE

The UCINITE CO.
Newtonville 60, Mass.
Division of United-Carr Fastener Corp.

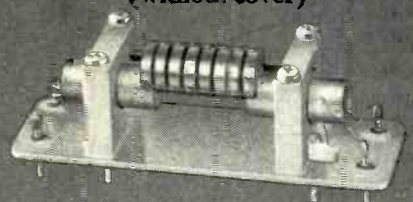
Specialists in
ELECTRICAL ASSEMBLIES,
RADIO AND AUTOMOTIVE

The Collins Mechanical Filter for MAXIMUM SELECTIVITY





Collins Mechanical Filter (without cover)



Collins 18S-4 Transmitter/Receiver

Today's expanded air-ground radio communications have greatly increased the problem of adjacent channel interference. It has become increasingly difficult to control sideband radiation and maintain good channel selectivity.

Collins has solved these problems by incorporating the Mechanical Filter in the Collins 18S-4A HF Transmitter/Receiver. The Mechanical Filter, recently developed by Collins, produces a better signal-to-noise ratio — greatly increases channel selectivity — practically eliminates adjacent channel interference. The effect of the Mechanical Filter on the 18S-4A's selectivity is clearly shown on the accompanying graph.

Collins 18S-4A provides both receiving and transmitting facilities — up to twenty crystal controlled frequencies assigned anywhere in the range of 2.0 to 18.5 mc. Transmitter output, nominally rated at 100 watts cw or voice, is sufficient to assure communication over very long distances. Full remote control is provided over a positive 26-wire system. The proven performance of the Collins 18S Transceivers coupled with the increased selectivity afforded by the Mechanical Filter in the 18S-4A offers aviation the most advanced transmitting-receiving equipment available today.

For additional information on the Collins 18S-3 or 18S-4 or the Collins Mechanical Filter line, now available to industry, contact your nearest Collins office. Technical brochures will be forwarded on request.

For complete information and technical details, contact the Collins office nearest you.

COLLINS RADIO COMPANY Cedar Rapids, Iowa

261 Madison Ave., NEW YORK 16 | 1930 Hi-Line Drive, DALLAS 2 | 2700 W. Olive Avenue, BURBANK

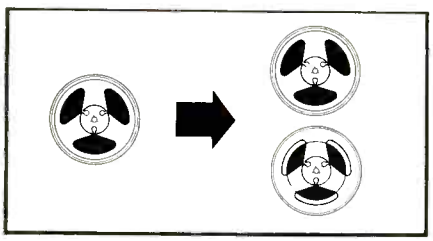
COLLINS RADIO COMPANY OF CANADA, LTD., 74 Sparks Street, OTTAWA, ONTARIO

COLLINS

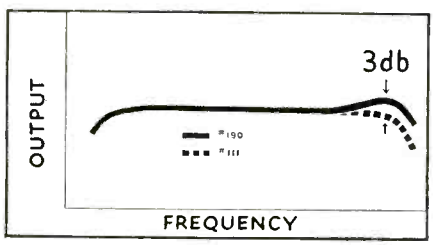
New Extra Play tape gives 50% more recording time!

A revolutionary development for radio stations, recording studios—in fact all users of magnetic tape! New "Scotch" Brand Extra-play Magnetic Tape 190A makes it possible to record entire symphonies, lengthy news and sports events without stopping for reel change. With 50% more tape on each reel, new Extra-play tape offers the same recording time found on 1½ reels of standard tape.

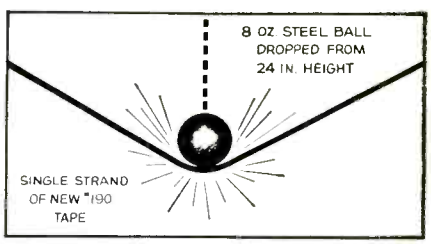
Exclusive feature of new "Scotch" Brand 190A tape is a thinner magnetic coating. Made of high-potency oxide, the new coating has been reduced from standard 0.6 mils to 0.3 mils and the high frequency range extended appreciably. A 30% thinner tape backing offers more uniform hi fi response with crisper, cleaner tones, yet maintains "Scotch" Brand's reputation for sturdy, long-life tape construction.



EXTRA THIN TAPE—50% thinner, more potent oxide coating, 30% thinner backing permit more 190A tape to be wound on standard-size reel. Result: one roll of new tape does job of 1½ reels of standard tape.



INCREASED FREQUENCY range of new Extra-play tape enables tape machines to produce recordings with greater hi fi response than formerly possible with most conventional magnetic tapes.

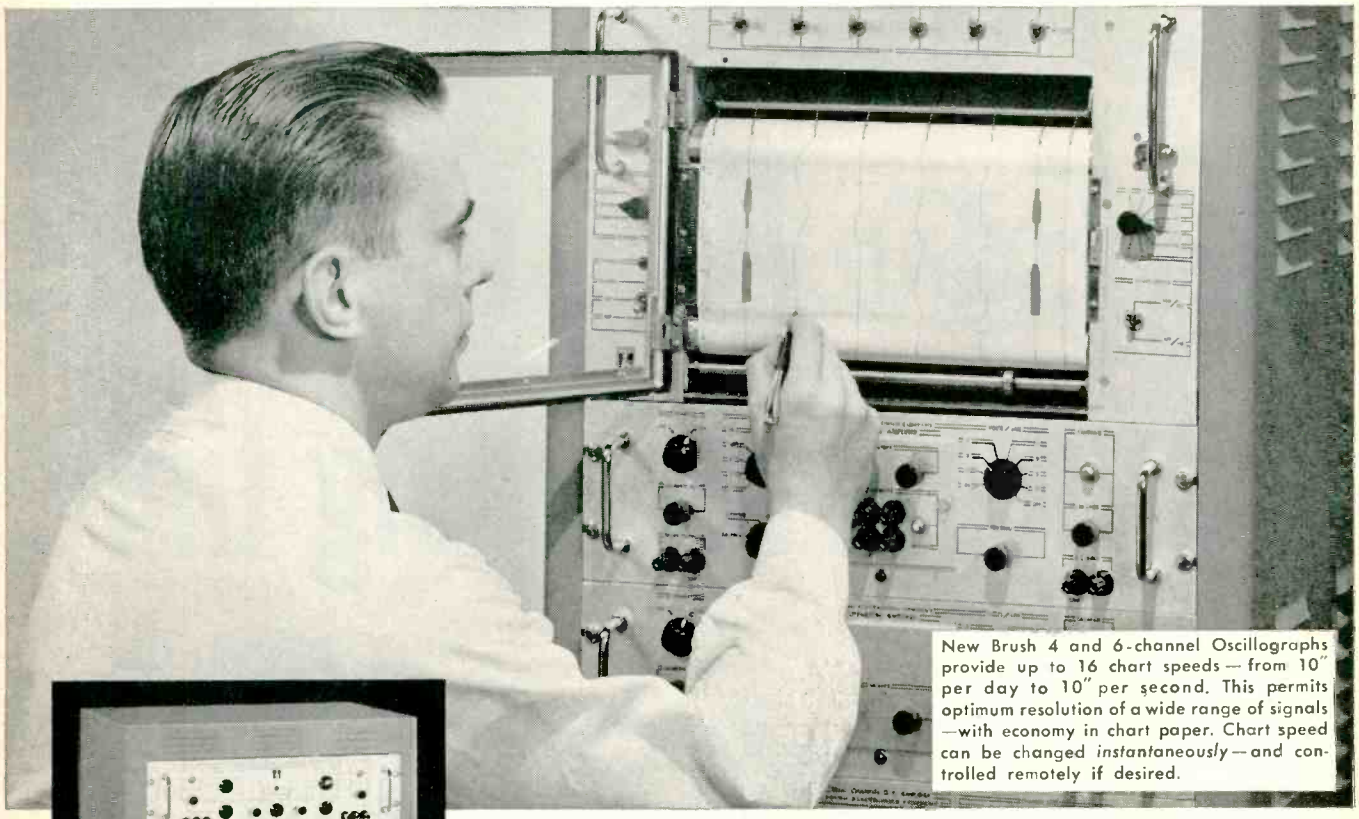


STRENGTH TO SPARE—New 190A tape stands up under even grueling steel ball drop test. Naturally it's tough enough to withstand severe stresses of sudden machine stops, starts and reverses.

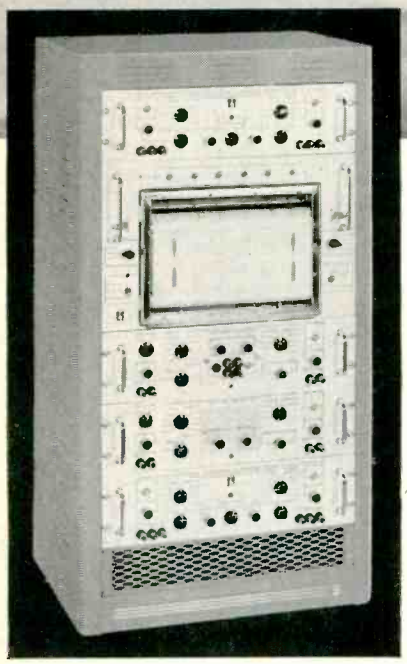
NEW! REG. U.S. PAT. OFF. SCOTCH BRAND Extra Play Magnetic Tape 190A

The term "SCOTCH" and the plaid design are registered trademarks for Magnetic Tape made in U.S.A. by MINNESOTA MINING AND MFG. CO., St. Paul 6, Minn. General Export: 122 E. 42nd St., New York 17, N. Y. In Canada: London, Ontario, Canada.

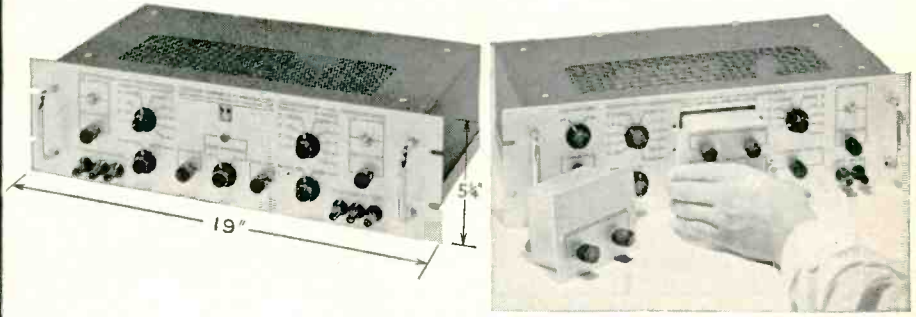
FULL RANGE INSTRUMENTATION!



New Brush 4 and 6-channel Oscillographs provide up to 16 chart speeds — from 10" per day to 10" per second. This permits optimum resolution of a wide range of signals —with economy in chart paper. Chart speed can be changed *instantaneously* — and controlled remotely if desired.



NEW BRUSH RECORDING SYSTEMS *offer you greatest flexibility in measurements*



New Brush Recording Systems are designed to meet many mounting requirements — standard 19-inch racks, bench-top, or floor consoles. New Brush Amplifiers are lighter, smaller and can be stacked closely as shown.

Above: New Brush dual-channel D. C. Amplifier Model BL-530 accepts either single ended or balanced signals, provides a 50 millivolt sensitivity and accurate calibration of the signal to be recorded.

Right: New Brush Universal* Amplifier Model BL-520, when used with the appropriate resistive or inductive transducer, permits measurement and direct recording of physical phenomena: strain, torque, force acceleration, velocity, displacement, pressure, temperature, etc. Maximum sensitivity is equivalent to ½ microvolt per chart millimeter; or in strain measurements — .25 microinch per inch. The Amplifier includes a medium gain direct-coupled amplifier section with calibrated attenuator that may be used separately for voltage and current measurements.

*Trade Mark

Brush Recording Systems have an important place in your research and production instrumentation. Write today or call your nearby representative for complete information. Brush Electronics Co., Dept. K-9A, 3405 Perkins Avenue, Cleveland 14, Ohio. In Canada: A. C. Wickman, Ltd., Toronto.

BRUSH ELECTRONICS COMPANY

INDUSTRIAL AND RESEARCH INSTRUMENTS
PIEZO-ELECTRIC MATERIALS • ACOUSTIC DEVICES
MAGNETIC RECORDING EQUIPMENT
ULTRASONIC EQUIPMENT

formerly
The Brush Development Co.
Brush Electronics Company
is an operating unit of
Clevite Corporation.

Potter & Brumfield
RELAYS
SIMPLE • RELIABLE • LOW COST

PLATE CIRCUIT SERIES "LB"

The simplicity of the LB design provides the lowest possible cost for a sensitive relay built for long life and unfailing reliability.

1. Coils up to 34000 ohm winding
2. Sensitivity to 3 MA pull-in current (approximately .09 watt)
3. SPDT silver contacts rated 5 amps (¾ HP) with ample wipe
4. Breakdown tested to 500 V RMS
5. Centrifugally varnish impregnated coil
6. One piece back spring and contact arm
7. Laminated base—screw or rivet mount
8. Tinned solder terminals
9. Permanent air armature gap precludes residual sticking
10. Readily readjustable for pull-in
11. Dimensions 2⅝″ x 1″ x 1⅜″ high—mounting holes 2¼″ centers

APPLIANCE SERIES "MW"

The MW general purpose appliance relay is most inexpensive to buy but will serve well in a wide variety of applications.

1. Available with AC or DC coils
2. Large silver contacts rated 5 amps (¾ HP) with plenty of wipe
3. Underwriters creepage spacing
4. Breakdown tested to 1500 V RMS
5. Clip on solderless terminals
6. Heavy copper shading precludes chatter and hum
7. Molded bakelite coil bobbin
8. Laminated bakelite base
9. Varnish impregnated coil for moisture proofing
10. Mounting by either rivets or screws
11. Dimensions 2″ x 2″ x 1½″ high—mounting holes 1⅝″ centers

Samples Available for Immediate Shipment
Quotations on Request

POTTER & BRUMFIELD • PRINCETON, INDIANA

EXPORT: 13 East 40th Street, New York, New York
Sales Offices in Principal U. S. and Canadian Cities

Potter & Brumfield

offers you the benefits of

20 years' custom engineering

. . . with more than 100 Basic Relay Types!

These basic relay types have been evolved from the design and production of more than 15,000 different custom relays. Used as they are or with slight modifications they will fit most any and all applications.

Thus you are assured of:

1. **Proven Design**—P & B standard relays have been field tested under all kinds of conditions, thereby giving long, trouble-free service.
2. **Lower Costs**—Because these relays are already tooled and manufactured in production quantities—a substantial cost saving is passed along to you!
3. **Fast Delivery**—Orders for standard relays can be filled from stock or with minimum delay.
4. **Available through Distributors**—Standard types available through P & B franchised Electronic Parts Distributors in all principal cities.

Potter & Brumfield engineers are available for consultation on special relay problems—design or application.

A FEW OF THE MANY P&B BASIC RELAY STRUCTURES

POWER RELAYS Heavy (PR) and medium (MR) duty. For across the line power circuits, high current switching —SPST to 3PDT.

PR

PLATE CIRCUIT RELAYS—Actuate on few milliwatts. Fit many applications. LM series also available. From SPST to DPDT.

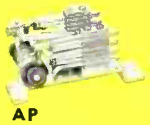
LB

SUPER SENSITIVE RELAYS Operate on less than 10 MW. Dual coils, 10G vibration resistance. Wide versatility. One Form C-SPDT.

SS

LIGHT DUTY RELAYS Small, light weight, sturdy. Withstand high vibration and shock. From SPST to 3PDT.

KR



IMPULSE RELAYS Automatic stop prevents backlash. Precise, repetitive switching regardless of operating speed. DPDT or 4PDT.

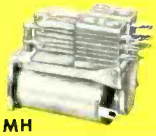
AP

400 CYCLE AC RELAYS For aircraft or ground equipment. Withstand better than 10G shock. Heavy cast mounting foot. SPST to DPDT.

AF

MULTIPLE CONTACT RELAYS—Longer coil provides power sufficient to actuate additional contacts. For multiple switching—SPST to 4PDT.

KL



TELEPHONE RELAYS Meet practically all telephone relay requirements. Many contact combinations. MH, MT, LT and ST types also available.

MH

SUPER MIDGET RELAYS—Tiny and rugged —plug-in—SPDT. High degree of resistance to vibration and shock.

SM

MULTIPLE LEAF RELAYS For temperature, indicating or protective circuits. Heavy, tin-coated phosphor bronze contact springs. From SPST to 4PDT.

SU

MOTOR STARTING RELAYS Voltage controlled to insure throwout of starting winding when motor reaches rated speed. SPST-NC or SPST-NC-DB.

MS

SUBMINIATURE SENSITIVE RELAYS Standard 7 pin plug-in. Ruggedized for vibration and shock. Operating power 25MW. Contact load 2 amps.

PW

LATCHING RELAYS Compact—high utility switching. Coils operate on AC or DC. Voltage or current. From SPST to 4PDT.

LK

HEAVY-DUTY SHOCK-PROOF RELAYS Can be mounted in any position. Particularly resistant to vibration and shock. From SPST to DPDT.

SP

MINIATURE DC POWER CONTACTOR — Heavy duty contacts, rated 60 amperes, 28 V DC, non-inductive load. Rugged construction. Withstands high vibration and shock. SPST-NO-DM.

MB

ALL P & B STANDARD RELAYS CAN BE SUPPLIED WITH DUST COVERS OR HERMETICALLY SEALED CANS WITH SOLDER OR PLUG-IN HEADERS

Write home office in Princeton or phone your local P & B Sales Office for new master catalog describing our wide line of basic relay structures, housings and enclosures. Samples, recommendations and quotations promptly furnished on special applications.

P & B Standard Relays available at your local Electronic Parts Distributor

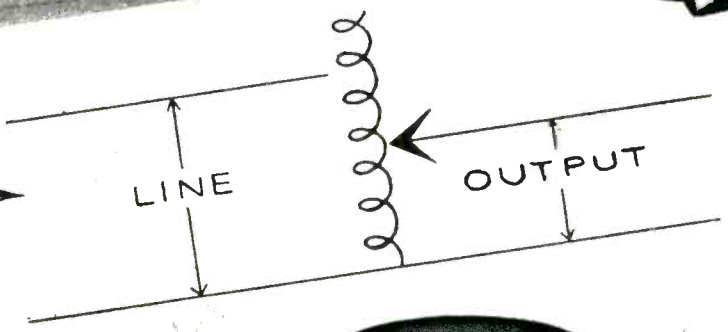
Potter & Brumfield

PRINCETON, INDIANA

EXPORT: 13 E. 40TH STREET, NEW YORK, NEW YORK

SALES OFFICES IN PRINCIPAL U. S. AND CANADIAN CITIES

For Designs that Require Adjustable A-C Voltage



Put this symbol in your circuit and a POWERSTAT Variable Transformer in your products and you'll get:—

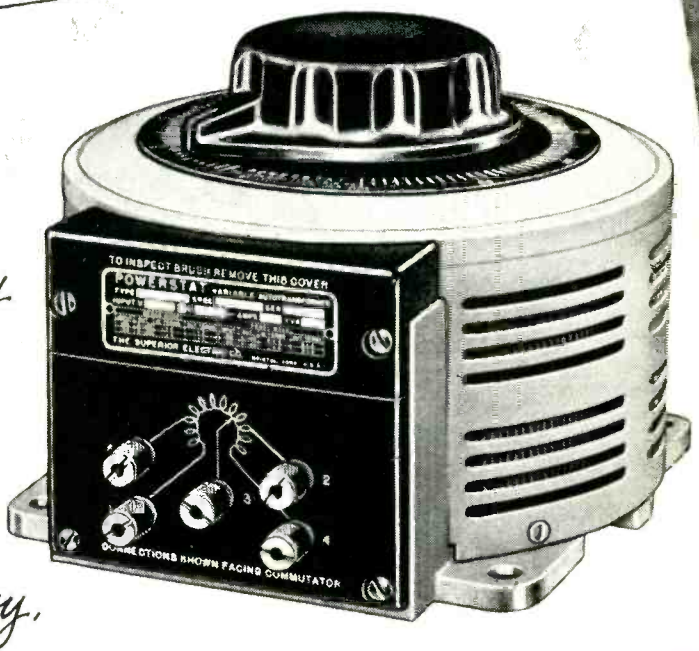
...Cool operation

...Power savings.. high efficiency

...Does not have to be tailored to the load

...Smooth control—glass smooth commutator surface

...Conservative ratings and easy, simple mounting



In many applications where you might usually use a rheostat, *investigate Powerstat variable transformer to do a better job* — and you can get a Powerstat for as little as $8.50.

You'll find Powerstats are superior. Their dimensional and physical characteristics make them easier to "design into" a product. Their conservative ratings, smooth operation and long life make them a "plus" feature of value.

For the best in continuously-adjustable voltage control use variable transformers. For the best in variable transformers always specify POWERSTATS.

You can choose from a complete standard line of Powerstat variable transformers. Units are offered in manually-operated and motor-driven assemblies for 120, 240 and 480 volt duty in capacities from 150 VA to 100 KVA.

Be sure to see Superior Electric's Mobile Display when it is in your area.

THE SUPERIOR ELECTRIC COMPANY

209 CLARKE AVENUE, BRISTOL, CONN.

Manufacturers of: Powerstat Variable Transformers • Stabiline Automatic Voltage Regulators • Voltbox A-C Power Supplies • Powerstat Light Dimming Equipment • Varicell D-C Power Supplies • Superior 5-Way Binding Posts

THE SUPERIOR ELECTRIC CO.
209 Clarke Avenue, Bristol, Conn.

Please send complete literature on Powerstat variable transformers.

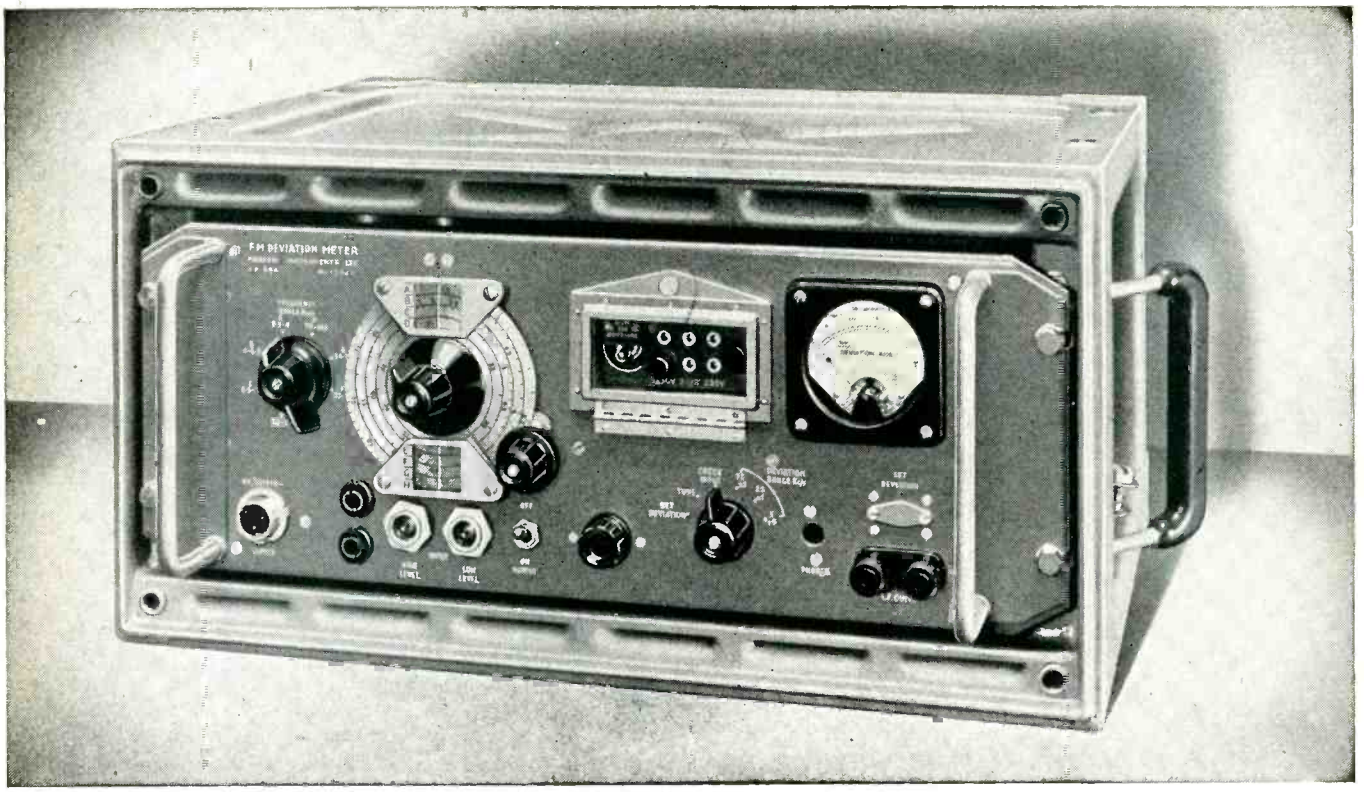
Name.....

Position.....

Company Name.....

Company Address.....

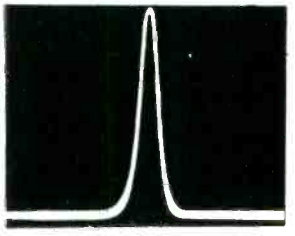
City.....Zone.....State.....



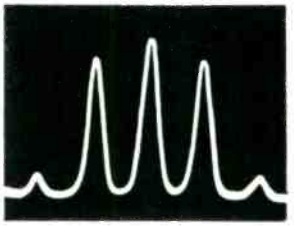
F.M. DEVIATION DIRECTLY MEASURED

THE BESSEL ZERO or "Disappearing Carrier" method of measuring deviation requires complex monitoring equipment, an accurately known modulation frequency, and, finally, mathematical interpretation of results.

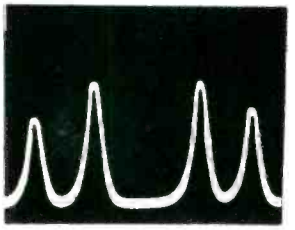
With the compact and easy-to-use Marconi Deviation Meter, the modulation frequency need not be known and deviation is directly read on a meter scale.



Unmodulated Carrier



Modulation Index 1.3



Modulation Index 2.4
The Carrier "Disappears"
BESSEL ZERO METHOD

F. M. DEVIATION METER TYPE TF 934

Carrier Frequency Range : 2.5 to 200 megacycles.
R.F. Input Level : 55 millivolts to 10 volts.
Deviation Measurement Ranges : 0 to ±5 kc, 0 to ±25 kc and 0 to ±75 kc.
Accuracy of Deviation Measurement : ±3% from full-scale to half-scale up to 12 kc and ±6% up to 15 kc.

Full data and prices of any of the items listed below will be mailed immediately on request:

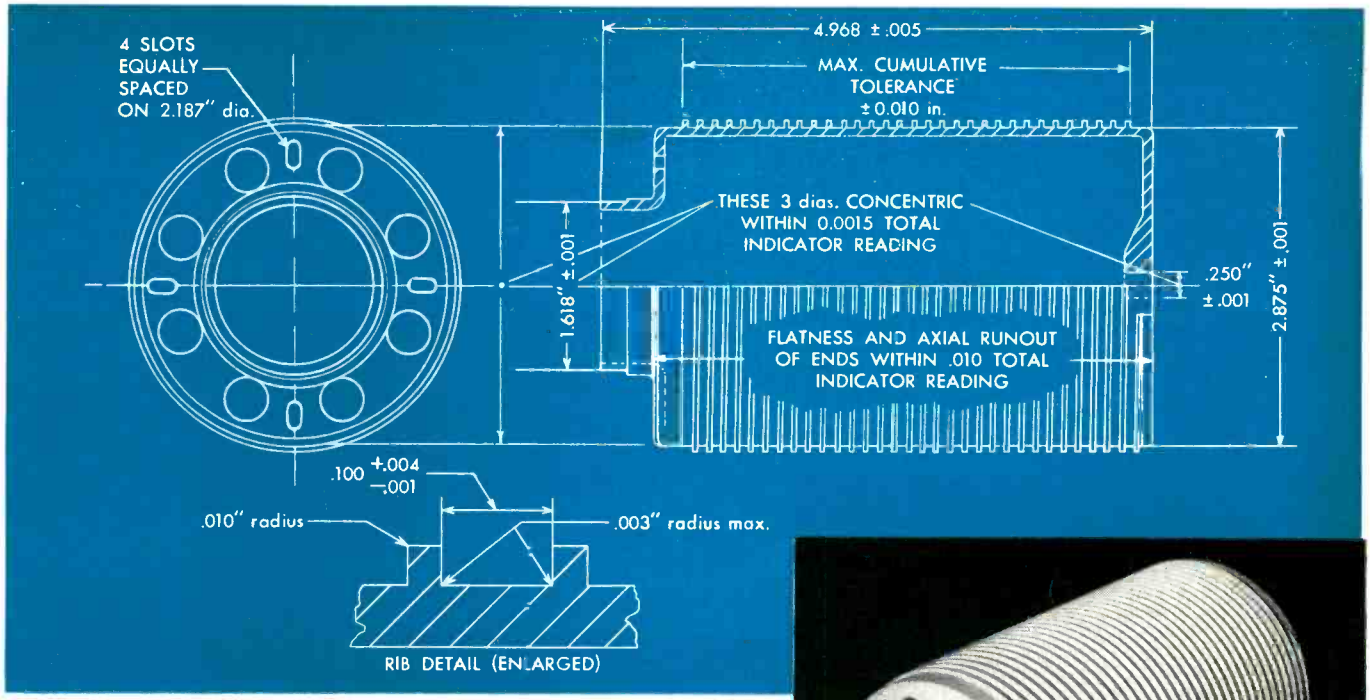
F.M. DEVIATION METER TF 934 · UNIVERSAL BRIDGE TF 868
FM/AM SIGNAL GENERATOR TF 995A · STANDARD SIGNAL GENERATOR TF 867
Also
VACUUM TUBE VOLTMETERS · FREQUENCY STANDARDS · OUTPUT METERS
WAVEMETERS · WAVE ANALYSERS · Q METERS · BEAT FREQUENCY OSCILLATORS

MARCONI INSTRUMENTS

23-25 BEAVER STREET · NEW YORK 4

CANADA : CANADIAN MARCONI CO., MARCONI BUILDING, 2442 TRENTON AVENUE, MONTREAL
ENGLAND: Head Office: MARCONI INSTRUMENTS LIMITED, ST. ALBANS, HERTFORDSHIRE
Managing Agents in Export: MARCONI'S WIRELESS TELEGRAPH COMPANY LIMITED, MARCONI HOUSE, STRAND, LONDON, W.C.2

TC40



Stupakoff

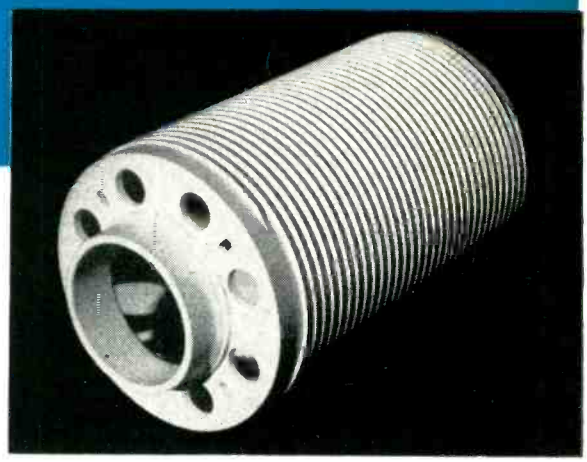
CLOSE-TOLERANCE Manufacture

SOLVES CRITICAL COIL-FORM PROBLEM

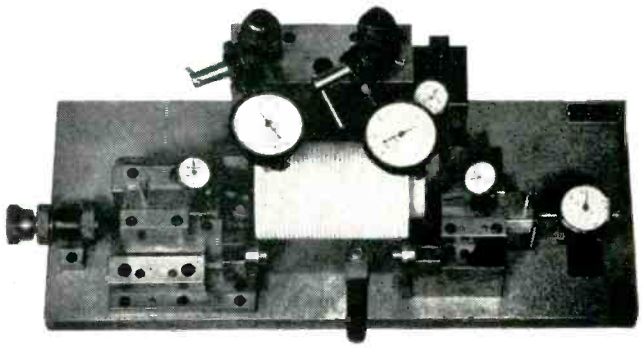
The ability of Stupakoff to make ceramic parts of exceptional dimensional accuracy solved a critical problem for the Stewart-Warner Corporation. The antenna tuning coil-form illustrated is part of a mobile radio transmitter. The tuning coil—a silver ribbon—is wound between the ribs of the threaded portion, the accuracy of which maintains the proper spacing and number of the coil turns necessary for precise tuning of the antenna to any one of many wave lengths. The close tolerances to which these and other key dimensions are held assure precise assembly of the part in the transmitter and its smooth functioning in operation.

For many years, Stupakoff has specialized in the manufacture of precision ceramic parts—meeting close specifications not only in dimensions, but also in body composition. Our facilities include large, well-equipped laboratories, modern precision production machinery and an experienced staff of quality-conscious technicians.

If precision-made ceramic parts can reduce your costs or improve your products, Stupakoff has the skill, experience and facilities to produce them in the quantity and dependable high quality you require.



This coil form is made from vitrified alumina. Threads and other surfaces are ground after firing. Some of the critical dimensions and tolerances are given in the drawing above.



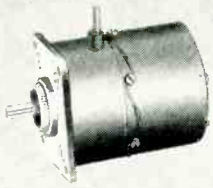
Specially designed gauge, providing direct readings in ten-thousandths of an inch, checks every coil form for critical dimensions, concentricity, flatness, and axial runout.

Stupakoff

CERAMIC & MANUFACTURING COMPANY

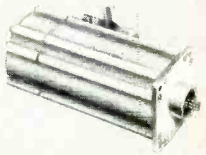
LATROBE, PENNSYLVANIA

DIVISION OF THE CARBORUNDUM COMPANY

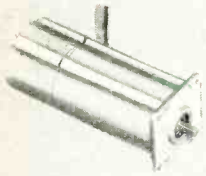


Fast action clutch-brake of unique Lear design utilizing two opposing coils to force clutching and declutching. Increases the speed of both operations. Typical application: digital mechanical computor.

Specially designed Lear motor utilizing offset gear train to allow close tolerance between mounting surface and output shaft. Typical application: aircraft scavenger pump.



Lear intermittent duty AC motor. Has high torque AC brake capable of stopping both rotor and connected inertia load. Typical application: positioning actuator for jet engine air intake doors.



Lear AC brake motor with exceptional environmental resistance. Non-corrosive materials used throughout, including laminations. Typical application: aileron trim tab actuation.

AC motor of the air-over-totally-enclosed type. Has special mylar high dielectric insulation. Typical application: hydraulic pumps.

Synchronous AC motor. Has exceptional high starting torque which overcomes starting drag characteristics. Provides optimum low temperature operation. Typical application: radar scanning device.

DC intermittent duty motor incorporating Lear Fastop Clutch. Extensively used for heavy duty. Typical application: cowl flap power unit.

Miniature DC motor. Unusual specifications required armature which could be stalled continuously and a field to match 10,000 ohm impedance of vacuum tube amplifier. Typical application: trim tab servo.

Lear DC motor with noise filter designed integrally into special pump base. Totally enclosed and self-ventilated. Typical application: pumps.

Gearhead DC motor. Demonstrates building block flexibility. Gearhead components are available in a variety of gear ratios for all Lear motors. Typical application: guided missile fin actuation.

DC brake motor with quick stopping and high holding torque. Optional thermal protection. Typical application: seat actuator.

SALES OFFICES—Grand Rapids: 110 Ionia Ave., N.W. ★ Los Angeles: 11916 W. Pico Blvd. ★ Westbury, L.I., N.Y.: 578 Grand Blvd. ★ Wichita: 307½ Laura St. ★ Fort Worth: 6100 Camp Bowie Blvd.

Motors by the Million

...and all of aircraft quality!

Although Lear's production of electric aircraft motors impresses by its magnitude, the major emphasis is first, last, and always upon ***quality.*** It is doubtful that any other company invests as much engineering time into every motor it builds. An entire, top-calibre engineering department is devoted exclusively to motor design, making Lear exceptionally qualified to handle the more exacting and difficult applications which most manufacturers hesitate to tackle.

Lear's excellent ***facilities*** for the design, engineering, production, and testing of motors are devoted to building *aircraft* motors and aircraft motors alone. Lear motors are designed to meet every applicable military specification.

Lear has accumulated immense ***experience*** in the manufacture of motors of aircraft quality, having built over one million since 1941. All motors used on precision Lear equipment such as electro-mechanical actuators, vertical gyro indicator systems, and F-5 autopilots, are Lear motors, so they *have* to be good.

Lear is an acknowledged leader in the field of motor noise ***filtering.*** Noise filters are engineered into Lear motors at the design stage — not added as an afterthought when the product is finished — thus providing substantial savings in weight and space, and tangible bonuses in performance.

Lear motors achieved early prominence through the use of the Lear "Fastop" clutch, and are now available with a complete line of ***braking*** devices, including both AC and DC brakes of the single-disk and multiple-disk types (which incidentally, are offered as separate components to other manufacturers).

Although all Lear motors are new ***designs,*** an infinite variety of additional models are available through combination of arrangements used in our regular families of motors, of which only a small part are illustrated here. Thus, Lear-quality models can be designed, and are designed, to meet practically any specialized requirement.

If you need any kind of an aircraft electrical motor — and if you want the best — it will pay you to consult Lear. Write, wire, or phone your nearest Lear Sales Office or Lear, Inc., 110 Ionia Avenue, Grand Rapids 2, Michigan.

Gearhead DC motor. Continuous duty, air-over-totally-enclosed type with single stage reduction spur gearing and built-in filter. Typical application: aircraft fuel pump.

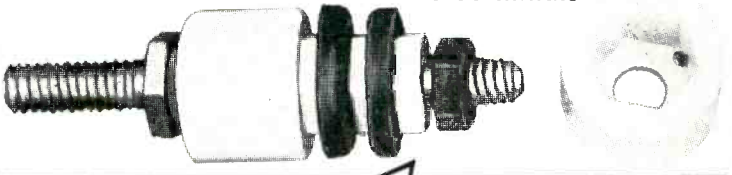
LEAR GRAND RAPIDS DIVISION

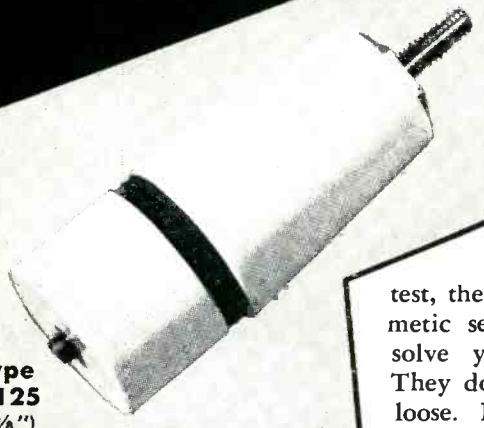
EM-5

Wash., D.C.: 1701 K St., N.W. ★ San Diego: 429 Robinson Ave. ★ Dayton: 53 Park Ave. ★ Seattle: Term'l Bldg., Boeing Field ★ Toronto, Ont. and Montreal, P.Q.: Railway & Power Engr. Corp., Ltd.

NOW Heldor TERMINALS especially designed to MEET MIL-T-27 TWIST TEST

Photograph showing Lock-in Features of these Terminals



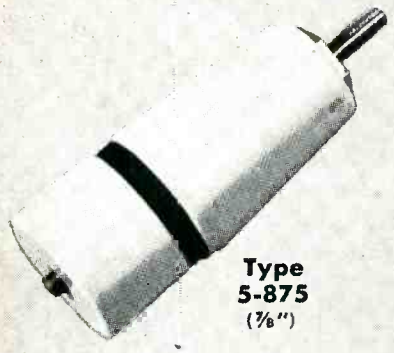


Type 5-1125 (1⅛")

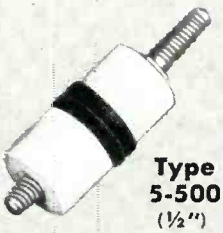
Type 5-218 (7/32")

DESIGNED specifically to meet the MIL - T - 27 twist test, these four compression-type, hermetic seal Heldor Lock-in terminals solve your "twist-test" headaches. They do not turn, twist or become loose. Not only do they possess typical Heldor bushing advantages but they also have increased electrical insulation, the result of an increased length of steatite.

Now available as standard, these four terminals can be revised to meet your specified requirements. Heldor can effect further marked economies with its assembly services — assembly of these and other terminals to covers as well as the final assembly of the finished components. Write for samples and prices based on your needs. Do it NOW!



Type 5-875 (⅞")



Type 5-500 (½")

Send Data ☐ Lock-in Terminals ☐ Dual Conductor.

My name ..... Title .....

Company .....

Address .....

.....

NEW DUAL CONDUCTOR

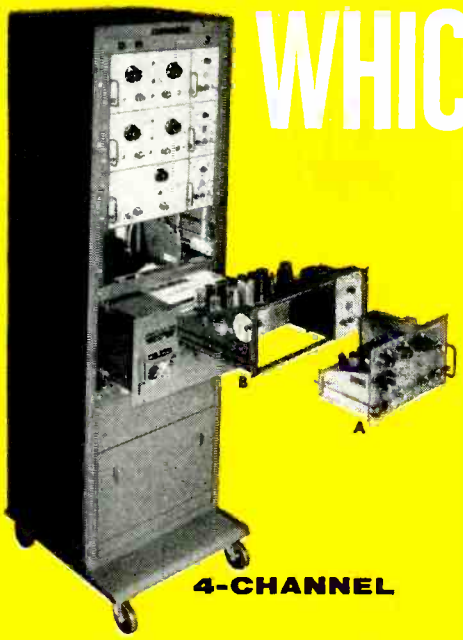
Heldor announces its new dual conductor HDC-1250. *Write for data!*

HELDOR MANUFACTURING CORPORATION

HELDOR HERMETIC SEAL COMPANY, INC.

238 Lewis Street • Paterson, N. J.

WHICH "150" fits your oscillographic recording need?



4-CHANNEL

As a graphic example of the design idea that has brought new versatility to industrial recording, a Carrier Preamplifier (A) is shown above in position to plug into a Driver Amplifier in framework with Power Supply (B) which are normally already in place in the Basic Cabinet Assembly.

The identical design principles of the four-channel system are provided in the two-channel, the only difference being the number of channels.

Sanborn "150" Recording Systems that put to use the original design concept of amplifier interchangeability (illustrated at the left) start with either a four-channel or two-channel standard Basic Assembly, to which the user adds whatever selection or combination of pre-amplifiers (A) are needed for his recording problem. The standard Basic Assemblies comprise a metal Cabinet, Recorder, and a built-in Driver Amplifier and Power Supply (B) for EACH channel. Presently available Preamplifiers are: AC-DC, Carrier, DC Coupling, Servo Monitor, Log-Audio, and Low Level Chopper.

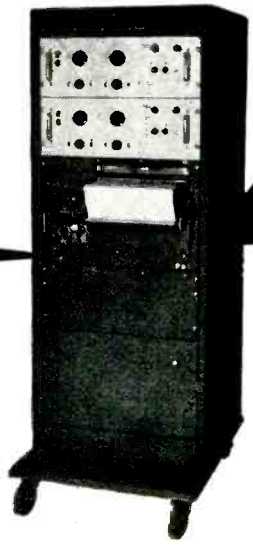
Advantages common to ALL Sanborn Recorders are: inkless recording (by heated stylus) on plastic coated strip chart paper, and in true rectangular coordinates . . . high torque galvanometer movement . . . time and code markers . . . numerous paper travel speeds.

2-CHANNEL

"150"

COMPLETE FOUR-CHANNEL SYSTEM FOR USE WITH ANALOG COMPUTERS

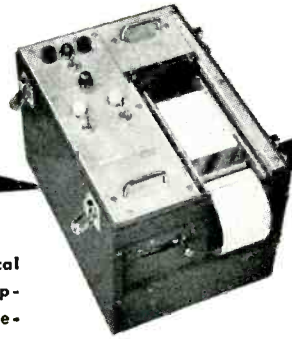
This "150" system consists of a Cabinet Assembly, a four-channel Recorder, and *two* dual channel DC Amplifiers. Each amplifier is complete with a common power supply. Each measures and records two separate single-ended signals, at sensitivities between one and one hundred volts per centimeter. The *two*-channel version of this system will comprise Cabinet, *two*-channel Recorder, and *one* dual channel amplifier.



"150"

SINGLE-CHANNEL RECORDER

A compact, lightweight unit for use when only one channel is required — provides permanent, inkless recording in *true* rectangular co-ordinates; *five* paper speeds (5, 10, 25, 50, 100 mm/sec.); *extra* stylus for either manual or remote timing and coding marks. Designed for simple, patch cord connection to *any* of the several "150" preamplifiers (plus driver amplifier and power supply), available soon in portable metal cases.



Ask, also, for a copy of the *Right Angle* — a Sanborn publication devoted to oscillographic recording in industry.

Catalog and technical data on all "150" equipment available on request.

SANBORN COMPANY

Industrial Division

CAMBRIDGE 39, MASS.

MILLIONS OF VARIABLE

COMPLETE MILITARY LINE AVAILABLE.

POPULAR MILITARY TYPES ILLUSTRATED.

CORRESPONDING COMPLETE LINE FOR COMMERCIAL APPLICATIONS ALSO AVAILABLE.

5 acres of plant area . . . over 1000 employees . . . making ALL TYPES of variable resistors by the million. . . . for ALL your requirements. CTS SPECIALIZES in precision mass production of variable resistors and associated switches . . . makes nothing else.

Most controls available with switches and in concentric shaft tandems or with two controls operating on one shaft. Also available with locking bushing, water sealed bearing and many other special features not illustrated.

Immediate delivery from stock on many JAN-R-94, JAN-R-19 and other types.

WRITE FOR ILLUSTRATED CATALOG—

Describes Electrical and Mechanical characteristics, Special Features and Constructions of a complete line of variable resistors for military and civilian use. Includes dimensional drawings of each resistor

EAST COAST OFFICE
Henry E. Sanders
130 North Broadway
Camden 2, New Jersey
Phone: Woodlawn 6-1668
TWX No. FLANDERS PA 414

WEST COAST OFFICE
Robert A. Stackhouse
928 So. Robertson Blvd.
P. O. Box 35073
Los Angeles 35, California
Phone: Crestview 4-5931
TWX No. BEV H 7666

CANADIAN DIVISION
C. C. Meredith & Co., Ltd.
Streetsville, Ontario
Phone: 310

SOUTH AMERICA
Jose Luis Pontet
Buenos Aires, Argentina
Montevideo, Uruguay
Rio de Janeiro, Brazil
Sao Paulo, Brazil

OTHER EXPORT
Sylvan Ginsbury
8 West 40th Street
New York 18, New York
Phone: Pennsylvania 6-8239

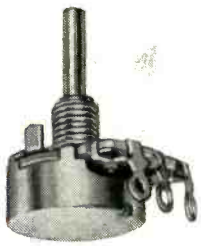
SOUTHWESTERN U.S.A.
John A. Green Company
6815 Oriole Drive
P.O. Box 7224
Dallas 9, Texas
Phone: Dixon 9918

CHICAGO TELEPHONE SUPPLY *Corporation*

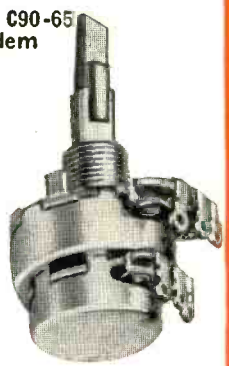
ELKHART • INDIANA

1/2 watt 70°C, 3/4" diameter miniaturized variable composition resistor.

TYPE 65
(Miniaturized)



TYPE C90-65
Tandem



1 watt 70°C, 15/16" diameter variable composition resistor.

TYPE 90

TYPE GC-90
With Switch

TYPE C2-90
Tandem

Meets JAN-R-94 type RV4
2 watt 70°C, 1-1/8" diameter variable composition resistor. Also available with other special military features not covered by JAN-R-94.

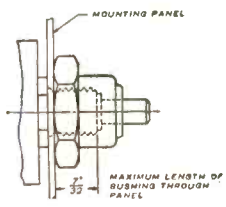
TYPE 95

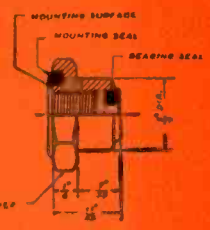
TYPE GC-95
With Switch

TYPE C2-95
Tandem

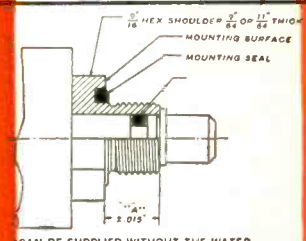
UNPRECEDENTED PERFORMANCE CHARACTERISTICS

Types 65, 90 and 95 are specially designed for military communications equipment subject to extreme temperature and humidity ranges: −55°C to +150°C ...aridity to saturation.





WATER SEALED MOUNTING AND BEARING FOR TYPE 65



CAN BE SUPPLIED WITHOUT THE WATER SEALED MOUNTING SHOULDER)

WATER SEALED MOUNTING AND BEARING FOR TYPES 45, 35, 90, 95, 25, 252.

Burton browne advertising

RESISTORS...FOR EVERY NEED

Meets JAN-R-94
type RV3

1/2 watt 1-1/8" diameter variable composition resistor. Also available with other special military features not covered by JAN-R-94.

Meets JAN-R-94
type RV2

1/4 watt 15/16" diameter variable composition resistor. Also available with other special military features not covered by JAN-R-94.

Meets JAN-R-19
types RA25 and RA30

4 watt 1-17/32" diameter variable wirewound resistor. Also available with other special military features not covered by JAN-R-19.

Meets JAN-R-19
type RA20

2 watt 1-17/64" diameter variable wirewound resistor. Also available with other special military features not covered by JAN-R-19.

TYPE 35

TYPE 45

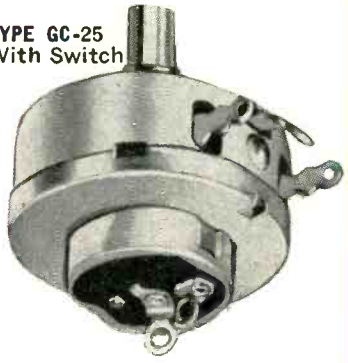
TYPE 25

TYPE 252

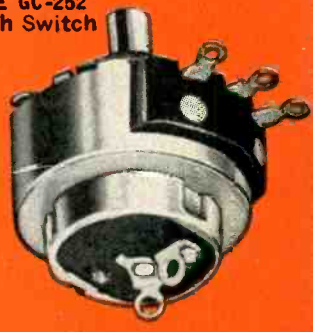
TYPE GC-35
With Switch

TYPE GC-45
With Switch

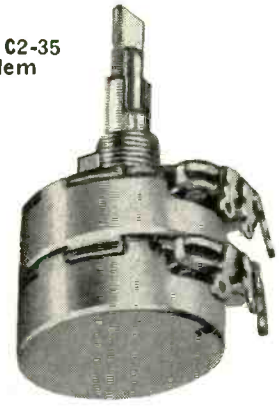
TYPE GC-25
With Switch



TYPE GC-252
With Switch



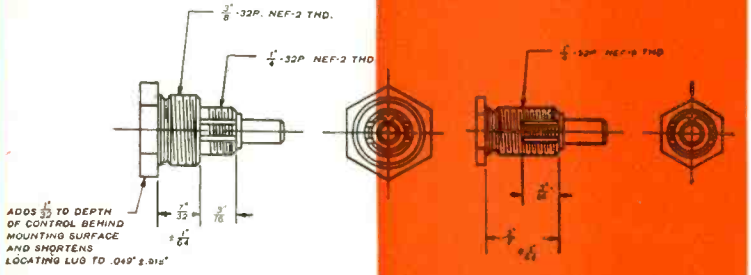
TYPE C2-35
Tandem



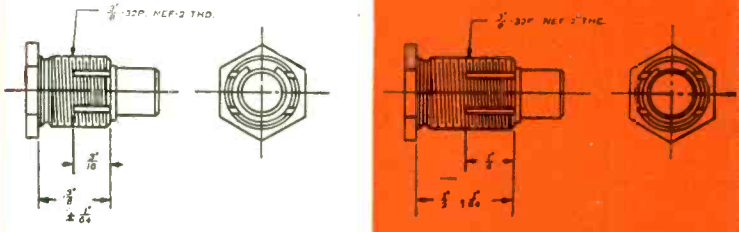
TYPE C2-45
Tandem

TYPE C2-25
Tandem

TYPE C2-252
Tandem

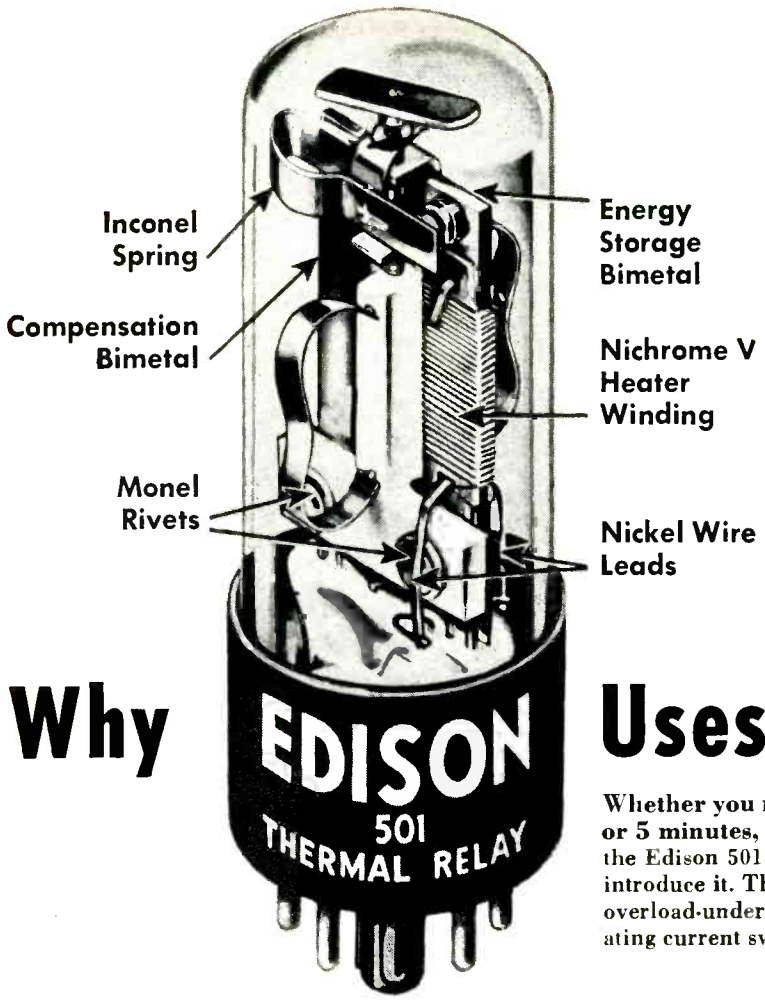


LOCKING BUSHINGS FOR TYPE 65 CONTROL.



LOCKING BUSHINGS FOR CONTROL TYPES 25, 252, 95, 35, 90, 45.

Specialists in Precision Mass Production of Variable Resistors • Founded 1896



Why Uses 7 Nickel Alloys

Whether you need a circuit delay of 2 seconds or 5 minutes, a heating element and bimetal in the Edison 501 Thermal Relay can be selected to introduce it. The relay can also be used as an overload-underload detector, as a cyclically operating current switch, and as an integrator of pulses.

One of the most important requirements in a time delay relay is maintaining contact pressure. The answer in this Edison Time Delay Relay was a preloaded Inconel spring.

Inconel was chosen because it remains strong and resilient, retains its spring properties at the operating temperature of the bimetal elements, and throughout the evacuation and out-gassing process in manufacture.

A second Inco Nickel Alloy, Monel, is used for rivets that rigidly support the two bimetal elements. Monel rivets combine corrosion-resistance and high strength. They are easily clinched, too.

Nichrome V*, another high nickel alloy, is specified for the heater resistance wires. It offers long life at high temperatures, and stability during life.

"A" Nickel wire leads are used for stable electrical characteristics after repeated heating, and for ease of welding.

Invar, for its low expansion, and **Wilson Alloy #20****, for its high expansion, are the two metals bonded to form each bimetallic element of the thermal relay. Both are nickel alloys.

Dumet†, a nickel and iron alloy, is used for glass-to-metal wire leads because it has expansion-contraction characteristics similar to glass and is easily wetted by molten glass for vacuum seal.

If you have a design problem

Follow the example of Thomas A. Edison Incorporated's Instrument Division. When you need metals with special properties for special jobs, look to Nickel and Nickel Alloys. Send for a copy of *Standard Alloys for Special Problems* to get an idea of *how many things* INCO Nickel Alloys can do.

*Reg. U. S. Pat. Off. Driver-Harris Co.
**Product of H. A. Wilson Co.
†Product of Westinghouse Electric Co.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street New York 5, N. Y.

INCO TRADE MARK **Nickel Alloys**

MONEL® • "R"® MONEL • "K"® MONEL • "KR"® MONEL "S"® MONEL • INCONEL® • INCONEL "X"® INCONEL "W"® • INCOLOY® • NIMONIC® Alloys • NICKEL LOW CARBON NICKEL • DURANICKEL®

New, wide band thermistor and bolometer mounts require no tuning, speed microwave measuring

-*hp*- 420A Crystal Detector

Employs a silicon crystal to detect rf signals in a coaxial line employing Type N fittings. Covers frequencies 10 mc to 12.5 kmc. Frequency response flat within ±3 db full range, excellent conversion efficiency. No tuning. Uses modified 1N21 crystal. $50.00.

-*hp*- X421A Crystal Detector

X-Band Crystal Detector for use in waveguide systems at frequencies 8.2 to 12.4 kmc. Frequency response is flat within ±2 db. No tuning. Detector has square law characteristic within ±1 db over a 40 db dynamic range. $75.00.

-*hp*- 477A Thermistor Mount

For coaxial measurements. Provides complete coverage of all frequencies 10 mc to 10 kmc. VSWR is less than 1.5. Operates with -*hp*- 430B Power Meter for direct power readings. No tuning. Not subject to burnout. Input connector is Type N; output is Type BNC. $75.00.

-*hp*- 487A Thermistor Mount

For fast, accurate waveguide measurements. Each mount covers full range of its waveguide frequency. Available for all frequencies 3.95 through 12.4 kmc. No tuning required, VSWR less than 1.5. Not subject to burnout. Operates with -*hp*- 430B Power Meter for direct power readings. $75.00 to $95.00.

Here are four new wide band thermistor and bolometer mounts for use with coaxial or waveguide equipment at frequencies between 10 mc and 12.5 kmc. These new instruments are extremely simple to use, require no tuning, have low VSWR, and may be used with a power meter such as -*hp*- 430B to provide direct reading measurements.

Brief descriptions of new -*hp*- 420A and X421A Detector Mounts and -*hp*- 477A and 487A Fixed Tuned Thermistor Mounts appear at left. The broad complete coverage -*hp*- line of detectors and mounts is listed below. For details, see your local -*hp*- sales engineer, or write direct for Technical Bulletin, specifying instrument model number.

Complete Coverage—All Frequencies!

Model	Instrument	Frequency	Element	Price
420A	Detector Mount	10 mc to 12.5 kmc	1N21 Crystal	$ 50.00
X421A	Detector Mount	8.2 kmc to 12.4 kmc	1N26 Crystal, mod.	75.00
440A	Detector Mount	2.4 kmc to 12.4 kmc	Crystal, Bolometer	85.00*
442B	Broad Band Probe	2.4 kmc to 18.0 kmc	—	35.00
444A	Broad Band Probe	2.6 kmc to 18.0 kmc	—	50.00
475B	Tunable Bolometer Mount	1.0 kmc to 4.0 kmc	Barretter, Thermistor, Fuse	200.00
476A	Universal Bolometer Mount	10 mc to 1.0 kmc	1/100 amp. fuses	85.00
477A	Thermistor Mount	10 mc to 10 kmc	Thermistor	75.00
S485A	Detector Mount	2.6 kmc to 3.95 kmc	Bolometer	125.00*
G485B	Detector Mount	3.95 kmc to 5.85 kmc	Bolometer, Crystal	95.00*
J485B	Detector Mount	5.85 kmc to 8.2 kmc	Bolometer, Crystal	90.00*
H485B	Detector Mount	7.05 kmc to 10.0 kmc	Bolometer, Crystal	85.00*
X485B	Detector Mount	8.2 kmc to 12.4 kmc	Bolometer, Crystal	75.00*
P485C	Detector Mount	12.4 kmc to 18.0 kmc	Thermistor	110.00
G487A	Thermistor Mount	3.95 kmc to 5.85 kmc	Thermistor	95.00
J487A	Thermistor Mount	5.85 kmc to 8.2 kmc	Thermistor	90.00
H487A	Thermistor Mount	7.05 kmc to 10.0 kmc	Thermistor	80.00
X487A	Thermistor Mount	8.2 kmc to 12.4 kmc	Thermistor	75.00

All mounts contain element unless marked (*).

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

INSTRUMENTS FOR COMPLETE COVERAGE

HEWLETT-PACKARD COMPANY

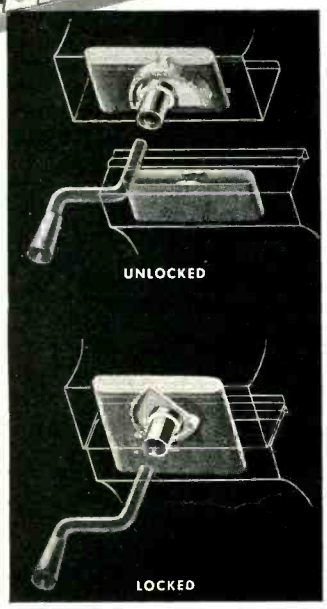
3149A Page Mill Road • Palo Alto, California, U. S. A.

Sales and service engineers in all principal areas.

Export Division: 275 Page Mill Rd., Palo Alto, Calif.
Cable "HEWPACK"

"Nothing can go wrong with Roto-Lock performance"

Says Elgin Metal Casket Company



Roto-Lock operation is simple: Serrated, tapered cam engages latch — draws panels tightly together when turned by crank or other hand tool.

Simmons Roto-Lock Fasteners are used by Elgin Metal Casket Co., of Elgin, Illinois, to give its Permaseal Caskets a perfect hermetic seal against air and water. Drawn down with a pressure of up to 1500 lbs., Roto-Lock guarantees an absolutely tight seal and strength far beyond requirements.

President E. B. Stewart of Elgin says: "Roto-Lock worked out particularly well because of the simplicity of its construction, and the fact that it was a lock already in a housing which could readily be sealed. Functionally the lock is very good since it pulls the lid down with ease and is a quick-operating mechanism. In other words, *the locking and sealing operation can be accomplished quickly and easily in a matter of seconds.* Since the whole locking and sealing mechanism contains only one moving part, *there is nothing that can go wrong with the performance of the lock.* Of course, this is important since mal-function at a funeral service would be a serious matter."

and there's a Roto-Lock application to improve your product

Roto-Lock, which makes butt or right-angle joints quickly, is finding wide application in portable shelters, air freight and cold storage shipping containers, walk-in coolers, demountable furniture and scaffolding. It fastens in any misaligned or semi-open position and recesses completely into panels. *Wherever* demountability is important, there's a Roto-Lock application.

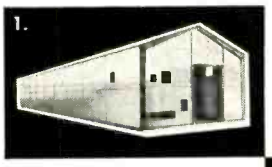
Write today for our 36-page catalog. It's filled with applications of Roto-Lock and Simmons' four other special fasteners engineered to improve products and reduce assembly costs.

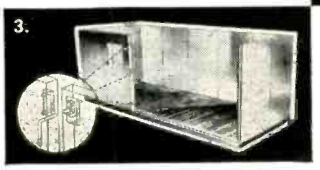
SIMMONS FASTENER CORPORATION
1750 N. Broadway, Albany 1, New York

Simmons

QUICK-LOCK · SPRING-LOCK · ROTO-LOCK · LINK-LOCK · DUAL-LOCK

FASTENERS WITH USES UNLIMITED



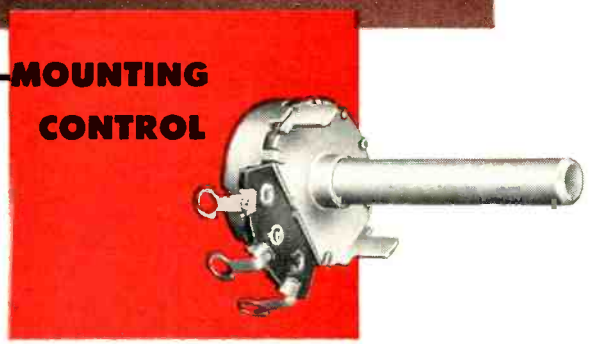


Some applications of Roto-Lock:

1. Portable Shelter
2. Partition
3. Demountable Refrigerator Unit
4. Demountable Desk

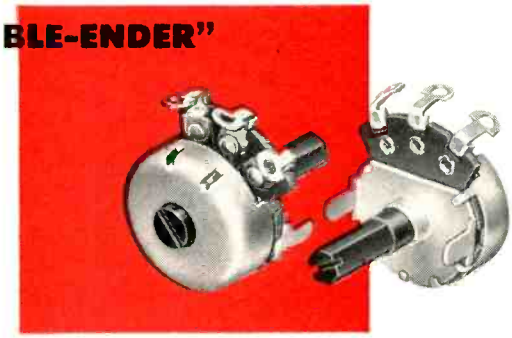
3 Low Cost VARIABLE RESISTORS for COMPACT CIRCUITS

COST-CUTTING TAB-MOUNTING CONTROL



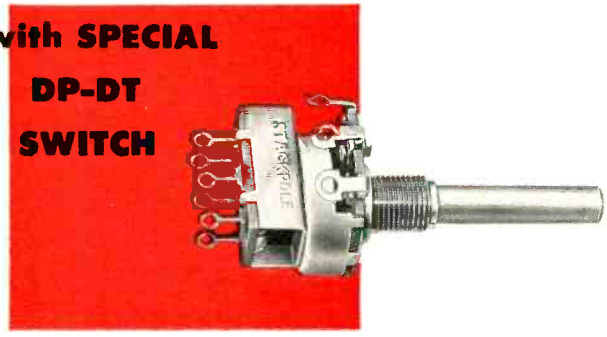
0.5 watt metal shaft type for TV picture adjustment, pre-set gain controls, etc. Tab-mounting cuts mounting time, eliminates hardware. Nine different Stackpole line switches available for this control. *Send for specifications on Type LR-5.*

TAB-MOUNTING "DOUBLE-ENDER"



Just right for rear-of-chassis or concealed front panel controls in TV receivers . . . especially in high voltage circuits. Bakelite shaft can easily be adjusted from either side of control. Measures only .894" in diameter, yet handles a full .5-watt. *Write for data on Stackpole Type LR-6.*

MINIATURE TONE CONTROL with SPECIAL DP-DT SWITCH



A really versatile space-saver for midget radios, combination receivers, or amplifiers. Helps reduce the number of controls on complicated sets. U.L. Approved .5 amp., switch throws at opposite ends of control rotation—maintains full 270° shaft motion in either position. Ideal for band changing, input or bandwidth switching. *Write for details on Stackpole Type LRSS-150.*

Electronic Components Division
STACKPOLE CARBON COMPANY
St. Marys, Pa.

STACKPOLE

In Canada: Canadian Stackpole Ltd., 550 Evans Avenue, Etobicoke, Toronto 14, Ontario

KEPCO VOLTAGE REGULATED POWER SUPPLIES

MODEL 750

MODEL	VOLTS	CURRENT	REGULATION	RIPPLE
750	0-600	0-750 Ma.	0.5%	10 Mv.
760	0-600	0-1.5 Amp.	0.5%	10 Mv.
770	0-600	0-2.25 Amp.	0.5%	10 Mv.
780	0-600	0-3 Amp.	0.5%	10 Mv.

DC POWER SUPPLY SPECIFICATIONS

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

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

***REGULATION FOR BIAS SUPPLIES:** 10 millivolts for line 105-125 volts. ½% for load at 150 volts.

†All AC Voltages are unregulated.

VOLTS	CURRENT	REGULATION	RIPPLE	6.3 V. AC. CT.	MODEL
0-1500	0-200 Ma.	0.5%	20 Mv.		1520
0-1200	0-20 Ma.	0.1%	10 Mv	10 Amp.	1220
0-1000	0-500 Ma.	0.5%	20 Mv.		1350
200-1000	0-500 Ma.	0.5%	20 Mv.		1250
0-1000	0-50 Ma.	0.1%	10 Mv.	10 Amp.	1020
0-600	0-3 Amp.	0.5%	10 Mv.		780
0-600	0-2.25 Amp.	0.5%	10 Mv.		770
0-600	0-1.5 Amp.	0.5%	10 Mv.		760
0-600	0-750 Ma.	0.5%	10 Mv.		750
0-600 0-150 Bias	0-300 Ma. 0-5 Ma.	0.5% *	10 Mv. 5 Mv.	10 Amp.	615
0-600	0-300 Ma.	0.5%	10 Mv.	10 Amp.	500R
#1 0-600 #2 0-600	0-200 Ma. 0-200 Ma.	0.5% 0.5%	5 Mv. 5 Mv.	10 Amp. 10 Amp.	800
0-600 0-150 Bias	0-200 Ma. 0-5 Ma.	0.5% *	5 Mv. 5 Mv.	10 Amp.	815
#1 200-500 #2 200-500	0-200 Ma. 0-200 Ma.	0.5% 0.5%	5 Mv. 5 Mv.	6 Amp. 6 Amp.	510
200-500	0-200 Ma.	0.5%	5 Mv.	6 Amp.	245
0-400 0-400 0-150 Bias	0-150 Ma. 0-150 Ma. 0-5 Ma.	0.5% 0.5% *	5 Mv. 5 Mv. 5 Mv.	10 Amp. 10 Amp.	2400
0-400 0-150	0-150 Ma. 0-5 Ma.	0.5% *	5 Mv. 5 Mv.	10 Amp.	400
0-400	0-150 Ma.	0.5%	5 Mv.	10 Amp.	141
100-400	0-150 Ma.	0.01%	1 Mv.	10 Amp.	2000
0-350	0-3 Amp.	0.5%	10 Mv.		730
0-350	0-2.25 Amp.	0.5%	10 Mv.		720
0-350	0-1.5 Amp.	0.5%	10 Mv.		710
0-350	0-750 Ma.	0.5%	10 Mv.		700
100-325 0-150 Bias	0-150 Ma. 0-5 Ma.	0.5% *	5 Mv. 5 Mv.	10 Amp.	131
0-300 0-150 Bias	0-150 Ma. 0-5 Ma.	0.5% *	5 Mv. 5 Mv.	5 Amp.	315
0-150	0-50 Ma.	0.5%	5 Mv.		150
3-30	0-30 Amp.	0.5%	0.1%		3030
1-13	0-10 Amp.	0.5%	10 Mv.		3200

WORKMANSHIP

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

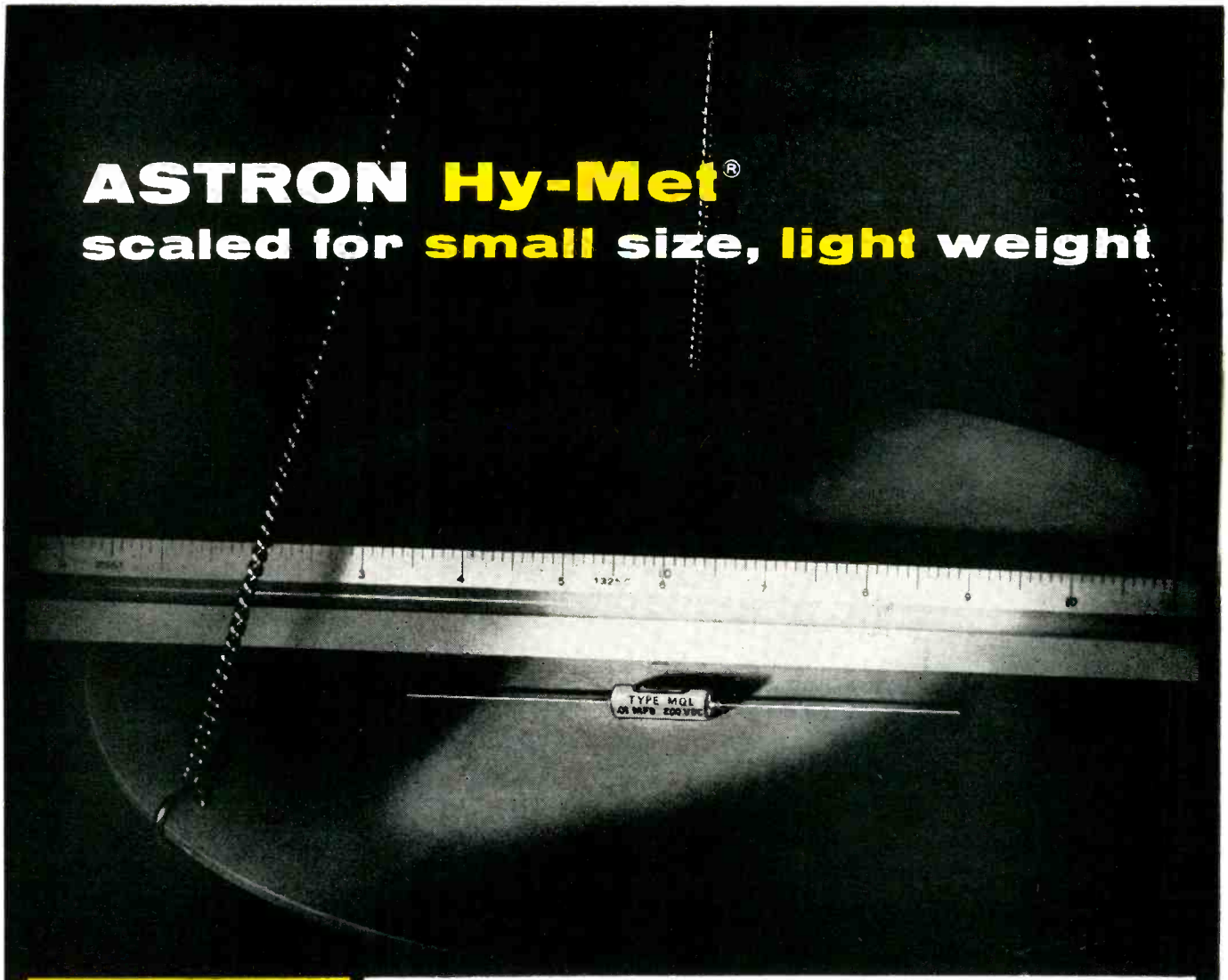
FOR NEW POWER SUPPLY CATALOG — WRITE DEPT. No. 789

MANUFACTURERS OF ELECTRONIC EQUIPMENT • RESEARCH • DEVELOPMENT

KEPCO LABORATORIES

131-38 SANFORD AVENUE • FLUSHING 55, N. Y. • INDEPENDENCE 1-7000

ASTRON Hy-Met®
scaled for small size, light weight



operation up to 125°C

©NTI

Metalite Hy-Met* ASTRON capacitors are crafted to feature small size, light weight, and to operate up to 125°C for all types other than cardboard tubular MLL (100°C). ASTRON technicians process the fine quality materials that comprise the famous Hy-Met capacitor line with skillful attention to minute details. *Self-healing* Hy-Met capacitors accept momentary overvoltages and surges without permanent damage—possess high dielectric strength and vastly improved insulation resistance over conventional metallized paper types—are *effectively protected* from humidity—give *low r.f. impedance* due to small size—are ideal for R.F. filters and noise suppression. All these features are common to the Metalite Hy-Met *plus* the greater dependability and longer life derived from added care in construction and quality control. Write today for ASTRON capacitor and filter literature.

**Trademark*

ASTRON CORPORATION

ASTRON®

255 GRANT AVENUE — EAST NEWARK, N. J.

Export Division: Rocke International Corp., 13 East 40th St., N. Y., N. Y.
In Canada: Charles W. Pointon, 6 Alcina Ave., Toronto 10, Ontario

Veeder-Root Hand Tally counts anything you see. Press thumb lever once for each count. Reset to zero with one turn of knob. $8.30 ea. (Write for quantity prices.) Immediate delivery.

If this Clicks often enough... then the show clicks, too!

Added Evidence that—

Everyone Can Count on VEEDER-ROOT

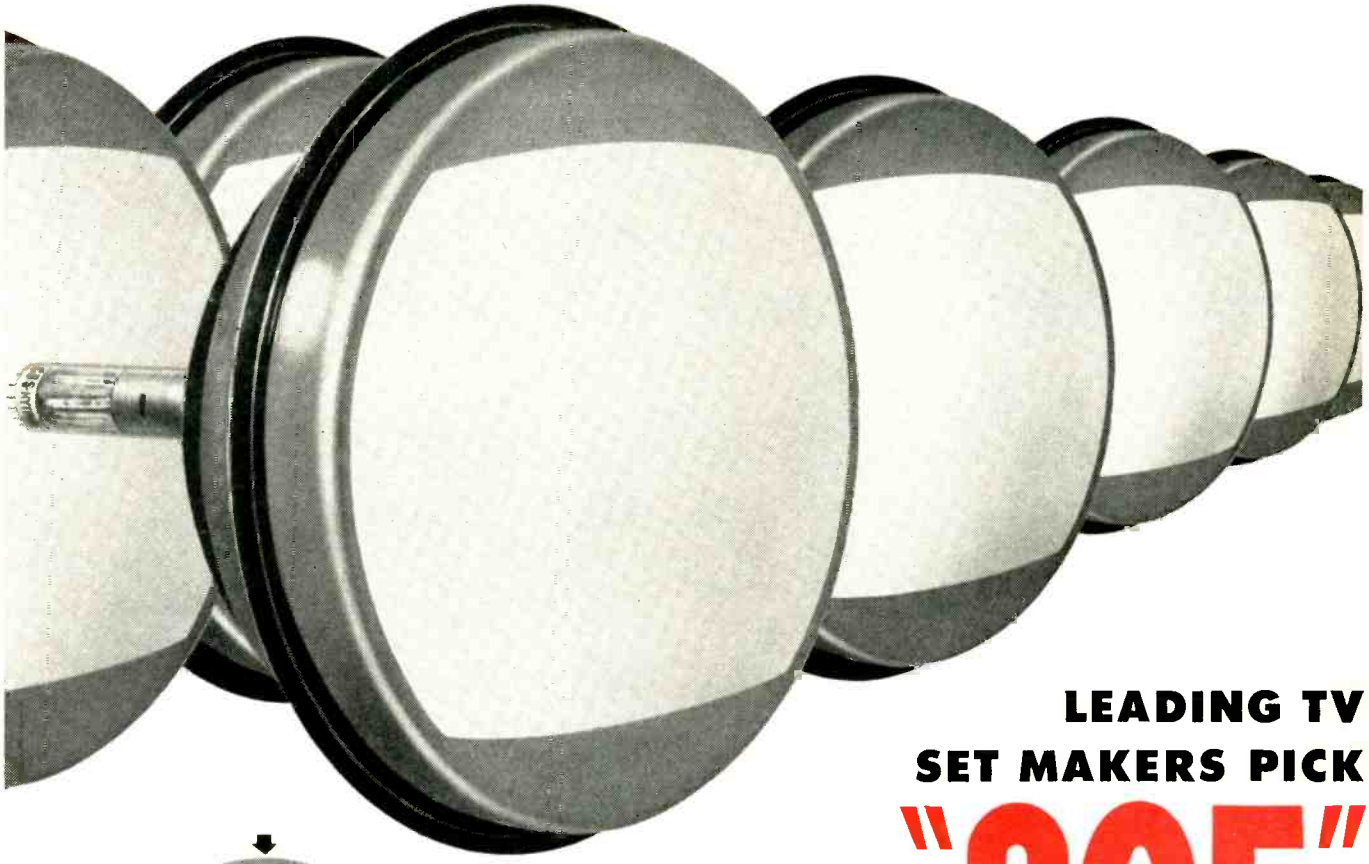
275 laughs in 113 minutes . . . this was the certified count taken at a recent performance of a Broadway show by two executives of Fact Finders Associates, Inc. . . . both using Veeder-Root Hand Tallies.

This is another one of the hundreds of uses for each of the hundreds of Veeder-Root Counters which are made for manual, mechanical and electrical operation. Chances are that *you*, too, can count on Veeder-Root . . . with counters built into your products as standard parts, or attached to your production equipment. We'll help you to figure out how. Write:

VEEDER-ROOT INCORPORATED
HARTFORD 2, CONNECTICUT

Chicago 6, Ill. • New York 19, N. Y. • Greenville, S. C.
Montreal 2, Canada • Dundee, Scotland
Offices and Agents in Principal Cities

"The Name That Counts"



LEADING TV SET MAKERS PICK "205"

CBS-COLORTRON "205"

LEADING BIG-SCREEN COLOR TUBE

. . . for Biggest Picture
. . . for Superior Performance
. . . for Delivery NOW!

The CBS-Colortron "205" is *today* traveling in freight cars and trucks to the nation's leading TV set manufacturers. It was chosen by them, because of: The "205's" larger 205-square-inch screen. The "205's" over-all superior performance. The "205's" easier circuit adjustments. The "205's" absence of "pincushioning" and other distortion. And the "205's" availability in production quantities now!

BIG-SCREEN COLOR TV IS HERE . . . today . . . at CBS-Hytron. Original . . . simple . . . functional . . . advanced design of the "205" made this possible: 1. With its curved screen-mask construction. 2. With its maximum use of the screen area. 3. With its electromagnetically converged three-beam electron-gun assembly. And CBS-Hytron's huge, new Kalamazoo plant stands ready to step up the "205's" availability when needed. Yes, you can look to CBS-Hytron as the leader . . . and major producer of big-screen color picture tubes.

HOW "205" ACHIEVES BIGGEST PICTURE

As its name implies, picture area of "205" is a big 205 square inches. The "205" achieves this maximum utilization of screen area: 1. By photographic printing of tricolor screen directly on inside of curved face. 2. By using a simple, light-weight shadow mask. 3. By positioning the three mask supports above and below the desired screen area . . . where the screen is masked off anyway by the set maker to obtain the desired 4 x 3 aspect ratio. This permits full lateral use of screen.

IT'S CBS-HYTRON FOR NEW COLOR RECEIVING TUBES TOO

TYPE	DESCRIPTION
CBS-Hytron 3A3	Half-wave, high-voltage rectifier
CBS-Hytran 6AM8	Diade, sharp-cutoff pentode
CBS-Hytran 6AN8	Medium-mu triode, sharp-cutoff pentode
CBS-Hytran 6BD4A	Sharp-cutoff beam triode, high-voltage regulator
CBS-Hytran 6BD6	Sharp-cutoff r-f pentode colar demodulator
CBS-Hytran 6BJ7	Triple-diade d-c restorer

NEW . . . FREE "205" DATA

Keep abreast of big-screen colar TV. Four-page sheet on CBS-Colortron "205," RETMA type 19VP22, contains complete data an: Construction . . . operatian . . . application . . . installation . . . adjustment . . . electrical and mechanical characteristics. Write far Bulletin E-227 today!

CBS-HYTRON Main Office: Danvers, Massachusetts

A Division of Columbia Broadcasting System, Inc.

A member of the CBS family: CBS Radio • CBS Television • Columbia Records, Inc. • CBS Laboratories CBS-Columbia • CBS International • CBS-Hytron

RECEIVING • TRANSMITTING • SPECIAL-PURPOSE • TV PICTURE TUBES • CRYSTAL DIODES AND TRANSISTORS

MAGNET WIRE.....

NEW SODEREZE!*

- **Instant Soldering Without Stripping**
- **Improved Moisture Resistance**
- **Good Electrical Properties**
- **Excellent Flexibility and Toughness**

New Sodereze represents a spectacular advance in ready-to-solder magnet wire. It's a new and typical Phelps Dodge development designed to keep pace with industry's growing need for wires that handle easily, save time, reduce overall costs and satisfy a variety of different operating conditions. The versatility and outstanding properties of New Sodereze not only permit its use wherever solderable wire has been *proved* practical and dependable but suggest its application in unlimited other electronic and electrical fields to replace conventional wires.

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

*SODEREZE is a Phelps Dodge Trademark.

PHELPS DODGE COPPER PRODUCTS CORPORATION

INCA MANUFACTURING DIVISION

FORT WAYNE, INDIANA

THE VERY SMALLEST YET

AIRPAX A175 MIDGET

60 cycle chopper

- wide temperature range
- broad frequency range
- hermetically sealed
- very low noise
- long proven life
- vibration proof
- chatter free
- shock proof
- reliable
- rugged

Phase Angle at 6.3v, 60 cycles is 21° ± 5°, at 30 cycles is nominally 20°, at 100 cycles 26°.

Contacts are SPDT, break-before-make, and are rated up to 100 volts maximum, 1 ma maximum.

Dwell Time is approx. 170°. The nominal value of dwell time changes only slightly from 30 cycles to 100 cycles.

Coil demand at 6.3 volts, 60 cycles, is approximately 37 milliamperes, coil resistance approximately 165 ohms D.C.

Noise with all 3 contacts at one megohm impedance, and with wide band amplifiers, will have an effective value of 50 microvolts or less. The offset of narrow band amplifiers will be very much less. The specification of noise requires careful definition, users should refer to the detail specifications and bulletin 103.

Temperature may be any value from —65°C to 85°C. The nominal phase angle will vary from about 17 degrees at —65°C to 25 degrees at 85°C.

Vibration from 10 to 55 cycles will not damage the chopper up to as high as 30 G. At these higher G values there will be some modulation of the phase angle.

Frequency of operation may be any value from 25 to 110 cycles, to maintain full performance, balance, etc.

Humidity may be any value, except of course for external condensation on the header.

Shock values as high as 50G will not damage the chopper.

Altitude may be any value, as the unit is hermetically sealed.

AIRPAX PRODUCTS COMPANY

DESIGNERS ENGINEERS

MIDDLE RIVER BALTIMORE, MD.

TUNG-SOL TUBES FOR

2AF4
(Prototype—6AF4)
Heater Volts 2.35
Heater Current 0.6 A

3AL5
(Prototype—6AL5)
Heater Volts 3.15
Heater Current 0.6 A

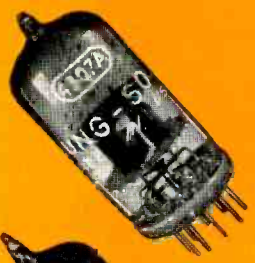
3AU6
(Prototype—6AU6)
Heater Volts 3.15
Heater Current 0.6 A

3AV6
(Prototype—6AV6)
Heater Volts 3.15
Heater Current 0.6 A

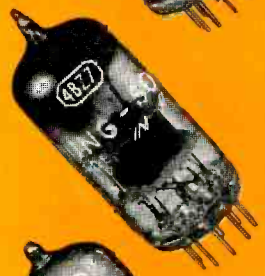
3BC5
(Prototype—6BC5)
Heater Volts 3.15
Heater Current 0.6 A

3BE6
(Prototype—6BE6)
Heater Volts 3.15
Heater Current 0.6 A

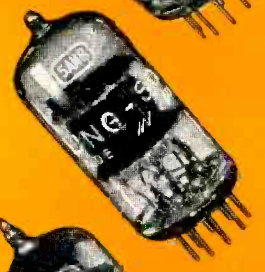
3CB6
(Prototype—6CB6)
Heater Volts 3.15
Heater Current 0.6 A



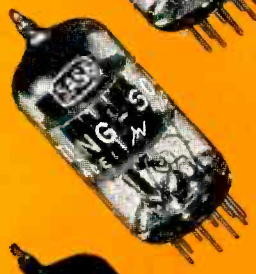
4BQ7A
(Prototype—6BQ7A)
Heater Volts 4.2
Heater Current 0.6 A



4BZ7
(Prototype—6BZ7)
Heater Volts 4.2
Heater Current 0.6 A



5AN8
(Prototype—6AN8)
Heater Volts 4.7
Heater Current 0.6 A



5AS8
(Prototype—6AS8)
Heater Volts 4.7
Heater Current 0.6 A

5T8
(Prototype—6T8)
Heater Volts 4.7
Heater Current 0.6 A

5U8
(Prototype—6U8)
Heater Volts 4.7
Heater Current 0.6 A

*Using heaters parallel connected

...designed and engineered to highest performance requirements

These are the new Tung-Sol Receiving Tubes for television sets having all of the heaters series-connected across the power line. Thermal characteristics of all the heaters are controlled so that heater voltage surges during the warm-up cycle are minimized, provided of course, that these tubes are used with other types similarly controlled.

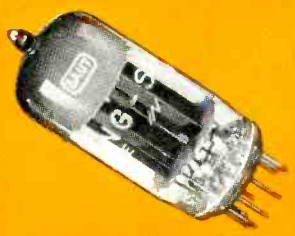
Heater ratings are based on 600 milliamperes of current with the heater voltage adjusted for the same power as in the prototype. All other characteristics and ratings are identical to those of the prototype. Use of these tubes provides completely satisfactory receiver characteristics during warm-up.

All of the statistical quality control methods which make the performance of Tung-Sol tubes so outstanding, are utilized in the manufacture of these new types. In performance, uniformity and dependability they will be found fully reliable. For more detailed information, write Commercial Engineering Department, Tung-Sol Electric Inc., Newark 4, New Jersey.

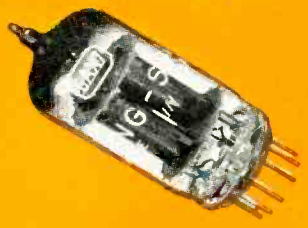
Sales Offices: Atlanta, Chicago, Columbus, Culver City (Los Angeles), Dallas, Denver, Detroit, Newark, Philadelphia, Seattle.

Tung-Sol All-Glass Sealed Beam Lamps, Miniature Lamps, Signal Flashers, Picture Tubes, Radio, TV and Special Purpose Electron Tubes and Semiconductor Products.

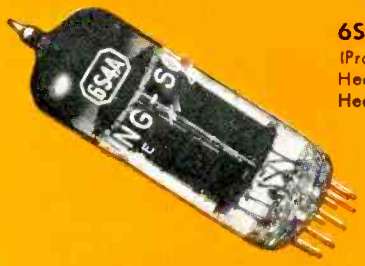
SERIES STRING TV SETS



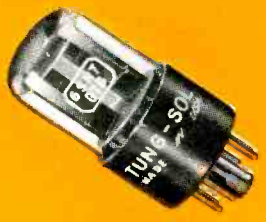
6AU7
(Prototype—12AU7)
Heater Volts 3.15*
Heater Current 0.6 A



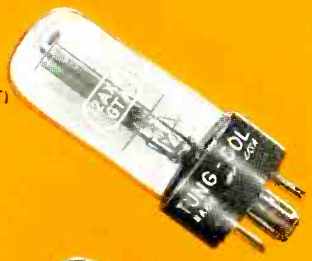
6AX7
(Prototype—12AX7)
Heater Volts 3.15*
Heater Current 0.6 A



6S4A
(Prototype—6S4)
Heater Volts 6.3
Heater Current 0.6 A



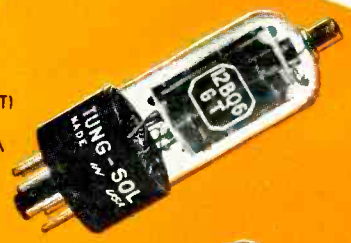
6SN7GTB
(Prototype—6SN7GTA)
Heater Volts 6.3
Heater Current 0.6 A



12AX4GTA
(Prototype—12AX4GT)
Heater Volts 12.6
Heater Current 0.6 A

12B4A
(Prototype—12B4)
Heater Volts 6.3*
Heater Current 0.6 A

25CD6GA
(Prototype—25CD6G)
Heater Volts 25
Heater Current 0.6 A



12BQ6GT
(Prototype—6BQ6GT)
Heater Volts 12.6
Heater Current 0.6 A

12BH7A
(Prototype—12BH7)
Heater Volts 6.3*
Heater Current 0.6 A

12L6GT
(Prototype—25L6GT)
Heater Volts 12.6
Heater Current 0.6 A

12BY7A
(Prototype—12BY7)
Heater Volts 6.3*
Heater Current 0.6 A.

12W6GT
(Prototype—6W6GT)
Heater Volts 12.6
Heater Current 0.6 A

19AU4
(Prototype—6AU4GT)
Heater Volts 18.9
Heater Current 0.6 A

*Using heaters parallel connected

TUNG-SOL RADIO AND TV TUBES, DIAL LAMPS

Tube life in time-proved GATES 5/10kw AM transmitters "exceeds estimates"

QUINCY
ILLINOIS
U. S. A.

GATES

MANUFACTURING
ENGINEERS
SINCE 1922

Gates Radio Company

Eitel-McCullough, Inc.
San Bruno, California

Gentlemen:

A few years ago our engineering department was requested to design several entirely new transmitters in the 5/10KW power range for both medium and short wave commercial service. — One of the requirements was the establishment of a modern tube complement that would substantially reduce tube cost both initially and in greater life expectancy.

After considerable investigation and exhaustive tests in our own development section, the Eimac 3X2500F3 was decided upon. Performance-wise, the results were excellent but even successful abuse tests could not be a substitute for several years that must pass to obtain records on life expectancy.

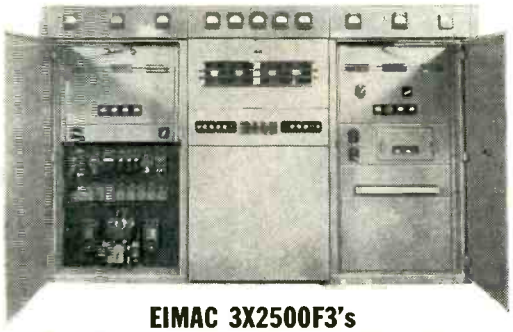
These several years have now passed. Gates transmitters employing the 3X2500F3 are all over the world in every kind of service including 24-hour a day international communications, broadcasting and many 5KW mobile units for military service. Checks indicate, as both radio frequency amplifiers and Class B modulators, the life expectancy is not only meeting our original estimates and expectations but in many instances far exceeding them.

We congratulate you on an excellent product that has indeed saved the industry untold thousands in tube expense and again express our appreciation for the excellent cooperation of your engineering department.

Yours very truly,

GATES RADIO COMPANY

P. S. Gates
President



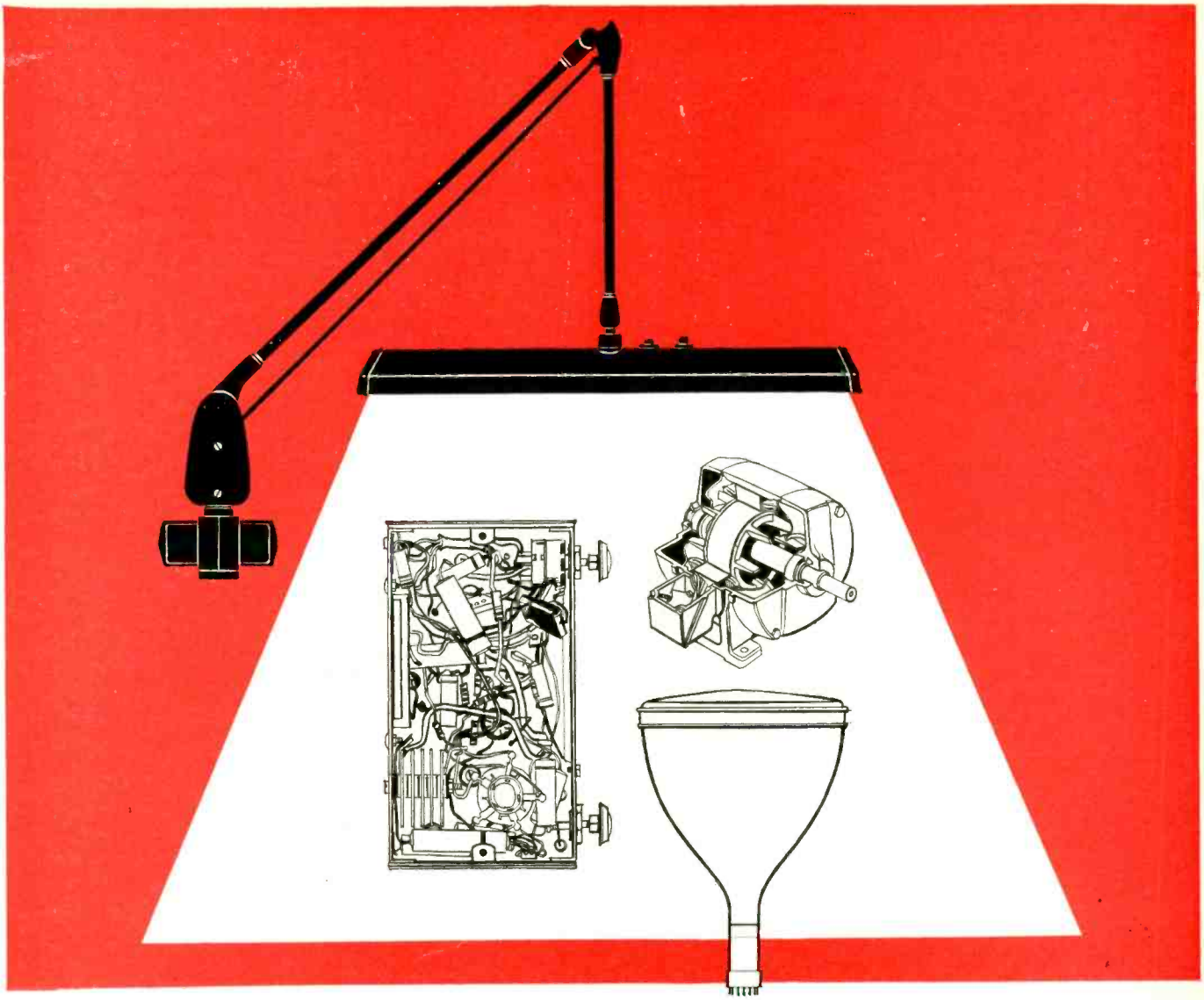
EIMAC 3X2500F3's IN GATES 5/10KW AM TRANSMITTERS

GATES TRANSMITTER	MODULATOR	PA
BC-5B	2 Eimac 3X2500F3's	Eimac 3X2500F3
BC-10B	2 Eimac 3X2500F3's	2 Eimac 3X2500F3's

Eimac 3X2500F3's featured in Gates models BC-5B and BC-10B the world over.

Eimac

EITEL-McCULLOUGH, INC. SAN BRUNO, CALIFORNIA



from Hydrazine...
new light on old soldering problems

For greater efficiency and economy in the production of electrical and electronic components, a remarkable new series of soldering fluxes has been developed by McCord Corporation.

Based on compounds of hydrazine, these fluxes —called CORONIL—are non-corrosive and can be used without hazard. They remove oxides and other films from most commercially used metals such as copper and brass—as well as others—to permit more effective work and fewer rejects. In addition to their use by electrical and electronic equipment manufacturers, these hydrazine-based CORONIL fluxes are being successfully applied in the production of automotive radiators and other heat exchangers, carburetor floats, oil strainers, and various other products where safe, non-corrosive soldering is essential.

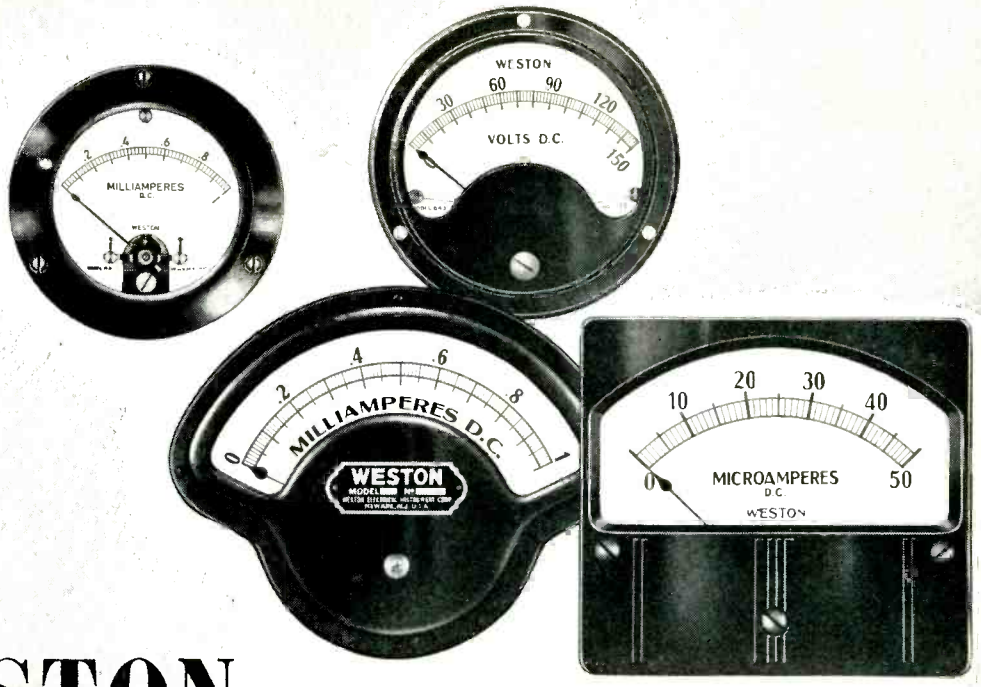
* * *

A new data sheet containing the latest information on hydrazine-based soldering fluxes is now available; it refers specifically to the removal of oxides and other films from copper and brass. **Write for your copy today.**

MATHIESON

OLIN MATHIESON CHEMICAL CORPORATION
Baltimore 3, Maryland

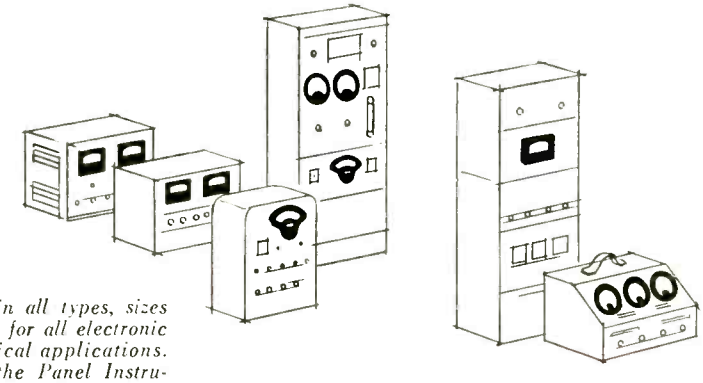
2580



WESTON

PANEL INSTRUMENTS...

...outward evidence of the high quality built within fine electronic equipment



Available in all types, sizes and ranges for all electronic and electrical applications. Send for the Panel Instrument bulletin.

WESTON ELECTRICAL INSTRUMENT CORPORATION, 614 Frelinghuysen Avenue, Newark 5, N. J.

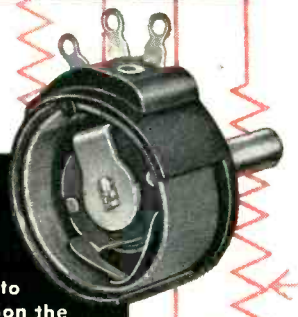
"DRIVER-HARRIS ALLOYS

have contributed greatly in making our performance possible"

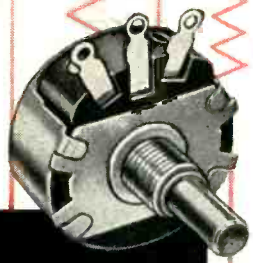
says

CHICAGO TELEPHONE SUPPLY *Corporation*

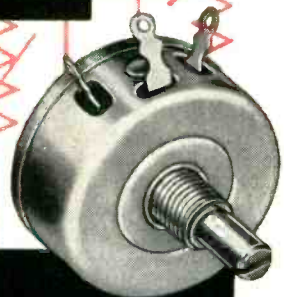
CTS 45 Series 15/16" dia. variable composition resistor with blade type printed circuit terminals.



Cutaway view of CTS 252 Series, 1 7/64" diameter 2 watt wirewound variable resistor. The total resistance can be varied from 3 ohms to 15,000 ohms, depending upon the size and type of resistance wire used.



CTS 252 Series 2 Watt Wirewound 3-15,000 ohms



CTS 25 Series 2 Watt Wirewound 3-25,000 ohms

Chicago Telephone Supply Corporation has succeeded in accomplishing two things indeed difficult to combine, as summed up in their slogan "Specialists in Precision Mass Production of Variable Resistors." They manufacture the high quality variable resistors indispensable to radio, television, and military electronics. In fact, they are the world's largest producers of variable resistors.

To achieve this outstanding record, they concentrate their entire effort on variable resistors, they maintain close control over all manufacturing processes, and fabricate their own parts under close supervision from basic raw materials. Naturally, they make no secret of the importance to them of high quality materials.

States Chicago Telephone: "To make our raw material program effective, we have stressed the importance of dependable, quality-minded sources of supply. Driver-Harris is a supplier with these qualities, *and Driver-Harris alloys have contributed greatly in making our performance possible.* For many years we have been using Driver-Harris Nichrome*, Karma*, Advance*, and other D-H Alloy wires for our resistance windings, with excellent results. We can strongly endorse Driver-Harris' dependability and high quality products."

Nichrome, Advance, and Karma are at your service too, as are more than 80 other D-H alloys developed for application in the electrical and electronic fields. If a high degree of resistance and absolute uniformity of output are "musts" for *your* product, let us have your specifications. We'll be glad to make recommendations based on your specific requirements.

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

Sole producers of Nichrome, Advance, Karma

Driver-Harris Company

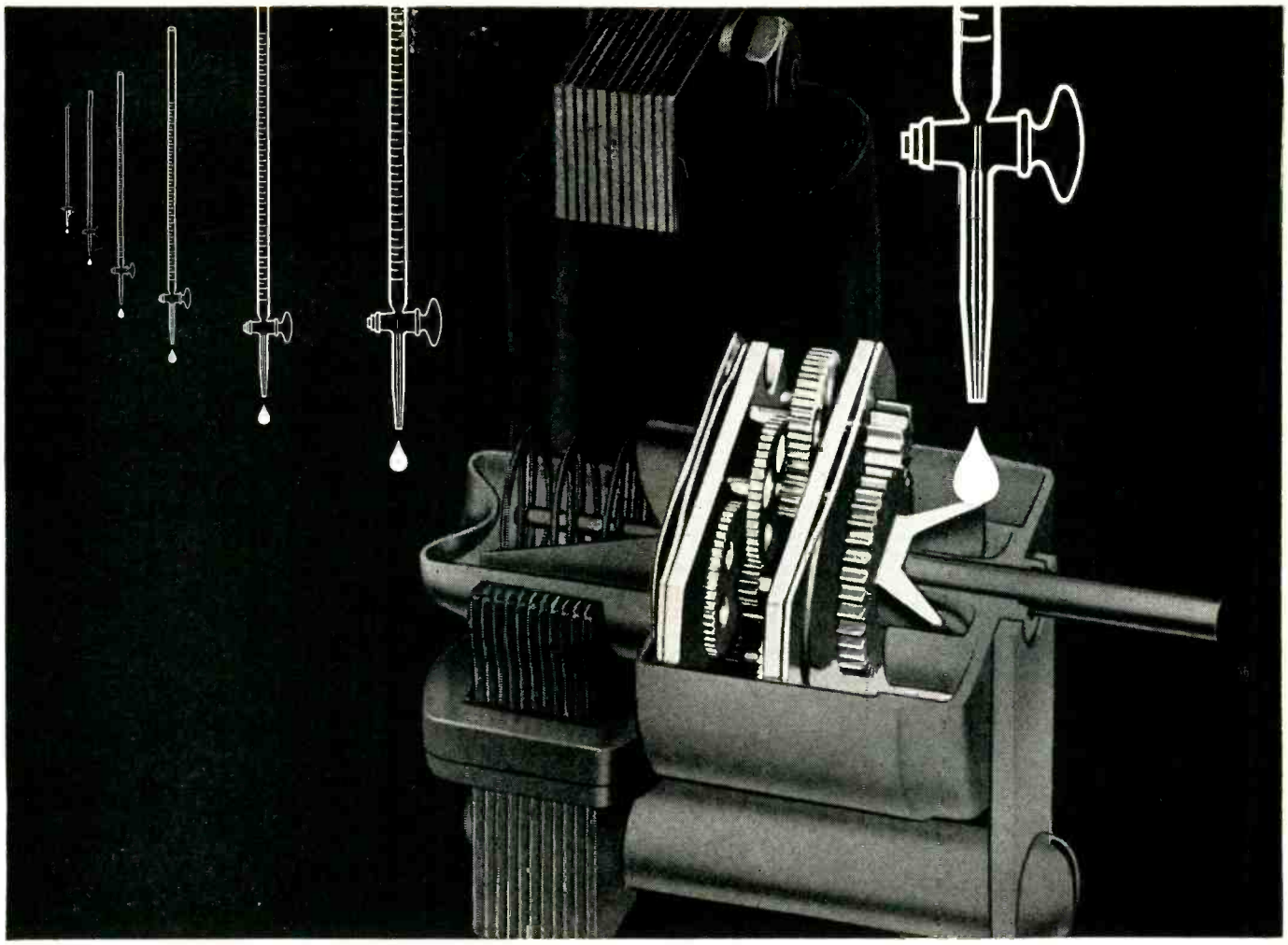
HARRISON, NEW JERSEY

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

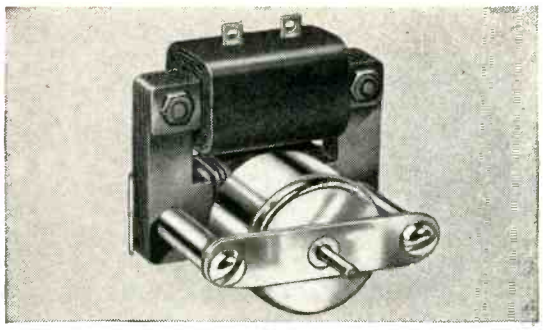
In Canada: The B. GREENING WIRE COMPANY, Ltd., Hamilton, Ontario.

MAKERS OF THE MOST COMPLETE LINE OF ELECTRIC HEATING, RESISTANCE, AND ELECTRONIC ALLOYS IN THE WORLD

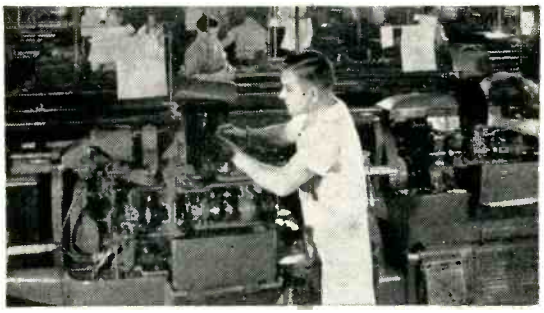
Visit us at the Instrument Exposition—Booths 559-561



MORE evidence of the extra VALUE in TELECHRON timing motors...



Telechron motors play a major part in switching many of America's jobs to "automatic." They are unmatched in the field of electric timing with such features as lightweight rotors for instant starting... open-air design for cool running... and truly synchronous performance.



Big production by our automatic screw machines—typical of our large motor plant capacity—plus an experienced engineering staff, assure speed in deliveries.

CONTROLLED, SEALED-IN LUBRICATION LASTS THE LIFE OF THE MOTOR

Too much oil interferes with a timing motor's accuracy. Too little causes excessive wear. The key factor in the instant starting and long life of a Telechron timing motor is its unique controlled system of lubrication.

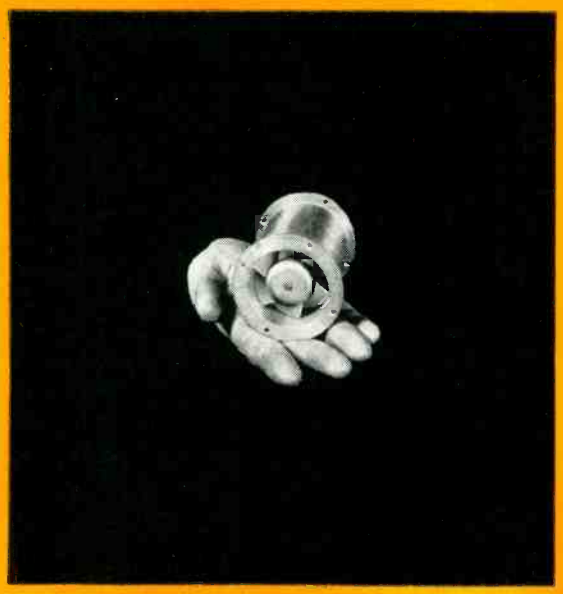
Each Telechron motor carries a lifetime reservoir of oil sealed in its rotor unit. Capillary action carries the oil to bearings, where its flow is controlled to all moving parts.

This exclusive lubrication system is one reason why—rating for rating—a Telechron timing motor will outlast and outperform any other synchronous timing motor made.

Telechron timing motors come in a wide range of speeds and torque ratings, for any standard AC power source. Write for full details about our Application Engineering Service. Telechron Department, General Electric Co., 49 Homer Ave., Ashland, Mass.

Telechron®
MARK OF TIMING LEADERSHIP

From VERY SMALL ... to LARGE CAPACITY



JOY AXIVANE® FANS

are available to meet any ELECTRONIC COOLING NEED

Joy AXIVANE Electronic Cooling Fans are expressly designed to meet the needs of this exacting field of service. They are built in a complete range to suit any requirements, such as: spot cooling of ventilated units where local high-temperature conditions arise; heat removal from pressurized or hermetically-sealed units; or heat removal where space is so restricted that natural ventilation through the unit or over its surface is insufficient. Important operating advantages of these fans are their strength, high resistance to shock and vibration, and efficiency in low or high-pressure service. Aluminum and magnesium construction keeps weight at a minimum.

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

Consult a Joy Engineer

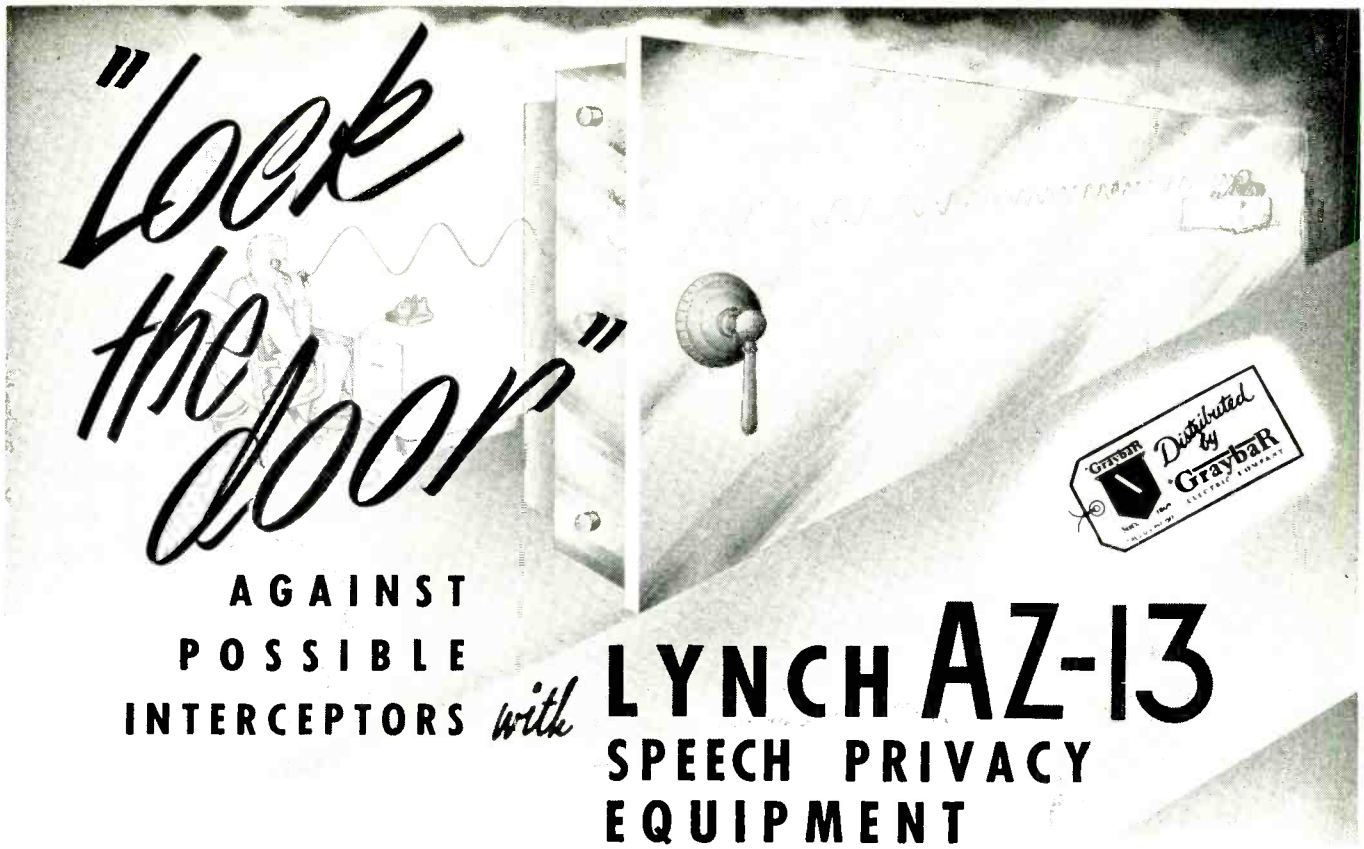
In general, keep these facts in mind: that the light, compact design, low power consumption and high overall efficiency of Joy AXIVANE Fans provide more satisfactory cooling for electronic equipment in either air-borne or surface units.

If you have a problem in heat dissipation from electronic units, let us place at your disposal JOY'S experience as the world's largest manufacturer of vaneaxial-type fans. ● Write ***Joy Manufacturing Company, Oliver Building, Pittsburg 22, Pa.*** In Canada; *Joy Manufacturing Company, (Canada) Limited, Galt, Ontario.*

W & D 140648

JOY

WORLD'S LARGEST MANUFACTURER
OF VANE-AXIAL FANS



AGAINST POSSIBLE INTERCEPTORS *with* LYNCH AZ-13 SPEECH PRIVACY EQUIPMENT

LYNCH AZ-13 equipment added to both ends of your existing land-wire or radio telephone circuit will insure complete privacy of conversation . . . will literally "lock the door against possible interceptors"!

This desirable effect is achieved by intricate electronic circuitry which acts to divide the speech frequency spectrum into numerous small increments, each of which is subjected to a complex modulation process, controllable by the "combination" selector switches. By this method the transmitted speech may be so thoroughly "scrambled" that it will bear absolutely no relation to the original conversation.

This system is similar to an extremely complex puzzle where a solution is possible only when each of the random-order sections is returned to its proper position within the frequency spectrum. Despite the outward complexity of the system, operating personnel require no special knowledge; the coding and decoding functions being accomplished automatically by positioning rotary switches to predetermined settings. The original intelligence is restored clearly at the receiving end of the circuit when proper AZ-13 terminal equipment is used . . . provided . . . selector switches at both ends of the circuit are positioned to identical numbered settings. The decoding procedure is analogous to a combination safe with two geographically-separated combination dial locks, both of which must have exactly the same settings if the safe is to be opened. However, while most safes have only a single combination, the selector system in the AZ-13 makes instantly available, any of two hundred thirty-three different, highly complex combinations!

OTHER IMPORTANT SPEECH PRIVACY FACTORS....

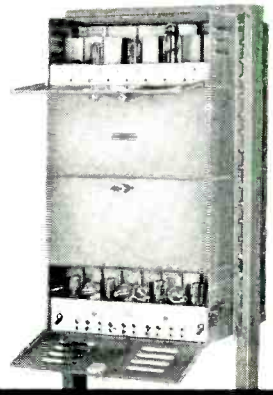
(1). Different code combinations may be used for each direction of transmission. Interceptors must then cope with 466 different combinations in order to decode both ends of a conversation.

(2). Complexity of the very highest order can be obtained by instituting a cyclic change in coding selector combinations at both ends of the circuit on a prearranged basis.

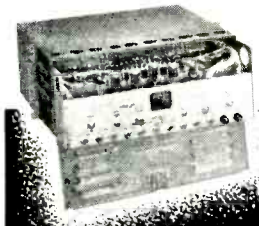
(3). All of these factors combine to make successful decoding extremely improbable even where identical equipment is used by possible interceptors.

IMPEDANCE - - - LEVELS

The switchoard side of the AZ-13 is either two or four wire, 600 ohm balanced. The line side is four wire and requires separate 600 ohm pairs. The equipment operates on a no gain-no loss basis. Adaptation equipment is available for applications where other impedances and levels are involved.



B-69 FOR LESS RIGID SPEECH PRIVACY REQUIREMENTS



A second Lynch equipment, B-69 speech-inverter is available for use where highest privacy is not essential but where the intent is merely to prevent understanding by the casual listener.

Contact Our Representatives For Further Information

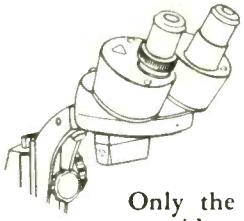
LYNCH CARRIER SYSTEMS INC.
SAN FRANCISCO, CALIF.

Export Department: PHILIPS EXPORT COMPANY, Division of North American Philips Company, Inc.
100 East 42nd Street, New York 17, N. Y., U. S. A. Cables: PHILYORK

Keeps Production to Capacity . . . All Day Long!

Bausch & Lomb TRANSISTOR MICROSCOPE

Boosts output, cuts spoilage, because anti-fatigue features assure full-work-day efficiency!

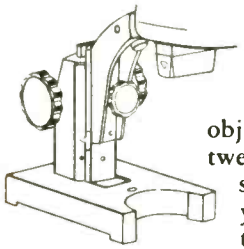


SET AT ANY DESIRED ANGLE FOR GREATEST COMFORT — FITS ANY WORK AREA

Only the B&L Transistor Microscope provides this *individualized* comfort. Full 180° rotatability of inclined eyepiece assembly permits setting at *exact* angle for natural position of head and neck. Operator is free from strain, able to work better, faster.

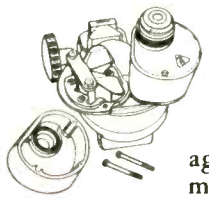
NATURAL ENLARGED VIEWS OF TINY PARTS . . . NO EYESTRAIN

Simplifies ultra-precision work by providing clear, sharp magnified images . . . shows work right side up, in natural 3-dimensional relief. Permits hour-after-hour use without eye fatigue . . . in assembly, measurement and inspection.



LARGE, UNOBSTRUCTED WORK SPACE PERMITS FASTER, EASIER ASSEMBLY

Ample clearance between objective lens and stage for hands, tweezers, tools. Focusing knobs are set back, within effortless reach, yet out of the way of jigs and tools.



SHOCKPROOF, DUSTPROOF FOR LIFE . . . SAVES MAINTENANCE COSTS, KEEPS PRODUCTION ROLLING

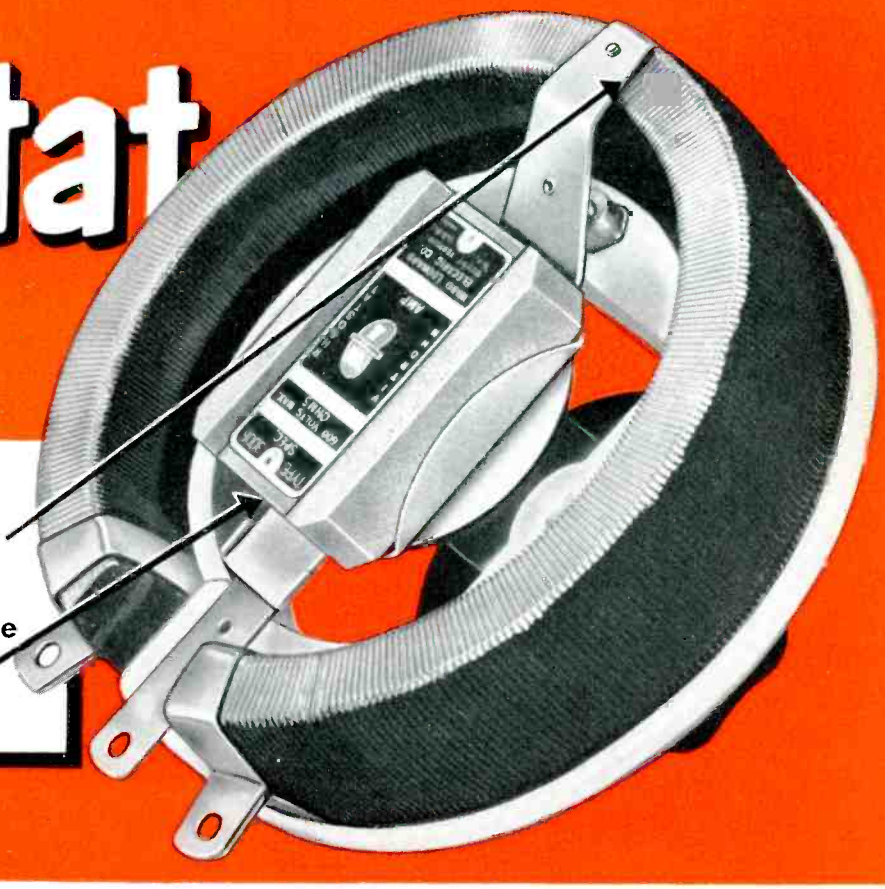
Clamps and gibs lock prisms into life-time alignment, safe from shock damage. Permits safe, trouble-free mounting in machine or fixture. Patented Neoprene ring seals out dust. Saves money on repairs, down-time.

WRITE NOW for descriptive literature (D-1036) and for on-the-job demonstration on your own production lines. Bausch & Lomb Optical Co., 61433 St. Paul St., Rochester 2, N. Y.

BAUSCH & LOMB

SINCE B&L 1853

New 300-watt Vitrohm ring Rheostat



Exclusive "twin" contact shoes insure uniform contact resistance

You get extra-smooth performance from Ward Leonard's unique double-shoe design which gives you two contacts — one on the collecting ring as well as one on the resistance winding.

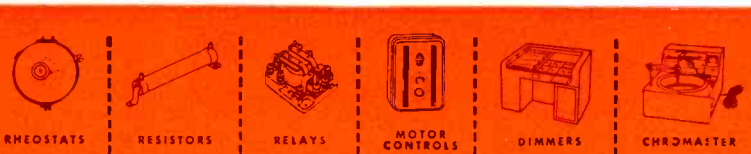
Sintered, self-lubricating twin-shoe construction prevents galling or seizing often caused by metal-to-metal contacts of ordinary rheostats. That's why you get smoother control, more uniform contact resistance and longer operational life from this new Ward Leonard ring rheostat.

Other construction advantages of this biggest, most recent addition to the famous Vitrohm ring rheostat line include the rigid contact arm-housing assembly that eliminates backlash and radial motion. Compression spring in housing insures proper pressure of twin contact shoes on both resistance winding and collector ring. And Ward Leonard's 6" Vitrohm ring rheostat with identical mounting dimensions, shaft diameter and shaft flat as other makes, occupies less back-of-panel space.

For detailed specifications on the new type 300 R ring rheostat, write today for Bulletin 1116. Ward Leonard Electric Co., 400 South Street, Mount Vernon, N.Y.

4.7

WARD LEONARD ELECTRIC COMPANY
MOUNT VERNON, NEW YORK



Result-Engineered Controls Since 1892

Meet the exclusive "twin-shoe" line of Vitrohm ring rheostats

If it's performance you're looking for, check these exclusive features of Ward Leonard's complete line (25 through 300 watts) of Vitrohm ring rheostats:

The "twin" contact shoes of sintered material assure uniform contact pressure and unusually smooth, trouble-free operation.

Special alloy resistance wire is toroidally wound on core and held permanently secure by the Vitrohm vitreous enamel.

Core and base are molded of highest quality ceramic materials and bonded together by Vitrohm enamel.

Whether your product is heavy industrial apparatus, sensitive electronic equipment, or a simple appliance requiring rheostats, you'll get more accurate, dependable performance per dollar from the Vitrohm ring line. Write for data-packed bulletins to Ward Leonard Electric Co., 400 South St., Mount Vernon, New York.

Rheostat Type	Watt Rating (based on 300°C Rise)	Total Resistance* Min. Ohms	Total Resistance* Max. Ohms	Approx. Number of Steps at Min. ohms	Approx. Number of Steps at Max. ohms
25R	25	1.0	5,000	27	520
50R	50	1.0	10,000	49	998
100R	100	1.0	10,000	41	1041
150R	150	1.0	10,000	43	1240
300R	300	1.0	2,500	40	710

* Wide range of resistance values stocked for immediate shipment.

WARD LEONARD ELECTRIC COMPANY
MOUNT VERNON, NEW YORK

RHEOSTATS | RESISTORS | RELAYS | MOTOR CONTROLS | DIMMERS | CHROMASTER

Result-Engineered Controls Since 1892

Send for this *Free* SAMPLE FOLDER...

Contains 25 different Test Samples of high-dielectric INSULATING TUBING and SLEEVING

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.

Varflex
CORPORATION
Makers of Electrical Insulating Tubing and Sleeving

MAIL COUPON TODAY FOR SAMPLES!

VARFLEX CORPORATION,
506 W. Court St., Rome, N. Y.

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

I am particularly interested in insulation for:

NAME.....

COMPANY.....

STREET.....

CITY.....ZONE.....STATE.....

Federal

DIVISION OF IT&T

ANNOUNCES

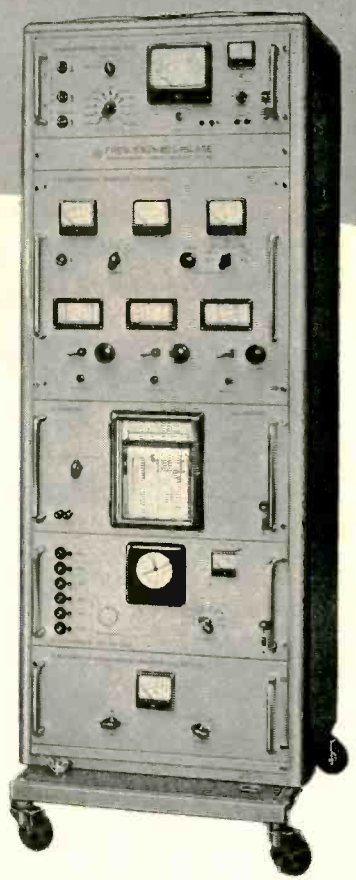
the organization of an

INSTRUMENT DIVISION

for the manufacture and distribution of precision-built

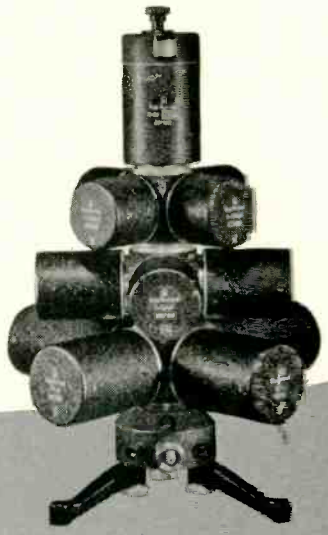
MEASURING AND TESTING INSTRUMENTS

for science and industry



Frequency Decade by Rohde and Schwarz, 30 cps to 600 mc—accuracy ± ' x 10⁻⁷.

Unique in design and construction and engineered to provide the utmost in accuracy and dependable performance, this equipment brings to American research and industry the products of domestic and foreign manufacturing divisions of the world-wide IT&T system—as well as those of outstanding independent instrument makers abroad.



Fixed and variable standard capacitors and connecting base by R. Jahre.

SEE FEDERAL'S EXHIBITS AT THE

FIRST INTERNATIONAL INSTRUMENT CONGRESS AND EXPOSITION, Commercial Museum and Convention Hall
PHILADELPHIA—SEPT. 15-22
Booths 202 and 204

NATIONAL ELECTRONICS CONFERENCE
HOTEL SHERMAN
CHICAGO—OCT. 4-5-6
Booths 9 and 10

Federal Telephone and Radio Company

A Division of INTERNATIONAL TELEPHONE AND TELEGRAPH CORPORATION
INSTRUMENT DIVISION, 100 KINGSLAND ROAD, CLIFTON, N. J.

C-D first again!

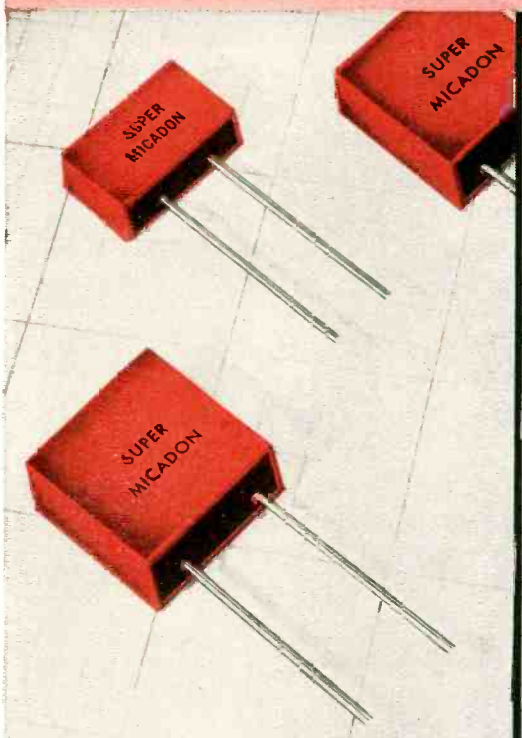
with an entirely new concept in midget mica capacitor design..

'SUPER MICADON'*

encapsulated mica capacitors

Read the chart— Here's the proof!.....

They said it couldn't be done, but C-D did it! 5 to 6 times the capacity in the same space! Temperature characteristics never before attained . . . 10 to 35 times higher insulation resistance! The world's greatest innovation in hermetic seal . . . nearly 20 times the moisture resistance! Nothing like it ever before . . . with a life expectancy as high as 19 times greater than conventional types.



There are more C-D capacitors in use today than any other make!

SPECIFICATION	"SUPER MICADON" 1A	CONVENTIONAL CM-30	"SUPER MICADON" 5A	CONVENTIONAL CM-20
CASE SIZE	Same as CM-30	Same as 1A	Same as CM-20	Same as 5A
CAPACITY RANGE at 500 VDCW	To .015 MFD.	To .0033 MFD.*	To .0036 MFD.	To .00051 MFD.
CAPACITY RANGE at 300 VDCW	To .02 MFD.	To .01 MFD.†	To .0051 MFD.	To .001 MFD.
LIFE TEST FAILURES After 4000 Hours at 1000 VDCW (2 x Rated Voltage at 85°C)	4%	76%	Similar results predicted as for Type 1A—pending tests	
TEMPERATURE RANGE	—55°C to +130°C	—55°C to +85°C	—55°C to +130°C	—55° to +85°C
MOISTURE RESISTANCE After 10 Cycles of MIL-C-5A Test	200,000 Meg.#	10,000 Meg.	300,000 Meg.	15,000 Meg.
INSULATION RESISTANCE at 25°C	1,000,000 Meg.	100,000 Meg.	1,500,000 Meg.	100,000 Meg.
INSULATION RESISTANCE at +130°C	15,000 Meg. (.005 Mfd.)	500 Meg. (.005 Mfd.)	20,000 Meg. (.001 Mfd.)	700 Meg. (.001 Mfd.)
INDUCTANCE	UP TO 40% LESS THAN FOR CONVENTIONAL TYPES			
PARALLEL PLUG-IN LEADS	Yes	No	Yes	No
MOLDING DEFORMATION	No	Yes	No	Yes
MAX. TEMP. COEFF.	Char. "F"	Char. "E"	Char. "F"	Char. "D"
SINGLE DIRECT LEADS TO FOIL CONTACTS	Yes	No	Yes	No
NEED FOR WAX COATING	No	Yes	No	Yes
MARKING	Stamped with Cap. and Volt.	Color coded—only for Cap.	Stamped with Cap. and Volt.	Color coded only for Cap.

*Even the larger CM-35 case is limited to .0062 mfd. capacity. †Requires larger CM-35 case for this capacitor.
#Over 40,000 Megs. after 20 Cycles.

Wire, write or call today for descriptive literature, samples, or engineering assistance to: Cornell-Dubilier Electric Corp., Dept. K-94, South Plainfield, N. J.

For over 40 years, a symbol of capacitor leadership . . . in engineering, design and dependability.

*®

CORNELL-DUBILIER CD CAPACITORS

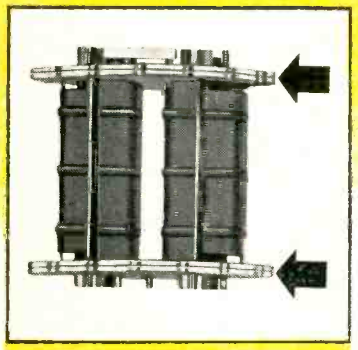
ONSISTENTLY EPENDABLE
CORNELL-DUBILIER CAPACITORS

PLANTS IN SOUTH PLAINFIELD, N. J., NEW BEDFORD, WORCESTER AND CAMBRIDGE, MASS., PROVIDENCE AND HOPE VALLEY, R. I., INDIANAPOLIS, IND.; SANFORD AND FUQUAY SPRINGS, N. C., SUBSIDIARY: THE RADIART CORPORATION, CLEVELAND, O.

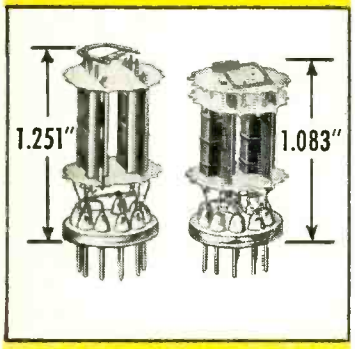
MOST RELIABLE TUBES YOU CAN INSTALL!

5-Star Tubes

. . . for aircraft navigation, control, and communications.



● Double mica spacers at top and bottom brace 5-Star Tube structures . . . widen surfaces in contact with glass envelope . . . make for a tube that will stand up in hard service.



● Compact, sturdy tube cages withstand shocks and vibration. Note that 5-Star GL-5751 (right) is 13% shorter than 12AX7 prototype, with heavier, more substantial design.

SPECIALLY DESIGNED!

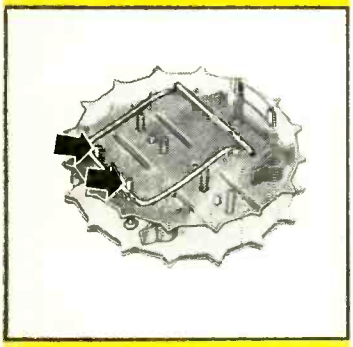
Superior dependability of G-E 5-Star Tubes is designed in, with many special features contributing to performance.

NOT selected tubes, but tubes engineered at the drawing-board level for greater reliability! General Electric 5-Star Tubes are special in every aspect of their design.

Resistance to shocks and vibration is superior to standard tubes because of double mica spacers, sturdy tube cages, double-staked getters, and other built-in strength and safety features.

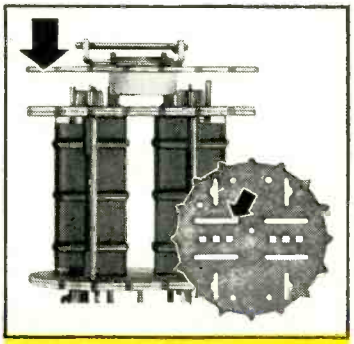
Fewer "shorts", more uniform electrical characteristics—these result from heavier, better-insulated heater wire; from steps taken to prevent inter-element leakage; from still other 5-Star design improvements that pay off in stable performance.

Millions of General Electric 5-Star Tubes—now giving far more reliable service for a longer period of time—prove that increased receiving-tube dependability *starts at the design stage!*

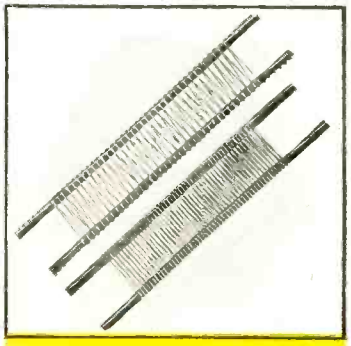


● 5-Star Tube getters are double-staked to the mica spacer beneath. This gives firm support against shocks—is characteristic of strong tube construction throughout.

● 5-Star heater-wire bends are coated a second time to prevent "shorts". Left, how flaked-off coating can expose wire. Right, after special insulating treatment.



● Double plate-to-grid leakage protection in many types! Left: getter flash shield wards off conductive deposits. Right: spacer slots interrupt leakage paths.



● Grid legs of 5-Star Tube (right) are smooth, not nicked. This assures a tight fit where legs pass through spacers, reducing grid vibration and microphonic noise.

SPECIFY THEM FOR CRITICAL APPLICATIONS!

. . . for 2-way radio emergency communications.

. . . for radar installations.

. . . for remote-controlled transmitters and unattended relays.

. . . for studio and transmitter equipment in AM-FM-TV broadcasting.

SPECIALLY MANUFACTURED!

Utmost care in manufacture follows. G-E 5-Star Tubes are built to only one standard of quality . . . the highest!

INCREASED reliability brought about by special tube design, is further accented by pre-assembly inspection of individual parts, painstaking manufacture, and thorough testing.

5-Star Tubes are built in separate G-E factory areas, by selected operators whose output features quality, not quantity. Advanced optical equipment is used to magnify parts and to check measurements. Many such inspections involve every 5-Star Tube.

The industry's strictest quality-control standards are observed. Final tube tests are comprehensive and exacting. All G-E 5-Star Tubes receive a final 46-hour "burn-in" before shipment.

Design, manufacture, testing—all focussed on dependability—join to make G-E 5-Star Tubes the best and most reliable you can install! *Tube Dept., General Electric Company, Schenectady 5, N. Y.*

ATTENTION: EQUIPMENT DESIGNERS!

33 G-E 5-Star Tubes—19 miniatures, 1 glass octal-base, 2 metal, 11 subminiatures—give you a wide choice, enabling you to put high reliability in virtually every socket. Ask for *new* Bulletin ETD-548C, with full tube listing and application data!

● 5-Star Tube parts are individually inspected by microscope. Grids are micrometer-gaged for accurate dimensions. These are pre-assembly checks with every G-E 5-Star Tube.

● During rigid short-circuit tests, 5-Star Tubes are tapped with a cork mallet. A single flicker of the short test indicator brings immediate tube rejection.

● Every 5-Star Tube receives a 46-hour "burn-in" under Class A conditions. This avoids early life failures, and assures stable electrical performance.

Progress Is Our Most Important Product

GENERAL ELECTRIC

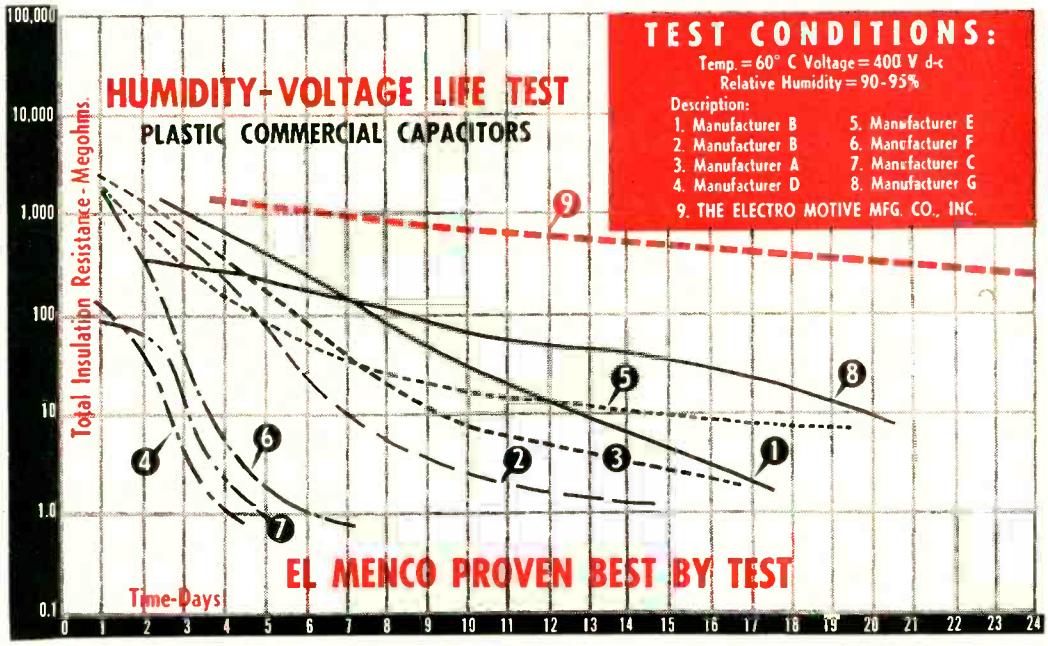
162-1B10

...how good is BEST?

BEST { ... By TEST! ... By PERFORMANCE! * }

These curves are authentic recordings taken from actual results obtained from a nationally known independent testing laboratory.

and here's proof!



* CERAMIC CASED PAPER DIELECTRIC CAPACITORS —

* More than 60 million of these capacitors have been used by nationally known radio and television manufacturers with no reported field failures. These ceramic capacitors are available in 200, 400, 600 and 1000 working voltage ratings.

Write for sample and catalog on your firm's letterhead.

Jobbers and Distributors are requested to write for information to Arco Electronics, Inc., 103 Lafayette St., New York, N. Y.

El-Menco

MOLDED MICA CAPACITORS

MICA TRIMMER

Foreign Electronic Manufacturers Get Information Direct from our Export Dept. at Willimantic, Conn.

THE ELECTRO MOTIVE MFG. CO., INC. WILLIMANTIC, CONNECTICUT

MORE PROOF that engineers rate Lambda power supplies

BEST... REGARDLESS OF PRICE!

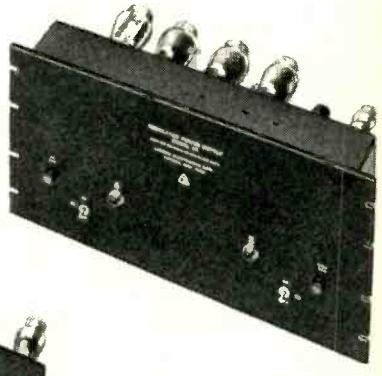
TWO NEW, INDEPENDENT SURVEYS SHOW WIDE PREFERENCE FOR LAMBDA

Stock models which have been modified to customers' requirements.

Bench Model 41
Unregulated
0-500 VDC @ 0-200 MA
$149.50

Bench Model 50
0-500 VDC @ 0-500 MA
$415.00

Bench Model 25
200-325 VDC
@ 0-100 MA
$64.50



Rack Model 28
200-325 VDC @ 0-100 MA
$57.50

Rack Model 32
200-325 VDC @ 0-300 MA
$129.50

Rack Model 32M
200-325 VDC @ 0-300 MA
$159.50

LAMBDA POWER SUPPLIES ARE RANKED FIRST — 50 per cent ahead of the next identified manufacturer — by engineers who participated in a comprehensive survey of buying practices and preferences just released by one of the leading electronics publications.

Another independently conducted survey, also recently concluded, places Lambda in the same position of leadership.

The reasons for this preference for Lambda by men who know power supplies intimately are simple: Lambda power supplies are *precision* equipment — dependable, and attractively priced. Lambda is a pioneer in the development of power supplies and a specialist in this field only.

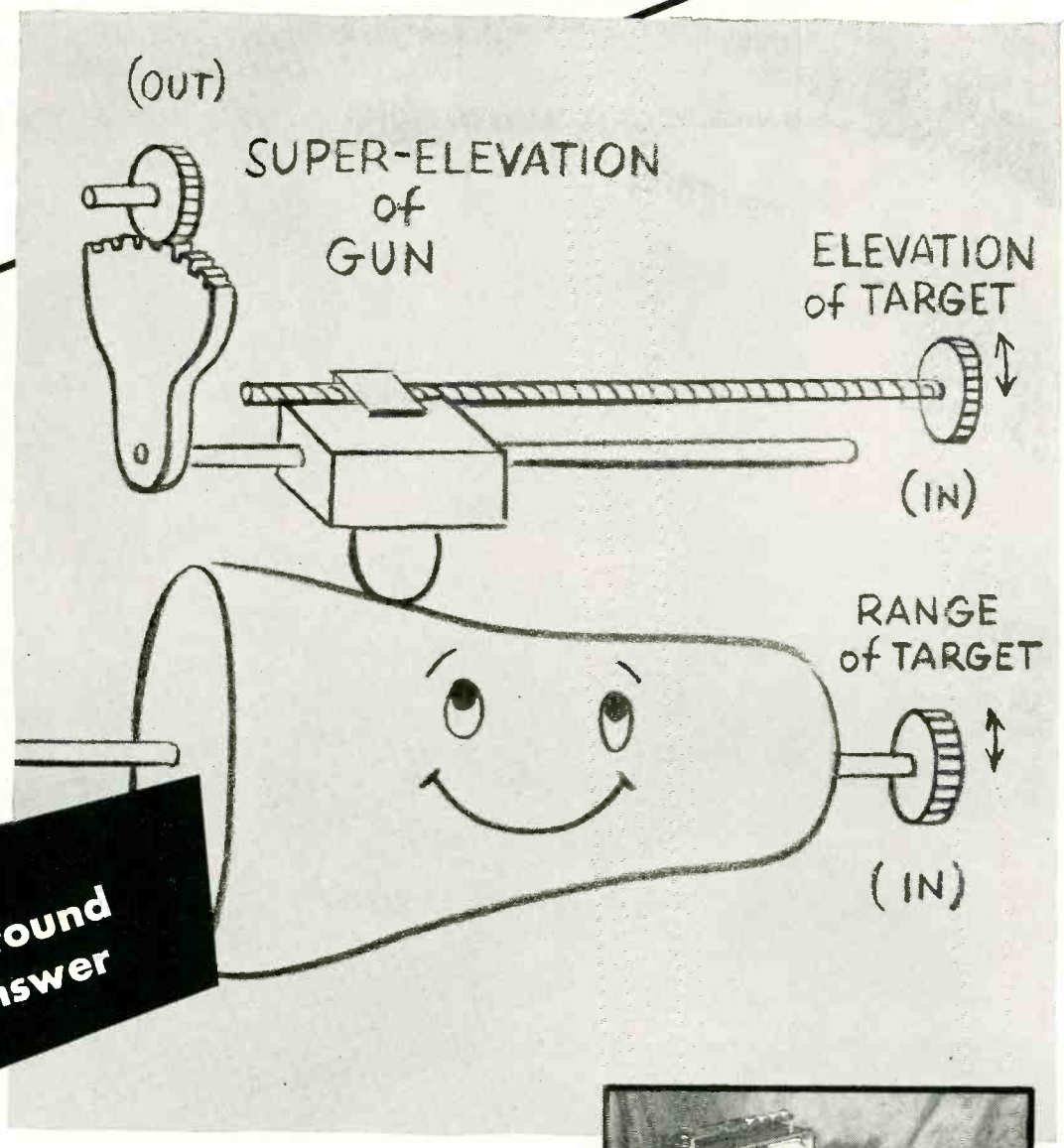
Send for new Lambda Power Supplies Catalog 11

LAMBDA ELECTRONICS CORP.

THE FIRST NAME IN POWER SUPPLIES

103-02 NORTHERN BOULEVARD • CORONA 68, NEW YORK

HOW TO TAP THE BRAIN
of a piece of metal



And FORD found the answer

In making computers, such information as mathematical functions can be stored in a precision-cut cam, thus allowing its follower to be displaced in accurate reply to the input position of the cam. Ford Instrument Company designs and makes cams of all sizes and shapes to achieve these results. To manufacture such cams with the precision demanded, the engineers of Ford Instrument have devised remarkable automatic machines which, by following a carefully plotted ink line on a roll of paper, cut the exact shape into the metal. Then, careful point-by-point checks, sometimes as many as 2000 measurements, insure finest accuracy.

If you have a cam problem—call on Ford Instrument Company.

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

28

FORD INSTRUMENT COMPANY

DIVISION OF THE SPERRY CORPORATION

31-10 Thomson Avenue, Long Island City 1, N. Y.

EAST or WEST... NORTH or SOUTH

only KARP can offer deep cuts in your enclosure costs!

Distance is no barrier to the money-saving advantages of KARP'S exclusive "one-stop" Service.

Where else can you find . . .

★ 3000 stock tools and dies that eliminate or reduce new tooling costs . . . Complete fabrication, finishing and assembly facilities, in an 88,000 sq. ft. modern plant that permits mass production techniques, assuring . . . Rapid production output geared to cut your inventory needs, through . . . Experienced design counsel and Engineering Service.

Let KARP prove that your initial and production costs on cabinets, enclosures, chassis, and housings can be low, whether you need ten or ten thousand units. There is no obligation for quotations on your blue prints, samples or sketches. Write or phone, today!

KARP METAL PRODUCTS CO.

Division of H & B American Machine Company Inc.

Main office & Plant
211 - 63rd Street, Brooklyn 20, N. Y.
Telephone: HYacinth 2-7700

West Coast Plant
3420 Wesley Street, Culver City, Calif.
Telephone: LAmont 9-4343

enclosures reflect the skills within

FACILITIES FOR ENGINEERED SHEET METAL FABRICATIONS: in aluminum or steel • long run or short • spot, arc, gas or heliarc welding • any type finish

- Modern plant—3 city blocks long
- Thousands of dies available
- Most modern of sheet metal fabricating equipment
- U. S. Air Force Certified Welding Facilities
- Air-conditioned spray room . . . complete baking facilities
- Complete sub-assembly facilities

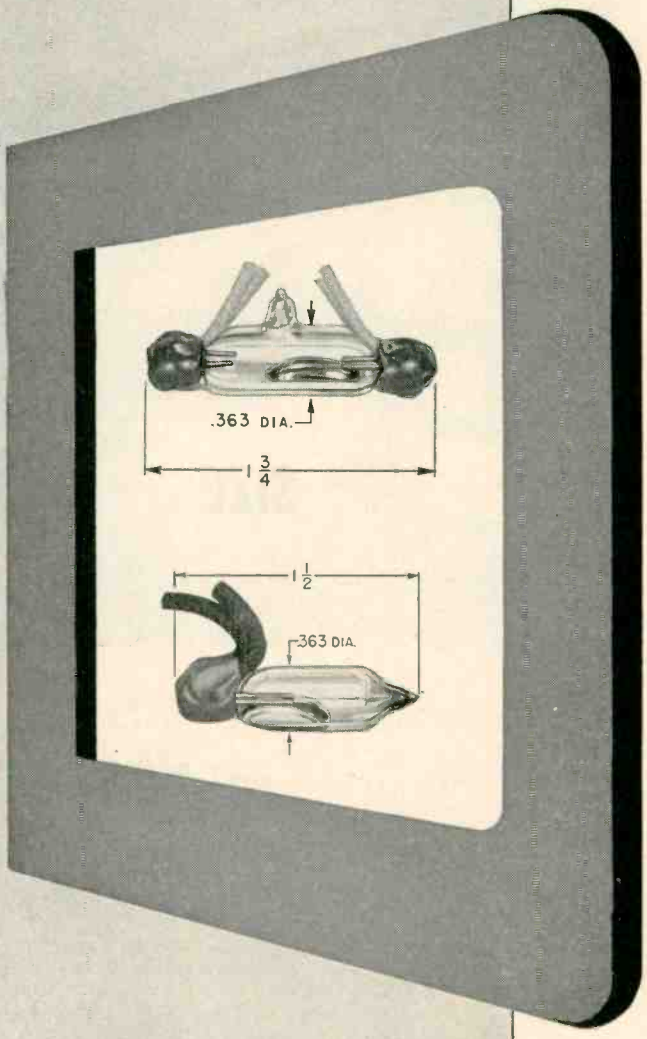
HONEYWELL Mercury Switches

A PRINCIPLE OF GOOD DESIGN

small Mercury Switches to meet demands of—

1. Small load circuits

2. Limited operating space



• Ratings of some types of small Honeywell Mercury Switches may often be extended down to micro-volt milli-ampere ranges. They are especially designed for reliable service in low energy circuits for applications where space economy is a critical factor.

These switches are widely used by manufacturers of control and indicating devices, home freezer units, alarms, animated displays and other applications which involve tilt motion and low force.

Whatever your specific requirement, if a mercury switch is indicated, there is a Honeywell Mercury Switch to meet it. In addition to the small switches mentioned here, there are:

- **High capacity mercury switches**
- **Sensitive mercury switches**
- **Protected mercury switches**
- **General purpose mercury switches**

Let a MICRO SWITCH field engineer, fully experienced in every type of switch application, help you select the right switch for your application. Call the nearest MICRO SWITCH branch office. Ask for Catalog 90.

MICRO SWITCH provides a complete line of extremely reliable, small-size, high-capacity, snap-action precision switches and mercury switches. Available in a wide variety of sizes, shapes, weights, actuators and electrical characteristics. For all types of electrical controls.

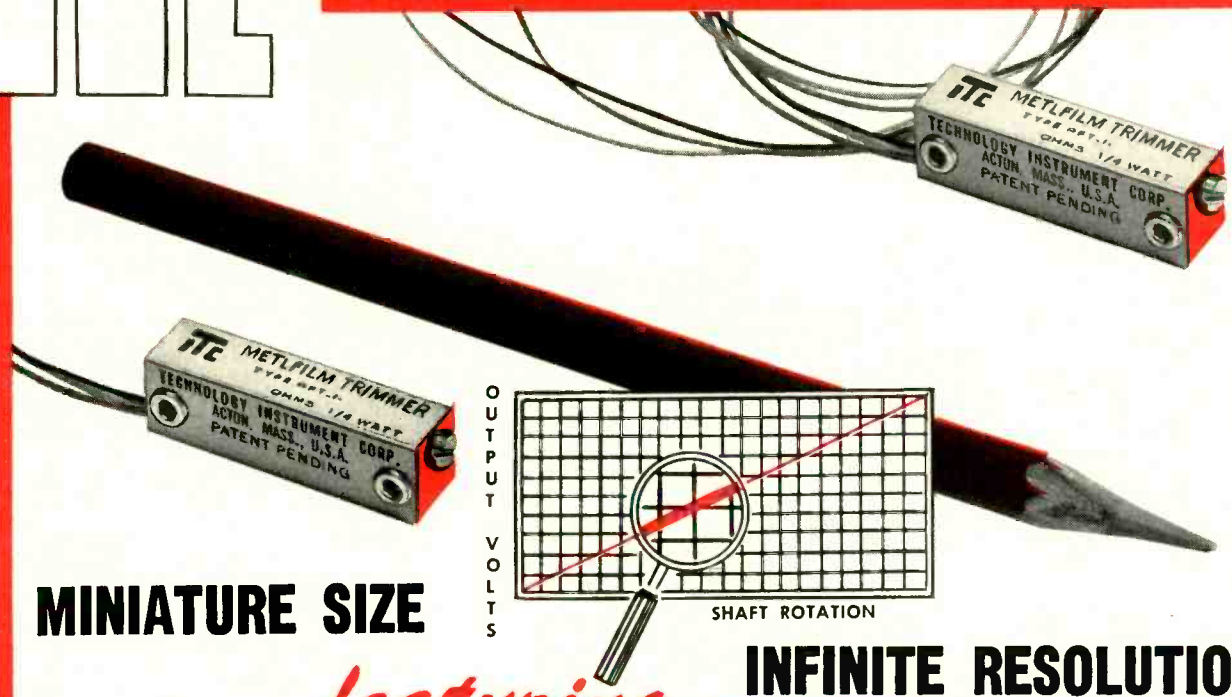
MICRO SWITCH

A DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR COMPANY

FREEPORT, ILLINOIS

H HONEYWELL

METLFILM TRIMMER POTS



MINIATURE SIZE

featuring **plus**

INFINITE RESOLUTION

"ZERO PHASE SHIFT"

Infinite Resolution

. . . of the unique deposited metal resistance element embodied in Type RFT Metlfilm Trimmer Potentiometer is available over a wide resistance range. 9000° of adjustment, the equivalent of 25 turns of the adjustment screw on which sliding contact rides, permits voltage settings to be set and maintained with extreme precision.

Diminutive Size

. . . (approximately ⅜" square end surface), permits stacking seven units in a square inch of panel area. Ideal for trimming adjustments in computers, analyzers, telemeter and airborne electronic equipment.

Rugged construction insures dependability despite wide changes in ambient temperature and extreme conditions of salt spray, humidity and vibration.

TIC accumulative Handbook and Catalog on precision potentiometers available at $2.00

SPECIFICATIONS

Electrical

Resistance Range: 50-25,000 ohms

Total Resistance Tolerance: ± 10%

Independent Linearity: ± 5% of total resistance

Resolution: Infinite

Power Rating: ½ watt at 40°C., ¼ watt at 125°C. per JAN-R-19 test specification.

Ambient Temperature Range: — 65°C to + 125°C.

Temperature Coefficient of Resistance Element: .000250/°C (nominal)

Dielectric Test: 500 volts DC between all leads, shaft and mounting eyelets for 5 seconds without flashover or breakdown.

Mechanical

Resistance Element: Metal film deposited on inert base.

Mechanical Rotation: 26 complete turns (nominal).

Usable Mechanical Rotation: 90% minimum of slider travel is on resistance element.

End Stops: Will withstand 1 inch pound maximum applied torque.

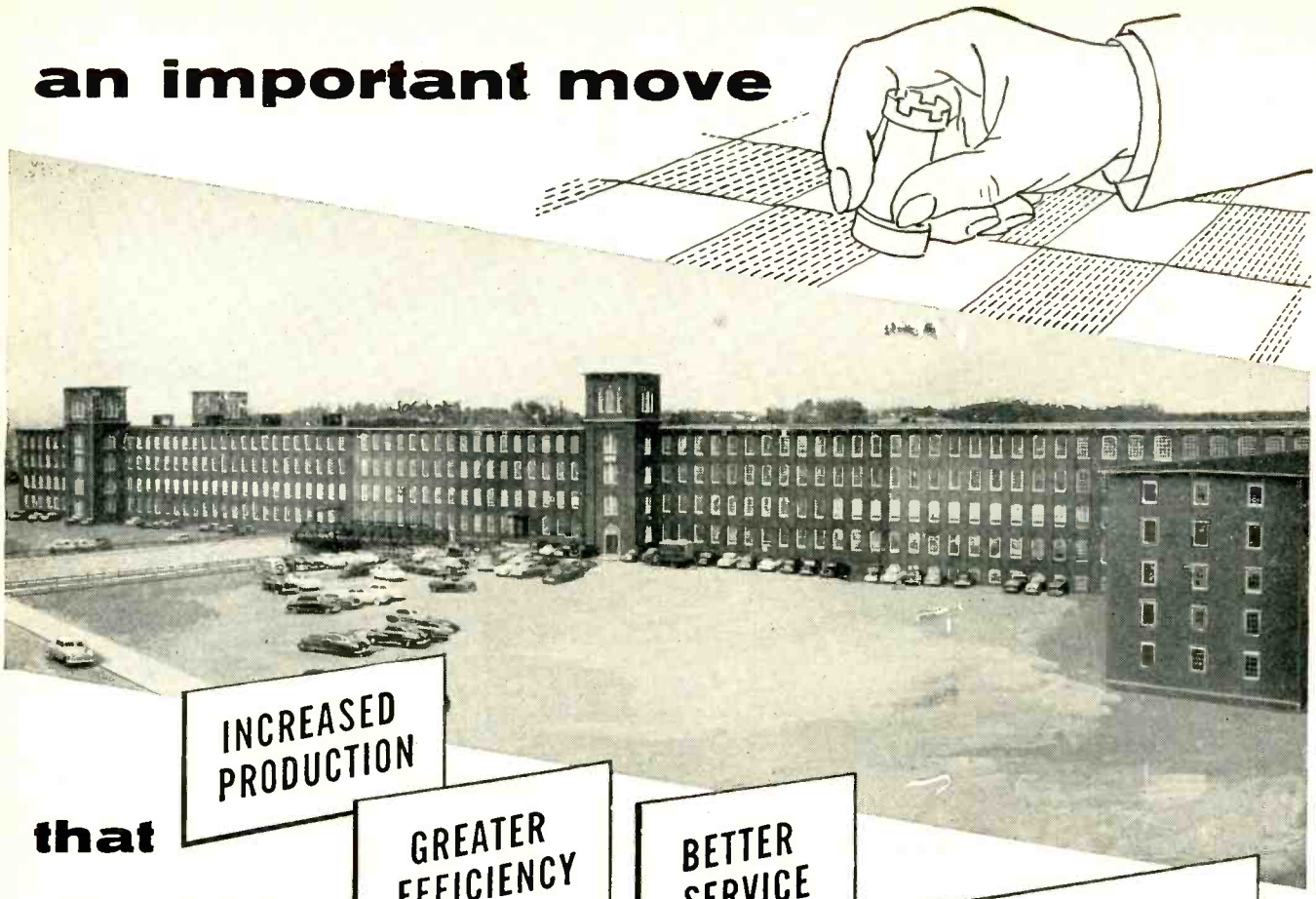
Vibration: Exceeds exacting requirements of MIL-E-5272a.

For further details write:

TECHNOLOGY INSTRUMENT CORP.

533 Main Street, Acton, Mass. COlonial 3-7711
West Coast Eng'r'g. Facility 731 No. LaBrea Ave., Hollywood, Calif. Whitney 0108

an important move



that means — INCREASED PRODUCTION — GREATER EFFICIENCY — BETTER SERVICE FOR EAD CUSTOMERS

Until recently, EAD's expansion was the acquisition of more and more small plants clustered about our main building in Brooklyn. Sooner or later something permanently suitable to our growing needs had to be found . . . and our new plant, in Dover, New Hampshire, is it. Now, under one tremendous roof — with more than 130,000 square feet of working space occupied, and additional space available for future needs — EAD has the elbow room to offer you better service than ever on all your motor and blower requirements. In looking forward to still greater expansion, we recognize the source of our progress — you, our customers and friends — and we shall strive to keep your friendship through constant development of newer and better rotating electrical equipment.

Solving Special Problems Is Routine at EAD

If your problem involves small rotating electrical equipment, bring it to EAD. Our completely staffed organization will modify one of our standard units or design and produce a special unit to meet your most exacting requirements.

EAD

EASTERN AIR DEVICES, INC.

SOLVING SPECIAL PROBLEMS IS ROUTINE AT EAD

INDUCTION MOTORS — CENTRIFUGAL BLOWERS — TACHOMETER GENERATORS — FANS — ALTERNATORS — GEAR MOTORS

387 CENTRAL AVENUE—DOVER, NEW HAMPSHIRE

CUT TV COSTS, MAINTAIN QUALITY WITH G.E.'S NEW 600-SERIES TUBES!

Now, for the first time, designers can have "series-string" economy at no sacrifice of TV reliability!

- ★ Every G-E 600-Series Tube has same heater warmup time. Greatly reduces tube failures, because voltage will not build up excessively in some tubes while others are warming up more slowly.
- ★ All filaments are 600-ma. They employ special large-diameter wire, with fewer bends for better insulation against heater-cathode shorts.
- ★ 24 G-E 600-Series types are ready now! More coming.

QUALITY TV performance—costs sharply reduced! G-E tube-design service brings you both benefits with the new 600 Series. Now, by means of "series-string" design, you can *save* on transformer and circuitry . . . yet maintain highest standards of receiver dependability, with service callbacks at a minimum.

Meet today's stiff TV competition at its own price level, but with far superior performance! Use G-E 600-Series Tubes, *designed for "series-string" operation.* List at right shows wide range of types available. Others soon. Get full information from *Tube Department, General Electric Company, Schenectady 5, N. Y.*

CHECK YOUR CIRCUIT NEEDS AGAINST THIS LIST!

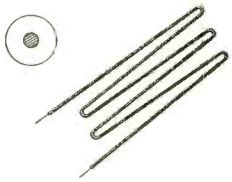
G-E 600-Series Tubes	Prototypes
3AL5	6AL5 12AL5
3AU6	6AU6 12AU6
3BC5	6BC5
3BE6	6BE6 12BE6
3BN6	6BN6
3BY6	6BY6
3CB6	6CB6
5AQ5	6AQ5 12AQ5
5BK7-A	6BK7-A
5J6	6J6
5T8	6T8
5U8	6U8
5V6-GT	6V6-GT 12V6-GT
6S4-A	6S4
6SN7-GTB	6SN7-GTA
12AX4-GTA	12AX4-GT
12B4-A	12B4
12BH7	12BH7
12BK5	6BK5 25BK5
12BQ6-GA	6BQ6-GA 25BQ6-GA
12BY7-A	12BY7
12L6-GT	25L6-GT
12W6-GT	6W6-GT 25W6-GT
25CD6-GA	25CD6-G

Other types to follow soon

COMPARE HEATER-WIRE THICKNESS AND NUMBER OF BENDS!

G-E 600-SERIES 3AU6

Wire diameter .00366" (coated diameter approximately .009"). 4 strands, with only 3 bends.



STANDARD 6AU6

Wire diameter .00226" (coated diameter approximately .008"). 6 strands, with 5 bends in all.

GENERAL ELECTRIC

162-1A4

PROBLEM: Reduce manufacturing costs and waste in fabrication of electrical contact Spring Clips

SOLUTION: General Plate provided the solution with long continuous length coils of coin silver clad to phosphor bronze . . . a Composite Metal

A manufacturer of television tuners required a contact material for use in the fabrication of narrow and thin contact spring clips. Extremely close tolerances and long continuous lengths were prerequisites.

The problem was presented to General Plate who quickly found the solution with coin silver clad to phosphor bronze and provided the material in coils up to 20 inches diameter of a single continuous length. This saved the manufacturer many dollars by eliminating idle machine time and reducing waste practically to zero. The coin silver gave a non-porous, long wearing contact surface — the phosphor bronze excellent spring qualities.

You, too, can benefit with General Plate raw stock contact materials. They are available in various combinations, single or double inlay, overlay, single or double edgelay and Top-Lay. General Plate Composite Contact Materials will save you money and enable you to make contact assemblies superior to those produced by other methods.

In addition to raw stock, General Plate fabricates contacts and complete contact assemblies. 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.

The long experience, diverse facilities and manufacturing skill of General Plate will benefit you in the form of service, quality and savings.

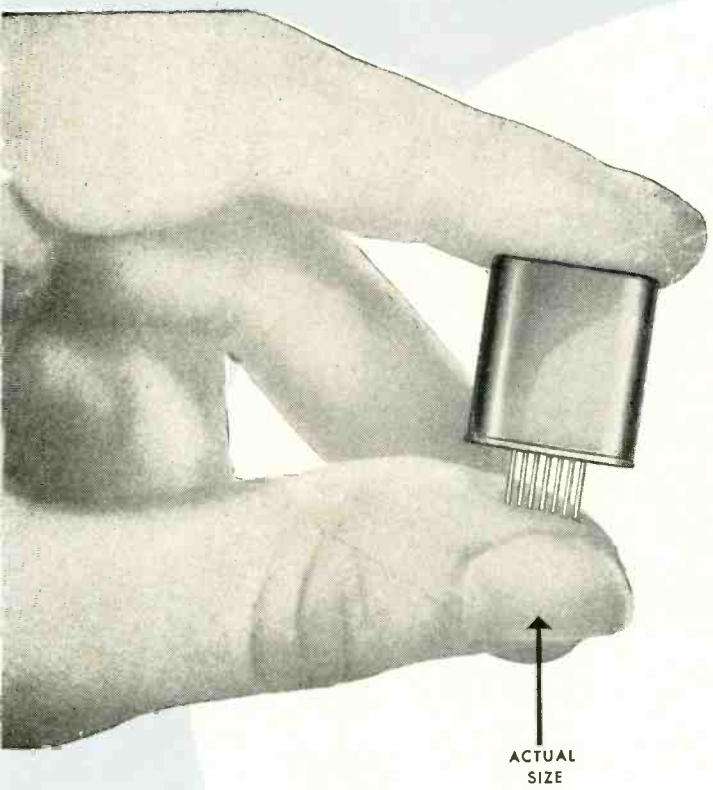
Write for complete information and Catalog PR700.

You can profit by using
General Plate Composite Metals

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

New Sub-Miniature Relay

APPLICABLE TO PRINTED CIRCUITS



ALLIED TYPE KH RELAY
weighs .32 oz. —
has low capacity for
RF switching

ELECTRICAL SPECIFICATIONS:

CONTACTS: Maximum of double pole rated at .25 amperes at 26.5 volts DC or 115 volts AC resistive

COIL: Sensitivity—nominal 1.0 watts, maximum 0.3 watts
Resistance—up to 1500 ohms
Voltage—up to 40 volts DC

TEMPERATURE: Minus 60° C to plus 125° C

VIBRATION: 10G up to 500 cycles

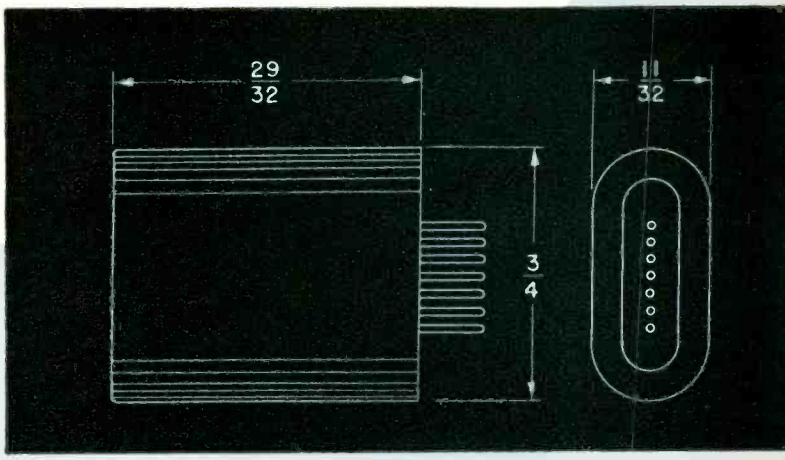
SHOCK: 50G plus (operating)

SPEED OF OPERATION: 1.5 millisecond at nominal voltage direct from battery supply and 1 millisecond with series resistance

ALTITUDE: 70,000 feet or 1.3 inches of mercury

TERMINAL TYPES: Printed circuit, solder terminals and plug-in

CAPACITY: N. O. contact to case 0.85 mmf



Write for catalog sheet giving complete information

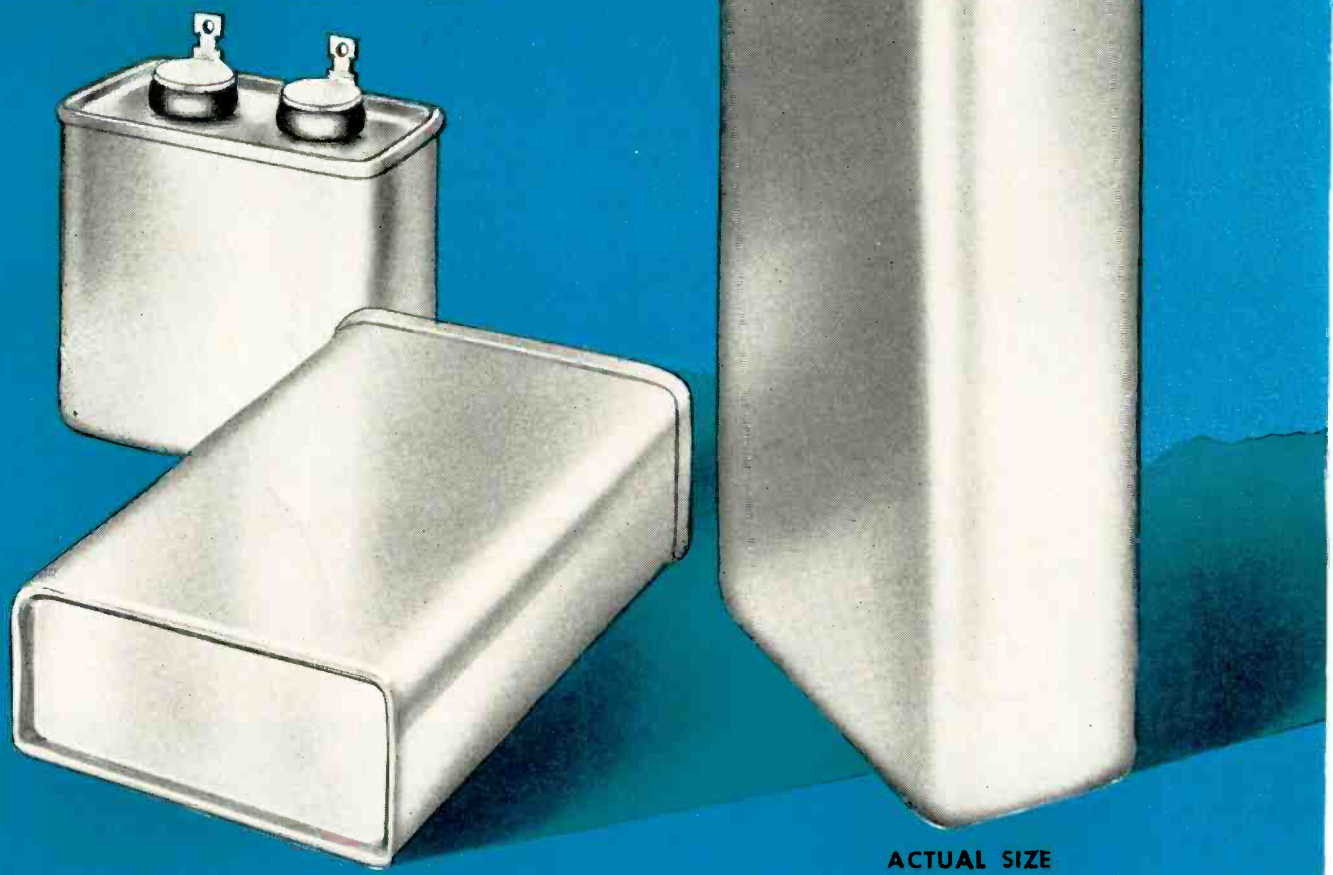
ALLIED CONTROL

ALLIED CONTROL COMPANY, INC., 2 EAST END AVENUE, NEW YORK 21, N.Y.

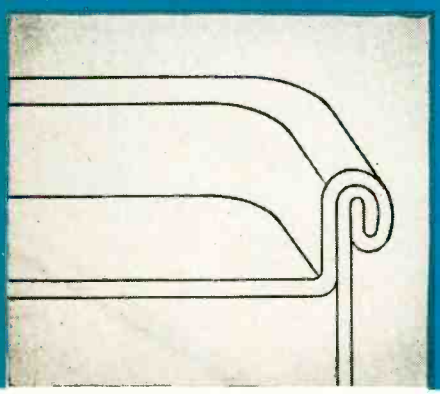
General Electric announces another

OTHER G-E CAPACITOR FIRSTS

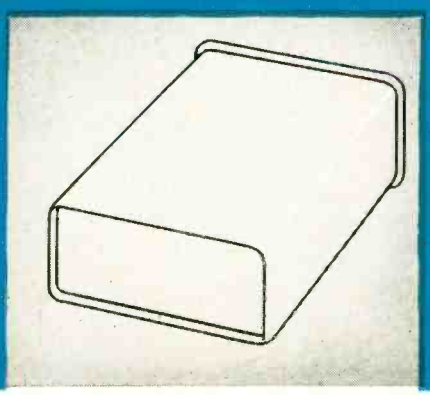
- ★Thin kraft-paper dielectric
- ★Pyranol* liquid impregnant
- ★Drawn-oval capacitors with double-rolled seams
- ★Silicone bushings with stud-welded construction
- ★Permafil solid impregnant



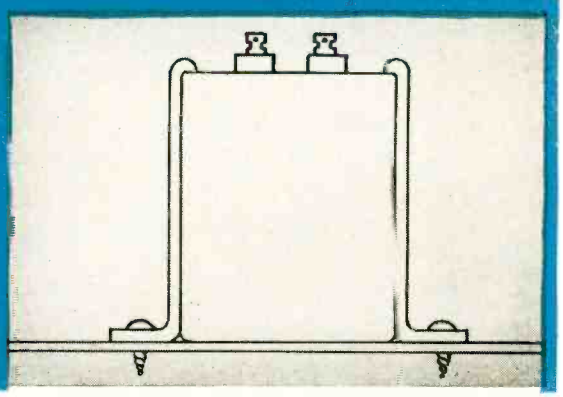
ACTUAL SIZE



SOLDERLESS DOUBLE-ROLLED COVER SEAM makes a mechanically strong, hermetic seal that remains leakproof.



DRAWN-RECTANGULAR CASE has no soldered seams . . . does not depend on solder for mechanical strength and effective sealing.



UPRIGHT OR INVERTED MOUNTING is possible, using footed brackets (above). Bottom of case is indented for inverted mounting.

FIRST to the electronics industry

NEW DRAWN-RECTANGULAR CAPACITORS

★ **Solderless, double-rolled cover seam**

★ **Seamless case with standard dimensions**

To answer the needs of the electronics industry, General Electric's capacitor engineers have developed a fixed paper-dielectric capacitor in a seamless, solderless case with standard dimensions. Because these new capacitors are the same sizes and have the same mounting dimensions as fabricated units, they can be applied to existing electronic equipment without changing component layouts.

Drawn construction offers the user important advantages. The seamless case is virtually leakproof. There is no dependence on solder for mechanical strength and effective sealing. The double-rolled seam between case and cover further assures a true hermetic seal.

G-E Drawn-rectangular capacitors can be supplied with suitable bushings for a wide range of voltage ratings or special applications. The new units comply with or exceed MIL specifications.

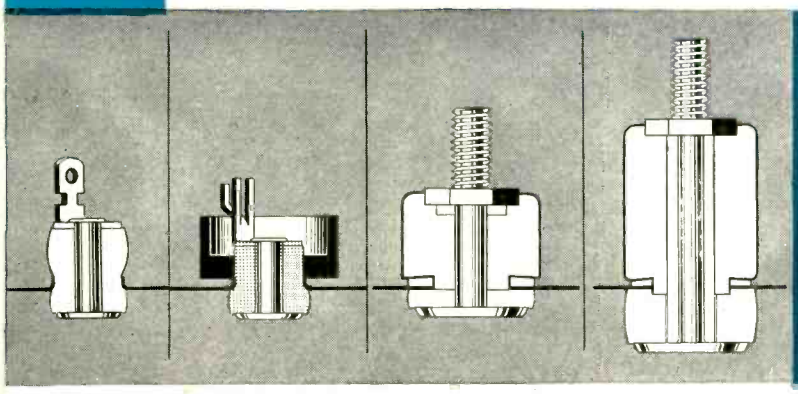
Proof of the dependability of the rugged construction of these new drawn-rectangular capacitors can be found in another General Electric pioneered development, the drawn-oval capacitor, of which there are more than 55 million being used in electrical and electronic equipment today.

For further information contact your nearest G-E Apparatus Sales Office. *General Electric Company, Schenectady 5, New York.* 442-23

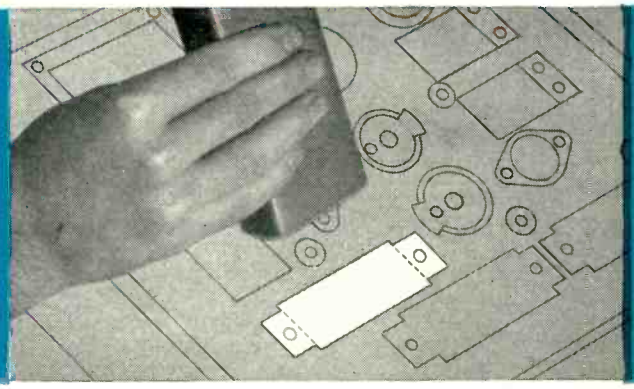
* *Reg. trade-mark of General Electric Co.*

Progress Is Our Most Important Product

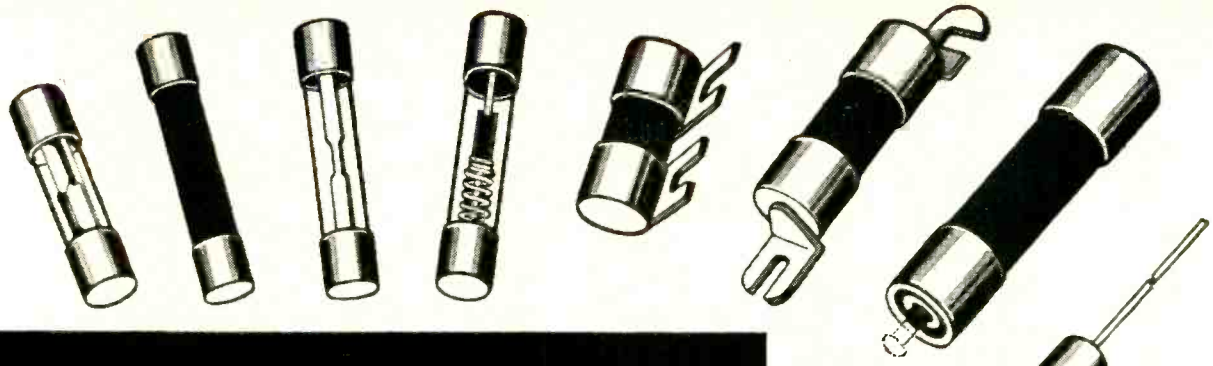
GENERAL ELECTRIC



FOUR BUSHING STYLES can be furnished, depending on rating and application requirements. All bushings are designed to provide a liquid-tight seal along with generous air-strike and creepage distance.



STANDARD CASE SIZES of G-E Drawn-rectangular capacitors are interchangeable with existing fabricated styles. This makes it unnecessary to change drawings or circuit layouts.



YOU CAN FILL ALL YOUR FUSE NEEDS FROM ONE SOURCE

. . . by Standardizing on BUSS FUSES

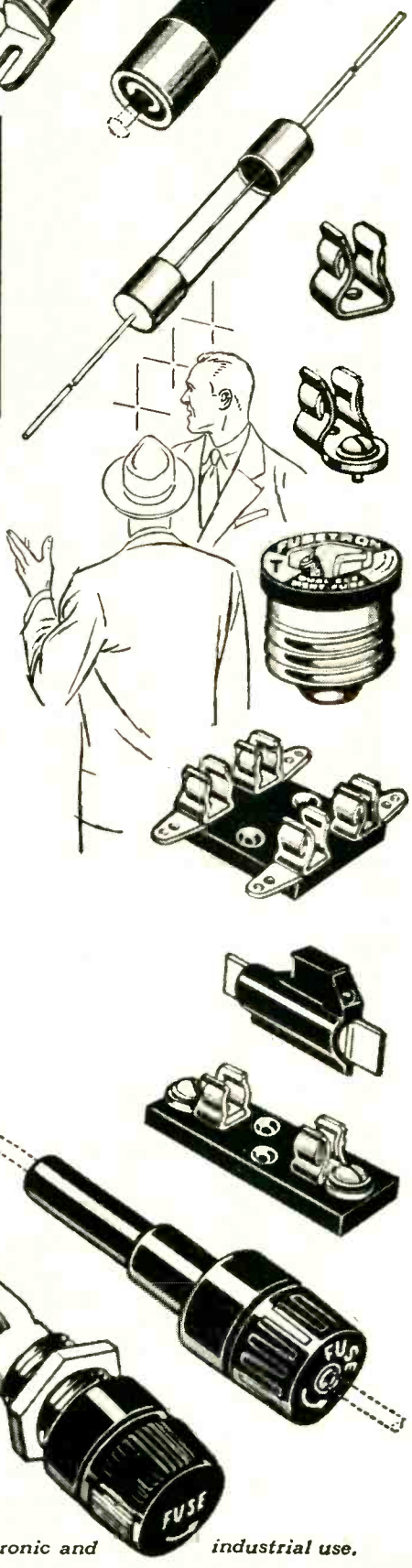
Just turn to BUSS for all your fuse requirements in any size from 1/500 ampere up. The line is complete:—standard type, dual-element (slow blowing), renewable and one-time types . . . plus a companion line of fuse clips, blocks and holders.

You'll find that by obtaining all your fuses from one source you can save time and money by simplifying your purchasing, stock handling and records.

Why BUSS fuses give "trouble-free" protection.

To make sure of dependable electrical protection under all service conditions, — every BUSS fuse normally used by the Electronic Industries is tested in a sensitive electronic device that rejects any fuse not correctly calibrated, properly constructed and right in all physical dimensions.

Should you have a special problem in electrical protection . . . over 39 years of research and practical experience is available to you when you turn your electrical protection problem over to BUSS. The facilities of the world's largest fuse research laboratory will be brought to bear on the problem — helping you select the fuse or fuse mounting best suited to your needs.



BUSSMANN Mfg. Co. (Div. McGraw Electric Co.)
University at Jefferson, St. Louis 7, Mo.

Please send me bulletin SFB containing facts on BUSS small dimension fuses and fuse holders.

Name..... Title.....

Company.....

Address.....

City & Zone..... State..... ELRC 954

FOR MORE INFORMATION MAIL THIS COUPON

Makers of a complete line of fuses for home, farm, commercial, electronic and industrial use.

PROUDLY WE FLY WITH THE C-97 STRATOFREIGHTER

BENDIX-PACIFIC SALUTES
the Boeing Airplane Company on its delivery of the 500th C-97 Stratofreighter.

Standard equipment on this and other C-97s is the AN/APS-42A Radar Set, developed and produced by Bendix-Pacific. APS-42A is a material aid to navigation, providing the crew with an excellent "view" of the terrain over which the airplane is passing, showing mountains, lakes, rivers, cities and other vital check-points. APS-42A is also used for weather detection and collision warning. It locates storm fronts in the airplane's path, gives range and bearing of other aircraft in the vicinity.

TOPS IN ELECTRONIC DEVELOPMENT. You can meet your aircraft electronic needs quickly and effectively by calling on Bendix-Pacific's Research and Engineering facilities. Write us for complete information.

RADAR

SONAR

HYDRAULICS

TELEMETERING

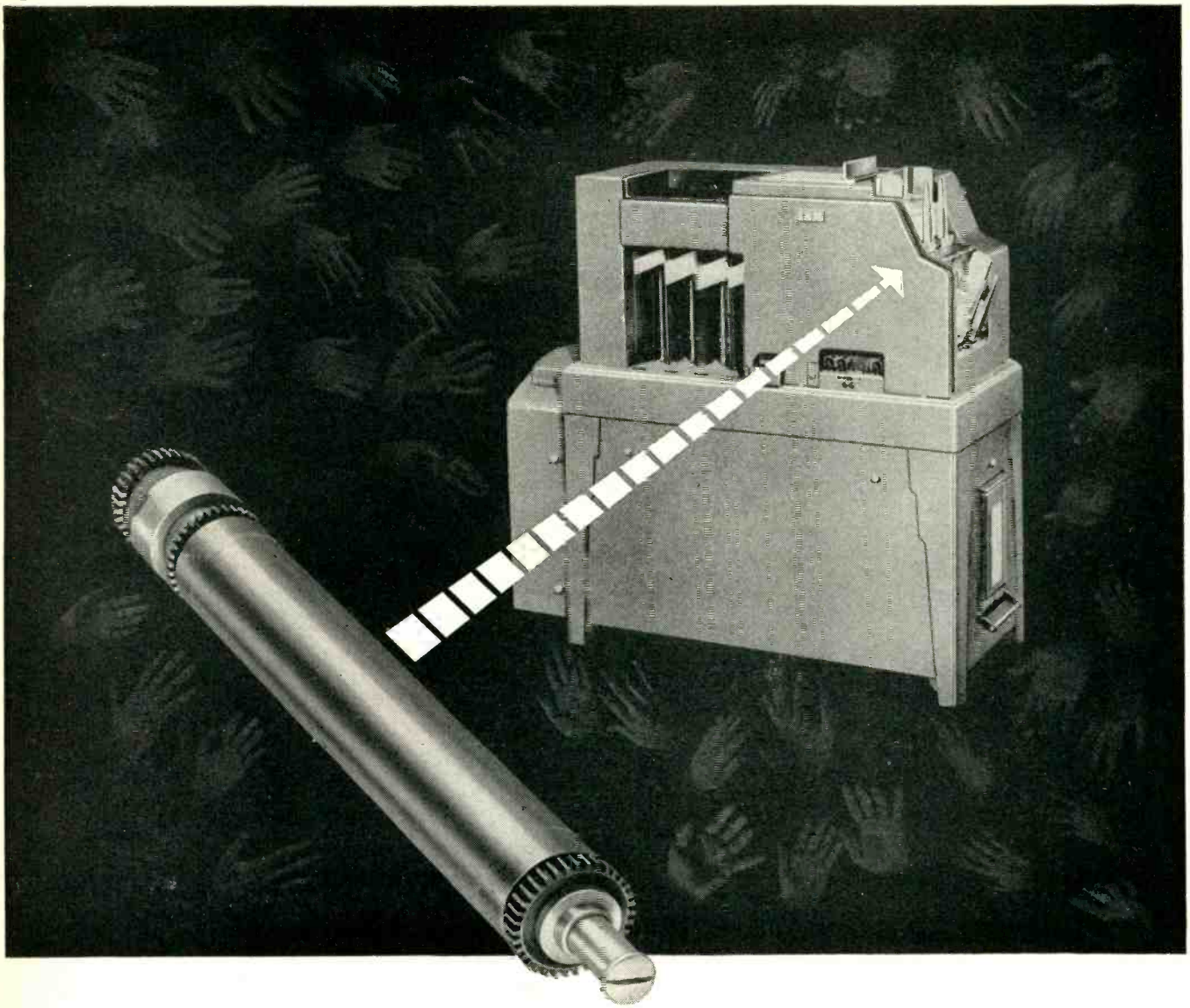
ELECTRO-MECHANICAL

ULTRASONICS

BENDIX PACIFIC

PACIFIC DIVISION • Bendix Aviation Corporation
11600 Sherman Way, North Hollywood, California

East Coast Office: 475 5th Ave., N.Y. 17
Export Division: Bendix International 205 E. 42nd St., N.Y. 17
Canadian Distributors: Aviation Electric, Ltd., Montreal 9



Out of IBM's Collator pops a tubing idea for you!

This is IBM's Collator—a mechanical super-accountant that shuffles, selects, matches and merges punched cards at the rate of four per second!

Heart of this electronic gee-whizzer is an extraordinary kind of tubing—a contact roll over which the cards must pass. Eighty miniature, hard steel brushes finger each card as it skims by—penetrate it through pre-punched holes, touch the contact roll and close the electronic circuit—flipping the card into the right slot.

Collator contact rolls must have good wear resistance to stand this high-speed workout. And they must resist corrosion and be good electrical conductors. So IBM employs Superior WELDRAWN* Beryllium Copper and low carbon steel composite tubing for Collator contact rolls. This tubing meets IBM's tight specifications for wear resistance, peak hardness and conductivity. Superior supplies the composite tube in 1⅛" O.D. with .049" wall.

When tubing troubles put the hex on your plans, call on Superior.

We have years of experience, the modern test and development facilities, and more than 55 analyses in many metals to unravel your problem. Write for a copy of our new Technical Bulletin #7-2 on Seamless and WELDRAWN* Beryllium Copper Tubing. Superior Tube Company, 2500 Germantown Ave., Norristown, Pa.

Round and shaped tubing available in Carbon, Alloy and Stainless Steels; Nickel and Nickel Alloys; Beryllium Copper; Titanium; Zirconium

Superior Tube

THE BIG NAME IN SMALL TUBING

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

West Coast: Pacific Tube Company
5710 Smithway St., Los Angeles 22, Calif. RAymond 3-1331

*Reg. U.S. Pat. Off.

E&C Plastics for Electronics

CASTING RESINS for ELECTRONIC APPLICATIONS

Stycast® 2850 GT
WIDE TEMPERATURE RANGE

−100°F to +400°F (to +500°F for short periods)

THERMAL EXPANSION COEFFICIENT
Approximately the same as aluminum and brass

GOOD ADHESION — LOW SHRINKAGE

Gray Opaque

Stycast® TPM
ELECTRICALLY OUTSTANDING

LOW LOSS — HIGH Q — White Opaque

Dissipation Factor *60 to 10^{10} cps* — Below .0009

Dielectric Constant *2.36 to 2.38*

Volume Resistivity, *Ohms - cm^3, above 10^{13}*

Stycast® 35
Polystyrene Casting Resin
Dissipation Factor below .0005
Easy to Cure

Stycast® 1030 CM
Tough and Rubbery — Black Opaque — Useful at very low temperatures. Extremely low exotherm

Stycast® 40
CRYSTAL CLEAR — WATER WHITE

For preliminary embeddments or where visual inspection is required

Stycast® 5050 CM
Simple to use — Black Opaque — for Production items

Temperature Range −67° F to +300° F

Cures rapidly at room temperature

Stycast® 4030 CM
Hard and Rigid — Black Opaque

Good Surface Finish — Easy to Use

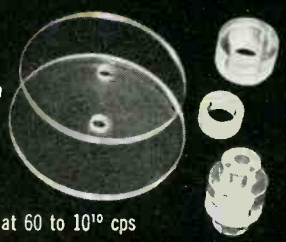
Cures at Room Temperatures

PLASTIC ROD and SHEET STOCK

Stycast® 0005
for RF and Microwave Insulation

Low Loss — A thermosetting plastic — will not flow at high-temperatures — Machines easily

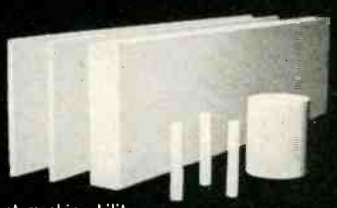
Dissipation Factor below .0005
Dielectric Constant 2.53 - 2.56
at 60 to 10^{10} cps



Stycast® Hi-K
Any Dielectric Constant
3 through 20

Wide temperature range — Excellent machineability

Dissipation Factor, 60 to 10^{10} cps, below .001



PLASTIC FOAMS

Eccofoam S
Sheet Stock which can be fabricated into a wide variety of items. High bulk densities useable to +300°F. Available in bulk densities from 3 to 25 lbs. cu. ft.

Eccofoam FP
Supplied in liquid form. For foamed-in-place electronic embedments, sandwich structures, radomes, etc.

IMPREGNANTS for WINDINGS

Ecco W 28G
Low viscosity — Solvent-free — Excellent adhesion — Useable to +400°F — Volume Resistivity
at 75°F above 10^{16}
at 300°F above 10^{13}
ohms - cm^3

Ecco W 44HT
Solvent free
Long "pot life"
Wide temperature range
Easy to use
High Dielectric Strength

High Frequency Absorber 853
One of several absorbers and/or attenuators for electrical energy. Can be molded to size, made resilient or rigid.

Conductive Plastics and Adhesives
Produced in several bulk resistivity ranges.

Mold Release 1225
Prevents adhesion of plastic to molds used in casting and laminating.

Vacuum Tube Coating 453B
Resilient unicellular coating for sensitive components to be embedded.

Laminating Plastics for Fiber Glass

Ecco L44 for non-porous, void-free laminates in low loss applications – radomes, printed circuits, etc.

Ecco L28 for fiber glass laminates of high volume and surface resistivity—High dielectric strength—temperature range —100°F to +400°F. For terminal strips, mounting boards, etc.

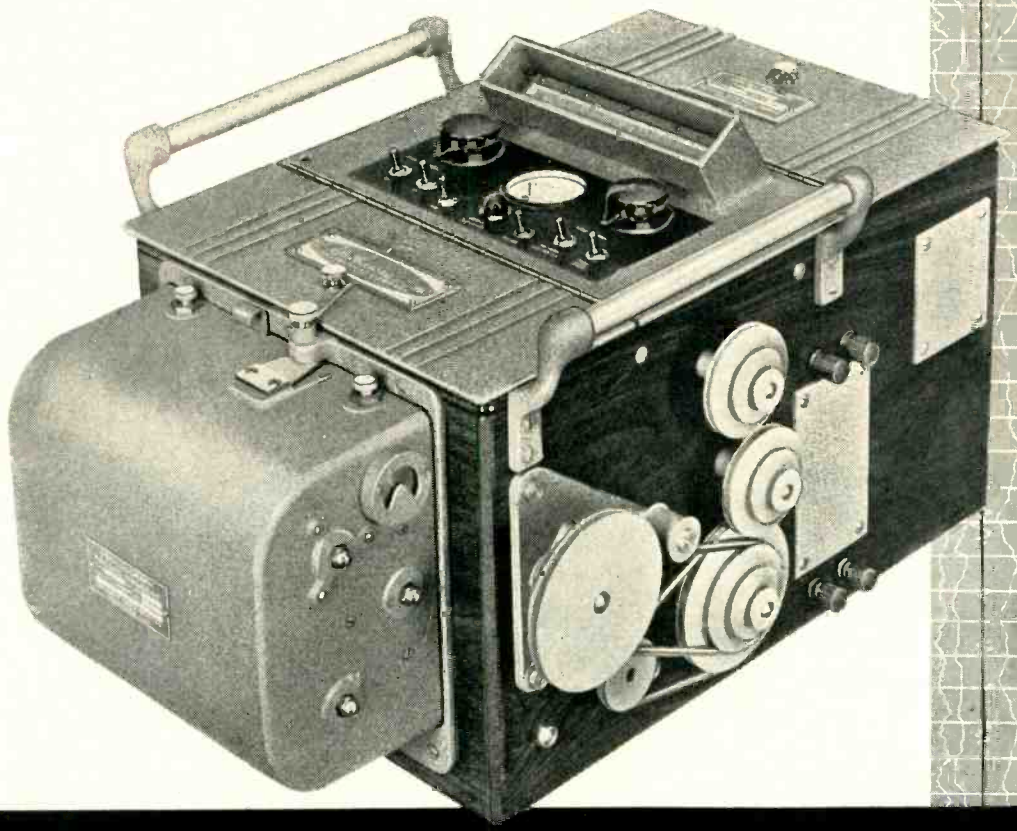
Bulletins Available on all of the above products. Write for them.

Emerson & Cuming, Inc. will quote on production of electronic embeddments, fiber glass laminates and fabricated plastic items.

Emerson & Cuming, Inc.
PLASTICS for ELECTRONICS
9698 Washington Street, Canton, Mass.

NEW ENGLAND	NEW YORK	WASHINGTON, D.C.
R. W. Gray, Inc.	35 West 53rd Street	D. J. Shamp
572 Washington Street	New York 19, New York	1500 Massachusetts Avenue
Wellesley, Massachusetts	PLaza 7-0524	Washington 5, D.C.
WEllesley 5-5296		HUdson 3-4167

YOU can't afford to be without the HATHAWAY S14-C OSCILLOGRAPH



the world's most complete and versatile OSCILLOGRAPH

for recording electrical quantities, processes, flight functions, dynamic pressure, strain, vibration, acceleration, temperature...

for testing relays

for testing welding equipment

for biological recording

for analysis of high-speed engines and compressors

Galvanometers are available for current, voltage, power, covering a most extensive range of characteristics.

Attachments available for almost any recording need—

automatic transient recording
wave-shape measurements
wave-shape scanning
long records to 100 inches per second
short records to 1,000 inches per second

PROVE TO YOURSELF THAT THE S14-C IS...

● The Most Versatile ● The Easiest to Maintain ● The Easiest to Operate ● The Finest in Craftsmanship

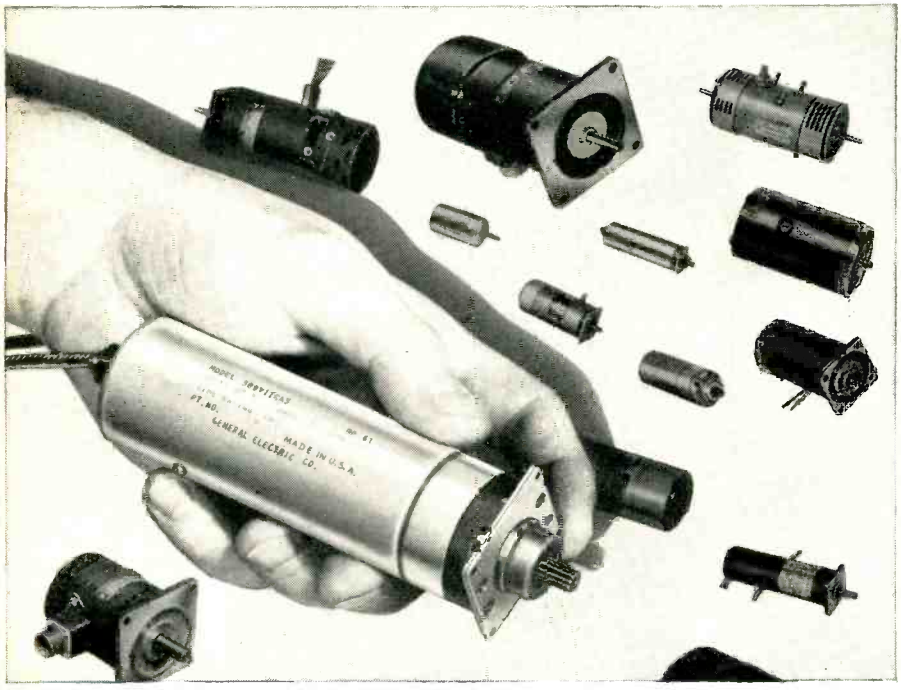
Write for Bulletin No. 2D-1K and your free copy of Hathaway Engineering News

Visit Our Booth No. 302 at the International Instrument Congress at Philadelphia

Hathaway
INSTRUMENT COMPANY
1315 SO. CLARKSON STREET • DENVER 10, COLORADO

DESIGNER'S

Wide selection of G-E specialty motors designed to meet your needs



New permanent-magnet, 1 3/8" diameter motors latest addition to aircraft line

Experience gained by General Electric engineers in the design and manufacture of many types of specialty motors is another reason why G.E. is best equipped to supply the aircraft motor you need. In addition, complete testing facilities assure you that your special aircraft motors meet environmental requirements.

Shown at left is one in a series of new permanent-magnet, totally enclosed, shunt motors now part of General Electric's extensive line of aircraft motors. It is rated 1/100 hp, gear-reduced to 130 rpm, and operates on 27.5 volts. Designed for dynamic braking it can be stopped in 1/10 revolution by a fast acting relay. Such performance makes it ideal for radar tuners, actuators, blowers, and similar applications. **Write for Bulletin GEC-988.**

G-E Hermetically sealed relays feature reliability, high speed

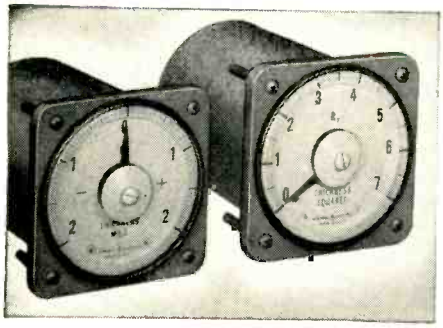
HIGH SPEED RELAY—General Electric's high speed relay can be furnished with contact configurations up to 4 PDT, yet fits in an AN-3304 size can. This versatile relay is more reliable even under severe shock, vibration, extreme temperatures and other adverse conditions. Operating speeds range from 250 microseconds to 1 millisecond. It is available with multiple coils or windings and with multiple independent SPDT units in a single can. **Write for Bulletin GEA-6212.**

SUBMINIATURE RELAY—Lightweight, reliability, and resistance to shock and high vibration are a few of the important advantages of the G-E subminiature relay. Low capacitance makes it ideal for switching high frequency signals or pulses. Pickup time is 5 milliseconds or less and dropout time is 2 milliseconds or less. It is available with a variety of d-c coil voltages and 400 cycle a-c coil. **Write for Bulletin GEA-6211.**

GENERAL ELECTRIC

DIGEST

TIMELY HIGHLIGHTS ON G-E COMPONENTS



Announcing two new integrating instruments

Mean and standard deviation of variables can now be readily and accurately determined with General Electric's two new direct reading integrating instruments.

Widely applicable, the instruments measure such variables as current, thickness, width, diameter, density, or any other electrical or non-electrical quantity.

Integrating deviation and deviation-squared, the instruments, used with suitable primary detector, reduce statistical analysis of variables to a simple slide-rule calculation. Accuracy of the instruments is about ±3% full scale when integrating over a two-minute period.

For further information about these unique time-saving instruments contact your nearest General Electric Apparatus Sales Office. **Write for Bulletin GEC-1230.**

Capacitors of many ratings, styles help solve design problems

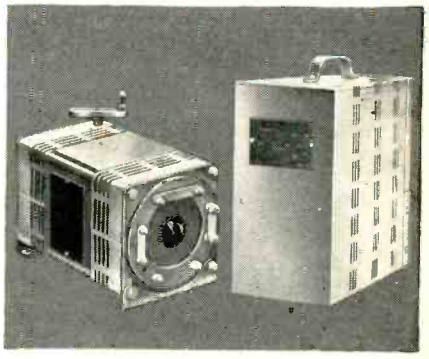
The variety of case sizes and styles of G-E fixed paper dielectric capacitors makes it easy to select units that meet your needs. Ratings at 236 to 660 volts a-c and at 400 to 100,000 volts d-c are available. All units are treated with Pyranol* impregnating liquid and are hermetically sealed to prevent leakage or contamination. **Write for Bulletin GEC-809.**

*Reg. trade-mark of General Electric Co.

Electronics easily taught

General Electric's More Power to America program, "Industrial Electronics," offers a practical, easily understood 12-lesson sound slidefilm course on the fundamentals of electronics and its applications in modern industry. It is a particularly interesting method for plant management, production men, and electrical and maintenance staffs to improve their understanding of the operation of industrial electronic equipment. **Write for Bulletin GEA-5339.**

Inductrols—for automatic or manual voltage regulation



G-E Inductrols end the poor performance and excessive burnouts of electronic tubes due to poor voltage. Compact design of these finely controlled regulators lets you fit them into any location. Models are available for indoor service on circuits 600 volts and below, single phase 3 to 240 kva; three-phase 9 to 520 kva. **Bulletin GEC-795** covers single-phase inductrols; **GEA-5824,** 3-phase models.

EQUIPMENT FOR ELECTRONIC MANUFACTURERS

Components

- Meters, instruments
- Dynamotors
- Capacitors
- Transformers
- Pulse-forming networks
- Delay lines
- Reactors
- Motor-generator sets
- Inductrols
- Resistors
- Voltage stabilizers
- Fractional-hp motors
- Rectifiers
- Timers
- Indicating lights
- Control switches
- Generators
- Selsyns
- Relays
- Amplidynes
- Amplistats
- Terminal boards
- Push buttons
- Photovoltaic cells
- Glass bushings

Development and Production Equipment

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

General Electric Company, Apparatus Sales Division
Section A667-29, Schenectady 5, New York

Please send me the following bulletins:

√ for reference only X for planning an immediate project

- ☐ **GEC-988** Aircraft and Ordnance Motors
- ☐ **GEA-6211** Subminiature Relays
- ☐ **GEA-6212** High Speed Relays
- ☐ **GEC-1230** Integrating Instruments
- ☐ **GEC-809** Paper-Dielectric Capacitors
- ☐ **GEA-5339** Industrial Electronics Training Course
- ☐ **GEC-795** Single-phase Inductrols
- ☐ **GEA-5824** Three-phase Inductrols

Name.....

Company.....

City..... State.....

You are invited to visit the

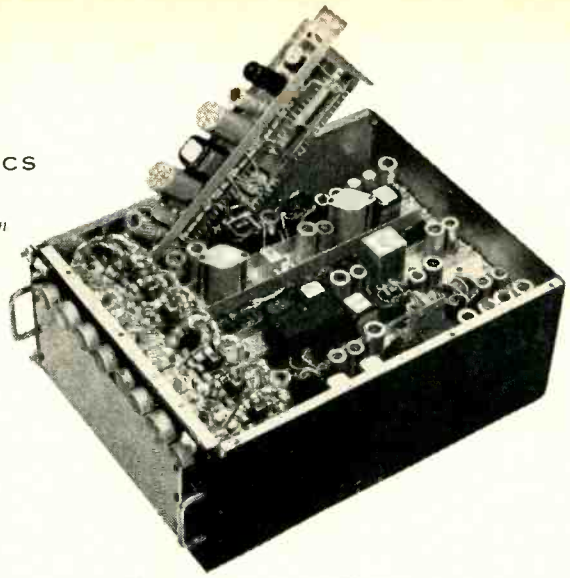
HUGHES EXHIBIT

Booth Nos. 23 and 24

NATIONAL ELECTRONICS CONFERENCE

Chicago, October 4, 5, 6 • Hotel Sherman

Problem:



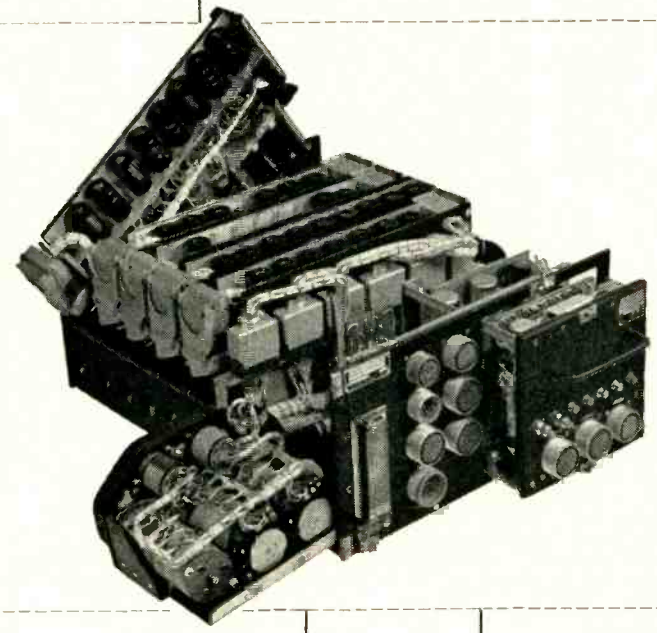
Redesign of an airborne analog computer to perform additional functions called for 20 per cent more parts— with no over-all increase in size, or change in form. At the same time, a high degree of reliability had to be maintained.

APPROACH TO RELIABILITY

Advanced radar fire control systems for military aircraft demand the highest degree of reliability under severe restrictions. These include quantity manufacturability, minimum size and weight, protection from shock and heat, serviceability, and exacting performance.

At Hughes, one objective of equipment design engineers is to maintain consistent essential performance of the systems while steadily improving reliability. Following is an example of accomplishment by Hughes engineers in this specialized area:

Solution:



By use of improved components, unique packaging techniques, and thorough environmental testing, Hughes design engineers were able to meet specifications and improve reliability as well. Result was that the new computer operated at mean internal temperatures in excess of 120°C and withstood shocks of 50 g's— as against 85°C and 30 g's for the original unit.

ENGINEERS experienced in the fields of product design, electronics packaging, miniaturization and component reliability will find outlets for their abilities in new advanced packaging and reliability problems.

Relocation of applicant must not cause disruption of urgent military project.

Scientific and Engineering Staff

HUGHES

RESEARCH AND DEVELOPMENT LABORATORIES

Culver City, Los Angeles County, California

Hughes *Fusion-Sealed* Germanium Diodes

ACTUAL DIMENSIONS
DIODE BODY:
0.265 by 0.130 inches (maximum)
SHUNT CAPACITANCE:
0.5 μμf (maximum)
AMBIENT OPERATING TEMPERATURE RANGE:
−78° C to +90° C

Hughes Point-Contact Germanium Diodes are fusion-sealed in a one-piece, gas-tight glass envelope . . . impervious to moisture, fumes or other external contaminating agents. The flexible dumet leads are especially suitable for spot-welding; or they can be iron- or dip-soldered as close as ¼ inch to the diode body—without special precautions.

The germanium crystal is permanently bonded to one lead, the cat whisker is welded to the other, and the point of the cat whisker is welded to the crystal. Hughes diodes are highly resistant to shock and vibration. *Positive* mechanical stability is achieved without risking contamination from fluxes, waxes or impregnants. And—*each diode is thoroughly tested* to ensure the stability of its electrical and physical characteristics. All this means: sturdy, highly reliable diodes.

TYPES—The Hughes line of diodes comprises standard RETMA, JAN, and many special types. Special types are produced according to customer specifications and are tested at high or low temperatures . . . for specific recovery time . . . for matching in pairs or quads.

ELECTRICAL SPECIFICATIONS AT 25° C *unless otherwise indicated*

DESCRIPTION	RETMA or Hughes Type	Clip-in Hughes Type	Peak Inverse Voltage† (volts)	Absolute Maximum Inverse Working Voltage (volts)	Minimum Forward Current @ + 1V (mA)	Maximum Inverse Current @ − 50V (mA)	Maximum Inverse Current Other (mA)	Other Characteristics
HIGH PEAK	1N55B	HD 2052	190	150	5.0		0.500 @ 150V	
	1N68A	HD 2053	130	100	3.0		0.625 @ 100V	
1 MEG TYPES	1N67A	HD 2054	100	80	4.0	0.050	0.005 @ 5V	
	1N99	HD 2055	100	80	10.0	0.050	0.005 @ 5V	
	1N100	HD 2056	100	80	20.0	0.050	0.005 @ 5V	
500K TYPES	1N89	HD 2057	100	80	3.5	0.100	0.008 @ 5V	
	1N97	HD 2058	100	80	10.0	0.100	0.008 @ 5V	
	1N98	HD 2059	100	80	20.0	0.100	0.008 @ 5V	
	1N116	HD 2060	75	60	5.0	0.100		
	1N117	HD 2061	75	60	10.0	0.100		
	1N118	HD 2062	75	60	20.0	0.100		
GENERAL PURPOSE	1N90	HD 2063	75	60	5.0	0.500		
	1N95	HD 2064	75	60	10.0	0.500		
	1N96	HD 2065	75	60	20.0	0.500		
JAN TYPES	1N126*		75	60	5.0	0.850	0.050 @ 10V	Non-JAN equivalent, HD2070; clip-in, HD2066
	1N127**		125	100	3.0	0.300	0.025 @ 10V	Non-JAN equivalent, HD2071; clip-in, HD2067
	1N128***		50	40	3.0		0.010 @ 10V	Non-JAN equivalent, HD2072; clip-in, HD2068
	1N198		100	80	5.0	0.250	0.075 @ 10V	
					These values tested 100% at 75°C			
COMPUTER TYPES	1N191	HD 2077		§	5.0	400K Ω min. between −10 and −50V @ 55°C§		Back resistance recovers to 50K Ω and 400K Ω (200K Ω for 1N192) in 0.5 μsec and 3.5 μsec max., respectively.‡
	1N192	HD 2078		§	5.0	200K Ω min. between −10 and −50V @ 55°C§		
	HD2013				50 @ 1V & 1 @ 0.35V		0.120 @ −3V	0.2 μsec recovery time.⊙
	HD2014				50 @ 1V & 1 @ 0.35V		0.60 @ −6V	0.2 μsec recovery time.⊙
UHF	HD2016A				UHF MIXER DIODE			
MISCELLANEOUS	HD2051		125	100	4.0	0.050		1N63 equivalent.

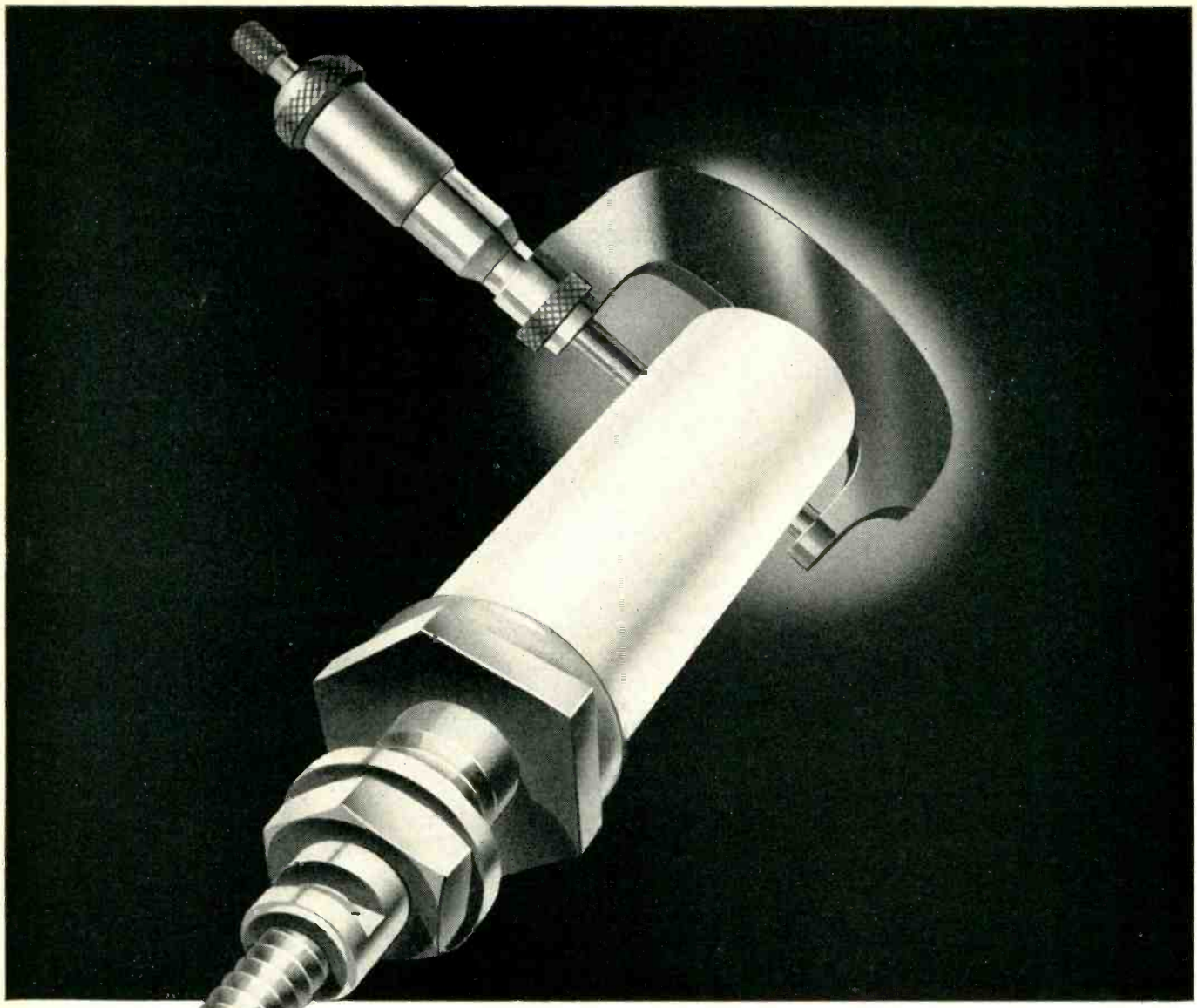
†*That voltage at which dynamic resistance is zero when back voltage rises linearly at 90e/sec.*
‡*Back Recovery Time is measured with a forward pulse of 30mA, followed by a reverse pulse of 35 volts. Loop resistance of test circuit 2500 Ω max.*
⊙*Recovery time is that point at which the diode voltage reaches −1V after the initiation of a 6V back pulse through 20K Ω from an initial 3 mA forward bias. Total shunt capacitance is 20 μμf.*
§*Tested at 55°C. Test voltage is a continuous 60 cps sine wave. Peak Reverse Voltage across the diode is 70V. Peak Forward Voltage not less than +2V or Peak Forward Current not less than 20 mA, whichever occurs first.*
**Formerly 1N69A.* ***Formerly 1N70A.* ****Formerly 1N81A.*

Descriptive Bulletin SP2A is available on request.

Hughes

SEMICONDUCTOR SALES DEPARTMENT

Aircraft Company, Culver City, Calif. *New York* *Chicago*



How to pass a physical exam

CTC's coil forms pass their physical exams in great shape — thanks to precision manufacture.

The basic materials of these forms are certified, then checked again by us, before the forms are made. Each manufacturing detail is quality controlled to the high quality standards that enable us to offer *guaranteed* electronic components, custom or standard.

Forms then get these physical checkups: *mounting studs* checked for internal and external threads, for general size and electroplating; *form* checked for I.D., O.D. and concentricity; *slug* checked for threads, dimensions, electroplating and checked electrically for Q and permeability; *final assembly* checked for tightness, chips and cracks.

Other CTC components benefiting from CTC precision manufacture include terminal boards, terminals, capacitors, swagers, hardware, insulated terminals and coils. For all specifications and prices, write to Cambridge Thermionic Corporation, 437 Concord Avenue, Cambridge 38, Massachusetts. West Coast Manufacturers contact: E. V. Roberts, 5068 West Washington Blvd., Los Angeles 16 and 988 Market St., San Francisco, California.

Coil Form Data: Made of grade L-5 silicone impregnated ceramic. Winding diameters from .205" to ½". Mounted heights from $1\frac{1}{32}$" to $1\frac{11}{16}$". Certain forms, known as Type C, are also available with silicone fibreglas terminal retaining collars permitting 2 to 4 terminals. These are excellent for bifilar windings and advantageous for single pie windings because they permit terminals to be located above or below winding, thus shortening wiring to circuit elements.

Laboratory Coil Kit. Type X2060 aids in developing prototypes and pilot models. Contains 10 slug tuned coils of L86 size Type C, ranging from 2 Microhenries to 800 Microhenries, each slightly overlapping next coil in scale. Kit contains mounting hardware and lists such information as inductance range, wire size, number of turns, Q value. Coils are color-coded to chart for easy quantity-order.

CTC

CAMBRIDGE THERMIONIC CORPORATION

makers of guaranteed electronic components, custom or standard

Ampex magnetic tape recorders

...lasting quality for every professional use

Ampex machines are built with sustained quality and durability – the prime requirements of the major broadcast networks and recording studios. These perfectionists have chosen Ampex, some as long as six years ago, and their machines are still in use today. For example, one Ampex, after 18,000 hours of heavy duty still maintains performance equal to published specifications for new machines! This is the kind of lasting value that is the Ampex standard of excellence in sound recording.

- *Frequency Response – 40 to 15,000 cps.*
- *Tape Speed – 7½ in/sec.*
- *Signal-to-Noise – over 55 db.*
- *Flutter and Wow – under 0.25%.*

MODEL 600 • THE NEWEST AMPEX

The Ampex 600 is a portable model that weighs less than 28 pounds. It is an Ampex in design and performance and gives the same class of fidelity, accuracy of timing and reliability as other Ampex recorders. It is the ideal instrument for radio stations, music conservatories, educators, high fidelity enthusiasts and other professional and semi-professional users.

SERIES 300 • THE FINEST AMPEX

The 300 Series comprises the most perfect sound recording machines yet offered by any manufacturer. They are unexcelled for performances deserving the finest recording and reproduction it is possible to make. Superb design and flawless mechanical stability achieve the utmost in program fidelity, operating reliability and timing accuracy.

- *Frequency Response – 30 to 15,000 cps.*
- *Tape Speed – 7½ and 15 in/sec.*
- *Signal-to-Noise – over 60 db.*
- *Flutter and Wow – under 0.1%.*

SERIES 350 • THE MOST VERSATILE AMPEX

The 350 Series is universally preferred for original and delayed broadcasts, exchanging taped programs, music and drama rehearsals and other performances requiring extensive cueing and editing. Tape editing is remarkably fast with "feather touch" controls mounted within easy reach on a 30°-slanted top-plate. The 350 Series is unusually accessible for installation and servicing, and is available in a variety of tape speeds and mounting styles.

- *Frequency Response – 30 to 15,000 cps.*
- *Tape Speeds – 7½ and 15 ips, or 3¾ and 7½ ips.*
- *Signal-to-Noise – over 60 db.*
- *Flutter and Wow – under 0.2%.*

MODEL 450 • FOR BACKGROUND MUSIC

The Model 450 is a reproducer which provides sustained high fidelity background music anywhere. It is ideal for the finer hotels, restaurants, department stores, funeral parlors, factories and other users of pre-recorded programs. It plays continuously for 8 hours. Starting, stopping, reversing and repeating can be controlled automatically.

- *Frequency Response – 50 to 7,500 cps.*
- *Tape Speed – 3¾ in/sec.*
- *Signal-to-Noise – over 50 db.*
- *Flutter and Wow – under 0.4%.*

SERIES S-3200 • FOR TAPE DUPLICATION

This Series of machines achieves true mass duplication of previously recorded tapes while preserving the superb fidelity of the master recording. Up to 10 exact replicas can be made simultaneously, and up to 2500 hours of program material can be produced in an 8-hour day (or one hour in 10 seconds!). The S-3200 Series duplicates both single and double track masters and 2 track stereophonic tapes, of any standard speed, in one pass either "forward" or "backward."

- *Frequency Response – 30 to 15,000 cps.*
- *Tape Speed – 30 and 60 in/sec.*
- *Signal-to-Noise – over 45 db.*
- *Flutter and Wow – under 0.2%.*

AMPEX
CORPORATION

WRITE FOR FURTHER INFORMATION AND COMPLETE SPECIFICATIONS TO DEPT. E-1723

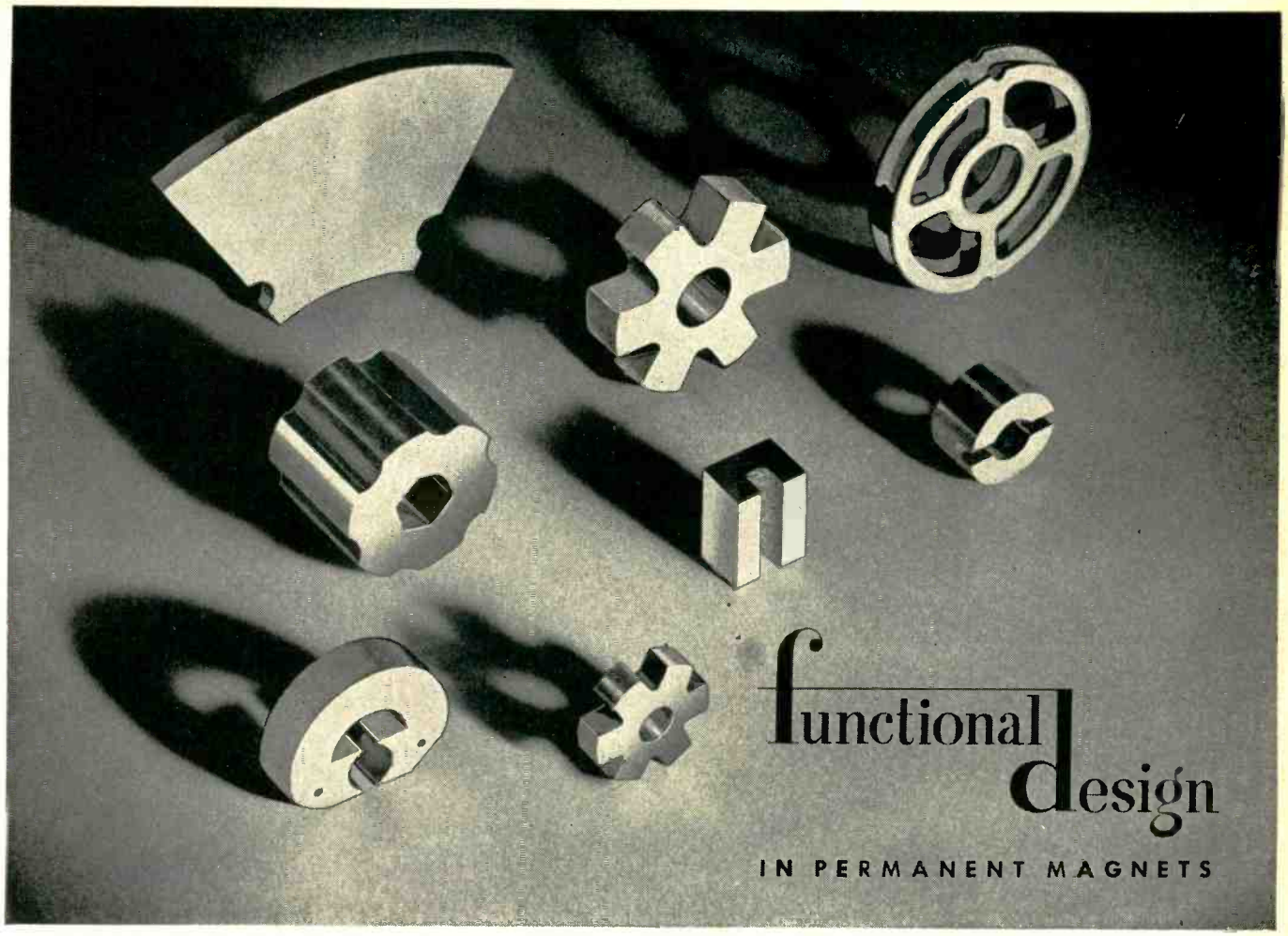
934 Charter Street • Redwood City, California

Branch offices: New York, Chicago, Atlanta, San Francisco and College Park, Maryland (Washington D.C. area)

Distributors in principal cities (Listed in Telephone Directory under "Recording Equipment")

Canadian General Electric Company in Canada

ONE IN A SERIES: discussing the importance of selecting the proper permanent magnet to use in your product



Why SOUND, FUNCTIONAL MAGNET DESIGN

guarantees superior product performance

Magnets must be "tailored" to your product . . . tailored in size, shape, and the material used . . . if greatest efficiency, at the lowest possible cost, is to be expected.

The magnet assemblies shown above are typical of such "tailoring." Those used in test meters, for example, are designed specifically to maintain a magnetic field of uniform high energy, so necessary to the precise operation of such meters.

Others—for holding applications—are designed so that their magnetic circuits provide the greatest possible tractive power. In applications where the magnet acts on moving parts of an assembly, still different designs may be required.

Our engineers—specialists in permanent magnet design and application—welcome the opportunity to assist you with your designs. For their recommendations—without cost or obligation—write us today. Or return the coupon below for a free copy of the helpful article, "Selecting the Proper Permanent Magnet Material for Your Product."

THE INDIANA STEEL PRODUCTS COMPANY
Valparaiso, Indiana

World's Largest Manufacturer of Permanent Magnets

INDIANA PERMANENT MAGNETS

The Indiana Steel Products Co., Dept. 9A
Valparaiso, Indiana

Please send me a free copy of "Selecting the Proper Permanent Magnet Material for Your Product."

Name_____ Title_____

Company_____

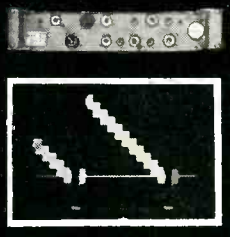
Street_____

City_____ Zone_____ State_____

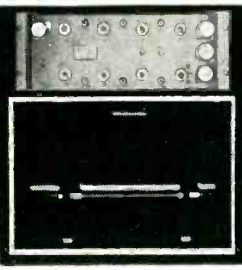
NEW

TELECHROME INCORPORATED

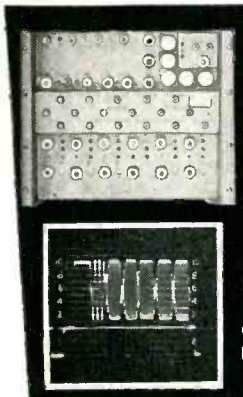
VIDEO TRANSMISSION TEST EQUIPMENT



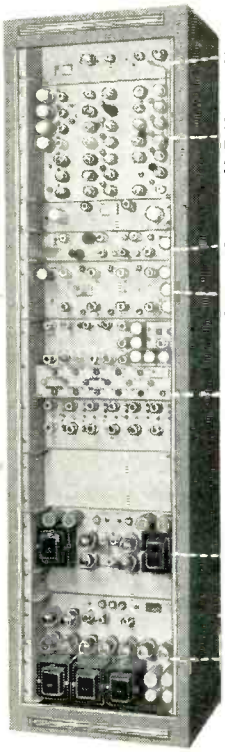
1041-BR STAIR STEP GENERATOR (Variable) Checks lineary and grey scale output relationship in linear or non-linear system. Built-in color carrier generator may be added to steps. Back porch burst allows lock-in to 3.58 MC color equipment.



1071-AR WINDOW GENERATOR (Variable) Determines ringing, smears, steps, low frequency tilt, phase shift, mismatched terminations, etc. in TV signals or systems.



1070-BR MULTI-BURST FREQUENCY GENERATOR (13 freq. selectable from .5 to 6 MC) Checks wide band coaxial cables, microwave links, individual units, and complete TV systems for frequency response characteristics. Produces six frequencies simultaneously plus white bar reference. Switchable color burst on back porch.



AUTOMATIC FREQUENCY CONTROL 304AR

COMPOSITE SYNCH GENERATOR 303BR

STAIR-STEP GENERATOR

WINDOW GENERATOR

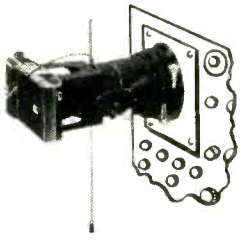
MULTI-BURST FREQUENCY GENERATOR

REGULATED POWER SUPPLY 512AR

REGULATED POWER SUPPLY 613BR

New Telechrome equipment designed to provide test signals for precise checking of video facilities.

This equipment is now in use by major networks, TV stations, and the Bell Telephone System. This type of equipment was recently described by H. Gronberg of NBC before the NARTB Engineering Conference in Chicago. These units are available individually or as an integrated system with 75 ohm or 110 ohm balanced output.



OSCILLOSCOPE CAMERA
MODEL 1521-A (Polaroid Land Type)

for instantaneous 1-to-1 ratio photo-recording of these or other test signals.

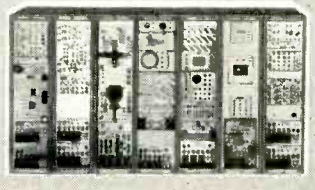
MODEL 608-A HI-LO CROSS FILTER

MODEL 524-D OSCILLOSCOPE

Chromalyzer

Chromascope (Signal Certification)

Phase Slope (Envelope Delay) Curve Tracer



Full facilities Transmits, receives, monitors, analyzes composite color pictures

Literature on these and more than 100 additional instruments for color TV by TELECHROME are available on request.

TELECHROME INCORPORATED

The Nation's Leading Supplier of Color TV Equipment
88 Merrick Road Amityville, N. Y.
AMityville 4-4446

New "Airbrasive" cutting method solves many tricky cutting problems

CUTTING BY IMPINGEMENT of carefully graded abrasive particles in a very fine stream propelled by CO_2 or other dry, inert gas – that's the new "AIRBRASIVE" method.

As applied with the S.S.WHITE INDUSTRIAL "AIRBRASIVE" Unit, the method is subject to close control and can be readily adapted for mass production, where relatively small quantities of material are to be removed.

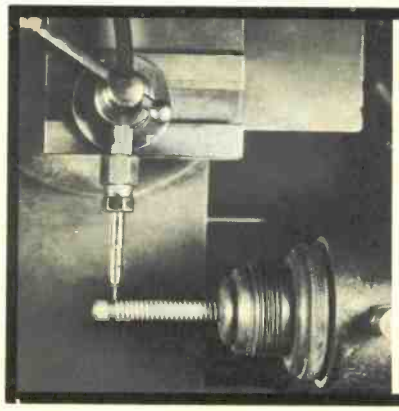
Already, the "AIRBRASIVE" Unit is doing a variety of unusual cutting jobs for industry, many of which could not be done as well – *or at all* – by previously available methods.

Typical of the cutting operations for which the "AIRBRASIVE" Unit is especially well suited are those illustrated.

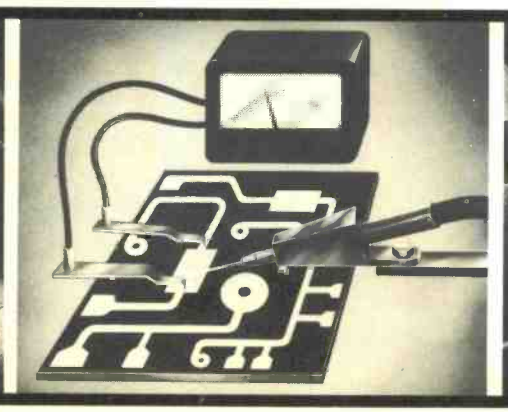
Other applications include:

- Controlled removal of coatings on glass, ceramic and other surfaces.
- Cutting germanium and other hard, brittle materials.
- Etching on glass and metal.
- Producing matte finish on glass and metal.
- Light deburring from inside or outside.

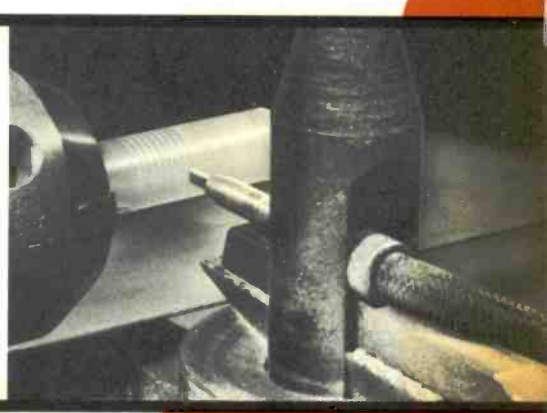
THE S.S.White INDUSTRIAL DIVISION
DENTAL MFG. CO.
10 EAST 40th ST. NEW YORK 16, N.Y.
WESTERN DISTRICT OFFICE • TIMES BUILDING, LONG BEACH, CALIFORNIA



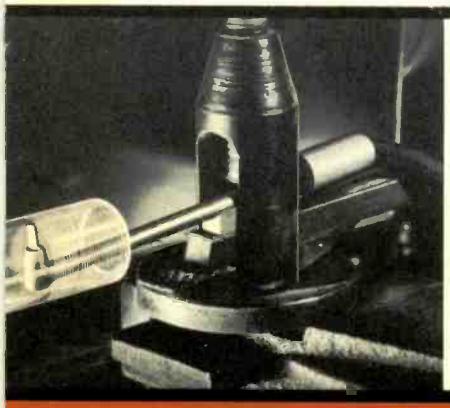
Cutting spiral grooves in carbon resistor with automatic set-up on lathe.



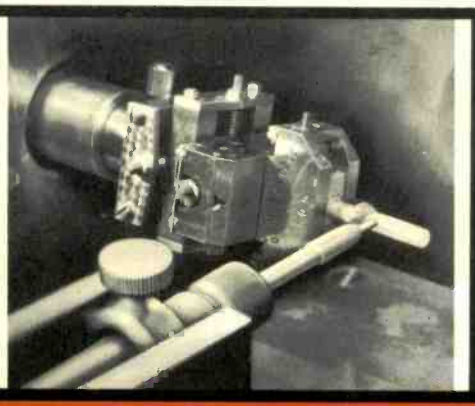
Abrading printed resistors using device that automatically controls resistance value.



Cutting double thread about .005" deep on ground glass tubing.



Cutting inside thread in glass tubing of ½" inside diameter.



Cutting fragile crystals into accurate cylinders with no danger of fracture.

Drilling a contact depression in a quartz disc .030" dia. .015" deep.

TURN THE PAGE

for a description of the S.S.White "AIRBRASIVE" Unit and a summary of the advantages offered by the "AIRBRASIVE" method of cutting.

SEE WHAT IT DOES ON PRECEDING PAGE...

Here's all there is to operating the S.S.White INDUSTRIAL "AIRBRASIVE" UNIT

Contrary to what you might expect, the equipment for applying the versatile "AIRBRASIVE" cutting method is surprisingly simple and correspondingly inexpensive.

The "AIRBRASIVE" Unit measures a compact 12″ x 18″ x 12″. Weighing only 44 pounds, it is readily portable. All you do is plug in its cord to a source of 110 Volt, 60 Cycle A.C. current and connect its tubing to a cylinder of *dry*, inert gas – CO_2, nitrogen or air – never oxygen.

Everything you need is supplied with the unit except the gas cylinder and the dust collecting device. Nozzles of various types are available. The abrasive generally used is aluminum oxide of carefully controlled particle size.

"AIRBRASIVE" CUTTING ADVANTAGES

- *There's no heat — no vibration — no shock.*
- *Pressure on the work is negligible.*
- *Cutting agent is always sharp.*
- *Cutting is unaffected by irregularities in surface of work.*
- *Depth and width of cut are subject to close control.*
- *High cutting rates are generally possible.*

Will "AIRBRASIVE" cutting benefit you?

We'll be glad to help you get the answer. If you're near our New York City or Long Beach, Calif. offices, bring in sample parts for a trial. Or, send us the parts with a statement of your requirements. There's no obligation for this service.

For "AIRBRASIVE" details in print...
write today for a copy of Bulletin 5307. Dept. EB.

THE S.S.White INDUSTRIAL DIVISION
DENTAL MFG. CO.

10 East 40th Street, New York 16, N.Y.

WESTERN DISTRICT OFFICE • TIMES BUILDING, LONG BEACH, CALIFORNIA

IRON FIREMAN

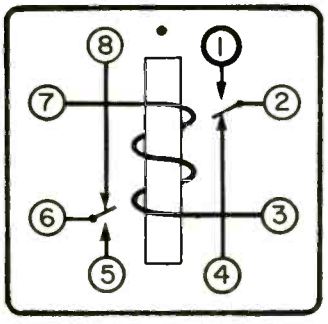
SENSITIVE RELAYS

Another new Iron Fireman product! These small current-sensitive DPDT relays operate positively where very little power is available, such as in vacuum tube circuits. Yet, their contacts will handle upwards of 200 watts. They are especially designed for dependable performance under adverse conditions of vibration, shock, temperature.

Model No. MSR-300

Size: $1\frac{15}{16}$" high; 1" wide

Meets requirements of MIL-R-57-57- B



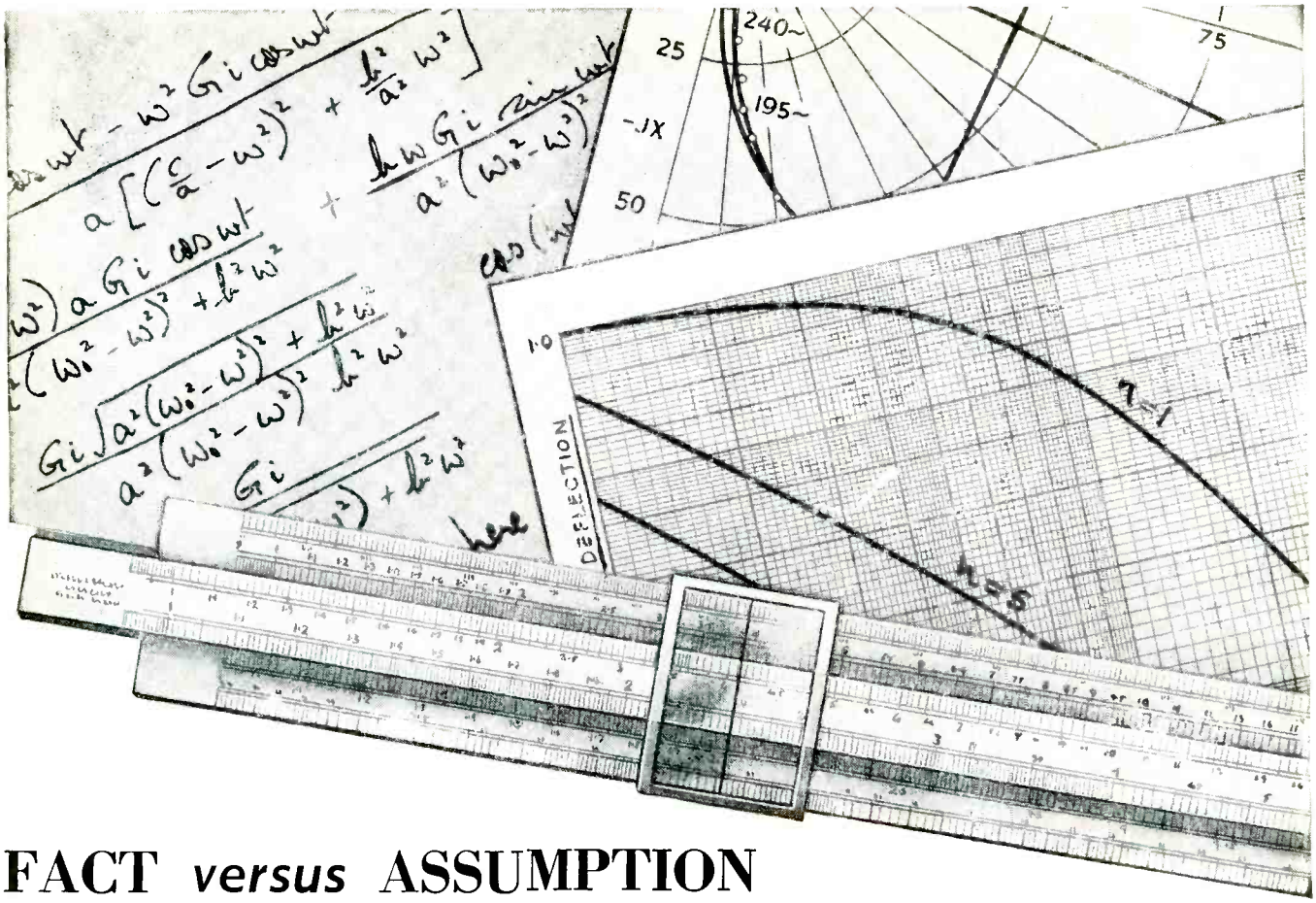
Typical relay circuit diagram

- ★ **Exclusive new design**
- ★ **Resistant to shock and vibration**
- ★ **Hermetically sealed**
- ★ **Wide temperature range**
- ★ **Long life**

For more information on Sensitive Relays as well as Choppers and High-Speed Relays, write to:

®Iron Fireman Electronics DIVISION

2800 S. E. 9TH AVENUE, PORTLAND 2, OREGON

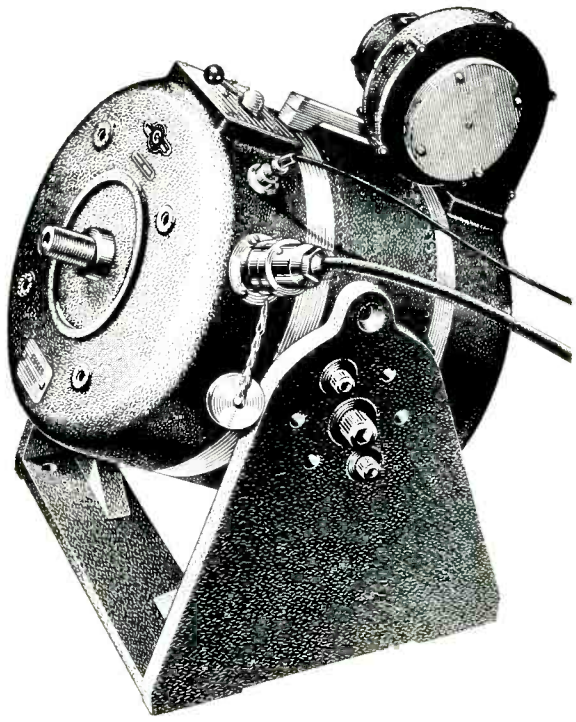


FACT *versus* ASSUMPTION

Vibration effects can be assessed by assumption, estimation and long calculation. Prototypes can be built on those assumptions, but with many anxious moments awaiting operational test results—results which may nullify months of patient effort. It is much simpler, and certainly more economical, to conduct preliminary tests in the laboratory by creating vibrations under controlled conditions—and so obtain the facts. That is the precise function of Goodmans Shakers. They provide vibratory sinusoidal forces at controlled frequency and amplitude, by which specific vibratory conditions over a wide frequency range can be accurately simulated, to assess their effects on materials, structures and components.

Applications include FATIGUE TESTING, ELECTRICAL COMPONENT TESTING, VALVE MICROPHONY TESTING, TORSIONAL VIBRATION TESTING, FLEXURE TESTING OF METALS AND PLASTICS ETC., and MECHANICAL STRUCTURE TESTING.

The range includes models from the 8/600 illustrated, developing a force of ±300 lbs to the midget model with a force of ±2 lbs.



GOODMANS

PERMANENT MAGNET SHAKERS

MAIL THIS COUPON

TO GOODMANS INDUSTRIES LIMITED
AXIOM WORKS, WEMBLEY, MIDDX., ENGLAND

Please mail me your catalogue and technical data sheets in connection with your PERMANENT MAGNET Shakers.

Name .....

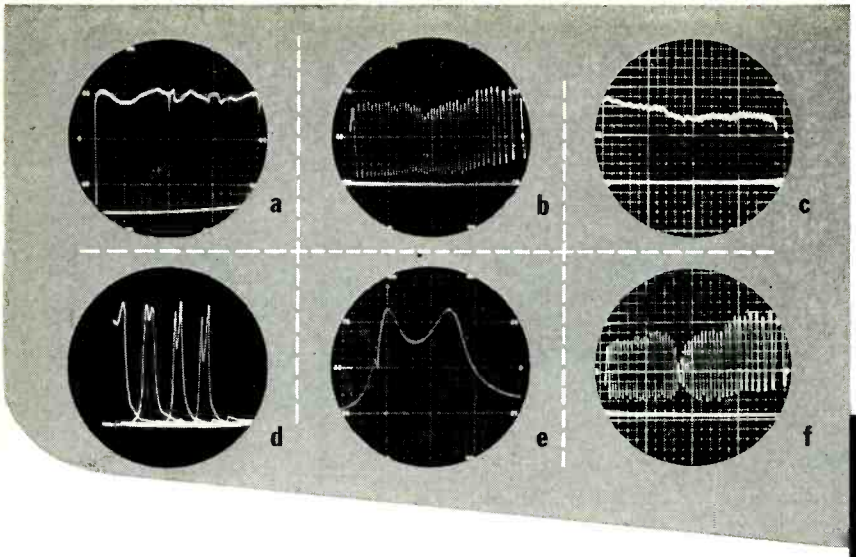
Company .....

CITY ..... ZONE ..... STATE ..... E/U

GOODMANS INDUSTRIES LTD.

AXIOM WORKS • WEMBLEY • MIDDX • ENGLAND

Cables: GOODAXIOM WEMBLEY, MIDDX.



470 to 890 MC. CHARACTERISTICS TAKEN WITH 2144-02 GENERATOR

a) Detected output of sweep generator, showing marker at 650 mcs.

b) VSWR display of unterminated transmission line.

c) VSWR display of terminated transmission line.

d) Preselector responses of UHF tuner at channels 14, 20, 30 and 40.

e) Preselector response of tuner at channel 50, expanded on scope.

f) Input VSWR display of tuner at channel 50.

now sweep over 400 mc. at UHF without tuning

3 Stock models cover 225 to 420 mc. 470 to 890 mc. and 850 to 1275 mc. Special ranges on request.

New Kollsman TYPE 2144 Wide Range Sweep Generator

SPECIFICATIONS

Frequency Range	2144-01	225 to 420 mc.
	2144-02	470 to 890 mc.
	2144-03	850 to 1275 mc.
Minimum Power Output		10 milliwatts
Output Impedance		50 ohms
Maximum Source VSWR		1.25
Amplitude Linearity		± 1 db.
Marker Frequency Calibration		5 mc.
Marker Frequency Accuracy	2144-01	± 1 mc.
	2144-02	± 1.5 mc.
	2144-03	± 2 mc.
Sweep Rate		60 cycle
Tube Complement		6AF4, 6J6, OA2, 6X4
Primary Power		117 volts, 60 cycles, 60 watts

Also Available—Step Attenuator TYPE 2171-01

SPECIFICATIONS

Insertion Loss	Less than ½ db.
Attenuation Steps	0, 3, 6, 9, 12, 15, 20, 30, 40, 50, 60, 70, db.
Frequency Range	DC to 1000 mc.
Maximum VSWR	1.2
Other Attenuation Steps Available	

THE TYPE 2144 SWEEP GENERATOR SIMPLIFIES LABORATORY AND PRODUCTION MEASUREMENTS

- Instantaneous display of frequency response, impedance or VSWR over 400 mc. without test equipment adjustment.
- Simultaneous observation of desired and spurious receiver responses.
- Display antenna characteristics over entire operating band.

WITH THESE DESIRABLE FEATURES

- 50 ohm output.
- Low source VSWR and amplitude non linearity.
- Passive variable marker for stable, accurate frequency indication, with easily read dial.
- Oscilloscope horizontal sweep signal and base line retrace blanking.
- 60 cycle sweep rate for easy observation.
- Voltage regulation minimizes effect of line voltage variation.
- Uses only standard plug in tubes.

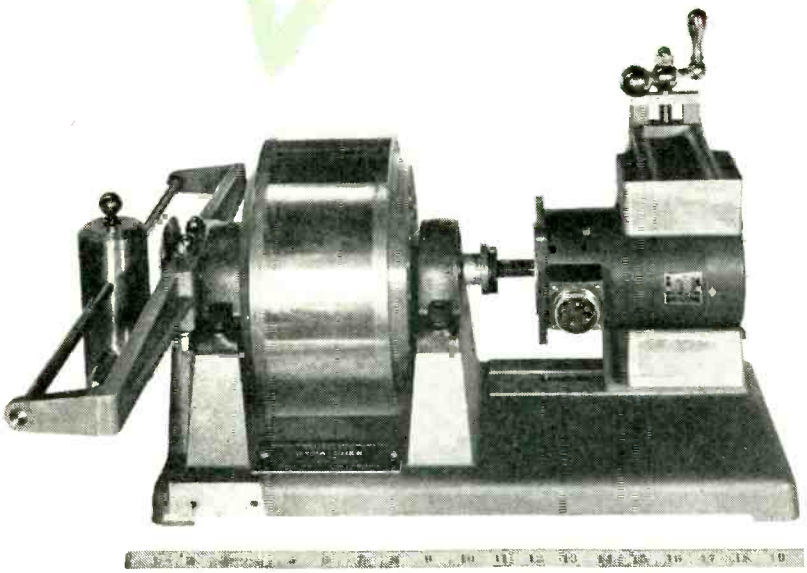
Write FOR COMPLETE INFORMATION ON KOLLSMAN TYPE 2144 SWEEP GENERATORS AND TYPE 2171 ATTENUATORS.

kollsman INSTRUMENT CORP.

80-06 45th AVE., ELMHURST, NEW YORK • GLENDALE, CALIFORNIA • SUBSIDIARY OF *Standard* COIL PRODUCTS CO. INC.

For specialized electronic equipment...

check Western Gear



Dyna-Chek ***provides tested and proven accuracy in measuring the output of fractional and integral horsepower motors —***

Model DM4 up to 1HP in continuous duty, and Model MDM for 1/10 HP or less. Manufactured by Mission-Western Engineers, Inc.,* Dyna-Chek provides a simple and convenient method of motor testing. Two types of broad range speed measuring equipment available as extra accessories, both supplying a high degree of accuracy. For information, address Mission-Western Engineers, Inc., 132 W. Colorado, Pasadena 1, Calif.

HIGH PRECISION GEARS *and precision fine pitch gearing* from 200 to 6 diametral pitch and dimensions from .125" to 10" diameter. Western Gear Works makes available complete engineering and manufacturing facilities for the application of high precision gearing and gear drives in electronics equipment. For assistance without obligation write Executive Offices, Western Gear Works, P.O. Box 182, Lynwood, Calif.

Since 1888

5422

WESTERN GEAR WORKS

PACIFIC-WESTERN PRODUCTS | POWER TRANSMISSION GEARS • MACHINERY •

PACIFIC GEAR & TOOL WORKS · SOUTH WESTERN GEAR WORKS

** An affiliate of Western Gear Works, since 1888 a leader in the mechanical power transmission field.*

PLANTS AT LYNWOOD, PASADENA, BELMONT, SAN FRANCISCO (CALIF.), SEATTLE, HOUSTON — REPRESENTATIVES IN PRINCIPAL CITIES

MOLDITE CORE "STANDARDS" For The ELECTRONIC INDUSTRY

Moldite has taken the initiative in establishing accepted electrical standards long required by the electronic industry. Every coil and set manufacturer, every engineer has designed coils to utilize Moldite "standards".

The reasons are obvious. *Moldite Core Standards Offer . . .*

ECONOMY	HIGH QUALITY	UNIFORMITY
AVAILABILITY	INTERCHANGEABILITY	FLEXIBILITY

This means a better product backed by years of Moldite leadership in engineering and research. No one has done more than Moldite to give the industry a superlative core or coil form for every electronic application.

So Design with Moldite Core Standards.

MOLDITE
FERRICORES
MOLDITE
MOLDED COIL FORMS
MOLDITE
MAGNETIC IRON CORES

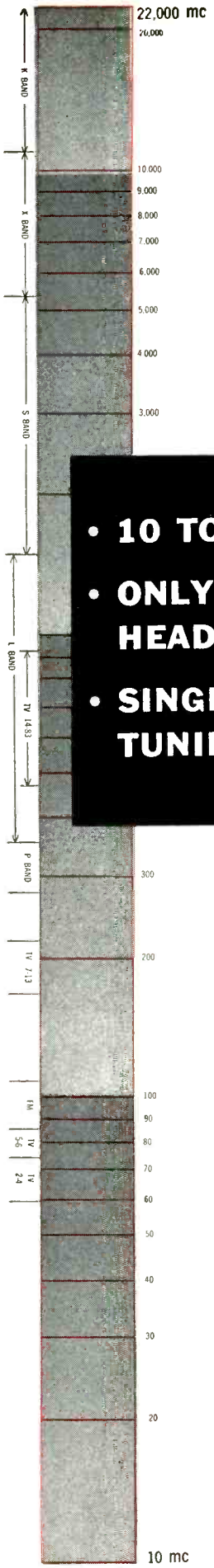
FERRITE CORES
MOLDED COIL FORMS
(iron and phenolic)
MAGNETIC IRON CORES
FILTER CORES
THREADED CORES
SLEEVE CORES
CUP CORES

Samples promptly submitted upon request for design, pre-production, and test purposes

. . . Send for our new Catalog No. 110 — THE MOST COMPLETE LINE OF CORES IN THE INDUSTRY!

NATIONAL MOLDITE COMPANY
1410 CHESTNUT AVE., HILLSIDE 5, N. J.

Robert T. Murray Co.	Jerry Golten Co.	Arnold Andrews	Perlmuth, Colman & Assoc.	Jose Luis Ponte
604 Central Ave.	2750 W. North Ave.	521 Cumberland Ave.	2419 S. Grand Avenue	Cardoba 1472
East Orange, N. J.	Chicago 22, Ill.	Syracuse, N. Y.	Los Angeles, Cal.	Buenos Aires



NEW! PORTABLE DIRECT READING SPECTRUM ANALYZER

- 10 TO 22,000 MCS
- ONLY 3 R. F. HEADS
- SINGLE DIAL TUNING

Now, a new Polarad spectrum analyzer only 21 inches high that covers the entire frequency range 10 to 22,000 mcs with but 3 interchangeable R—F tuning heads. The model TSA operates simply—single dial frequency control—with utmost frequency stability. It provides highest accuracy, and reliability for observation and true evaluation of performance over the entire R—F spectrum—saving engineering manhours.

This instrument is designed for maximum utility and versatility in the laboratory and on the production line providing an easy-to-read 5 inch CRT display of the R—F spectrum.

The model TSA Spectrum Analyzer has these exclusive Polarad design and operating features:

- Single frequency control with direct reading dial. No klystron modes to set. Tuning dial accuracy 1%.
- Only three interchangeable R—F tuning units for the entire frequency range 10 to 22,000 mcs.
- Temperature compensation of Klystron Oscillator.
- Swept IF provides 250 kc to 25 mc display independent of R—F frequency setting.
- Internal R—F attenuator.
- Frequency marker for measuring frequency differences from 100 kc to 25 mc.

Write today to your nearest Polarad representative, or directly to the factory for complete information.

Model No.	Equipment
Model TSA	Spectrum Display and Power Supply
Model STU-1	R-F Tuning Unit 10-1,000 mc.
Model STU-2	R-F Tuning Unit 910-4,560 mc.
Model STU-3	R-F Tuning Unit 4,370-22,000 mc.

SPECIFICATIONS:

Frequency Range:
10 mc to 22,000 mc

Frequency Accuracy:
1%

Resolution:
20 kc

Frequency Dispersion:
Electronically controlled, continuously adjustable from 50 kc/in. to 7 mc/in.

Input Impedance:
50 ohms

Over-all Gain:
120 db

Attenuation:
RF....Internal: 120 db continuously variable
IF....60 db continuously variable

Input Power:
400 watts

Polarad

ELECTRONICS CORPORATION

100 METROPOLITAN AVENUE, BROOKLYN 11, NEW YORK

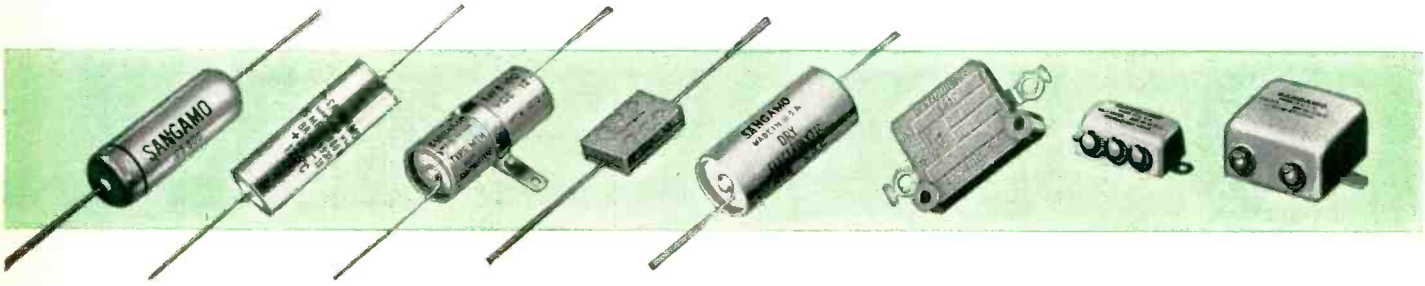
REPRESENTATIVES • Albuquerque • Atlanta • Boston • Chicago • Cleveland • Fort Worth • Kansas City • Los Angeles • New York
Philadelphia • San Francisco • Seattle • St. Paul • Syracuse • Washington, D.C. • Canada, Arnprior — Export: Rocke International Corporation

...that's why IBM uses Sangamo

The amazingly complex IBM "702" electronic calculator is hailed as the fastest and most flexible commercial data processing system ever devised. The central Arithmetical and Logical Unit performs calculations and makes decisions at a rate of more than 10,000,000 operations in an hour. Data and instructions for processing are stored in an electrostatic memory bank of cathode ray storage tubes. Output can be in the form of punch cards at the rate of 100 per minute.

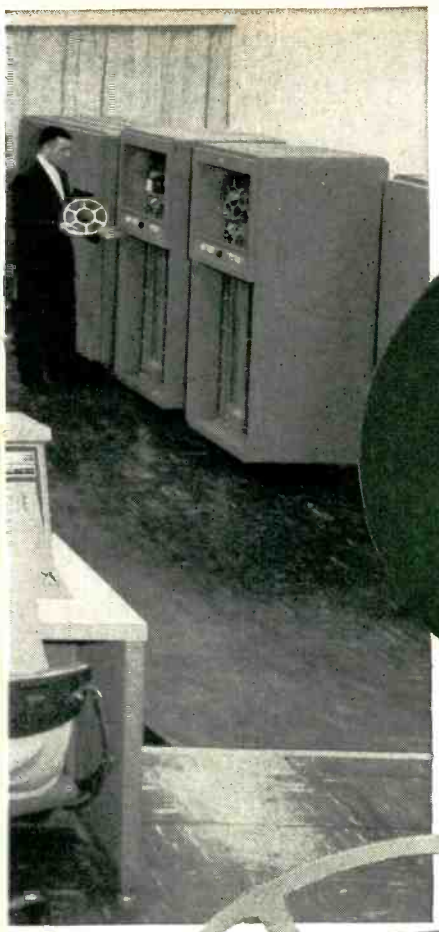
A machine like this needs components that assure maximum performance to meet its exacting demands. That's why several different types of Sangamo Capacitors are used in the 702.

If you need capacitors for demanding electronic applications, Sangamo engineers can help you. You can choose from a complete line of paper, mica, electrolytic and button type capacitors for every industrial, electronic, and radio application.



SANGAMO ELECTRIC COMPANY

MARION, ILLINOIS



Longer Life
at High Temperatures

SANGAMO
CAPACITORS

Stability
Under All Conditions

Capacitors in the new 702

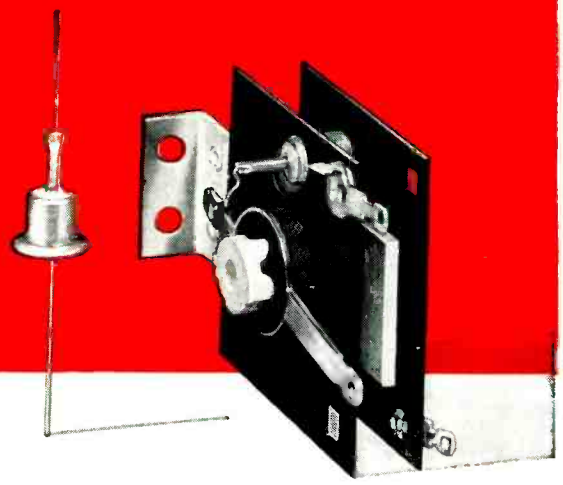
Those who know...  *choose Sangamo*

SC54-14

G. E.'s LATEST CONTRIBUTION TO

STACKED

CUSTOM BUILT TO PROVIDE 143 POWER COMBINATIONS!



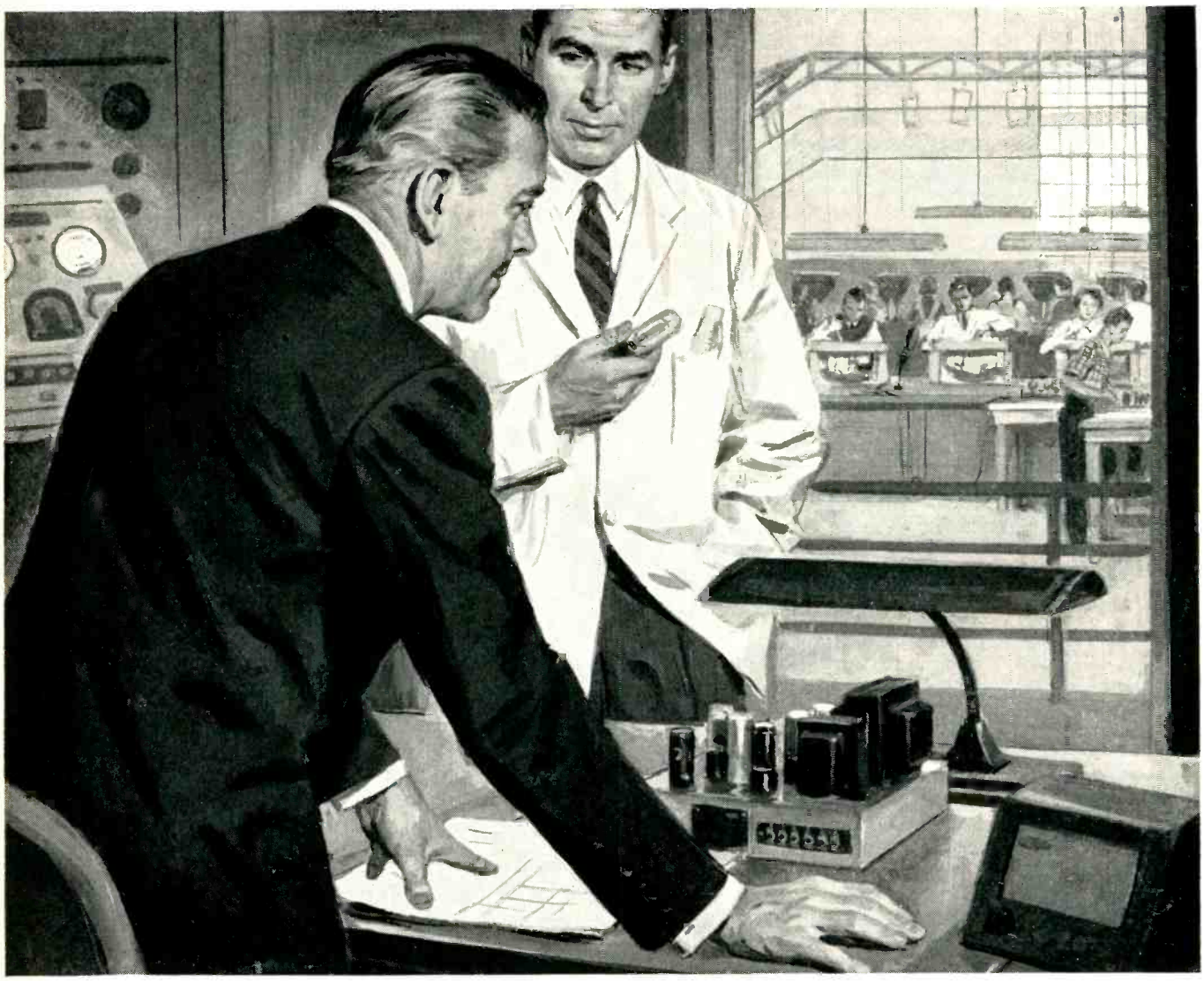
- ★ **Smallest unit size yet developed!**
- ★ **Most reliable performance of any rectifier within this category!**
- ★ **Hermetically sealed for lifetime use!**

The following germanium rectifier stacks, each occupying a volume of only 1.62" x 2.5" x 6.00", are typical of the 143 standard stacks in G. E.'s new rectifier line.

CIRCUIT	D.C. OUTPUT (55°C Resistive Load)
Half Wave	2 amps @ 280 volts or 3 amps @ 190 volts
Full Wave Center Tap	2 amps @ 280 volts or 3 amps @ 190 volts
Full Wave Bridge	1 amp @ 565 volts or 3 amps @ 210 volts
Three Phase Half Wave	1.12 amps @ 420 volts or 4.5 amps @ 140 volts
Three Phase Bridge	1.3 amps @ 575 volts or 2.6 amps @ 280 volts
Three Phase Star	1.8 amps @ 280 volts or 3.6 amps @ 140 volts

★ ★ ★

TO AVOID LOSSES ON OBSOLETE PARTS



Ship American Airlines AIRFREIGHT

The Most Experienced Air Cargo Service Assures You of Expert Handling

Today, many manufacturers have found they can maintain production with only a fraction of the inventories that were once required. Warehousing costs are reduced; less capital is tied up, and, most important, they can make quicker engineering modifications without obsoleting huge stocks of component parts. They accomplish all this by specifying American Airfreight when they contract for supplies.

They have good reason for specifying American. With more experience and more service to more key industrial centers than any other Airline, American is better able to provide expert handling, prompt forwarding and dependable, on-time deliveries. American Airlines, Cargo Sales Division, 100 Park Ave., New York 17, N. Y.

AMERICAN AIRFREIGHT ALSO LEADS IN

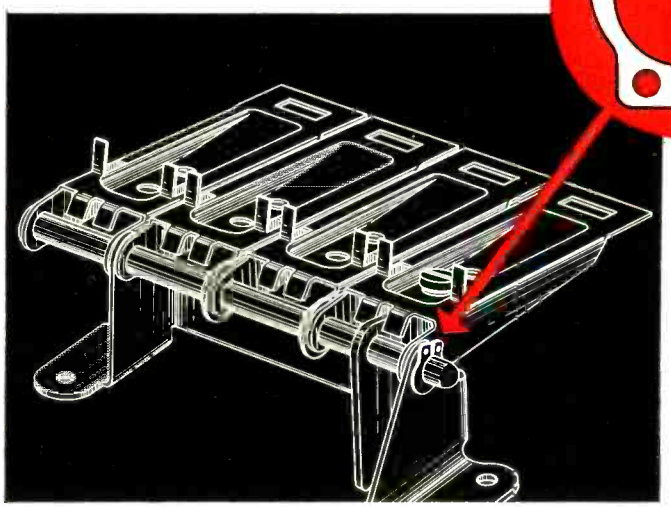
SPEED—American's own terminals and special handling techniques provide prompt forwarding, on-time deliveries.

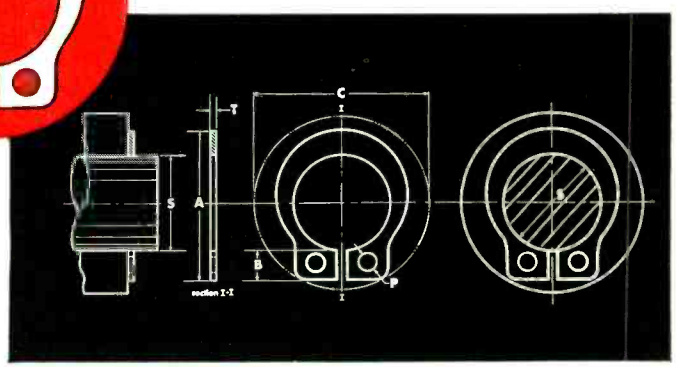
CAPACITY—American has the greatest cargo capacity of any Airline with the right space at the right places.

COVERAGE—American serves more leading industrial centers than any other Airline.

America's Leading Airline **AMERICAN AIRLINES INC.**

New Waldes Truarc GRIP Ring requires no groove, holds fast by friction, can be used over and over again





The Waldes Truarc Grip Ring is a new, low cost fastener that provides a positioning shoulder secure against moderate thrusts or vibration. Installed on a straight ungrooved shaft, the Truarc Grip Ring can be assembled and disassembled in either direction with Truarc pliers.

The Grip Ring can be installed tightly against a machine part in order to take up end-play. The basic Truarc design principle assuring complete circularity around periphery of the shaft and the ring's unusually large radial width combine to exert considerable frictional hold against axial displacement. The ring can be used again and again.

Find out what Waldes Truarc Retaining Rings can do for you. Send us your drawings. Waldes Truarc engineers will give your problems individual attention without obligation.

Ring # 5555		5555-12	5555-13½	5555-18	5555-25	5555-21	5555-37
SHAFT DIAMETER	Fract. Equiv. S	1/8"	—	3/16"	1/4"	5/16"	3/8"
	Dec. Equiv. S	.125	.136	.187	.250	.312	.375
	TOL.	±.002	±.002	±.002	±.002	±.003	±.003
RING DIMENSIONS	Thickness T	.025	.025	.035	.035	.042	.042
	TOL.	±.0015	±.0015	±.002	±.002	±.002	±.002
	Length A	.268	.285	.364	.437	.553	.626
	Lug B	.078	.078	.097	.097	.141	.141
	Hole P	.042	.042	.042	.042	.078	.078
	Min. Ring Clear C	.33	.34	.44	.50	.67	.73
Approx. Ultim. Thrust Load (lbs)		20	20	25	35	50	60

SEND FOR NEW CATALOG

WALDES

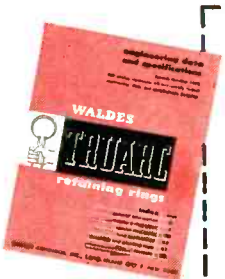
TRUARC

REG. U. S. PAT. OFF.

RETAINING RINGS

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

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



Waldes Kohinoor, Inc., E-096
47-16 Austel Place, L.I.C. 1, N. Y.

☐ Please send me sample Grip-Rings (please specify shaft size _____)

☐ Please send me the complete Waldes Truarc catalog.

(PLEASE PRINT)

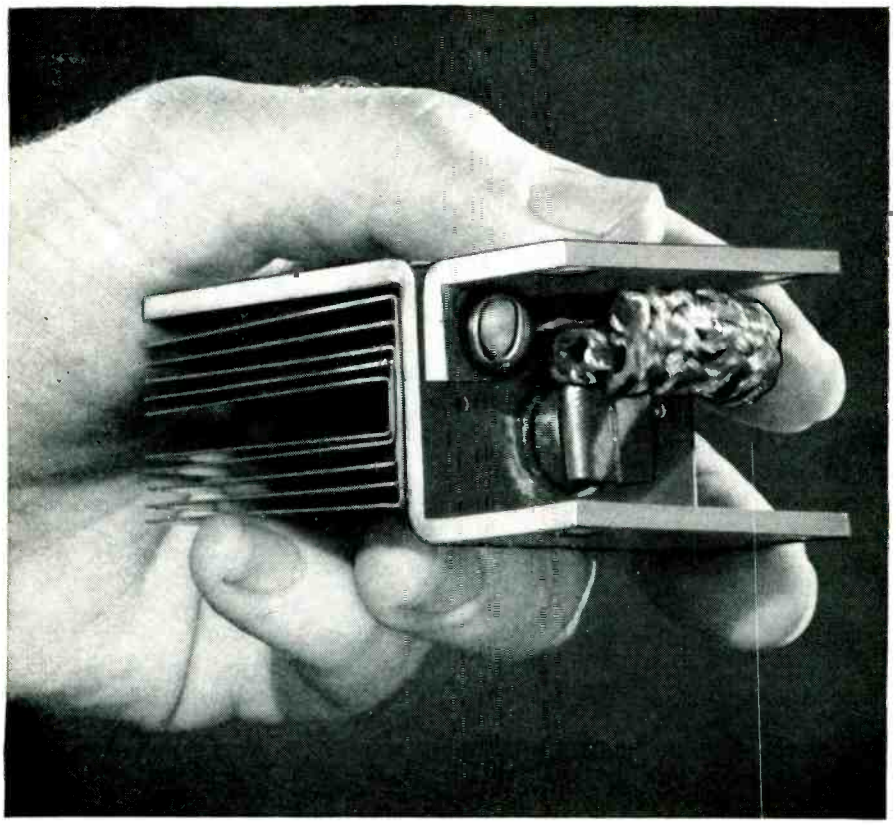
Name_____

Title_____

Company_____

Business Address_____

City_____ Zone____ State_____



THIS NEW MIDGET GERMANIUM RECTIFIER HAS AN OUTPUT OF OVER TWO KILOWATTS

Get High Power and Save Space With G-E Germanium Rectifiers

Germanium is a material to stimulate the imagination, so endless are its possible applications. Germanium rectifiers, pioneered by General Electric, offer design engineers tremendous possibilities for product improvement. Combining extreme compactness with the highest efficiency of any metallic rectifier known, G-E germanium cells show practically no aging. D-C power supplies for welders, battery chargers, and electrochemical processes are just a few of the possible applications.

COMPACT—The compactness of germanium rectifiers makes possible real savings in space, volume, and weight. The dime-sized cell, pictured above with its heat exchanger, has a rating of two kilowatts with air cooling at a rate of 1000 fpm. Six of these tiny rectifiers connected in a three-phase bridge will deliver up to 65 volts d-c with a rated capacity of over 14 kw. To do a comparable job with selenium would take six stacks of 30 cells each, or a total of 180 selenium plates.

OTHER RATINGS—Besides the rectifier illustrated above, two other types are available. One is a sealed convection-cooled unit with a half-wave rating of 0.4 amperes d-c output with up to 125 r.m.s. volts a-c input. A second is the plate-mounted convection or fan-cooled rectifier with half-wave ratings of from 4 to 20 amperes d-c output. All assemblies can be used in doubler, center-tap, and full-wave bridge circuits with corresponding increases in ratings.

MORE INFORMATION is available from your nearest G-E Apparatus Sales Office, or write *Section 461-32, General Electric, Schenectady 5, N. Y.*

Progress Is Our Most Important Product

GENERAL ELECTRIC

METALLIC RECTIFIER FACTS FOR ENGINEERS

Germanium

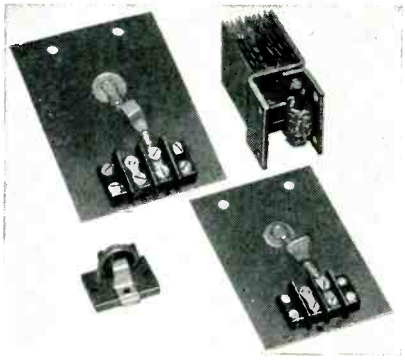
The Rectifier of the Future

by C. E. Hamann

Seldom if ever has the rectifier industry experienced such widespread interest in a new development as has occurred with germanium. While much is being written of the capabilities of germanium in the low current area of diodes and transistors, its possibilities in high-power applications are equally amazing.

Perhaps a simple comparison with selenium of the relative current densities will serve to illustrate its fantastic properties as a power rectifier. It is standard industry practice to operate selenium in a 3-phase bridge circuit at a current density of 75 milliamperes per square centimeter of cell area. With an adequate air-cooling system this current density may safely be doubled.

Germanium is presently being operated successfully at a current density of 75 amperes per square centimeter of cell area with every indication that

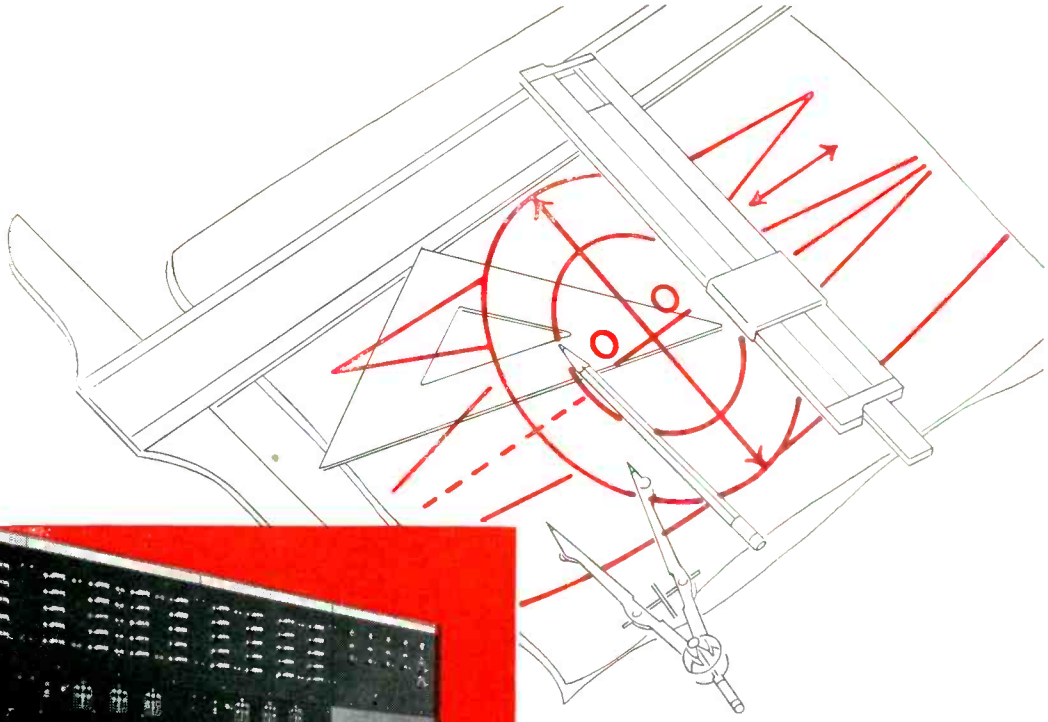


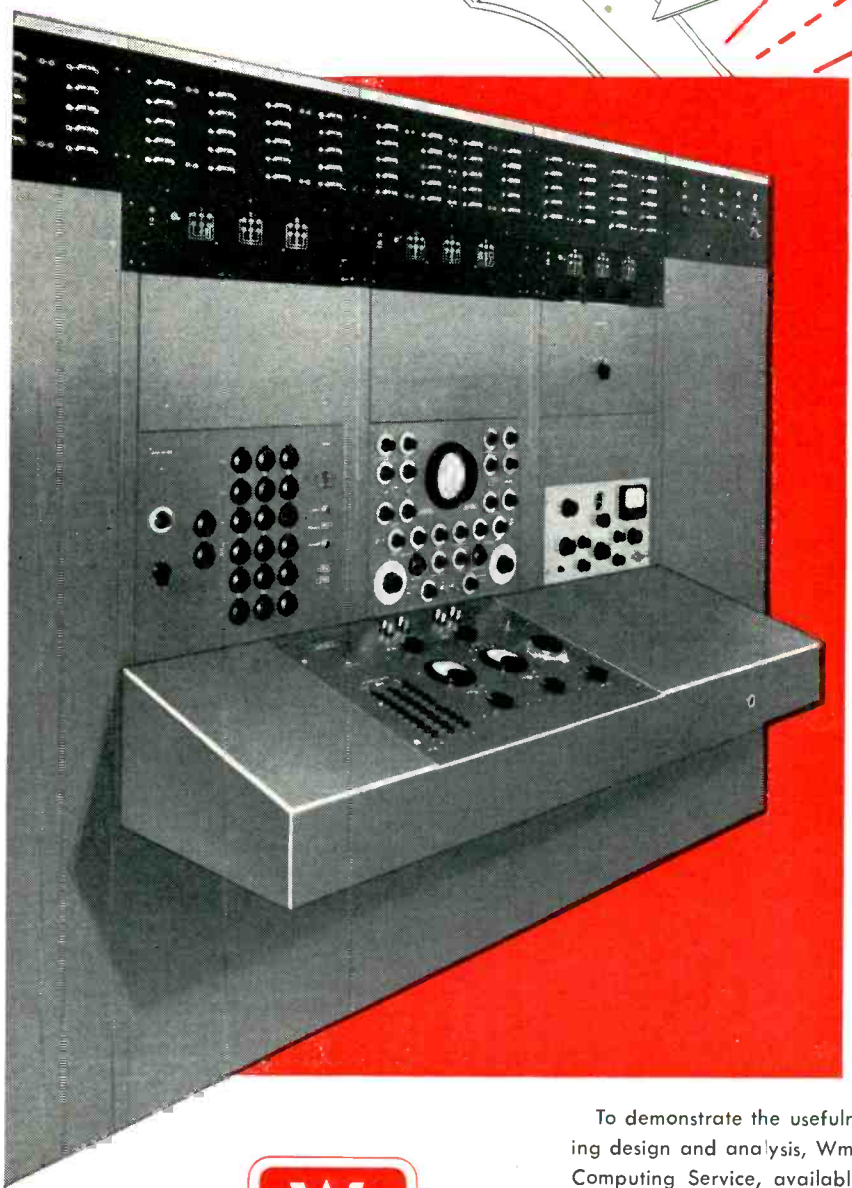
the top limit of capability has not yet been reached. Considering that germanium is also being operated at r.m.s. voltages per cell more than double that of the best available selenium, it will be seen that its power capabilities are at least 1000 times greater than selenium on a cell area basis.

The reason for this phenomenal ability lies in its inherently high efficiency which in turn means very little heat loss to be dissipated. The cell operating efficiency is in the range of 98 to 99 percent.

C. E. Hamann

General Electric Company





Save Development Time...

REDUCE COSTS

Evaluation of design without actual construction of preliminary models is today an engineering necessity. The MILAC Analog Computer makes this short-cut possible by rapid solution of mathematical-electronic models of new systems or structures. Different approaches and solutions may be tried out more freely, for the cost of construction and test of prototypes for each design change is eliminated. Development costs and engineering man-hours are thus vastly reduced, for the MILAC accurately predicts and rules out faulty designs before final performance tests.

To demonstrate the usefulness of the MILAC Computer in engineering design and analysis, Wm. Miller Instruments maintains an Analog Computing Service, available for solution of either a single design problem or an overall development program.

Detailed information about either the MILAC Computer or the Analog Computing Service will be sent on request.

WM PASADENA

WM MILLER INSTRUMENTS, INC.

CUSTOM INSTRUMENT DESIGNERS AND MANUFACTURERS

325 N. HALSTEAD AVENUE · PASADENA 8, CALIFORNIA · RYAN 1-6317

FACTS ABOUT **VACUUM-MELTED** METALS AND ALLOYS

Get Less Out-Gassing Here

Vacuum-melting at pressures as low as one millionth part of atmospheric removes gases from metals. Components of electronic tubes, such as thyratrons, made with vacuum-melted metals have a new low level of dissolved and occluded gases. Result: faster pump down time . . . increased tube reliability . . . longer tube life. Write for more facts.

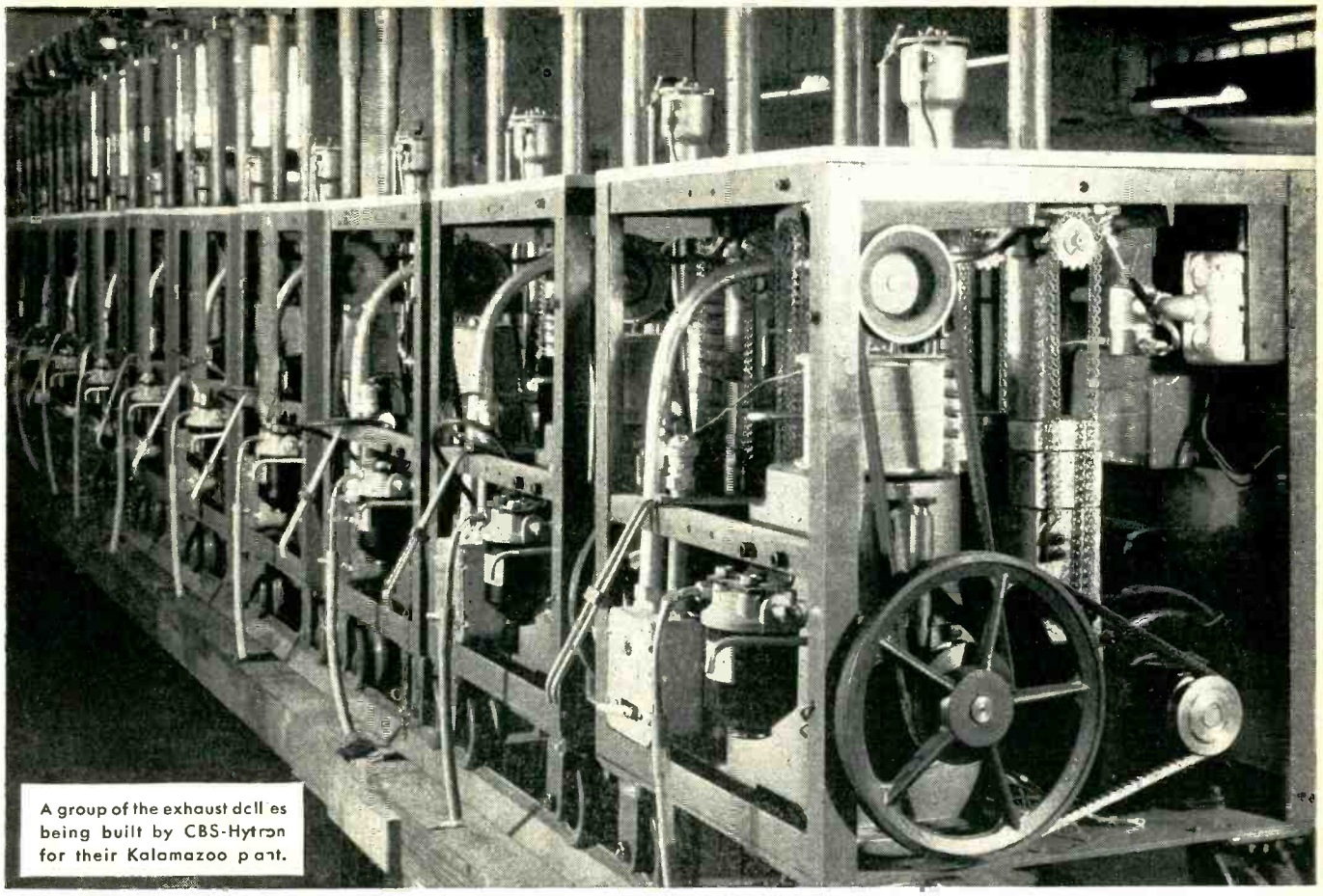
These Vacuum-Melted Metals Now Available

CUPROVAC® E
Electronic Grade Copper
CUPROVAC® CR
Copper-chromium (.85% Cr.) alloy
NIVAC® P
High purity, passive nickel
SEALVAC® A
Glass-to-metal sealing alloy

VACUUM METALS CORPORATION

P. O. BOX 977, SYRACUSE 1, NEW YORK

Jointly owned by Crucible Steel Company of America and National Research Corp.



A group of the exhaust coll es being built by CBS-Hytron for their Kalamazoo p ant.

CBS-HYTRON SELECTS

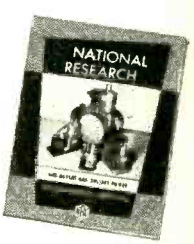
Vibration-Free, Low Cost Performance of

NRC ROTARY GAS BALLAST PUMPS

Before ordering rotary vacuum pumps for their new Kalamazoo plant, CBS-Hytron ran evaluation tests to find what pump best met their needs. NRC Rotary Gas Ballast Pumps won hands down. Their vibration-free, low cost performance led to the purchase of more than 400 NRC units.

Behind these results is a design story that might well save you money, too. More efficient mechanically and with greater speed at low pressures, NRC Rotary Pumps permit minimum blow back and leakage past pumping members. Result? They pull down *faster* from atmospheric to operating pressures. And since water vapor won't condense in an NRC pump, fast pump down time is *always* maintained and shrinkage reduced.

Easy to service, dependable to operate, users report NRC Gas Ballast Pumps have long life, low operating costs under the most adverse conditions.

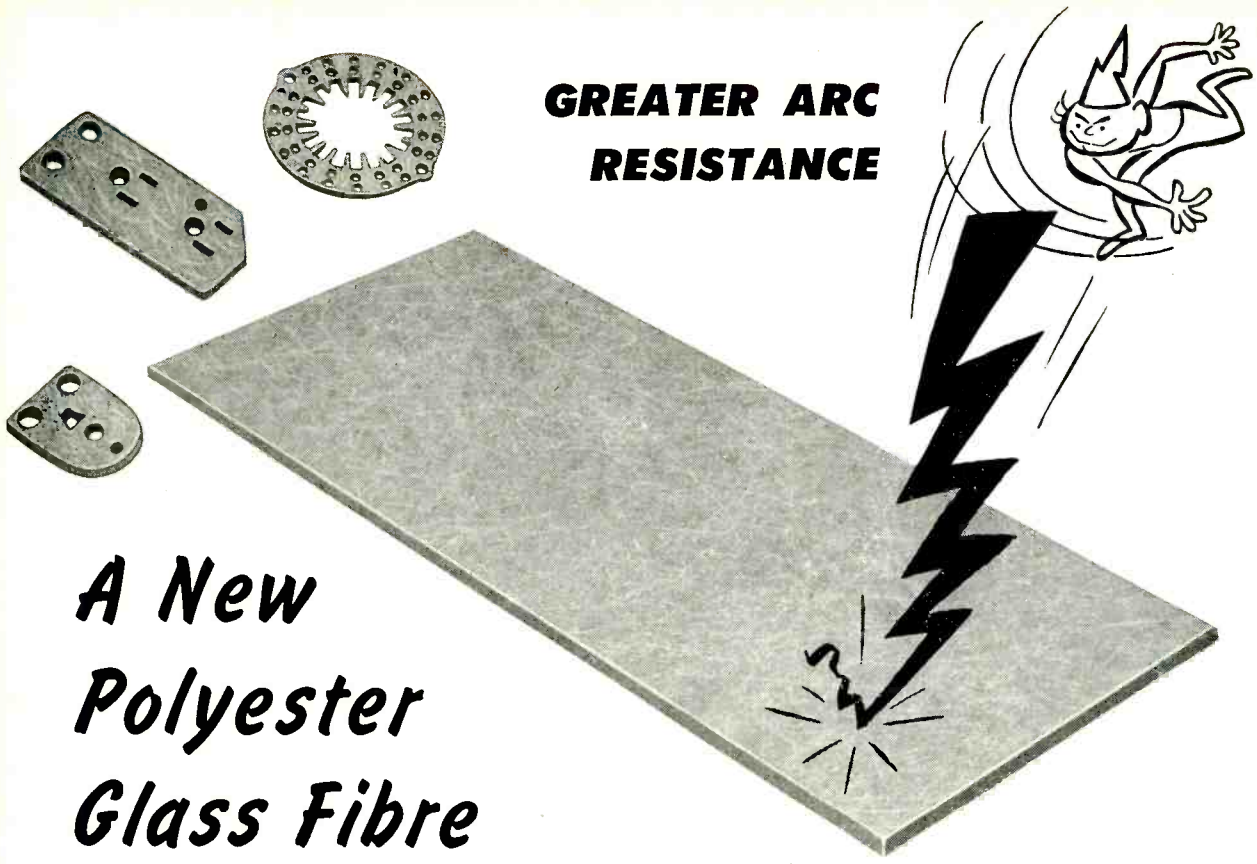


Send today for new Bulletin explaining the Gas Ballast principle plus complete operating and construction data.

NRC

National Research Corporation

Equipment Sales Subsidiary: NARESCO EQUIPMENT CORPORATION
160 Charlemont St., Newton Highlands 61, Mass.
OFFICES: PALO ALTO, CALIF. • CHICAGO • CLEVELAND • NEW YORK CITY
PHILADELPHIA



GREATER ARC RESISTANCE

A New Polyester Glass Fibre Insulating Sheet – INSUROK® XT-200

• If you are looking for an insulating laminate that combines excellent electrical properties with good structural strength, consider this new Richardson laminate. INSUROK XT-200 is an excellent material for pole insulators, cable holders and switches, where arc resistance is important, as well as for motor-generators, transformers, switchgear, electroplating equipment, and various kinds of electrical and electronic heating devices. Moreover, INSUROK XT-200 has very satisfactory fabricating qualities. It is available in sheets 34″ x 34″, in thicknesses of 1/16″, 1/8″, and 1/4″. The Richardson Company will be glad to supply further information and samples.

Send for Data Sheet XT-200

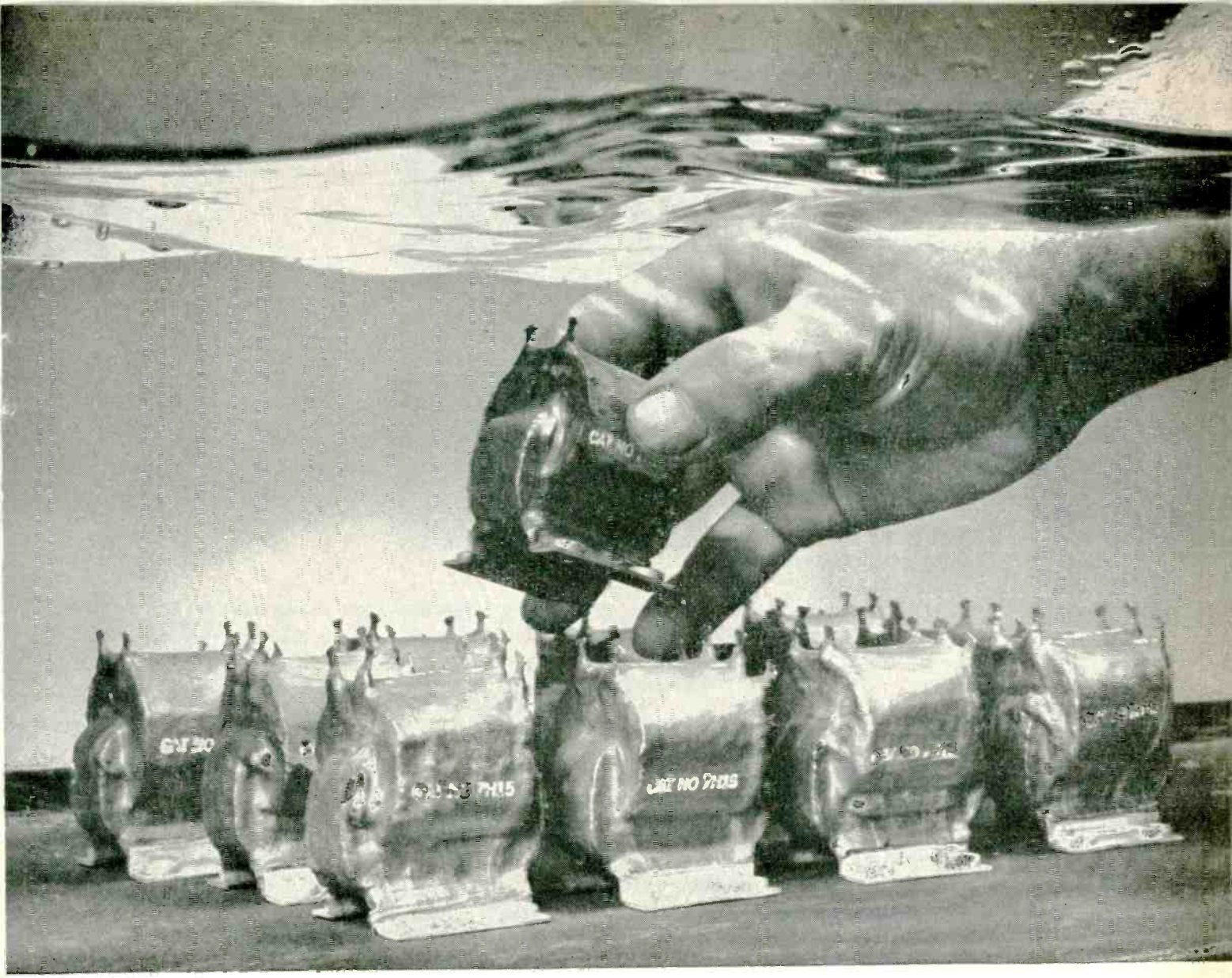
- **GOOD ELECTRICAL PROPERTIES**
- **EXCELLENT STRUCTURAL STRENGTH**
- **HIGH HEAT RESISTANCE**
- **LOW MOISTURE ABSORPTION**
- **PUNCHES COLD TO INTRICATE SHAPES**

The RICHARDSON COMPANY

FOUNDED 1858

2797-P Lake Street, Melrose Park, Illinois (Chicago District)

MELROSE PARK, ILL. | INDIANAPOLIS, IND. | NEW BRUNSWICK, N. J. | NEWNAN, GA. | OGDEN, UTAH | TYLER, TEXAS



Westinghouse Fosterite® Transformers must pass this 4-hour underwater test

If you're looking for a small, open-type transformer, fully protected against moisture, check the line of Westinghouse Fosterite impregnated transformers. This four-hour underwater test proves the point:

All Fosterite-treated transformers are completely submerged in hot water at 60° Centigrade for two hours, after which they are "thermal-shocked" in cold tap water, and soaked there for an additional two hours. An electrical test is then applied, in which each transformer must show an insulation resistance reading of at least 2000 megohms. Fosterite has to be good!

This is just one of many severe tests to which Westinghouse specialty transformers are subjected. They assure you of quality that will meet your requirements exactly . . . quality that stands up under extreme conditions.

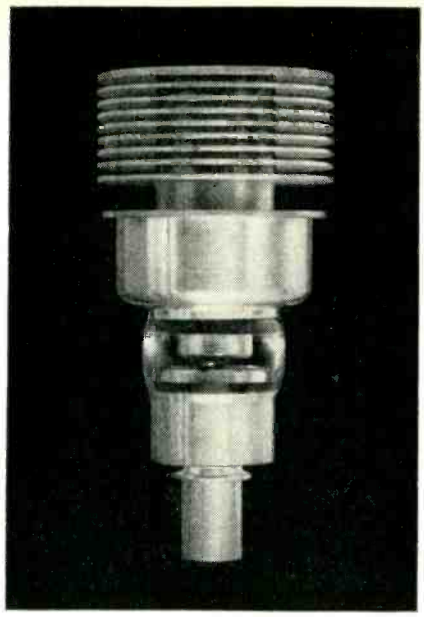
Fosterite impregnated and coated transformers can be made available to meet your most stringent specifications. In addition to moisture protection, Fosterite makes drastic weight reductions possible . . . as much as 30 to 50%, when compared to enclosed types.

Call your Westinghouse representative for further information, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa. J-70678

YOU CAN BE SURE... IF IT'S

Westinghouse

Uniformity
Ruggedness
Reliability
make the



MACHLETT 2C39A

Preferred Choice of Equipment Manufacturers, Military and Commercial Users

New Standard for Electrical Uniformity

The ML-2C39A sets the highest standard of electrical uniformity for UHF planar triodes.

Close tolerance parallelism between electrodes prevents uneven heating at high frequencies, minimizes arcing.

Uniquely processed grid, mechanically stable at high temperatures, assures frequency stability over broadest range of operating conditions.

Machined emitter surfaces with extremely uniform oxide deposit assure optimum cathode emission as well as freedom from uneven, grid distorting, heat.

400% More Rugged

Average strength of the ML-2C39A is over 400% greater than *any other* 2C39A, as measured in torque and pry tests.

Unmatched Reliability

Quality in design, materials, and production techniques build superior reliability into the ML-2C39A.

Final inspection includes r-f oscillation in both test oscillators, and prototypes of field equipments, to assure tubes of high power output and long, trouble-free life.

Electrical Characteristics of ML-2C39A*

Heater voltage, 6.3 volts	Grid-plate capacitance, 2.0 uuf
Amplification factor, 100	Maximum frequency, 2500 mc/sec
Transconductance, 22,000 umhos	Useful power output, 12-35 watts

**Manufactured to JAN specifications.*

Also made by Machlett to highest quality specifications: **ML-381** for pulsed applications (3500 V peak; 3 microsecond pulse; ½% duty cycle) and the **ML-322** clipper diode.

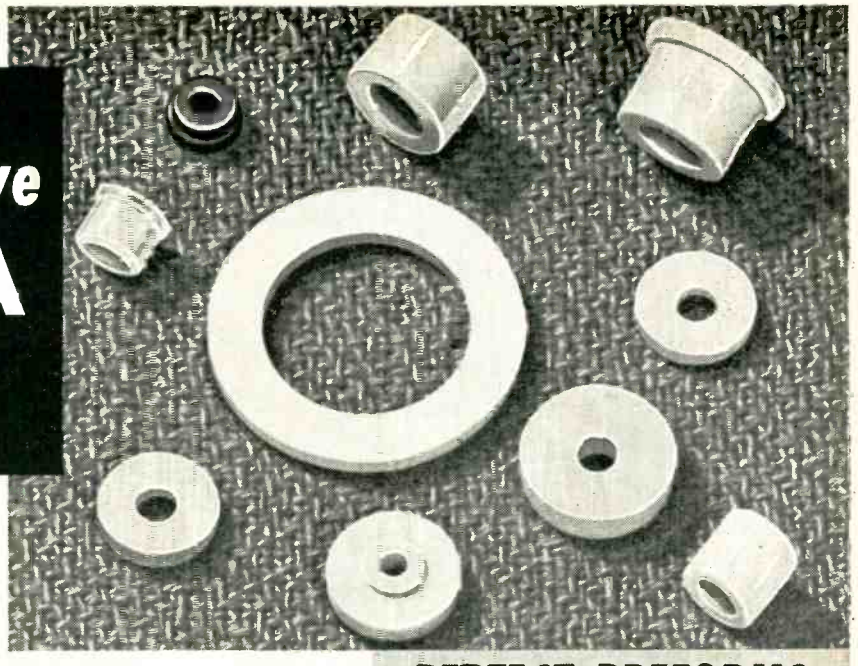
MACHLETT

For complete specifications and operating data, write to:

MACHLETT LABORATORIES, INC. • SPRINGDALE, CONN.

Over 55 years of electron tube experience!

NOW—Tests Prove FORMULA 800--



...the Only Adhesive Preform that will bend and act as a Conductive or Non-Conductive Resin Weld!

FORMULA 800 — extracted from epoxy resins. "800" can be used in preforms and for conductive or non-conductive small parts welding at 400° F. Wherever you are now using the parts method of bonding, investigate FORMULA 800. It possesses extremely high bonding strength, with no shrinkage, on metals to metals and metals to non-metals.

This is a new chemical-resistant material of construction that warrants your consideration when the properties of standard resin cements and coats are not adequate for the service you desire. For an adhesive preform or a small parts resin weld, it will pay you to contact Mansol.

- If you are still making your own preforms, Mansol would like to show you how to save money and eliminate rejects.
- Write to Dept. N for the complete story about preforms, FORMULA 800 and our production facilities. No obligation, of course.

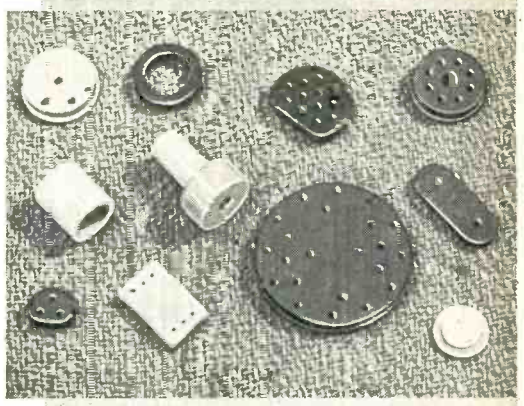
mansol

MANSOL CERAMICS COMPANY
140 LITTLE STREET BELLEVILLE, N. J.

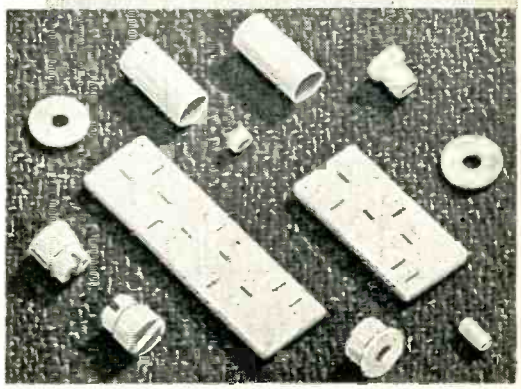
CABLE ADDRESS: MANSOL

STEATITE PREFORMS — We specialize in small die-pressed ceramic parts held to closest tolerances. All tools and dies are made in our shop to assure quick delivery. For immediate attention to your requirements, contact Mansol today

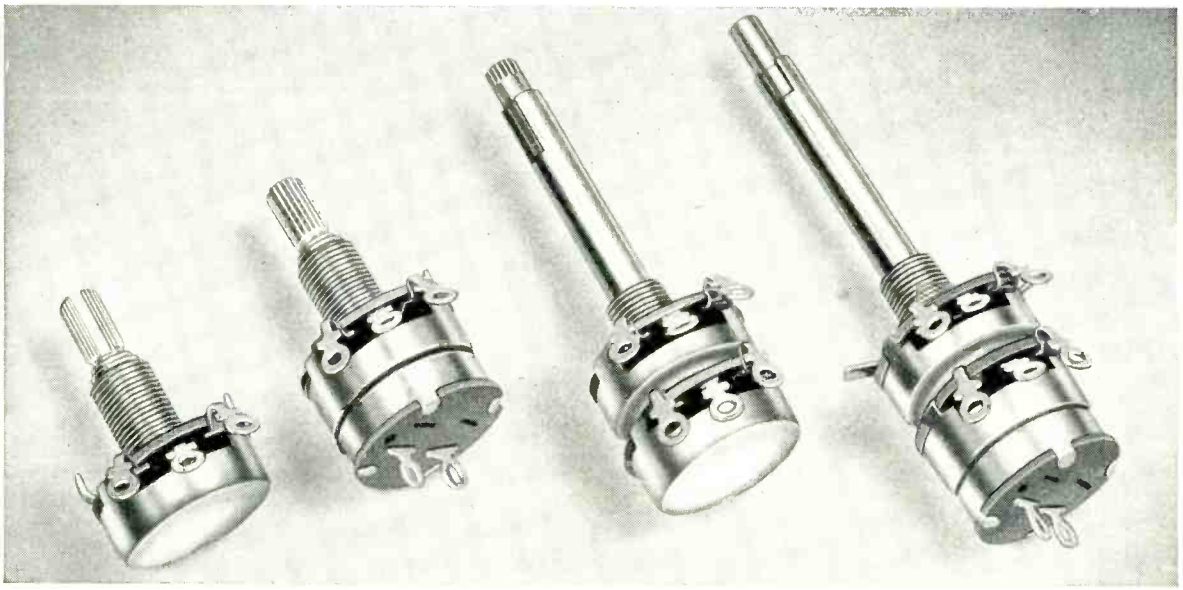
PERFECT PREFORMS from POWDERS custom-molded to exact specifications



GLASS PREFORMS — The ideal preforms for Iron Sealing and Kovar Sealing, matching the expansion of these metals over their entire working range. They resist mercury attack, have ample mechanical strength, and seal readily. Our Laboratory is prepared to assist you in selecting the proper glass for any metal.



Stable, Low-Noise Carbon Controls in ANY Combination You Want



You don't have to compromise with quality to get the carbon controls your application requires. For Mallory Controls are available in a complete range of constructions, including single, dual concentric and dual tandem types . . . with or without switch.

Their noise level is unusually low, resistance values are unusually stable, and humidity drift is held to 10% . . . thanks to carbon elements with a high degree of surface smoothness and unusual density. Switches are built for long, trouble-free service, with special silver contactors and heavy gauge terminals.

Mallory Controls are built with ample ruggedness to stand any production line handling. They incorporate such mechanical features as welded assembly, vibration-proof clinched terminals, and heavy gauge fastenings.

Write today for the new catalog that describes all Mallory fixed and variable resistors . . . including both carbon and wire-wound types.

CUSTOM-BUILT CONTROLS

The control illustrated is typical of the many special types which Mallory manufactures. Designed for service adjustments in television receivers, it is a tab-mounted, bushingless model with a phenolic shaft . . . for especially economical mounting.

We'll be glad to consult with you on any special adaptations to fit your individual resistor requirements . . . also, to analyze your circuits for opportunities for resistor cost reduction.

Expect more . . .
Get more
from P.R. MALLORY & CO. Inc. **MALLORY**

Parts distributors in all major cities stock Mallory standard components for your convenience.

Serving Industry with These Products:

Electromechanical—Resistors • Switches • Television Tuners • Vibrators
Electrochemical—Capacitors • Rectifiers • Mercury Batteries
Metallurgical—Contacts • Special Metals and Ceramics • Welding Materials

P.R. MALLORY & CO. Inc.
MALLORY
P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

electronics

W. W. MacDONALD, Editor

SEPTEMBER • 1954

CROSS TALK

► **WIRING . . .** As predicted, there has been a pronounced upturn in the use of mechanized wiring. Oddly enough, instrument makers are setting the pace, with more of them introducing it in new models than makers of mass-produced radio and television sets. Here, users tell us, are some reasons why:

Mechanized wiring reduces the possibility of expensive errors in the assembly of highly complex and delicate gear. Fixed dressing of leads permits the omission of certain component parts. It reduces the number of adjustments that have to be made on final test and simplifies calibration. Last but not least, it insures ruggedness in the field and reduces maintenance requirements.

► **MEDICINE** . . . Several people have traveled far out of their way recently to ask if we have heard of an electronic device designed to diagnose a wide variety of physical ills. We have indeed heard of such a device, for which very broad claims are made, but do not have sufficient information concerning it for evaluation. Nor do we know of anyone who does have sufficient information, engineer or medic.

A number of electronic devices have proven themselves effective in the hands of experienced diagnosticians, the most obvious of them being the fluoroscope, x-ray and electrocardiograph. Therapeutic usefulness is attributed in various degrees to such devices as diathermy and so-called shock-treatment machines. Certainly electronics will contribute heavily to the science of medicine in the future, in research, in diagnosis and perhaps even in therapy. But it should be noted that the devices specifically mentioned here perform highly specialized functions.

Nothing, not even electronics, promises a diagnostic much less a therapeutic cure-all.

► **TRANSISTORS . . .** Transistors are now being made in sufficient variety to make it clear that there may some day be as many different types as there are tubes.

Some effort is already being made within individual plants to avoid producing transistors with only slightly different characteristics. Several industry committees are trying to avoid a future log-jam by early standardization.

We have it on good authority that the basic difficulty at this time is due to inadequate knowledge of proper test procedures. A government bureau is working on the problem and may come up with some answers before the end of the year.

► **NOT BREAD ALONE . . .** Engineers move for money. But that bait is no longer enough; there are many fishermen.

Two phrases currently appearing in the technical help-wanted ads should bring bites. The first angles for "engineers who won't be held back." The second dangles "important engineering freedoms."

► **PLANT CURIOS . . .** In a factory devoted largely to the manufacture of airborne radar antennas the employees have apparently grown so accustomed to using magnesium that this extremely lightweight metal was more or less automatically used to make wedges employed as office doorstops. . .

A luggage manufacturer who makes waterproof cases for electronic equipment tests each one by shoving it under water heated to 160 degrees for several minutes to build up internal air pressure, then checking for leaks with a brush and soapsuds in a manner similar to that used by the corner gas station to find pinholes in innertubes. . . .

Highlight of a safety-poster competition for the children of employees in a western tube plant was one small fry's artistic effort, which pictured many little round red objects falling to the ground. The caption read "Beware of Apple Trees!"

Gravity method of geophysical exploration. Operator, left, is using a portable gravity meter, while jeep driver, right, keeps track of crew's location with odometer

Electronics in the

Increased quantity and quality of petroleum products result from use of electronic equipment for instrumentation, radiolocation, communications and automatic control. Applications are found in geophysical exploration, drilling, pipelining, refining, research and development, and marketing

By JOHN M. CARROLL *Associate Editor,* ELECTRONICS

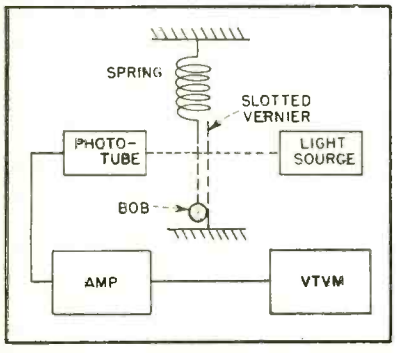


FIG. 1—Schematic of modern gravity meter. Sensitive photoelectric vernier permits measurement of minute changes in the earth's gravitational field

FROM THE DISCOVERY of crude oil to the marketing of refined products, electronics is important in the oil industry.

Geophysical instruments and radio navigation equipment make possible the discovery of new oil resources. Well-logging equipment aids in efficient exploitation of oil fields. Microwave and mobile radio both play important roles in pipeline operations, while oil refineries and development laboratories employ many electronic instruments and automatic control devices. In marketing, electronics enters the picture through use of two-way radio.

The petroleum industry is the fourth largest American industry, with $40 billion in gross assets and 1,700,000 employees. It is numbered among the growth industries from which great things are expected in the future.

Geophysical Exploration

Location of oil deposits by geophysical exploration involves the study of the physical character-

Seismic crew, left, unpacks portable amplifiers while operator, right, inserts photographic paper leader into recording oscillograph that is fed by the geophone amplifiers

Oil Industry

istics of subsurface formations. Four general methods of geophysical exploration involve (1) study of the earth's gravitational field within the area of interest, (2) study of the earth's magnetic field, (2) seismic study of the elastic properties of subsurface formations, and (4) the study of electrical properties. In 1953, 1,307 wells were geophysically surveyed.

Of these four techniques, the first three comprise the primary methods of petroleum geophysics. As of Dec. 31, 1953, 615 seismic crews, 87 gravity crews and 3 magnetometer crews were known to be in the field in the U. S. Electrical methods are of considerable importance in mineral exploration, but have had limited applications to date in petroleum exploration.

A fifth method of geophysical exploration involves study of the radioactive characteristics within the area of interest by use of scintillation counters. This method has so far attained more prominence in the field of well-logging than in field exploration.

Gravity, Magnetic, Electrical

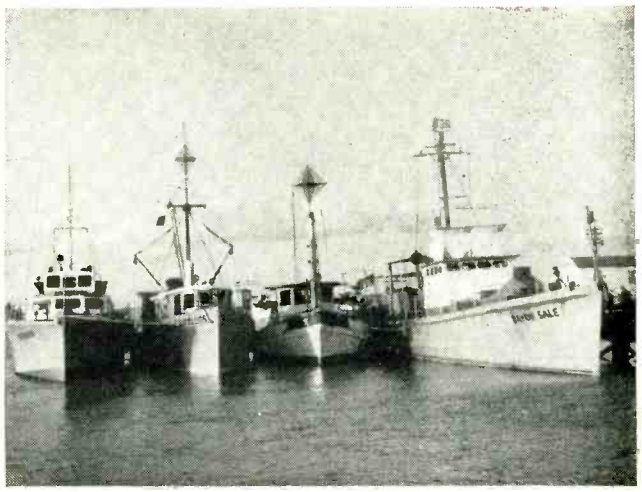
The gravity method of field exploration entails taking gravity-meter readings at various points. The modern gravity meter measures the earth's gravitational field by the deflection of a spring-suspended bob. A photoelectric vernier of the type illustrated in Fig. 1 may be employed to read minute variations in spring deflection. A photograph shows the use of a portable gravity meter in the field.

Magnetometric field survey requires taking a number of precise measurements of the earth's magnetic field from point-to-point within the area of interest. The ground magnetometer commonly used is highly portable and set up like a surveyor's transit.

In areas where it would be difficult or impossible to operate a ground magnetometer crew, or in surveying operations where a rapid reconnaissance is required, the airborne magnetometer (ELECTRONICS, p 143, Oct. 1953) may be employed.

In field surveying it is important that the crews know their location precisely at all times. Survey jeeps are often equipped with odometers (ELECTRONICS, p 94, Nov. 1944) to determine location. In this device the pointer is moved north to south and east to west, and is geared to the jeep's transmission. Over a several mile survey, this instrument is accurate to about 100 ft.

There are two methods of electrical field surveying: the study of the reflection of radio waves set up by a discontinuity in the subsurface rocks; and the telluric



Seismographic operations in the Gulf of Mexico. Radar ship, left, keeps track of other ships in fleet. Target antennas mounted on ships anchored, right, provide positive radar identification

method that involves measurement of earth currents.

Seismic Methods

The seismic method is most widely used in present-day exploration. Electronic seismographs and special radio links were used when a-m broadcasting was in its infancy.

This method involves study of the seismic echoes reflected from geophysical interfaces in subsurface formations, or from geological beds. The seismic waves are generated by exploding a charge of dynamite in a shot hole.

The seismograph, which is generally truck mounted, records three quantities of interest: shock moment, or the exact time that an interruption of electrical current fires the charge of dynamite; the up-hole time or instant the elastic disturbance reaches the top of the shot hole; and the relative times at which echoes are received by pick-up devices called geophones.

Geophones are located on the earth's surface at some distance from the shot hole. The shot instant and up-hole time may be transmitted to the seismograph console by either land line or radio link.

Voice communication is also necessary to coordinate operations between recorder and shooter. This involves distances from a few thousand feet to ten or twelve miles. A seismic crew operating in off-shore waters may make extensive use of ship-to-ship and ship-to-shore radio for coordination.

The geophysical seismograph system consists essentially of three units. First is a detector, some type of geophone that is used to pick up the vibration at the earth surface. In land operations the geophones used are generally of the moving-coil type, while for underwater exploration crystal geophones are often employed. Second unit is an amplifier, while the third is the oscillograph to record the oscillation. The modern truck-mounted seismograph often has 24 channels.

The amplifier is the heart of the seismograph. The range of seismic frequencies is from 5 to 1,000 cps. Most of the useful reflection energy is contained in the band of frequencies extending from 20 to 100 cps. The first requirement of a geophysical amplifier is that it be flat within 3 db down to 5 cps.

All 24 amplifiers used in a truck-mounted seismograph must match with time differences between them of less than one millisecond. In audio work, component differences of 10 to 20 percent from rated values may be used without altering operation, but in seismic work tolerance requirements on the components are 1 to 2 percent. Seismic amplifiers have an overall gain of about 120 decibels, although only a small portion of this gain may actually be used.

The amplifiers are commonly R-C coupled and consist of three or more stages. Important is the input transformer that matches a 500-ohm geophone to the high-impedance grid circuit of the first tube.

Capacitances in the order of 25 to 50 microfarads are required for cathode by-pass to reduce attenuation and phase shift. Bias voltage may also be obtained from flashlight or specially constructed dry cells. In the circuit shown in Fig. 2, both battery and self bias is employed.

Filtering

A certain amount of filtering is usually done in seismic amplifiers. Equipment is usually peaked in the 20 to 80 cps range to take advantage of the predominant frequencies of the reflections and reduce interference. Low frequencies of from 5 to 20 cps may be filtered by a high-pass filter. However, the high-pass characteristics in the transformers, coupling capacitors, cathode capacitors and screen by-passes can accomplish the same result. High frequency interference caused by wind, hole blow or other high-frequency sources may be eliminated by low-pass filters. An automatic-gain-control circuit is incorporated to prevent excessive amplitudes and to balance all traces to the same order of magnitude. The agc should hold the signal nearly constant over an input signal range of at least 1,000 to 1.

Vacuum tubes used in the seismic amplifier shown are of the 12-v miniature type. They are provided with a center-tapped heater that permits operation from either 6.3 or 12.6-v supplies. The transformers used have windings of the humbucking type and are hermetically

sealed. The input transformer has a response not more than 1 db down at 2 cps and flat from 10 to 1,500 cps. It is shielded to reduce 60-cps hum pickup approximately 120 db.

Oscillographs used for recording are frequently of the optical type in which a beam of light is deflected across the surface of a photosensitive paper chart. A recent development has been the use of magnetic recording in seismic operations. Many times it is physically impossible or economically impractical to obtain a number of shots from one hole. It is advantageous in such situations to record a seismic record on magnetic tape, enabling the operator to play back the record at a later time under controlled conditions.

Radio Location

Electronic equipment for radio location is particularly important in off-shore exploration and drilling operations. Radio location methods include use of radar, shoran and phase comparison systems including Raydist, Lorac, loran and Decca. Radar is often employed by waterborne seismic crews.

In the Gulf of Mexico, radar is used to determine the position of geophysical survey boats, as a harbor-surveillance device in marine drilling operations and for detecting changes in weather, such as line squalls or hurricanes. In 1953 some 26 radars were licensed to geophysical operators.

Parenthetically, the use of maritime radio and radar by the oil industry is also important. The tanker fleet consists of nearly a thousand ocean-going vessels of 2,000 gross tons or more. The industry has over 2,000 tank barges.

Shoran

The shoran system developed for aircraft guidance and precision bombing is in use in operations involving the airborne magnetometer and in water-borne operations on the continental shelf. Operations are conducted in the microwave band.

The transmitter sends out a short pulse that triggers an auxiliary transmitter. The beacon pulse is received at the base station and the distance to the object carrying it determined by the time delay between the original pulse and the pulse from the beacon. There are 32 shoran transmitters licensed to operate in the United States. These are operated by four companies, two oil companies and two service companies providing either radio surveying or complete geophysical service.

Two service companies now offer radio location service based on phase comparison methods. Four networks have been licensed covering 275 miles along the Louisiana and Texas coast. Companies are the Hastings Instrument Co. who offer the Raydist service and Seismograph Service Co., offering the Lorac service.

Of the various types of Raydist, the type N system is generally used in geophysical work. This system requires only two narrow-band frequency assignments in the middle or low-frequency bands. The system is unsaturable. Any number of ships or vehicles can obtain position-fixing data simultaneously and continuously. It is illustrated in Fig. 3.

The heterodyne principle is used. The two transmitting stations have a frequency difference of about 400 cps. Position is obtained by comparing the phase of the heterodyne signal received directly at the

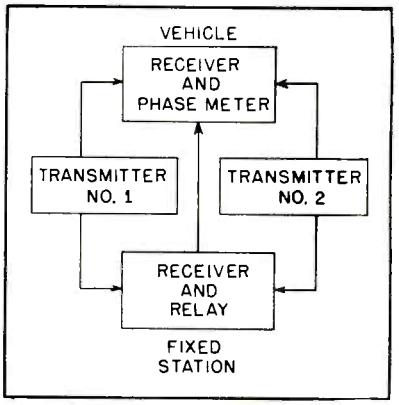


FIG. 3—Functional representation of c-w phase comparison system used for radio location in offshore exploration

vehicle with the phase received at the fixed station and relayed to the vehicle. The system is hyperbolic; the line-of-position pattern is a family of hyperbolas established between pairs of fixed transmitters that are foci of the hyperbolic grid. Frequencies used for this service lie in the band from 1,750 to 1,800 kc and ranges up to about 100 miles from the coast are obtained using transmitters of less than ½-kw.

An additional use of electronic equipment in radio location is that of radar altimeters in airborne topographical survey work. The final electronic application in exploration is frequently the use of electronic computers to solve field

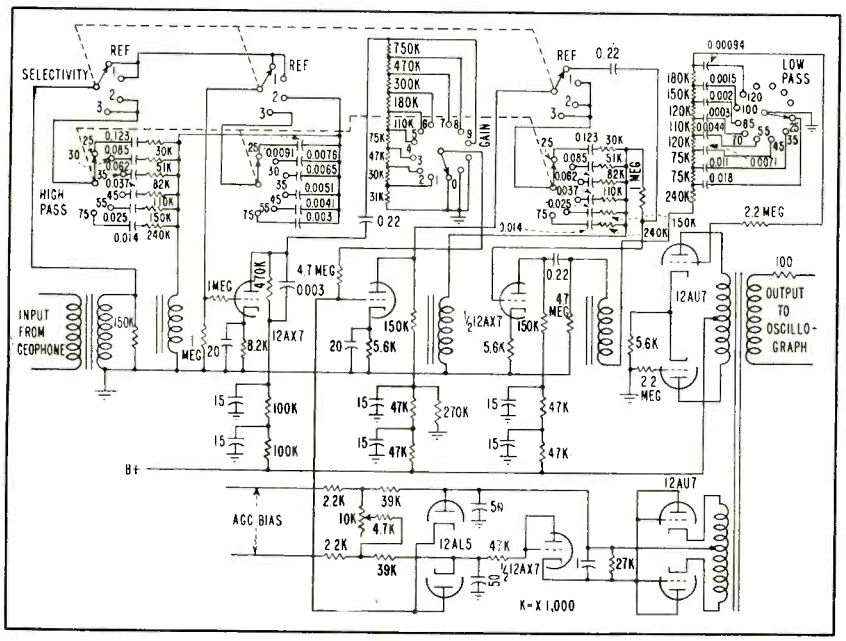


FIG. 2—Schematic diagram of a modern seismic amplifier. Instrument provides an overall gain of 120 db and responds to frequencies from 10 to 100 cps

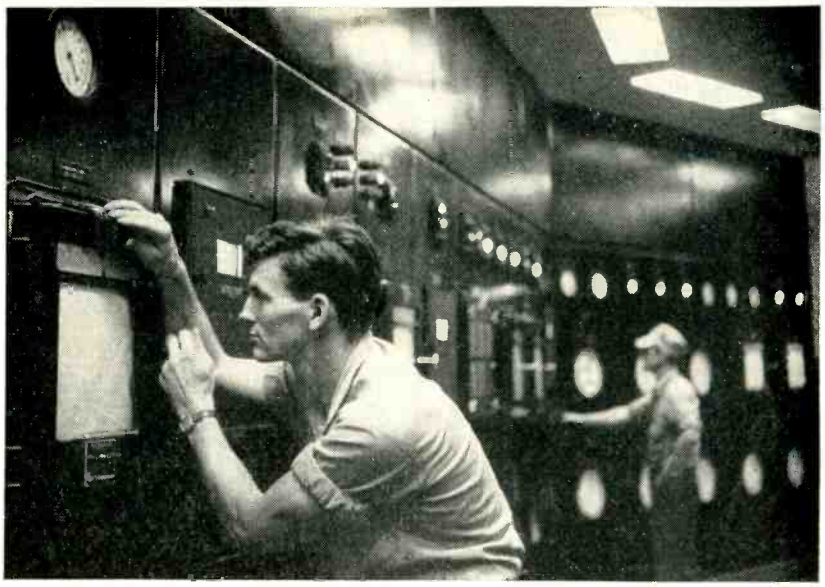
problems. Both digital and analog machines are used.

Well Logging

During the past 20 years electrical well logging has become widely accepted as an important tool in the search for and production of oil and gas. Electrical log is a measurement of the spontaneous potential and the resistivity of earth formations forming the sides of the bore hole to the flow of electric current.

Measurement of these quantities provides a record of the formations traversed by a drill and may give information regarding the fluid content of reservoir rocks. The technique requires direct contact with the mud filling the bore hole by electrodes connected to insulated conductors of the supporting cable. A constant current is made to flow in the surrounding medium and potential differences proportional to the average resistivity are picked up by one or more measuring electrodes in the bore hole and recorded continuously at the surface of the ground, giving a resistivity log.

Where direct contact between electrodes and drilling mud is not possible as in holes drilled with cable tools or holes where nonconductive oil-base mud is used in rotary drilling, the electrical logging method requires the use of scratcher electrodes. For such cases the technique of induction logging has been introduced. An alternating current is made to flow through a coil that is referred to as the transmitter and is supported on an insulated mandrel. The alternating field generates eddy currents that flow in circular paths coaxial with the coil system in the formation surrounding the hole.



Control panel in fluid catalytic cracking plant. Electronic equipment contributes to automatic operation of giant refineries

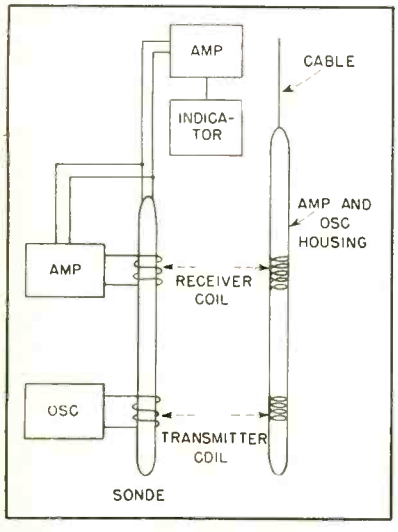


FIG. 4—Sonde used in inductive well logging. Schematic diagram, left, gives electrical characteristics. Drawing, right, is a physical representation of instrument lowered in well hole

These eddy currents create a secondary magnetic field which induces an electromotive force in a second coil or receiver mounted on the nonconductive mandrel a certain distance from the transmitter. The conductivity of the ground determines the secondary field created by the eddy currents and the signal generated in the receiver. The signal is recorded continuously at the surface while the apparatus is moved along the hole. The equipment setup for induction logging is illustrated in Fig. 4.

Seismic velocity measurements made in oil wells can be used as a geophysical tool. Two pickups are spaced one foot apart, thus differences in travel time from the sound source to pickups will vary from 50 to 200 microseconds for the normal range of velocities in earth.

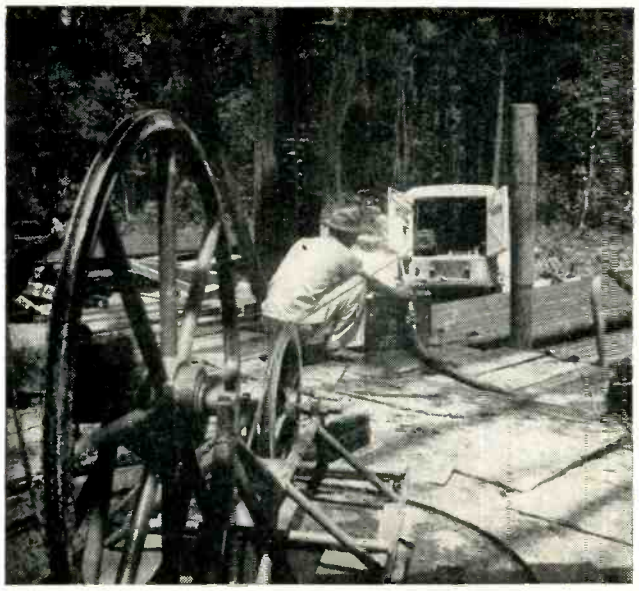
The sonde, or the device which is lowered into the well to depths of 15,000 ft or more, must contain much electronic equipment, including power supply for the sound source, amplifiers and a timing device to determine differential travel time over the one-foot space between pickups. All of this is contained within a cylinder of maximum diameter of 4½ in. capable of withstanding pressures in excess of 6,500 lb per sq in. and temperatures above 250 F.

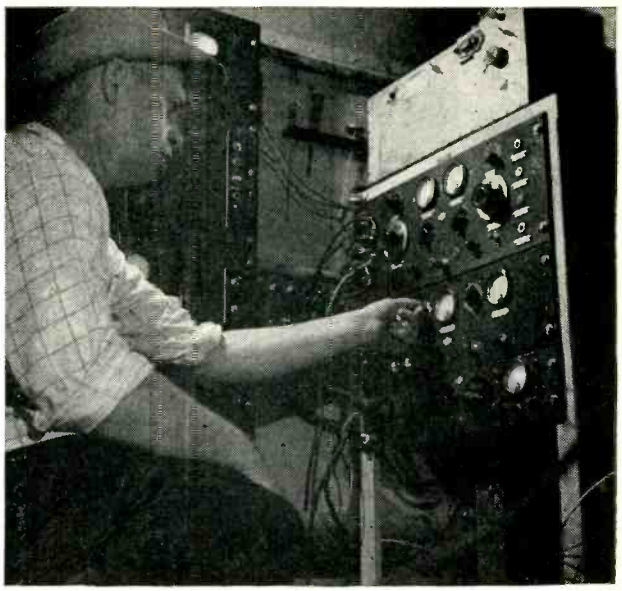
Radioactive Logging

The atomic nuclei of certain elements are unstable. They decay and form atoms of lighter but related elements. During the process of disintegration usable energy is released as alpha and beta particles and gamma rays.

Geologists have found a record of gamma radiation intensity from minute quantities of radioactive material along the bore hole a clue to the geophysical structures traversed during drilling. Thus, radioactive well logging has recently come into prominence. Gamma rays originating in rock impinge upon an ionization chamber. The voltage proportional to the current caused by ionization of the gas by gamma rays is delivered to a preamplifier. The signal is then transmitted over an insulated cable to the surface where it is further amplified and recorded by an automatic pen recorder on the panel of the instrument truck.

Gamma-ray logging does not depend upon the electrical induction properties of the bore hole. Unlike





Hoist, left, lowers sonde into bore hole while operator, right, monitors instrument panel in truck containing the electronic instrumentation for analyzing results

inductive logging, it is not affected by the presence of metallic casing in the hole, thus a well that has already been cased may be surveyed by the gamma-ray method. Often such surveys reveal that oil-bearing rock has been by-passed in the drilling process.

Neutron Instruments

A second method of radioactive logging is neutron logging. A neutron source and an ionization chamber similar to the one used in the gamma-ray instrument are combined in a single device. Fast neutrons produced by the source collide readily with atomic nuclei in their path. As a result gamma rays may be emitted. These artificially stimulated gamma rays are measured by the ion chamber.

Where hydrogen exists in the formation, neutrons are slowed up near the source. This reduces the number of neutrons available for capture, thus the neutron curve is highly responsive to the presence of hydrogen in the formation and gives an indication of the fluid content of the bore hole.

Other instruments used in well logging include the collar log, the photoclinometer and the dip meter. Once a casing is set and cemented, the electrical collar locator may be used to establish a relationship between the casing collars and the formations through which the well was drilled.

The collar locator consists of a set of springs held in contact with the side of the casing. When a collar is encountered an electrical impulse is generated which is passed through the amplifier to actuate the recording pen and indicate the collar location. The photoclinometer is a magnetic directional surveying instrument that enables the operator to obtain a fast and accurate record of the deviation and direction of deviation of a bore hole from vertical, while the dip meter is used in conjunction with either resistivity or spontaneous potential measurements to obtain information regarding formation slope and its direction.

Pipelining

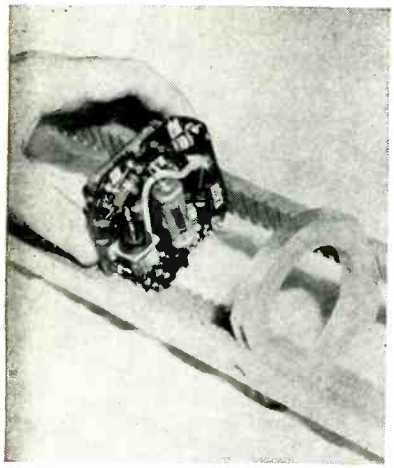
Pipelines that carry natural gas, crude oil and refined products are in themselves an industry of considerable size. During 1950 oil pipelines accounted for 12.7 percent of all intercity freight traffic, both public and private. By the end of 1953 327,063 miles of oil and gas transmission, field and gathering lines were in operation. The need for communication along these extended right-of-ways has brought about one of the largest applications of electronic equipment in the oil industry, privately owned microwave radio-relay facilities.

There are at present 20 such systems in operation covering 10,679.2 route miles. The largest system now in operation is the Transcontinental Natural Gas pipeline which extends for 1,668 miles between Houston, Texas, and Newark, New Jersey. The system alternates between frequencies of 1,905 and 1,855 mc.

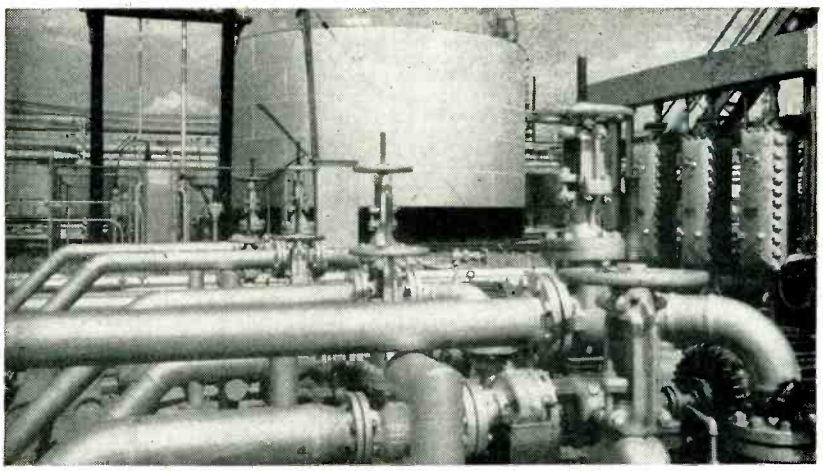
It consists of 47 microwave terminals, 19 compressor stations, one regulator station and two headquarters. The system utilizes pulse-position modulation to achieve eight voice channels. In addition, Transco maintains 161 mobile vhf stations, each equipped with a 50-w f-m transceiver operating on 48.74 mc. Each of the 19 compressor stations has a 250-w f-m transmitter and controls from 5 to 20 mobile stations. These mobile stations located in cars used by maintenance personnel greatly facilitate operation along the pipeline system.

Station Details

Each station provides a 20-watt output and a one-half microsecond pulse is used for signaling. One voice channel between Newark and Linden has recently been devoted to an experimental photofacsimile service. An important trend in pipeline operations has been increasing use of supervisory control and telemetering to run compressor stations unattended. One such setup is installed on the Plantation Pipeline Co.'s north branch line, Bremen, Ga., to Knoxville, Tenn. Two new booster stations will be



Closeup of sonde used in seismic well logging shows construction details



Explosion-proof housings, right, contain relays used in remote control of the refinery pumps in the foreground

operated over microwave from attended stations.

Plantation's 2,000-mc microwave system comprises two terminal stations and five repeaters covering a distance of 156 route miles. Aside from supervisory control and telemetering, the system provides for party-line telephone communication between four pumping stations as well as a service channel with telephone at each radio equipment location and an alarm indication at Bremen for faults throughout the microwave system.

Standby generators at each station are arranged for remote test starting from Bremen weekly with a minimum run of 20 minutes. This is accomplished over the microwave system and an indication of operation provided at Bremen. The supervisory control is centered on a diagram panel at each controlling station. The panel contains three indicators for continuously telemetered pressure—pump suction and pump discharge on outbound lines—and also a recorder for telemetered flow.

Instrumentation is actuated by an electrical strain-gage cell. The voltage from each cell bridge is amplified for actuation of a local pressure indicator with an intermediate output through the pressure telemetering transmitter. Flow measurement is by differential pressure across an orifice on the discharge side of the pump, similarly telemetered through a flow recorder at the controling station.

For protection of centrifugal pumps in event of roughness an acceleration mechanism responds to vibration at the frequency of pump speed to close a tripping contact when a predetermined amplitude is attained. Another innovation is the use at each remotely controlled station of two induction type detectors to signal the approach and departure of a line scraper commonly called a pig.

To prevent the pig from lodging where the station suction piping takes off from the main line, the incoming detector installed upstream from this point shuts down the station as the pig passes.

Refined products lines in which several different products may be transmitted sequentially find an additional use for electronic equipment. Radioactive isotopes are injected in small quantities and their passage monitored by radiation detection equipment. This enables operators at the receiving end to tell when a different product begins to flow. The Salt Lake Pipeline Co. pioneered this technique.

Oil Refining

In the refining of petroleum for the manufacture of petrochemicals four variables are of prime importance. These are temperature, pressure, rate of flow and liquid level. Electronic equipment has been devised to measure each of these four variables and feedback control techniques exist such that each one can be brought under automatic process control if so desired. The oil industry has, however, been generally conservative about adopting electronic equipment in process control.

Electronic instrumentation is of prime importance in the measurement and control of temperature. Here the equipment used is the standard junction thermocouple used in conjunction with appropriate electronic amplifier channels. In many chemical processes in petroleum refining temperature is the variable of greatest importance. The fine control made possible by use of junction thermocouples has made improved varieties of refined products a reality.

Since many refinery operations are conducted in an explosive atmosphere electronic equipment, if used, must be mounted in explosion-proof housings. These housings may be dome-shaped and made from cast iron or cast steel. Where two halves for the housing are fitted together the housing is equipped with a wide flange so that if combustion occurs within the housing the hot gases will have cooled before they reach the explosive atmosphere on the outside.

Such exposion-proof housings are characteristically hard to ventilate. This often has the effect of shortening the lives of electronic components. Safety rules in oil refineries generally require that operations be shut down when any of the explosion-proof housings are to be opened.

Many interesting applications of electronic equipment in refinery operations involve the use of radioactive tracers. A small quantity of radioactive isotope may be introduced into the flow system of the catalytic cracker. Two sets of Geiger tubes spaced 25 to 50 ft apart along the catalyst standpipe

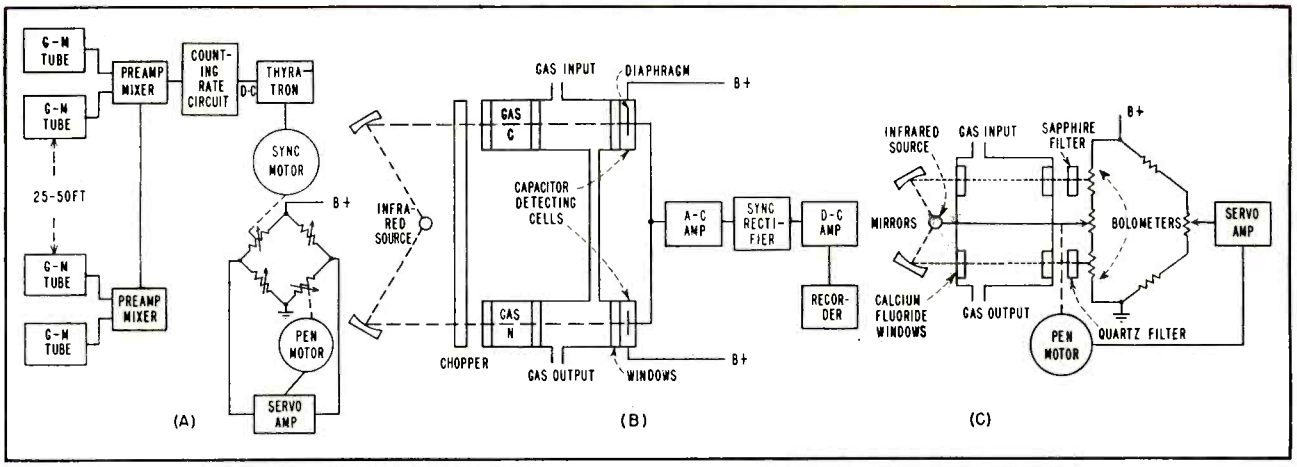


FIG. 5—Process control instrumentation designed for the petrochemical industry. Radioactive flowmeter (A) monitors descent of catalyst in cracking tower, while infrared analyzers (B) and (C) continuously monitor carbon-dioxide content of plant gases

can then determine the time required for a radioactive pellet to pass between them. This time is fed into a computer, which is also fed the density of the catalyst, and the result is a plot of tons per hour of circulation. This system is illustrated diagrammatically in Fig. 5A.

Continuous rapid analysis of plant streams may be had by use of a recording infrared analyzer. See Fig. 5B. Absorption of infrared radiation by gases depends upon their molecular structure. Gases such as nitrogen, oxygen, hydrogen and noble gases which either have homoatomic molecules or are monoatomic show no absorption of infrared radiation, while gases such as carbon dioxide, carbon monoxide, and the hydrocarbons strongly absorb infrared.

This detector for an infrared analyzer can consist of a sealed chamber filled with a pure sample of the gas to be measured and provided with a window to admit infrared radiation, and a sensitive microphone to detect small pressure changes in gas.

Another type of infrared analyzer, Fig. 5C, is the double-beam differential photometer type. Dual infrared beams are transmitted through two sections of the sample cell which is equipped with calcium chloride input windows. The output window of one section of the cell is of sapphire, and the other output window is of quartz. Bolometer elements forming arms of a temperature measuring bridge are mounted behind the two output windows. A high-gain servo amplifier operates a slide-wire potentiometer to restore bridge unbalance and the shaft motion is passed to a recording pen. If the bridge is balanced against a standard sample of gas containing a known amount of carbon dioxide the carbon dioxide content of an unknown gas may be recorded continuously by recording the bridge unbalance caused by a different degree of absorption of infrared energy passing through the quartz filter.

Tank Farms

Operators of tank farms in which petroleum products are stored find it necessary to know the liquid level in all the various tanks of the field. Measuring liquid level by the dip stick can be a tedious and time-consuming chore in a large tank farm. Likewise, there is a certain hazard from explosive fumes when the tanks are open. Two electronic devices have been developed to measure liquid level in tanks. One (ELECTRONICS, p 156, Apr. 1954) involves placing a sonic transducer at the bottom of the tank and measuring depth by the time it takes to receive an echo from the air-liquid interface.

A second method is the radioactive float gage in which a small quantity of radioactive isotope is placed in a float and radiation detection equipment mounted along the side of the tank to determine the level of the liquid.

The author acknowledges the assistance of Midwestern Geophysical Laboratory, the Lane-Wells Co., Schlumberger Well Surveying Corp., National Petroleum Council's Committe on the Use of Radio and Radar, American Petroleum Institute, Standard Oil Co. of New Jersey, and the staffs of the McGraw-Hill petroleum publications.

BIBLIOGRAPHY

Electronics in Oil, ELECTRONICS, p 15, Dec. 1935.

L. G. Howell, Gamma-Ray Measurements in Oil Wells, ELECTRONICS, p 130, March 1944.

F. P. Hochgesang and C. H. Schlesman, Electronics in Petroleum Plants, ELECTRONICS, p 116, Sept. 1944.

Electronic Indicator in Oil Refinery, ELECTRONICS, p 144, Nov. 1944.

Acoustic Oil Well Sounder, ELECTRONICS, p 150, Sept. 1948.

Radio Isotope Applications in Refining, ELECTRONICS, p 93, Jan. 1949.

Radio Aids in Oil Prospecting, ELECTRONICS, p 70, Aug. 1949.

Survey of Electronic Applications in Petroleum, ELECTRONICS, p 77, Oct. 1949.

A. A. McKenzie, Vehicular Communications Symposium, ELECTRONICS, p 200, Feb. 1953.

S. Kaufman, Analog Computer Solves Geophysical Problems, ELECTRONICS, p 174, June 1953.

Harold Mooney, Magnetics in Geology, ELECTRONICS, p 143, Oct. 1953.

R. L. Rod, Ultrasonic Liquid Level Indicator Systems, ELECTRONICS, p 156, Apr. 1954.

F. W. Littell, "Report of the National Petroleum Council's Committee on the Use of Radio and Radar," Washington, D. C., May 28, 1953.

Merritt Hyde, Electricity's Contribution to Modern Pipelining, *Westinghouse Engineer*, p 154, Sept. 1953.

H. G. Doll, Introduction to Induction Logging and Application to Logging of Wells Drilled with Oil Base Mud, *Journal of Petroleum Technology*, p 2, June 1949.

E. J. Handley, How Magnetic Recording Aids Seismic Operations, *The Oil and Gas Journal*, Jan. 11, 1954.

J. M. Benson and J. E. Swafford, Raydist Systems for Radio Location and Tracking, *Electrical Engineering*, p 983, Nov. 1953.

E. J. Handley, Control of Variables in the Observation of Seismic Echoes, *World Petroleum*, March 1952.

V. N. Smith, A Recording Infrared Analyzer, Paper delivered to Conference of the ISA, Sept. 1952.

K. V. Kratochvil and D. E. Berger, Analytical Control of Butylene Dehydrogenation Catalyst Regeneration with Phillips Automatic Infrared Analyzer, Paper presented to Conference of ISA, Sept. 1952.

Jerome Kohl, Check These Uses for Radio Isotopes, *Petroleum Refiner*, Nov. 1952.

Color Video Tester

By H. P. KELLY
Bell Telephone Laboratories
Murray Hill, N. J.

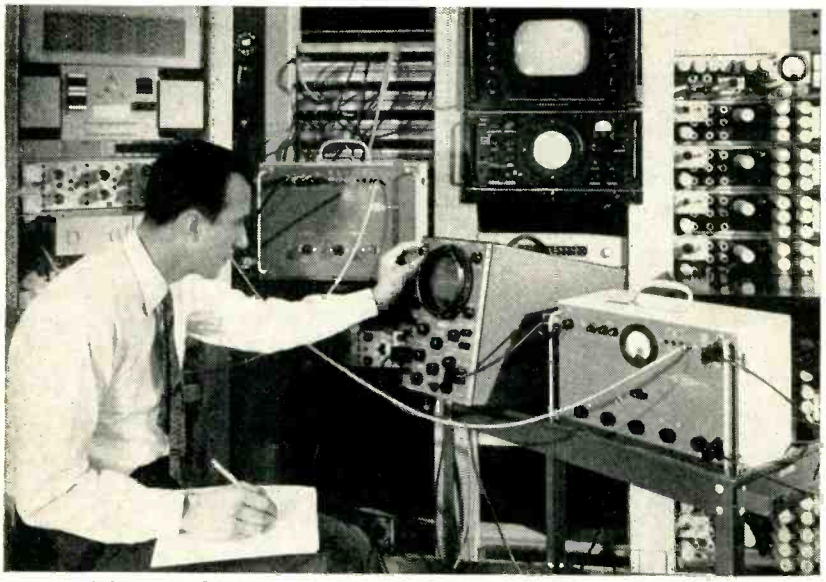


FIG. 2—Schematic diagram of a modern seismic amplifier. Instrument provides an overall gain of 120 db and responds to frequencies from 10 to 100 cps

COLOR TELEVISION signal transmission circuits must meet stringent linearity requirements. Minimizing differential phase and gain at the color carrier frequency is one important new consideration.

Color Information

In color television, saturation and hue information are added to the luminance information by means of a color carrier.[1] The amplitude of this signal represents color saturation. Large amplitude represents high saturation or a brilliant color. Distortion of color saturation will occur if the gain of the transmission system to the color carrier is different for different amplitudes of the luminance signal.

Such variation is called differential gain. Presence of differential gain in a system used to transmit color television may result in a picture in which some colors appear dim or washed out while others appear oversaturated.

The time or phase relationship of the color carrier signal to a reference synchronizing signal (color burst) determines the hue of the color. Distortions of hue will occur if the transmission system produces a different phase shift in the color carrier at different amplitudes of the luminance signal. Such variation in phase shift is called differential phase. Presence of differential phase in a system used to transmit color television results in a change in the hue of the colors.

The term differential gain was first proposed by S. Doba. The measurement method suggested here is one of several[2] that might be used to measure differential phase and gain. It was selected as giving the desired results quickly and accurately.

Practical measurement equipment comprises a portable transmitter and portable receiver. The transmitter generates a simulated color-television signal, which is connected to the input of the system under test. Output signal from the system is examined by the receiver to determine if it has been subjected to differential phase or gain.

Portable Equipment

Transmitter and receiver are physically independent of each other. The only connection between them is the circuit being tested. This independence is necessary since video circuits within a studio-control room complex or between studio and distant transmitter may be hundreds of feet or miles apart.

A simplified block diagram of the system is shown in Fig. 1. The transmitter consists of three major parts: a luminance (black-and-white) signal generator, a sync-pulse generator and a constant color carrier generator. The luminance signal generator is a 15.750-kc sine-wave oscillator. Amplitude of this signal can be adjusted to represent a full range of luminance from dark to bright. Sync pulses are derived from the negative peaks of the luminance signal so their positioning on the negative peaks is automatic.

Color Frequency

The color carrier generator is a 3.579545-mc crystal oscillator. Its output represents a constant hue and saturation signal. These three signals are combined at the output of the transmitter. The signal sent into the system under test consists of a constant color carrier signal superimposed on a luminance signal that is continuously varied over the entire range from dark to bright. The effect of the luminance signal is to change the position of the color carrier in the amplitude range of the transmission system. It is this change in position that gives rise to differential phase and gain.

At the receiver, the luminance signal and color carrier are separated by a filter. The luminance signal is applied to a cathode-ray oscilloscope to produce a left-to-right deflection of the beam. Instantaneous amplitude of the luminance signal is shown from dark level (left) to bright level (right).

The received color carrier has been drawn in Fig. 1 to illustrate the presence of differential gain.

Checks Distortion

Measurement of differential phase and gain on color television transmission circuits is effected with separate portable transmitter and receiver units. Video equipment adjustment using oscilloscope display prevents distortion of colors at broadcast stations

The color carrier signal is split into two paths. A sharp filter in one path removes any variation present and provides an undistorted color carrier signal. This signal is used as a reference against which the distorted signal in the other path is compared in the detector. The function of the detector can be switched for either amplitude or phase comparison.

When differential gain is being

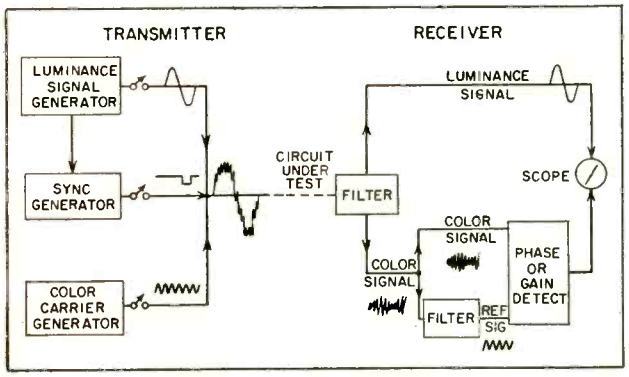


FIG. 1—Complete test system used on color video lines

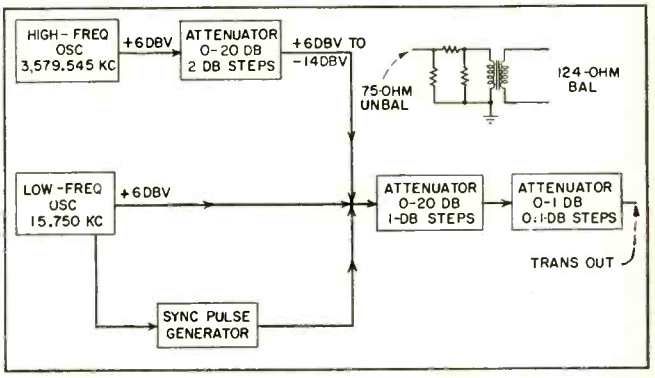


FIG. 2—Detail of sending set shows interconnections and network

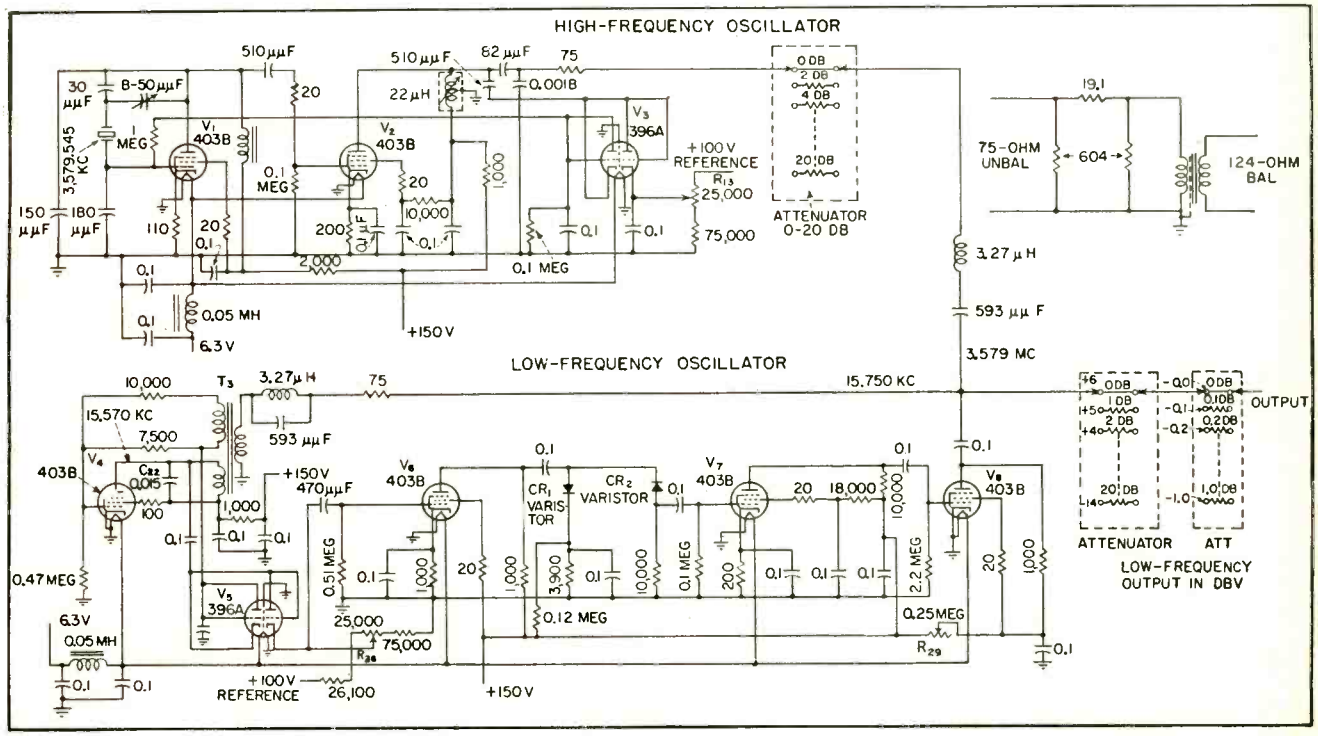


FIG. 3—Circuit diagram of sending set has been simplified by leaving out conventional power supply and plug interconnections. Circuit in upper right adapts unbalanced 75-ohm output to balanced 124-ohm output

measured, the comparison is made on an amplitude basis. The voltage obtained at the output of the detector is proportional to the difference in amplitude between the distorted and reference signals. In a similar manner, when differential phase is being measured, a voltage is obtained at the output that is proportional to the instantaneous difference in phase between the distorted and reference signals.

In either case the output of the detector is applied to the oscilloscope to produce an up-and-down deflection of the beam. The amount by which the beam is deflected vertically is a measure of the amount of differential phase or gain present in the circuit under test. The presentation of the complete measurement is therefore a line on a cathode-ray tube. This might be considered as a graph in which the amplitude of the luminance signal is plotted as a horizontal co-ordinate against differential gain or phase in the vertical co-ordinate. Sensitivity of the measurement is such that the amount of distortion considered just perceptible causes the beam to be deflected vertically one inch. This sensitivity permits measurement and correction for distortions below subjective perceptibility.

Sending Unit

A block diagram of the transmitter unit is shown in Fig. 2 and the complete circuit diagram is given in Fig. 3. The low-frequency (15.750-kc) oscillator circuit comprises V_4, T_3 and C_{22}. Tube V_6 and associated components form a peak-to-peak detector circuit that is used to provide avc for the oscillator. This detector circuit is back biased by a positive d-c reference voltage on the second cathode. So long as the peak-to-peak value of the 15.750-kc sine wave at the plate of V_4 does not exceed the d-c reference voltage on the detector, no d-c output is obtained at the first plate of V_5.

However, when the peak-to-peak value does exceed the reference voltage, a negative d-c voltage is obtained at the first plate of V_5, which is proportional to the amount of this excess. This voltage is fed back as bias to the grid of the oscillator tube and thus tends to limit the output of the oscillator. Potentiometer R_{36} provides a means of varying the reference voltage to the detector and thereby the output of the oscillator. The reference voltage is supplied by a gas tube. Changes in output are held to less than ± 0.1 db for ± 10-percent variations in supply voltages. Frequency accuracy is in the order of ± 1-percent.

Sync Signal

A voltage representing a small portion of the positive peak of the sine wave is obtained at the second cathode of V_5. This voltage is transmitted to the sync generator that comprises V_6, V_7, V_8, CR_1, CR_2 and associated components. The sine-wave tips from the low-frequency generator are amplified and shaped into sync pulses in this circuit. Potentiometer R_{29} provides a means of adjusting the amplitude of the sync pulse output.

The color carrier generator uses a 3.579545-mc crystal oscillator V_1, a buffer stage V_2 and an avc circuit V_3, which is similar in its operation to that described for the low-frequency oscillator. Potentiometer R_{13} permits adjusting the output of the oscillator.

Output of the color carrier generator is transmitted through an attenuator before it is combined with the other two signals. This attenuator establishes the ratio between the high and low-frequency amplitudes. The combined output is transmitted through a pair of attenuators.

These attenuators are calibrated in terms of the low-frequency or luminance signal output and cover a range of + 6 to − 15 dbv in 0.1-db steps. A transformer provides either a balanced 124-ohm output or an unbalanced 75-ohm output.

Receiving Unit

A block schematic of the receiver is shown in Fig. 4. The input filter consists of complementary low and high-pass filters with their inputs connected in parallel. This filter separates the luminance signal from the color carrier signal. The low-frequency luminance signal is obtained at the output of the low-pass section.

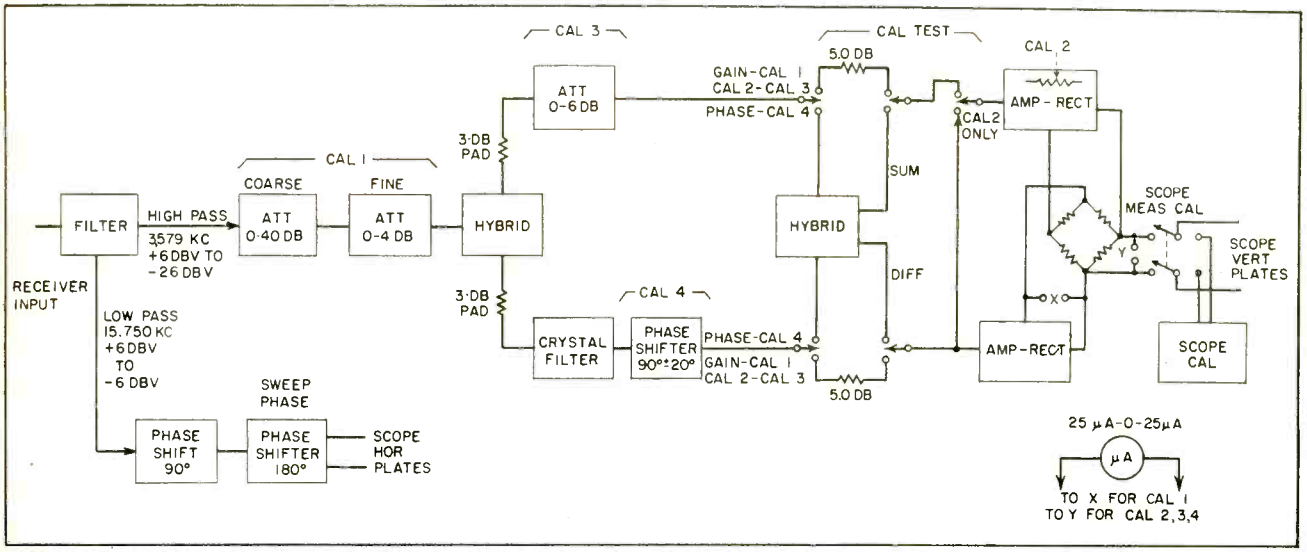


FIG. 4—Interconnections and switching of receiving equipment, shown simplified, include provision for measuring both phase and gain

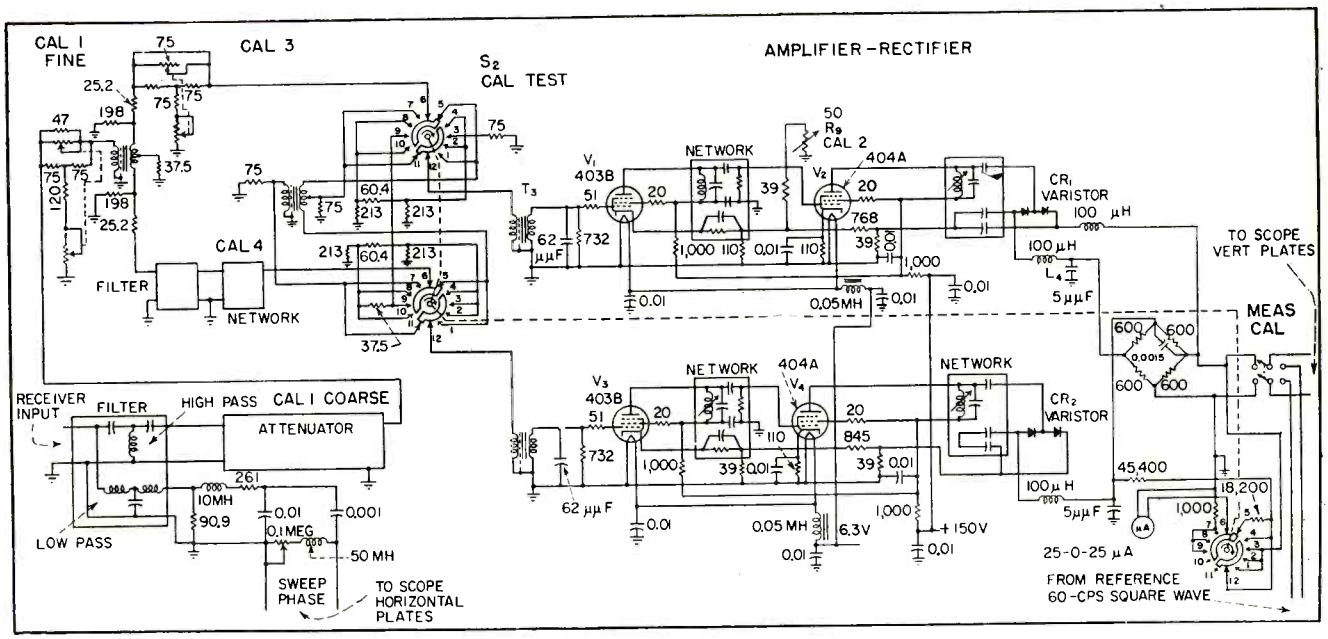


FIG. 5—Power supply and oscilloscope are omitted from the complete circuit of differential phase and gain receiving equipment

The high-frequency color carrier signal is obtained at the output of the high-pass section. A sweep phase control in the luminance signal path adjusts the horizontal sweep so the extreme left-hand end of the oscilloscope trace represents the black level of luminance.

The high-frequency color signal is split into two paths in the first hybrid coil. A sharp crystal filter in one of the paths removes any distortion that might have been produced in the system under test and provides at its output an undistorted reference signal. This signal is used as a reference against which the distorted signal in the other path is compared.

When measuring differential gain, the reference and distorted signals are each connected to the input of the amplifier-rectifier shown in Fig. 5. The rectified outputs are compared in a bridge circuit and a voltage representing their difference is connected to the oscilloscope vertical input. The two amplifier-rectifiers are adjusted to have equal sensitivity by means of R_9 (CAL 2). If at any instant the reference and distorted signals are equal in amplitude, output from the bridge circuit is zero.

Checking Phase

When differential phase is measured, the reference and distorted signals are connected into a pair of conjugate branches of a hybrid coil. The two outputs from the other pair of conjugate branches represent the vector sum and the vector difference of the two signals. The vector sum is connected to the input of one of the amplifier-rectifiers and the vector difference to the other. The outputs are combined in the same manner as for differential gain. The output from the bridge circuit at any instant is proportional to the phase difference between the reference and distorted signals. Zero output is obtained from the bridge when the two signals are 90 degrees out of phase.

The number 1 position of rotary switch S_2 provides the same circuit arrangement as for gain. The CAL 1 controls are used to adjust input level for the proper value of rectified current from the reference signal amplifier-rectifier as indicated by a reading of 20 μa on the panel meter.

The second position of S_2 connects the reference signal to the input of both amplifier-rectifiers. The panel meter is connected to the output of the bridge circuit. Adjustment of CAL 2 control for zero output from the bridge then insures equal sensitivity in the two amplifier-rectifiers.

The third position of S_2 provides the same circuit arrangement as for gain except that the meter is connected to the output of the bridge. The CAL 3 control is then adjusted for equal transmission in the two paths as indicated by a zero reading of the meter.

The fourth position is the same as the phase position except that the meter is connected to the output of the bridge circuit. The CAL 4 control is adjusted in this position to obtain a 90-degree difference in phase shift in the two paths as indicated by a zero reading of the meter.

Each of the two amplifier-rectifier circuits consists of a two-stage 3,579-kc amplifier terminated in a varistor rectifier. Each circuit has approximately 26 db of negative feedback. Since the rectifier circuit is included in the feedback loop, a high degree of linearity and stability is obtained.

This test set provides approximately 50 millivolts to the vertical input of the oscilloscope for 1 db of differential gain or 5 degrees of differential phase. Several oscilloscopes are available that will provide a two-inch vertical deflection for this voltage. A 50-millivolt calibrating signal is available in the receiver for adjusting the vertical sensitivity of the oscilloscope.

References

(1) Donald G. Fink, NTSC Color Television Standards, ELECTRONICS, p 138, Dec. 1953.
(2) W. C. Morrison, K. Karstad and W. L. Behrend, Test Instruments for Color Television, *Proc IRE*, 42, p 247, Jan. 1954.

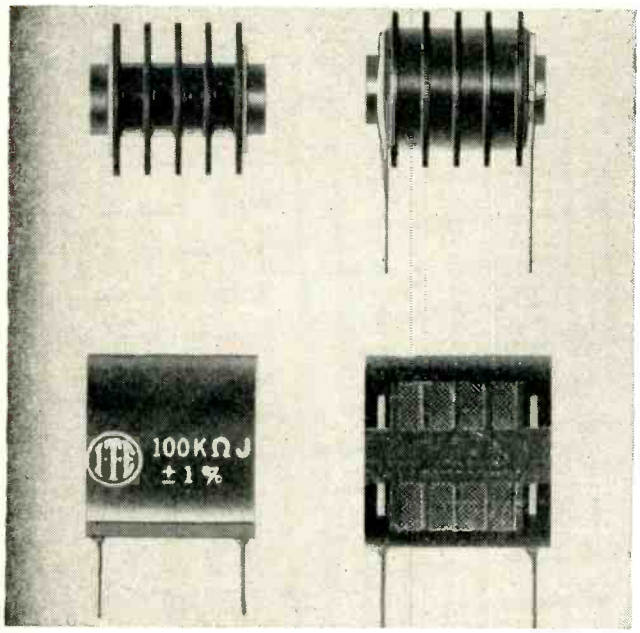
COMPONENT DESIGN TRENDS

Fixed Resistors Show

Part III of a series interpreting recent developments in basic components. Advances in fixed-resistor design emphasize greater stability under adverse environmental conditions. Precision resistors have improved reliability and power resistors provide greater heat dissipation per unit volume

By FRANK ROCKETT

Research and Engineering Division
Airborne Instruments Laboratory, Inc.
Mineola, N. Y.



Construction of ITE precision wire-wound resistors. Bobbin is wound with resistance wire. Entire assembly is then encapsulated in epoxy resin. Cross-section shows internal construction of completed unit

Production-line testing at Daven plant selects resistors within specified tolerance range. Improved fabrication methods have narrowed range of quality variations, producing more accurate resistors at lower cost

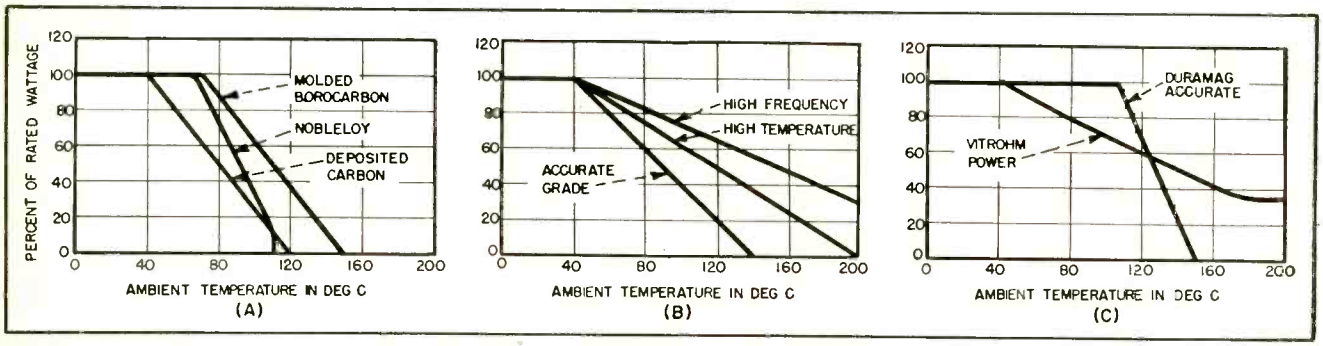


FIG. 1—Derating curves for carbon-film resistors (A), film-on-glass (B) and wire-wound type (C)

Stability Improvements

RESISTORS are probably the most numerous of components in electronic equipment. Composition resistors have been and continue to be the general purpose units. Improved encapsulation protects them from humidity but they are inherently temperature sensitive and noisy.

Boron-Carbon Resistors

For enhanced reliability, pyrolytic carbon-film resistors are being perfected for general use. In one form of film resistor, boron-treated carbon is deposited on a ceramic body to form the resistance element. Initial development by IRC and others indicated that it had a low and positive temperature coefficient and close retrace characteristic suitable for semiprecision low-power units.

A molded phenolic jacket on newer units protects the resistance film from both moisture and vapor and, unlike conventional varnishes, is inert to the film material. These resistance elements have inherently low voltage coefficients of resistance and are manufactured with low contact-resistance terminations. Sprague Electric rates this type resistor for full-load operation to 70 C in contrast to full-load operation to 40 C for earlier types.

The recommended derating for these units is shown by Fig. 1A to be intermediate to that for currently available resistors of representative types. Between −55 C and 105 C their rated temperature coefficient does not exceed 0.01 percent per deg C for units below 20,000 ohms and 0.02 percent per deg C for units above 20,000 ohms.

Depending on resistance and wattage, deposited resistors may consist of a continuous film or of a slightly inductive spiral. For high-voltage operation as in 30-kv supplies for color television receivers, dust precipitators and nuclear electronic apparatus, a widely spaced spiral is applied to the coated ceramic rod to achieve a long resistance path in small space with relatively low voltage per unit length. A unit 5 inches long and ¾-inch in diameter, including cast plastic housing, rated at 5 watts and 30 kv has a minimum resistance of 1 megohm and a rated temperature coefficient of resistance below −0.05 percent per deg C from 25 C to 100 C.

In a similar construction, a metallic Nobleloy film resistor, also formed on a ceramic base but by a pyrochemic process developed by Continental Carbon, provides a unit with a temperature coefficient rated not to exceed +0.05 percent per deg C for units below 1 megohm or −0.08 percent per deg C for units of 1 megohm or over.

A premium version of this resistor has corresponding coefficients rated as +0.03 and −0.05. The units are protected by a rubberized enamel with the result that in manufacturer's tests, units conditioned for 250 hours at 95 percent relative humidity and 40 C show a maximum resistance change of 3 percent with an average change of 2 percent. Recommended derating begins at about 65 C ambient.

Deposited Carbon

Deposited carbon resistors have been improved during the past few years. Units with temperature coefficients comparable to those described above are made by Radell. When tested for military use for a total elapsed time of 1,000 hours at 40 C and rated voltage applied intermittently 1.5 hours on and 0.5 hour off, their resistance change is no more than 1 percent.

Similar resistors produced as precision units have a rated voltage coefficient less than 0.002 percent per volt, with the average coefficient less than half this value. The rated distributed capacitance is in the order of a micromicrofarad. As a rule of thumb for high-frequency operation, when the product of frequency in megacycles and resistance in megohms is unity, the a-c resistance is about 90 percent of the rated d-c resistance; when the product is ten, the a-c resistance is about 60 percent of the rated resistance.

The temperature coefficient of these units is shown in Fig. 2. As an indication of the effect of applied load on the temperature and hence on the resistance of these units and their heating effect on adjacent components, Fig. 3 shows the rise in surface temperature for units of various rated wattages.

If the unit must withstand humid environment, a hermetic seal is formed by inserting the unit in a ceramic sleeve that has metallized ends. These ends are then silver soldered to the resistor leads. So protected, units are rated to withstand 95-percent relative humidity at 40 C for 250 hours with an average change of 1 percent. The sleeve also provides protection from potting compounds and fungicidal spray, which may attack some conventional coatings.

The details of another construction are shown in Fig. 4. The carbon film is deposited on the ceramic core in a vacuum furnace into which hydrocarbon gas is in-

Previous Articles in Series

Part I: Fixed Capacitors Undergo Miniaturization, p 120, July 1954.

Part II: New Variable Capacitors Extend Tuning Range, p 130, Aug. 1954.

COMPONENT DESIGN TRENDS

- Printed resistors for high-voltage high-resistance applications
- Mixed-metal alloys to provide wide range of temperature coefficients
- Welding of resistance wire to terminal lugs cuts contact noise

troduced at a controlled rate. After the end caps and leads are secured in place, the unit is varnished and molded in low-loss thermosetting resin. This size of 0.5-watt unit is available from 100 ohms to 0.5 megohm in tolerances of 1, 2 and 5 percent; the change on life test at 40 C is less than ±1 percent.

Film-on-Glass

Because of its ability to withstand high temperature, glass is also used as a base for metallic-film resistors. Three variants of this film-on-glass resistor are produced: a high-frequency resistor, an accurate-grade resistor, and a high-temperature resistor. Basically each unit consists of a stable conductive coating fired onto a glass rod or tube.

The resistive coating can be cycled from near absolute zero to red heat without impairing its conductivity. In the complete unit, silver terminals that are fired on provide low-resistance terminations and a silicone coating baked onto the unit provides additional environmental protection.

In the high-frequency resistor, the film is appreciably less than the depth of penetration at vhf. Table I summarizes ratings of this and the related units. Tolerance is the normal manufacturing value. Stability is the permanent resistance change after 500 hours operation at maximum rating and 40 C ambient. Temperature coefficient is the maximum absolute value. The voltage coefficient of resistance of these units is practically negligible: less than 0.001 percent per volt.

Whereas the high-frequency resistors are rated from 1 to 150 watts depending on size, the accurate-grade resistors are rated from 0.5 to 2 watts depending on style. The high-temperature resistors are rated from 1 to 115 watts based on a 225 C hot spot at 40 C ambient, and are about half the size of equivalent film-type resistors; for example a 25-watt unit is 4 inches long, $\frac{7}{8}$-inch in diameter, available from 20 to 300,000 ohms.

This example also indicates that their resistances exceed those of conventional wire-wound units of comparable size. Figure 1B shows recommended derating for these units. The temperature coefficient in Table I is for the higher resistance units; for very low resistances, 10 to 100 ohms, the coefficient is positive and increases toward 0.03 percent per deg C as a maximum.

For greater power dissipation, these glass units can be cooled by forced air. This increases the ratings of the high-frequency units for example, four fold, or 50 to 100 fold by liquid cooling, but only continuous-film units should be required to dissipate over 50 watts per square inch. The resistors thus are especially useful where high momentary overloads are expected and as dummy r-f loads.

Another glass resistor, available from 10 to 100,000 ohms at tolerances of 1, 0.5 and 0.25 percent, is produced by Balco Research Laboratories. It consists of a pure metallic spiral film inside a glass tube closed with bonded end caps to form a hermetic barrier rated at over 60 psi.

Wafer Resistors

A subminiature resistor especially designed for use in transistor circuits is now produced by Glenco Corp. rated at 0.1 watt (0.25 watt on special order). This unit, about a quarter of an inch long, is formed by depositing the resistance material on a thin ceramic base, curing and cutting to the desired resistance. It is furnished as cut or with leads, and with protective coating, or it is assembled on a shock-resistant ceramic base with other circuit components connected with leads printed on the base.

Various approaches are being evolved for automatically produced circuits. Success to date indicates that ultimately printed resistors may replace conventional carbon-composition resistors. Experience

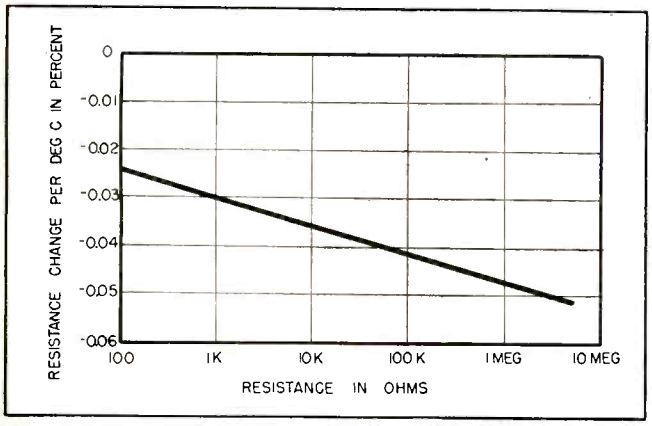


FIG. 2—Temperature coefficient for deposited-carbon resistors. The units for which this data applies are encased in plastic sleeves

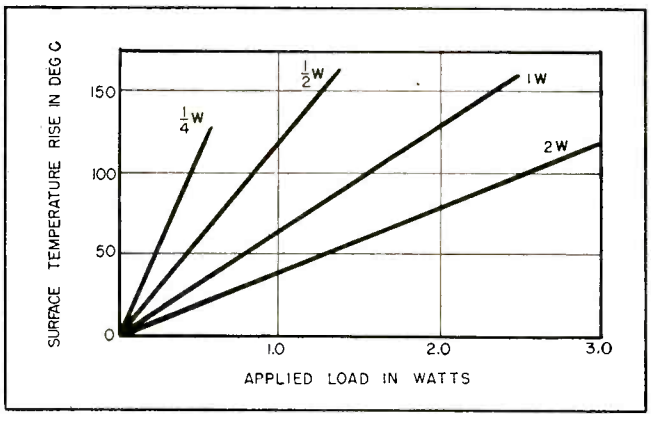


FIG. 3—Rise in surface temperature for four rated wattages of deposited-carbon resistors

at Micro-Circuits Co., for example, has been that tape resistors, although providing a compromise between conventional resistors and printed resistors, do not make full use of the reduction in cost achievable with more mechanized circuit production.

Conductive coatings developed to date make possible the printing of resistors having characteristics similar to those of many conventional resistors and, if not interchangeable with them, are substantially lower in cost and more adaptable to design needs and of greater inherent range in electrical characteristics.

Surge protection for series filament strings and compensation for temperature effects can be provided by printed resistors of high negative temperature coefficient. Among others working in this field, Micro-Circuits Co. is developing resistor paints to provide comparable magnitudes of both positive and negative temperature coefficients. An interesting possibility is a resistor in which most of the resistance change occurs within a relatively narrow temperature range. A resistance above about a thousand ohms is possible with substantial voltage coefficient.

The protection afforded by a fully enclosed printed circuit adapts this style construction especially to high-voltage high-resistance applications in nuclear instruments and television receivers. Fixed voltage dividers, tapped bleeders and decade units to 10^6 megohms may be commercially available in the near future as stock items.

Controlled Temperature Coefficient

Development at International Resistance Co. indicates that thin metal films laid down by vacuum evaporation have electrical properties which may differ from the bulk material. In addition to the effect on resistance of the decreased mean free path in thin films, of the formation of crystals with distorted lattices, and possibly of semiconductor behavior, controlled mixed-metal films make possible the wide range of temperature coefficients shown by the shaded area in Fig. 5.

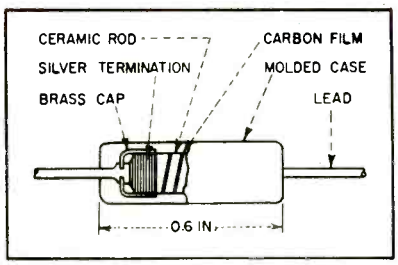


FIG. 4—Cross-section of ceramic-cored deposited-carbon resistor

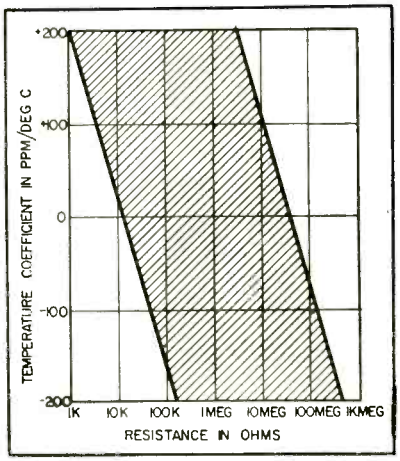


FIG. 5—Resistors having controlled temperature coefficients can be made in the range shown by the shaded area using mixed-metal films

Thus, it is possible to tailor-make resistors to a required temperature coefficient over a broad resistance range. At 100,000 ohms the temperature coefficient can be specified to any value between +200 to −200 parts per million per deg C. Furthermore, the desired value can be obtained within ten percent of the extreme value.

Units with small temperature coefficient, less than 5 ppm per deg C, retain this characteristic over a moderate temperature range. An 11,000-ohm resistor can be formed with an almost nil resistance-temperature characteristic value from 0 C to about 100 C. Units in an organic resin casting show a shelf stability on the order of 0.1 percent; that is, approaching the stability of a wire-wound resistor.

From the success indic
these results from pilot-pla
duction, development is
directed toward use at higher
quencies, higher ambients, an
greater power dissipation. It can be expected that, in full-scale production, the cost of evaporated metal resistors will be comparable to boron-carbon units.

Wire-Wound Resistors

Precision wire-wound resistors, commonly manufactured with resistance tolerances to 0.1 percent, are low-wattage units used where their stable characteristics justify their greater expense over composition and deposited resistors. During the past five years the major improvements in this type resistor have been increased accuracy and stability, more constant and closer matched temperature coefficients, use of finer diameter wire, more durable coil protection, higher temperature ratings and smaller overall size.

One of the more troublesome characteristics of precision resistors has been erratic contact resistance between the resistance wire and the resistor terminals. Because of the metallurgical properties of resistance wire and its small size, it is not always possible to solder or weld the wire to its terminals. In Riteohm resistors made by the Ohmite Manufacturing Co. the enameled alloy resistance wire is welded to the terminals to provide stable and permanent electrical connection of low noise level. The resistance wire is noninductively pie-wound on a rigid steatite bobbin.

Resistance element, terminals and bobbin are completely encapsulated by a resin whose temperature coefficient of expansion is chosen to match closely that of other materials in the completed unit. The assembled resistor thus holds the windings firmly in place

Table I—Characteristics of Film-on-Glass Resistors

	High Freq	Accurate	High Power
Tolerance	±2%, 10%, 15%	±1%	±1%, 2%
Stability	3%	0.5%	2%
Temp Coeff	0.03%/°C	0.02%/°C	0.02%/°C

NENT DESIGN TRENDS

ated by
nt pro-
being
re-
d

ınd encapsulation reduce size of wire-wound

- ermetic sealing for operation at hot-spot temperatures up to 140 C and at up to 95 percent relative humidity
- Ceramic insulation coating for operation up to 150 C

and repels moisture. It is rated for operation to 125 C.

Accuracy and Stability

The basic characteristics for which precision wire-wound resistors are used are accuracy and stability. As an example of present attainments, Daven calibrates all precision resistors to better than ±0.1 percent tolerance even though customer requirements may be less stringent. This practice permits close inspection and checking of each manufacturing operation. Resistors that undergo protracted aging and temperature cycling can be supplied to a tolerance of ±0.02 percent with a stability of ±0.005 percent.

Part of the improvement in stability is a consequence of refinements in wire production. Wire manufacturers now supply resistance wire that is consistently within ±20 parts per million per deg C. With winding techniques that avoid causing intermittent shorted turns that may be mistaken as an error in temperature coefficient, it is possible to retain this tolerance in the finished resistor. One precaution is to cushion the windings by a pocket of dry air inside the encapsulation. Where required, temperature coefficients can be matched on a production basis to ±3 parts per million per deg C by selecting two different alloys for the same resistor. Figure 6 shows temperature characteristics of several common wires.

Improved drawing and enameling techniques by the wire manufacturers make possible the use of 0.0008-inch diameter wire, but such wire must be handled on machines that provide close control of winding tension and requires protection by hermetic sealing in metal cases or by encapsulation. The trend toward smaller size and higher impedance is focusing development in this direction. Improved, more flexible impregnants now in use are molded completely around the unit.

The ultimate in coil protection is complete hermetic sealing in a metallic case with glass or ceramic bushings around the leads. An advantage of this protection is that several precision resistors or a complete network can be furnished in one case where all parts will be at substantially the same temperature for close tracking as, for example, in the Sealed-Ohm networks produced by The Daven Co. Resistors in such cases operate at hot-spot temperatures up to 140 C with newer enamels applied by wire manufacturers. Probably within the next three years, further development will result in less expensive encapsulation techniques, use of 0.0005-inch wire for higher resistances in smaller sizes and widespread adoption of encapsulated axial-lead type wire-wound resistors.

Higher Temperature

For operation at higher temperatures, resistance wire is coated with ceramic insulation such as Ceron made by Sprague Electric Co. Accurate resistors made with wire so insulated operate up to a hot-spot temperature of 150 C instead of the usual 105 C hot-spot limit. These resistors are enclosed in a protective casing molded from a mineral-filled thermosetting phenolic under high temperature and pressure. Their power rating at 105 C is as much as five times the rating for conventional resistors at 85 C.

The solid molded matrix is impervious to salt water during immersion with the result that electrolysis failures are avoided with these hermetically sealed resistors. This is accomplished to some extent by molding the lug terminals as an integral part of the winding form. In addition, the resistance wire is terminated on a rigid terminal which is isolated mechanically from the external wiring terminal to avoid damage during installation.

Because of the enhanced ability to withstand high temperature, the usual method of power rating, by determination of the wattage dissipation necessary to produce the maximum safe hot-spot temperature, resulted in unrealistic ratings. Instead, the manufacturer life-tested resistor lots for 500 hours of operation in an ambient of 105 C with the resistors cycled 1.5 hours on and 0.5 hour off at various wattage dissipations. The data plotted in Fig. 7 shows the probability of a given percentage change in resistance due to the thermal cycle as a function of power applied.

For example, if operated at 125 percent of rated power, it is 77 percent probable that the resistors will suffer a 0.2-percent change in resistance. Thus, power rating is based on retrace stability, which is of critical importance in most applications of precision resistors. Resistors are rated in this way to assure a retrace stability of one-quarter the initial resistance tolerance through 150 thermal cycles from −70 C to +150 C.

Commonly, precision resistors

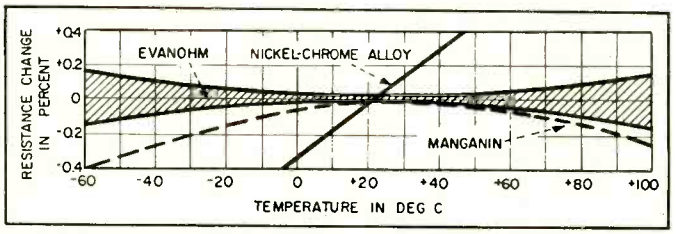


FIG. 6—Temperature characteristics of wires commonly used in resistor manufacture

are fabricated with a hole through the center of the bobbin by which the unit can be mounted on a bolt from the chassis.

For more compact construction, it is desirable to mount resistors by their leads in point-to-point wiring. Radial pigtail-type resistors such as those produced by Cinema Engineering Co. can be mounted by inserting the pigtails through holes in an insulated mounting board. For terminal boards, axial-lead resistors such as Sprague Permaseal units are available. These resistors are wound with Ceron ceramic insulated wire and have axial leads projecting through the molded case. If space is at a premium, Cinema provides an uncased resistor about 0.45 inch long and 0.18 inch across with a maximum resistance of 150,000 ohms rated at 0.3 watt.

The complete encapsulation of wire-wound resistors in epoxy resin has been used for several years by ITE Circuit Breaker Co. Potting in this or other compounds has decreased the cost and weight of hermetically sealed units and simultaneously made possible an increase in maximum resistance for a given overall size. Use of silicone and Teflon insulated resistance wire in conjunction with epoxy resin is expected to result in precision resistors rated to 200 C in the foreseeable future.

A power resistor, like a precision resistor, usually consists of a ceramic core on which are clamped terminals and around which is wound a wire of high-resistance alloy. For both electrical and mechanical stability it is desirable that the junctions between resistance wires and terminals are first mechanically joined and then silver brazed to insure a permanent positive low-resistance bond between wire and terminals. The complete assembly is protected by a glaze such as Vitrohm enamel developed by Ward Leonard. The enamel should be a hard tough moisture and acid-resistant cover possessing high heat conductivity.

Power units are usually fabricated to standard tolerances of ±5 or 10 percent depending on the type resistor, but are available at increased price to closer tolerances. The power rating of such resistors

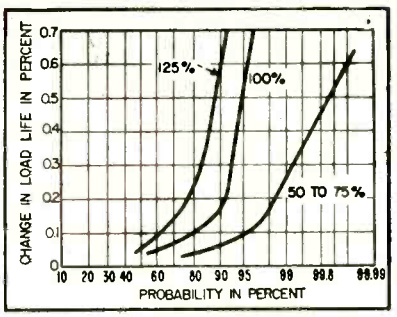


FIG. 7—Probability of resistance change in high-temperature resistors operating at various percentages of load

is usually based on operation in free air at an ambient room temperature of 40 C and a hot-spot temperature of 300 C.

For units not encased in a vitreous enamel, the maximum allowable temperature rise may be 375 C. However, because resistors are seldom mounted in free air, their normal wattage ratings must be reduced to avoid exceeding the maximum allowable temperature rise.

If the normal operating temperature of an equipment is to exceed the ambient temperature of 40 C, resistors must be further derated.

Low-Inductance Windings

The wide variety in which power resistors are available is indicated by the fact that three forms of noninductive resistors are made by Ward Leonard Electric Company. A 24-watt unit, termed Discohm, available in resistance values ranging from 1 ohm to 5,760 ohms with 0.0014-inch wire (1,740 ohms with 0.002-inch wire) consists of a radial winding assembly on a Fiberglas core. The resistance wire is silver brazed to copper terminals.

A more common means to keep both distributed capacitance and inductance to a minimum is the Ayrton-Perry winding consisting of two parallel single-layer windings running in opposite directions. The windings should cross at points exactly 180 degrees apart for maximum cancellation. On an ordinary tubular resistor, uniform wire cross-over is difficult to accomplish. Ward Leonard, therefore, uses a flattened core which both assures that the crossing points are exactly 180 degrees apart and also provides a better grip for the wire. Because the winding is more uniform, the winding crossover points are at the same potential for minimum capacitance.

The inductance of these units at 1 mc ranges from 0.05 microhenry for a 1-ohm unit to 0.54 microhenry for a 1,000-ohm unit with power ratings of 35 watts. Higher-wattage units have greater distributed inductance. Where both space saving and noninductance are required the Plaqohm resistor can be used. This unit is useful where inductance at frequencies up to 1 mc and distributed capacitance up to 5 mc must be negligible. The higher-resistance units consist of a uniform toroidal winding of resistance wire on a Fiberglas core which is then laid out in a flat winding with current flowing in opposite directions in adjacent segments.

Where ventilation and wattage ratings permit resistors to be mounted directly against other metal parts, it is usually necessary to provide additional insulation if the resistor operates substantially above ground potential. In Kool-ohm resistors, the resistance wire is insulated with inorganic material sintered on the wire at temperatures on the order of 1,000 C. This insulation is rated to have a dielectric strength on the order of 350 volts per mil at 400 C and can be operated at red heat.

The use of this insulated resistance wire also facilitates the winding of noninductive Ayrton-Perry windings. With pattern windings relatively large values of inductance with small distributed capacitance can be obtained. Residual inductance of a 40,000-ohm inductively wound unit rated at 5 watts is less than 8 millihenries. Flash voltage to ground is over 10,000 volts at 60 cps under dry conditions. These units are available from 50 to 120-watt ratings. Where a resistor is required to withstand severe thermal shock and salt-water immersion, the unit is protected with a metal-to-glass seal. In special units adapted to glass winding forms and enclosures, with winding ends welded to nickel lead wires, operating temperatures as high as 700 C can be tolerated.

Moving Target Detection

By R. S. SARGENT
Head, Radar Section
Bureau of Aeronautics, Navy Department
Washington, D. C.

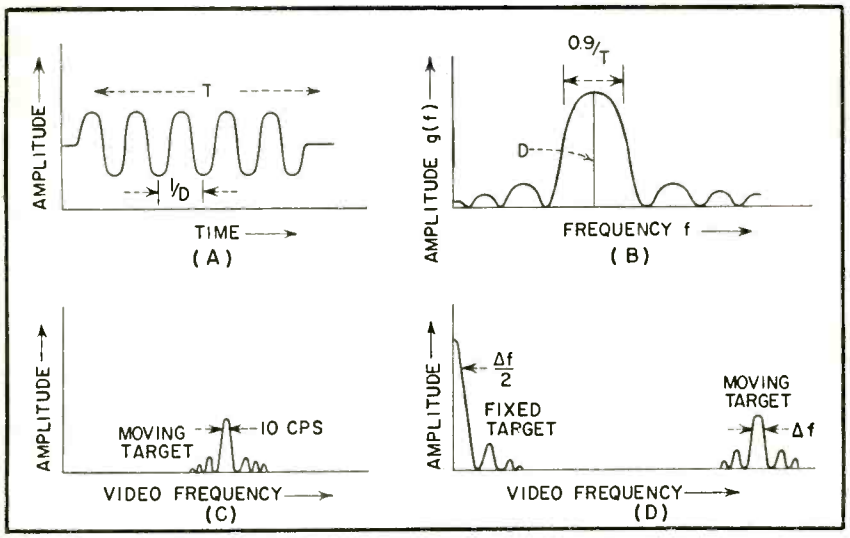


FIG. 1—Stationary c-w radar with nonscanning antenna looks at target. Waveforms show detected video on time scale (A) and corresponding Fourier analysis (B). Also shown are spectrum of target moving through beam (C) and echoes returned to scanning radar (D)

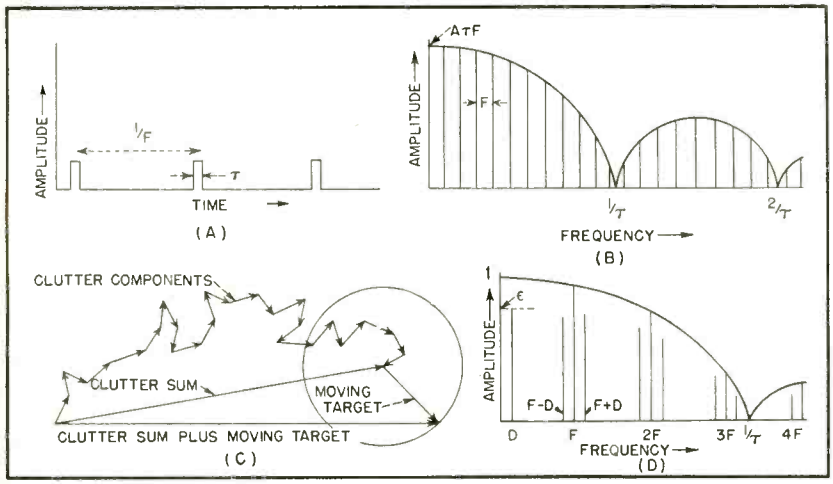


FIG. 2—Ideal echo return of pulse radar (A). Fourier analysis reveals modulation envelope of pulse width (B). Vector diagram (C) shows behavior of ground clutter while (D) illustrates modulation at Doppler frequency

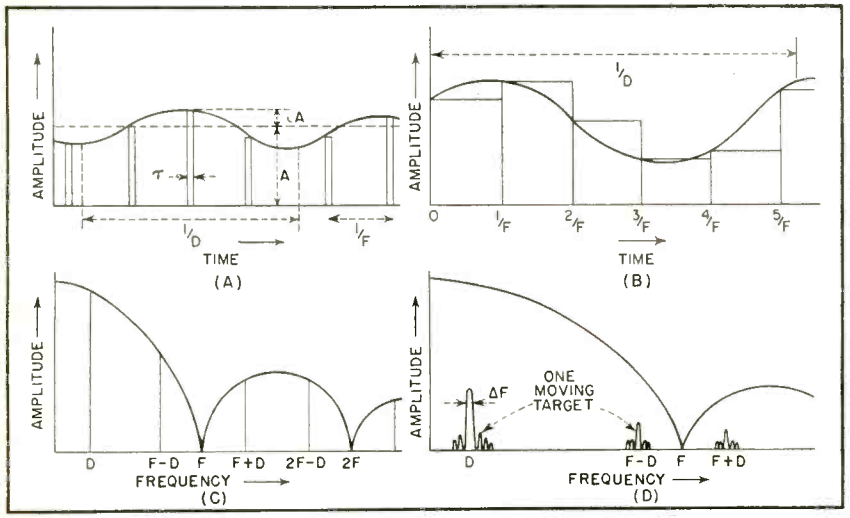


FIG. 3—Spectrum of Doppler modulated pulses (A), effect of boxcar demodulation (B) and cancellation of prf harmonics (C). Waveform (D) is moving target spectrum

PULSE DOPPLER radar is significant primarily because it retains the wide-band, high-information-rate feature of standard pulsed radar and combines with it the ability of continuous-wave radar to distinguish targets by their relative motion. Pulse Doppler radar is any pulsed radar whose method of detection utilizes the Doppler shift in frequency due to radial target motion.

It is distinguished from standard AMTI radar, which delays one sweep and subtracts it from the next, in that the detection system includes relatively narrow-band video filters that detect the Doppler frequency directly.

Basic Theory

Consider a simple stationary c-w radar with a nonscanning antenna looking at fixed targets among which is one moving target. The transmitter sends on a fixed frequency f_o. All fixed targets return echoes of the same frequency. The moving target, however, returns the frequency shifted by an amount proportional to its radial speed. The amount of this Doppler shift in cps is $D = 2V/\lambda$, in consistent units, or $D = 100V/\lambda$ where V is the radial speed of the moving target in knots and λ the wavelength of the transmitted frequency in centimeters. At X-band, the Doppler shift is about 30 cycles per knot.

If the returned r-f echoes from both fixed and moving targets are beat against the transmitted frequency, the return from fixed targets will come through the detector at approximately zero frequency while the return from the moving target will come through at the

By Pulse Doppler Radar

Method of detection utilizing Doppler frequency shift due to relative motion of target and radar is qualitatively described. Effects of clutter are discussed and functions of boxcar demodulator and coherent oscillator outlined

Doppler frequency, D.

A fundamental limitation on the narrowness of the returned spectrum is imposed by the finite duration of the observed moving target signal. If a moving target stays within the beam for only T seconds, the detected video is as shown in Fig. 1A. A Fourier analysis of this waveform, expressing amplitude as a function of frequency, becomes

$$g(f) = \left(\frac{AT}{2\pi}\right)\left[\frac{\sin \pi T\,(f - D)}{\pi T\,(f - D)}\right]$$

This function is shown plotted against frequency in Fig. 1B. The width of the principal peak between half-power points is $\Delta f = 0.9/T$. If a target that returns a pure tone when viewed for a long time is in the beam only for 0.1 second, then $\Delta f = 10$ cps and the video spectrum is as shown in Fig. 1C. Thus the ultimate theoretical limit on frequency resolution is the observation time.

When a stationary c-w radar scans, all targets, fixed and moving, will remain in the beam a finite length of time that depends on the beamwidth and rate of scan. The detected video now resembles the waveform shown in Fig. 1D.

Pulsed System

The original stationary, fixed-beam system is now converted into a pulsed system. Within a certain range, the return from a fixed target is then ideally a series of equal-amplitude pulses, separated by the time interval between pulses, as shown in Fig. 2A.

If F is the pulse repetition frequency, τ the pulse width and A the amplitude, Fourier analysis gives the amplitude versus frequency spectrum shown in Fig. 2B.

The frequency spectrum consists of an infinite series of harmonics of the repetition frequency, whose envelope is determined by the pulse width. The first zero occurs at $1/\tau$ which in pulsed radars will occur at around 1 mc.

If a moving target is outside the clutter region the detected video will ideally be a series of equal-amplitude pulses at the pulse repetition frequency and the frequency spectrum will comprise harmonics of the prf as in the case of fixed targets.

If the moving target is within the clutter region consisting of echoes sent back by fixed targets, the amplitude of the moving target echo will be modulated by the Doppler frequency. The ground clutter may be regarded as a group of random scatterers out of phase with each other but adding vectorially to give a finite return as depicted in Fig. 2C.

If a moving target in the midst of the clutter gives a discernible return during one pulse and moves a half wavelength radially during the pulse repetition interval, the r-f energy has to move a full wavelength farther and will arrive at the radar receiver in the same relative phase with the ground clutter that it had on the preceding pulse.

The tip of the vector representing the sum of clutter plus moving target describes a circle as shown in Fig. 2C. When the clutter signal is large compared to the target the resultant clutter-plus-target vector has a sinusoidal modulation. The fundamental modulation frequency is the reciprocal of the time required for the target to advance a half wavelength. This is the Doppler frequency.

Figure 3A shows the frequency spectrum of a series of equally spaced rectangular pulses amplitude-modulated by a sine wave.

The modulating frequency is D, the pulse repetition frequency F, the percent modulation ε and the pulse width τ.

The Fourier analysis gives a d-c component, a component at the modulation frequency D, a component at each multiple of the prf, a component at each multiple of the prf minus the modulation frequency and a component at each multiple of the prf plus the modulation frequency.

The relative amplitudes vary in that each harmonic of the prf has an amplitude modified by the factor $\sin \pi\tau f/\pi\tau f$ where f is the frequency of each harmonic and τ is the pulse width. If the product is an integral number that particular harmonic will vanish. The harmonics will be enclosed in the envelope illustrated in Fig. 2D.

The modulation frequency component and each sideband will have an amplitude ε times the ordinate of the envelope at that frequency.

Demodulation

All of these components of pulsed radar have small energy content, as can be seen qualitatively by the fact that the signal is present for only a small fraction of the time. The usual way in which unwanted frequencies are eliminated and amplification accomplished is by a boxcar demodulator—a circuit that measures the amplitude of each signal pulse and stretches it

for the full pulse repetition interval as seen in Fig. 3B.

The pulse width τ is now equal to $1/F$ and at each harmonic of the prf the sin $\pi\tau f/\pi\tau f$ factor goes to zero (Fig. 3C).

If a moving target remains in the beam a finite length of time T, each of the line spectra from the moving target is broadened into a band $\Delta f = 0.9/T$.

The video-frequency spectrum of the return from one range element containing both fixed and moving targets is shown in Fig. 3D. No spectra from fixed targets will be present.

Moving Radars

If a pulsed radar is installed in an aircraft the spectra of fixed and moving targets is somewhat modified. In Fig. 4A, an aircraft flying in the Z-direction with speed V is a height h above the ground plane. Consider any cone whose apex is at the aircraft, whose axis of symmetry is in the Z-direction and which has a half-angle α. This cone will intersect the ground plane in a hyperbola and a line drawn from each point on the intersection to the aircraft will make the angle α with the velocity vector V. The relative velocity of each point on the hyperbola to the aircraft is V cos α and the hyperbola is the locus of points having the same relative velocity. For a given V and h a family of hyperbolas can be drawn —one for each value of α. Figure 4B, a plan view looking down on the aircraft, shows how this family of hyperbolas divides the ground into strips, in each of which each point moves with the same speed relative to the aircraft.

Consider now a radar beam making some angle α with V and illuminating a patch of ground as shown. At a distance from the aircraft, the hyperbolic lines are essentially radial. If the reflecting surface is assumed to be made up of uniformly distributed random scatterers, the power reflected from each strip is then proportional to the power illuminating it, which is a function of the beam shape. Each strip will return its characteristic Doppler frequency which can be considered to be a narrow band of noise centered at the Doppler frequency.

On the assumption that the lines are radial, the difference in relative speed dV between two strips separated by an angle $d\alpha$ can be calculated.

From Fig. 4C, the difference in relative speeds is $dV = V \sin \alpha\, d\alpha$. Since the Doppler shift at X-band is 30 cycles per knot, the Doppler spread will be $30V \sin \alpha\, d\alpha$.

This formula fails when the beam is centered at zero. The expression $V \cos \alpha$ can always be used for the relative velocity, however.

Figure 5A, top, shows the r-f frequency spectrum from fixed targets at some small range interval when the radar beam is at some angle with V. The amplitude of the return from each strip is determined by the beam pattern. The beamwidth θ is in radians and is substituted for $d\alpha$ in the expression above.

When the signal is detected each strip will beat with every other strip to produce a spread of Doppler frequencies as wide as the frequency difference between the two outside strips. If dp is the frequency difference between adjacent strips, there will be $(n-1)$ pairs of strips beating together to produce the Doppler frequency dp, $(n-2)$ pairs to produce 2 dp, $(n-3)$ pairs to produce 3 dp and one pair to produce $(n-1)$ dp or $30\ V\theta \sin \alpha$. The strongest Doppler

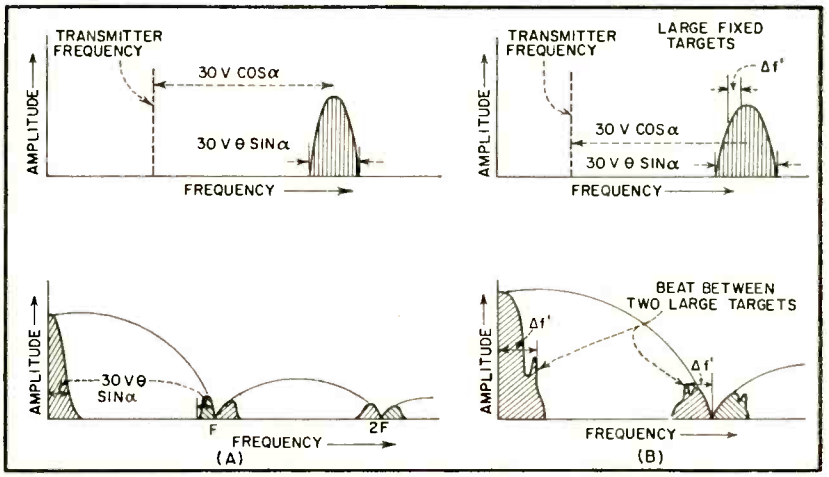


FIG. 5—Airborne radar echoes; r-f and video spectrums (A) denote single large fixed target while (B) shows effect of two such targets

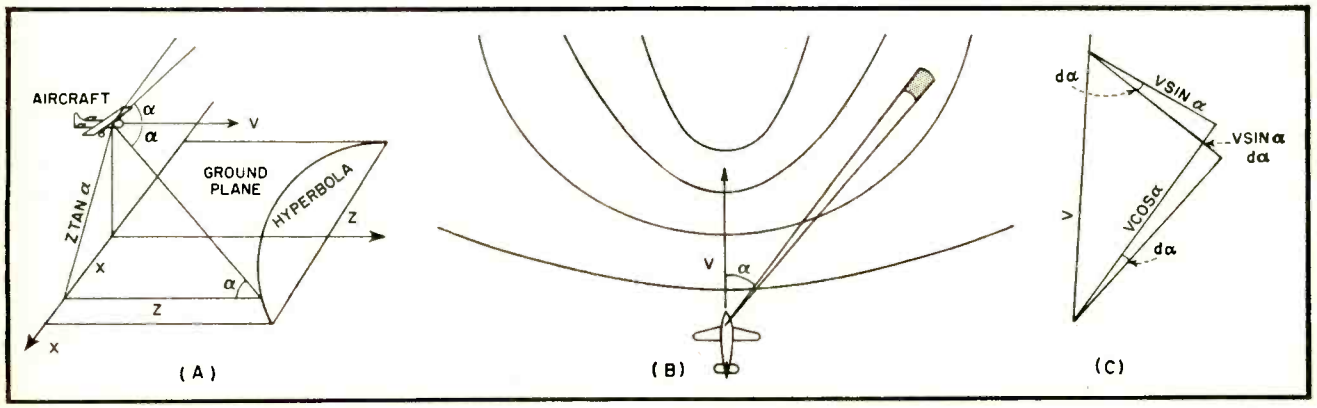


FIG. 4—Motion of aircraft (A) and hyperbolas of constant relative velocity (B). Vector diagram (C) shows relative speeds

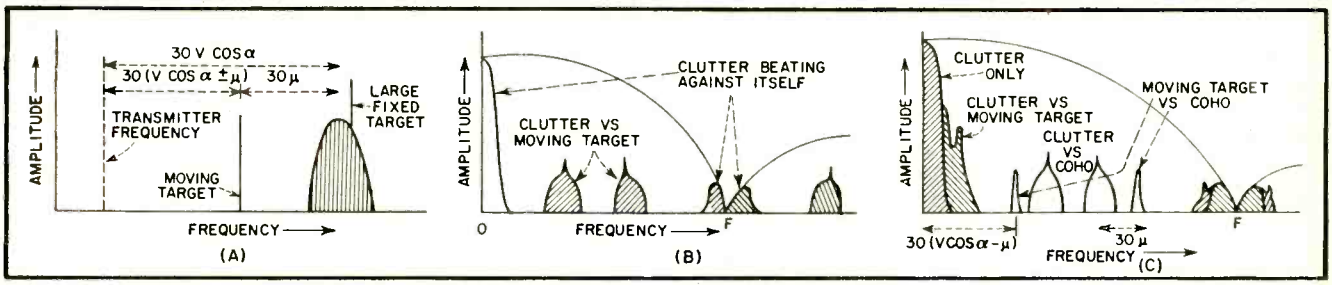


FIG. 6—Radio-frequency (A) and video spectrums (B) illustrate echoes received by airborne radar ranging on moving target. Waveform (C) shows effect of coherent oscillator

frequency will begin at zero and taper off to a small value at $30V0$ sin α.

Each one of these Doppler frequencies will amplitude-modulate the received pulses and will have a frequency spectrum consisting of the Doppler component, the components at the multiples of the prf and the sidebands on each side of each multiple of the prf. If the video is boxcar demodulated and the sin $\pi\tau f/\pi\tau f$ factor thus adjusted so that the zeros fall on the prf multiples, the result will be as shown at the bottom in Fig. 5A.

If one large target is in the beam, the entire video spectrum will be raised in amplitude without altering the shape of the envelope. However, if two large distinct fixed targets are in the beam, the r-f spectrum will resemble the top waveform in Fig. 5B and the video spectrum will be as shown below.

A determination of $\Delta f'$ from the large signal provided by the beat between the two large targets is a measure of the angular separation of the two targets by direct substitution in $\Delta\alpha = \Delta f'/30V \sin\alpha$ where $\Delta\alpha$ is the angular separation. This azimuth resolution does not depend on the beamwidth but only on aircraft speed, bearing of the antenna, frequency resolution of the system and transmitting frequency.

If three large targets are present, there will be three large spikes, representing the various beat combinations between pairs; if four are present, six, and so on according to $N = n!/2(n-2)!$ where N is the number of beat combinations and n is the number of large targets.

If a moving target moves into the beam at the gated range with a radial speed such that it is displaced out of the r-f clutter spectrum, the r-f spectrum will be as illustrated in Fig. 6A.

Moving Targets

If μ is the radial velocity of the moving target with respect to the ground Fig. 6A shows that the displacement of the moving target signal from the center frequency of the ground clutter is 30μ. The sign of μ is positive if the target is approaching the radar-equipped aircraft. In Fig. 6A the target is shown receding. The detected video after range-gating and boxcar demodulation is shown in Fig. 6B.

Coherent System

The final modification involves making the radar coherent by introducing a coherent oscillator (coho) to beat against the returned echo. What is required is an oscillator that is phase-locked to the transmitter pulse and continues to oscillate at a constant frequency during the entire pulse repetition interval.

Phase lock and constant frequency insure that the echo from a target moving with zero relative radial speed will arrive at the transmitter with the same phase relative to the coherent oscillator from one pulse to the next. If it has the same relative phase, the detected video will have no amplitude modulation and will not have the characteristics of a moving target.

If the transmitter and r-f coho frequency are constant and equal and the signal shown in Fig. 6A is present in the receiver the detected video will be as shown in Fig. 6C.

Advantages

The use of the coherent oscillator or coho greatly improves knowledge of the nature of the targets. First, the spectrum of the ground clutter beating against the coho accurately reproduces the azimuth position of all fixed targets within the beam, within the limits of the frequency resolution of the system. This does not apply to a moving target, which may be displaced completely out of the beam in frequency. All that is known about it is that it is physically somewhere within the beam. However, the number of frequency lines outside the beamwidth clutter spectrum corresponds to the number of swiftly moving targets. The coho therefore provides accurate information about the number and azimuth of large fixed targets and the number of moving targets.

Coherent detection tells whether a target is advancing or receding. The moving target versus clutter video spectrum is the same whether a target is coming or going with respect to the clutter; the moving target versus coho video frequency is different.

Furthermore, the radial speed of a moving target can be detected more accurately with coherent detection since the displacement of a narrow spike of frequency is measured rather than the average displacement of one band of frequencies from another, both a beamwidth wide in frequency.

Many times it is more convenient to beat the coho and signal together at i-f rather than r-f. This is conventionally accomplished by the introduction of a stable local oscillator or stalo, which is centered in frequency and separated from the transmitter frequency by the i-f center frequency.

The writer acknowledges the aid of reports of the Control Systems Laboratory of the University of Illinois, particularly those by C. W. Sherwin.

Frequency Control for Multiple Transmitters

Ultrasonic tone transmitted over wire lines synchronizes carrier frequencies of widely separated transmitters used in low-power educational broadcasting. Technique is potentially applicable to commercial wired-radio systems

LOW-POWER educational radio stations may operate in the standard broadcast band without licensing if they obey FCC regulations that limit the coverage of their transmissions to a radius of several hundred feet.

At Cornell, it was necessary to operate more than one transmitter to reach a widely scattered student body. All the transmitters were required to operate on the same channel without undesirable carrier-frequency difference beats.

Some stations have solved this problem by distributing a modulated r-f signal to several radiation points by coaxial cable. At each point, a linear r-f amplifier is used to boost the signal before radiation. This system, however, is costly when it becomes necessary to feed five or six widely separated transmitters and involves obtaining permission to string cable both on campus and in neighboring residential areas.

However, leased telephone lines are available to connect the remote transmitters to the studio feed. These lines may be utilized for carrier synchronization as well as carrying program material. An ultrasonic tone having an integral submultiple relationship to the desired carrier frequency is sent over the telephone lines to the remote transmitters where it is converted to the carrier frequency. Frequencies on the order of 50 kc are practical for use on lines up to several miles in length, provided a line-carrier system is not in use over part of the route.

Since the carrier frequency of WVBR is 640 kc, 40 kc was selected as the synchronizing frequency. A frequency multiplication of 16 is required at the transmitter to obtain the 640-kc carrier.

Frequency Multiplier

The 40-kc master frequency is generated by a resistance-stabilized bridged-T Colpitts oscillator. The 40-kc and audio signals are fed to the remote transmitters.

At each transmitter, the audio and master-frequency signals are separated and routed to the appropriate circuits. The most direct way to derive a 640-kc output from the 40-kc master frequency is by class-C frequency multiplication. To reduce harmonic content in the 640-kc output, it was necessary to use four frequency doublers with double-tuned interstage networks as shown in Fig. 1.

The 40, 80 and 160-kc tuned circuits use ferrite-core variable inductors designed as width controls in television deflection circuits. Small powdered-iron-core variable inductors are used for the 320 and 640-kc tuned circuits.

Controlled Oscillator

Another scheme for generation of the 640-kc carrier is shown in Fig. 2. The local-oscillator frequency is made identical to the 640-kc output of the multiplier by an automatic-frequency-control system using a germanium-diode phase detector and triode reactance tube. Since a moderately high harmonic content can be tolerated in the multiplier output, two pentode frequency quadruplers are sufficient.

The local oscillator that feeds the final amplifier is isolated from the phase detector by a triode buffer so that spurious frequencies in the multiplier output cannot feed through. Use of an electron-coupled local oscillator minimizes the loading effect of the final amplifier on oscillator frequency stability.

The afc-oscillator circuit shown in Fig. 2 provides an r-f carrier of sufficiently low harmonic content and requires only about half the number of tuned circuits needed in the straight multiplier circuit shown in Fig. 1. The multiplier

LOW-POWER BROADCASTING

Radio stations operating between 425 and 1,605 kc, such as the one described in this article, may be operated without a license provided their radiated field is less than 15 microvolts per meter at a distance

$$D = \lambda/2\pi = 157 \times 10^3/f$$

where D is in feet and f in kc.

However, new regulations are being formulated that will place more severe restrictions upon this type of operation. When issued, the new restrictions will apply immediately to all systems beginning operation after that date and existing systems will be required to conform before June 30, 1955.

By ROBERT FLORY
Station WVBR, Cornell University
Ithaca, New York

circuit is, however, basically more stable inasmuch as the afc circuit can get out of synchronization with the master frequency if the local oscillator drifts beyond range of afc action. Both circuits have, nevertheless, proved practical in operation. The multiplier circuit (Fig. 1) appears easier to maintain.

Transmitter Circuit

The schematic of the transmitter is shown in Fig. 3. A 6146 beam power tetrode is used in a plate-modulated class-C r-f amplifier. A 40-kc trap is inserted in series with the modulated d-c supplied to the final amplifier and reduces the amplitude of the 40-kc sidebands in the transmitter output. These result from 40-kc signal that feeds through the modulator. The series-resonant primary of the 40-kc input transformer reduces the amplitude of the 40-kc signal entering the modulator driver.

A panel meter monitors final cathode current, modulator cathode current, modulated plate voltage and phase detector output in the afc-type transmitter. The transmitter is constructed on a 13 × 17 × 3-in. chassis and is contained in a metal cabinet fronted by a 19-in. rack panel 12-in. high.

Performance

Three transmitters have been installed and no audible interaction between them can be observed. Where there is destructive interference of the signals from more than one transmitter, areas of weak signal occur. However, if more than two transmitters cover an area, the field strength pattern is more uniform. The assistance of C. B. Meyer who constructed some of the equipment is acknowledged.

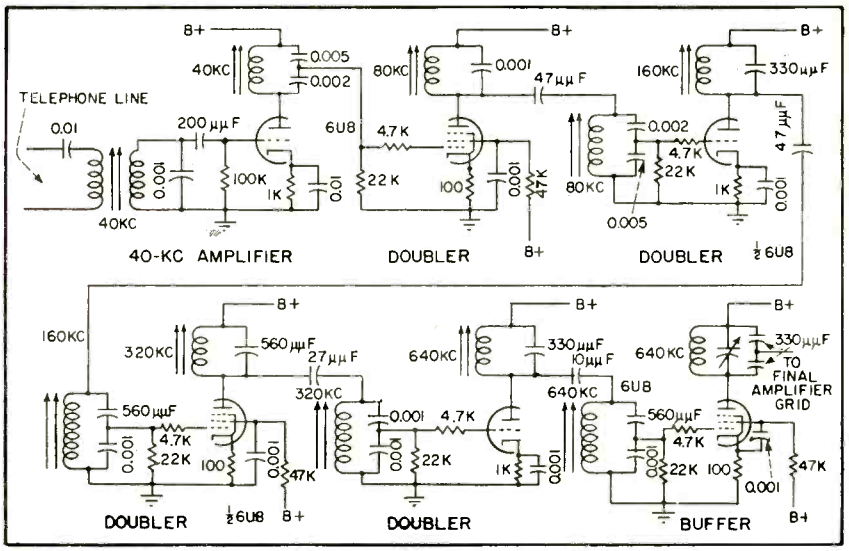


FIG. 1—A series of frequency doublers derives 640-kc r-f carrier from 40-kc tone transmitted over wire lines

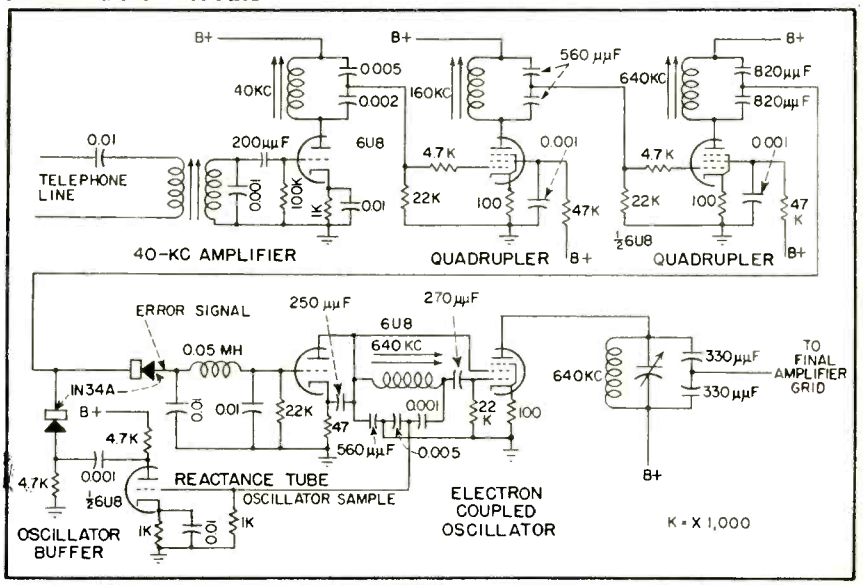


FIG. 2—Alternative arrangement syncs local oscillator frequency with 640-kc signal derived from 40-kc tone

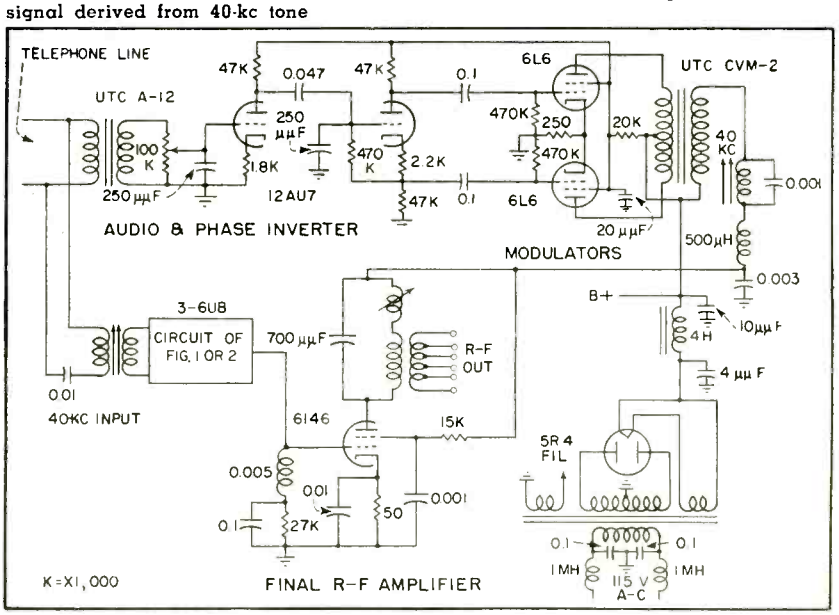


FIG. 3—Booster transmitters use a single 6146 in their final stage and obtain r-f drive from either frequency multiplier or afc local oscillator

Multiplier for

Circuit that takes logarithm of each term, adds them and takes antilogarithm of sum combines high versatility and reasonable accuracy. Applications of equipment include solving nonlinear differential equations and improving response of servo loops

NEED FOR A versatile arbitrary function generator of a dependent variable is strongly felt in feedback control system design. In a control system, the response of which requires improvement, it may be possible to better the performance if appropriate nonlinear functions are added, either in the forward loop or in the feedback path.

In determining the nature of this nonlinear function, a high degree of absolute accuracy is not required. Rather, it is important that one function may easily be modified into another in the attempt to discover an optimum. The design problem then demands a highly versatile computer with only reasonable accuracy, perhaps 5 percent. The arbitrary function generator to be discussed satisfies the needs of the computer designer in that the form of the nonlinearity can be changed by the setting of two knobs.

In many problems it may be necessary to generate products of arbitrary functions of two or more variables. The computer described permits products of the general form

$$[f(x)]^{\alpha}\,[g(y)]^{\beta}\,[h(z)]^{\gamma} \qquad (1)$$

where $f(x)$, $g(y)$ and $h(z)$ may be the dependent variables of a given problem or may be any independent variables. The constant exponents α, β and γ may be either positive or negative.

The operation of the multiplier is based on the logarithmic function, having the property

$$\alpha \log_a f(x) + \beta \log_a g(y) + \gamma \log_a h(z) = \log_a \left\{ [f(x)]^{\alpha} [g(y)]^{\beta} [h(z)]^{\gamma} \right\} \qquad (2)$$

where a is any number greater than unity.

Since summation is easy with electronic circuits, the logarithms of three voltages can be added simply and the inverse logarithm of the sum results in the product. Hence analog multiplication or division is performed easily by adding voltages.

Multiplying Process

A block diagram of the analog multiplier used for two input voltages is shown in Fig. 1. The signals e_1 and e_2 are rectified and fed to the linear-to-logarithmic converters, which produce the logarithms of the magnitudes of e_1 and e_2.

After appropriate attenuation or amplification, the signal is fed to the logarithmic-to-linear converter. The sign is restored by the output polarity restorer. As an example of multiplication suppose e_1 is a linear sweep $e_1 = k_1 t$ and e_2 is a sine wave $e_2 = k_2 \sin \omega t$.

Figure 2 shows oscillograms for products of these functions when multiplied and raised to desired powers. The exponent of either function can be changed easily from -5 to $+5$ simply by changing the attenuator setting.

To ascertain the accuracy of the multiplier, the function $y = Ax^n$, $A = 3$ and $n = 0.5$, was set up on the computer. This was accomplished by removing all but one input. From an enlarged copy of Fig. 3A, the points were plotted on log.-log. paper as shown in Fig. 3B. From the resulting straight line, the curve was determined to be

$$y = 2.98x^{0.488} \qquad (3)$$

Comparison of the exponent yields a discrepancy of 2.4 percent between the two expressions, with the constant multiplier in error by 0.7 percent. From the scatter of the points the error is estimated to be 3 percent. Since judgment is required in reading the oscillogram this last value probably could be improved with practice.

Circuit Details

The linear-to-logarithmic converter[1] converts the all-positive input voltage according to

$$e_0 = -\log_a e_{in} \qquad (4)$$

The final circuit of the converter is shown in Fig. 4 where the parallel connected 12AX7 provides the

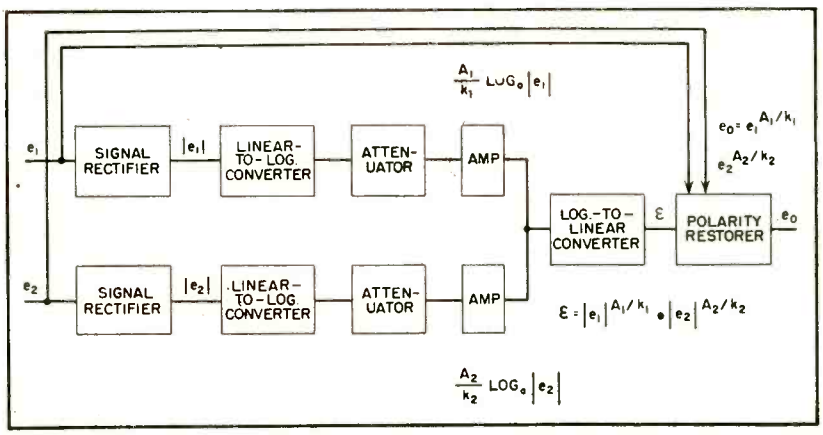


FIG. 1—Functional block diagram illustrates how unit performs analog multiplication using linear-to-log and log-to-linear conversions

Analog Computers

By C. J. SAVANT, JR. and R. C. HOWARD

Associate Professor
University of Southern California
Los Angeles, California

Bell Telephone Laboratories
New York, New York

logarithm characteristic. The 6S4 cathode follower reduces the output impedance of the converter while permitting adjustment of the d-c offset voltage. Many triodes, diodes and rectifiers[2] exhibit logarithmic characteristics with a large attenuation and over only a limited range. In this converter, however, use of a high plate voltage permits high-gain conversion that corresponds to a low logarithmic base.

The 270,000-ohm grid-cathode resistor provides a logarithmic characteristic over a wide voltage range, 0.3 to 300 v applied yields +3 to −32 v output. A 350,000-ohm plate-load resistor is used to keep the d-c level at a reasonable value. Good stability, 75 millivolts per hour, and reproducible characteristics are obtained by tube aging.

Since the converter operates on a positive signal only, a signal rectifier must be used before the converter. This input signal rectifier operates much the same as a full-wave rectifier. Hence, for varying voltages in the range −150 to +150 v, the output is positive, ranging from 0 to +105 v.

Circuit Operation

Conformation of the logarithmic-to-linear converter is illustrated in Fig. 5. The basic equations of the circuit are

$$(e_f + e_{in})/2 = e \quad (5)$$

$$(e + \delta)\, A = e_0 \quad (6)$$

$$-\log_a e_0 + \Delta = e_f \quad (7)$$

Here Δ and δ are the drift of the logarithmic-to-linear converter (referred to its output) and the drift of the amplifier (referred to its input), respectively.

Equations 5, 6 and 7 result in

$$e_0 = \exp_a (e_{in})\ \exp_a [(\Delta + 2\delta - 2e_0/A)] \quad (8)$$

This expression demonstrates that the output of the logarithmic-

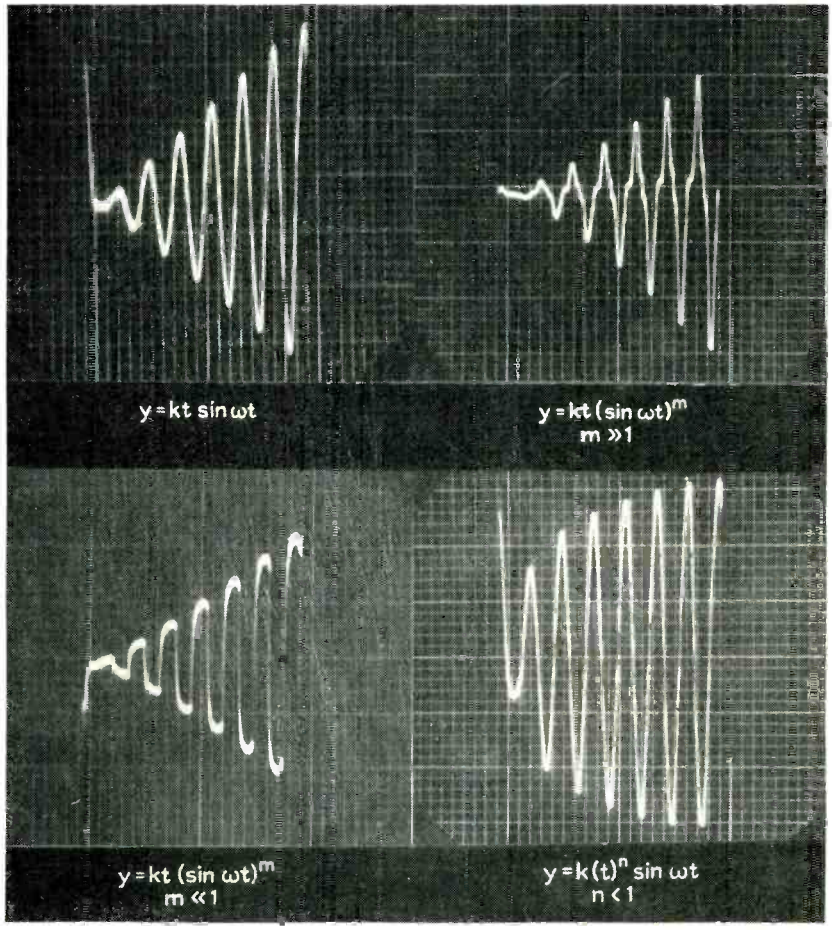


FIG. 2—Functions of form $y = k_1(t)^n k_2(\sin\omega t)^m$ illustrating multiplication of terms and raising to powers

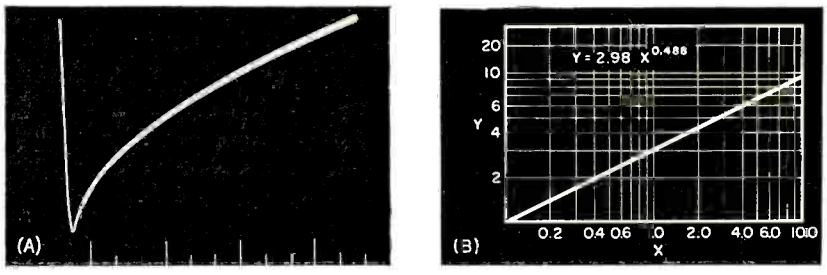


FIG. 3—Checking accuracy of multiplier. Function is set up and output taken, left. Straight line plotted on log-log paper, right, reveals discrepancies

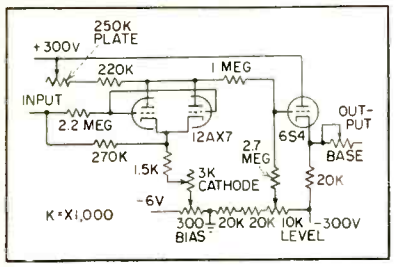


FIG. 4—Circuit of logarithm-taking element of multiplier

to-linear converter is proportional to the product of two factors the first of which is the desired result and the second of which is the combined error. Since the polarity of error is unknown, the most pessimistic case is considered. Expanding the second term is a series

$$e_0 \leqq \exp_a (e_{in}) [1 + (\Delta + 2\delta) \ln a] \times \left[1 + \frac{2}{A} e_0 \ln a \right] \quad (9)$$

From Eq. 9 approximate percent-error expressions resulting from drift and insufficient gain can be obtained

Percent error from drift

$$\Delta E_d \leqq 100 (\Delta + 2\delta) \ln a \quad (10)$$

Percent error from lack of gain

$$\Delta E_g \leqq 200 e_0 \ln a/A \quad (11)$$

With normal values, $\Delta = 50$ mv, $\delta = 25$ mv, $a = 1.2$, $e_o = 300$ and $A = 8{,}000$, substituted in Eq. 10 and 11, the maximum possible errors are

$$E_d = 2.3 \text{ percent and } E_g = 2.1 \text{ percent} \quad (12)$$

However, with appropriate adjustment of the final unit E_d can be reduced considerably and E_g eliminated completely.

Since only positive signals are acceptable to the multiplier, a polarity restoring circuit is needed. The heart of the restorer is a pair of amplifiers; one inverts the input signal, and the other does not.

The sensing part of the inverter allows only one amplifier to operate at a time controlling the polarity of the output. Input signals applied to the sensing input terminals control the sensing circuit such that the correct algebraic sign is restored to the output. If in the multiplication of two voltages both have the same polarity, the output voltage should be positive. If, however, the two input signals have opposite signs, the output voltage should be negative.

The sensing input terminals of the output inverter are connected at points in the circuit where the signals to be multiplied have proper signs and the correct signs of signals passing through the output inverter are restored.

Nonlinear Differential Equation

To demonstrate the operation of the multiplier in a typical analog computation

$$\ddot{X} + c\dot{X} + (\alpha x + \beta x^3) = F \cos \omega t \quad (13)$$

is solved. This equation occurs in several physical problems such as the pendulum with an external periodic force applied, mass subjected to a spring restoring force, saturation effects in iron core inductances and in rotating machinery. Explicit solutions of simple form are not known. The computer solution is demonstrated in Fig. 6A. Loop analysis yields the analogous electric equation

$$L\ddot{q} + R\dot{q} + \frac{1}{C} q + kq_n = E \cos \omega t \quad (18)$$

Variation of the exponent adjustment permits the choice of any desired n. The classical equation dictates an n of 3, but any $n > 1$ demonstrates similar phenomena.

To demonstrate the resonance hysteresis obtained with this equation consider Fig. 6B, which was obtained with the nonlinear multiplier. When the frequency is increased, the amplitude suddenly jumps down at a certain frequency. When the frequency is decreased,

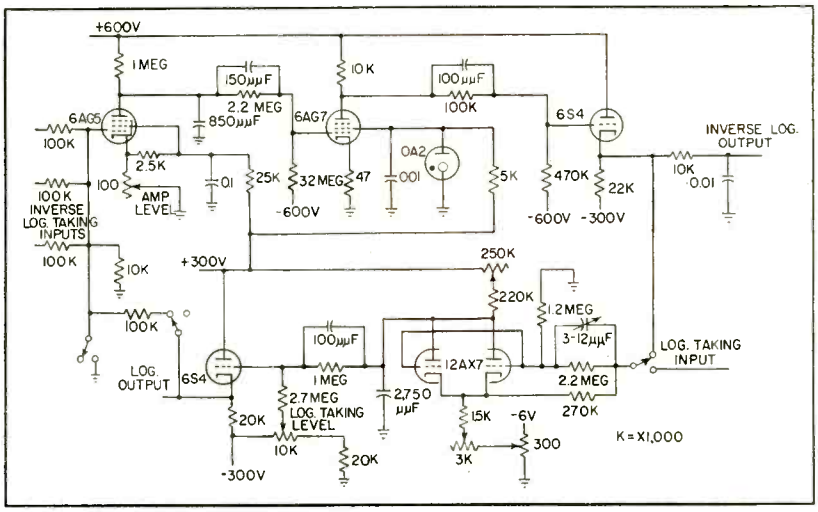


FIG. 5—Circuit of inverse or antilogarithm-taking element of multiplier

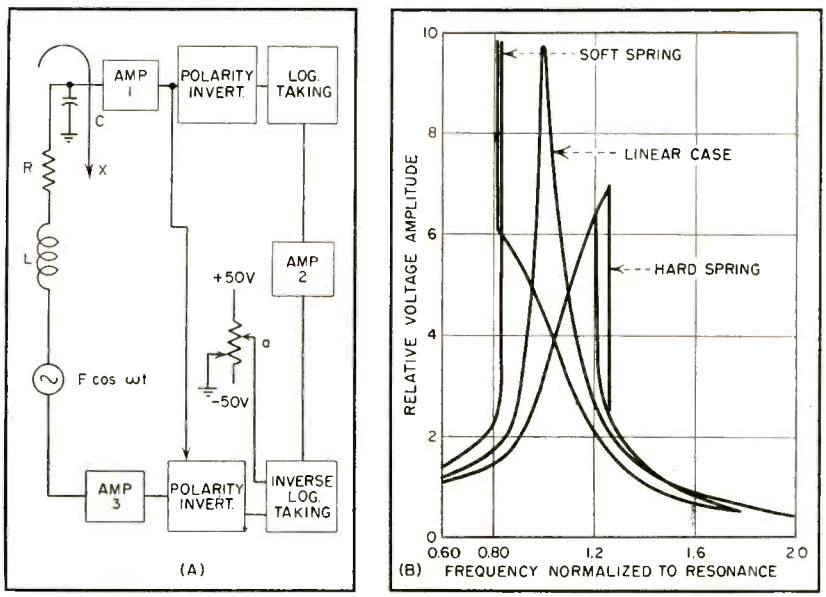


FIG. 6—Setup for solving nonlinear differential equation (A) and resonance hysteresis effects obtained with multiplier (B)

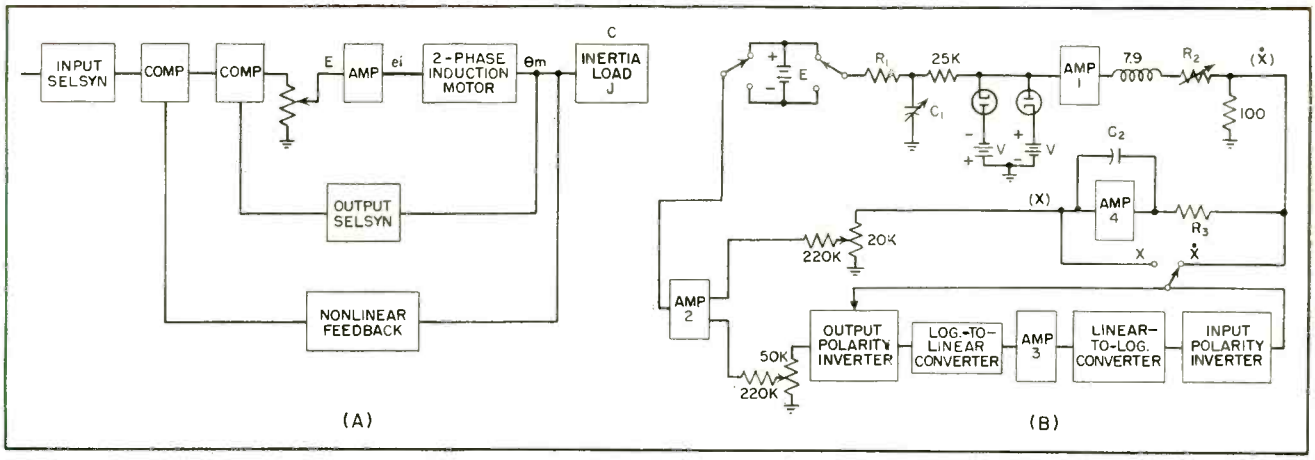


FIG. 7—Simple position servomechanism (A) and analog computer setup for improving response (B)

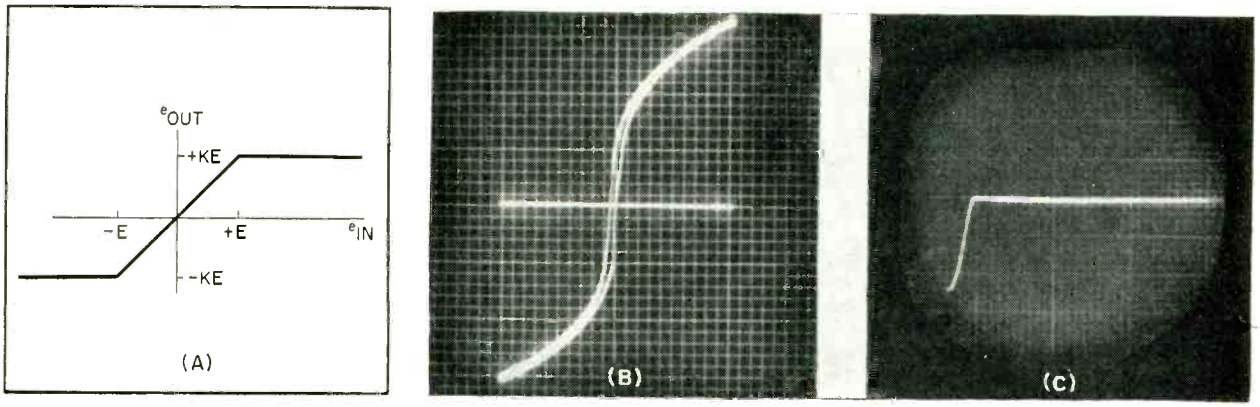


FIG. 8—Saturated amplifier characteristics (A); rate feedback function for improved response (B) and improved response to step function (C)

however, the corresponding jump up occurs at a lower frequency. This nonlinear phenomena has been studied with the aid of the multiplier.

Servomechanism Design

In design of closed-loop systems, a common problem is unavoidable nonlinear operation of certain forward-loop elements. Amplifier saturation, gear-train backlash, brush friction dead space and controller-force saturation are typical examples. By using a large amount of linear feedback, the response can be improved; however, with the use of nonlinear feedback functions a greater range of possibilities is available. The multiplier provides a method for designing the proper function.

Consider the servomechanism shown in Fig. 7A. The system consists of two selsyns, an amplifier, a two-phase induction motor, an inertia load and a nonlinear function generator. The open-loop transfer function of the control system is

$$C = k\,\epsilon/p\,(\tau_a\,p + 1)\,(\tau_m\,p + 1) \qquad (19)$$

where τ_a is the amplifier time lag, τ_m the motor time lag, k the gain around the open loop, and $p = d/dt$. Figure 7B shows the electric analog of the open-loop system.

Writing the circuit equations

$$q = k_1 e/p\,(\tau_1\,p + 1)\,(\tau_2\,p + 1) \qquad (20)$$

where $\tau_1 = R_1C_1$, $\tau_2 = L/R_2$ and $k_1 = A_1/R_2$. Comparison of Eq. 19 and 20 demonstrates the analogy. To provide the necessary position feedback, the voltage across the 100-ohm resistor is integrated obtaining $e_2 = R_2q/R_3C_2$. With the multiplier an error function

$$e = q + f\,(q) + q\,(dq/dt)$$

can be formed.

If the control system has an amplifier that saturates according to the characteristic given in Fig. 8A, it finds its analogy in Fig. 7B in the two back-biased diodes. Adjusting the gain of amplifier[3], the feedback function can be varied over a large range of exponents. The improved response is obtained with a function

$$g(\dot{x}) = (\dot{x})^{0.35}$$

which is shown in Fig. 8B. Figure 8C shows the final response to a step function when using position plus $\dot{x}^{0.35}$ feedback.

Conclusion

The multiplier is small in size, and relatively easy to adjust. A fixed voltage source provides rapid calibration. Many functions are possible and the form of the function is rapidly changed over a wide range. During service of more than six months, the system was found to be reliable and adequately stable.

References

(1) R. C. Howard, C. J. Savant, Jr. and R. S. Neiswander, A Linear-to-Logarithmic Voltage Converter, Electronics, p 156, July 1953.

(2) Ivan A. Greenwood, Jr., J. Vance Haldom, Jr. and Duncan Macrae, Jr., "Electronic Instruments", Vol. 21 Rad. Lab. Series, p 125, McGraw-Hill Book Co., New York 1948.

Machine Methods Make

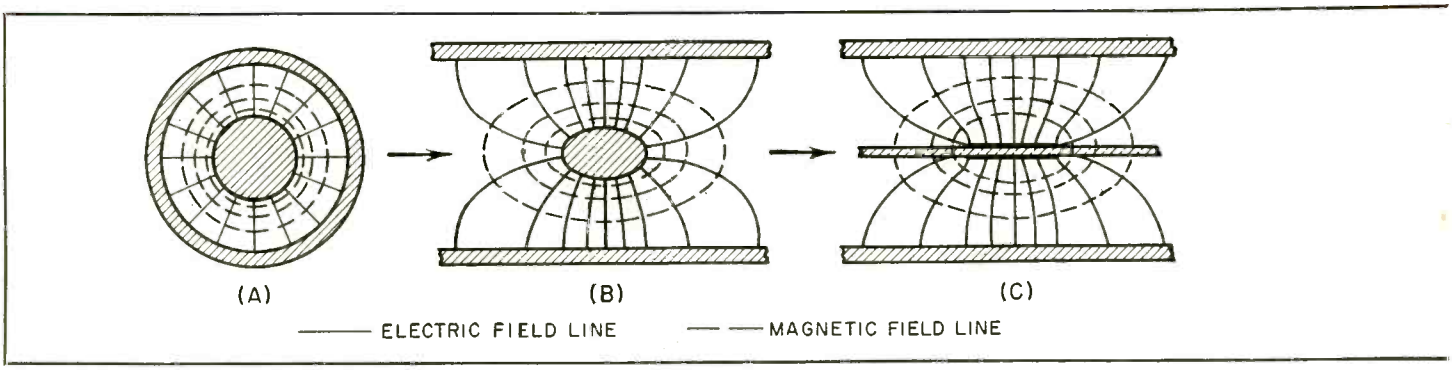
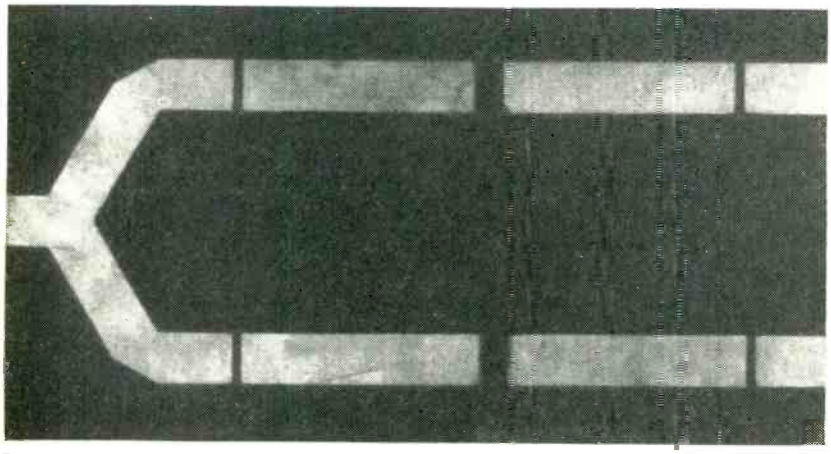
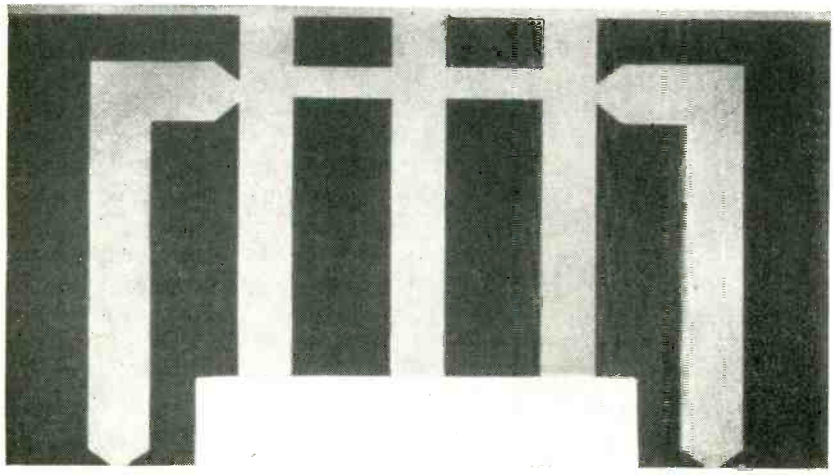


FIG. 1—Diagram shows the evolution of high-Q strip transmission line from coaxial line (A), slab line (B), to final form at (C)

Copper-clad dielectrics allow machine fabrication of microwave components. Practical physical size is only limit on top frequency for transmission line which has been operated up to 10 kmc. Uses include high-Q applications such as filters and resonators



Branching filter with one input and two outputs has 2-db insertion loss



A three-section bandpass filter of quarter-wave elements

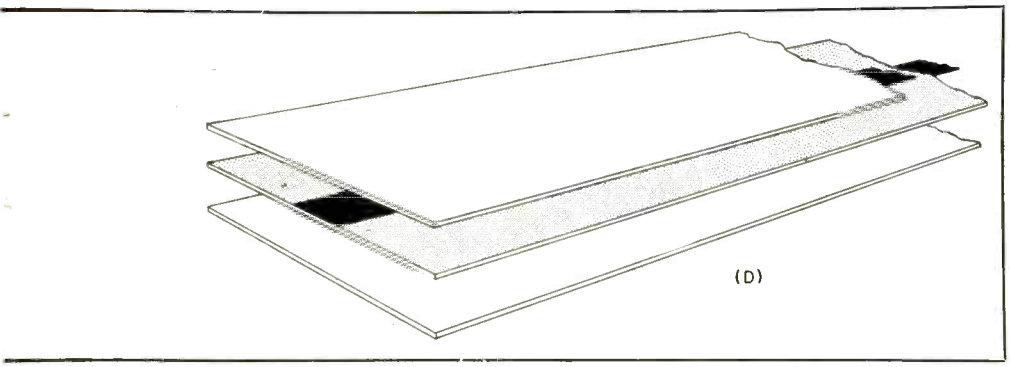
ETCHING of electronic circuits and the printing of components have been confined mostly to those applications involving lumped-constant circuits. More recently the application of these techniques to microwave circuits has begun. Such applications are inherently most successful in the case of planar structures and for this reason have resulted in the exploitation of strip transmission lines.

This type of transmission line, comprising a conducting strip located in fixed relation to a ground plane or planes, has been known for many years. Because it offers no advantages in performance over more conventional types, its use has awaited the advent of these fabrication methods.

Construction

Although strip transmission lines have been described in recent literature[1,2], they have been too lossy for applications where a high-Q is desired, such as in filters and resonators. A new type of strip transmission line will be described, which has low losses and consequently is suitable for use in

Strip Transmission Line



and sketch of final form at (D) showing conducting strip in black

By K. S. PACKARD

Airborne Instruments Laboratory, Inc.
Mineola, New York

resonant structures. It is the semi-closed symmetrical type wherein the conducting strip is centrally located between two ground planes as shown in Fig. 1.

The essential feature of this line is the splitting of the conducting strip into an upper and lower half so that a supporting dielectric sheet may be placed between. If the two halves of the strip are maintained at the same potential, no electric field (except for fringing effects) exists in the dielectric and dielectric losses are negligible.

In most cases it is sufficient to connect the two halves of the strip together at the input and output connectors to ensure that they will be at the same potential everywhere. The dielectric sheet supporting the strip may be held in a central location by means of supporting members external to the electric field. Therefore, the losses are essentially the conductor losses and are of the same order of magnitude as the losses in air-filled coaxial line and waveguide.

Modes

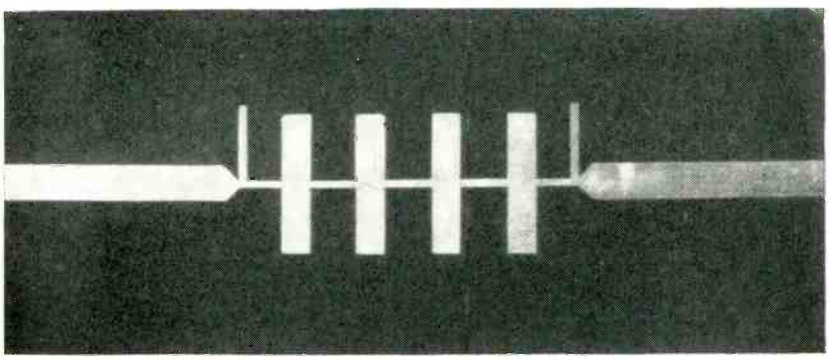
The mode of transmission is TEM and since the conductor losses decrease as the physical size is increased, the largest practical size of the line would be desirable. However, if the plate separation is made too great, higher modes may be propagated. Some of the modes may be prevented by keeping the plate separation less than one-half wavelength at the highest frequency to be used so that for these modes the parallel plane system is a waveguide below cutoff. In addition, the path length around the perimeter of the center strip must be less than a wavelength so that higher modes will not be propagated.

These limitations are similar to those encountered in coaxial line and in most cases are not too severe. Thus the upper-frequency limit for this type of transmission line is chiefly a question of practical size and tolerances. A ground plane spacing of one-quarter inch is reasonable and this has been used up to 10 kmc. There is no low-frequency limit except that the length of resonant elements becomes impractical below about 100 mc.

Characteristic Impedance

This structure may be considered equivalent to a line having a solid center strip of equal thickness. The characteristic impedance of such a transmission line is shown in Fig. 2, where several different strip thicknesses are indicated. These curves are calculated for a solid center strip, but experimental results show that they hold for the dielectric-supported strip with only a 1-percent deviation. These results are true for relatively thin strips and a characteristic impedance in the neighborhood of 50 ohms.

For very thick strips or very narrow strips (high characteristic impedance) the fringing effect would be relatively greater and therefore the effect of the dielectric would be greater. For most practical applications the strip thickness t or more precisely the ratio t/D, where D is the separation between ground planes, may be kept



Low-pass filter with the narrow tabs at either end of the strip-transmission-line-equivalent of *m*-derived sections to control performance near cutoff

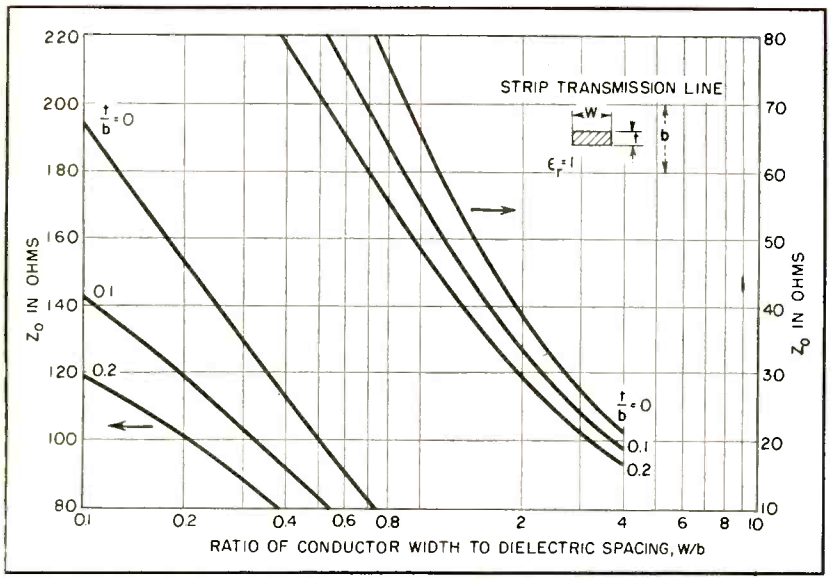


FIG. 2—Characteristic impedance of balanced strip transmission line with several different strip thicknesses

below 0.1. In this case, for characteristic impedances below 100 ohms, the assumption that the center strip is solid is sufficiently accurate.

Attenuation

The attenuation off to the side of the center strip may be considered as the attenuation of the TM_{11} mode in a waveguide below cutoff. Thus the attenuation in a direction perpendicular to the longitudinal direction of the strip is $54/2D$ db per unit length, which is a rather high rate of attenuation. One result of this high attenuation rate is that very sharp bends may be made in the center strip without introducing radiation losses.

Another result is that two transmission paths may be physically close together without having significant interaction. These results permit the design of a complex circuit or system that may be compressed into a small space. The use of resonant lengths of line at frequencies in the vhf region is facilitated by the fact that they may be coiled or bent in the plane of the strip so as to be in a more practical form.

Tolerances

Although the characteristic impedance is not generally of a critical nature, this line has the same sort of logarithmic dimensional dependence possessed by many other transmission systems. In the neighborhood of 50 ohms the percentage variation in the characteristic impedance is only 0.36 times the percentage variation in the linear dimensions.

The criticalness of centering is of greater importance, but small deviations introduce negligible coupling to undesired radiating modes. The theoretical dependence on centering has not been fully worked out as yet, but a variation of ± 0.020 in. for 0.500-in. ground plane spacing produces no noticeable effects. Therefore, the centering tolerance does not produce any practical difficulties.

The only really important tolerance is on the longitudinal tilt of the center strip, but even in this instance, close tolerances need only be maintained in certain special cases. The effect of tilt is to generate higher, radiating modes resulting in a loss of energy. This loss is not important in many low-Q applications, but for high-Q circuits a tilt of 0.5 degree can reduce the Q by fifty percent. The use of posts to connect the ground planes together in the vicinity of the strip will suppress these modes and with proper spacing, a tilt of 1 degree has no effect.

The planar form of this transmission line as well as the field configuration permit the convenient introduction of various tuning and attenuating devices. These may have either rotary or translational motion. In either case the control mechanism may pass through or between the ground planes without affecting the field. In this way flap attenuators, variable capacitors, sliding shorts and other similar devices may be included

Because one pair of ground planes suffices for a complete r-f system, several economies and conveniences result. The complete system is embodied in the strip conductor pattern, which may be fabricated in its entirety in the manner of lumped-constant printed circuits. The support structure, tuning mechanisms and vacuum tubes may be mounted on the ground planes.

The assembly of the complete system is simple and noncritical. Due to the absence of intervening walls between the various components there is a saving in size and weight.

Filters

Successful applications of this strip transmission line include various types of filters, the r-f portion of a radar receiver and the r-f portion of a microwave link equipment. Some of these filters are shown in the photographs of center strips fabricated from copper-clad dielectric.

One of these is a low-pass filter comprising series inductive and shunt capacitive sections. The second is a three-element bandpass filter. This uses conductively coupled quarter-wave elements and may be tuned over a broad frequency range. The other is a branching filter with about 2-db insertion loss and more than 60-db isolation between the two output terminals. This filter operates at about 2 kmc and the branches are separated by 68 mc.

The work described is the result of efforts of the Special Devices Section of the Airborne Instruments Laboratory under the guidance of E. G. Fubini and W. E. Fromm. Acknowledgement is also due to S. Cohn for information relative to Fig. 2.

References

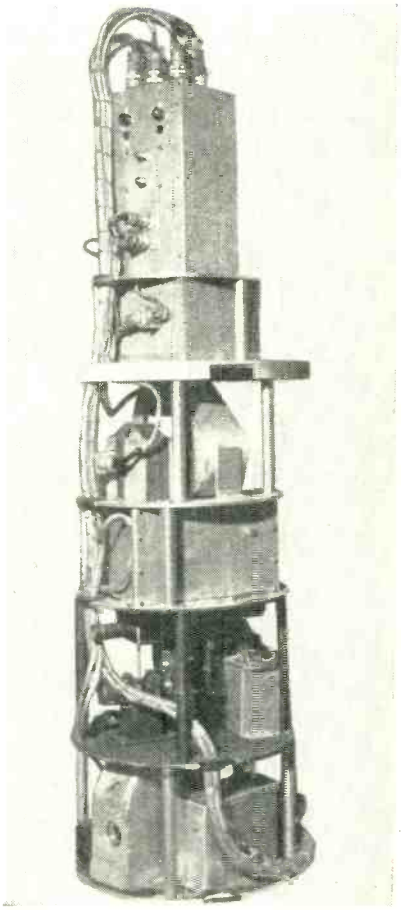
(1) R. M. Barrett, Etched Sheets Serve as Microwave Components, ELECTRONICS, p 114, June 1952.
(2) D. D. Grieg, and H. F. Engelmann, Microstrip—A New Transmission Technique for the Kilomegacycle Range, *Proc IRE*, p 1,644, Dec. 1952.

Rocket-Borne Photometer Measures Sky Light

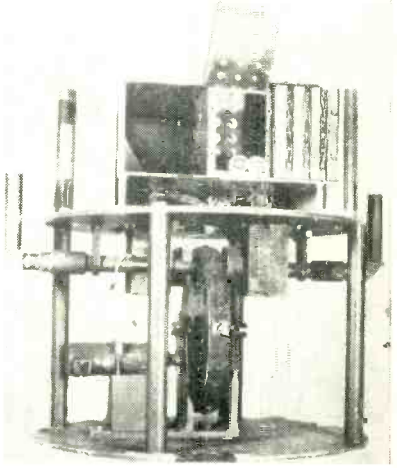
Spectral and intensity characteristics of sky at different altitudes over eight regions of visible spectrum are sampled. Sensitivity of system is automatically varied to accommodate different signal levels

By A. CORMAN and J. F. BEDINGER

Air Force Cambridge Research Center
South Boston, Massachusetts



Photometer ready for installation in Aerobee rocket. Units are, from top to bottom: missile control box; 28-v battery; 16-mm camera; phototube high-voltage supply; rotating filter disk and entrance optics; 16-mm camera



Light collimator and rotating filter disk; pressurized high-voltage battery box (above) showing method of packing miniature batteries

MODERN ADVANCES in air transportation have greatly increased interest in the properties of the atmosphere at high altitudes. Such advances have also afforded a means of directly measuring some atmospheric properties which had previously been difficult or impossible to measure from lower altitudes. The instruments to be described were installed in high-altitude sounding rockets at Holloman Research and Development Center, New Mexico to determine the intensity and spectral characteristics of the light of the day sky from the ground to altitudes exceeding 70 miles.[1]

Photometric Receiver

Figure 1 is a block diagram of the basic system. All the rocket instrumentation is controlled from a blockhouse situated some distance from the launching tower. The state of the equipment can be determined at any time prior to launching by means of a system of indicator lights and calibrated voltage readings.

The rocket-borne equipment consists of a 1P21 multiplier phototube and a series of narrow-band interference filters. Eight filters are mounted on a motor-driven disk, which revolves in front of the phototube at 88 rpm. With each revolution of the disk, an intensity measurement of the sky radiation near zenith is taken in each of the eight different regions of the visible spectrum.

The photometer and associated circuits are designed to meet the rigid requirements of weight, size, ruggedness and dependability which rocket operation imposes.

The equipment has often been recovered in excellent condition and flown again.

Figure 2 is a schematic diagram of the circuit with six sensitivity ranges. For simplicity the auxiliary controls and calibration circuits have been omitted and only the basic photometer, sensitivity control and output circuits are shown.

Sensitivity

A wide sensitivity range is necessary for accurate measurements due to the great variation of the intensity of sky light with altitude. The method of obtaining the required range is restricted by the fact that the only acceptable input signal to the telemetering system is zero to five volts positive. A variety of sensitivity ranges are easily

obtained by varying either the load resistor or the voltage on the dynodes of the phototube. The latter method gives the greatest range without encountering saturation or instability in components.

Figure 3 shows the result of varying all dynode voltages simultaneously by the same amount. This method is satisfactory but imposes massive switching arrangements in the rocket equipment, as each stage must be switched independently.

To eliminate this difficulty, tests were conducted to study the effect of varying the voltage on a single dynode or on only two dynodes while the remaining dynodes were held constant. From the results of these tests, as shown in Fig. 3, it was decided that varying the voltage on dynodes 3 and 4 by the same amount while the other dynodes were held constant was sufficient for our purpose. This considerably simplified the high-voltage switching circuits.

Sensitivity changes must occur at rapid intervals and at appropriate times because of the great vertical speed of the rocket. Also, the change need only cause increased sensitivity because the skylight intensity decreases monotonically with altitude. The control device must be simple and rugged to insure dependable operation during the rocket flight. To meet these requirements, an electronic relay controlled by the photometer output was designed.

Sensitivity switch S_1, in Fig. 2, is operated by the electronic relay. Sections B and C control the voltage to the third and fourth dynodes of the phototube. Section D changes the 1P21 load resistance. This allows finer adjustment of sensitivity ranges since the supply voltage changes are discrete and determined by the batteries used. Section E monitors the sensitivity range by presenting to telemetering a known voltage identifying the switch position at all times during flight.

Both S_1 and S_2 are wafer-type gang switches and are operated by rotary stepping-drive mechanisms. The 1P21 is powered by the batteries through on-off switch S_2. Section 10 of this switch is used as an on-off monitor by producing a voltage reading at the ground-control center when the switch is on.

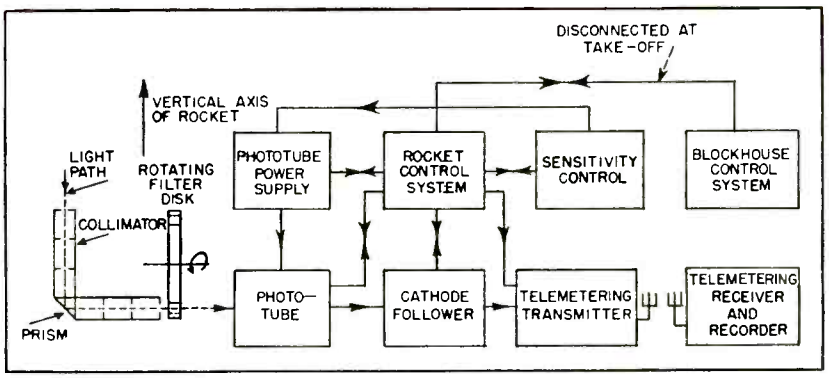


FIG. 1—Block diagram of complete rocket-borne photometer system

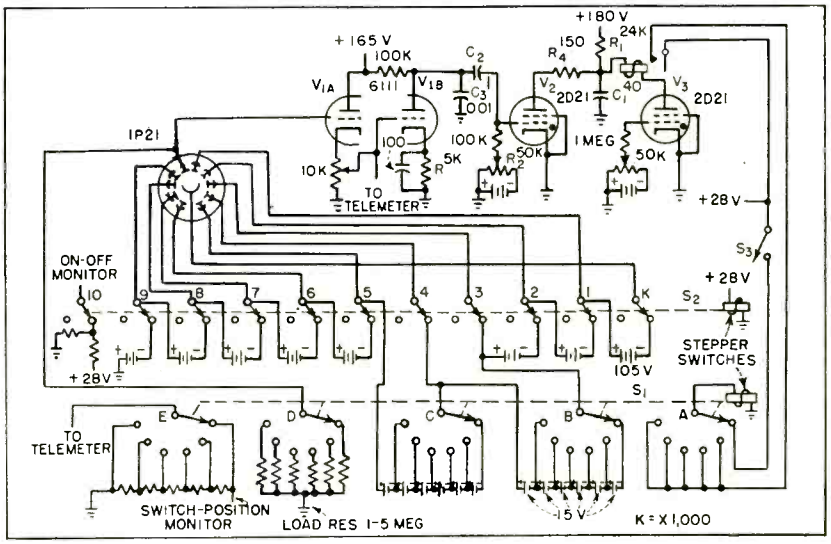


FIG. 2—Simplified schematic of photometer. Switch S_2 is energized through an on-off control switch

Control Circuit

The output of the multiplier phototube, as measured at the telemetering input, is shown in Fig. 4. The shape and amplitude of a given pulse is determined by the optical filter characteristics, speed of the rotating disk and spectral characteristics of the sky light being measured. An attempt was made with the help of neutral filters to obtain constant amplitude for all eight filters, but limitations forced acceptance of a variation of about 30 percent.

The signal must be made to conform to the telemetering input requirement which is zero to five volts across 100,000 ohms. This is accomplished with cathode follower V_{1A} whose cathode resistor is adjusted to give plus five volts output at zero input.

As the multiplier-phototube output increases, the drop across the load drives the cathode-follower grid negative until the tube cuts off. This insures that the telemetering limits are not exceeded. The resulting output is not linear but the curve is known and corrections are made when the data is analyzed.

Amplifier V_{1B} is in parallel with the telemetering input and is self-biased to a value such that a cathode-follower output of five volts, corresponding to zero phototube output, causes zero bias on the amplifier. This applies a minimum voltage to the grid of control thyratron V_2. Conversely, when the phototube output is maximum, with zero cathode-follower output, the resulting bias on the amplifier is negative driving the thyratron grid in a positive direction.

After establishing the minimum phototube output at which sensitivity is to be increased, the control

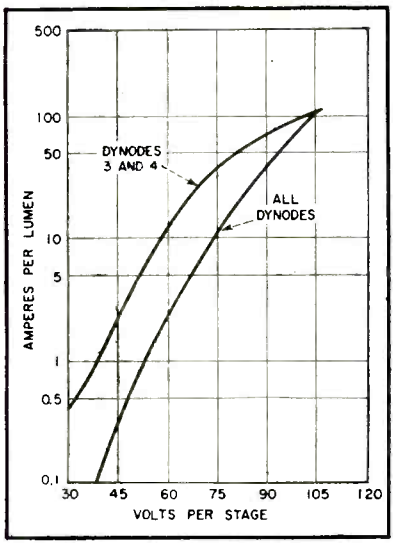


FIG. 3—Photomultiplier sensitivity versus dynode voltages

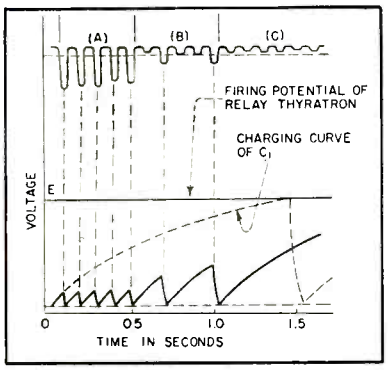


FIG. 4—Photomultiplier tube output (top) and corresponding relay-thyratron plate voltage (below)

thyratron's fixed bias is adjusted so that a phototube output greater than the minimum will drive its grid positive and fire the tube. When the output drops below this minimum value, the thyratron will remain cut off. This action of the circuit is used to control the operation of relay thyratron V_8.

Firing Point

The fixed bias of the relay thyratron is adjusted so that the tube fires at a plate potential of about 125 volts. Both thyratrons are supplied through an R-C circuit (R_1 and C_1) having a one-second time constant.

If a single pulse from the phototube is greater than the minimum value required to fire the control tube, the plate voltage on the relay tube cannot rise to its firing potential. If the signal is insufficient to fire the control tube, capacitor C_1 will charge to the firing potential of the relay tube. The plate relay, which is operated by the action of the relay thyratron, activates the rotary sensitivity switch and the voltages on dynodes 3 and 4 are increased by 15 volts each. This raises the phototube output, which in turn drives the control-thyratron grid positive, firing the tube and cutting off the relay tube. If a single step in sensitivity is not sufficient, the relay tube will act as a relaxation oscillator and fire again as C_1 is recharged.

To prevent recycling of the sensitivity switch, the associated relay is powered through section A of S_1. When this switch has reached the position of maximum sensitivity, the relay circuit is opened and subsequent firing of the relay tube has no effect. The switch can be recycled during preflight operation by means of S_3, which is located in the blockhouse control unit for the equipment.

As the operation of the sensitivity switch is dependent upon the time constants of the circuit, its range is widely adjustable. In this case the output pulse of the multiplier phototube for a given filter is repeated once per second. The relay tube is adjusted to fire at a 1.5-second rate. Thus if the output from any one filter remains above the desired minimum potential, V_2 will fire rapidly enough to maintain V_3 at cutoff.

Figure 4 shows the thyratron plate voltages and firing characteristics with varying sky-light intensity. Section A of Fig. 4 depicts a high signal which fires the control thyratron on each pulse. In section B, some of the pulses are below the minimum value indicated by the dotted line at 4 volts and will not fire V_2. This allows C_1 to continue to charge until a strong pulse fires the tube.

Section C shows the signal for all filters less than the minimum value. Thus C_1 charges as shown by the dotted curve. The relay thyratron will fire at the potential E initiating the operation of the sensitivity switch which increases the multiplier-phototube supply voltage and consequently restoring the signal to a value similar to that in section A.

The bias of amplifier V_{1B} is determined by its cathode resistor, giving maximum swing in plate current for the zero to five-volt input. The size of the coupling capacitor C_2 and cathode-bypass capacitor is determined by the square-wave frequency to be passed. In this case the fundamental frequency is about 10 cps therefore the capacitors are large. Capacitor C_8 is an r-f bypass to prevent stray pickup from triggering the control thyratron.

The control thyratron maximum can be adjusted by R_2 to fire on any pulse represented by a signal of from 5.0 to 2.5 volts from the cathode follower. The firing rate of switching thyratron V_3 is adjusted by R_1.

It was found that the plate-relay resistance and current-limiting resistor R_4 had to be kept below 200 ohms to permit extinction of the tubes when C_1 discharged. The plate relay has a 3,470-turn coil and a resistance of 60 ohms. Chattering of the relay contact arms under vibration was remedied by removing the contacts and replacing them with a miniature Micro Switch.

Power Supply

The phototube operates from a constant and dependable high-voltage source consisting of miniature hearing-aid batteries chosen to conform to size and weight requirements. However, these batteries do not have the current capacity necessary for a stable voltage-divider system as generally used with multiplier phototubes. Therefore, each dynode is supplied separately from a battery as shown in Fig. 2.

The thyratrons are powered from an independent plate supply to insure constancy in the cathode follower characteristics when the thyratrons are firing.

The authors thank their associates in the Atmospheric Visibility Section of the Geophysics Research Directorate for their helpful attitude toward the design of the equipment and the preparation of this manuscript.

Reference

(1) H. A. Miley, E. H. Cullington and J. F. Bedinger, Day Sky Brightness Measured by Rocket-Borne Photometers, *Trans Amer Geophys Union*, 34, p 680, Oct. 1953.

Crystals Reduce

Intermodulation interference caused by stations close in frequency located in same geographical area can be eliminated or reduced by using quartz crystals as radio-frequency filters between antenna and first stage of mobile radio receivers

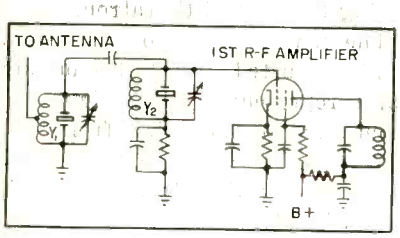


FIG. 1—Simplified circuit of first r-f stage shows crystal filters. Either or both units can be employed

By ARTHUR G. MANKE and RICHARD T. MYERS

General Electric Co.
Syracuse, N. Y.

RAPID GROWTH of mobile communications and the system used of assigning a block of frequencies for a specific class of users have increased the problem of intermodulation interference. These conditions have resulted in a closer study of the mechanism by which intermodulation takes place. This work has stimulated additional study of mechanical or crystal-filter circuits.

With information now available, the receiver intermodulation problem can be disposed of entirely where it results from not more than four signals and for operating frequencies up to 54 mc. Cost increase in the receiver is moderate. For frequencies up to 170 mc, a considerable reduction in intermodulation in the receiver can be accomplished at an equally moderate cost increase.

The intermodulation problem results primarily from the fact that most receivers have a broad passband preceding the first grid. In addition, the relationship of grid voltage to plate current in the r-f amplifier is not linear. Radio-frequency amplifier tubes while operating as amplifiers are also detectors, especially during relatively large grid swing.

A common case of intermodulation can be illustrated by a simple numerical example. Consider three adjacent channels—*A* 41.420, *B* 41.460 and *C* 41.500 mc. Since these frequencies are close, the usual antenna transformer will pass the three signals to the grid of the r-f amplifier tube without discrimination. It is assumed that 41.460 and 41.500 are fairly strong signals—in the order of 1,000 microvolts. The second harmonic of 41.460 will be 82.920 mc. If this beats with the higher-frequency signal, the resulting frequency will be 82.920 minus 41.500 = 41.420 mc, which is a signal exactly one channel lower in frequency than 41.460 mc.

This artificial carrier will have modulation from channels *B* and *C*. It is therefore a potent source of interference and may be in addition a strong carrier as it is usually in the order of only 65 db down from the carriers that produce the intermodulation signal. Likewise, the intermodulation product may fall one channel higher than 41.500 mc, or on a channel *D* (41.540 mc), when it is produced by the second harmonic of the 41.500-mc signal beating with the 41.460-mc signal.

Since the average communications receiver on 40-kc channels has an intermodulation ratio in the range of 60 to 66 db and the average communications receiver used on 20-kc channels has an intermodulation characteristic in the order of 48 to 56 db, the problem is frequently serious, depending upon geographical location of station or mobile transmitters.

A calculation of received signal strength on the basis of 50-watt stations having 100-foot antenna towers with stations *B* and *C* on the same building results in a condition wherein the intermodulation signal produced on channels *A* and *D* (owing to transmitters *B* and *C* being on the air at the same time) is equivalent to a one-microvolt signal at a radius of 1.5 miles in the case of a mobile and a signal of 5 microvolts for a station receiver with a 100-ft tower.

The condition cited exists in both the 25-to-50 and the 152-to-174 mc range, although it is more frequent in the upper band.

Quartz Filters

In a search for more selective devices without disadvantages of size, expense and loss of cavities, an answer has been found in the use of standard piezoelectric quartz crystals properly applied to the circuit or circuits preceding the first grid. Crystals cause a negligible loss in the input circuit at the desired frequency and are available with proper temperature characteristics. The circuit in Fig. 1 shows that for series resonance of the crystal each coil of the antenna transformer will be loaded

Mobile Interference

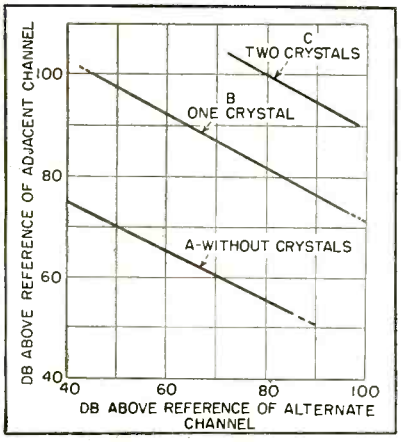


FIG. 2—Intermodulation characteristics of commercial mobile receiver without filter (A), using one crystal (B) and with two crystals (C)

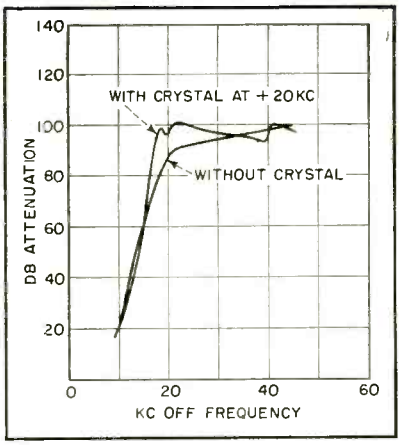


FIG. 3—Typical desensitization curve for receiver tuned to 43-mc channel, showing improvement with crystal in use as radio-frequency filter

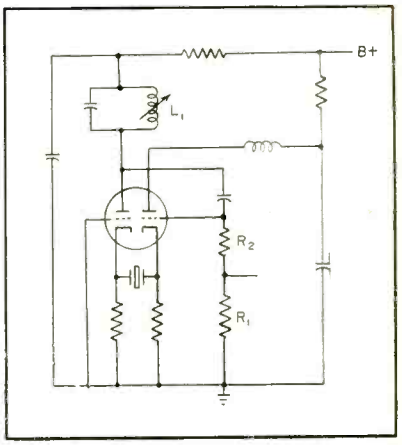


FIG. 4—Series-resonant frequency of crystal is checked by tuning L_1 for maximum grid current in R_2 and measuring frequency

with the equivalent resistance of the crystal (approximately 30 ohms for undesired frequencies), which is an effective short-circuit across each winding of the antenna transformer at the undesired carrier frequency (channels *B* and *C*).

Impedances of the coils in the antenna transformer are in the order of 100,000 ohms. Consequently, at crystal resonance, transmission of carrier through this transformer is determined largely by stray coupling and ground currents that can be reduced essentially to zero by proper mechanical design of the antenna transformer. Within a 20-kc channel, crystals will also pass through parallel resonance, at a slightly higher frequency than series resonance. At parallel resonance crystals have an absorption effect that broadens the effective frequency spectrum over which the crystals disable the antenna transformer.

Double Filtering

For severe cases of intermodulation, a crystal is used across each coil of the double-tuned preselector. For the case cited, crystal Y_1 would have its series resonance adjusted to 41.460 mc and crystal Y_2 to 41.500 mc, or vice versa. Standard third-mode crystals are sharp enough to be used on adjacent 20-kc channels in the 25-to-50 mc band with negligible loss to the desired signal.

The intermodulation characteristic of a standard commercial receiver is shown in Fig. 2. The receiver without crystals in the antenna transformer is represented by curve *A*. Response with crystal Y_1 added is given at *B* and the intermodulation characteristic with both crystals Y_1 and Y_2 in curve *C*. In the 25-to-50 mc band and for adjacent-channel signals the use of crystals Y_1 and Y_2 results in no intermodulation interference for 50-watt transmitters even though the stations are located so close together that break-through occurs on a receiver having a two-signal performance selectivity of 75 db. This means that further reduction of intermodulation would not improve reception conditions. This information is also available from curve *C*, since the intermodulation ratio for equal values of signal is 93 db.

When the same technique is applied to stations operating in the 150-to-160 mc band, considerable improvement in intermodulation ratios can also be accomplished. Series resistances of the best crystals obtainable at this time, however, are above 100 ohms and the circuit impedance (QX_c) of the input circuit to the first r-f amplifier is appreciably less. With 60-kc channels, 5th and 7th-mode crystals are sharp enough to avoid loading the input circuit at the desired frequency by the series-resonant crystal on the undesired frequency.

Improving Attenuation

With severe desensitization of either adjacent channel or for any frequency within the pass-band of the antenna transformer, the low resistance of the crystal at series resonance improves the desensitization characteristic of the receiver. Crystal Y_2 is applied to the secondary winding of the antenna transformer shown in the circuit of Fig. 1.

Where a single crystal is used, improvement obtained in desensitization for an adjacent 20-kc channel is 10 to 15 db. Should a further improvement in desensitization be desired, another 10 db can be obtained by placing a series-resonant crystal across the resonant circuit associated with the antenna (Y_1).

A typical desensitization curve is shown in Fig. 3. Only crystal Y_2 was used. The series-resonant frequency of the crystals for this application can be obtained by connecting the crystal in the cathode-type oscillator circuit shown in Fig. 4. Frequency of the oscillator is measured after tuning L_1 for maximum grid current in R_2.

Magnetic-Tape Pickup

Electron-beam head with perpendicular core structure provides equalized playback response of 0 to 10,000 cps at tape speed of 3 feet per second. Device useful in industrial and other applications requiring low-frequency recording

By J. WARREN GRATIAN

Research and Development Department
Stromberg-Carlson Company
Rochester, New York

RECENTLY PUBLISHED PAPERS on the use of the electron-beam tube for magnetic-tape playback have dealt primarily with longitudinal-type recording systems.[1,2] The disadvantage of the longitudinal system for certain instrumentation problems is that overall low-frequency response depends upon the wavelength of the recorded signal. The magnitude of the flux intercepted by the pickup core falls rapidly as the wavelength of the recorded signal becomes greater than the physical dimensions of the pickup.[3] Hence, even though the electron-beam tube provides a voltage output proportional to flux through the tube, true d-c response can be achieved only when some magnetic recording method other than longitudinal is employed.

The perpendicular-type core structure in combination with the electron-beam tube[1] provides an equalized response range from 0 to 10,000 cps at a tape speed of three feet per second with a signal-to-noise ratio exceeding 40 db. The core was developed with particular attention to problems associated with the use of commercial coated tape. It was found that phase distortion could be minimized by centering the magnetic tape-coating between the faces of the perpendicular-type pole pieces.

Phase Relationships

When the magnetic coating of a recording medium is not centered between the pole faces of a perpendicular-type recording head, an appreciable longitudinal component is recorded in addition to the desired perpendicular component. This results from the fact that the fringing flux at the trailing edge of the recording gap (at which point the final remanent induction in the tape is determined) is perpendicular to the pole faces and recording medium only in that plane which is equidistant from the two pole faces. The manner in which these two components of magnetization combine in playback to produce phase distortion is illustrated in Fig. 1. Assume recording conditions have been such that the internal inductions representing the perpendicular and longitudinal components are in phase as indicated in Fig. 1A, B, C, D and E. In the case of perpendicular magnetization, internal induction, surface induction and flux through the perpendicular pickup, are in phase regardless of the centering of the tape coating between the pole faces.

For longitudinal magnetization, the internal induction and the flux through the ring-type pickup are in phase. The polarity or direction of the flux through the pickup in relation to that within the tape is of no significance here. However, as indicated in Fig. 1G, surface induction is displaced 90 degrees with respect to the internal induction of the medium. Although due to longitudinal magnetization, the surface induction is directed perpendicular to the medium and will produce a net component in the perpendicular pickup when S_1 is not equal to S_2. This component of the pickup response is 90 degrees (or 270 degrees) out of

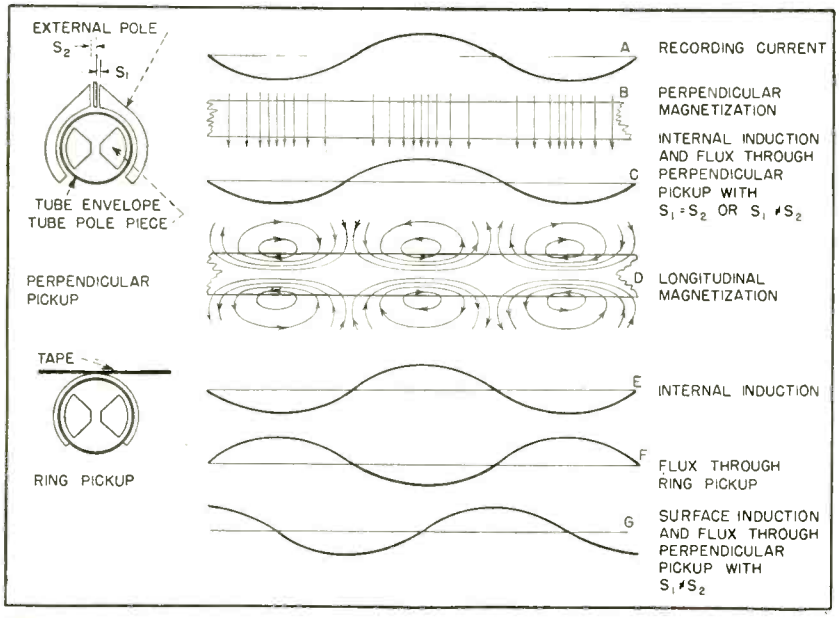
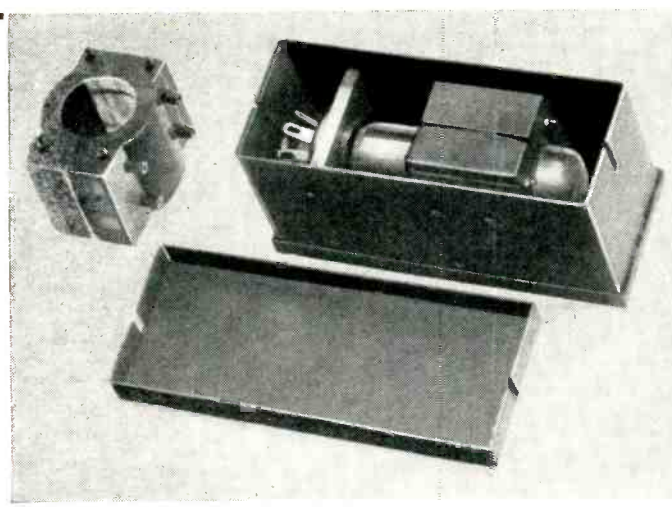
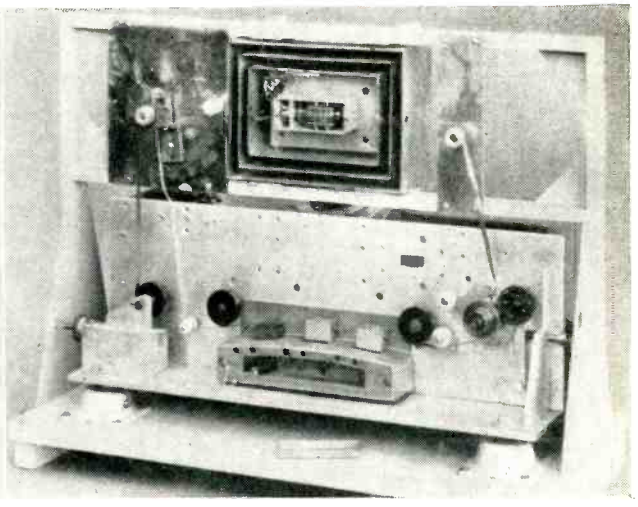


FIG. 1—Phase relations in longitudinal and perpendicular recording

Has D-C Response



Perpendicular-type core and electron-beam pickup with shield



Electron-beam pickup mounted on loop-drive mechanism

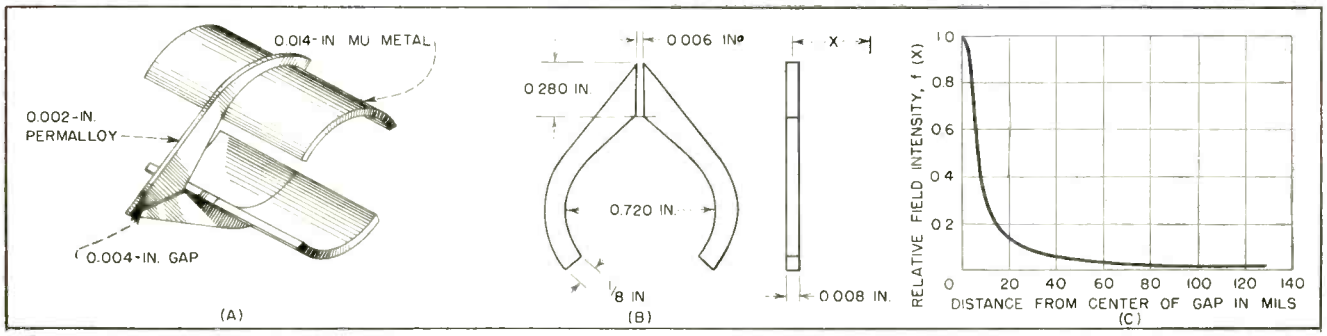


FIG. 2—Magnetic-core structure (A) of electron-beam pickup; typical pole piece (B) and associated field distribution curve (C)

phase with that due to perpendicular magnetization of the medium.

At shorter wavelengths, comparable with the effective pole-piece dimensions, the flux pickup due to longitudinal magnetization becomes significant. It adds substantially to the high-frequency output which would be obtained from perpendicular magnetization alone. However, since the two components are displaced 90 degrees in phase, reproduced complex waveforms will exhibit phase distortion. Thus, the two components may be utilized to provide improved high-frequency response for applications where phase distortion can be tolerated, but for those cases in which phase distortion is to be avoided, the magnetic coating must be centered between the pole faces of perpendicular-type heads.

The external core structure, shown to the left in the photograph, consists of a magnetic core supported in a cast-plastic housing. A groove having a depth slightly greater than one-quarter inch is provided in the top of the housing to permit insertion of standard recording tape. One groove wall is beveled so that tape tension holds the tape against one wall of the groove and the internal pole piece, which is flush with the groove wall.

The form of the magnetic structure is shown more clearly in Fig. 2. Use of a four-mil gap length in combination with the beveled slot was dictated by two considerations:

(1) The thicknesses of the magnetic coating and nonmagnetic backing of plastic tape are approximately 0.6 mil and 1.6 mils. When the tape is operated with the backing in contact with the beveled side of the slot and the associated pole face, the tape coating is approximately centered in the playback gap; phase distortion in the reproduced signal is then negligible. Alternatively, the tape may be turned over and operated with the coating in contact with the pole face to provide improved high-frequency response for applications in which phase distortion is of no consequence.

(2) To pass through the gap, a conventional splice must be compressed considerably. A satisfactory lap splice may be made by first dipping the tape ends in toluene to remove the tape coating and then cementing the lapped ends.

C-shaped coupling pieces shown in Fig. 2A are cast into the four quarter-sections of the housing.

For some applications the use of

a wider pole piece provides more uniform response and higher output over a restricted low-frequency range. With wider pole faces the ratio of fringing flux to flux induced in the pole faces is decreased to the point at which only that flux induced in the pole faces contributes significantly to the total output of the pickup. For example, with eight-mil pole faces there is a negligible rise in output beyond one-inch recorded wavelength; by comparison, for a two-mil pole face there is a rise of three db over this range and an output which is four to seven db below that obtained with eight-mil poles.

Theoretical Response

The unequalized midrange response of the perpendicular pickup rises gradually and continuously as signal wavelength is increased; the high-frequency cutoff is relatively gradual. By contrast, a longitudinal pickup with the electron-beam tube provides a relatively wide midrange of uniform response; the high-frequency cutoff is much more abrupt. To show more clearly the reasons for these differences and to determine whether the playback gap is the controlling factor, the theoretical response of a perpendicular pickup having the nominal dimensions shown in Fig. 2B was calculated using the general theory developed by Clark and Merrill[3].

Instead of initially measuring the longitudinal component of field intensity, the perpendicular component was determined from a graphically-constructed field map for the playback gap. The curve of relative field intensity versus distance from the center of the playback gap, as obtained from the field map, is shown in Fig. 2C.

The total flux induced in the core is

$$\phi \propto \int_0^\infty f(x) \cos(2\pi x/\lambda)\, dx$$

where $f(x)$ is the relative field intensity at distance x from the center of the gap and λ is the wavelength of the recorded signal.

Assuming that tape magnetization at distances greater than 200 mils from the center of the gap contributes negligibly to the total flux, $f(x)$ may be approximated analytically to give

$$\phi \propto \int_0^8 (1.0 - 0.01x^2)(\cos 2\pi x/\lambda)dx + \int_8^{20} (0.8e^{-0.10x})(\cos 2\pi x/\lambda)dx + \int_{20}^{100} (0.2e^{-0.03x})(\cos 2\pi x/\lambda)dx + \int_{100}^{200} (0.02 - 0.0001x)(\cos 2\pi x/\lambda)dx$$

The response as calculated from the above formula is shown by the solid-line curve of Fig. 3. The dashed-line curve shows the measured response. Points have been arbitrarily shifted to the left to permit easy comparison of the shapes of the calculated and measured response curves. As measured, the response appeared to approach a minimum of approximately 14 mils instead of 11.5 mils as plotted, indicating that the actual gap length and pole-face width are somewhat greater than the nominal dimensions. The similarity in the shapes of the calculated and measured curves, however, is evidence that the shape of the response curve is controlled almost entirely by the reproducing core.

For comparison the remaining curve of Fig. 3 shows relative response as calculated from the formula

$$\text{loss} = 20 \log_{10} \frac{\pi l/\lambda}{\sin \pi l/\lambda} \text{ db}$$

This formula, which is generally used for calculating the gap loss associated with ring-type reproducing heads is true only for an ideal rectangular slit or field-distribution curve. The actual field-distribution curve for a typical perpendicular-type gap, as shown in Fig. 2C, is far from rectangular.

Fringing flux, in particular that flux which enters the sides of the pole pieces, contributes substantially to the response at longer signal wavelengths and is responsible for the continuous rise as wavelength is increased. At very long signal wavelengths, flux induced directly in the internal tube pole pieces and the C-shaped coupling pieces of the external core also contributes significantly to the total tube output. The d-c response of the tube and core with pole pieces removed from the external core is 11 db below that obtained with the pole pieces in place; at one-inch recorded wavelength the difference is approximately 29 db.

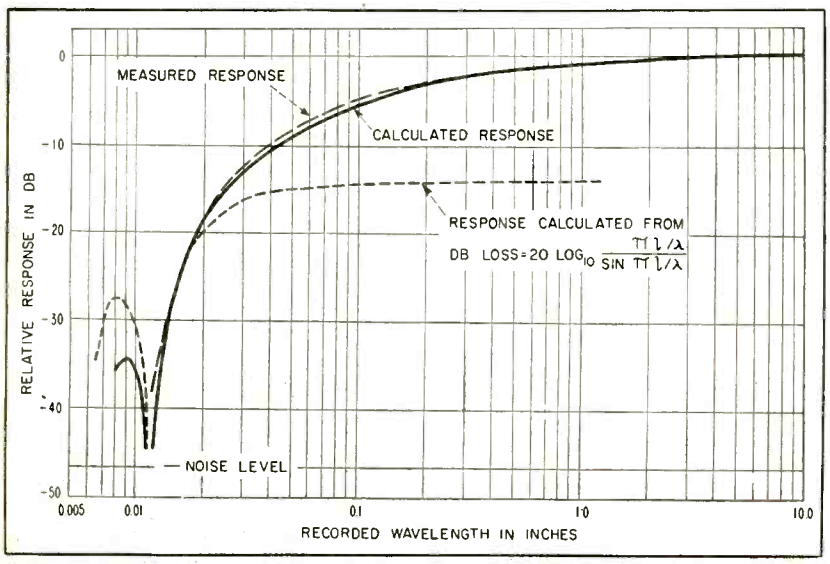


FIG. 3—Measured and calculated response curves for perpendicular pickup core

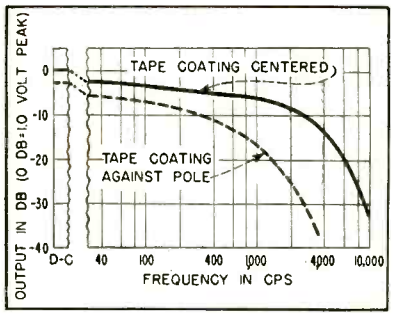


FIG. 4—Unequalized response of pickup with perpendicular core. Curves shown are for a tape speed of 3 ft per sec

Performance

The photograph shows the pickup mounted on a loop-drive mecha-

nism. A perpendicular-type recording head is mounted at the upper left. Conventional ring-type erase, record and reproduce heads are located near the lower center of the front panel. For the tests to be discussed, the tape was erased using the conventional erase head. Recordings were made with either the conventional ring recording head or the perpendicular recording head and the continuous-loop recording was reproduced by the electron-beam-tube pickup.

Figure 4 shows the overall unequalized frequency-response characteristics when using constant recording current, a perpendicular-type recording head and commercial coated tape operating at a speed of

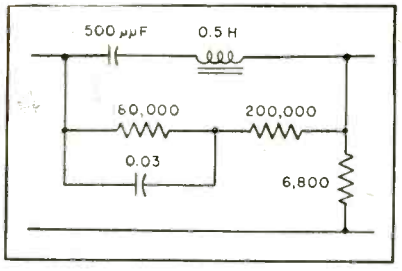


FIG. 5—High-frequency equalizer provides 35-db boost at 10 kilocycles

three feet per second. With the tape coating against one pole face, the d-c tube output is approximately one volt when operating with recording and bias currents adjusted to provide maximum output at a distortion level of three-percent third harmonic as measured at a fundamental-signal wavelength of 0.3 inch.

Equalizer

With the addition of the equalizer of Fig. 5, which provides approximately 35 db of high-frequency emphasis at 10 kc, the response was flat from 0 to 10,000 cps ± 2 db. Overall signal-to-noise ratios with the pickup tube heated by d-c were 41 db for equalized and 58 db for the unequalized unit. With a-c heating the respective signal-to-noise ratios were 40 db and 48 db. The signal level used as a reference in the figures for the unequalized system is the d-c signal output level of one volt.

Waveforms of the unequalized

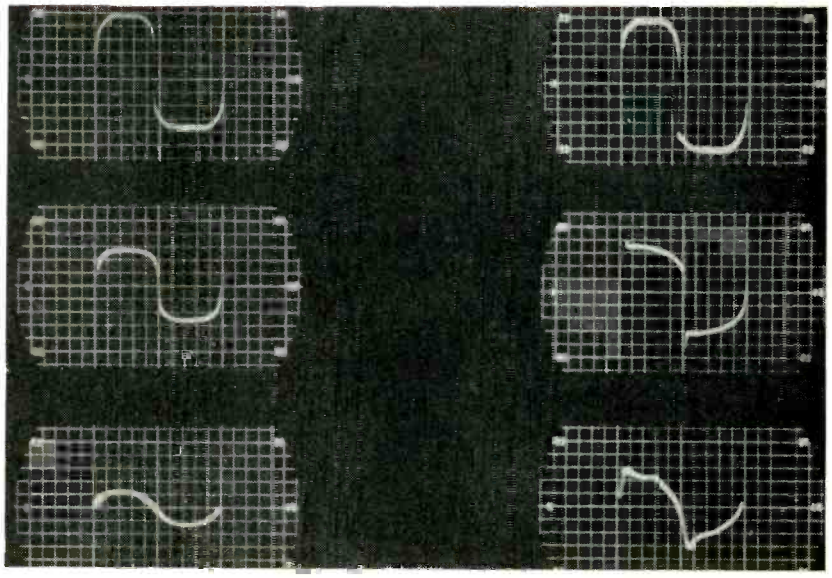


FIG. 6—Unequalized square-wave response for perpendicular-core pickup. The fundamental frequencies are 5, 50 and 500 cps for the top, middle and bottom rows. Waveforms at left were obtained with tape coating centered; those on right, with the tape coating against poles of the pickup

square-wave response of the pickup at fundamental frequencies of 5, 50 and 500 cps are shown in Fig. 6. The left-hand waveforms, which were obtained with the tape coating centered, show no appreciable phase distortion. By comparison, the right-hand waveforms, as obtained with the tape coating against one pole face of the recording and reproducing heads, show a high degree of phase distortion.

Two qualifications concerning the right-hand waveforms should be noted. The actual reproduced waveform at five cps showed a narrow spike at the reversals in polarity; this is not evident in the photographs. The general slope of the waveform at 50 cps may be controlled by offsetting the reproducing pole pieces. With an offset of 1.8 mils, phase distortion is not evident except for the narrow spike at the polarity reversals.

Applications

Prior to the development of the electron-beam tube, longitudinal recording had largely replaced perpendicular recording for two reasons. First, the high-frequency response of the perpendicular pickup is relatively poor because of the large gap required for passage of the tape. Secondly, the conventional perpendicular-type pickup, which employs a pickup coil offers no worthwhile improvement in low-frequency response. With the electron-beam tube, however, use of perpendicular recording makes it possible to attain d-c response. A system utilizing both longitudinal and perpendicular recording is most effective in applications requiring maximum high-frequency response as well as d-c response.

Acknowledgements

This work on core development at Stromberg-Carlson Company and work on tube development at National Union Radio Corporation has been sponsored by the Bureau of Ships of the U. S. Navy under Contract NObsr-57452. Individuals associated with Stromberg-Carlson Company who contributed to the work described in this paper are L. C. Holmes, N. Cole, A. W. LeBeouf, W. B. Latchford and L. L. Merrill.

REFERENCES

(1) A. M. Skellett, L. E. Loveridge and J. W. Gratian, Electron-Beam Head for Magnetic Tape Playback, ELECTRONICS, 26, p 168, Oct. 1953.
(2) J. W. Gratian, Investigation of Core Structures for the Electron-Beam Reproducing Head in Magnetic Recording, *Trans IRE-PGA*, Jan. 1954.
(3) D. L. Clark and L. L. Merrill, Field Measurements on Magnetic Recording Heads, *Proc IRE*, 35, Dec. 1947.

BIBLIOGRAPHY

D. E. Woolridge, Signal and Noise Levels in Magnetic Tape Recording, AIEE Technical Paper, p 46, Dec. 1945.
Von K. Schwarz, Beiutrag zur Klarung des Inneren Mechanismus der Magnetton-Aufzeichnung, *Frequenz*, 6, p 37, 1952.
S. J. Begun, Magnetic Field Distribution of a Ring Recording Head, *Audio Eng*, 32, Dec. 1948.

Temperature-Compensated Aircraft Fuel Gage

Compensating capacitor immersed in fuel in bottom of each aircraft fuel tank automatically corrects for changing dielectric constant of fuel with temperature, and also compensates for variations in dielectric constant of fuel itself

By ROBERT J. LEVINE *

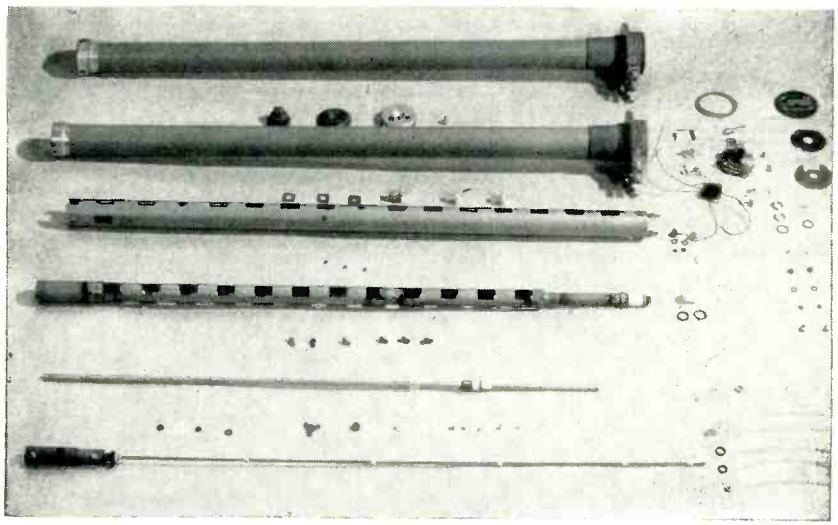
Chief Engineer
Avien-Knickerbocker, Inc.
Woodside, New York

ACCURATE measurement of fuel quantity in an airplane is one of the more difficult instrumentation problems. The most accurate and reliable gages in current use are of the capacitance type. They present a linear dial indication regardless of number or shape of fuel tanks and provide compensation for variations in the dielectric constant of the fuel being measured.

Capacitance gages sense fuel quantity by measuring the change in capacitance caused by fuel rising between two concentric metal tubes mounted in the tanks. The fuel, acting as a dielectric, causes a capacitance change which is measured in a simple servo-rebalance system. The servo is located in the fuel-gage indicator case and rotates a pointer in proportion to the capacitance change.

Liquid hydrocarbons and aircraft fuels in particular make good capacitor-dielectric materials since the dielectric constant K is about 2.0 at room temperature and bulk resistivity is in excess of 10^{15} ohm-cm.

In gaging the fuel it is desirable to indicate weight rather than volume since the energy content of the fuel is proportional to weight. A capacitance gage makes this possible because the dielectric constant of fuel is a function of the specific gravity, p. A plot of K versus p for aircraft gasolines (AN-F-48) and jet fuels (AN-F-58) is shown in Fig. 1 for a temperature range of −55 C to +70 C.



Probe of fuel gage in progressive order of disassembly

Capacitance is determined by the wetted length of the probe and the difference between the dielectric constant K of the fuel and that of air (or vapor) which is very close to a value of 1.00. The capacitance measured is therefore proportional to $K-1$.

Since the gage is calibrated in pounds the $K-1$ function must correspond to a value of specific gravity p for each value of K

thus $$K - 1 = Ip \qquad (1)$$

or

$$\frac{K-1}{p} = I \text{ (Capacitance Index)} \qquad (2)$$

If Eq. 1 is plotted in Fig 1 for mean values of K and p the slope of the curve does not fall along a line of best fit for the fuel plotted. Thus, a gage following the simple function of Eq. 1 will have inherent errors when used with fuels having values of K varying from that for which the gage was calibrated. The gage error increases by either a positive or negative amount as the difference between the actual and calibration values of K increases.

Error Elimination

To eliminate these errors, the slope of Eq. 1 must be increased to follow line CD in Fig. 1. If this line were straight the resulting value of the K axis intercept would be less than 1.0, which is not physically

*Author is now vice-president of Control Laboratories, Inc.

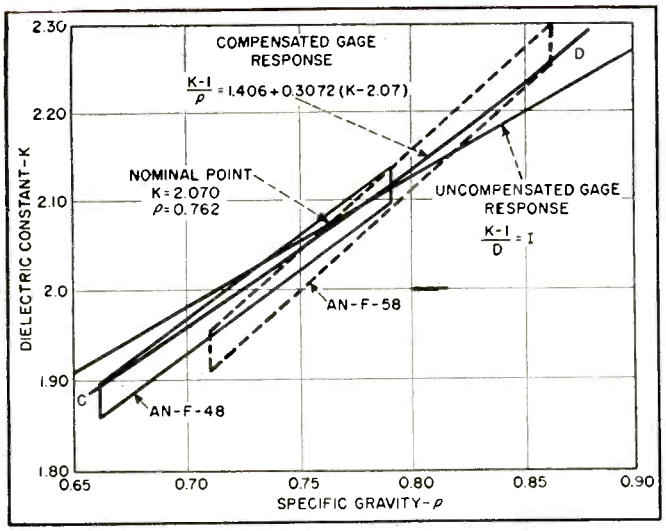


FIG. 1—Variation of dielectric constant with specific gravity. Parallelograms include 95 percent of all data points taken

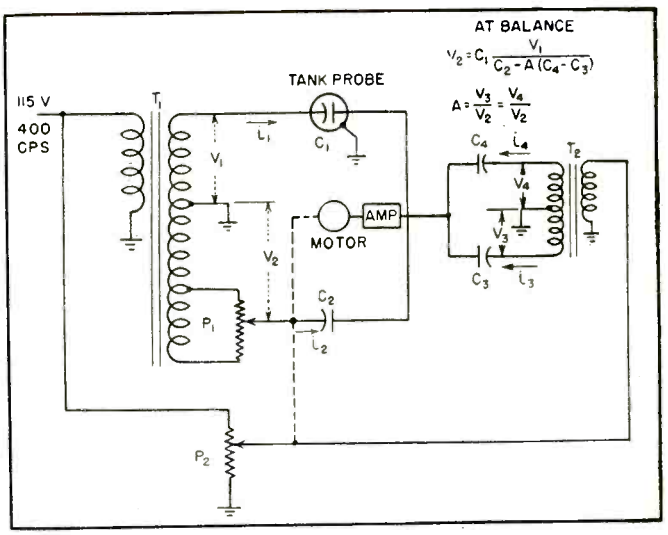


FIG. 2—Capacitance-index compensation achieved by circuit section containing capacitor C_3 normally immersed in fuel

possible. Since the value of the K intercept must remain at 1.0, the slope must increase along line CD and the gage response line must still pass through the nominal point, it is apparent that the best response line must be nonlinear.

Extensive investigation has produced a line of best fit for both fuels of Fig. 1 having the equation

$$\frac{K-1}{p} = 1.406 + 0.3072(K - 2.07) \quad (3)$$

To obtain a gage response following the form of Eq. 3, the value of K must be measured twice since it enters the equation twice. Examination of the equation reveals that the difference between it and Eq. 2 is that the right side has been multiplied by a function of $K-2.07$. The extra K function has the effect of varying the slope of the $(K-1)/p$ relationship as a function of K. Circuitwise this is accomplished by taking a separate measurement of K not affected by level, which is done by locating the extra sensing probe at the lowest part of the deepest tank, and introducing this value into the bridge circuit as an independent input. This correction measurement is known as capacitance-index compensation.

Compensating Circuit

The circuit shown in Fig. 2 illustrates a common way of achieving capacitance-index compensation. The compensation circuit consists of capacitances C_3 and C_4 connected across opposite legs of the center-tapped compensated transformer T_2. Voltage to T_2 is supplied from potentiometer P_2 which is coupled to the original rebalance potentiometer P_1. The compensator bridge circuit is arranged so that with C_3 immersed in the fuel of a nominal value of K, it will be equal to the compensator reference C_4.

Since V_3 equals V_4, the output of this bridge will be zero regardless of the input voltage when C_3 is immersed in a fuel of nominal dielectric constant. When the dielectric constant of the fuel is other than nominal, a voltage and current output from the compensator bridge circuit will be developed which is in phase opposition to the voltage and current flowing through V_1 winding and C_1. In other words, the phase of current i_3 will be opposite to the phase of current i_1. The result of this is a different rebalance voltage V_2 and thus a different dial indication since i_2 must be equal to the sum of i_1 plus i_3.

Probe at right measures capacitance change as gage at left indicates weight of remaining fuel

Capacitance index compensation can also be achieved in a slightly different manner. The compensator capacitor is connected in parallel with the reference capacitor on the opposite side of the bridge. A compensation current is thus developed which is proportional to the dielectric constant of the fuel. This compensation current is also in phase opposition to the main sensing current and thus changes the conditions of balance in the circuit.

Example

Assume a fuel having a dielectric constant of 2.25. From Fig. 1, the mean value of specific gravity for this dielectric constant is about 0.852. The dial indication that would be obtained with an uncompensated gage would be 0.890 which would result in an error of 0.038/0.852 or a reading which was 4.45 percent too high. The compensation circuit is thus required in this case to reduce the apparent density by 4.45 percent. This it does by introducing the current i_3 in phase opposition to the current i_2. The value of i_3 in the compensated circuit will reduce the apparent dielectric constant to a value of 0.855 for a total error of 3 parts in 852 or 0.35 percent from the nominal value. The compensator circuit has thus reduced the error in the fuel gage from approximately 4 percent to less than 1 percent.

Dual-Mode Horn Feed for

By D. J. LeVINE and W. SICHAK

Federal Telecommunication Laboratories
Division of International Telephone & Telegraph Corp., Nutley, N. J.

THE GENERAL multiplexing problem relates to the utilization of one or more component parts of a system to convey several channels of intelligence simultaneously and independently. Because of weight and space problems it is usually desirable to multiplex the antenna system in order to use only one radiator for several communication channels. One such system uses the decoupled properties of orthogonally polarized fields in waveguides and space.[1, 2]

The decoupling between cross-polarized fields is of interest because of its frequency independence, and because of the simplicity of the system which results from its use. Even though a cross-polarized mode radiator decouples only two channels, the 40 db or more decoupling that is obtained rather cheaply simplifies the receiver filtering problem considerably. In view of this, a dual-mode cross-polarized square-waveguide-feed horn was investigated and built.

Multimode Transmission

The orthogonal properties of either E-mode or H-mode field structures are adequately described in the literature.[3] Examination of these properties leads to the conclusion that it is possible to propagate energy in a waveguide in two or more modes, with each mode independent of the other, ideally with zero crosstalk.

Practically, the use of multimode transmission is limited by the mechanical quality of the waveguide, the type of radiation pattern desired from the end of the guide and by the types of mode launchers and filters required. Only two modes can be used if the horn and parabola are simple. Higher modes, such as the TE_{11} and TM_{11}, can be used in the waveguide but these produce unsatisfactory patterns when used with a system designed for the lowest mode. The E_0 modes, for example, would produce a cusp-shaped pattern with the zero in the direction of maximum radiation for the lowest mode.

It has been found that two-mode transmission (TE_{10}, TE_{01}) in square-cross-section waveguide, dimensioned below cutoff for all higher modes, was satisfactory. The use of standard drawn tubing for short lengths introduced no appreciable error in mode decoupling. Circular waveguide could also be used for this purpose but slight ellipticities and minor irregularities can cause gradual shifts in polarization which lead to crosstalk betwen modes.

An important point to consider in the design of a device which propagates orthogonally polarized fields in square waveguide is the cutoff relationship to higher-order modes which cross-couple the fields. A specific case of difficulty caused by higher modes arises when the standard rectangular guide width is used for the side dimensions of the square waveguide. In this case it will generally be found that it is possible to propagate a TE_{11} mode at the high-frequency end of the band when only a TE_{01} or TE_{10} is desired.

Multiplexing Unit

Basically the multiplexing unit considered herein is a device which accepts two signals, converts them into orthogonally polarized waves in square waveguide and then radiates both cross-polarized fields simultaneously.

The methods of exciting the square waveguide involve the use of tapers from rectangular guide to square guide, or coaxial probes or loops directly exciting the square guide.

The structure excited by tapers from rectangular waveguides was investigated and found to have adequate decoupling properties but poor input vswr's in each waveguide arm.

A better structure which can be used to multiplex two signals is the probe-excited square waveguide shown in Fig. 1. Test results for this are plotted in Fig. 2. In this unit, the probes are 90 deg apart and are tuned by locating their length and position with respect to the short-circuiting plug or the fins. The fins in this device are required to tune the second probe (that nearest the radiating horn) and to reduce the frequency sensitivity, since the second probe could also be tuned with respect to the short-circuit plug although through a long length of line. The probes are not placed in the same transverse plane to avoid direct probe-to-probe coupling.

The coaxial-line-excited multiplexing unit is much simpler and smaller mechanically, and has better input-impedance properties than the waveguide-fed unit. If it is necessary to run waveguide feeds, it is still possible to use this device if short waveguide-to-coaxial-line transducers can be used.

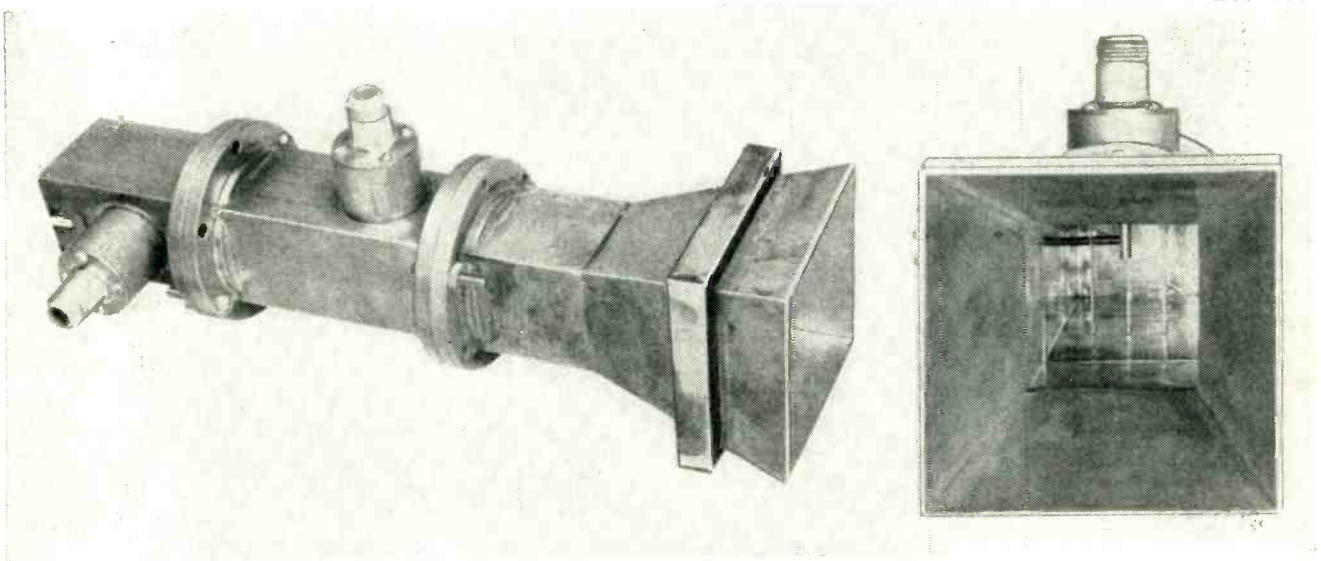
Antenna Systems

The multiplexing-unit horn can be used to illuminate a parabolic reflector either directly or through an auxiliary reflector. Figure 3A shows a square waveguide horn exciting a small primary parabolic reflector which in turn excites the large secondary parabolic reflector. This antenna is compact and easy to support but its disadvantages are that the gain is lower than other types due to spillover past the two parabolas. The side lobes are higher because of the relatively large portion of the aperture that is blocked off, and reflections from the two parabolas are high and difficult to match out without loss in gain.

Figure 3B shows a square-waveguide horn exciting an eccentric

Microwave Multiplexing

Probes 90 degrees apart in square-waveguide horn are energized with identical carrier frequencies in 4.4 to 5.1 kmc band to give two-channel transmission in two modes, with better than 50-db decoupling, for illuminating parabolic reflector of microwave link



Side and front views of horn excited by two probes. The three tuning fins are just behind first probe

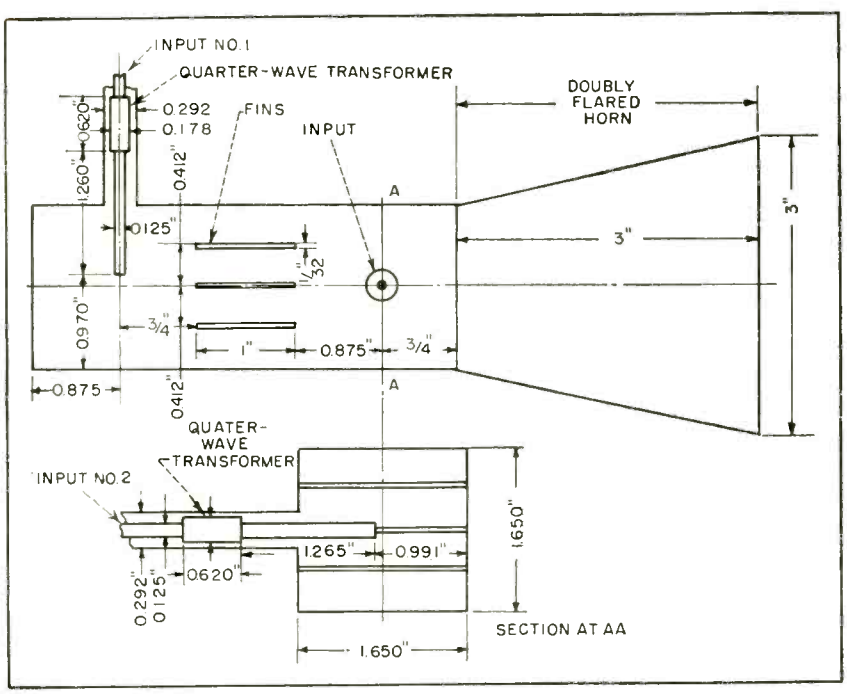


FIG. 1—Internal dimensions of probe-excited multiplexer with tuning fins

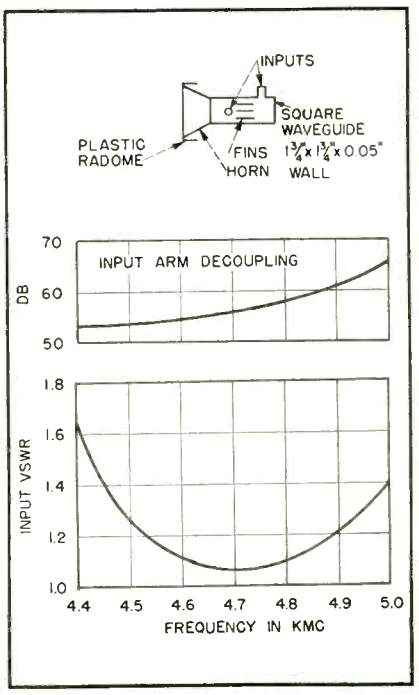


FIG. 2—Multiplexer test results

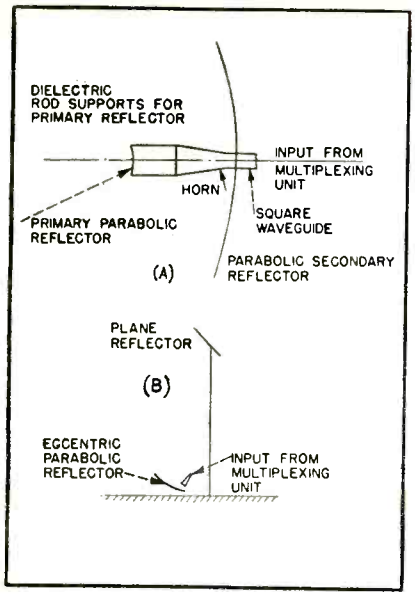


FIG. 3—Two methods of using multiplexer horn in two-channel relay system

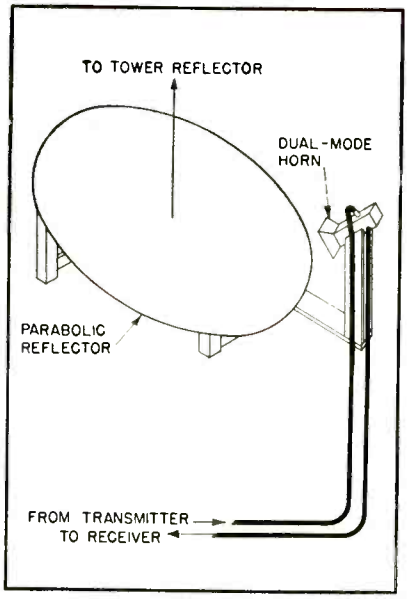


FIG. 4—Details of ground-mounted parabolic reflector used with horn

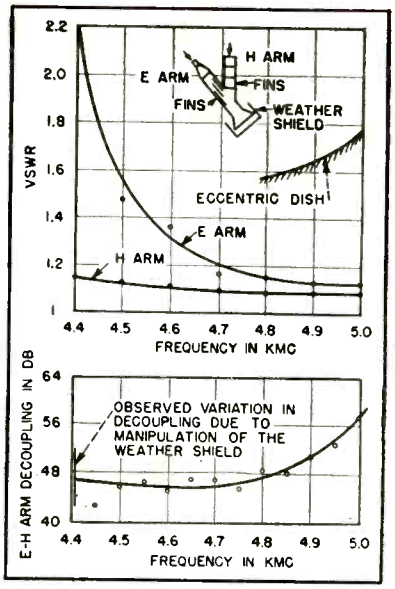


FIG. 5—Test results for mode filter and eccentric dish system

parabolic dish as part of a portable radio-relay link. This antenna is less compact than the one discussed above but its electrical characteristics are superior. The gain is high and the side lobes low because no obstructions are in the aperture, and the reflections from the parabola are very low (swr less than 1.01).

Weatherproofing and water sealing are readily accomplished by boxing the open end of the horn with some low-loss plastic. If necessary, the unit could be pressurized.

For use with radio-relay links, this antenna can be mounted directly on the tower or it can be mounted near the ground if a secondary reflector on top of the tower or mast is used, as shown in Fig. 3B and 4. A long run of transmission line between the transmitter and antenna is undesirable for high-quality links even if an r-f amplifier is used.[4] The secondary reflector system can be used with any transmitter by mounting the transmitter tube on the multiplexing horn. The distance to the mouth of the horn (the furthest source of reflections) can be made less than one foot so that long-line effects are no longer important. The extra loss (roughly 3 db for towers up to 100 feet high) due to spillover past the secondary reflector is only slightly greater than the loss in the long waveguide.

The transmission region which is most critical is that propagating the two modes. All metallic surfaces should be smooth and straight, and all unavoidable discontinuities (such as horn flares) should exhibit 90-deg symmetry. Solder joints should be positive, clean and without fillets. Metallic fin edges should be without burrs and probes should be straight and centered in the side walls.

The above requirements are not extraordinary as far as waveguide techniques are concerned, and should not be construed as limiting the use of dual-mode components in antenna systems. Several of these devices were built, observing normal machine-shop practices for fairly precise work and using stock drawn tubing for the dual-mode regions. The results were satisfactory, and indicated that broaching operations were not necessary for the dual-mode sections of tubing.

Results

In general, the decoupling between polarizations on the different units tested ranged from 35 to 55 db and the vswr on the input arms ranged from 1.0 to 2.5. The test results are plotted on Fig. 5 for a unit constructed from 2 in. x 2 in. OD 0.062-in.-wall square waveguide. This unit was waveguide-fed through tapers and exhibited decoupling greater than 40 db, good H-arm input vswr (approximately 1.1 to 1.2) and bad E-arm vswr (greater than 2). The input impedance of the E-arm was generally such that broad-band matching was very difficult.

Tests on the probe-excited square waveguide gave 50 db minimum decoupling and 1.6 maximum vswr over the 4,400-5,000-mc band (Fig. 4). These results, particularly the input vswr, could be improved with proper redesign of the probe circuits. Both inputs had the same properties. One loop-excited unit was tested, and found to have very poor decoupling properties. The probe-fed multiplexing unit thus has better input impedance properties both in magnitude and ease of matching than the waveguide taper-fed unit.

Acknowledgement is due to H. A. Augenblick and A. T. Brown for making some of the measurements described in this paper. The project itself was sponsored by the Bureau of Ships, Navy Department and the Signal Corps Engineering Laboratories.

References

1. A. B. Bronwell and R. E. Beam, "Theory and Application of Microwaves", McGraw-Hill Book Co., 1947, p 395.
2. Southworth, U. S. Patent 2,129,711, March 16, 1933; Southworth, U. S. Patent 2,129,712, Dec. 9, 1933; King, U. S. Patent 2,088,749, Oct. 30, 1935; German patent 668,231, May 26, 1935.
3. C. G. Montgomery, R. H. Dicke and E. M. Purcell, "Principles of Microwave Circuits", McGraw-Hill Book Co., 1948, p 51.
4. Lewin, Muller and Basard, Phase Distortion in Feeders, *Wireless Engineer*, p 143, May 1950.

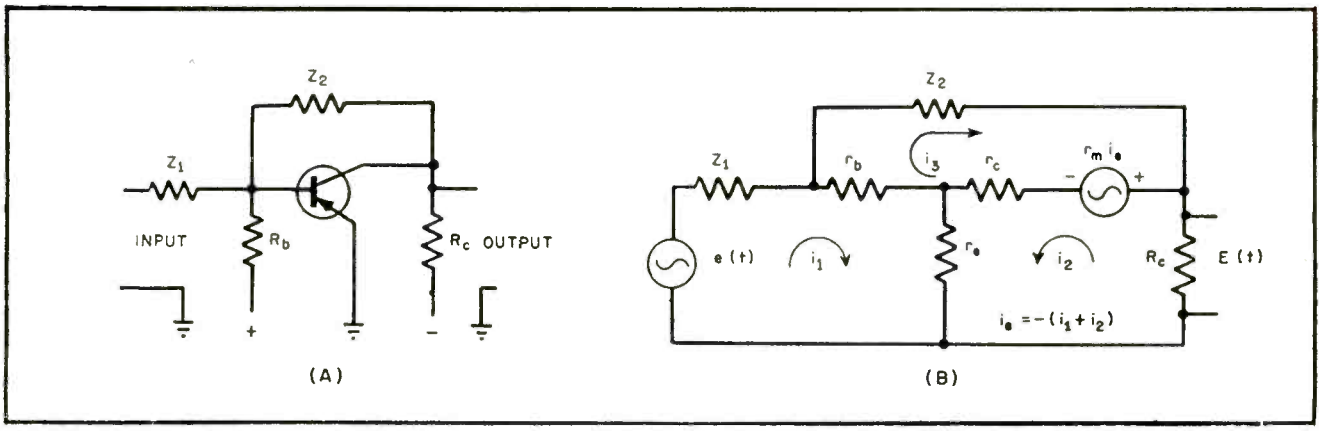


FIG. 1—Transistorized operational amplifier (A) and generalized equivalent circuit (B) assuming that the transistor parameters are resistive at the highest harmonic frequency in the output

Junction Transistor Pulse Forming Circuits

Analysis of integration and differentiation circuits using *npn* junction transistors. Practical circuits are given for saw-tooth generator, square-wave and pulse generator and triangular-wave differentiator

By J. B. OAKES

Applied Physics Laboratory
The Johns Hopkins University
Silver Spring, Maryland

DESIGN of complex systems involves use of analog elements and a need often arises for operational pulse and sinewave shaping circuits. Where accuracy requirements are not too strict, single-stage amplifiers having finite gain and employing appropriate feedback can be used for this purpose. The Miller integrator, employing capacitive plate-to-grid feedback, is one example of this type of circuit element. Similar results may be obtained using transistors as the active elements in feedback operational amplifiers. This paper shows the analytical approach used in designing several of these practical transistor operational circuits.

Circuit Analysis

In the following analysis it is assumed that small signal, linear circuit theory applies and that the low-frequency equivalent transistor circuit can be used. The second assumption implies that the transistor parameters are purely resistive at the highest harmonic frequency present in the output waveform. The validity of these assumptions depends on the agreement between calculated and experimental results.

Choice of circuit configuration is determined by a consideration of the properties required of the amplifier. The active element must have voltage gain and a phase shift of $90 < \phi < 270°$ at low frequencies. Of the three single-stage configurations, only the common-emitter circuit has these properties, assuming no phase-inverting transformer is used.

The circuit diagram for the transistorized operational amplifier is shown in Fig. 1A and the generalized equivalent circuit in Fig. 1B. Elements Z_1 and Z_2 represent the input and feedback impedances usually associated with

this type of circuit. In the usual case, it can be assumed that R_b is much greater than the input impedance of the transistor. The three loop equations for this circuit are

$$\begin{aligned} \bar{e} &= \bar{i}_1(\bar{Z}_1+r_b+r_e)+\bar{i}_2 r_e-\bar{i}_3 r_b \\ 0 &= \bar{i}_1(r_e-r_m)+\bar{i}_2(r_c+r_e+R_c-r_m) \\ &\quad +\bar{i}_3 r_c \\ 0 &= -\bar{i}_1(r_b+r_m)+\bar{i}_2(r_c-r_m) \\ &\quad +\bar{i}_3(r_b+r_c+\bar{Z}_2) \end{aligned} \qquad (1)$$

Methods of the Laplace transformation are useful in treating these circuits. Therefore, the quantities of Eq. 1 have been transformed, term by term, assuming zero initial conditions. The transformed quantities are indicated as such by the use of superbars.

The transformed output voltage $\bar{E}$ is given by $\bar{E} = -\bar{i}_2 R_c$, or, in determinant notation

$$\bar{E} = -R_c \frac{\begin{vmatrix} (\bar{Z}_1+r_b+r_e) & \bar{e} & -r_b \\ (r_e-r_m) & 0 & r_c \\ -(r_b+r_m) & 0 & (r_b+r_c+\bar{Z}_2) \end{vmatrix}}{\Delta} \qquad (2)$$

where Δ is the circuit determinant

$$\begin{vmatrix} (\bar{Z}_1+r_b+r_e) & r_e & -r_b \\ (r_e-r_m) & (r_c+r_e+R_c-r_m) & r_c \\ -(r_b+r_m) & (r_c-r_m) & (r_b+r_c+Z_2) \end{vmatrix}$$

Therefore, expanding Eq. 2

$$\bar{E} = R_c \bar{e}\,[A + (r_e - r_m)\,\bar{Z}_2]/\Delta \qquad (3)$$

where $A = (r_b r_c + r_b r_e + r_c r_e - r_b r_m)$. Eq. 3 may be used, with appropriate substitutions, to examine in detail a number of useful transistor operational circuits.

Circuit Applications

To investigate integration of step waveforms, a unit-step input is applied to the circuit of Fig. 1A. Impedance Z_1 is resistive and Z_2 is capacitive for the integrator. The substitutions $e = 1/s$, $Z_1 = R$ and $Z_2 = 1/(sC)$ are made in Eq. 3 and an inverse transformation is carried out.[1] The resultant expression is

$$E(t) \cong \frac{-R_c(r_m-r_e)}{CD}\left[1 - \exp\left(-\frac{D}{RA+R_cB}\,t\right)\right] \qquad (4)$$

where $B = A + R(r_b + r_c)$ and $D = [A + R(r_c + r_e - r_m) + R_c(r_b + r_e + R)]/C$. Therefore the output voltage for a positive unit-step input decreases exponentially to a voltage $-[R_c(r_m-r_e)]/(CD)$ with a time constant $(RA+R_cB)/D$.

An expression for the perfection of integration is obtained in the following way. A theoretically perfect integrator with phase inversion would respond to a step input with an output voltage of constant slope $dE\ (t)/dt = -k$.

The integrator analyzed in this example yields an exponentially decreasing pulse. At any time τ the deviation σ of the output from linearity is given by

$$\sigma = \frac{\left[\frac{dE(t)}{dt}\right]_{t=0} - \left[\frac{dE(t)}{dt}\right]_{t=\tau}}{\left[\frac{dE(t)}{dt}\right]_{t=0}} \qquad (5)$$

Performing the operation indicated on Eq. 4

$$\sigma = 1 - \exp\left(\frac{D}{RA+R_cB}\,\tau\right) \qquad (6)$$

The effect of internal and external circuit parameters on the

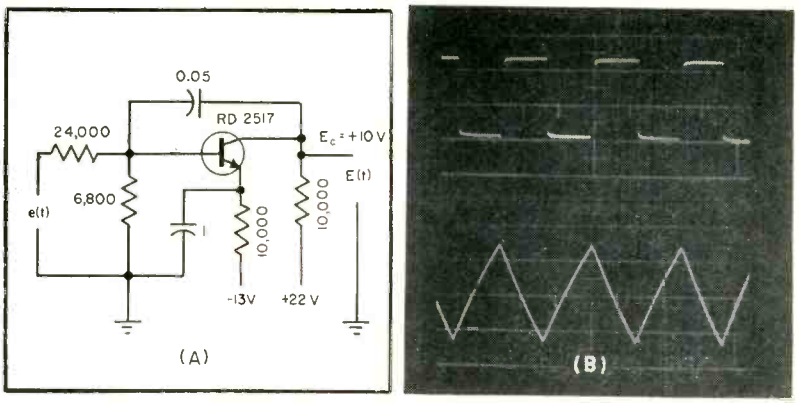


FIG. 3—Transistor circuit (A) integrates square waves with low fundamental frequencies. Waveforms (B) show 1,000-cps square-wave input and corresponding triangular-wave output

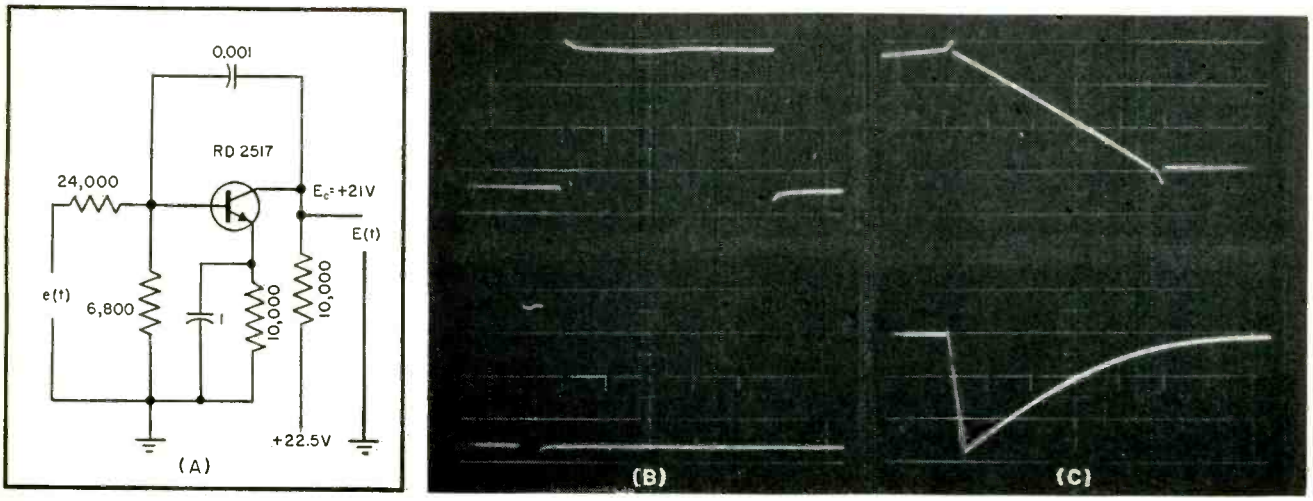


FIG. 2—Integration circuit (A) uses RD 2517 *npn* transistor. Ten microsecond positive-pulse input (B) produces saw-tooth waveform output (C). Vertical-deflection sensitivity of oscilloscope is 60 volts full scale for both input waveforms and 24 and 20 volts full scale for upper and lower output wave forms

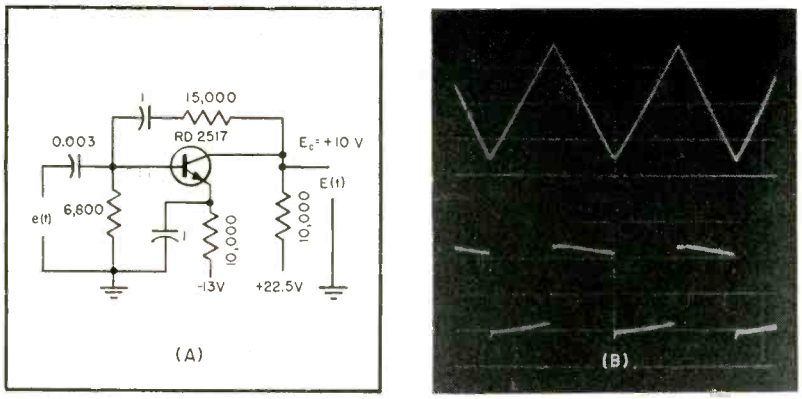


FIG. 4—Transistor differentiation circuit (A); waveforms (B) of 1,000-cps triangular-wave input and square-wave output

output waveshape may be determined by considering the initial slope S_o of the output pulse. Slope S_o is equal to the final voltage attained by the output divided by the time constant of the circuit

$$S_o = -[R_c (r_m - r_c)]/[C (RA + R_c B)] \quad (7)$$

For average transistors, this simplifies to $S_o \cong -\alpha/(RC)$ and the initial slope of the output pulse is determined only by the values of input resistor, feedback capacitor and current gain of the transistor.

Saw-Tooth Generator

As a specific circuit, consider Fig. 2A. This circuit is used for generating saw-tooth pulses from a low duty-cycle train of positive fifty-volt pulses 10 microseconds in width. The output waveform, shown in Fig. 2C has a slope of −1.8 volts per microsecond as compared with a slope of 2 volts per microsecond as calculated from Eq. 7.

The linearity of the output waveshape calculated from Eq. 6 is 3 percent. The collector voltage of +21 volts in Fig. 2A indicates a quiescent operating point near cutoff. This allows a full swing of the collector from nearly $+E_{cc}$ to 0 when a positive input pulse is applied and in addition, keeps the average power consumption low.

Negative pulses may be integrated by employing a *pnp* transistor and reversing the bias polarities.

A final consideration in the design of this circuit is the choice of the collector load resistor R_c. The value of R_c has little effect on the slope of the output saw tooth, but determines to a large extent the recovery time of the circuit since capacitor C discharges through R_c to a voltage E_c after each pulse. The upper-limit value of R_c is therefore determined by the pulse spacing while the lower-limit value is set by the maximum allowable collector dissipation.

Another application of integrators which has been considered experimentally is that of integrating square waves of a relatively low fundamental frequency. For example, the circuit of Fig. 3A is used to integrate square waves having a repetition rate of 1,000 per second. The input and output voltage waveforms are indicated in Fig. 3B.

Differentiation

To investigate differentiation of triangular waveforms, a linearly rising waveform $e(t) = kt$ is applied to the circuit of Fig. 1A. Impedance Z_1 is capacitive and Z_2 is resistive for the differentiator. The substitutions $\bar{e} = k/s^2$, $\bar{Z}_1 = 1/(sC)$ and $\bar{Z}_2 = R$ are made in Eq. 3 and an inverse transformation is carried out. The resultant expression is

$$E(t) = \frac{R_c k\,[A + R\,(r_e - r_m)]}{G}\left[1 - \exp\left(-\frac{G}{RA + R_c F}\,t\right)\right] \quad (8)$$

where $F = A + R\,(r_b + r_e)$ and $G = [A + R\,(r_c + r_e - r_m) + R_e\,(r_b + r_c + R)]/C$. Therefore the output voltage for a linearly rising input approaches a value $E_o = R_c k\,[A + R\,(r_e - r_m)]/G$ with a time constant τ whose value is $(RA + R_c F)/G$. This output should be a step function and will approach this value of E_o if τ can be made small. This can be done physically by keeping C small since G is proportional to $1/C$.

The expression for the output step height may be further simplified. If average values of the transistor parameters are considered, assumptions can be made which lead to the approximate expression

$$E_o \cong -k\,\alpha\,RC. \quad (9)$$

Thus the output step is negative when the input slope is positive and has an amplitude which depends only on the external parameters R and C, the input slope and the transistor current gain.

As a specific circuit example, consider the diagram of Fig. 4A. This circuit is used for the differentiation of a 1,000-cps triangular wave of 40-volts peak-to-peak amplitude. The measured peak-to-peak square-wave output height is 6.2 volts, while that calculated from Eq. 9 is 6.8 volts. The input and output waveforms are shown in Fig. 4B.

Additional Considerations

The practical integrator and differentiator circuits described were designed to meet the specific requirements of an a-c actuated control system. Because of this, no attempts were made to stabilize the d-c operating point of the transistors against temperature and supply voltage variations. However, such stabilization might be profitably applied in circuits where integration or differentiation of low frequency a-c or d-c voltages is required. Where the d-c output levels are important the initial circuit conditions should be inserted in Eq. 1. In cases where still more accurate operations are to be carried out, the feasibility of multistage-transistor feedback amplifiers should be considered.

This work was conducted under contract NOrd 7386, Bureau of Ordnance, Department of the Navy.

REFERENCE

(1) Gardner and Barnes, "Transients in Linear Systems," John Wiley and Sons, New York, N. Y., 1942.

Modified Color Signal

By S. K. ALTES and A. P. STERN

Electronics Division
General Electric Company
Syracuse, N. Y.

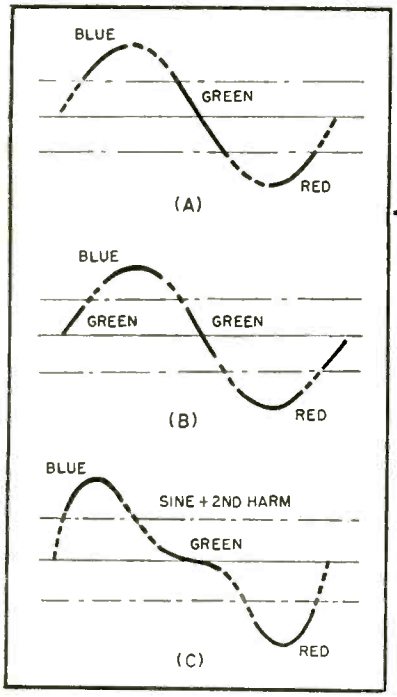


FIG. 1—Sinusoidal color-switching waveform with minimum required blanking time shown by dotted line for a sequence of three (A), sequence of four (B) and sequence of three samples per switching cycle with second-harmonic component added (C)

RECENT APPROVAL of compatible color television standards has focused attention on the problem of the most appropriate color picture tube.

A color television image can be transmitted by sending the three independent variable video signals simultaneously through three separate channels or through a single channel in a periodically recurring time sequence. Sequences can recur at field rate, line rate or dot rate corresponding to the time required to form one picture element.

It is possible to change from a sequential type of transmission into a simultaneous one with the aid of complex storage systems. In the dot-sequential case, passage from the sequential to the simultaneous system can be achieved with the aid of relatively simple circuits consisting of synchronous detectors and adders. The simplicity of this conversion from a dot-sequential to a simultaneous signal has led to the notion that the two types of transmission are basically identical.

An NTSC color television receiver using a picture tube equipped with three guns is an example of such a combined system. The NTSC signal as it appears at the second detector of the receiver is dot sequential. It is converted into three simultaneous signals which are applied to the three guns of the picture tube.

Single-gun tubes with a color-control electrode require a sequential signal. The question arises whether the unmodified NTSC signal could be applied to the gun of such a tube to produce color pictures. Color distortion is present owing to the fact that although the NTSC signal at the second detector is dot sequential, it never represents a pure primary color at any instant in the cycle, but always a linear combination of the three primaries.

Techniques have been developed whereby the incoming NTSC signal is converted into a different dot sequential signal permitting accurate color reproduction. The inherent advantages of the sequential mode of display are obtained in this way since the same circuit elements and tube fields are used to form all three color images.

Operating Characteristics

In a single-gun tube the beam excites one of the three color phosphors depending on the instantaneous voltage on the color-control electrode, to which a periodic wave is applied. This color-switching wave is analogous to the horizontal and vertical-sweep fields insofar as it is not modulated by picture information. Each color is displayed for a certain voltage range on the control electrode, transitions occurring betwen these ranges. The control voltage passes through these transition ranges in changing from one value to another, each value corresponding to one color. The color of the face of the tube may not be uniform if the color-control voltage operates the tube in any of these transition ranges.

In field and line-sequential systems, the transitions must occur during the vertical and horizontal blanking periods, respectively. The control voltage must stay fairly constant during the field or line period in these systems. A stairstep waveform is, therefore, required in both cases. The stairstep would also be desirable in a dot-sequential system but the high switching frequency in such systems renders the use of this waveform uneconomical.

In most single-gun tubes, the color-control electrode has a large capacitance. For reasons of efficiency, this capacitance is resonated by an inductive reactance at the frequencies contained in the switching wave if these frequencies are high. The tuning network must be reasonably simple and, therefore, the number of frequency components in the switching waveform is limited.

Fortunately, the blanking time during color transitions can be made relatively long in dot-sequential systems. It can equal or exceed 50 percent of the switching period. Consequently, it is possible to use a single sine wave as a switching waveform. The long blanking period does not fundamentally affect the operation of the system, but is not desirable due to the resulting loss in brightness.

The addition of one properly phased higher harmonic to the switching wave improves the speed and timing of the transitions. The

for Single-Gun Tubes

Alteration at receiver of the NTSC color signal corrects for color distortion present when unmodified signal is applied to single-gun picture tube. Modulators and demodulators in the receiver are synchronized by waves at subcarrier frequency and its second harmonic

corresponding reduction of the required blanking period and resulting increase in brightness warrant the use of a more complicated switching waveform in many cases.

A tuning network resonating the capacitance of the color-control electrode at two frequencies can be designed using two inductances and one capacitance. A class C driving amplifier will generate a harmonic frequency component of sufficient amplitude.

Dot-Sequential Sampling

Selection of a color in single-gun picture tubes is achieved by deflection of the electron beam by one or more color control electrodes. In the Lawrence tube, deflection occurs in one direction dependent on the voltage on one set of electrodes. For such a tube the beam must pass twice in one switching cycle over the centrally located color stripe. Tubes in which color deflection occurs in two perpendicular directions have been made. In the latter type of tube, the beam can be deflected in a circle exciting each phosphor once in each switching cycle. The single-gun shadow mask tube was an example of this type. The natural switching mode is a sequence of four samples per switching cycle for the tube types mentioned first.

It is, however, possible to blank the beam during one of its passages through the centrally positioned color stripe. Under these conditions, each color is sampled only once per switching cycle. This mode of operation will be referred to as a sequence of three.

In Fig. 1, the sinusoidal color switching waveform is shown for the sequence of three with the minimum required blanking period indicated by the dotted line. The actual required blanking period will exceed the indicated 50 percent to allow for tube imperfections. In Fig. 1B, the same waveform is shown as used in a sequence of four. In this case, blanking is not required for a perfect tube.

The composite waveform in Fig. 1C improves the performance of a sequence-of-three sampling system considerably. The waveform is obtained by addition of a second-harmonic component having half the amplitude of the fundamental wave. The two peaks and the principal zero crossing occur at instants 120 degrees apart. The passage through the other zero crossing is fast.

This waveform could be used with a blanking period of less than 50 percent without excessive requirements concerning uniform tube construction. The sequence of three is not recommended unless the composite waveform of Fig. 1C can be used.

The video signal at the gun must represent at any instant the color that is being excited. For a symmetrical sequence of three, the required dot-sequential signal is given by the following expression

$$E_M = \frac{1}{3} K_R E'_R + \frac{1}{3} K_G E'_G + \frac{1}{3} K_B E'_B + \left[\frac{1}{3} K_R E'_R - \frac{2}{3} K_G E'_G + \frac{1}{3} K_B E'_B \right] \sin (\omega t - \theta) + \frac{1}{\sqrt{3}} (K_R E'_R - K_B E'_B) \cos (\omega t - \theta) \quad (1)$$

This signal has the following properties: $E_M = K_R E'_R$ for $\omega t - \theta = 30°$, $E_M = K_B E'_B$ for $\omega t - \theta = 150°$, and $E_M = K_G E'_G$ for $\omega t - \theta = 270°$.

The factors K_R, K_G and K_B are determined by the relative phosphor efficiencies, the transmission characteristics of a possible color-correction filter on the face of the picture tube and the colorimetric properties of the eye.

The received NTSC signal is described by the expression

$$E_N = 0.30 E'_R + 0.59 E'_G + 0.11 E'_B + 0.88[0.70 E'_R - 0.59 E'_G - 0.11 E'_B] \cos \omega t + 0.49 [-0.30 E'_R - 0.59 E'_G + 0.89 E'_B] \sin \omega t \quad (2)$$

The similarity of Eq. 1 and 2

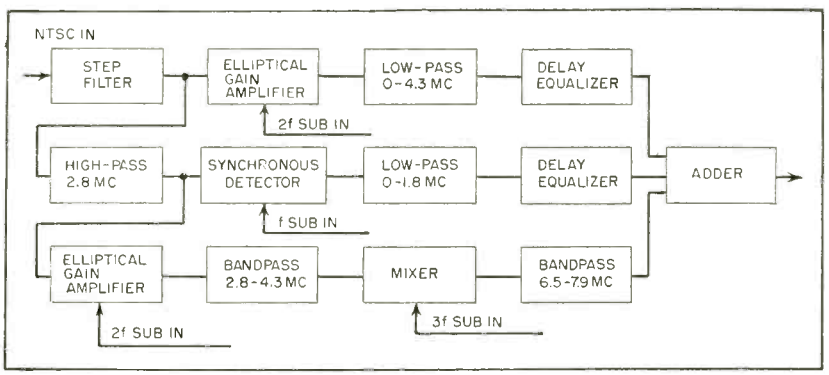


FIG. 2—Block diagram of system for modifying NTSC color signal. Circuit employs elliptical-gain amplifier consisting of tube whose gain is varied at twice the subcarrier frequency

suggests the possibility of a direct conversion of the NTSC signal into the symmetrical dot-sequential signal. This transformation can be achieved in several ways.

In a first attempt, use was made of two conventional circuit elements: a balanced modulator and a synchronous detector. The synchronous detector derives a low-frequency signal from the NTSC chrominance component, which, if added to the NTSC luminance component, forms the low-frequency component of the transformed signal.

The balanced modulator derives a signal from the luminance component of the NTSC signal, which is added to the NTSC chrominance component and the combination forms the subcarrier component of the modified signal. The resulting signal is symmetrical if proper phase relationships and relative amplitudes are observed.

A step filter boosts the chrominance component by approximately 7 percent in order to obtain the correct ratio of high and low-frequency components in the output signal.

The step filter can be made variable to correct for differences in the relative amplitudes of chrominance and luminance components caused by the transmission path. The following values of the gain factors can be computed: $K_R = 1.07$, $K_G = 1.00$, $K_B = 0.68$.

Similar results can be obtained using a novel circuit element called an elliptical-gain amplifier and a synchronous detector. The elliptical-gain amplifier consists of a tube the gain of which is varied at twice the subcarrier frequency rate by applying a wave of this frequency to one of its control grids. The output circuit of the tube suppresses all frequency components above approximately 4.3 megacycles.

The output of this amplifier will contain all frequency components present at the input. In addition, it will also contain a component derived from the original chrominance signal by heterodyning with the second-harmonic reference carrier.

This new component will also be a suppressed-carrier quadrature-type signal. The phase relationship of the two quadrature components is, however, reversed. The addition of the original quadrature modulated signal to the derived one leads to a new quadrature-modulated signal.

The resultant signal is zero if the incoming chrominance signal is zero. This is the only limitation on the output signal and any signal having this property can be obtained. The symmetrical type of dot-sequential signal has this property if the relative gain factors K_R, K_G and K_B are equal. The reproduced color should be neutral white if a constant signal is applied to the gun.

The phase and amplitude relationships used in the synchronous detector are different from those in the previous case as the required low-frequency component is not the same owing to the difference in gain factors K_R, K_G and K_B. Three degrees of freedom are available in the conversion scheme for the low-frequency signal and these are sufficient to permit the generation of any new low-frequency signal consisting of the sum of three primaries. Two degrees of freedom are represented by the amplitudes of the NTSC luminance component and the detector output, the third by the phase of the reference carrier.

A blanking wave of three times the switching frequency is applied to the picture tube to suppress the beam during the transitions. It is desirable to apply the beam-blanking voltage to an independent control grid of the tube. The results obtained by adding it to the grid driven by the video signal are acceptable. The most noticeable effect associated with this technique is a change of the effective-gamma curve of the tube.

Sequence of Four Video

In a sequence of four, the composite video signal consists of a low-frequency component and two modulated carrier components: one at the switching frequency and one at twice this frequency. Neither of the two carrier signals is quadrature modulated. The signal is described by the following expression

$$E_M = \frac{1}{4} E'_R + \frac{1}{2} E'_G + \frac{1}{4} E'_B + \frac{1}{2} (E'_R - E'_B) \cos (\omega t - \theta) + \left[\frac{1}{4} E'_R + \frac{1}{4} E'_B - \frac{1}{2} E'_G \right] \cos 2 (\omega t - \theta) \quad (3)$$

The signal has the following properties

$E_M = E'_R$ for $\omega t - \theta = 0°$
$E_M = E'_G$ for $\omega t - \theta = 90°$
$E_M = E'_B$ for $\omega t - \theta = 180°$
$E_M = E'_G$ for $\omega t - \theta = 270°$

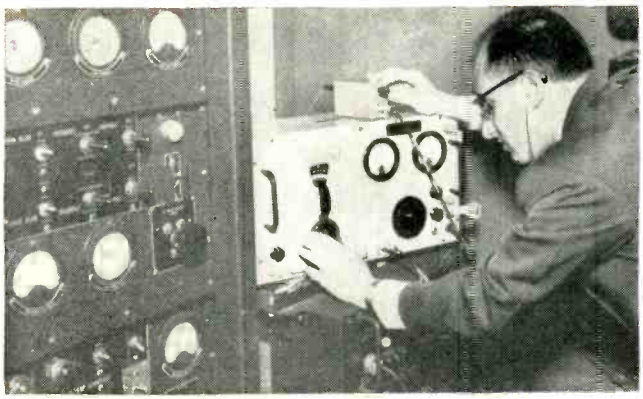
This signal is seen to differ considerably more from the NTSC signal than the previously considered sequence-of-three signal. A more elaborate circuit is needed to obtain the direct conversion of Eq. 2 into Eq. 3.

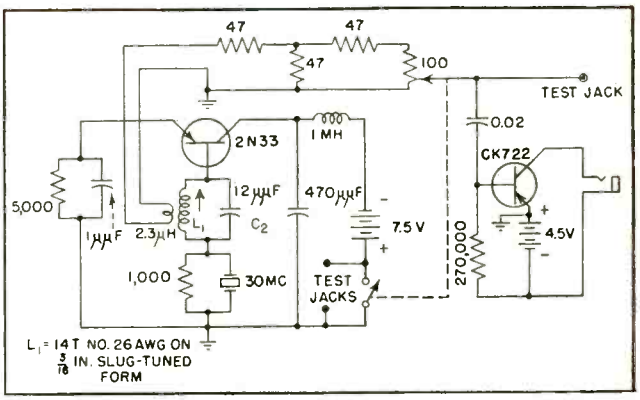
Two elliptical-gain amplifiers are used instead of one, as shown in Fig. 2. The amplitude of the second-harmonic reference carrier is increased to obtain an operating point such that one quadrature component is completely suppressed. The tube in the elliptical-gain amplifier passes current only in short pulses recurring at twice the subcarrier rate. That quadrature component of the input signal, the peaks of which coincide with the current pulses, is passed while the other quadrature component is almost completely suppressed as the zero crossings of the input wave coincide with the pulses.

Another way of analyzing the operation of the quadrature suppressor is by considering it to be an elliptical-gain amplifier with equal normal and conversion transconductance. The original and the derived quadrature signal will add for one and cancel for the other quadrature phase.

The components $(E'_R - E'_B) \cos (\omega t - \theta_1)$ and $[E'_R/2 + E'_B/2 - E'_G] \cos (\omega t - \theta_2)$ both occur in the NTSC subcarrier plane. Each of them is selected by a quadrature suppressor and the latter one is heterodyned with a carrier at three times the subcarrier frequency to obtain the carrier component at twice the subcarrier frequency in the output signal.

The low-frequency components are again obtained by adding the output of the synchronous detector to the NTSC luminance component. The phase and gain setting of this arrangement is different from those used in the previous circuits.





Using transistor frequency standard to service military radar in the field. Schematic diagram gives details of oscillator and detector-amplifier stages

Transistorized Oscillator

Pocket-sized crystal-controlled oscillator using two transistors is useful instrument for servicing radar equipment in the field. Unit described operates on 30 mc; similar devices will furnish reference frequencies up to 110 mc

By JAMES F. MADSEN

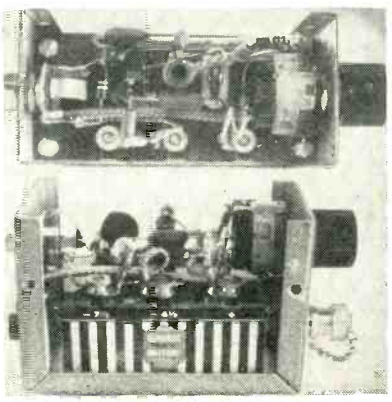
Bendix Radio Division
Bendix Aviation Corp.
Baltimore, Maryland

USE OF TRANSISTORS provides a convenient 30-mc crystal-controlled oscillator for servicing radar and communications equipment. Applications include aligning i-f strips, afc units, coherent oscillators and phase detectors. Similar units can oscillate up to 50 mc—or 100 mc with selected transistors.

The model shown uses commercial parts, measures $2 \times 2\frac{3}{4} \times 4$ in. and weighs 12 oz. No attempt at subminiaturization has been made although printed circuits can be employed. Battery size also can be reduced. Current drain is 1.7 ma and output can be maintained constant for 150 hours continuous operation. Transistor life is estimated at 10,000 hours. Maximum power output is 35,000 microvolts to a 50-ohm line.

Circuit

The circuit can supply a 30-mc c-w signal or establish a reference frequency for checking a vfo by feeding the vfo output into the oscillator and detecting zero beat. The crystal may be either a CR-23 or CR-32, either of which can give 0.005 accuracy at normal operating temperatures. The CR-32 has an accuracy of 0.002 at 75 C and should be carefully selected when used at room temperature. The CR-23 has 700 cps deviation from −55 to +90 C and an effective resistance of 16 ohms.



Top and side views of oscillator

The crystal oscillates in its low-impedance, series-resonant third mode and replaces the usual r-f bypass capacitor. The tank circuit has a medium L/C ratio and is peaked using a grid-dip meter. Oscillation can be determined using a milliammeter in the test jack while adjusting the tuning slug for increasing current flow. The coupling link consists of two widely spaced turns tightly coupled to the output tank.

The detector amplifier uses a CK722 which requires a $4\frac{1}{2}$-v supply and delivers power to 2,000-ohm headphones. Audio cutoff is about 200 cps. The chassis is of $\frac{1}{16}$-in. phenolic sheet supported within the case on four rods. The phone and current test jacks must be isolated from chassis ground.

BIBLIOGRAPHY

Fifty-Mc Oscillator, ELECTRONICS, p 204, Sept. 1953.
QST, p 13, March 1953.

Pulsed Curve Tracer for

Pulsed voltage sweep technique for determining *V-I* characteristics in semiconductors decreases thermal effects on measurements. Comparison with curves taken with non-pulsed supply can be used to find cause of rectifier breakdown

SEMICONDUCTOR devices exhibit a pronounced thermal sensitivity that often limits their usefulness. Even when the ambient temperature is constant, the characteristics are affected by the power dissipated within the device.

In *p-n* junctions the reverse impedance decreases with increasing voltage[1]. Similar effects have been predicted and observed in the case of point-contact rectifiers.[2-9]

In tracing the voltage-current characteristic across a junction, the current is measured while a known varying voltage is applied. The resulting *V-I* curve is displayed on an oscilloscope. Thermal effects can be greatly reduced if the voltage is applied for a short time during which the measurements are made. The equipment to be described gives an 80-μsec pulse every 4.4 milliseconds. The pulses increase linearly with time over a range of 0 to 350 volts. A d-c bias of 0 to 100 volts may be added serially to the pulses, thus allowing investigations up to 450 volts. These excursions are repeated every 144 milliseconds, about 7 per second.

The circuit comprises a pulse generator and a saw-tooth generator which feed their outputs into a gate. The output of the gate, shown in Fig. 1, is a recurring sequence of increasing pulses which are amplified in the final stage.

The short pulses are generated by a one-shot multivibrator of the positive-grid-return type as shown in the circuit diagram of Fig. 2. This multivibrator is driven by a self-triggering multivibrator.

In the saw-tooth generator pentode V_3 feeds a constant current to a capacitance C developing a voltage proportional to time. When this voltage reaches the firing potential of the thyratron V_4 the capacitor is discharged and another

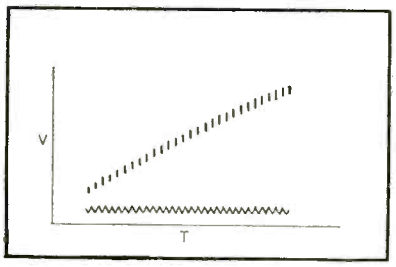


FIG. 1—Gate output is pulsed series of increasing amplitude

charging cycle is started. The resulting saw-tooth wave from the plate of V_3 consists of a potential decreasing by 100 volts in 144 milliseconds.

The gate[10] comprises two cathode followers, V_6, having a common cathode load. The saw-tooth signal is applied to one grid of V_6. The pulses are applied to the other grid. Since the cathode of a cathode follower rides with the most positive voltage, the cathodes of V_6 are normally near the potential determined by the balance adjustment. This adjustment matches the maximum potential of the grid receiving the saw-tooth signal. The balance adjustment establishes the reference level about which the gate operates. When a negative pulse occurs, the cathodes of V_6 drop to a potential approximately equal to the potential of the saw-tooth at this particular time. At the end of the negative pulse the cathodes return to maximum potential, which is the above reference level. The next pulse brings the cathodes to a potential lower than for the previous pulse, since the potential at the other grid has decreased in the meantime. This action is shown in Fig. 3. The pulse height can be adjusted by the cathode potentiometer.

Amplifier

The output of the gate consists of negative pulses the magnitude of which increases from 0 to 80

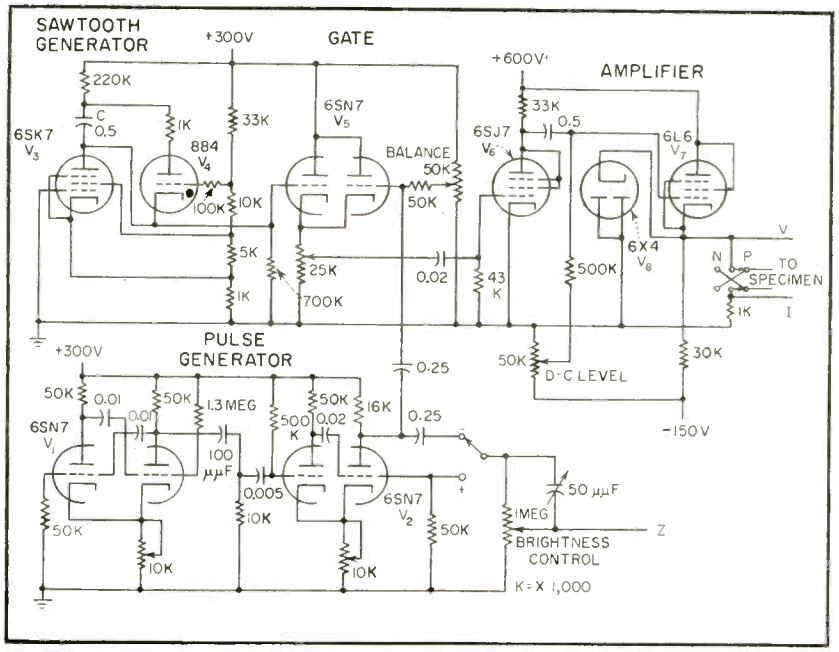


FIG 2—Signals from saw-tooth generator and pulse generator are combined in cathode-follower gate to produce pulsed voltage for measuring *V-I* characteristics

Semiconductor Testing

By J. I. PANKOVE
RCA Laboratories
Princeton, N. J.

volts. These pulses are amplified and inverted by V_6 which drives cathode follower V_7. The pulse magnitude varies from 0 to 350 volts.

These pulses are applied across a 1,000-ohm resistor in series with the rectifier whose *V-I* characteristics are desired. The current through the rectifier junction is then one milliampere per volt, appearing across the *I* terminals. The voltage across the specimen is nearly equal to the voltage across the *V* terminals. This approximation for the voltage is good as long as the resistance of the device is very high compared to 1,000 ohms. A 1-percent error is made for a specimen impedance of 100,000 ohms.

In order that the steady-state voltage across the specimen be zero, the cathode of V_7 is tied through a resistor to −150 volts and through diode V_8 to ground. In the steady state, with a negative bias on the grid, the cathode of V_7 will be clamped to ground by diode V_8. When the grid of V_7 becomes positive its cathode follows in the same direction and diode V_8 exhibits a high impedance. Hence, the cathode of V_7 can produce positive excursions but always returns to zero potential.

An additional control is available through the d-c grid bias of V_7. This bias can be adjusted to raise the steady-state potential of the V_7 cathode from 0 to 100 volts. Under the extreme condition, the 0 to 350-volt pulses start at a d-c level of 100 volts, so that the pulsed *V-I* characteristic covers the range of 100 to 450 volts.

Because the cathodes of V_7 and V_8 experience large excursions in voltage, their filaments are supplied by a separate transformer.

The *V* and *I* outputs are used to deflect the beam of an oscilloscope along the *x* and *y* coordinates respectively, the display appearing as a series of dots describing the *V-I* characteristic. The normal position of the beam, corresponding to the d-c level, exists much longer than the other dots and its brightness hinders observation and photography of the display. To circumvent this difficulty, pulses from the multivibrator are used to intensify the oscilloscope beam at every dot other than the d-c level spot. A trimmer capacitor optimizes the squareness of the pulse.

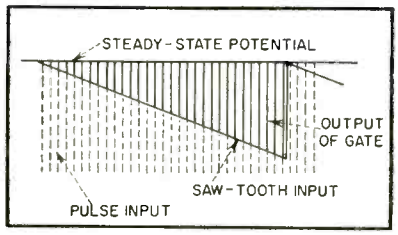


FIG. 3—Combination of waveforms used to produce growing pulse series

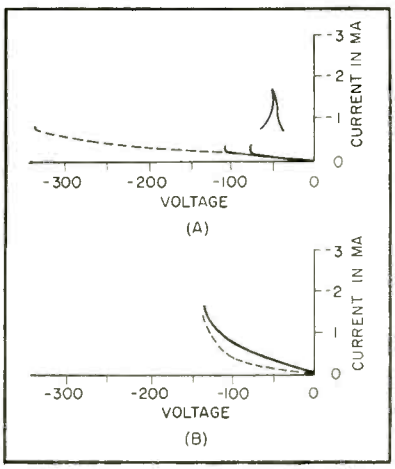


FIG. 4—Curves showing breakdown caused by thermal effects (A) and weakness in rectifying barrier (B)

Applications

Breakdown of a semiconductor may also be due to a weak spot in the rectifying barrier. In this case, the breakdown is not dependent upon the duty cycle of the applied voltage.

Therefore, if duty cycle affects the breakdown characteristics of the device a thermal phenomenon is taking place. This is shown in Fig. 4A, the reverse characteristic of a point contact on a 15-ohm-cm *n*-type germanium crystal. The full line, with a thermal hysteresis after a −110 breakdown, was taken with a 60-cps semisinusoidal voltage. The dotted line was displayed on the same oscilloscope with short duty cycle pulses from the apparatus described. The voltage breakdown was −350 volts.

In Fig. 4B, the reverse characteristic of an old 1N46 germanium rectifier shows that the breakdown voltage (−130 volts) is nearly the same under 60-cps display and under pulsed display. However, here the thermal effect manifests itself in the larger reverse current for the longer duty-cycle display.

The author's thanks are due to M. W. Green for some valuable suggestions.

REFERENCES

(1) W. A. Cady and J. A. Mulhern, Theory of P-N Junction Diodes, Presented at Transistor Research Conference at Penn State College July 1953.
(2) S. Benzer, High Inverse Voltage Germanium Rectifiers, *Jour. Applied Phys*, **20**, p 804, August 1949.
(3) L. P. Hunter, The Inverse Voltage Characteristic of a Point Contact on n-type Germanium, *Phys Rev*, **81**, p 151, Jan. 1, 1951.
(4) A. I. Bennett, L. P. Hunter, Pulse Measurement of the Inverse Voltage Characteristic of Germanium Point-Contacts, *Phys Rev*, **81**, p 152, Jan. 1, 1951.
(5) E. Billig, Application of the Image-force Model to the Theory of Contact Rectification and of Rectifier Breakdown, *Royal Soc Proc*, **207**, p 156, June 1951.
(6) J. R. Tillman, J. C. Henderson, Some Thermal Properties of Point Contact Germanium Diodes. *Philosophical Magazine*, **44**, p 677, July 1953.
(7) P. M. Tipple, H. K. Henish, Thermal Effects at Point Contact Diodes, *Phys Soc Proc*, **66**, p 826, Oct. 1953.
(8) J. H. Simpson, H. L. Armstrong, Reverse Characteristics of High Inverse Voltage Point Contact Germanium Rectifiers, *Journ App Phys*, **24**, p 25, Jan. 1953.
(9) H. L. Armstrong, Thermal Effects in Point Contact Rectifiers, *Journ App Phys*, **24**, p 1332, Oct. 1953.
(10) J. Kurshan, Cathode Follower Gate Circuit, *Rev Sci Inst*. **18**, p 647, Sept. 1947.

Saturable Transformers

Ferrite-cored units control flow of information into particular information channel at high switching rates. Gating action is analyzed in relation to core material, design and construction. Applications include magnetic-drum read-out systems for computers

IN INFORMATION-HANDLING systems such as digital computers, vacuum tubes, semiconductor diodes or electromechanical relays have been used to allow or inhibit the flow of information, usually in the form of electrical impulses, in a particular information channel. A saturable magnetic element can also be used as a gate for this application.

As shown in Fig. 1, either a saturable reactor or a saturable transformer may be used to control the voltage developed across a load resistor. For a constant-voltage source, the reactor used would be equivalent to a variable inductor in series with the load. For a constant-current source, the saturable transformer is used and is equivalent to a variable inductor shunted across the load. The work described utilized the transformer mode, since a high-impedance driving source such as the plate circuit of a high-mu triode seemed the simplest approach to conditions likely to be encountered in practical applications.

Impedances considered in the equivalent circuits for both modes of operation are functions of the permeability μ of the core material. For the reactor mode of operation, a decrease in μ would result in an increase in the output voltage while for the transformer mode, a decrease in μ would cause a decrease in the output.

Core Characteristics

A typical hysteresis loop with a definition of terminology is shown in Fig. 2. Instrument limitations prevent measuring the small flux changes needed to determine reversible permeability of μ_r as the limit of a set of values of μ_Δ. Thus it has become conventional to use the incremental permeability measured at $\Delta B = 20$ gauss as the reversible permeability. This gives a good approximation to the true μ_r when ΔH is small, as it will be in high-permeability materials.

The *B-H* characteristic for an ideal core material is presented in Fig. 3. Hysteresis losses are nil, retentivity is zero and the saturation level is sharply defined. If control current is zero, a signal pulse on the transformer primary will produce a certain flux change and the voltage induced across the terminals of the secondary winding will be proportional to the time rate of change of the magnetic flux. If a control current producing a biasing field H_m is applied to the transformer core, a signal pulse on the input winding will produce no further flux change, and no signal will appear at the output terminals.

The hysteresis loop of a typical core material suitable for magnetic gating purposes is illustrated in Fig. 4. Because the signal consists of unipolar pulses rather than an alternating waveform, and because the control field is always applied in the same direction, the states of the core characterizing the two points of operation are the remanence point ($H = 0$, $B = B_r$) and some point of saturation ($H = H_m$, $B = B_m$). When the control or bias field is zero, a signal pulse will cause the state of the core to trace out a minor loop with its nose at remanence. The size of the minor loop will depend on the amplitude of the input pulse and the amount of cur-

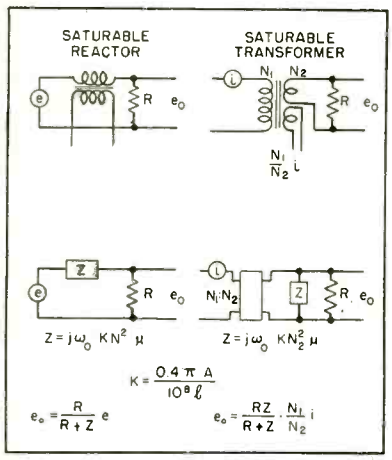


FIG. 1—Equivalent circuits for saturable reactor and saturable transformer

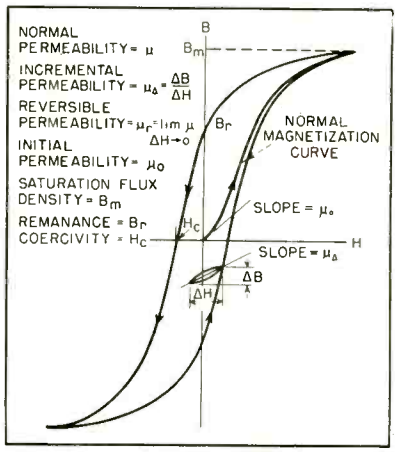


FIG. 2—Typical hysteresis loop with quantities defined

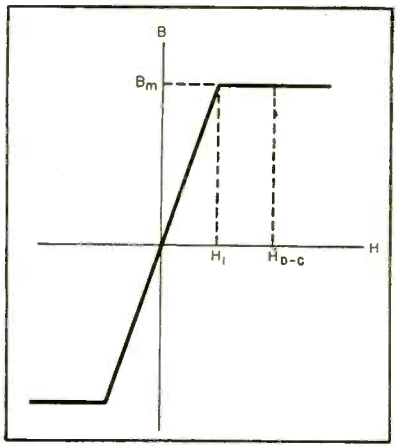
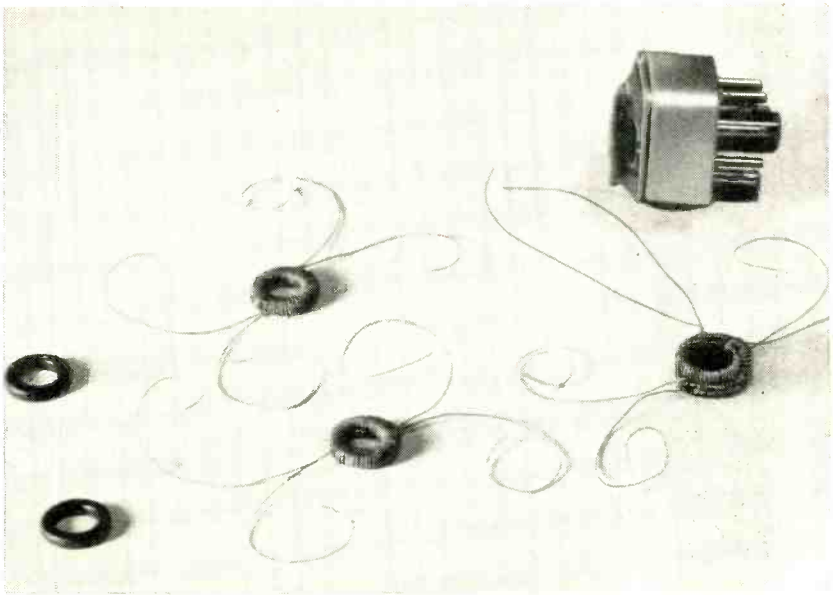


FIG. 3—Characteristic curve for theoretical core material

as Gates

By BURNHAM MOFFAT
University of Pittsburgh
Pittsburgh, Pa.



Construction of magnetic gates from ferrite cores. Input and output windings are wrapped on each core and control windings are wrapped around both. Final unit is installed on octal tube base

rent allowed to flow in the secondary circuit giving rise to a counter-flux in the core.

When the core is saturated by the control flux, the signal pulse will produce virtually no flux change and therefore no output voltage. The operating ratio is the ratio of the output signal with zero control flux to the signal output voltage when the control flux is applied.

Core Materials

The design objective is to maximize the operating ratio and minimize the transition time required to open or close the gate. It is also desirable to prevent interaction between control flux and signal flux, so that turning the control current on and off will not introduce transients which would cause spurious pulses to appear in the output signal.

High incremental permeability at remanence, a sharp saturation level at low values of magnetizing force and low hysteresis and eddy current losses are desirable characteristics for a core material.

To eliminate eddy current difficulties, only ferrite core materials were considered. The two commercially available ferrites found to be suitable were Ferramic I and Ferroxcube 101.

Their properties are summarized in Table I. Ferrites chemically constituted to give minimum magnetic anisotropy, and heat treated to keep crystallite size small, should prove most satisfactory as core materials.

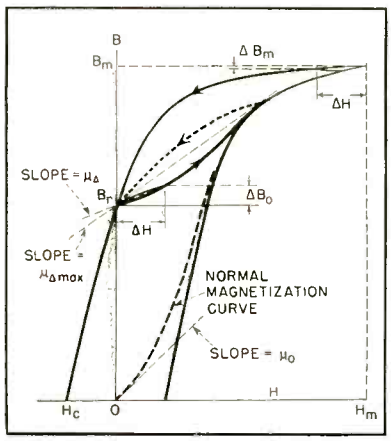


FIG. 4—Curve for typical magnetic-gate core material

Design and Construction

In magnetic amplifiers, a commonly employed technique of preventing pickup of the a-c carrier in the control winding is to use a three-legged core. The same method is applicable to magnetic gates. As is shown in Fig. 5, the control winding is placed on the center leg, and the input and output windings are split, with the respective halves placed on the outer legs of the core and connected in series. The flux produced by the control winding divides and induces equal and opposite voltages in the two halves of the output and input windings, thereby producing zero net-output voltage. The signal flux produced by the two halves of the input winding cancels in the center leg of the core.

With ferrites it is often more convenient to use a pair of small toroidal cores rather than a single three-legged core. The equivalence of the two configurations is given in Fig. 5C, which shows a double-core arrangement.

An experimental gate was constructed using two toroidal cores of Ferroxcube 101. Each core had a mean diameter of 1.00 cm and a square cross section of 0.056 cm^2. Each toroid was wound with two single-layer windings of 31 turns each of No. 32 cotton-covered, enamel-coated wire and sprayed with an acrylic plastic.

The two toroids were sandwiched together, with the windings juxtaposed to minimize the capacitance between input and output coils. The input winding of one toroid was placed directly beside the input winding of the second toroid, and the output windings were correspondingly adjacent. The control winding, consisting of 52 turns of No. 28 enamel-coated wire, was wound around the two cores. The unit was wrapped with electrical tape and mounted on an octal-tube base. The photograph shows the component in various stages of construction.

The gate was tested by applying current pulses to the input winding, periodically applying a current to the control winding and observing the degree of suppression of the output pulses obtained for different values of control current. Signal pulse amplitude was 65 milliamperes, pulse duration was 3.5 microseconds and the pulse repetition

frequency was 25 kc.

Gating current was a square wave with a frequency one-eighth the pulse repetition frequency, giving a four-on four-off pulse pattern. The operating ratios obtained for different values of control current are given in Table II.

Typical waveforms are presented in Fig. 6. In this case, the control field was calculated to be 4 oersteds and the operating ratio observed to be about 15 to 1.

Performance

To test the performance of an array of magnetic gates, a four-input single-output channel selector was constructed using six gates. Figure 7 is a schematic diagram of the channel. Adopting the convention that the shaded half of each box represents the half of the flip-flop that is producing a control current, it can be seen that the cross-hatched gates are in a saturated or nontransmitting condition. An input signal on channel 1 is the only one which will appear at the output terminals.

A block diagram of the channel selector test setup is given in Fig. 8 and waveforms are shown in Fig. 9. Each of the four inputs was fed with a different repeated four-digit binary number and the control windings were driven by a two-stage binary scaler with cathode follower outputs.

Figure 9C (top) shows ungated output-voltage waveform. With no control current flowing in the windings of any of the cores, the output voltage waveform consists of a superposition of all four input signals. The gated 16-v output signal is obtained with control current adjusted to produce a biasing field of 3 oersteds in each core. Observed operating ratio is about 8 to 1.

Owing to a small amount of cross-talk, which was apparently unaffected by the control field, practically no improvement in operating ratio was obtained when the control field was raised as high as 8 oersteds. Input pulse amplitude was 38 milliamperes, pulse duration was 2.5 microseconds and pulse repetition rate was 100 kc.

A small ringing effect in the output-voltage waveform was damped out by a 1,000-ohm resistor across the output terminals. The ringing effect was caused by the inductance of the output winding resonating with the input capacitance of the oscilloscope. The channel selector was also operated satisfactorily at a pulse repetition frequency of 150 kc, but deficiencies in the performance of the control scalers at this frequency introduced some spurious pulses and degraded the operating ratio.

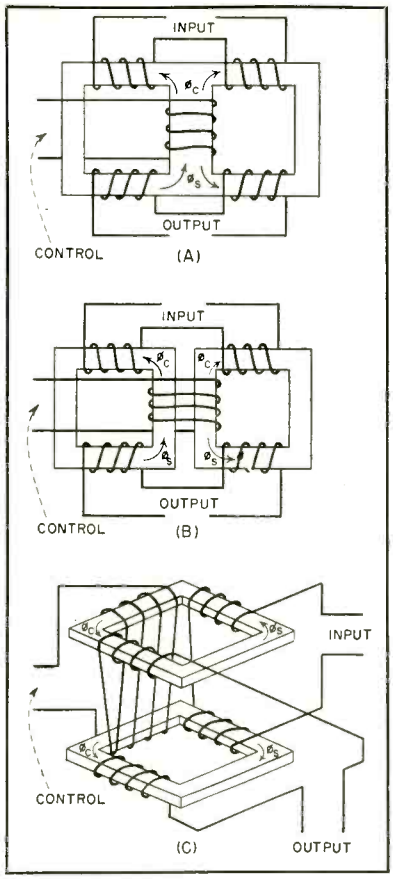


FIG. 5—Three-legged core (A), double core (B) developed from (A) and double-core arrangement (C) used in saturable-transformer gates

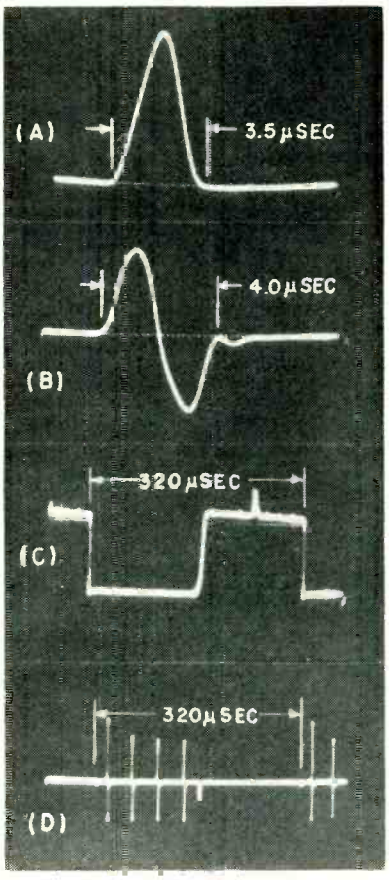


FIG. 6—Input pulse of 65 ma to magnetic gate (A) and typical 18-v output pulse (B). Gating current pulse is shown at (C) with gated output at (D)

The channel selector is a simple but typical application of the magnetic-gate principle. An 8-to-1 operating ratio is adequate for the handling of binary information such as a magnetic drum pulser.

The maximum number of cascaded levels in a channel selector would depend on the permissible attenuation of the signal, and on the minimum usable overall operating ratio. In the experimental channel selector described, the attenuation was about 1.9 db per stage. The number of stages which may be cascaded is roughly proportional to the operating ratio of a single element. With the operating ratio available in the experimental magnetic gates, four or five levels would seem to be the practical limit. With four cascaded levels, sixteen inputs are available; with five levels, thirty-two, and with six levels sixty-four input channels can be controlled.

In contrast to switches using square loop materials, there is no difficulty in attaining high-frequen-

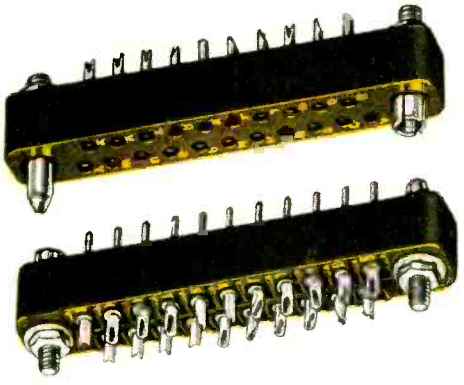
Table I—Magnetic Characteristics of Materials Used in Gates

Material	μ_o	μ_{max}	B_s	B_r	B_r/B_s	H_c	T_c
Ferramic I	900	1,600	1,510 gauss	725 gauss	0.48	0.24 oersted	70 C
Ferroxcube 101	1,000	2,870	2,245 gauss	1,089 gauss	0.48	0.18 oersted	120 C

SPARTAN • TELEQUIP • STEWART-WARNER • SYLVANIA • STROMBERG-CARLSON • MOTOROLA • TRAD • TRAV-LER • WESTINGHOUSE • WILCOX-GAY • ZENITH • DELCO RADIO • FEDERAL • MEISSNER • INDUSTRIAL TELEVISION • KAYE HALBERT HAZELTINE • SETCHELL CARLSON • WELLS-GARDNER • WEBSTER CHICAGO B.M. • WESTERN ELECTRIC COMPANY • SPERRY • FEDERAL TELEPHONE AND IO • COLLINS RADIO • STANDARD COIL • SARKES-TARZIAN • ADMIRAL • AIR • ANDREA • ANSLEY • AUTOMATIC RADIO • NATIONAL-SIMPLEX- ORTH • NIELSON • ARVIN INDUSTRIES • OLYMPIC RADIO • PACKARD • CONRAC • CROSLEY • ALLEN B. DuMONT • EMERSON • GAROD • GENERAL • FADA • FEDERAL TELEVISION • HALLICRAFTERS • BELMONT • BENDIX • K • CAPEHART-FARNSWORTH • CERTIFIED RADIO • HOFFMAN • INTER- TELEVISION • MAGNAVOX • MARATHON • PHILCO • PILOT RADIO • INGTON • SCOTT • SENTINEL • SPARTAN • TELEQUIP • STEWART- LVANIA • STROMBERG-CARLSON • MOTOROLA • TRAD • TRAV-LER SE • WILCOX-GAY • ZENITH • DELCO RADIO • FEDERAL • MEISSNER ELEVISION • KAYE HALBERT • HAZELTINE • SETCHELL CARLSON • • WEBSTER CHICAGO • I.B.M. • WESTERN ELECTRIC COMPANY • TELEPHONE AND RADIO • COLLINS RADIO • STANDARD COIL

Centrally located plants at Chicago, Shelbyville, Indiana and St. Louis

THE NUMBER OF ☆ USERS, THE QUANTITY USED, TESTIFY TO CINCH QUALITY



(At left) Miniaturized Micro Connectors that save space, weigh less and are more efficient . . . 14, 21, 34 and 50 contacts available in low loss material for chassis mounting applications.

Cinch components available at leading electronic jobbers . . . everywhere

CONSULT CINCH

CINCH MANUFACTURING CORPORATION

1026 South Homan Ave., Chicago 24, Illinois

Subsidiary of United-Carr Fastener Corporation, Cambridge, Mass.

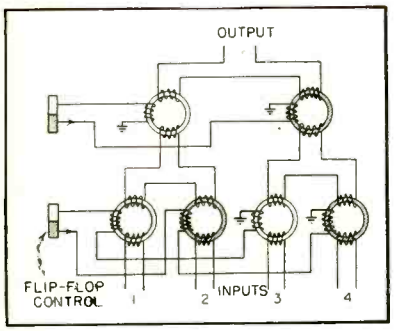


FIG. 7—Four-input single-output channel selector. Shaded cores are in saturated condition

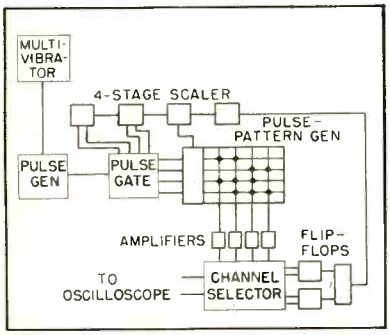


FIG. 8—Test arrangement for four-input single-output channel selector

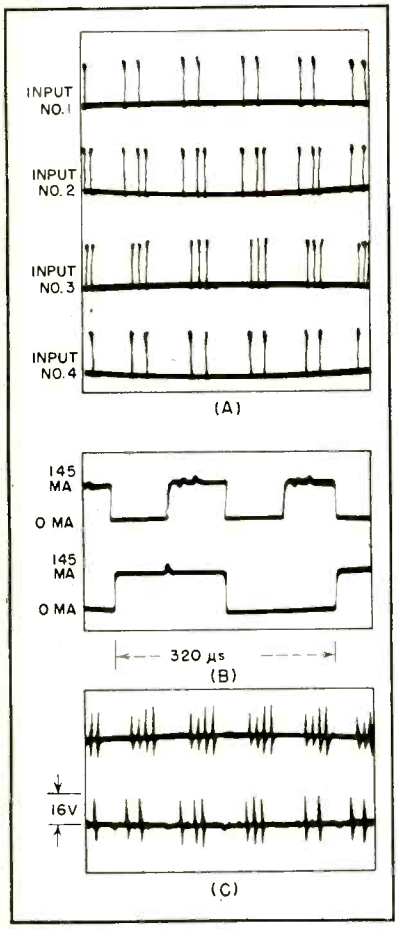


FIG. 9—Four input signals to channel selector (A), gating current waveform (B) and resulting output (C)

cy operation in saturable transformer gates. Since the state of the core traverses only a minor loop, neither hysteresis heating nor switching time creates a problem. The desired frequency response and pulse-shaping characteristics may be obtained by consideration of factors in pulse-transformer design.

The magnetic gate can be compared with the electromechanical relay. In both devices the information circuit is opened or closed by direct-current in the control windings.

The magnetic gate and the relay differ in range of signal frequencies which may be transmitted, insertion loss, operating ratio and switching rate. The closed contacts of a relay form a low-impedance connection that can handle signals of any frequency from d-c to r-f.

Magnetic coupling between input and output precludes the transmission of static voltage levels by the magnetic gate. The insertion loss of a relay is nil, whereas in the magnetic gate it is a definite amount which depends on leakage flux and core losses. The operating ratio of a relay is essentially infinite, whereas for the magnetic gate the operating ratio is finite.

The finite insertion loss and operating ratio of the magnetic gate limit the number of stages which may be cascaded without affecting adversely the quality of the signal. The best relays have a switching speed of the order of one millisecond. The magnetic gate can be switched in less than ten μsec.

Applications

Use of magnetic gates in the channel-selection system of a magnetic-drum storage unit of a digital computer would result in considerable simplification in circuitry as compared with other high-sped selection systems.

Table II—Operating Ratios with Different Control-Current Values

Control Current in Ma	Calculated Control Field in Oersteds	Observed Operating Ratio
0	0	1:1
48	1	2:1
96	2	7.5:1
192	4	15:1
384	8	25:1

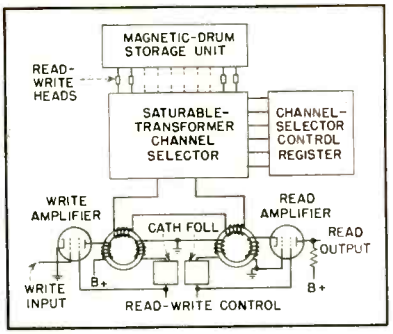


FIG. 10—Application of magnetic gates to magnetic-drum storage system. Only one read and one write amplifier are required

High-speed channel selectors generally employ both a read and a write amplifier for each pickup head. Thus, for an n-channel magnetic drum, $2n$ gating amplifiers would be needed, plus a diode matrix containing $n\log_2 n$ diodes.

The matrix can be eliminated, and the number of gating amplifiers can be reduced to one read and one write amplifier by the use of a flip-flop controlled relay system but only at a considerable sacrifice in operating speed. The same advantage in the saving of equipment, but with no loss of operating speed, may be realized by using magnetic gates instead of relays.

A proposed channel-selector system is shown in Fig. 10. The additional pair of magnetic gates acts as a switch to connect the channel selector either to the read or to the write amplifier. This isolation is necessary to prevent the write pulse from damaging the read amplifier.

The work described in this article was supported by the Electronic Directorate of the U. S. Air Force Cambridge Research Center and Development Command under contract AF 19/604/943.

REFERENCES

R. M. Bozorth, "Ferromagnetism," D. Van Nostrand, 1951.

J. K. Galt, J. Andrus and H. G. Hopper, Motion of Domain Walls in Ferrite Crystals, *Rev Mod Phys*, 25, p 93, 1953.

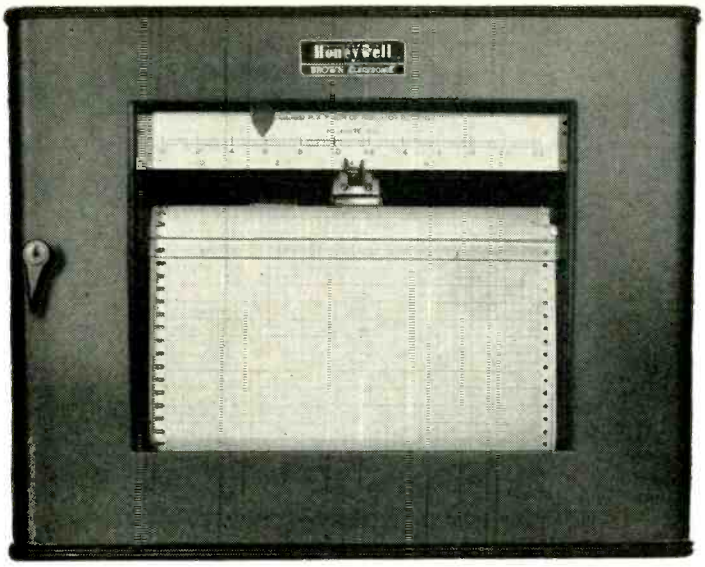
J. A. Rajchman, Static Magnetic Memory and Switching Circuits, *RCA Rev*, 13, No. 2, June 1952.

K. H. Olsen, A Magnetic Switch and Its Incorporation into a Coincident-Current Memory. MIT Digital Computer Laboratory Report R-211, June 1952.

W. N. Papian, A Coincident-Current Magnetic Memory Unit, MIT Digital Computer Laboratory Report R-192, Sept. 1950.

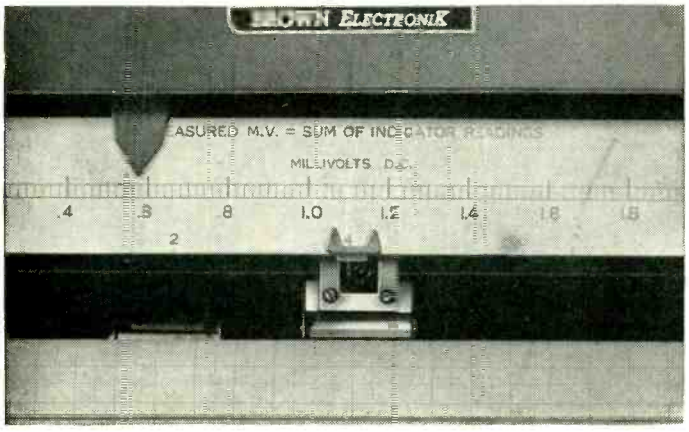
A. S. Fitzgerald, Magnetic Amplifier Circuits, *Jour Franklin Inst*, 244, p 249, p 323, p 415.

G. N. Glasoe, J. V. Lebacqz, "Pulse Generators", Vol. 5, MIT Rad Lab Series, McGraw-Hill Book Company, New York, 1948.



Now...the answer to high-resolution recording of test data

...*the* Extended Range *ElectroniK* Recorder



Closeup of indicating scale. Upper pointer shows millivolts within the span; lower pointer indicates millivolts to be added. Total reading: 4.58 mv.

DESIGNED especially for recording variables which change over a wide range, this new *ElectroniK* instrument records on a chart effectively *55 inches in width*. It has five equal measuring spans. Whenever the variable being measured reaches either the upper or lower limit of one of these ranges, the instrument automatically steps to the adjoining range and continues recording.

Two indicating pointers show the range in use and the value within the range. Connected to each pointer is a pen; one draws a purple record showing the range, the other draws a red record of the variable itself. To get the complete reading, you simply add both pen or pointer indications.

The complete range is 10.2 millivolts, in five 2-millivolt steps with an extra 0.2 millivolts on the high end of each span to provide an overlap that facilitates measurements near the changeover point. Pen speed of 4½ seconds full scale affords rapid response to quickly changing variables.

You'll find this new instrument particularly valuable in strain gage measurements and in dozens of other uses where high resolution aids interpretation of data. Your nearby Honeywell sales engineer will be glad to discuss your specific application . . . and he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.

● **REFERENCE DATA:** Write for Data Sheet No. 10.0-18, "Extended Range Recorder."

MINNEAPOLIS **Honeywell**

BROWN INSTRUMENTS

First in Controls

ELECTRONS AT WORK

Edited by ALEXANDER A. McKENZIE

OTHER DEPARTMENTS featured in this issue:

Fifty-foot diameter radar reflector weighs fourteen tons. Position of antenna is controlled by computer through servo system

Accelerator for Food Industry

Electron linear accelerator now under construction by Applied Radiation Corp. is expected to be more powerful than comparable devices including resonant-transformer and Van de Graaff machines. At an estimated cost of $100,000 weighing about a ton and requiring a space 4 by 4 by 9 feet, the new accelerator may provide a means for industry to preserve meats, vegetables and fruit without refrigeration. Electronic radiation destroys bacteria and inhibits enzyme action

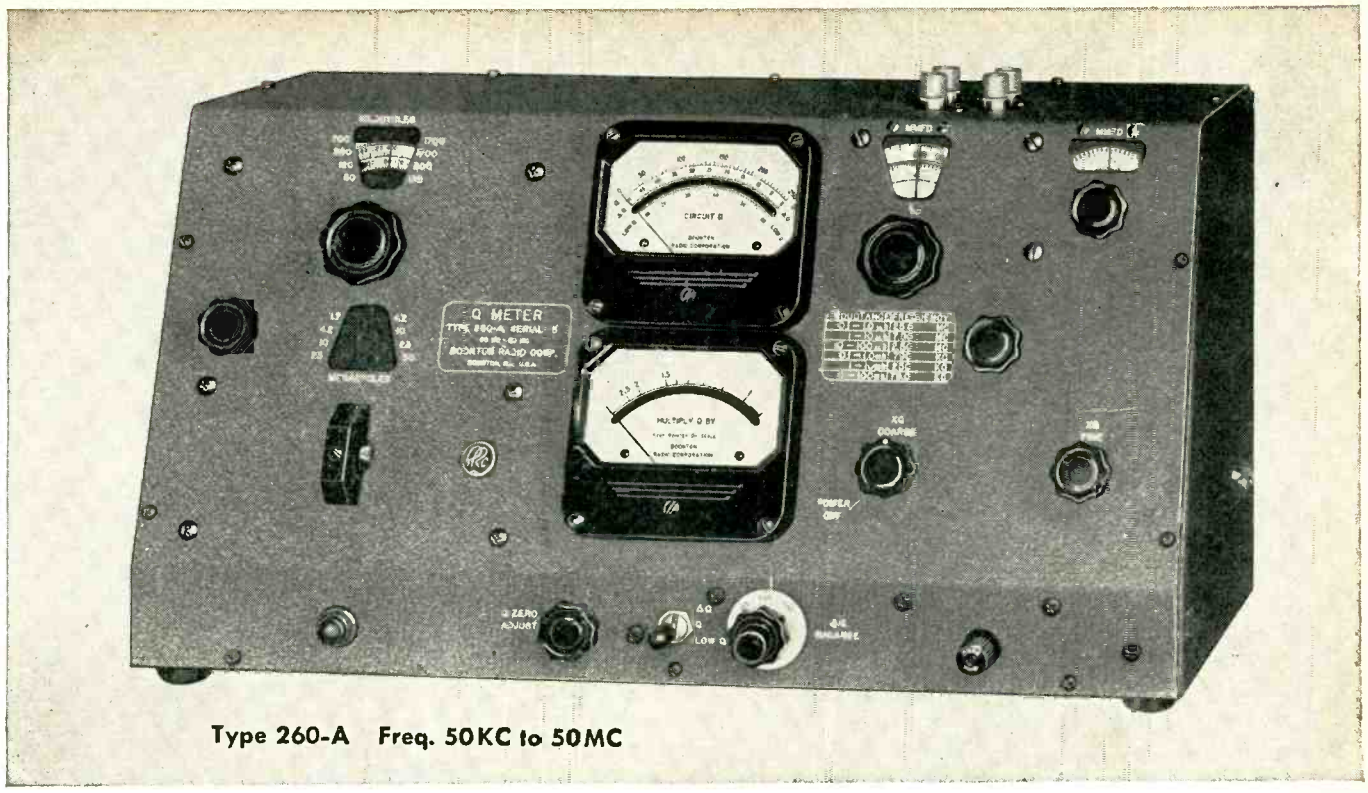
Radar Antenna Follows Stars

By W. VIRGIL STINE
Mechanical Engineer
Evans Signal Laboratory
Fort Monmouth, N. J.

ON THE SITE where the first radar signals were bounced off the moon, a powerful new radar antenna has been erected for future wave-propagation studies.

The radar mount is a steel structure weighing sixty-five tons that rotates a parabolic reflector weighing fourteen tons. The parabolic reflector, fifty feet in diameter, is positioned by an electronic computer feeding azimuth and elevation co-ordinates to a servosystem, following celestial bodies as the earth rotates. Radio-frequency energy is fed to the antenna through a six-inch coaxial rigid transmission line. The radar, when completed, will be one of the largest and most powerful in existence.

The antenna and mount will withstand winds of 100 miles per hour or a snow load of 30 tons. The reflector surface consists of a rolled expanded metal screen formed to contour over radial curved trusses. An adjustable dipole, 16½-feet long, will feed r-f energy to the reflector. The reflector and dipole are positioned from an adjacent building by the computer and servocontrol



Type 260-A Freq. 50KC to 50MC

18 years of improvements are combined in this NEW Q Meter

NEW FEATURES

- Lo Q Scale permits Q readings down to a value of 10.
- △Q Scale reads the difference in Q of two circuits or components up to a value of 125.
- Thermocouple for indicating current inserted into measuring circuit redesigned for high burnout point well above operating current.
- Oscillator maximum output level adjusted to minimize possibility of thermocouple failure.
- Voltage insertion resistor decreased to 0.02 ohms to minimize effect on measuring circuit. New type low reactance metalized coaxial resistor used.
- All indications on large meters with parallax correction and accuracy of ±1% full scale.
- Range switch controls mask and arrow which indicate correct scale on frequency dial.
- Oscillator rigidly supported by casting which supports turret ball bearings and circuit using long life subminiature triode.

The Q Meter Type 260-A replaces our Type 160-A, one of Boonton Radio's Q Meters which has been standard equipment in laboratories and on production lines for eighteen years. Many improvements have been made during this time, but several of our ideas for a better instrument were too extensive to put into a model already in production. These ideas were carefully tested for use in a new model. The Q Meter Type 260-A includes all past improvements and the extensive changes that we have accumulated.

SPECIFICATIONS:

FREQUENCY COVERAGE: 50 KC to 50 MC Continuously variable in eight ranges.

FREQUENCY ACCURACY: Approximately ±1%.

RANGE OF Q MEASUREMENTS: 10 to 625.

RANGE OF DIFFERENCE Q MEASUREMENTS: 0 to 125.

INTERNAL RESONATING CAPACITANCE RANGE:
Main Tuning Dial: 30 to 450 mmf (direct reading) calibrated in 1.0 mmf increments from 30 to 100 mmf: 5.0 mmf increments from 100 to 450 mmf.
Vernier: —3.0 to +3.0 mmf (direct reading) calibrated in 0.1 mmf increments.

ACCURACY OF RESONATING CAPACITOR:
Main Tuning Dial: Approximately ±1% or 1.0 mmf, whichever is the greater.
Vernier: ±0.1 mmf.

POWER SUPPLY: 90-130 volts—60 cps (internally regulated).

POWER CONSUMPTION: 65 Watts.

Model available for other Power Supply voltages and frequencies.
Type 103-A Accessory Inductors Available for entire frequency range.

PRICE: $725.00 F. O. B. FACTORY

BOONTON RADIO Corporation
BOONTON·N·J·U·S·A·

equipment located there.

The rotating mechanism is located atop a 26-foot tower. The tower is 15-feet square at the base, tapering to 7½ feet at the top. Each leg of the tower consists of two 5 × 5 × ½ in. structural angles, laced together.

An 8-inch wide flange structural ring section 17½-feet in diameter is used as a ring section to support the small radial trusses to form the antenna. The base ring is in turn supported by a truss structure with elevation bearings 19½-feet apart.

The elevation bearings are supported on the ends of a reinforced box-girder section, 19-feet long, 7-feet wide and 4-feet deep, which rotates upon an azimuth bearing 100-inches in diameter. An electrical slip ring assembly and an azimuth r-f rotating joint are housed in the center compartment of the girder. Another r-f rotating joint for the elevation rotation is located adjacent to the elevation bearing through which the radio-frequency transmission line passes.

The elevation drive mechanism consists of a ½-horsepower 230-volt d-c servomotor connected through a 1,274,528-to-1 gear reduction. A clutch and brake mechanism, a 2-horsepower slew motor and a sector gear and pinion make up the balance of the drive system.

Total overall gear reduction from servomotor to antenna movement of over 1,000,000-to-1 results in a very slow speed for the antenna, enabling it to follow celestial bodies. The 2-horsepower motor is used for slew positioning of the antenna and when in use the servomotor is uncoupled by means of a magnetic clutch mechanism. When power to the servo and slew motor is off, a magnetic brake system locks the mechanism.

The azimuth drive mechanism is identical to the elevation drive mechanism except that the angular velocity is twice as fast. The antenna can be moved from a west to an east position and from a zenith to a horizon position in less than fifteen minutes when reorientation is required. The azimuth bearing is 100 inches in diameter with an internal 90-inch pitch-diameter gear cut on the inner race. The tooth spacing error was specified not to exceed 0.001 inch over any three consecutive teeth. The 9-inch pinion on a 5-inch shaft will transmit a maximum torque of 546,000 inch-pounds needed only under the high-wind conditions.

A 32-ring slipring assembly is provided for power, controls and telephone to the rotating mechanism.

In moving from the zenith to the horizon position 30,000-pound counterweights move out to maintain the centering of the weight on the tower. At the horizon position the bottom edge of the reflector is 12 feet above ground level.

Synchro data boxes, housing four synchros, two each at 1-to-1 gear ratio and two each at 36-to-1 gear ratio, are driven from the elevation axis. Similar synchro data are taken from the azimuth rotation. The synchro information is interconnected with the servocontrol in the adjacent building and at the operator's position.

A small low-power optical telescope with night-lighted cross hairs is located parallel with the axis of the reflector for visually placing the radar on track and for optically checking the computer positioning.

The servosystem used for positioning the antenna is operable from three data systems; the local operator's control, the electronic computer data system which computes azimuth and elevation positions with respect to time or a separate optical telescope transmitting synchro data.

Microsecond-Spike Generator

By Karl Greif
Vestal, N. Y.

Need for a simple means to obtain pulses of less than 1-microsecond widths at audio repetition-rates has resulted in the development of a spike generator that operates reliably from 0 to 8,000 pps, is completely free of jitter, relatively insensitive to input amplitude variations and provides a low-impedance output. The input may be either a sine wave or a square wave.

The circuit shown schematically in Fig. 1 appears to be similar to the sawtooth generators used in oscilloscope sweep circuits. Its components are, however, quite different. The small discharge capacitor C is charged through the high-charging resistor R_1 from the B+ supply. The 2D21 gas-discharge tube is cut off by proper biasing with the potentiometer. After capacitor C is fully charged, the circuit is in a standby state.

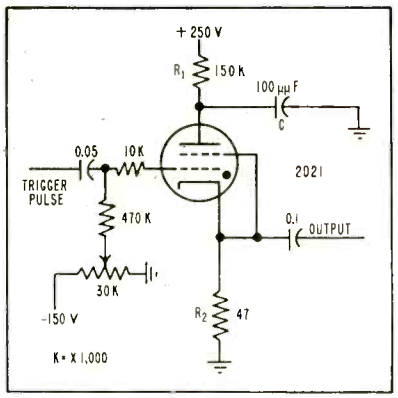


FIG. 1—Thyratron spike generator will operate at trigger rates up to 8,000 pps

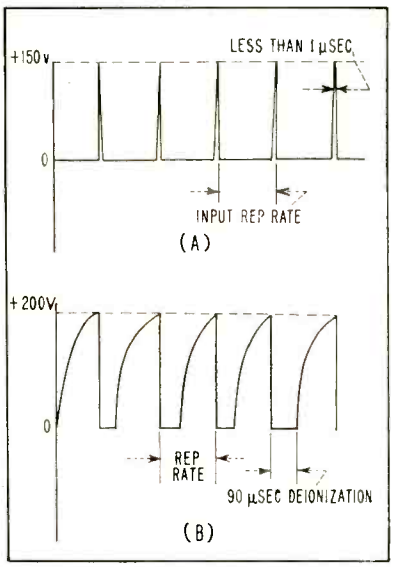


FIG. 2—Output of thyratron spike generator (A) and plate-voltage cycle (B)

When the positive half of a sine wave or square wave or a positive

LIQUID-LEVEL GAUGE WEARS 7 LEAGUE BOOTS

Taking inventory was an oil-industry headache until the Shand & Jurs Company of Berkeley, California developed its Electronic Precision Remote-Reading Tank Gauge System... relying on HELIPOT* precision potentiometers for translating critical measurements into voltages which are transmitted to an indicator located miles away.

Tank-gauging starts with a float riding on vertical guides. A perforated metal tape runs up from the float...over a sprocket-wheel...and down to a counterweight.

The sprocket-wheel, through a gear train, drives two HELIPOTS. The shaft of the first... a Model A, 10-turn unit...rotates 3600° as the float moves from the bottom of the tank to the top. The shaft of the other... a Model F, continuous-rotation unit... makes a full turn for each foot the float moves.

The voltage outputs of the two HELIPOTS are conducted to the remote station where either can be fed to the circuit of a Brown Instrument Co. self-balancing Wheatstone bridge.

The voltage of the Model A HELIPOT is read directly in feet... that of the Model F HELIPOT in ⅛" increments. Inventory of any number of tanks can be made quickly... by successively switching the outputs of their HELIPOTS into the circuit of the indicator.

Operating on a tank containing petroleum vapor, the HELIPOTS must be housed in an explosion-proof chamber. To overcome the problem of moisture condensation, the HELIPOTS operate completely immersed in oil...which enters the HELIPOTS themselves through holes in their housings. Condensation is drained periodically from the bottom of the chamber. Identical HELIPOTS, laboratory-tested while similarly immersed, showed negligible wear of coil or slider contact after 2 million revolutions.

Application Data ... For complete details on this and other applications, write for Data File No. 901

*T. M. REG. U. S. PAT. OFF. 314

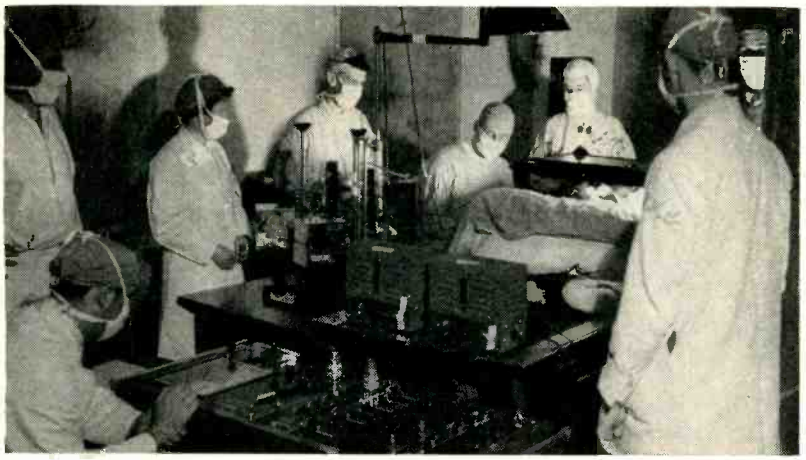
HELIPOT makes a complete line of single-turn and multi-turn precision potentiometers, and turns-counting DUODIALS. Many models are regularly carried in stock for immediate shipment.

Helipot *first in precision potentiometers*

Helipot Corporation/South Pasadena, California
Engineering representatives in principal cities
a division of BECKMAN INSTRUMENTS, INC.

BECKMAN

THE FRONT COVER



ELECTRONIC EQUIPMENT shown above includes two electromanometers and a four-channel direct-writing recorder. Graphs of pressure within the heart, from an artery remote from the heart, an electrocardiogram and one other desired physiological phenomenon can all be recorded simultaneously.

The electromanometer coverts pressure into a proportional voltage, which is amplified before recording. The device used to measure variation in pressure level is a condenser microphone with a stiff diaphragm. A fluid-filled catheter probe transmits pressure changes.

Connected as one arm of an alternating-current bridge, variation in the capacitance of the microphone unbalances the detector and causes an upward deflection of the writing stylus of the Sanborn recorder.

The system measures pressures having components at any frequency from zero to 100 cps. Full-scale deflection is obtained at any pressure range from 4 to 400 mm of mercury. The recorder speed can be varied from 0.25 to 50 mm a second.

pulse from another source is applied to the input the tube will ionize. When the tube fires, the circuit consists simply of C, the tube and the small cathode resistance R_2. Since C is small, it discharges rapidly through the tube and resistor impressing a relatively high voltage across the effective load resistor R_2. The charge is completely dissipated, producing a spike of 150-volts amplitude with a width of less than a microsecond.

A capacitor is used to couple this spike out to external equipment. The high resistance of R_1 and the bias control prevent continuous ionization. Because of the very low impedance of the circuit and of R_2, an extremely sharp leading and trailing edge is obtained, Fig. 2A.

Even though the capacitor is fully discharged in less than 1 microsecond, the tube continues in an ionized state for approximately 90 microseconds before the recharging cycle of C through R_1 can be again effected. After this deionization period, the capacitor again charges and waits to be discharged again into the load resistor with the next incoming positive triggering signal.

The series grid resistor reduces grid current. Although the constants shown are typical values that work well in the arrangement given here, the components can be varied to meet various special requirements.

The bias control, while providing more flexible usage, can be eliminated in most cases, with the 470,000-ohm resistor tied directly to ground.

In examining the pulse, the oscilloscope sweep speed should be adjusted such that 3 or 4 spikes fall across the screen. If close examination fails to reveal the spikes, connect the oscilloscope to the plate of the thyratron. If a picture similar to Fig. 2B is observed, the circuit is operating properly and the spikes are too narrow to be seen on the oscilloscope. If the plate is at zero, the bias should be increased. If the plate remains at full B+, the tube is not being triggered.

These are the only three circuit conditions and as such they permit easy adjustment of the circuit.

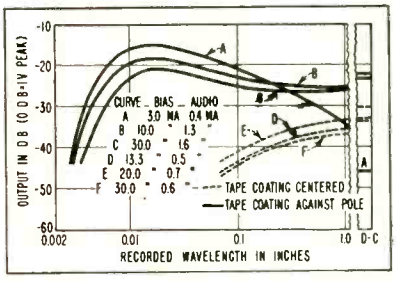
Characteristics of Ring Recording Heads

BY J. W. GRATIAN

Research and Development Dept.
Stromberg-Carlson Co.
Rochester, N. Y.

EXISTENCE OF PERPENDICULAR magnetization as well as longitudinal magnetization is known when recordings are made with the ring-type head of conventional magnetic recording systems. The figure shows overall frequency response data for a system utilizing the perpendicular electron-beam pickup, coated tape and a ring recording head having a recording gap length of slightly less than one mil.

In a conventional longitudinal-type system this recording head requires a bias current of two to three milliamperes. Curve A shows relatively low d-c response at this bias value, thus indicating a low degree of perpendicular magnetization within the recording medium. As shown by curves B and C, a bias current in the order of ten times



Response curves for ring recording head, coated tape and crt pickup with perpendicular core having aligned poles

WIREWOUND AND FILM RESISTORS

FOR POINT-TO-POINT OR TERMINAL BOARD WIRING

THERE'S ONE IN THE SPRAGUE FAMILY TO MEET YOUR PARTICULAR REQUIREMENTS!

PERMASEAL® RESISTORS

Precision wirewound • Resin encapsulated • Tolerances up to ±0.1% • Ambient temperatures to 150°C • Wattage ratings to 1.5W • Resistances to 2.8 megohms • Write for Engineering Bulletin 122

BLUE JACKET® RESISTORS

Power-type wirewound • Vitreous enamel coating • Tolerances to ±5% (to ±2% on special order) • Available in 5W and 10W ratings • Resistances to 35,000 ohms • Write for Engineering Bulletin 111

KOOLOHM® RESISTORS

Power-type wirewound • Ceramic encased • Tolerances to ±5% (to ±1% on special order) • Inductive or non-inductive windings • Available in 5W and 10W ratings • Resistances to 70,000 ohms • Write for Cat. 100

FILMITE B® RESISTORS

Borocarbon-film • Molded phenolic housing • Tolerances to ±1% • Ambient temperatures to 70°C • Available in ½W, 1W, and 2W ratings • Resistances to 10 megohms • Write for Eng. Bul. 130

SPIRAMEG® RESISTORS

Film resistance element • Resin encapsulated • Voltage ratings to 15KV • Available in 1W, 1½W, and 2½W ratings • Resistances to 200 megohms • Standard tolerance, ±20% (to ±5% on special order) • Write for Engineering Bulletin 135

The Sprague family of axial lead resistors offers sizes, ratings, and characteristics to meet most any application requirement. Their tough impervious jackets provide maximum protection against physical damage and atmospheric conditions. Completely tested and proven, these extremely stable units assure consistent and reliable performance in commercial and military equipment. ★ ★ ★ ★ ★ ★ ★

SPRAGUE
ELECTRIC COMPANY
35 Marshall Street
NORTH ADAMS, MASSACHUSETTS

Depend upon SPRAGUE for quality, production capacity, and economy.

the conventional range of values is required to provide smoothest response in the perpendicular system.

For the data in the figure, bias currents were chosen arbitrarily and the associated signal levels adjusted to those values that would give 3 percent third harmonic distortion at 0.3-inch signal wavelength on an equalized system.

The low output with the tape centered is surprising; further tests showed that distortion increased slowly with recording level, reaching 6.4 percent at a level approximately 20 db above that shown in the curves for 3 percent distortion.

When offset poles were substituted for aligned poles and the tape was operated with its coating against one pole of the reproducing head, data were similar to those represented in the figure. However, with the tape coating centered, the low-frequency output levels for 3 percent distortion were approximately 20 db higher and the high-frequency response extended to within one octave of that obtained with the tape coating against the pole. Square-wave tests showed a high degree of phase distortion.

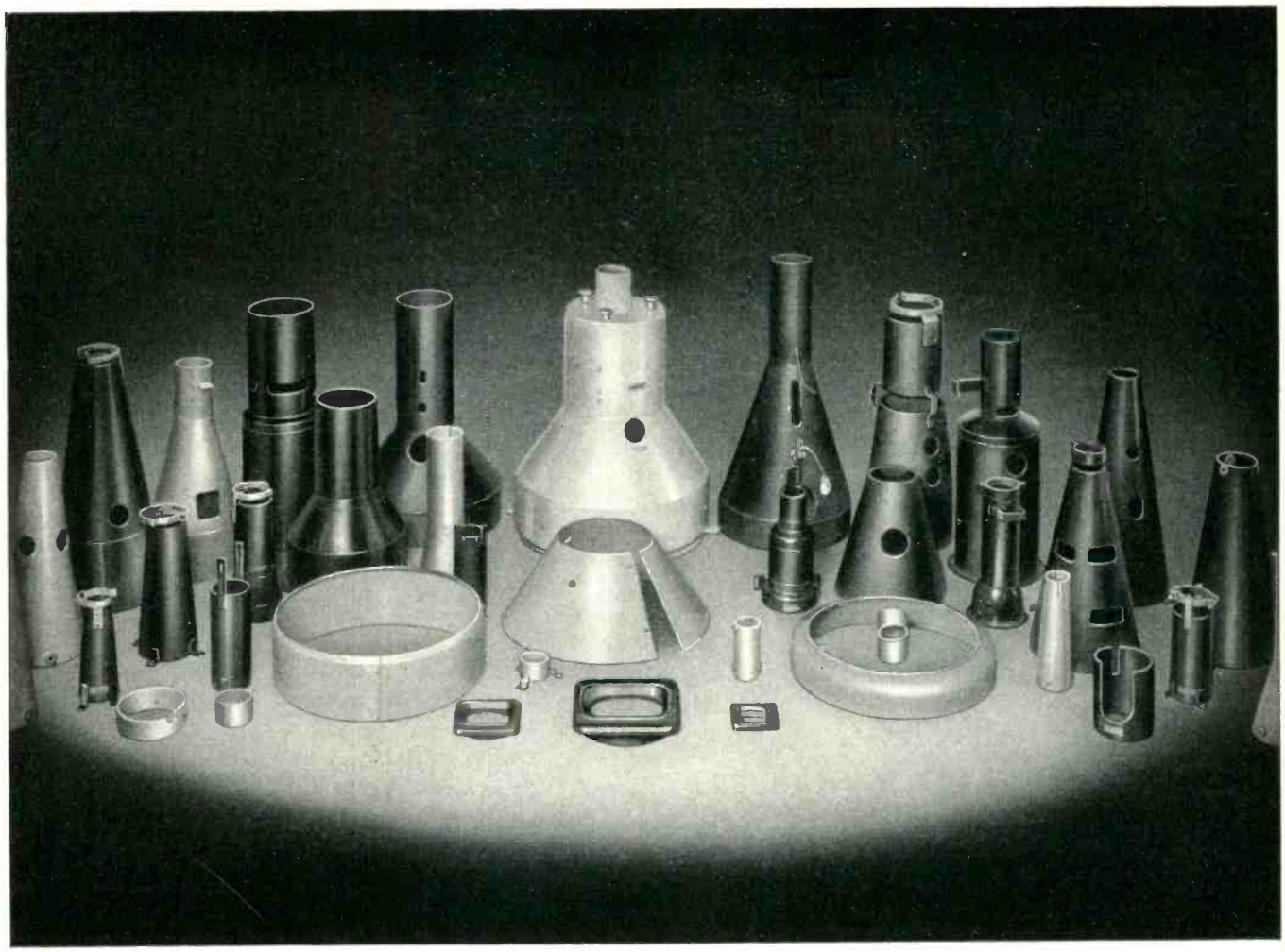
This information supplements that given in an article on p 156 in the feature section of this issue.

Hard Tube Operates Magnetic Counters

By L. FLEMING
Instrumentation Consultant
Falls Church, Va.

COUNTING EVENTS at rates under about 10 a second is often performed by means of a magnetic counter and a thyratron. A hard-tube circuit works better, however, because it can deliver better-shaped pulses of current to the counter magnet and because it will never fail to return to the nonconducting state after each actuation.

Figure 1 shows a hard-tube circuit that will actuate a counter on receipt of negative input pulses of 0.5 volt or more. It is a one-shot multivibrator. First stage V_1 is designed for high voltage gain; the second stage V_2 for high current output. The best type of counter for use with this circuit is one



Designed for Application

Mu Metal Shields

The James Millen Mfg. Co. Inc. has for many years specialized in the production of magnetic metal cathode ray tube shields for the entire electronics industry, supplying magnetic metal shields to manufacturing companies, laboratories and research organizations. Stock shields are immediately available for all of the more popular sizes and types of cathode ray tubes as well as bezels for 2″, 3″ and 5″ size tubes.

Many production problems, however, make desirable special shields designed in conjunction with the specialized requirement of the basic apparatus. Herewith, are illustrated a number of such custom built shields. Our custom design and fabrication department is at the service of our customers for the development and manufacture of magnetic metal shields of either nicoloi or mumetal for such specialized applications.

JAMES MILLEN MFG. CO., INC.

MAIN OFFICE AND FACTORY

MALDEN, MASSACHUSETTS, U.S.A.

rated for 110-volt d-c operation. About 60 ma is required in the coil for positive operation. Tube V_2 delivers 100 ma peak.

Power tube V_2 is normally cut off by means of bias resistors R_2, R_3. Some initial adjustment may be required by selecting resistors. About 65-v bias is required. If V_2 is not completely cut off, the circuit will operate free-running. If bias is excessive, sensitivity will suffer and peak power delivered to the counter will be reduced.

The feedback paths between V_1 and V_2 are through coupling capacitor C_1, and common cathode resistor R_4.

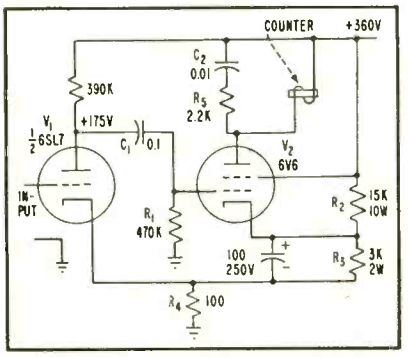


FIG. 1—Trigger circuit supplies pulse for reliable operation of 60-ma 100-v d-c magnetic counter

The shape of the current pulse delivered to the counter coil is approximately square-topped. Current is about 100 ma with a duration of 1/20 second. It may be observed by connecting an oscilloscope across R_4.

Value of R_4 is determined mainly by the voltage required to cut off V_1. The 10 volts developed is adequate. Larger values will reduce the output power.

Pulse duration is mainly determined by the interstage time constant C_1R_1. Too-long pulses will impair the maximum time resolution of the circuit-counter combination and too-short pulses will fail to give positive actuation.

A surge-absorption circuit C_2 R_5 across the counter coil was found advisable to absorb the high voltage induced in the coil at the instant when V_2 cuts off.

If operation is desired only on signals exceeding a preset threshold level, the biased series-diode circuit of Fig. 2 is added ahead of

telling the story of 'dag' dispersions

Dry-Film Lubricant Is Ideal For Electrical Mechanisms

If lubrication is difficult because of heating elements or similar conditions . . . and if it must be permanent because it cannot be renewed . . . you need 'dag' colloidal graphite dispersions.

'dag' dispersions, because of graphite's unusual resistance to heat, are ideal for such applications. 'dag' Colloidal Graphite, forming a permanent, slick, adherent, *dry lubricating film,* functions without contaminating the load or affecting delicate electrical and electronic systems.

For switches, relays, and other mechanical components which must work unattended or operate throughout wide temperature ranges, dry films produced by 'dag' dispersions solve the most vexing lubrication problems.

And where a *conductive* lubricant is desired, graphite alone of the commonly used lubricants can provide this unique double service.

To learn how 'dag' dispersions can help you, write for Bulletin No. 433-J2.

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

Acheson Colloids Company

Port Huron, Michigan

...also ACHESON COLLOIDS LIMITED, LONDON, ENGLAND

try 'dag' resin-bonded dry films for permanent lubrication

dag DISPERSIONS®

the input to V_1. The constants shown allow operation at any level between about 0.5 volt and 10 volts. A series diode is superior to a shunt diode in this application.

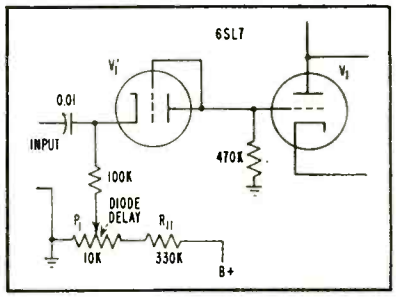


FIG. 2—Biased series-diode circuit can be added ahead of trigger circuit if operation is desired only above preset input level

If triggering is desired on positive pulses instead of negative, the phase may be reversed by means of an interstage audio transformer. To obtain triggering equally on inputs of either polarity, a push-pull transformer or a phase inverter, with a full-wave diode rectifier is appropriate.

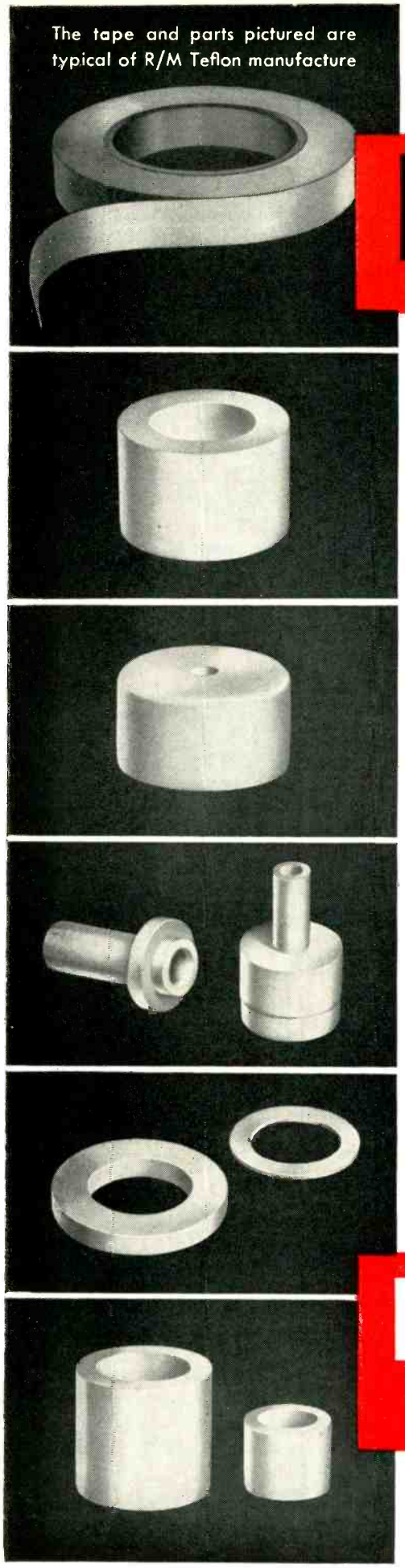
Input Requirements

The input signal must last at least 0.1 millisecond for reliable triggering. The signal should not be so large as to produce an excessive charge on coupling capacitor C_1 and the negative triggering pulse should not be followed by a much larger pulse of positive polarity.

Excessive charge on C_1 takes too long to leak off and impairs the time resolution. No such impairment occurs unless the pulse is larger than about 20 volts. No deterioration in operation occurs with the application of audio-frequency sine or square waves to the input.

This circuit is applicable not only to the counting of purely electrical events, but aids in the counting of signals obtained from electrical contacts. Contact bounce and chatter often produce skips and multiple counts when operating a counter directly. With this circuit, most of the restrictions on contact resistance and dwell time are removed and positive reliable counter operation is obtained even from improvised contact arrangement.

(Continued on Page 192)



R/M Teflon*

gives you the plus of R/M's unmatched skill, experience, facilities

It is difficult to write about Teflon without appearing to exaggerate. For in many different ways this almost magic plastic—the most important derivative of the new wonder chemical fluorocarbon—is making the seemingly impossible possible. Parts made of R/M Teflon have already brought many startling improvements to the electronics and electrical manufacturing fields. And everyone working with it senses that the surface has barely been scratched—that hundreds of applications remain to be revealed.

There undoubtedly are ways in which Teflon can be profitably put to use in your own plant. So we have this suggestion to make to you: consider the properties of Teflon listed below—then get in touch with us if you think that any of them might make a contribution to your operation. We will fabricate parts to your own specifications or supply you with Teflon in the form of rods, sheets, tubes or tape.

Properties

High resistance to acids and gases even at high temperatures • Moisture absorption zero • Unaffected by weather • Excellent heat stability up to 500°F. in continuous operation • As tape, leaves no carbon residue along discharge path • High impact resistance • Nonadhesive • Stretches easily • Tensile strength 1500-2500 psi

**Du Pont's trade-mark for its tetrafluoroethylene resin*

R/M

RAYBESTOS-MANHATTAN, INC.

ASBESTOS TEXTILE DIVISION

MANHEIM, PA.

FACTORIES: Manheim, Pa.; No. Charleston, S. C.; Passaic, N. J.; Neenah, Wis.; Crawfordsville, Ind.; Peterborough, Ontario, Canada

RAYBESTOS-MANHATTAN, INC., Asbestos Textile • Packings • Brake Linings • Brake Blocks • Clutch Facings • Fan Belts • Radiator Hose • Rubber Covered Equipment • Industrial Rubber, Engineered Plastic, and Sintered Metal Products • Abrasive and Diamond Wheels • Bowling Balls

Recorder Monitors Test Flight

ELIMINATING the human element from test flights of new aircraft has long been the goal of aircraft designers. Information obtained in test flights must be interpreted keeping in mind the unfortunate fact that no two pilots react the same to any given condition.

One approach toward pinning down flight-test data has been to monitor important engine and aircraft gages and pilot reactions and to telemeter the information so obtained to a ground station. Unfortunately, this technique involves considerable equipment aboard the plane itself. Often the addition of such gear has a misleading effect on the operation of the plane, which may limit the usefulness of the tests.

USAF recorder for recording flight test data during flight

The photograph shows a compact recorder designed to be tucked away in the airplane to keep running records of the necessary functions during flight tests. The resulting records are permanent and easily interpreted after the test is completed.

Flight data recorded include forces applied to the pilot's stick and rudder controls, altitude, rate of roll, vertical accelerations applied to the aircraft and so on. To obtain this information some of the instruments normally contained on the plane's instrument panel are duplicated in the recorder; other data are collected by taking off signals from existing panel instruments.

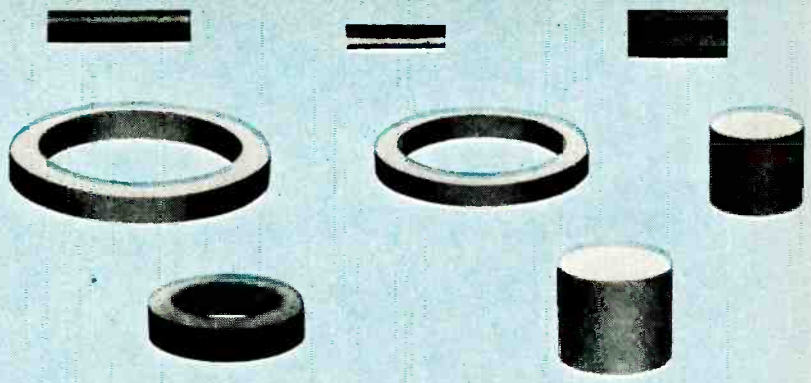
A block diagram of the complete recording system is shown in Fig. 1. Sensing elements for altitude,

- Photographic Equipment Resistor used in Photo-Flash Circuits

- Bleeder Resistor for . . . Power-Line Capacitors

- Heat Anticipator Resistor for Wall Thermostat

- Resistance Rings, Pins, and Plugs for Lightning Arresters



- Film Resistors for Automatic Light Dimmers

Where Design Calls for . . . Custom Resistance Products

Specify **ERIE** RESISTOR CORP.

- Resistor for Aircraft Magneto

- Ring Resistor for Speed Control Device

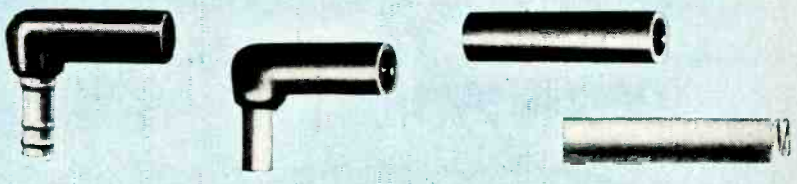
- Gasoline Gage Resistor

- Resistor for Electric Clock

- Strain-Gage Resistor for Detecting Strain in Airplane Wings and Propellers

- Voltage Dividers for TV Sets with Special Coating to Prevent Corona Discharge

- Special and Standard Case Ignition Noise Suppressors



For 26 years Erie Resistor Corporation has been designing and manufacturing highest quality resistance products. That experience is at the service of every manufacturer needing individual design and application to meet product requirements.

The illustrations show a few of many custom resistance components manufactured by Erie. We also specialize in the application of resistance material on steatite plates and phenolic bases for printed circuits and special resistor applications.

You will find at Erie a ready understanding of your resistance and other electronic component problems, and an unusual skill in helping you to solve them.

ERIE RESISTOR CORP.

ERIE RESISTOR CORPORATION . . . ELECTRONICS DIVISION

Main Offices and Factories: **ERIE, PA.**

Sales Offices: Cliffside, N. J. • Camden, N. J. • Chicago, Ill. • Detroit, Mich. Cincinnati, Ohio • Fort Wayne, Ind. • Los Angeles, Calif. • Toronto, Ontario

Manufacturing Subsidiaries:

HOLLY SPRINGS, MISSISSIPPI • LONDON, ENGLAND • TRENTON, ONTARIO

rate of roll, airspeed and yaw are contained in the recorder instrument. Control position and two pilot actions are derived from external sensing devices.

The acceleration channel contains an electronic analog-to-digital conversion system to meet the frequency response required on this channel. The accelerometer signal is amplified, rectified and applied to a comparator that compares the accelerometer signal amplitude with a signal from a 100-step voltage generator. At regular intervals signals are sent from the comparator through a system of counters and matrices to the styli in the recorder, which in turn plot the function digitally.

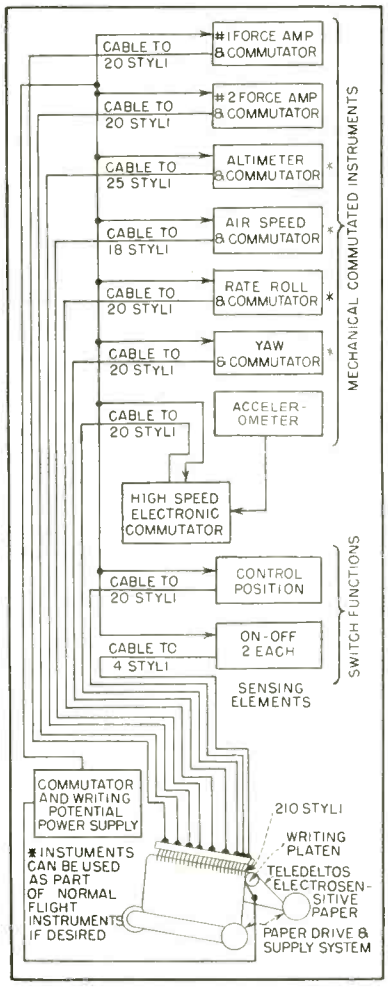
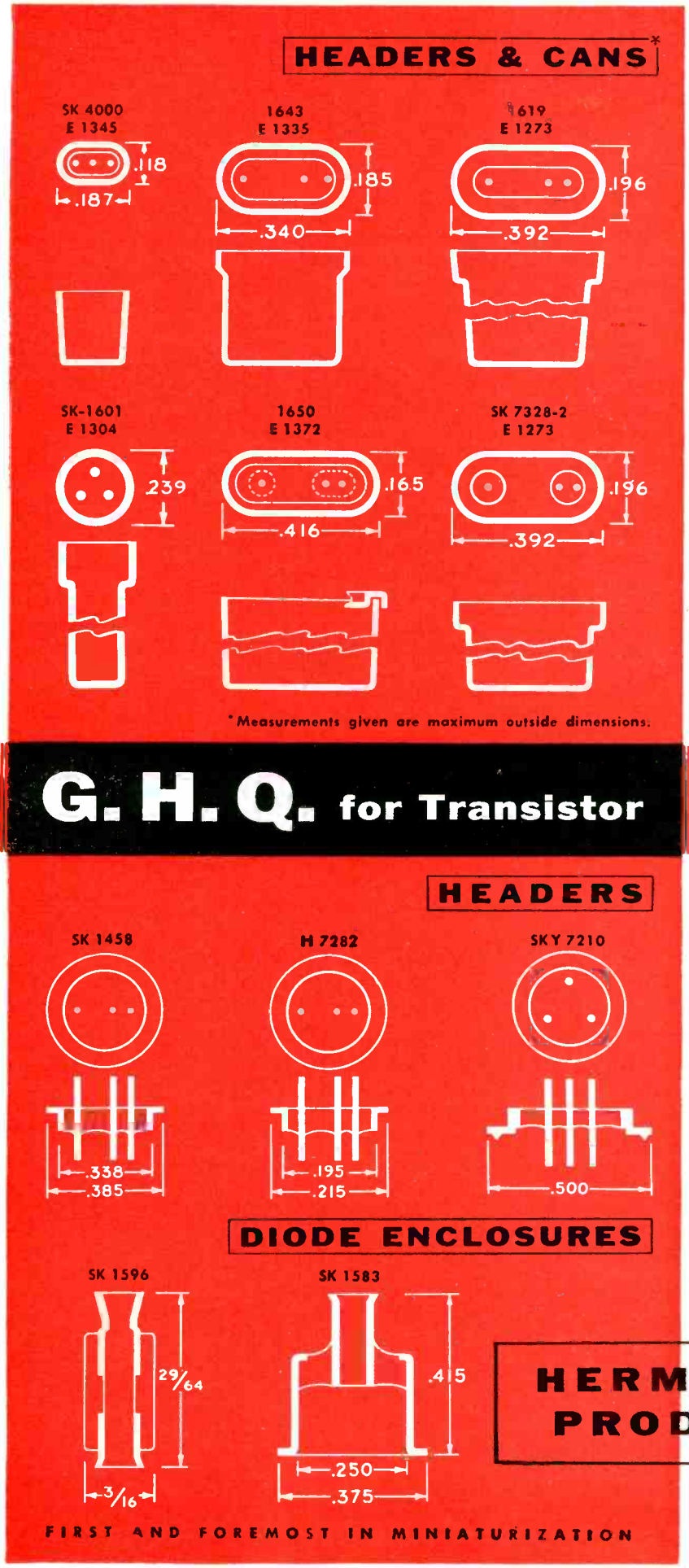


FIG. 1—Block diagram of flight test recorder

By converting the analog-type signals from the sensing elements into decimal digital information in the converter unit, the values of the function from 1 to 100 can be represented with relatively few styli,



Hermetic Headers for Every Application:

1. Hermetic gives you widest variety in size and design.
2. Hermetic "custom-builds" to include such features as:
   - Welding closure
   - Provision for isolation of heat zone
   - Variable terminal spacing
   - Polarity indication
   - Special sizes and shapes
   - Clear glass windows for photo-sensitive elements
   - Compression-seal or matched-glass types
3. Hermetic's quality production techniques are field performance-proved leak-proof. Mass spectrometers and similar inspection devices are employed. Extra quality finishing operations at Hermetic include hot tin dipping for ease-of-solderability.

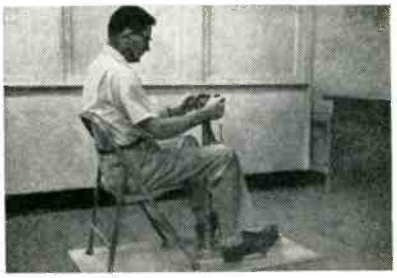
Hermetic headers are equally applicable for other miniaturized electronics "packaging": rectifiers, relays, printed circuit assemblies, etc. Ask for our catalog.

SEALED IN by HERMETIC HEADERS

HERMETIC SEAL PRODUCTS CO.

31 South Sixth St.
Newark 7, New Jersey

two sets of ten styli representing tens and units.



Simple mockup "calibrates" pilots' reactions

A simplified diagram of the comparator circuit is shown in Fig. 2A. The output from this circuit, obtained at the point of amplitude comparison, pulses all of the output plates and activates the recorder pens of the two tubes that are positively gated at that instant. The gates are obtained from the counter matrix with one hundredth count triggering the recycling pulse generator.

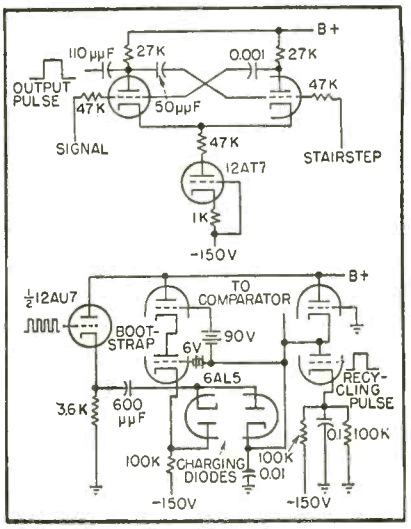
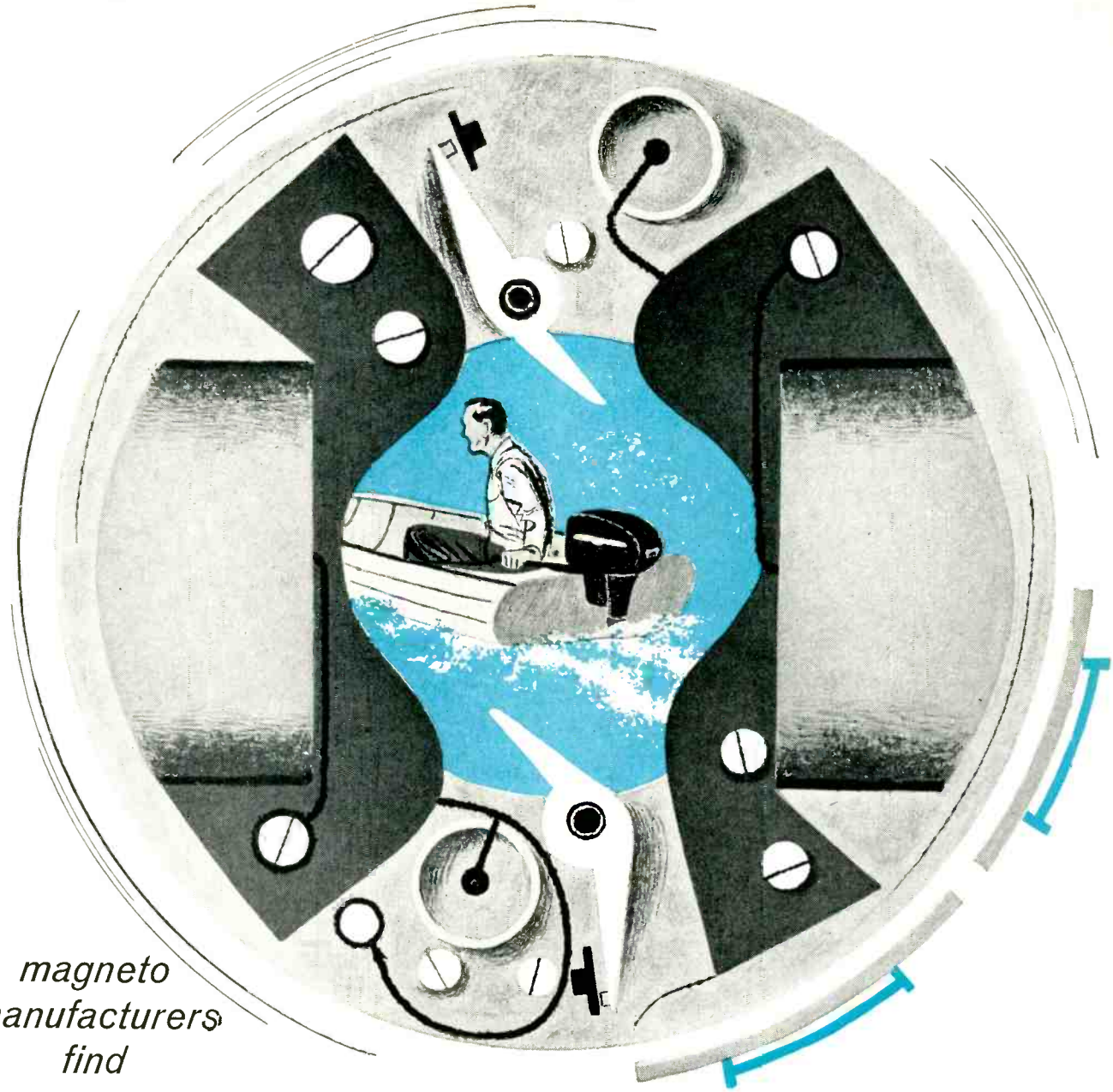


FIG. 2—Simplified circuits of comparator (A) and stair-step generator (B)

The stair-step generator (Fig. 2B) uses a conventional step counter with charging and discharging diodes and a dual cathode-follower bootstrap circuit for linearization. One cathode follower linearizes the charging curve of the collecting capacitor and the other linearizes the first cathode follower. The leading edge of the square-wave output of a free-running multivibrator triggers the stair-step generator. The trailing edge of the same pulse triggers the counter circuit. Thus there is automatically a count for each step and no string-



magneto manufacturers find

CRUCIBLE PERMANENT MAGNETS

provide maximum energy... minimum size

The *consistently higher* energy product of Crucible Alnico permanent magnets enables manufacturers to use smaller, more powerful magnets in the magnetos of outboard motors, power mowers and other gasoline-powered equipment.

In fact, ever since Alnico alloys were first developed, Crucible has been supplying them to manufacturers of permanent magnet magnetos, generators and motors and all types of magnet-equipped devices.

Pioneers in magnet design and production, Crucible's magnet division is backed by a half-century of fine special steelmaking. So when you have a magnet application it will pay you to *call Crucible.*

CRUCIBLE first name in special purpose steels

54 years of Fine steelmaking **ALNICO PERMANENT MAGNETS**

CRUCIBLE STEEL COMPANY OF AMERICA, GENERAL SALES OFFICES, OLIVER BUILDING, PITTSBURGH, PA.

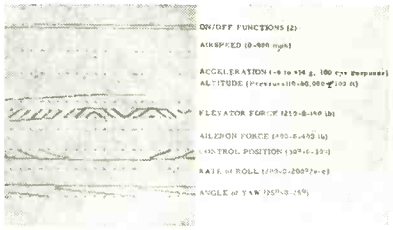
STAINLESS • REX HIGH SPEED • TOOL • ALLOY • MACHINERY • SPECIAL PURPOSE STEELS

Canadian Distributor — Railway & Power Engineering Corp., Ltd.

ent requirements are placed on stability of either counter or generator.

The recycling pulse generator is a monostable multivibrator with a sufficiently long time constant to allow the stair-step generator to become discharged. The discharge tube is normally biased off but conducts heavily when under the influence of the recycling pulse. The cathode follower on the discharge circuit insures that the stair-step generator discharges to the same potential on every cycle.

The disabling tube is normally held off but conducts during the recycling period. This, in turn, causes one section of the multivibrator to become cut off and held off, disabling the multivibrator for the duration of the recycling period.



Typical recording of flight data

Sensitivity and stability requirements for the comparator circuit are severe. The circuit must be capable of delivering full output with less than 1.5 volt change

Plastic Research Aid

Lighthouse tube (right) taken from production line reveals secrets of internal structure when filled with plastic and sawed in half (left). Plastic casting technique holds each tiny part in exact position. Tube to be examined is immersed in liquid plastic and seal is cracked. Atmospheric pressure forces liquid into envelope. Plastic hardens in about a day after which a cutting wheel slices it

Good-ALL

MIFILM CAPACITORS WITH MYLAR* DIELECTRIC

Built to Your Specified Sizes

SUBMINIATURE SIZES OVER THE COMPLETE CAPACITY AND VOLTAGE RANGE. Typical is the .173" dia. x ½" long (.001 mfd, 600 VDC). We can put these subminiature capacitors into any case style or type of mounting and still provide the same extremely small space factor—approximately ½ of paper capacitors.

HERMETICALLY SEALED—METAL ENCLOSED. These MIFILM Capacitors are uneffected by extreme climatic changes.

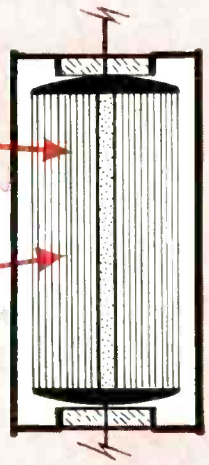
MYLAR* DIELECTRIC—retains extreme high insulation resistance over complete temperature range of −65° C to 150° C. Special sizes can be made to withstand even higher temperatures.

**DuPont trademark for polyester film.*

MIRACLE X IMPREGNATED—completely impregnated in this *high temperature impregnant* to prevent troublesome voids.

SPECIAL TOLERANCES as low as ±1%.

These same **MYLAR DIELECTRIC CAPACITORS** are also available in commercial type construction—Types 620 and 621. Specify type when ordering.



Types 612 and 613
EXTENDED FOIL CONSTRUCTION
612 One End Grounded
613 Both Ends Insulated

Types 614 and 615
TAB CONSTRUCTION
614 One End Grounded
615 Both Ends Insulated

Write for complete catalog covering all types of Good-All long-life capacitors. We invite sample orders for your evaluation. Our engineers are always ready to work with you on any capacitor problem.

Good-ALL CAPACITORS

So Superior... They are being used extensively by leading Electronic, TV, and Radio Manufacturers throughout America.

GOOD-ALL ELECTRIC MFG. CO. Good-All Bldg.,
114 W. FIRST ST., OGALLALA, NEBRASKA • PHONE 112 OR 113—CABLE ADDRESS "GOODALLA"

(step-voltage increment) in the stair-step voltage; any drift will cause corresponding inaccuracy.

To sense and record forces applied by the pilot in maneuvering a test airplane, strain gages are attached to appropriate control mechanisms in the plane. Calibration of the force channels of the equipment is achieved by the mockup shown in the photograph. Before leaving the ground, the pilot flys the broomstick and thus his particular habits are measured. When he takes over control of the plane in flight, signals derived from strain-gage detectors can be calibrated in terms of actual force applied.

Selenium Rectifier Testing Techniques

By Edward L. Pagano

Development Engineer
Bradley Laboratories, Inc.
New Haven, Conn.

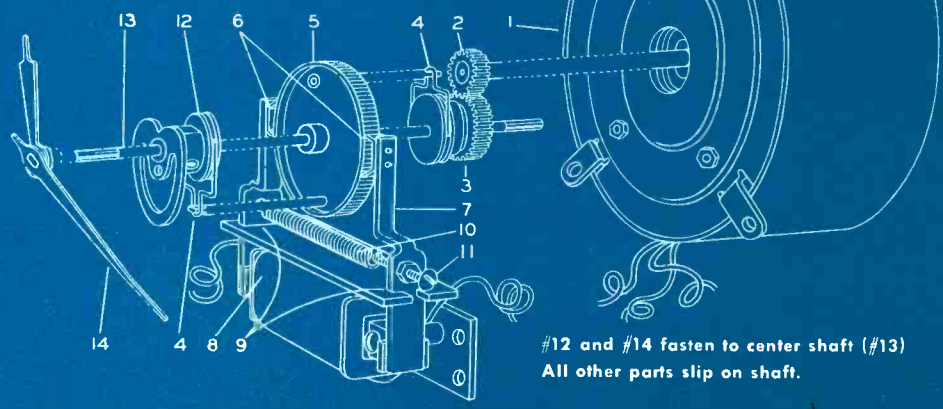
Test results are not always a true indication of the life of a selenium rectifier in actual application.

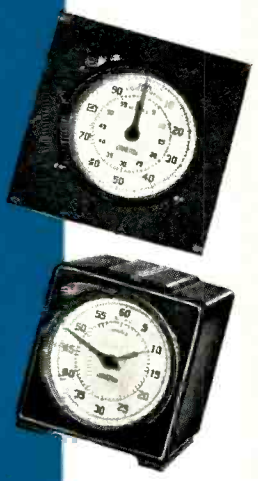
Surveys of testing techniques and various manufacturing processes in which desirable rectifier characteristics are obtained show that it is possible to produce selenium rectifiers that will test exceptionally well on all the conventional preliminary tests, but will not last as long as some rectifiers that do not show up as well.

The manufacturer can determine this difference by control of his manufacturing processes and thus knows which rectifier will be better before it is tested. The user of selenium rectifiers does not have this information and must rely on proper initial testing and the reputation of the manufacturer.

The forward resistance of a rectifier can be analogous to the internal resistance of a d-c generator or battery; as forward resistance increases, the output voltage decreases. However, it is important to remember that since a rectifier is a nonlinear device the forward resistance will change as load-current changes. The load current flowing through the forward resistance of the rectifier produces a power loss, decreases output volt-

Facts behind the S-1 Timer's extraordinary .005 Sec. ACCURACY





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

● High torque (2 inch-ounce at 100 RPM) industrial grade motor (#1) with no internal gear train so small changes in load due to binds or hand acceleration cause no phase shift between rotor and rotating field . . . runs continuously to eliminate starting error.

● Precision cut gears (#2, #3). Any eccentricity or inaccuracies in gearing reflect directly in timer reading.

● Slip clutch composed of hardened steel spring (#4) riding a V-grooved graphited (for long wear) collet, applies .6 inch-ounces of torque to aluminum (for low inertia) control disc (#5) with 314 tiny teeth in its periphery.

● To hold control disc (#5) at rest, 2 hardened steel brake shoes (#6), ground to square knife edges, grip periphery of control disc in 4 places . . . control disc position to under ½ of a degree (1/720 second).

● Electro magnet (#8) pulls brake shoes away from control disc through armatures (#7). Air gaps kept to minimum for speed. Precision made fulcrums prevent stickiness or unequal movement of armatures.

● Adjusting screw (#11) adjusts tension of armature spring (#10) so that time between energizing magnet coil and starting of control disc is same as time between de-energizing magnet coil and stopping of control disc. This compensates for starting and stopping errors.

● Second friction clutch (#12) transfers control disc motion to center staff (#13); allows hands to be reset when control disc is held stationary.

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

STANDARD SINCE 1884

To Split the Split Second with ACCURACY, Take a Minute Now and Send Us This Coupon

The STANDARD ELECTRIC TIME COMPANY

97 LOGAN STREET • SPRINGFIELD 2, MASS.

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

THE STANDARD ELECTRIC TIME COMPANY
97 Logan Street • Springfield 2, Massachusetts
Gentlemen: Please send me complete Engineering Data on the S-1 Timer.

Name_____

Firm_____

Street_____

City_____ State_____

age, increases temperature and decreases usable life. To keep the forward resistance at a minimum, the area of the individual rectifier cells is selected for the load current flowing through the rectifier.

On the reverse half cycle, the leakage current through the reverse resistance also produces a power loss, decreases output voltage, increases temperature and decreases usable life. To keep the reverse resistance at a maximum, the quantity of individual rectifier cells is selected for the maximum peak inverse voltage existing across the rectifier.

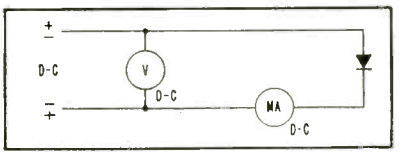


FIG. 1—Test setup for measuring static reverse and forward characteristics

The reverse characteristic has a tendency to form; that is the reverse leakage current begins to decrease after the first cycle of applied voltage; therefore, when testing the reverse characteristics of a rectifier, especially those stored for a period of time, ample time should be allowed for forming.

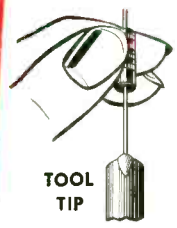
There are various tests to determine the quality of a rectifier and each of these has its advantages as well as disadvantages. Some of the primary factors to be considered in the selection of the appropriate test are the application of the rectifier, quantity to be used, cost of the rectifier and the accuracy and type of test equipment available.

A particular type rectifier, depending upon the circumstances, may have several different tests and each may be perfectly valid. For example, with the common radio and television type rectifier, the serviceman, because of the small quantity involved, would probably be content to test the rectifier with an ohmmeter or in the actual circuit for satisfactory output. However, the radio and television manufacturer, because of the large quantity involved of this same type rectifier would perform, on a sampling basis, more elaborate tests on the forward and reverse

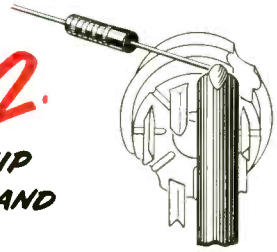
MAKE *Wire-Wrap** CONNECTIONS *in half the time!*

WEIGHS ONLY ONE POUND

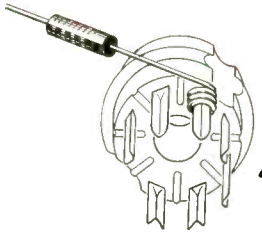
*Trademark



1. INSERT WIRE



2. ZIP ...AND



3. IT'S FASTENED

Available in air or electric models

Keller "*Wire-Wrap*" Tools produce electrical connections that need no soldering

ZIP . . . and this amazing new power tool wraps wire around a terminal to make a permanent electrical connection. Costly hand wrapping and soldering are eliminated . . . production goes up while costs go down.

Hour after hour, this new lightweight "*Wire-Wrap*" Tool makes uniform connections without fatigue to the operator. *Wire-Wrap* connections retain their characteristics under severe conditions of corrosion, vibration, or aging.

For lower costs, fewer rejects, faster production, product compactness, and strong, low-resistance connections, investigate this revolutionary new tool.

SOLDERLESS *WIRE-WRAP* CONNECTIONS

are made by wrapping wire tightly around rectangular terminals. Each quarter turn is locked under tension, providing a permanent mechanical and electrical bond. These clean, high-pressure connections have a contact area greater than the cross section of the wire . . . yet can be easily removed when desired. Send for Bulletin No. 11 for detailed information.

Wire-Wrap Tools are now available from Keller—the original manufacturer

Wire-Wrap Division

KELLER TOOL COMPANY

1335 Fulton Street Grand Haven, Michigan

characteristics as well as output voltage and life.

One of the simplest rectifier tests is the static or d-c test as shown in Fig. 1. A small predetermined d-c voltage is impressed across the rectifier causing current to flow in the forward direction. If this current is above a specified value the rectifier has a forward resistance below the specified maximum allowable. A large predetermined d-c voltage is then impressed across the rectifier in the reverse direction, and if leakage current is below a specified maximum the reverse resistance is above the minimum allowable.

Forward and reverse resistance as measured by the static test is valid only for the particular voltage and current at which it is tested and does not necessarily show the merit of the rectifier under actual operating conditions. The advantage of this type of test is that it is fairly simple to perform but it should serve only as an indication, unless the rectifier is to function as a d-c valve or in a similar application.

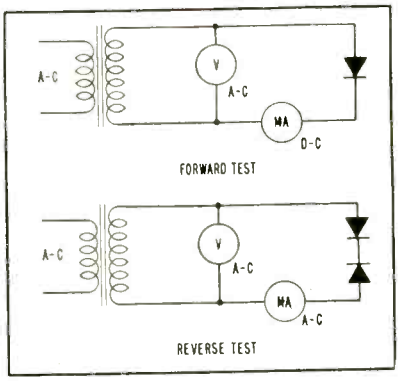


FIG. 2—Basic circuits for making a-c dynamic tests of rectifier characteristic

Since the basic rectifier operates in an a-c circuit, a more realistic test is made under a-c conditions. There are several dynamic tests and one of the simplest is illustrated in Fig. 2. The forward characteristic is measured by impressing a specified a-c voltage across the rectifier and measuring the d-c current flowing, while the reverse characteritic is tested by impressing the rated a-c voltage across two similar rectifiers connected back to back and measuring the a-c flow.

Although this test is relatively

MAGNETIC SHIELDS

Are you ready for a major electronic and electrical first—Magnetics, Inc. "Performance-Guaranteed" Shields for shielding of standard cathode ray and other tubes against moderate and high flux external fields . . . and custom-designed "Performance-Guaranteed" Shields for specific shielding problems?

Here are shields which eliminate waste . . . are guaranteed to your performance specification . . . *and are sold at standard prices*

THE WIDEST CHOICE IS YOURS

MATERIALS . . . Premium quality Performance-Guaranteed Shields are usually made from Mumetal or A.E.M. 4750, dry-hydrogen annealed for optimum isolating properties. Shields can be made from any other commercially available magnetic and non-magnetic materials when required by performance specifications.

METHOD OF MANUFACTURE . . . Performance-Guaranteed Shields can be fabricated or drawn by Magnetics, Inc., depending upon which is most economical for your requirements.

FINISH . . . Performance-Guaranteed Shields can be furnished painted, lacquered or unfinished, as your requirements dictate. Paint color can be matched to any equipment shade you select. Pre-painting by Magnetics, Inc. eliminates danger of damage to shields in painting operations in your plant . . . provides you with shields immediately ready for your assembly operations.

FREE ENGINEERING DESIGN . . . Our Engineering Department will carry out all phases of your shield design . . . including magnetic analysis . . . mechanical design . . . and production engineering to your cost requirements.

write on company letterhead

MAGNETICS inc.

DEPT.E-9, BUTLER, PENNSYLVANIA

simple to perform and does not require elaborate test equipment, it has several disadvantages. The forward test depends entirely upon the type of a-c voltmeter used, and the impedance of the transformer. During the forward-conduction period of the rectifier, the voltage waveform has a tendency to be distorted owing to transformer loading and if the resistance of the transformer is high, the distortion will become pronounced and the type of a-c meter used will be important.

Since the input voltage wave will be distorted only during the forward-conduction half cycle, using the same transformer, different results will be obtained with a peak-reading, rms reading or average-reading meter. If a half-wave-rectifier type meter is used, different results will be obtained by simply reversing the loads, because this effectively switches the meter from the distorted half cycle to the undistorted half cycle or vice versa.

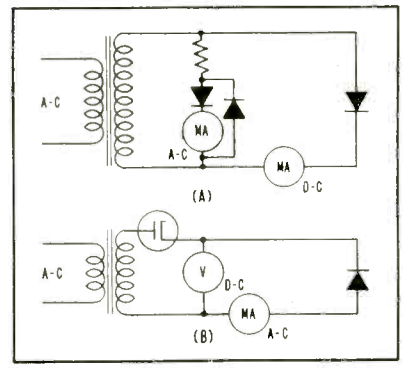


FIG. 3—Dynamic measurement setup that closely duplicates actual operating conditions

The reverse test also has its faults. With the back-to-back circuit, the leakage current is the rms current contributed by both rectifiers. Therefore, the rectifier being tested is directly dependent upon the rectifier that it backs and the indication will be a composite of the two. Under these conditions, depending upon the rectifier it backs, a good rectifier may test bad and vice versa.

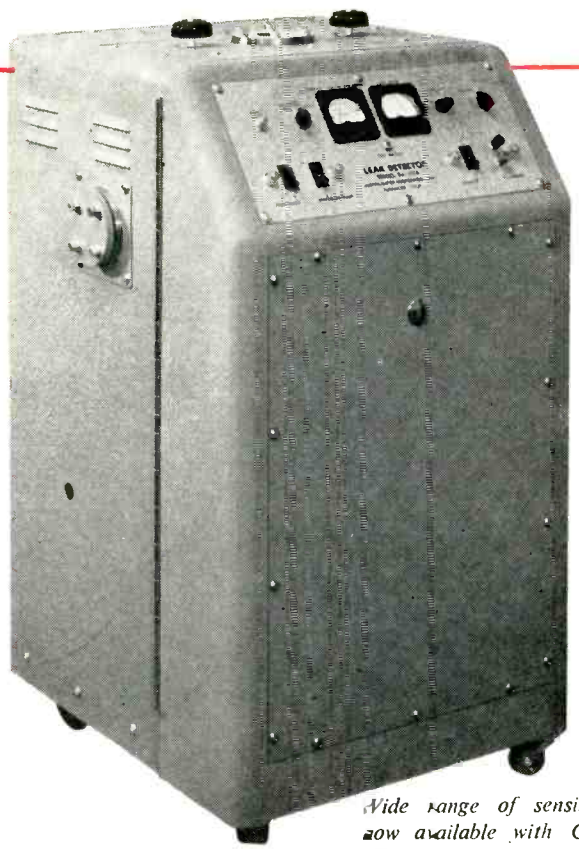
With slight variations of the dynamic test circuit, these difficulties can be corrected. Figure 3, illustrates an improved dynamic test that closely duplicates actual operating conditions. The input voltage is adjusted until rated current

Sensitive to 1 part in 2,000,000

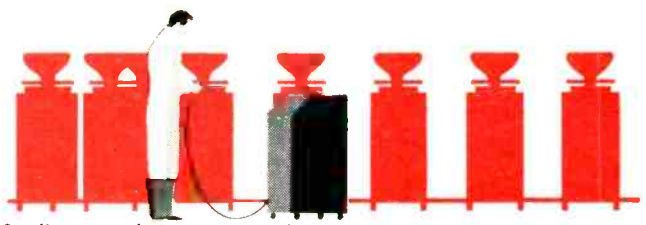
Consolidated's new Model 24-110 Leak Detector

For leak detection applications where the utmost in sensitivity is required, Consolidated's new Model 24-110 Leak Detector meets the most stringent requirements. The latest addition to the Consolidated leak detector line is a modification of a high precision instrument built by CEC for the Atomic Energy Commission. Operating on the mass spectrometer principle made famous by CEC's widely used Model 24-101A industrial leak detector, the sensitivity of the 24-110 has been multiplied by a factor of 10 through advanced electronic techniques. Its uses include testing of both evacuated and pressurized equipment, revealing the existence or the absence of leaks, finding the locations of leaks, and determining the rates of leakage. Outstanding features include: an audible alarm whose sound-pitch varies with the magnitude of the leak; an accessory sampling probe for rapid pressure-system leak testing; a selector switch that provides six ranges of sensitivity; a visual leak-rate meter capable of indicating the presence of 1 part helium in 2,000,000 parts air. Compact, self-contained and mobile, Consolidated's new Model 24-110 Leak Detector is a perfect tool for highly critical applications such as detection in ultra high vacuum laboratory equipment, leak-checking of TV color tubes, and safety control in nuclear material manufacturing.

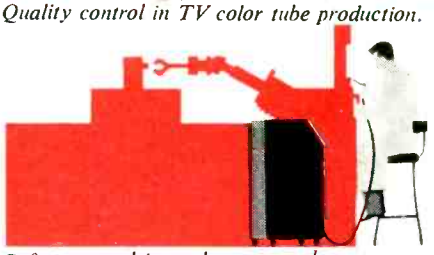
Request Bulletin CEC 1838-X5



Wide range of sensitivity now available with CEC Models 24-101A and 24-110.



Quality control in TV color tube production.



Safety control in nuclear research.

Leak detection for ultra-high vacuum equipment.

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

ANALYTICAL INSTRUMENTS FOR SCIENCE AND INDUSTRY

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

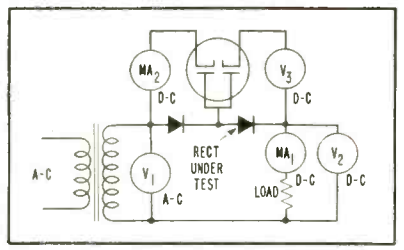


FIG. 4—Circuit for making rapid dynamic forward and reverse characteristic tests on large quantities of rectifiers

flows through the rectifier and the forward voltage drop across the rectifier is indicated by the voltmeter. To measure the forward voltage drop, the voltmeter must indicate only during the half wave in which the rectifier is conducting in the forward direction. This can be accomplished by calibrating a half-wave-rectifier type a-c meter for half-wave d-c as shown in Fig. 3A. This method reduces the importance of the transformer resistance and insures identical results regardless of the voltmeter used, providing it is a properly calibrated half-wave-rectifier type.

An alternate method is to use a series arrangement of a low-resistance half-wave-rectifier tube and a high resistance d-c voltmeter as shown in Fig. 3B.

The reverse test measures each rectifier on an individual basis and is therefore an improvement over the back-to-back test. A half-wave d-c voltage, similar to that encountered under actual operating conditions, is impressed across the rectifier being tested and the reverse leakage current is measured. The voltmeter indicates the average of the half wave impressed across the rectifiers; therefore the peak inverse voltage is equal to this average value divided by 0.318.

If a large quantity of the same type rectifier is being used, it may be desirable to test the forward and reverse characteristics simultaneously. Figure 4 illustrates a circuit arrangement used for this purpose. The input voltage is adjusted until rated input voltage is indicated by V_1, and the load resistor is then reduced until rated current flows through MA_1. Output voltage is indicated by V_2, while V_3 indicates the forward voltage drop and MA_2 the reverse leakage current. This circuit is simple,

Spotlighting Standardization!

E-I hermetically-sealed terminations and miniature closures*

● **MULTIPLE HEADERS** — Strain-free, vacuum tight headers featuring cushioned glass construction. Silicone treated for maximum dielectric strength and tin dipped for easy soldering.

● **SEALED TERMINALS** — These E-I terminals offer high thermal shock resistance and feature cushioned glass construction. Available in many economical preferred types and special designs.

● **OCTAL HEADERS** — Both plug-in and multiple types feature a new principle of hermetic sealing. Solid metal blanks afford maximum rigidity and mechanical strength.

● **E-I END SEALS** — Completely strain-free. Provide a permanent hermetic seal. For condensers, resistors and other tubular-type components. Available in many standard types.

● **COMPRESSION TYPE HEADERS** — Super rugged, practically indestructible and absolutely rigid. Exclusive E-I process affords increased resistance to shock and vibration.

● **LUG-TYPE, LEAD-THRU INSULATORS** — Compression sealed, super rugged. For applications requiring voltage ratings from 2000 to 4000 (rms.)— transformers, "bath-tub" condensers, etc.

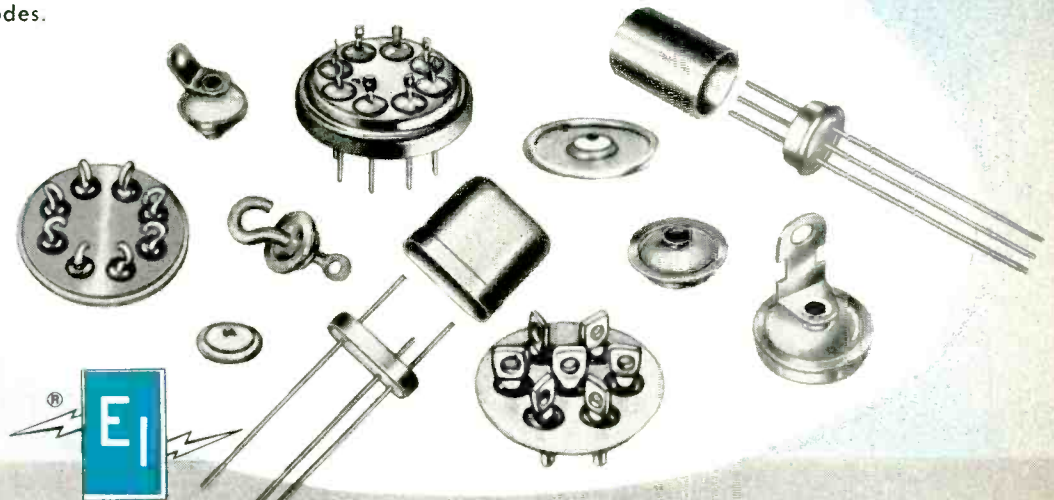
● **MINIATURE CLOSURES** — For transistors and other components requiring hermetic sealing. Square, rectangular and round cases. Supplied in E-I standard types or custom designs to specifications.

● **COLOR-CODED TERMINALS** — Featuring glass inserts with permanent coloring in the glass. All types offered in standard, easily-identified RMA color codes.

*PATENT PENDING
ALL RIGHTS RESERVED

AVAILABLE IN A WIDE RANGE OF STANDARD TYPES TO ECONOMICALLY MEET SPECIAL REQUIREMENTS!

Economical E-I standardized hermetically-sealed terminals and miniature closures are available to meet almost any electronic application. Samples and recommendations on your particular needs will be supplied promptly on receipt of your data. Call or write for complete E-I catalogs, today!



ELECTRICAL INDUSTRIES

44 SUMMER AVENUE, NEWARK 4, NEW JERSEY

DIVISION OF AMPEREX ELECTRONIC CORP.

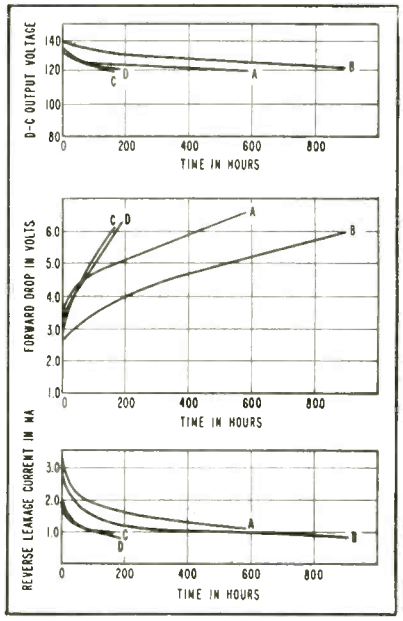


FIG. 5—Curves for accelerated life tests on four 75-ma selenium rectifiers made by different manufacturing techniques show length of life determined by forward and reverse characteristics

compact and will test the characteristics of the rectifier under actual operating conditions with rated input voltage and rated current.

There are several tests that may be used to determine the quality of a rectifier, and although all the tests are based upon measuring the forward and reverse characteristics, the real criterion for quality is the change in forward and reverse characteristics during the life of the rectifier.

The curves of Fig. 5 emphasize the fact that initial conditions do not necessarily disclose the absolute quality of the rectifier. These curves are the results of extensive accelerated life tests on 75-ma rectifiers of the radio-television type produced by different manufacturing techniques. Rectifiers *C* and *D* exhibit low initial forward voltage drop and low initial reverse leakage. However, their life is seriously curtailed due to the rapid increase of forward voltage drop. Although rectifiers *A* and *B* have a larger initial reverse leakage current than either *C* or *D*, the rate of decrease is rapid and the rectifiers have a longer useful life. Life is usually defined as the time required for the output voltage to decrease to 90 percent of its initial value. This time is definitely determined by a combination of the inherent quality

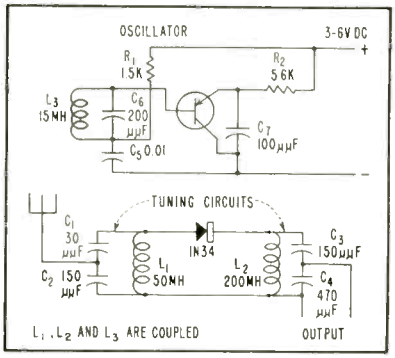
of both the forward and reverse characteristics.

Transistor Converter

By Leo J. Hruska
Engineer
The Glenn R. Martin Co.
Baltimore, Md.

THE PROTOTYPE model of the converter described here was made for operation at 3.5 mc. However, with the newer transistors, it is feasible to make similar converters that will operate at frequencies up to and including 50 mc.

The circuit, shown below is a simple crystal mixer-oscillator circuit. Coil L_1 in conjunction with C_1 and C_2 tunes broadly to the signal frequency centered at approximately 3.75 mc. This comprises the input circuit. Coil L_2 with C_3 and C_4 tune in similar manner to the center of the broadcast band, about 1 mc. Both tank circuits are tapped down by the capacitance split C_1 C_2 for antenna match, and C_3 C_4 for receiver match.

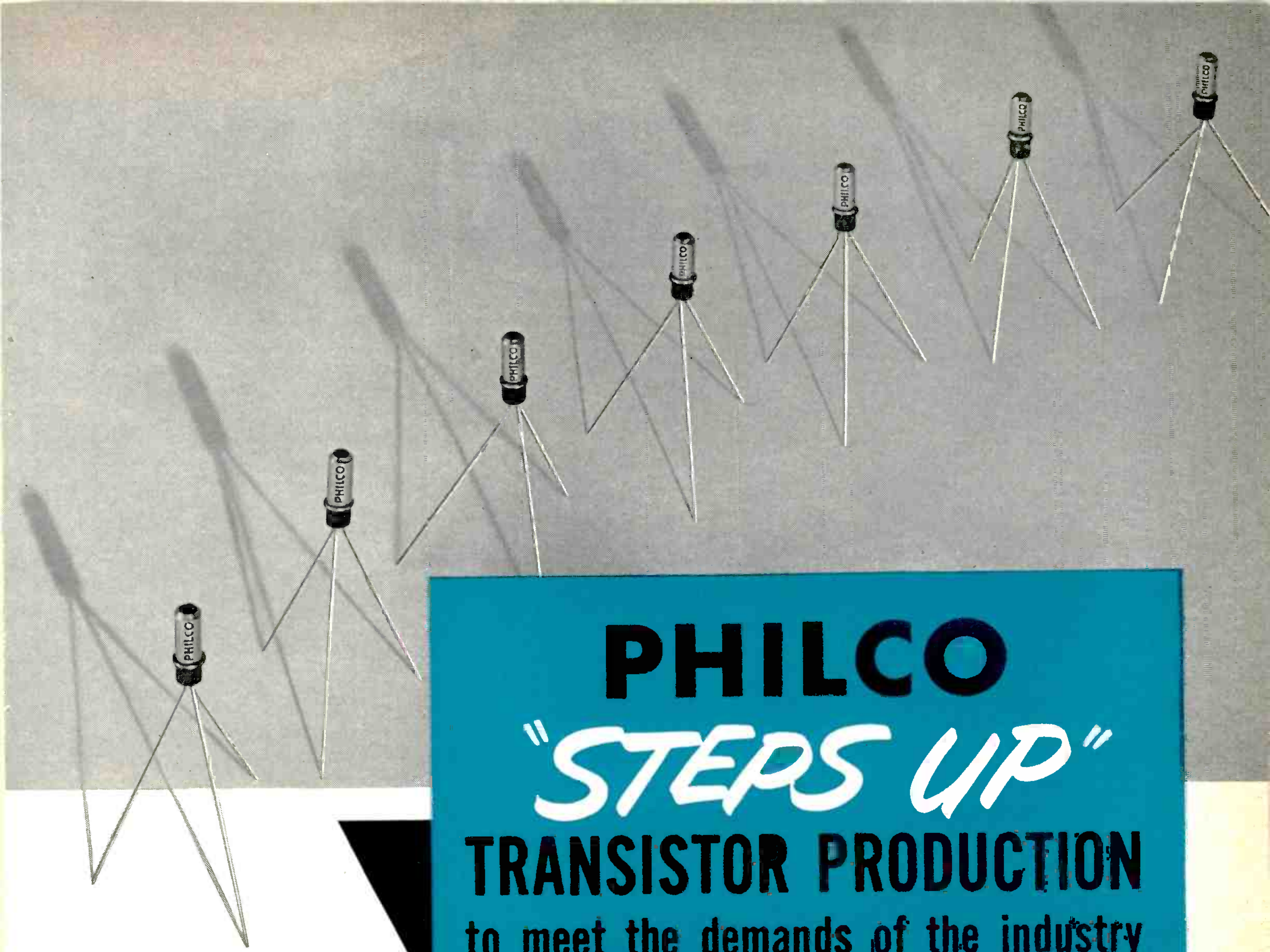


Transistorized short-wave tuner. Coil L_3 is placed between L_1 and L_2 and is inductively coupled to both

The oscillator is built around a point-contact type transistor with the tuned impedance in the base circuit and feedback between emitter and collector. This circuit has been found to oscillate on as low as three volts. Current drain at six volts is about 1.75 ma.

Inductive injection is used in the detector-mixer circuit. By locating oscillator coil L_3 adjacent to and between the input and output coils and phasing the connections so that the flow is additive, a beat-frequency signal is passed thru the diode. The difference frequency is used in this converter.

The fact that there is no direct



PHILCO "STEPS UP" TRANSISTOR PRODUCTION

to meet the demands of the industry

SUPERIOR PERFORMANCE makes Philco Transistors the recognized standard. With Philco Alloy Junction Transistors you gain the advantages of small size, low power consumption and simplified circuitry to improve your product.

RELIABILITY . . . six years of Philco research and development in semi-conductors have established the quality, uniformity and production standards (from basic materials to tested transistors) required for large scale production.

AVAILABILITY...recognizing the potential transistor requirements of the electronic industry, Philco planning has resulted in production facilities which assure an unfailing supply of high quality transistors—now!

Phone, write or wire Dept. E today for descriptive literature and specifications on Philco transistors.

PHILCO TRANSISTORS FEATURE . . .

- *Maximum reliability*
- *Hermetically-sealed resistance-welded case . . . leads fused in glass*
- *Uniform characteristics*
- *Minimum size*
- *Ruggedized construction*

PHILCO CORPORATION

GOVERNMENT & INDUSTRIAL DIVISION • PHILADELPHIA 44, PA.

connection between the oscillator and mixer circuits permits either pole of the battery to be grounded.

PERTINENT PATENTS

By Norman L. Chalfin
Hughes Aircraft Co.
Culver City, Calif.

Automatic control devices depend upon reliable methods of sensing. Interest in this field is reflected by a number of patents described below.

Unbalance Detector

A Balancing Machine is the subject of U. S. patent 2,651,937 awarded F. A. Martin and S. J. Jeffery of St. Catherines, Ontario, Canada, assignors to the General Motors Company of Detroit, Michigan.

The Balancing Machine is designed to indicate the amount, location and angular position of an unbalance in high-speed rotating masses such as armatures, gyroscopes and the like.

The device to be balanced is placed in a special carriage suspension arrangement, like that shown in Fig. 1 and driven by some external means such as air or a motor and drive belt to the part. Pressure-sensing devices are in contact with the carriage to detect the variations in pressure that occur when there is unbalance of the rotating mass in the suspended carriage.

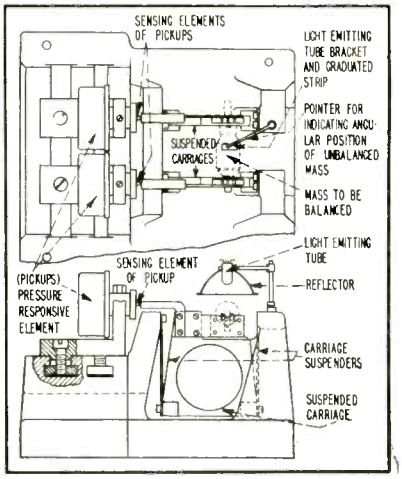
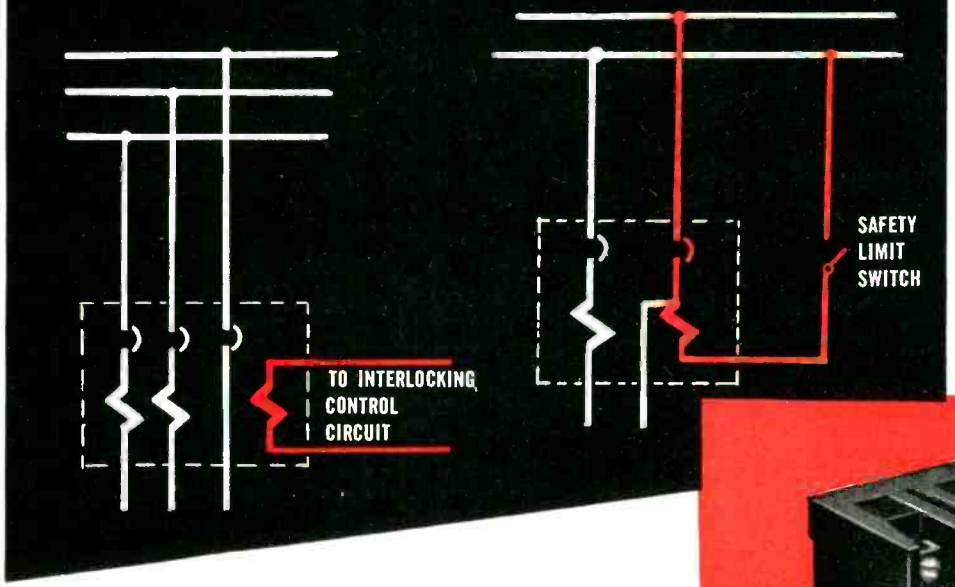


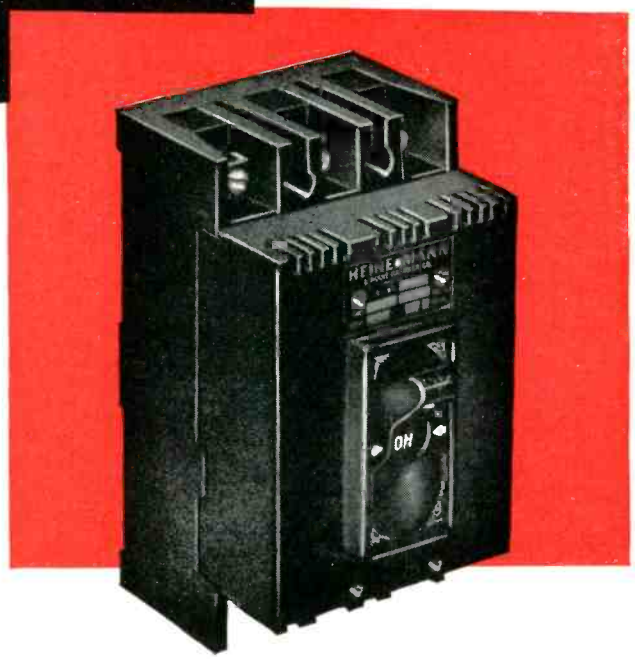
FIG. 1—Balancing machine

The signal resulting from the vibration is picked up by the sensing devices and amplified in the

HERE'S A SIMPLE WAY

...to provide control interlocks



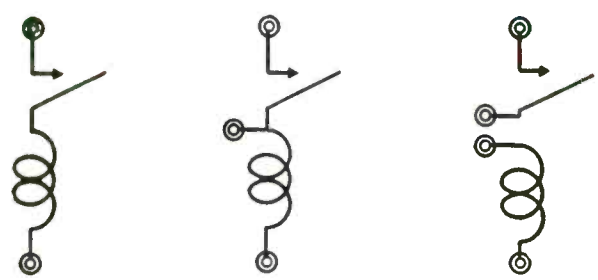


Design engineers looking for a simple and low cost means of interlocking control circuits often find their answer in Heinemann circuit breakers. Operating on basically a solenoid principle, these circuit breakers permit a choice of circuit arrangements in single pole units or *any combination* of circuits in multiple-pole breakers. One or two coils of the circuit breaker can provide overload protection while another coil interlocks with a separate control circuit.

The separate control circuit may be energized by a "stop" pushbutton, pressure switch, thermostat or other high-low limit control. Or, the interlocking coil of the circuit breaker may be used for overload protection, tripping the circuit breaker and opening the main power supply when an overload occurs in the interlocked circuit. Thus, a single Heinemann circuit breaker can serve three functions: (1) As the power switch, (2) as overload protection, and (3) as the means of control interlock.

By combining several functions in a single Heinemann circuit breaker, many manufacturers have achieved highly desirable design simplification and better protection for their products . . . at substantially reduced overall costs.

Your local Heinemann representative will be pleased to render full engineering assistance . . . or send for Bulletin 3410.



For any pole of a Heinemann circuit breaker, you have a choice of circuit arrangement, instantaneous or time delayed operation, response characteristics, and precise ratings to your requirements.

HEINEMANN ELECTRIC COMPANY

97 Plum Street • Trenton 2, N. J.

amplifier-indicator circuit shown in Fig. 2. The circuit comprises a straightforward push-pull amplifier and a metering arrangement to indicate the amplitude of the unbalance signal. A portion of the signal also drives a sawtooth generator. The signal generated is amplified and applied to a stro-

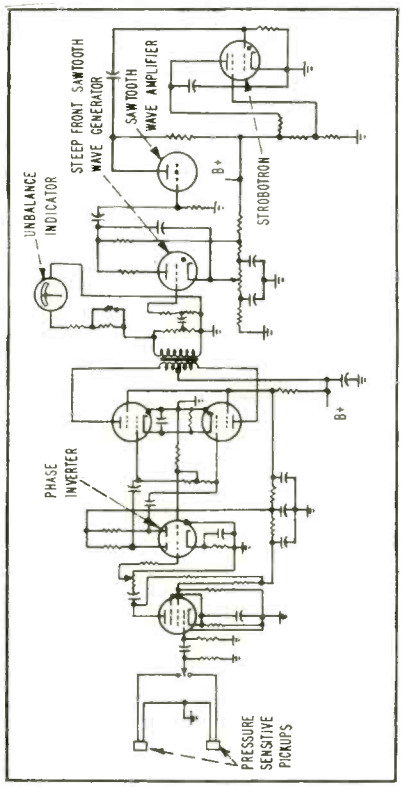


FIG. 2—Unbalance indication is illuminated by stroboscopic flash

botron. On the mechanical assembly a pointer is provided. A graduated strip is attached to the armature or other unit under test. When the unbalance voltage fires the strobotron, stroboscopic flashes occur coincident with the angular position of the armature at the instant of firing.

The pointer then stands still at some position on the graduated strip.

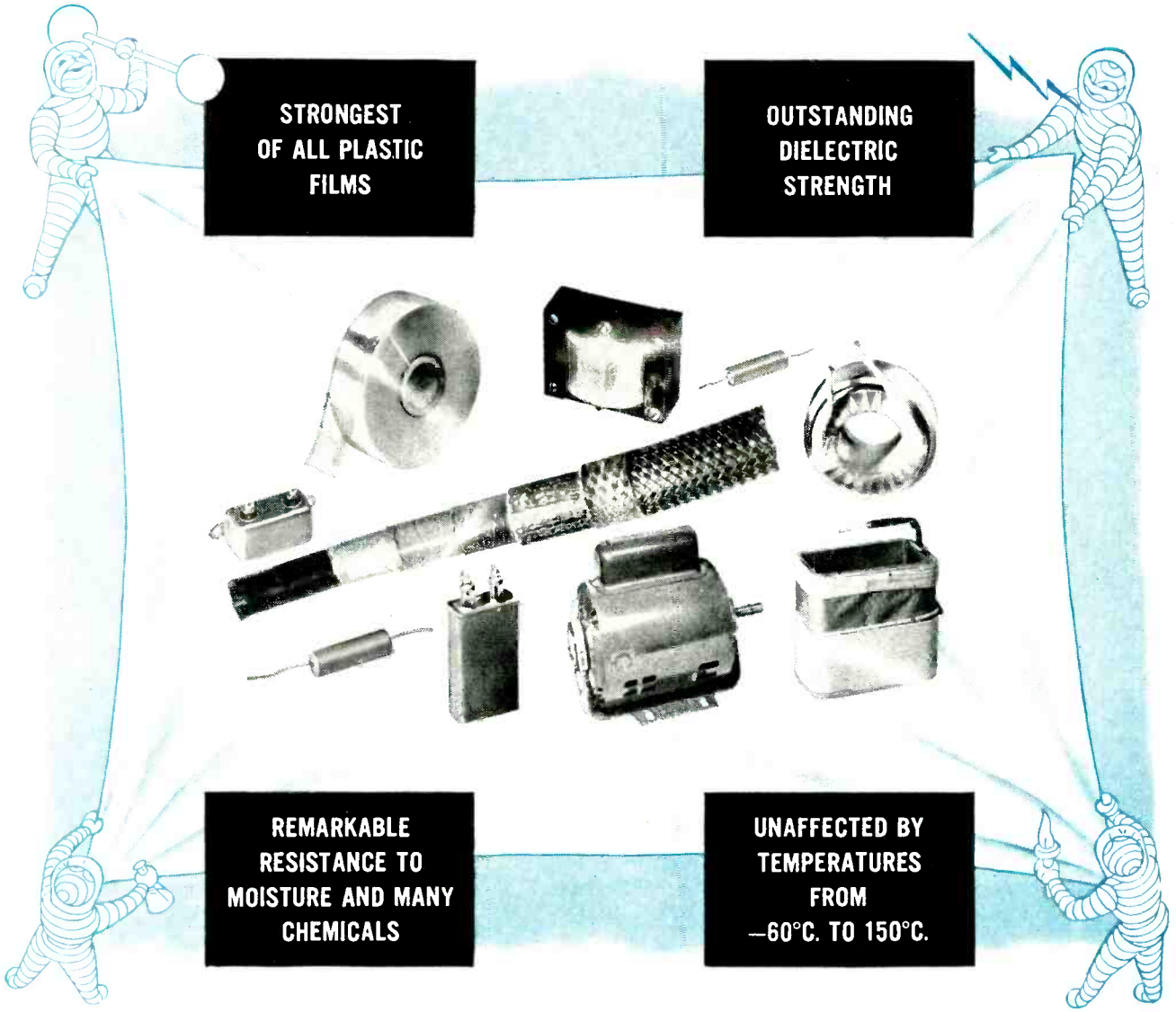
By this means an accurate indication is made of the degree of unbalance (amplitude of the meter indication) and the position of the unbalance (flashing of the strobotron).

Liquid Level Control

Apparatus for Measuring Liquid Level is the subject of patent 2,651,940 issued to K. H. Kline, Oak

Unusual properties make Du Pont MYLAR® ideal for a wide variety of insulating uses

REG. U.S. PAT. OFF.



A new product of Du Pont research—"Mylar" polyester film—offers you a balance of physical, electrical, chemical and thermal properties never before available in a plastic material.

The unique properties of versatile "Mylar" open new possibilities in the design of electrical equipment. It is already being used to advantage as slot, phase, and wedge insulation in motors, layer insulation in capacitors, conductor insulation in transformers and as a barrier tape for wire and cable. Why not see how Du Pont "Mylar" can help you with your product development or improvement?

SEND FOR FREE BOOKLET: To help you evaluate the advantages of "Mylar" for your product, this free booklet gives you the property specifications of "Mylar"... shows how this new film can be used to improve electrical products. Write E. I. du Pont de Nemours & Co. (Inc.), Film Dept., Room 3EM, Wilmington 98, Delaware.

DU PONT MYLAR®

Polyester Film

DU PONT

REG. U.S. PAT. OFF.

BETTER THINGS FOR BETTER LIVING . . . *THROUGH CHEMISTRY*

Film Department 3E
E. I. du Pont de Nemours & Co. (Inc.)
Wilmington 98, Delaware

Please send me more information about Du Pont "Mylar."

*Name*_____

*Title*_____

*Firm*_____

*Street & No.*_____

*City*_____ *State*_____

Ridge, Tennessee, assigned to the United States of America as represented by the United States Atomic Energy Commission.

The general circuit and physical arrangement of the equipment of

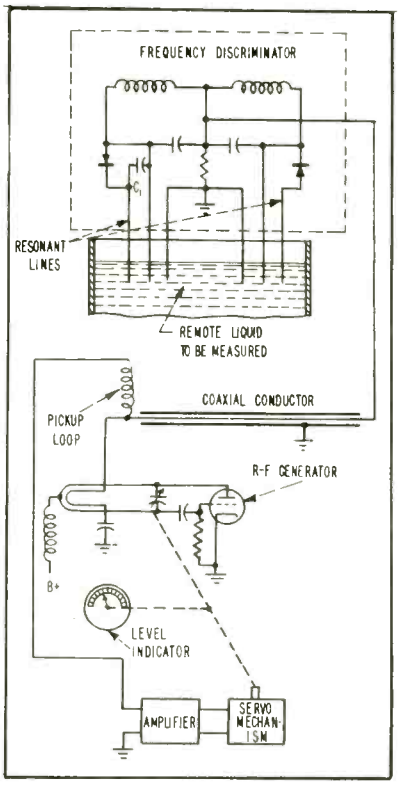


FIG. 3—Capacitors in liquid show unbalance

this invention is shown in Fig. 3. An r-f generator in the form of a triode oscillator generates a predetermined frequency f_o that is applied to a novel discriminator circuit. The discriminator circuit is a double-tuned type and the resonant circuits comprise coaxial or other resonant lines inserted into the liquid, the level of which is to be measured.

The liquid and its container are remotely located. Lines are coupled

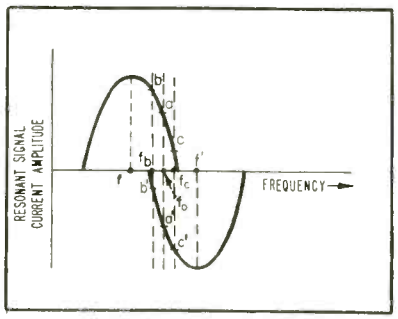


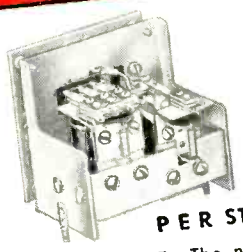
FIG. 4—Discriminator characteristic

12 PAGES of STEPPING RELAYS by GUARDIAN®

New!

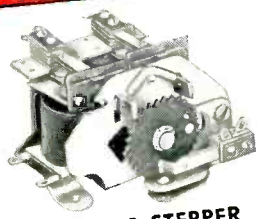
Your Free Copy is Waiting • Write for it today . . .

EXAMPLES:



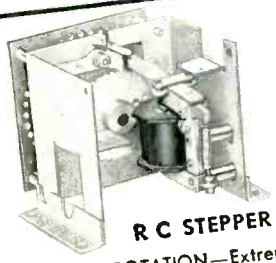
P E R STEPPER

ELECTRICAL RESET—The new Guardian PER Stepper is especially rugged, and fast acting. All wiring for circuit selection terminates on disc to permit accessibility. Auxiliary switches available. Available in PER Electrical Reset model (illustrated), or as PC Continuous Rotation unit.



M A S STEPPER

ADD AND SUBTRACT—This midget unit is extremely compact and lightweight. Advances one step at a time in either direction. Standard ratchet has 30 points of which a total of 27 may be actuated. Also with special ratchets. Up to 20 steps per second. Available for A.C. or D.C.



R C STEPPER

CONTINUOUS ROTATION—Extremely papular. Standard unit has 40 point disc. D.C. types may employ two discs with separate common fingers for each disc. Employing one disc, unit may carry up to 4 contact fingers. A.C. types may employ one disc with up to 2 raws of contacts. Also available with snap-action interrupter switches to permit automatic stepping.

Steppers by Guardian . . . your answer for sequence selecting, circuit selecting, automatic counting, programming, pulse multiplying, pulse dividing, latching, slave and master sets and many other complex operations. Just call or write for fast, capable assistance on stepper applications. Guardian's factory trained representative in your territory will gladly assist you. Production samples and prices are immediately available on all standard steppers. Estimates on specials will be forwarded upon receipt of your requirements. Act Now—get this new 12-page booklet on Guardian Steppers—without cost or obligation.

RELAYS • SOLENOIDS • SWITCHES • SPECIAL CONTROLS

GUARDIAN ELECTRIC

1625-K W. WALNUT STREET CHICAGO 12, ILLINOIS

A COMPLETE LINE OF RELAYS SERVING AMERICAN INDUSTRY

to the r-f generator by coaxial cables.

Each of the resonant lines is resonant at a particular frequency.

Figure 4 shows the relationship of the frequencies utilized in the operation of this invention.

The lines resonate at f and f_1 respectively. At a mean frequency between them f_o the discriminator will develop an error voltage of zero. At f_b or f_c an error voltage will be developed having one polarity or its opposite.

This voltage is applied to a servomechanism to operate a control device coupled to the frequency-controlling element of the r-f generator so it generates a frequency such that zero discriminator output voltage is maintained.

As the level of the liquid changes in the liquid container the resonant frequency of the lines inserted in the liquid changes. The servomechanism control in adjusting the frequency controlling element of the r-f generator also rotates an indicator calibrated to indicate the level of the liquid.

In an alternative use of the system, the servomechanism is connected to a valve and pump control, which in response to the error voltages permits additional liquid to flow into the container, or drain out of the container as required to maintain a predetermined level of liquid. The r-f generator frequency-controlling element is manually set to some predetermined frequency corresponding to a desired liquid level.

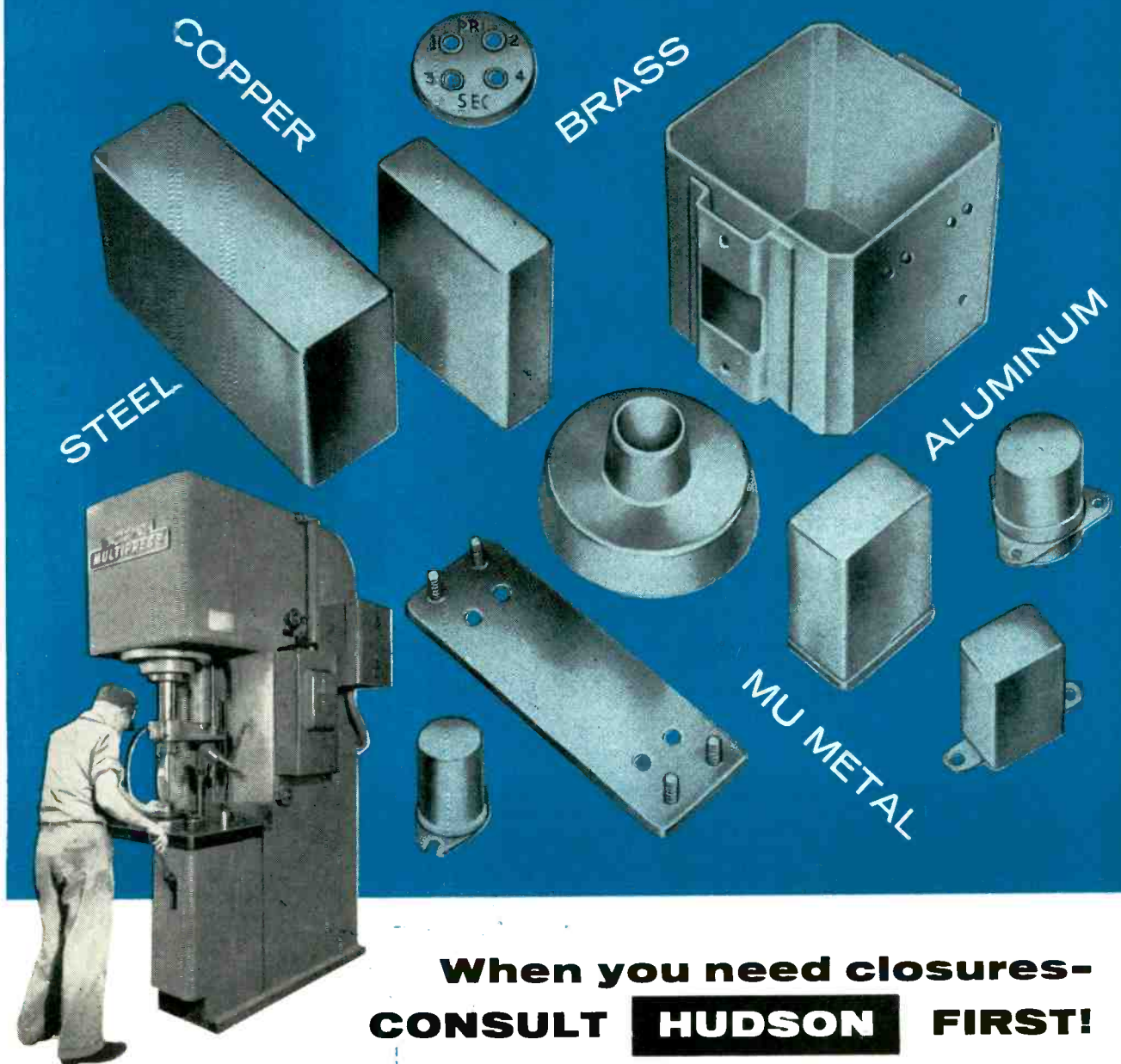
Nonlinear Winder

In patent 2,653,772 issued to B. B. Scott of Schenectady, New York, assigned to the General Electric Company, an electronically controlled Winding Machine is described.

For winding variable wire-wound resistors that have nonlinear characteristics this inventor has devised a control system for the machine that automatically varies the spacing between wire turns to correspond to some predetermined resistance characteristic, such as logarithmic, sine or cosine.

A master linear resistor, sampled under the control of a cam contact

Your SPECIAL requirement may be a STANDARD Hudson precision drawn component!



When you need closures- CONSULT HUDSON FIRST!

Quality Metal Stampings To Exact Specifications

Simple stamping or complex, multi-operation sub-assembly, Hudson can produce your parts, quickly and economically. For quotations on specific components, send drawings mentioning quantities required. Call or write today for the new Hudson catalog.

The HUDSON system of standardized production methods makes it possible to supply even unusual closures, quickly from stock. The HUDSON standard catalog line of cases and covers includes hundreds of different shapes and sizes with numerous optional features. Sizes range from large to miniature and unit costs reflect mass production savings. Check with HUDSON today, for closures of brass, copper, aluminum, steel and MU metal.

PRECISION DRAWN CLOSURES AND QUALITY METAL STAMPINGS EXCLUSIVELY

HUDSON TOOL and DIE COMPANY • Inc

118-122 SO. FOURTEENTH ST., NEWARK 7, NEW JERSEY

to have the desired characteristic, forms one leg of a resistance bridge. The resistance being wound forms an adjacent leg. Any difference between them produces an unbalance voltage across appropriate diagonals of the bridge. The resulting d-c unbalance voltage is interrupted by a vibrator and amplified. The resultant output is both connected to an oscillograph and a servocontrol circuit. An additional circuit is responsive to positive signals developed for too close spacing.

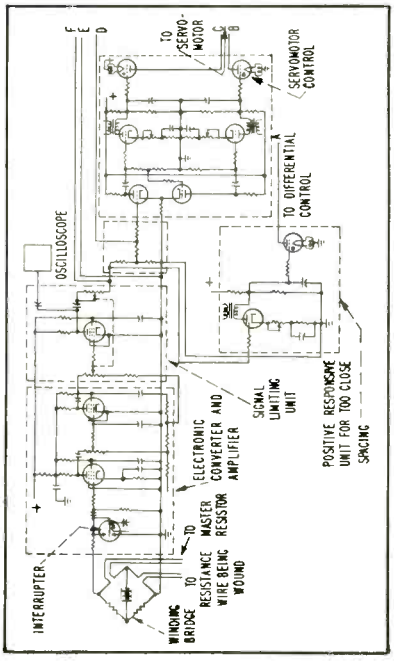


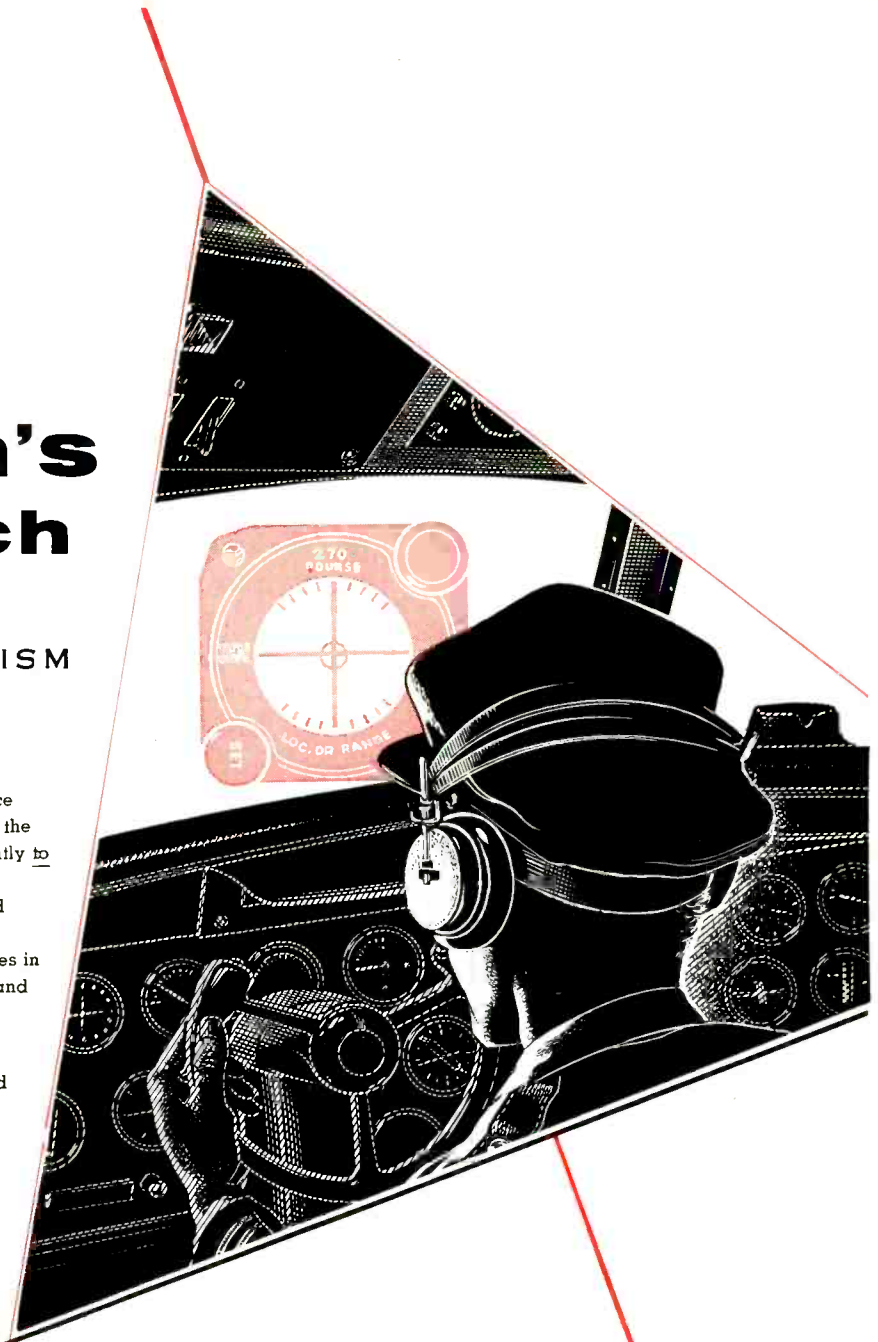
FIG. 5—Winding bridge and servomotor connects to Fig. 6

The circuit arrangement of the winding control is shown in Fig. 5. The electronic converter and amplifier unit is a straightforward d-c interrupted amplifier arrangement where an a-c amplifier is provided for the interrupted d-c bridge unbalance voltage. This is followed by a limiting amplifier that has a gain limit of some predetermined value. These units comprise the control signal generator of the winding circuit.

The output of the control signal circuit is interrupted by a shorting cam arrangement for 180 deg of each winding turn. While closed, the control circuits adjust the turn spacing and winding rate according to the most recent signal information, while during the open interval the control signal generator circuit

marion's approach

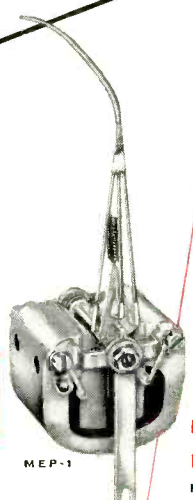
TO INSTRUMENT MECHANISM DESIGN . . .



In any aircraft instrument system, reliable performance depends on an indicating mechanism which presents the information accurately, rapidly, simply and intelligently to the pilot. To Marion, who makes both moving coil mechanisms as components of indicating systems and complete integrated systems, this means specifically designing mechanisms to accomplish system objectives in an environment of vibration, rapid attitude changes and other influences, with full realization of the human elements involved.

This approach is represented by Marion's MEP-1 and Coaxial Mechanisms, which were designed to meet specific performance requirements in an indicating assembly for radio navigational use. The MEP-1 exhibits exceptional, gyro-like stability even under the influence of severe vibration and rapid attitude changes. The Marion Coaxial Mechanism is an extremely small, lightweight and rugged movement; its performance and durability exceed that of much larger and heavier moving coil mechanisms.

COAXIAL



MEP-1

These are typical Mechanisms by Marion — examples of advancement in instrument design to better meet the critical needs of specific applications. Marion invites your inquiry concerning the application of Marion Mechanisms to your problems.

Marion Electrical Instrument Company, 401 Canal Street Manchester, New Hampshire, U. S. A.

marion
advancement in instrument design

Reg. U. S. Pat. Off.

marion meters

MANUFACTURERS OF RUGGEDIZED AND "REGULAR" METERS AND RELATED PRODUCTS

Export: Rocke-International Corporation
Rocke-International Building 13 East 40th Street New York 16, New York Cable Address: ARLAB

samples the standard resistance and the resistance being wound for bridge balance.

Any unbalance provides a new set of signals to the servomotor control. If negative they drive the motor; if positive, they operate the positive responsive unit to brake the differential control motor and slow down the space-winding rate

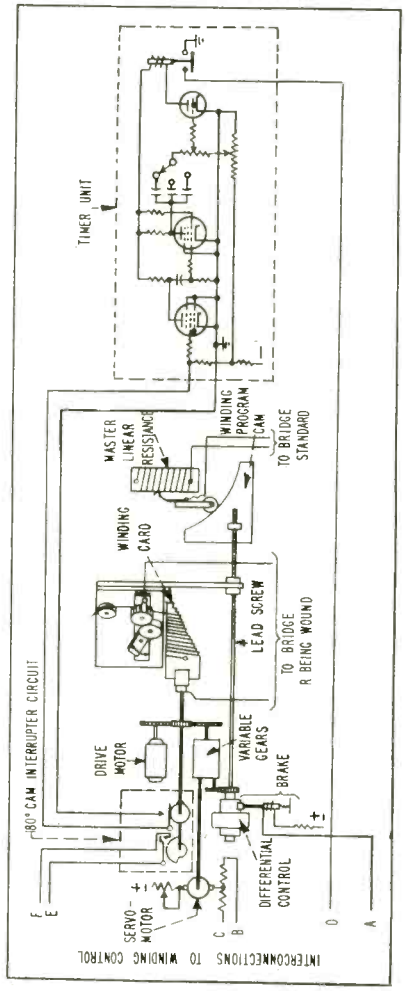


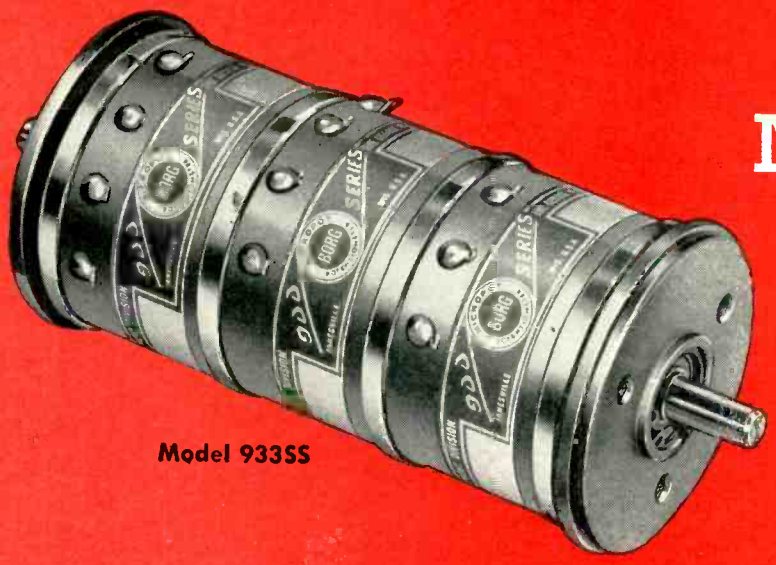
FIG. 6—Leads from Fig. 5 connect at left

as shown in Fig. 6. The inventor claims typical machines built to the specification of this invention have wound enameled nickel-chromium-iron alloy wire of 0.00225-in. diameter at speeds of 330 rpm. It is claimed that wire of 0.0015 in. diameter has been positioned accurately on a card to within 0.0001 inch. The incremental corrections can be accomplished within a 90-deg rotation of the winding card.

Subscription TV

In patent 2,636,936 recently issued to Alfred N. Goldsmith and

BORG MICROPOTS



Model 933SS

the NEW STANDARD of precision multi-turn potentiometers

BORG 900 SERIES 3-TURN AND 10-TURN MICROPOTS

3-TURN MODELS 931-935


931S 932BB 933SK 935SS

10-TURN MODELS 901-903


901SK 902B 903BK 903S

Standard models of Borg 900 Series Micropots offer such flexibility that they meet special design needs. Borg has created a new standard for high-precision, multi-turn potentiometers.

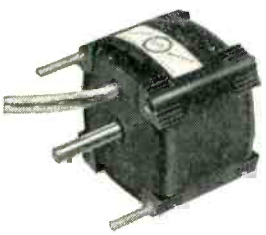
Advantages of the Borg 900 Series include greater accuracy, finer resolution, lower torque, longer life, better performance under severe and excessive vibration, greater adaptability and versatility of application.

Standard models include: 10-turn precision Micropots in 1 to 3 gang models, 3-turn in 1 to 5 gang models, single or double shafts, servo or bushing mounts on either or both ends. Available to designers and engineers in any quantity.

SYNCHRONOUS AND INDUCTION BORG-MOTORS

1000 SERIES 2 POLE AND 4 POLE MODELS
With and Without Gear Trains

These Borg-Motors were designed specifically for instrumentation, control and timing devices. They are recommended for all applications where low torque, constant speed and long life are positive requirements.



For Complete Engineering Data

SERVO-CONTROL
Borg-Motors

Two phase, 115 volt, 400 cps induction type Borg-Motors for servo control applications. Approximate size 1½" diameter x 2" long with a locked rotor torque of 0.82 ounce-inch.

ATTACH TO YOUR LETTERHEAD

BORG EQUIPMENT DIVISION
THE GEORGE W. BORG CORPORATION
JANESVILLE, WISCONSIN

NAME.....

TITLE.....

Please send complete information and engineering data on items checked.

- ☐ Precision Multi-Turn Potentiometers, 900 Series
- ☐ Borg Standard Potentiometer, 1100 Series
- ☐ Precision Multi-Turn Counting Dials
- ☐ Servo Control Motors
- ☐ Frequency Standards
- ☐ Instrument Motors
- ☐ Contract Manufacturing

BORG EQUIPMENT DIVISION
THE GEORGE W. BORG CORPORATION
JANESVILLE, WISCONSIN

See us at Philadelphia—Booths 260 and 262, Instrument Congress and Exposition

assigned to the Radio Corporation of America, for a Television Secrecy System a cryptographic principle is employed.

The inventor categorizes cryptographic systems into those in which the elements of the intelligence are transposed and those in which there is a substitution of another element of intelligence or a character for each element of the desired intelligence.

It is the first of these techniques that is employed in this invention. A block diagram of the arrangement is shown in Fig. 7. Here the

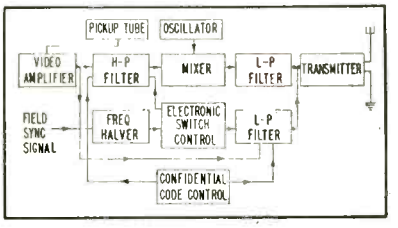


FIG. 7—Block diagram of coded transmitter

inventor proposes to transpose the elements of a video signal into a band of frequencies outside their nominal range so that a local heterodyne signal is required to recover the intelligence.

By a prearranged code between the television transmission agency and the receiver the transposition band and consequently the heterodyne frequency required at the receiver may be changed. The block diagram of Fig. 8 illustrates the receiver system employed in the television secrecy system.

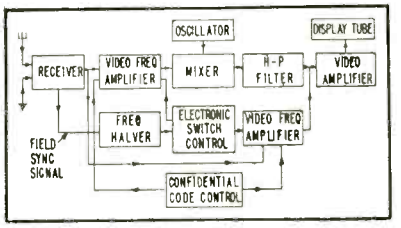


FIG. 8—Coded receiver unscrambles video signals

Assuming, for example, a bandwidth of 7.5 mc and intelligence signals in that band, a bandpass filter system incorporating a high-pass and a low-pass filter centering at 3.5 mc is used to separate into individual channels all frequencies above and below the center frequency, respectively. An electronic switch synchronized to the line-

WHAT DO YOU NEED?

SPECIFY

L. L. Constantin & Co.

Glass-to-Metal VACUUM Seals
Manufacturing Engineers
Rt. 46, Lodi, N. J.

KOVAR and COMPRESSION HEADERS • AN CONNECTORS • TRANSISTOR MOUNTS • SINGLE TERMINALS • END SEALS • CRYSTAL BASES • MINIATURIZATION

scanning frequency may be employed alternately to energize each of the channels while a local oscillator heterodynes each channel as it is switched. The circuit of the bandpass filters and electronic switch is shown in Fig. 9.

In Fig. 10 there is shown a variation of the switching system of the invention where a mechanical programming cam and lever arrangement are employed to tune the filters so as to shift the respective cutoff frequencies in accordance with the positions of the cam wheel. In such a circuit the code is not tied to the line or frame-scanning frequencies. Similar circuits and mechanical devices can be incorporated in the receiver to recover the intelligence.

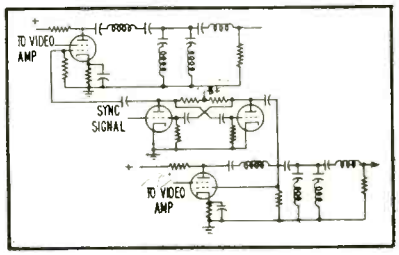


FIG. 9—Bandpass filters and electronic switch

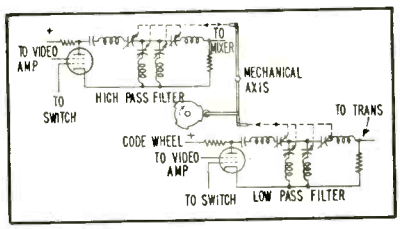


FIG. 10—Mechanical device shifts cutoff frequencies

Equipment such as described in this patent are useful in the proposed pay-as-you-go type of television broadcasting.

Spectrometer Control

In patent 2,640,935 recently awarded Stanford B. Spracklen, of Oak Ridge, Tenn., and assigned to the United States of America as represented by the U. S. Atomic Energy Commission, there is described a Mass Spectrometer Control.

A mass spectrometer is an apparatus for sorting ions that have different mass-to-charge ratios. It is used in the qualitative and quantitative analysis of the elements contained in mixtures, compounds,

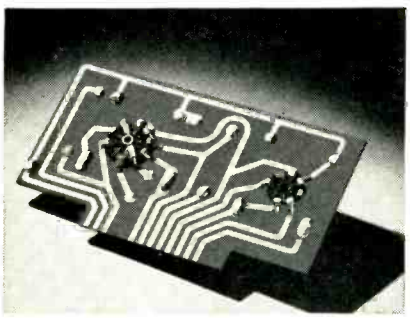
Get better printed circuits . . . lower costs . . . fewer rejects

with NEW C-D-F METAL CLADS

All manufacturers of metal clad stock for printed circuitry have made considerable progress in improving their product—a material with a metal foil surface bonded to a non-conducting base. How this has been done by one leading manufacturer, the Continental-Diamond Fibre Company, illustrates some of the problems involved in buying this type of material and in understanding its design potentials.

C-D-F CONSOLIDATED GRADES

At first, small test lots of Dilecto laminated plastic with copper surfaces were made. Almost every core material was used. Finally the number of practical grades for printed circuit work narrowed down to these few grades which retained to a large degree the inherent electrical qualities of their base material and resin at high temperatures:

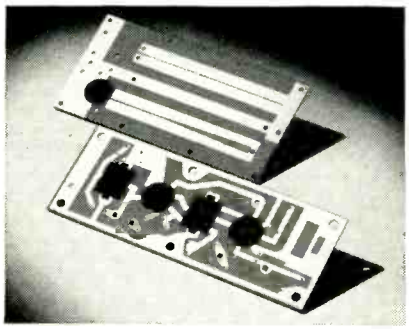


COPPER CLAD GRADE XXXP-26

A laminate with excellent electrical and mechanical properties. High moisture resistance and dimensional stability. Recommended for applications where high heat and high insulation resistance plus low dielectric loss under high humidity is needed. Low cold flow characteristics. Can be hot punched to ⅛". Good flexural strength. Natural green color.

This is one of the *improved C-D-F Dilecto laminates.* Advances in resins and manufacturing techniques makes this grade almost homogeneous, with improved impregnation of the filler. Thorough impregnation eliminates entrapped moisture and air, giving greater moisture resistance and better dielectric properties.

Any metal clad is no better than its base and the care taken in laminating. With the cost of material high, compared to labor and inspection, the purchase of a *uniform* metal clad material, like this C-D-F grade, becomes vital.



COPPER CLAD GRADE XXXP-24

Similar to grade XXXP-26 in electrical and moisture resistance properties, but not quite as strong mechanically. Equal cold flow and punching characteristics. Natural brown.

COPPER CLAD GRADES GB-112S AND GB-261S

These silicone grades use a glass fabric laminate with a copper foil surface on one or both sides. Recommended where high heat resistance and low dielectric loss properties are required. For certain tuners and inductances the low dielectric loss factor of this grade makes its higher cost acceptable. A continuous filament (Grade GB-112S) is used for thicknesses 1/32 to 1/16". A staple filament (Grade GB-261S) is used for thicknesses over 1/16".

COPPER CLAD GRADE GB-116T

A glass base laminate using duPont's tetrafluoroethylene resin, Teflon, for outstanding resistance to high heat with extremely low dielectric loss properties. A fine weave continuous filament glass fabric cloth is used for superior mechanical strength and good machining qualities. In spite of its high cost, this C-D-F grade has demonstrated that it can save money and do a job that no other single material can in microstrip high-voltage, high-frequency circuit elements. Remember, C-D-F is a major supplier of sheets, tapes, rods, tubes of Teflon, has valuable experience in its manufacture and fabrication. Write for samples.

C-D-F INCREASED BOND STRENGTH

By developing a special thermo-setting adhesive particularly suited for metal clads, C-D-F was able to increase the bond strength of their laminates considerably above their original figures. Bond or peel strength, the amount of pull required to separate the foil from the core material, is one of the most important physical properties. Therefore, the purchaser should compare his source of supply with these C-D-F average test values:

BONDING STRENGTH—FOIL TO LAMINATE

MATERIAL	Average or Typical Value Lbs. pull per 1" width of foil to separate
XXXP-24 or XXXP-26 plus 0.0014" copper	5 to 8
XXXP-24 or XXXP-26 plus 0.0028" copper	7 to 9
GB-116T plus 0.0014" copper	5 to 12
GB-112S plus 0.0014" copper	6 to 8
GB-261S plus 0.0014" copper	7 to 10

These values are based on tests at prevailing room temperature (20-30°C.)

C-D-F INCREASED HEAT RESISTANCE

Special efforts by C-D-F technicians to increase the heat resistance of all C-D-F Metal Clads have resulted in certain special grade variations able to withstand higher soldering temperatures without damage. As production methods change, C-D-F offers materials to meet your requirements.

NOW . . . HOW ABOUT YOUR STORY?

Notice how we have talked about C-D-F and what we have done to improve quality and uniformity of metal clad products. Much of this has been accomplished with the guidance and cooperation of leading users of printed circuit stock. No one company knows all the answers . . . but C-D-F, a big reliable source of supply, can help you get better printed circuits . . . lower costs . . . fewer rejects. Look up the address of your nearest C-D-F sales engineer in Sweets Design File, write us for samples you can test in the lab and on the production line, technical bulletins, help on your specific project. We want to work with you!

CDF Continental-Diamond Fibre

CONTINENTAL-DIAMOND FIBRE COMPANY

NEWARK 16, DELAWARE

mixtures of compounds and particularly for the determination of the isotopic ratios that exist in most elements.

Most control devices in the prior art provided for the control of mass spectrometers were designed for the laboratory use of such instruments. When used for automatic production control these have proved inadequate. For the production control use relatively constant sensitivity is required. This can only be maintained if the mass spectrometer is operated below a certain pressure in the chamber of the spectrometer.

The control circuit of this invention provides means for automatically preventing the operation of the mass spectrometer at higher than some predetermined pressure until a manual reset is made.

The circuit of Fig. 11 shows the invention as applied to a mass spec-

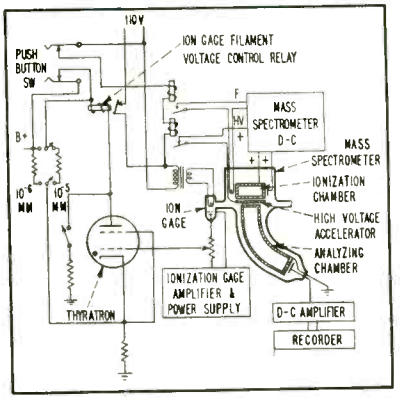


FIG. 11—Mass spectrometer control for automatic production

trometer. The control circuit includes a thyratron that is under the control of the voltage drop across a variable resistor a. The drop across it develops when the pressure in the mass spectrometer, as represented by a current through an ion gage changes. Resistor R_1 is the plate load, so to speak, of the ion gage. A relay in the thyratron plate circuit is rendered operative when the thyratron conducts to open the primary of a filament transformer and the spectrometer high-voltage supply. Ranges in the order of 10^{-6} to 10^{-5} millimeters of mercury are possible as the control areas of the circuit of this invention. Adjustment is possible through thyratron screen control and the setting of R_1.

BLUE RIBBON RESISTORS

Our Blue Ribbon Resistor—designed in 1939—was the *first* flat or strip resistor in the field. And now, though there are others of similar type, the Hardwick, Hindle Blue Ribbon still holds first place—and *is still winning "blue ribbons,"* and such comments as quoted above.

Although its basic design is the same, recent improvements assure you "the finest flat resistor made."

Our crazeless gray enamel completely eliminates the disastrous crazing which results in failure of the resistive element due to moisture penetration from humidity, salt and other severe atmospheric conditions —thus giving greater dielectric strength.

The aluminum thru-bar, in contact with the internal surface of the ceramic core, distributes the heat more uniformly along its entire length—than conventional tubular resistors.

The studs—corrosion and rust resistant—are peened to serve as mounting supports and also to permit the stacking of two or more units when space need be saved. And our unique method of fastening the tube to the thru-bar prevents loosening under vibration.

As compared to the conventional tubular resistor Blue Ribbons give you:

1. Higher wattage rating per unit space requirement.

2. Reduction in space behind the panel or mounting surface.

3. Sturdy but simple mounting, either single or stacked.

4. Lighter weight.

5. Lower induction.

Our Blue Ribbons are designed for and manufactured in accordance with JAN-R-26A specifications.

Send for our catalogue, showing these and other Hardwick, Hindle resistors of distinction.

HARDWICK, HINDLE, INC.

Rheostats and Resistors

Subsidiary of

THE NATIONAL LOCK WASHER COMPANY

Established 1886

NEWARK 5, N. J. U.S.A.

The mark of quality

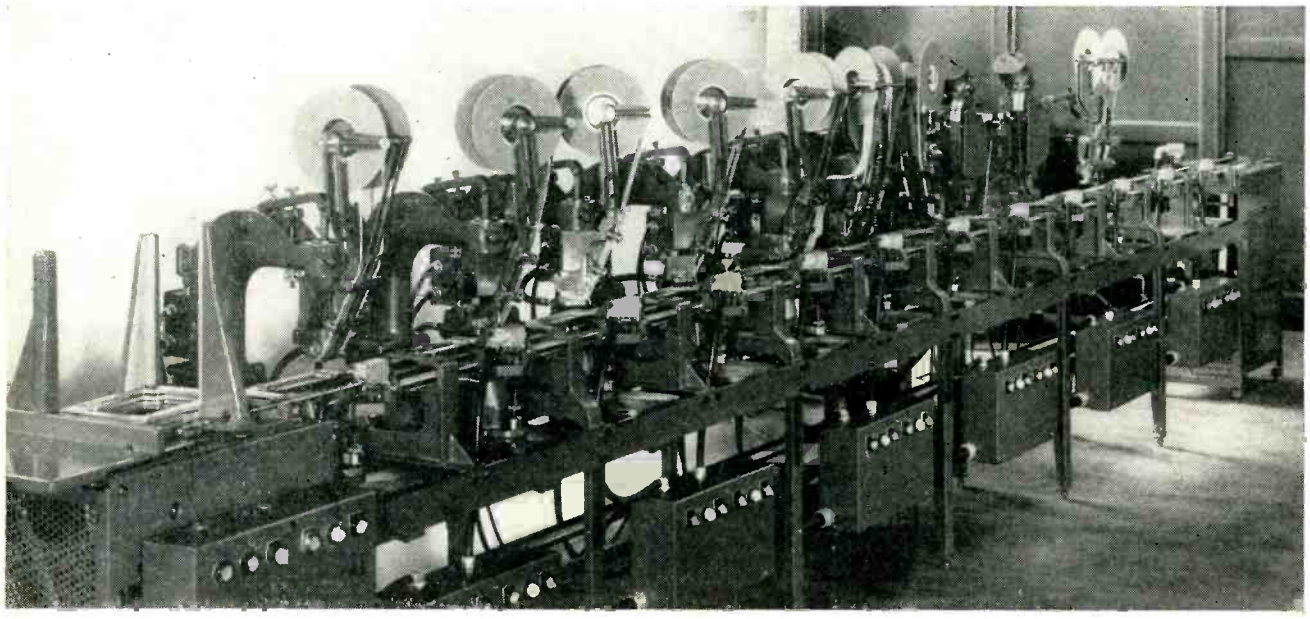
For more than a quarter of a century

Production Techniques

Edited by JOHN MARKUS

OTHER DEPARTMENTS featured in this issue

Machine Inserts Components in Printed Wiring Boards



Machine setup for inserting components accurately in holes of printed wiring boards. Reels above inserting stations contain components belted together with adhesive tape. Pallets with wiring boards are loaded into vertical rack at left

AN EXPERIMENTAL conveyor-type machine automatically inserts resistors, capacitors, jumper wires and eyelet-type terminals in printed circuit wiring boards at the rate of 9,600 boards in an 8-hour day. This automatic assembly machine, developed in the Beverly, Mass. Research Division of United Shoe Machinery Corp., is readily adjustable to provide for changes in circuitry and components.

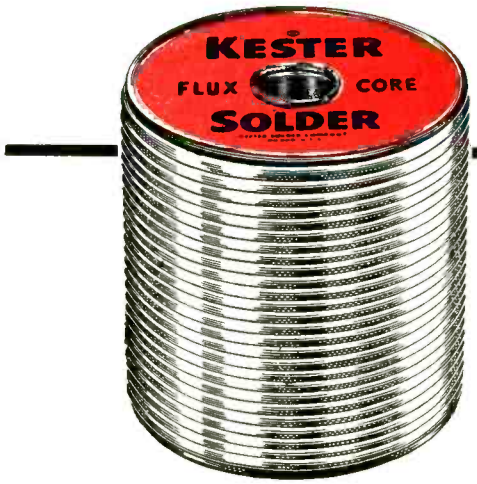
In its present state of development, printed wiring boards up to 5 × 8 in. are loaded by hand onto pallets or frames and stacked at the input end of the machine. From here a conveyor picks up the pallets one by one and moves them past the inserting stations. At each of these stations, a pallet is stopped and one component automatically inserted in any desired location on the board.

As it now stands, the experimental machine will insert only resistors, tubular and disk ceramic capacitors, jumper wires and eyelets. The complete system for automatic assembly of electronic equipment will include means for automatic placement of printed wiring boards in the pallets, additional inserting heads for tube sockets, coils and other components, stations for dip soldering, testing and pallet unloading, and provision for automatic return of pallets to the loading station.

A unique method of belting pigtail components is used to achieve optimum feeding conditions. One machine has already been built for belting resistors, the basic design of which may be readily extended to other axial-lead components. The resistors are fed automatically through a lead-straightening position, then to taping stations where self-adhesive tape is folded over the ends of the leads to form a

"Maverick" usually spells trouble, on the production line as well as out on the range. Being an unknown quantity or a "Johnny-come-lately," it leaves room for genuine doubt both as to performance and quality. And that's the reason so many experienced buyers —production experts to supervisors—insist on Kester . . . the one "brand" that is synonymous with the best solder and solder products.

Next time, choose one of these famous solder products: "44" Resin, "Resin-Five" and Plastic Rosin—all made only by KESTER . . . Key Name in Flux-Core Solder for More Than 50 Years.

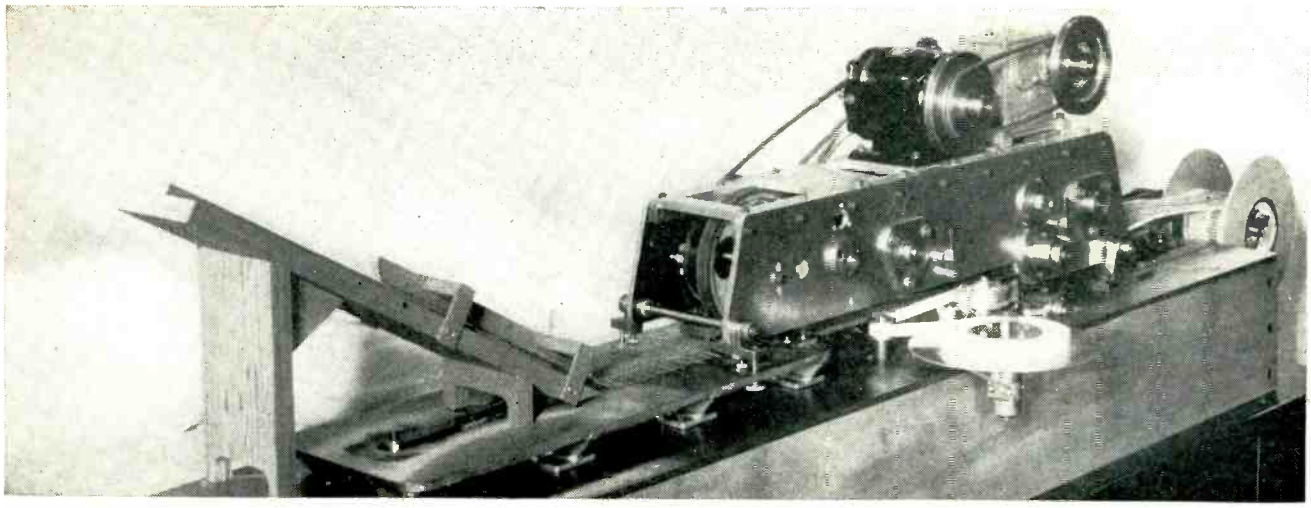


KESTER

SOLDER COMPANY

4204 WRIGHTWOOD AVENUE, CHICAGO 39, ILLINOIS
NEWARK 5, NEW JERSEY • BRANTFORD, CANADA

WRITE TODAY for Kester's ***NEW*** 78-Page Informative Textbook, "SOLDER . . . its fundamentals and usage"



Machine for applying adhesive tape over ends of axial-lead resistors after first straightening the leads. Loose resistors are loaded into chute at left, and belted units are reeled at right

resistor belt that is wound on a reel.

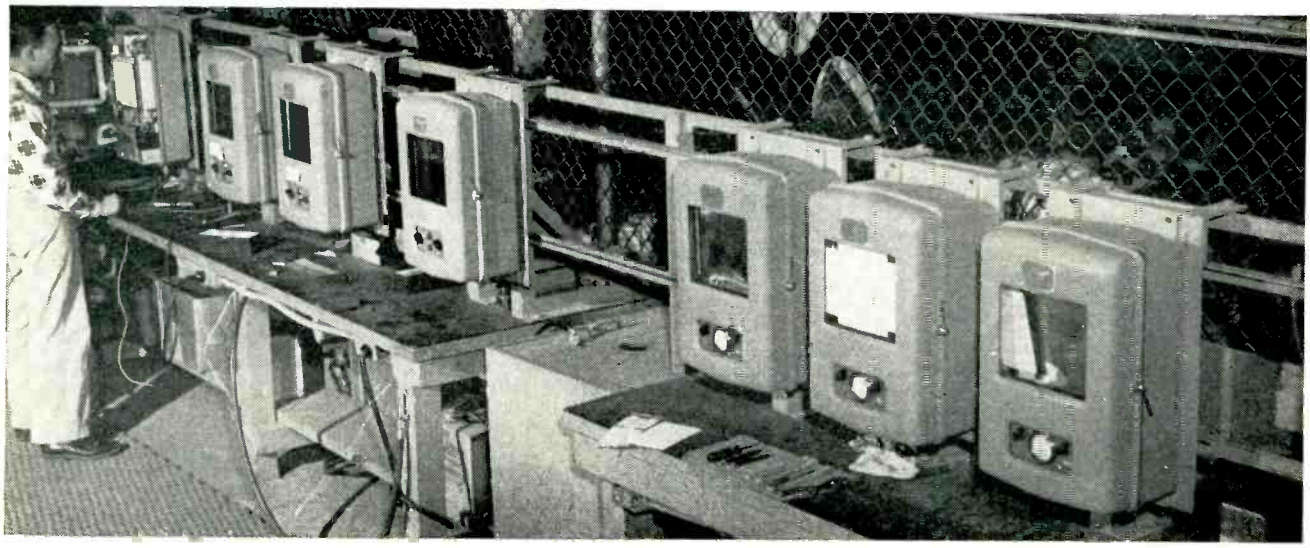
At the conveyor, belted components are fed from reels into the inserting heads. These automatically cut and form the wire leads and insert them through the prepunched holes in the printed wiring boards. At the same station the lead ends protruding through the board are automatically clinched to hold each component in place until the board is dip soldered. Surplus lead length is thus chopped automatically, leaving the cut ends sticking to the belt so they are pulled right through the machine for convenient disposal. To avoid damage to the bodies of components, they are handled by their leads throughout the belting, inserting and clinching operations.

Safeguards built into the assembly machine include provisions to stop the machine when a station is empty, when a component is missing or not correctly inserted, or when an inserting head does not complete its cycle. Positioning is checked by using a split anvil for clinching the leads underneath, with the anvil parts insulated and connected to a continuity checking circuit. This checks continuity from each inserting head (which grips the lead near the resistor body) to the corresponding anvil under the board to make sure each lead is properly inserted.

Pallets on Rails Speed Assembly of Ultrasonic Depth Recorders

FOR FINAL assembly and test of depth recorders in the North Hollywood, Calif. plant of Bendix Aviation Corp., the cast metal housings of the recorders are hung on metal pallets equipped with rollers that run on rails bolted to vertical supports at the rear of the work bench. The units are moved along the rails by hand one by one as work is completed at each position.

Metal pegs on the vertical pallets, inserted at a slight upward angle, are positioned so that the mounting straps for a housing fit over the pegs. When all work on a unit is completed, the unit is lifted off these pegs and transferred to the



Method of using pallets on rail line for assembling ultrasonic depth recorders

The NEW WAY to product improvement at LOWER COST!

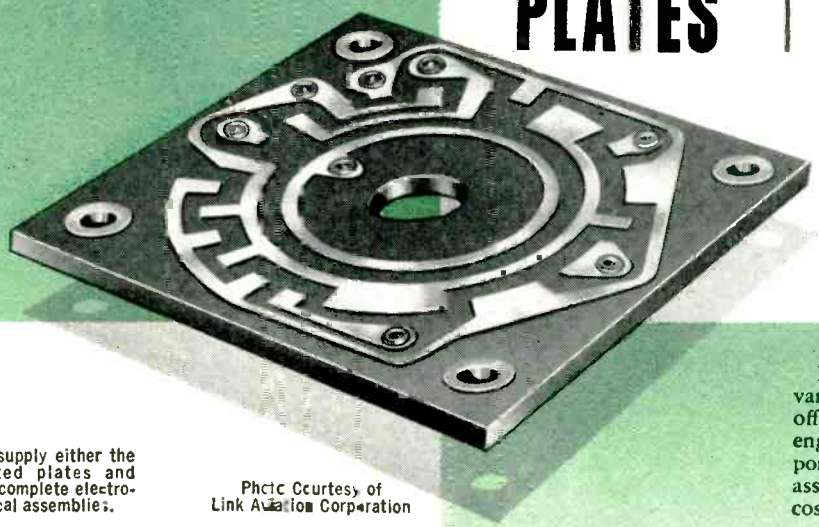
Photocircuits

PRINTED-CIRCUIT SWITCH PLATES | COMMUTATOR DISCS

and associated

ELECTRO-MECHANICAL ASSEMBLIES

(to your specifications)



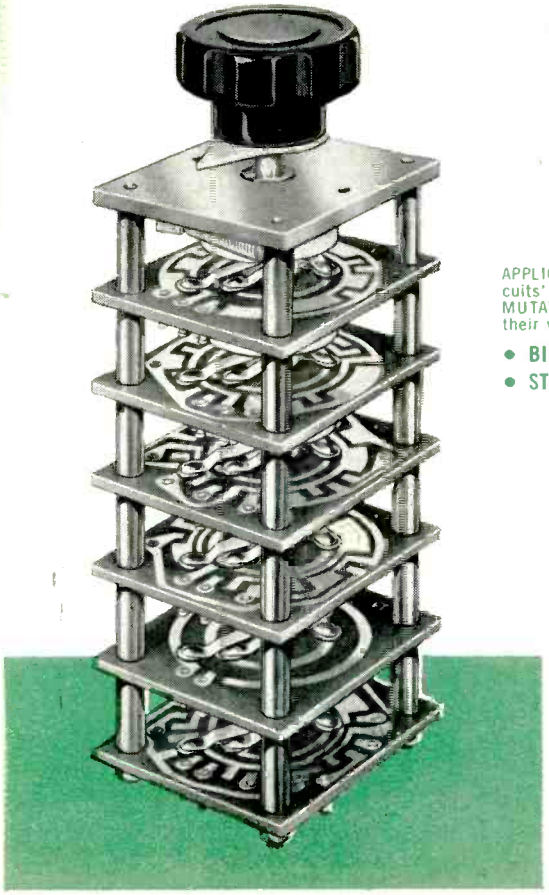
We can supply either the fabricated plates and discs or complete electro-mechanical assemblies.

Photo Courtesy of Link Aviation Corporation

Photocircuits has made many important advances in the art of printed circuitry and now offers its skill and experience in the design, engineering and production of these components and "packaged" electro-mechanical assemblies to effect great improvement and cost reduction of your end products.

COST ADVANTAGE EXPERIENCED!

In the case of a 6-deck, 27-position decade switch assembly using raised silver-plated contacts on one side with inter-connecting conductor pattern on second, and terminal lugs at pattern terminations for external wiring, a cost reduction of approximately 40% has been realized.



These are some of their ADVANTAGES:

FLUSH SURFACE. For long wearing "bounceless" rotary action.

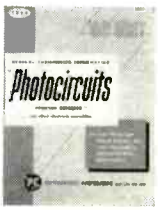
NICKEL-RHODIUM Plating. For smooth, hard, long life contacts. *(Silver-Rhodium, Silver and Gold plating available as needed.)*

COMPOSITE LAMINATE. Of appropriate plastic core to insure flatness and good mechanical strength. *IMPORTANT! Switch plates and commutator discs can be backed with either aluminum or steel for rigidity and strict flatness.*

LONG LIFE. With proper combination of laminates, brush pressures and contact materials, satisfactory life experiences from 10 million to 100 million revolutions have been reported.

APPLICATIONS where Photocircuits' SWITCH PLATES and COMMUTATOR DISCS have proved their value:

- BINARY CONVERTERS
- STEPPING SWITCHES
- SHAFT READ-OUT DEVICES
- PROGRAMMING & TIMING SWITCHES
- TELEMETERING SWITCHES
- CODE DISCS



This Engineering Brochure FREE on request.

For full information call or write

Photocircuits CORPORATION

PC

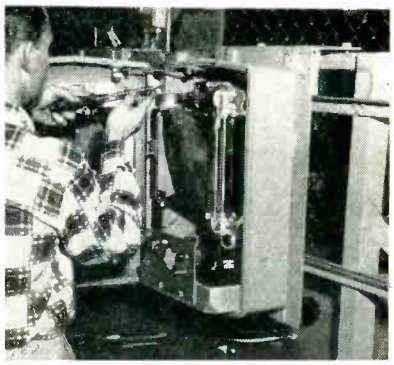
Pioneers in Low-Cutting Printed Circuit Techniques

*Trade Mark

Dept. E9, GLEN COVE, NEW YORK

Glen Cove 4-4000 • Flushing 3-5050

BOSTON: 25 Huntington Ave. • COpley 6-7705
CHICAGO: 4258 W. Irving Park Rd. • PAlisades 5-1170
PHILADELPHIA: 1531 Spruce St. • KIngsley 5-1205
ROCHESTER, N. Y.: 3 Juniper St. • CUlver 7635
LOS ANGELES: 6907½ Melrose Ave. • WEbster 3-7276
DAYTON, O.: 1521 Burroughs Drive • RAndolph 5907
KANSAS CITY, MO.: 903 McGee St. • VIctor 8090
TORONTO, CAN.: 290 Lawrence Ave., W. • ORchard 3003



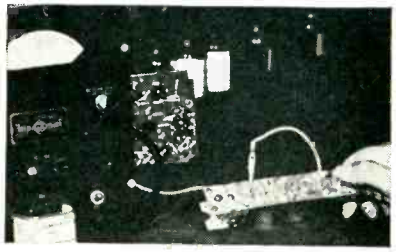
Details of pallet riding on rails, and method of hanging recorder housing on pegs set into pallet

shipping department, after which the pallet is lifted off the rail and returned to the beginning of the line.

This type of mechanized line has proved ideal for job lot assembly because it places the equipment at the most convenient working level for an operator standing at the bench. The front of the bench is always free to hold tubes and test equipment. The pallets can easily be lifted up and stored to permit complete use of the bench for other work when desired.

Printed-Circuit Flux Reduces Panel Leakage

A FLUXCOAT material applied centrifugally or by dip or spray to printed circuits immediately after the etching process dries rapidly to a non-tacky film. This serves to insulate the board and protect the copper or silver circuit from oxidation, yet allow a smooth, even tinning operation. The insulating residue does not have to be removed after tinning. Insulation measurements taken after dip-tinning showed readings of 50,000 megohms across the board at 350 F, and finished equipment showed no traces of hum due to electrical leak-



Measuring surface conductivity of etched wiring panel after tinning conductors by dipping in molten solder

age across the phenolic boards used as a base.

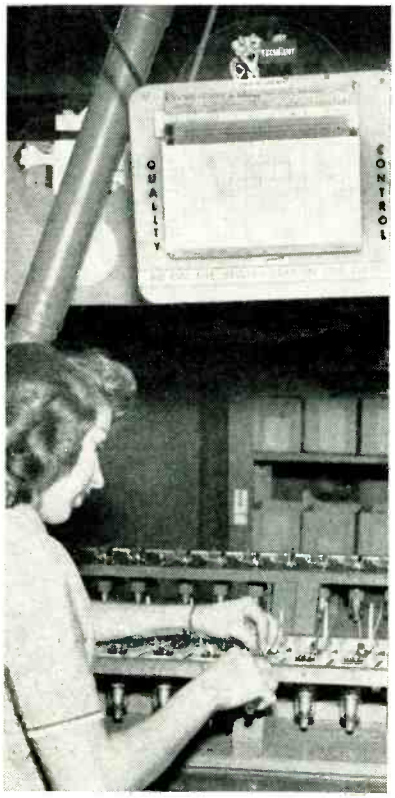
The new insulating rosin coating, known as Lonco Fluxcote 21-XR, is made by London Chemical Co., Chicago, and is being tested in the Chicago plant of Hallicrafters Co.

Scoreboard Boosts Quality on Production Line

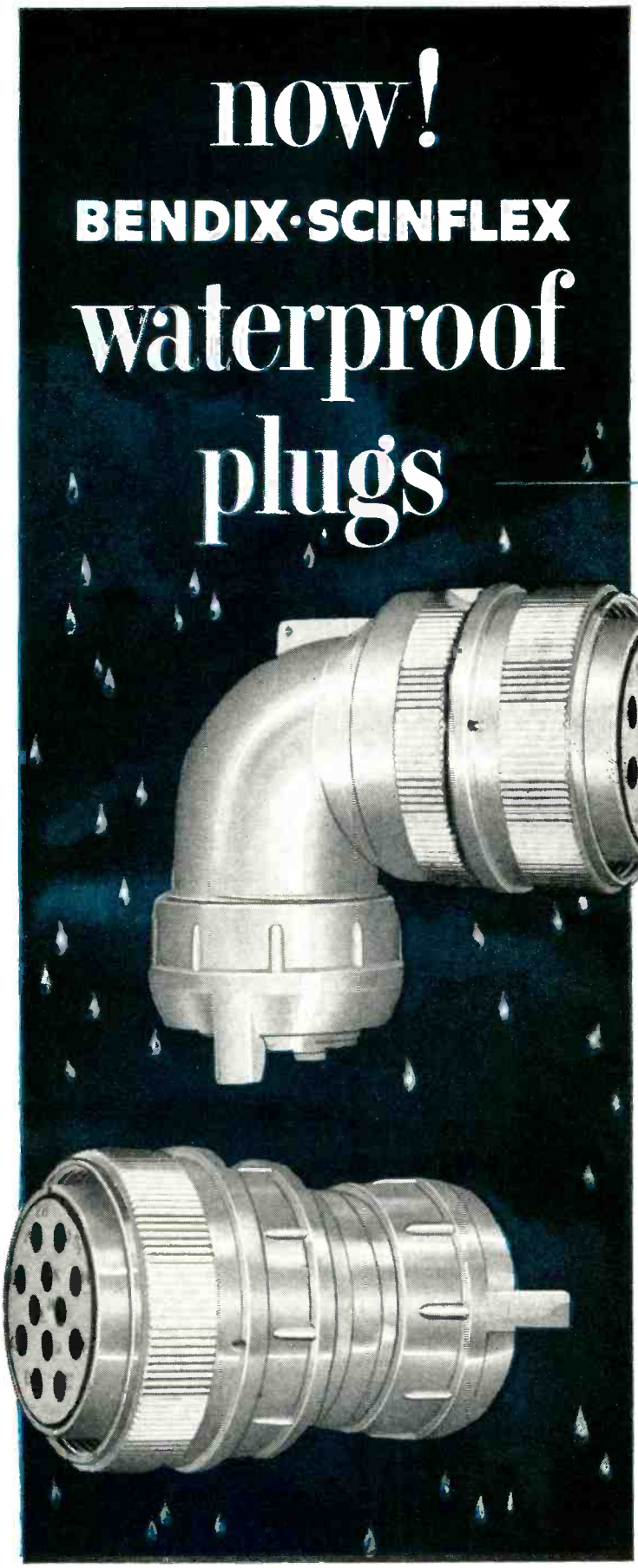
A PERSONAL eye-catching yellow plastic scoreboard at each position on Motorola radio and tv receiver lines has boosted quality by singling out individuals who are doing the best work and giving them recognition among their associates on the line.

The competitive rating of employees is the focal point of the program. The idea is to detect errors or rejects in the radio and tv sets while they are still in the production stage by making people conscious of their jobs.

Hooked to the front of the plastic slate is the quality control chart, divided into sections showing the errors made for each hour



High-voltage power pack assembly line for television receivers, showing quality control board suspended from overhead fluorescent lamps by straps



for use with multi-conductor cables

These new Bendix*-Scinflex *waterproof* plugs are a modification of our standard AN type "E" (environment resistant) connector. They are designed to meet all "E" performance requirements when used with multi-conductor cables. Each plug includes a modified AN3057B cable clamp which provides inward radial compression on multi-conductor cables. This unique feature completely eliminates cable strain—a common source of circuit trouble.

In addition, there are gaskets at all mating surfaces and an accessory sleeve is available to accommodate an extreme range of cable sizes. A folder describing this new waterproof plug—and the various sizes in which it is manufactured—may be obtained by writing our Sales Department.

*REG. TRADE-MARK

THESE BUILT-IN FEATURES ASSURE TOP PROTECTION AGAINST CIRCUIT FAILURE:

Shock and Vibration Resistant • Die Cast Aluminum Shell • Cadmium Plate—Olive Drab Finish • Moisture-Proof, Pressurized • High Arc Resistance, High Dielectric Strength • Silver-Plated Contacts • Resilient Inserts

SCINTILLA DIVISION

Bendix
AVIATION CORPORATION

SIDNEY, NEW YORK

Export Sales: Bendix International Division
205 East 42nd St., New York 17, N. Y.

Bendix

Factory Branch Offices: 117 E. Providencia Avenue, Burbank, California • Brouwer Building, 176 W. Wisconsin Avenue, Milwaukee, Wisconsin • Stephenson Building, 6560 Cass Avenue, Detroit 2, Michigan • 512 West Avenue, Jenkintown, Pennsylvania • 8401 Cedar Springs Rd., Dallas 19, Texas • American Building, 4 South Main Street, Dayton 2, Ohio

that the whole line operates. The group leader marks the quality chart each hour. He also counts the individual's errors and scores them according to his or her quality performance.

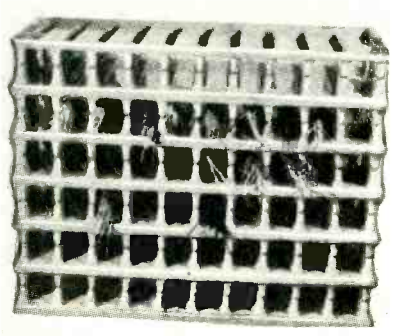
The ratings, classified as excellent, good, fair and poor, are marked on a plastic wheel which is fastened to the back of the yellow slate. The wheel is spun to the position showing the operator's current rating. In each instance, "Professor Sharin," Motorola's mythical symbol for its profit-sharing fund, is the central figure in the decal marking. He holds a colored card with the rating lettered on it.

Directly under the quality index chart is the job classification. The jobs which compete for quality performance fit into four categories—trainee, operator, key operator and group leader.

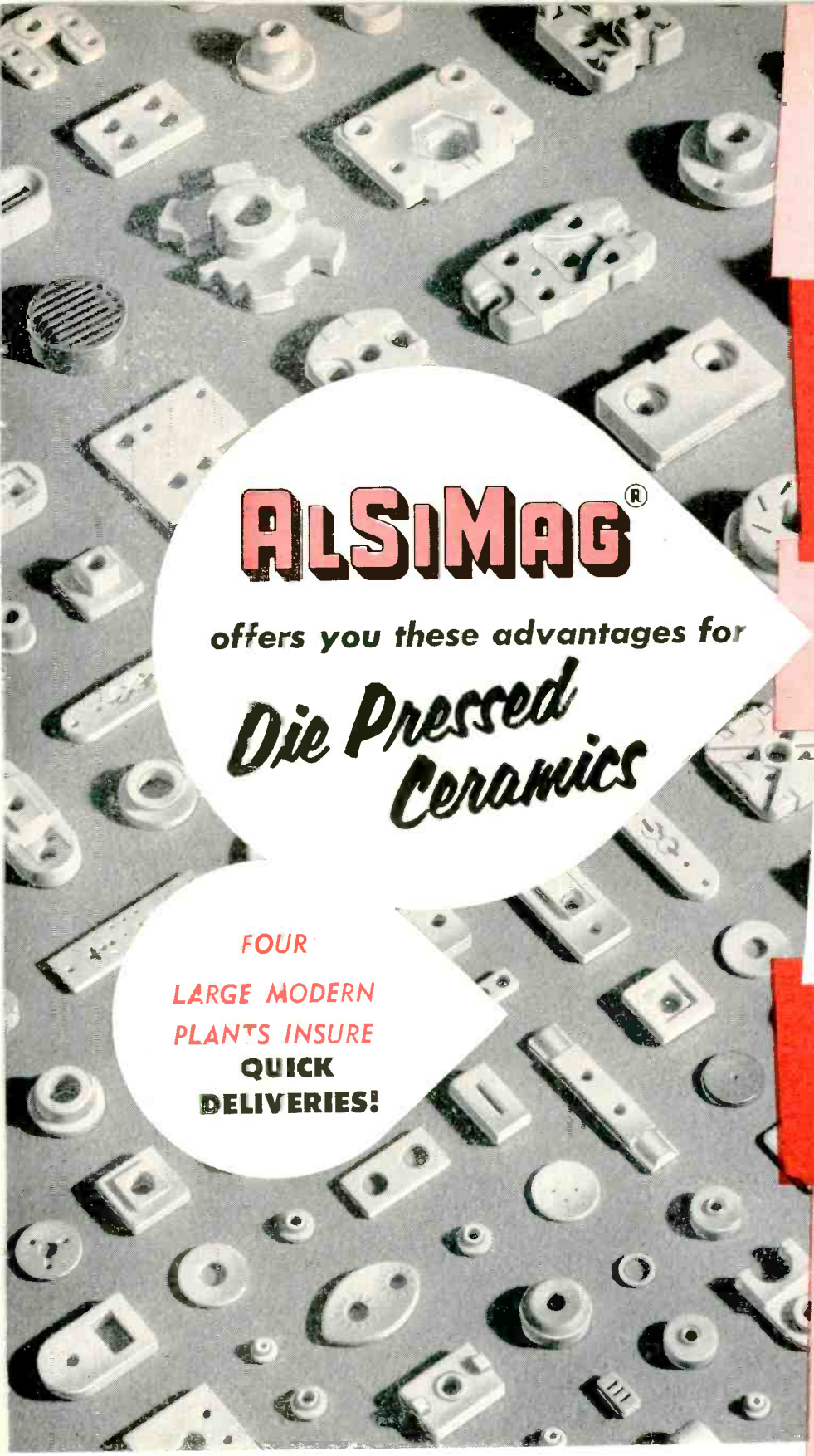
Though the plastic scoreboards have scarcely made their debut, employees have already sliced the error problem in half. Many are quite curious to see just which rating sign Prof. Sharin has hanging above their next-door neighbors' heads.

Plastic Trays Modernize Assembly Benches

CUSTOM-MOLDED plastic bins and trays for small parts and hardware reduce bench space requirements and at the same time improve reliability of electronic assemblies by minimizing handling losses. These new bench-modernizing tools are available in both stock and custom designs from Product Engineering Laboratories Co., Inc., Newark, N. J. Materials used in molding include Boltaron 6100 and Boltaron



Stacking and locking trays for cut wires



ALSIMAG®

offers you these advantages for

Die Pressed Ceramics

FOUR LARGE MODERN PLANTS INSURE **QUICK DELIVERIES!**

Capacity: Whether you require a few hundred or several million parts, the right size and type of equipment is available. Ample kilns available plus many special kilns, including controlled atmosphere kilns, provide firing capacity at optimum temperature.

Volume: Batteries of presses include several rotaries, each capable of producing up to 1,800,000 parts a day of small, simple designs. These are backed by vast volume resources for raw material preparation, firing and machining both before and after firing.

Low Cost: The right equipment for every job means that your work is produced at the most favorable cost.

Variety of Materials: In AlSiMag you have the widest choice of materials so that you can most readily match the material to your requirements. Latest property chart sent on request.

Versatility: More than fifty years of specialized experience has made it possible to produce AlSiMag parts that meet "impossible" requirements.

Engineering Assistance: If you will send details of your requirements, our engineers will submit suggestions on material and design to assist you in finding the most efficient and economical solution to your requirement.

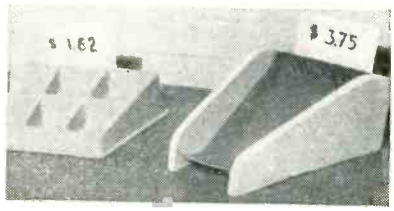
53RD YEAR OF CERAMIC LEADERSHIP

AMERICAN LAVA CORPORATION

CHATTANOOGA 5, TENNESSEE

A SUBSIDIARY OF MINNESOTA MINING AND MANUFACTURING COMPANY

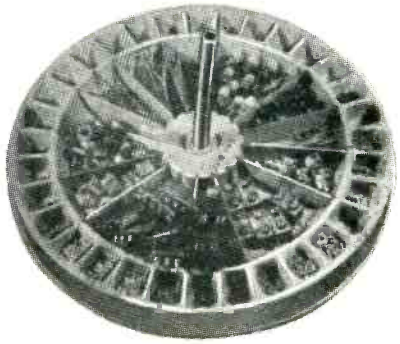
OFFICES: METROPOLITAN AREA: 671 Broad St., Newark, N. J., Mitchell 2-8159 • SYRACUSE, N. Y., 647 S. Warren St., Phone 74-4889 and 74-4880 • CLEVELAND: 5012 Euclid Ave., Room 2007, Express 1-6685 • NEW ENGLAND: 1374 Mass. Ave., Cambridge, Mass., Kirkland 7-4498 • PHILADELPHIA: 1649 N. Broad St., Stevenson 4-2823 • ST. LOUIS: 1123 Washington Ave., Garfield 1-4959 • CHICAGO: 228 N. LaSalle St., Central 6-1721 • SOUTHWEST: John A. Green Co., 6815 Oriole Dr., Dallas 9, Dixon 9918 • LOS ANGELES: 5603 N. Huntington Dr., Capitol 1-9114 • SOUTH SAN FRANCISCO: 320 Shaw Rd., Plaza 6-0800 PITTSBURGH: 911 Plaza Bldg., Atlantic 1-2075



Cost comparison of new molded plastic tray (left) and shop-improvised wood and metal rack

PVC made by Bolta Corp., Royalite made by U. S. Rubber Co., and Rigid Vinylite made by Bakelite Division.

Experience with the new Pelco trays in a number of electronic plants has shown that they make workers have more respect for delicate parts stored therein. With old wood or galvanized trays that quickly acquired a coating of dirt and grease, the psychological effect

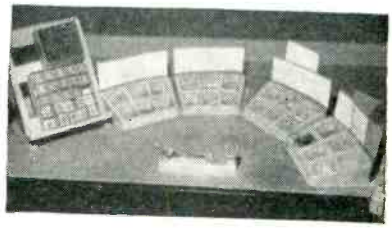


Rotary bin for small parts

was often much like that of delivering diamonds in a coal scuttle. The new trays have a glossy smooth surface with no finish to chip or peel and no sharp corners, permitting absolute cleaning to eliminate sources of contamination.

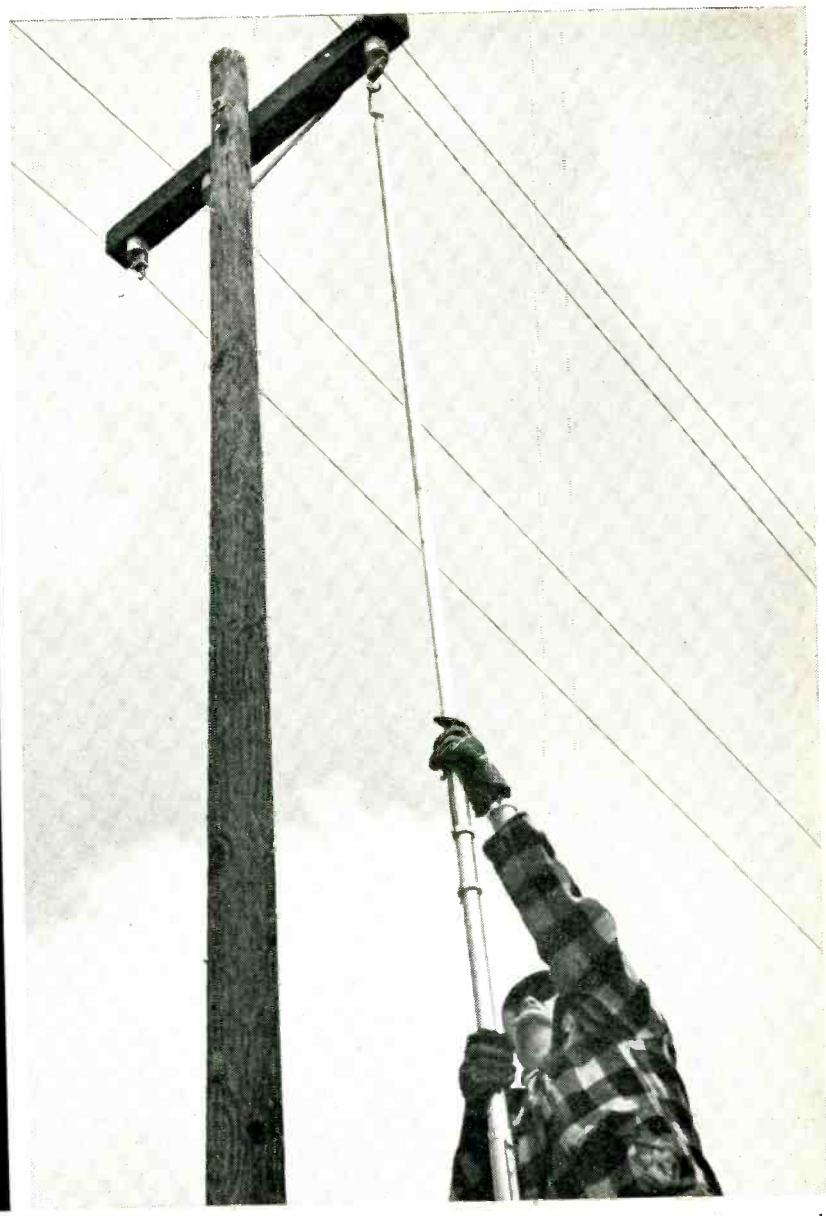
Ten-position trays for cut wires stack and interlock to produce as many compartments as are desired for wiring positions. These are equipped with slanting-rod wire snubbers for one-wire extraction.

A lazy-Susan rotary bin mounted



Typical assembly bench arrangement using combination of plastic and wood racks, with subassembly jig in foreground fastened to bench

The pole that need not be climbed

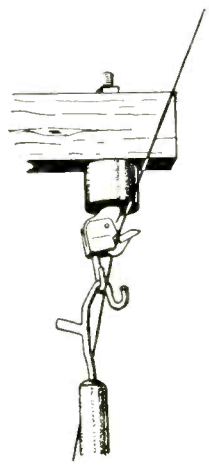


Fastening wires with new tool.

Since telephony began, there has been just one way to install telephone wires on poles: have a trained man climb up and fasten them there. Now Bell Laboratories engineers have developed a special pole line for rural areas. The entire line can be erected without climbing a pole.

The whole job is done from the ground. Light-weight poles are quickly and easily erected. Newly created tools enable men to fasten wires to crossarms 10 to 25 feet over their heads.

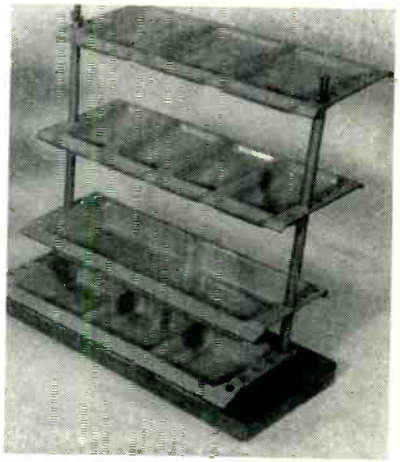
This inexpensive line promises more service in sparsely populated places. From original design to testing, it exemplifies a Bell Telephone Laboratories team operation in widening telephone service and keeping costs down.



Key to the new "climbless" pole is this insulator. Ground crews use long-handled tools to place the wire in position and then lock it fast.

Bell Telephone Laboratories

IMPROVING TELEPHONE SERVICE FOR AMERICA PROVIDES CAREERS FOR CREATIVE MEN IN SCIENTIFIC AND TECHNICAL FIELDS



Method of using pipe sections on vertical rods to space trays. Five punched holes in each end of each tray permit staggered mounting

Spring-clip supports for trays

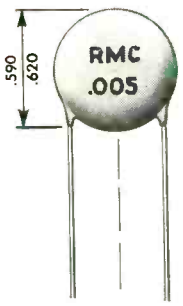
on a pipe stand has 32 scoop-shaped cups on its outer circumference for hardware. The inner circle has slots for removable partitions that give up to 16 additional larger compartments for components.

Two types of mountings are used for stacking dispenser trays with varying clearances between trays. Both use wood bases with vertical rods. In one, the trays have five punched holes at each end for threading onto the vertical rods, and pipe sections are used as spacers between trays. Wing nuts on the threaded upper ends of the rods lock the entire assembly together. By using different tray holes, a staggered arrangement is achieved that gives easy access to each tray.

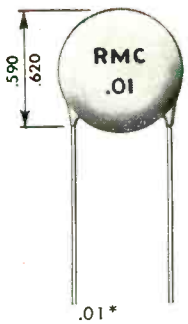
Another arrangement, having still greater flexibility because it can be adjusted without taking anything apart, uses plain vertical rods

UNEXCELLED FOR BY-PASS OR FILTERING APPLICATIONS

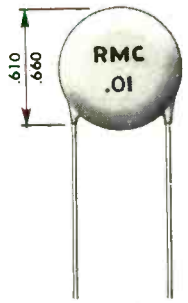
RMC HEAVY DUTY DISCAPS®



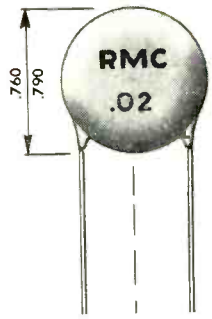
.0047
.005
2x.002



.01*
±20%
.02*
+80%−20%



.01*
.02*

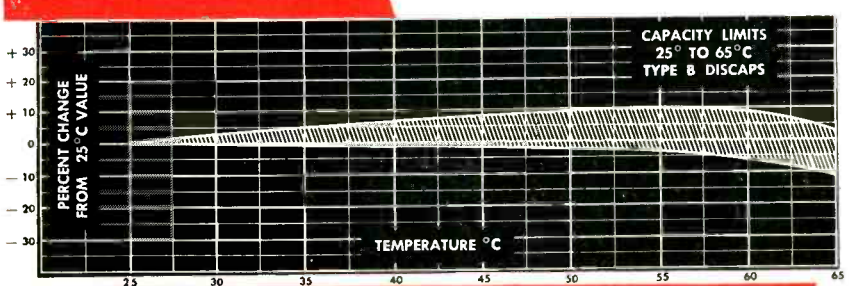


.01
.02
2x.004

SPECIFICATIONS

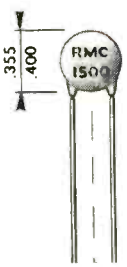
GUARANTEED MINIMUM VALUE

POWER FACTOR: 1.5% Max. @ 1 KC (initial)
POWER FACTOR: 2.5% Max. @ 1 KC (after humidity)
WORKING VOLTAGE: 1000 V.D.C.
TEST VOLTAGE (FLASH): 2000 V.D.C.
LEADS: No. 22 tinned copper (.026 dia.)
INSULATION: Durez phenolic—vacuum waxed
INITIAL LEAKAGE RESISTANCE: Guaranteed higher than 7500 megohms
AFTER HUMIDITY LEAKAGE RESISTANCE: Guaranteed higher than 1000 megohms

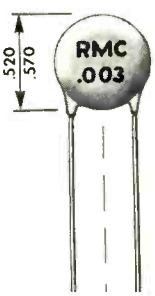


TYPE B
1000 V.D.C.W. By-Pass Series
***Rated 600 V.D.C.W. Flash test 1200 V.D.C**

.00015
.00047
.00068
.0008
.001



.0015
.002
2x.001

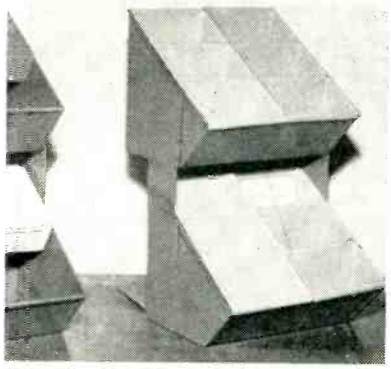


.003
.004*
.005*
2x.0015
2x.002*

DISCAP CERAMIC CAPACITORS

RMC

RADIO MATERIALS CORPORATION
GENERAL OFFICE: 3325 N. California Ave., Chicago 18, Ill.
FACTORIES AT CHICAGO, ILL. AND ATTICA, IND.
DISTRIBUTORS: *Contact* **Jobbers Sales Co., P. O. Box 695, Fairlawn, N. J.**



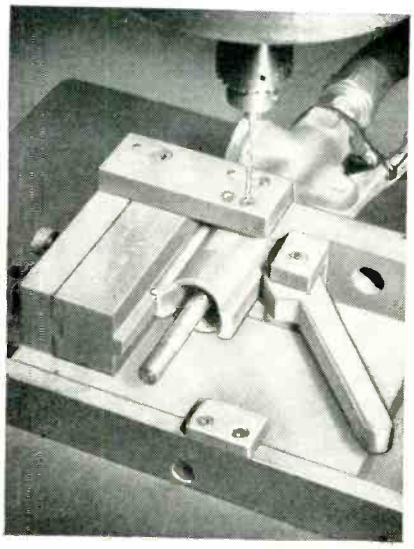
Use of molded plastic inserts in standard metal parts rack. Old metal inserts are in rack at left

without spacers. At each end of each tray is a wire rod on which a spring clip can be slid back and forth. Detents in the tray ends permit positioning this clip quickly in any of five positions, corresponding to the punched holes in the other type of tray. When these clips are squeezed together the trays may be slid up or down on the rods easily. When the clips are released, they lock in position on the rods.

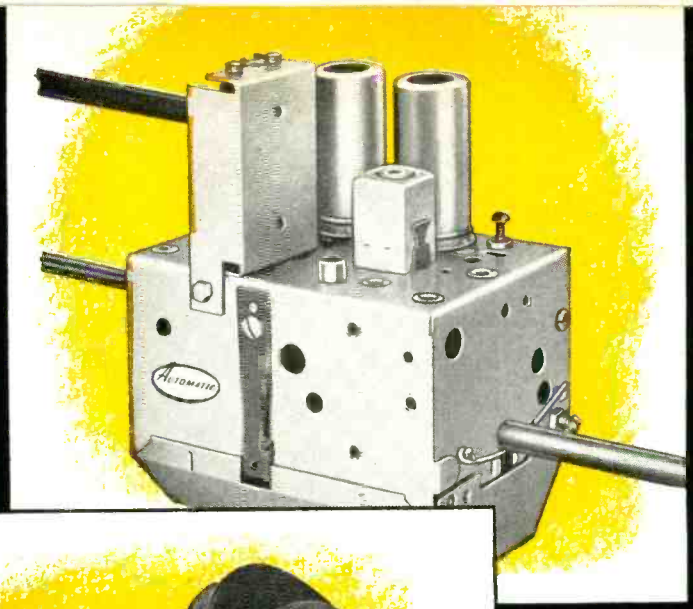
Drilling Jig for Potentiometer Rotors

A SPECIAL JIG developed by Helipot Corp., South Pasadena, California, is used in the manufacture of rotors for standard 10-turn precision potentiometers. The jig serves as a guide for drilling the two holes necessary for attaching the saddle strap of the slip ring contact spring.

The rotor is first locked into position on the jig. Sliding the carriage to the left registers the rotor for



Rotor drilling jig



Superior Design

+ Mass Production

= Low Cost

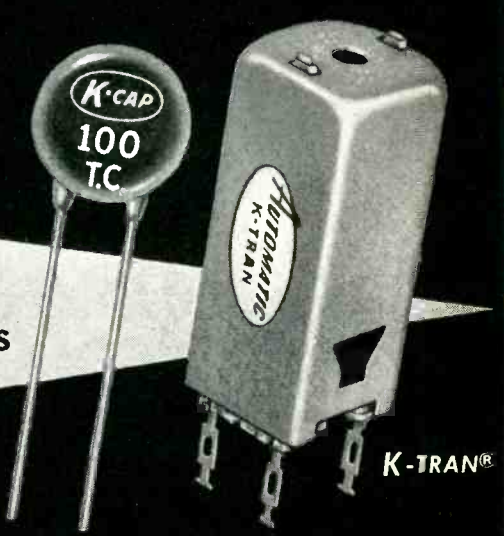
TV TUNERS, YOKES and FLYBACKS

BY AUTOMATIC

AUTOMATIC MANUFACTURING CORPORATION

65 GOUVERNEUR ST., NEWARK 4, N. J.

MASS PRODUCERS OF ELECTRONIC COMPONENTS



K-CAP®

K-TRAN®

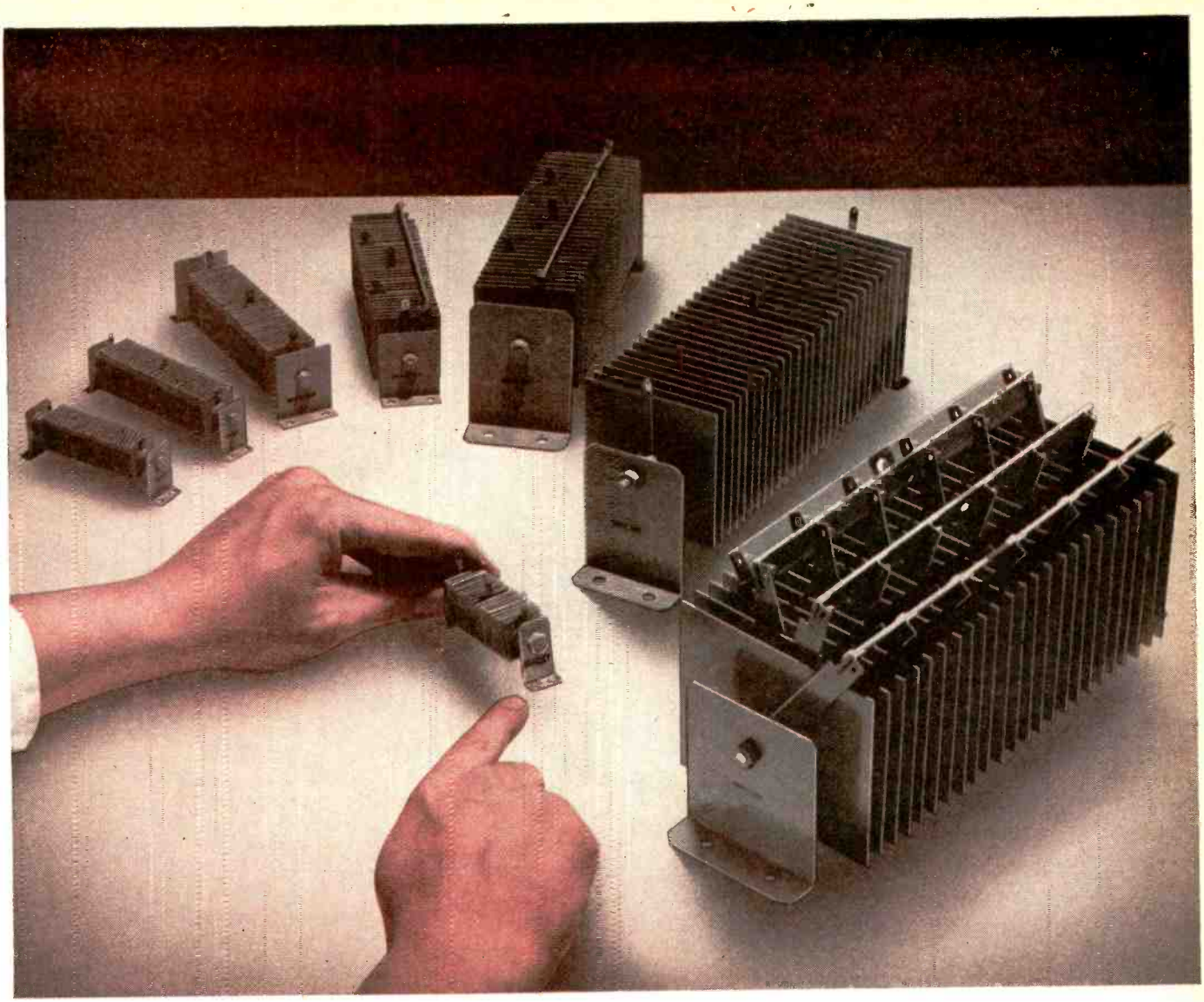
drilling the right-hand hole. The drill is then withdrawn and the carriage slid to the right to locate the rotor for the second hole. Compressed air from a hose removes all chips and curls.

Plastic Windows Improve Wire Strippers

WITH CONVENTIONAL solid metal guards on motor-driven wire strippers, a safety hazard existed because operators continually used the machine with guard open so they could see the wire ends being twisted. The problem was solved in Bendix Pacific Division's plant in North Hollywood, California by bolting a transparent plastic guard permanently in position.

Mounting of the wire strippers on a slanting wood platform served to increase output and reduce worker fatigue because it permitted performing the operation while the hands of the worker were in a normal relaxed position. The standard model of Speedcraft insulated wire stripper, made by The Wire Stripper Co., Cleveland, Ohio,

Mounting wire stripper at forward angle as shown greatly reduced worker fatigue. Ruler mounted behind twisting head makes length setup easier



STACKS OF STABILITY

Bradley rectifiers invariably exceed performance requirements, but this quality bonus does not carry a premium price. Our exclusive vacuum process not only assures stability and long life; it also assures low cost. We would like to prove it by quoting now on your rectifier needs. Please fill out the form below — no obligation, of course. You will get quick action.

VACUUM PROCESSED—for performance as rated

BRADLEY LABORATORIES, INC., 168E COLUMBUS AVENUE, NEW HAVEN 11, CONNECTICUT

Bradley
LABORATORIES, INC.

DC Output: Volts Min. _____ Amperes Max. _____ Circuit _____

AC Input: Volts Max. _____ Phase _____

LOAD: Res. _____ Ind. _____ Cap. _____ Battery _____

DUTY: Continuous _____ Intermittent _____ On _____ Off _____

COOLING: Convection _____ Forced _____ Ft. Per Min. _____

Max. Ambient Temp. _____ °C

FINISH REQUIRED: _____

QUANTITY: _____

NAME _____

ADDRESS _____

_____

Method of mounting transparent plastic guard on stripper. Wire stripping is one of many electronic production operations that is being performed efficiently by handicapped workers in this plant

is employed. With the stripper projecting over the edge of the bench, it was no longer necessary to drill a hole through the bench from the motor switch to the foot pedal used by the operator for starting and stopping the stripper.

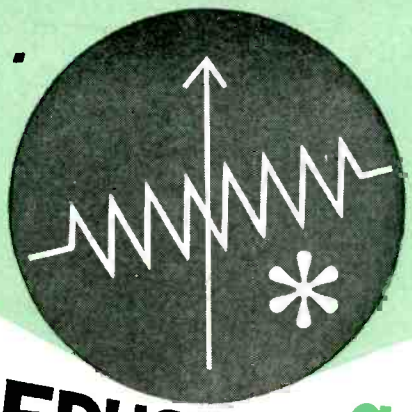
Economic Inspection of Soldered Connections

WITH RESPECT to loose soldered connections in military electronic equipment and in telephone dial exchange equipment, the quality control organization at the Hawthorne plant of Western Electric Co. has set a bogey of not more than one loose connection per 10,000 connections. The degree to which this has been attained is shown on the accompanying chart.

Production problems, quality control, inspection methods and operator training programs related to soldered connections were discussed by C. S. Barrett of this plant at the Conference on Reliability of Electrical Connections in Chicago, April 16, 1954. The following material was abstracted from his paper.

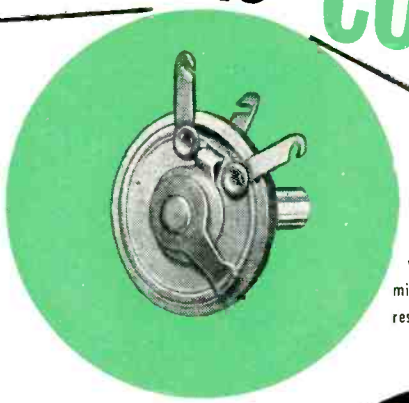
In the audit inspection of the product, defects are assessed

From "The House of Resistors"** come . . .



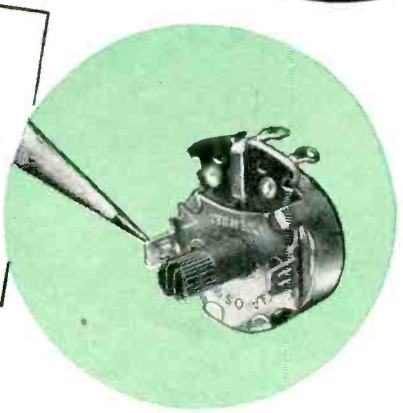
COST-REDUCING CONTROLS

So you must *get cost down* in designing that assembly? That's just the time to enlist Clarostat's cost-saving talents and facilities. The same superlative engineering and production skill that accounts for the finest quality in controls and resistors, is also available for designing and fabricating cost-reducing components. Three typical examples are presented herewith. These are *standard* items, promptly available in any quantities, at marked savings. And for any extraordinary requirements, *special* controls and resistors can be developed, tooled-up and produced.



The original "Humdinger" Series MH. Compact, rugged, wire-wound control. Virtually millions in use. Fibre base holds resistance winding. Movable arm and shaft. 1-watt. 2 to 1000 ohms.

Latest "Humdinger" Series 39. Metal-case mounted with rivets or screws. Mounting surface serves as cover. Semi-fixed setting by screwdriver slipped into rotor slot – no shaft 2-watt 4 to 5000 ohms.



Twist-Tab Mounted Series 47. Eliminates usual bushing, lockwasher, nut. Composition-element control. Metal or plastic shaft. Plastic shaft has rear slotted protrusion, therefore adjustable from front or rear.

**Trade Mark

* *It's easy*

to do business with CLAROSTAT!

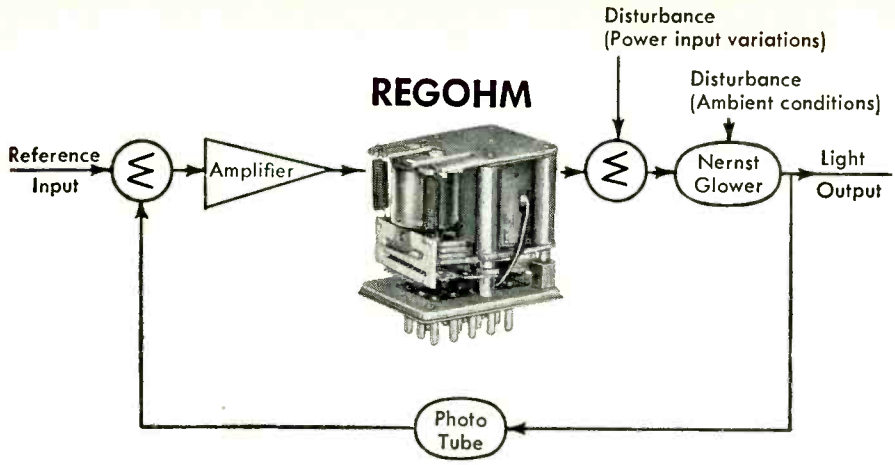
Agents in all principal cities. ★ Wire Western Union — we have a direct wire. ★ Telephone Dover 975 — we have added trunk lines to render service. ★ Teletype — our TWX number is Dover 275-U.

STAND PAT WITH CLAROSTAT ®

CONTROLS and RESISTORS

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

In Canada: CANADIAN MARCONI CO., Ltd., Toronto, Ont.



Regohm keeps radiation energy constant for new infrared spectrometers

Since infrared analysis must be able to record changes as slight as 1 part in a million of a chemical substance, the energy source must be kept constant. The above block diagram shows how Regohm does this for a Perkin-Elmer Infrared Spectrometer.

In most applications, Regohm directly senses what it controls. Here, however, Regohm serves as a power amplifier. A photo tube acts as the sensing device. Its output is electronically amplified, using a balanced DC amplifier to raise the power level of signal and eliminate the effects of drift.

The photo tube is constantly sensitive to changes from the Nernst glower by delivering current output proportional to changes in radiation. Output from the Reference Balanced Amplifier changes above and below fixed voltage.

Reacting to milliwatt output changes in the amplifier, Regohm produces large changes in power input to the Nernst glower. Hence, the Regohm circuit adjusts for all variations in source intensity, counteracting disturbance from power input changes and ambient temperature conditions. Regohm's dashpot stabilizes the control system.

Electric Regulator takes pride in the fact that high performance alone was the reason for P-E's choice of Regohm for equipment that is the "Cadillac" in its field.

Assembling a Perkin-Elmer Infrared Spectrometer

7 Reasons why Regohm can simplify your control problem

1. Regohm is small in size—It is compact, lightweight, position-free.

2. Regohm is a high-gain power amplifier—Milliwatt variations in signal energy control energy changes millions of times greater.

3. Regohm's isolated signal and control circuits eliminate impedance matching problems—Signal coils may have ratings from 0.01 to 350 amperes. Control resistance range unlimited.

4. Regohm will correct system instability—A reliable, sturdy dashpot aids system damping.

5. Regohm's effect can be calculated in advance—Its response is independent of rest of servo system.

6. Regohm assures continuous control—In "closed loop" systems a high-speed averaging effect occurs.

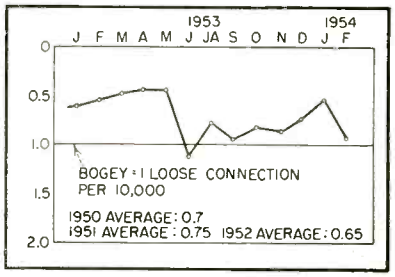
7. Regohm has long life—Plug-in feature simplifies replacement when necessary.

Regohm can be applied to your control system or regulation problem. Our engineering and research facilities are always at your service. Write for Bulletin 505.00, analyzing Regohm's characteristics and applications. Address Dept. E., Electric Regulator Corporation, Norwalk, Conn.

penalties in accordance with a four-fold classification, the demerit values depending on the seriousness of the defects. Loose connections are assessed the maximum-seriousness weight value.

Training Procedures

The first consideration in achieving good soldered connections is the selection of qualified people for wireman jobs. Tests determine an applicant's ability to learn and his



Quality control record for soldered connections

capabilities with respect to such factors as hand, eye and arm coordination and finger dexterity. Embryo wiremen are placed in an instruction group for a maximum of 20 weeks. Carefully chosen from supervisory ranks, the instructor is temporarily transferred to the Training Department. Trainees are paid on a day-work basis.

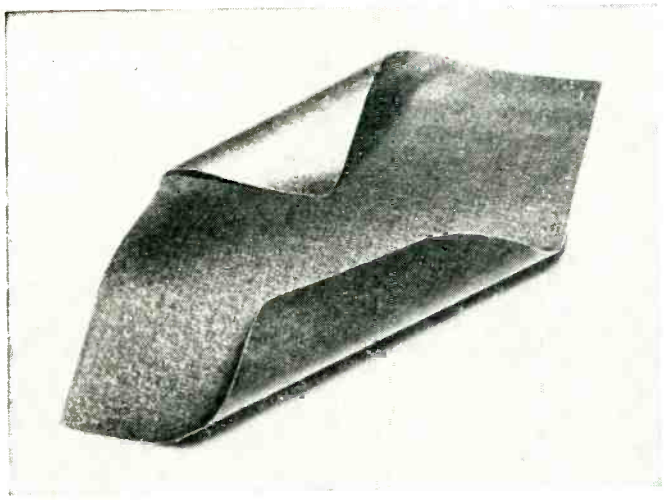
A performance chart is kept for each trainee, and individuals who do not make satisfactory and progressive advancement are placed in some other field of work. Individuals may and can complete the training and take their place in the production unit before 20 weeks have elapsed if they show above-average ability and accomplishment.

After training, new wiremen are placed on the simpler wiring jobs. Candidates for the advanced wiring jobs come from the group of employees engaged in doing the simpler wiring. Before being placed on the advanced job they are given a second period of training covering a maximum of 10 weeks.

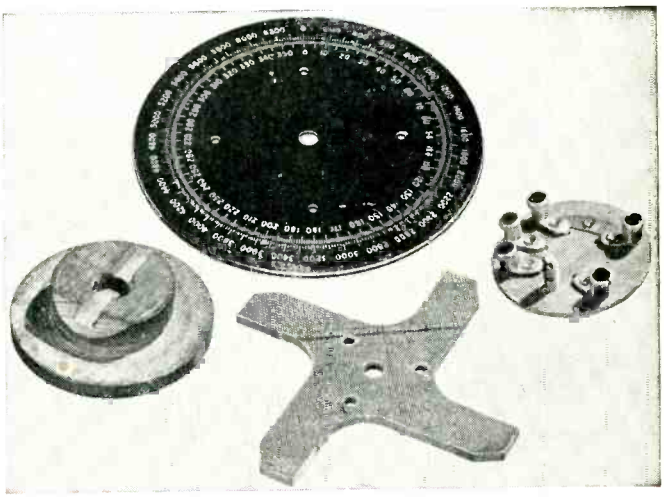
100-Percent Inspection

Although all manufacturing departments recognize the importance of operator training and the necessity for a high level of quality for soldered connections, there have been relatively few groups of oper-

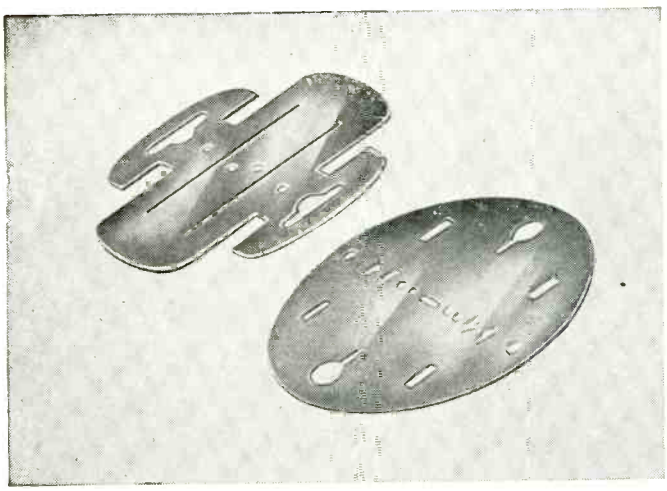
Do you have any of these problems?



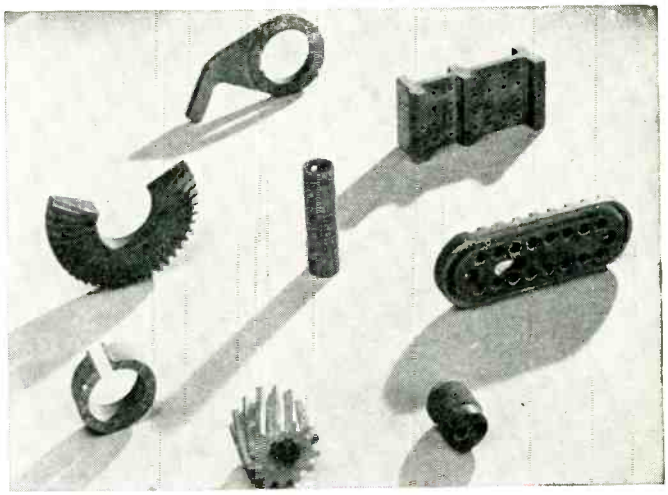
1. Looking for a thin, flexible insulating material that will not break down under extremely high temperatures? ISOMICA® Flexible Plate, Class B and Class H, built-up from continuous mica sheets, gives superior electrical and thermal insulation for coil wrappings and similar applications.



2. Need a material with special mechanical, thermal and insulating properties? LAMICOID® — a laminated plastic made with various fillers—gives you the properties you need for antenna parts, coil forms, tube sockets, switch gear and relay parts, panels, motor and transformer parts, and dozens of other uses.



3. Need accurately punched mica stampings for filament, grid and plate supports? MICO produces mica stampings to extremely fine tolerances. Whenever you need precision-fabricated mica of the highest quality, call on MICO. We have 60 years of experience in this field.



4. Looking for precision-made fabricated parts? Let us solve your problems with parts fabricated from LAMICOID®—a thermo-setting plastic—strong as metal, lighter than wood. We are fully equipped with the latest machinery and can provide you with the best possible service.

Whatever electrical insulation material you need—Class A to Class H —MICO makes it best. We manufacture it, cut it to size, or fabricate it to your specification. Send us your blueprints or problems today.

MICA *Insulator* COMPANY

Schenectady 1, New York

Offices in Principal Cities

In Canada—Micanite Canada Ltd., Granby, Quebec

LAMICOID ® (Laminated Plastic) • MICANITE ® (Built-up Mica) • EMPIKE ® (Varnished Fabrics and Paper) • FABRICATED MICA • ISOMICA ®

ators which have produced this level of quality consistently. Most operating departments meet their bogey by inspecting the output 100 percent and correcting the defects found in inspection.

Experience has shown that 100-percent inspection will not guarantee removal of all defects. This is especially true in an inspection of the type involved for loose soldered connections, where the inspector has to examine visually thousands of good connections with very little probability of finding a single defect. Very good inspectors are not 100-percent efficient in detecting loose soldered connections. Furthermore, repeated inspection of soldered connections in wired equipments can be deterimental. Several years ago, a shop got into soldering difficulties and in an honest effort to improve the quality repeated the 100-percent inspection several times. Most of the poor joints were located and corrected, but it was almost like burning down the barn to get rid of the rats—so many broken wires began to develop as a result of the overzealous inspection that it was necessary to rip off the cables and rewire the equipments.

Sampling Inspection

Although sampling for soldering has not been introduced generally, one sampling layout has been issued. Soldering defects other than loose connections are inspected on a regular lot-by-lot AOQL sampling plan, while sampling for loose connections is on a continuous sampling plan developed around H. F. Dodge's Bell Telephone System Monograph 1834, CSP 1. The values of $f = 25$ percent and AOQL $= 0.01$ percent were used. The plan provides that 25 percent of the soldered connections of each equipment unit be inspected for loose connections. If a defect is found in the course of sampling, 100-percent inspection is initiated and continued until 6,000 consecutive good connections have been inspected, after which 25-percent sampling is again resumed. Assuming that all defects are found and removed in all portions of the product inspected, this plan will

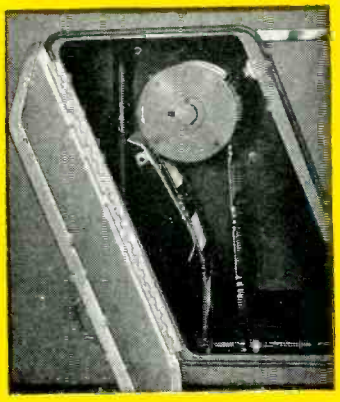
NOW! the new Gray telop III

Eliminates extra manpower requirements

opaque and transparency projector

REMOTE OR LOCAL CONTROL CHECK THESE NEW FEATURES

- Completely automatic . . . utilizing features contained in the now famous Telop and Telojector . . . Slides change by push button control.
- Sequence of up to 50 slides can be handled at one loading . . . additional pre-loaded slide holders easily inserted in unit.
- Remote control of lap dissolves . . . superposition of two slides . . . and slide changes.
- Shutter type dimming permits fades without variation of color temperature . . . opaque copy cooled by heat filters and adequate blowers . . . assembly movable on base which permits easy focus of image.



Telop III. . . interior view of automatic slide holder which accommodates 4" x 5" opaque slides. . . One lens . . . no registration problem . . . no keystoning.

SCREEN OUT HIGH PRODUCTION COSTS FOR LOCAL SPONSORS

Telop III by the elimination of extra manpower assures the production and projection of low-cost commercials that local sponsors can afford. It can be used with any TV camera including the new Vidicon camera. Telop III projects on single optical axis opaque cards, photographs, art work, transparent 3¼" x 4" glass slides, strip material, and 2" x 2" transparencies when Telojector is used with optical channel provided. Telop III eliminates costly film strips and expensive live talent.

WRITE FOR: Illustrated bulletin describing Telop III specifications. Your request will receive prompt response.

GRAY RESEARCH

AND DEVELOPMENT CO., Inc., Hilliard St., Manchester, Conn.
Division of the GRAY MANUFACTURING COMPANY
Originators of the Gray Telephone Pay Station and the Gray Audograph and PhonAudograph.

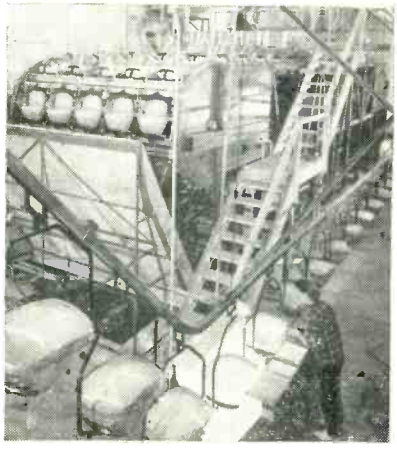
assure a maximum average outgoing quality of one defect in 10,000.

In addition to the regular fractional sample inspection, the layout provides for another inspection of 600 connections from each soldering operator each day. The purpose of this inspection is to furnish additional inspection control and provide a complete pattern of the quality of each soldering operator's work. If a loose connection is found in this inspection the sample is extended to another 1,800 additional connections with no additional defects allowed. All defects are returned to the operators for repair. Frequently only a small portion of the operators and/or machines are principally responsible for most of the defects. Operator sampling is an efficient means for reducing the defects to an economic level.

Screen-Settling Conveyor for 27-Inch Picture Tubes

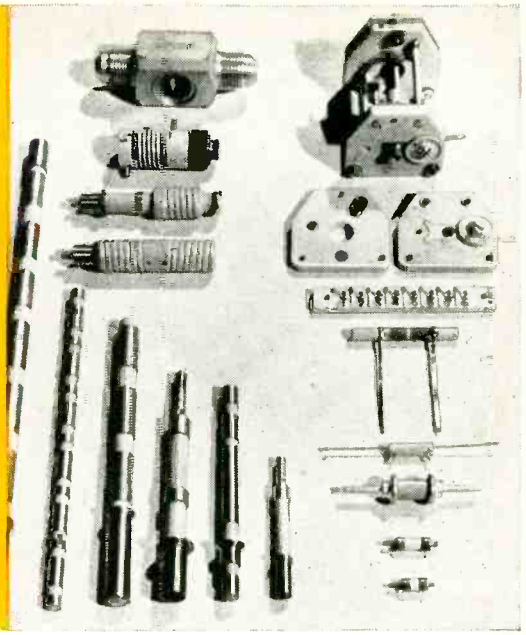
A NEW MACHINE 47 feet long and capable of handling up to 210 27-inch picture tubes at a time is being used in Raytheon's Quincy, Mass. plant for applying screen phosphors automatically. Operators merely load empty bulbs five in a row and take them off after one trip around the huge endless conveyor.

Each bulb is automatically filled with chemicals. As the bulbs move smoothly and steadily across the



Automatic screen-applying machine for 27-inch picture tubes. Man at right rear unloads finished tubes for transfer to overhead conveyor which brings them past fluorescent-lamp inspection position in foreground

ceramics and metal are permanently and accurately combined



The metal bands on the rotor shafts shown at the left, above, are concentric with the shaft to within 0.001 in.

Stupakoff assemblies

Your production procedure is simplified when you use high-precision Stupakoff ceramic-to-metal assemblies. Extensive experience in the field of electrical and electronic ceramics, thorough familiarity with methods of metallizing, and the use of modern precision manufacturing methods insure the high quality and uniformity of Stupakoff Assemblies.

Among the assemblies made by Stupakoff are: rotor shafts, strain and spreader insulators, stand-offs and trimmers. Ceramic bodies are specially formulated for the intended service; metals used include silver, copper, brass, stainless steel and monel. Stupakoff's broad experience in this field insures the selection of a method of assembly best suited to meet service conditions.

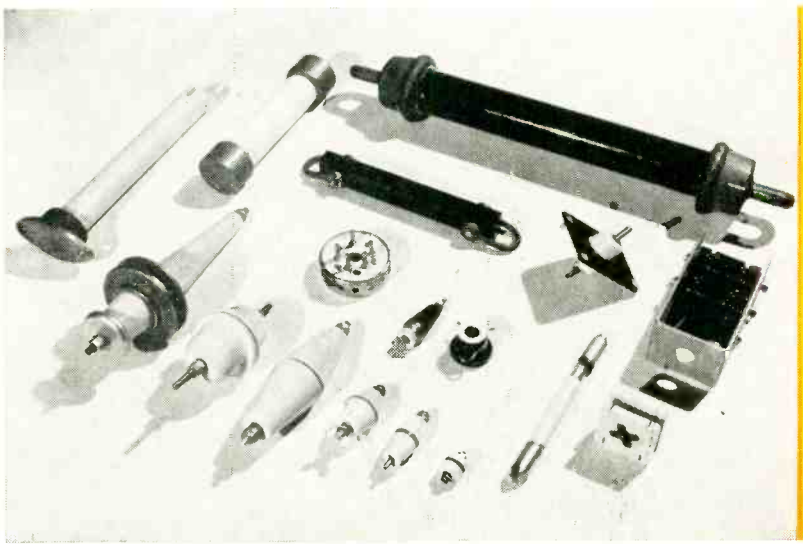
A few types of Stupakoff Ceramic-to-Metal Assemblies are illustrated in the photographs on this page.

STUPAKOFF CERAMIC & MANUFACTURING COMPANY

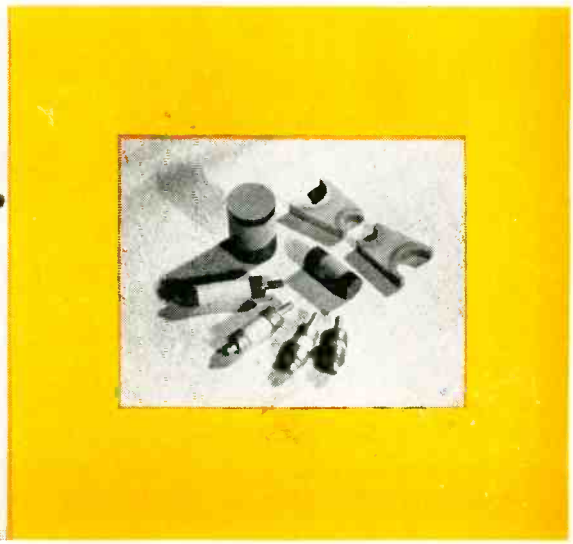
LATROBE, PENNSYLVANIA

DIVISION OF THE CARBORUNDUM COMPANY

Some of the larger types of Stupakoff metallized ceramic parts.



Small metallized ceramic parts are accurately made and dependably uniform.

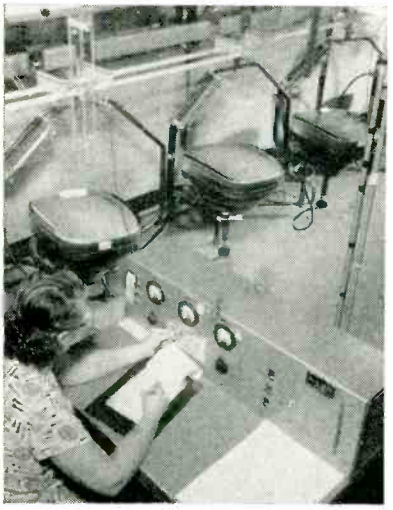


top of the machine, the phosphors settle on to the face. The liquid is automatically poured out of each bulb as the bulbs move around the end of the machine. All bulb holders are adjustable to accommodate the various tube sizes which might be produced—primarily 21-inch, 24-inch and 27-inch.

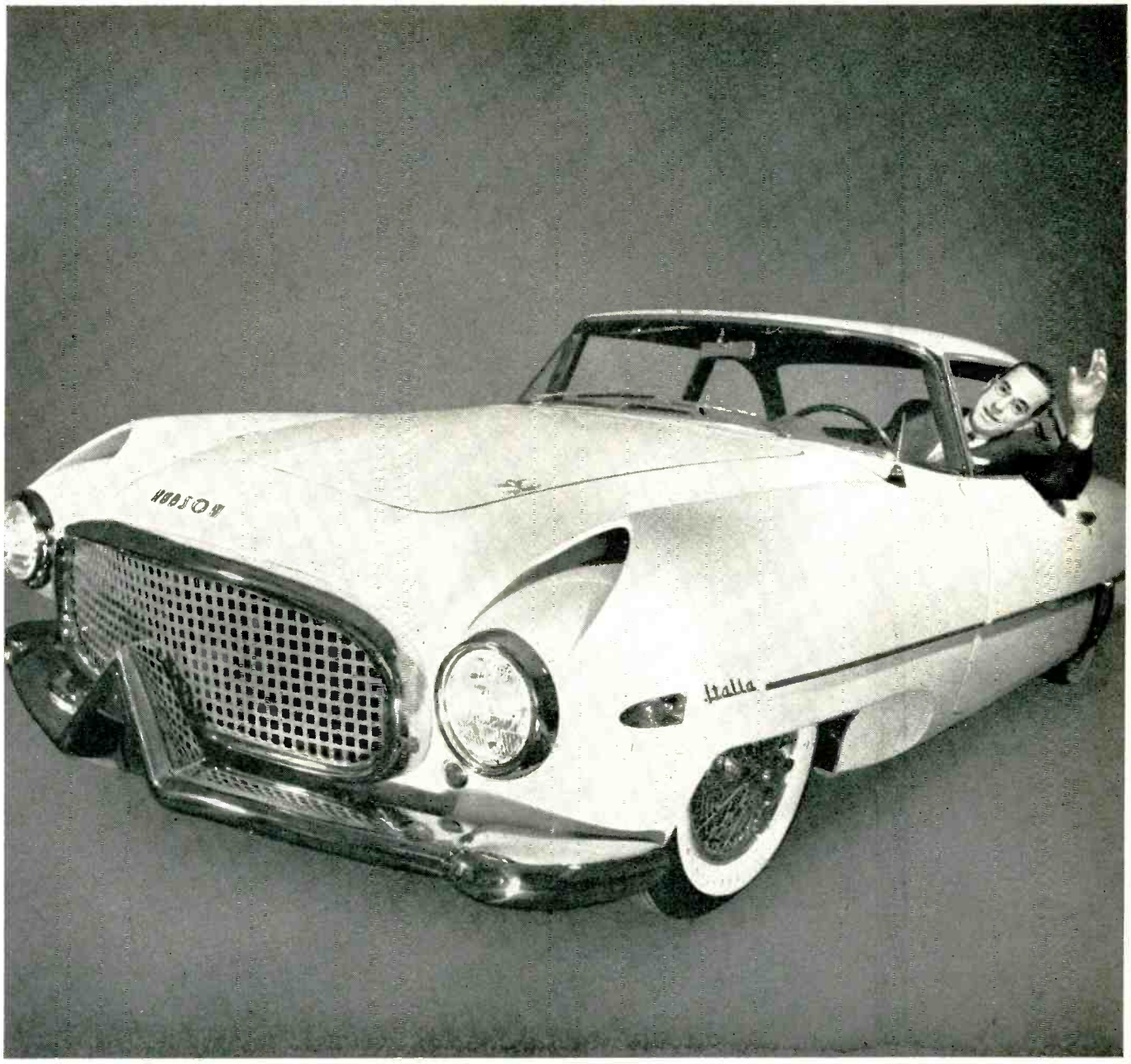
In the underpart of the machine the bulbs are automatically dried by suitable air blasts. They are then unloaded and set into an overhead conveyor which runs slowly through an inspection table where the inspector checks for all types of screen blemishes. These are illuminated by the light from the fluorescent bulbs underneath the inspection table. Unsatisfactory bulbs are marked. At a later point on the conveyor, these bulbs are removed and put through a washing process, after which they go back to the settling machine for another screen. The procedure is mechanized in such a manner that screen rejects can be reprocessed as easily as for a new bulb.

Testing Picture Tubes On Conveyor Line

A TEST SET located alongside the overhead picture-tube conveyor line in Raytheon's Quincy, Mass. plant gives a complete electrical test in the 20-second period that is available for this purpose. By manipu-



Setup for testing picture tubes as they move past on conveyor. Operator notes readings of meters as she pushes each of the four test buttons in turn with her left hand as shown



Taking the wheel of Hudson Motor Car Co.'s "Italia," N. K. VanDerzee, V.P. in Charge of Sales, explains:

How a new Hudson avoids traffic problems!

"Here is the new *Italia*—a look into the future and the latest member of the Hudson family which includes the Hornet, the Wasp, and the Jet," says N. K. VanDerzee.

"But new design naturally creates new traffic problems—in the factory. It's a big job to prevent parts shortages from stalling assembly lines. Air Express is a tremendous help.

"As our Traffic Department puts it: One phone call, and it's a load off our minds. Air Express delivers in a matter of hours. This dependable speed gives us the safety margin we need to keep production rolling. We handle about 2,500 lbs. a month by Air Express. Naturally, we're thinking about speed. But our records show that most of our Air Express shipments also *cost less* than they would by any other air service!

"Add to this the country-wide coverage and Air Express' ability to pinpoint shipments in transit, and you have some idea of why our Traffic Department turns to Air Express for our most urgent traffic.

"We in Sales are proud of our reputation for on-time deliveries of new cars. In large part, we owe that reputation to our Traffic Department—and Air Express."

It pays to express yourself clearly. Say Air Express! Division of Railway Express Agency.

Air Express

GETS THERE FIRST via U.S. Scheduled Airlines

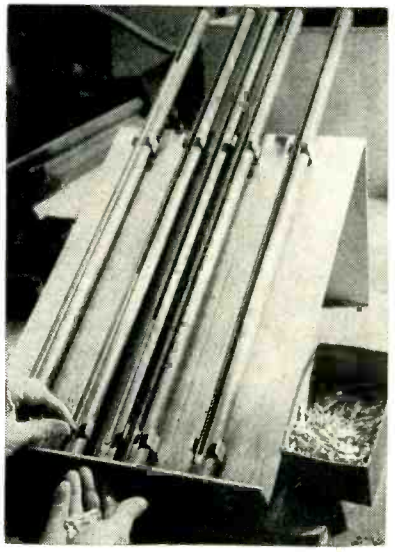
lating pushbuttons while watching meters the operator checks in turn for gas, cathode emission, control grid cutoff voltage and short-circuits.

Socket and second anode leads run from the picture tube to brushes mounted on the frame of the conveyor unit. As the picture tube approaches the test set, these brushes make contact with copper busbars that are connected to the test set. Provision is made for energizing the filament with longer busbars to heat up the tube before it is tested. Transparent plastic sheets mounted alongside the copper conductor strips provide added insulation for the second anode voltage. A small fluorescent lamp attached to each conveyor unit serves as a safety warning by glowing when the tube reaches the high-voltage busbar for the actual test.

Inserting T-Shaped Lugs in Phenolic Boards

INSERTION and fastening of T-shaped soldering lugs in phenolic boards can be done rapidly and accurately by means of a special machine designed and built by engineers at the Lenkurt Electric Co., San Carlos, Calif.

After the boards are sawed to desired sizes, they are punched with T-shaped holes for the lugs. Necessary markings on the boards are



Loading lugs into magazines held by spring clips on sheet metal fixture. Curved metal stud projecting up into each magazine at bottom leaves starting space for insertion of lug

HOW ARE YOUR COMMUNICATIONS ?

Do the booklets, pamphlets, and manuals you use really *work* for you? Are these vital publications, that tell the story of your products and your company, as effective, readable, well designed and illustrated as they can be? Today more than ever, your entire operation is judged by each annual report, employee manual, and public relations piece that you produce. Have you examined your communications lately? If you have any doubt as to the impact of your instructional and promotional literature, remember . . .

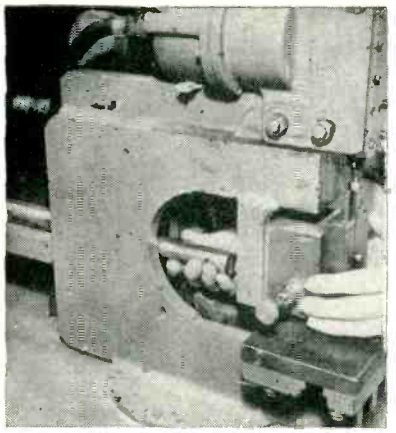
COMMUNICATION IS OUR BUSINESS

For a good many decades McGraw-Hill has stood for complete coverage in the business literature field. Now the McGraw-Hill TECHNICAL WRITING SERVICE offers a new approach to your publication problems — an *integrated* writing, editing, illustrating, and printing service for the *custom* production of: INSTRUCTION MANUALS, PRODUCT BULLETINS, TRAINING AIDS, INDUSTRIAL RELATIONS LITERATURE, ANNUAL REPORTS, COMPANY HISTORIES, PROCEDURAL GUIDES and other collateral literature. More than 150 editorial and graphic experts are at your disposal, ready to prepare high-quality material to your own or government specifications. Save time, save money . . . and make your communications work! Let *our* staff be your staff for technical and business publications.

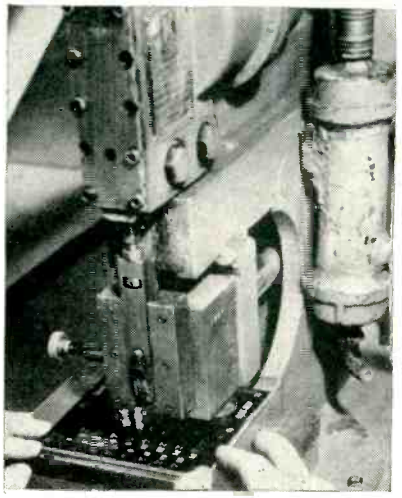
McGraw-Hill Book Co. TECHNICAL WRITING SERVICE

Write or phone Technical Writing Service, McGraw-Hill Book Co., Inc.
330 West 42nd Street, New York 36, N. Y. • LOngacre 4-3000

This service is available through ad agencies.



Loading filled magazine into press. Magazine is solid rod having milled slot running its entire length



Driving lugs into panel with air-actuated press controlled by foot treadle

applied by engraving or hot stamping. The lugs are stamped from $\frac{1}{16}$-inch brass ribbon.

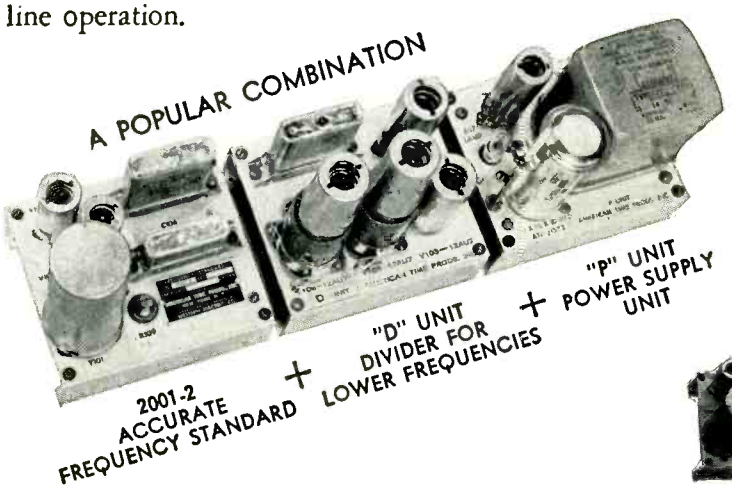
The lugs are loaded manually one by one into a magazine that will hold 375 in one filling, using a fixture that facilitates loading from the bottom. The magazine is then put into a feeding tube. The next step is connecting the loaded tube to the air supply for the machine's driving head. The air equipment utilized with the machine is manufactured by the Keller Tool Co., Grand Haven, Mich.

The lugs are driven into a phenolic board as the machine operator actuates a foot treadle. A pilot button on the table surface of the machine is used in positioning the board. As the operator moves the board along the surface, the button protrudes into a hole opening and the operator knows the board is positioned properly for insertion of

FREQUENCY STANDARDS *Modular system*

DESIGNED AS A

The Type 2001-2 series provides frequencies from 30 to 30,000 cycles with an accuracy of .001% (at room temperatures) in units suitable for integration with instruments of your own design — or for panel rack mounting with your own power sources — or for line operation.



WHICH WILL MEET YOUR

CUSTOM NEEDS

FROM A COMBINATION OF

STOCK UNITS

TYPICAL COMBINATIONS

2001-2	2001-2 + M
2001-2 + L	2001-2 + M + P
2001-2 + L + P	2001-2 + L + P + R
2001-2 + H	2001-2 + H + P + R
2001-2 + H + P	2001-2 + M + P + R

TYPE "2001-2" FREQUENCY STANDARD
Frequencies, 200 to 3,000 cycles. Output, approximate sine wave at 5 volts.

ACCESSORY UNITS

"L" UNIT.
DIVIDER, (MULTI-VIBRATOR TYPE)
Provides frequencies from 30 to 200, controlled by the 2001-2 unit.
Output, approx. 5V. Approx. sine wave.

"M" UNIT
AMPLIFIER
Provides 2 watts at 6 and 110 volts.

"D" UNIT.
DIVIDER, (COUNTER TYPE)
Provides 40 to 200 cycles controlled by the 2001-2 unit. (fail safe)

"P" UNIT
POWER SUPPLY
Provides power for combinations of units illustrated, if other sources are inconvenient or not available.

"H" UNIT
MULTIPLIER
Provides frequencies from 3,000 to 30,000 cycles, controlled by the 2001-2 unit. Output, approximately 5 volts.

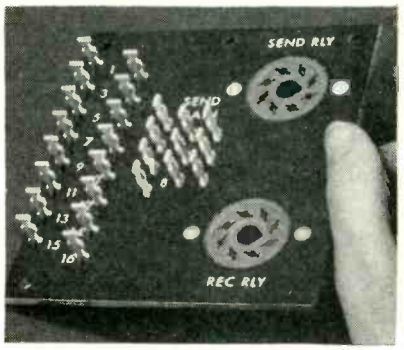
"R" UNIT
PANEL MOUNTING
Accommodates up to three units. Standard size is 8¾ inches high, 19 inches long.

For details, please request our "Type 2001-2" Booklet.

American Time Products, Inc.

580 Fifth Avenue ***New York 36, N. Y.***

OPERATING UNDER PATENTS OF WESTERN ELECTRIC COMPANY



Appearance of lugs in panel

a lug. This enables the operation to be done rapidly and assures perfect alignment of the lugs.

An average-size terminal board can be stamped with 26 lugs in a matter of seconds.

Quantity Reproduction of Photo-Oscillograms

By DANIEL NAIDAMAST
New York, N. Y.

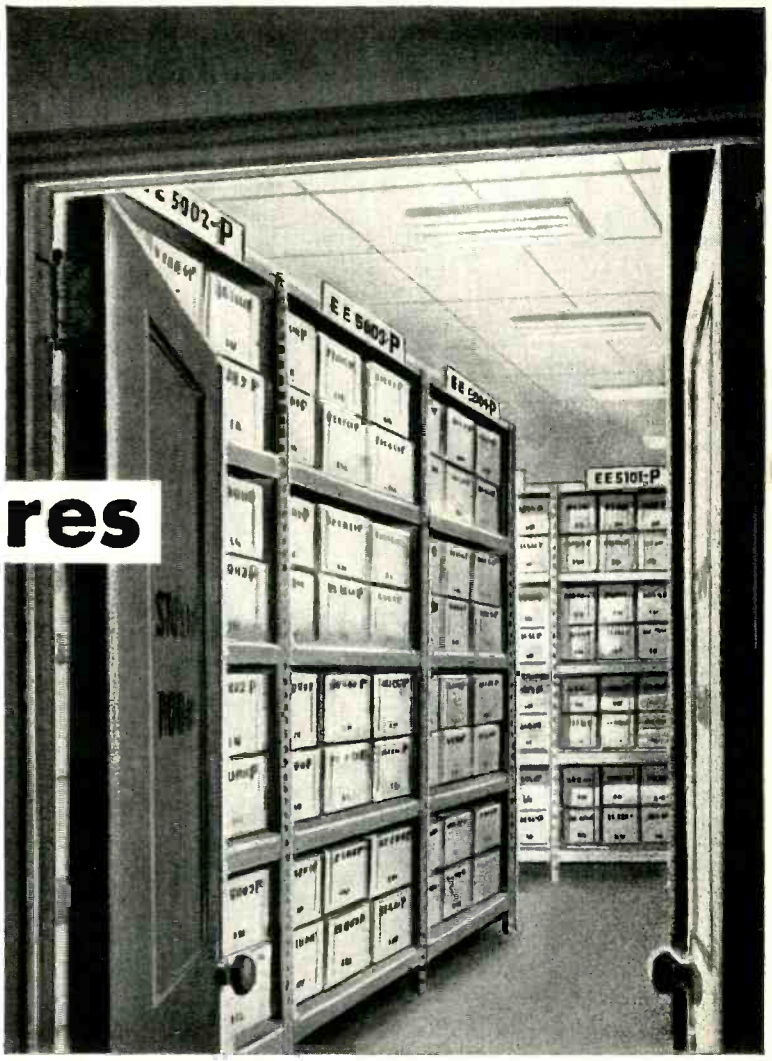
THE REPRODUCTION of photographs of oscilloscope patterns for inclusion in manuals and reports has often been a source of expense and delay. A technique which permits rapid and inexpensive reproduction by small companies, using their own facilities, is described below.

The use of the Land-Polaroid camera for oscillographic work (as modified and sold by the Fairchild Camera and Instrument Co.) greatly simplifies photographic recording. The reason is that darkroom facilities for the two-step negative-positive process are no longer required. However, a useful negative is not available, and the positive print must be used for additional copies. Resolution obtained by the Land-Polaroid process may not compare hypercritically with that obtained using a conventional camera and film, but photographs of patterns, using a steady, well-synchronized sweep, are excellent in detail and clarity. Such prints are easily usable for calibration and also, to a considerable extent, for analysis.

The inclusion of these prints, or copies of them, in progress reports and instruction manuals requires that there be little sacrifice in definition and that the expense be moderate. Where government or military work is concerned, the

Now Available

PYROFERRIC
POWDERED IRON
ENGINEERED
Economy Cores
SHIPPED FROM STOCK
at savings up to 25%



PYROFERRIC INSERT CORES
Diam: .245 to .250 • Insert: 4-40 x 1" Extending
Slot in Core: 1/32 x 1/32

Part No.	Material	Length
EE 5001-P	PY 12A (IRN-8)	3/8"
EE 5002-P	PY 1A (Carbonyl E)	3/8"
EE 5003-P	PY 1A (Carbonyl E)	1/2"
EE 5004-P	PY 14A (Carbonyl TH)	3/8"
EE 5005-P	PY 14A (Carbonyl TH)	1/2"

PYROFERRIC THREADED CORES
Material: PY 1A (Carbonyl E)

Part No.	Diameter	Length	Thread	Adjusting Slot
EE 5101-P	.248-.250	3/8"	28 T.P.I. Shallow	Hex Hole .103-.105
EE 5102-P	.237-.239	3/8"	32 T.P.I. Shallow	Hex Hole .103-.105
EE 5103-P	.180-.182	5/16"	32 T.P.I. Shallow	Screwdriver slots both ends

All Pyroferric products are produced to conform to the strictest engineering standards of uniformity, controlled quality of materials, and performance that lives up to the most exacting specifications.

PYROFERRIC
PYROFERRIC BLDG. | BRONX BOULEVARD at 216th St., N.Y.C. 67

Please send me specification sheets on Pyroferric Economy Cores

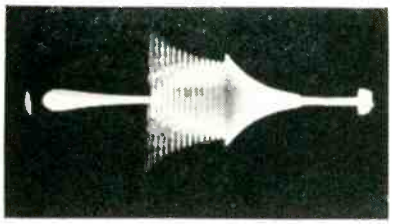
Write on your letterhead or latest Catalog No 238

NAME_____ TITLE_____ FIRM_____

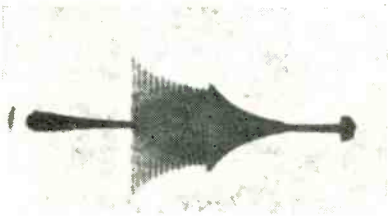
ADDRESS_____ CITY_____ STATE_____

facilities must also meet security requirements concerning location and personnel. The best location, of course, is within the plant. The necessary equipment includes an Ozalid or similar reproducing machine, a 10 × 12-inch photographic contact printer, three 11 × 14-inch trays, a rotary print dryer, a press and a Fairchild (Land-Polaroid) camera.

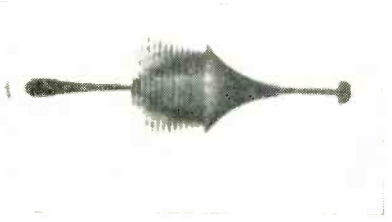
Most companies today have the first item, as it is a valuable short-order printer; many plants have, in addition, the desk-size 8½ × 11-inch reproducer. The contact printer, dryer and press represent an additional outlay of less than $100. They require about 30 square feet of floor space that is sufficiently dim so as not to fog the photographic paper to be used as negative material.



Original Land-Polaroid photograph of waveform on oscilloscope screen



Reflex paper negative made from photograph



Ozalid process blue-on-white print made from reflex negative

This paper is known as a reflex paper, manufactured by the Eastman Kodak Co. (Kodagraph Contact, Standard, extra thin for Wratten safelight No. 1A) and is available in a very thin stock. It is reflex-type in that it is sensitive to reflected light, while not fogging when light is passed through it. It

is an excellent photostat paper. The developing process is identical to that used for conventional printing except that a light-tight darkroom is not essential.

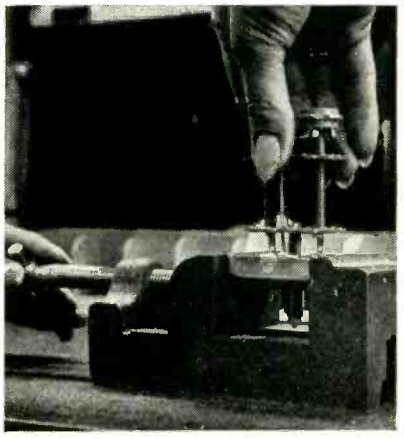
A reflex negative is made by placing a sheet of the paper on the printer, sensitive surface up; the photograph to be copied is placed face down against it and the exposure made by passing light through the paper.

The result after developing and drying is a thin paper negative. Captions or textual matter may be typed, pencilled or inked on the reverse side of the paper, with carbon backing for better reproduction. The final negative is then printed in the Ozalid machine in any desired quantity, and may be filed away for future use.

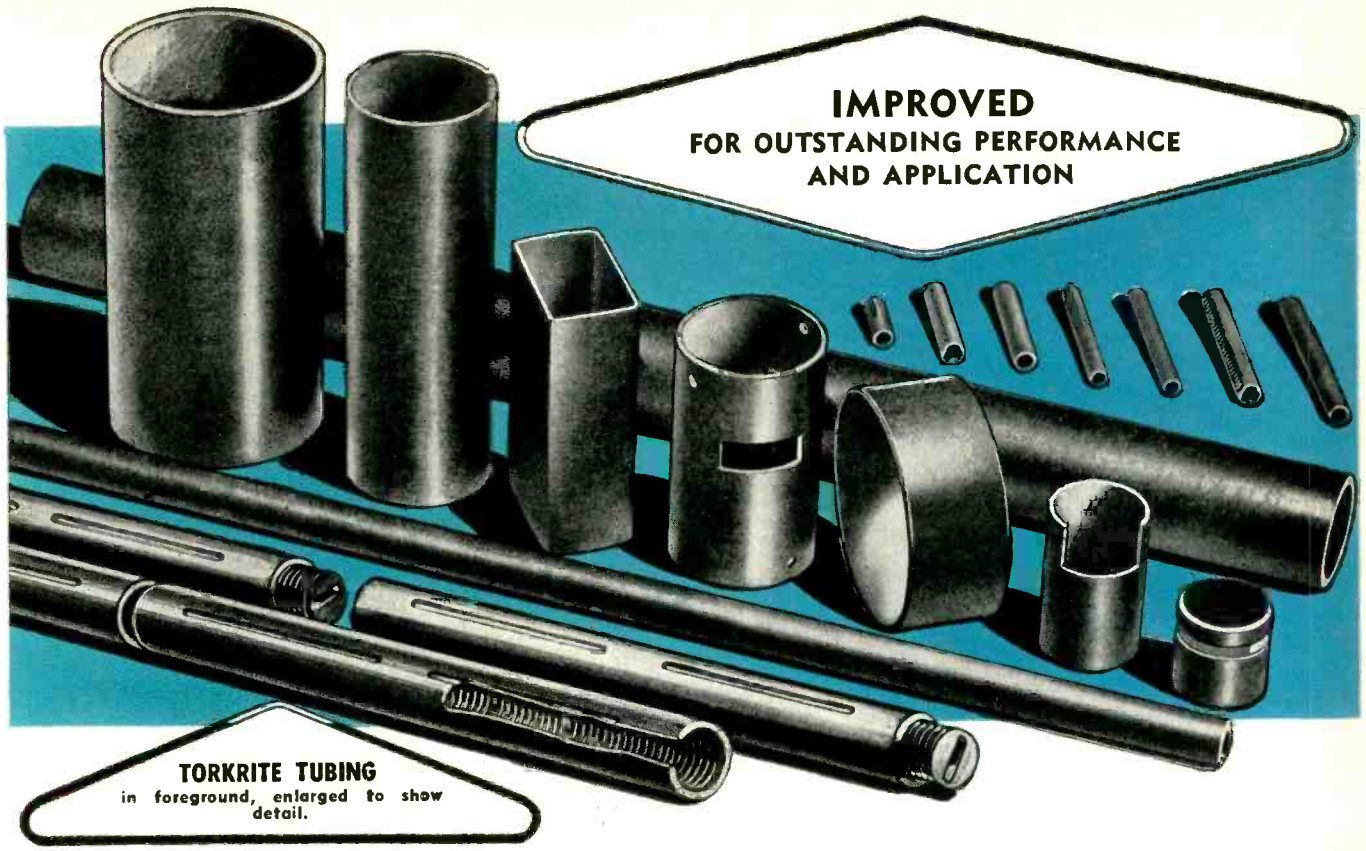
The accompanying illustration shows the three steps in the process —the original Fairchild camera photograph, the negative in reverse and the final blue-on-white Ozalid print. There is little loss in detail or clarity. This technique has been found excellent as regards speed, time and cost, and the results are of the desired professional quality.

Nine Assembly Jigs

NEW JIGS to speed and simplify fabrication and assembly operations are continually being devised at Hewlett-Packard, Palo Alto, Calif. Its products are continuously in a stage of development for the rapidly changing needs of the electronic industry, hence production



This standard drill vise is used for a number of assembly jobs, to hold resistor cards, decade dividers and in this case a discriminator unit



★ ★ ★

TORKRITE POSSESSES MANY ADVANTAGES

Torkrite affords unmatched recycling ability. After a maximum diameter core has been recycled in a given form a reasonable number of times, a minimum diameter core can be inserted and measured at 1" oz. approximately.

Torkrite has no hole or perforation through the tube wall. This eliminates the possibility of cement leakage locking the core or cores.

Torkrite permits use of lower torque as it is completely free of stripping pressure.

With Torkrite, torque does not increase after winding, as the heavier wall acts to prevent collapse and core bind.

Improved new Torkrite is now available in various diameter tubes. Lengths from 3/4" to 3-1/8", are made to fit 8-32, 10-32, 1/4-28 and 5/16-24 cores.

★ ★ ★

Fast, Dependable Delivery at all times.

CLEVELITE*

LAMINATED PAPER BASE PHENOLIC TUBING

In seven specific grades, Clevelite is one of the finest and most complete lines of tubing available to the electronic and electrical industries.

Grade	Application
Grade E	Improved post-cure fabrication and stapling
Grade EX	Special grade for TV yoke sleeves
Grade EE	Improved general purpose
Grade EEX	Superior electrical and moisture absorption properties
Grade EEE	Critical electrical and high voltage application
Grade XAX ...	Special grade for government phenolic specifications
Grade SLF	Special for very thin wall tubing having less than .010 wall

High performance factors, uniformity and inherent ability to hold to close tolerances, make Clevelite outstanding for Coil Forms, Collars, Bushings, Spacers and Cores.

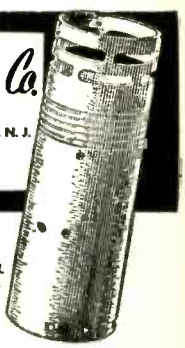
Competent Research and Engineering facilities are always available to aid in solving those tough and stubborn design and fabrication problems. May we help you?

WHY PAY MORE? For Good Quality . . . call CLEVELAND!

*Reg. U. S. Pat. Off.

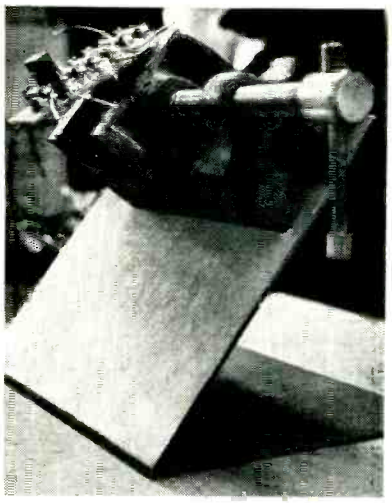
The CLEVELAND CONTAINER Co.
6201 BARBERTON AVE. CLEVELAND 2, OHIO

PLANTS AND SALES OFFICES at Chicago, Detroit, Memphis, Plymouth, Wisc., Ogdensburg, N. Y., Jamesburg, N. J.
ABRASIVE DIVISION at Cleveland, Ohio
CANADIAN PLANT: The Cleveland Container, Canada, Ltd., Prescott, Ontario



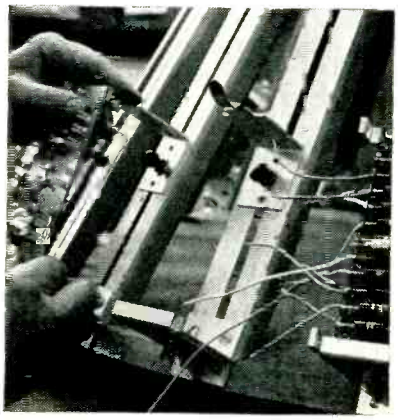
REPRESENTATIVES

NEW YORK AREA R. T. MURRAY, 604 CENTRAL AVE., EAST ORANGE, N. J.
NEW ENGLAND R. S. PETTIGREW & CO., 62 LA SALLE RD., WEST HARTFORD, CONN.
CHICAGO AREA PLASTIC TUBING SALES, 5215 N. RAVENSWOOD AVE., CHICAGO
WEST COAST IRV. M. COCHRANE CO., 408 S. ALVARADO ST., LOS ANGELES



Standard drill vise mounted on a slanting sheet metal panel to hold resistor cards at a convenient angle and level for the worker

Lazy Susan jig holds resistor cards for soldering and assembly. Use of this setup cut by 40 percent the time required when individual jigs were used. Operator spins the jig to do the same operation on each card in turn, then repeats for the next operation



Close-up shows adjustable spring clamp holders on Lazy-Suzan jig. Use of the multiple jig saves time and has incentive value—the worker gets satisfaction out of seeing a number of completed units. Units come off the jig all at once after the last operation on each of them

(Continued on p 272)

it takes two

DISPLAY ADVERTISING

- AROUSES INTEREST
- CREATES PREFERENCE

DIRECT MAIL

- GETS PERSONAL ATTENTION
- TRIGGERS ACTION.

After your prospect has been convinced by DISPLAY ADVERTISING, he still must take one giant step. *He must act.* A personalized mailing piece direct to his desk, in conjunction with a display campaign, is a powerful action getter.

McGraw-Hill has a Direct Mail Division ready to serve you with over 150 specialized lists in the Industrial Field.

To get your copy of our free INDUSTRIAL DIRECT MAIL CATALOGUE (1954) containing complete, detailed information about our services, fill in the coupon below and mail it to McGraw-Hill.

Do it now! The best advertising programs are planned well in advance.

Direct Mail Division,
McGraw-Hill Publishing Co., Inc.
330 West 42nd St., N. Y. 36, N. Y.

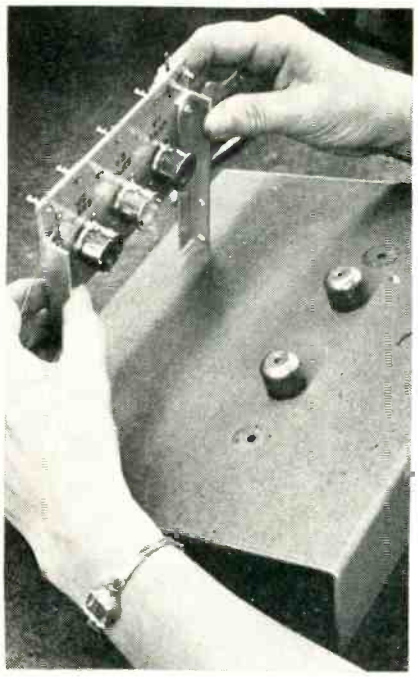
Please forward my free copy of the McGraw-Hill "Industrial Direct Mail Catalogue."

NAME_____

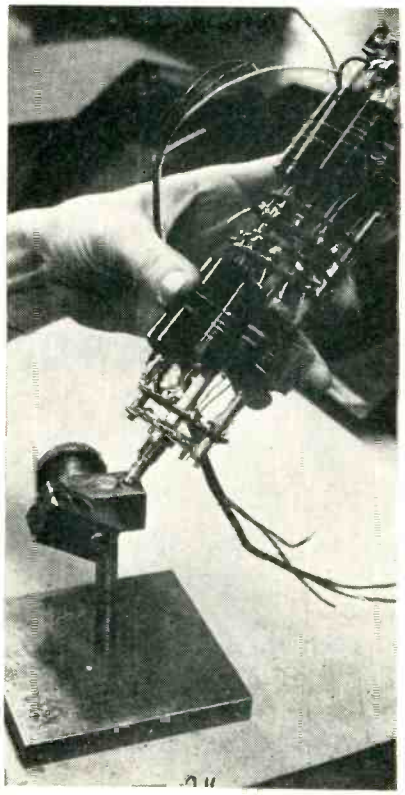
COMPANY_____

ADDRESS_____

CITY_____ STATE_____



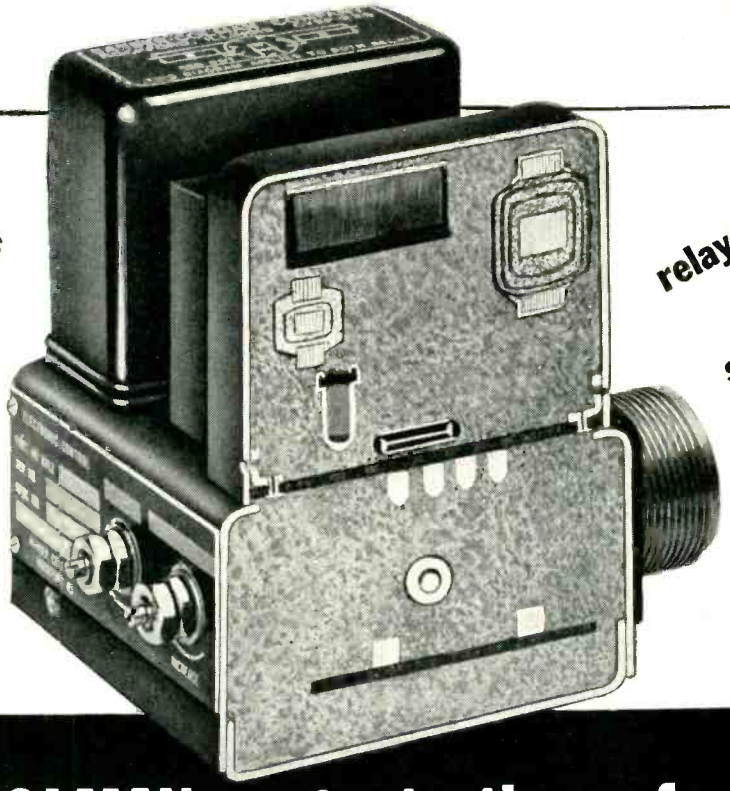
A single-purpose jig mounts two studs for quick positioning of a subassembly for a high-frequency oscillator circuit. Shielded tube socket bases in the assembly are used as holding fixtures. Note that studs were previously mounted farther apart for a larger assembly



This turret switch fabrication jig at a soldering station is adjustable two ways, vertically and radially and has three different sizes of holes to hold different switches

(Continued on p 274)

What's inside this Aircraft Temperature Control?...



resistors

transformers

potentiometers

capacitors

relays

sub-miniature vacuum tubes

radio noise filter

BARBER-COLMAN protects these from shock, vibration, humidity with NOPCO® LOCKFOAM

Barber-Colman Company, Rockford, Ill., is well known for its varied line of aircraft temperature and positioning control systems, actuators, air valves, and other accessory equipment. In designing the electronic temperature control shown here, they required a potting material to protect the fragile components and the connecting wiring. It was necessary that the material be both light and strong, have good electrical insulation properties, and be impervious to salt spray and humidity. Curing temperature was not to exceed 250° F., and after curing had to withstand ambient temperatures up to 220° F.

Their search for the right material ended when they tried one of the 50 different formulations of Nopco Lockfoam. "By using Nopco Lockfoam as the potting material," states Barber-Colman, "we were able to meet environmental operating requirements with an economy in manufacturing and assembly time."

These properties of Nopco Lockfoam are finding new applications almost daily—and they are by no means limited to electronics or aviation. Since Nopco Lockfoam is poured-in-place, it exactly fills the configurations you wish to fill. It is consistent and reproducible.

One of the many formulations of Nopco Lockfoam may be the means of improving some product of yours, or even of bringing into being a product that so far exists only on your drafting board. Send for the free informative booklet today.

Plastics Division

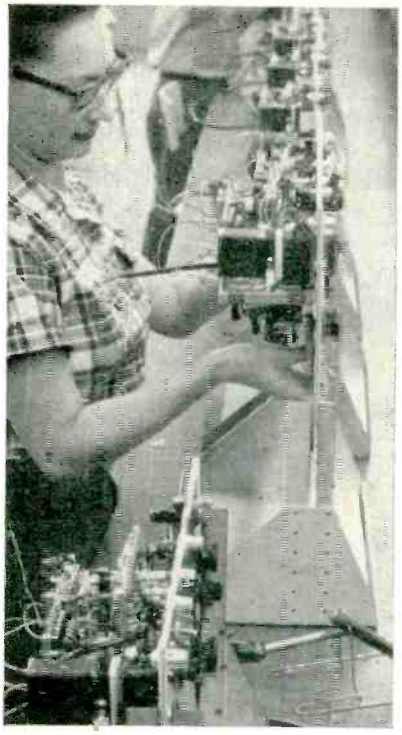
NOPCO

CHEMICAL COMPANY

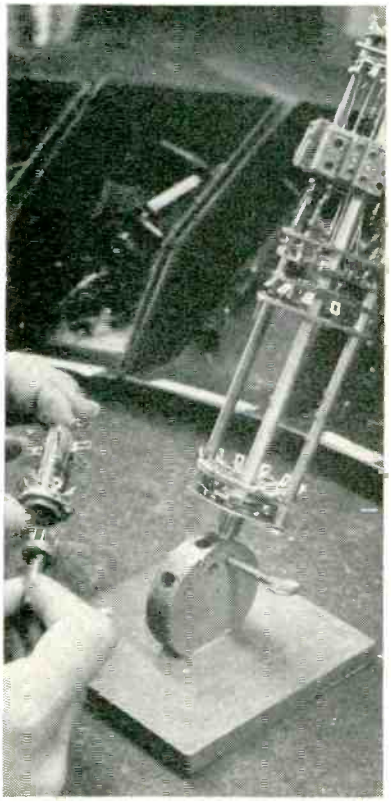
Harrison, New Jersey

4858 Valley Blvd., Los Angeles 32, Calif.

NOPCO TRADEMARK EVOLVED THRU RESEARCH



Panel jigs here hold subassemblies for pulse generators. Panel rests in groove on stop bolt in one set of a series of holes, making the jig adjustable vertically. The back supports of the jigs are covered with a vinyl tape to protect the painted surface of the panels



Simple metal jig for switch fabrication offers only three steps of radial adjustment. The worker holds a fitting which enables this jig to serve also for tube socket turret fabrication

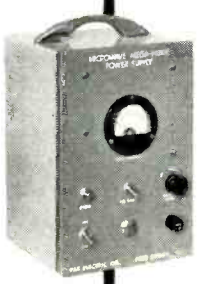
(Continued on p 276)

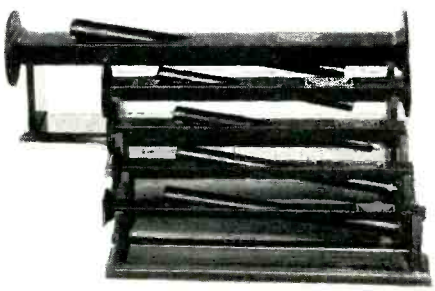
A COMPLETE LINE of calibrated random NOISE SOURCES

- FREQUENCY RANGE FROM 5 to 26,500 mc.
- MEASURE NOISE FIGURE AND RECEIVER GAIN

Microwave Mega-Nodes
NOW AVAILABLE WITH NEW GAS TUBES... INDEPENDENT OF OPERATING TEMPERATURE

NOISE sources provided in 8 waveguide sizes



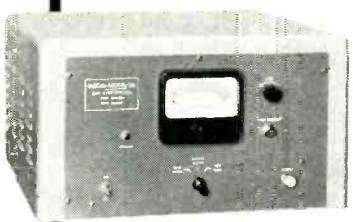


In addition to the fluorescent tubes, new type gas tubes are also available. These new gas tubes eliminate the necessity of correcting for temperature variations.

MICROWAVE MEGA-NODE SPECIFICATIONS

Waveguide Sizes	Frequency (mcs.)
RG-69/U	1,200— 1,400
RG-48/U	2,600— 3,900
RG-49/U	3,950— 5,850
RG-50/U	5,850— 8,200
RG-51/U	7,050—10,000
RG-52/U	8,200—12,400
RG-91/U	12,400—18,000
RG-53/U	18,000—26,500

NOISE OUTPUT (all guides): 15.8 db.
ACCURACY: To ±0.25 db.
EQUIPMENT SUPPLIED: Power supply, fittings, power cables, instruction manual.
PRICE:
Single waveguides (with either gas tube) RG-48/U, RG-49/U, RG-50/U, RG-51/U or RG-52/U $195.00
Power Supply for any of above (for use with waveguides using fluorescent tubes).....$100.00
Power Supply for any of above and RG-69/U guide (for use with new gas tube).....$150.00
RG-69/U (L-Band) waveguide (with either gas tube $400.00
Power Supply (for use with fluorescent tube) for RG-69/U guide $120.00
Set consisting of standard power supply and one each of the following waveguides: RG-48/U, RG-49/U, RG-52/U $600.00
Prices are f.o.b. factory



MEGA-NODE SR. SPECIFICATIONS:

FREQUENCY RANGE: 10 mc to 3000 mc.
OUTPUT IMPEDANCE: 50 ohms unbalanced into Type N Connector.
NOISE FIGURE RANGE: 0 to 20 db.
METER CALIBRATION: Linear in DB Noise Figure.
Logarithmic in DC. MA.
PRICE: $995.00 f.o.b. factory.

MEGA-NODE SPECIFICATIONS:

FREQUENCY RANGE: 5 to 220 mc.

OUTPUT IMPEDANCES:
Unbalanced: 50, 75, 150, 300, Infinity
Balanced: 100, 150, 300, 600, Infinity

PRICE: $295.00 f.o.b. factory.

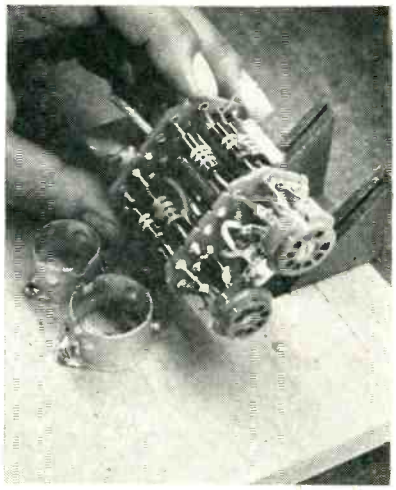
NOISE FIGURE RANGE:
0 to 16 db at 50 ohms
0 to 23.8 db at 300 ohms

METER CALIBRATION:
Linear in DB Noise Figure
Logarithmic in DC. MA.

Write for NEW CATALOG

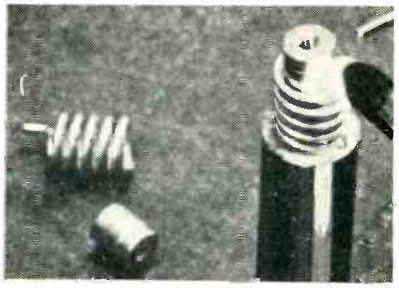
KAY ELECTRIC COMPANY
14 Maple Avenue Pine Brook, N. J.
CAldwell 6-4000

PRECISION TEST AND MEASURING INSTRUMENTS FOR LABORATORY, PRODUCTION AND FIELD



Two-position jig holds discriminator unit for soldering. Bakelite wafers in unit rest in grooves at back of jig for one work position. Unit is then upended and sockets slipped into tube shield cans for further assembly work

This jig lines up coils and terminations to be soldered together before plastic molding. A Wyse arc-melt soldering unit (Wyse Labs, Dayton, Ohio) is used, with one graphite electrode and one clip attached to the metal jig

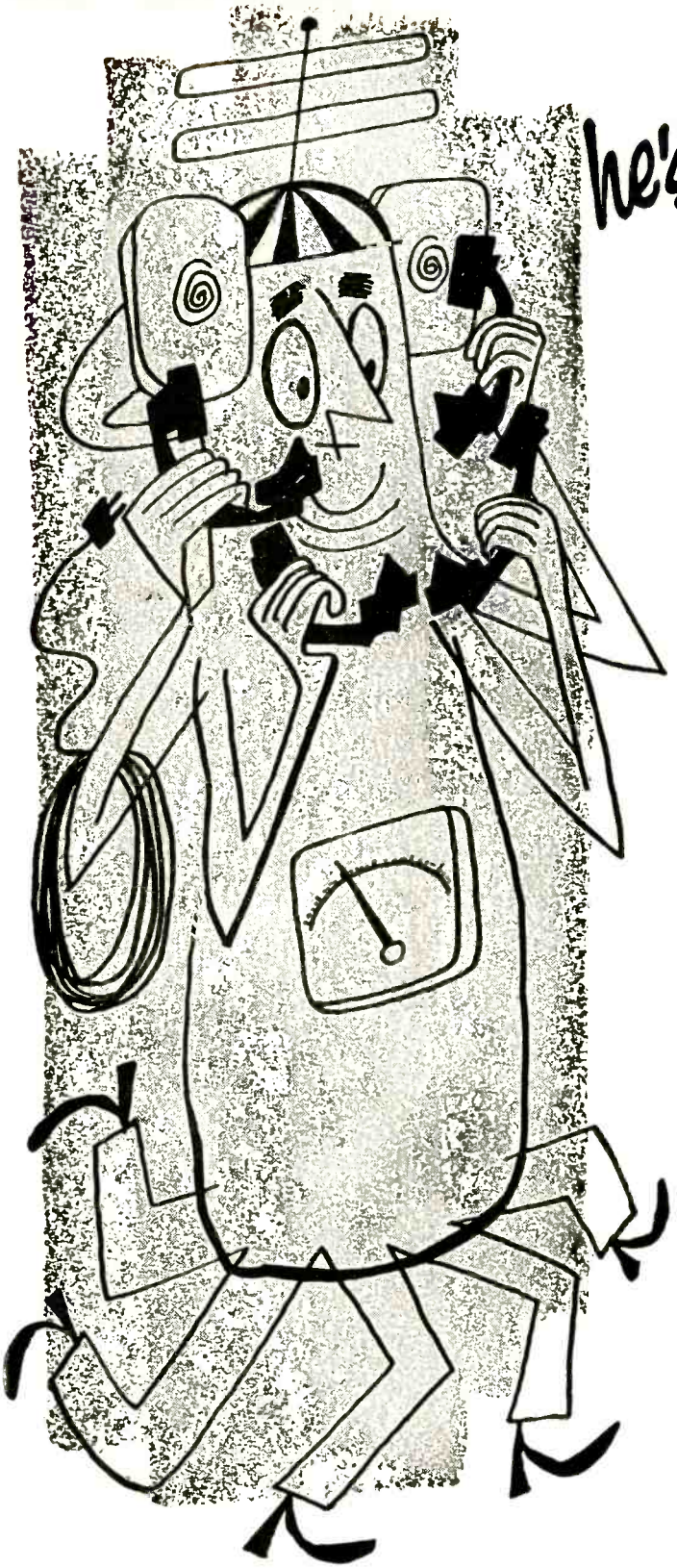


Closeup of coil terminal soldering with graphite electrode

runs are often relatively short.

For the shortest runs, the company has found that a simple vise suits its needs well. Sometimes it is satisfactory even on long runs, especially when adapted for the job —by the addition of a slanted panel, for instance.

Some components are handled in



he's working for you

THIS FELLOW IS TRAINED IN YOUR BUSINESS. His main duty is to travel the country — and world — penetrating the plants, laboratories and management councils . . . reporting back to you every significant innovation in technology, selling tactics, management strategy. He functions as your all-seeing, all-hearing, all-reporting business communications system.

THE MAN WE MEAN IS A COMPOSITE of the editorial staff of this magazine. For, obviously, no one individual could ever accomplish such a vast business news job. It's the result of many qualified men of diversified and specialized talents.

AND, THERE'S ANOTHER SIDE TO THIS "COMPOSITE MAN," another complete news service which complements the editorial section of this magazine — the advertising pages. It's been said that in a business publication the editorial pages tell "how they do it"—"they" being all the industry's front line of innovators and improvers — and the advertising pages tell "with what." Each issue unfolds an industrial exposition before you—giving a ready panorama of up-to-date tools, materials, equipment.

SUCH A "MAN" IS ON YOUR PAYROLL. Be sure to "listen" regularly and carefully to the practical business information he gathers.

McGRAW-HILL FOR BUSINESS

McGRAW-HILL PUBLICATIONS

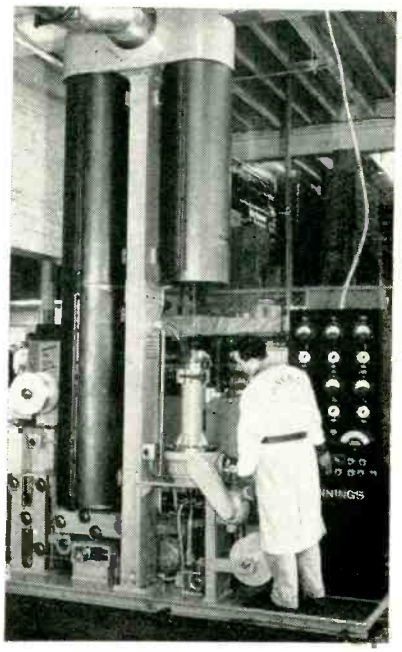
sufficient quantity to justify the building of jigs that do only one job. However, most components are subject to minor changes, even if they stay relatively stable in form. For these the jigs are flexible, fitted with screws or pegs so that the components or assemblies they hold may vary in size and may be worked on from varying angles. Examples of all types are shown in the accompanying illustrations.

Teflon Extruder for Wire

AUTOMATIC equipment for extruding Teflon (tetrafluorethylene resin) around stranded or solid wire in sizes ranging from No. 12 to No. 26 Awg has been developed by Jennings Engineering Inc., Philadelphia, Pa. Dies and wire guide components must be changed to accommodate different wire sizes. Speed and heat flexibility are adequate for this range of sizes.

The machine is now being used both by wire processors and by electronic equipment manufacturers that would normally buy their own insulated wire.

For any particular wire, the thickness of a coating can be varied with any one die by adjusting the ratio between wire speed and extruding speed and by adjusting the heaters. Greater variations in



Machine setup for applying Teflon insulation to bare wire

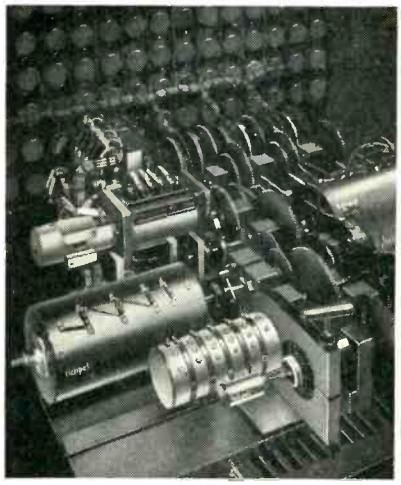
thickness are obtained by changing dies.

Spaghetti tubing and certain sizes of beading can also be run through for addition of Teflon insulation. Even tape can be handled.

Once the correct dies have been installed, operation is entirely by pushbutton control. The bare-wire supply wheel is at the front of the machine near the floor, and the takeup wheel is higher at the rear. The sintering oven and vaporizing oven are mounted vertically and extend up approximately 14 feet. The ovens require venting with a 12-inch circular furnace pipe.

Linearity Tester for Precision Potentiometers

AN ULTRASENSITIVE recording linearity tester in use at Helipot Corp., South Pasadena, California, equates potentiometers under test against



Linearity test setup, with master pot at right and pots under test at left foreground. Trim pots are on panel at rear

the master precision potentiometer. Trim potentiometers in the tester are preset to insert voltage in series with the master pot at 360 points.

The master potentiometer is linear within 0.01 percent, having been checked against a Leeds and Northrop voltage divider which is accurate within 0.001 percent. Through the inclusion of the trim pots in the master circuit, the tester is made accurate within 0.003 percent. Intricate gear-trains drive the sliders of the potentiometers under test—whether they be single-turn models or 3, 10, 15, 25 or 40-turn-units—in phase with a 40-turn master potentiometer.

It's always a good spring

WHEN YOU USE BRIDGEPORT PHOSPHOR BRONZE♦

In any season, electrical parts made from Bridgeport Phosphor Bronze (Alloys 35 and 36) retain their resiliency and high flexural strength, year after year. They also resist corrosion and wear due to the inherent characteristics of these Bridgeport Alloys, and their excellent electrical properties help improve the operating efficiency of the parts.

To use the advantages of Bridgeport Phosphor Bronze for your parts, and for prompt service on your metal needs, call your nearest Bridgeport Sales Office.

♦ *One of the many Bridgeport Metals with High I.Q. (Inner Quality) for economical fabrication and improved products.*

BRIDGEPORT BRASS COMPANY ♦ BRIDGEPORT, CONNECTICUT

Bridgeport

Serving Industry with a Nationwide Network of Conveniently Located Sales Offices and Warehouses
Mills in Bridgeport, Conn, Indianapolis, Ind., and Adrian, Mich.
In Canada: Noranda Copper and Brass Limited, Montreal

NEW PRODUCTS

Edited by WILLIAM P. O'BRIEN

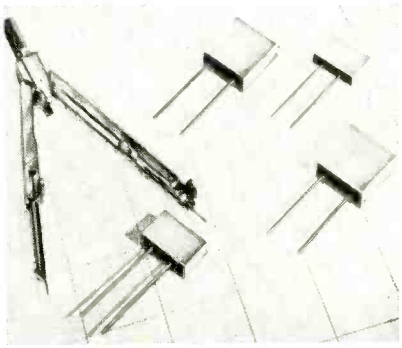
60 New Products and 41 Manufacturers' Bulletins Are Reviewed . . . Control, Testing and Measuring Equipment Described and Illustrated . . . Recent Tubes and Components Are Covered

OTHER DEPARTMENTS featured in this issue:

MICA CAPACITOR

is tiny encapsulated unit

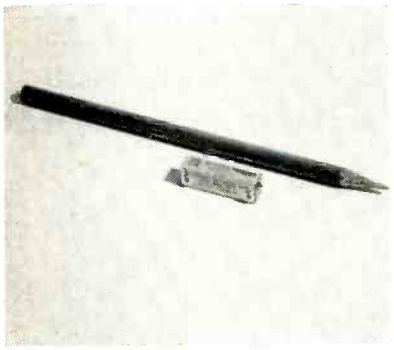
CORNELL-DUBILIER ELECTRIC CORP., South Plainfield, N. J., has developed a new style of midget mica capacitor in the form of an encapsulated unit. The capacitor section is separately processed in its entirety and then inserted and sealed into a premolded case. The Super Micadon will house 5 to 6 times the capacitance now possible in CM-20 and CM-30 cases. Two sizes are available. Type 5A is 51/64 in. × 15/32 in. × 7/32 in., type 1A is 53/64 in. square × 9/32 in. In a 4,000-hour life test at twice rated



voltage) 76 percent of conventional capacitors failed, compared to only 4 percent failure for the Super Micadons. In rigorous humidity tests the new capacitors revealed a moisture resistance of nearly 20 times conventional types, while insulation resistance ranged from 10 times higher at room temperature to 35 times higher at + 120 C. They are designed with flat, clinched wire leads giving improved voltage breakdown safety and enabling overall inductance to be reduced by 30 percent over ordinary types.

TRIMMER POTS

have rugged construction

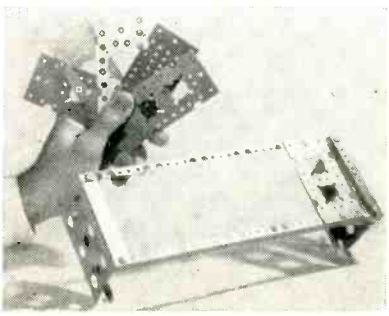


TECHNOLOGY INSTRUMENT CORP., Acton, Mass. Now infinite resolution is available in miniature trimmer potentiometers with a wide range of total resistance values. The type RFT Metlfilm trimmer embodies a unique deposited metal resistance element. A 90-deg turn of the drive screw results in an approximate voltage change of 1 percent of the applied voltage. The diminutive size of the type RFT makes it ideal for trimming adjustments in computers, analyzers, telemeter and airborne electronic equipment of high component density. They are available in standard resistance values ranging from 50 to 25,000 ohms ± 10 percent. Power dissipation is rated at 0.5 w at 40 C, 0.25 w at 125 C, derated to 0 at 100 C. The operating ambient temperature range is from −55 C to + 100 C. The deposited metal resistance element has a nominal temperature coefficient of 0.00025 per deg C.

BREADBOARD CHASSIS

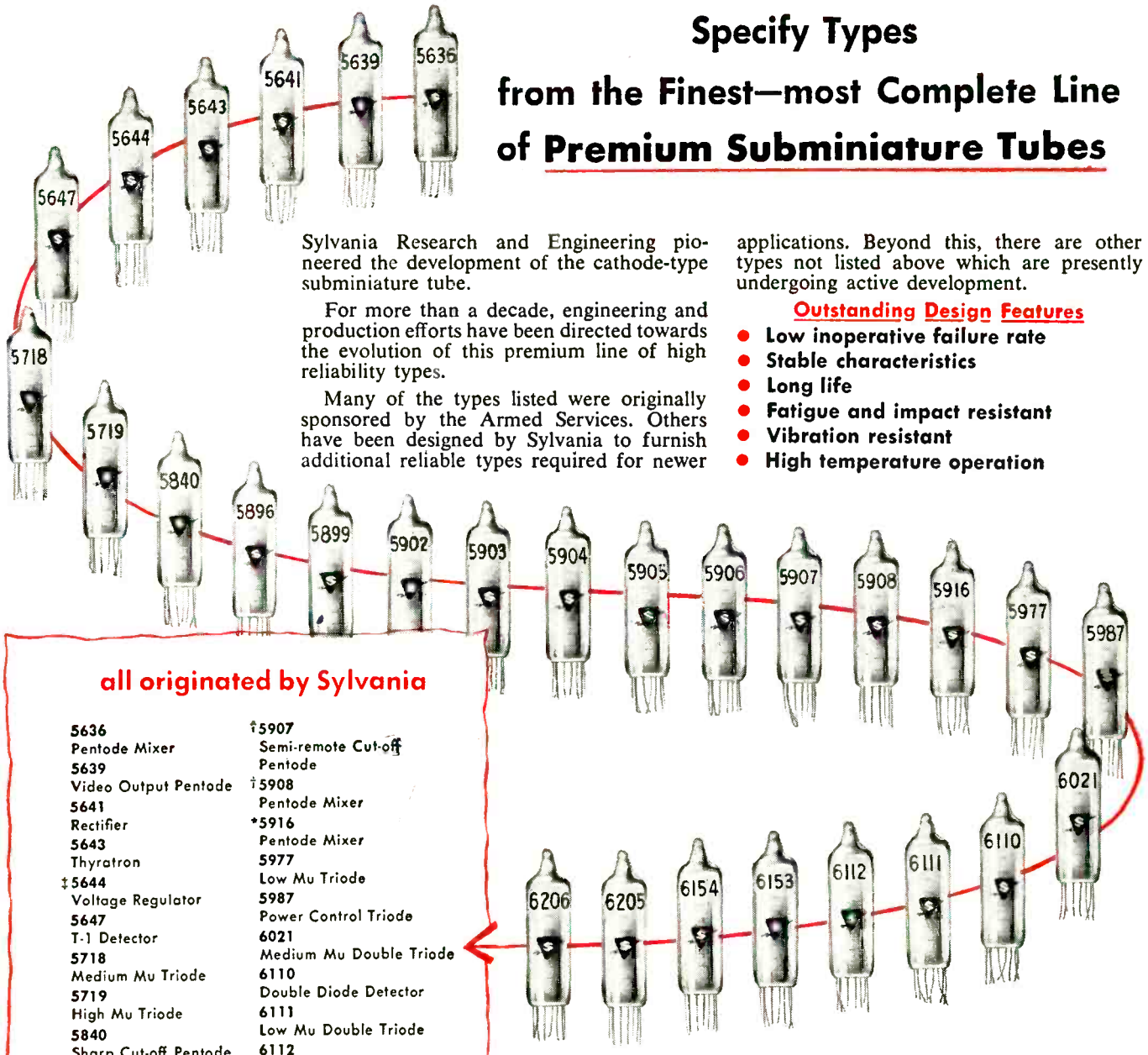
for circuit development

ALLEN B. DUMONT LABORATORIES, INC., 750 Bloomfield Ave., Clifton, N. J., has available a universal circuit breadboard chassis. The breadboard and its component parts greatly reduce circuit construction time and accommodate a complete variety of components without the need for a single power tool. It promotes neat wiring both above and below the chassis, facilitates rapid modifications on circuit components, simplifies circuit layout and provides prototype wiring for



FOR YOUR EQUIPMENT-

Specify Types from the Finest—most Complete Line of Premium Subminiature Tubes



Sylvania Research and Engineering pioneered the development of the cathode-type subminiature tube.

For more than a decade, engineering and production efforts have been directed towards the evolution of this premium line of high reliability types.

Many of the types listed were originally sponsored by the Armed Services. Others have been designed by Sylvania to furnish additional reliable types required for newer applications. Beyond this, there are other types not listed above which are presently undergoing active development.

Outstanding Design Features

- **Low inoperative failure rate**
- **Stable characteristics**
- **Long life**
- **Fatigue and impact resistant**
- **Vibration resistant**
- **High temperature operation**

all originated by Sylvania

5636
Pentode Mixer
5639
Video Output Pentode
5641
Rectifier
5643
Thyratron
‡**5644**
Voltage Regulator
5647
T-1 Detector
5718
Medium Mu Triode
5719
High Mu Triode
5840
Sharp Cut-off Pentode
5896
Double Diode Detector
5899
Semi-remote Cut-off Pentode
5902
Audio Power Pentode
*__5903__
Double Diode Detector
†**5904**
Medium Mu Triode
†**5905**
Sharp Cut-off Pentode
†**5906**
Sharp Cut-off Pentode
†**5907**
Semi-remote Cut-off Pentode
†**5908**
Pentode Mixer
*__5916__
Pentode Mixer
5977
Low Mu Triode
5987
Power Control Triode
6021
Medium Mu Double Triode
6110
Double Diode Detector
6111
Low Mu Double Triode
6112
High Mu Double Triode
6153
Sharp Cut-off Pentode Low Cgp (Separate suppressor)
6154
Remote Cut-off Pentode Low Cgp (Separate suppressor)
6205
Sharp Cut-off Pentode (Separate suppressor)
6206
Semi-remote Cut-off Pentode (Separate suppressor)

‡6308 Voltage Reference Tube.

*26-volt heater †26 volts all elements ‡Cold Cathode Type
All other types are 6.3 volt heaters.

For complete data sheets and specifications concerning any of the above tube types and for application information, see your Sylvania Sales Engineer or write to: Sylvania Electric Products Inc., Dept. 4R-1609. 1740 Broadway, New York 19, N. Y.

SYLVANIA

LIGHTING • RADIO ELECTRONICS TELEVISION

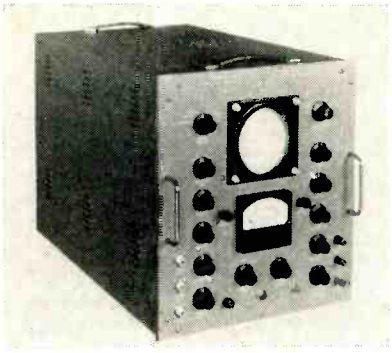
In Canada: Sylvania Electric (Canada) Ltd., University Tower Bldg., St. Catherine St. Montreal, P. Q.

the design of printed circuits. The universal breadboard consists of a chassis frame and an assortment of phenolic subchassis which can be mounted with speed and convenience. The cadmium plated chassis frame is 4 in. wide, 12 in. long and 3 in. high, mounted together with 6-32 self-tapping screws. End brackets of the frame have a series of ⅛-in. holes to accommodate regular and miniature potentiometers, fuses and switches. Chassis frames may be tiered, mounted side-by-side, or end-to-end by means of self-tapping screws to accommodate construction of large circuits.

SYNCHROSCOPE

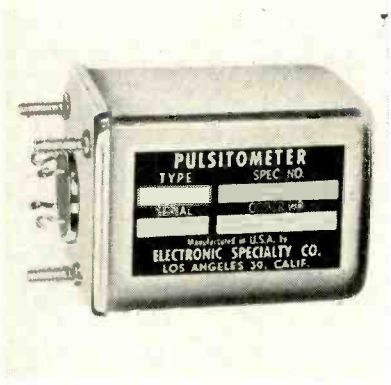
has five major improvements

T. L. G. ELECTRIC CORP., 31 W. 27th St., New York 1, N. Y. Model C-04 synchroscope represents a significant redesign of the P-5 synchroscope. New circuits have resulted in five major improvements: much faster writing rate (0.05 μsec per in.), much higher vertical channel frequency response (600 mc without resonance or distortion) much greater stability (drift is less than 0.4 percent per month), greatly increased calibration accuracy (distortionless comparison to d-c without removing pattern from screen, against 0.5 percent hand-calibrated Weston meter), and a new stiffer and faster trigger output (directly firing any hydrogen thyratron up to the 5C22). Shielding and geometry of the input circuit permit use of the model C-04 in close proximity to the 40-megawatt pulsers. Characteristics of the C-04 meet or exceed the most recent SCEL memorandum on synchroscope improvement for radar pulse observation.



TIME DELAY RELAYS

for airborne applications

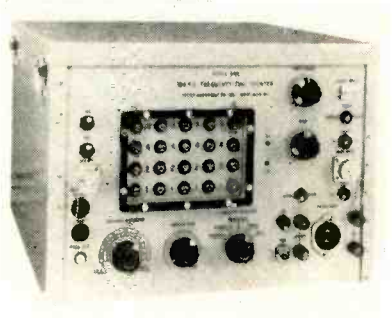


ELECTRONIC SPECIALTY CO., 3456 Glendale Blvd., Los Angeles 39, Calif., has introduced a new line of time delays relays designed for airborne applications where an accurate, reliable and vibration resistant time delay or time pulse is required. They utilize a very rugged and reliable relay in conjunction with a resistor-capacitor circuit. Dimensions are 1 5/8 in × 1 7/16 in. × 2 1/4 in. and weight is 6 1/2 oz. The relays are contained in hermetically sealed enclosures filled with inert gas and operate over the range of 18 to 30 v d-c. They feature quick recycling time, long life (500,000 cycles minimum), 5-ampere resistive load contact rating, and they meet applicable Air Force environmental requirements. They are available with factory set timing period from 15 to 500 milliseconds, with normally closed or normally open contacts, one to four pole, single throw or double throw, and various bases, including miniature tube plug-in and solder terminals.

COUNTER

measures frequency and time

POTTER INSTRUMENT CO., INC., 115 Cutter Mill Road, Great Neck, N. Y. Model 3149 is a general-purpose instrument for making direct frequency and time measurements under field conditions with laboratory type accuracy and complete reliability. Gold-plated switch contacts and JAN components are used throughout. Direct measurement of frequency up to 150 kc is provided by means of 5 electronic counter decades that count the cycles of the unknown for an exact crystal-controlled interval of time.



Low frequencies are measured by counting time-base pulses occurring during 1 or 10 cycles of the unknown. Time intervals may be measured to the nearest 0.00001 second. The instrument also serves as a secondary frequency standard and as a totalizing counter.

PRECISION RESISTORS

in grouped type

OHMITE MFG. CO., 3664 Howard St., Skokie, Ill., has announced a new grouped model of the Riteohm encapsulated precision resistors. The units are made up from 2 to 6 individual, lug-type Riteohm resistors, arranged end-to-end in a one-piece, molded resin body. A special resin

The security of experience. Pyramid has more experienced personnel in years of actual designing and manufacturing of capacitors than any other manufacturer.

The advantage of leadership. Pyramid supplies capacitors to all leading TV set manufacturers, and to *ALL* Branches of Government. Being so close to initial product developments, the design engineer, purchasing agent and production man benefit by new developments in the Pyramid line.

The control of specially designed facilities. Pyramid is the only manufacturer of capacitors whose plants were planned and built specifically for the entire manufacturing process of capacitors from drawing board conception through reception of raw materials, fabrication, packaging and shipment.

what is available from Pyramid

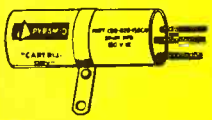
commercial
MIL-SPEC
capacitors

The guarantee of one standard. All Pyramid capacitors are one quality, made of the same quality materials demanded by rigid military specifications. Pyramid capacitors have a low leakage factor due to the non-hygroscopic insulating material used on all production. Pyramid delivers the best at no premium.

A complete line of capacitors—full ranges in all ratings and types.

ELECTROLYTICS


Type TD, TDL,


Type CDB


Type MC


Type TM


Type DO

PAPER

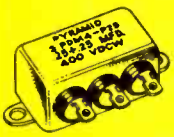

Type 85LPT


Type PTIM, CP 25


Type PG "Glasseal," CP04, TOCP11


Type CT


"IMP" Molded


Type PDM, CP 53

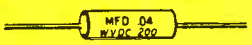

Type PEM, CP 67, CP 69


Type PKM, CP61 to CP65


Type PLMF, CP70


Type PJ, CP70

METALLIZED PAPER


Type MT

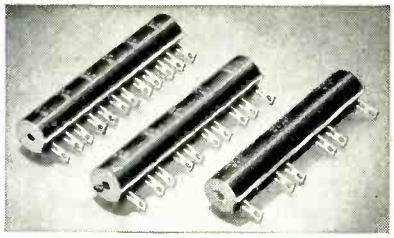

Type MPD


Type MPT

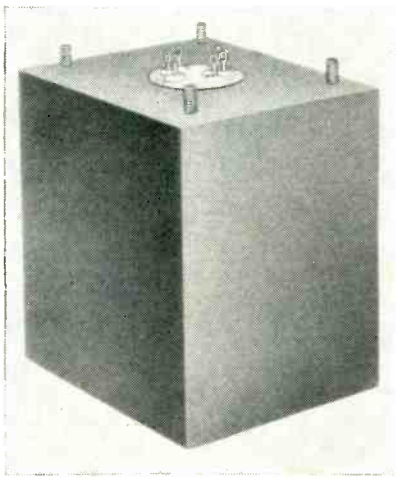

Type MGO

Burton browne advertising

PYRAMID ELECTRIC COMPANY 1445 HUDSON BOULEVARD • NORTH BERGEN, N. J., U.S.A.



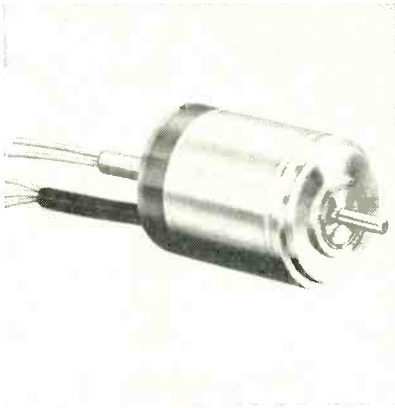
completely encloses the individual resistors and gives maximum protection against mechanical damage and ambient conditions. The coefficient of expansion of the resin closely matches that of the other materials of the unit. The grouped Riteohms are available in lengths up to approximately 3 in. The individual resistor units in the group can be obtained in wattage sizes of ¼, ½ and 1 w (125 C ambient), and in resistance values up to a maximum of 1,950,000 ohms. Tolerances as close as ±0.1 percent are available. Descriptive bulletin No. 145 gives full details.



MAGNETIC AMPLIFIER features 1-cycle response

POLYTECHNIC RESEARCH & DEVELOPMENT CO., INC., 202 Tillary St., Brooklyn 1, N. Y. The R6G10W1 magnetic amplifier is ideally suited, without need of a preamplifier, for many medium performance indicating or position type servomechanisms. Though the addition of a simple preamplifier, it may be employed in the most accurate and demanding type of control systems. Design of the unit for 1-cycle response assures the widest possible bandwidth consistent with the use of 60 cps as the power supply frequency and thus reduces many of

the stabilization problems formerly encountered when incorporating magnetic amplifiers in servomechanisms. The type R6G10W1 delivers 10 w reversible phase output for reversible phase a-c or reversible polarity d-c input.

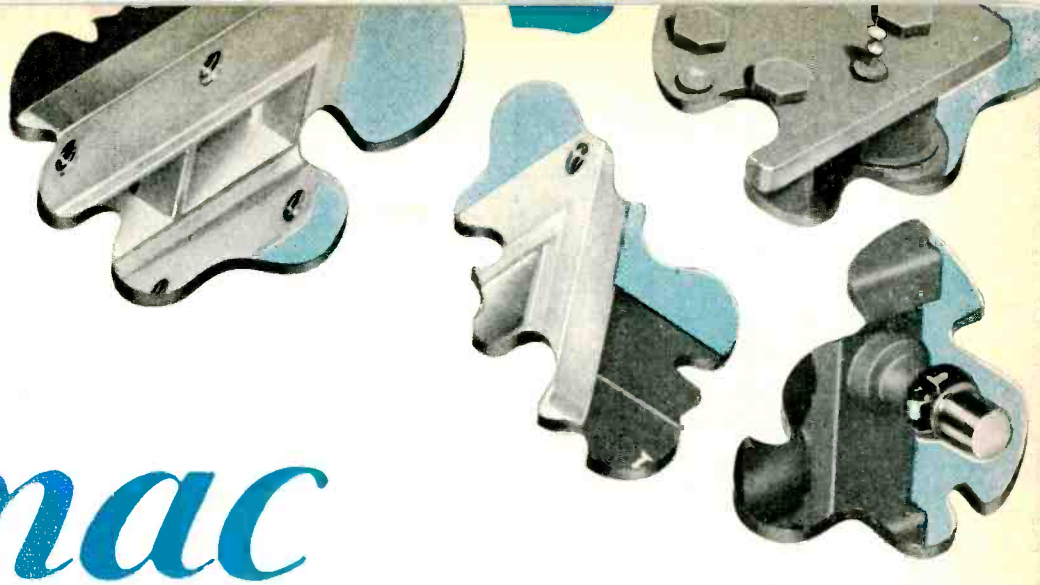


SYNCHROS
feature high accuracy

CLIFTON PRECISION PRODUCTS CO., INC., Marple at Broadway, Clifton Heights, Pa., has developed a new series of size 10 synchros. These units feature accuracies available before only in much larger units. Maximum diameter is 0.937 in. and maximum overall length is 1.281 in. Weight is 1.8 oz. The synchros are available with 12-in. leads, with radial terminals or with axial terminals. Cast stator and clamped bearing race construction insure lifetime alignment and accuracy. Dielectric insulation between the windings and case is rated in excess of 550 v a-c. The units are available in the following types: signal generators, repeaters, control transformers, high impedance control transformers, control differentials, resolvers and sine-cosine generators.

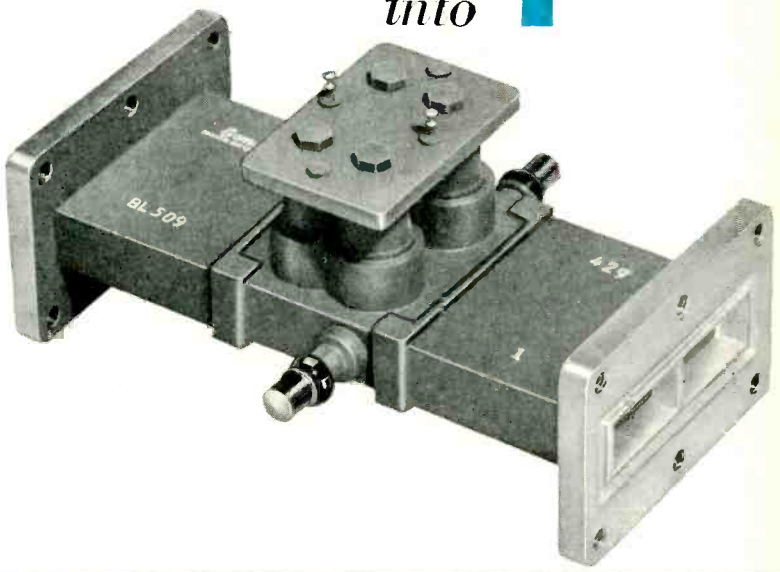
D-C POWER SUPPLIES
are voltage regulated

ASSOCIATED SPECIALTIES CO., 1751 Main St., Orefield, Pa. Model I electronically regulated constant



Bomac

combines 4 COMPONENTS *into* 1



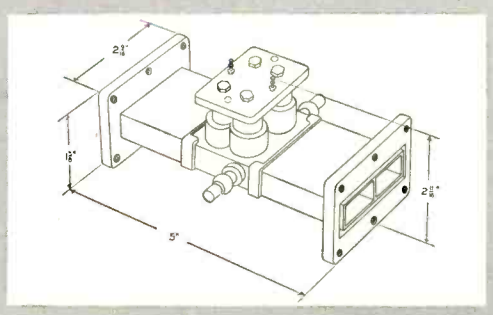
A complete **Duplexer** **NOW** *in One Compact Unit*

For the first time, Bomac offers to the electronic industry a complete duplexer as a single component . . . the **BL-509.**

Combining (1) a Bomac TR tube having (2) integral shutters, with (3,4) two hybrid junctions, the BL-509 eliminates the necessity of specifying these components separately. Light weight and compact, it also assures superior electrical performance and mechanical strength.

This duplexer may be fabricated to customer's configurations.

DIMENSIONS



RATINGS

Shutter Holding Current	0.060 amp
Shutter Operating Current	0.280 amp
Shutter Operating Voltage	28 V.
Ignitor Current	100-200 μ Adc
Ignitor Interaction, 100 μ Adc (max.)	0.1 db
Voltage Drop, 100 μ Adc	200-375 Vdc

CHARACTERISTICS

Duplexer Loss (max.)	1.2 db
Arc Loss (max., at 4 KW)	0.6 db
Spike Leakage (at 40 KW)	0.1 erg
Flat Leakage (at 40 KW)	20 MW
Bandwidth	8490-9578 MC
Center Frequency	9000 MC
Recovery Time (at 200 KW)	7 μ sec.
Shutter Attenuation (min.)	40 db
Isolation	20 db min. at center, 15 db min. at ends

We invite your inquiries regarding

- ENGINEERING
- DEVELOPMENT
- PRODUCTION

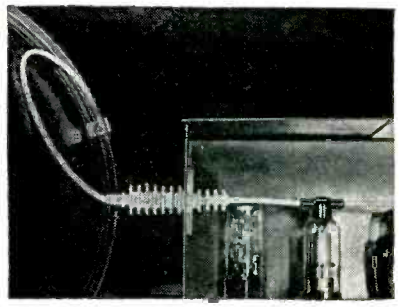
Bomac Laboratories, Inc.

BEVERLY, MASSACHUSETTS

GAS SWITCHING TUBES · DIODES · HYDROGEN THYRATRONS · DUPLEXERS · MAGNETRONS
MODULATORS · CAVITIES

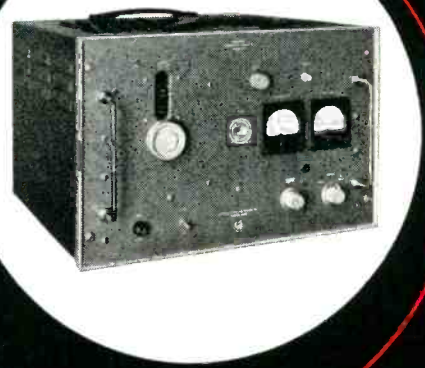
Catalog on request. Write (on your company letterhead) Dept. E-9 BOMAC Laboratories, Inc. Beverly, Mass.

voltage power supplies have a d-c output voltage continuously variable from 200 to 325 v for load currents of 0 to 100 ma. Ripple output is less than 10 mv rms. Both positive and negative sides of the output are isolated from ground. Either side may be grounded or the output may be left floating. An isolated a-c voltage of 6.3 v at 3 amperes is available at the output terminal connections. All input and output connections are made to a single terminal strip conveniently located on the rear of the chassis. Weight of the unit is about 20 lb. Price is $56.



CONNECTOR CABLES are integrally molded

ALDEN PRODUCTS CO., 117 North Main St., Brockton 64, Mass., has developed a new cabling technique making it possible to mold several cable connector components into one integral unit by molding the connectors right onto the wire insulation. The cost is low, space is saved and the problems of strain relief, wire insulation pull back, wire fatigue under vibration and h-v arc over at wire holes are eliminated. Very compact designs are possible because of a homogeneous body of insulation molded right around the contacts and leads. A minimum of material is required by eliminating the need for long leakage paths at the wire joints. The h-v potential sources are sealed into the insulating jacket greatly reducing the problems of corona suppression and shielding. Developed for color tv, these integrally molded cables have a wide field of application in other areas, such as h-v power supplies, h-v rectifier circuits in such equipment as radar, transmitters and x-ray. Illustrated is an integrated cable tailored to



Ultra-stable Microwave Oscillator

LFE Model 804 X-band Microwave Oscillator holds frequency to 1 part in 100,000,000, giving you *real* stability. It is the oscillator you need for VSWR or Q measurements, general narrow band design work, or any application where a high degree of stability is required.

This same stability is available in C-band as well as X-band oscillators and in other microwave frequencies to meet your specifications.

SPECIFICATIONS: (Model 804)

Frequency Coverage
8,500 — 10,000 Mc-X-Band

Dial Calibration
Calibrated directly in frequency — 1 Mc per division

Frequency Stability
Short Term Deviation — less than one part in 10^8
Long Term Drift — negligible after complete warm-up

Modulation
Can be modulated 25% when stabilized; 100% modulation possible when stabilization is removed

Power Output
80 — 100 milliwatts
Output flange — UG 40/U

Power Consumption
160 watts

Size
12 7/32" x 19" front panel, 19 1/4" deep, cabinet or rack mounting

Weight
100 lbs.

L/E ®

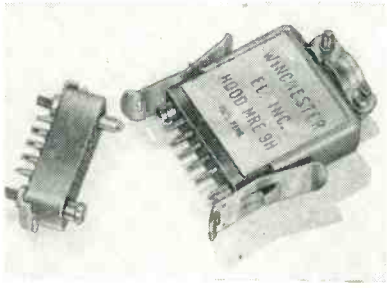
LABORATORY for ELECTRONICS, INC.
75 Pitts Street • Boston 14, Mass.

PRECISION ELECTRONIC EQUIPMENT • OSCILLOSCOPES • NUMAR CHEMICAL SPECTROMETER • COMPUTERS • SOLID DELAY LINES

customers' specifications for 20,000-v anode power supply — made up from "in line" tube cap, h-v disconnect and anode clip.

SOUND PROBE
weighs less than 5 lb

THE GEL-ME CO., P. O. Box 293, Bloomington, Ill., announces the electronic sound probe, a scientific instrument that changes vibrations into electrical energy, multiplies sound volume and transmits directly into earphones. The compact tool enables users correctly to diagnose and locate trouble spots in any mechanically operating piece of equipment. The instrument comes complete with tubes and batteries. A four-page folder now available points out the unit's many applications.



VIBRATION LOCK
for electrical connectors

WINCHESTER ELECTRONICS, INC., Glenbrook, Conn., has designed a new vibration lock that locks automatically by simply engaging the mating connector parts. Simplicity of operation is the outstanding design feature and time-consuming, troublesome lock screws have been eliminated. Quick unlocking action is achieved merely by depressing the extended lever arms and requires no additional handling operation than is normally encountered when disengaging the plug and receptacle connectors. Spring-action

FREED MAGNETIC AMPLIFIERS

Series MAHS

Designed for

Aircraft and Guided Missile Control Systems

DRIFT-FREE & RELIABLE AT 200° C

The MAHS series of FREED MAGNETIC AMPLIFIERS is characterized by:

- Reliable operation in ambient temperatures up to 200°.
- Fast response—2 cycles of power frequency delay for 100% response to step input signal.
- Phase reversible A.C. output with ZERO DRIFT OF NULL POINT.

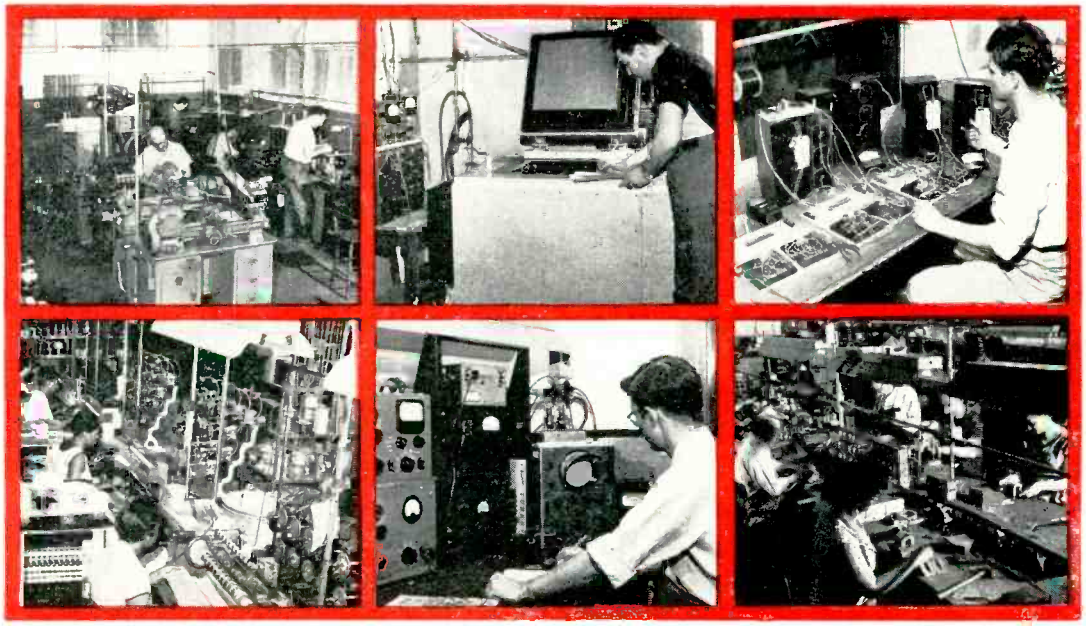
The MAHS series includes the units described below. Engineering and development facilities are available for the design and development of Magnetic Amplifiers having special performance characteristics.

HIGH TEMPERATURE MAGNETIC AMPLIFIERS — DRIFT-FREE

1φ Supply Voltage and Frequency	Full Power Output	Max. Voltage Output	Signal Req. for full output	Max. Power Gain	Typical Motor Load Mfr. and Type No.	Stall Torque	No Load Speed	FREED Type No.
115V., 60	15 watts	115V. AC phase reversible	.1V. AC (10,000 ohms input impedance)	1.5 x 10^7	Diehl FPE 25-11	5.5 in-oz	3500 RPM	MAHS-1
115V., 400	2.7	26V. AC phase reversible	.1V. AC (10,000 ohms input impedance)	2.6 x 10^6	Kearfott R 118	.32	7200	MAHS-2
115V., 400	5	57.5V. AC phase reversible	.1V. AC (10,000 ohms input impedance)	5 x 10^6	Kearfott R 110-2	1.5	5300	MAHS-3
115V., 400	10	57.5V. AC phase reversible	.1V. AC (10,000 ohms input impedance)	1 x 10^7	Kearfott R 111-2	2.4	5300	MAHS-4

SEND FOR LATEST DETAILED BULLETINS AND CATALOGS

FREED RESEARCH, Engineering and Production Facilities Combine to Produce Transformers and Instruments of Top Performance.



FREED TRANSFORMER CO., INC.

1722 WEIRFIELD ST., BROOKLYN (RIDGEWOOD) 27, N. Y.

Freed Magnetic Amplifiers, Saturable Transformers and Reactors are designed for efficient operation and long life. They can be used wherever reliable, rugged and maintenance free systems are required.

The types of amplifiers listed are designed to control AC servomotors.

Development facilities are available for the design of magnetic amplifiers to meet specific requirements.

All standard units are hermetically sealed and meet MIL-T-27 Specifications.

SATURABLE TRANSFORMERS — Controlled with dual triode; plate supply can be either DC or AC; no rectifiers; AC or DC control signals.

PUSH-PULL MAGNETIC AMPLIFIERS — AC or DC control signals; high gain; may be used with magnetic or vacuum tube preamplifiers if needed.

FAST-RESPONSE MAGNETIC AMPLIFIERS — High gain; half-cycle per stage response time; AC or DC control signals; RC feedback networks for control system stabilization can be used directly; preamplifier not needed.

HIGH TEMPERATURE MAGNETIC AMPLIFIERS — Designed to operate in ambient temperatures as high as 200°C.; AC or DC control signals.

DRIFT-FREE MAGNETIC AMPLIFIERS — For rigid drift-free requirements of control systems; designed to meet specific requirements.

OTHER FREED PRODUCTS

TRANSFORMERS

- High Fidelity
- High Level Pulse
- High Q Toroids
- Power
- Slug-Tuned
- Hermetically Sealed
- Step-down
- Miniature Transistor
- High Q Reactors
- High Temperature
- Miniature Audio
- Charging Reactors
- Sub-miniature
- Precision Reactors
- Precision Filters

INSTRUMENTS

- Comparison and Limit Bridges
- Low frequency "Q" Indicators
- Incremental Inductance Bridges
- Universal Bridges
- Null Detectors and V.T. Voltmeters
- Power Supplies
- A.C. Bridges and Accessories
- Differential Voltmeters
- Harmonic Distortion Meters
- Wide Band Amplifiers
- Decade Amplifiers
- Decade Inductors
- Decade Capacitors
- Megohmmeters
- Filters
- Magnetic Voltage Regulators

lever arms provide secure locking in excess of 50-g shock impact and 10-g vibration acceleration. An important feature is that the locking mechanism is easily assembled to MRE connectors now in field service.

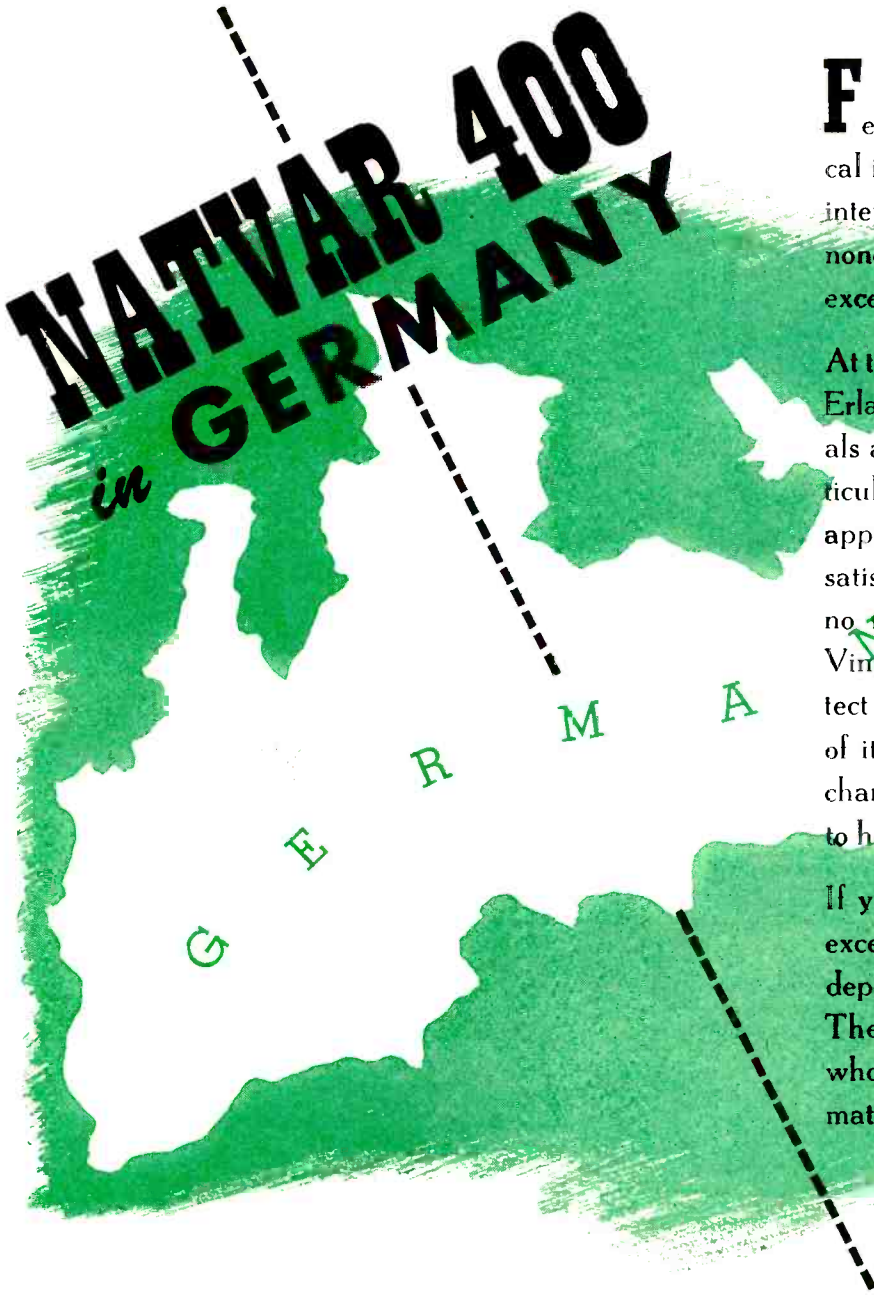
VHF COAXIAL DIPOLE
of all brass construction

OMEGA LABORATORIES, P. O. Box 33, Arlington 74, Mass. Model OXA-146-W vhf coaxial dipole features all brass construction, is sealed against corrosion and cut to specified frequency. It also features power inputs to 750 w. Input impedance is 51 or 72 ohms, and standing wave ratio, 1.15. The unit was designed for use by amateurs, civil air patrol-civil defense, and communication services who desire an omnidirectional antenna that will stand up under the most rugged service. Price is $19.95 net.

TINY TRANSFORMERS
weigh only 1.5 oz

TORWICO ELECTRONICS, INC., 961 Frelinghuysen Ave., Newark 5, N. J., has in production a line of miniature transformers with outputs of 3 v-a and 6 v-a. Typical is the TW-6 unit illustrated. This is

NATVAR 400 in GERMANY

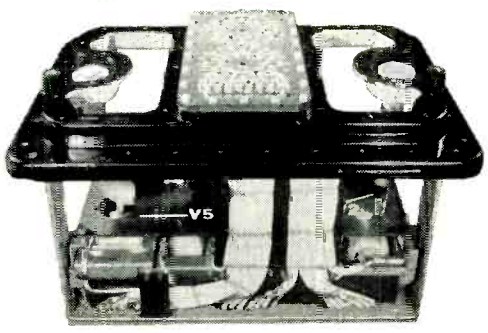


Few, if any, are the names in the electrical industry that are more *widely* known internationally than Siemens. Certainly none are more *favorably* known for the excellence of their products.

At the Siemens-Reiniger-Werke A. G. in Erlangen, Germany, construction materials are carefully tested and selected, particularly for such equipment as X-Ray apparatus which is expected to operate satisfactorily for many years with little or no maintenance. Natvar 400 Extruded Vinyl Tubing is used to insulate and protect leads of X-Ray transformers because of its uniformly good electrical and mechanical characteristics and its resistance to heat and oil.

If you need insulating materials with exceptionally good properties, you can depend on Natvar flexible insulations. They are available either from your wholesaler or direct, and are the same no matter when or where purchased.

Interior view of a 125 kv transformer used in X-Ray equipment manufactured by Siemens-Reiniger-Werke A. G. It is an oil immersed type and operates from a 380 volt AC power source. Primary leads are insulated and protected with Natvar 400 Extruded Vinyl Tubing which retains its excellent electrical and mechanical properties in spite of heat and oil.



Natvar

Natvar Products

- Varnished cambric—cloth and tape
- Varnished canvas and duck
- Varnished silk and special rayon
- Varnished—Silicone coated Fiberglas
- Varnished papers—rope and kraft
- Slot cell combinations, Aboglas®
- Vinyl coated—varnished—lacquered tubing and sleeving
- Extruded vinyl tubing and tape
- Styroflex® flexible polystyrene tape
- Extruded identification markers

Ask for Catalog No. 23

NATVAR CORPORATION

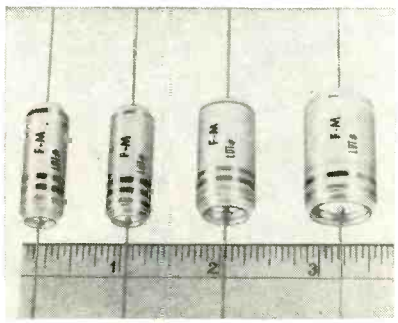
FORMERLY THE NATIONAL VARNISHED PRODUCTS CORPORATION

TELEPHONE RAHWAY 7-8800

CABLE ADDRESS NATVAR: RAHWAY, N. J.

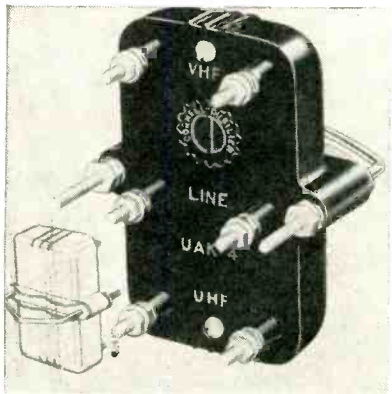
201 RANDOLPH AVENUE • WOODBRIDGE, NEW JERSEY

only 1 in. o.d. × ¾ in. high and weighs 1.5 oz. Electrical ratings are: input, 115 v, 400 cycles; power output, 6 v-a; regulation, 10 percent; heat rise 40 C, class A. It is hermetically sealed in a metal case to MIL-T-27 requirements.



COILS
are hermetically sealed

THE FUGLE-MILLER LABORATORIES, 398 Main St., Metuchen, N. J., announces production of a new series of hermetically-sealed coils for electronic and electrical applications. The coils are offered in a wide range of electrical and mechanical characteristics. Features include: hermetic sealing to provide absolute protection against the effects of moisture; true glass-to-metal sealing techniques; insulated metal case; and specifications exceeding the most rigid requirements.



FILTER NETWORK
for tv antennas

CORNELL-DUBILIER ELECTRIC CORP., 333 Hamilton Blvd., South Plainfield, N. J., announces the model UAK-4 filter, network for tv antenna installations. It is not just a printed circuit but a truly engineered filter network with coils

FOR IMMEDIATE DELIVERY

CLIFTON'S new size 10 synchro series at ½ the size and weight of size 15's

. . . yet at better accuracy and comparable price

Designed and produced by the same engineering team which built the original high precision synchro, this new series is a further step in the line of synchro development.

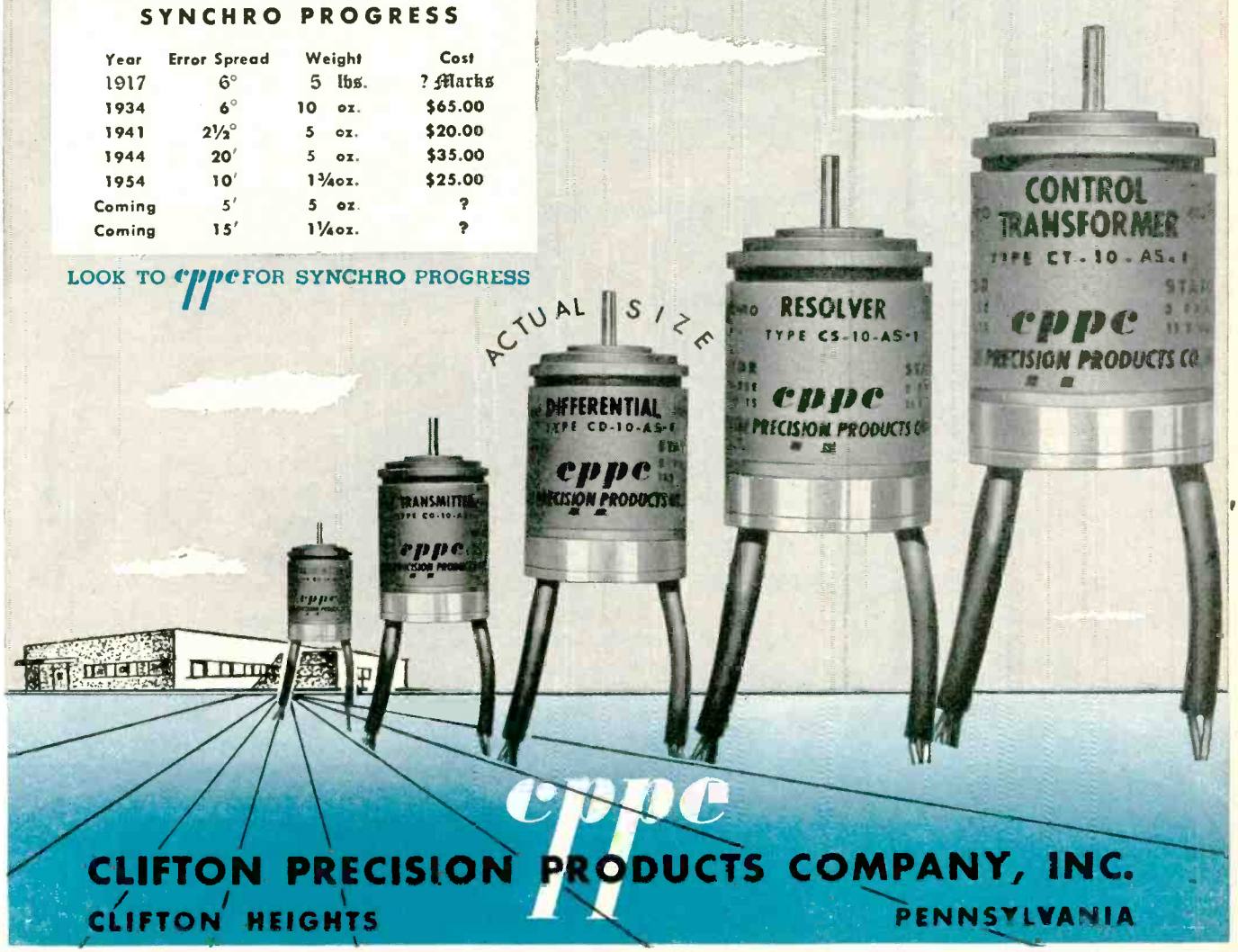
Full engineering information, drawings, electrical characteristics of these and our size 11 and size 15 series are available. We are also producers of miniature A.C. servo and D.C. motors for industry and the government.

Write or telephone A. E. Hayes, Sales Dept. Telephone (Phila.) MAdison 6-2101. West Coast Rep Wm. J. Enright, 988 W. Kensington Rd., Los Angeles 26, Calif. MUtual 6573

SYNCHRO PROGRESS

Year	Error Spread	Weight	Cost
1917	6°	5 lbs.	? Marks
1934	6°	10 oz.	$65.00
1941	2½°	5 oz.	$20.00
1944	20′	5 oz.	$35.00
1954	10′	1¾oz.	$25.00
Coming	5′	5 oz.	?
Coming	15′	1¼oz.	?

LOOK TO cppc FOR SYNCHRO PROGRESS

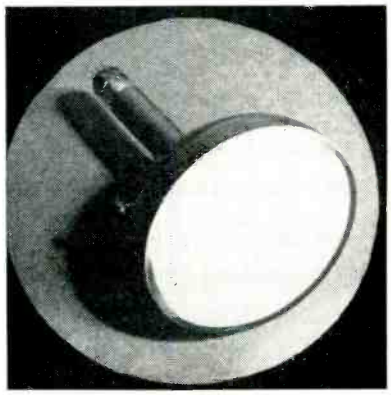


cppc

CLIFTON PRECISION PRODUCTS COMPANY, INC.

CLIFTON HEIGHTS PENNSYLVANIA

and capacitors, no resistors, and functioning truly as a low-loss filter. Other features include sealed polystyrene case with molded standoffs, maximum signal rejection ratio insuring minimum signal interaction, easy installation, positive gripping to fit almost any mast, and no ghosts or images because there is a minimum reflection loss. It is ideal for segregating vhf and uhf at the set and is guaranteed to work with uhf.



MINIATURE C-R TUBE
for daylight use

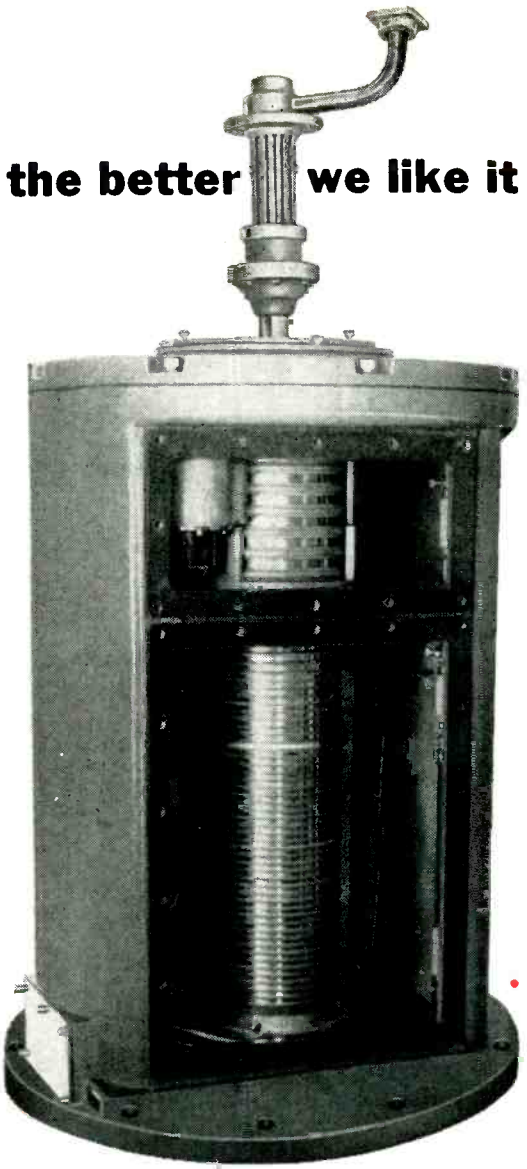
NATIONAL UNION RADIO CORP., 405 Lexington Ave., New York, 17, N. Y., announces a new c-r tube with a 5-in. face, a heater power consumption of only 1.26 w and an overall length of only 7½ in. It has special features that make it easily read in bright daylight. The tube, with a standard 9-pin miniature base, uses magnetic focus and deflection and produces beam currents of 0.5 to 1.0 ma under normal operation. It can be designed into airborne or small, compact equipment or can be used where strong, surrounding light levels are encountered.

PULSE GENERATOR
is a rotary type unit

SARGROVE ELECTRONICS LTD., Alexandra Road, Hounslow, Middlesex, England, has developed a rotary pulse generator, which generates a train of pulses directly proportional to the linear motion of material being rolled out by a rolling mill. The pulse generator, originally developed to give a highly accurate remote indication of the velocity of

the stiffer the "specs" the better we like it

Virtually every project in the electronics manufacturing field involves operations within the scope of the D. E. Makepeace Company. As specialists, Makepeace is able to supply electronic assemblies for components which meet the most exacting specifications.



WAVEGUIDE TUBING AND MICROWAVE ASSEMBLIES

Long experience in the manufacture of precision drawn waveguide tubing, enables Makepeace to meet tolerances much tighter than specified in MIL-T-85-B. This precision is maintained in the production of components such as rotary joints, crystal mixers, antenna feeds, and many specialized assemblies to meet various requirements.

We shall be glad to confer with you on the design and manufacture of prototypes and production runs. Our exceptional testing facilities are at your disposal.

COLLECTOR RINGS AND BRUSHES

Because Makepeace pioneered in the production of solid and laminated precious metal slip rings, a range of sizes and special alloys is available to meet almost any requirement for space, weight, electrical noise, torque, or power handling capability.

In addition to the rings and brushes themselves, Makepeace has utilized its experience in this field in the design and manufacture of complete self contained ring and brush assemblies. The design of such a unit often poses unusual problems. The Makepeace engineering group having met many of these problems, can plan and manufacture a unit to meet your specifications. Before such an assembly is shipped, it is checked out and completely tested for electrical noise, voltage breakdown, impedance matching, power handling capability, and other test specifications as required.

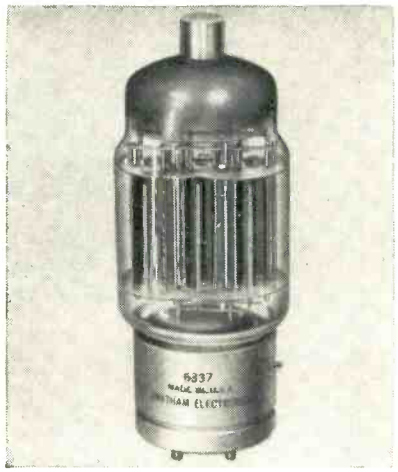
PRECISION RECTANGULAR WAVEGUIDE TUBING
MICROWAVE COMPONENTS • MICROWAVE TRANSMISSION ASSEMBLIES • ELECTRICAL CONTACT MATERIAL • FORMED ELECTRICAL CONTACTS
CROSSBAR WELDED CONTACTS • SLIP RING AND SLIP RING ASSEMBLIES • BRUSH ASSEMBLIES
PRECIOUS METALS CLAD TO BASE METALS
SHEET—TUBING—WIRE AND ASSEMBLIES
SENDZIMIR PRECISION ROLLING

electronic assemblies and components by

Makepeace

D. E. MAKEPEACE COMPANY
Division of Union Plate and Wire Co.
Attleboro, Mass.
Sales Offices: New York • Chicago • Los Angeles • Columbus

heavy machinery in steel rolling mills, can be used for a number of different purposes. For example, it will measure the linear motion of rolled material with sufficient accuracy to enable the material to be guillotined to an accuracy of 0.1 percent. It can also be used to feed information into high-speed counting or batching machines, and can be geared to a radar antenna or searchlight beam to give a direct angular positional indication of the beacon bearing by means of the pulses it generates.



POWER TRIODE
is low-mu regulator tube

CHATHAM ELECTRONICS CORP., Livingston, N. J. Type 6337 power triode features high plate dissipation and high perveance, plate current held within ± 10 percent and absence of plate current drift. Compact in design, the new tube is capable of withstanding 500 g. A hard glass envelope and a button stem that strengthens the mount, provide high immunity to extreme shock and vibration. Wide interlead spacing practically eliminates electrolysis. These and other features make the tube highly dependable in critical regulating circuits.

TUBE GRAPH BOOK
with price list available

SCHNURR-SCHULTZ-WEBER, Consultant Engineers, 7251 Teal Ave., St. Louis 14, Mo. "Vacuum Tube Characteristics and Design Sheets" is a 42-page book containing design data on 36 tube types and a 9-page

THER-MONIC INDUCTION HEATING CORP. NEW YORK

LINDBERG Weltronic

SCIENTIFIC ELECTRIC

ECCO HIGH FREQUENCY CORP.

AMERICA'S LEADING EQUIPMENT MANUFACTURERS USE AMERICA'S BEST INDUSTRIAL TUBES...

...that's why you'll find

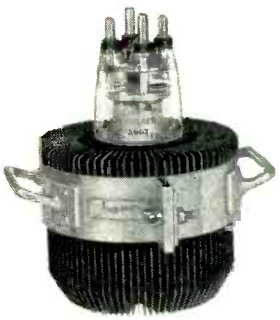
Amperex® tubes

in some of the finest

INDUCTION and DIELECTRIC HEATING EQUIPMENT

in the country!

5604



5667

880

Amperex

FORCED-AIR & WATERCOOLED TUBES SPECIALLY DESIGNED FOR HEAVY DUTY INDUSTRIAL RF APPLICATIONS

5870/AGR — 9951

5619

6446

6333

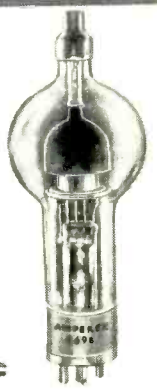
There can be no question about it. AMPEREX tubes deliver outstanding performance at lower operating cost. Because of Ruggedizing and other exclusive techniques, AMPEREX tubes have a substantially longer life and withstand heavy, industrial use much better . . . both physically and electrically. Whether you manufacture or use Induction and/or Dielectric Heating Equipment, you will obtain smoother, more reliable performance at lower maintenance cost with AMPEREX tubes.

Technical Data and Brochures Are Available on Request from our Application Engineering Department.

575A

5924/AX — 9904R

857B



869B

Available At Your Local Parts Distributor

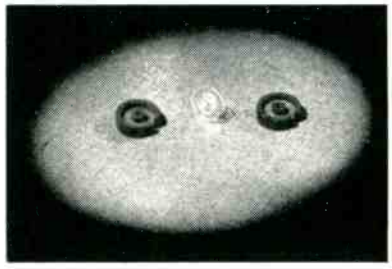
AMPEREX ELECTRONIC CORP.

230 Duffy Ave., Hicksville, Long Island, N. Y.

In Canada: Rogers Majestic Electronics Ltd. • 11-19 Brentcliffe Road, Leaside (Toronto) 17

AMPEREX

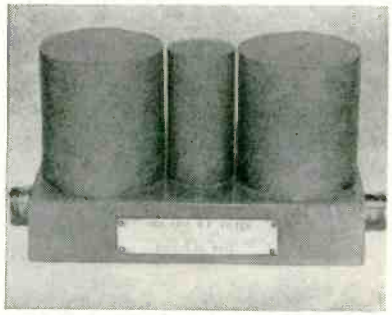
explanation of the use of the design curves with numerical examples. It features large scale, easy-to-work-with plate characteristic curves on 8½ × 11-in. sheets. Punched holes, for insertion in a data book or laboratory report, permit the curves to be removed from the book and retained as a permanent record of circuit design. In addition each sheet includes: absolute maximum ratings according to the military specifications for electron tubes, MIL-E-1B; absolute maximum plate dissipation hyperbola; and a tube schematic. All information pertinent to the design and breadboarding of a circuit utilizing a particular tube is given on a single uncluttered sheet. In addition to the 42-page book, single sheets are also available for 45 tube types, 6 of which are widely used subminiatures.



FERRITE POT CORE
is miniature size

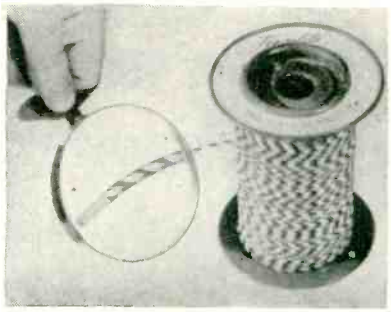
SPRAGUE ELECTRIC CO., North Adams, Mass. A miniature pot core made of Ferroxcube type 3C ferrite material permits construction of very small coil assemblies having moderate inductance values with a relatively high Q. The windings are of coil assemblies made of this pot core, and are entirely surrounded by high permeability material so that shielding is excellent and stray fields are minimized. Assemblies of this pot core may be placed close together and even stacked in some applications with negligible coupling between adjacent coils. A nylon bobbin, part A508-72, is also available from Ferroxcube Corp. of America, Saugerties, N. Y., for use in assemblies of the new pot core. (The bobbin is illustrated between two halves of the pot core structures.) The new Ferroxcube pot core finds wide ap-

plication in blocking oscillator transformers, pulse transformers, filters, delay lines and oscillator inductances.



FILTERS
for use in 52-ohm circuits

SCIENTIFIC SPECIALTIES CORP., Snow and Union Sts., Boston 35, Mass., has available symmetrical high-pass ladder type filters with transmission line sections for use in unbalanced transmission systems. The filters are noted for their low loss in the passband and high attenuation in the stop band. They can be used in the antenna transmission lines of h-f receivers or transmitters to permit power transmission at certain frequencies and stop power transmission at other frequencies. The filters are designed for use in 52-ohm circuits but other impedances can be supplied. Insertion loss at frequencies near the cutoff is less than 3 db. At lower frequencies the insertion loss is less than 0.5 db.



TEFLON WIRE
is spirally striped

TENSOLITE INSULATED WIRE CO., INC., 196 Main St., Tarrytown, N. Y., is now offering production quantities of spirally striped Tensolon high temperature Teflon insulated hookup wires for color coding and

circuit identification. Spiral striping conforms to commercial (GEN-104) and military (MIL-W-76A) specifications for color coding. There are 819 different striped combinations possible using black, brown, red, orange, yellow, green, blue, purple and grey inks on neutral or white insulation. Finished wire is supplied in conductor sizes from No. 26 to No. 10 Awg. The Teflon insulation has a nominal wall thickness of 0.010 in. to meet the requirements of MIL-W-16878A specification for type E wire rated for operation at 600 v up to 250 C continuous temperature.

RESISTORS
are flat, card wound

THE DAVEN CO., 191 Central Ave., Newark 4, N. J., announces availability of their flat, card wound resistors. For many precision wirewound resistor applications, where space is at a premium, these resistor cards provide a workable, economical solution in place of the usual spool or bobbin type. The cards are $\frac{1}{8}$ in. thick and $\frac{5}{8}$ in. wide. Length is determined by the number of individual resistance sections required for a particular application. Normal power rating is 0.6 w. Up to 5,000 ohms per section may be obtained. Accuracies to 0.1 percent are available. Cards can be impregnated to withstand severe military or industrial environmental tests.

TRANSFORMERS
and filter reactors

CHICAGO STANDARD TRANSFORMER CORP., 3501 Addison St., Chicago

18, Ill., has made available a full line of stock 400-cycle power and filament transformers and filter reactors. All of these units were designed to meet MIL-T-27, class B specifications for high temperature operation. They are housed in seamless drawn steel, hermetically sealed cases, with stud-type terminals. Detailed specifications and prices are given in bulletin 32.

DISTORTION METER
has 0.1-percent accuracy

FREED TRANSFORMER CO., INC., 1715 Weirfield St., Brooklyn 27, N. Y. Model 1410 distortion meter has a frequency range from 20 kc to 1 mc in 10 overlapping ranges. Distortion range is from 0.1 percent to 30 percent. Input level range allows signal levels from 0.2 v to 1,000 v to be measured directly. An accuracy of 0.1 percent is obtained at signal levels as low as 0.2 v. Other features include an easy-to-read 4-in. meter used as distortion indicator and monitor, the meter being protected against overload. Residual signal is measured by high gain vtvm with flat response up to 3 mc. The unit has a low-impedance, distortionless preamplifier with monitoring circuit. A null T network assures complete attenuation of fundamental.

MASS SPECTROMETER
is sensitive and portable

CONSOLIDATED ENGINEERING CORP., 300 N. Sierra Madre Villa, Pasadena 8, Calif., has developed a new mobile, process monitoring and control type mass spectrometer, model 21-620. It utilizes a cycloidal-fo-

cusing principle. The unit will furnish the petroleum, chemical and petrochemical industries with a highly-sensitive portable tool for making high-speed and accurate analyses of gaseous and light liquid mixtures.

SIGNAL GENERATOR
for microwave checking

POLARAD ELECTRONICS CORP., 100 Metropolitan Ave., Brooklyn 11, N. Y. Model B signal generator has been designed to check equipment requiring multiple pulse modulated microwave frequency energy whose widths and delays can be accurately controlled. It consists of 4 interchangeable r-f heads providing continuous coverage from 950 to 10,750 mc, with single dial, direct reading tuning controls. A direct reading r-f attenuator is provided in each r-f head. The modulator portion furnishes five independently adjustable pulse channels, each capable of being adjustable in time and width as well as supplying pulse time modulation. A high speed oscilloscope is incorporated in the unit to monitor accurately pulse adjustments. All power supplies are operated from a line voltage regulator to insure utmost stability of operation.

CORE TESTER
delivers a pulse program

RESE ENGINEERING INC., 301 Walnut St., Philadelphia 6, Pa. Model MPT-1 magnetic core pulse analyzer was designed for testing ferrite cores for high-speed memories

in digital computers. It can also be used for pulse evaluation of any magnetic materials. Cores are tested by being submitted to a program of pulses to simulate the conditions of actual computer operation, and observing the output of the core on a suitable oscilloscope. An 8-step program is available which will give any combination of positive, 1/2 positive, negative or 1/2 negative pulses, as selected by 16 toggle switches on the front panel. The program is repeated continuously and the prf of the individual pulses is variable from 1 kc to 10 kc.

AIRCRAFT BATTERY ELIMINATOR

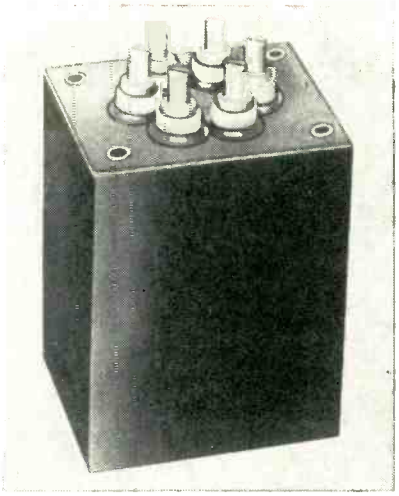
for testing communication equipment

OPAD-GREEN Co., 71 Warren St., New York 7, N. Y. Model K101F aircraft battery eliminator, for testing and operating aircraft electrical and communication equipments, operates on 115 v a-c, 60 cycles single phase and provides a continuously variable output from 0 to 28 v d-c. Maximum continuous load current rating is 20 amperes, and overload capacity is 400 percent for ½ minute and 200 percent for 2 minutes. Ripple does not exceed 1 percent at maximum ratings. Bulletin No. 150 giving electrical and mechanical specifications is available.

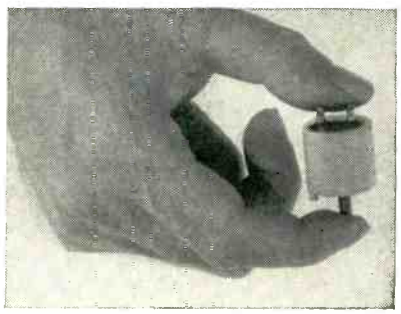
MAGNETIC AMPLIFIERS

available in three types

FREED TRANSFORMER CO., INC., 1715 Weirfield St., Brooklyn 27, N. Y., has developed three types of magnetic amplifiers to meet best known



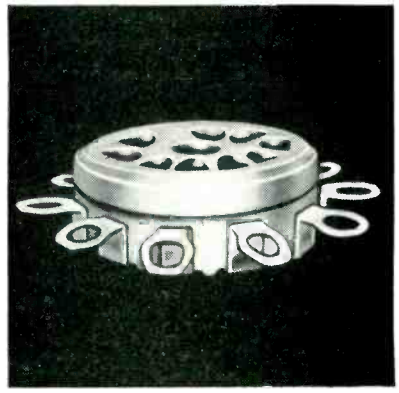
requirements: (1) high-temperature magnetic amplifiers to operate reliably in ambient temperatures as high as 200 C, with a time constant as low as 0.003 sec; (2) half-cycle response units for closed-loop systems which require high gain and fast response, for operation in ambient temperatures from −55C to +70C; and (3) full-wave magnetic amplifiers using self-saturating or external feedback circuitry to operate in ambient temperatures from −55C to +40C. All are built to the most rigid specifications and feature highest quality with efficient operation and long life.



TINY INDUCTORS
from 2.2 to 220 mh

MICO INSTRUMENT CO., 80 Trowbridge St., Cambridge 38, Mass. Type SL1 miniature inductors are particularly suited for use as inductor elements in tuned circuits and filter networks in receiving, telemetering and navigation systems, computers or laboratory measuring equipment. They are designed for use in any application where a compact, stable and durable inductor having high Q is required to operate in the frequency range

of 5 to 500 kc. Chief features, specifications and ordering data are included in a recent bulletin.



TUBE SOCKET
for printed-circuit use

MYCALEX TUBE SOCKET CORP., Clifton Blvd., Clifton, N. J. The socket shown, for general use in printed circuitry, is made of Mycalex 410 glass-bonded mica, which affords the following advantages over phenolics: loss factor of 0.014 at 1 mc; power factor of 0.0015 at 1 mc; high dielectric strength; no carbonization; no cold flow; a high thermal shock resistance that prevents damage in soldering; precision dimensional accuracy and permanent dimensional stability. Connections can be made to both top and bottom of this socket. The specially designed contact permits a positive mechanical attachment in conjunction with a soldered connection. This feature is vital to assure immunity to shock and vibration and also to prevent loosening of connections under the stress of inserting and extracting tubes.

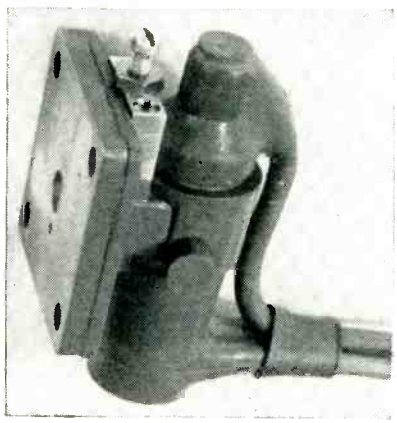
MINIATURE RESISTOR
designed for h-f use

INTERNATIONAL RESISTANCE CO., 401 N. Broad St., Philadelphia 8, Pa. Type HFR is a ½-w h-f miniature resistor constructed of special, solid ceramic rods to which a thin resistive film is permanently bonded. It exceeds specification MIL-R-10683A. The resistor is recommended for use in circuits requiring excellent frequency response over a wide band of frequencies, h-f circuits, and any

application where low shunt capacity is desirable. Standard tolerance is ± 20 percent, with ± 10 percent and ± 5 percent available. Body length is 9/16 in.; body diameter (over caps), 3/32 in.; lead length 1 1/2 in. and lead diameter, 0.025 in.

RECORDING EQUALIZER
offers a choice of 5 curves

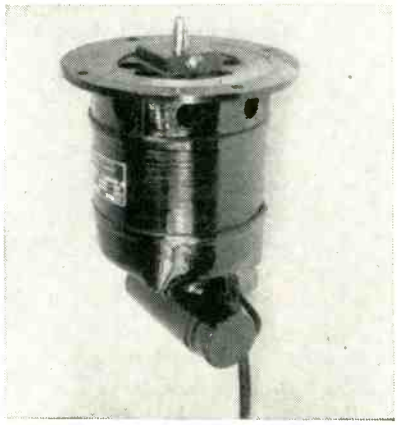
FAIRCHILD RECORDING EQUIPMENT Co., 154th St. and 7th Ave., Whitestone, N. Y., has announced a new universal recording equalizer, model 639, to the recording industry. Readily adaptable to any recording system, this unit offers the recording engineer a choice of 5 curves to modify the frequency characteristics of the recording system. The 5 positions permit the rapid selection of flat, intermediate, AES, L-P and NARTB recording curves. Two units are available. Model 639A has an insertion loss of 24 db, while model 639B includes a booster amplifier for an overall gain of 16 db. Both units are for insertion in a 600-ohm system.



KLYSTRON
for airborne applications

VARIAN ASSOCIATES, 990 Varian St., San Carlos, Calif., announces a new K_u-Band reflex klystron. The VA-94 klystron is a compact, rugged, low-voltage oscillator type tube especially designed for missile and radar applications in the frequency range of 16 to 17 kmc. At 300-v beam potential it provides a minimum of 20 mw power output and 55-mc bandwidth, assuring ample

performance in mixer and test set applications. Features include the convenience of waveguide output, matched load operation, miniature size (2 in. × 1¼ in. × 1¼ in.), minimum weight (4 oz), and molded silicone rubber leads for high altitude and high temperature service. A small screw tuner provides convenient frequency-adjustment at a slow tuning rate. Microphonics are negligible, even under high-amplitude 10-g vibration or 150-g impact conditions.

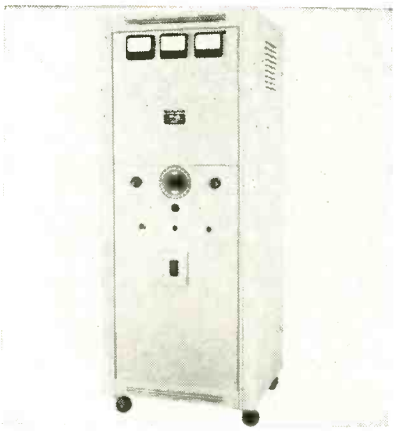


SYNCHRONOUS MOTOR
with squirrel-cage rotor

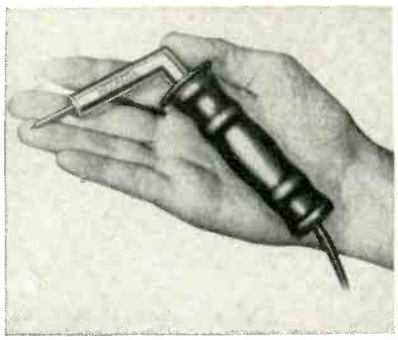
HOLTZER-CABOT MOTOR DIV., National Pneumatic Co., Inc., has developed the RBH-5425 synchronous motor that is suitable for wide variation of voltage and ambient temperature. It is rated at ½ h-p, 115 v, 60 cycles, 1,800 rpm, ball-bearing, flange-mounted, designed for vertical operation shaft up, but may be mounted in any position. It is approximately 5½ in. in diameter. This motor is of the reluctance type, with squirrel-cage rotor having no brushes or slip rings.

GENERATOR
covers 50-6,000 cycles

COMMUNICATION MEASUREMENTS LABORATORY, INC., 350 Leland Ave., Plainfield, N. J Model 1425 electronic generator delivers 900 v-a power output from 80 to 135 v or 160 to 270 v. Four frequency ranges covering from 50 to 6,000 cycles are provided. The distortion is less than 5 percent at full load. Voltage regulation (no load to full



load) is within 2 percent. It is useful as a power source in testing airborne equipment, servo systems and other equipment operating at standard or special power supply frequencies.

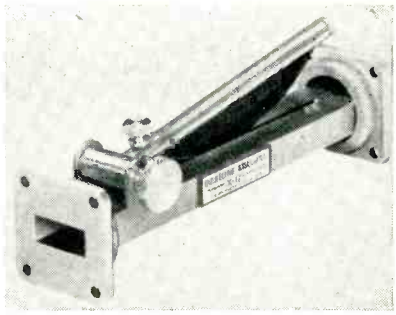


SOLDERING IRON with hatchet design

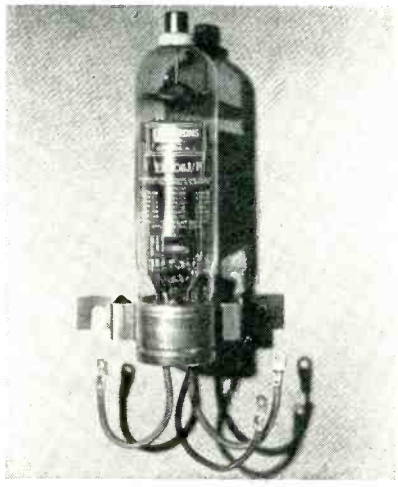
HEXACON ELECTRIC CO., 130 W. Clay Ave., Roselle Park, N. J., announces a new very small hatchet soldering iron weighing but 3 oz. Perfect balance due to hatchet design makes the iron effortless to hold and thus gives more accurate control of soldering, resulting in better soldered joints. It is recommended for fast soldering of instruments, small electronic equipment and subassemblies. The iron operates identically on d-c or a-c, any cycle. It is available in 110 or 220 v.

FLAP ATTENUATOR with positive lock

TRANSLINE ASSOCIATES, 57 State St., Newark, N. J. A new flap attenuator provides a simple and convenient method of adjusting power levels and isolating oscilla-



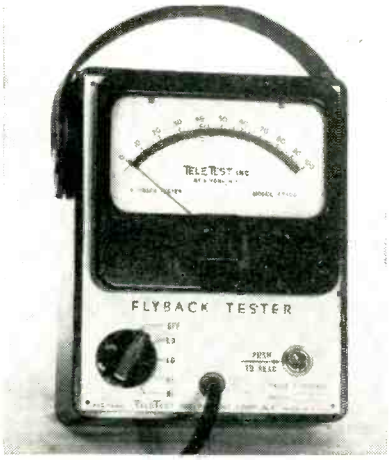
tors from the pulling effects of variable loads. With a fully inserted flap it may be employed as a load. The unit operates over the X-band spectrum from 8,200 mc to 12,400 mc. For attenuation values less than 20 db, maximum vswr is less than 1.15. A simple screw mechanism positively varies the attenuation continuously from 0 to over 30 db. An auxiliary locking device, when used, offers insurance against variations in attenuation due to vibration or shock.



THYRATRON TUBE is temperature-stable

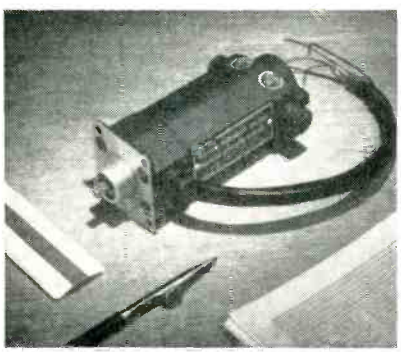
ELECTRONS, INC., 127 Sussex Ave., Newark 3, N. J., has available the type ELC6J/F temperature-stable thyraton tube. This Xenon gas-filled, grid-controlled rectifier tube is especially manufactured for panel mounting. Flexible lead connections eliminate the conventional socket and thereby assure reliable, trouble-free contacts between tube and circuit. Pertinent maximum ratings are: anode average current, 6.4 amperes d-c; oscillograph peak current, 77 amperes; peak inverse voltage, 1,250 v; peak forward voltage, 1,000 v; average tube drop, 9

v; and critical grid voltage at pfb is −4.6 ± 1.6 v.



FLYBACK TESTER
is a versatile unit

TELE TEST, INC., 30-01 Linden Place, Flushing, L. I., N. Y., has available a flyback tester that tells exactly what condition any flyback is in. It tests good flybacks as well as bad. The tester checks continuity, yokes, width coils and linearity coils for shorted turns. The instrument checks the flyback under the full operating voltage. Many other testers need a known good reference flyback of the exact type being tested. Users of the new flyback tester have been able to reduce their inventories of unneeded flybacks almost down to the zero level. The portable, compact instrument sells for $44.95.



ACTUATOR MOTOR
for intermittent duty

DALMOTOR CO., 1329 Clay St., Santa Clara, Calif. The SR-43 compact motor for intermittent duty suggests itself for such applications as low or high-speed, linear or ro-

tary-actuator mechanisms. It incorporates an automatic clutch brake which applies 2 oz in. of brake torque to the load, and disengages the armature automatically when power is removed. Totally enclosed, the unit turns up 20,000 rpm at 1¾ oz in. torque with 3.8 amperes of 28-v d-c power. The locked-rotor torque is 10½ oz in. Rotation is reversible and various shaft arrangements including plain shafts, splines, keyways and gears to specification can be provided. Electrical connections are by integral shielded leads which can be of various lengths as specified.

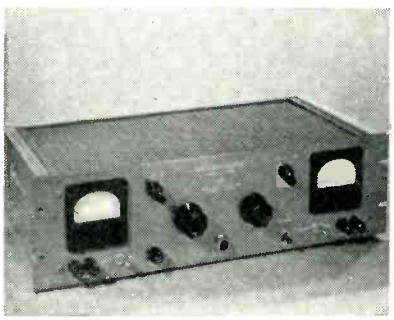
VTVM'S
for a-c and d-c use

MILLIVAC INSTRUMENT CORP., 444 Second St., Schenectady 6, N. Y. A new series of sensitive electronic volt and ampere meters for a-c and d-c has been thoroughly redesigned, both externally and internally. They include the MV-17B d-c millivoltmeter (now MV-17C) having 0 to 1-mv sensitivity, the MV-11B d-c micromicroammeter and several a-c voltmeters. Their new housings are streamlined in appearance while an improved retunable d-c modulator and redesigned amplifiers assure higher accuracy and stability in these new instruments.

MIDGET RESISTOR
measures only ¼ in. long

I-T-E CIRCUIT BREAKER CO., 19th and Hamilton Sts., Philadelphia 30, Pa. A tiny, wire-wound resistor has been developed to meet the needs of the industry's subminaturizing program. Built to cus-

tomers' specifications, this hermetically sealed resistor is available in standard sizes down to ¼ in. × ¼ in. The resistors are designed to operate precisely in ambient temperatures ranging from −55 C to + 55 C. They feature: (1) low temperature coefficient of ± 20 ppm per deg C and (2) high stability. Resistance change with time is less than one-third the tolerance.



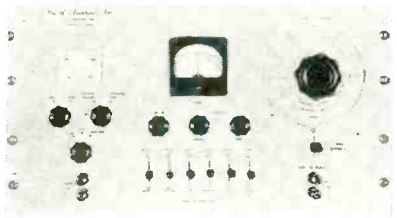
REGULATED SUPPLY
for use with transistors

DRESSEN-BARNES CORP., 250 N. Vinedo Ave., Pasadena 8, Calif., has developed closely regulated d-c tube type power supplies for powering transistors. The new models embody two basic types. Model T-100-B is a meter-equipped regulated dual voltage power supply with two duplicate outputs. Each of these outputs has 3 ranges: positive or negative 0-1 v, 0-10 v and 0-100 v. Adjustment of the 3 ranges is made by decade switches and potentiometers. Maximum d-c current output is 100 ma. Model T-100-D has no meters. It provides the same output ranges as the T-100-B, but adjustment is by direct-reading decade switches in steps of 0.1 v, with 0.1-percent accuracy. Regulation of the units is 0.05 percent from no load to full load. The d-c internal impedance is 0.6 ohm, 0.1 ohm at 120 cycles,

0.4 ohm at 50 kc. Input regulation is 0.1-percent change per ± 10-percent variation in line voltage. Ripple is 1 mv maximum.

TUNING CAPACITORS
for tv and other h-f use

THE HERMASEAL CO., Elkhart, Ind., has introduced new high-frequency tuning capacitors for tv and other h-f apparatus. The present miniature model is being produced in a range of 0.4 to 0.8 μμf. Of a balanced dielectric construction, the capacitors consist of a metallized glass rotor fitting to close tolerance within a metallized glass stator. Made of precision-bore glass tubing, rotor and stator are directly soldered to standard brass fittings for conventional chassis mounting. Minimum Q is 500 at 50 mc. Tolerance is still within prescribed limits after 100,000 revolutions.



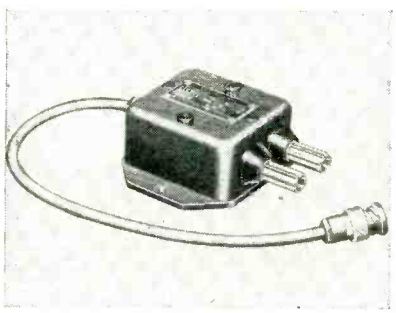
TRANSISTOR TEST SET
designed for lab use

BAIRD ASSOCIATES, INC., 33 University Rd., Cambridge 38, Mass. Model GP1 transistor test set features dependable, direct measurement of transistor characteristics at any frequency from 100 cps to 1 mc. Designed as a versatile laboratory instrument, its speed and simplicity of operation adapt it for

routine production testing. It tests *npn* and *pnp* type transistors in either grounded base or grounded emitter configuration. The test set is used in conjunction with an external oscillator and vtvm. Provision is made for measuring phase angle as well as magnitude of the hybird coefficients, thus permitting accurate design of a-f, i-f and r-f circuits.

TOROID COILS
for resonating L-C circuits

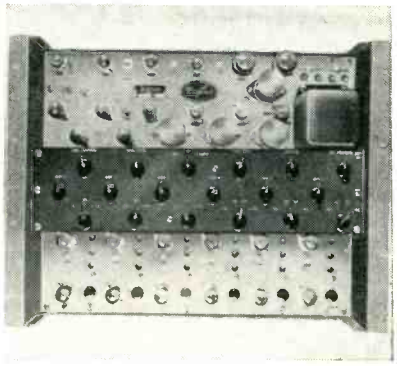
HYCOR CO., INC., 11423 Vanowen St., North Hollywood, Calif. The PR adjustable toroid coils offer a simple and economical means of resonating L-C circuits. The termination of the winding is left free for the addition or removal of turns. Coils are factory adjusted to within ±5 percent of nominal inductance values and are economically priced due to the elimination of critical adjustment and impregnation. A catalog sheet is available.



COUPLING UNIT
measures 1¼ in. × 2½ in. × 3¾ in.

BOONTON RADIO CORP., Boonton, N. J. Type 564-A coupling unit

permits the coupling of an external oscillator into the new type 260-A Q meter for Q measurements in the audio and supersonic frequency ranges. The new unit, measuring 1¼ in. × 2½ in. × 3¾ in. provides binding posts for connection of the external oscillator and a coax cable with BNC connector for convenient connection to the Q meter. Physical mounting is by means of a drilled mounting flange which is provided. Input impedance is 500 ohms; output impedance, 0.3 ohm; frequency range, 1 kc to 50 kc; and input voltage requirements, variable up to 22 v.



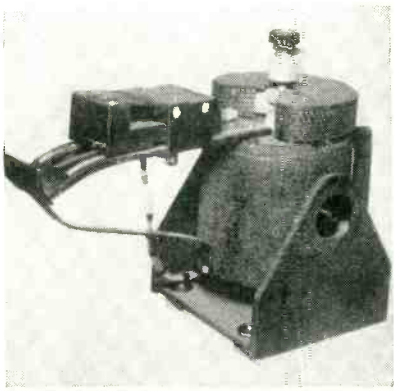
SIGNAL GENERATOR
tests television systems

WICKES ENGINEERING AND CONSTRUCTION CO., 12th St. and Ferry Ave., Camden 4, N. J. Model MBG-1 is a multiburst video test signal generator for quick and accurate frequency response checks of individual units or complete color or monochrome tv systems. It generates discrete bursts of frequencies from 0.5 mc to 6.0 mc, and offers a choice of 13 frequencies in 6 overlapping ranges. Any 6 frequencies are obtainable simultaneously. It features an adjustable burst width and amplitude, a built-in filament supply, and will simulate composite color or monochrome video signal. Brackets are supplied for bath tub and internal-rail standard rack mounting.

POWER SUPPLY
for varied laboratory uses

SPECIALIZED INSTRUMENTS CORP., 535 O'Neill Ave., Belmont, Calif. Suitable for a wide variety of lab-

oratory power-supply applications, the new Duostat includes, in a single unit, facilities for both constant-current and constant-voltage operation. Energized from a standard 115-v 50/60-cps power outlet, the Duostat is capable of providing currents ranging from 5 to 50 ma, automatically regulated to ±2 percent at voltages ranging from 100 to 500 v. In its constant-voltage mode of operation, the unit is self-regulated to ±1 percent from 160 to 500 v, and over a load-current range of 0 to 50 ma. Output is relatively unaffected by line-voltage changes between 105 and 125 v. The unit weighs 11½ lb.



VIBRATION EXCITER
tests miniature tubes

THE MB MFG. CO., New Haven, Conn., has announced a small, new shaker that vibrates at frequencies up to 10,000 cps for production vibration testing of subminiature electron tubes. This electromagnetic equipment provides for rigidly clamping tubes in the vibrating armature. It also includes a flat-top table for use in calibrating small vibration pickups and accelerometers. Testing tubes with this shaker provides data on a tube's vibratory response and its ability

to withstand severe vibration in service.

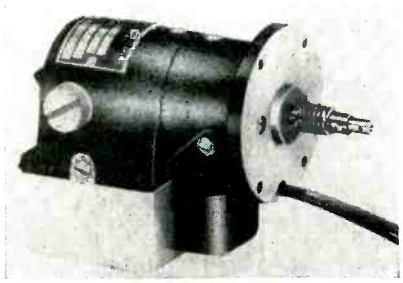
TRANSFORMER
for transistorized circuits

TELEX, INC., Telex Park, St. Paul 1, Minn., has announced a transistor transformer with a wide variety of industrial applications. The tiny unit has been made available for commercial transistorized circuitry use in audio amplifiers, hearing aids and control circuits. Measuring $\frac{1}{2}$ in. $\times$ $\frac{7}{16}$ in. $\times$ $\frac{3}{8}$ in., it comes in three models—No. 8641 transistor input, No. 8642 transistor interstage and No. 8643 transistor output. Units are packaged in a clear Lucite box for easy identification, and each box contains an insert label giving complete specifications on the transformer.

ELECTRONIC COUNTER
will operate on 100-120 v

POST ELECTRONIC PRODUCTS DIV., Post Machinery Co., Beverly, Mass. Model F-1 serves many counting operations. It is designed to count

continually at a speed of 2 to 3 per second. Any Post photohead can be used, and line voltages from 100 to 120 will operate the model F-1. The counter can be located as far away as 100 ft from the photohead. The photohead can be used in highly confined areas and the counter can be located as far away as 100 ft from the photohead. The photohead can be used in highly confined areas and the counter can be mounted in plain view somewhere on the production machine. Standard Model F-1 counter is provided with an 8-ft length of cord from counter to photohead. Longer cords can be provided on request.



SHUNT WOUND MOTOR
designed for military use

ELECTRO ENGINEERING PRODUCTS Co., 609 W. Lake St., Chicago, Ill., has announced a new shunt wound d-c motor designed for military use. Operating on 28 v, the motor is rated at 0.02 hp at 12,000 rpm. It is furnished complete with noise filter and high-altitude brushes. Constructed as part of AN/ARA-8, the motor employs precision ball bearings and stainless steel shafts for extra-heavy duty. All parts are finished in accordance with rigid military specifications.

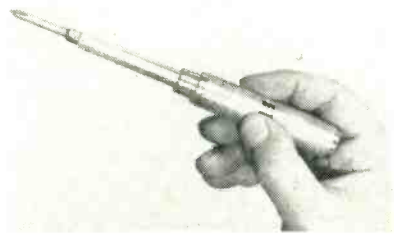
INDUSTRIAL X-RAY
is a portable unit

BALTEAU ELECTRIC CORP., Stamford, Conn., is manufacturing a new line of portable industrial x-ray equipment. Designed "Baltograph", the equipment features maximum penetration for minimum weight. The self-contained x-ray head of the model rated at 195 kv, 5 ma weighs only 153 lb and measures 26½ in. × 14 in. × 8¼ in. The head

houses both x-ray tube and h-v transformers of radical new design. All models operate directly from 110 v or 220 v, 60-cycle lines and do not require cooling pumps or special accessories.

SOLDERING ALLOY
for low-temperature use

HOWE INTERNATIONAL, 431 Danforth Ave., Jersey City 5, N. J., announces a new soldering alloy, developed especially for electronic applications, production and service. Known as Howalloy No. 425, the new alloy is applicable through any application of heat generating 425 F. It possesses the same flow and capillary characteristics of the silver brazing alloys, and is entirely free of zinc and lead. It has excellent corrosion resistance, and applies easily to copper, stainless, brass, and other materials regularly used in electronic work. When used with No. 425 flux, it is invaluable in eliminating the usual problems encountered in joining various metals, including copper, nickel, Invar, resistance wire, Alnico and chrome-plated surfaces. Complete information, with new descriptive folder, may be obtained directly from the manufacturer.



TORQUE SCREWDRIVER
for precision assembly

RICHMONT INC., 922 So. Myrtle Ave., Monrovia, Calif. The new Livermont Roto-Torq model PM-5 was developed for use in electronics assembly, where tiny screws, nuts and bolts require extremely low torque combined with absolute torque accuracy. A feather-weight tool, it tips the scales at slightly over 3 oz, with standard bit included. It comes equipped with magnetic bit holder and can be used with screwdriver bit or hex

sockets of various sizes. Torque capacities are 4 in. oz to 80 in. oz. Length is 5½ in. (without bit). Weight is 3½ oz.

Literature

Laboratory and Maintenance Instruments. The Clough-Brengle Co., 6014 Broadway, Chicago 40, Ill. Form 143 covers 12 models of laboratory and maintenance instruments for the radio and allied communications fields. Included are illustrated descriptions of a beat frequency oscillator, audio-frequency generators, a transmission measuring set, a standard signal generator, a band-spread oscillator, an i-f sweep generator, an extended range audio oscillator, a standard r-f signal generator and a capacitance-resistance-inductance bridge.

Ultrasonic Soldering Iron. Alcar Instruments, Inc., Fair Lawn, N. J. A single-page bulletin illustrates and describes the model AA1 Ultra Gen, a source of low frequency, 18-kc ultrasonic energy for use as a driver for magnetostrictive transducers, such as those used in soldering and mixing. Prices are included for the ultrasonic soldering iron complete, the Ultra Gen (only) and the soldering gun-transducer (only).

Ballistocardiograph. Industrial Development Laboratories Inc., 19 Pollock Ave., Jersey City 5, N. J., has available a single-page reprint dealing with the Arbeit Ballistocardiograph that records the displacement, velocity and acceleration component of the body motion due to cardiac systole. The unit described covers the frequency range of internally impressed forces up to 20 cps; and requires no adjustments of filters, ambient vibrations being electronically eliminated.

Meterless Resistance Bridge. Industrial Development Laboratories Inc., 17 Pollock Ave., Jersey City 5, N. J. A recent catalog sheet illustrates and describes the model R-10 Signa-Glow, a resistance bridge that uses no bat-

teries, and effectively measures, at line frequency, resistance to 50 megohms. The meterless bridge discussed features a Dual-Null indicator. Specifications and information on operation are included.

Precision Power Supplies. Lambda Electronics Corp., 103-02 Northern Blvd., Corona 68, N. Y., has available a mailing piece dealing with a line of heavy-duty, precision regulated power supplies. It contains illustrations, special features, technical specifications and prices.

All-Plastic Tank Unit. Avien, 58-15 Northern Blvd., Woodside, N. Y., has issued a catalog sheet illustrating and describing a new all-plastic tank unit that features low cost, fewer parts, smaller size, greater accuracy, simplified maintenance and overhaul, less weight and greater reliability. The gaging unit discussed, with only two tubes, performs all the sensing functions of fuel gaging and management which formerly required 3, 4 and 5-tube structures. The electronically actuated gage described gives greater structural resistance to fatigue and meets MIL-G-7818 vibration requirements in all lengths.

Aperiodic Coupling Units. Motorola Communications & Electronics, Inc., 4501 W. Augusta Blvd., Chicago 51, Ill., has published brochure E-108 on aperiodic coupling units, coupling capacitors and potential devices. The 8-page booklet, of particular interest to power utility engineers, describes improved equipment developed by the company for wide-band coupling of carrier current signals to high-voltage transmission lines. Included in the brochure are circuits of the aperiodic coupling network high-pass filter and the potential device, insertion loss characteristics, photographs and drawings showing dimensions and construction. Specifications are given in detail.

Instrument Generator. Dalmotor Co., 1329 Clay St., Santa Clara, Calif. A 9-oz, p-m, continuous-duty generator recommended as a

precision voltage source is described in a new leaflet, Form GPM-44A. Part of a series, the leaflet illustrates the unit, provides dimensioned outlines and tabulates physical and electrical characteristics. Operating parameters of phase voltage versus load-per-phase are presented graphically for operating speeds of 1,200, 2,100 and 4,500 rpm giving frequencies of 20, 35 and 75 cps.

Encapsulated Precision Resistors. Ohmite Mfg. Co., 3668 Howard St., Skokie, Ill., has published a 2-page bulletin, No. 145, giving specifications and features of type 85 Riteohms with axial leads and type 86 with lug terminals. These are precision, wire-wound resistors in $\frac{1}{4}$, $\frac{1}{3}$, $\frac{1}{2}$, $\frac{3}{4}$ and 1-w sizes that are encapsulated in a special resin and have the resistance wire welded to the terminals. The bulletin shows both individual units and grouped units (several individual units in the same molded resin body), and gives resistance values, wattages, voltage ratings and dimensional drawings of the new resistors.

Photo-Record Processor. Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 15, Calif. The test engineer's dilemma —how to develop and dry large quantities of test data on rolled sensitized paper—is solved by the type 23-109 oscillogram processor described and illustrated in bulletin 1537A-DM. The self-contained instrument discussed is built for operation at the actual testing site, is capable of processing records as rapidly as 15 ft per minute, requires no external water supply and can be used in daylight or in a normally illuminated room.

Beryllium Copper Strip. Penn Precision Products, Inc., 501 Crescent Ave., Reading, Pa. The 4-page bulletin 2, "Introducing Penntemp Beryllium Copper Strip," presents information on a new type of mill-hardened beryllium copper strip that requires no heat treatment. It describes material supplied with thickness and flat-

ness tolerances not previously available. The bulletin includes discussion of temper selection together with tables covering sizes and properties.

Vibration and Shock Mountings. Robinson Aviation, Inc., Teterboro, N. J. How to stop vibration, eliminate shock, reduce noise and cut down on the wear and tear of industrial machinery, is the subject of booklet 850. The booklet describes a new concept of vibration and shock control based on the employment of resilient, primary load-carrying cushions of knitted metal wire (Met-L-Flex). Examples of typical industrial mounts and mounting systems are illustrated and engineering data are given. Applications range from delicate precision equipment to massive machinery.

Frequency Recorder. Minneapolis-Honeywell Regulator Co., Wayne and Windrim Aves., Philadelphia 44, Pa. Instrumentation data sheet 9.1-8a describes the Electronik frequency recorder with a new pulse-type measuring circuit. Having a calibrated accuracy of ± 0.01 cps the instrument discussed is sensitive to frequency deviations as small as 0.005 cps. Available for both 50 and 60-cycle systems, it incorporates the high speed of response and accuracy inherent with electronic potentiometers and continuous-balance measuring systems.

Molded Mica Capacitor. Arco Electronics Inc., 103 Lafayette St., New York 13, N. Y. A single-page bulletin describes the CM-42 molded mica capacitor that can be wired indirectly without need of additional mounting facilities. Dimensions and capacitance ranges are included.

Closed Circuit Television. Radio Corp. of America, Camden, N. J. An informative brochure describes and illustrates 20 basic applications of the company's "TV Eye" closed-circuit tv equipment. It details the equipment's specifications and describes its application in production, control, remote observation, training and instruction, process control, surveillance,

property protection, dangerous viewing, materials handling and work coordination. Ask for form 3R2335.

Accessories Catalog. Javex, Redlands, Calif. Catalog 254 displays 35 advance design electronic accessories. It covers tv installation practices, types of accessories available for a multiplicity of installations, giving sizes, prices, colors and ratings. Special services are also listed.

Microwave Duplexers. Airtron, Inc., 1103 West Elizabeth Ave., Linden, N. J. A 6-page technical bulletin, "Branching and Balancing Duplexers", covers design theory and applications of microwave duplexers. Listed as technical bulletin T-2200, it offers an analysis of the operational and electrical characteristics of various practical duplexer designs. This enables the microwave engineer or equipment manufacturer to evaluate the type best suited to his particular transmitter-receiver application.

Dag Dispersions for Industry. Acheson Colloids Co., Division of Acheson Industries, Inc., Port Huron, Mich., has issued a 4-page booklet containing a list of 40 dispersons of colloidal, graphite, molybdenum disulfide, vermiculite and zinc oxide. Typical applications, densities, carriers and other important data are given. Recent additions to the list are dispersions which offer the advantages of the valuable new epoxy resins as bases for dag colloidal graphite and molybdenum disulfide dry-film coatings.

Switches for Industry. Micro Switch, a division of Minneapolis-Honeywell Regulator Co., Freeport, Ill. The 20-page catalog 101 covers 22 families of switches, describing 258 different switches, actuators and enclosures. Dimensionalized photos, complete characteristics, electrical ratings and technical data are intended to aid the design or plant engineer in the selection of the right switches for his particular applications. The catalog illustrates a good cross-section of the company's thousands of precision, snap-action switches

designed for a-c or d-c industrial and commercial applications.

Pillow Speakers. Telex, Inc., Telex Park, St. Paul, Minn., has issued a 2-color catalog sheet on its dynamic and magnetic pillow speakers. The dynamic speaker described features a wide frequency range and excellent tone control, while the magnetic type is a lightweight plastic unit. Specifications and advantages of both are listed in the sheet, and it explains their many uses in hospitals, homes, hotels and commercial transportation vehicles.

Amplifier Pentode. Sylvania Electric Products Inc., 1740 Broadway, New York 19, N. Y. A recent mailing piece describes the type 6BZ6 amplifier pentode which is specifically designed for operation as an automatic-gain-controlled i-f amplifier in tv receivers. Chief features and electrical data are given.

Transformer Catalog. United Transformer Co., 150 Varick St., New York 13, N. Y. The 26-page catalog A presents a complete line of transformers for broadcast, amateur, laboratory and replacement purposes. Each of the lines described is distinguished by individual characteristics ideally suiting the items to the specific application intended. An index and price list are included.

Television Transmitters. Allen B. DuMont Laboratories, Inc., Clifton, N. J., has available bulletins TR-633 and TR-634 dealing with the 25-kw and 50-kw television transmitters respectively. The former illustrates and describes the series 9000 designed to operate between channels 2 to 6; the latter, the series 12000 for channels 7 to 13. Chief features, specifications and diagrams are included.

TV Transformer Replacements. Chicago Standard Transformer Corp., Addison and Elston Sts., Chicago 18, Ill., has published catalog bulletins announcing the addition of 38 new tv transformer replacements. The Stancor replacements described include: 23 power

transformers; 8 vertical output transformers; 5 width and linearity controls; 1 deflection yoke and 1 filter choke.

Photoelectric Cells and Power Rectifiers. Standard Telephones and Cables Ltd., Warwick Road, Boreham Wood, Herts., England. A 4-page catalog folder covers a line of germanium junction photoelectric cells and power rectifiers. Full descriptions, dimensional diagrams and specifications are included.

TV Studio Cuing System. Allen B. DuMont Laboratories, Inc., 1500 Main Ave., Clifton, N. J. Bulletin TR-637 illustrates and describes the type No. 5409-A tv studio cuing system. Technical features, specifications and a line drawing are given. The Tele-Q described is a small, controllable-speed viewer which is attached to the image orthicon camera just below the line-of-sight of the lenses, providing a moving, highly visible printed text for cuing or direct reading.

Resistance Strips and Concentric Disk Resistors. International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa. Catalog data bulletin T-1 covers resistance strips and concentric disk resistors. It gives 4 pages of comprehensive data on construction, tolerances, resistance values, power and voltage ratings, dimensions, machining technique, temperature coefficient and voltage coefficient. Charts and graphs are included.

Capacitor Catalog. Gudeman Co., 340 W. Huron St., Chicago 10, Ill. A new 20-page catalog No. X-100, illustrating and fully describing a complete line of miniature, hermetically sealed, high-temperature (−55 C to +125 C) tubular paper capacitors is now available. Included are dimensional drawings, electrical characteristics, engineering data and tables of voltages, capacitance values and tolerances.

Germanium Diodes. International Rectifier Corp., 1521 E. Grand Ave., El Segundo, Calif., has available a new, 4-page bulletin GD-1A,

Just Published!

MILLIMICROSECOND PULSE TECHNIQUES

Describes pulse circuits operating in the millimicrosecond time range, covering both basic principles and latest developments. Devotes primary attention to systems of large bandwidth and discusses basic theories, transmission lines, transformers and a novel pulse invertor, pulse generators, amplifiers, cathode-ray oscilloscopes, etc. Explains important nuclear physics applications. **By Ian D. Lewis and Frank H. Wells, Atomic Energy Research Establishment, Harwell, England. 250 pp., $7.50**

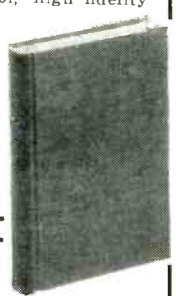
Just Published!

ANALOG METHODS IN COMPUTATION AND SIMULATION

An organized treatment emphasizing engineering and scientific applications. Describes mechanical, electromechanical, electrical, and electronic analog components and how they may be combined into mathematical machines for solving many types of equations. Covers such recent advances as schemes for multiplication of variables and the uses of high-gain feedback amplifiers. **By Walter W. Soroka, Professor of Engineering Design, U. of California. 400 pp., $7.50**

Just Published!

ACOUSTICS



A practical approach to better acoustics—for improved noise control, high fidelity music reproduction, and other applications. Uses the background of electrical engineers and communication physicists to solve a wide variety of acoustical problems. Discusses effects of sound in many aspects. **By Leo L. Beranek, Technical Dir., Acoustics Lab., M.I.T. 467 pages, 312 illus., $9.00**

SHORT-WAVE RADIATION PHENOMENA

Gives hundreds of facts, formulas, and numerical examples to provide a thorough understanding of modern and classical wave-propagation concepts. Intensive treatment in 2 volumes explains and shows application of every frequency — from those of about 30 megs. per sec., to the highest radio frequencies in practical use. **By August Hund, McGraw-Hill Radio Communications Series, 2 vols. (not sold separately). 1382 pp., 97 tables, 394 illus., $20.00** (available on terms)

SEE THESE BOOKS 10 DAYS FREE

McGRAW-HILL BOOK CO., Dept. L-9
330 W. 42 St., NYC 36

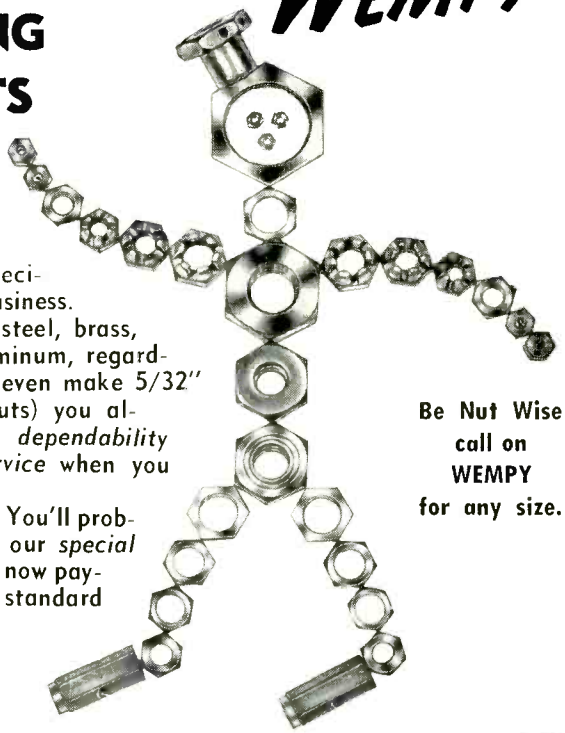
Send me the book(s) checked below for 10 days' examination on approval. In 10 days I will remit for book(s) I keep, plus few cents for delivery, and return unwanted book(s) postpaid. (We pay for delivery if you remit with this coupon; same return privilege.)

- ☐ Lewis & Wells—Mill. Pulse Tech.—$7.50
- ☐ Soroka—Analog Meth. in Comput. and Sim.—$7.50
- ☐ Beranek—Acoustics—$9.00
- ☐ Hund—Short-Wave Radiation Phenomena—$20.00 (payable $5 in 10 days; $5 a month)

(Print)
Name .....
Address .....
City ..... Zone .... State .....
Company .....
Position .....
This offer applies to U. S. only L-9

TAKE IT FROM WEMPY

THE KING OF NUTS



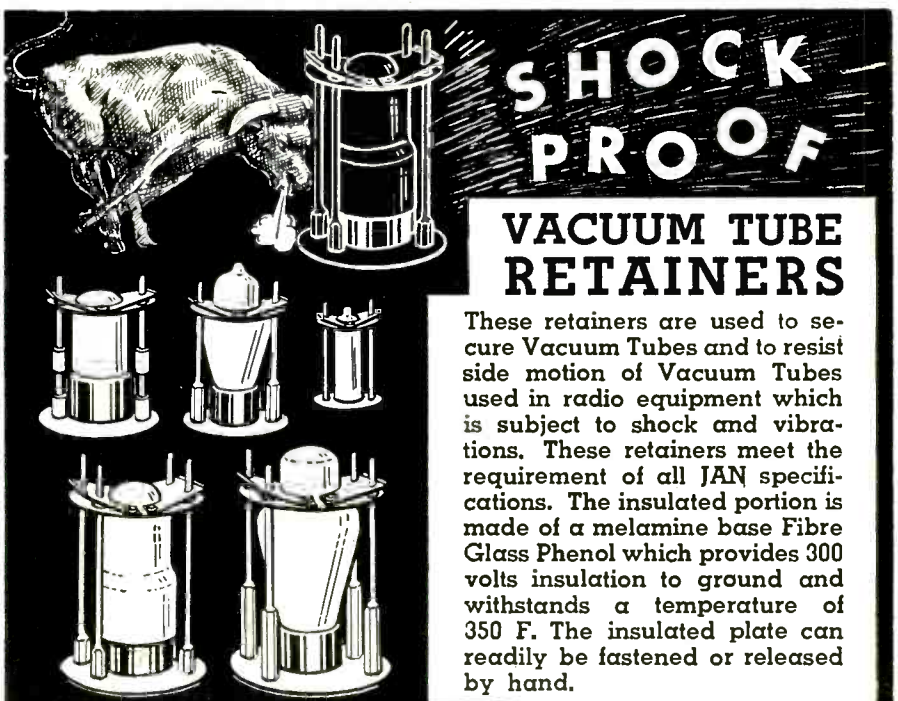
Special nuts, custom made to your exact specifications is my business. Whether you require steel, brass, stainless steel or aluminum, regardless of capacity (We even make 5/32" hexagon miniature nuts) you always get *uniformity, dependability* and the *quickest service* when you deal with us.

And remember this: You'll probably pay no more for our *special fasteners* than you are now paying for ready-made standard nuts.

Be Nut Wise call on WEMPY for any size.

Write Dept. A for Illustrative Catalog

WESTFIELD METAL PRODUCTS CO., INC.
WESTFIELD, MASS.



VACUUM TUBE RETAINERS

These retainers are used to secure Vacuum Tubes and to resist side motion of Vacuum Tubes used in radio equipment which is subject to shock and vibrations. These retainers meet the requirement of all JAN specifications. The insulated portion is made of a melamine base Fibre Glass Phenol which provides 300 volts insulation to ground and withstands a temperature of 350 F. The insulated plate can readily be fastened or released by hand.

Available for envelope types T7, T8, MT8, T9, T12, ST12, T122DI, ST14, S14, ST16, T5½, T6½, MT-IC, ST19, T14, ST128CT-9.

Manufacturers of Electronic Components

JAMES IPPOLITO & CO., INC.
401 CONCORD AVENUE, BRONX 54, N. Y.

listing ratings and specifications on its germanium diodes. Included is a complete replacement guide of international germanium diodes for replacing RETMA type diodes, and ratings and characteristics for new Red Dot germanium diodes for 100 C applications.

Television Camera Equipment. Allen B. DuMont Laboratories, Inc., Clifton, N. J. Bulletin TR-605 illustrates and describes the type 5400-A tv Porta Dolly and type 5401-A Porta Tripod. With the units described, a full range of easy and convenient height adjustments is available from a full 56-in. elevation for awkward, hard-to-get, high-angle shots down to a low-level mounting for dug-out shots. Features and specifications are included.

Traveling-Wave Tube Amplifiers. Hewlett-Packard Co., 2997D Page Mill Road, Palo Alto, Calif., has available a 4-page loose-leaf perforated folder illustrating and describing the 490/491A traveling-wave tube amplifiers that feature broad-band high-gain, low-noise amplification for S band. Complete technical specifications are given.

Radiation Measuring Equipment. Nuclear Instrument & Chemical Corp., 229 W. Erie St., Chicago 10, Ill., has recently printed a new 40-page, 2-color catalog. It describes the company's line of radiation measuring equipment including scalers, count rate meters, Geiger proportional and scintillation counters, along with complete radioisotope laboratories.

Temperature Indicator. Beckman & Whitley, Inc., 913 E. San Carlos Ave., San Carlos, Calif. A new leaflet describes a sensitive, rapid-responding temperature indicating instrument available in several types, each with either a span of 130 F in six overlapping ranges, or a single span of 30 F. The basic thermistor-type instrument is illustrated and described, including specification data on accuracy, battery life, response time and cable length. The literature also includes data on a portable aspirated-type psychrometer for wet and dry-bulb temperature

measurements, or dry-bulb free-air temperature measurements. Also listed is an aircraft type accessory shield, which permits mounting thermistor units on wing-tips for meteorological inversion temperature measurements and similar studies. Ask for Form 196.

Electronic Regulator. Reliance Electric & Engineering Co., 1088 Ivanhoe Rd., Cleveland 10, Ohio, has issued a two-page bulletin describing and illustrating the VSR —a new electronic regulator for speed, voltage and current regulation for industrial electric motor drives. With illustrations and a diagram, the bulletin explains the function of the regulator in controlling motor or generator field excitation in response to the input signal from the quantity being regulated. Also featured in the bulletin are the company's Sealpak units, an innovation providing the advantages of electronics together with the ruggedness required for industrial application.

External Fluxes for Industry. Alpha Metals, Inc., 56 Water St., Jersey City 4, N. J. A 4-page folder discusses fluxes for the electrical and electronics industry that are compounded of the highest quality water white rosin and a suitable solvent. Activated and nonactivated rosin fluxes and their specific thinners are listed. Other information about the company's fluxes is included.

Transistors. Federated Semi-Conductor Co., 66 Dey St., New York 7, N. Y., has available literature describing a line of hermetically sealed *npn* grown junction transistors. Specification and price sheets cover four types of triodes and three types of tetrodes. Recommended applications for each are included.

Beryllium Copper Tubing. Superior Tube Co., Germantown Ave., Norristown, Pa. Properties, applications and advantages of seamless and Weldrawn beryllium copper tubing are presented completely in data memorandum No. 7-2. The alloy described, which

can be formed cold in the soft annealed or slightly work-hardened condition, after heat treatment shows high strength and hardness, wear resistance and electrical conductivity. Mechanical and physical properties, heat treating procedures, welding and brazing methods, pickling solutions, corrosion resistance tables, standard production limit tables and tubing tolerances are listed.

Airborne Power Supplies. The Perkin Engineering Corp., 345 Kansas St., El Segundo, Calif., announces a new bulletin No. A453 dealing with their airborne transformer-rectifiers and power supplies. The transformer-rectifiers described are rated at 28 v with current ratings up to 200 amperes and the complete power supply units are for airborne-radar applications.

Mobile System. Allen B. DuMont Laboratories, Inc., 760 Bloomfield Ave., Clifton, N. J., has published a single-page illustrated bulletin covering the type MCA-401-A complete mobile system designed for use in the uhf 450 to 470-mc band. The system described offers the inherent advantages of minimum electrical noise, availability of several channels, plus a design that incorporates unparalleled ruggedness and performance.

Titanate Ceramics for Capacitors. American Lava Corp., Chattanooga 5, has issued bulletin 542 entitled "Titanate Ceramics for Capacitors." The bulletin outlines the physical properties of AlSiMag dielectric compositions, and explains the applications of the two classes of AlSiMag ceramic dielectrics. Several easy-to-read charts are included.

Relay Symposium Papers. Potter & Brumfield, Princeton, Ind., has released a new volume of relay symposium papers. Like its 1953 predecessor all papers are presented exactly as given at the symposium—no attempt has been made to edit or arrange them in any specific sequence. The new volume is available without charge to engineering, manufacturing, purchasing, teaching and student personnel.

PLANTS AND PEOPLE

Edited by WILLIAM G. ARNOLD

Government names electronic engineers, sets up new consulting groups . . . Manufacturers announce plant expansion plans . . . Engineers and executives are promoted . . .

OTHER DEPARTMENTS featured in this issue:

Defense Department Names Shockley

WILLIAM SHOCKLEY, research physicist of the Bell Telephone Laboratories, has been appointed director of research for the Weapons Systems Evaluation Group of the Defense Department.

In this position, he also serves as deputy to the director, Lieutenant General Geoffrey Keyes, and as chief scientific officer of the group.

Primary function of the WSEG is to respond to calls for service and assistance from the Joint Chiefs of Staff and the Assistant Secretary of Defense (Research and Development) for analytical studies and evaluations of the comparative effectiveness and costs of present and future weapons systems.

Dr. Shockley is on leave of absence from his position as director of the transistor physics department of Bell. He joined Bell in 1936.

The point contact transistor, first announced in 1948, was invented by J. Bardeen and W. H. Brattain while working under Shockley's supervision. The junction transistor, used in hearing aids, was invented by him. He has also invented the unipolar and several other types of transistors. The recently announced Bell "Solar Battery" was developed in part in Dr. Shockley's department.

For his contributions to the transistor, Dr. Shockley received a "Citation of Honor" from the Air Force Association, the Morris Liebmann Prize from the Institute of Radio Engineers, and the Oliver E. Buckley Prize from the American Physical Society.

Manufacturers Confer With Navy On Tubes

GOVERNMENT and electronic industry officials gathered at the Navy's Electronic Supply Office (ESO) in Great Lakes, Ill. to confer in regard to structuring a new code for electron tubes to be used in determining military requirements for raw material and finished product. They are, left to right, H. A. Kent and W. S. Sims of Continental Electric; G. Rivers of RCA; R. J. Higgins of Eitel-McCullough; A. Guthrie of ESO; G. F. Wunderlich of Eitel-McCullough; S. Gertzis of Amperex Electronic; C. Anderson of Chatham Electric; H. M. Schwalbach of ESO; W. F. Sandberg of Amperex Electronic; L. G. Kleinlein, D. Persinger, S. Osterlund, Chairman, and M. Shuck of ESO; M. Deitchman and R. S. Facer of Army Signal Corps; J. Prichard of EPRA; H. A. McGettigan, E. N. Kather and P. R. Keeler of Raytheon; W. J. Walker of GE and J. E. Cunningham of CBS-Hytron.

E. Finley Carter Joins Stanford Research

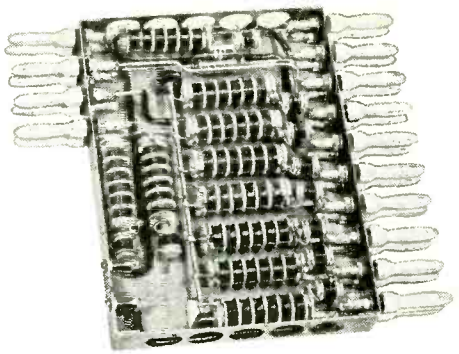
E. FINLEY CARTER, vice-president and technical director of Sylvania, has joined Stanford Research Institute as manager of research operations, effective October 1.

He will supervise the three research divisions carrying SRI's main programs and projects—physical sciences, engineering and

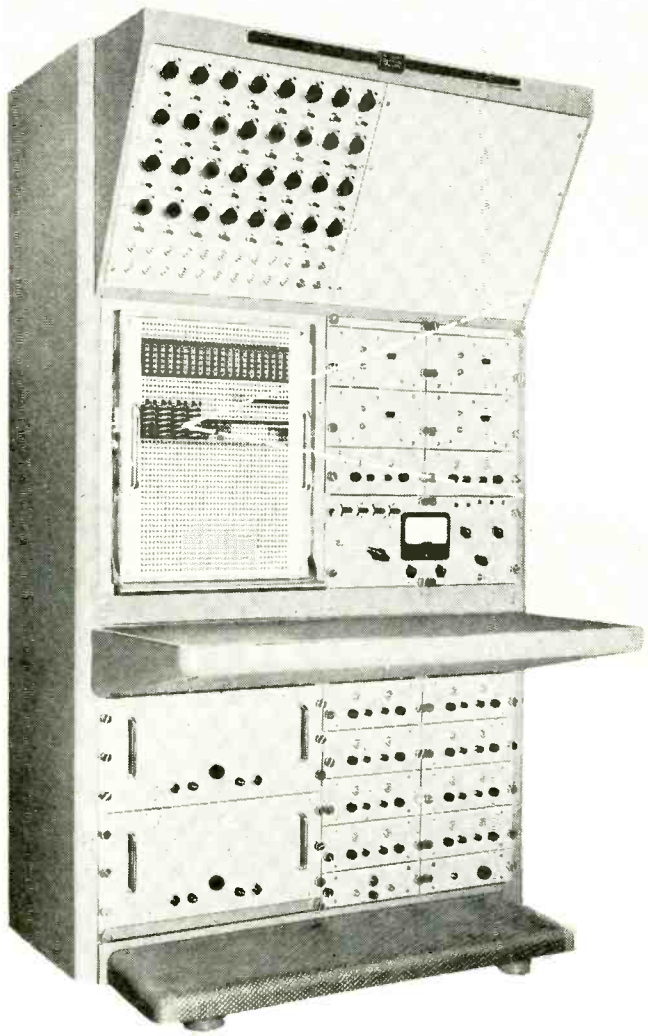
Electronic Associates Specifies

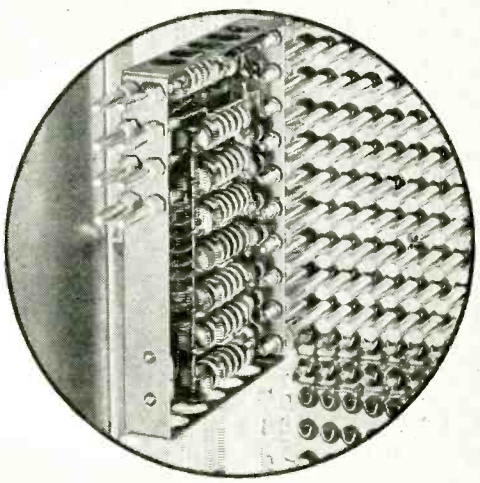
EASTERN PRECISION RESISTORS

For FIRST LOW COST Precision Analog COMPUTOR



The EPR SS-5L Low Capacity Precision Resistor selected by Electronic Associates for use in their Analog Computor 16-31R. Only EPR SS-5L Low Capacity Resistors were found to have a distributed capacitance of less than 2.0 mmf. Each plug-in network contains a series of these resistors and each resistor is matched to within .05%. EPR techniques in winding and artificially aging guarantees stability of the network over a wide temperature range. Such accuracy and long term stability are the reason Electronic Associates relies on EPR.





Booth 1517
Instrument
Cong. & Exp.
Phila. - Sep. 13-24

EPR makes a wide variety of encapsulated, sub-miniature, high-temperature and standard type precision wire-wound resistors.

The General Purpose Analog Computer 16-31R developed by Electronic Associates, Inc. of Long Branch, N. J., presents important advances in this field. In addition to high accuracy, versatility and dependability—it provides ruggedized construction . . . a new high-gain low-drift contact stabilized d-c amplifier with outstanding accuracy, gain frequency response and output power characteristics. By the addition of standard operational groups such as amplifiers, servo-multipliers, resolvers, etc., it may be expanded to more complex systems. Its success is due to the right combination of imagination, engineering talent and superior components. We of Eastern Precision Resistor Corp., are proud to have contributed.

New Illustrated Catalog on Request

EPR

EASTERN PRECISION RESISTOR CORP.
Richmond Hill 18, New York

economics research.

Carter will retain an association with Sylvania, assisting in contacts with the Department of Defense and consulting on major research and development contracts.

Carter joined Sylvania in 1932 as a consulting engineer, later became radio-division engineer, then assistant chief engineer.

In 1941 he was appointed director of Sylvania's new industrial relations department. He was subsequently elected a vice-president of the company.

Podolsky Heads Group On Mil Parts Specs

LEON PODOLSKY, technical assistant to the president of Sprague Electric, has been appointed chairman of a new group to review all military electronic component part specifications with a view toward improving the performance of these components in the light of equipment requirements for new, very high reliability applications.

Podolsky was requested to undertake chairmanship of this Ad Hoc Group by M. Barry Carlton of the office of the assistant secretary of defense for applications engineering.

The other members of the committee will be P. S. Darnell of the Bell Telephone Laboratories, J. T. Brothers of Philco and one representative each of the Air Force, Army, Navy and the Armed Services Electro Standards Agency.

Podolsky previously headed similar military task force engineering committees during World War II.

The need for the present program arises in the very large numbers of electronic components which appear in modern electronic systems, such as guided missiles, radar warning nets, and navigation systems, where there are many thousands of components in comparison to a few dozen which appeared in World War II electronic systems. The committee will determine what revisions are required in military component specifications to insure meeting existing equipment requirements for high reliability operation.

Association Honors Ten Past Chairmen

THE Northern Council of the West Coast Electronics Manufacturers Association presented commemorative plaques to its ten past chairmen. Those honored with the year of office are left to right, first row:

1944, Jack Kaufman, president of Lewis and Kaufman, Los Gatos; 1945, Clayton Bane, owner of Clayton F. Bane Advertising, San Francisco; 1946, Ralph Shermund, vice-president and production manager of Specialized Instruments, Belmont; 1948, William R. Hewlett, vice-president of Hewlett-Packard.

Second row: 1950, O. H. Brown, director of field engineering of Eitel-McCullough, San Bruno; 1951, Paul F. Byrne, vice-president and chief engineer of Sierra Electronic Corporation, San Carlos; 1947, W. W. Wahlgren, partner and technical director of Electro Engineering Works, Oakland; 1949, W. Noel Eldred, sales manager of Hewlett-Packard Company; 1952, Noel E. Porter, production manager of Hewlett-Packard Company; 1953, N. Moore, president of Litton Industries, San Carlos, (not shown).

The Northern Council of WCEMA comprises 45 electronic companies in Northern California, Oregon and Washington.

Present officers of the Northern Council are James J. Halloran, chairman, partner and chief engineer of Electro Engineering Works; H. Myrl Stearns, vice-chairman, executive vice-president and general manager of Varian Associates, Palo Alto and Winfield Wagener, secretary-treasurer, field engineer at Eitel-McCullough.

NBC Expands for Color Television

THE National Broadcasting Company is developing additional studio facilities which will permit, by next Fall, the production of 12 to 15 hours of live color programs weekly. This will enable, at capacity, the scheduling of more than 500 hours of color programming throughout the season.

The network's color programs are being broadcast over 31 affiliated stations across the United States. By October, with further progress in the color-conversion of network lines, 64 stations will be broadcasting in color, making colorcasts available in areas comprising 78 per cent of the nation's television homes.

By September, NBC will have expended $15 million in research funds earmarked for making a commercial broadcasting reality of the compatible color system. This figure is in addition to the $25 million already spent by RCA in the development of color.

Rapid expansion of NBC colorcasting facilities is now under way in New York and Hollywood. In New York, the Brooklyn studios acquired from Warner Brothers will

SUPPOSE YOU DREAMED UP ONE LIKE THIS?

It does happen, you know... an inspired twist, a new application... a microwave component that seems impossible to produce.

Yet, so many fine ideas lie dormant... never leave the design board for want of production know-how, like the microwave assembly below. Luckily, in this case, the illustration is only an artist's conception. But suppose you dreamed it up and it had to be produced, with all its complicated bends, exacting tolerances, specialized finishes.

That's where the many years of unique production experience and the unusual facilities of Budd Stanley could help you in so many ways.

For we at Budd Stanley are manufacturing specialists in microwave components only. We constantly tackle the seemingly impossible design and engineer new production methods of our own to accomplish its manufacture... exactly as you specified it.

So, if you are designing or wish to specify a component that seems difficult to produce ... write, phone or wire us. We'll be glad to lend our know-how to your problem.

BUDD · STANLEY CO. INC. *43-01 22nd Street · Long Island City 1, N. Y.*

Tel. STillwell 6-1706

Cable address: "BUDDSTAN"

specialists in microwave application

be fully equipped for color by September and will carry a large part of the color production load. In Hollywood, a new color studio is being built and equipped at a cost of $3,600,000 and will be ready by Jan. 1, providing an added color production capacity.

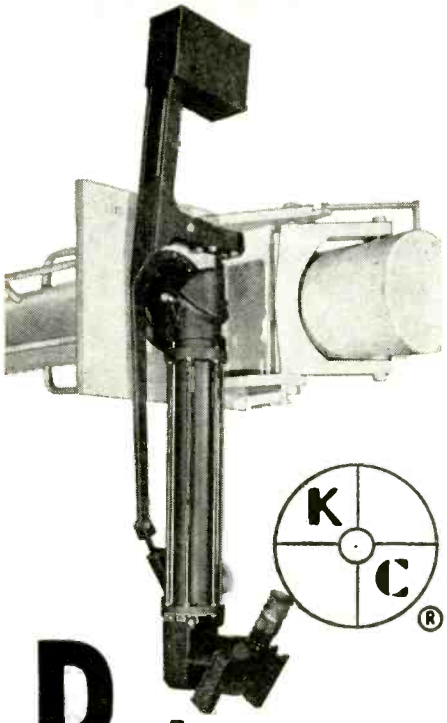
Existing color studio facilities in New York are the Colonial Theater and Studio 3-H in Radio City.

Sylvania Dedicates Plant, Elects Officer

SYLVANIA dedicated its new 422,000 sq ft tv-set assembly plant in Batavia, N. Y., largest of its plants, under one roof.

The Batavia plant on which construction began in the summer of 1953, commenced operations last March. The manufacture of production model receivers gradually was transferred to Batavia from the company's plant in Buffalo. Now all commercial tv sets are being produced there. The plant now employs approximately 1,200 persons. Television engineering, including development work on color television sets and the production of prototype models, is being carried on in Buffalo. In the new plant four reciprocating lifts carry material from the second to the first floor. A continuous lift device carries incoming goods to the second floor. In the process-test area, television chassis are placed on a moving slat conveyor so that electrical tests can be made while each chassis is moving toward the next operation.

Arthur L. B. Richardson has been elected secretary and general counsel of Sylvania, succeeding



Periscopes

For "HOT SPOT" Remote Observation

A custom designed industrial periscope is very often the answer to "Hot Spot" remote control handling, instrumentation and observation. We have designed and manufactured many such periscopes.

If you have a problem calling for a periscope or for any precision optical system, check with us. For nearly half a century Kollmorgen has designed, developed and manufactured precision optical products including Industrial and Naval Periscopes, Fire Control Devices, Projection Lenses and Navigational Instruments for Industry and for the Armed Services.

Send for Bulletin 301

KOLLMORGEN Optical CORPORATION

Plant: 347 King Street, Northampton, Mass.
New York Office:
30 Church Street, New York 7, New York

ZOPHAR

WAXES

COMPOUNDS

Zophar Waxes, resins and compounds to impregnate, dip, seal, embed, or pot electronic and electrical equipment or components of all types; radio, television, etc.

Cold flows from 100°F. to 285°F.

Special waxes non-cracking at −76°F.

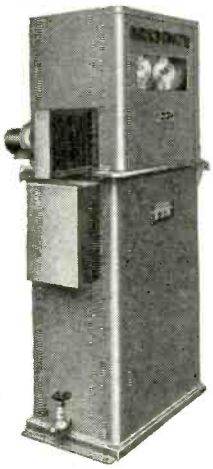
Compounds meeting Government specifications plain or fungus resistant.

Let us help you with your engineering problems.

ZOPHAR MILLS — QUALITY — SERVICE — 108 YEARS EXPERIENCE

ZOPHAR MILLS, INC.
112-130 26th Street,
Brooklyn 32, N. Y.

NOW...SOLVE YOUR HIGH VOLTAGE PROBLEMS with BETTER EQUIPMENT



34 KW 17,000 V.D.C.

MAGNATRAN

Our years of experience gives you MAGNATRAN Heavy Duty High Voltage products . . . built for longer life and rugged performance

← NEW UNITIZED RECTIFIERS
For high voltage D.C. sources . . . lower initial cost . . . minimum upkeep . . . convenient — ready to connect to AC. line and D.C. load . . . compact — requires minimum floor space.

AIR . . . OIL . . . ASKAREL
Plate Transformers . Filament Transformers . Filter Reactors . Modulation Transformers . Distribution Transformers . Pulse Transformers . Testing Transformers . Precipitation Transformers . General Purpose Transformers . Hi-Voltage Transformers.

Askarel Immersed Filter Reactor 50,000 Volt Test

WRITE FOR DETAILED INFORMATION MEETS STANDARDS OF AIEE-NEMA

A NAME SYNONYMOUS WITH EXPERIENCE

MAGNATRAN INCORPORATED
TRANSFORMERS AND ELECTRICAL EQUIPMENT
WALTER GARLICK, JR., PRESIDENT
246 SCHUYLER AVE., KEARNY, NEW JERSEY

MAGNATRAN ®

A. L. B. Richardson

John S. Learoyd who retires.

Richardson has been general counsel for the company since 1953. He joined Sylvania in 1945 as patent attorney, and in the same year was appointed manager of the patent law department. In 1950, he was named general attorney for the company and in 1953 was elected general counsel.

Previous to his Sylvania affiliation, Richardson was an attorney for a Chicago law firm. Prior to this, he had been assistant patent attorney in GE's patent department. He joined GE as an electrical engineer in 1934.

Palley Joins Temco Aircraft

I. NEVIN PALLEY, formerly chief of missile design for Chance Vought Aircraft, has joined Temco Aircraft Corp. of Dallas, Texas in the newly created post of vice-president of engineering.

Palley will have complete respon-

sibility for all Temco engineering and electronic activities. Reporting to him will be H. G. Erickson who will continue as chief engineer and G. B. Spaulding who will continue as superintendent of electronics.

Palley was recently appointed a member of the Technical Advisory Panel on Aeronautics for the Assistant Secretary of Defense for Research and Development.

Palley left Curtiss-Wright to join Chance Vought Aircraft in 1941 and six months later was made head of the preliminary-design group.

Starting with a group of thirty engineers he directed the Regulus missile project from its inception to the point where he was directing 600 engineers and the Regulus became a successful operational missile.

At Temco, Palley will direct advanced projects both in the piloted aircraft and missile fields.

Emerson Research Names Engineers

RAYMOND E. WILSON has been appointed principal physicist at the Emerson Research Laboratories in Washington, D. C., a division of Emerson Radio. Dr. Wilson transferred from the National Bureau of Standards where he served as chief of the temperature measurements section and assistant chief of the heat and power division. Prior to specializing in the field of temperature measurements, he was engaged in underwater ordnance work for the U. S. Navy.

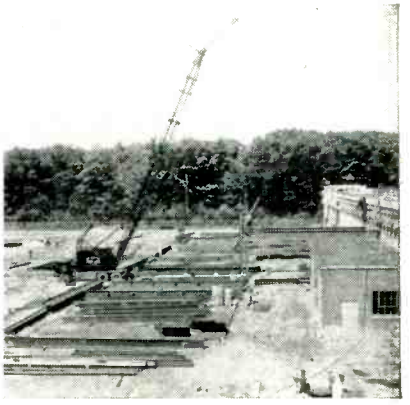
Sydney Rattner has joined the staff of Emerson Research as a principal electronic engineer. Prior to joining Emerson, Rattner was a member of the Diamond Ordnance Fuze Laboratories where he served as an assistant branch chief of the guided missile fuze laboratory. This laboratory was formerly the ordnance electronics division of the National Bureau of Standards.

Norman A. Kahn has been appointed as a principal mechanical engineer at the Laboratories. Kahn was formerly assistant mechanics branch chief of the guided missile fuze laboratory of the Diamond Ordnance Fuze Laboratories. He has specialized in the development

of electromechanical devices for guided missiles, rockets, fire control systems and underwater ordnance equipment.

James Bonelli has been appointed manager of the materials division of Emerson Radio.

Bonelli has an electronics background extending back to 1938 when he entered the industry as an engineer. In subsequent years, he was plant manager for two major electronics manufacturing companies.



Carboloy Plant Construction Underway

CONSTRUCTION starts as first steel beams swing into place for the million-dollar plant addition at Carboloy department of General Electric Company in Detroit. The structure, to be completed this fall, will add 36,000 sq ft of floor space to the department's metals building. It will accommodate new engineering and manufacturing equipment and allow the rearrangement of other facilities to make 16,000 sq ft of vacated space available for advanced-engineering activities, including pilot plant and laboratories

B.B.C. Engineers Tour Du Mont's Tele-Centre

AS ONE of the stops in a two-week tour of American television facilities, a group of executives for the British Broadcasting Corporation recently inspected the Du Mont Television Network's Tele-Centre.

The proposed studio control room layout for the B.B.C.'s soon due TV studios in White City, London, are

to be patterned after the Tele-Centre's split arrangement.

The B.B.C. group included: R. H. Howell, chief of building construction and maintenance; H. W. Baker, supervising engineer of the B.B.C.'s television studios; S. W. Watson, head of television design engineering; R. H. Mannons, head of television planning and installation and Reginald Patrick, chief engineer for the B.B.C's New York office.

ElectroData Names Bradburn President

JAMES R. BRADBURN has been elected president of ElectroData Corporation, electronic computer affiliate of Consolidated Engineering.

Bradburn, who was named executive vice president of the computer firm in February, 1954, succeeds P. S. Fogg as president. Fogg will continue as chairman of the board.

Bradburn joined Consolidated in 1945 as treasurer and assistant to the president. In 1946, he became director of sales and vice-president in charge of commercial engineering. He subsequently served as vice-president and director of engineering. In December, 1953, he was named vice-president and director of Consolidated's computer division.

Dixson To Head Clevite Research

JOHN W. DIXON, executive vice-president of Clevite Corp. since

1951, has been named to coordinate the activities of the firm's new research center with those of the other units in the corporation.

In the newly-created post of vice-president in charge of coordination of research and new product development, Dixon will devote his full time to the activities of the center.

The research center, which is scheduled for its official opening this fall, brings together some 300 scientists, technicians, and administrative assistants whose work was previously conducted in a number of separate places.

Included in the center are two self-contained units, each with its own management: The Brush Laboratories Company, the corporation's basic research group, and Clevite-Brush Development Company, its product development unit.

The Brush Laboratories Company, headed by C. Baldwin Sawyer, president, is principally concerned with fundamental research, much of it toward developing new materials and evolving the basic technology related to their use.

Clevite-Brush Development Company, with A. L. W. Williams as president, is directly concerned with the development or improvement of products which can be produced and marketed by Clevite operating units.

Ford Instrument Names Slawson

KENNETH SLAWSON has been named vice-president of Sperry's Ford Instrument. He will continue to assist president and general manager R. F. Jahn in the general management of the company.

Slawson joined the company in

1928. When Sperry acquired E. G. Staude Manufacturing in 1946, he was appointed manager. He continued at E. G. Staude until he rejoined Ford Instrument this year as assistant to the president.

Convair Plans Computer Expansion

CONVAIR division of General Dynamics Corp. will build a reinforced concrete "data reduction building" soon at its San Diego, Calif. plant. The preliminary cost estimate is $100,000, for the building to be constructed on Convair-owned land.

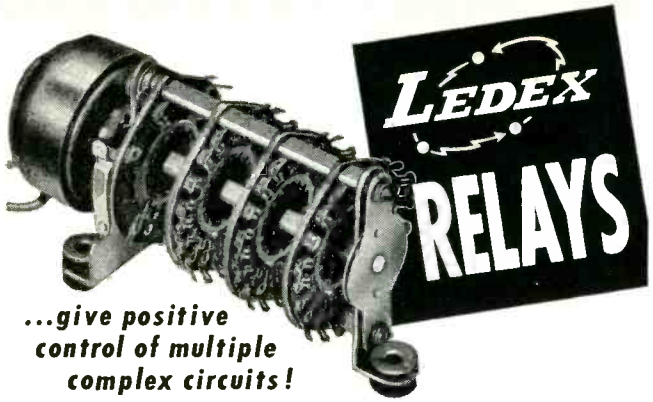
The building will house several million dollars worth of electronic computing devices, and will be built near the $1.2 million engineering research building.

Pacific Northwest Group Elects Officers

G. L. OSBORNE, president of Osborne Electric, was elected president of the Northwest Association of Electronic Manufacturers. M. J. Murdock, general manager of Tektronix, and Leonard Larson, sales manager of Iron Fireman's electronics division, were elected vice-president and secretary-treasurer, respectively. Ray Morrow, president of Morrow Radio, was elected director at large. Last year's president of NAEM, Douglas Strain, president of Electromeasurements, is the other director for the coming year.

Maxson Appoints General Slaughter

BRIG. GENERAL Willis R. Slaughter, U. S. Army Retired, has joined W.



LEDEX RELAYS

...give positive control of multiple complex circuits!

The versatility of Ledex Relays makes it possible to produce special switching combinations for specific applications. Stepping or selective controls are available depending upon the requirements. A wide range of operating voltages can be used by selecting the proper Ledex coil wire size.

HERE'S HOW A LEDEX RELAY OPERATES . . .

A LEDEX ROTARY SOLENOID provides the mechanical power to drive the gang of rotary, wafer type switches. SELECTIVE CONTROL —The commutating switch of the Ledex in combination with the control wafer switch makes it possible to select the multiple circuits to be connected by a single manually operated switch. RATCHETS are used to transmit the oscillating action of the Rotary Solenoid to the Relay rotor shaft. CIRCUIT WAFERS are produced in combinations of 8, 10, 12, 18 and 24 positions. All wafer sections are versatile in application. For example the 12 position wafer switch may be designed to utilize almost any of the factors of 12 such as 1P-12T, 2P-6T, 3P-4T, or 4P-3T. The clips and rotors of the wafer switches are of silver alloy. For most applications the switch insulation is of wax-impregnated bakelite. Ledex Relays are available with foot, flange or panel mountings.

The Engineering staff of G. H. Leland, Inc., will assist you in developing solenoid operated Relays best suited to your products!

WRITE FOR DESCRIPTIVE LITERATURE TODAY!

G. H. LELAND, INC.

123 WEBSTER ST., DAYTON 2, OHIO

DC-7

NEVER BEFORE

such Magnificence . . . such Power

such Performance!

and NEVER BEFORE

has the A. W. HAYDON COMPANY

been so proud of its contribution . . .

In the never-ending conquest of the vast barriers of space and time, Douglas goes ever forward meeting every challenge that men and machines must face. The newest — and brightest — star in the aviation firmament, the Douglas DC-7, is truly a miracle of the mastery of men over machines . . . and in this great work sixteen A. W. Haydon timing devices play an important part.

We at A. W. Haydon take pride in our contribution toward bringing a mass of metal and machinery into integrated performance which meets Douglas' high standards. Integrated performance is born of a multitude of small component parts, working in perfect mechanical and electrical coordination. The A. W. Haydon precision timing instruments are a vital part of this vast network.

DOUGLAS

DOUGLAS DC-7, the ultimate in comfortable and safe air travel. Swift, luxurious, dependable — the new DOUGLAS DC-7 justly deserves the accolades it is receiving.

A. W. Haydon Time Delay Relay is a very important component of the automatic prop feathering system.

A. W. Haydon Time Delay Relay times duration of prop feathering.

A. W. Haydon Repeat Cycle Timer is a vital part of the prop deicing equipment.

A. W. Haydon D.C. Timing Motors are used in the cabin pressurization systems.

when timing poses a problem — consult

(Catalog sent on request)

The A. W. HAYDON COMPANY

235 NORTH ELM STREET

WATERBURY 20, CONNECTICUT

Design and Manufacture of Electro-Mechanical Timing Devices

For Cooling Hot Spots

Lightweight Arrowhead FLEXIBLE DUCTING

ABILITY TO WITHSTAND extreme vibration and flexing conditions have definitely proved the superiority of Arrowhead's Airtron flexible ducting for electronic equipment cooling. This Fiberglass ducting retains its resilient flexibility in all temperatures from −125° F. to +700° F.

Arrowhead's flexible ducting is made in 130 standard types and constructions to serve various engineering applications. It absorbs vibration and torque motions and can be compressed or distorted for easy installation in confined areas. Non-corrosive, Airtron ducting is resistant to oils. vapors, acids and alkalies.

ARROWHEAD BUILDS SPECIAL DUCTS

Laminated Fiberglass plastic ducts in practically any conceivable shape in experimental or production quantities to close tolerances without elaborate or expensive tooling.

WRITE FOR COMPLETE DATA

showing types and applications. Comparative charts show characteristics, temperature ranges, weights, pressure ranges, etc.

ARROWHEAD RUBBER COMPANY — Division of National Motor Bearing Company, Inc.

2350 Curry St., Long Beach 35, Calif.

L. Maxson Corp. as plans and programs advisor. Former Commanding General of the Ordnance Training Command at Aberdeen Proving Ground, General Slaughter will serve Maxson as a technical advisor in systems applications of its products and in long-range planning and evaluation of military projects.

General Slaughter retired from the Army after 41 years of active service, having spent the major portion of his military career in Army Ordnance. His most recent duty included an assignment as Deputy Commanding General of the Aberdeen Proving Ground where the Army's newest weapons and vehicles are studied and tested.

Boeing Builds Wooden Electronics Plant

SINCE large amounts of steel would make accurate testing impossible, Boeing Airplane built a new electronics building at Seattle, principally of wood, with glue-laminated girders and columns.

A small portion of the building is two stories high, thus qualifying the project as one of the few multiple-story structures yet constructed of laminated timber.

The building has 58,000 sq ft of floor space.

Schneider Named By National Union

GERHARD G. SCHNEIDER, who joined National Union Electric in 1934 as a designer and tool maker, has been elected vice-president in charge of production for the firm.

He was originally employed by

National Union to conduct research in the design, development and construction of automatic machinery, manufacturing equipment and devices for the improvement of quality in mass production of radio receiving tubes.

He worked his way up in the company as an equipment engineer, machine shop foreman, plant superintendent, production manager and a member of the operations committee.

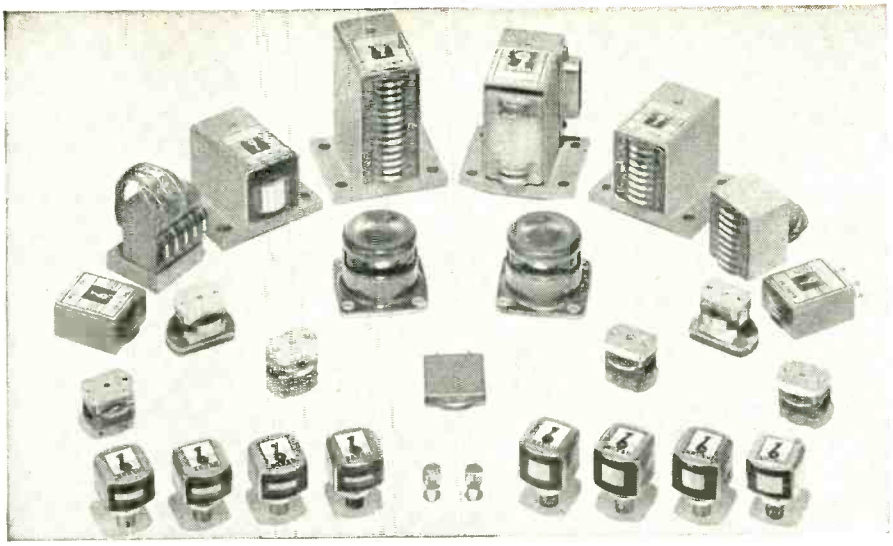
Schneider holds a number of patents, including those for automatic grid-winding machines, electronic tube-base making machines, heater-folding machines, tube-sealing machines, a spray-coating mechanism, heater-inserting machines, tube-removing mechanisms, a pin feeding mechanism and a piece handling machine.

Korean Distributor Promotes Ballentine

EDWIN C. BALLENTINE has been promoted to director of engineering for Korcad, RCA Distributors for Korea in Seoul. In this capacity he will be responsible for all engineering activities and policies of the new company, headed by J. B. Miller, president and G. B. Morgulis, vice-president. Ballentine is also serving as consulting engineer to several associated companies in Korea. Extensive new radio broadcasting facilities were recently purchased by the ROK Government, according to Ballentine.

Jordan Leaves Hughes Aircraft

WILLIAM C. JORDAN, executive vice-president of Hughes Aircraft Co.,



FOR ALL YOUR REQUIREMENTS IN MAGNETIC HEADS

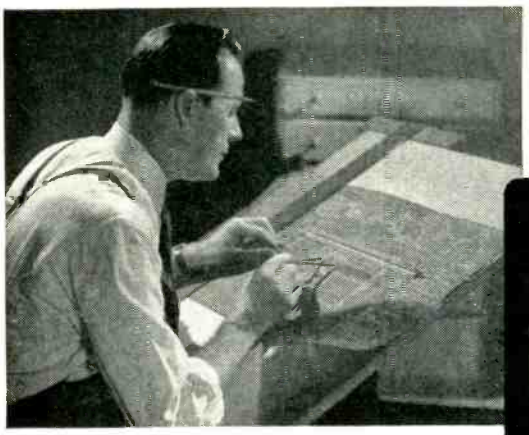
• The performance of magnetic recording equipment depends on the quality of the magnetic head—which records, reproduces or erases. Brush offers a complete line of heads, outstanding for precision alignment and balanced magnetic construction. For assistance in application, call on Brush's unequalled experience in this field. Write Brush Electronics Company, Department K-9B, 3405 Perkins Avenue, Cleveland 14, Ohio.

BRUSH ELECTRONICS COMPANY

INDUSTRIAL AND RESEARCH INSTRUMENTS
PIEZO-ELECTRIC MATERIALS • ACOUSTIC DEVICES
MAGNETIC RECORDING EQUIPMENT
ULTRASONIC EQUIPMENT

BRUSH ELECTRONICS

formerly
The Brush Development Co.
Brush Electronics Company
is an operating unit of
Clevite Corporation.



"HOW MEYERCORD SERVES INDUSTRY"
No. 1 of a Series

MEYERCORD *Nameplate* DECALS Help You DESIGN Your Product

Here's a way to shave production costs starting in the blueprint stage . . . a complete and continuous service to you and everyone in your organization concerned with product development and merchandising.

Meyercord Nameplate Decals identify your product and instruct consumers in its use. We produce Meyercord Nameplate Decals for *any* commercial surface . . . for *any* temperature condition . . . for *any* production run, short or long. And we take over the design problem.

Your Meyercord representative will show how our decals surpass in ease and speed of application . . . with low unit cost. He'll show you how to cut time, labor, and material costs . . . and he'll place our laboratory at your service . . . without obligation.

FREE! "Mark-It" Manual of Decal Nameplates

Send today, on your company letterhead, for this valuable full-color guide to every industrial problem in marking, identification, instruction, and information.

THE MEYERCORD CO.
World's Largest Decalcomania Manufacturers

DEPT. W-303
5323 WEST LAKE ST.
CHICAGO 44, ILLINOIS

TEKTRONIX

Type 531 SAVES ENGINEERING TIME

The Type 531 Oscilloscope saves engineering time two ways. It provides you with an extremely wide range of facilities. It eliminates the need to hunt up another oscilloscope when your requirements change—say from "high-gain" to "wide-band", or to "dual-trace".

Plug-in preamplifiers are used for maximum flexibility in signal handling. Sweep-speed range is 600 million to one—the widest you can get in a single oscilloscope. Accelerating potential is high enough to permit photographing a single sweep . . . even at the fastest sweep speed.

Direct-Reading in Time and Amplitude. You can read time and amplitude with accuracies comparable to indicating meters.

Sweep Range—0.02 μsec/cm to 12 sec/cm.
10KV Accelerating Potential
Versatile Triggering Circuitry
Price—$995 plus price of desired plug-in units

PLUG-IN UNITS

TYPE 53A—DC to 10 mc, 0.05 v/cm to 50 v/cm $85
TYPE 53B—Same as 53A with additional ac-sensitivity to 5 mv/cm $125
TYPE 53C—Dual-trace unit. Two identical amplifier channels, dc to 8.5 mc, 0.05 v/cm to 50 v/cm. Electronic switching triggered by oscilloscope sweep, or free-running at about 100 kc $275
TYPE 53D—Differential input. DC to 350 kc at 1 mv/cm—passband increasing to 2 mc at 50 mv/cm. Full range—1 mv/cm to 125 v/cm $145

Prices f.o.b. Portland (Beaverton) Oregon

See the Type 531 at the INTERNATIONAL INSTRUMENT EXPOSITION Philadelphia—and at the NATIONAL ELECTRONIC CONFERENCE, Chicago.

TEKTRONIX

Tektronix, Inc.
P. O. Box 831A
Portland 7, Oregon
Phone: CYpress 2-2611
Cable: TEKTRONIX

has resigned. Pending appointment of his successor, the executive committee of the company will assume the responsibilities of general management. The executive committee is composed of Howard Hughes, president; R. J. Shank, vice-president and director of research and development—radar; Nathan I. Hall, vice-president and director of research and development—missile division; Raymond B. Parkhurst, vice-president and plant manager—electronic manufacturing and W. W. Wooldridge, vice-president and plant manager—missile manufacturing.

Jordan served as executive vice-president since October 15, 1953, after agreeing to accept the post on a temporary basis.

Johnson Elected By Cornell-Dubilier

LESLIE A. JOHNSON was elected a vice-president of Cornell-Dubilier and appointed manager of the firm's new Sanford, N. C. plant.

Johnson has been associated with Cornell-Dubilier since 1939. Prior to that date, he was employed by Rohm and Haas Chemical Co. He was assistant manager of the firm's New Bedford plant from 1941 to 1945. From 1947 to 1953 he was manager of the Worcester plant, which produces capacitors for military use.

Remler Forms Research Division

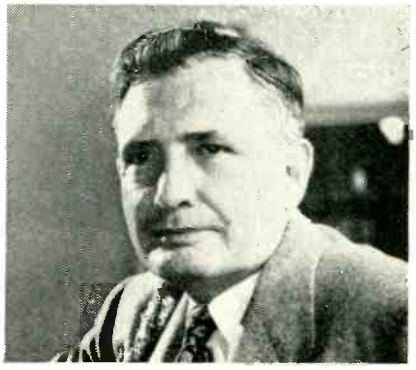
REMLER COMPANY, electronics manufacturer of San Francisco, has set up a new research unit to be known as the Gray Scientific Division.

The new unit will be active in re-

Winfield W. Salisbury

search and development work for industry and the armed services in the fields of radio, radar and electronic physics.

Gray Scientific will be directed by Winfield W. Salisbury, recently director of accelerator research at California Research and Development.



Littelfuse Names Blake New President

THOMAS M. BLAKE has been appointed president of Littelfuse of Des Plaines, Ill.

Blake, for the past eight years, has been executive vice-president of the company.

In his new position, he will take over the responsibilities formerly handled by E. V. Sundt, who will continue as a technical consultant to the company and chairman of the board of directors.

Blake joined Littelfuse when it was incorporated in 1938. For the

preceding nine years, he was associated with the General Outdoor Advertising.

Communications Group Elects R. C. Fuller

R. C. FULLER, general manager of Bendix Aviation's Pacific division, has been elected president of the Armed Forces Communications Association, Southern California Chapter.

Other new officers are C. A. La Har of RCA, vice-president, and Lester R. Daniels of Audio Products, secretary-treasurer.

The AFCA, formed in 1946, is composed of industry representatives and retired and active service communications officers, and is dedicated to "defense and security of the country and toward cooperation with armed forces communications."

Donald H. Allen

Gudeman Opens California Plant

THE GUDEMAN COMPANY of California opened new laboratory and production facilities for the design and production of its products in Los Angeles. The new plant is under the direction of Donald H. Allen, formerly vice-president and general manager of PCA Electronics.

RCA Victor Names Division Engineers

JOHN L. FRANKE has been appointed chief engineer of the engineering department of RCA Vic-

AIRCRAFT SERVO COMPONENT

The Type 71-5 Baroresistor is a pressure actuated potentiometer designed for operational use in aircraft. It features:

HERMETICALLY SEALED MECHANISM

The potentiometer winding and operating parts are hermetically sealed in a vacuum. Pressure is applied inside the bellows only. Therefore, the Type 71-5 Baroresistor is not affected by dust, fungi, or moisture.

RUGGEDIZED CONSTRUCTION

A special high force mechanism was developed for the Trans-Sonics Baroresistor to avoid the necessity for employing micro force potentiometer elements. Shock of 30g in any direction will not cause electrical discontinuity.

MACHINE CALIBRATION

Each instrument is calibrated by machine and its performance is automatically recorded as a graph of resistance versus pressure. Every turn of the winding is inspected. All electrical characteristics are automatically checked in an eleven stage inspection cycle.

Condensed Data

Range: 0-14.7 psi, absolute
Resistance: 7500 ohms
Maximum voltage: 75 volts
Resolution: ⅓%
Accuracy: 2% of full scale

Typical Applications

Servos—Vary servo loop gain as a function of altitude.
Computers—Voltage divider, P total/P static.
Fire Control—Air density measurements.
Telemetering—Pressure transducer.
Recording—Pressure transducer.

Write for Bulletin No. 71-5 for further details

Price: $225.00 Short delivery

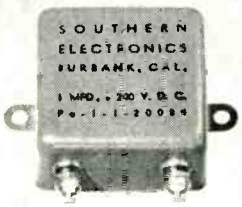
TECHNICAL REPRESENTATIVES

Los Angeles, Calif. Telephone: Cumberland 3-4183
Dayton, O. Telephone: Hemlock 1254
San Carlos, Calif. Telephone: Lytell 3-2189
Seattle, Wash. Telephone: Main 7005
Boston, Mass. Telephone: Capitol 7-9797
St. Louis, Mo. Telephone: Sweetbriar 2175
Houston, Tex. Telephone: Monroe 5-5624

Home Office: Telephone Lexington 9-2508

TRANS-SONICS, INC.

5 Forest Street Bedford, Mass.



1 MFD. 2" x 2" x 1"

0.5 MFD. 1¾" x 1¼" x 1⅛"

0.25 MFD. 1¾" x 1¼" x ⅞"

0.1 MFD. 1¾" x 1" x ⅞"

0.05 MFD. 1¾" x ⅞" x 11/16"

ULTRA-HIGH PRECISION POLYSTYRENE CAPACITORS

as low as 0.1% tolerance in most values

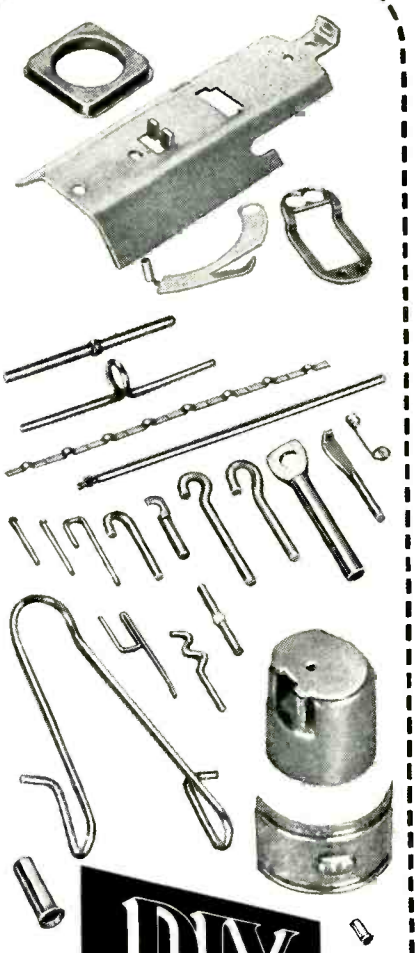
CAPACITANCE AVAILABLE—0.05 to 10.0 MFD.
VOLTAGE AVAILABLE—100 to 400 VDC
INSULATION RESISTANCE—10^6 MEG./MFD.
TEMP. COEFF.—100 P.P.M. per °C (—20° to 140°F)
DIELECTRIC ABSORB.—.015%
DISSIPATION—.0002

Special Values to Close Tolerances—Our Specialty

Write for new, complete catalog to Dept. IA

SOUTHERN ELECTRONICS CORP.

239 W. Orange Grove Avenue, Burbank, Calif.



PIX

Dependable • Precision Wire Forming and Stamping Specialists

Precision Parts to meet your Production and Engineering needs. From .002" dia. to .125" dia. Radio tube parts—Stampings—Drawings. Modern facilities, high-production equipment.

Send sketch or print for quotation.

PIX

MANUFACTURING CO., Inc.

24A Bedford Street
Newark 3, New Jersey

tor's radio and Victrola division.

Alexander D. Burt was named manager of record changer engineering and Paul R. Bennett was appointed manager of radio and phonograph engineering, both reporting to Franke. Thomas S. Weeks has been appointed general plant manager for the division.

Franke previously served as manager of radio and phonograph engineering. He has been with RCA Victor since 1930, when he started as a draftsman.

Burt joined RCA in 1930 as a loudspeaker engineer. Since 1946 he has supervised record changer engineering activities for the home instrument division.

Bennett has served as chief engineer of RCA Victor's plant in Buenos Aires, Argentina. In 1943 he was transferred to the engineering section in Camden and in 1951 was named manager of its electrical and export group, the position he leaves to assume his new duties.

Weeks, who started with RCA as an assembly line operator in 1933, was manager of the company's tv set plant in Bloomington, Ind. prior to his new appointment. G. L. Leinenweber has been named to succeed Weeks as Bloomington plant manager. He was previously assistant to the home instrument division general plant manager.

ESC Moves To New Plant

ESC CORP., manufacturers of delay lines, transformers and networks, has moved to a new and enlarged plant in Palisades Park, N. J.

The Newton Company Buys American Tool

THE Newton Company of Manchester, Conn. has purchased the machinery and equipment of American Tool Works of Hartford. These facilities will be removed to the purchaser's plant in Manchester. Many of the former employees of American have been employed on the newly acquired facilities. The new addition complements Newton's engineering, research and development activities with facilities for

you could print your own money...

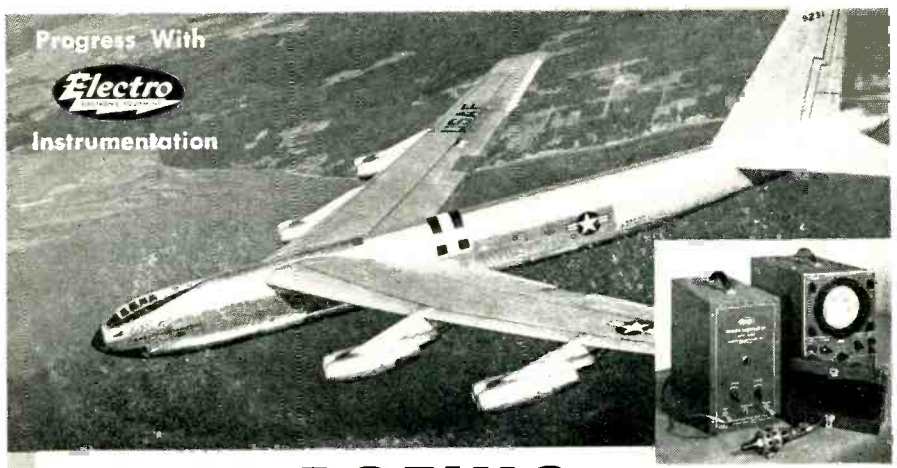
But those who've tried it report that the results are never worth the effort and trouble.

That's how it is with coils, too. Why make your own—when in most cases we at Coto-Coil can make them for you faster, better and at less cost? We've had nearly 40 years of coil design and manufacturing experience. We know the best types of materials for each type of coil. We use automatic production equipment, the most modern testing devices.

Find out how this combination can cut costs for you.

Coto-Coil Company, 63 Pavilion Avenue, Providence 5, R. I. New York Office: 10 E. 43rd Street, New York 17, N. Y.

Coto PRECISION WOUND Coils



ELECTRO DYNAMIC MICROMETER
Model 3600-A

USED BY BOEING TO HELP BUILD THE B-52

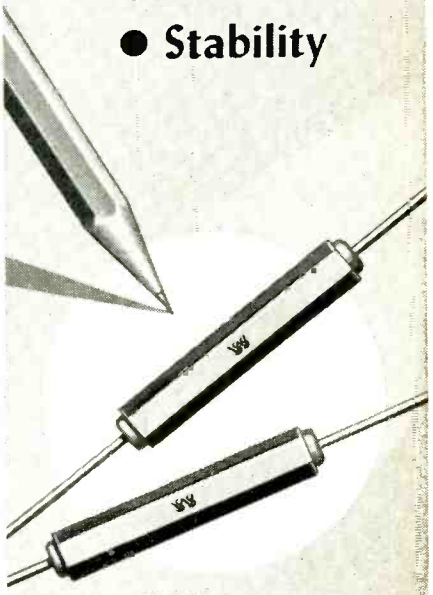
Extremely fine tolerances required in the production of these more than 600 m.p.h. Stratofortresses are made possible with the Electro Dynamic Micrometer. It accurately measures, wihout contact or "loading" axial or radial displacement to .0001". Also views the amplitude of dynamic movement of any metal body at any speed. Measurements are independent of acceleration or frequency of displacement. The sensing unit is calibrated for direct reading.

- Measures radial expansion due to high speeds • Bearing slap in motors
- Travel, bounce of relay contacts • Eccentricity of commutators, slip rings
- Shaft whip • Vibration in motors, turbo compressors, heat exchangers.

Write for Detailed Bulletin DM 1250

ELECTRO PRODUCTS LABORATORIES
4501-Ed N. Ravenswood, Chicago 40, Ill.
Canada: Atlas Radio Corp., Ltd., Toronto, Ont.

- Low noise level
- Precision
- Stability



S.S.White 65X MOLDED RESISTORS

RATING—1 watt.

TEMPERATURE COEFFICIENT—From approx. +0.1%/°F for 5000 ohm values to approx. —0.2%/°F for 10 megohm values.

VOLTAGE COEFFICIENT—Rated at less than 0.02%/Volt.

UPPER TEMP. LIMIT—170°F for continuous operation.

NOISE LEVEL—Low noise level inherent, but at extra cost we can test and guarantee standard range resistors with "less noise than corresponds to a resistance change of 1 part in 1,000,000 for the complete audio frequency range."

VALUES

Standard Range—1000 ohms to 9 megohms.

Extra High Value Range—Up to 10,000,000 megohms.

BULLETIN 4906 has full details. Send for a copy. Attention Dept. R

THE S.S.White INDUSTRIAL DIVISION
DENTAL MFG. CO.
10 EAST 40th ST. NEW YORK 16, N.Y.
Western District Office • Times Building, Long Beach, Calif.

the production of special tools and precision components.

Among the former officers and management of the American Tool joining Newton are John Sundkvist, founder, who will act as a consultant. Norman Nelson will continue as sales manager and Edward Wild will continue as superintendent of the production department.

J. J. Bachner

Chicago Molded Elects Officers

EDWARD F. BACHNER, SR., has been named to the newly created post of chairman of the board of Chicago Molded Products. Marcel F. Bachner, formerly vice-president and treasurer, has been elected president and treasurer. John J. Bachner has been upped to executive vice-president and general manager. All other officers were re-elected.

Gams Named By T. L. G. Electric

THEODORE C. GAMS, consulting electrical engineer, has been retained by T. L. G. Electric to organize and direct its new custom engineering department. The new division will specialize in short-run, one-of-a-kind and developmental production of electronic test and processing equipment.

Gams has been a consulting engineer for many years. He taught electrical engineering and electronic design in both the graduate and undergraduate schools at the

for Radar • Communications • Laboratory • Computers

SERIES M200
Miniature i. f. Amplifiers

Here's a brand new way to design i. f. strips! Simply reach for your purchase order pad, specify the characteristics you desire, and mail to Instruments for Industries, Inc. Standard models are available from stock, special designs get prompt attention from our engineering and production staff.

I. F. I.'s fast, convenient service on i. f. strips and other types of broad-band amplifiers has saved valuable design and production time for many leading companies. For complete details write: Instruments for Industries, Inc., 125 Old Country Road, Mineola, N. Y.

Specifications of Standard Units

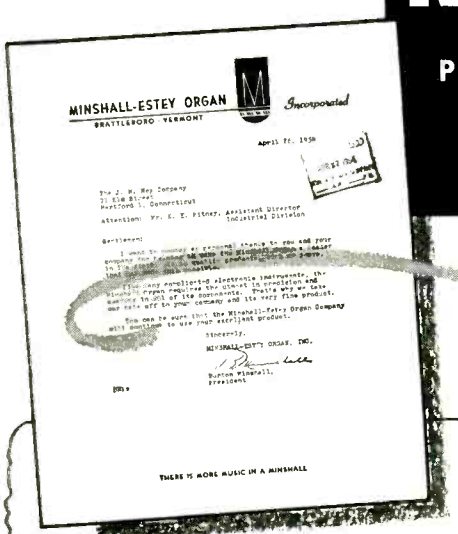
	M260	M230
Band center frequency	60 mc	30 mc
Band width	10 mc	2 mc
Voltage gain	110 db	120 db
Output power	up to 0.02 watts	up to 0.1 watts
Input impedance	50 ohms	50 ohms
Input V. S. W. R.	less than 1.2:1 over pass band	less than 1.2:1 over pass band

Note: M230 model available with 1.5 db noise figure

- 8 — 6AK5's mounted on flat chassis, 1½" x 15"
- Standard BNC cable connectors used for r-f terminals

INSTRUMENTS FOR INDUSTRIES, INC. 126 Old Country Road Mineola, N. Y.

NEY'S SMALL PARTS PLAY A BIG PART IN PRECISION INSTRUMENTS



"Like many complicated electronic instruments, the Minshall Organ requires the utmost in precision and quality in all of its components. That's why we take our hats off to your company and its very fine product."

With ideal physical and electrical properties, resistance to tarnish and most corrosive atmospheres, Ney Precious Metals, fabricated into slip rings, brushes, wipers, and contacts, have again demonstrated their superiority for use in precision electrical and electronic apparatus. Improve the accuracy and prolong the life of your instrument by using Ney Precious Metal Alloys. Write today to...Engineering Department.

THE J. M. NEY COMPANY

Specialists in Precious Metal Metallurgy Since 1812

179 ELM STREET, HARTFORD 1, CONNECTICUT

13NY54B

DC-AC CHOPPERS

0-500 cycles
DEPENDABLE

All military specifications met. Liberal factors of safety to meet emergency conditions.

1. Production sampled daily and life tested to check 1,000 hour rating.
2. Every Chopper given not only one but two tests over the full range of military temperatures before shipment.
3. Only gold contacts used for superior operation in the vital 0-1½ volt d-c range.
4. Liberal safety factors to meet emergency conditions.
   a. 0-500 cps.
   b. Input voltage ±30%

WRITE FOR THESE CATALOGS
No. 371, 0-500 CPS.
No. 370, 60 CPS.

STEVENS ARNOLD
INCORPORATED

22 ELKINS STREET
SOUTH BOSTON 27, MASS.

S/A-11

Polytechnic Institute of Brooklyn for seven years, from 1945-52.

His most recent major consulting activity was the organization of the custom engineering department of Douglas Laboratories, suppliers of test and processing equipment, which he directed from 1952 to 1954.

Gams has also served as chief engineer of Allied Laboratory Instruments and as director of the School of Industrial Technology.

In his new post, he will have the title of director of engineering operations.

Canada Names Arthur Levin

AT THE request of the Canadian Government Arthur Levin, director and chief engineer of Cossor (Canada), will assist the Government in special work for the armed services for a few months.

Resistor Firm Organized By Monson

MONSON MANUFACTURING in Chicago was recently formed to manufacture resistors. The firm plans to also make a line of capacitors and other electronic components.

Harry Monson is president and general manager of the new firm. He is also president of Monson Corp., manufacturers' representative. He was formerly vice-president and sales manager of Ampro Corp., now a division of General Precision Equipment.

Hal F. Fruth is vice-president in

Harry Monson

charge of research. He holds 67 patents granted or pending on electronic components and processes. Dr. Fruth formerly headed research departments at Raytheon and P. R. Mallory and was assistant research director at Western Electric and Motorola.

Axel Monson, secretary-treasurer, organized, developed and headed Ampro Corp. for many years until it was purchased by General Precision Equipment.

Otis Boykin, chief engineer, holds a number of patents on electronic components. He is also a research consultant in the electronic and chemical fields.

Harry Miller, production engineer, was formerly production engineer at Zenith, Motorola and Communication Coil Co. He is also a consultant in production and electronic equipment design.

Philharmonic Adds Two V-P's

PHILHARMONIC RADIO & TV CORP. has promoted Eli Saltz to vice-president in charge of manufacturing and Mike J. Morris to vice-president in charge of engineering. No changes will be made in either's duties since both men were heads of their respective departments. Both have been with Philharmonic for the past four years.

Astatic Names G. L. Werner

G. LEONARD WERNER, formerly sales manager of Mark Simpson Mfg., has been appointed general sales manager of The Astatic Corp.

While with Simpson, Werner also

held the positions of chief engineer and director of sales engineering. He originated and designed the company's products and was directly concerned with production, sales promotion and advertising. His wide scope of duties also included liaison and sales engineering work with government agencies.

Werner entered the radio business in 1930 and for a number of years manufactured sound and intercom equipment and other electronic devices.

Granco Doubles Production Capacity

GRANCO PRODUCTS, makers of uhf tuners, has opened its new plant annex in Long Island City, N. Y. The single-story structure is equipped with new machinery, assembly lines and test positions to provide for more than twice the previous production capacity. In the new and old buildings over 300 workers can be accommodated on a one-shift basis and production capacity has more than doubled.

Burnell Opens West Coast Division

A PLANT has been opened in California by Burnell and Company of Yonkers, New York, designers and manufacturers of electronic parts.

The new firm, a wholly-owned subsidiary, is known as Burnell and Company, Pacific division, and will maintain office and factory operations in South Pasadena, California.

Frank W. Edmonds has been named president of the Pacific division. Edmonds was formerly chief

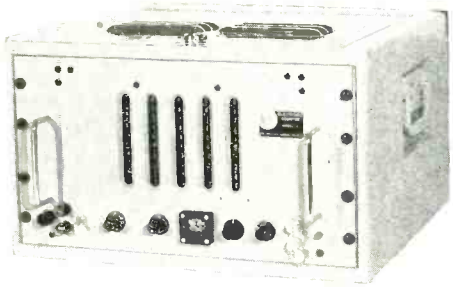
Frank W. Edmonds

Electronic Counter — MODEL 111

- **All Digital Operation for High Reliability.**
  No frequency adjustments are made. The counting interval is generated by digital division of the crystal standard frequency.
- **Internal Self Checking Features.**
- **Input Level Metering Circuit.**
- **Military Quality Premium Components Throughout.**
- **Rugged Construction for Field Use.**

SPECIFICATIONS

Frequency Range	Sinewave 10 to 100,000 cps. Pulse 0 to 100,000 counts/sec.
Accuracy	±1 Count
Counter Capacity	99,999.
Input	Sinewave 0.1 to 100 v peak-peak. Positive pulses 0.1 to 100 v peak.
Input Voltage	0.1 Volt Minimum Peak-Peak
Input Impedance	1 Megohm Shunted by 50 mmfd.
Counting Interval	1 or 10 Seconds.
Interval Accuracy	±0.0005 Percent.
Count Display Time	1, 2, 5, 10 Seconds or Manual Reset
Power Input	3 Amperes, 105-125 Volt, 55-65 CPS.
Ambient Temp.	-20° - 150° F.
Cabinet Size	22" Wide X 12½" High X 17" Deep
Weight	120 Pounds.



Price: $2250 F.O.B. Los Angeles

DUNKIRK 2-7353

Electronic Engineering Company *of California*

180 SOUTH ALVARADO STREET...LOS ANGELES 57, CALIFORNIA

Beat THE Heat (AN OLD CORNISH CUSTOM)

with **"TEF-COR"**

HOOK-UP WIRE

CORNISH scores another triumph with this tough, super-flexible product that has proven itself under fire.

Heat-resistant to 500° F.

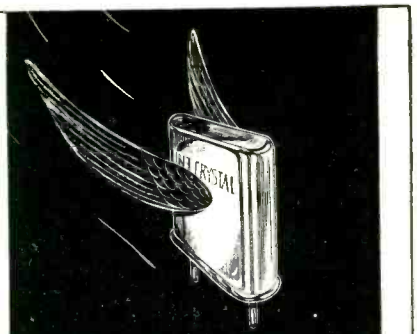
This new super-heat wire, insulated with "TEFLON," is ideal for guided missile, jet and low-tension aircraft applications, transformer and coil leads. Sizes from AWG10 through 28. Also supplied with silver coated copper shields, and to individual customer requirements. Write for further information.

- ***Cold-resistant to —67° F***
- ***High dielectric properties***
- ***Does not support combustion***
- ***Impervious to known solvents***
- ***Perfect concentricity***
- ***Tough, homogeneous, uniform***

Companion to the famous "NOFLAME-COR"

"MADE BY ENGINEERS FOR ENGINEERS"

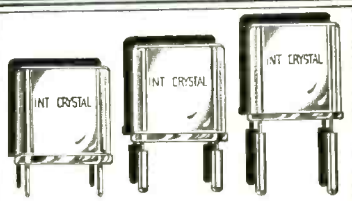
CORNISH WIRE CO., INC.
50 Church St., New York 7, N.Y.



ONE DAY SERVICE on QUARTZ CRYSTALS

throughout the range of frequencies from 1500 kilocycles to 50 megacycles. Fundamental Crystals — 1500 KC - 15000 KC. Overtone Crystals — 15 MC - 50 MC.

All orders of less than five units of any one frequency in the range 1500 KC - 50 MC – will be mailed within 24 hours from the time received.



F-605	F-609	F-612
Pin dia. .050 Pin lngth. .238	Pin dia. .095 Pin lngth. .445	Pin dia. .125 Pin lngth. .620

Pin spacing on each of above is .486

WHEN ORDERING SPECIFY:

(1) Frequency
(2) Holder Type*
(3) Circuit Data (32 mmf load, series resonance, etc.)
(4) End Use (Equipment type & manufacturer, development, etc.)

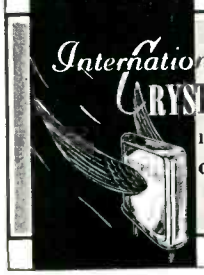
*Adaptors can be supplied for ¾" pin spacing.

Calibration

All fundamental crystals are calibrated into 32 mmf unless otherwise specified. All overtone crystals are calibrated for series resonance, unless otherwise specified.

All units are calibrated to .0025% or better of their nominal frequency at 25° C.

For further information write, wire or call:



International CRYSTAL Mfg. Co., Inc.
18 N. Lee
OKLAHOMA CITY, OKLA.
Phone FO 5-1165

engineer of the transformer division of Langevin Mfg., general manager of Radio Development and Research Corp. and chief engineer of the transformer division of Federal Telephone and Radio.

The Pacific Division, according to Edmonds, will stock the firm's complete line of products. It will engage in limited production of some of these products and plans to gradually expand productive facilities to full production of all types of Burnell coils and filters.

Dearborn Glass Expands Plant

DEARBORN GLASS COMPANY, specialists in glass processing, has transfered all Chicago operations to their new plant and office building in Bedford Park, Ill.

The new building provides 100,000 sq ft of floor space and is located on a 22 acre plot. This is the first phase in an overall expansion program. Plans are now underway which will eventually triple present facilities.

Moloney Electric Promotes Engineers

MOLONEY ELECTRIC COMPANY, transformer manufacturer in St. Louis, Mo., recently made the following appointments: Howard D. Tindall, formerly section engineer of the distribution and specialty transformer divisions has been named assistant chief engineer and vice-president. He joined the firm in 1940 as a design and development engineer.

Edward F. Classen and D. E. Spackler were appointed vice-presidents of the company. Classen was previously with Emerson Electric

Howard D. Tindall

and McDonnell Aircraft before joining Moloney in 1950. Spackler joined the firm in 1950 as a member of the sales department.

Honeywell Names New Marine Head

JERRE V. MANNING has been appointed general manager of the marine equipment division of Minneapolis-Honeywell.

The division, with headquarters in Seattle, Wash., produces the Sea Scanar, an ultrasonic underwater scaning device used for fish-finding, salvage operations and navigation.

Manning, who succeeds Walter Munson, resigned, has been divisional manager in Chicago for the firm's Micro Switch division. He joined the company in 1940.

Automatic Control Elects Officers

NEW OFFICERS for the Automatic Control Company in St. Paul, Minnesota, manufacturing engineers of control systems, have been elected. L. H. Mogck, treasurer, has been named president and treasurer; J. S. Williams retains his position as vice-president and R. A. Sandberg, production manager, becomes secretary.

Du Mont Names Keeton Arnett

KEETON ARNETT has been named vice-president, administration, of Du Mont Laboratories.

Arnett has served as general assistant to the president since 1951.

Union Carbide Appoints Kinzel

AUGUSTUS B. KINZEL has been appointed director of research for Union Carbide and Carbon Corp.

In his new capacity he will be responsible for the administration and co-ordination of the research activities of all divisions of Union Carbide. These activities are carried on in seven major laboratories.

Dr. Kinzel has been actively engaged in research work with Union

Carbide since 1926 when he joined Electro Metallurgical Company as a research metallurgist. He became chief metallurgist of the Laboratories in 1931 and a vice-president of Electro Metallurgical in 1944.

L. E. Packard

Technology Instrument Promotes Officers

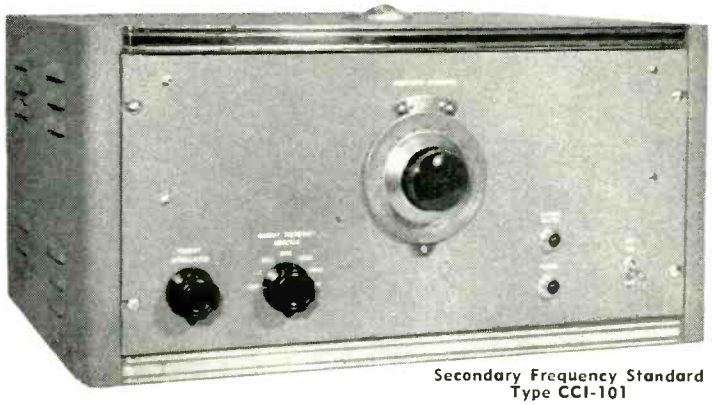
L. E. PACKARD is now chairman of the board of directors of Technology Instrument of Acton, Mass., with R. W. Searle serving as president and treasurer of the corporation. F. P. Perier has been named general manager and W. W. Graustein is chief engineer. Both Perier and Graustein are newly appointed to the TIC board of directors.

Eitel-McCullough Names Engineers

BYRON BALLOU and William McAulay have recently been added to the field engineering staff at the San Bruno, California, plant of

Byron Ballou

PROVEN PERFORMANCE!



Secondary Frequency Standard
Type CCI-101

Seven Years PROVEN Performance

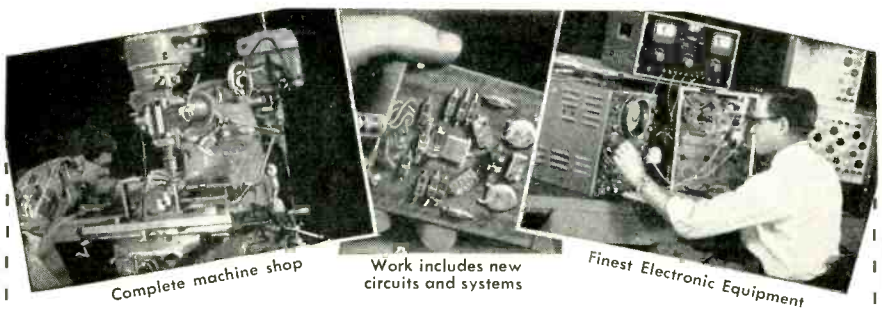
Compare these outstanding features:

- Stability 1 part/10 million over period of hours
- Standard oscillator variable 40 PPM with dial calibrated in parts per million and directly readable to 0.1 part per million
- Resetability to within 0.1 PPM
- 1 KC Harmonic to 15 Mc
- 10 KC Harmonics to 100 Mc
- 50 KC Harmonics to 150 Mc
- 100 and 250 KC Harmonics to beyond 250 Mc
- Low output impedance
- Low cost

First Time Available! A sliding secondary frequency standard with direct reading in parts per million up to 40 PPM.

Eng Prod. Div. **ORDER NOW!** **WRITE IMMEDIATELY!**

Continental Communications, Inc.
452 WEST CHICAGO AVENUE, CHICAGO 10, ILLINOIS



Complete machine shop | Work includes new circuits and systems | Finest Electronic Equipment

Leaders and Specialists in **"ENGINEERING"**

offered splendid opportunities in Boston Engineering Laboratory!

Men qualified to handle high level assignments in electronics are offered a challenging opportunity in Boston, under ideal working conditions divorced from production. The laboratory provides stimulating projects, an atmosphere of scientific progress and provides assistance towards your personal advancement or professional recognition. You will work with a top level technical staff possessing the finest facilities. Administrative positions are open to men qualified to guide the efforts of others.

MICROWAVE ENGINEERS

Senior engineers to handle design and development projects and provide technical direction of other top-level engineers working on microwave circuits and microwave plumbing in the development of military airborne electronic equipment. Should have 5 years' experience in such work and at least a BS degree.

RADAR SYSTEMS AND CIRCUIT ENGINEER

To assume responsibility for electronic circuit design for major elements of complex airborne electronic equipment. Should have a BS degree and about 5 years' experience.

Sylvania provides financial support for advanced education as well as a liberal insurance, pension and medical program. Investigate a career with Sylvania.

INTERVIEWS BY APPOINTMENT

Don Bradley, Personnel Manager, Boston Engineering Lab. Dept. B

SYLVANIA ELECTRIC PRODUCTS INC.

70 FORSYTH STREET • BOSTON, MASSACHUSETTS • KEnmore 6-8900

HERE'S WHAT *we* MEAN BY-

Miniature

BEARINGS!

TYPE RF FILMOSEAL

from 0.1969" O.D.

Smallest Sealed Retainer Type Radial Ball Bearing

An **RMB** *First*

This is a miniature bearing! It looks like a big bearing, doesn't it? That's because it has all the features of a big bearing, such as—

- **Deep groove races**
- **Balanced two-piece or snap-type ball retainer**
- **Non-rubbing capillary oil seal**
- **Removable and replaceable dust shield**
- **Precision tolerances**

RMB Type RF Filmoseal bearings (illustrated) are available in sizes from 0.1969" O.D.

Type RF now available in R2 size (ABEC-1, 3, 5) (⅛" bore—⅜" O.D.)

Bring your Miniature Bearing Problems to **RMB**

A complete line of over 250 miniature and instrument bearings including radial and roller types available for prompt delivery. Experimental quantities from stock.

Write for catalog 12
Or see our catalog in Sweet's Files.

RMB LANDIS & GYR,
INCORPORATED
45 WEST 45TH ST. • NEW YORK 36, N. Y.

William McAulay

Eitel-McCullough.

Ballou has been with Eimac for the past ten years. He was previously employed by Globe Wireless and the University of California radiation laboratory.

McAulay came to Eimac from NBC where he was a station engineer and transmitting engineer.

Winder Aircraft Expands Facilities

WINDER AIRCRAFT of Winder, Georgia, is expanding in the electronic and guided weapons field.

The firm is acquiring specialized electronic research and test equipment, and hiring engineers and technicians for work in electronics.

Sterling Names Chief Engineer

FRAZIER O. STRATTON has been named chief engineer of Sterling Engineering in Laconia, N. H.

Prior to joining Sterling in 1953 as assistant sales manager, Stratton was associated for seven years with C. P. Clare as sales engineer. He also served as a staff engineer in the sales department of Automatic Electric following five years as chief engineer of the New York Stock Exchange. From 1939 to 1942 he was general manager of service with Thomas A. Edison.

Atkinson Opens Tape Plant

ATKINSON LABORATORY, of Hollywood, Calif., color film processing specialists, opened a subsidiary plant for the manufacture of magnetic sound recording tape in Bev-

erly Hills. The plant is now in full production.

Tech-Master Moves To Brooklyn

TECH-MASTER of New York City has moved to new larger quarters in Brooklyn, New York. The company manufactures television kits, custom-built chassis and high fidelity sound equipment.

B & R Electronics Acquires Tele-Tone Name

B &R ELECTRONICS Co of New York City, manufacturers of radios and phonographs, has purchased the name, trademark and patents of Tele-Tone. A complete new line, including radios, portable phonographs, combinations and high-fidelity units will be made under the new label.

The addition of Tele-Tone will not effect B & R's present manufacturing program under its other trade names.

Oak Manufacturing Plans Expansion

OAK MANUFACTURING of Chicago, makers of radio and tv parts, plans an expansion of facilities and personnel at its advance development laboratory in Rockville Center, New York.

The development group there is headed by Rudolf Selbmann, engineering manager; Walter Piwinski, senior project engineer and Morris Tucci, chief mechanical engineer, all under the home office direction of R. E. Wood, chief electrical engineer.

Buxton Industries Expand

BUXTON INDUSTRIES of Pasadena, Calif., tv antenna manufacturer, has moved into a new plant in Pasadena that more than triples the previous plant's area.

Midwest Research Appoints Levy

SHELDON L. LEVY, formerly a mathematics professor at Brown University, has been named manager

of the applied physics division at the Midwest Research Institute.

Dr. Levy succeeds Dr. R. R. Hancox who has taken a position with the Great Lakes Pipeline Company.

Link Radio of New York Is Organized

A NEW company, Link Radio Corp., in New York City, has taken over complete rights and title to all of the assets of the former Link Radio Corp.

Murray Platt, president of the new company, announced that the concern is now in a strong financial position and that production lines are in full swing for all types of past and present Link equipment.

The new Link Radio Corp. is owned and operated exclusively by Platt. Key executives working with him are: James B. Ferguson, chief engineer; Paul H. Bellingham and Robert W. Fisher, both assistant chief engineers and district managers; and Ignatius R. Barbitta, central district manager.

Franklin Electric Enlarges Plant

FRANKLIN ELECTRIC, manufacturers of electric motors', placed contracts for the construction of an addition to their main plant in Bluffton, Ind., doubling its size to provide for employment of up to 1,000 workers.

Federal Labs Names Dodington

S. H. DODINGTON has been named laboratory head in charge of the radio navigation and radio equipments of Federal Telecommunication Labs.

Dodington, who joined FTL in 1941, has long been associated with the development of airborne navigation systems and has been granted over twenty patents for his contributions to the field.

Canadian Reps Elect Officers

FRED HARRIS was elected chairman of CESR (Canadian Electronic

TRANSIT CASES

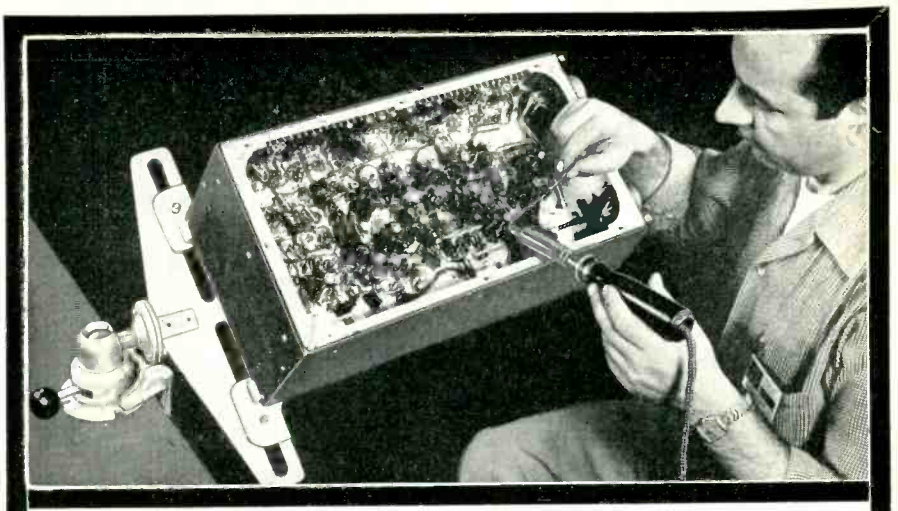
Stronger, Lighter Versatile . . .

Absolute protection for delicate Electronic Instruments, Machine Tools, Dies, Jigs, Arms, Charts, Maps, Records, Film, etc. — against SUBMERSION, SHOCK, CORROSION, OXIDATION, DEHYDRATION, ROT, FUNGUS, HUMIDITY. Contents ready for instant use when case is opened . . . No gummy substances to remove. Withstands temps. —85°F to 210°F.

Exclusive Feature! Preservation Gas installation optional in all cases. Write or phone for complete data.

Phillip H. Harrison & Co.

Route 34, Matawan, N. J.
Matawan 1-3113



LOOK! NO HANDS!

Wilton's PowRarm Work Positioners leave both hands free, and make work pieces easily accessible from any angle. This permits workers to spend less time getting a job ready, and more time in actual productive labor. PowRarms are more versatile than custom built fixtures, cost much less, and are available immediately for either stationary or conveyor installations.

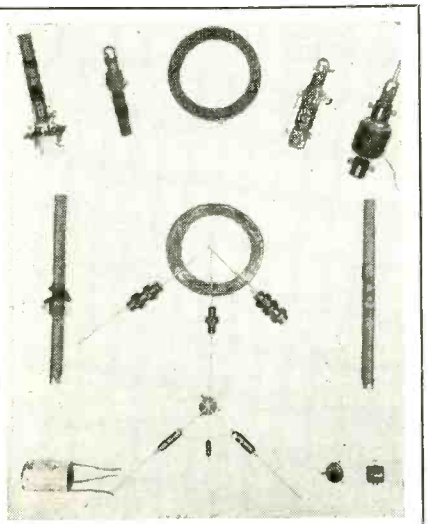
Attach This Ad to Your Letterhead and Mail to Us for a Free 10 Day Trial or Free Literature!

"The Finest Name In Vises"

WILTON TOOL MFG. CO., INC.

925 WRIGHTWOOD AVE. • CHICAGO 14, ILLINOIS

WILTON TOOL CANADA LTD. GUELPH, ONTARIO, CANADA



Coils of Special Order to the Customer's prints are wound at Moran Electronic Components Inc. to a high quality at reasonable cost — with best possible delivery.

Moran Electronic Components Inc. offers a standard line of most used Chokes of the Solenoid and Universal Pie types, ranging in Inductance from .47 Micro-Henry to 25 Milli-Henry.

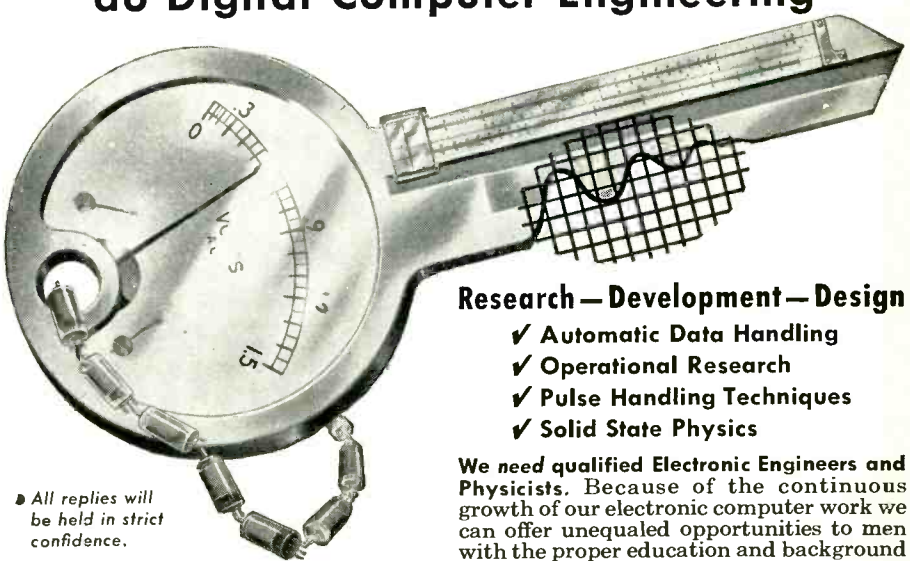
Complete Data available on request.

MORAN ELECTRONIC COMPONENTS INC.

10515 Metropolitan Ave., Kensington, Md.

UNLIMITED OPPORTUNITIES for . . .

Electrical Engineers and Physicists to do Digital Computer Engineering



- *All replies will be held in strict confidence.*
- *Interviews will be arranged at our expense.*

Research — Development — Design

- ✓ **Automatic Data Handling**
- ✓ **Operational Research**
- ✓ **Pulse Handling Techniques**
- ✓ **Solid State Physics**

We *need* qualified Electronic Engineers and Physicists. Because of the continuous growth of our electronic computer work we can offer unequaled opportunities to men with the proper education and background in the Electronics field . . . permanent positions, financial security, professional development.

HERE IS THE KEY TO YOUR FUTURE...

ENGINEERING RESEARCH ASSOCIATES
DIVISION OF **Remington Rand**

1902 West Minnehaha Avenue, Dept. E-00, St. Paul W4, Minnesota

Sales Representatives) for the ensuing year. Other officers elected were C. G. Pointon and Chas. L. Thompson, vice-presidents and A. T. R. Armstrong, secretary-treasurer.

Parker Pen Renovates Electronics Lab

PARKER PEN CO. has completed the modernization of its 6,000 sq ft research and development department. Its electronics laboratory has been enlarged and has a screen room for radiating equipment where work with dielectric and induction heating equipment can be performed.

Carboloy Names Manufacturing Head

PETER J. JENSEN has been named manager of manufacturing at Carboloy department of GE.

He has been manager of Carboloy's Michigan sales district since 1948.

In 1946 he served as executive engineer in the Carboloy engineering and research department until he was named Michigan district sales manager.

He joined the firm as a tool engineer in 1937, after a year in Schenectady on GE's test course.

John A. Muldoon succeeds Jensen as manager of the Michigan sales district. He was previously manufacturing manager.

Elco Moves To New Plant

ELCO CORP., manufacturer of tube-sockets, shields and connectors, has moved to a new plant in Philadelphia.

All facilities existing in two other plants in Philadelphia are consolidated in the new facility.

The new plant covers 50,000 sq ft of floor space and is located on a 3 acre site.

Computer Research Becomes NCR Division

THE Computer Research Corp. of California has become the electronics division of National Cash

Register. NCR purchased the controlling interest in Computer Research in March, 1953 and made the company a wholly owned subsidiary with the purchase of the remaining stock early this year. As an NCR division, it will manufacture electronic computers for business applications, in addition to its present line of computers. The division has a staff of over 350 people.

White Industries Plans Expansion

WHITE INDUSTRIES intends to more than double its present manufacturing facilities under a new expansion program.

Under the newly organized aircraft division an electronics products department, electro-mechanical products department and a mechanical products department will be formed. New machinery and personnel will be added to the present staff and equipment.

American Car Changes Name, Acquires W-K-M

AMERICAN CAR and Foundry, parent company of Avion Instrument and ACF Electronics, has changed its name to ACF Industries. The name was adopted as being more descriptive of the company's present business and future objectives.

The company acquired for cash the entire assets of W-K-M company of Houston, Texas, which will in the future be known as W-K-M Manufacturing Company and will operate as a wholly owned subsidiary of ACF. The firm makes high pressure steel valves.

IBM Subsidiary Elects President

ARTHUR K. WATSON has been elected president of the IBM World Trade Corp., an IBM subsidiary. He was formerly vice-president and general manager and succeeds Harrison K. Chauncey, who was elected vice-chairman of the board.

Three vice-presidents of the corporation, John E. Brent, Charles K. Campbell and Thomas A. Kirk-

land were elected to the board of directors of the corporation. Thomas J. Watson, Sr., chairman of the board, continues as chief executive officer.

General Precision Names Cunningham

JAMES M. CUNNINGHAM has been named western regional sales manager for General Precision Laboratory.

He has a background as a design engineer and systems engineer with West Coast firms.

Schonfeld Promoted By Avien

SAUL N. SCHONFELD has been appointed chief application engineer for Avien, manufacturers of aircraft fuel management equipment and other aeronautical instruments.

Prior to joining Avien, Schonfeld was with Simmonds Aerocessories for 8 years, most recently as manager of the company's application engineering department.

He succeeds Frank DeNardo who has been appointed regional engineering representative for Cal-Avien in Culver City, Calif.

General Manager Appoint For IRC Subsidiary

CLARENCE HARDING has been appointed general manager of Ircal Industries, California subsidiary of International Resistance. Edward A. Stevens, vice-president & treasurer of IRC was recently named president of the Los Angeles concern.

Harding has been assistant treasurer & controller at IRC for the past nine years, and will, in his new position, be responsible for all operations of Ircal Industries.

Batelle Institute Expands

BATELLE INSTITUTE of Columbus, Ohio, has bought 397 acres of land for new experimental projects in engineering and agriculture.

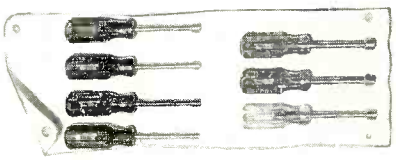
The present staff of 2150 people

XCELITE Hand Tools
PREFERRED BY THE EXPERTS

NEW!

"TAKE-ANYWHERE" KIT OF COLOR-CODED NUT DRIVERS!

Closed—a compact case



Open—ready to use!

XCELITE No. 77 Set

On the bench or on the job—the nut driver you need in a flash! 3/16, 7/32, ¼, 9/32, 5/16, 11/32 and ⅜" XCELITE nut drivers in sturdy plastic kit! Same most-used size range as in the popular No. 127 lockable wall set!—No more fumbling for the right nut driver on the job—far less chance of leaving tools behind. Ask your supplier for this No. 77 time-saver!

. . . . AND WHILE YOU'RE AT IT be sure you have the right XCELITE pliers and screwdrivers for your jobs—your supplier has what you need!

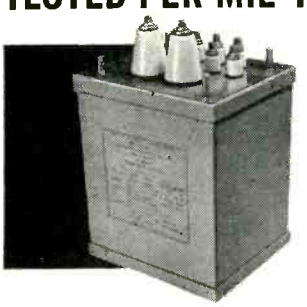
XCELITE, INCORPORATED
(Formerly Park Metalware Co., Inc.)
Dept. C Orchard Park, N. Y.

For Originality LOOK TO XCELITE

What is RōTōRoiD®?

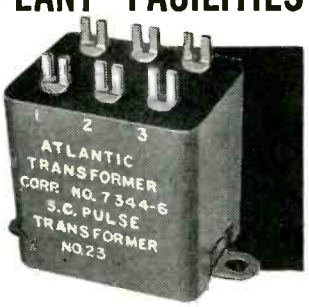
See page 21

TESTED PER MIL-T-27 IN OUR "IN-PLANT" FACILITIES



We are now producing government and commercial transformers in quantity. Our top flight engineering staff and complete electrical test facilities can help solve your toughest transformer problems.

"In-plant" testing means a minimum of waiting before passing Government tests. *Write or phone for detailed information.*

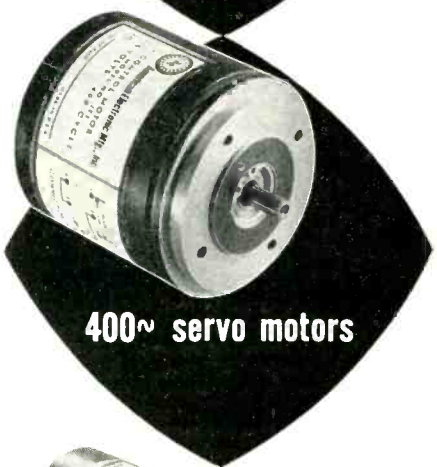


HIGH VOLTAGE PLATE TRANSFORMER

MOLDED MINIATURE BLOCKING OSCILLATOR TRANSFORMER

ATLANTIC TRANSFORMER CORP. 30 Hynes Ave., Groton, Conn.

precision resolvers
SIZES 11, 15, 23



400~ servo motors

brushless induction potentiometers

RELIABLE AND STABLE PERFORMANCE
•
servo components, instruments, synchros

ae

Let us quote on your detailed requirements.

American Electronic Mfg., Inc.

9503 W. JEFFERSON BLVD., CULVER CITY, CALIF.
TELEPHONE: TExas 0-5581 • VErmont 8-6402

at Batelle is double that employed in 1945. Approximately $13.5 million dollars was used in research in 1953.

McDonald Joins Cinema Engineering

JOSEPH MCDONALD has joined the mechanical engineering staff of Cinema Engineering at its Burbank, Calif., plant He will work with Charles Broneer, supervisor.

He has been with the P. R. Mallory resistor division plant at Frankfort, Ind., as a draftsman and designer and more recently in a similar capacity with Lockheed Aircraft and Hydro-Aire Corp.

New TV Station and Plant Planned In Philippines

STEWART LABORATORIES plans to set up a new television station and a new tv plant in the Philippines. The station will have a 30 kw transmitter with a 500 ft. tower. The plant, to employ 250, is to assemble 15,600 television sets and 36,500 picture tubes annually.

It is hoped that the factory will be able to supply television sets and tubes for sale not only in the Philippines but also in Japan, Thailand, Indonesia and other far eastern countries. A relay station in Cebu to cover practically the whole island group between Mindanao and Luzon is planned. The projected station, DZBB-TV, will be equipped with mobile units and field cameras.

U. S. Relay Forms Projects Laboratory

U. S. RELAY of Los Angeles has set up a Shelf Projects Laboratory for the development and testing of higher efficiency relays for guided missiles and aircraft of the future.

The organization, through electronic engineer Harold Fox, U. S. Relay chief engineer Paul Chamberlin and assistant chief engineer John Schuessler, has perfected a new sub-miniature relay said to be about half the size and weight of the smallest now in use. The relay

is hermetically sealed, is six pole double throw and weighs two ounces.

Cook Division Moves To Larger Plant

THE ELECTRONIC SYSTEMS division of Cook Electric has moved to a larger plant in Chicago.

Formed several months ago, the division outgrew initial plant facilities. The new, two-story location provides doubled working area and modern facilities for electronic development and production. The division is headed by Edward J. O'Brien.

National Union Radio Changes Its Name

THE NATIONAL UNION Electric Corporation is the new official name of the National Union Radio Corp. The change in names was made to reflect the expanded activity of the company.

Azilda Nielsen Named President of Best

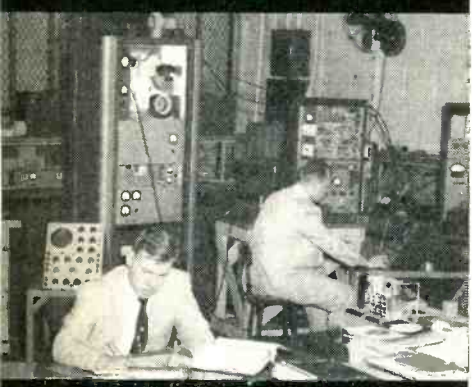
AZILDA NIELSEN has been elected president of Best Manufacturing of Irvington, N. J. and its associate companies, Sampson Electric Products of Clinton, N. C. and Fidelity Products of South Orange, N. J.

Mrs. Nielsen succeeds her late husband, E. W. Nielsen as president of the firm which manufactures radio and tv components and sound reproducing equipment.

Holland Joins Stromberg-Carlson

JOHN J. HOLLAND, formerly electronic equipment contracting officer for the U. S. Army Signal Corps at Fort Monmouth, N. J., has joined Stromberg-Carlson's radio-tv division as head of quality control and inspection. His duties will encompass both commercial and military production. Holland's background is in the field of electronics engineering.

He was also with the Signal Corps in Philadelphia.



NEW BOOKS

Vector and Tensor Analysis

BY G. E. HAY, *Dover Publications, Inc., New York, N. Y.*, 1953, 194 *pages*, $1.50 *paper bound*, $2.75 *in cloth.*

FOR some reason or other, this reviewer has always had a fascination for vector analysis. The probable reason for this feeling is the fact that he once roomed with the mathematician Schelkunoff who had a theory that vector analysis ought to be taught in the lower grades and not postponed until after the student had digested virtually everything else in the way of mathematics. At any rate, this fascination has impelled the perusal of many books on the subject with the result that, sooner or later, an impasse or hurdle was reached beyond which this reader could not go.

Professor Hay's book seems to let the unskilled go further than most before the hurdle appears and this may be because of the choice of examples of usage of the fundamental operations, especially those applying to geometrical problems. At any rate the book is a useful addition to the library on the subject.

The paperbound edition is easy to handle for it is light in weight and while publishers in general do not look with favor on such unorthodox (and unprofitable) presentations there is much to recommend them to the student or engineer. It is regrettable that not enough purchasers exist for highly technical books for all of them to appear in light-weight, coat-pocket, low-cost format.

Having proved, by very few moves, that the three medians of a triangle meet in a single point which trisects each of them, one is inclined to believe that Schelkunoff was right: vector analysis is easier than geometry and ought to be taught first.—K.H.

Relaxation Methods

BY D. N. DEG. ALLEN. *McGraw-Hill Book Company*, 257 *pages*, 1954, $7.50

THIS is a fascinating book for the engineer. It is not, as this reviewer

first surmised, devoted to flip-flop circuits and the consequences of the van der Pol equation. Nor does it have anything to do with serenity and the good life. It is in fact an ordered technique for applying the method of successive approximations to mathematical and physical problems of almost any complexity and analytic difficulty. Now every engineer knows of the method of successive approximations and has probably solved at least one problem by its use, but this is a systemization of the method which allows one to readily obtain numerical solutions of the problem of heat flow in 3 dimensions.

The method is of course based on the fundamental truth, which any digital computer knows, that all of the mathematical processes are in reality sophisticated forms of addition and subtraction. To become adept in "relaxation methods" one must learn to think more or less like a digital differential analyzer.

The technique in its simplest mode is to organize the controlling equations in a particular form and then to vary each independent variable separately (or in groups) until the stated equations are solved. While a naive application of this might well take a lifetime for some problems, Sir Richard Southwell and his fellow relaxers have developed a technique and philosophy of the method which make the solution of many difficult problems seem ridiculously simple.

There are two especially interesting details brought out in the discussion. The first is that the individual practicing the method is not only free to, but is encouraged to, break any or all rules when it seems advantageous. The second, which was a godsend to this novice relaxer, is that the ability to keep a check book accurately is not a requisite, since the system is self-checking.

In this "first book of its kind to show the reader *how to use the techniques of relaxation*", Chapters 1 and 2 are used to establish the fundamental method of relaxing and to make the reader cognizant of certain techniques for shortening the actual computational process.

In Chapter 3 the method is applied to both two-and three-dimen-

sional frames, both pin-jointed and stiff-jointed, to which external forces are applied. It is here that the reason for choosing the name for the method becomes evident. The frame is first assumed in equilibrium and the external force or load applied. It is seen that the "operations table" represents the mechanical process of "the systematic relaxation of (local) constraints" until all the members are again in equilibrium—in new locations which are given by the calculated displacements.

Chapter 4 applies the method to obtaining particular solutions of ordinary differential equations. The particular problem chosen for study is that of the deflection of a beam under stress. Here the trick of using finite-difference approximations to derivatives is introduced with its resulting inaccuracy. It is shown, however, that this inaccuracy can be reduced to any degree desired. If more accuracy is required, the unit finite difference must be made smaller. This results in more equations and so more computation and tedium in solving them. It is shown by a numerical example that finally the answer will not be changed by decreasing the size of the finite difference, so that here, as in the case of automatic computers, accuracy can be exchanged for time and complexity.

Applications to Laplace and Poisson Equations

The next six chapters (5–10) contain the relaxational approach to the solution of Laplace's and Poisson's equations. Here the power of the method in obtaining numerical solutions at particular points (which can be as closely spaced as you wish) becomes evident. Complex problems which can be solved analytically only with considerable difficulty here become simply tedious. (To relieve this the author advises "it is virtually essential that a calculating machine be available".) The quasi-pole-potential generalized form of Poisson's equation proves to be just as amenable to the method as the more simple forms which are generally solved in analysis. In fact, the fourth-order biharmonic equation (useful in the bending and exten-

sion of flat elastic plates) and simultaneous partial differential equations of the second order only increase the tedium without introducing any marked perplexity.

Chapters 11 and 12 apply the method to Eigenvalue problems arising from the study of vibrational questions, first for a finite and then for an infinite number of degrees of freedom in two dimensions. Three problems in particular which are solved are: the vibration of a rectangular membrane with fixed edges; the critical thrust in a strut with clamped ends; electromagnetic vibrations in a wave guide. It is indicated how the method could be readily extended to solve problems which "are not capable of exact analytical solution; from a relaxational point of view, the greater difficulty, if any, lies only in additional computation". Chapter 13 extends the method to multiply connected regions such as the extensional problem for a flat plate containing holes and the stressing problem for an axially symmetric solid with cavities.

Problems of two-dimensional flow, where the boundaries may be unknown, are considered in Chapters 14 and 15. The percolation of a fluid through a porous material, the irrotational flow of an incompressible fluid, the heat-conduction equation and the stressing of a uniform cylinder in torsion sufficiently so that part of the material is stressed to its elastic limit are some of the problems tackled.

The final chapter gives an introduction to the use of Relaxation Methods to three-dimensional problems. The method itself is so powerful that it can be stated: "The major difficulty . . . . . was that involved in finding a satisfactory technique of recording on paper a calculation which in reality should take place on a three-dimensional lattice". A suggested successful technique is to record the relaxational computations on an isometric projection of the lattice. The final touch in the book is to show how three-dimensional problems with irregular boundaries may be handled.

The book is well organized and well written. The problems are

carefully graded to introduce the newcomer to the field and to carry him along as if the subject had scarcely any difficulties. The format is good; the bibliography and index seem reasonable.

My one complaint is the author's statement: " . . . in particular, no mention is made of the solution of non-linear equations", without stating whether the method has some fatal flaw in this connection. My own guess would be that this should be a powerful tool with which to attack some of the stickier non-linear problems. I should suspect that there is some exciting mathematical research in this direction.

This book should be a stimulation to the introduction and increase of the use of the powerful relaxation methods in this country and should be studied by every engineer who is required to get particular solutions of problems which do not lend themselves well to easy analytic solutions. It furthermore will probably prove enlightening to many concerning the processes of the modern computing machines.—KNOX MCILWAIN, *Hazeltine Electronics Corp.*

THUMBNAIL REVIEWS

Symposium on Light Microscopy. American Society for Testing Materials, Philadelphia, Pa., 132 pages, 1954, $2.50. Useful articles for any research engineer employing the microscope as a tool. Titles are: The Methods of Microscopy, by Clyde W. Mason; Apparatus for Microscopy, by H. W. Zieler; Some Applications of Light Microscopy in the Study of Textile Materials, by V. W. Tripp; Polarized Light Microscopy and Supplementary Techniques by W. C. McCrone; Applications of Light Microscopy in Concrete Research, by Katharine Mather; The Microscopical Examination of Metallic Specimens, by J. R. Vilella; Resinography, the Microscopy of Resins and Their Plastics, by T. G. Rochow; Methods of Particle-Size Analysis, by R. P. Loveland.

Radio Amateur's Handbook. ARRL, West Hartford, Conn., 800 pages, 1954, $3.00. An up-to-date revision of this famous handbook, annually awaited. Contains material on semiconductors, color television and other new topics.

Highlights of Color Television. By John R. Locke, Jr., General Electric Co., Syracuse. John F. Rider Publisher, Inc., New York, 1954, 44 pages, $.99. Concise summary of technical

aspects of the present FCC-approved compatible electronic television system, for those already familiar with monochrome television principles.

Wireless and Electrical Trader Year Book 1954. Trader Publishing Co., Ltd., Dorset House, Stamford St., London, S. E. 1, England, 25th edition, 296 pages, 1954, 10s 6d. Data on 250 current tv receivers, tube and cathode-ray tube base connections, etc. Useful to anyone connected with sales or service or interested in contacting British sources of supply.

Applied Electronics Annual 1953/54. British-Continental Trade Press Ltd., 222 Strand, London W. C. 2, England, 258 pages, 1954, £ 1. Articles on electronics in fishing, textiles and printing, plus directory of manufacturers of electronic apparatus, components and a British Who's Who of the executives of many electronic firms throughout the world.

Economic Almanac 1953–1954, Edited by Frederick W. Jones and Anita R. Beckerman, NICB. Thomas Y. Crowell Co., 432 Fourth Ave.. New York 16, N. Y., 671 pages, 1954, $3.95. Handbook of useful facts about business, labor and government in United States and other areas.

Basic Radio, a Practical Training Manual. Howard W. Sams & Co., Inc., Indianapolis 5, Ind., 240 pages, 1953. Simple, well-planned manual for training technicians in all phases of the electronics industry from lecture and classroom notes used at Coyne Electrical School. Thirty-six lessons, questions and problems.

Auto Radio Service Data Manual, Vol. 2 and Vol. 3. Compiled and published by Howard W. Sams & Co., Indianapolis, Ind., 1953, $3.00 each. Circuit diagrams and servicing data on recent models of auto radios, creatively presented for maximum usefulness to practicing servicemen.

Audio Amplifiers & Associated Equipment, Vol. 4. Compiled and published by Howard W. Sams & Co., Indianapolis, Ind., 1953, $3.95. Circuit diagrams and service data on audio amplifiers, a-m and f-m tuners, preamplifiers and associated equipment of interest to high-fidelity enthusiasts.

Human Behavior in Industry. By W. W. Finlay, A. Q. Sartian and W. M. Tate. McGraw-Hill Book Co., New York, 1954, 247 pages, $4.00. Written to assist project engineers, chief engineers and other executive engineers in meeting and solving personnel and human relations problems. Chapter topics include: delegation of authority and responsibility; dealing with engineering unions; use of incentives; selection and evaluation of employees; improving attitudes and morale; gaining interest and cooperation; handling disciplinary problems; improving management-employee communication.

Jig and Fixture Design for Woodworking Safety. National Safety Council, 425 N. Michigan Ave., Chi-

cago, 11, Ill., 100 pages, 1954, $1.75. How to use saws, jointers, shapers, routers and belt sanders without getting hurt. For the woodworking or carpenter shop.

1953 Supplements, ASTM Standards. ASTM, 1916 Race St., Philadelphia 3, Pa., seven parts listed below, $3,50 each part or $24.50 for complete set. Part 1, Ferrous Metals, 380 pages; Part 2, Non-ferrous Metals, 288 pages; Part 3, Cement, Concrete, Ceramic, Thermal Insulation, Road Materials, Waterproofing, Soils, 400 pages; Part 4, Paint, Naval Stores, Wood, Fire Tests, Sandwich Constructions, Building Constructions, Wax Polishes, 174 pages; Part 5, Fuels, Petroleum, Aromatic Hydrocarbons, Engine Antifreezes; 348 pages; Part 6, Rubber, Plastics, Electrical Insulation, 208 pages; Part 7, Textiles, Soap, Water, Paper, Adhesives, Shipping Containers, 308 pages.

Temperature Measurement with Rayotubes. By Paul H. Dike, Leeds & Northrup Co., Philadelphia 30, Pa., 1953, 48 pages, $1.00. A monograph on the theory, design and use of Rayotubes including actual temperature measurement, standardization and calibration. Rayotube is the trade name for "total" radiation pyrometers produced by L&N.

TIC Potentiometer Handbook. Technology Instrument Co., 531 Main St., Acton, Mass., 207 pages, 1954, $2.00, including periodic release of new material. Design, construction, performance, mounting and ganging, bibliography and catalog.

Professional Income of Engineers—1953. Engineers Joint Council, 29 West 39 St., New York 18, N. Y., 32 pages, 1954, $2.00. Income of about 72,000 engineers in industry, government and education in relation to year of receiving first degree in engineering.

Discrete Sources of Extra-Terrestrial Radio Noise. Special Report Nr. 3, URSI, (International Scientific Radio Union) 42 Rue des Minimes, Brussels, Belgium, 1954, 56 pages, $1.15. A brief account of well established experimental data and techniques as of the 1952 General Assembly URSI.

Radiation Biology. Edited by Alexander Hollaender, Oak Ridge National Laboratory; Volume 1 of a three-volume work, in two parts, McGraw-Hill Book Co., 1954, $17.50. An exhaustive treatise on the biological effects of radiation from the physical, chemical and biological points of view.

Psychology of Industrial Relations. By C. H. Lawshe, Professor of Psychology, Purdue University, McGraw-Hill Book Co., New York, N. Y., 1953, 350 pages, $5.50. Written for industrial people in supervisory and managerial ranks as a day-to-day practical aid for meeting and handling personnel problems. Coverage includes human behavior, employment placement, training and supervision, handling of complaints, establishing wage rates, dealing with unions and aiding production by making work easier.

BRANSON MINIATURE RELAY

. . . for aircraft and missile applications Branson Type MRH relay is about the size of a miniature tube. Occupies a volume of .75 cubic inches and weighs 1.4 ounces. All contact insulation is ceramic and glass, which makes the relay extremely useful for high frequency switching applications where low, high quality capacities are required.

Branson Type MRH relay provides 2 amp. contacts in double-pole, double-throw combination. Withstands 50g shock and 20g vibration up to 500 cps. Built for ambients of 85° C or up to 200° C for special purposes. Coil resistances up to 10,000 ohms are available. Can be supplied with a plug-in arrangement or new ferrule mounting.

BRANSON Corp. *Write for complete information*

BOONTON, NEW JERSEY

PHAZOR PHASE METER

Pat. Pend.

MODEL 200 A

PRICE $349.50 F.O.B. NEW YORK

- HIGH ACCURACY
- MEASURES FROM 0 TO 360 DEGREES
- READINGS NOT AFFECTED BY NOISE AND HARMONICS
- PHASE SHIFTS OF THE ORDER OF .01° CAN BE MEASURED EMPLOYING SPECIAL CIRCUIT TECHNIQUES
- MEASURES IN-PHASE AND QUADRATURE COMPONENTS SEPARATELY

For further information contact your nearest representative or write for brochure

REPRESENTATIVES

KITTLESON CO., 416 No. La Brea Ave., Los Angeles 36, Calif.
BROGER INSTRUMENT SALES CO., INC., 739 Boylston St., Boston 16, Mass.
F. R. JODON, INC., 2902 Porter St., N.W., Washington 8, D. C.
G. G. WILLISON CO., 1821 W. Alabama, Houston 6, Texas
LEEMARK ASSOCIATES, P. O. Box 8467, Kansas City 14, Mo.
RON MEREDITH CO., 2410 Beacon Ave., Seattle 44, Washington

Manufacturers of:

PHASE METERS

•

NULL DETECTORS

•

IMPEDANCE COMPARATORS

•

POWER OSCILLATORS

•

Other Electronic Test Equipment

INDUSTRIAL TEST EQUIPMENT CO.
55 E. 11th ST. · NEW YORK 3 · GR. 3-4684

NEW HORIZONS

Today's horizons in electronic engineering are limited only by the vision of the individual himself. To those qualified men who desire to stand on the constantly changing frontiers of electronic development, we offer a chance to pioneer and grow with a soundly-established, yet young and progressive company.

• Electronics Field Engineers

Local & Field Assignments Available

At least 5 years' experience in any one of these fields: Servo Mechanisms; Special Weapons; Microwaves; Antennas; Circuit Design; Flight Simulators; Radio Propagation; Electronic Computers and Communications.

Qualified to instruct in the operation and supervise installation, maintenance and repair of Radar, Sonar, Flight Simulators and allied electronic equipment in the field.

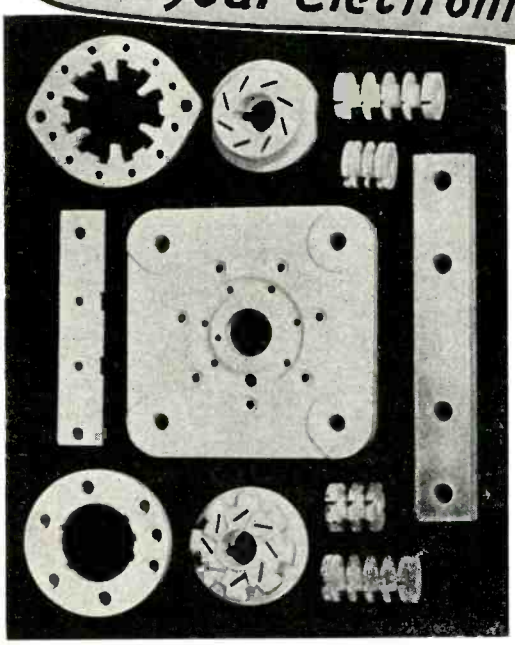
Salary and advancement commensurate with ability; liberal vacation, sick leave, 9 paid holidays, group life, sickness and accident insurance plans, and a worthwhile pension system.

STAVID ENGINEERING, INC.

Personnel Office, 312 Park Avenue
Plainfield, N. J.—PLainfield 6-4806

STAR STEATITE

for Your Electronic Needs



STAR low-loss STEATITE has proved an ideal insulation for electronic applications. It is a strong, dense material with excellent dielectric and mechanical strength.

Every STAR STEATITE part is engineered for your specific job and precision made to meet demands for dimensional accuracy. And STAR'S facilities for volume output assure you a steady flow of material to maintain your production schedules.

Star PORCELAIN COMPANY

49 Muirhead Avenue · Trenton 9, N. J.

BACKTALK

Engineering Personalities

DEAR SIRS:

THE RELATIONSHIP between genechromosome pattern and functional dominance in personality, and between personality and trait, is well enough known to provide adequate criteria against which to rate the list of personality traits set out in *Cross Talk* (ELECTRONICS, July 1954) and applied to engineers.

The constellation of aptitude weights personality into three major categories of functional dominance. (W. H. Sheldon, "The Varieties of Human Physique", Harper & Brothers Publishers; James F. Bender, "The Technique of Executive Leadership," McGraw-Hill Book Company, Inc.). Two of these categories can be indicated by the general psychological terms introvert and extrovert.

Neither of these personality-patterns corresponds to the aptitude pattern generally taken to identify the engineer. The third category, described in the technical term mesomorph-somatotonia, is found to be populated with persons who do gravitate toward the functions of engineering.

In true or false annotation, the four points all score false. . . .

Dogmatism, hostility, secretiveness, and inability to delegate are all observable factors in human relations. To present what appear to be features of functional disturbance as characteristics of personality, and descriptive of engineers, requires rather more justification than seems to be readily available.

In my experience, the firm where hostility and rebellions spot the margins of cold and warm fronts down the line of executive functions will be host to the impossible demands associated with high labor turnover, and ensuing from techniques applied by any one of several parties in the contract.

Dividend-producing firms of happy atmosphere will be found to comprise a dynamic balance of functional dominants, demonstrating the company of characteristic aptitudes. Administration and its function of recording, communica-

ting, inspecting and sensing, will be populated with persons having high talent for accurate observation and low coefficient of imaginative activity. Production personnel will feature ability to balance out, or govern, applications of energy—in policy, direction, skill, and development. Distribution will engage the talent for persuading and response to consumer-potential associated with the roly-poly endomorph.

In this general panorama, the scientists gravitate toward energy-costing in the laboratory or money-costing in administration. The engineer moves toward the cybernetics of production, at various levels. And the promoter-salesman joins his talent to this dynamic community to spread the good news of a better way of life.

Case History

The following case history throws some interesting light on the general situation. Mr. A employs 25 persons in the manufacture of a major household appliance. With expansion in mind, he engaged me to conduct a survey and introduced me to Mr. B, general manager, with whom I would be working. Both Mr. A and Mr. B confided to me that Mr. C, chief engineer and works manager, was a source of concern because of his uncooperative attitude. Dr. Pearse's evaluation represented management's description of Mr. C, to a T.

My findings, however, showed Mr. C to be superbly competent in his field, admired by his men, in love with his work, extremely capable in customer-relations (he supervised field installations), well-poised in personality. He responded warmly to suggestion and improvement.

In due time, the situation clarified. Both Mr. A and Mr. B typed out as dominant introverts. The breakdown in communication, which they imputed to Mr. C, was traceable unerringly to themselves.

The reason was not their dominant pattern, by any means. Both were talented in directions appropriate to their dominance. But of all possible management techniques, Mr. B had instituted a

course which set the conditions for flaring temper and frustration as surely as looking into a gas tank with a lighted match. . . .

RALPH E. SPENCER
Vancouver, B. C. Canada

Engineers and Executives

DEAR SIRS:

I DISAGREE with Dr. Pearse (*Cross Talk*, p119, July 1954). He describes a pattern of behavior which may apply to any intellectual group.

An engineer is a special creature of this earth, deeply concerned with accuracy. He has an intense passion for test and measurement. He recognizes the inconclusiveness of theory. His evaluations are made with a blend of the empirical and mathematical method.

Dr. Pearse is interested in developing executives. All executives are not engineers. This is simple proof that the executive may differ from the engineer.

Can a good executive be made from an engineer? Certainly; but first, something must happen to his inner self, to his mental attitude.

The executive is concerned with broad policy, with overall results. He does not waste his time on the fine detail and restrictive accuracies which occupy the staff engineer.

The executive must always be making assessments of intangibles. He needs an understanding of statistical analysis and probability. He must know how to evaluate the limitations of men and machines, without confusing one with the other. He should be ready to admit errors of judgment and seek corrective measures. Above all, he must have a strong emotional stability, to withstand with serene composure the stress of adversity.

His leadership is measured by how well he is able to inspire subordinates with the will to cooperate.

These are super qualities that cannot be equated with the average group. They are obtained by careful selection and specialized training.

JOHN J. RIVERA
Senior Designer
Federal Telecommunication Laboratories
Belleville, N. J.

PROFESSIONAL SERVICES

Consulting—Patents—Design—Development—Measurement

in

Radio, Audio, Industrial Electronic Appliances

ANNIS ELECTRIC RESEARCH LABORATORY, INC.

CONSULTING — RESEARCH — DEVELOPMENT AND DESIGN OF RADIO AND ELECTRONIC EQUIPMENT

Antennas, Wave Propagation, Information Storage, Computers, Impedance Matching and Variable Speed A-C Motors.

P. O. Box 581 — 1401½ S. Nell St.
Champaign, Ill. — Tel. 6-1780

Professional Assistance . . .

in solving your most difficult problems in the specialized field of electronic devices is offered by consultants whose cards appear on this page.

NIAGARA ELECTRON LABORATORIES

CONSULTATION - DESIGN - CONSTRUCTION
MFG. THE THERMOCAP RELAY

Specializing in solution of problems of electronic and electro-physical instrumentation for the research or analytical laboratory. Industrial plant problems also invited.

Andover, New York Cable Address: NIATRONLAB

ROGER BARRETT BROSS

Consulting Engineer

SPECIAL ELECTRIC MOTORS
ELECTROMAGNETIC COMPONENTS
Design - Development - Manufacture
Testing - Application

25 Curtis Rd — OL 3-9235
Box 157, Natick, Mass.

HIGHLAND ENGINEERING CO.

William R. Spittal & Staff

DESIGN, DEVELOPMENT AND MANUFACTURE OF TRANSFORMERS, CHOKES, ETC.
FOR THE
ELECTRONIC, INDUSTRIAL & ALLIED FIELDS

Westbury, L. I., New York
WE-7-2933

PICKARD & BURNS, INC.

Consulting Electronic Engineers

Analysis and Evaluation
of Radio Systems

Research, Development and Production
of Special Electronic Equipment

240 Highland Ave. — Needham 94, Mass.

CROSBY LABORATORIES, INC.

Murray G. Crosby & Staff

Radio - Electronic
Research Development & Manufacturing
Communication, FM & TV

Robbins Lane, Hicksville, N. Y.
Hicksville 3-3191

HOGAN LABORATORIES, INC.

John V. L. Hogan, Pres.

Applied Research, Development, Engineering

Est. 1929. Electronics, Optics, Mechanisms, Facsimile Communication, Digital Computers (Circle), Electro-sensitive recording media. Instrumentation.

155 Perry Street, New York 14, — CHelsea 2-7855

ALBERT PREISMAN

Consulting Engineer

Television, Pulse Techniques, Video Amplifiers, Phasing Networks, Industrial Appliances
Affiliated with
MANAGEMENT-TRAINING ASSOCIATES

3224-16th St., N. W. — Washington 10, D. C.

EDGERTON, GERMESHAUSEN & GRIER, INC.

Consulting Engineers

Stroboscopy — Transient Oscillography
Photoelectricity — Pulse Techniques — Timing
High-Speed and Electric Flash Photography
Telemetering - Industrial Television Applications

160 Brookline Avenue — Boston 15, Mass.

INTERFERENCE MEASUREMENT LABORATORY

Interference Study per Government Specifications
Shielded Space for Interference Investigation
Field Surveys for F.C.C. Certification of Induction and Dielectric Heating Equipment

907 East 51st Street • Brooklyn 3, New York
Ingersoll 9-1765

JOSEPH RACKER COMPANY

Radar Consultants & Editors

Technical Manuals
Research and Development

140 Nassau Street — New York 38, N. Y.
Worth 4-1463

Eldico of New York, Inc.

Pioneers of Television Interference Elimination from Transmitters, Induction Heaters, Diathermy and etc.

Donald J. S. Merten & Engineering Staff

70 E. Second St. — Mineola, L. I., N. Y.
Garden City 7-0383

THE KULJIAN CORPORATION

Consultants • Engineers • Constructors

Electronic Control
Specialists
Utility • Industrial • Chemical

1200 N. Broad St. — Phila 21, Pa.

THE TECHNICAL MATERIAL CORPORATION

Communications Consultants

Systems Engineering
General Offices and Laboratory

700 Fenimore Rd., Mamaroneck, N. Y.

ELECTRONIC RESEARCH ASSOCIATES, INC.

"TRANSITORIZE" YOUR PRODUCT!

Complete Service in consulting, research, development, and production on Transistor circuitry, products and instrumentation.

715 Main Street — North Caldwell, N. J.
Caldwell 6-6729

ROBERT McCABE

Radio Noise Measurement and Elimination
Field Intensity Surveys

1781 Ride-a-Wee Park — Columbus 5, Ohio

TELECHROME, INC.

Electronic Design Specialists

COLOR TELEVISION EQUIPMENT

Flying Spot Scanners, Color Synthesizers, Keyers, Monitors, Oscilloscopes and Related Apparatus
J. R. Popkin-Clurman, *Pres. & Ch. Engr.*

88 Merrick Rd. — Amityville, L. I., N. Y.

ERCO RADIO LABORATORIES, INC.

Radio Communications Equipment

Engineering - Design - Development - Production
Our 25th Year in Air to Ground
Communications and Radio Beacons
Garden City • Long Island • New York

Measurement Corporation

Research & Manufacturing Engineers

Harry W. Houck — Martial A. Honnell
John M. van Beuren

Specialists in the Design and Development of Electronic Test Instruments

Boonton, New Jersey

WHEELER LABORATORIES, INC.

Radio and Electronics
Consulting — Research — Development
R-F Circuits — Lines — Antennas
Microwave Components — Test Equipment
Harold A. Wheeler and Engineering Staff

Great Neck, N. Y. — HUnter 2-7876

HANSON-GORRILL-BRIAN INC.

Product & Mfg. Development

ELECTRICAL - ELECTRONIC
HYDRAULIC - MECHANICAL

One Continental Hill — Glen Cove, N. Y.
Glen Cove 4-7300

NEW ROCHELLE TOOL CORP.

FOR CERTIFICATION OF INDUCTION AND DIELECTRIC HEATING EQUIPMENT IN ACCORDANCE WITH F.C.C. RULINGS

Mobile Test Unit Available Entire U. S.

320 Main St. — New Rochelle, New York
Phone NE 2-5555

YARDNEY LABORATORIES, INC.

Research - Design - Development

Electro-Chemical Generators of Energy

40-46 Leonard Street — Worth 6-3100
New York 13, N. Y.

CONTACTS
FOR THE FIELD of ELECTRONICS

REPLIES (Box No.): Address to office nearest you
NEW YORK: 330 W. 42nd St. (36)
CHICAGO: 520 N. Michigan Ave. (11)
SAN FRANCISCO: 68 Post St. (4)

SEARCHLIGHT SECTION

POSITIONS VACANT

RELAY DESIGN Engineer. Must have experience in design, production, patents and sales of relays and components for electronics. Write outlining experience — salary — and what you think you can do with a free hand in charge of newly formed relay division or small (70 employees) Northern Ohio manufacturer. Salary, commission and other financial inducements to the man who can qualify. Assembly Products, Inc., P. O. Box 191, Chagrin Falls, Ohio.

ELECTRONICS ENGINEERS wanted grade GS-5 to GS-9, $3,410.00 to $5,810.00 per annum, for the Electronics Office of Phila. Naval Shipyard. The Electronics Office has complete responsibility for the technical control, inspection, testing and installation of all electronic equipment installed on naval vessels and at shore activities in the Fourth Naval District. Complete modern test equipment is available to aid the engineer in his work. An application for Federal Employment, Standard Form 57, should be filed with the Industrial Relations Department, Building #698, Philadelphia Naval Shipyard, Naval Base, Philadelphia 12, Pa. by interested persons. Application forms may be obtained from the Industrial Relations Department, or any first or second class post office, or from any Civil Service Regional Office.

ELECTRONIC DEVELOPMENT Engineer needed by Ohio company manufacturing commercial electronic equipment. Must have had 5 or more years experience at designing pulse circuits and preferably servo systems. Must be capable of both system and detail design of electronic and electrical controls for customer equipment. Also must be capable of the design and development of production test apparatus. Salary approximately $7500 per year. Allowance for moving expense. Replies held in confidence. Submit resume to P-3537, Electronics.

POSITIONS WANTED

SALES ENGINEER—preferably for broadcast or two-way radio equipment. 15 yrs. varied experience in communications. Prefer territory in South or Southeast. PW-3467, Electronics.

POSITIONS WANTED

COMMUNICATIONS ENGINEER--Technician desires job with small firm specializing in communications equipment, or small communications firm. No degree. Have ten years practical communications experience, backed by technical know-how and imagination. Available U. S. in Dec. C. E. Greene, Pago Pago, Samoa, Via Airmail.

POSITIONS WANTED

GOOD TECHNICAL training with twenty-four year experience building and designing electronic apparatus recent experience in Ultra Sonic generators seeking position where experience is the primary requirement. Further information to Box PW-2696, Electronics.

(Continued on opposite page)

WANTED

Several Junior Electrical Engineer graduates with B.S. degrees, with or without experience, to assist Senior Engineers in the design of sub-fractional motors and electromagnetic servo-mechanism devices. Excellent working conditions and fringe benefits. Located in scenic southern New Hampshire, on the coast. Give complete details in original resume.

EASTERN AIR DEVICES, INC.
(Mr. Charles Crocco)
385 Central Ave. Dover, N. H.

POSITIONS WANTED

(Continued from the opposite page)

PYROLITIC RESISTANCE Films: Chemical engineer, experienced in the development and improvement of Boron-Carbon resistance films, familiar with all operations used in the production of film resistors, desires position in development of same or similar processes. PW-3585, Electronics.

INDUSTRIAL ENGINEER, B.S.E.E., M.S. Physics. 15 years experience with large well-known electronics organization, specializing in power-electronics, photo-electronics, and audio-electronics seeks position as chief engineer with small manufacturer. Prefer location in medium-sized city. PW-3552, Electronics.

SELLING OPPORTUNITIES WANTED

SALES ENGINEERING Organization, manufacturers representatives, equipment specialists. Available for New York, New Jersey, Eastern Pennsylvania. Exceptional technical backgrounds and sales records for industrial, research and nuclear equipment instruments and specialized components. RA-3598, Electronics.

RECENTLY ORGANIZED. Top notch sales force available to sell, promote and demonstrate new equipment to all major aircraft and electronics prime contractors East of the Mississippi. Our sales engineers use all-weather personal planes in making closely scheduled sales visits. All product demonstration equipment is carried aboard. Excellent terms. Write SA-3562, Electronics.

SALES ENGINEER—married, 27, B.E.E., 5 years experience field and sales engineering on various electrical devices. Seeks position metropolitan N. Y. area. SA-3565, Electronics.

NEW BOOKS

"Amplitude—Frequency Characteristics of Ladder Networks," by E. Green, M.Sc., with foreword by M. Dishal of Federal Telecommunication Laboratories. This book, destined to be a world standard source of modern network theory design information, deals with the synthesis of ladder networks to give either Butterworth or Chebyshev amplitude response in the passband. It includes solutions for any ratio of terminal loads with applications to low pass and bandpass networks, and practical examples. A "Marconi Review" publication obtainable from Marconi's Wireless Telegraph Co. Ltd., Marconi House, Chelmsford, Essex, England. Price $4.50 post free.

MANUFACTURERS REPRESENTATIVES AVAILABLE SALES ENGINEERS

We are a small, highly trained, hard hitting organization of electronic and industrial engineers with a record for *creating* sales. Due to expansion we seek additional progressive principals in the electronic, nuclear or industrial instrument, equipment or specialized components field. Territory: New York, New Jersey, Eastern Pennsylvania.

RA-3601, Electronics
330 W. 42 St., New York 36, N. Y.

Attention—Electronic Mfgrs.

Experienced engineering representative, Los Angeles, desires top electronic lines saleable to airframe and electronic industry in Western States. Best technical representation guaranteed, incl. applications engineering.

RA-3610, Electronics
1111 Wilshire Blvd., Los Angeles 17, Calif.

TRANSISTORS Transistor Components

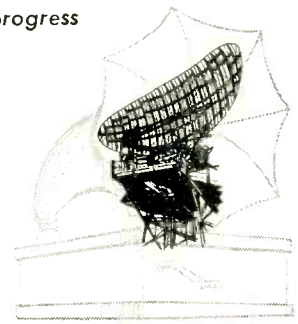
Business man-Engineer can develop six figure volume for transistors, transistor transformers or other electronic components specifically for transistors. Desire to obtain substantial interest in small established manufacturing company now active in this field. Must have marketable transistor components.

BO-3310, Electronics
330 W. 42 St., New York 36, N. Y.

ENGINEERS with EXPERIENCE

in electronic development

with experience comes progress



are you EXPERIENCED in

RADAR - MISSILE CONTROL
AIRBORNE COMMUNICATIONS
MOBILE COMMUNICATIONS
AUTO RADIO

. . . does an analysis of your background show that — at present — you are employed at THE HIGHEST LEVEL OF YOUR SKILL?

. . . Send us a resume of your background. We may have a higher level position open for you!

Send resume to Mr. L. H. Noggle, Dept. J

BENDIX RADIO

Division of Bendix Aviation Corp. Baltimore 4, Md.

PHYSICISTS and ENGINEERS

Electronic
Mechanical
Chemical

Interested in *Research, Advanced Development* and *Product Design* involving

TRANSISTORS AND SEMI-CONDUCTOR DEVICES
COMMERCIAL AUTOMOBILE RADIO
MILITARY RADIO AND ELECTRONIC EQUIPMENT
ELECTRONIC COMPONENTS
INTRICATE MECHANISMS (tuners, mechanical linkages, controls, etc.)

Diversified and challenging work in an informal friendly atmosphere with congenial associates and modern equipment and facilities. Liberal employee benefits.

Opportunities available for recent graduates and for experienced men with Bachelor or advanced degrees.

All inquiries treated confidentially and given prompt attention. Relocation expense allowed for those employed.

WRITE OR APPLY

DELCO RADIO DIVISION

GENERAL MOTORS CORPORATION

Kokomo, Indiana

I.R.E. PROCEEDINGS FOR SALE

Complete set through Feb. 1954 except 1915 Nos. 2 and 3. Another set of 199 out of 210 issues for 1916 through 1938. Also 60 copies of miscellaneous issues. Submit offers to

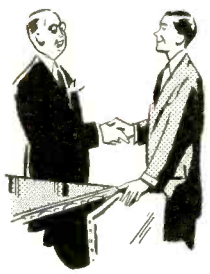
CRAVATH, SWAINE & MOORE
15 Broad Street, New York 5, N. Y.

HAVE YOU A BETTER MOUSETRAP?

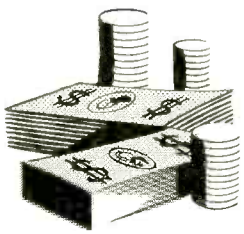
Let us introduce it at *GRIFFISS AFB*, center for all AF ground electronic equipment and see that you no longer miss any AF business.

WRIGHT ASSOCIATES
Manufacturer's Representatives
127 W. Liberty St. Rome, New York

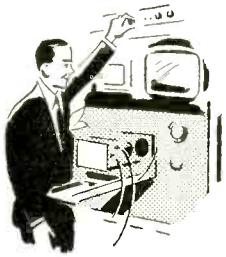
What means most to an Engineer?



PROFESSIONAL RECOGNITION



GOOD SALARY



UNEXCELLED FACILITIES

SUBURBAN LIVING

RCA offers all These...and more!

RCA offers career opportunities for qualified ELECTRICAL and MECHANICAL ENGINEERS . . . PHYSICISTS . . . METALLURGISTS . . . PHYSICAL CHEMISTS . . . CERAMISTS . . . GLASS TECHNOLOGISTS.

Positions now open in Systems, Analysis, Development, Design and Application Engineering. Your choice of long range work in commercial or military fields.

At RCA you'll work in an atmosphere conducive to creative work — laboratory facilities unsurpassed in the electronics industry . . . constant association with leading scientists and engineers.

Delightful suburban living easily available. Modern retirement program . . . liberal tuition refund plan for advanced study at recognized universities . . . modern company paid benefits for you and your family.

Individual accomplishments readily recognized. Ample opportunity for increased income and professional advancement.

Join the team at RCA and grow with the world leader in electronics.

Personal interviews arranged in your city.

Please send a complete resume of your education and experience to:

MR. JOHN R. WELD

Employment Manager, Dept. 300 I
Radio Corporation of America
30 Rockefeller Plaza, New York 20, N.Y.

SYSTEMS—ANALYSIS—DEVELOPMENT—DESIGN—APPLICATION ENGINEERING

in the following fields:

AVIATION ELECTRONICS (FIRE CONTROL, PRECISION NAVIGATION, COMMUNICATIONS)—Radar—Analog Computers—Digital Computers—Servo-Mechanisms—Shock & Vibration—Circuitry—Heat Transfer—Remote Controls—Sub-Miniaturization—Automatic Flight—Transistorization—Automation

RADAR—Circuitry—Antenna Design—Servo Systems—Information Display Systems—Gear Trains — Stable Elements — Intricate Mechanisms

COMPUTERS—Digital and Analog—Systems Planning—Storage Technique—Circuitry—Servo-Mechanisms—Assembly Design—High Speed Intricate Mechanisms

COMMUNICATIONS — Microwave — Aviation — Mobile—Specialized Military Systems

MISSILE GUIDANCE—Systems Planning and Design—Radar and Fire Control—Servo-Mechanisms—Vibration and Shock Problems—Telemetering

COMPONENT PARTS (COLOR & MONOCHROME TV)—HV Transformers—Coils—Deflection Yokes

SEMI-CONDUCTORS—Transistors—Diodes

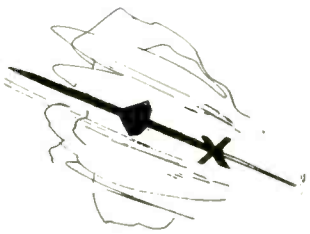
ELECTRON TUBE DEVELOPMENT — Receiving — Transmitting—Cathode-Ray—Phototubes and Magnetrons—Power Tubes—Camera Tubes

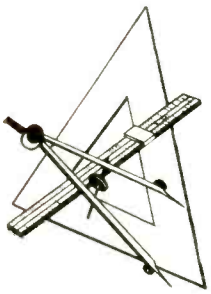
ELECTRONIC EQUIPMENT FIELD ENGINEERS — Specialists for domestic and overseas assignment on military electronic Communications Navigational Aids, and Guided Missiles.

RADIO CORPORATION of AMERICA

Tmks. ®

Help Build Tomorrow's World TODAY!

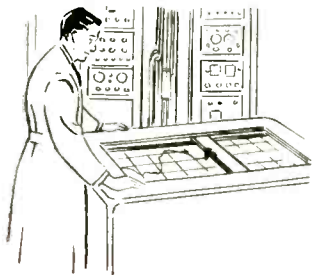




GOODYEAR AIRCRAFT CORPORATION, pioneer and leader in lighter-than-air craft, offers you a new employment opportunity with a well-established and fast-growing company where "careers are planned."

DESIGN AND DEVELOPMENT engineering opportunities are available for capable and imaginative men and women in the field of airships, aircraft and aircraft components.

RESEARCH AND DEVELOPMENT projects — missiles, electric and electronics systems, servomechanisms, new special devices, fiber resin laminates — all present an urgent need for engineers with fresh talent, aptitude and ambition.



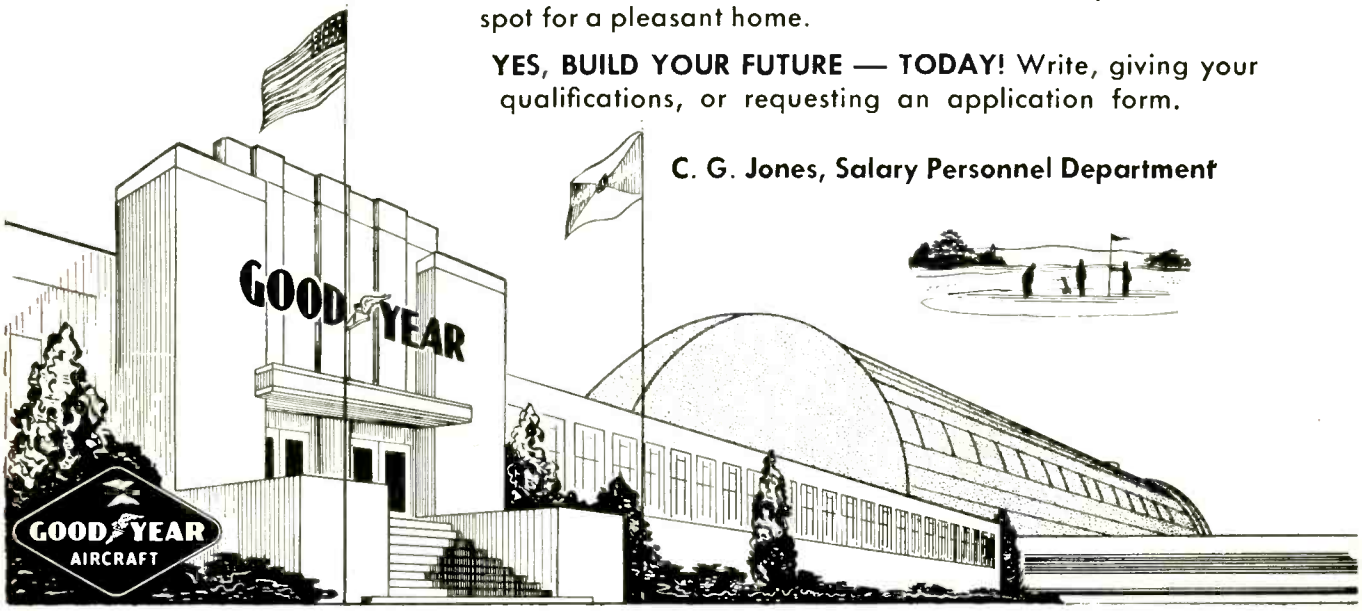
POSITIONS ARE OPEN at several levels in various fields with salaries based on education, ability and experience.

Physicists	Civil engineers
Mechanical engineers	Electrical engineers
Aeronautical engineers	Technical editors
Welding engineers	Technical illustrators

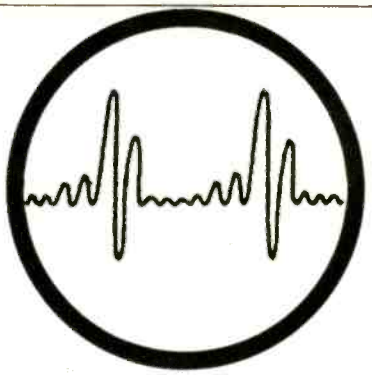
AKRON, THE HOME OF GOODYEAR AIRCRAFT, is located in the lake region of northeastern Ohio. Cosmopolitan living, year-round sports and recreation, cultural and educational advantages make this thriving city an ideal spot for a pleasant home.

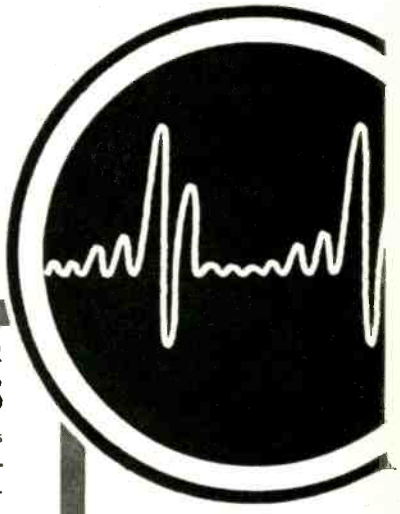
YES, BUILD YOUR FUTURE — TODAY! Write, giving your qualifications, or requesting an application form.

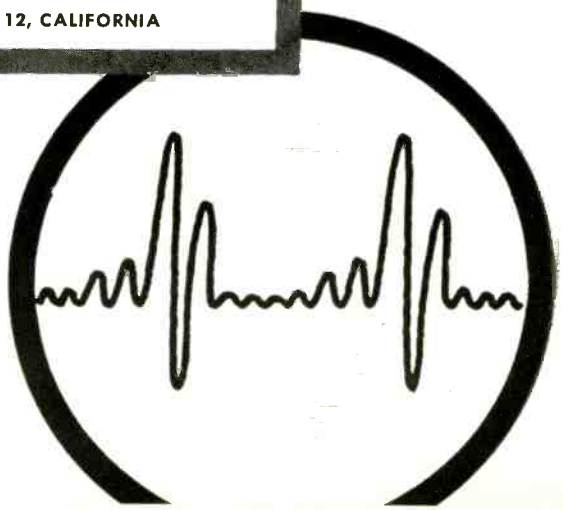
C. G. Jones, Salary Personnel Department

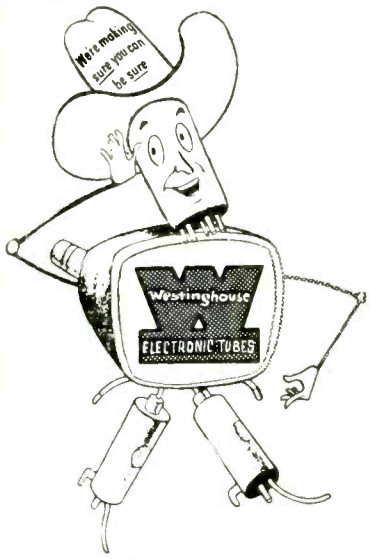


GOODYEAR AIRCRAFT CORPORATION, 1210 MASSILLON RD., AKRON 15, OHIO









ELECTRONIC ENGINEERS and PHYSICISTS

Our new, aggressive, expanding Tube Division is seeking top-quality Electrical Engrs with 2 or more years' experience in the following fields.

THESE POSITIONS OFFER:

A pleasant life in Elmira, N. Y. . . . amid New York State's resort lakeland! Good housing, excellent schools, hunting, fishing, sailing, etc. . . . An opportunity for Professional Progress . . . stock-purchase and pension plans . . . tuition-refund program, etc.

TUBE DESIGNERS . . Any of these fields: Micro-wave tubes, receiving tubes, solid-state devices, image orthicon, traveling wave tubes.

APPLICATION ENGRS Circuit experience in one of these fields helpful: Radio, TV, VHF, semi-conductors, and sweep circuits.

PRODUCTION ENGRS
1. For black-&-white and color TV manufacturing. Knowledge of photo-sensitized screens, silk screens or printed screens desirable.
2. For power-tube operations, including magnetrons, micro-waves and semi-conductors.
3. For quality-control. Elec'l Engineering background preferred.

WESTINGHOUSE will pay expenses of Engineers invited to Elmira for interview. Send resume:

WESTINGHOUSE ELECTRIC CORP.

P. O. BOX 284, ELMIRA, N. Y.

You can be SURE . . . if it's WESTINGHOUSE

Electronics Engineers and Applied Physicists

For a long-range research and development program in air armament. Interested in both senior and junior men for work on:

Infrared systems and components.
Simulators and computers.
Ordnance and ordnance test equipment.
Instrumentation for aircraft and missile test ranges. (Locate in Chicago or Florida.)

Complete, modern laboratory and shop facilities. Professional atmosphere on a university campus, with salaries equivalent to industry. Liberal vacation and other benefits. U. S. citizenship required. Send brief resume with request for application form to:

Scientific Personnel Office

CHICAGO MIDWAY LABORATORIES
The University of Chicago
6040 South Greenwood Ave.,
Chicago 37, Illinois

Electronic Engineering Company *of California*

The Electronic Engineering Company of California is an independent firm engaged in the design, development and fabrication of electronic equipment for private industry and the Armed Forces. Founded and managed by electronic engineers, the Electronic Engineering Company offers a broad background of experience, highly trained personnel, excellent facilities plus a well integrated, expanding organization.

The Electronic Engineering Company has openings for engineers with experience and background in industrial and military electronics.

Please send resume of experience and education with salary requirements to:

Electronic Engineering Company *of California*
180 SOUTH ALVARADO STREET
LOS ANGELES 57 CALIFORNIA

RECEIVER ENGINEERS
With Experience in VHF and UHF Frequencies

Career Opportunities
With Old Established
Central Connecticut Firm
Interesting Projects
Top Salaries
Suburban Living

Replies Held in Strict Confidence
Wire or Phone Collect
Personnel Mgr. SHerwood 7-2741

THE ALLEN D. CARDWELL ELECTRONICS PRODUCTIONS CORPORATION
Plainville, Connecticut

INSTRUMENT ENGINEER

Project Responsibility for the Mechanical Design and Development of Air Data Sensing Instruments.

SERVOMECHANISMS INC.
POST & STEWART AVE'S
WESTBURY, L. I.

PHYSICIST

Experienced physicist or electronics engineer with Ph.D. degree for development work on electronic tubes. Minimum of five to ten years experience in this field is prerequisite. Send complete resume or apply in person to:

Research Division
NATIONAL UNION ELECTRIC CORP.
350 Scotland Rd. Orange, N. J.

REPRESENTATIVES WANTED

Manufacturer of electronic test equipment for military and commercial applications needs technically qualified representatives. Write giving qualifications, lines handled, territory covered.

RW-2178, Electronics
1111 Wilshire Blvd., Los Angeles 17, Calif.

ENGINEERS

SYSTEMS
RADAR
SERVO
COMPUTER

BACKGROUND: Responsible positions open for top level development and project engineers with practical and research experience in:

Advanced Electronic Circuits and Systems
Microwave Radar
Microwave Receivers and Transmitters

MAXSON

Requirements emphasize advanced analytical and/or management experience on highly complex electronic and electro-mechanical systems.

Kindly send resume and salary requirements to

The W. L. MAXSON Corp.
460 W. 34th ST., NEW YORK 1, N.Y.

Electronic Filter Design
ENGINEER

Excellent salary and opportunity offered by expanding, nationally known manufacturer of coils and filters. Location: Metropolitan Area, N.Y.C. Necessary qualifications: thorough knowledge of filter design theory.

P-3526, Electronics
330 W. 42 St., New York 36, N. Y.

CALIFORNIA CALLS
ELECTRONIC ENGINEERS

Interesting Assignments In

DESIGN & DEVELOPMENT

of

SERVOS
GYROSCOPES
SCANNING DEVICES
ELECTRONIC DEVICES

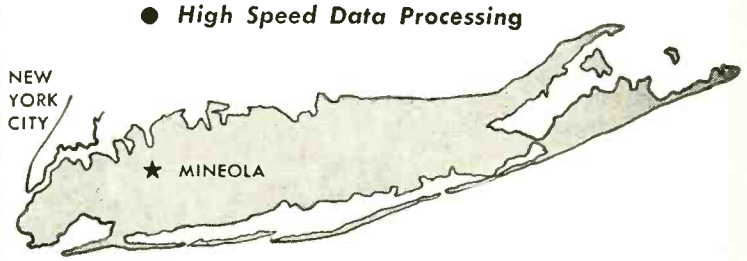
Experience required in development of delicate electromechanical, electro-optical or electronic systems.

AEROJET-GENERAL CORPORATION
SUBSIDIARY OF
The General Tire & Rubber Co.
6352 N. IRWINDALE AVENUE
AZUSA, CALIFORNIA

THIS IS WHERE *initiative*
PAYS OFF

Have you reached a blank wall?
Have your ideas been stymied?
AIRBORNE INSTRUMENTS LABORATORY INC. has challenging design and development problems, and is increasing its research staff.
Men with BS, MS & PhD Degrees are being sought for creative work in the following fields:

- *Radar Systems*
- *Microwave Components*
- *I.F., R.F. and Video Circuitry*
- *Navigation and Communication Devices*
- *Analog and Digital Computors*
- *Transistor Development*
- *Servo Mechanisms*
- *High Speed Data Processing*



Ideally situated on Long Island for suburban living with access to graduate study . . . and still close enough to reach New York City in less than an hour . . . AIRBORNE INSTRUMENTS LABORATORY INC. might prove to be "the spot you are looking for". Employee benefits include paid vacations and holidays, insurance, pension and hospital plans, tuition refunds, etc.

Howard Gresens,
Personnel Manager

Pioneer 2-0600

AIRBORNE INSTRUMENTS LABORATORY INC

160 OLD COUNTRY ROAD, MINEOLA, L. I., N. Y.

BIG WAR TERMINATION INVENTORY CLEARANCE SALE

DIFFERENTIAL GEAR SYSTEMS

AT GREATLY REDUCED PRICES

SPIDER DIFFERENTIAL

1⅛" spur gear, 72 teeth. 1" gear, 31 teeth. Size: 2⅜" long x 1⅛" dia.

$2.00 ea.

FOUR GEAR SPIDER DIFFERENTIAL

2"—96 teeth—48 pitch gear; 4" of 48 pitch, 12 teeth pinon wire. Size: 8½" long x 4⅜" wide x 2" high.

$3.00 ea.

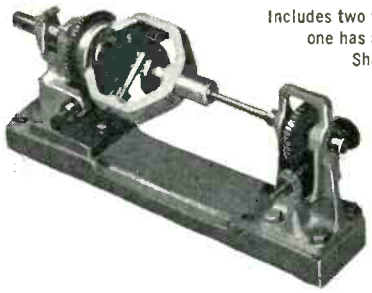
FRICTION DIFFERENTIAL

with two 5"—170 teeth spur gears. Size: 3⅝" long x 5" wide x 5½" high.

$12.50 ea.

THREE GEAR SPIDER DIFFERENTIAL

Includes two worm gears, 24 pitch . . . one has 50 teeth, other 40 teeth. Shaft ½". Size: 11¼" long x 3¼" wide x 5½" high.



$12.50 ea.

SPIDER DIFFERENTIAL

Three spur gears. Size: 7½" long x 1¾" wide x 2¾" high.

$5.00 ea.

SIMPLE DIFFERENTIAL

1:1 reverse ratio, 60 teeth on large gear; ¼" shaft. Size: 3" long with 1-15/16" dia.

$3.95 ea.

SAVE UP TO 85%

EQUIPMENT FULLY GUARANTEED

IMMEDIATE DELIVERY

C&H SALES CO.

2176-E East Colorado St.
Pasadena 8, California
RYan 1-7393

WRITE OR WIRE FOR INFORMATION ON OUR COMPLETE LINE OF SURPLUS ELECTRONIC COMPONENTS. ALL PRICES NET F. O. B. PASADENA, CALIFORNIA.

SPIDER DIFFERENTIAL

Size: 6½" long x 1¾" wide with 3/16" shaft.

$2.50 ea.

GEAR DRIVE SPIDER DIFFERENTIAL

System includes seven gears and spider. Size: 5¼" long x 3½" wide x 3" high.

$5.00 ea.

SIMPLE DIFFERENTIAL

1:1 reverse ratio. Size: 2½" long x 29/32" dia. Shaft ⅛" dia.

$3.50 ea.

DUAL SIMPLE DIFFERENTIAL

1:1 reverse ratio on both. Size: 3¼" long x 1-7/16" dia. Shaft size: ⅛" and 5/32".

$7.50 ea.

SIMPLE DIFFERENTIAL

1:1 reverse ratio. Size: 6¾" long x 2¾" dia. Shaft size: 11/32".

$7.50 ea.

SIMPLE DIFFERENTIAL

Size: 5½" long x 2¼" dia. Shaft size: ⅜" on one end and 11/32" on other end. Hub is 1-3/32" dia. on each end.

$7.50 ea.

SPIDER DIFFERENTIAL

Size: 2⅜" long x 1-3/16" dia. Shaft size: ⅛".

$2.50 ea.

PRECISION PLANETARY DIFFERENTIAL

1:1 reverse ratio, ring gear 3" dia., 120 teeth. Overall length 5¼", shaft dia. 11/32", ⅛" key on one end.

$7.50 ea.

COMMUNICATIONS EQUIPMENT CO.

MICROWAVE COMPONENTS

10 CM.—RG48/U Waveguide

10 CM ECHO BOX: Tunable from 3200-3333 Mc. For checking out radar transmitters, for spectrum analysis, etc. Complete with pickup antenna and coupling devices.....$27.50

10 CM ANTENNA ASSEMBLY: 3000-3300 Mc. Parabolic Dish, 29 inch Diam. Feed from dipole Rotation: 360 Deg. Azimuth at speeds of 20 and 10 RPM. Tilt: 20 deg. above and below horizontal. Motor-Driven by 2-28V motors, 4.5 A Total Drain. Azimuth info. is fed to selsyn mechanism, and elevation data is obtained from Azimuth potentiometer. Net weight 65 lbs.....$78.50

POWER SPLITTER for use with type 726 or any 10 CM Shepherd Klystron. Energy is fed from Klystron antenna through dual pick-up system to 2 type "N" output connectors.....$22.50 EACH

DIRECTIONAL COUPLER. Broadband type "N" Coupling, 20 db, with std flanges, Navy #CABV47A-AN-2.....$32.50

LHTR, LIGHTHOUSE ASSEMBLY. Parts of RT39 APG 5 & APG 15, Receiver and Trans. Cavities w/assoc. Tr. Cavity and Type N CPLG. To Recvr. Uses 2C40, 2C43, 1B27. Tunable approx. 2400-2700 MCS. Silver Plated.....$22.50

BEACON LIGHTHOUSE cavity p/o UPN-2 Beacon 10 cm. Mfg. Bernard Rice, each.....$27.50

MAGNETRON TO WAVEGUIDE Coupler with 721-A Duplexer Cavity, gold plated.....$45.00

721A TR BOX complete with tube and tuning plungers.....$12.50

McNALLY KLYSTRON CAVITIES for 707B or 2K28 2700-2900 Mc.....$4.00

WAVEGUIDE to ⅞" Rigid Coax "Doorknor" Adapter Choke Flange Silver Plated Broad Band.....$32.50

AS14A AP-10 CM Pick up Dipole with "N" Cables.....$4.50

HOLMDELL-TO-TYPE "N" Male Adapters. W. E. #D167284.....$2.75

I.F. AMP. STRIP: 30 MC, 30 d.b. gain, 4 MC Bandwidth, uses 6AC7's—less tubes.....$24.00

BEACON ANTENNA, AS31/APN-7 in Lucite Ball. Type "N" feed.....$22.50

ANTENNA, AT49A/APR: Broadband Conical, 300-3300 MC Type "N" Feed.....$12.50

"E" PLANE BENDS, 90 deg. less flanges.....$7.50

3 CM.—RG 52/U Waveguide

FLEX. WAVEGUIDE SECTION, 1 ft. long. With UG-40/UG-39 flanges. Attenuation is less than 0.1 db. at 9375 mc, and VSWR is less than 1.02. Rubber covered.....$7.50

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.....$85.00

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

VSWR Measuring Section: Consisting of 6" straight section, with 2 pick-up. Type "N" Output Jacks, mounted ½ Wave apart.....$7.50

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

Rotary joint choke to choke with deck mounting...$7.50

90 degree elbows. "E" plane 2½" radius.....$12.50

Microwave Receiver, 3 CM. Sensitivity: 10-13μ Watts. Complete with L.O. and AFC Mixer and Waveguide Input Circuits, 6 I.F. Stages give approximately 120 DB, gain at a bandwidth of 1.7 MC. Video Bandwidth; 2 MC. Uses latest type AFC circuit. Complete with all tubes, including 723A/B Local Oscillator.....$175.00

ADAPTER, waveguide to type "N", UG 81-U, p/o TS 12, TS-13, Etc.....$14.50

ADAPTER. UG-163/U round cover to special btl. Flange for TS-45, etc.....$2.50 ea.

3CM Motor-Driven Echo Box

Cavity Q is 30,000. Tuning range 80 mc. Motor operates from 24 VDC, Type "N" INPUT.....$32.50

1¼" x ⅝" WAVEGUIDE

VSWR SECTION. 6"L, with 2-type "N" pickups mounted ½ wave apart.....$7.50

GG 98B/APQ 13 12" Flex. Sect. 1¼" x ⅝" OD...$7.50

X Band Wave GD 1¼" x ⅝" O.D. 1/16" wall-aluminum.....per ft. 75¢

Slug Tuner Attenuator W.E. guide, gold plated...$6.50

Bi-Directional Coupler. Type "N" Takeoff 25 db. coupling.....$22.50

Bi-Directional Coupler. UG-52. Takeoff. 25 db. coupling.....$17.50

Waveguide-to-Type "N" Adapter, Broadband....$17.50

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	$1.65	UG 52A/U	$3.40

CATHODE RAY TUBES

3FP7*	$1.50	5FP7*	$1.50
3EP1*	$2.50	*Mfrs. Quantity	

MAGNETRONS

Type	Freq. Range (MC)	Peak Power Out (KW)	Duty Ratio	Price
2J21A	3345-9405	50		$8.75
2J22	3267-3333	265		7.50
2J26	2992-3019	275	.002	7.49
2J27	2965-2992	275	.002	19.95
2J29	2914-2939	275	.002	44.95
2J31	2820-2860	285	.002	24.50
2J32	2780-2820	285	.002	28.50
2J38*	3249-3263	5		16.50
2J39*	3267-3333	8.7		24.50
2J48	9310-9320	50	.001	24.50
2J49	9000-9160	50	.001	59.50
2J56*	9215-9275	50	.001	132.50
2J61†	3000-3100	35	.002	34.50
2J62†	2914-3010	35	.002	34.50
3J31	24-27KMC	50	.001	85.00
4J34	2740-2780	900		125.00
4J38	3550-3600	750	.001	169.45
4J42†	670-730	30	.003	169.50
5J23	1044-1056	475	.001	49.00
700B	690-700	40	.002	22.50
700D	710-720	40	.002	39.75
706EY	3038-3069	200	.001	32.50
706CY	2976-3007	200	.001	32.50
725-A	9345-9405	50	.001	7.50
QK259†	2700-2900	800	.001	249.50
QK60†*	2840-3005	.100	CW	85.00
QK61†*	2975-3170	.100	CW	85.00
QK62†*	3135-3350	.100	CW	85.00

*—Packaged with magnet.
†—Tunable over indicated range.

THERMISTORS

D-164699 Bead Type DCR: 1525-2550 Ohms @ 75 Deg. F. Coefficient: 2% Per. Deg. Fahr. Max. Current 25 MA AC/DC.....$2.50

D-167332 Bead Type. DCR is 1525-2550 Ohms. Rated 25 MA at .825-1.175 VDC.....$1.35

D-167613 Disk Type DCR: 355 Ohms @ 75 Deg. F.P.M. 2.5%, 1 Watt.....$1.35

D-166228 Disk Type 7120 Ohms @ 60°F. 4220 Ohms @ 80°F. 2590 Ohms @ 100°F., 1640 Ohms @ 120°F $1.35

VARISTORS

D-167208	$1.35	D-171812	$1.63
D-171858	$1.42	D-172155	$1.50
D-168687	$1.35	D-167176	$1.25

400 CYCLE TRANSFORMERS

(All Primaries 115V. 400 Cycles)

Stock	Ratings	Price
KS9608	1233VCT/.35MA, 1140VCT/.07A	$5.79
352-7102	6.3V/2.5A	1.45
M-7472426	1450V/1.0MA, 2.5V/.75A, 6.4V/3.9A, 5V/2A, 6.5V/.3A, P/O 1D-39/APG-13	4.95
352-7039	640VCT @ 380MA, 6.3V/.9A, 6.3V6A 5V/6A	5.49
702724	9800/8600 @ 32MA	8.95
K59584	5000V/290MA, 5V/10A	22.50
KS9607	734VCT/.177A, 1710VCT/.177A	6.79
352-7273	700VCT/350MA, 6.3VO.9A, 6.3V 25.A 6.3V/.08A, 5V/CA	6.95
352-7070	2x2.5V/2.5A (2KV TEST) 6.3V/2.25A, 1200/100/750V. @ .005A	7.45
352-7196	1140/1.25MA, 2.5V/1.75A, 2.5V/1.75A —5KV Test	3.95
352-7176	320VCT/50MA, 4.5V/3A, 6.3VCT/20A, 2x6.3VCT/6A	4.75
RA6400-1	2.5/1.75A, 6.3V/2A—5KV Test	2.39
901692	13V 9A	2.49
901699-501	2.77V @ 4.25A	3.45
901698-501	900V75MA, 100V/.04A	4.29
Ux8855C	900VCT/.067A, 5V/3A	3.79
RA6405-1	800VCT/65MA, 5VCT/3A	3.69
T-48852	700VCT/806MA5V/3A, 6V/1.75A	4.25
352-7098	2500V/6MA, 300, VCT, 135MA	5.95
KS 9336	1100V/50MA TAPPED 625V 2.5V/5A	3.95
M-7474319	6.3V/2.7A, 6.3V/.66A, 6.3VCT/21A	4.25
KS8984	27V/4.3A, 6.3/2.9A, 1.25V/.02A	2.95
52C080	650VCT/50MA, 6.3VCT/2A, 5VCT/2A	3.75
32332	400VCT/35MA, 6.4V/2.5A, 6.4V/.15A	3.85
68G631	1150-0-1150V	2.75
80G198	6VCT/.00006 KVA	1.75
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	2.5V1.79A, 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
D163253	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

TEST EQUIPMENT

TSX-4SE ANALYZER

3 cm. Spectrum analyzer, similar to TS 148, but with greater sensitivity. Freq. range: 8500-9600 MC. Features: Absorption wavemeter, waveguide-Beyond-cutoff attenuator, 20 mc I.F. Strip, 120 db gain. Operates from 115V/220 V, 50-1200 CPS
Price On Request

TS 100 SYNCHROSCOPE

Precision range calibrator, with both circular and linear sweeps. Accuracy .0002. Circular sweep is 12.361 Usec per scan. Triggered linear sweeps of 0.8/30/350 miles. Variable delay up to 620 Usec. Operates from 115 v. 50-400 cy. Used, exc.....$165

BOONTOWN 102F. Sig Gen. 2700-3400 mc. Uses 2C40. Commercial equal to TS 155/UP. Used, exc.....$350

IE-19 Test Set. For checking out SCR 522 and other VHF equipment. Contains field strength meter, sig. gen. battery box, etc. Range: 100-156 mc. Used, exc. (Price on request)

PULSE NETWORKS

15A—1-400-50; 15 KV, "A" CKT, 1 microsec. 400 PPS, 50 ohms imp.....$22.50

G.E. #3E (3-84-810) (8-2.24-405) 50P4T; 3 KV "E" CKT Dual Unit; Unit 1, 3 sections, 0.84 Microsec. 810 PPS. 50 ohms imp; Unit 2, 8 Sections, 2.24 microsec. 405 PPS 50 ohms imp.....$6.50

7-5E3-1-200-67P, 7.5 KV "E" Circuit, 1 microsec. 200 PPS. 67 ohms impedance 3 sections.....$7.50

7-5E4-16-60, 67P, 7.5 KV "E" Circuit, 4 sections 16 microsec. 60 PPS. 67 ohms impedance.....$15.00

7-5E3-3-200-67P, 7.5 KV, "E" Circuit, 3 microsec. 200 PPS, ohms imp, 3 sections.....$12.50

H-616 10KV. 2.2 usec., 375 PPS. 50 ohms imp..$27.50

H-615 10KV. 0.85 usec., 750 PPS. 50 ohms imp..$27.50

KS8865 CHARGING CHOKE: 115-150 H @ .02A, 32—40H @ .08A, 21 KV Test.....$37.50

G.E. 25E5-1-350-50 P2T. "E" CKT. 1 Microsec. Pulse @ 350 PPS, 50 OHMS Impedance.....$69.50

KS9623 CHARGING CHOKE: 16H @ 75 MA. 380 Ohms DCR. 9000 Vac Test.....$14.95

G.E. 6E3-5-2000 50 P2T: 6 KV., "E" Circuit 0.5 usec /2000 PPS/50 ohms/2 sections.....$7.50

PULSE TRANSFORMERS

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

Westinghouse 4P37; Primary: 50 ohms imp, 750 v. Sec. 15 kv, 1000 ohms imp. Biflar filament trans. built-in, delivers 12.6 c at 2.5 amp. (pri. 115 v. 400 cy.) $37.50

RAYTHEON WX 4298E: Primary 4KV., 1.0 USEC. SEC: 16KV-16 AMP DUTY RATIO: .001 400 CYCLE FIL. TRANS. "BUILT-IN".....$42.50

WECO: KS 9948: Primary 700 ohms; Sec. 50 ohms. Plate Voltage: 18KV, Part of APQ-13.....$12.50

GE #K-2449A

Primary: 9.33 KV, 50 ohms Imp.
Secondary: 28 KV, 450 ohms.
Pulse length: 1.0/5 usec @ 635/120 PPS, Pk Power Out: 1,740 KW
Biflar: 1.5 amps. (as shown)..$62.50

GE #K2748-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. Biflar rated at 1.3 Amp. Fitted with magnetron well.....$39.50

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. Biflar: 1.3 Amp. Has "built-in" magnetron well.....$42.50

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. Biflar: 1.3 Amp. Fitted with magnetron well..$39.75

UTAH X-151T-1: Dual Transformer, 2 Wdgs. per section 1:1 Ratio per sec 13 MH inductance 30 ohms DCR.....$5.00

UTAH X-150T-1: Two sections, 3 Wdgs. per section, 1:1:1 Ratio. 3 MH. 6 ohms DCR per Wdg.....$5.00

68G711: Ratio: 4:1 Pri: 200V, Sec. 53V, 1.0 usec Pulse @ 2000 PPS. 0.016 KVA.....$4.50

TR1049 Ratio 2:1 Pri. 220 MH, 50 Ohms, sec. 0.75 H. DCR 100 Ohms.....$6.75

K-904695-501: Ratio 1:1. Pri. Imp. 40 Ohm, Sec. Imp. 40 Ohms. Passes pulse 0.6 usec with 0.05 usec rise.....$8.95

RAY UX 7896—Pulse Output Pri, 5v sec. 41v....$7.50

RAY UX 8442—Pulse inversion—40v + 40v.....$7.50

PHILCO 352-7250, 352-7251, 352-7287

RAYTHEON: UX8693, UX5986, UX-7307.....$5 ea.

W.E.: D-166310, D-166638, KS9800, D-163247

UTAH #9262, with Cracked Beads, but will operate at full rated capacity.....$5.00

UX 8693 (SCS #229627-54); 3 Wdgs. 32 turns #18 wire. DCR is: 362/.372/.4 ohms. Total voltage 2500 vdc.....$5.00

D-166173: Input: 50 ohms Z. Output: 900 ohms 3 Wdgs. Freq. range 10 kc-2mc. P/O AN/APQ*-13.....$12.50

K-2450: Pulse-inversion auto-transformer: primary 13 kv, 4 usec. Output: 14 kv @ 100 kw peak.....$34.50

PULSE EQUIPMENT

MIT. MOD. 3 HARD TUBE PULSER: Output Pulse Power 144 KW (12 KV at 12 Amp.) Duty Ratio: .001 max. Pulse duration: 5, 1.0, 2.0 microsec. Input voltage: 115 v, 400 to 2400 cps. Uses: 1-71B, 4-89-B, 3-'72's, 1-'73. New.....Less Cover—$135

ASD Modulator Units, mfd. by Sperry. Hard tube pulser delivers Pk. pulse of 144 kw. Similar to Mod 3 unit. Brand new, less tubes.....$85.00

Airborne RF head, model AIA, delivers 50 Kw peak output at 9000 mc. at .001 duty. Complete with pulser unit and all tubes.....$185.00

MAIL ORDERS PROMPTLY FILLED. ALL PRICES F.O.B. NEW YORK CITY. 25% DEPOSIT WITH ORDER. BALANCE C.O.D. RATED CONCERNS SEND P. O.

131 Liberty St., New York 7, N. Y. Dept E-9 Chas. Rosen Phone: Digby 9-4124

DYNAMOTORS

TYPE	INPUT VOLTS	INPUT AMPS	OUTPUT VOLTS	OUTPUT AMPS	Price
35X-859	19	3.8	405	.095	$4.35
POS X-15	14	2.8	220	.08	8.95
DA-7A	28	27	1100	.400	15.00
DM32A	28	7	540	.250	3.95
BD AR 93	28	3.25	375	.150	7.50
2335B	27	1.75	285	.075	3.95
B-19	12	9.4	275	.110	6.95
			500	.050	
DA-3A*	28	10	300	.260	6.95
			150	.010	
			14.5	5.	
PE 73 CM	28	19	1000	.350	22.50
BD 69‡	14	2.8	220	.08	8.95
DAG-33A	18	3.2	450	.06	4.49
DM 25†	12	2.3	250	.05	6.95

‡ Less Filter. * Replacement for PE-73A.
† Used, Excellent.

PE 94-C, Brand New..... 6.95

INVERTERS

800-1B Input 24 vdc, 62 A. Output: 115 V, 800 cy, 7A, 1 phase. Used, excellent..... $18.75

PE-218H: Input: 25/28 vdc, 92 amp. Output: 115V. 350/500 cy 1500 Volt-ampere. NEW..... $37.50

PE-906: Input: 28 vdc, 36 amps. Output: 80 v 800 cy, 500 volt-amps. Dim. 13 x 5½ x 10½ New..... $22.50

"SEA-DOG" CONVERTER

Designed for Buships, this rugged, compact dynamotor is rated as follows:

INPUT: 115 VDC—6 AMPS
OUTPUT: 13 VDC at 40 AMPS
—OR—26 VDC at 20 AMPS

Brand New, with Switchbox and Spare Parts..... **$89.50**

POWER TRANSFORMERS

COMBINATION—115V/60~INPUT

CT 133 150-C-150V/65MA, 6.3V/2.5A, 6.3V/0.6A..... $1.79

CT 005 350-C-350V/125MA, 5VCT/3A, 5VCT/2A, 2.5V/10A, 6.3V/4A.... 8.10

CT-048 350-0-350V/90MA, 5V/3A, 2.5VCT/10A, 6.3V/3.5A..... 5.68

CT-005 350-0-350V/70MA, 5VCT/3A, 2.5VCT/9A..... 5.10

CT-007 400-0-400V/110MA, 5VCT/3A, 2.5VCT/15A, 2.5VCT/3.5A..... 5.35

CT-312 290-0-290V/90MA, 5VCT/3A, 6.3VCT/2.8A..... 3.25

PLATE—115V/60~INPUT

PT 034 125V/45MA..... $1.15

PT 159 900-0-900 VAC (750VDC) or 800-0-800 VAC (660VDC) at 225MADC.. 10.35

PT 167 1400-0-1400 VAC (300MADC) or 1175-0-1175 VAC (1000VDC) at 300MADC..... 25.50

PT 371 210-0-210V at 2.12Amp..... 9.45

PT 133 3140/1570V, 2.36KVA..... 105.00

PT 801 22,000V/234 MA., 5.35 KVA, "Lo-Cap" Donut..... 135.00

PT 521 7500V/.06A, Half-Wave..... 85.00

PT 813 2500V/12 MA H'SLD..... 4.95

PT 12A 280VCT/1.2A..... 3.95

PT-38-2 37.5/40V AT 750 MA..... 2.15

THIS MONTH'S SPECIALS

PRESSURE SWITCH. For Art-13, CR2927-B-100. SPST. N.O. 10 AMP AT 24 VDC up to 40,000 ft. Trips at 9.72" mercury; resets at 12.10" Merc. Collins 260N457 (As Shown)..... $6.49

S-501 ARC-3 Push-Button Assy. SCS# 8Z9824-83.1..... $1.19

C-38 ARC-5 Control Box..... 1.50

SA4A/APA-1 Motor-driven Yagi Antenna Switch-24 VDC. DPDT..... 14.50

CHROMALUX Standby Heaters. 115VAC-DC. 150 W. Screw-in Base Std. Socket.... 1.00

MOD. XFMR Screen For SCR 274- SCS# 2Z9047-3.2..... 1.19

MOD. XFMR Plate, Symbol T-104/ARC-3.. 2.15

AN-154-A Antenna For RC145, 148, etc. Consists of 3 Vert. Dipoles Working against a screen reflector. Range 150-200 MC..... 27.50

C.F.I. UNITS For Art-13, less tubes and crystals..... 12.50

SERVO-AMPLIFIER: 2CV3A1. Less Tubes.. 122.50

MK-12 Pressurizing limit for APS-2, etc... 27.50

TRANSTAT: Type TH 45BC. Input: 230-130V 2Ph., 60 Cy. Out: 0-260V. 11.7A 45Amp... 165.00

INTERLOCK, Cory Type B986. Safety Type with Lock and Key. Contacts Rated at 20 Amp. DPST..... 2.85

TRANSTAT: Input: 130V/230V. AC 66Cy. Out: 0-260V/8.5A/1.69KVA Amertran TH 6½B. Used, Exc..... 15.00

POWER SUPPLY: PP 104/APT-5, for T-85/APT-5 Jammer..... 19.50

SPEAKER-TWEETER Used on Beachmaster Amplifier. Has 2" Voice Coil and Diaphragm. Response to 20,000 Cycles. Will Handle up to 50 Watts. Complete with Spare Cone..... 9.95

ANTENNA-AS-33APT-2, for Jammer Transmitter..... 8.50

CRYSTALS, Type IN45, Western Electric... .75

VIBROPACK. Input 12VDC/0.58 Amp. Out: 2X4.3V/50MA. 2X45VDC/0.5MA. 2X85-VDC/5MA. New. Complete with Spare Vibrator. Well-Shielded and Portable..... 4.75

Send M.O. or Check Shipping Chgs. C.O.D.

COMMUNICATIONS EQUIPMENT CO.
131 Liberty St Dept. E9 New York City 7, N. Y.

GUARANTEED COMPONENTS

All Fresh Termination Stock!
Sold on a Money Back Guarantee!

OIL FILLED

1 mfd @ 600v	$.59
2 mfd @ 600v	.79
3 mfd @ 600v	1.15
4 mfd @ 600v	1.45
5 mfd @ 600v	1.69
6 mfd @ 600v	1.85
8 mfd @ 600v	1.69
10 mfd @ 600v	2.75
1 mfd @ 1000v	.59
3 mfd @ 1000v	.99
4 mfd @ 1000v	1.89
8 mfd @ 1000v	3.10
.5 mfd @ 1500v	.69
1 mfd @ 1500v	.99
4 mfd @ 1500v	2.25
5 mfd @ 1500v	2.45
8 mfd @ 1500v	3.95
10 mfd @ 1500v	4.95
.1 mfd @ 2000v	.99
.25 mfd @ 2000v	1.19
1 mfd @ 2000v	1.79
2 mfd @ 2000v	2.65
4 mfd @ 2000v	2.95
2x.25 mfd @ 2000v	1.39
.1 mfd @ 3000v	1.39
.25 mfd @ 3000v	1.59
.5 mfd @ 3000v	1.79
.25 mfd @ 4000v	1.99
2 mfd @ 4000v	8.95
.1 mfd @ 5000v	1.70
.25 mfd @ 6000v	1.49
2x.15 mfd @ 6000v	2.49
2x.1 mfd @ 7000v	1.69
.1 mfd @ 7500v	2.49
.5 mfd @ 7500v	6.95
2x.4 mfd @ 7500v	6.95
2x.5 mfd @ 9000v	17.50
.1 mfd @ 25,000v	44.50

BATHTUBS

.05 mfd @ 400v	.28
5 mfd @ 400v	.35
1 mfd @ 400v	.46
2x.1 mfd @ 400v	.33
2x.25 mfd @ 400v	.35
3x.1 mfd @ 400v	.39
3x.25 mfd @ 400v	.39
.01 mfd @ 600v	.29
.1 mfd @ 600v	.35
.05 mfd @ 600v	.29
.5 mfd @ 600v	.49
.25 mfd @ 600v	.39
2x.1 mfd @ 600v	.35
2x.05 mfd @ 600v	.35
2x.25 mfd @ 600v	.49
3x.1 mfd @ 600v	.32
1 mfd @ 600v	.55
2 mfd @ 600v Bot. Term.	.85
2 mfd @ 600v Side Term.	.89
2x1 mfd @ 600v	.49
.1 mfd @ 1000v	.44
.25 mfd @ 1000v	.49
2x.1 mfd @ 1000v	.39
2x.02 mfd @ 1500v	.34

AC UNITS

5 mfd @ 220v 60cy	1.69
3 mfd @ 230v 60cy	1.69
1.75 mfd @ 330v 60cy	.79
7.5 mfd @ 330v 60cy	1.85
10 mfd @ 330v 60cy	2.50
15 mfd @ 330v 60cy	4.50
8 mfd @ 440v 60cy	3.00
8 mfd @ 660v 60cy	4.25

PILLAR TYPE MICA

.09 mfd @ 1500v	7.95
.03 mfd @ 2000v	9.95
.0008 mfd @ 30,000v	59.50

UPRIGHT MICA

.002 mfd @ 6000v	2.45
.004 mfd @ 5000v	2.25
.008 mfd @ 300v	1.75

POSTAGE STAMP MICAS

33 mmf @ 300v 2%	7.00/C
120 mmf @ 200v 5%	8.00/C
2700 mmf @ 500v 1%	30.00/C
320 mmf @ 400v 2%	8.00/C
2000 mmf @ 200v 5%	22.50/C

CERAMICONS

10 mmf @ 500v	6.25/C
27 mmf @ 500v	8.00/C

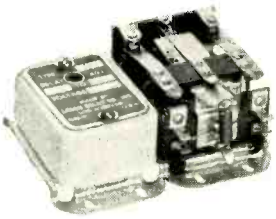
CONNECTORS

AN 3102-28-2P	1.65
28-15S	3.17
22-4P	1.39
28-16P	2.80
14S-2S	.67
18-1S	1.22
18-16S	.65
AN3106-18-8S	1.57
18-16P	1.04
28-14S	2.57
22-10P	1.44
28-16S	3.06
UG19/v	1.32
UG21/v	.61

Other Components Not Listed Write for Our Brochure

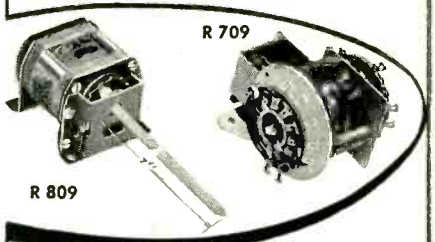
LOUIS SEGAL CO.
DEPT J 120 LIBERTY ST.
NEW YORK 7, N. Y. WOrth 2-0895
Rated Firms Open Acc.; *Send Purchase Order*

world's largest stock RELAYS immediate delivery!



ADJUSTABLE THERMAL TYPE TIME DELAY RELAY

Operates on 115 V.A.C. Continuously adjustable delay from 5 to 20 seconds. ¼ Inch D.P.D.T. 12½ amp. contacts. Primarily designed for use with radio transmitters but has wide variety of other applications.
Catalog No. R 686 Price $6.10 each



STEPPING UNIT

Operates on 22 to 30 V.D.C. 12 Position driving mechanism operates through 360° in progressive steps. Indexes one position for each momentary current impulse. Attached wafer switch may be used for self interruption. 7 inch flatted shaft will drive pulley, gear or one or more wafer switches.
Catalog No. R 809 Price $2.45 each

SOLENOID OPERATED RATCHET STEPPER

Operates on 6 V.D.C. Operates three 12 position wafer switches. Most standard wafers are interchangeable with those supplied. Rotates 30° with each impulse.
Catalog No. R 709 Price $3.90 each

HUNDREDS OF RELAY TYPES IN STOCK

- Standard Telephone Relays
- Short Telephone Relays
- Midget Relays
- Timers
- Aircraft Contactors
- Rotary Relays
- Western Electric Type "E" Relays
- Keying Relays
- Hermetically Sealed Relays
- Voltage Regulators and Cutouts
- Differential and Polarized Relays
- Special Relays
- BK-Series
- Antenna and Ceramic Relays
- Motor and Control Relays
- Relay Assemblies
- Latching and Interlocking Relays
- Mechanical Action Relays
- Ratchet and Stepping Relays

All relays are new, individually inspected and unconditionally guaranteed. They are first line products of leading manufacturers. Special attention given to orders of one or more relays. 24 Hour delivery.
Write for new catalog.
Phone, write or wire your requirements.

Relay Sales
AUstin 7-0709
4717 W. Madison St.
Chicago 44, Ill.

SPECIAL PURPOSE TUBES

OA5	$3.25	3C45	8.00	12GP7	15.00	276A	3.75	702A	1.25	837	1.00
1B24	6.00	3D22	9.75	FG-17/5557	3.00	282A	6.00	702B	2.00	838	2.50
1B27	8.75	3DP1	2.00	RK-19	1.50	283A	3.00	703A	2.00	846	85.00
1B42	7.75	3EP1	3.00	RK-21	1.25	286A	5.50	707A	3.50	849	15.00
2AP1	5.00	3GP1	1.75	RK-23	3.00	304TH	5.00	707B	7.00	850	20.00
2C33/RX-233A	1.50	4-65A	17.50	28D7W	3.00	304TL	3.75	708A	1.00	860	1.50
2C39A	12.00	4B26	4.50	Twin 30	10.00	305A	3.50	709A	1.50	861	10.00
2C40	6.00	4B27	5.00	FP-54/5740	44.00	307A	1.75	715A	2.00	866A	1.00
2D21	1.00	4C22/HF-100	7.50	HK-54	3.50	310A	2.75	715B	3.00	869B	30.00
2E22	1.50	4C27/CV-92	7.50	RK-60/1641	1.75	311A	5.00	715C	10.00	872A	1.50
2J21A	3.50	4C35	16.50	RK-62	1.75	313C	2.50	719A	7.50	878	1.00
2J22	3.00	4E27	12.00	RK-65/5D23	20.00	316A	1.00	721A	1.00	884	1.00
2J26	4.75	4J34	50.00	RK-73	1.00	323B	3.50	723A/B	11.50	885	1.35
2J27	7.00	4J35	75.00	FG-95/5560	14.75	328A	3.25	724A	1.00	891R	100.00
2J29	25.00	4J42	50.00	C-100D	2.00	329A	5.50	724B	1.00	892R	150.00
2J30	50.00	5BP1	2.00	F-128A	35.00	348A	6.00	725A	4.00	902-P1	6.00
2J32	14.00	5BP4	2.00	HK-154	4.00	349A	6.50	726A	10.00	913	9.00
2J33	18.00	5CP1	3.75	VT-158	15.00	350A	4.00	726B	30.00	922	1.00
2J34	16.00	5C30/C5B	2.00	FG-190	5.00	354A	15.00	726C	30.00	923	1.00
2J36	70.00	5D21	8.00	HF-200	9.50	355A	15.00	803	2.50	931A	3.00
2J37	9.00	5FP7	1.00	C-202	10.00	393A	4.50	805	2.50	959	1.35
2J38	8.00	5FP14	6.00	203Z	5.00	394A	2.00	807	1.00	CK-1006	1.00
2J40	22.50	5JP1	9.00	204A	8.00	417A	6.50	808	1.50	1500T	75.00
2J55	55.00	5JP4	9.00	205B	1.00	GL-434A	5.00	810	9.25	1624	1.00
2J56	80.00	5J26	50.00	F-207	40.00	446A	1.00	811	2.00	1904	10.00
2J61	20.00	5J30	18.50	217A	2.00	446B	3.25	811A	3.00	2050	1.00
2J62	7.50	5J32	35.00	WL-218	20.00	WL-460	10.00	812	2.50	ZB-3200	50.00
2J-B51	1.00	5R4GY	1.00	235R	75.00	464A	3.50	813	8.25	5551/652	50.00
2K33A	47.50	C6A	6.00	250R	6.75	WL-468	15.00	815	2.00	5610	1.50
2K41	65.00	C6L/5528	5.00	250TH	14.00	CK-510AX	1.50	822	15.00	5725	3.25
2K54	20.00	6BM6	50.00	251A	45.00	527	12.50	826	1.00	CK-5829	2.25
2K55	20.00	6C21	15.00	252A	15.00	WL-530	10.00	828	8.00	5963	1.25
3AP1	4.50	6G4/X-102B	3.00	253A	5.00	WL-531	4.50	829B	9.00	8002R	25.00
3BP1	2.50	6J4	4.50	257A	3.00	559	1.00	830B	1.50	8005	4.00
3B24	3.50	7EP7	2.00	267B	6.00	575A	15.00	832	5.00	8012	1.50
3B24W	6.75	9GP7	3.75	271A	5.00	WL-579B	12.50	832A	6.00	8012A	2.50
3B25	2.50	9LP7	2.00	274B	1.50	701A	2.00	833A	30.00	8013	2.50
3B26	2.50									8020	1.00
3B28	3.50									8025	2.50
3C23	5.00									PD8365	50.00
3C24/24G	1.00										

western engineers

*Prices do not include transportation

ELK GROVE, CALIFORNIA

GEORGE WHITING, OWNER

* Fully guaranteed

IT'S Harjo FOR GREATER VALUES!

BARGAINS IN METERS

PORTABLE KILOWATT HOUR METER KIT contains new standard kilowatt meter and heavy duty lab-type case with handle. With instructions. A $50 value $9.95

3-INCH BLACK DIALFACE 0-750 MA 4.50

500-0-500 MICRO 6.50

WESTON FREQ. METER. Model 637, 350 to 450 cycles 100 to 125 V. Removed from new equip. Reg. price, $100—reduced to 19.95

PANEL METERS, 3" square Weston 0-2.5 amps DC 4.95

TUBE VALUES

DUMONT 3GP1 Cathode Ray Tube. Brand new, boxed with schematic and parts list. $1.79

701A Kilowatt Screen-Grid Transmitting Tube, great for new final AM or SSB. New ..... $2.95 or 2 for $5

FILAMENT TRANSFORMER for 701A, 8V @ 7½ amps $3.95

Hundreds of other values in tubes—check us first!

RCA TUBE HANDBOOK
Type HB-3 in 3 volumes. May be registered so that supplements can be received regularly from RCA. Special at just $4.95

RADAR EQUIPMENT

APS-4 complete Radar Set	$650.00
SN complete	400.00
T25/TPS-2	75.00
R65/APN-9	550.00
AN/PPN-1 (Eureka)	50.00
AN/PPN-2 (Eureka)	75.00

Special! RCA Surplus

TELEVISION CAMERA

Can't Miss at

$225

With 1848 Iconoscope and 6-stage video amplifier and clipper. For use in movie pickup chains and training and experimental work. Write for complete information.

TEST EQUIPMENT

TS-11	$45.00	TS-265	37.50
TS-13	695.00	IE-19	200.00
TS-34	250.00	I-222	89.50
TS-47/APR	200.00	I-139A	12.50
TS-50U	14.95	I-183A Freq. Meter	
TS-89	32.50		22.50
TS-100	85.00	I-185A Oscillator	24.50
TS-101	7.50	BC-221 Meter	89.50
TS-126	75.00	BC-1287A (s band)	
TS-131	14.95		125.00
TS-184	$45.00	LM	85.00

SOUND POWERED HEAD & CHEST SET
Navy type, no batteries needed. Ideal for TV antenna installations. 20' cord. new, $25 value $7.95

TS45/APM X-Band SIGNAL GENERATOR
Now $125
For small labs, schools, service shops

Western Electric HANDSET
$2.95
Standard telephone type complete with Cord. For mobile & home systems. Xlnt, cond.

TRANSMITTERS & RECEIVERS

ARC-3 complete, certified	$580.00
BC-640 & BC-639, RA-42	750.00
AN/TRT-1 Mine Trans.	100.00
ART-13	350.00
BC-797 ground stas.	750.00
SCR-284	100.00
BC-1333 Marker Revrs. Certified	75.00
BC-733D CAATC	35.00
ASB-7 Xmtrs with tubes. For 420 MC and TV relay work	7.95
ANDREW TYPE 876 Dry Air Pump for use with coax transmission lines. New	9.95

POWER SUPPLIES INVERTERS

MG-149F Rotary convertors. Certified	$ 45.00
RA-34 Hi-voltage for BC-191, etc.	149.50
RA-62 Hi-voltage for SCR-522	150.00

1st Time Offered! MINIATURE

LINE MATCHING TRANSFORMERS

Orig. Govt. Cost Approx. $14! Will Duplicate functions of $55 parts! **$1** Complete with Schematic. (add 25¢ for postage)

- For blocking oscillators on TV camera input circuits
- For blocking oscillators on TV Receivers
- Tone Oscillator transformer for electric organ
- For digital computor systems, blocking and count down
- For phone patches
- For transistor circuits
- 100's other uses.

Tiny transformer weighs only 4-oz. 1 3/16" x 1 3/16" x 2" high. Mfg'd under JAN specs & test standards, it's hermetically sealed. Four windings —2 input of 150 ohms impedance each—and 2 output of 1 of 105 ohms and one of 600 ohms impedance. Rated MW 200-5000 Cy. 500 V RMS test. Hurry—they won't last long at this low price!

WE PAY CASH FOR SURPLUS EQUIPMENT
Get what you want in spot cash without delay for your idle equipment. Write today for immediate reply!

WILLARD 6V Batteries, $1.29 each or 4 for $5
1" BULLSEYE & DIALITE SOCKETS, candelabra type (removed from new equip) ..39¢ ea.
220 V. CANDELABRA BULBS to fit above, 19¢ each or 7 for $1
MICRO SWITCHES brand new. ..... 4 for $1
SCOPE TRANSFORMERS. Primary 110 V. 60 cyl. Sec. 3500 V. 25 MA 10 KV ins. Shpt. wt. 15-lbs. $1.95

JUST RECEIVED! One Million POTENTIOMETERS, wire-wound resistors and all sizes. Write for complete list! ALSO RECEIVED HUNDREDS OF CASES OF OIL CONDENSERS, bathrub, channel and hi-voltage types—Write for list!

RESISTORS, insulated, standard brands, 5%, 10%, ½ & 1 watt asst. Postpaid. 100 for $1.79
TV TUNERS standard coil, cascode with 6BQ7, 6J6, new $13.95
CERAMIC CONDENSERS, kit of 100 asst. brand new, standard brand, $10 value $1

1000's MORE ITEMS IN STOCK! VISIT OUR SHOWROOMS OR WRITE FOR FREE CATALOG!

Harjo Sales Co.

4109 Burbank Blvd. ..... Burbank, Calif.
P.O. Box 1187 ..... Magnolia Park Station
Cable: HARJO ..... Phone: Victoria 9-2411

INVERTERS

Onan MG-215H. Navy type PU/13. Input 115/230, 60 cy., 1 Ph. Output: 115, 480 cy., 1 Ph., 1.2Kw and 26 V DC at 4 amps. New.....$295.00
Onan MG-0-75. Navy type PU/11 Input 115/230, 60 cy., 1 Ph., Output: 115, 480 cy., 1 Ph., 5.3 amps. and 26 VDC @ 3.8 Amps. New.....$225.00
Leland Elec. Co. PE206A. Input: 28DC at 38 Amps. Output, 80V, 800 cy., 1 Ph., 485W. New.....$16.50
PE218H. Input: 28DC. Output: 115, 400 cy., 1 Ph., 1.5KVA. New.....$32.50
G.E. 5AS131JJ11A. Input: 28DC. Output: 115, 400 cy., 1 Ph., 1.5 KVA. Regulated. New.....$89.50
Elcor, 32VDC to 110AC, 60 cy., 1 Ph. at 2.4 Amps. New.....$29.50

DYNAMOTORS

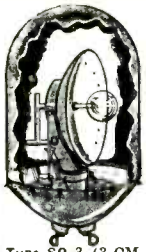
Navy type CAJO-211444. Input: 105 to 130VDC. Output: either 26VDC at 20 amps. or 13VDC at 40 amps. Radio filtered and complete with line switch. New.....$89.50
Type PE94CM. For SCR-522. Brand new in overseas cases. Has wide band input and output filters.....$14.95

AMPLIDYNES

5AM21JJ7. Input 27 VDC @ 15 A. Output 60 VDC @ 2.5A 4600 RPM. New.....$34.50
5AM31NJ9A. Input 27 VDC @ 44 A. Output 60 VDC @ 8.8 A., 7500 RPM. New.....$23.50
5AM31NJ18A. Input 27 VDC @ 44 A. Output 60 VDC @ 8.8 A., 8300 RPM. New.....$12.50

SMALL DC MOTORS

G.E. 5BA50LJ2A. Armature 60VDC at 8.3 Amps. Field 27.5VDC at 2.3A RPM 4000. H.P. 0.5. New.....$27.50
Oster E-7-5. 27.5DC. 1/20 HP, 3600 RPM Shunt Wound. New.....$9.50
Dumore Co. type ELBG. 24 VDC, 40-1 gear ratio. For type B-4 Intervalometer. New.....$2.75



RADAR ANTENNAS

TYPE SO-13 ILLUSTRATED

Type SO-1 (10CM) assembly with reflector, waveguide nozzle and drive motor. New....$279.50
Type SO-3 (3 CM.) Surface Search type with reflector and drive motor, but less plumbing. New in original cases..$99.50
Type SO-13. (10CM.) Complete assembly with 24" dish, dipole, drive motor and gearing. New.....$89.50

RADAR SETS

MODEL SQ. Portable radar set, 10CM. Operates on 90-130 volt. 60 cy., 1 Ph. "A", "B", and "PPI" presentation. Complete with tech manual and full set of operating spare parts. Used but in good condition.....$749.50
MODEL ASG-1 Radar unit consisting of transmitter and converter assembly CPR-43ABC, Antenna Assembly CRP-ACZ. Mouting Base CPR-10ABE, etc. New in original case.....$279.50

SCR-545A RADAR

Removed from trailer. Includes: Azimuth and Elevation Control Units; 214A and 154A Indicators; Input and Output Servo Amplifiers; Three BC-1035A Scopes; Power Panel and RA-65A Power Supply; Range Cont. Unit; Range Converter; Search Rec. and Cont. Unit; Search Trans; Track Rec. and Control Unit; Track Trans; Range Unit; Auto. Controller; no Antenna included. In good condition. A terrific value at $1375.00
Only one set available.

REPAIR PARTS For BC 348

MODELS H, K, L, R, ONLY

Main Tuning Capacitor	$ 2.00
1st I-F Transformer Assembly	2.00
2nd I-F Transformer Assembly	2.00
3rd I-F Transformer Assembly	2.00
4th I-F Transformer Assembly	2.00
Crystal Filter Assembly	6.50
C. W. Oscillator Assembly	2.00
915 kc Crystal mounted	2.75
Antenna Unit Assembly	12.50
R. F. Unit Assembly	12.50
Resistor: Volume Control	2.75
Knob for Main Tuning Condenser	.50
Band #1 Coils—per set of 6	3.00
Band #2 Coils—per set of 4	2.00
Band #3 Coils—per set of 4	2.00
Band #4 Coils—per set of 4	2.00
Band #5 Coils—per set of 4	2.00
Band #6 Coils—per set of 4	2.00

G. E. SERVO AMPLIFIERS

Used in B29 planes for Central Station Fire Control Systems B2, B3 and B4. Used to drive Amplidyne 5AM31NJ9A and Control Motor 5BA50LJ2A listed in 1st column. New less tubes.....$29.50

TUBE SPECIALS

1N21B	$1.49	3BP1	$2.95
1B24	3.9	3CP1	1.95
2J62	12.5	7BP7	2.75
2J531	1.75	861	9.50
3B22	1.6	C6J	4.00

SCR-522 EQUIPMENT

Complete BC-624C receivers and BC-625AM Transmitters including mounting racks, plugs, connectors, dynamotor. Brand new equipment with instruction manuals. Write for full details.

BARGAINS IN TRANSMITTING MICA CAPACITORS

High voltage Transmitting types, thousands in stock. Wide selection of sizes, types & ratings. All new and made by top manufacturers. Write for complete listings.

SYNCHRO CAPACITORS

.6-.6-.6 mfd Mark 12, Mod. 2, type 1C $1.75
10-10-10 mfd Mark 1, Mod. 2, type 3C $2.95

300-1200 MC. XMITTER

AN/APT-5 Brand New in original cases. $139.50

AN-APR-1 RECEIVERS

Less tuning units. Excellent condition. $149.50

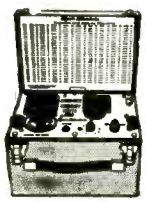
REACTORS

KS9589 Retard. 4HY @ 100MA...$1.00
#2C2270/R2 For Keyer Unit BC409.$3.75
Multi-Choke 3 hy @ .275A 70 ohms, 17 hy. @ .125A 200 ohms, 17 hy. @ .125A 200 ohms 7⅛ x 6⅝ x 3¾.....$2.95

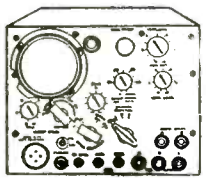
SPECIAL! HIGH-POWER OIL-FILLED CHOKE

16 Henries, 450 MA, 125 Ohms resistance, 6000 volt test. OA size: 7¼ x 5-3/16 x 6". Net Wt. 27 lbs. Price, New.....$9.95

FREQUENCY METER 375 to 725 MCS

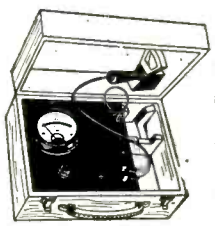


Model TS-127/U is a compact, self-contained, battery powered, precision (± 1 Mc) frequency meter which provides quick, accurate readings. Requires a standard 1.5V "A" and 45V "B" battery. Has 0-5 Min. time switch. Contains sturdily constructed HI-"Q" resonator with average "Q" of 3000 working directly into detector tube. Uses 957, 1S6 and 3S4 Tubes. Complete new with inst. book, probe and spare kit of tubes. Less batteries..... **$47.50**



PANADAPTER and SCOPE AN/APA-10

A combined Panoramic Adapter and Oscilloscope. Has 3 coax input connectors for feeding in from receivers having 1.F. of 455kc., 5.2 mc or 30mc. Designed also to be used as regular oscilloscope for testing other equipment. Has both vertical and horizontal push-pull amplifier inputs, etc.
Complete with 21 tubes including 3" CR scope tube.
For operation on 115V, 400 Cy. Price.....$99.50
For operation on 115V, 60 Cy. Price.....$145.00
SPECIAL OFFER!
AN/APA-10 TECH, MANUAL, 80 pages. Postpaid in U.S.A......$1.00



FLUXMETER

Used to calibrate field strength of magnets from 500 to 4000 gauss and indicate polarity. Probe has gap of 1¼". Beautifully built in hardwood case with hinged cover. Instructions for operation on under side of cover. Size 12¾ x 9 x 6 in. Ideal for lab and school use. New. An exceptional value at..... **$24.50**

400 CY. BLOWERS

Westinghouse Type FL. 115V, 400 cy., 6,700 RPM. Airflow 17C.F.M. New $3.95

SYNCHROS

Ford Inst. Co. Synchro Differential Generator. Mod. 3 Type 5SDG. 90/90V. 400 cy., Ord. Dr. 173020. New.....$4.50
Armor. Synchro Differential Generator. Type 6DG. New.....$29.50
Hobart Mfg. Co. Synchro Dif. Generator Type XIX 115V, 60 Cy. New $4.95
5F, 5G, 5CT Also In Stock

D.C. SELSYN MOTOR

Step by step type for use with potentiometer in D.C. Selsyn Control Systems.
Bendix—Type CAL 14810 (MK1 Mod 0). 70 Volts DC input.....$4.95

MOTOR GENERATORS

2 KKVA O'Keefe and Merritt. 115DC to 120AC, 50 cy., 1 Ph., Export Crated. New.....$125.00
MOTOR GENERATOR, TYPE CGU-2 Unit of U. S. Navy TCK-7 Transmitter Motor: 2 H.P. 230V, D.C., 10 amps. Generator: 1800V. D.C., 0.4 A, 500V. D.C., 0.35A, 115V. D.C., 1.5A, 12 V. D.C., 2A. 3480 R.P.M. Self excited. Brand new including spare armature. $95.00
ALLIS-CHALMERS 230DC to 115AC, 60 cy., 1 Ph., 1.25 KVA.....$149.50

FREQUENCY STANDARD

Complete self contained, dual 100/1000 kc crystal, multivibrator and harmonic amplifier. Calibrates with WWV and provides 1000, 100, and 10 kc check points from 100 to 45,000 kc. 115V. 60 cycles. New with instructions. **$23.95**

Radar Repeater Adapters NAVY TYPE CBM-50AFO

A repeater unit for video signals and trigger pulses designed to work in conjunction with standard Navy radar equipments wherein provision is made for operation of remote P.P.I. sets. This adapter provides four video and trigger pulse lines for operating one or more remote P.P.I. control installations. 115 Volts, 60 cycles A.C. Dimensions are 31½ x 21 x 15 in.....New $97.50

HIGH POT TRANSFORMER

Westinghouse. Pri: 115, 60 cy. Sec: 15,000V C.T., @ .060 A.C.T. ungrounded. Excellent for high-potting tests. Size OA 12H x 8½W x 9¼D. Weight 67 lbs. Fully enclosed steel case. Price...$29.50

30-10,000 CYCLE MODULATION TRANSF.

For RCA, Type 250-K Broadcast Transmitter (MI-7242) P to P Primary Imp. 15,000 ohms. Secondary Load 5,030 ohms. Size 11¼x9½x13". Wt. 143 lbs. New.....$49.50

60 CYCLE TRANSFORMERS

G. E. Step-Down. 6KVA. Pri: 230/460. Sec: 115/125, 60 cy. Size: 20" x 11" x 9½". Weight 225 lbs. Navy grey finish, integral junction box and mounting brackets.....$69.50
Plate Trans. Raytheon. U-5815. Pri: 440/220, 60 cy. 3 phase. Sec: each phase 1310V @ 0.67A test 6000V.....$59.50
Plate Trans. Pri: 115V., 60 cy., 1 Ph. Sec: 1470V. C.T. @ 1.2A tested at 5500V. RMS. Raytheon. Size 12¼ x 10 x 10 in. Shipping wt: 150 lbs. New. Price.....$27.50

ALTITUDE INDICATOR

Type ID-14A/APN-1. Brand New in original cartons. Special.....$2.95

SPECIALS

ATTENUATOR. Daven Type T-800 Circuit: TEE. Imp. 50,000., 0.5 D.B. per step. New.....$2.75
CRT Shields for 3" Tube.....$2.75
FIRE DETECTOR. Designed for use on aircraft, tanks, armored vehicles. Heating of outside casing as by fire causes inside snap blade switch to close. Good Experimenters item.....3 for $1.00
JACK BOX. BC-1366M. Band New $.65
JACK PLUG ASSEMBLY. 787Q. New. 10 for $1.00
PARABOLOIDS. 17½" dia. spun magnesium, 4" deep, 1½ x 1⅝" opening at apex. Per pair.....$12.50
SAWTOOTH POTENTIOMETER. Continuous winding, 2 rotating and 2 take-off brushes. GE251X95.....$2.75
SOLENOID. 24V DC, 2 lb. pull, ¾" stroke. New.....$1.45
SWEEP GENERATOR CAPACITOR. 5/10 mfd., split stator coax type. Hi. speed ball bearings.....$1.95

SOUND POWERED CHEST SETS

U. S. Instrument Co. No. A-260 Combination headset and chest microphone. Brand new, including 20 ft. of rubber covered cable and plug....$17.50 each
FIELD TELEPHONES. RM29A Complete with carrying cases and TS-13 handsets. New in original cartons $17.50
HEADSET ADAPTER. MC-385C Matches hi to lo imp., for HS-33 or 38 phones. New in original cartons.....$1.65
TRANSMITTER CAPSULE for TS-13 handset. New in original cartons..$1.75
COMMANDO POLE JACKS. A weatherproof jack and terminal box. Used with EE8 phones in the field. New.....$.95

HIGH VOLTAGE OIL CAPACITORS

Mfd.	Volts	Price
.001	50 KV	$22.50
.01	5 KV	1.29
.02	8 KV	2.65
.02	20 KV	9.75
.025	50 KV	26.50
.05-.05	50 KV	34.50
.1	3 KV	.95
.1-.1	4.5 KV	3.50
.135	7.5 KV	6.95
.2	50 KV	39.50
.25	15 KV	15.50
.25	20 KV	17.50
.25	50 KV	44.50
1.	7.5 KV	6.95
1.	15 KV	39.75
2.	5.5 KV	9.50
2.	6 KV	12.50

SPECIAL $6.95

9 CONDUCTOR CABLE

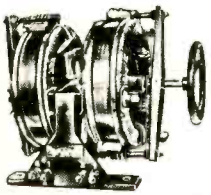
Army spec. CO-215 Weatherproof 9 Cond. No. 20 AWG stranded tinned copper, plastic ins., color coded, double vinyl jackets with tinned copper braid between. Dia. 9/16" made by G.E. Available 1000, 1500, 2000 ft. reels.....Price $.12 ft.
Sample 100 ft Coil.....$15.00

TERMS: Rated Concerns Net 30, FOB Bronxville, New York. All Merchandise Guaranteed. Prices Subject to Change.

PHONE: DEERFIELD 7-0044
ELECTRONICRAFT INC.
Cable Address: Electraft, N.Y.
27 MILBURN ST. BRONXVILLE 8, N. Y.

HERSHEL RADIO CO. BIGGEST BUYS!

TRANSTAT 100 AMP



ONLY $149.

Pri. 115 VAC 60 cy 11.5 KVA Sec. 0-115 VAC 60 cy 100 Amp Max. MFD. Amertron.

CIRCUIT BREAKER

100 AMP

$19.95

3 Pole 250 VAC. 100 Amp 15,000 Amp interrupting capacity. "Wesco".

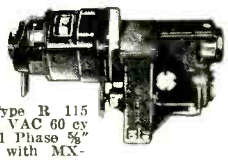
PULSE TRANSFORMER

$62.50

G.E. Type K2746A Dia. 9216934 Used with Cy-153/TPL-1.

GEAR REDUCTION MOTOR

$49.50



¼ H.P. Type R 115 VAC or 230 VAC 60 cy 1725 RPM 1 Phase ⅝" Shaft used with MX-186/TPL-1

SIGNAL GENERATOR I-122

ONLY $49.50

RF Signal 15 to 25 MC and 90 MC to 125 MC modulated at 400 cy or 625 cy 110 VAC 60 cy with carrying case.

OIL COND.

MFD	VDC	Price
.05	3000	$1.95
.05	7500	2.29
.1	4000	1.29
.1	7500	2.49
.5	2500	1.75
2x.5	8000	1.49
1	3000	2.49
1	3600	2.95
1	5000	4.95
2	1000	.95
2	3000	4.95
4	1000	1.95
6	600	1.29
7	600	1.39
8	600	1.75
8	1000	2.49
10	600	2.49
10	1500	4.95
Dual ½4	1000	
2x4	600	3.95

PAPER CAN

MFD	VDC	Price
250	10	$ .39
500	12	.49
1000	3	.69
1000	15	.95
1000	25	1.29
1200	10	.95
1600	15	1.29
24000	3	1.49
177	110 VAC	1.45

PHOTO FLASH SPECIAL

MFD	VDC	Price
525	450	$9.95

POWER UNIT ARMATURE

For PE 85 Athure. Brand New MFD. Leece Neville.

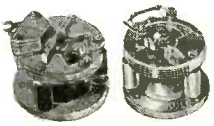
$17.50

BUTTERFLY CONDENSERS

YOUR CHOICE $4.95

TYPE A
106 to 330 MC Can Use 95S Type Tube

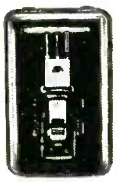
TYPE B
135 to 485 MC Silver Plated.



TYPE C
300 to 1000 MC Can Use 368AS Tube Silver Plated

TYPE D
300 to 1000 MC Has Clip For Xtal Detector

DE-ION MOTOR WATCHMAN



$9.95

3 Pole 3 Position Toggle 110 VAC 13.5 Amp—3 PH Motors 110 VAC 1½ H.P.—Cont Rated 15 Amp CW. 2 Relay Heaters Trip at 3 Amp. Size 0 Mfd. Wesco.

RHEOSTAT 5.0hm

7.5 - 5.8 Amp 125V Used with Rectifier RA-39.

$3.95

RCA OUTPUT TRANS.

PP 6L6's 25 Watt Pri. 5.00 Ohm Sec. ±1 5.0 Ohm #2 6.0 Ohm Sidetone 15 to 15,000 cy Flat.

$1.95

PLATE TRANS.

Only $9.95

Pri. 90 VAC 60 cy 3 Amp. Sec. 6400 V. 1 Amp 6¾ x 5¾ x 6¼ H.

TRANSFORMERS

Tapped Pri. 100, 105, 110, 115, 120, 125 VAC 60 cy Sec. 2 Windings 2.6V 10 Amp, 5.15V 3 Amp, 6.4V 5 Amp; 2 Windings 10.1V 8 Amp. 434 VCT—120 MA.	$14.95
Pri. 117 VAC 60 cy Sec. 2000V. RMS 2.5 MA; 2.5 V at 1.75 Amp; 6.3V at 6 Amp Moisture Proofed.	$2.75
Pri. 100 VAC 60 cy; Sec. 400 VCT 20 MA 6.3V 1 Amp; 5V 2 Amp.	$1.29
Pri. 117.5 VAC 50-60 cy Sec. 6.3V, 0.9 Amp.	$.95
Output Pri. Impedance 20,000 Ohms Sec. Impedance 2,000 Ohms 5 MA. DC. Freq Response ±2db. 100 to 5000 cy. Used with Freq Meter BC 438.	$.95
Pri. 117.5 VAC 60 cy Sec. 220 V. at 50 MA; 5V. 6 Amp; 6.3V 2 Amp; 6.3V. 1 Amp.	$1.29
Pri. 115V 400 cy. Sec. 800V 150 MA; 200V 30 MA 5V 3 Amp; 6.3V 7.5 Amp.	$3.95

CHOKES AND REACTORS

Dual 4.5 H 120 MA; 4.54 70 MA	$1.95
Dual 1 H 400 MA; 4.2H 75 MA	$2.95
Swinging 2-7 H 550 MA	$5.95
15 H 80 MA. 385 Ohm	$1.95
1.3 H 1 VDC .020 Amp 60 cy. 600 V Ins	$ .49
5 H 225 MA 400V Ins	$1.95
Coil: Telephone Retardation—27 H 3 Amp 2 Ohm DC Res	$7.50
Coil Repeating 20, 135 and 1000 cy Signaling; Impedance Ratio 1-1	$4.95
Reactor Oil Filled 60 H 50 MA Used with SCR 682-A	$19.95

FILTER UNITS

FL-15U Freq up to 57 MC—Drake.	$3.95
FL-17 Used with Dyn. PE 101.	$.95
FL-41 Used with Control Unit RM-35.	$2.95

BK22K RELAY

Used with SCR-269F Change over contains 28V Step Relay 5 Deck 6 Position SW D.P.S.T.

$3.95

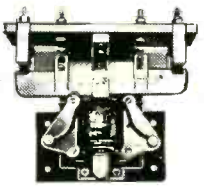
POWERSTAT

15 AMP

$29.95

Pri. 115 V 60 cy Sec. 0-135 V-2KVA 15 Amp. Brand New.

CONTRACTOR RELAY



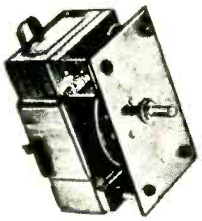
$9.95

110 VAC 60 cy 4P.S.T. 15 Amp Contacts 2500 V. RMS to Ground Mycalex Ins. Brand New.

RELAY SPECIALS

Coil 14 VDC .47 Amp 30 Ohm Res. D.P.S.T. Contacts 1000 VDC. G.E.	$2.45
6 Contact D.P.D.T. 115 VAC 6 Amp. 530 Ohm DC Res. Each.	$3.95
Oper. Voltage 18 V. 60 cy. 4 Amp Contacts Rated 115 VAC 8 Amp. Single Winding Coil S.P.D.T. AC Res. of Coil 4 Ohm.	$3.95
24 VDC 5 Amp 240 Ohm—120 VAC 400 cy Inductive Load. Potter Brumfield.	$1.49
D.P.D.T. 110 VAC 15 Amp Will Operate 24 VDC 15 Amp Fast Action.	$2.45
D.P.D.T. Coil 3V. 27 Amp DC Res 11 Ohm.	$1.49

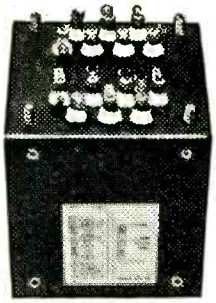
VARIABLE TRANSFORMER



$4.95

Pri. 115 VAC. 4 Amp 50-60 cy. Sec. 30 to 135V. 25 Amp. Used with Dictaphone Reproducer MFD. U.T.C.

FILAMENT TRANSFORMER



$4.95

Pri. 117 VAC 60 cy. Sec. #1 6.4V 12 Amp. #2 6.4 V 10 Amp, #3 5.0V 3 Amp. #4 5.0 V 3 Amp. #5 5.0V 8 Amp. #6 2.5V 1.75 Amp. Size 5-9/16" x 5-1/16" x 5¼" H.

CIRCUIT BREAKERS

115 Vac 3 Amp	$.95
115 Vac 15 Amp	1.95
115 Vac 25 Amp	2.45

Mfg. Heineman Co.

HERSHEL RADIO CO.

5245 GRAND RIVER
Detroit 8, Michigan
Phone TYler 8-9400

TERMS: Cash with order or 25% DOWN—BALANCE C.O.D. NET 10 DAYS RATED ACCOUNTS ALL PRICES NET F.O.B. DETROIT
Merchandise Subject to Prior Sale

QUARTZ CRYSTALS!

Guaranteed to oscillate!

COMPLETE SETS

SCR-508

Channels 0-79. FT-241 HOLDERS. Fundamental crystal frequency range: 370.370 to 516.667 KC. Set of 80 crystals..... **$25.00**

SCR-509 & SCR-510

Channels 0-79. FT-243 HOLDERS. Fundamental crystal frequency range: 5706.7 to 8340 KC. Set of 80 crystals..... **$32.00**

SCR-608

Channels 270-389. FT-241 HOLDERS. Fundamental crystal frequency range: 375.000 to 540.277 KC. Set of 120 crystals.. **$48.00**

TRC-1, -2, -3, -4

Channels 700-999. In 2 types of holders: TRANSMITTER Crystals in FT-241 HOLDER. Fundamental crystal frequency range: 729.167 to 1040.625 KC. RECEIVER Crystals in FT-243 HOLDER. Fundamental crystal frequency range 7500 to 8750 KC.
MATCHED PAIR (1 transmitter crystal and 1 receiver crystal)..... **$1.50**
SET OF 300 TRANSMITTER CRYSTALS **$300.00**

SCR-609 & SCR-610

Channels 270-389. FT-243 HOLDERS. Fundamental crystal frequency range: 5675-8650 KC. Set of 120 crystals..... **$48.00**

HANDIE-TALKIE CRYSTALS

Fundamental Output Frequencies

4035	4330	4580	4880	5205	5437.5	5687.5	5907.5
4080	4397.5	4635	4930	5245	5500	5730	5950
4165	4445	4710	4980	5285	5545	5780	5995
4240	4495	4780	5030	5327.5	5587.5	5820	
4280	4540	4840	5127.5	5397.5	5645	5860	

Matched pairs of Transmitter-Receiver crystals in FT-243 HOLDERS. Receiver crystal is 455 KC. higher than the frequency of Transmitter crystal.

SCR-536

YOUR CHOICE OF ANY MATCHED PAIR. PER PAIR.....$1.00

ALSO AVAILABLE IN LARGE QUANTITIES

AA9-A	AVA-53	DC-9	DC-35	MC-7
AR4-W	BSD	DC-11A	FT-171	MX9-E
AR7-W	CR-1A	DC-15	FT-164	Collins Type 1-C
AVA-10J	CR-4	DC-34	FT-249	RCA MI-8412 A or B

QUANTITY DISCOUNTS AVAILABLE

WE INVITE INQUIRIES FROM FOREIGN BUYERS, AIRLINES, MILITARY AND EXPORT PURCHASERS, MANUFACTURERS, JOBBERS, WHOLESALERS AND VOLUME DEALERS. WRITE FOR FREE CATALOGUE.

U. S. CRYSTALS, INC.
805 S. UNION AVE. DEPT. E.
LOS ANGELES 17, CALIFORNIA

WIRE

- Magnet Wire
- Enamel
- Formvar
- Glass
- Silk
- Cotton
- Litz
- Mancanin
- Copper Braid
- Florist
- Bare Wire
- Tinned
- Plastic Covered
- Building
- Power
- Lead Covered
- Varnish & Cambric
- Hookup
- Pushback
- Shielded
- ANJC 48-A
- JANC-76
- SRIR
- Assault
- Blasting
- Telephone
- Intercommunication
- Multiple Conductor

ATLANTIC & PACIFIC WIRE CABLE CO., INC.

112-01 Northern Boulevard E. Elmhurst, N. Y.

Phone HIckory 6-1080-1 Cable Address: Atpawire, N. Y.

WAREHOUSE INVENTORY OVERSTOCK

Ready for Immediate Delivery

G.E. SWITCHBOARD METERS

MODEL DD-6 All meters self contained, surface mount type.

0–15 Amps DC, 5/10 Amps DC, 150 Ma DC — 400 Volts DC, 500 Volts DC, 500 Ma DC — **$22.50 ea.**

ANY OF ABOVE

We will convert meters to any workable range in Volts, Ma, or Amps. (Multipliers or shunts extra)..... **$27.50 ea.**

WHEELCO LIMITROLS

(TEMPERATURE SAFETY PYROMETERS) WHEELCO CAT. #724-5

Range 0—1200°F, Chromel-Alumel Calibration—Shuts off heaters on rise of temperatures. (Like New) **$55.00 ea.**

3φ SWITCHBOARD VOLTMETER SWITCHES, E.M. TYPE **$8.50 ea.**

Cat. #40371 Fig. 19

OHMITE HEAVY DUTY TAP SWITCHES **$3.50 ea.**

Cat. #3125, 25 Amps, 5 Position, 300 Volts A.C.

FIELD RHEOSTATS **$7.00 ea.**

20 Ω, 3.1 Amps, 600 Volts Max. 7" Dia. Plate, Metal Switchboard type.

RHEOSTATS 50 WATT 40 Ω OHMS **$1.50 ea.**

1.12 Amps. Standard Shaft Type.

10 or more $1.00 each

ALL ABOVE SUBJECT TO PRIOR SALE. RATED FIRMS SEND P.O. TO ALL OTHERS WE WILL SHIP C.O.D.

JML MANUFACTURING CO.
57 LISPENARD STREET
NEW YORK 13, N. Y.

RADIO - RADAR - INSTRUMENTS
AIRCRAFT - PHOTO EQUIPMENT

AIRLINES • GOVERNMENTS RESEARCH • LABORATORIES

We carry a large inventory of NEW and Guaranteed overhauled U.S. Signal Corps and U.S. Navy Surplus Equipment.
We solicit your inquiries.

TRANSMITTERS
RECEIVERS
RADAR
DYNAMOTORS
INSTRUMENTS
SELSYNS. PLUGS
AERIAL PHOTO EQUIPMENT
SPARE PARTS

WE WILL NOT BE UNDERSOLD!

Send for FREE catalogues on

- Communication Equipment ☐
- Inverters - Dynamotors ☐
- Radio-Radar Test Equip. ☐
- Aerial Photographic Equip. ☐

EQUIPMENT WANTED

Semler Industries, Inc.

6853 Lankershim Blvd., North Hollywood, Calif.

NEW WESTON SURPLUS METERS

301 D.C. Micro A. 0-100, 0-200.....	$11.00
731 D.C. Micro A. 0-25, 15-0-15.....	18.50
643 D.C. Micro A. 0-100.....	15.00
301 D.C. M.A. 0-1., 0-50., 0-150.....	7.50
301 D.C. Volts 0-10, 0-50, 0-250.....	7.50
301 D.C. V. 0-500, 0-1. K.V., 0-2.5 K.V.	12.00
476 A.C. Volts 0-10, 0-130, 0-150.....	7.50
476 A.C. Amp. 0-3, 0-5.....	7.50
476 A.C. Amp. 0-100, 0-150, with C.T...	12.00

All above Meters have standard scales and cases.

MARITIME SWITCHBOARD
Instruments and Accessories
336 CANAL ST, NEW YORK 13, N. Y.
WOrth 4-8216 (7)

FAY-BILL DISTRIBUTING CO.

PARTIAL LISTING ONLY

803 $2.69

LARGEST SURPLUS TUBE DEALER IN THE COUNTRY
STANDARD BRANDS—TRANSMITTING & RECEIVING

815 $2.49

Tube	Price	Tube	Price	Tube	Price	Tube	Price	Tube	Price
AB150	$2.99	2J34	28.50	3C33	10.25	5JP1A	19.95	VT-67	.29
CEP-220	.94	2J38	29.50	3C45	11.69	5JP5	22.00	VU-111	.49
OA2	.94	2J39	14.99	3D21A	6.75	5J29	15.95	100TH	5.99
OB2	.86	2J40	29.50	3D23	4.99	5J33	11.95	100TL	7.99
OB3/VR-90	.86	2J42	49.95	3E29	9.49	5LP1	12.99	F123A	5.99
OC3/VR-105	.92	2J61	21.95	3EP1	3.35	5NP1	15.99	F128A	49.49
OD3/VR-150	.84	2K22	18.49	3FP7	1.99	6C21	19.85	204B	9.49
OZ4	.59	2K23	14.95	3GP1	2.25	7BP1	6.99	205B	.99
1B22	1.19	2K25	23.49	3HP7	5.50	7C22	89.50	F-207	49.50
1B23	4.96	2K28	24.95	3J21	129.50	7C25	99.00	211/VT4C	.79
1B24	6.25	2K33A	59.50	3J30	109.50	7C30	87.50	215A	3.49
1B26	1.46	2K34	129.50	4A-11	.99	7BP7	6.99	221A	2.49
1B27	10.45	2K41	109.50	4B22	7.49	7FP7	3.49	221A	1.99
1B29	2.59	2K44	99.00	4B25/EL6CF	7.75	9LP7	6.99	231D	1.39
1B32/532A	1.49	2K45	91.00	4B28/CE-225	2.99	10Y	.29	242C	4.95
1N21	1.64	2K54	59.50	4-125A	27.90	15E	1.09	249B	4.69
1N23	2.10	2K55	59.50			15R	.34	250TH	19.50
1N27	7.99					18C	.59	250TL	18.50
1P-28	12.79							253A	7.99
1P-30	3.99							258B	4.49
2AP1	6.99							264C	3.19
2B22	1.99							271A	5.99
2C21/1642	.79							274B	1.49
2C22	.99							276A	4.99
2C26	.29							284B	7.49
2C33/RX233	1.99							286A	6.49
2C34/RK34	.39							287A	5.15
2C39	11.99							304TL	4.95
2C39A	16.50							304TH	5.85
2C40	7.49							305A	4.49
2C43	15.77	2X2A	1.39	4C28	33.91	24R	1.99	307A/RK75	1.39
2C44	.96	2X2	.39	4C35	18.99	35TG	4.44	388A	.96
2C46	14.99	3A5	.89	4D22	19.99	C5B	1.99	393A	5.59
2C51	4.29	3AP1	4.99	4D32	19.89	C6J	8.99	394A	2.95
2D21	.99	3BP1	2.99	4E27/HF-200	10.99	C8J	99.50	431A	99.50
2E22	2.29	3B22	2.33	257B	17.50	HF-300	19.99	417A	9.49
2E24	2.45	3B23	3.99	5AP1	4.99	RK38	.89	GL-434A	9.95
2E26	3.29	3B24	4.99	5EP1	2.99	RK39	.89	446A	.99
2J21	4.55	3B25	3.39	5BP4	3.89	RK59	1.75	446B	3.99
2J21A	5.99	3B27	11.95	5CP1	4.45	RK60	2.49	WL-460	12.99
2J22	4.79	3B28	3.69	5C21/C6J	8.99	RK72	1.19	464A	5.99
2J26	5.99	3C22	79.50	5C22	43.50	RK73	.99	450TH	52.00
2J27	7.99	3C23	6.55	5D21	14.50	RX21A	8.99	450TL	49.00
2J31	19.99	3C24	.98	5FP7	1.25	VR-78	.98	471A	2.15
2J32	19.99	3C27	3.25	5HP1	5.49	VT-52	.49	527	15.99
2J33	22.95	3C31/C1B	2.25	5JP1	16.75	HK54	4.59		

Tube	Price	Tube	Price	Tube	Price	Tube	Price	Tube	Price
5HP4	3.99	724A/B	1.69	865	.89	2A3	.89	6BH6	.89	6SN7	.81	12SR7	.56
WL-530	14.99	725A	8.49	866A	.99	3A4	.64	6BN6	1.19	6SR7	.59	12SF5	.44
WL-531	4.69	726A	17.49	869B	44.69	3B7/1291	.35	6BJ6	.69	6SQ7	.52	12SG7	.69
WL-532	2.25	726C	44.50	872A	1.99	3D6/1299	.34	6CS6	1.04	6U4	.89	12SH7	.62
4J-34	29.95	730A	28.75	874	.96	3S4	.62	6C4	.49	6Y6	.92	12SJ7	.46
4J-42	43.50	750TL	74.50	878	1.29	3Q4	.62	6C6	.54	6W4	.61	12SK7	.51
GL-559	.99	801A	.29	884	1.09	3Q5	.79	6C8G	.59	6X4	.49	12SN7	.74
KU-610	14.99	802	3.99	885	1.49	3V4	.66	6P6	3.19	6X5	.52	12SL7	.66
QK60	51.00	803	2.69	891R	185.00	4AP10	4.99	6P5	.49	6T8	.86	14A7	.63
QK62	56.00	805	2.89	893R	189.50	5Y3	.46	6D4	2.70	7A5	.89	14B6	.64
QK68	.49	807	1.49	918	1.99	5U4	.69	6J4	4.91	7A6	.69	14B8	.66
615	.49	808	1.99	927	1.75	5R4GY	1.24	6J5	.45	7A7	.69	14N7	.76
700/A/B/C/D	8.25	809	3.49	931A	4.69	5T4	1.19	6J6	.72	7B6	.69	14R7	.69
701A	5.35	810	9.69	954	.22	5V4	.92	6J7/M	.69	7B7	.69	14W7	.69
		811	2.58	955	.39	5Z4	.96	6J7G	.59	7C4	.28	25L6	.69
				956	.39	5W4	.99	6K4A	4.69	7C5	.86	25Z6	.56
				957	.39	6AC7	.87	6K6	.59	7C6	.69	28D7	1.49
				958A	.59	6AB7	.76	6K7	.44	7F7	.79	35L6	.76
				959	1.49							35Z5	.51
				991	.45							35Y4	.49
				1500-T	86.50							50A5	.72
				CK-1005	.49							50B5	.69
				1608	.99							50C5	.79
				1613	1.70							50L6	.79
				1616	.69							77	.59
				1619	.29							78	.59
				1624	1.24							81	.89
				1625	.29							83/V	.99
				1626	.19							84/6Z4	.59
				1629	.21							117Z3	.69
				1630	.69							5518	7.55
				1632	.42							5559	21.70
				1639	.89							5560	24.49
				1642	.89							5633	10.95
				1806/P1	3.66							5634	11.45
				2050	1.31							5651	2.69
				2051	.89							5654	1.69
				1A3	.69	6AF4	1.31	6L5	.54	7F8	.81	5670	3.59
				1A7	.64	6AG5	.69	6L6M	1.39	7H7	.59	5687	4.10
				1B3/GT	.89	6AG7	.96	6L6G	.92	7N7	.79	5718	5.99
				1B4/GT	.59	6AH6	3.49	6L7G	.41	7G7	.69	5763	1.49
				1LC5	.59	6AJ5	.99	6L7M	.86	7Q7	.69	5814	1.79
				1LD5	.79	6AK5	.99	6SC7	.72	7Y4	.49	5964	2.19
				1LN5	.69	6AK6	.89	6SF5	.69	7Z4	.49	5933	.14
				1L4	.49	6AN5	3.39	6SF7	.79	12A6	.53	8002R	34.95
				1L6	1.09	6AQ6	.66	6SG7	.78	12AU7	.79	8012	1.94
				1H5	.59	6AR6	2.69	6N7GT	.46	12AT7	.88	8013A	3.99
				1N5	.69	6AS5	.79	6N7	.76	12AV7	.89	8020	1.94
				1R5	.69	6AS7G	3.49	6S4	.66	12AX7	.71	8025	2.91
				1S4	.62	6B4G	1.12	6SA7	.48	12AY7	1.44	8602	.69
				1S5	.62	6BA7	.89	6SG7	.59	12BA7	.79	9001	1.08
				1T4	.48	6B5	1.09	6SH7	.58	12BH7	.96	9003	1.21
				1X2A	.89	6B8	.69	6SK7	.58	12SC7	.71	9004	.24
				1V2	.79	6BG6G	1.62	6SL7	.58	12SQ7	.54	9006	.24

SPECIAL

718 AY/BY/CY/EY	$18.95
720 BY/CY/DY/EY	29.75
830B	1.69
8002R	34.95
869B	44.69
304TL	4.95
304TH	5.85
307A	1.99

WE BUY YOUR SURPLUS TUBES. SEND US YOUR LIST FOR HIGHEST QUOTATION

SPECIAL

KU610	$14.99
5J33	11.95
2K55	59.50
F207	49.50
2K33A	59.50
2K54A	59.50
F-128A	49.49
GL-434A	9.95

FAY-BILL DISTRIBUTING CO. DEPT. E1
418 Broome St., N. Y. 13, N. Y.
Telephone CAnal 6-8404

All boxed and fully guaranteed. Special quantity discount—10% on 100 or more of same type. Minimum order $10.00. Thousands of other types in stock . . . Send us your requirements. F.O.B. New York 25% deposit with order or if paid in advance save C.O.D. charges. Rated firms net 10 days. Prices subject to change without notice.

At Your BUSINESS Service.

The Classified Advertising Sections (Searchlight Sections) of McGraw-Hill publications are at your service for the satisfying of almost every business need or want.

Because these publications are specialized in the field that they cover, your classified advertising of used or surplus new equipment, of securing a position of personnel, of offering or securing business opportunities will reach the right men, quickly and economically.

Classified Advertising Division

McGraw-Hill Publications, Inc.
330 W. 42nd St., New York 36, N. Y.

NEW SPRING CATALOG NOW AVAILABLE!

605B General Radio Standard Signal Generator	Exc.	$400.00
723A General Radio 1000 Cycle Vacuum Tube Fork With Power Supply	New	80.00
TS33/AP Test Set Freq. Range 8700 to 9500 MC. For Measuring CW. Pulsed Signals or Radar Sets	Exc.	200.00
726A General Radio Tube Voltmeter	Exc.	125.00
Weston Model 155 5 Amp AC Ammeter	Exc.	PUR*
AN/APR4 Radar Search Receiver Range 38 to 4000 MC. With 5 Tuning units	Exc.	PUR*
Model 686 Weston True Mutual Conductance Vacuum Tube Analyzer	New	500.00
AN/APN4 Loran Set Frequency Range 1700-2000 KC. Complete With 1D6B/APN4 Indicator, R9A/APN4 Receiver, Plugs, Crystal, Mounts, and Plugs	Exc.	160.00
PE-206 Inverter For Use With Loran	New	14.90
Kay Mega-Marker Range 19 to 29 MC. Sound Discriminator Adjustment 4.5 MC	Exc.	39.50
BC.779 Super-Pro Receiver, 100.400 KC. 2.5-20 mc Rack mounting	Exc.	175.00
Kay Mega Pepper Crystal Control, No Switching, Pips Simultaneously Visible	Exc.	100.00
General Radio Type 620A Hetrodyne Frequency Meter Panel Mounting 33KC.-33MC.	Exc.	425.00
TS-13AP X-Band Signal Generator, Wavemeter, Wattmeter	Exc.	PUR*
LR-1 Direct Reading Frequency Meter 150-30,000 KC. 115V.AC. 60 CY. With Crystal Calibration	Exc.	1000.00
G. E. Instrument Current Transformer, Model 9JP1HAF1 Type JP-1	Exc.	PUR*
Tuning Forks GR-723A 1000 Cycles	New	70.00
General Radio Hetrodyne Frequency Meter 720A 10-3000 MC.	Exc.	300.00

* PUR—Price Upon Request.

NOTE: One of the largest and most complete electronic surplus stocks in the country. We have thousands of tubes, capacitors, plugs, accessories, transmitters-receivers, test equipment, etc. Send us your requirements.

WANTED

All types of radio and electronic surplus as well as standard test equipment. Please state accurate description, condition, and your lowest price. Explain modifications, if any. We pay freight charges.

PHOTOCON SALES
417 N. Foothill Blvd. SYcamore 2-4131
Pasadena 8, Calif. RYan 1-6751
CABLE: Photocon, Pasadena

WAVEGUIDE RG52/U 12' min. 80¢ per ft.

"X" BAND

BEND 90 DEGREE. E or H plane. Std. radius. UG39cvr to UG40 chk. Silver plated. $10.50.
TWIST 90 DEGREE. UG39 to UG40. Silver plated. $7.50
CRYSTAL MOUNT. Hold any IN23 type xtal. 1" x ½" guide std coax output. UG40 flg. input. $15.00.
DIRECTIONAL COUPLER. Uni. Bi directional types 20db, type "N" output. UG39 flg. to UG40chk. $18.50
FLEX. SECT. Apx 6". UG39 flgs. $10.00, 12" at $17.50
TR-ATR SECTION. Duplexer assy w/UG-39 to UG40 run, iris cplg. cplg. to 1B24 type TR tube. ATR cavity 724 type compl. w/tuning slugs, $8.50
ROTARY JOINT. 3 types, miniature E input output, miniature L input output, large E input output. 90 deg. rotary coupling for lab or high speed scanner, $15.00
LINE STRETCHER, $34.50

"S" BAND

F-28/APN-19 FILTER CAVITY. 2700-2900mc. Max. 1.5-db loss at ctr. freq. over band, 3db at 15 mc band ends. JAN spec. Guaranteed. $25.00
CRYSTAL MOUNT. Type N fittings, tuneable silver plated, $5.50 special.
LIGHTHOUSE CAVITY. For 2C40 tube. Tuneable 2700-2900mcs w/suitable grid cvls. Can be freq. modulated. $22.50
STANDARD OR REFERENCE CAVITY. 2650-3050mc. Invar tuning center conductor of ¾ wave-lgth. 50 ohm coax "N" input output conn. Imc/sec- stability. Loaded Q betwn 650 and 3000 w/xmsn loss .5 to 5 db adjustable. Unloaded Ω apx 6000. Concentric xmsn type resonator. Tuning mech. lock. $25.00
FEEDBACK DIPOLE ⅞" coax. for parabola. 11¾" o.a. $14.50
ECHO BOX. TS-207/UP, 2700-2900mc. micro adj. $64.50

"K" BAND

MAGIC TEE, precision milled.....$45.00
DIRECTIONAL COUPLER bi-dir. UG-136/U flanges $45.00
KLYSTRON OUTPUT COUPLING for 2K50. RG 66/U guide. $12.50
H BEND 90 deg. CG346/U.
E BEND 90 deg. CG345/U. Cplg. UG-117 to UG-116. RG68 guide. $25.00 each.
ADAPTERS 1½" lg UG116 to UG116, UG117 to UG117 ea.....$10.00
Western Electric Stepping Relay. 4 circuits. 22 points, 360°, self-stepping. 6 volt coil, gold plated contacts. WE D162768. Brand New.....$19.50 each.

RADIO-RESEARCH INSTRUMENT Co.
550 - 5 Ave., N. Y. 36, N. Y. *Tel: JU 6-4691*

INDEX TO THE SEARCHLIGHT ADVERTISERS

SEPTEMBER, 1954

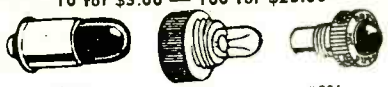
This index is published as a convenience to the readers. Care is taken to make it accurate but ELECTRONICS assumes no responsibility for errors or omissions.

SEARCHLIGHT SECTION
(Classified Advertising)
H. E. Hilty, Mgr.

ADVERTISERS INDEX

(Continued on page 436)

GRAIN OF CORN LAMPS
10 for $3.00 — 100 for $25.00



#328 28 Volts | #326 2½ Volts | #321 28 Volts

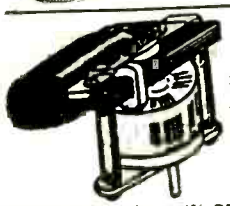
½" Ford Spark Coil by Delco-Remy..... $2.75

Smallest Buzzer Made!
EDWARDS BUZZER
Size "O"—1"x1¼" **$1.45**

DIEHL MOTOR
P.M. 10,000 RPM, FD621 **595**

HAYDON TIMING MOTORS

110v, 60 cycle 30 RPM		$2.60
110v, 60 cycle 1 RPM		2.85
230V 60C	1 RPM	1.00
	2 RPM	1.00



TELECHRON Motors

2 RPM	$2.90
3 RPM	3.90
4 RPM	2.90
3.6 RPM	3.15
1 RPM	3.95
60 RPM	4.30
3 R.P. Hr.	2.85
1 R.P. 2 Hr.	2.80
1 R.P. 12 Hr.	3.25

4 RPM on 50 cycles or 4¾ RPM on 60 cycles..2.85
Laboratory Special 1 of Each Above $25.00

DELCO REVERSIBLE GEARED-MOTOR
P.M.-Permanent Magnet Alnico Field
#5071895 ¼" SHAFT or 11/16 GEAR.. **$17.50**
#5069600 ..... **$18.50**

See back issues of ELECTRONICS for other Bargains

ALL PRICES F.O.B. N. Y.

EST. 1923 **BLAN** EST. 1923
64H Dey St. New York 7, N. Y.

CONTROL your COSTS on . . . SELSYNS-SYNCHROS

1CT Cont. Trans. 90/55V 60~	$60.00
1D Diff. Mtr. 90/90V 60~	67.50
1DG Diff. Gen. 90/90V 60~	60.00
1F Syn. Mtr. 115/90V 60~	60.00
1G Gen. 115/90V 60~	60.00
1HCT Cont. Trans. 90/55V 60~	67.50
1HDG Diff. Gen. 90/90V 60~	67.50
1HG Gen. 115/90V 60~	67.50
1N Syn. Mtr. 115/90V 60~, Bendix	45.00
1N Syn. Mtr. 115/90V 60~, Henschel	27.50
1SF Syn. Mtr. 115/90V 400~	17.50
2J1A1 Gen. 115VAC 400~	17.50
2J1A2 Gen. 115VAC 400~	17.50
2J1B1 Cont. Trans. 55VAC 400~	17.50
2J1D1 Gen. 115/90V 400~	12.50
2J1E1 Cont. Trans. 57.5VAC 400~	17.50
2J1F1 Gen. 115/57.5V 400~	9.50
2J1F3 Gen. 115/57.5V 400~	9.50
2J1FA1 Gen. 115/57.5V 400~	17.50
2J1G1 Cont. Trans. 57.5/57.5V 400~	9.50
2J1H1 Diff. Gen. 57.5V 400~	12.50
2J1H2 Gen. 115/57.5V 400~	12.50
2J1M1 Cont. Trans. 105/63VAC 60~	60.00
2JD1P1 Syn. Mtr. 115/90VAC 60~	60.00
2J5A2 Gen. 115/105VAC 60~	34.50
2JD5A2 Syn. Mtr. 115/105V 60~	50.00
2J5A4 Gen. 115/105VAC 60~	50.00
2JD5C2 Syn. Mtr. 115/105V 60~	50.00
2J5F1 Cont. Trans. 105/55V 60~	50.00
2J5FB1 Cont. Trans. 105/55V 60~	50.00
2J5H1 Gen. 115/105V 60~	60.00
2J5HA1 Gen. 115/105V 60~	60.00
2JD5HA1 Syn. Mtr. 115/105V 60~	60.00
2JD5HB1 Syn. Mtr. 115/105V 60~	60.00
2J5J2 Gen. 115/90V 60~	60.00
2JD5J2 Syn. Mtr. 115/90V 60~	60.00
2J5M2 Cont. Trans. 90/57.5V 400~	50.00
2J5K3 Cont. Trans. 90/55V 60~	60.00
2J5L1 Cont. Trans. 105/55V 60~	60.00
2J5LA1 Gen. 115/105V 60~	60.00
2JD5R1 Syn. Mtr. 115/90V 400~	27.50
2J5RB1 Diff. Gen. 90/90VAC 400~	37.50
2J6F1 Gen. 115/105VAC 60~	60.00
2J6F2 Gen. 115/90VAC 60~	60.00
2J6F3 Gen. 125/105VAC 60~	60.00
2J8A1 Syn. Mtr. 120 Volts D. C.	80.00
2J15B2 Cont. Trans. 90/57.5V 400~	37.50
2JA39BB2 Syn. Mtr. 110/55V 60~	60.00
2J55JB1 Gen. 110/55V 60~	60.00
2J55V1 Gen. 110/55V 60~	60.00
2JD55V1 Syn. Mtr. 110/55V 60~	60.00
2J65F1 Gen. 110/55VAC 60~	60.00
2JDA66PA5B Mtr. 110/55VAC 60~	42.00
2JD123A16 Mtr. 110/55VAC 60~	38.00
5A Syn. Mtr. 115/90V 60~	22.50
5B Syn. Mtr. 115/90V 60~	22.50
5CT Cont. Trans. 90/55V 60~	45.00
5D Diff. Mtr. 90/90V 60~	50.00
5DG Diff. Gen. 90/90V 60~	50.00

LOWEST PRICES * GUARANTEED

5E Arma Gen. DRG213315	$50.00
5F Syn. Mtr. 115/90VAC 60~	45.00
5F400 Syn. Mtr. 115/90VAC 400~	50.00
5G Syn. Gen. 115/90VAC 60~	45.00
5HCT Cont. Trans. 90/55V 60~	65.00
5HG Syn. Gen. 115/90VAC 60~	80.00
5G Special Gen. 115/90VAC 400~	29.50
5HG400 Gen. 115/90VAC 400~	60.00
5M Syn. Mtr. 115/90VAC 60~	22.50
5N Syn. Mtr. 115/90VAC 60~	22.50
5SB Cont. Mtr. 115/90VAC 60~	60.00
5SCT Cont. Trans. 90/22.5VAC 60~	50.00
5SDG Diff. Gen. 90/90V 400~	37.50
5SF Syn. Mtr. 115/90VAC 400~	32.50
5SG Gen. 115/90VAC 400~	32.50
5SG, KS5950-L2, Gen. 115/90V 400~	22.50
5SN Cont. Mtr. 115/90VAC 60~	60.00
6CT Cont. Trans. 90/55VAC 60~	55.00
6DG Diff. Gen. 90/90V 60~	60.00
6G Syn. Gen. 115/90VAC 60~	50.00
6SG Syn. Gen. 115/90VAC 60~	50.00
7DG Diff. Gen. 90/90V 60~	67.50
7G Syn. Gen. 115/90VAC 60~	60.00
18CT4 Cont. Trans. 90VAC 400~	45.00
FJE22-1 Syn. Repeater 115VAC 400~	27.50
R210-1A Kearfott Trans. 26/11.8V 400~	59.50
R220-1A Kearfott Repeater 26/11.8V 400~	59.50
R235-1A Kearfott Resolver 26/11.8V 400~	59.50
81E115 Trans. 115/90VAC 60~	45.00
5MJ35CB1A GE Syn. Mtr. 55/55V 60~	85.00
ZL26JF3117 Wag. Syn. Mtr. 115V 60 Cy. 180 RPM	45.00
8TJ9PXAN GE Transmitter 24V	9.50
8TJ9PXAN GE Transmitter 24V	9.50
C44968-6 Repeater 115V 60~	17.50
C44968-8 Transm. 115V 60~	22.50
C56701 Type II-4 Rep. 115V 60~	22.50
C56776-1 Type II-5 Rep. 115V 60~	22.50
C69405-2 Type I-1 Transm. 115V 60~	22.50
C49406 Syn. Transm. 115V 60~	22.50
C69406-1 Type II-2 Rep 115V 60~	22.50
C76366 Volt. Rec. 115V 60~	17.50
C76535, FJ84-2 Volt. Rec. 115V 60~	17.50
C77610 Syn. Rep. 115V 60~	17.50
C78248 Syn. Transm. 115V 60~	17.50
C78249 Syn. Diff. 115V 60~	7.50
C78254 Type XII Diff. 115V 60~	22.50
C78359, FJE84-4, Rec. 115V 60~	22.50

All synchros fully guaranteed to meet customer's specifications. Fob Boston. Allow us to quote you on any of your rotating equipment requirements, such as Rate Generators or Motors, Servo Motors, Autosyns, Kollsman Units, Resolvers, Ttc.

Phone CApitol 7-3456

ELECTRO Sales Company Inc. ESCO
50 EASTERN AVE., BOSTON 13, MASS. CAPITOL 7-3456

EMELTONE ELECTRONICS
71 W. Broadway, N. Y. 7, N. Y.
Rector 2-1696

Your best source for special purpose tubes

OB2	.90	7BP7	3.50
VR90	.75	VT98	12.00
VR150	.75	307A	1.95
2C39A	13.00	707B	13.00
2D21	1.10	723A/B	16.00
2K25	19.00	724A	1.00
2K41	110.00	724B	1.00
3B22	2.25	836	2.50
3DP1-S2	6.00	860	2.50
4E27	14.00	884	1.10
5C22	35.00	2050	1.20
5D21	12.00	2051	.90
5J26	125.00	5687	3.50
6AK5	.60	8025	3.95
6F5	.39	9002	.60
6J4	4.25	9005	1.95

NOTICE *—ALL ITEMS PREVIOUSLY ADVERTISED ARE STILL IN STOCK! WRITE US ABOUT THESE AND YOUR OTHER NEEDS!*

BLOWERS:

115 Volt 60 cycle BLOWER (pictured) — approx. 100 CFM Dia. 2¼" Intake; 2" outlet. Quiet running. Motor size: 2½"x3¼". NEW — Not Gov't. surplus. Order No. 1C939..... **$8.95**

DUAL BLOWER — Same as RN-520 above, except has blower assembly in each side of motor. Order No. 1C880 ..... $13.95

COMPACT TYPE — 108 CFM, motor built Inside squirrel case, 4-½" Intake: 3-⅝" x 3" Dia. Complete size: 4-¾" W. x 9-⅝" H. x 8-½" D. Order No. 2C067 ..... $14.50

FLANGE TYPE—140 CFM, 3-½" Intake: 2-½" Dia. Complete size: 8-½" W. x 7-¼" H. x 6-¾" D. Order No. 1C807 ..... $13.95

FLANGE TWIN—275 CFM. 4-½" Intake: 3-¼" x 3" Dia. Complete size: 11-¾" W. x 9-⅝" H. x 8-1/16" D. No. 2C069 ..... $21.95

MINIATURE BLOWERS — 24 VDC; oblong Outlet 1" x ⅞". Dual 20 CFM..$7.95. Single 10 CFM..$5.95

INVERTERS:

5D21NJ3A—27 VDC input; output 110 Volt 400 cycle, 1 Phase 450 VA $39.95
PE-218—Input 28 VDC 100 A.; output 115 Volt 400 cycle, 1 Phase 1500 VA..... NEW: $49.95
PU-7/AP—Input 28 VDC 160 A.; output 115 Volt 21.6 A. 400 cycle, 2500 VA..... $89.95

MOTORS:

REVERSIBLE MOTOR—24 VDC, 3.7 RPM, 40 lb. per minute Torque. Motor Size: 5-½" x 4-1/32" x 3-5/16". Shaft Size: 21/32" x 5/16". Philco No. 441-1008 ..... $5.95
AC TRANSFORMER to operate above Motor.... $5.95
GEARED HEAD MOTOR—Heavy Duty, 24 VDC, 8 Amp. 100/200 RPM. Shaft Size: 5/16" x 1". Right Angle Drive. Price..... $8.95
115 VAC 60 CYCLE 1.9 RPM, 75 oz. in Torque. Size: 2-½" x 2-½" x 2½". Holtzer & Cabot RWC-2505. Price $9.95

TRANSFORMERS: 110 Volt 60 cycle Pri.; 5 Volt CT. 25 Amp.—10,000 V. Open Frame..... $7.95
24 Volt—4 Amp or 12 Volt 8 Amp..... $5.95
24 Volt—8 Amp Cased..... $5.95
24 Volt—½ Amp....$1.50 24 Volt 1 Amp.... $1.95

Address Dept. E • All Prices are F.O.B., Lima, Ohio • 25% Deposit on C.O.D. Orders

FAIR RADIO SALES • 132 SOUTH MAIN ST. LIMA, OHIO

APR-4 with TN-17, TN-18, $745.
T47A/ART-13 with DY-17
BC-342, BC-312, BC-348-R
BC-221, LM, OAP-1, Boehme keyers

ALLTRONICS
Box 19 Boston 1, Mass.
Telephones: Richmond 2-0048, 2-0916

FOR SALE

Radio Receivers, manufactured by Air Communication, =1A1, TC=830 Used Good—$30.00 each
Automatic Radio Direction Finders—manufactured by Sperry MKF, part #644490, CAATC 445. Used Good $37.50 each.

Midwest's Largest Surplus Dealer.
NATIONAL SURPLUS SALES COMPANY
723 East 18th Street
Kansas City, Missouri

INDEX TO THE SEARCHLIGHT ADVERTISERS

SEPTEMBER, 1954

This index is published as a convenience to the readers. Care is taken to make it accurate but ELECTRONICS assumes no responsibility for errors or omissions.

(Continued from page 434)

NEW YORK'S RADIO TUBE EXCHANGE

TERRIFIC SLASHES in PRICE up to 70% from PREVIOUS LOW PRICES

TYPE	PRICE	TYPE	PRICE	TYPE	PRICE
OA2	51.00	4J31	150.00	707A	9.75
OA3	1.10	4J32	150.00	707B	15.00
OB2	.99	4J33	150.00	714AY	18.00
OB3	1.10	4J34	100.00	715A	4.50
OC3	.96	4J35	150.00	715B	9.00
OD3	.89	4J36	150.00	715C	22.50
C1B	2.95	4J37	150.00	717A	1.50
1B21	1.50	4J38	150.00	718AY/EY	30.00
1B22	1.50	4J39	150.00	719A	22.50
1B23	6.95	4J40	150.00	720AY/GY	150.00
1B24	12.00	4J41	150.00	721A	3.50
1B26	1.75	4J42	190.00	722A	3.50
1B27	12.50	4J51	190.00	723A/B	18.00
1B32	2.95	4J52	225.00	724A	1.95
1B38	35.00	4J53	225.00	724B	2.25
1B50	23.00	C5B	250.00	725A	9.00
1B51	7.50	5BP1	3.95	726A	18.00
1B56	35.00	5BP2A	12.00	726B	45.00
1B60	35.00	5BP4	3.95	726C	45.00
1N21	1.25	5CP1	7.50	723AY/GY	15.00
1N21A	1.75	5CP7	6.95	730A	22.50
1N21B	2.75	5CP7A	14.00	750TL	99.00
1N21C	19.50	5D21	18.00	801A	.90
1N22	1.00	5EP7	1.95	802	3.95
1N23	1.95	5JP1	27.50	803	5.95
1N23A	2.75	5JP2	19.50	805	4.95
1M23B	2.75	5JP4	27.50	807	1.50
1N23C	7.50	5J23	45.00	808	1.95
1N25	4.50	C6A	11.00	809	2.95
1N26	6.75	C6J	7.50	810	10.50
1N27	3.50	7BP7	5.00	811A	3.75
1N34A	.79	7DP4	9.00	812A	3.95
1N43	2.25	12AP4	50.00	813	13.75
1P25	75.00	12DP7	24.00	814	3.75
2B4	1.25	LM15	225.00	815	6.25
2B22	1.75	15E	1.75	816	1.45
2C34	.15	15R	.75	829	11.00
2C40	9.00	NE16	.59	829A	12.00
2C42	12.00	20-4	.75	829B	15.00
2C43	14.50	KY21A	8.25	830B	2.00
2C44	.60	HX21	8.00	832A	9.95
2C46	7.50	HK24G	1.50	833A	45.00
2E22	2.25	25T	2.95	834	7.50
2J21A	12.00	45 Special	.35	836	3.95
2J22	9.00	RK39	2.75	837	2.75
2J26	15.00	HF50	1.75	838	5.95
2J27	15.00	VT52	.35	849	35.00
2J31	24.00	HK54	4.50	860	3.50
2J32	29.00	RK72	1.00	861	25.00
2J33	32.00	RK73	1.00	866A	1.50
2J34	36.00	FG95	19.95	869B	67.50
2J36	90.00	100TH	7.95	869BX	50.00
2J38	8.95	FG105	20.00	872A	3.50
2J39	8.95	122A	1.75	878	1.50
2J40	29.00	203A	7.50	879	.50
2J42	135.00	211	.95	880	250.00
2J49	60.00	217C	12.00	884	1.50
2J50	55.00	242C	10.00	885	1.50
2J55	150.00	244A	9.50	914A	75.00
2J56	110.00	249C	4.25	931A	5.00
2J61	35.00	250TH	19.95	954	.35
2J62	35.00	250TL	12.00	955	.50
2K22	15.00	282A	3.00	956	.75
2K23	15.00	274B	2.75	957	.25
2K25	27.50	304TH	10.00	958A	.60
2K26	68.00	304TL	10.00	959	2.25
2K28	35.00	307A	3.50	E1148A	.25
2K29	35.00	310A	4.50	1280	.95
2K33A	75.00	310B	4.95	1500T	135.00
2K39	140.00	311A	6.50	HK1554	75.00
2K41	135.00	312A	3.50	1603	5.00
2K45	80.00	323A	15.00	1612	1.50
2K50	275.00	327A	3.75	1613	1.25
2K54	125.00	323A	6.75	1616	1.25
2K55	125.00	350A	7.50	1619	.45
2K56	72.00	350B	5.95	1622	1.50
3AP1A	10.00	HK354C	15.00	1624	1.75
3BP1	7.20	357A	15.00	1625	.35
3B24	4.50	368AS	4.95	1626	.25
3B25	5.50	371B	1.50	1851	1.80
3B26	5.00	385A	4.50	2000T	150.00
3B28	8.00	388A	1.80	2050	1.80
EL3C	5.50	393A	7.50	2051	1.00
3C22	99.00	394A	3.95	Various 5000 and 6000 series of new production	
3C24	1.50	MX108U	.50		
3C31	2.95	417A	15.00		
3DP1	7.50	434A	15.00	5280	475.00
3DP1A	10.00	446A	1.95	8012	2.00
3DP1A-52	10.00	446B	3.95	8012A	2.50
3EP1	5.00	450TL	45.00	8013	3.00
3E29	15.50	450TH	52.50	8013A	3.50
3FP7	5.00	464A	7.50	8019	1.75
3HP7	5.00	471A	1.25	8020	1.80
3GP1	5.00	527	18.00	8025	3.75
3J21	75.00	WL530	23.00	PD8365	96.00
4B26	5.40	WL531	22.50	9001	1.25
4C27	22.50	WL532	1.75	9002	.90
4C28	35.00	WL533	15.00	9003	1.25
4E27	16.00	HK654	35.00	9004	.35
4J25	150.00	700A/D	10.00	9005	2.75
4J26	150.00	701A	4.50	9006	.25
4J27	150.00	703A	3.95		
4J28	150.00	704A	1.95		
4J29	150.00	705A	21.75		
4J30	150.00	706AY/FY	25.00		

Thousands of other tubes

NEW MICROWAVE TEST EQUIPMENT TS148/UP SPECTRUM ANALYZER

Field type X Band Spectrum Analyzer, Band 8430-9580 Megacycles.

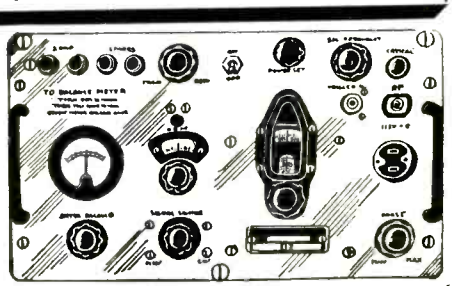
Will check Frequency and Operation of various X Band equipment such as Radar Magnetrons, Klystrons, TR Boxes. It will also measure pulse width, c-w spectrum width and Q or reasonant cavities. Will also check frequency of signal generators in the X band. Can also be used as frequency modulated Signal Generator etc. Available new complete with all accessories, in carrying case.

NEW UNUSED SURPLUS TS 259 K BAND

23400-24500 MEGACYCLES SIGNAL GENERATOR

NEW

TS-147 B/UP TEST SET
TS-147 C/UP TEST SET
Hard-to-get X-Band SIGNAL GENERATOR
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.

SPECIAL! 5,000 V. POWER SUPPLY — $990

For IP25 Infrared Image Convertor from 3 V. Battery Sources.
NEW, Complete with RCA 1654 Tube

Other test equipment

checked out; used, surplus

- TSK1/SE K Band Spectrum Analyzer
- TS3A/AP Frequency and power meter S Band
- RF4A/AP Phantom Target S Band
- TS12/AP VSWR Test Set for X Band
- TS13/AP X Band Signal Generator
- TS14/AP Signal Generator
- TS33/AP X Band Power and Frequency Meter
- TS34/AP Western Electric Synchroscope
- T35/AP X Band Signal Generator
- TS36/AP X Band Power Meter
- 1-96A Signal Generator
- TS45 X Band Signal Generator
- TS47/APR 40-400 MC Signal Generator
- TS69/AP Frequency Meter 400-1000MC
- TS100 Scope
- TS102A/AP Range Calibrator
- TS108 Power Load
- TS110/AP S Band Echo Box
- TS125/AP S Band Power Meter
- TS126/AP Synchroscope
- TS147 X Band Signal Generator
- TS270 S Band Echo Box
- TS174/AP Signal Generator
- TS175/AP Signal Generator
- TS226 Power Meter
- TS239A-TS239C Synchroscope
- TS323 Frequency Meter
- TF890/1 X Band Spectrum Analyzer
- 834 General Radio Frequency Meter

SURPLUS EQUIPMENT

- APA10 Oscilloscope and panoramic receiver
- APA38 Panoramic Receiver
- APS 3 and APS 4 Radar
- APR4 Receiver and Tuning Units
- APR5A Microwave Receiver
- APT2-APT5 Radar Jamming Transmitter

FREQUENCY CONVERTORS
INVERTORS from 60 cycle to 400 or 800 cycle.
We supply various motor generators with frequency and voltage automatically controlled, from 300 watts to 1500 watts and higher. ATTRACTIVE PRICES.

MINIMUM ORDER 25 Dollars

SPECIAL

Wide Band S Band Signal Generator 2700/3400MC using 2K41 or PD 8365 Klystron, Internal Cavity Attenuator, Precision individually calibrated Frequency measuring Cavity. CW or Pulse Modulated. externally or internally.

- Large quantities of quartz crystals mounted and unmounted.
- Crystal Holders: FT243, FT171B others.
- Quartz Crystal Comparators.
- North American Philips Fluoroscopes Type 80.
- Large quantity of Polystyrene beaded coaxial Cable.

YOU CAN REACH US ON TWX NY1-3235

Phone: WOrth 4-8262

LIBERTY ELECTRONICS, INC.
135 LIBERTY STREET, NEW YORK 6, N. Y.

Cables: TELSERUP

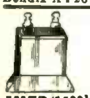
OIL CONDENSER SPECIAL

2 MFD 600 VDC

Type PO9. Steatite insulators Adjustable Mounting Clamp. Case 2" Dia x 2¾" High. Brand New Special..........49c;10 for $3.50
10 MFD/600 V Condenser...$1.98

SYNCHRO'S

2J1H1 GE Selsyns..........Each $8.98
2J1F3 GE Brand New 115V/400 cy. ea......9.75
C78248 Sync. Trans. 115/60 cy..$25.00; 2 for $45
C78249 Sync. Diff. 115V/60 cy..9.00; 2 for 15.00
Sync. Repeater 115/60 cy Type 11-4..2 for 99.00
Bendix Autosyns AY1 & AY5..........2 for 6.95
Bendix AY20 New Orig Crtns..........12.98



OIL CONDENSERS

NEW WAREHOUSE LIST

.00025MFD/25KV.....$4.00; 2/$7
.0016MFD/15KV.....$7.00; 2/$12
2X.1MFD/2000V.....$1.39; 2/$2
.5MFD/600V..........25c; 6/$1
.5MFD/1500V..........85c; 3 for $2.00
1MFD/500V..........33c; 4 for $1.00
1MFD/600V..........39c; 3 for $1.00
4MFD/3000V..........$7.98; 2 for $14.00
4MFD/5000V..........$19.95; 2 for $35.00
5MFD/600V..........$1.50; 3 for $4.00
16MFD/600VAC/1800VDC...$5.95; 2 for $10.00
10MFD/600V(2.5-2.5-5MFD)oil 1.98; 12 for $18
Write for Quantity Price

MICA CONDENSERS

A B C

Fig.	MFD	WVDC	PRICE
A	.03	600	69c; 5 for $2.39
A	.02	600	69c; 5 for 2.25
A	.015	2500	1.25; 3 for 3.15
B	.01	600	30c; 5 for 1.35
B	.01	1200	50c; 5 for 2.25
A	.005	2500	60c; 5 for 2.75
B	.004	600	40c; 3 for 1.05
B	.002	1200	30c; 4 for 1.00
A	.002	2500	98c; 3 for 2.25
A	.001	1200	25c; 3 for .66
C	.0007	3000	89c; 3 for 2.39
A	.0004	2500	39c; 6 for 1.95
C	.0001	3000	89c; 3 for 2.00
C	.0001	5000	1.49; 4 for 5.00
C	.00005	3000	39c; 4 for 1.00

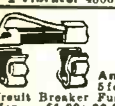
Write for Mica Condenser Catalog

U. S. A. INFRARED SNOOPERSCOPE

Includes portable light weight M-1 vibrator power supply compact only 4 lbs. operates two 1½ volt or 3VDC battery. Delivers DC 4000V & Taps at 600. 100 & 15V includes new 1P25 Infrared tube SPECIAL $100.00

BRITISH SNOOPERSCOPE

See-in dark 2" diameter image converter tube Hi-sensitivity Willemite screen date & data & M-1 vibrator supply..........$29.95
M-1 Vibrator 4000VDC power supply....$21.95



CIRCUIT BREAKER FUSES

PUSH TO RESET

Amps 5-7-10-15-20 Ea. 27c. 5 for $1; 25 for $5.; 100 Asst $15.
Circuit Breaker Fuse W/2 Mounting Clips 39c. 3 for....$1.00; 20 for....$5.98; 100 for....$20.
Fuse is 3AG Size. Operates up to 24 Volts; Please State Amps (current) desired.

CIRCUIT BREAKERS

Heinmann Magn Bkrs. Amps; .220, 3, 7, 9, 12, 20, 30, 35, 40, 80, 180...EA: 1.98 12/$20; 50/$75.
Sq. D & CH Toggle Sw Bkrs. Amps; 5, 10, 15, 20, 25.....98c; 10 for $8.98; 50 for $39
Klixon Therma Push Button Bkrs Amps; 5, 10, 15, 20, 25, 30. 89c; 10 for $7.98; 50 for $34

NEW POCKET AC-DC VOM

MODEL 727C MULTITESTER

$9.99

(+25c Ship in U. S. A.)
1000-Ohms Per/V Reads AC & DC Volts; 0 to 5, 25, 250 & 1000 Volts. DCMA; 0 to 1, 10, 100 MA Ohms; 0 to 10K & 100K
Hi-Accuracy—1% Wire Wound Resistors & HV Deposited Resistors. Rugged Jeweled D'Arsonval Microamp Meter Movement Excellent Damping. Xtra Long Meter Scales, with Vivid Red & Black Calibrations. The Size of 2 Packs of King Cigarettes, 1¼"D. 4⅝"L. 3¼"W. A Must for Every Eng. Ham, Experimenter, Serviceman, or Beginner. Built Ready to Work (No Kit) Complete with Test Leads.
Model 552 Smallest Precision Built, Hi-Accuracy, Pocket Multitester, 1% Deposited Carbon Resistors, Jeweled D'Arsonval Microamp Meter Movement, Xtra Long Meter Scale. AC & DC Volts; 0-10 250 & 500V. DCMA; 0-1 & 250 MA. Ohms; 0-100K. Miniature Size 2⅛"D. 4"L. 3⅛"W. With Test Leads..........$6.99
Plus 25c for Shipping in U. S. A. Money Back Guarantee. Write for Quantity Price.

DYNAMOTORS & INVERTERS

INPUT 6VDC, Output 200V/100ma, or 12/24V Output 500V/50ma P. Magnt. As Illustrated... 6.95
INPUT 28VDC 1.4A Output 250V/60ma..$2.95; 2/$5.00
DA3A 28V/10.5A output 300VDC/260ma 150VDC/10ma. 14.5vdc/5 amp..........$4.98
PE94 Plate Supp. Uses DA3A (SCR522)....$5.95
INVERTER GE 5D21NJ3A Input 28VDC output 115Volt/400cy/485VA. New..........$59.95
CONVERTER Carter D1025sf/150Watt/115V DC to 115VAC/60cy(LN) $92.50 Reg. Special $29.95

HI-MEG HI-VOLT RESISTORS

.75 MEG "MVP" 10W 10KV... .79 10 for 55.00
2 MEG "MVG" 4W 5KV.... .89 10 for 7.50
2 MEG 5W 10KV.... .99 10 for 8.50
2.5 MEG "MVA" 20W 25KV.. 1.50 10 for 12.00
2.5 MEG "MVT" 5W 7.5KV.. .89 10 for 7.00
7 MEG "MVP" 10W 10KV.. 1.35 10 for 12.00
10 MEG "MVP" 10W 10KV.. 1.69 10 for 15.00
12MEG 10W 10KV.... 1.69 10 for 15.00
20 MEG "MVO" 35W 50KV.. 2.25 10 for 20.00
50 MEG "MVE" 25W 40KV.. 2.75 10 for 25.00
100 MEG "MVP" 10W 10KV.. 2.25 10 for 20.00
WRITE FOR QTY PRICE

"TAB" THAT'S A BUY

BARGAINS—BARGAINS

JUST OFF THE PRESS. "TAB" SCOOP SHEET. ITEMS SOLD WAY BELOW USUAL SALE PRICES. WRITE NOW FOR MONEY SAVING CATALOG

STANDARDS & TEST EQUIP.

I-222A Sig. Gen 8-15MC 45-76MC (150-230MC Harmonic)..........$55.00
BC221 Freq Meter 125-20,000 KC..........$125.00
LM Freq Meters 125-20,000 KC..........$45.00
T85/APT5 Xmittr 300-160MC less tubes. $25.00
G.E. FM Transmitter ET78/40-50 Mc/ 50 Watts and 117 V 60 cy Power Supply New..........$ 99.00
G.E. Oscilloscope ST-2A & Accs..........$275.00
G.E. Sweep Generator ST-4A & Accs...$275.00
G.E. Marker Gen. ST-5A & Xtal/Accs...$300.00
G.E. XYZ-1 Decade Scaling Unit. Rate 5x106 (5MC) Counts Per Sec Max.....$252.00

"TAB" RHEOSTAT SALE

Priced Below Manufacture

15 ohm 25W w/knob..........$1.10; 10 for $7.00
50 ohm 25 Watt..........1.10; 10 for 7.00
60 ohm 50W w/knob..........1.98; 10 for 14.00
75 ohm 25W W. Leonard..........1.98; 10 for 14.00
100 ohm 50 W..........1.50; 10 for 9.00
125 ohm 25 W Model H..........1.10; 10 for 7.00
225 ohm 50 W..........1.98; 10 for 15.00
250 ohm 25W..........1.10; 10 for 6.00
300 ohm 225 W Model P..........2.98; 5 for 10.00
500 ohm 25 W Model H..........1.10; 10 for 7.50
800 ohm 50 W Model J..........1.98; 10 for 15.00
1200 ohm 225 W Model P..........2.98; 2 for 5.00
2500 ohm 25 W..........1.10; 10 for 7.00
5000 ohm 25 W Model H..........1.25; 10 for 9.00
350,500'5000 ohm Slotted Shaft 25 Watt..........79c; 3 for 2.00

BOXED CRYSTAL DIODES IN LEAD*

1N23B*......$2.; 5 for $9.; 50 for $70
1N21A*..........$1.55; 5 for $7.00
1N21B*..........$2.10; 5 for $9.50
1N21C*..........Each $24.50
1N25*...$5.95; 6 for $33.; 20 for $100
1N32*.$22.95; 6 for $128.; 12 for $240
1N41..........$8.95; 2 for $16.00
1N42..........$16.95; 2 for $28.00
1N34......63c; 5 for $3.; 100 for $58
1N34A.....88c; 6 for $5.; 100 for $75
1N39...$4.49; 6 for $25.; 100 for $375
1N21 Boxed 30c; 50 for $12.50; 100 for $20

FL-5 FILTER

Range or voice. Filters 1020 cycle audio, excellent for CW Work. $1.98; 2 for $3.

BANDPASS FILTER

Sharp Cutoff HIQ. Cased & Shielded 60, 90, 150 cycles..........Each $1.50; 3 for $3.75
UTC 854, 1024, 1250 Cyc. Ea. $1.25; 2 for $2.00

SELENIUM RECTIFIERS

FULL WAVE BRIDGE*

"TAB" specializes in power rectifiers to your specifications. From one amp up to and above 1000 amps, convection or fan cooled, single or 3 phase, also magamps. Write for rectifier catalog.

Max Amps	18VAC* 14VDC	36VAC* 28VDC	72VAC* 56VDC	130VAC* 100VDC	144VAC* 118VDC	266VAC* 217VDC	Ctr Tap AC/DC 30/12	3 Phase AC/DC 120/150	Bridge AC/DC 240/300
1	$1.40	$2.40	$4.60	$8.50	$12.75	$22.25	$2.10	14.90	28.95
2	2.10	3.00	6.00	10.50	15.75	28.85	Q	15.90	30.90
2½	3.00	4.20	8.00	13.00	18.75	31.85	Q	Q	Q
4	3.75	7.50	14.50	25.25	26.75	38.85	2.95	18.90	36.95
6	4.50	9.00	17.50	33.00	34.75	54.85	3.25	20.90	39.95
10	6.60	12.75	25.00	42.50	44.75	84.85	4.75	36.90	71.95
12	8.20	16.25	30.00	46.00	54.75	99.85	5.95	41.90	81.95
20	13.25	25.50	49.00	79.50	82.75	160.85	7.95	50.90	97.95
24	16.25	32.50	58.00	86.50	94.75	190.85	9.95	89.90	159.95
30	20.00	38.00	72.00	121.50	128.75	235.85	Q	117.90	225.95
36	25.00	48.50	88.00	158.50	165.75	295.85	14.95	134.90	269.95
50	32.00	62.50	Q	189.75	195.75	405.85	23.95	179.90	359.95
100	60.00	120.00	Q	380.75	390.75	795.85	39.95	359.90	719.95

Rectifier & Transformer Combination Sel/Bridge 115 Volt 60 cyc Input

up to 14DVC at 12 amps Cont. Duty...$19.98
up to 28VDC at 4 amps Cont. Duty.... 14.98
up to 28VDC at 12 amps Cont. Duty... 29.98
up to 28VDC at 24 amps Cont. Duty... 63.98
up to 28VDC at 50 amps Cont. Duty...127.00

HIGH CURRENT PWR SUPPLIES

Variable 0-28VDC. Completely Built, Ready to Go. Full Wave Selenium Rectifier, Transformer, Variac, Volt & Amp Meters, Switch, Terminals & Fuse. In Heavy Duty Steel Cabinet Standard 115V/60cy Input 220V Input & Others On Special Order.....write

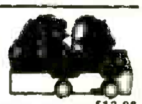
Stock Number	Continuous Rating	With Meters
T28V5A	0-28VDC at 5 Amp	$47.75
T28V12A	0-28VDC at 12 Amp	89.00
T28V24A	0-28VDC at 24 Amp	129.50
T28V50A	0-28VDC at 50 Amp	239.50

T816 0-8 or 16VDC Variable up to 10 Amps, Rated 6 or 12VDC Filtered. Continuous Duty....$34.00

RECTIFIERS XFMRS

PRIMARY 115V 60 cyc
SEC 18-15-9-0-9-15-18 Volts
4 amp..........$8.75; 2 for $15.75
12 amp..........$16.75; 2 for $29.95
25 amp..........$35.75; 2 for $69.95
30-32-34-36V/48A..........59.50
18 Volt 2 amp..$2.25 @ 2 for $4
25.2V/2A or 12.6V/4A or 2X12.6V/2A Cased 2⅜W/3⅛H/2⅜"D..........$3.59; 3/$10.; 12/$36

DC POWER-SUPPLY



Variable DC Power Supply Full Wave Rectification 6000MFD Condenser Filter Ready to Operate Input 115V 60cy Output 6.3V or 12.6V 2 Amp.
Model 2DCF (2 amp)..........$12.98
Model 4DCF (4 amp)..........$20.98

METER SALE

50% OFF REG RESALE PRICE

0-1MADC/3½" RND/MR35-W001DCMA/$8.33 Reg.....$3.95
0-5MADC/3½" RND/MR35-W005DCMA/$8.33 Reg.....$3.95
0-100MADC/3½" RND/MR35W100DCMA/ $8.33 Reg..........$3.95
0-30VDC/2½" RND/Aircraft "AN"..........$2.98
0-800VDC/Weston 301/3½" SQ/1000-Ohms Per Volt/$25.00 List..........$9.95
0-1500VDC/3½" RND/$12.95 Reg..........$5.95
0-150VAC/Westinghouse 3" SQ..........$4.95
120-0-120ADC/with-Shunt; "AN"..........$4.95

RECTIFIER CHOKES

CH07/4 Amp/.07HY/.6 Ohm/10 Lbs..........$7.95
CH01/12 Amp/.01HY/.1 Ohm/12 Lbs..........$14.95
CH004/24 Amp/.004HY/.025 Ohm/20 Lbs..$29.95

TRANSFORMERS

ALL 115V 60 CYC INPUT

2500V/20MA, 6.3V/.6A, 2.5V/1.75A 4/BC412 Scope Replmnt.....$7.98
1600VCT/5MA, 6.3VCT/3A, 6.3 CVT/10A, 2.5VCT/5A $7.95; 2 for $14.00
950VCT/100MA, 5V/2.5A, 5V/5A, 45V/1A. 10V/1.5A WESTERN ELECT..........$4.99; 3 for $13
900V/35MA, 2X2.5V/2A, Xclent 1800V DBLR TWO 2X2 FIL WNDGS..........$2.25
778VCT/200MA, 5V/3A, 6.3VCT/5A THORDARSON.....$4.98; 2 for $9; 6 for $24
770V/2.5MA, 2.5V/3A, HVINS HMSLD Includes FILTER PARTS 4/scope.....$3.69; 2 for $6.00
700VCT/70MA, 5VCT/3A, 6.3VCT/2.5A...$3.95
600VCT/50MA, 6V/3A, 6V/1.5A, 5V/1A HALF SHELL..........$2.49; 2 for $4.50; 10 for $20.00
550VCT/250MA, 5V/2A, 6.3VCT/2.5A, 12.6V/3.5A CSD RCA..........$4.50; 2 for $8.00
420VCT/90MA, 6.3V/1.9A, W/INPUTS 6, 12, 24, 115VDC & 115 & 230 VAC @..........$1.49
2X330VCT 10MA, EACH WNDG..........$3.49

TRANSFORMER SPECIAL!!

6.3 Volt 3¾ Amp.

CONTINUOUS DTY
115VAC Input
SIZE 2 5/16H/2L/1⅛" W
HVY DTY CHANNEL MTG
8 INCH WIRE LEADS
$1.00; 12 for $10

Filament Trans. 115V/60 Cy. Input

2.5VCT/10A 5KVINS $3.59; Same 10KV..$3.98
2.5VCT/10A 12.5 KVINS.....$5.50; 3 for 14.00
5VCT/13A 5 KVINS UTC S-59..........3.95
7.5VCT/12A CSD 15 KVINS. 10.95; 2 for 17.50
25.2V/2A or 12.6V/4A or 2X 12.6V/2A Cased 2⅜W 3⅛H 2⅜D $3.59 @ 3 for:10; 12 for $36
42.5V/2A Sel. Rect. Xfmr.....$4.98; 2 for $8.00
64V/1Amp Hmsld..........$3.49; 2 for $5.00
PRI 110 & 220V SEC 16.6V/1.25A, 12.6VCT3.5A $4.98; 2 for $8.00

FILTER CHOKES

10Hy/75ma..........$1.25
10Hy/125ma/UTC/Csd H's d/1 KVins..........1.98
50Hy/125ma/Csd/H'S d..........2.89
20Hy/300ma or 15Hy/400ma/ 12KVins Kenyon Csd..........8.95
13.5Hy/1 Amp/17KVins/Raytheon..........35.00
Dual 2Hy/300ma USN..........95c; 2 for 1.49
6 Hy 175ma 250 Ohm..........$1.49; 2 for 2.49
10 Hy 100ma Freed..........1.39
2.5 Hy/300 ma/60 Ohm..........$1.69; 2 for $3

230 TO 115V AUTOFORMERS

For 220-240V/50-60cy Input. To 110-120V or Step-up with Cord Plug & Receptacle.
TPA050/50W.... $2.55; TPA075/75W... $3.65
TPA100/100W... 4.00; TPA200/200W.. 5.75
TPA250/250W... 6.75; TPA300/300W.. 7.25
TPA500/500W... 8.25; TPA750/750W.. 11.75
Model TPA1000/1000 Watts/1KW.......... 16.95
TPA1500/1500W $22.50; TPA2000/2KW.. 28.95
Model TPA3000/3000 Watts/3KW.......... 49.95
Write for Qty Prices—Exporters

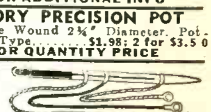
LINEAR SAWTOOTH DC POTENTIOMETER KS15138

Electric power is supplied through 2 fixed taps 180° apart. 2 rotating taps, and take off brushes are provided for output voltage. Varying position of the brushes, varies the output voltage in accordance with a linear sawtooth wave. Operates 24VDC
SPECIAL.....$2.95; 2 for $5.00; 10 for $20.00
WRITE FOR ADDITIONAL INFO

LABORATORY PRECISION POT

20,000 Ohm Wire Wound 2¾" Diameter. Potentiometer. GR Type..........$1.98; 2 for $3.50
WRITE FOR QUANTITY PRICE

REGULATOR MERCURY THERMO



DUAL CKT, 105° F & 32° F. Extremely sensitive & accurate for most exacting requirements—Research, Fire Prev., Freeze, Pt Control, or Max Min Temp Control. Brand New, w/data & ckt. Ea. 98c; 12 for $10.00

"TAB" LAB GRAB BAG

PRICED LOW FOR QUICK TURNOVER

Helipot 100 Ohm/0.5%/10 Turn..........$7.98
Helipot 2000 Ohm/0.5%/10 Turn...$7.98; 2/$15
Micropot 20,000 Ohm/0.1%/10 Turn $7.98; 2/$15; 10/$65
Helipot 30,000 Ohm/0.5%/10 Turn..$7.98; 2/$15
Helipot 50,000 Ohm/0.5%/10 Turn..$7.98; 2/$15
RM29 Remote Control Unit..........$4.98; 2/$8
RF Choke 20MH/200MA "PI"..........39c; 10/$2
Relay DPDT 12VDC Telephone..........98c; 6/$5

TUBES

"TAB" TESTED & GUARANTEED

PRICES SUBJECT TO CHANGE WRITE FOR COMPLETE TUBE LISTING

Tube	Price	Tube	Price	Tube	Price
OA2	$0.88	4J31	99.51	6SJ7	.58
OA3/VR75	1.04	4J52	199.99	6SK7GT	.56
OB2	1.37	EL5BHD	15.99	6SL7GT	.64
OB3/VR90	.96	5C21/C6J	9.89	6SN7GT	.68
OC3/VR105	.92	5C22	38.95	6SQ7GT	.62
OD3/VR150	.92	5D21	14.98	6SR7	.62
1B3/8016	.80	5R4GY	1.20	6T8	.96
1B22	1.82	5R4GYW	1.75	6U4	.74
1B23	8.87	5T4	1.48	6U8	.99
1B24	8.98	5U4G	.55	6V6	1.39
1B26	2.24	5V4G	.95	6V6GT	.59
1B27	11.98	5Z3	.99	6W4GT	.52
1B32/532A	2.48	5Z4	1.49	6X4	.49
1B35	9.15	6A3	.90	6X5GT	.54
1B37	14.87	6A7	.85	6Y6G	.88
1B38	29.45	6A8GT	.90	7A8	.68
1B42	17.48	6AC7	.80	7C7	.76
1B46	1.98	6AG5	.71	7F7	.82
1B63	45.00	6AG7	1.14	7F8	1.24
1L4	.48	6AH6	1.21	7H7	.72
1L6	1.35	6AJ5	1.40	7N7	.92
1LD5	.98	6AK5	.87	7V7	1.06
1LN5	.78	6AK5W	2.79	7Y4	.63
1P5	.78	6AK6	.92	8D21	298.00
1U4	.52	6AL5	.48	12AL5	.54
1U5	.54	6AL7GT	.98	12AT6	.54
1V2	.70	6AN5	3.27	12AT7	.89
1X2A	.98	6AQ5	.52	12AU6	.72
2C36	27.00	6AQ5W	2.78	12AU7	.69
2C39A	26.98	6AQ6	.81	12AV6	.52
2C40	4.98	6AQ7GT	1.29	12AV7	.98
2C43	17.48	6AR6	3.27	12AW6	1.18
2V44	1.15	6AS5	.79	12AX7	.98
2C51	3.88	6AS6	2.22	12AY7	1.69
2D21	1.18	6AS7G	3.48	12BA6	.59
2E43	1.49	6AT6	.54	12BA7	.94
2J31	27.00	6AU5GT	1.10	12BD6	.59
2J32	29.48	6AU6	.56	12BE6	.59
2J33	27.00	6AV5GT	.98	12BF6	.85
2J34	24.98	6AV6	.49	12BH7	1.29
2J37	12.70	6B4G	1.18	12SA7GT	.68
2J38	69.98	6B8G	.60	12SC7	1.08
2J39	6.98	6BA6	.54	12SF5GT	.54
2J42	148.98	6BA7	1.09	12SF7GT	.84
2J48	24.45	6BC5	.63	12SG7	.80
2J49	84.00	6BC7	1.23	12SH7	.63
2J50	99.98	6BD6	.83	12SJ7GT	.54
2J51	238.98	6BE6	.54	12SK7	.66
2J56	149.00	6BF5	.98	12SL7GT	.62
2J62	49.45	6BG6G	1.58	12SN7GT	.68
2K22	23.48	6BH6	.63	12SQ7GT	.54
2K23	11.48	6BJ6	.69	12SR7	.66
2K25	28.49	6BK7	1.58	FG17	3.90
2K25/723AB	23.88	6BL7GT	1.19	24G/3C24	1.32
2K28	27.48	6BN7	2.69	25BO6GT	.98
2K33	219.48	6BQ6GT	1.20	26L6GT	.67
2K39	134.99	6BQ7	1.65	25Z5	.78
2K41	126.00	6C4	.52	25Z6GT	.58
2K42	145.00	6C21	24.50	FG-27A	8.24
2K45	129.48	6BC6	.59	35Z5GT	.54
2K48	99.48	6CD6G	1.69	35T	4.88
2P23	298.00	6D4	2.70	35L6	.67
2X2	.42	6D6	.84	35Y4	.68
3B22	2.48	6F4	6.20	45Z3	.88
3B23/RK22	4.95	6F6	.79	48	1.98
3B24	4.70	C6J/5C21	9.89	50A5	.76
3B26	3.70	6J4	6.66	50C5	.54
3B28	7.90	6J5	.54	50L6GT	.62
3C22	85.00	6J6	.58	RK61/XFG1	2.65
3C23	8.67	6K6GT	.54	FG67	14.68
3C31/C1B	3.45	6K7	.58	HY69	4.98
3C33	9.51	6K8	1.08	71A	.74
3C45	9.98	6L6	1.48	78	.78
3D6/1299	.69	6L6G	1.08	80	.58
3D21A	8.15	6L6GA	1.08	81	1.38
3D22	13.97	6L6GAY	1.98	83	1.12
3D23	4.90	6SA7GT	.66	83V	1.22
3E29	14.49	6SC7	.90	84/6Z4	.62
4C35	21.49	6SF5	.78	100TH	9.88
4D21	18.99	6SF7	.73	FG104	24.58
4E27	22.49	6SG7	.64	FG105	19.48
4J22	129.51	6SH7	.61	VXR130	4.50

Tube	Price	Tube	Price
CV148	9.98	927/CE25	1.70
FG166	48.49	CK1005	.68
FG172	29.00	1613	.82
211/VT4C	.86	1614	1.95
RX215	7.98	1625	.32
RX233A	3.49	1632	.68
250TH	18.97	1633	.98
250TL	17.75	1636	3.08
304TH	12.49	1642	.62
304TL	12.49	1644	.92
371B	.88	2050	1.48
388A	1.48	2050W	2.48
GL434A	12.69	5618	3.50
446A	1.05	5636	11.57
446B	3.48	5637	6.53
450TH	49.97	5640	11.57
450TL	52.00	5641	7.52
460/HF200	15.95	5643	11.57
CK502AX	1.49	5644	11.57
CK503AX	1.49	5646	11.57
CK505AX	1.79	5651	2.24
CK512AX	1.45	5654	1.72
CK531AD	1.89	5656	12.08
531	5.72	RK5657	298.48
CK532DX	1.89	5663	1.06
WL532A	3.68	5670	3.44
CK536AX	.99	CK5672	1.20
CK539DX	2.19	CK5678	1.28
CK541DX	1.99	5687	3.74
CK543DX	.99	5691	7.54
CK544DX	.99	5692	8.52
CK546DX	1.99	5693	6.24
CK571AX/5886	2.49	5694	3.65
CK573AX/6029	3.49	CK5702	2.90
WL652	65.00	CK5703	1.29
WL676	34.98	5713	120.00
703A	4.72	WL5736	130.00
705A	1.88	5749	1.72
707A	7.90	5761	2.88
707B	14.88	5769	298.00
715A	4.96	5812	2.99
715B	7.94	5814	2.08
715C	17.98	5820	148.00
717A	.88	5840	7.98
719A	24.48	5844	2.98
721A	3.92	5881	2.70
722A/287	1.94	7012	2.58
723A/B	16.98	8013	3.92
724A	3.95		
724B	2.74		
725A	9.98		
726A	14.48		
726B	44.88		
726C	64.88		
801A	.42		
803	3.48		
805	3.22		
807	1.54		
808	2.62		
809	3.58		
810	10.88		
811	3.00		
812	2.70		
813	11.48		
814	4.98		
815	5.98		
829	7.94		
829B	12.48		
832	7.72		
832A	9.92		
833A	39.45		
836	5.95		
837	1.42		
849	29.45		
860	4.48		
865	1.26		
866A	1.50		
872A	3.29		
917	2.59		
925	2.14		

Xtal Diodes

Diode	Price
1N21A	$1.55
1N21B	2.10
1N22	1.22
1N23	1.35
1N23A	1.89
1N23B	2.00
1N25	4.98
1N26	8.75
1N27	1.55
1N34	.64
1N34A	.88
1N35	1.65
1N38A	1.29
1N41	8.95
1N42	16.95
1N45	1.45
1N46	.69
1N47	4.00
1N48	.47
1N51	.45
1N54	.78
1N54A	1.00
1N58A	1.15
1N60	.60
1N63/K63	2.49
1N64	.69

OTHER TYPES IN STOCK WRITE

THAT'S A BUY **"TAB"** THAT'S A BUY

Dept 9E 111 Liberty St., New York 6, N. Y., U.S.A. PH. RECTOR 2-6245 CABLE: "TABPARTS"

Money Back Guarantee (Cost of Mdse. Only) $5 Min. Order FOB N. Y. C. Add Shpg. charges or 25% Dep. Prepaid Mdse. USA only. Prices Subject to Change Without Notice.

INDEX TO ADVERTISERS

PROFESSIONAL SERVICES ... 407

SEARCHLIGHT SECTION
(*Classified Advertising*)
H. E. HILTY, Mgr.

SEARCHLIGHT ADVERTISING INDEX
434, 436

This index is published as a convenience to the readers. Every care is taken to make it accurate, but ELECTRONICS assumes no responsibility for errors or ommissions.

electronics

READER SERVICE SECTION

As a reader of ELECTRONICS, you may wish to write for additional information regarding a particular product or desire to discuss your product requirements with a representative of the manufacturer.

THESE POST CARDS ARE FOR YOUR USE

and

HERE IS WHAT YOU DO:

1. Fill in with ink or typewrite your name, company, address and title.

2. Then fill in the name of the specific product and the page number on which it appears.

3. Place a check mark in the box or boxes applicable to your needs.

4. Tear out the postcard on the perforated lines and address it to the manufacturer(s) whose products you are interested in. Place a stamp in the box indicated and drop into the mail.

THE MANUFACTURER WILL PROMPTLY SEE THAT YOU RECEIVE THE NECESSARY PRODUCT DATA OR THAT HIS REPRESENTATIVE CALLS UPON YOU, WHICHEVER YOU DESIRE.

If there is insufficient space on the postcard for describing your problem specifically, we suggest you write to the manufacturer, spelling out your requirements in detail. Be sure your filled-in post card accompanies your letter.

THIS SERVICE IS A CONVENIENCE FOR THE READER OF ELECTRONICS.

Name .....

Company .....

Address .....

Title .....

Please send me further information on

_____

As described on page ____ of September 1954

electronics

☐ I want this information for my files

☐ I wish to see your representative

☐ Please contact me by phone no. _____

Name .....

Company .....

Address .....

Title .....

Please send me further information on

_____

As described on page ____ of September 1954

electronics

☐ I want this information for my files

☐ I wish to see your representative

☐ Please contact me by phone no. _____

Name .....

Company .....

Address .....

Title .....

Please send me further information on

_____

As described on page ____ of September 1954

electronics

☐ I want this information for my files

☐ I wish to see your representative

☐ Please contact me by phone no. _____

Name .....

Company .....

Address .....

Title .....

Please send me further information on

_____

As described on page ____ of September 1954

electronics

☐ I want this information for my files

☐ I wish to see your representative

☐ Please contact me by phone no. _____

ELECTRONICS
September 1954

Place
Stamp
Here

To: _____

_____

_____

ELECTRONICS
September 1954

Place
Stamp
Here

To: _____

_____

_____

ELECTRONICS
September 1954

Place
Stamp
Here

To: _____

_____

_____

ELECTRONICS
September 1954

Place
Stamp
Here

To: _____

_____

_____

To the Readers

of

electronics

A New Reader Service designed to provide prompt response

You, as a reader, may never have thought specifically of the viewpoint of the advertisers whose informative and up-to-date product news reaches you through the advertising pages of ELECTRONICS.

They are VITALLY interested in you and your needs. You and thousands like you constitute the market and without you they cannot continue to present their product story; indeed, they cannot remain in business.

These manufacturers whose products and services are shown in this issue welcome your inquiries and your desire for more information.

If your requirements are complicated and you require more space, we suggest that you write directly to the manufacturer, stating your problem in detail and asking for specific information or assistance. Be sure to include the postcard with your detailed request in order that your inquiry be given prompt and expeditious attention. Make certain that you specify which PRODUCT you are interested in if more than one appears in the advertisement.

electronics

READER SERVICE SECTION

As a reaer of ELECTRONICS, you may wish to write for additional information regarding a particular product or desire to discuss your product requirements with a representative of the manufacturer.

THESE POST CARDS ARE FOR YOUR USE

and

HERE IS WHAT YOU DO:

1. Fill in with ink or typewrite your name, company, address and title.

2. Then fill in the name of the specific product and the page number on which it appears.

3. Place a check mark in the box or boxes applicable to your needs.

4. Tear out the postcard on the perforated lines and address it to the manufacturer(s) whose products you are interested in. Place a stamp in the box indicated and drop into the mail.

THE MANUFACTURER WILL PROMPTLY SEE THAT YOU RECEIVE THE NECESSARY PRODUCT DATA OR THAT HIS REPRESENTATIVE CALLS UPON YOU, WHICHEVER YOU DESIRE.

If there is insufficient space on the postcard for describing your problem specifically, we suggest you write to the manufacturer, spelling out your requirements in detail. Be sure your filled-in post card accompanies your letter.

THIS SERVICE IS A CONVENIENCE FOR THE READER OF ELECTRONICS.

Name ....

Company ....

Address ....

Title ....

Please send me further information on

____

As described on page _____ of September 1954

electronics

☐ I want this information for my files

☐ I wish to see your representative

☐ Please contact me by phone no. ____________

Name ....

Company ....

Address ....

Title ....

Please send me further information on

____

As described on page _____ of September 1954

electronics

☐ I want this information for my files

☐ I wish to see your representative

☐ Please contact me by phone no. ____________

Name ....

Company ....

Address ....

Title ....

Please send me further information on

____

As described on page _____ of September 1954

electronics

☐ I want this information for my files

☐ I wish to see your representative

☐ Please contact me by phone no. ____________

Name ....

Company ....

Address ....

Title ....

Please send me further information on

____

As described on page _____ of September 1954

electronics

☐ I want this information for my files

☐ I wish to see your representative

☐ Please contact me by phone no. ____________

ELECTRONICS
September 1954

Place Stamp Here

To: _____

_____

_____

ELECTRONICS
September 1954

Place Stamp Here

To: _____

_____

_____

ELECTRONICS
September 1954

Place Stamp Here

To: _____

_____

_____

ELECTRONICS
September 1954

Place Stamp Here

To: _____

_____

_____

For PRODUCTS and SERVICES

not specifically advertised

or described in this issue

of

Electronics

Consult your

1954-1955 ELECTRONICS BUYERS' GUIDE

or

Write to:

Reader Service Department

Electronics

330 West 42nd Street

New York 36, N. Y.

PRODUCTS OF WORLD-FAMOUS

DAVEN

CREATIVE-ENGINEERING

TYPE T-330

DAVEN ATTENUATORS

Exclusive Features:

1. **"Knee-Action" Blade**
   - Tamper proof
   - Uniform contact pressure and low contact resistance over the life of every unit.
   - Each rotor blade individually supported to give positive contact in operation under all types of conditions.
2. **Brass Case of 2-Piece Construction**
   - Greatly reduces clearance space required for removal of cover in rear of unit.
3. **"Lock-Tite" Dust Cover**
   - Held by positive, bayonet-type lock which prevents cover from falling off under stress of vibration.
4. **Enclosed Roller-Type Detent Mechanism**
   - For extra long life and positive indexing.
   - Addition of detent does not increase depth of unit.
5. **Low-Loss Molded Terminal Board**
   - For high resistance to leakage.
6. **Rigidly Supported Resistor Strips**
   - With air insulation.

YEARS AHEAD, CREATIVE-ENGINEERING has always characterized Daven's efforts in the production of electronic components and equipment.

The unit illustrated above is only one in a complete line of Daven's world-famous attenuators. Because this Company has pioneered and created so many worth-while improvements in units of this type, you can do no better than to specify Daven Attenuators.

Daven's skilled staff of specialist-engineers is at your "beck and call" to help with your problems in the selection of the right attenuators for the equipment you are designing.

Write for complete catalog data.

THE DAVEN CO.
191 CENTRAL AVENUE
NEWARK 4, NEW JERSEY

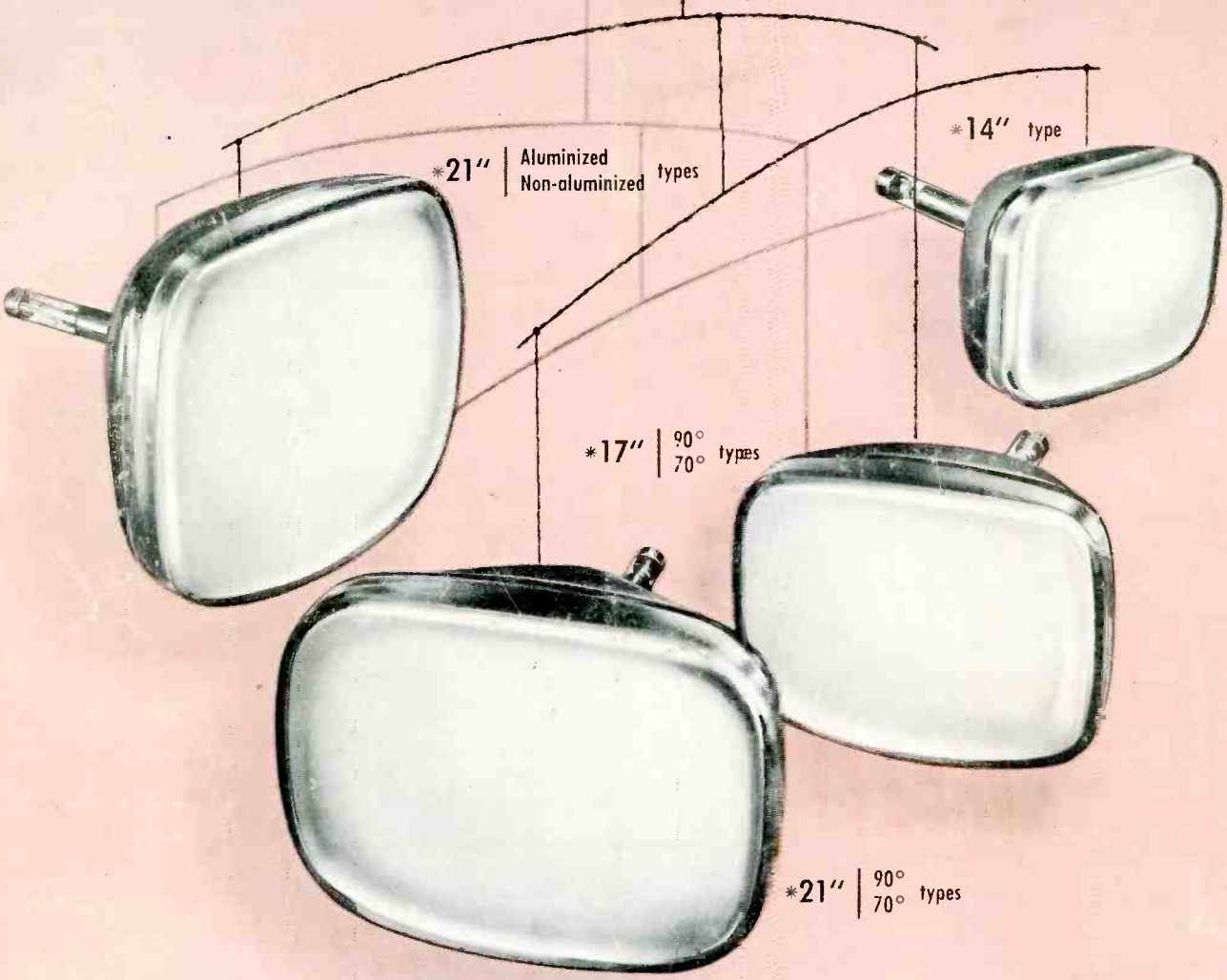
GREATLY EXPANDED PRODUCTION FACILITIES ENABLE DAVEN TO MAKE DELIVERY FROM STOCK ON A LARGE NUMBER OF STANDARD ATTENUATOR TYPES.

VISIT DAVEN'S BOOTH #405 AT THE I.S.A. SHOW

RCA PICTURE TUBES

"BALANCED" LINE

Planned for your market



Choose from RCA's "Balanced" Line for your new TV designs—

- **21-inch types**—aluminized or non-aluminized—for your "de luxe" line.
- **17- or 21-inch types** with 90° deflection for your compact "stylized" line.
- **17-inch types** for your "economy" line.
- **14-inch type** for your "lightweight" or "portable" line.

You choose best when you choose RCA Picture Tubes . . . famous for dependable quality and life performance . . . famous for excellent contrast, brightness, and picture clarity.

Ask your RCA Field Representative about the RCA "BALANCED" LINE of TV Picture Tubes—or write for information to your nearest RCA District Office.

DISTRICT OFFICES:

(EAST)
HUmboldt 5-3900
415 South Fifth Street
Harrison, N. J.

(CENTRAL)
WHitehall 4-2900
589 E. Illinois Street
Chicago 11, Ill.

(WEST)
MAdison 9-3671
420 S. San Pedro Street
Los Angeles 13, Calif.

RADIO CORPORATION of AMERICA

ELECTRON TUBES — **HARRISON, N.J.**