MAY · 1954

PRICE 25 CENTS

electronics

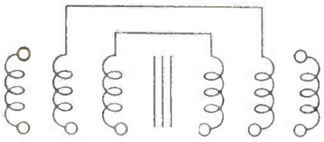
A McGRAW-HILL PUBLICATION

Etching Technique for Silicon Transistor

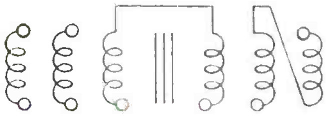
HERMETICALLY SEALED PULSE TRANSFORMERS

RCOF CASE
1 25/64 X 61/64″

SM CASE
11/16 X 1/2″



H-40



H-41

Because of the wide variety of blocking oscillator, interstage, and modulator pulse applications, the bulk of UTC pulse transformers are designed to customer's specifications. Through versatile design, however, the stock hermetic MIL-T-27 pulse transformers listed below take care of most low level applications. Wide ranges of pulse duration, loading, and level are obtainable by variations in the manner of connecting the balanced coil structure windings as shown in the engineering sheet accompanying each unit.

The H-40 and H-41 units employ identical windings suitable for different applications because of the manner in which the windings are brought out to the terminals. Pulse widths from .1 to 5 microseconds are realized with excellent fidelity. H-42 and H-43 are highly miniaturized units. They incorporate three equal windings capable of being inter-connected for wide versatility in blocking oscillator, interstage, and impedence matching service.

Type No.	Description*	Pulse Width Microsec.	Ins. Test Volts RMS	Case
H-40	Two 250 ohm windings . . . two 1000 ohm windings	.1 to 5	1000	RCOF
H-41	Two 250 ohm windings . . . two 1000 ohm windings	.1 to 5	1000	RCOF
H-42	Three 250 ohm windings	.15 to .75	500	SM**
H-43	Three 500 ohm windings	.5 to 2	500	SM**

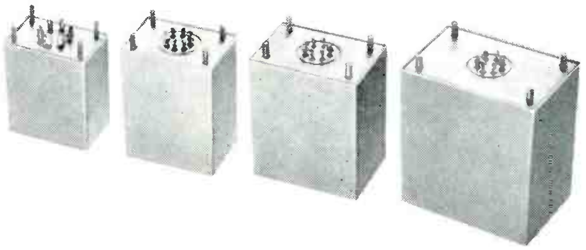
* Impedances shown are nominal, subject to wide variation with application.
**Mtg. screw is centered on large side of case.

for SPECIAL APPLICATIONS

SERVO MOTOR MAGNETIC AMPLIFIERS

The MAT 1-4 Magnetic Amplifiers are exceptionally stable units designed for the control of 2 phase 400 cycle servo motors. They are compact . . . hermetically sealed . . . magnetically shielded . . . meet MIL-T-27 . . . high input impedance . . . high damping . . . high gain. The output is sinusoidal, amplitude variable, and phase reversible. Control is provided by a dual triode such as a 12AU7 operating with a plate voltage of 115 volts, 400 cycles, or higher. The signal to the triode grids can be polarity reversible DC or phase reversible 400 cycles. Power gain of the MAGNETIC STRUCTURE is approximately 40 . . . response time approximately 7.5 milliseconds . . . maximum null voltage 3V. RMS.

For AC signal control, the circuit of Figure 1 is employed. For DC signal control, Figure 2 applies. Figure 3 shows the use of a power transformer (MAT-5) which provides higher plate voltages and eliminates the input transformer (MAT-6). The typical response curve of Figure 4 applies to all units, the larger units feeding heavier loads.



TYPE NO.	MAT-1	MAT-2	MAT-3	MAT-4
230 Volt Supply				
Power output	4 W.	8 W.	11 W.	18 W.
RL, ohms	3300	1600	1200	720
CL, mfd.	2	3	.5	.7
115 Volt Supply				
Power output	2 W.	4 W.	6 W.	9 W.
RL, ohms	6500	3300	2200	1450
CL, mfd.	.13	.2	.3	.45
Reson. Freq.	40 cyc.	35 cyc.	35 cyc.	20 cyc.
Log-Decr.	.18	.23	.03	.65
Cont. Wdg. Res.	6200 ohms	8450 ohms	4750 ohms	5650 ohms
Case				
Length, In.	1¼	1½	1¾	2⅛
Width, In.	1¹⁵⁄₁₆	2⅛	2½	3⅛
Height, In.	2⁵⁄₁₆	2¾	2¹⁵⁄₁₆	3⅜
Unit Weight, lbs.	.67	1.1	1.7	2.75

MAT-5 115V.-400 cyc. to 460 VCT; provides 230V. 48 MA DC or 460V. 24 MA DC. RC-37 Case . . . 1⅜ x 1⅜ x 1⅝ . . . ⅛ mtg. holes 1⅛ x 1⅛ . . . 6 oz.

MAT-6 Input . . . 10,000 ohms pri . . . 1.15 C.T. ratio . . . phase shift under 1° . . . RCOF case.

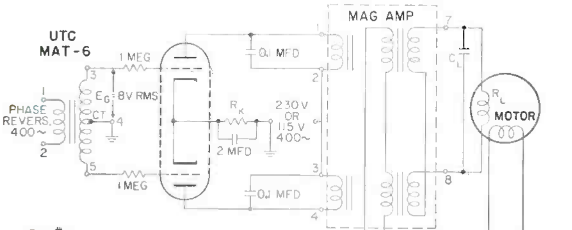


FIG.# 1
PUSH-PULL GRIDS-PARALLEL PLATES

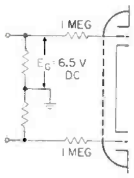


FIG.# 2
GRID CIRCUIT MODIFICATION FOR DC INPUT

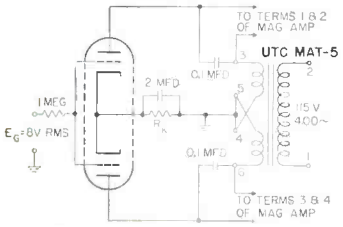


FIG.# 3
PARALLEL GRIDS-PUSH-PULL PLATES

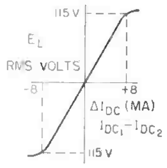


FIG.# 4

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ETCHING TECHNIQUE FOR SILICON TRANSISTOR—Enlargement of jet-etched silicon wafer, showing orange glow of white light transmitted through silicon window as it approaches final thickness of a few ten thousandths of an inch (see p 194) COVER

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electronic frequency changers

250VA and 1000VA capacity
60~ to 60 ~ or 60 ~ to 400 ~
accuracy to ±0.01%

- accurate control of frequency
- accurate control of voltage
- good wave shape
- portable
- no special wiring or installation

SPECIFICATIONS

Model	FCD250	FCD1000	FC1000
Input voltage	95-130VAC, 1Ø, 50-60~	208 or 230VAC, 1Ø, 50-60~	208 or 230VAC 1Ø, 50-60~
Output voltage	115VAC, 1Ø, adjustable between 110-120 volts		
Output Frequency	400~, adjustable ±10%	400~, adjustable ±10%	60~, adjustable between 45 and 65
Output voltage regulation	±1.0%	±1.0%	±1.0%
Output frequency regulation	±1.0% in standard models; ±0.01% with auxiliary frequency standard (output frequency is fixed when using frequency standard)		
Capacity	250VA	1000VA	1000VA
Load range	0.1 to full load		
Distortion	5% maximum		
P. F. range	Down to 0.7 F		
Time constant	0.25 seconds		
Envelope modulation	2% maximum		

These industrial and laboratory frequency changers resulted from contracts for precision inverters. They should prove useful for testing components or complete instruments that must operate over variable frequency conditions. They can also be used as sources for precision 60~ or 400~ for timing applications, or used with servo and/or gyro motors in design work.

Sorensen electronic frequency changers are also being used with field equipment such as geophysical vans, where motor generator set frequency control is often inadequate. Another use will be for checking equipment designed for 50~ (foreign) usage; conversely, the same instrument can be used to convert 50~ line to 60~ source.

Electronic frequency changers of other ratings are now in design. We shall be happy to send further information, or to correspond with you concerning your individual requirements. Address Sorensen & Co., Inc., 375 Fairfield Avenue, Stamford, Conn. In Europe, write directly to Sorensen A.G., Gartenstrasse 26, Zurich 2, Switzerland.

SORENSEN

375 FAIRFIELD AVENUE, STAMFORD, CONN.

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The scientific approach to vibration measurement

THE D-489
MUIRHEAD-PAMETRADA
WAVE ANALYSER

WITH the Muirhead-Pametrada Wave Analyser the localization of obscure vibrations can be carried out systematically. Designed specifically for such measurements, this instrument covers a range of 19-21,000 c/s with an accuracy of $\pm 0.5\%$. Its high selectivity enables component frequencies close to one another to be measured; the flat top of the tuning characteristic can be varied to simplify measurements of fluctuating frequencies.

In almost every branch of engineering there is a use for this novel instrument.

FEATURES

- Wide frequency band — 19c/s to 21 kc/s in 6 overlapping ranges
- Frequency accuracy $\pm$ 0.5% over entire range
- Response flat within $\pm$ 2db over entire range
- Flat-topped response curve — narrow or wide bandwidth selected at will
- Off-peak response proportional to percentage mistuning
- Output frequency is that of the selected component, and is available for oscilloscope viewing
- Octave discrimination better than 70db
- Mains operated from a separate stabilized supply unit

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FIGURES OF THE MONTH

RECEIVER PRODUCTION

(Source: RETMA)	Year Ago	Previous Month	Latest Month
	Feb. '53	Jan. '54	Feb. '54
Television sets	730,597	420,571	426,933
Home sets	402,742	271,036	233,063
Clock Radios	210,924	159,932	105,933
Portable sets	87,711	46,571	98,275
Auto sets	491,062	394,442	331,961

RECEIVER SALES

(Source: RETMA)	Feb. '53	Jan. '54	Feb. '54
Television sets, units	537,122	731,917	536,017
Radio sets (except auto)	507,527	310,623-r	262,679

RECEIVING TUBE SALES

(Source: RETMA)	Feb. '53	Jan. '54	Feb. '54
Receiv. tubes, total units	40,061,483	22,133,347	25,189,147
Receiv. tubes, value	$27,371,779	$16,412,505	$18,319,819
Pic. tubes, total units	836,451-r	557,681	645,715
Picture tubes, value	$20,030,681	$12,173,923	$13,916,478

SEMICONDUCTOR SALES

(Source: RETMA)	Jan. '53	Dec. '53	Jan. '54
Germanium Diodes	1,470,472	689,409	658,966

INDUSTRIAL TUBE SALES

(Source: NEMA)	Quarterly Figures: Year Ago	Previous Quarter	Latest Quarter
	4th '52	3rd '53	4th '53
Vacuum (non-receiving)	$12,790,000	$9,434,082	$9,467,331
Gas or vapor	$3,480,000	$4,145,018	$4,854,222
Phototubes	$760,000	$510,686	$405,000
Magnetrons and velocity modulation tubes	$10,510,000	$9,822,600	$13,073,095
Gaps and T/R boxes	$2,090,000	$1,554,000	$1,707,730

TV AUDIENCE

(Source: NBC Research Dept.)	Year Ago	Previous Month	Latest Month
	Feb. '53	Jan. '54	Feb. '54
Sets in Use—total	21,907,100	27,666,000	28,289,000

BROADCAST STATIONS

Source: (FCC)	Mar. '53	Feb. '54	Mar. '54
TV Stations on Air	164	379	385
TV Stns CPs—not on air	255	198	190
TV Stns—Applications	639	99	72
AM Stations on Air	2,424	2,529	2,539
AM Stns CPs—not on air	133	128	129
AM Stns—Applications	250	154	163
FM Stations on Air	607	554	555
FM Stns CPs—not on air	21	19	15
FM Stns—Applications	7	3	3

COMMUNICATION AUTHORIZATIONS

Source: (FCC)	Feb. '53	Jan. '54	Feb. '54
Aeronautical	37,825	42,314	43,682
Marine	39,001	43,918	44,140
Police, fire, etc.	12,482	14,865	15,003
Industrial	16,002	20,053	20,280
Land Transportation	5,636	6,556	6,600
Amateur	116,697	116,369	117,427
Citizens Radio	1,924	5,492	5,550
Disaster	101	256	257
Experimental	529	525	532
Common carrier	1,070	1,479	1,490

EMPLOYMENT AND PAYROLLS

(Source: Bur. Labor Statistics)	Jan. '53	Dec. '53	Jan. '54
Prod. workers, comm. equip.	330.5	368.4	355.5
Av. wkly. earnings, comm.	$69.22	$67.26	$67.49
Av. wkly. earnings, radio	$64.46	$67.03	$65.74
Av. wkly. hours, comm.	41.8	39.7	38.8
Av. wkly. hours, radio	40.9	39.9	38.9

STOCK PRICE AVERAGES

(Source: Standard and Poor's)	Mar. '53	Feb. '54	Mar. '54
Radio—TV & Electronics	310.7	281.7	301.9
Radio Broadcasters	294.3	284.8	302.1

p—provisional; r—revised

FIGURES OF THE YEAR

	1953 Total	TOTALS FOR THE FIRST TWO MONTHS: 1953	1954	Percent Change
Television set production	7,214,787	1,449,832	847,504	—41.5
Radio set production	13,368,556	2,285,581	1,641,213	—28.2
Television set sales	6,375,279	1,177,195	1,267,934	+ 7.7
Radio set sales (except auto)	7,064,485	922,248	573,302	—37.8
Receiving tube sales	437,091,555	77,367,556	47,322,494	—38.8
Cathode-ray tube sales	7,582,835	1,824,767	1,203,396	—34.1

INDUSTRY REPORT

electronics—MAY • 1954

Industry Hails Armed Forces' New Look

Outlay for electronic gear remains high despite cutbacks in defense spending

EMPHASIS on airborne and atomic weapons rather than balanced military forces, makes fighting men more dependent than ever upon electronic equipment.

► **Air Force**—Spearheading development of airborne electronic weapons is the USAF Air Research and Development Command. At 10 major research and development activities, in 160 colleges, universities and other nonprofit institutions and in 1,520 industrial plants and laboratories, work is underway on Air Force projects to implement the massive retaliation principle—should it become necessary.

► **Automatic Flight**—Several recently unveiled devices indicate that Air Force scientists are well on the way to relieving the pilot of his more arduous duties and in some cases replacing him entirely.

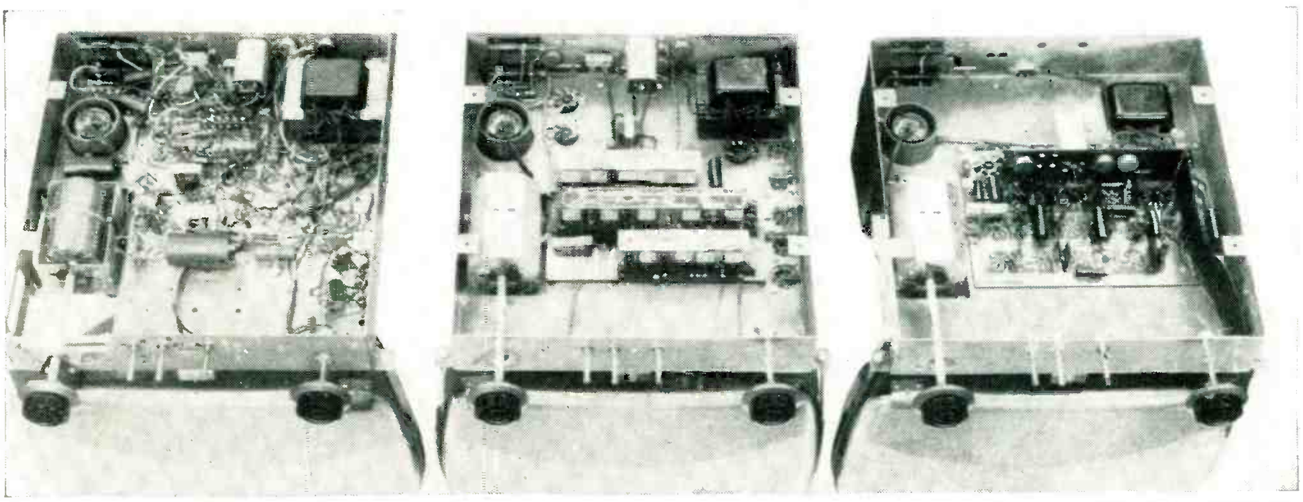
The N-1 gyro compass, now standard equipment aboard medium and heavy bombers, permits navigation over polar regions where magnetic compasses are unreliable. The A-1 dead-reckoning computer is a companion piece to the gyro compass. With heading, air speed, wind direction and velocity fed in, the pilot can read his latitude and longitude continuously.

Pilotless flight may be the eventual goal toward which the digital airborne computer and automatic sequence selector point. The former reportedly can guide an aircraft to specific targets, discharge appropriate weapons and get the intruder home without human direction.

► **Production**—Other developments include instruments to speed materials testing and research on air frames, power plants and propellants.

Electronic manufacturers are keenly interested in work on reliable components such as subminiature amplifiers that consume only ½ watt heater power compared to 2 watts for present units; small electron tubes capable of operating at high temperatures in sealed, ex-

Three Steps in Evolution of 3D Printed Circuits



Underside views of 21 inch tv chassis above illustrate space saving over conventional wiring, left, accomplished by Tinkertoy module technique in center (ELECTRONICS, p6, Feb., 1954) and at right, new printed-circuit method using Reliaplates developed by Sanders Associates. The plates contain interstage and bypass components and are mounted at right angles to main etched plate containing all tubes and wiring except high-voltage rectifier and front-end tubes. Main plate is 12 inches long, six wide pendable subassemblies and a miniaturized 100-watt water-cooled ceramic tetrode.

▶ **Radar**—Preliminary work is well under way on the $400,000,000 radar fence across the far north. The joint U. S.-Canadian undertaking is designed to provide six hours advanced warning in case of attempted attack by hostile aircraft on U. S. industrial centers.

The fence comprises both ground and airborne stations.

▶ **Missiles**—Development of electronic control systems for guided missiles is number one task for many electronic engineers and production of telemetering equipment by which designers learn how their birds perform during their first—and last—flight is becoming a big business.

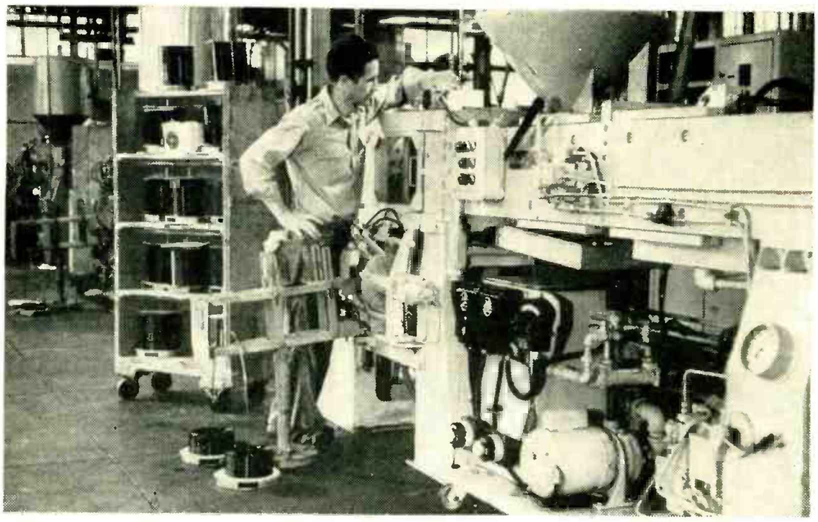
Suppliers report expanding sales of ground-station equipment and sales of airborne telemeters in lots of 50 to 100.

Congress Objects to FCC License Fees

RELUCTANT itself to impose fees upon operators and radio station licensees, FCC initiated proposals (ELECTRONICS, p 5, Mar.) following a directive of the Budget Bureau. Fees ranging from $3 (for operators) to $1,500 (for equipment type approvals) were proposed, effective May 1.

▶ **Backtracking**—Objections filed with the Commission by its April 1 deadline included that of National Association of Radio and Television Broadcasters. Discrimination against broadcasting as compared with other mass advertising media was claimed by NARTB, which recommended Congressional hearings on the subject.

Congress, through the Senate Interstate and Foreign Commerce Committee, has now asked FCC to withhold action on fees until July 1, 1955. The Budget Bureau still feels that FCC should comply with its directive resulting from an Act of the Congress. At press time, FCC had not indicated what action it would next take.



ONE MACHINE produces 200 7-inch or 70 12-inch records per hour when . . .

Disk Maker Adopts Injection Molding

New production method gives pair of stampers almost indefinite life

LARGE-SCALE record manufacturing by injection molding was recently inaugurated by Columbia Records at its Bridgeport plant.

Principle of the injection molding process is automatic molding of a plastic material that has been heated to fluid condition. Compression molding, used by the record industry for more than 50 years, molds a plastic mass that is heated to a semi-solid, gummy state.

▶ **Operation**—Polystyrene is poured in pellet form into a hopper resting on top of the machine. A metering device below the hopper regulates the release of pellets into a heating cylinder.

Under temperatures of 400 to 600 F the styrene is reduced to a liquid, similar to heavy oil in consistency. An injection plunger forces the fluid into a pair of mold cavities containing the stampers or grooved disks that mold each record surface. Double-mold cavities permit two records to be made at the same time.

Under hydraulic pressure the fluid styrene is molded into grooved disks which harden through a cooling medium while still in the machine.

When completely cooled, the finished records are automatically ejected onto a rack from which they tip automatically onto wire spindles. Records are of exact weight and thickness with perfect edges. Each groove is reproduced exactly as it appears on the stamper and each succeeding record produced is exact in every detail.

▶ **Stamper Life**—Since material is introduced into the closed disk as a fluid, friction and general wear on the record stampers is virtually nonexistent. A single pair of stampers has almost indefinite life, in contrast with compression molding stampers that yield little more than 1,000 disks before degradation in the quality of their surfaces sets in.

The complete molding cycle, from fluid state to finished record, takes 20 seconds for a 7-inch, 40 seconds for a 10-inch long-playing and 45 seconds for a 12-inch long-playing record.

Each double-cavity injection molding machine produces either 200 7-inch records or 90 10-inch $33\frac{1}{3}$ or 70 12-inch $33\frac{1}{3}$ rpm disks per hour. Long-playing records require a longer molding cycle than 7-inch disks because more material is injected to cover a larger record surface.

(Continued on page 8)

Introducing A New DECADE COUNTER TUBE

The 6476 is Another New Sylvania Development

Now Sylvania offers a new, visual electronic counting device. It's specially designed for control and totalizing applications in high-speed production equipment.

Operating by electrical impulses, this tube visually indicates consecutive numbers by light flashes within the tube—counting from one to ten.

All cathode leads are brought out individually and can be plugged into a socket, permitting independent control of pulses. Additional tubes may be added to the circuit thereby increasing counting capacity to hundreds or thousands.

You will find this new Sylvania tube is low in cost, compact in size, and extremely reliable. For detailed specifications address Dept. 4E-1605, Sylvania.

Electrical Data

Anode Current	**6 ma. max.**
Supply Voltage	**350 volts**
Max. counting rate	**4,000 pulses per second**

One more reason why it pays to specify Sylvania.

SYLVANIA

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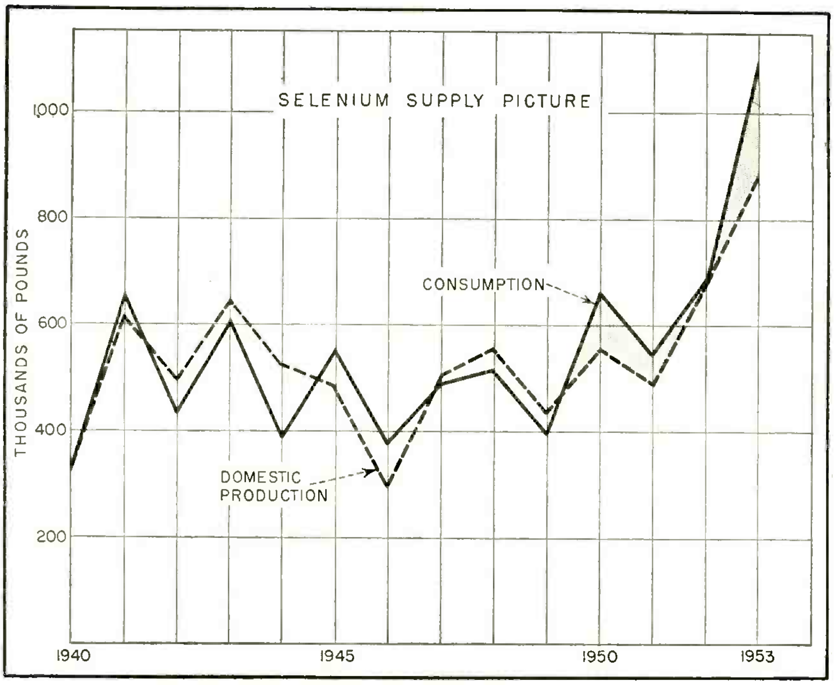

WIDENING gap between demand and supply sparks hunt for substitutes, as . . .

Planners Fear Selenium Shortage

Titanium dioxide and silicon are scanned as rectifiers; selenium scrap drive gains

INCREASING use of selenium rectifiers in radio, television and electronic equipment has brought about a potential shortage of the metal. Presently, domestic production and imports nicely balance consumption but manufacture of electronic equipment on a wartime basis could exhaust available selenium stocks in a matter of months.

▶ **Uses**—The electronics industry now uses 45 percent of all selenium consumed. Other users are the steel, glass, rubber and chemical industries. Selenium rectifier stacks provide reduced size and weight over copper oxide or copper sulphide stacks and have been replacing both hard and soft diode rectifiers in power supplies generally.

An important use of selenium outside electronics is as a catalyst in the organic chemical and drug business. Total selenium consumption in 1953 was 1,100,000 pounds.

▶ **Supply**—Selenium is produced as a by product of copper refining, being found principally in anode slimes. Domestic production totaled 890,000 pounds in 1953. Imports amounted to approximately 100,000 pounds. Canada supplies nearly 90 percent of imports; other sources are Japan, Sweden, West Germany and Belgium-Luxembourg.

Latest stockpile figures indicate that supplies of elemental selenium held by primary producers amount to only a two-month supply.

▶ **Conservation**—Throughout 1952 selenium was in short supply and the subject of study by the National Production Authority, Munitions Board, Defense Materials Procurement Agency and Bureau of Mines. During the year, 66,781 pounds were turned in as scrap by rectifier manufacturers and recovered from spent catalysts by the chemical industry.

Key to the problem is replacing selenium in dry-plate rectifiers. A titanium-dioxide rectifier is under development by the Bureau of Standards. Recent work with silicon junction diodes also gives promise in this direction.

The silicon junction diodes avoid the current limitations of the silicon point-contact units and the thermal instability of germanium. However, silicon junction diodes thus far produced have been for switching and demodulation and power rectifiers of this type represent largely a pious hope of defense planners and a gleam in the eye of semiconductor researchers.

Microwave Makers See Expanding Market

Push sales to pipelines, railroads and utilities; two new firms enter field

COMMUNICATIONS equipment manufacturers have resumed promotion of microwave systems for railroads, pipelines, power utilities and independent telephone companies. Some curtailment of sales effort resulted while manufacturers concentrated on fulfilling contracts undertaken in the 1951–52 boom.

Early post-war activity by common carriers started the microwave activity. The Bell System still leads with about 6,000 route miles of TD-2 radio relay in operation; a 1,000-mile system forms the backbone of Western Union's operations.

Pipeline companies have installed most of the privately owned equipment—well over 10,000 miles. In all, right-of-way companies spent nearly $40 million during 1951–52.

The armed services installed an additional $40 million worth of microwave—largely in Europe and North Africa.

▶ **Sales Potential**—Less than 10 percent of existing pipeline mileage is equipped with microwave communications and pipelines are growing at a rapid rate. Many new systems have been laid over mountains and in the far north where rock slides and ice conditions are bad for pole lines.

Railroads, by and large, have not turned to microwave but both RCA and Philco are making a play for the market. The problem of whether telephone companies will

(Continued on page 10)

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permit interconnection with new microwave systems with the same off-line calling privileges allowed for existing pole lines will probably influence this market.

▶ **New Firms**—Stromberg-Carlson and Collins have entered the microwave field. Collins will supply complete systems in the 5,925–5,700-mc range. Frequency-division multiplexing will provide 24 voice channels.

Stromberg-Carlson is teamed with RCA to supply the independent telephone company market. Stromberg will furnish the 30-channel multiplexing and channeling equipment while RCA will supply the r-f portions.

▶ **Airborne Color**—Meanwhile, the Bell System's network continues to expand under the impetus of color television (microwave will pass the complete color signal).

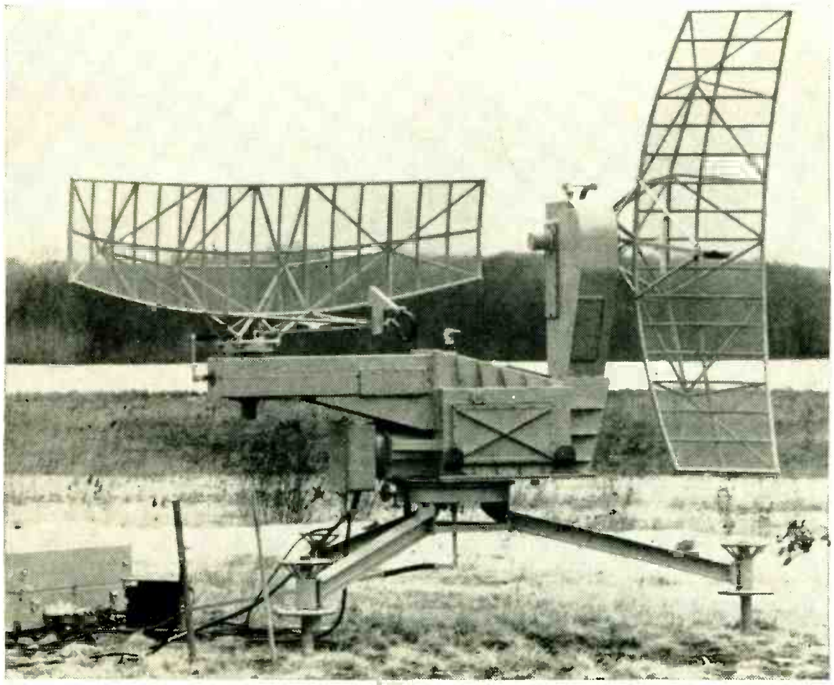
Most recent addition is a 164-mile leg from Atlanta to Montgomery, Ala.—part of a projected 400-mile route ultimately to reach Jackson, Miss.

Glass Makers Ready Color Envelopes

ANY foreseeable demands for color picture tube envelopes can now be met by the glass industry. Production and sealing problems have been solved by attaching metal flanges to the glass face plate and cone with which tube manufacturers can join the two glass pieces together with a cold sealing process, after inserting the color pack. This sealing method permits the bulb to be opened and resealed at least two times.

Sealing problems peculiar to rectangular tubes have been solved by development of an automatic sealing machine for this type of envelope.

Metal color-tube envelopes have also come on the scene. United Specialties, in cooperation with Westinghouse, has developed a stainless steel envelope for 21 and 24-inch tubes. Samples of a Westinghouse single-gun color tube using these envelopes will be available later this year.



MOVABLE tripod-mounted GCA antenna covers approaches for all runways as . . .

Airport Talkdown Facilities Improve

New accessories and GCA units for smaller airfields make bad-weather landings safer

DESPITE propwash among fliers relative to the merits of the instrument landing system (ILS) and ground controlled approach (GCA), both systems are mandatory for any big airport. For the small plane equipped only with two-way radio, GCA has often been a life-saver.

Technicians split up the functions of GCA into ASR (airport surveillance radar operating on 10 centimeters) for control of traffic 20 to 50 miles away and PAR (precision approach radar using two, higher resolution, 3-cm beams) for final landing approach. In either case, the pilot maneuvers according to suggestions from ground controllers who communicate the information by radio.

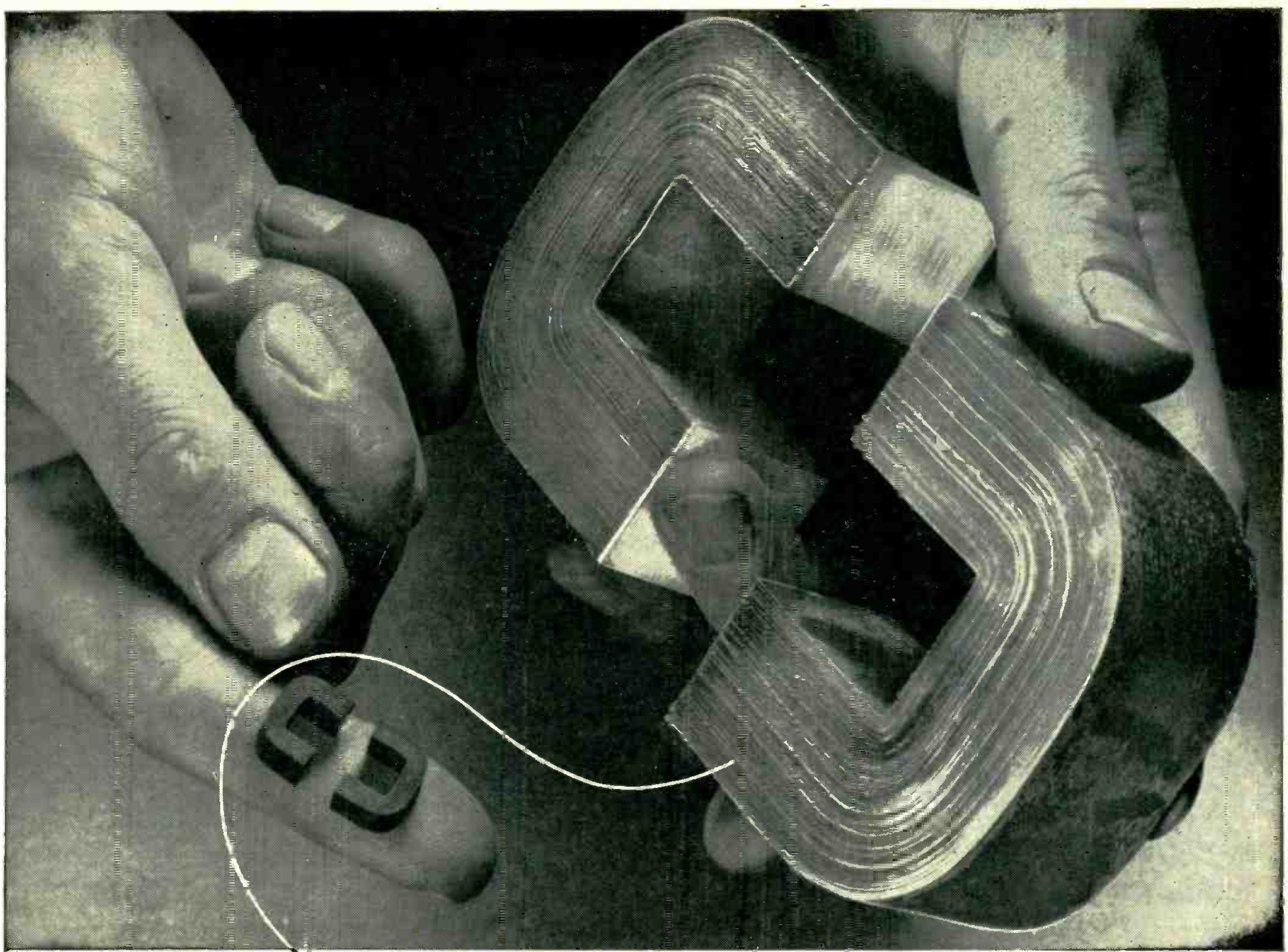
▶ **Costs**—Although GCA was designed at MIT's Radiation Laboratory during the war and its several refinements have been available on laboratory breadboards for some years, the installed cost of the deluxe equipment has slowed its general adoption. On the average, CAA will pay $261,300 for latest ASR and $184,000 for PAR.

The very-high frequency direction-finding equipment required in addition costs $24,635. Airports to receive the new Bendix GCA (some as replacements for older equipment) include Chicago, New York (Idlewild and LaGuardia), Washington, Atlanta, Los Angeles, Cleveland, Boston, Knoxville, Louisville, Nashville, Fort Worth, Miami, Burbank, Denver and Buffalo.

▶ **Gadgets**—Not just Rube Goldbergs, but real essentials for safe landings in bad weather are special items known as moving-target indicator, video mapping and automatic direction finder. The first, called MTI, enables the operator to cancel out fixed objects that would otherwise clutter his scope picture. Video mapping gives the ground radarman an electronically generated map that is mixed with his radar signals so as to display air traffic routes, navigation beacons and danger spots.

The direction finder, also known

(Continued on page 12)



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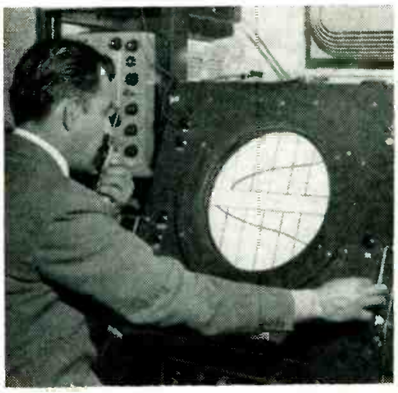

Scope presentation of airfield approaches gives ground operator plane position information from which he can direct pilot by radio

as vhf/d-f, points to the plane while its transmitter is in communication with the ground, eliminating the possibility of the ground controller's confusing blips on his radar screen.

▶ **The Economy Size**—To equip smaller airports having smaller budgets for initial equipment and fewer salaries, a Massachusetts firm has just brought out a small economy-size GCA.

The 75-tube PAR unit shown by Laboratory for Electronics is expected to sell for $30,000 to $35,000. Using a rotatable tripod-mounted antenna system, the unit can be placed to cover any runway of an airport.

Changeover of runways requires about thirty minutes. Initial setup requires about six hours.

▶ **Military Use**—At advanced airstrips in military operations, the equipment can be broken down into subassemblies that can be reassembled in about two hours.

Although it was designed and developed as a commercial unit, the new equipment is now being given a series of tests under field conditions by the armed services.

Silicon Invades Junction Diode Market

Four firms manufacture units, others announce pilot runs; military users corner output

LARGE-SCALE use of silicon alloy junction diodes seems closer with four manufacturers indicating that they are producing such new semiconductor devices. Texas Instruments, National Semiconductor Products of Evanston, Ill. and Transistor Products of Melrose, Mass. have announced commercial availability of their silicon diodes while Western Electric indicated that silicon diodes were being made at their Allentown plant.

▶ **Single Crystal**—Although diodes of polycrystalline silicon have been widely used since the early days of microwave radar, the high-purity single-crystal silicon diode is of recent vintage.

Tiny particles of silicon dioxide are transformed to monocrystalline silicon in an operation requiring temperatures as high as 1,500 C. Contacts are fused to thin wafers of silicon and the assembly is then hermetically sealed in light-tight aluminum cans about the size of a pencil eraser.

▶ **Performance**—Silicon diodes do everything that germanium diodes do and do it better. Back resistance is extremely high—in the order of thousands of megohms. The flow of current in the reverse direction is so small that a new unit has been set up to measure it. This is the nanoampere, one-billionth ampere.

These properties mean that silicon diodes can be used for telephone switching with a minimum of crosstalk. Impetus to development of the silicon diode has come from a Navy request for bids on a 100-line transistorized telephone exchange to use more than 2,000 silicon diodes.

▶ **Temperature**—Germanium diodes tend to break down under ambient temperatures between 65 and 75 C. The silicon units, however, can withstand 150 C. This high-temperature stability has led to their use in guided missiles and airborne systems.

One manufacturer reports that 80-percent of its silicon diodes are being used in rockets.

▶ **Pilot Runs**—Other manufacturers indicate that they are producing experimental units. These include Hughes Aircraft, Raytheon and Radio Receptor. Sylvania, in production on point-contact silicon diodes, says that it has junction units in an advanced stage of development.

Manufacturers relate that breakdown voltage on run-of-the-mine silicon junction diodes runs between 15 and 50 volts but that experimental units have withstood inverse peak voltages of 2,500 volts.

Development is underway on silicon power rectifiers to replace selenium stacks in radio and television receivers.

TV Tuners May Use Quartz Crystals

Industry considers this solution to color tuner drift; cost of crystals is chief drawback

OVERTONE crystals, for use in r-f oscillator stages of color television receivers, are getting attention in virtually every receiver engineering lab. The chief problem appears to be economic—the high cost of grinding crystals for the precise 6-mc-apart frequencies.

▶ **Cost Factors**—Even with mass etching techniques, crystal grinders are quoting around $2.50 apiece to tuner manufacturers for quartz plates ground to tv specifications. Tuner manufacturers say this cost must be cut in half before crystals can go in. Hand grinding costs still more. For the crystal industry the stakes are high, considering that each vhf color tuner would use an even dozen crystals. If predictions

(Continued on page 14)

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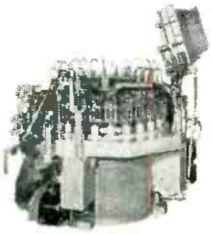
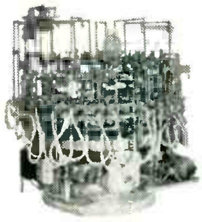
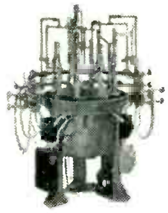
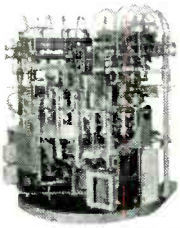
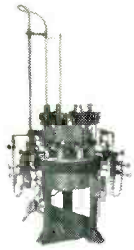
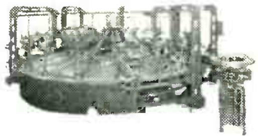

SUB-MINIATURE TUBES 24 HEAD

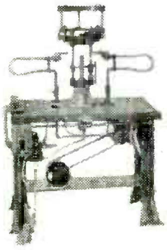

MERCURY LAMPS


HERMETIC SEAL 8 HEAD


RADIO RECEIVING TUBES SEAL EXHAUST MACHINE

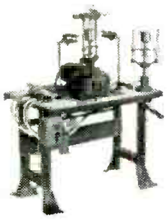

FLUORESCENT LAMPS 8 HEAD

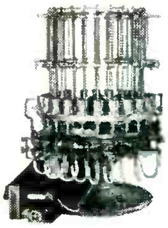

CR TUBES 16 HEAD

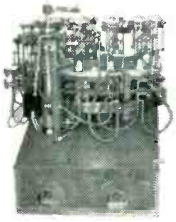

CR TUBES SINGLE HEAD

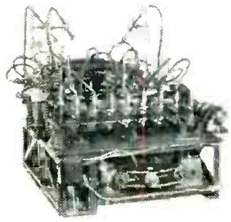

LIGHTHOUSE TUBES HIGH FREQUENCY SEALING

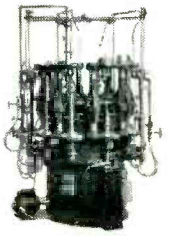

SUB-MINIATURE 12 HEAD

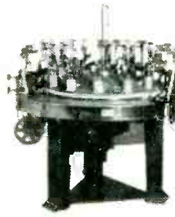

BI-POST LAMPS SINGLE HEAD

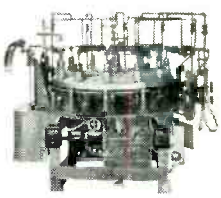

FLUORESCENT LAMPS 24 HEAD

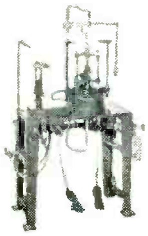

MOULDED NECK LAMPS

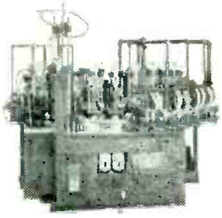

CR TUBE FACE PLATE SEALING SINGLE HEAD FOR COLOR TV TUBES


POWER TUBES 8 HEAD


MINIATURE TUBES 12 HEAD


HERMETIC SEAL 12 HEAD


POWER TUBES SINGLE HEAD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of 10 million color sets in the next five years come true, this would be something like a $160 million windfall for the crystal business.

▶ **Technical Factors** — Crystals would eliminate the oscillator drift problem that now calls for costly temperature-stabilized tuning arrangements, to eliminate the necessity for frequent retuning while watching a color program. The actual amount of drift is no more than with black-and-white tuners, since the same channel frequencies are involved, but with color the tuning becomes more critical.

Thinking of production men is along the lines of wiring in twelve crystals permanently one for each vhf channel, so that factory output of sets can be shipped anywhere without need for unpacking by a dealer to plug in the appropriate channel crystals for a locality.

With uhf color tuners, plug-in arrangements will be probably be necessary, but a single crystal could serve for three to five adjacent channels because a screwdriver-adjusted control can be used to shift the frequency of an overtone crystal.

A typical uhf channel might use 5th overtone operation of a crystal ground somewhere around 10 mc, to give a 50-mc signal for multiplying to 250 mc and then doubling to 500 mc or thereabouts for a uhf oscillator channel.

One quartz crystal per color tv set is already pretty much assured, for the 3.58-mc crystal filter for color sync.

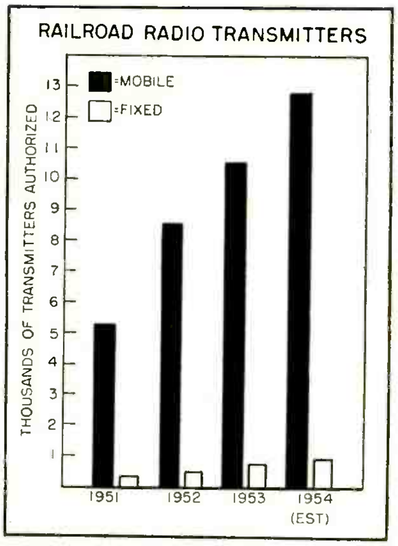
Railroad Electronics Market Expands

Manufacturers expand activities in the field as more roads install equipment

RECENT action by two major electronics manufacturers in the railroad electronics market has caused the industry to reappraise the field.

RCA has set up a railroad communications sales activity to sell a complete line of microwave radio relay equipment, including 960-mc and 2,000-mc system to railroads. Federal Telephone and Radio is extending its activities in communications equipment to include the railroad industry. It plans to offer main-line control as well as dispatching, signalling, train departure and other complete systems for railroad operation.

▶ **Activity**—One reason for increased activity by electronic manufacturers in the market is the steady growth of railroad radio. As of January 1, 1953, there were 10,827 mobile and fixed railroad radio transmitters authorized to operate. The present number of transmitter authorizations is approaching 13,000. Nearly 90 railroads in the U. S. have installed railroad radio equipment.



▶ **Future**—During the last session of Congress, a bill giving the Interstate Commerce Commission the authority to order railroads to install electronic safety equipment was passed by the Senate and sent to the House. Although it is still in committee and no action is planned on it during the present session, manufacturers hope that its eventual passage will swell sales in the field.

In addition to ordering installation, the bill would make it possible for the ICC to require railroads to establish rules and regulations for proper maintenance and use of electronic equipment in safety service.

At the present time, ICC can order installation of block signal systems, automatic train stops and similar devices. However, the ICC has no power to require installation or use of electronic devices and radio communications systems and would have to be given such authority by Congress.

Stripe Aids Color Set Installers

Signal received as vertical bar at right-hand side of picture, generator located at station

A COLOR test generator for television stations will add a narrow green-orange stripe to the station's monochrome transmission.

The color stripe is practically unnoticeable on monochrome receivers. Even though the receiver is correctly adjusted for color, it may not receive a satisfactory color picture at a particular location according to RCA engineers who developed the unit.

▶ **Need**—Under certain conditions of multi-path reception or improper orientation of the receiving antenna it is quite possible to pick up a satisfactory monochrome picture but to have the color subcarrier almost completely cancelled. Thus it is not possible to determine for sure that a particular color receiver installation will reproduce color programs from a specific tv station until an actual transmitted color signal is available.

The new color test generator can be added (by stations equipped for carrying network color programs) for approximately $500. The stripe can be transmitted more or less automatically during station breaks, thus not interfering with normal monochrome operation.

▶ **How It Works**—The color stripe generator is designed to be connected to the video line feeding the transmitter in such a way that the normal system operation is not

(Continued on page 16)

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changed. The generator does not change the basic signal but simply adds a small amount of color information: a color sync burst signal and a short test burst of color signal which is superimposed on the monochrome video signal at the right-hand side of the raster.

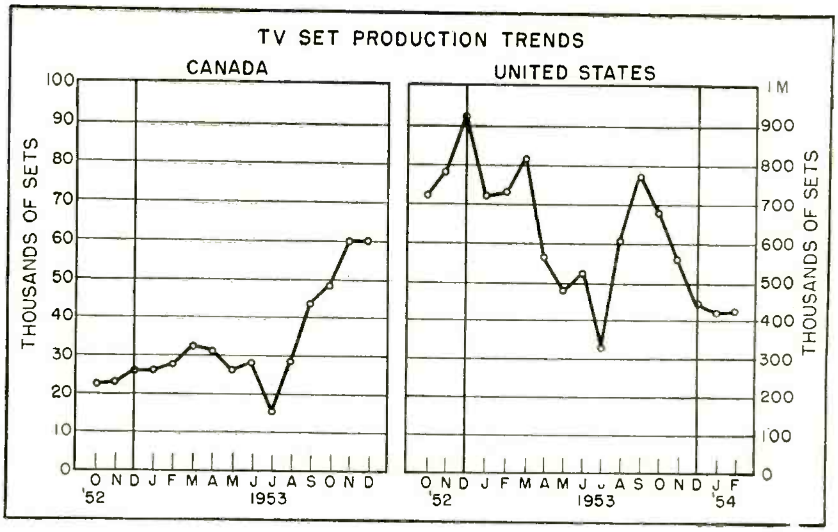
Monochrome receivers are relatively blind to these added signal components because most receivers have relatively low response at 3.6 mc. During a color transmission the color bar will be deleted.

The generator has been demonstrated to the FCC which indicated that it did not feel the test bar was objectionable on black-and-white receivers. It was put into continuous use at WNBT on all monochrome programming.

Some of the other networks have indicated that they were proceeding along these general lines but had not decided whether this particular piece of equipment or some other was the answer to aiding color tv.

Television Set Sales Boom In Canada

Dominion's production and sales head for new records as more stations go on the air



CONTRARY to recent tv set production trends in the U. S., output of receivers in Canada is moving sharply upward. U. S. production for the first two months of 1954 fell almost 42 percent compared to the similar period in 1953, from 1.4 million sets to 847,504.

In Canada, however, the value of tv sets sold jumped 38 percent in the first two months of 1954 compared with the same period in 1953. There were 73,675 sets sold valued at $27.2 million in January and February compared with 47,500 sets valued at $19.6 million in the same period last year.

As shown in the chart, 1953 was the biggest year on record for Canadian tv production. Output totaled 429,600 sets compared to 126,000 units in 1952, an increase of 240 percent. Monthly production averaged 35,800 last year while in 1952 it averaged 10,500 per month.

▶ **Reason**—Main reason for the increasing production and sales of sets in the Dominion is the rising number of tv stations that have taken to the air. There are now 9 stations on the air and 6 more are expected by the end of the year. A total of 15 grants are outstanding. At the end of 1953 over 60 percent of total Canadian population was within range of tv service.

▶ **Plants**—A number of U. S. tv manufacturers have set up production facilities in Canada to garner a share of the growing sales volume. Latest to announce plans for establishing a plant there is Emerson. The firm expects to quadruple its sales volume in Canada this year and estimates that more than $1 million in orders for its products have already been booked for 1954. Crosley is also expanding in the Dominion and is doubling its present plant capacity there to 90,000 sq ft.

British manufacturers are also moving into the Canadian market. Canadian Marconi and A. H. Hunt of London, England have formed a new company in Ontario to manufacture capacitors.

Electronic Cookers Head for Homes

UHF COOKING, used in the past on a small scale for commercial food preparation, may soon enter the home kitchen to cut down the time and work involved in preparing the family meals.

In twelve experimental models now being home tested by the Tappan Stove Co., a Raytheon magnetron is used to generate the uhf power. The stove, developed jointly by the two companies, would cost about $2,000 at present, but is expected to sell for about $1,000 in mass production. Although still in the developmental stages, the Tappan Company hopes to be marketing the stoves late in 1955.

▶ **Advantages**—In addition to high cooking speed (a cake bakes in three minutes), use of pots and pans is eliminated. Meals are cooked directly in the serving dishes since ceramic and china are not affected by the uhf radiation. Use of top burners is eliminated since the oven arrangement of the uhf stove will be able to handle all types of cooking jobs.

Cost of the stoves will be high

(Continued on page 18)

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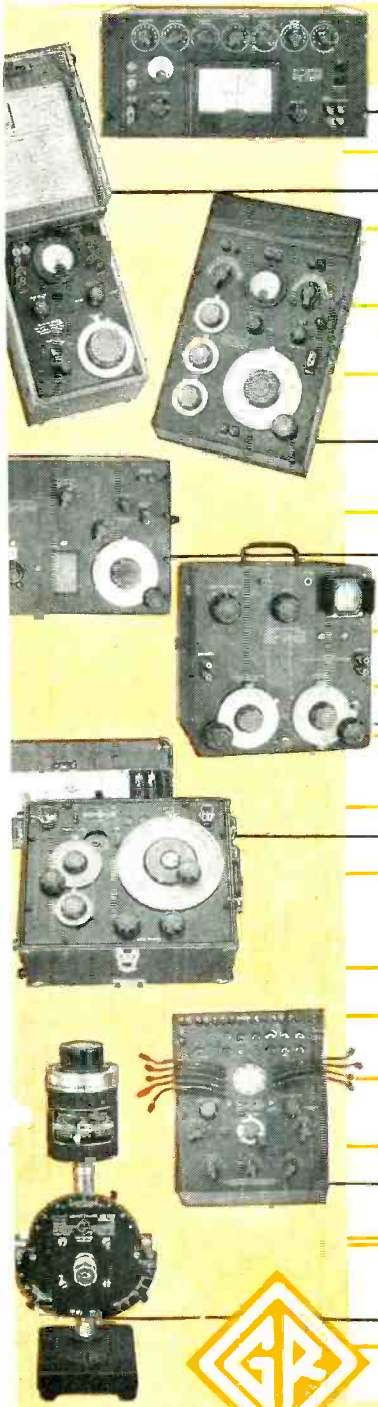

Instrument	*Measurement Frequency*	*Range of Measurements*	*Accuracy*	*Typical Uses*
1652-A Resistance Limit Bridge $425	dc	R: 1 to 1,111,111Ω	0.5% as limit bridge 0.25% by null method	Useful in production testing or laboratory
544-BA Megohm Bridge (with a-c power supply) $340	dc	R: 0.1 to 1,000,000 MΩ	±3% to 1000 MΩ ±4% to 100,000 MΩ	Measures high resistance — insulation, volume resistivity, etc.
740-B Capacitance Test Bridge $250	60 c	C: 5 μμf to 1100 μμf D: 0 to 50%	±1% ±1.5% of full scale	Production-test tool — measures ungrounded capacitors
1611-A Capacitance Test Bridge $475	60 c	C: 0 to 11,000 μf D: 0 to 60%	±1% ±2%	Testing insulators, bushings, cables, grounded capacitors.
650-A Impedance Bridge $260	dc 1 kc 1 kc 1 kc 1 kc	R: 0.001Ω to 1 MΩ L: 1μh to 100 h C: 1 μμf to 100 μf D: 0.002 to 1 Q: 0.02 to 1000	±1% ±2% ±1% ±20% ±20%	Completely self-contained, general-purpose laboratory and production bridge
716-CM Capacitance Bridge $570	1 kc 0.1, 10, 100 kc 0.1, 1, 10, 100 kc 0.1, 1, 10, 100 kc	C: 100 μμf to 1 μf C: 100 μμf to 1000 μμf C: 0.1 μμf to 1000 μμf D: 0.00002 to 0.56	±0.2% of full scale ±0.2% of full scale ±0.2% (substitution) ±2%	For capacitance standardization, precision measurements, dielectrics tests and studies
667-A Inductance Bridge $450	60 c to 10 kc	L: 0.1 μh to 1 h	±0.2%	Variety inductance measurements
1604-B Comparison Bridge $390	400 c, 1 kc, 5 kc	Z: 2Ω to 20MΩ	±0.1%	Rapid components testing, and sorting
916-AL Radio Frequency Bridge $535	50 kc to 5 Mc	X: ±11,000Ω at 100 kc R: 0 to 1000Ω	±2% ±1% (X-range varies inversely as frequency)	Measures impedances of antennas, transmission lines, etc. at r-f
916-A Radio Frequency Bridge $495	400 kc to 60 Mc	X: ±5,000Ω at 1 Mc R: 0 to 1000Ω	±2% ±1%	Similar to Type 916-AL but designed for higher frequencies
821-A Twin-T Bridge $570	460 kc to 40 Mc	C: 0 to 1000 μμf G: 0 to 100 μmhos at 1 Mc B: ±6000 μmhos at 1 Mc	±0.2% (G & B range ±2% vary directly as frequency)	Measures high impedances; parallel components, chokes, resonant impedance, solution conductivity, etc.
1612-A R-F Capacitance Meter $220	1 Mc	C: 0 to 1200 μμf	±4%	Rapid, accurate capacitance testing
1612-AL R-F Capacitance Meter $220	1 Mc	C: 0 to 100 μμf	±4%	Similar to 1612-A—adaptors available for measuring tube-socket capacitance
1601-A V-H-F Bridge $440	10 to 165 Mc	X: ±200Ω at 100 Mc R: 0 to 200Ω	±5% ±2% (X-range varies inversely as frequency)	For measurements on either lumped or coaxial circuits
561-D Vacuum Tube Bridge (also measures transistor low-frequency parameters) $750	1 kc	μ 0.001 to 10,000 rp: 50Ω to 20MΩ gm: 0.02 to 50,000 μmho	±2% ±2% ±2%	Adaptors furnished with instrument for measuring characteristics of receiving tubes and transistors
Slotted Line and Admittance Meter for Measurements to 5000 Mc				
1602-B U-H-F Admittance Meter $295	20 to 1500 Mc	B: ±0.2 to ±1000 mmho. G: 0.2 to 1000 mmho	±3% ±3%	For measurement of coaxial lines, antennas, networks, and components
874-LB Slotted Line $220	300 to 5000 Mc	VSWR, impedance, power	±2½% or better	Determines characteristics of standing waves in all 50-ohm systems

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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 compared to a $350 price of some electric stoves, but some savings on the electric bill will be obtained. The electric stove requires about 3,000 watts, as compared to 750 for the uhf cooker.

Electronic Paging Bids For More Business

New systems are expected to swell the market in commercial and industrial fields

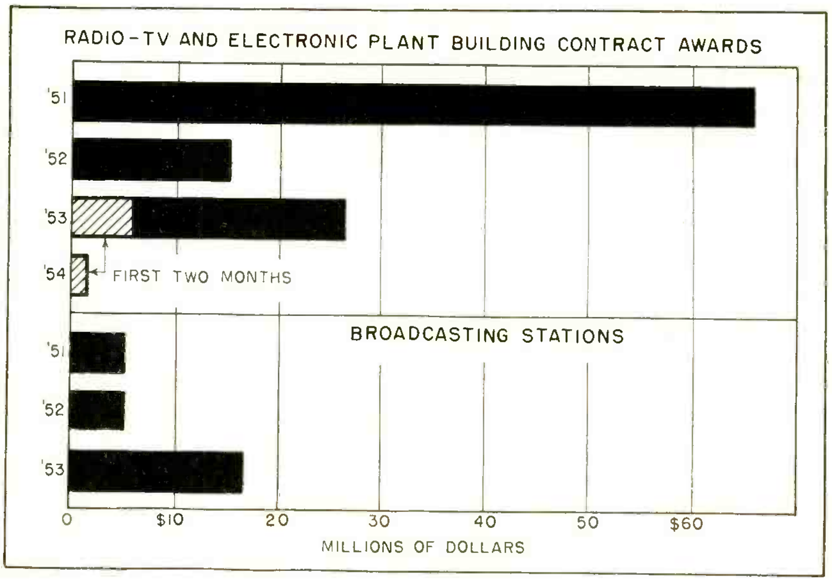
ELECTRONIC paging systems used for transmitting sound to personnel within buildings and plants represent substantial business for a number of manufacturers. Sales volume of such equipment may grow this year because of new systems.

▶ **Methods**—Dictograph Products has introduced a system that utilizes a coil that picks up audio frequencies from a closed loop in the building. The signal is amplified and fed to a midget loudspeaker attached to the coat lapel. Weight of the transistorized receiver and loudspeaker is under four ounces.

IBM has a system that superimposes pulses on regular a-c wiring. Personnel customarily paged are assigned paging codes which indicate the cadence in which the signals will operate. Paging is accomplished by inserting a selector plug in the central code selector. This carrier-current system operates relays and other electromechanical units without extra wiring.

▶ **Market**—According to Dictograph, an annual sales volume of $2 to $3 million can be expected from its personal paging system. Wide application of the equipment is seen in hospitals so that patients will not be disturbed, in department stores to curb thievery, civilian defense work and in outdoor movies. A major broadcasting network is interested in the system for its tv studios to cue floor operators.

IBM also expects increasing sales for coded systems and estimates that more than 7,000 of its electronic time and program systems have been installed.



Plant Building Lets Down Some

Construction contracts let by the industry rose 75 percent in 1953 but are low this year

BUILDING boom in the electronics industry showed signs of taking a breather this year after three years of high activity. Contracts for manufacturing plants let during January and February were far below those of the same period last year. The figure for broadcast station construction is not yet available but there are signs that it too is less substantial that it was a year ago.

▶ **Industrial**—Last year was one of the industry's big expansion years. In 1953, 28 plant construction contracts totaling $24.8 million were let compared to 16 contracts amounting to $14.3 million in 1952, according to *Engineering News Record*. In 1951, a high point for industrial expansion, 27 contracts totaling $62.5 million were awarded. There was a greater number of smaller expansions in 1953 while 1951 was a year of relatively few contracts for much larger expansions.

▶ **Stations**—The trend in broadcast station construction has been different. In 1953, construction contracts awarded by broadcasters were 30 percent higher than all of the contracts let in both 1951 and 1952 combined. Over 200 tv stations and 100 radio stations went on the air during last year, accounting for the increase.

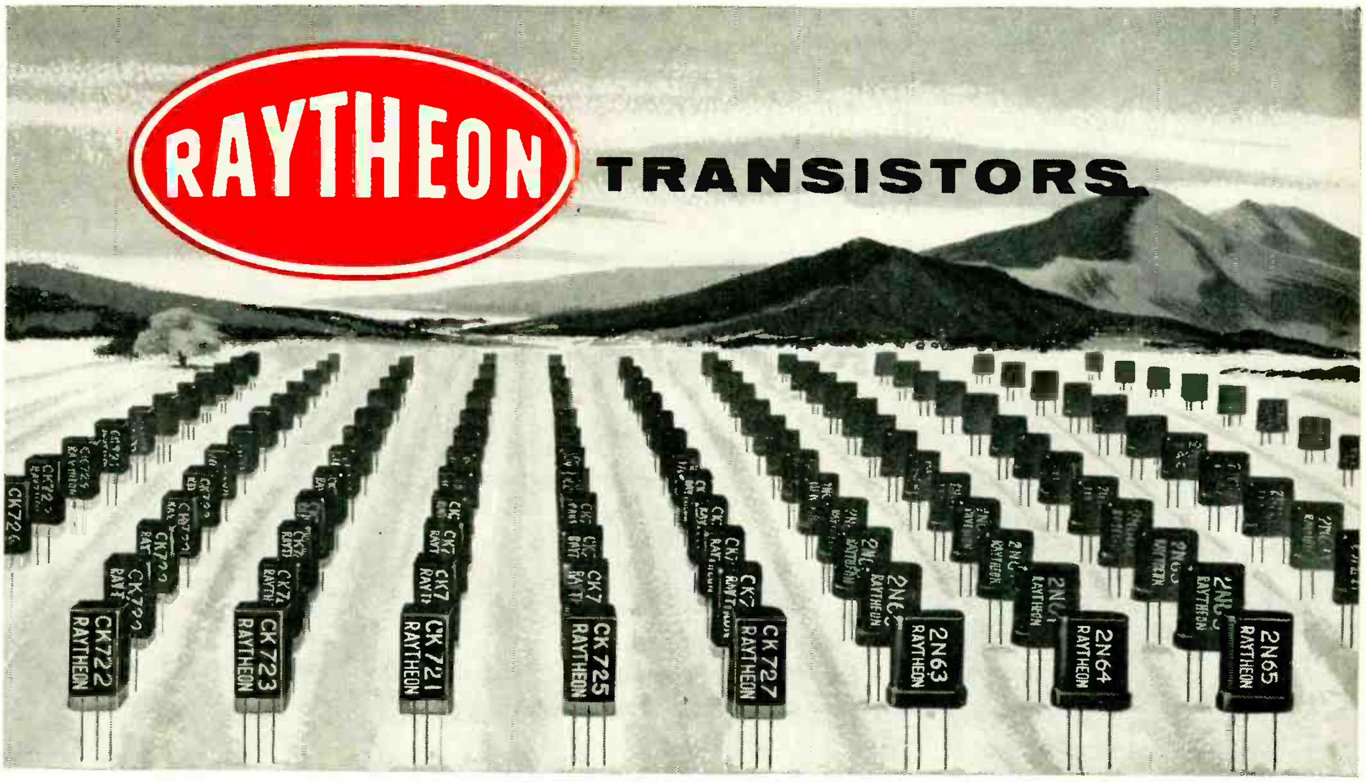
▶ **Defense**—Much of the plant expansion in the electronics industry in the past three years has been due to government encouragement through allowance of accelerated tax amortization.

Under the fast tax program, an electronics firm with a new $1 million plan, for example, could charge off the investment on its books within five years, at a rate of $200,000 a year, thus substantially decreasing the amount of tax that would be assessed during those years. The fast tax plan has been successful to the extent that many manufacturers hope it will be continued and expanded.

▶ **Future**—Despite the lower level of plant expansion activity that is expected this year, 1954 will still be important. More new tv stations will take to the air in 1954 and stations getting ready for color tv may build new studios. NBC recently announced plans for a $3.4 million studio to be built in Burbank, California.

Industrial plant expansion is continuing and companies such as

(Continued on page 20)



Foremost in the field

RAYTHEON TRANSISTORS are FOREMOST IN THE FIELD with PROVEN RELIABILITY Over 1,000,000,000 OPERATING HOURS of actual field performance in commercial equipment with only a FRACTION OF 1% FIELD RETURNS proves their reliability to be superior to the reliability of vacuum tubes.

RAYTHEON TRANSISTORS are foremost in number of units in use in commercial equipment. Raytheon successfully made transistors in "experimental," "pilot" and now MASS PRODUCTION phases. The latest continuous, mass production, and inspection techniques are employed in the making of Raytheon Transistors. HUNDREDS OF THOUSANDS are IN ACTUAL COMMERCIAL USE — MANY TIMES MORE THAN ALL OTHER MAKES COMBINED. No other manufacturers can make these statements.

RAYTHEON GERMANIUM DIFFUSED JUNCTION PNP TRANSISTORS

RATINGS: — ABSOLUTE MAXIMUM VALUES:	CK722	CK723	CK721	CK725	CK727	2N63*	2N64*	2N65*
Collector Voltage (volts)	−22	−22	−22	−22	−6	−22	−22	−22
Collector Current (ma)	10	10	10	10	10	10	10	10
Collector Dissipation (30°C) (mw)	33	33	33	33	30	33	33	33
Emitter Current (ma)	10	10	10	10	10	10	10	10
Ambient Temperature (°C)	50	50	50	50	50	50	50	50
AVERAGE CHARACTERISTICS (27° C)								
Collector Voltage (volts)	−6	−6	−6	−6	−1.5	−6	−6	−6
Emitter Current (ma)	1	1	1	1	0.5	1	1	1
Collector Resistance (meg)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Emitter Resistance (ohms)	25	25	25	25	50	25	25	25
Base Resistance (ohms)	250	350	700	1500	500	350	700	1500
Base Current Amplification Factor	12	22	45	90	35	22	45	90
Cutoff Current (approx.) (ua)	6	6	6	6	6	6	6	6
Noise Factor (max) (db)**	30†	25†	22†	20†	12††	25†	22†	20†

*Hermetically sealed in metal package
**In a one cycle band width at 1000 cycles

†Measured at Vc = −2.5 volts in common emitter circuit
††Measured at Vc = −1.5 volts; Ic = 0.5 ma in common emitter circuit

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Admiral, Motorola, and Raytheon have made plans for sizable plant additions. Electrical machinery firms plan capital spending of $553 million in 1954.

Financial Roundup

FINAL financial reports for most of the firms in the electronics field are now in for 1953 and for the most part showed that last year was very successful profitwise.

Survey by the National City Bank of New York covering 82 companies in the radio-tv, electrical equipment field showed net income up 10 percent from $418.3 million in 1952 to $461.5 million in 1953. Book net assets for the 82 firms rose from $2.8 billion to $3.0 billion during the year and percent return on net assets rose from 14.8 percent to 15.1 percent.

For individual companies reporting on 1953 net profits in the past month, the picture was as follows:

Company	Net Profit 1953	Net Profit 1952
Admiral	$ 8,213,165	$ 8,711,133
Arvin	2,255,000	2,209,733
Am. Cable & Radio	1,656,659	699,444
AMF	4,610,000	4,167,000
Clevite	3,478,611	3,444,240
CBS	8,894,642	6,445,506
Du Mont Labs	1,544,362	1,424,603
Eitel-McCullough	596,871	613,094
Electronic Assoc.	130,700	96,800
Federal Mfg. 9m	182,424	151,641
Gray Mfg.	184,333	408,965
Hoffman Radio	1,199,655	1,623,768
Lear	1,263,373	957,543
Minn. Honeywell	10,329,825	9,081,003
National Union	166,458	39,920
Radioactive Products	9,544*	1,586
Raytheon 9m	2,703,000	
Sprague Electric	2,888,281	3,136,853
Texas Instruments	1,270,125	908,000
Ultrasonic	268,818	105,441
Victoreen Instruments	40,681	
Westinghouse Air	10,009,199	10,515,186
Wilcox Gay	201,515	330,110

*Loss

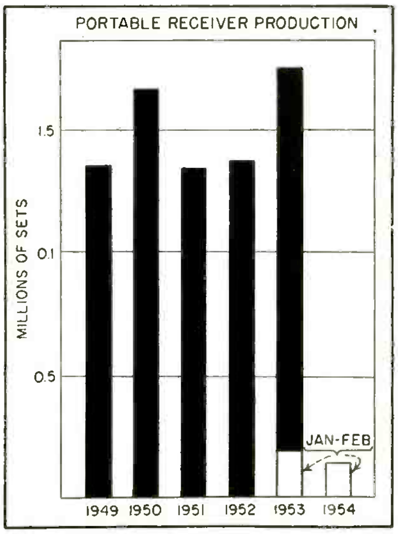
▶ **Securities**—Electro Data registered with SEC covering 450,000 shares of capital stock (par $1). Proposal is to offer 435,000 shares to common stockholders of Consolidated Engineering at ratio of one share for two of Consolidated. Offering price is to be $3.50 per share. Proceeds will be used to repay all working capital advances made by Consolidated. They amounted to $256,573 in March. Balance will be added to working capital and used for further development of the business.

Arcturus Electronics filed with SEC covering 100,000 shares of class A common (par one cent) to be offered at the market price. Proceeds are to go to D. E. Replogle, president of the company.

Setmakers Push Portable Sales

More personal radios are being made as radio size decreases; sales increase

RADIO for every person seems to be the aim of some manufacturers this year as the portable radio season gets underway. Newer, smaller models have been introduced and sales of the sets are expected to represent a larger part of total radio output this year.



▶ **Trend**—As shown in the chart, 1953 was the biggest year production-wise of the past five years for portables. Approximately 1.7 million sets were produced representing 13 percent of total radio production, compared to 12 percent in 1952.

In 1953, the percentages taken by each type of radio receiver were: auto, 39; home, 33; clock, 15 and portable, 13. Gains made in the portable field seem to have been made at the expense of home radio production which showed a sharp decrease compared to 1952 output.

▶ **Seasons**—April through June were the big production months for portables last year when nearly 38 percent of total output was produced. In the last 3 months 22 persent were made. In 1952, second quarter production accounted for 32 percent of total portable output while output in the last 3 months of the year represented 38 per cent of the total production. Thus, depending on the size of the Christmas rush, the second and sometimes the fourth quarter of the year are the big production seasons for the product.

▶ **Future**—Total portable radio production for the first quarter of this year is off compared to last year but manufacturers aren't too concerned. Many have scheduled heavy portable promotions and are counting on substantial sales to the graduation-wedding-vacation markets.

Of the new portable models, the smallest announced so far is Emerson's laboratory model that measures ¾ of an inch deep, 3 inches high and 3½ inches wide. It uses 4 subminiature tubes and both printed and etched-metal circuitry. Special core materials are used to reduce the size of the intermediate frequency coils, oscillator coils and output transformer.

The next step that may take place this year is the commercial introduction of a transistorized portable. Many of the components necessary for such a set are available now. GE has demonstrated an experimental vest pocket portable radio, weighing about 5 oz., that uses transistors and diodes and is powered by two penlight cells. Raytheon has also shown an all-transistor experimental receiver that may be marketed in 1955.

More TV Sets Work on Arrival

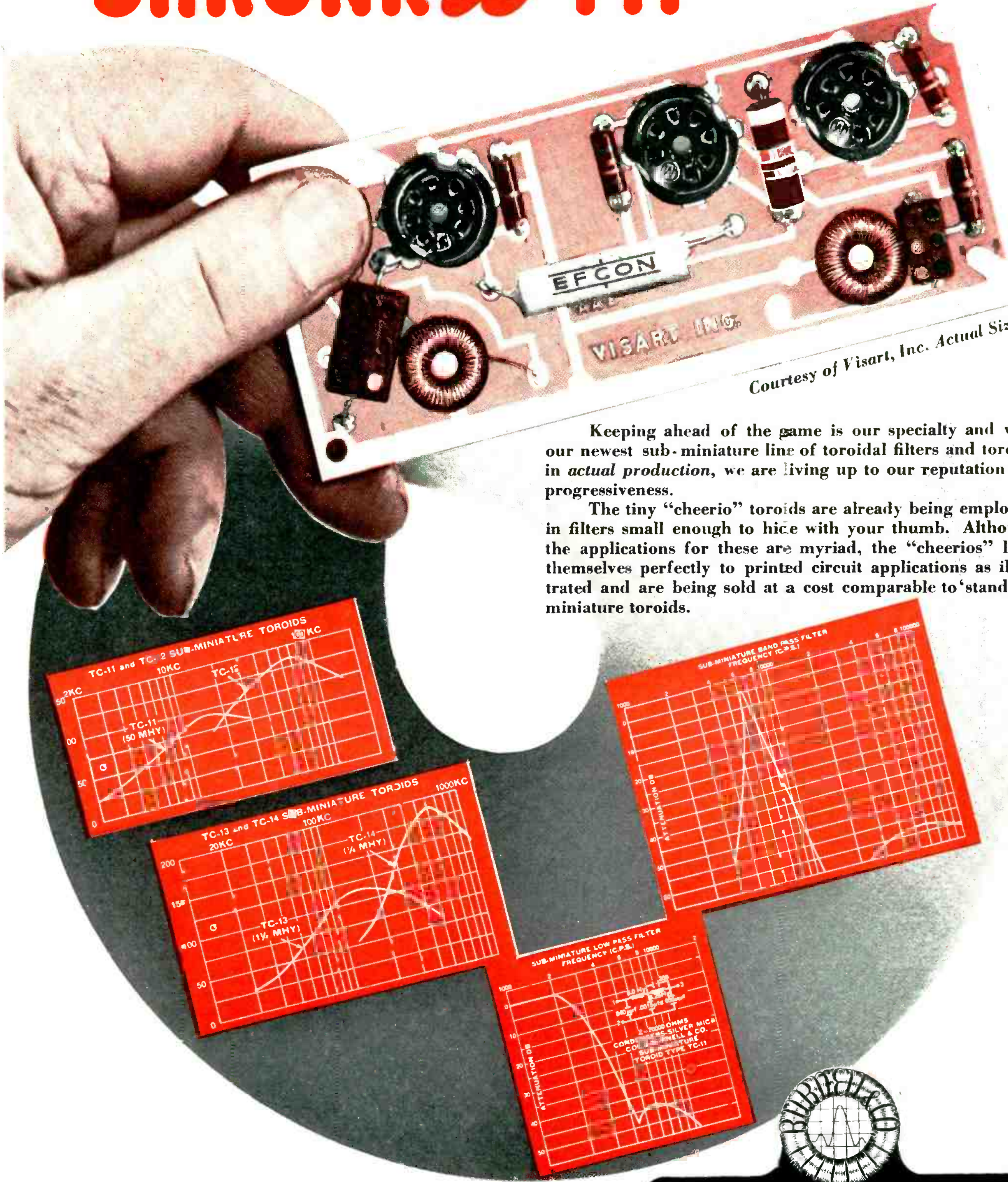
Only 15 percent fail to work when plugged in; small tubes are still biggest headache

CHANCES are about 85 in 100 today that a television set taken out of its sealed carton and installed in a home will work satisfactorily. In contrast, the odds five years ago were around 50-50, and on some makes and models practically every set required the attention of a

(Continued on page 22)

Burnell TOROIDS and FILTERS

"SHRUNK *to* FIT"



Courtesy of Visart, Inc. Actual Size

Keeping ahead of the game is our specialty and with our newest sub-miniature line of toroidal filters and toroids in *actual production*, we are living up to our reputation for progressiveness.

The tiny "cheerio" toroids are already being employed in filters small enough to hide with your thumb. Although the applications for these are myriad, the "cheerios" lend themselves perfectly to printed circuit applications as illustrated and are being sold at a cost comparable to 'standard' miniature toroids.

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serviceman for installation.

▶ **Today's Troubles**—Miniature tubes that go bad mechanically or electrically are responsible for about half of in-the-carton troubles. Here the situation is stalemated by the economics of low-priced sets and the resultant squeeze on components and tube prices.

The other 7½ percent of in-the-carton troubles are many and varied, with no single one standing out and with the pattern changing daily. Some problems are sockets that allow miniature tubes to pop out during shipment, shifting of single-spring ion traps, components that fail en route, rosin joints, parts placement resulting in shorts, and cabinet damage.

▶ **Yesterday's troubles**—Most important factor in making sets withstand transit is development of improved deflection system mountings, capable of holding the deflection yoke and focus coil or magnet in precisely the positions at which they were set at the factory. Equally significant is the increased stature of quality control departments throughout the industry, associated with absolute authority to shut down a line that's turning out too many lemons.

Radio-tv Is Big Business For Magnet Makers

Electronic products represent largest market; new magnets to appear

MANUFACTURERS of electronic gear have long been the chief customers for permanent magnet makers. Each year the industry takes 50 to 70 percent of p-m output. Sales are estimated at $10 million for last year.

Loudspeakers have used the most magnets, followed by c-r tubes, magnetrons, meters and instruments. Next important use is in toys and novelties.

▶ **Ceramics**—Nearly every major magnet maker is experimenting with ceramic-type magnets but at present only two companies have them available commercially. According to one ceramic magnet maker, the new material would make the product 35 to 40 percent lower in cost than alnico 5. There are still production problems with the new material however and most magnet firms do not expect volume output in the near future.

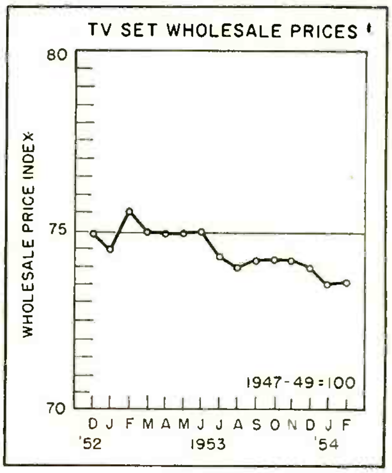
Coming applications of the new ceramic magnets are seen centering around its unusual properties. Its high coercive force makes it suitable for use as a focusing medium on crt's and travelingwave tubes. The material is practically a nonconductor so that it could be used for the purpose of rotation of the plane of polarization and for beam focusing or deflection.

▶ **Future**—Magnet makers are keeping pace with the developments of the electronics industry. Carboloy, for example, says it has magnet materials under development that are 10 times more powerful than any now in existence. Other companies doing military work also see new developments coming.

TV Prices Skid To New Low

January and February wholesale price index shows declining price trend

LOWER level of tv set prices is evident in the Labor Department's wholesale tv price index. In the first two months of this year the index stood at 73.5 and 73.6 respectively, the lowest levels of the past 14 months. The term "wholesale" as used with the index refers to sales in large lots and prices paid for the products in the first important commercial transaction.



As indicated by the index, factory prices for tv sets are more than 25 percent lower than they were in the 1947-1949 period of the business, a substantial drop in five years that is not duplicated by any other product in household durables except radios which dropped about 5 percent in price since the 1947-49 period. All other household durables are higher priced than they were five years ago, according to the index.

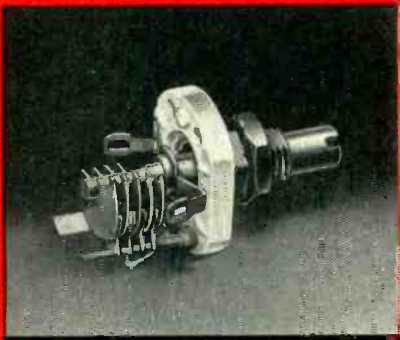
▶ **Why**—Several factors have been responsible for the recent decline in tv prices as indicated by the wholesale price index. Chief among these are the new lower priced models that have been brought out recently along with price reductions on current sets.

Emerson reports that its tv sales for January and February were up 31 percent over last year and attributes the increase to the company's heavy concentration on low-cost table models. The introduction of high-priced color sets is credited with aiding sales of low-cost monochrome receivers. Crosley, which recently introduced a $139.95 17-inch table model that uses a vertical chassis design, reports highly successful sales and predicts that compact light-weight and moderate-priced tv sets will account for the bulk of black and white sales in less than a year.

▶ **Color**—Price drops have even extended to the color field. Westinghouse has cut the suggested retail price of its 15-inch color set from $1,295 to $1,110. Admiral dropped its color set price to $1,000 bringing it in line with GE and RCA

(Continued on page 24)

To help you meet the Tolerance Squeeze



Miniature "MAC" Variable Capacitor

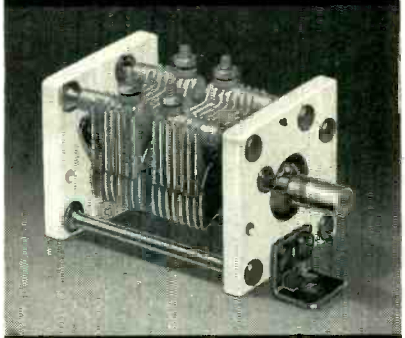
QUALITY CAPACITORS BUILT BY HAMMARLUND

Performance requirements for electronic products — commercial, industrial and military — are becoming more difficult to meet. Specifications call for the finest quality components available to fulfill exacting equipment tolerances.

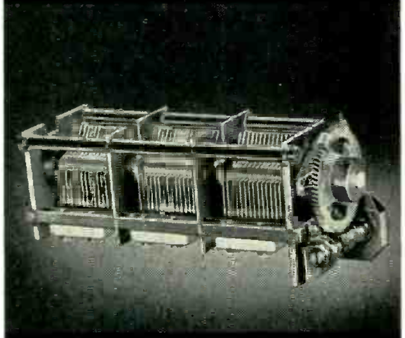
Hammarlund variable capacitors have been designed and built for more than 25 years to meet the most demanding of requirements. Check the general characteristics of these outstanding variables:

- Rotor and stator plates of brass stock soldered, *not staked*, to their supports to permanently insure perfect contact and prevent loosening of plates.
- Stator supports soldered into eyelets assembled to steatite insulators.
- Terminals hot-tinned for ease in soldering.
- Insulators of low-loss steatite, impregnated with DC 200 silicone fluid to prevent absorption of moisture.
- Rotor and stator assemblies nickel or silver-plated.
- Rotor contact springs of beryllium copper or phosphor bronze, and nickel or silver-plated.
- Precision soldering fixtures and assembly jigs used in fabricating to assure absolute uniformity of plate spacing.

These are basic reasons why Hammarlund capacitors should be used where highest dependability is required. Convince yourself in your engineering models and you will specify them for production.



"VU" Capacitor For Up to 500 Mc



Special 3-Gang Precision Capacitor

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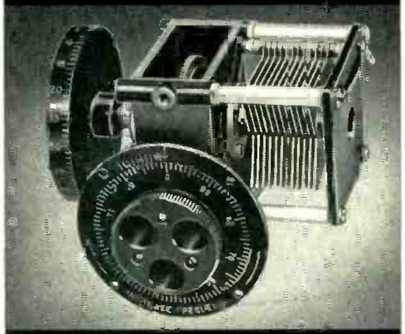

Precision Frequency Meter Capacitor

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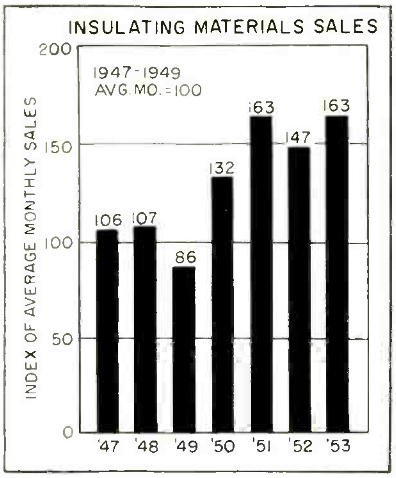
color receivers.

Reduction in the cost of color tube components has also been made. Effective April 15, the grid component for 21-inch rectangular Lawrence tubes will be reduced by $25 to a price of $125.

Insulation Sales Maintain Volume



DESPITE lower sales in the last quarter of 1953, the average monthly dollar sales billed by electrical insulating materials makers in 1953 were 17 percent higher than in 1952.

Sales last year were almost identical with those billed in 1951, the peak year for the industry. Components that make up the NEMA index include: laminated products, manufactured electrical mica, special dry process electrical porcelain, varnished fabric and paper, vulcanized fiber, varnished tubing and sleeving.

MEETINGS

MAY 3–6: Spring Technical Meeting sponsored by URSI and IRE, National Bureau of Standards Bldg., Washington, D. C.

MAY 3–7: 75th Semi-annual SMPTE Convention, Hotel Statler, Wash. D. C.

MAY 3–14: The British Industries Fair, London and Birmingham, England.

MAY 4–6: The 1954 Electronics Components Symposium, Department of Interior auditorium, Washington, D. C.

MAY 5–7: AIEE North Eastern District Meeting, Van Curler Hotel, Schenectady, N. Y.

MAY 5–7: 1954: Third International Aviation Trade Show, 71st Regiment Armory, New York, N. Y.

MAY 5–7: IRE Seventh Region Conference & Electronic Exhibit, Multnomah Hotel, Portland, Oregon.

MAY 6–8: Eighth Annual Armed Forces Communications Association Convention, Shoreham Hotel, Washington, D. C.

MAY 7–8: New England Radio Engineering Meeting, IRE, Sheraton Plaza Hotel, Boston, Mass.

MAY 10–12: The National Conference On Airborne Electronics, Dayton Biltmore Hotel, Dayton, Ohio.

MAY 17–20: 1954 Electronic Parts show, Conrad Hilton Hotel, Chicago, Ill.

MAY 24–26, 1954: IRE, IAS, ISA, AIEE Conference On Telemetering, Morrison Hotel, Chicago, Ill.

MAY 25–27: Eighth NARTB Broadcast Engineering Conference, Palmer House, Chicago, Ill.

JUNE 21–25: Summer and Pacific General Meeting, AIEE, Hotel Biltmore, Los Angeles.

JUNE 23–25: First Symposium on Global Communications, IRE, Washington, D. C.

JULY 16–18: High Vacuum Symposium, Committee On Vacuum Techniques, Berkeley Carteret Hotel, Asbury Park, N. J.

JULY 6–9, 1954: International Conference on Electron Microscopy, Joint Commission on Electron Microscopy of International Council of Scientific Unions, London, England.

JULY 8–12: British IRE 1954 Convention, Christ Church, Oxford, England.

AUG. 24–SEPT. 4: National Radio Show of Great Britain, Earls Court, London, England.

AUG. 25–27: 1954 Western Electronic Show & Convention, Los Angeles, Calif.

SEPT. 1–16: Golden Jubilee Meeting of the International Electrotechnical Commission, University of Pennsylvania, Philadelphia, Pa.

SEPT. 2–8: Scottish Industries Exhibition, Kelvin Hall, Glasgow, Scotland.

SEPT. 13–24: 1954: First International Instrument Congress And Exposition, Commercial Museum and Convention Hall, Philadelphia, Pa.

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

SEPT. 1954: International Scientific Radio Union, Amsterdam, Netherlands.

SEPT. 30–OCT. 2, 1954: Second Annual International Sight and Sound Exposition, Palmer House Hotel, Chicago, Ill.

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

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

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

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

Industry Shorts

▶ **Royalty-free** use of transistors has been granted by Western Electric to the hearing aid industry.

▶ **Final** attendance figures for the 1954 IRE Convention totalled 40,108 registrations, compared to 35,642 last year.

▶ **Britain's** newest tv station is to be built underground beneath the site of the old Crystal Palace.

▶ **Sales** of tv sets in Britain in January were the lowest recorded for that month since 1949, according to the British Radio and Television Retailer's Association.

▶ **Over** 1,000 AMF bowling-pin spotters were produced in 1953 and output of 3,000 is scheduled for this year. (See ELECTRONICS, p 148, June, 1953)

▶ **Questionnaire** to be sent by FCC to 25,000 licensees holding 50,000 grants authorizing installation of more than 350,000 mobile transmitters will determine actual usage of the land-mobile services.

▶ **Guided Missile** test range stations near Cocoa, Florida and on Grand Bahama Island, British West Indies, employ about 4,000 Air Force personnel and 1,700 civilians.

▶ **West German** production of tv sets for 1953 totaled 54,475 units of which 28,400 were built in the last quarter of the year.

▶ **Alpha Poppy** is the name of a new GE radiation detector designed to check work areas and clothing for sources of alpha radiation.

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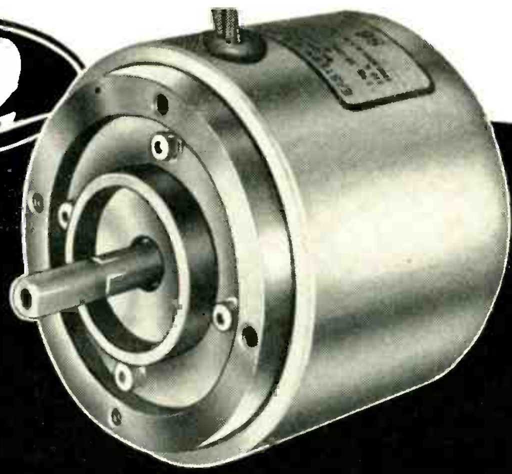
sine wave alternators give you less than 2% distortion!



Whether your needs are for an extremely pure sine wave voltage or for appreciable power output, EAD will make an alternator tailored to your requirements. Models are available from 30 to 1000 cps at voltages from 6 to 115 volts and in a wide range of frame sizes.

DUAL OUTPUT UNITS AVAILABLE WITH PHASE ANGLE OF ANY SPECIFIED VALUE HELD TO 1° OR BETTER

In addition to standard single frequency types, forms can be made with two separate outputs of either the same or integrally related frequencies. Phase angles between these two output waves can be held to extremely close tolerances.

Eastern Air Devices is a pioneer in the field of small permanent magnet alternators. No matter what your requirements may be, check with EAD first!

FEATURES

1. **Low Distortion:** Less than 2% distortion of open circuit voltage wave even in smallest sizes.
2. **Dual Frequency:** Models available with two separate, yet integrally related, output frequencies. Phase angle between two outputs can be any specified value.
3. **Wide Size Range:** Compact design. Models available in sizes as small as 1 inch in diameter.
4. **High Power Output:** Several hundred watts available in larger models where distortion is not critical.
5. **Military Specifications:** EAD alternators can be manufactured to meet the most exacting military specifications.

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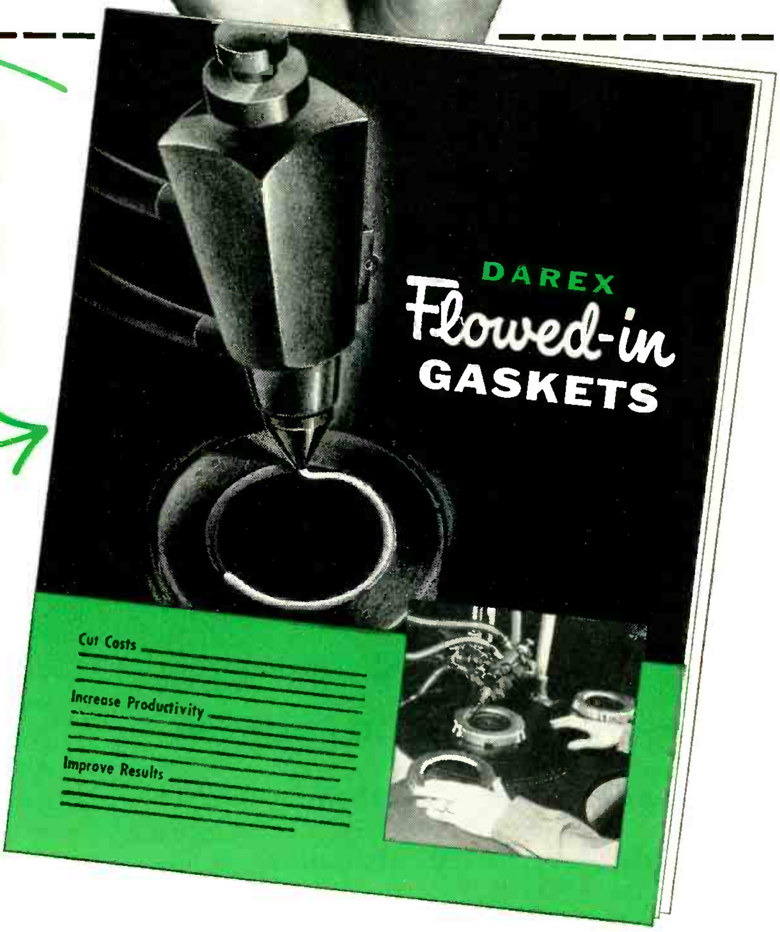
387 CENTRAL AVENUE—DOVER, NEW HAMPSHIRE

This FREE BOOK CAN HELP YOU CUT COSTS!



There's something new in electronics this year . . .

IT'S THE DAREX Flowed-in GASKET PROCESS!

And this fact-filled brochure gives you the whole Flowed-in Gasket Story. Here are a few samples of the things you'll read in this informative new book:

ABOUT COSTS

Using the DAREX Flowed-in Gasket Process, a major electronics manufacturer is saving $50,000 per year in labor and materials on a single gasketing operation. As a result of this striking cost reduction, the firm has recommended the DAREX Process for several more gasketing operations.

ABOUT THE PROCESS

The Flowed-in Gasket Process is a new application of a method of sealing developed by Dewey and Almy researchers over 30 years ago, and successfully used in food container manufacture ever since.

The DAREX Flowed-in Gasket Process is more than a sealing compound . . . more than a machine . . . more than an engineering service . . . *it's a complete Process!* So when you switch to Flowed-in Gaskets, you get all three.

Compounds—Over 800 formulations available to meet most needs. Or Dewey and Almy chemists will develop a "job-tailored" compound for you.

Machines—To apply the compound, Dewey and Almy designs and builds machines based on more than 30 years' field experience.

Service—Every machine is precisely adjusted to your specifications before it leaves the shop. When it arrives, a Dewey and Almy Engineer is on hand to install and adjust the machine. Then he trains your operators to full proficiency. And whenever you need him, the Dewey and Almy Man is at your service.

DEWEY and ALMY
Chemical Company
Cambridge 40, Mass.

Offices or subsidiaries in Buenos Aires, Chicago, Copenhagen, London, Melbourne, Milan, Montevideo, Montreal, Naples, Paris, San Leandro (Calif.), Sao Paulo, Tokyo.

Discover what DAREX "Flowed-in" GASKETS can do for YOU

MAIL THE COUPON TODAY!

DEWEY and ALMY Chemical Company
Dept. E
Cambridge 40, Mass.

Please send me the new DAREX Flowed-in GASKET Book.

Name ....

Firm ....

Street ....

City .... State ....

Want more information? Use post card on last page.

Announcing...

10 cps to

-hp- 400D VACUUM TUBE

Finest -hp- voltmeter built—successor to

10 cps to 4 mc

Accurate within 2% to 1 mc

0.1 millivolt to 300 volts

Input impedance 10 megohms

Reads directly in dbm

High sensitivity, stability

Light, small, portable

We believe the *-hp-* 400D is the finest vacuum tube voltmeter offered today. It is the best we have ever built, and we feel sure you will find it the most accurate, dependable and broadly useful voltmeter you have ever used.

The 400D is a completely new instrument, combining features never before available in one voltmeter with time-tested conveniences of the 400C.

Frequency coverage is twice that of the 400C, and accuracy is materially improved. The 400D has a new amplifier providing approximately 56 db of feedback in mid-range. This assures highest stability and freedom from calibration change due to external conditions.

Input impedance is 10 megohms, assuring that circuits under test are very lightly loaded. New output circuitry makes possible the use of the instrument as a broad band, high gain amplifier over the full frequency range.

Model 400D is protected against overloads as great as 600 volts on all ranges. Its indicating meter is a special 1%, 1 milliampere instrument with a 4″ scale and knife-edge pointer. All coupling and bypass condensers are sealed, and electrolytic condensers are long-life type designed for more than ten years of trouble-free service. Circuitry and mechanical layout are particularly clean and provide ready access to all parts. A new, compact, streamlined metal case insures handling ease and occupies minimum bench space. Fold-out front legs tilt the instrument for more convenient reading when desired.

SIMPLE OPERATION

-hp- instruments are noted for their simple operation; *-hp-* 400D is particularly easy to use. Ranges are quickly selected on a front panel switch which changes sensitivity in precise 10 db steps. This, plus calibration of the meter in db, means direct readings are available without calculation or conversion, between —72 dbm and +52 dbm. (0 dbm = 1 mw in 600 ohms.) Meter voltage scales are arranged in multiples of 1, 3, 10, 30, etc., so that readings are always in the upper two-thirds of the scale—where maximum accuracy is obtained. Further, a new circuit virtually eliminates switching transients.

COMPLETE COVERAGE | HEWLETT-PACKARD

VOLTMETER 4 mc

10,000 -hp- 400C'S!

NEW BROAD USEFULNESS

Its speed, accuracy and versatility permit the 400D to be used for measuring amplifier gain, network response, output level, and almost all audio and rf voltages as well as video and TV voltages. In many instances, the voltmeter will also measure hum and noise directly besides determining power circuit and broadcast high frequency voltages. It further serves as an audio level meter, a high gain broad band amplifier; it detects nulls, monitors waveforms (in conjunction with an oscilloscope) and measures coil "Q," capacity and resistance.

For Complete Details, See Your -hp- Representative or Write Direct

HEWLETT-PACKARD COMPANY
3033A Page Mill Road • Palo Alto, California, U.S.A.
Field representatives in all principal areas

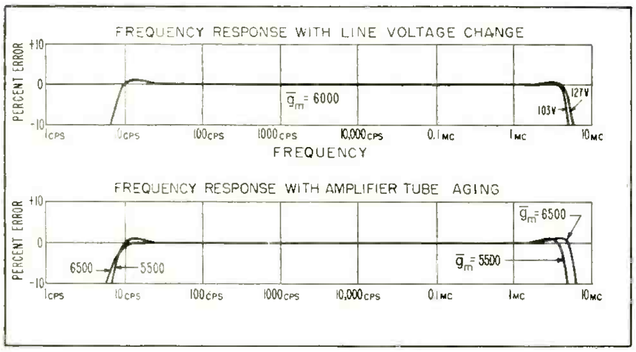


Fig. 1. Typical variation in accuracy with line voltage changes and mutual conductance changes (geometric mean value of the four amplifier tubes).

SPECIFICATIONS

Voltage Range: 0.1 millivolt to 300 volts. 12 ranges, front panel switch. Full scale readings from 0.001 to 300 volts.

0.001	0.03	1	30
0.003	0.1	3	100
0.01	0.3	10	300 volts.

Frequency Range: 10 cps to 4 megacycles.

Accuracy: With line voltages of ±10% (103 volts to 127 volts), overall accuracy is ±2% of full scale, 20 cps to 1 mc; ±3% of full scale, 20 cps to 2 mc; ±5% of full scale, 10 cps to 4 mc.

Long Term Stability: Reduction in Gm of amplifier tubes to 75% of nominal value results in error of less than 0.5%, 20 cps to 1 mc.

Calibration: Reads r.m.s. value of sine wave. Voltage indication proportional to average value of applied wave. Linear voltage scales, 0 to 3 and 0 to 10; db scale, —12 db to + 2 db, based on 0 dbm = 1 mw in 600 ohms, 10 db intervals between ranges.

Input Impedance: 10 megohms shunted by 15 μμfd on ranges 1 to 300 volts; 25 μμfd on ranges 0.001 to 0.3 volts.

Amplifier: Output terminals are provided so voltmeter can be used to amplify small signals or to monitor waveforms under test with an oscilloscope. Output approximately 0.15 volts r.m.s. corresponding to full-scale meter deflection. Internal impedance, 50 ohms. Gain approximately 150 for 0.001 volt range.

Power Supply: 115/230 volts ±10%, 50/1,000 cps, 70 watts.

Size: Cabinet, 10¾" high, 7" wide, 10½" deep. Rack mounting on 19" x 7" panel available at $10.00 additional.

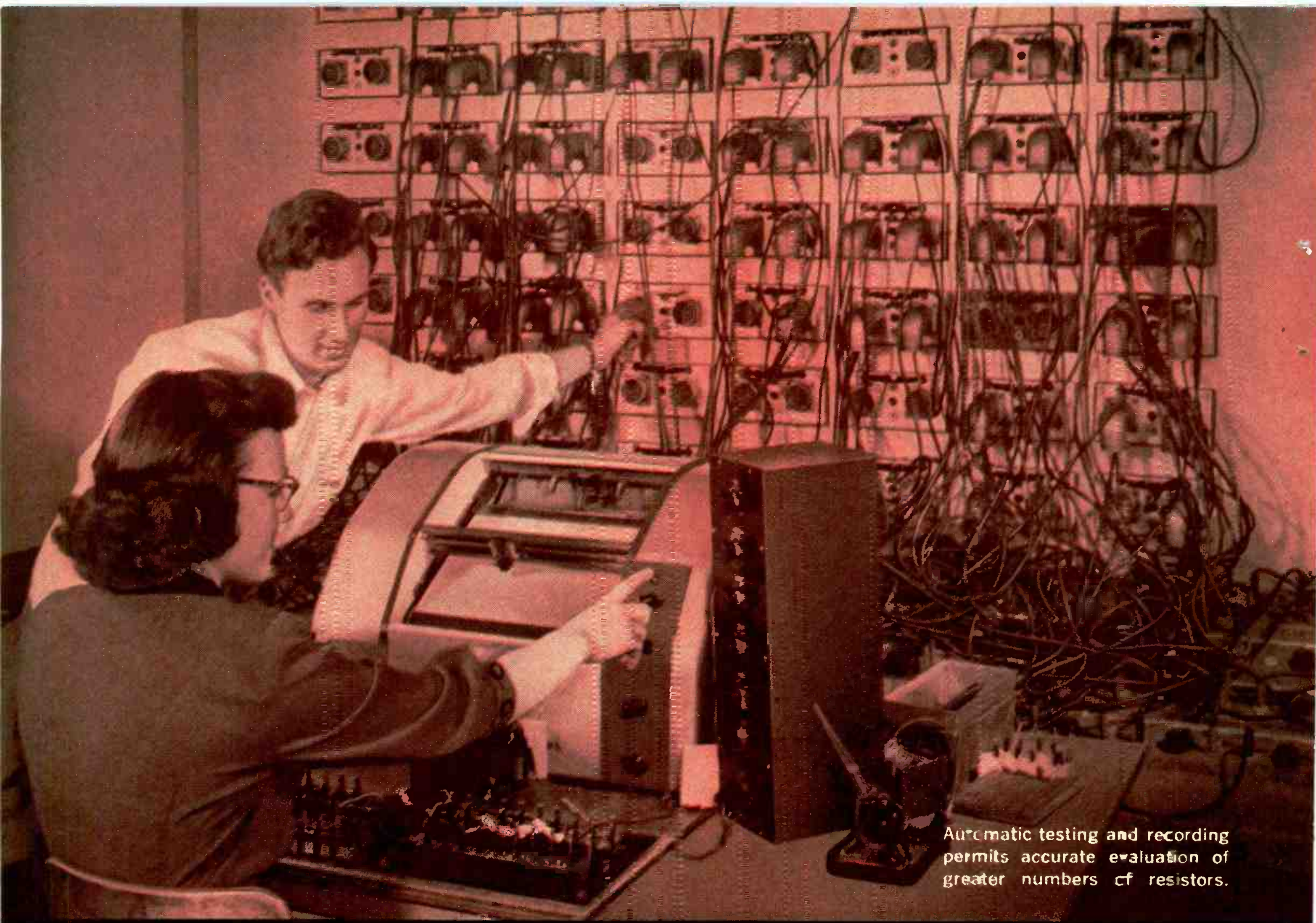
Weight: 19 lbs.; shipping weight, approximately 24 lbs.

Price: $225.00 f.o.b. Palo Alto, California.

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

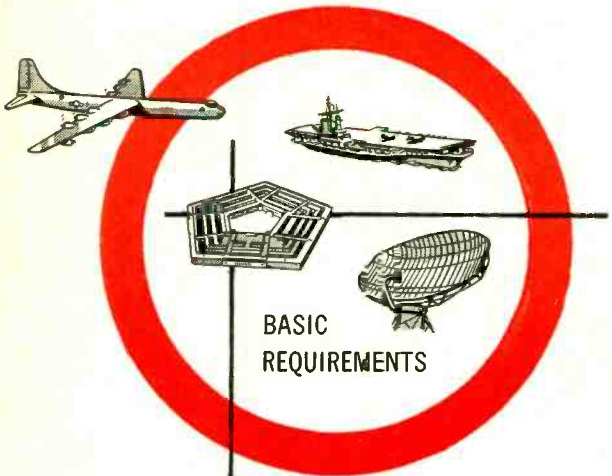
-hp- INSTRUMENTS | COMPLETE COVERAGE

Want more information? Use post card on last page.



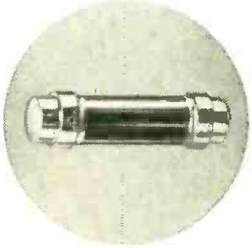
Automatic testing and recording permits accurate evaluation of greater numbers of resistors.

ONLY IRC MAKES SO MANY JAN AND



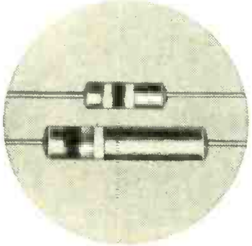
JAN and MIL Specifications are basic guideposts for electronic advancement, whether used as engineering reference points or as procurement standards. IRC's dual emphasis on mass production and frequent, accurate performance testing assures you of the highest performance standards at the lowest possible cost.

56 different IRC resistors is today's figure—all equivalent to JAN or MIL specifications. And all are standard units, available on excellent delivery cycle! If you manufacture end-equipment for the armed forces and must meet these specifications, or if you apply them as standards to your own requirements, depend on IRC for everything you need. For, manufacturing the widest line of resistors in the industry—127 different types in all—IRC is logically your best source of JAN and MIL type units.



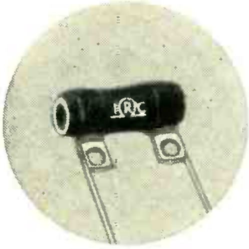
JAN-R-29 *specification*

For all requirements of JAN-R-29 Specification, Amendment 4, IRC sealed precision Voltmeter Multipliers function efficiently even when exposed to the most severe humidity. Used with 1-milliampere DC instruments, they enable voltage measurements to be made up to 6000 volts. Send for Bulletin.



JAN-R-184 *specification*

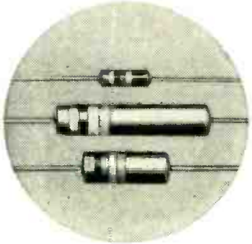
Unusually stable and inexpensive, IRC BW Wire Wounds meet JAN-R-184 Specification, Amendment 5, at ½ and 1 watt. Resistance element is uniformly and tightly wound on insulated core. Molded housing provides full insulation. Widely used in meters, analyzers, high stability attenuators, low-power ignition circuits, etc. Send for Bulletin.



MIL-R-26B *specification*

For high power dissipation, IRC Power Wire Wounds meet every commercial requirement of MIL-R-26B Specification, Characteristic G. Tubular, flat, fixed, adjustable, inductive, non-inductive, lead, lug and ferrule types provide resistors for virtually any circuit. From 5 to 225 watts. Send for Bulletin.

MIL TYPE RESISTORS



MIL-R-11A *specification*

IRC Advanced BT Resistors meet and beat MIL-R-11A Specification, Amendment 2. Filament-type resistance element and other exclusive features afford extremely low operating temperature and superior power dissipation in a compact, light, fully insulated unit. Available at ¼, ½ and 1 watt to MIL specification and 2 watts to commercial specification. Send for Bulletin.

NEW *product*

HERMETIC *sealing terminal*

Overcomes limitations of other types of hermetic sealing terminals.

Molded KEL-F* body—chemically inert to organic solvents, acids, oils, fumes.

Rugged construction—tough and resilient; withstands constant vibration.

Type HS-1 Feed-Thru Terminals, provide assured hermetic sealing for electrical and electronic components. Exclusive IRC molding Technique bonds Kel-F* to metal in a superior seal. Designed to the sealing requirements of MIL-T-27. Send coupon for full data

*Trademark—M. W. KELLOGG CO.

Boron & Deposited Carbon Precistors • Power Resistors • Voltmeter Multipliers • Low Wattage Wire Wounds • Insulated Composition Resistors • Volume Controls •

Wherever the Circuit Says

Precision Wire Wounds • Ultra HF and Hi-Voltage Resistors • Selenium Rectifers • Insulated Chokes • Hermetic Sealing Terminals •

IRC

INTERNATIONAL RESISTANCE CO.

403 N. Broad St., Philadelphia 8, Pa.

In Canada: International Resistance Co., Ltd., Toronto, Licensee

Send me data on ☐ MF Voltmeter Multipliers, ☐ BW Resistors, ☐ Power Wire Wounds, ☐ Advanced BT Resistors, ☐ HS-1 Terminals.

Name__________

Title__________

Company__________

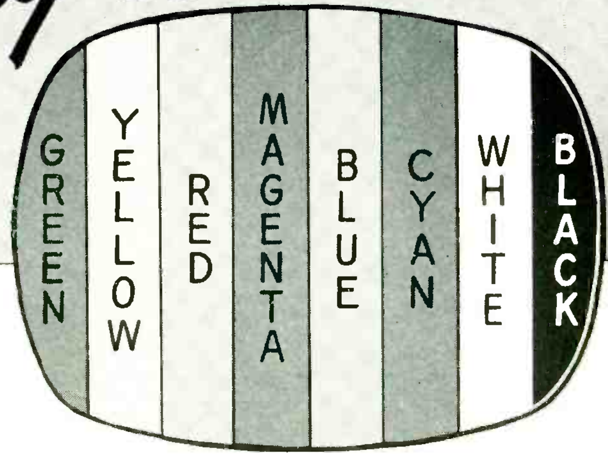
Address__________

City__________ Zone_____ State_____

TWO NEW INSTRUMENTS FOR PRODUCING

Full fidelity color

NTSC STANDARD COLORS



1. with
The MODEL MULTI-CHROME
CHROMABAR Multiple Color Bar Generator

features . . .

- No critical circuits to adjust.
- NTSC Standard Colors: Green, Yellow, Red, Magenta, Blue, Cyan, White and Black.
- No other equipment needed to produce colors on Color TV receivers.
- Includes crystal controlled color sub-carrier and built-in horizontal sync generator.
- Can be used to modulate the single or multi-channel Mega-Pix for overall checking of color receivers.
- Self-contained power supply. Designed for engineering, production and service.

2. with the MODEL UNI-CHROME
CHROMABAR Has All Above Features Except Colors Are Presented Singly. $395.00

(2) The Model Uni-Chrome Chromabar

Write for details, including information on convergence checking

(1) The Model Multi-Chrome Chromabar

Specifications . . .

OUTPUT:

Signal: All 6 NTSC standard colors plus black and white simultaneously at video frequency.

Polarity: Positive and Negative.

Amplitude: Continuously variable to maximum of 1.4 volts, peak-to-peak into 75 ohm load. Higher levels across higher impedances.

Power Supply: 117 v. ±10%, 50 to 60 cps. Power for all circuits electronically regulated.

Price: $795.00, f.o.b. Pine Brook, N. J.

KAY

KAY ELECTRIC COMPANY

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

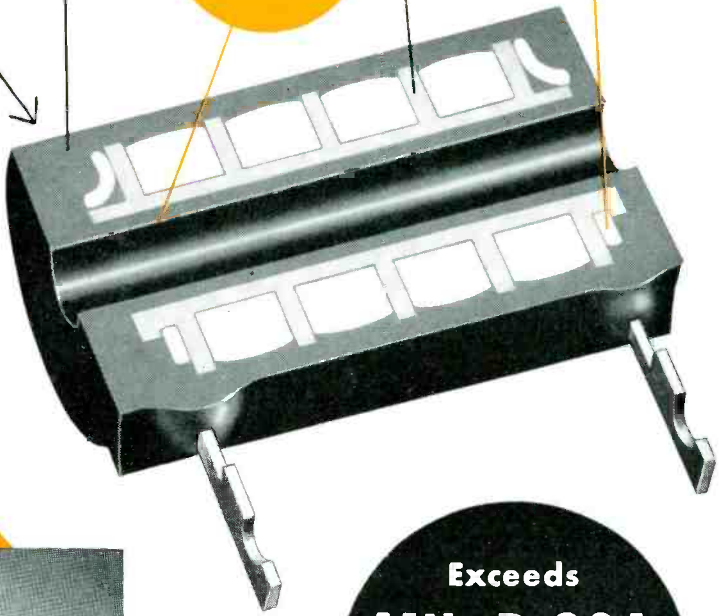
NEW!

Ohmite-compounded, special resin encloses *all parts*. Its coefficient of expansion closely matches that of bobbin, wire, and terminals.

Rigid steatite bobbin keeps pie windings in place.

Resistance wire welded to terminals insures perfect connections.

Bobbin is *completely* encapsulated — ends and even center hole.



OHMITE®

Proudly announces the

RITEOHM®

***completely* encapsulated**

precision resistor

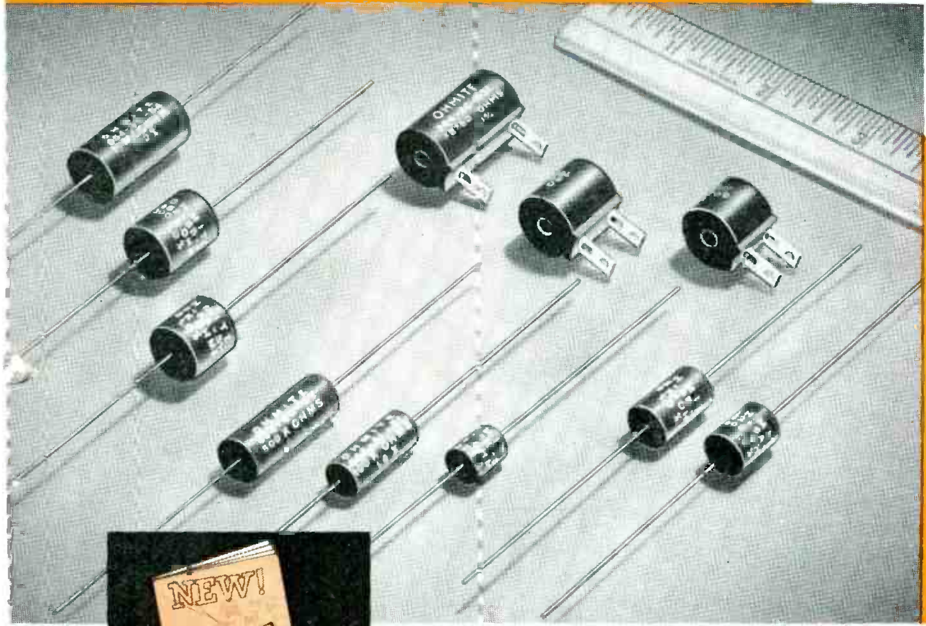
type 85 and 86

Exceeds

MIL-R-93A

Amendment 2

at 125°C ambient



Now . . . a new Ohmite encapsulated, wirewound, precision resistor, designed to provide absolute stability. Winding is protected against moisture or mechanical damage by a rigid steatite bobbin encapsulated in Ohmite-compounded, special resin. Resistance wire is welded to terminals. Axial-lead and lug types, in sizes from ¼ to 1 watt (125° C ambient) in a wide range of resistance values. Tolerances to ± 0.1%.

Write for New Descriptive Bulletin

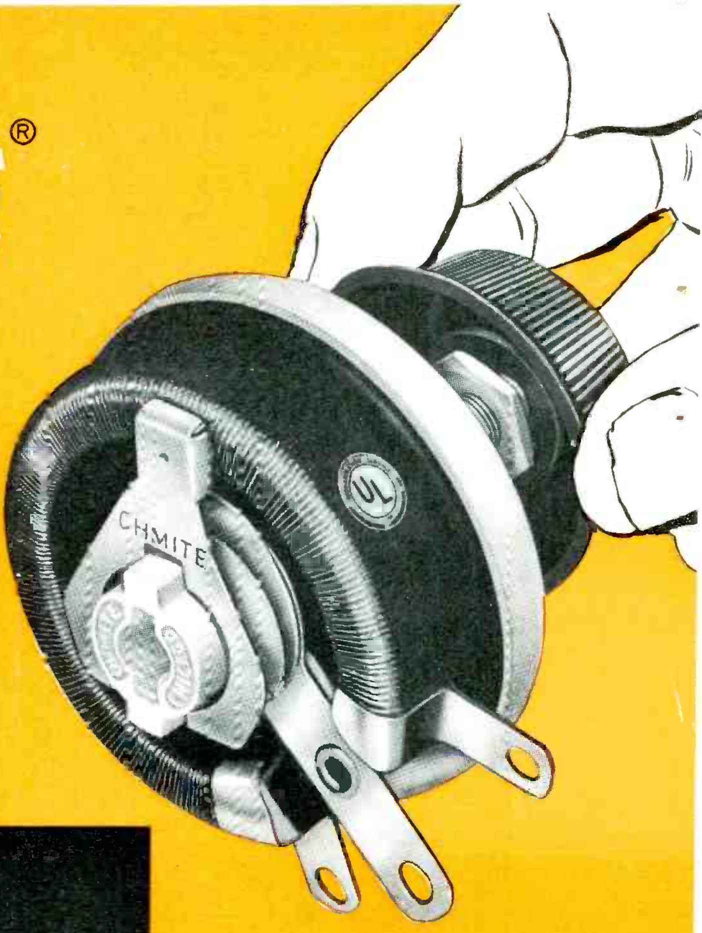
Be Right with **OHMITE**

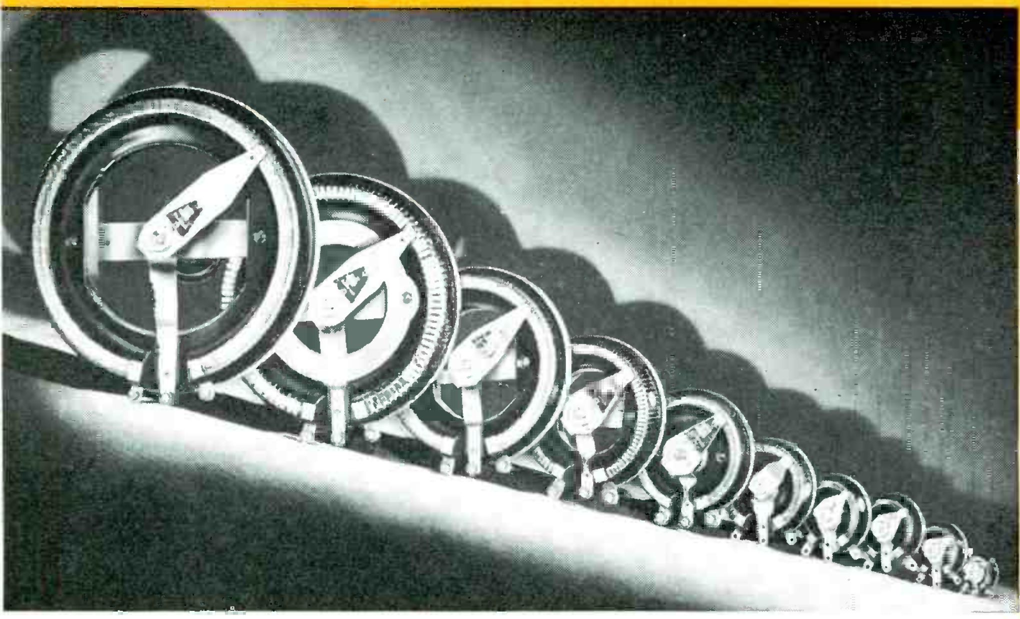
RHEOSTATS
RESISTORS
TAP SWITCHES

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

OHMITE®

The ONLY Complete Line of
RHEOSTATS
meeting the requirements of
MIL-R-22A





OHMITE MODEL	TYPE	WATT RATING	ENCLOSED	"OFF" POSITION
H	RP101	25	NO	NO
	RP102		NO	YES
	RP103		NO	YES
	RP111		YES	NO
	RP112		YES	YES
	RP113		YES	YES
J	RP151	50	NO	NO
	RP152		NO	YES
	RP153		NO	YES
	RP161		YES	NO
	RP162		YES	YES
	RP163		YES	YES
G	RP201	75	NO	NO
	RP202		NO	YES
	RP203		NO	YES
K	RP251	100	NO	NO
	RP252		NO	YES
	RP253		NO	YES
L	RP301	150	NO	NO
	RP302		NO	YES
	RP303		NO	YES
P	RP351	225	NO	NO
N	RP401	300	NO	NO
R	RP451	500	NO	NO
T	RP501	750	NO	NO
U	RP551	1000	NO	NO

Ohmite can furnish rheostats in *every* one of the 26 type designations to meet the requirements of MIL-R-22A. By standardizing on Ohmite rheostats, you can cover all of your needs for both civilian and government jobs and, at the same time, give your customers the utmost in rheostat performance. Ohmite rheostats have proved their dependability in meeting the severe requirements of MIL-R-22A . . . the 5-hour vibration test, 50-hour salt-spray corrosion test, 150-hour 95% humidity electrolysis test . . . and others. Their all-ceramic construction . . . uniform windings locked in place by vitreous enamel . . . smoothly gliding, metal-graphite brush . . . insure close control and years of trouble-free service. It will pay you to standardize on Ohmite rheostats for your products.

OHMITE MANUFACTURING CO., 3610 Howard St., Skokie, Illinois (Suburb of Chicago)

OHMITE

RHEOSTATS • RESISTORS
TAP SWITCHES

Today's most modern design for complete pulse analysis... *with* HIGH VOLTAGE

The new Du Mont Type 329, in addition to the most advanced circuitry for full signal analysis, provides the high accelerating potential — provides the high pattern brilliance required for viewing rapidly rising wave fronts of low repetition rate and high speed single transients. Moreover with such features as the d-c amplification, and sweeps extending down to 4 seconds duration the Type 329 is ideally suited for the entire range of general laboratory applications, including even low-frequency, mechanical investigations.

All operating voltages are electronically regulated to provide unchanging sensitivity necessary for accurate pulse measurements.

High-level, linear sweeps, driving the most distortion-free cathode-ray tube yet made (see box below) assure precision of signal measurements.

Precision attenuators. plus the low-drift, stable, regulated d-c amplifier provide accurate amplitude measuring capabilities.

Wide-range undistorted deflection of the Y-amplifier allows greatly expanded portions of signals to be positioned on screen for measurement.

Calibrated sweep expansion and delay are provided in the new Du Mont Notch Sweep. This feature permits any 5% of the pattern, such as pulse rise time, to be expanded precisely ten times while the remainder of the signal is displayed unexpanded and thus may be easily related to the expanded portion.

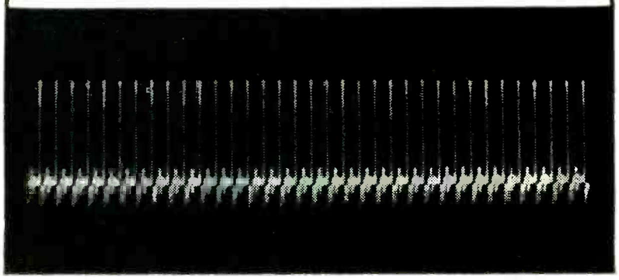
The latest circuit techniques and most advanced cathode-ray-tube design have been combined to make the Type 329 a truly modern, versatile high-frequency cathode-ray oscillograph. We invite your detailed examination of this fine instrument.

For full specifications or demonstration write to:

Technical Sales Department
ALLEN B. DU MONT LABORATORIES, INC.
760 Bloomfield Ave., Clifton, N. J.

TYPE 5ATP-
MONO-ACCELERATOR CATHODE-RAY TUBE

The extremely high precision inherent in the design of the Type 329 would have been achieved in vain were it not for the new Du Mont Type 5ATP- Mono-accelerator Cathode-ray tube. For Du Mont's mono-accelerator tubes alone provide the superb resolution, the unprecedented freedom from distortion required to exploit fully the precision of the electronic circuits.
This unretouched photo of the pulse chain illustrates the excellent edge-to-edge focus of the Type 5ATP-, as well as the fine linearity and resolution.



the NEW
DUMONT TYPE 329
Cathode-Ray Oscillograph

- D-c, wide-band oscillograph usable to 20 MC and beyond (3db down at 10 MC).
- D-c sensitivity, 0.2 volts full scale (0.14 volt per inch).
- Pulse response, 0.035 usec.
- New, high-voltage, high resolution Du Mont Type 5ATP- mono-accelerator Cathode-ray Tube for optimum pattern fidelity.
- Accelerating Potential, 6000 volts; equivalent brightness of conventional tube operated at 10,000 volts.
- Precision, directly calibrated sweeps. Simple one-point re-calibration against built-in standard.
- No tube selection necessary.
- New and unique Du Mont Notch Sweep for calibrated sweep expansion and delay.
- Precision amplitude calibration from built-in voltage standard.
- Any 1.4 inch portion of 2.8 inches of undistorted vertical deflection may be positioned on-screen.
- Electronic regulation of all power sources including critical filaments for maximum stability.

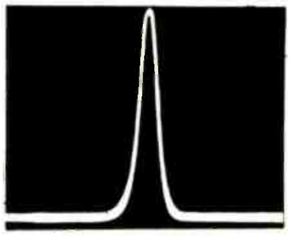
DOMESTIC PRICE $1,485

DUMONT

ALLEN B. DU MONT LABORATORIES, INC.
760 BLOOMFIELD AVE., CLIFTON, N. J.

Want more information? Use post card on last page.

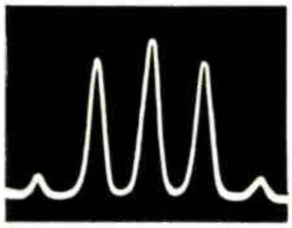
F.M. DEVIATION DIRECTLY MEASURED



Unmodulated Carrier

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.

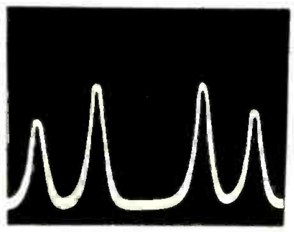
With the compact and easy-to-use Marconi Deviation Meter, the modulation frequency need not be known and deviation is directly read on a meter scale.



Modulation Index 1.3

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.



Modulation Index 2.4
The Carrier "Disappears"
BESSEL ZERO METHOD

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

C.65

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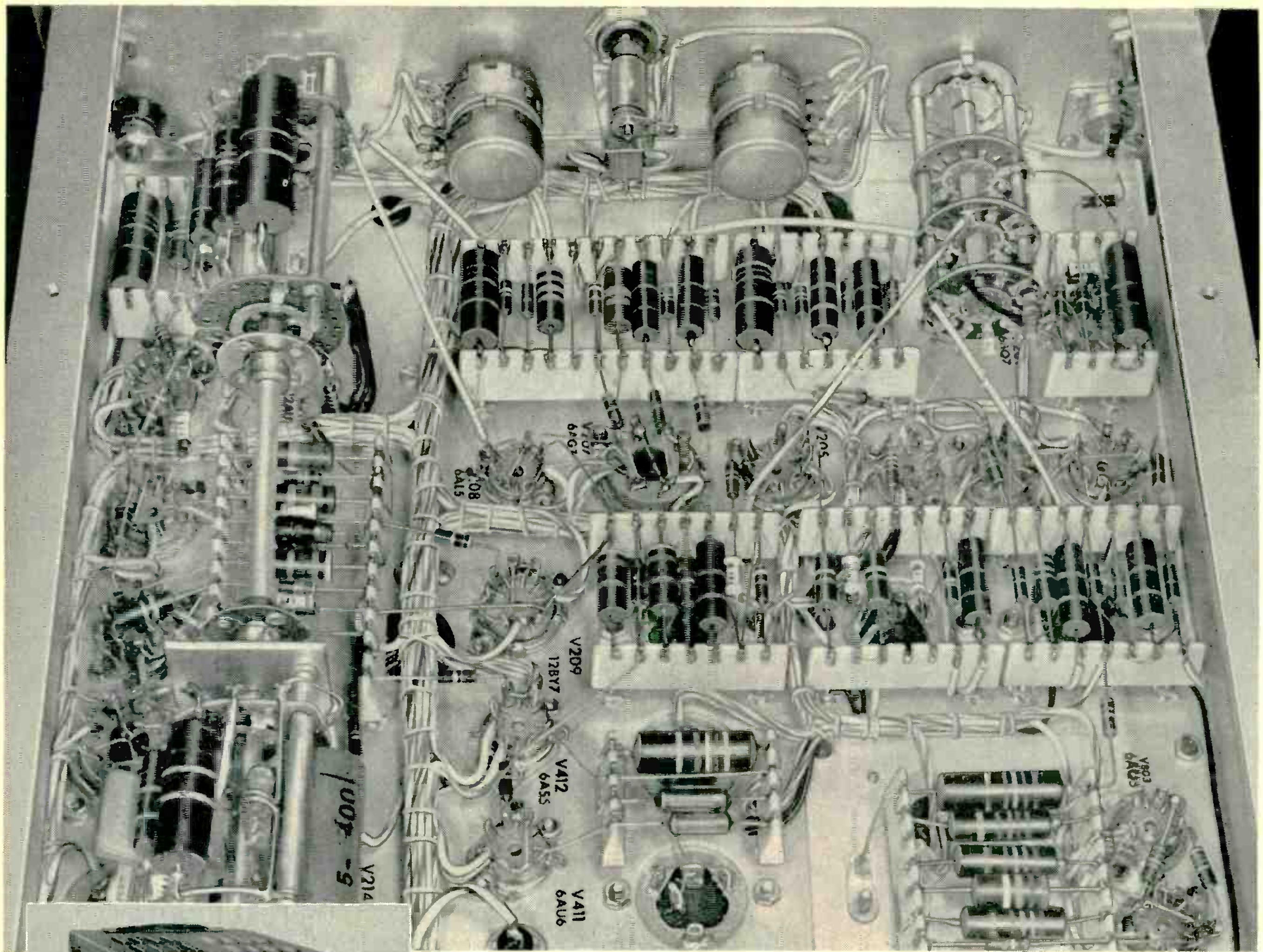


The Tektronix Type 524-D Oscilloscope features a built-in sync separator, variable delayed sweeps at the frame rate, d. c. to 10 mc frequency response, wide sweep range, 4 kv accelerating potential.

TEKTRONIX TYPE 524-D OSCILLOSCOPE

uses 243 Bradleyunits and 21 Bradleyometers

This portable, precision cathode-ray oscilloscope, made by Tektronix, Inc., of Portland, Oregon, is specifically designed for maintenance of television transmitter and studio equipment.

Its network of circuits employs hundreds of Allen-Bradley fixed and adjustable resistors . . . 264 units in all. Since these units are rated at 70C . . . instead of 40C . . . stability of the oscilloscope circuit characteristics is assured.

Bradleyunits and Bradleyometers withstand extremes of temperature and humidity. So, if your electronic equipment must give quality performance, avoid trouble by specifying Allen-Bradley radio resistors.

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

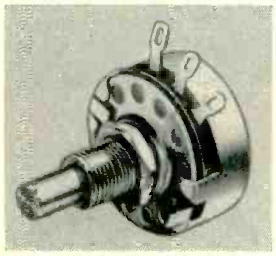
A-B Quality

ALLEN-BRADLEY

FIXED & ADJUSTABLE RADIO RESISTORS

QUALITY

Sold exclusively to manufacturers of radio and electronic equipment



The Type J Bradleyometer has a solid molded resistor ring which can be made to satisfy any resistance-rotation requirement. All ferrous parts are made of corrosion-resistant metal. There are no riveted, welded, or soldered connections in the Bradleyometer.

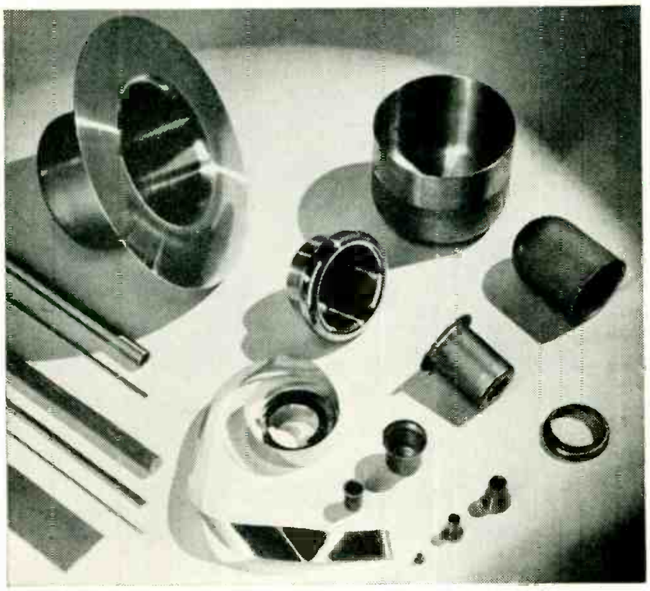
Years of experience

proves to users . . .

the dependability of

KOVAR*

Glass-sealing Alloy



* Westinghouse Trade Mark No. 337,962

The ideal alloy for glass sealing, Kovar matches the expansivity of certain hard glasses over the entire working temperature range. It resists mercury attack, has ample mechanical strength and seals readily. A permanent and impervious bond is obtained by a closely controlled thickness of oxide on Kovar alloy interfused with hard glass.

Kovar is a cobalt, nickel, iron alloy, manufactured under very carefully controlled conditions, and supplied by Stupakoff in the form of: SHEET, ROD, WIRE, FOIL, TUBING, EYELETS, LEADS and FABRICATED SHAPES. The prominent users of KOVAR and the length of time they have employed this metal are convincing proof of satisfaction.

Full information on the use of Kovar is given in Stupakoff Bulletin 145, which we will send upon request.

Stupakoff **CERAMIC & MFG. CO.**

Latrobe, Pennsylvania

18 YEARS

GE

18 YEARS

Western Electric

16 YEARS

AMPEREX

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TUBES

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FTR

11 YEARS

MACHLETT

15 YEARS

Bomac

6 YEARS

WESTINGHOUSE

W

18 YEARS

VARIAN associates

5 YEARS

RAYTHEON

18 YEARS

7 YEARS

SPERRY

13 YEARS

Want more information? Use post card on last page.

The "skin" we love to watch

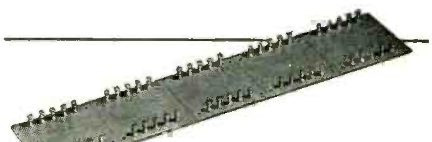
The "skin," or plated coating, on CTC terminals gets extremely close scrutiny from our quality control engineers. And we take pleasure in this careful watching because —

We know, as a result, that you can depend on CTC terminals for electroplated coatings of guaranteed minimum thickness — whether to government specifications or your own.

Our "watching" of these coatings includes periodic bend tests for adhesion, and periodic microscopic inspection of cross sections for coating thickness. These are but two of many examples of quality control that enable us to offer customers *guaranteed* electronic components . . . custom or standard.

Besides terminals, we pay close attention to the production of CTC terminal boards, capacitors, swagers, hardware, insulated terminals, coil forms and coils. For all specifications and prices, write to Cambridge Thermionic Corporation, 437 Concord Avenue, Cambridge 38, Mass. West Coast Manufacturers contact: E. V. Roberts, 5068 West Washington Blvd., Los Angeles 16 and 988 Market St., San Francisco, California.

Terminal Data: Our standard terminal line includes 30 types, each in varied shank lengths. Made of silver plated brass, coated with water dip lacquer to keep them chemically clean for soldering. Also available: combination screw and solder terminals in 3 sizes, and a complete line of phenolic and ceramic insulated terminals. All materials, processes and finishes meet applicable government specifications. Special order finishes include hot tin, electrotin, cadmium plate or gold plate.



Standard CTC Terminal Boards as well as those made to your own specifications by CTC are available. Standard in cotton fabric phenolic, nylon phenolic or grade L-5 silicone impregnated ceramic. Custom made in cloth, paper phenolic, melamine, or silicone fibreglas laminates, imprinted as required and lacquered or varnished to specifications MIL-V-173 and JAN-T-152.

CTC

CAMBRIDGE THERMIONIC CORPORATION

makers of guaranteed electronic components, custom or standard

Standardized for your convenience!

General Ceramics ALUMINA CERAMIC*

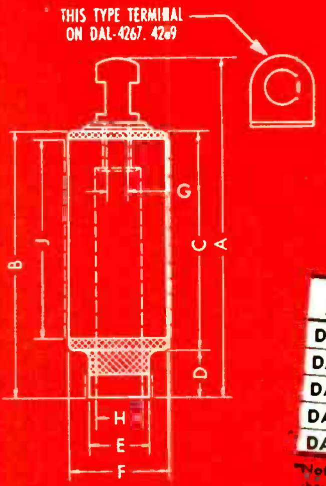
*Conforms to the requirements of Grade L-5A in accordance with JAN-1-10.

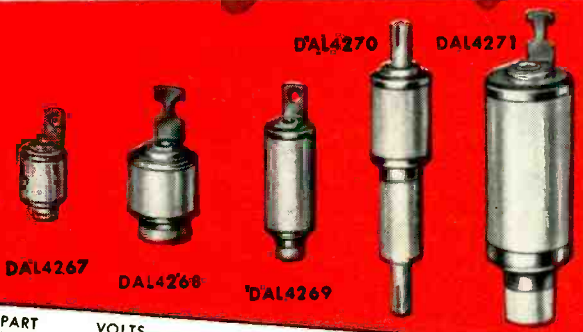
SOLDERSEAL HERMETIC TERMINALS

THE ITEMS SHOWN ARE STANDARD STOCK TERMINALS. DIMENSIONAL TOLERANCE, ±1½% BUT NOT LESS THAN ±.010"

featuring

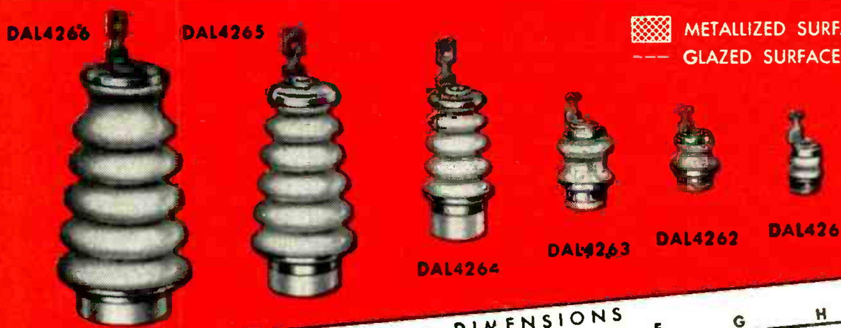
- High Mechanical Strength
- Resistance to Thermal Shock
- Fast, Easy Installation
- Permanent Hermetic Sealing



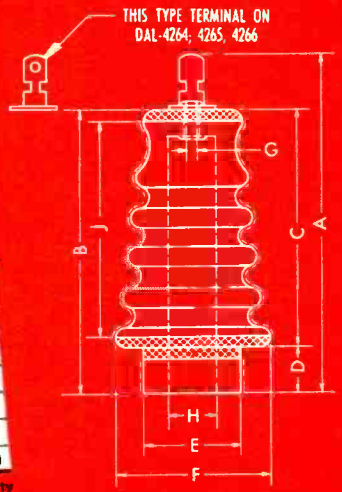


PART NUMBER	VOLTS RMS†	A	B	C	D	E	F	G	H	J
		DIMENSIONS								
DAL4267	4000	.547	.375	.281	.093	.125	.234	.446	.084	.250
DAL4268	5000	.687	.422	.312	.109	.250	.359	.069	.171	.281
DAL4269	8000	.875	.687	.562	.125	.156	.250	.046	.093	.531
DAL4270*	10000	1.187	.937	.437	.500	.234	.312	–	–	.375
DAL4271	15000	1.531	1.250	.937	.312	.281	.453	.0?0	.187	.781

*Note: Part No. DAL4270 employs solid thru-stud slotted at each end.



METALLIZED SURFACE
GLAZED SURFACE



PART NUMBER	VOLTS RMS†	A	B	C	D	E	F	G	H	J
		DIMENSIONS								
DAL4261	3000	.672	.391	.282	.09	.250	.312	.067	–	.171
DAL4262	4900	.750	.468	.312	.156	.312	.437	.067	–	.160
DAL4263	7000	.968	.687	.500	.187	.375	.500	.095	.156	.375
DAL4264	14000	1.343	1.250	.907	.343	.490	.625	.128	.250	.812
DAL4265	18000	2.218	1.750	1.407	.343	.656	.937	.118	.312	1.250
DAL4266	22000	2.655	2.187	1.844	.343	.812	1.187	.128	.375	1.640

†40% Relative Humidity

These terminals are made of glazed Alumina Ceramic. Lugs and eyelets are hot tinned brass and metallized areas are silver fired on ceramic, copper electroplated and tin fused for soft soldering. Immersion in 60/40 solder at 450°F for 1½ minutes for dip soldering will not injure the metallic coating. For complete information and quotations call, write or wire today.

GENERAL STEATITE INSULATORS

General CERAMICS CORPORATION
VALLEY 6-5100
GENERAL OFFICES and PLANT: KEASBEY, NEW JERSEY

MAKERS OF STEATITE, ALUMINA, ZIRCON, PORCELAIN, SOLDERSEAL TERMINALS, LIGHT DUTY REFRACTORIES, CHEMICAL STONEWARE, IMPERVIOUS GRAPHITE, FERRAMIC MAGNETIC CORES

FOR DEPENDABLE MEASURING INSTRUMENTS

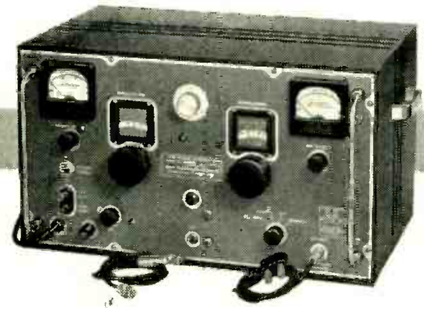
. . . come to NEW LONDON!

UHF TV SWEEP GENERATOR MODEL 130

The Model 130 features continuous frequency coverage in one band; at least one volt output into 75 ohms; wide sweep; blanked signal on return sweep provides a reference baseline.

SPECIFICATIONS

Freq. Range: 450-900 mc
Sweep: 60 cycle, sine wave
Output: (1.) 0.1-1.0 volts (2.) 0.01-0.1 volts approx.
Sweep Width: 0-40 mc min.

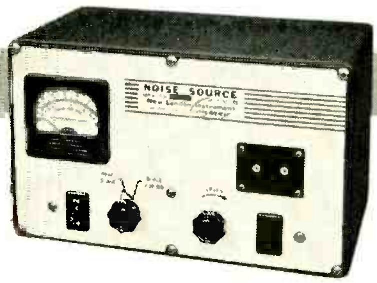


FM SIGNAL GENERATOR MODEL 100C

Designed to give precision performance over a single tuning range. Has negligible leakage and very low spurious outputs. No auxiliary frequency changer unit required.

SPECIFICATIONS

Tuning Range: 27-230 mc
Freq. Deviation: (1.) 0-30 kc; (2.) 0-150 kc
Output: 0.02-100,000 microvolts
Int. Mod.: 400 and 1000 cycles



VHF-UHF NOISE SOURCE MODEL 175

Ideal for measuring receiver noise in television tuners, receivers and other applications between 10 and 900 mc. Designed for operation with 300 ohm receivers with less than 0.5 db error. Noise figure 0-19 db

MICROWAVE GENERATOR MODEL 155

Designed to operate between 2700-3400 mc. Can be pulse modulated and is suitable for testing receivers and transmitters.

SPECIFICATIONS

Power Output: Atten. calib. to read peak power output in db below 1 mw in 50 ohm load.
RF Power Input: Measure average power up to 200 mw.
Leakage: Less than -95 dbm.

Other products manufactured by New London Instrument Company include: High Gain Wide Band Amplifier – UHF Grid Dip Oscillator – Square Wave Generator – Balun. Write for detailed specifications and catalog on our complete line of measuring equipment.

NEW LONDON INSTRUMENT Company

P. O. BOX 189E, NEW LONDON, CONN.

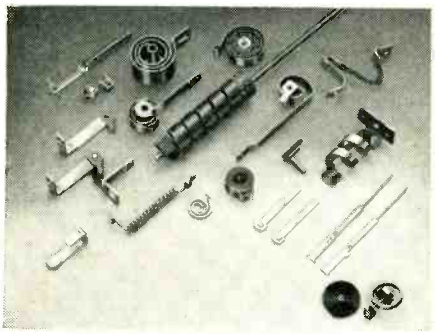
ACTUAL SIZE

Now . . . long-awaited *silicon junction diodes* are available; developed by Texas Instruments, a leading transistor manufacturer. Operating temperatures up to 150°C are safe, offering a new degree of design freedom!

New . . . extremely low back current characteristics, as low as 0.001 microamps at rated voltage. Glass-to-metal hermetic seals, of course. For more detailed information on these new silicon junction diodes — and on other new TI semiconductor products — write today.

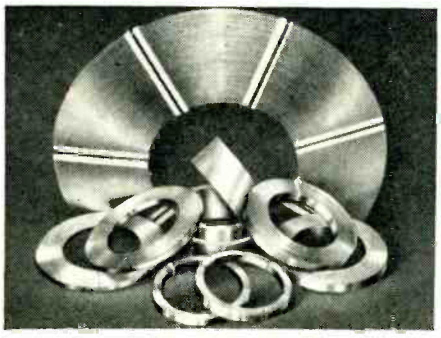
TEXAS INSTRUMENTS
INCORPORATED
6000 LEMMON AVENUE DALLAS 9, TEXAS

General Plate Products
that solve your Electronic Problems



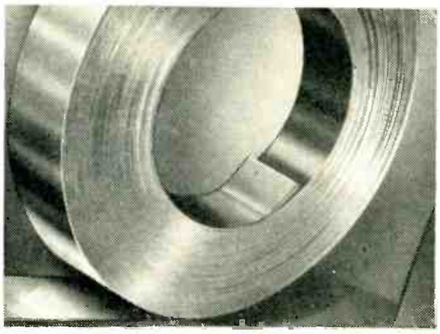
TRUFLEX THERMOSTAT METALS

TRUFLEX thermostat metals are manufactured in a wide variety of types, each with a different reaction to temperature. Uniformity of metal insures accurate and consistent performance. Precision parts fabricated to exact specifications.



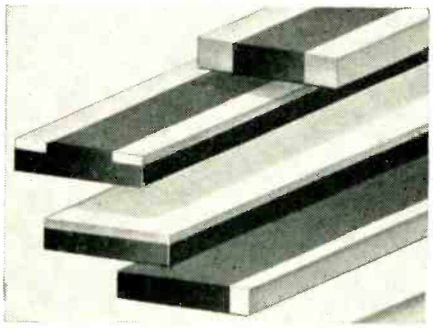
COMPOSITE METALS

Available in practically any combination of precious to precious, precious to base or base to base metals. Combinations for electronics include aluminum-clad iron, nickel-clad iron for anode materials.



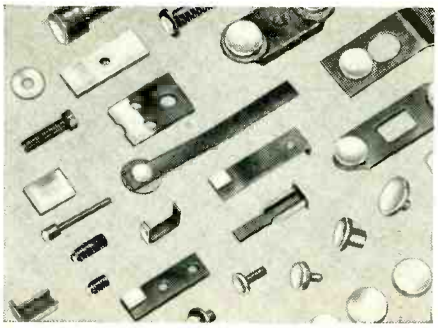
ALCUPLATE

Copper-clad aluminum for component cases or cans, chassis, cooling fins, etc., light weight, excellent conductivity. Copper surface is ideal for soft soldering and electroplating.



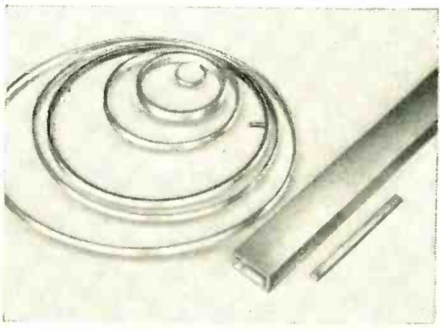
COMPOSITE CONTACT MATERIAL

Precious metals and alloys bonded to base metals available in following types — overlay, single and double edgelay, single and double inlay, Top-Lay, ready for you to fabricate into contacts.



COMPOSITE CONTACTS

General Plate can supply all types of fabricated composite contacts, buttons, rivets, contact assemblies made to customer's specifications. These contacts give electrical conductivity and long life at reduced costs.



WAVE GUIDE and COLLECTOR RINGS

RECTANGULAR WAVE GUIDES. Solid silver, silver lined brass or aluminum. Sizes to government specifications.
COLLECTOR RINGS. Solid silver or precious metal on base metal. All sizes.

GENERAL PLATE PRODUCTS

- **Alfer, Alnifer, Nifer** — Aluminum and Nickel-clad steel for anode plates.
- **Alcuplate®** — Copper-clad aluminum for component cases, chassis, cooling fins, condenser blades, etc.
- **Alsiplate®** — Silver-clad aluminum for lightweight condensers, etc.
- **Composite Contacts and Contact Materials**—Increased strength and longer life at reduced cost.
- **Collector Rings** — Fabricated from solid precious metals or precious-clad base metals. Sizes ranging from fraction of an inch to few feet in diameter.
- **Truflex® Thermostat Metal** — Sheet, strip, formed elements and assemblies produced to specification.
- **Thin Gauge Metals** — Beryllium copper, nickel, pure beryllium, Haynes Stellite alloys, etc.
- **Platinum-Group Metals** — Sheet, wire, tubing, parts of all types. Complete assay and refining facilities for platinum-group metals.
- **Silver and Gold Brazing Alloys** — Available as sheet, wire, powder and fabricated parts.
- **Bondwich** — Solder-clad brazing shim for carbide-tipped tools.
- **Bronco** — Phosphor Bronze-clad copper for high conductive springs.
- **Conflex** — Copper-clad spring steel for electrical and thermal conductive springs at low cost.
- **#720 Manganese Age-Hardening Alloy** — Corrosion resistant spring material for diaphragms, springs, finger stock, etc.
- **Rectangular Wave Guide Tubing** — Wide range of sizes to government specifications.

Write for catalog PR700

General Plate Composite Metals, made by metallurgically bonding one metal to another, are available in sheet, strip, tubing or wire in various widths, thicknesses and diameters.

Silver, gold and platinum-group metals bonded on base metals give solid precious metal performance at a fraction of the cost of solid precious metal. The precious metal provides specific performance requirements such as electrical conductivity and corrosion resistance while the base metal provides workability, strength, and solderability.

Composite base metals provide a new group of engineering metals with properties not available in solid metals. Their use frequently results in lower material costs as compared to solid metals.

In many electronic applications further economy results when General Plate supplies fabricated parts ready for assembly into your product. General Plate makes an infinite variety of fabricated parts, such as electrical contacts, collector rings and TRUFLEX thermostat metal parts to customer's exact specifications.

General Plate Engineers will gladly help you with your problems.

You can profit by using General Plate Composite Metals!

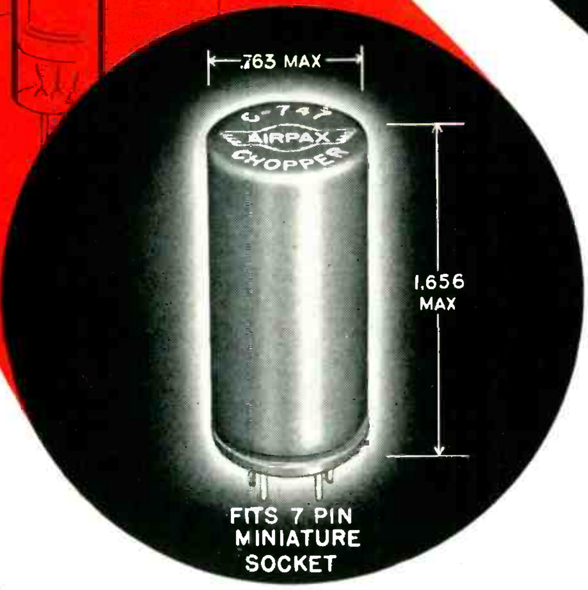
METALS & CONTROLS CORPORATION
GENERAL PLATE DIVISION
35 FOREST STREET, ATTLEBORO, MASSACHUSETTS

AIRPAX
C747 MIDGET
400 CYCLE CHOPPER

PROVEN PERFORMANCE
in large volume production is your best guarantee of quality!

✓ note these facts...

- AIRPAX has built nearly ¼ million choppers
- AIRPAX maintains an engineering staff constantly striving to improve choppers
- AIRPAX has ample capacity for large volume production of choppers
- And AIRPAX choppers have proven performance life and reliability



Weighs less than 1 oz.

AIRPAX PRODUCTS COMPANY
DESIGNERS ENGINEERS

MIDDLE RIVER BALTIMORE 20, MD.

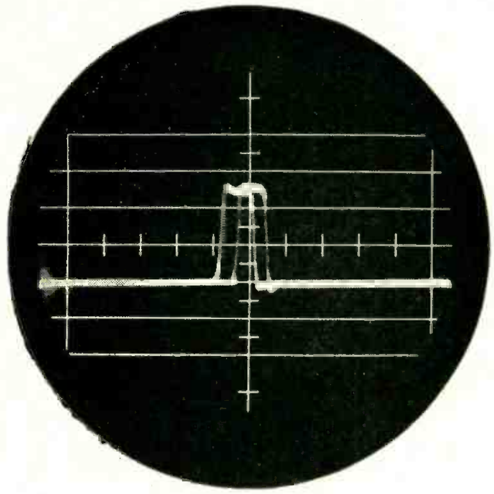


Figure 1. Unique modulating fidelity of -hp- 490A is shown in double-exposed oscillogram of 0.1 μsec pulses. First pulse (applied by -hp- 212A Pulse Generator) is modulating pulse having rise time of 0.02 μsec; delay through tube approximately 50 millimicroseconds. Second pulse is rf output; note absence of deterioration.

NOW! Broad band amplification

-*hp*- 490A and 491A Traveling-Wave Tube Amplifiers are precision broad band linear instruments making readily available a group of measurements hitherto almost unobtainable.

These distinctly different new amplifiers provide a convenient, straightforward method of amplification, modulation or power increase to 1 watt. They are ideal rf amplifiers for receiver and detector applications, and greatly simplify measurement of antenna patterns and wide range attenuators. They are also exceptionally useful as general purpose, low level, low noise laboratory amplifiers. Connected to a signal generator of 1 milliwatt output, -*hp*- 490A amplifier will provide a full watt of output for high level measurements.

COMPLETELY NEW DESIGN

Since 1946, when traveling-wave tube amplifiers were first described, the radio industry has been unable to benefit from them because of the difficulty in coupling signals in and out of the tube. -*hp*- has developed a simple new broad band coupling method employing helices. (See Figure 3.) There is no mechanical connection to the inner helix, yet full energy transfer is effected. The difficulties found in previous experimental amplifiers using multi-element networks, tapers and direct vacuum leads have been overcome. Thus, for the first time, a practical broad band high gain traveling-wave tube amplifier has been produced.

TWO AMPLIFIERS OFFERED

-*hp*- 490A is designed for high gain, low level applications. It provides at least 35 db gain, noise level is less than 25 db, and pulse modulation characteristics are remarkably good. (See Fig. 1.) -*hp*- 491A has 1 watt output full range. Minimum gain is 30 db. Thus, the equipment, together with a 1 mw "S" band signal generator such as -*hp*- 616A, provides a versatile 1 watt source for high power testing throughout the 2 to 4 kmc range.

Both instruments include simple controls for varying traveling-wave tube anode and helix voltages for best performance. Further, a panel meter and selector permit ready measurement of cathode, anode, helix, and collector currents for performance evaluation or continuous monitoring. No adjustments are necessary during operation.

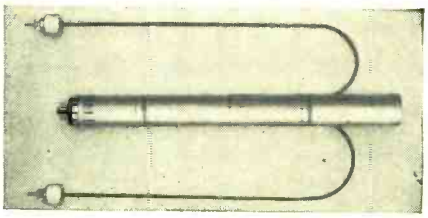


Figure 2. -*hp*- capsulated Traveling-Wave Tube. Note input and ouput coaxial lines with Type N plugs for connection to front panel of amplifier.

COMPLETE COVERAGE | **HEWLETT-PACKARD**

Want more information? Use post card on last page.

New *hp* 490/491A

Traveling-Wave Tube Amplifiers

- Radically new coupled-helix design
- Full "S" band coverage—2 to 4 kmc
- 1 watt output; 30 and 35 db gain
- Millimicrosecond pulse modulation
- Compact, portable, easy to use

high gain low noise for "S" band!

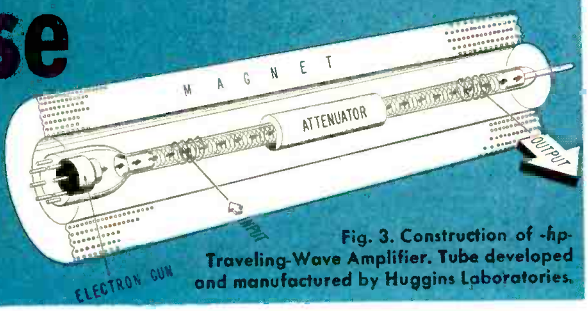


Fig. 3. Construction of -*hp*- Traveling-Wave Amplifier. Tube developed and manufactured by Huggins Laboratories.

REPLACEMENT TUBES

To eliminate critical adjustments and assure that tubes and coupled helix components are properly matched, –*hp*– replacement tubes are capsulated in a unit wherein the tube and coupling helices are integral. When delivered, the replacement tube is thoroughly tested, ready to plug in and use.

SPECIFICATIONS

-*hp*- 490A

Frequency Range: 2 kmc to 4 kmc.
Gain: 35 db minimum.
Output Power: 25 milliwatts minimum.
Noise Figure: Less than 25 db.
Pulse Rise & Decay Time: Order of a few millimicroseconds.
Pulse Delay: Approximately 50 millimicroseconds.
Modulating Voltage: Requires approx. 50 volts peak negative to reduce output to 0.1% of initial value. Input impedance: 50 ohms.
Hum, Spurious Modulation: At least 30 db below signal level.
Meter Monitors: Cathode Current, Anode Current, Helix Current, Collector Current.
Connectors, RF: Input and Output, Type N; Modulation Input, BNC.
Size: Approximately 7" wide x 10¾" high x 18" deep.
Weight: Approximately 70 pounds net, 90 pounds packed.
Power Supply: 115 volts ±10%, 50-60 cps, approximately 125 watts.
Replacement Tube Price: Including Capsulation, $650.00 less $125.00 credit for return of defective tube and capsule. Specify –*hp*– 490A-73A.
Price: Traveling-Wave Tube Amplifier, complete including capsulated tube. $1,100.00 F.O.B. factory.

-*hp*- 491A

Frequency Range: 2 kmc to 4 kmc.
Gain: 30 db minimum.
Output Power: 1 watt minimum.
Noise Figure: Less than 30 db.
Pulse Rise & Decay Time: Modulation not provided.
Pulse Delay: Modulation not provided.
Modulating Voltage: Modulation not provided.
Hum, Spurious Modulation: At least 30 db below signal level.
Meter Monitors: Cathode Current, Anode Current, Helix Current, Collector Current.
Connectors, RF: Input and Output, Type N; Modulation Input, not provided.
Size: Approximately 7" wide x 10¾" high x 18" deep.
Weight: Approximately 75 pounds net, 95 pounds packed.
Power Supply: 115 volts ±10%, 50-60 cps, approximately 250 watts.
Replacement Tube Price: Including Capsulation, $650.00, less $125.00 credit for return of defective tube and capsule.
Price: Traveling-Wave Tube Amplifier, complete including capsulated tube. $1,100.00 F.O.B. factory.

Above Data subject to change without notice

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FIELD ENGINEERS IN ALL PRINCIPAL AREAS

hp INSTRUMENTS | COMPLETE COVERAGE

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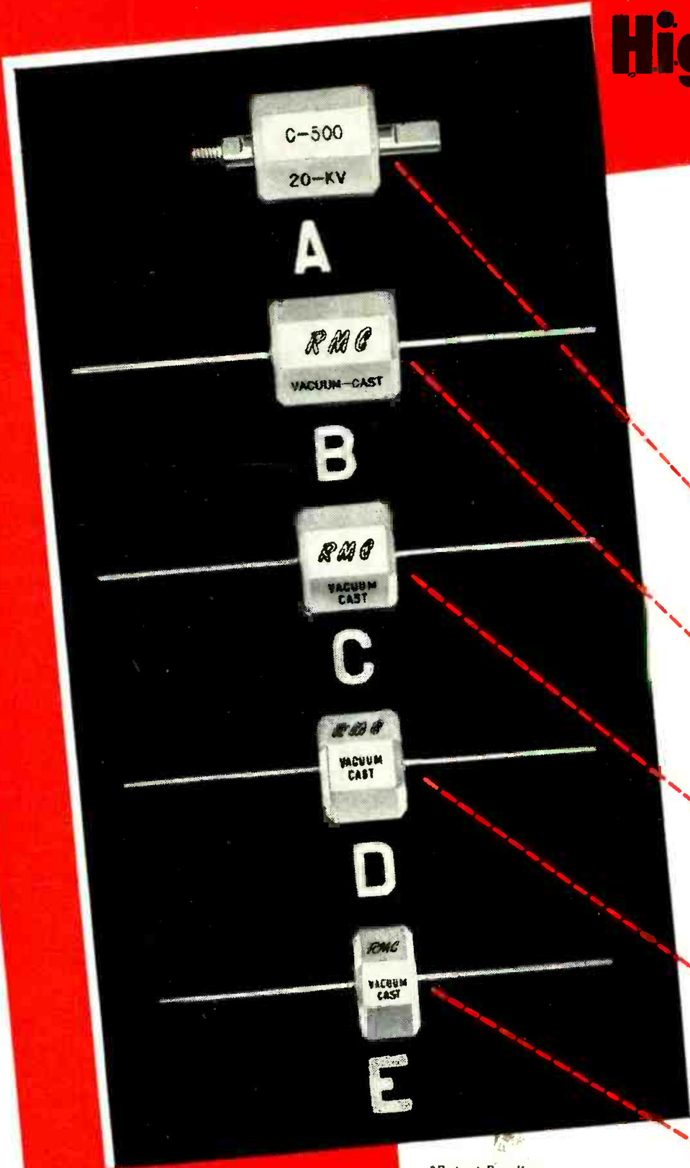
Another RMC First

"VACUUM CAST*"

High Voltage DISCAPS®



*Patent Pending

Vacuum Cast DISCAPS answer the demand for a dependable ceramic capacitor for high voltage applications.
The RMC Vacuum Cast process removes all air and gases to form a hermetically sealed casing in perfect contact with dielectric and terminals. The possibility of cracks or fissures in the casing is eliminated.
The exclusive casting material meets all the requirements of an outstanding capacitor casing; it is highly impervious to moisture, has great mechanical strength and exceptionally good electrical characteristics.
For extra dependability specify RMC Vacuum Cast DISCAPS . . . they are priced competitively with ordinary molded types. Your inquiry is invited.

1″ x ⅞″ across flats.
20 KV—500 mmfd with standard and special terminals.

Size—1″ x ⅞″ across flats.
20 KV—500 mmfd with No. 16 wire leads. Lead lengths optional.

¾″ x ⅞″ across flats.
15 KV—1200 K—50 to 200 mmfd
15 KV—4500 K—200 to 1000 mmfd

⅝″ x ⅞″ across flats.
10 KV—1200 K—50 to 250 mmfd
10 KV—4500 K—250 to 1000 mmfd

7/16″ x ⅞″ across flats.
8 KV—N-1500—10 to 50 mmfd
8 KV—1200 K—50 to 250 mmfd
8 KV—4500 K—250 to 1000 mmfd

C—D—E have No. 16 or No. 18 wire leads—length optional.

A New Development from the RMC Technical Ceramic Laboratories

POWER FACTOR AT 1000 CPS: 1% MAX.
LEAKAGE RESISTANCE: Guaranteed greater than 50,000 Megohms
LEAKAGE RESISTANCE AFTER HUMIDITY: 5000 Megohms

DISCAP CERAMIC CAPACITORS

RMC

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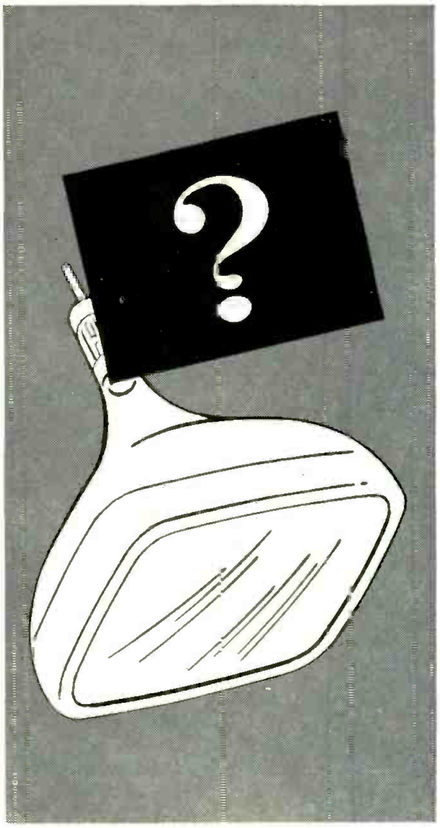
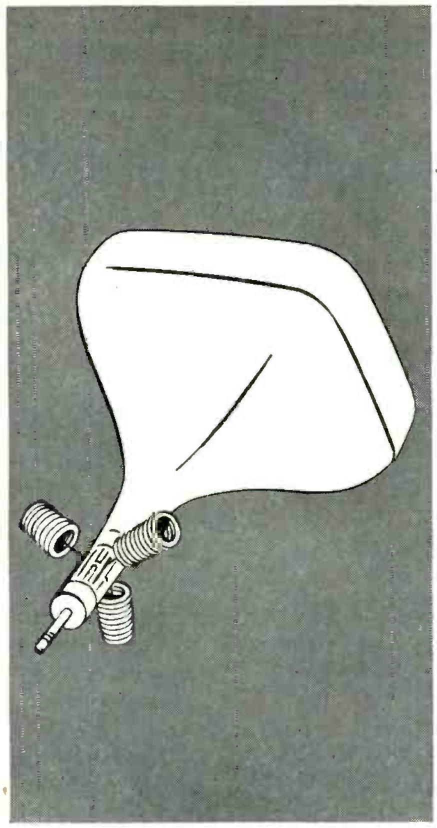
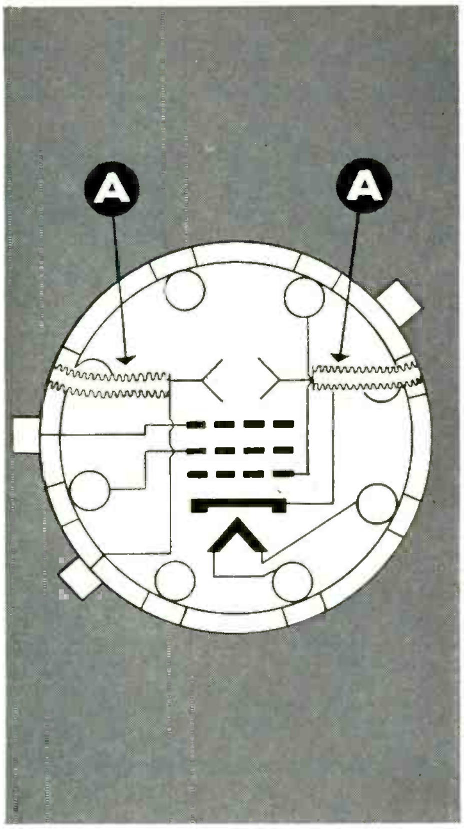
IDEAS that start in a BELLOWS







WHY ADJUST A COLOR TV TUBE FROM WITHIN?

If you can physically move the deflection plates within a TV tube without breaking the hermetic seal, you will get much finer tuning, clearer images. But how can this be done?

BELLOWS GIVES PROPER SEAL

To make *any* physical adjustment within a vacuum, you need a seal that is both leakproof and flexible. This is what you get when you use a Clifford Bellows. For instance —

HERE'S HOW IT CAN BE DONE

In the diagram, you can see how a Clifford Bellows (A) can be inserted in the deflection plate circuit. Plates can be adjusted within the TV tube without affecting the vacuum.

Have you ever worked with Bellows?

Although bellows aren't always featured in engineering courses, they have proved a welcome solution to many engineering problems.

The color TV tube application outlined above is but one of many ways in which these leakproof, flexible assemblies can prove useful. For instance, in the electronic field, Clifford Hydron Bellows change the frequency inside magnetron tubes, make adjustments inside hermetically-sealed instruments, move variable plates inside vacuum capacitors. They also act as expansion chambers in mercury-filled wave guides, oil-filled transformers and other electronic and electrical equipment.

Clifford Hydron Bellows permit extension, retraction and 360° rotations with 100% metallic seal.

CLIFFORD MANUFACTURING COMPANY, Grove Street, Waltham 54, Massachusetts. *Div. of Standard-Thomson Corporation.* Sales offices in New York; Detroit; Chicago; Los Angeles; Waltham, Massachusetts.

HYDRON METAL BELLOWS — CLIFFORD MANUFACTURING CO. WALTHAM, MASS. DIVISION OF STANDARD-THOMSON CORP. — Feather Weight HEAT EXCHANGERS

CLIFFORD MANUFACTURING COMPANY
119 Grove Street, Waltham 54, Massachusetts

Gentlemen:

Please send me information on bellows application for vacuum tube adjustments. Also for:
☐ Transmitting motion between mediums ☐ Controlling and indicating temperature ☐ Sealing rotary shafts or packless valves ☐ Transmitting motion hydraulically to remote points ☐ Providing for thermal expansion ☐ Providing shock mounting or vibration dampening ☐ Differential pressure maintenance

Name..

Company..

No. and Street..

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

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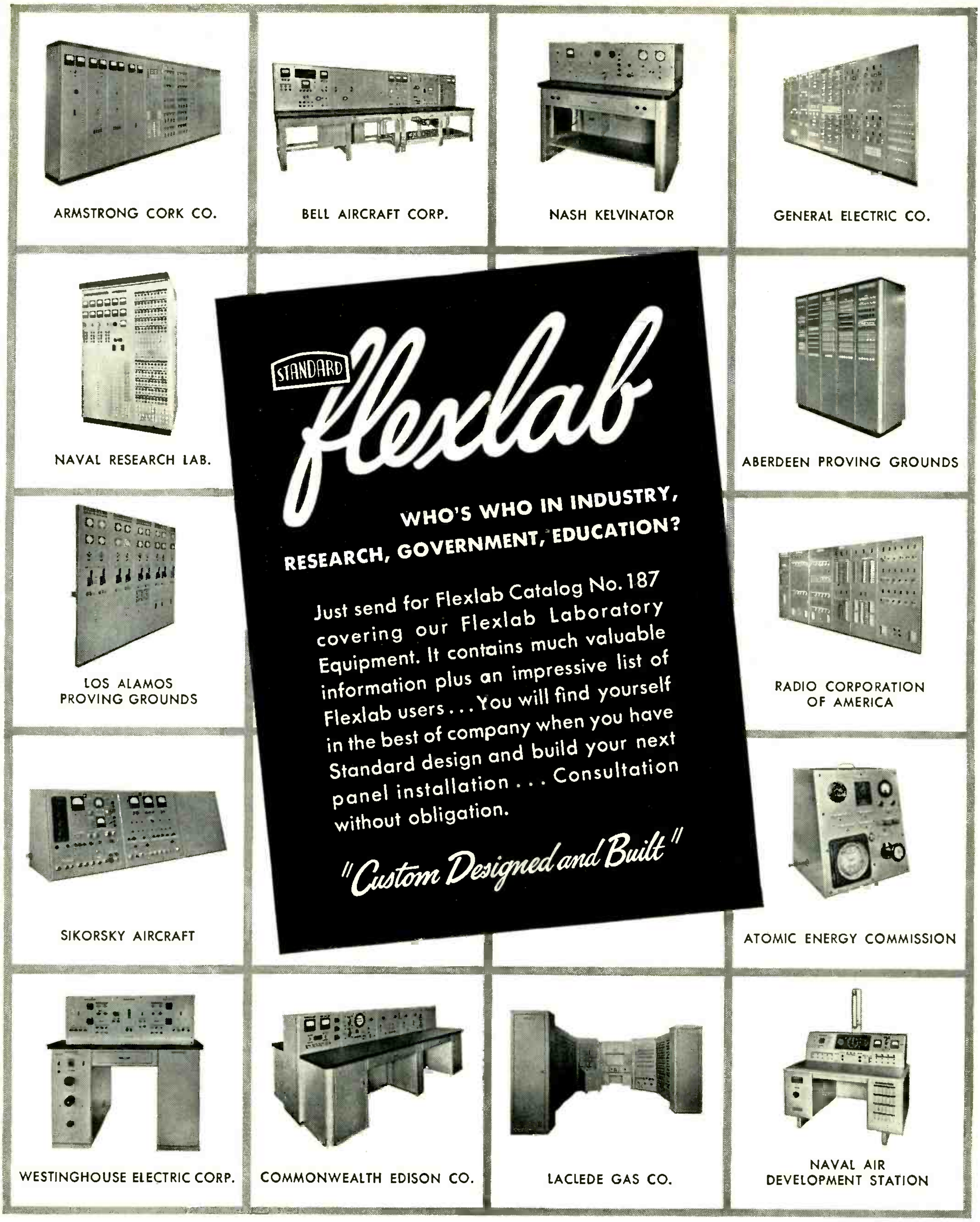

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DU PONT
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Better Things for Better Living
. . . through Chemistry

ELECTRICAL ENGINEERING NEWS

PROPERTY AND APPLICATION DATA ON THESE VERSATILE PLASTIC MATERIALS: DU PONT NYLON, "ALATHON," "TEFLON," "LUCITE."

NO. 2 — 1954

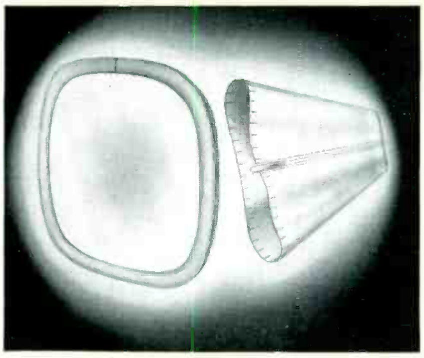
Anchored Sleeves of Du Pont Nylon Resist Corrosives, Heat, High Electrical Currents

TV tube carrying 20,000 volts insulated with Du Pont "Alathon"

A ring and sleeve extruded of Du Pont "Alathon" polyethylene resin is now being used by many television-set manufacturers to insulate the outer portion of their metal picture tubes that carry up to 20,000 volts.

"Alathon" has excellent dielectric strength, low dielectric constant (2.3) and low power factor (0.0005).

Because of its very low moisture-absorption rate (0.01 by A. S. T. M.



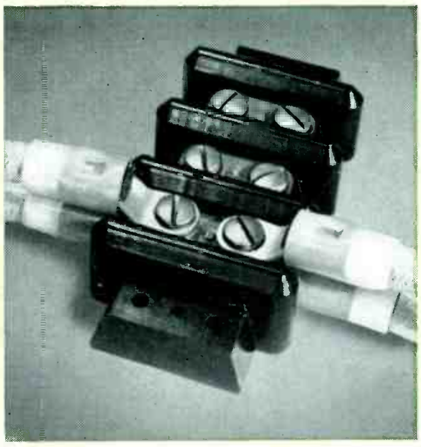
test D-570-42), "Alathon" easily passed exacting humidity tests necessary to maintain prolonged insulating value.

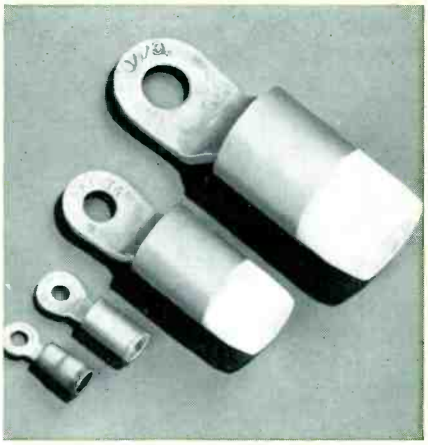
Du Pont "Alathon" offers another important advantage. Its flexibility simplified installation. Shipping costs are reduced because "Alathon" absorbs shock, making it possible to pack sets as units and thus eliminate shipping the delicate tubes separately. And reassembly time and labor costs at outlets are eliminated.

Du Pont "Alathon" is also widely used for such insulating applications as TV lead-in wire, and police and fire alarm cables.

One-piece nylon part permits installation of cable terminals in five fewer steps

A molded, one-piece insulating sleeve of Du Pont nylon has been developed by The Thomas & Betts Co., Inc. This sleeve is permanently staked on the terminal barrels of their Sta-Kon terminals, for conductor sizes from #22





AWG to 250 MCM.

Du Pont nylon is a good insulating material . . . 6,000 volts can be applied to the staked area without puncturing the nylon insulation. Molded nylon resists temperatures as high as 250°F., as well as aircraft hydraulic fluids, fuels, aromatic oils and corrosive attack. Nylon is also extremely resilient. It absorbs shock without chipping or cracking, and does not break down under flexing strains or crimping pressures.

Because of the efficient design of this molded Du Pont nylon sleeve, Thomas & Betts Co. has been able to eliminate five of the eight steps formerly required to insulate wire and cable terminals, thus saving time and reducing installation costs.

Parts made of Du Pont nylon are mass-produced rapidly, and economically, by injection-molding. Its wide range of valuable properties offer many advantages for you in the electrical field.

OVER

Properties of Du Pont "Lucite" acrylic resin

Du Pont "Lucite" provides a combination of properties of potential use to electrical design engineers. These properties include:

MECHANICAL: Tensile strength at 73°F: 9,000 psi; at 170°F, 4,300 psi. Modulus of elasticity at 77°F: 400,000 psi. Shear strength: 9,000 psi.

THERMAL: Coefficient of linear thermal expansion per °F: 5×10^{-5}. Thermal conductivity: 1.4 BTU/hr/sq ft. /°F/in.

ELECTRICAL: Dielectric strength, short time, 400 v/mil. Dielectric constant, 60 cycles: 3.9; 10^6 cycles: 2.9. Power factor, 60 cycles: 0.042; 10^6 cycles: 0.025. Properties unaffected by moisture, aging, weather, or fungus.

OPTICAL: "Lucite" transmits up to 92% of incident light. Refractive index: 1.49. Clarity unimpaired by aging or weather.

CHEMICAL: Dilute solutions of strong acids (like battery acids) or alkalies do not attack "Lucite". Nor will dilute alcohols, aliphatic hydrocarbons, and petroleum oils.

WEATHERING: "Lucite" does not craze or lose transparency after long outdoor exposure. Colorless "Lucite" is unaffected by sunlight.

DU PONT
Better Things for Better Living
. . . through Chemistry

ELECTRICAL ENGINEERING NEWS

PROPERTY AND APPLICATION DATA ON THESE VERSATILE PLASTIC MATERIALS: DU PONT NYLON, "ALATHON," "TEFLON," "LUCITE."

NO. 2 — 1954

POINTERS ON PROCESSING OF DU PONT POLYMERS

How to make experimental parts of Du Pont nylon

Parts for experimental purposes can often be machined of Du Pont nylon from standard shapes such as rod, strip or cylinders. Nylon is readily machinable to close tolerances. In cutting, high-speed steel tools, ground for minimum drag, should be used. Cutting tools should be kept sharp and vibration of machinery avoided. Coolants such as water and soluble oils allow higher cutting speeds. When working to close tolerances, make all measurements at room temperature.

Nylon can be sawed with regular band saws, jig saws and table saws without modifications. Hollow-ground metal cutting blades placed in a conventional table saw will yield a smooth cut at high speeds. Again coolants are useful.

Small parts machined from nylon rod. These parts are readily machinable to close tolerances.

Nylon is drilled satisfactorily with ordinary twist drills. To obtain a smooth hole of uniform diameter, use a slow, uniform feed with the highest speed that will not cause "gumming" or burning. Keep holes chip-free by removing the drill from the hole frequently.

Expansion-type reamers are preferred for nylon, but it can also be reamed with the usual types. Cuts taken with a fixed reamer will tend to be undersized because of the resiliency of nylon. Remove at least 0.010 inch with the final ream to get a hole of the correct size.

Threading and tapping of nylon can be done with conventional equipment. A lubricant or coolant is useful for tapping and threading but isn't always required. Conventional thread cutting techniques can be used and successive cuts should be made, as in metal. Finish cut should be no less than 0.005 inch.

For turning nylon, use bits with minimum drag. Nylon has exceptional abrasion resistance and resiliency, so finishing should be done with power-driven rotary steel burrs, abrasive disks, or high speed grinders.

Nylon can be cemented with a number of commercial adhesives.

The machined test parts should be stress relieved to insure dimensional stability. This is best accomplished by heating to 350°F in "Glycowax" or "Hitec" salt. In experimental work, where equipment is not available for high temperature stress relieving, boiling water will be adequate in many cases. Close tolerances can be maintained with nylon, as with other engineering materials, by following prescribed procedures.

Investigate Du Pont plastic engineering materials in your product development programs

One of the family of these versatile engineering materials is often a key factor in product improvement or new product design.

The wide range of properties available with "Alathon"* polyethylene resin, "Lucite"* acrylic resin, "Teflon"* tetrafluoroethylene resin, and Du Pont nylon are helping solve industrial design problems.

NEED MORE INFORMATION?

Clip the coupon for additional data on the properties and applications of Du Pont plastic engineering materials.

E. I. DU PONT DE NEMOURS & CO. (INC.)
Polychemicals Department
Room 225, Du Pont Building, Wilmington 98, Delaware

Please send me more information on the Du Pont plastic engineering materials checked: ☐ Du Pont nylon; ☐ "Alathon"; ☐ "Teflon"; ☐ "Lucite". I am interested in evaluating these materials for

____

NAME__________ POSITION__________

COMPANY__________

STREET ADDRESS__________

CITY__________ STATE__________

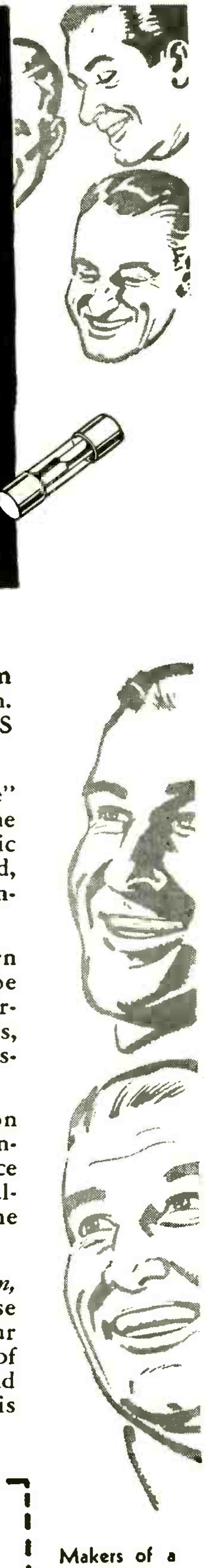
TYPE OF BUSINESS__________

*"Alathon", "Lucite", "Teflon" are registered trade-marks of E. I. du Pont de Nemours & Co. (Inc.)

Electrical properties of Du Pont "Teflon"

"Teflon" tetrafluoroethylene resin retains its electrical, chemical, and mechanical properties over a wide temperature range. Its exceptional thermal stability makes it suitable for use to 250°C. Yet "Teflon" is still tough and strong at −268°C.

Enamels made from "Teflon" are used as wire insulation in fhp motors, electronic transformers, thermocouples, and control equipment. The high service temperature and low power loss of "Teflon" make it ideal for these applications. Wires carrying high voltages and operating at high temperatures utilize thick-walled insulation of "Teflon". Power factor of "Teflon" is less than 0.0005 over the spectrum measured so far, 60 cycles to 30,000 megacycles. Volume resistivity is greater than 10^{-16} ohm-cm. "Teflon" absorbs no water, by ASTM D-570-42. Surface resistivity stays as high as 10^{13} ohms at 100% relative humidity.

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can help you build
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Manufacturers and service organizations know from experience that BUSS fuses won't let them down. For over 39 years, under all service conditions, BUSS fuses have given dependable electrical protection.

Rigid quality control is the reason for "trouble-free" BUSS fuses. Every BUSS fuse normally used by the electronic industries is tested in a sensitive electronic device that rejects any fuse not properly constructed, correctly calibrated and right in all physical dimensions.

So for the finest possible electrical protection, turn with confidence to BUSS fuses. The fuse that can be relied on to protect when there is trouble in the circuit. The fuse that eliminates those needless blows, which otherwise could be so annoying to your customer.

And there is another reason it pays to standardize on BUSS fuses. You can simplify your buying, stock handling and records by using BUSS as the one source for fuses. The line is complete: — standard type, dual-element (slow blowing), renewable and one-time types . . . in sizes from 1/500 ampere up.

If you have a special problem in electrical protection, Buss places at your service the world's largest fuse research laboratory and its staff of engineers. Let our engineers, who are fuse specialists, save the time of your engineers by helping you select the right fuse and fuse mounting for your job—if possible a fuse that is already available in local wholesalers' stocks.

For more information mail this Coupon ▶

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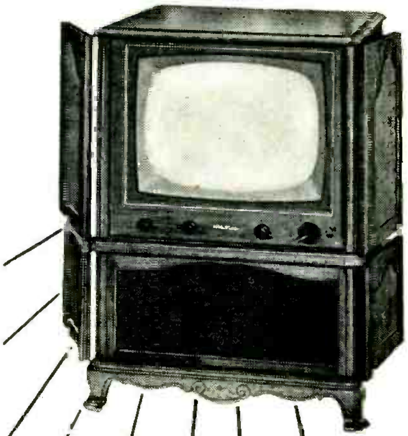
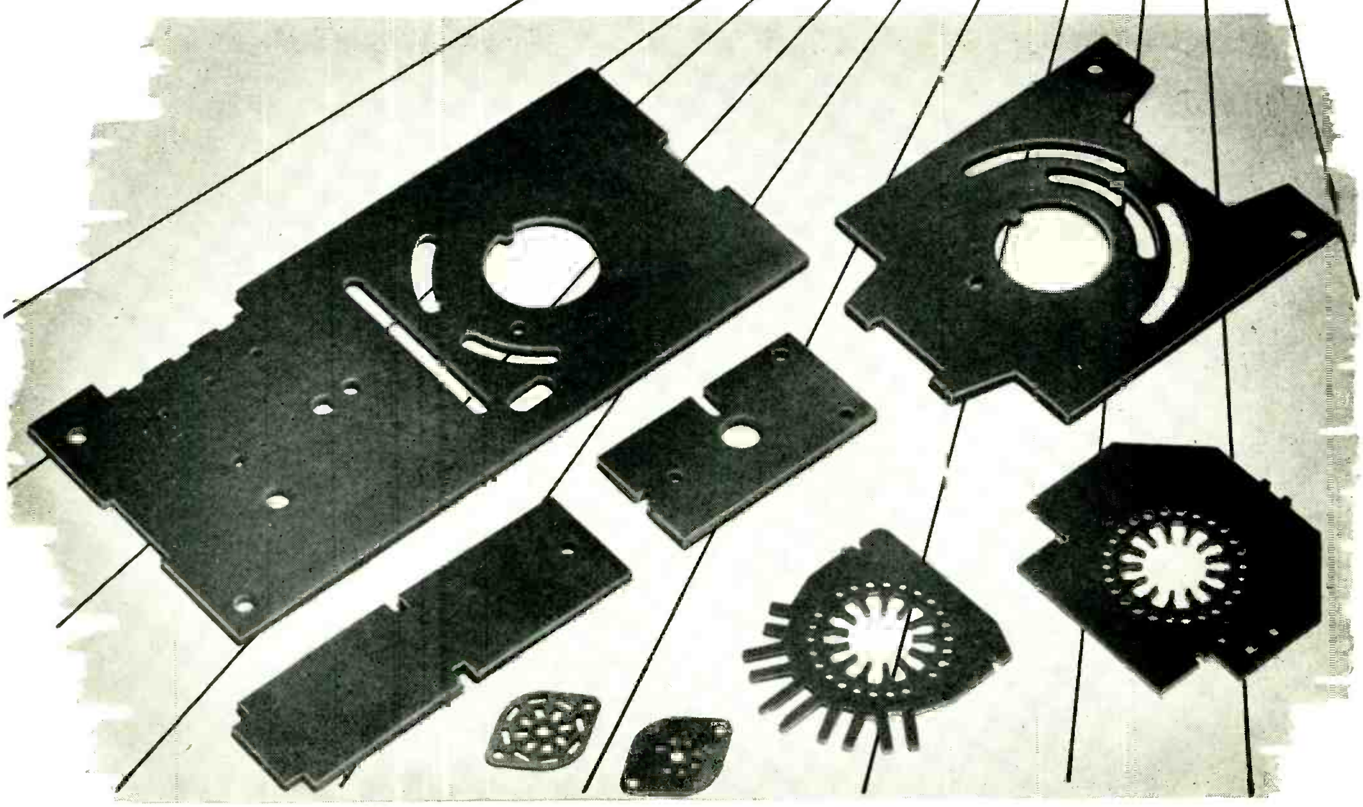


The RCA Victor name is a symbol for the highest quality in electronic equipment. To meet their exacting standards, RCA Victor engineers selected INSUROK Grade T-725 phenolic laminate for their television receivers.

INSUROK T-725 provides RCA Victor with a unique combination of electrical properties. It is used in the R.F. tuners, to maintain insulation resistance under high temperatures and humidities . . . in the I.F. tube sockets, to minimize capacity changes with changes in humidity . . . and in the high-voltage compartment, to provide high dielectric strength and surface resistivity.

For the "tough spots" in your product, write or phone about T-725 and the many other grades of INSUROK laminated insulation.



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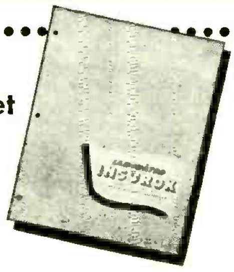

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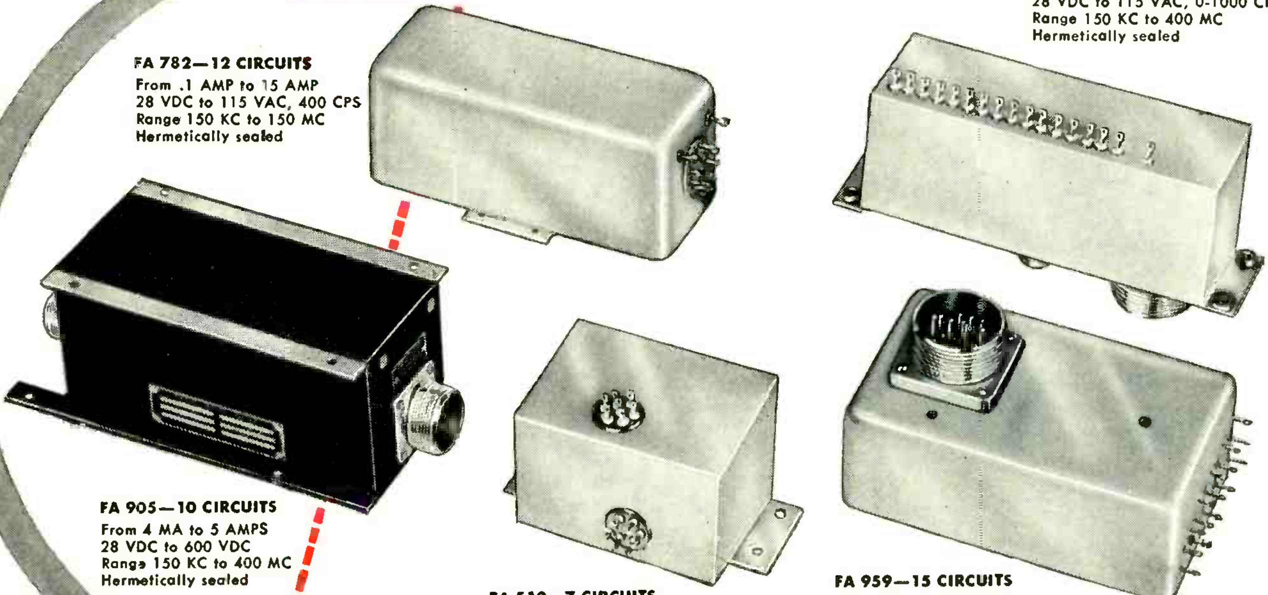

FA 1034A—18 CIRCUITS
From .5 AMP to 3 AMP
28 VDC to 115 VAC, 0-1000 CPS
Range 150 KC to 400 MC
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FA 782—12 CIRCUITS
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FA 905—10 CIRCUITS
From 4 MA to 5 AMPS
28 VDC to 600 VDC
Range 150 KC to 400 MC
Hermetically sealed

FA 512—7 CIRCUITS
From 100 MA to 5 AMP
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From 800 MA to 5 AMP
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Range 150 KC to 400 MC
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Representative multi-section, high attenuation, hermetically sealed R.F. Interference Filters for space saving, simple installation and light weight applications.

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Our complete engineering and manufacturing organization is devoted exclusively to the research, design and production of RF interference filters to make YOUR products noise-free.

The Filtron Company is a complete engineering and manufacturing organization that pioneered the development of special filter types: subminiatures, high attenuation, completely hermetically sealed, high altitude, high temperature and wide-band multi-section units. Today we are producing more filters than ever before.

ENGINEERING: *FILTRON'S highly specialized filter engineers will discuss, test, and design RF filters to make your products "noise-free". They will meet with you at your plant, or in our own shielded laboratories.*

TEST & DEVELOPMENT: *FILTRON'S test and development facilities are equipped with ALL interference-measuring and test equipment, in strict accordance with all Military Specifications.*

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An inquiry on your company letterhead will receive prompt attention.

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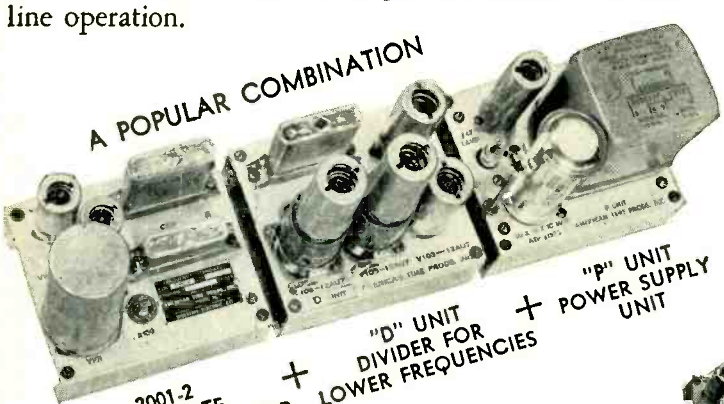
FREQUENCY STANDARDS

DESIGNED AS A *Modular system*

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

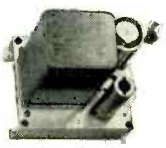
TYPICAL COMBINATIONS

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

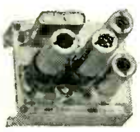
TYPE "2001-2" FREQUENCY STANDARD
Frequencies, 200 to 3,000 cycles. Output, approximate sine wave at 5 volts.

ACCESSORY UNITS

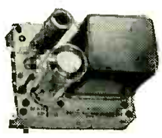
"L" UNIT.
DIVIDER, (MULTI-VIBRATOR TYPE)
Provides frequencies from 30 to 200, controlled by the 2001-2 unit. Output, approx. 5V. Approx. sine wave.



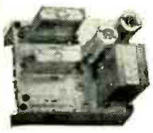
"M" UNIT
AMPLIFIER
Provides 2 watts at 6 and 110 volts.



"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.

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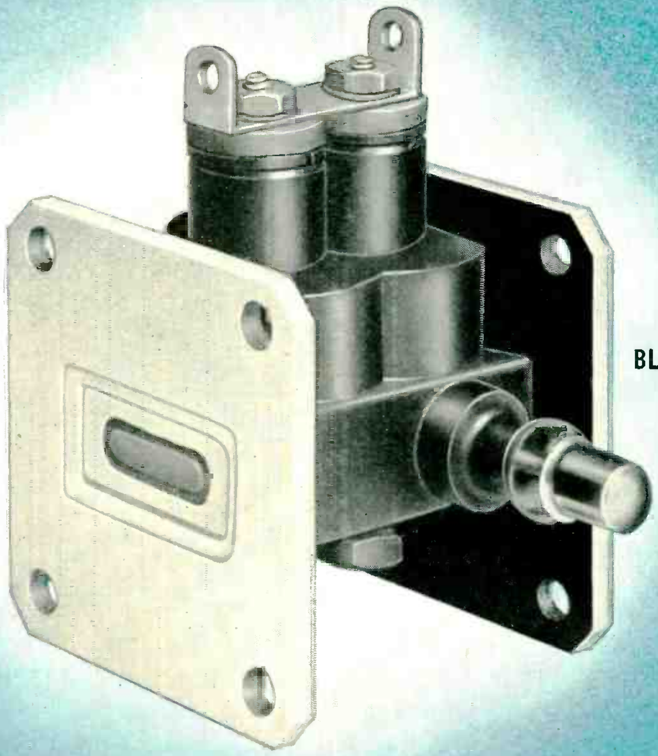

BL-58 *patent applied for*

BL-58 CHARACTERISTICS	
TR tube operation	same as 1B63A
Shutter operation	
Insertion loss	40 db min.
Vibration	16 g.
Coil ratings to open	6.0 Vdc $\pm$ 0.3v for 8 to 12 milliseconds approx. 5 amps dc
Coil ratings to hold open	0.65 Vdc (min.) to 0.75 (max.) 500-600 ma.
Shutter life	50,000 $\sim$ @ 1 $\sim$/sec.

Accessories are available to operate the shutter feature in TR at any voltage up to and including 28 Vdc.

the *NEW* TR shutter tube

Bomac offers to microwave equipment designers the first "complete package protection" —

wave guide shorting *plus* TR tube action

The Bomac BL-58 shown above is the first TR tube to offer continuous crystal protection.

When equipment is not in use, or is in standby condition with TR keep-alive voltage off, the fail-safe shutter provides a minimum of 40 db insertion loss ahead of the crystal. When equipment is in operation with voltages applied, the shutter action is automatically removed, and the TR functions normally.

This latest Bomac engineering achievement affords the user substantial savings in size and weight.

Bomac shutter tubes are available for other bands.

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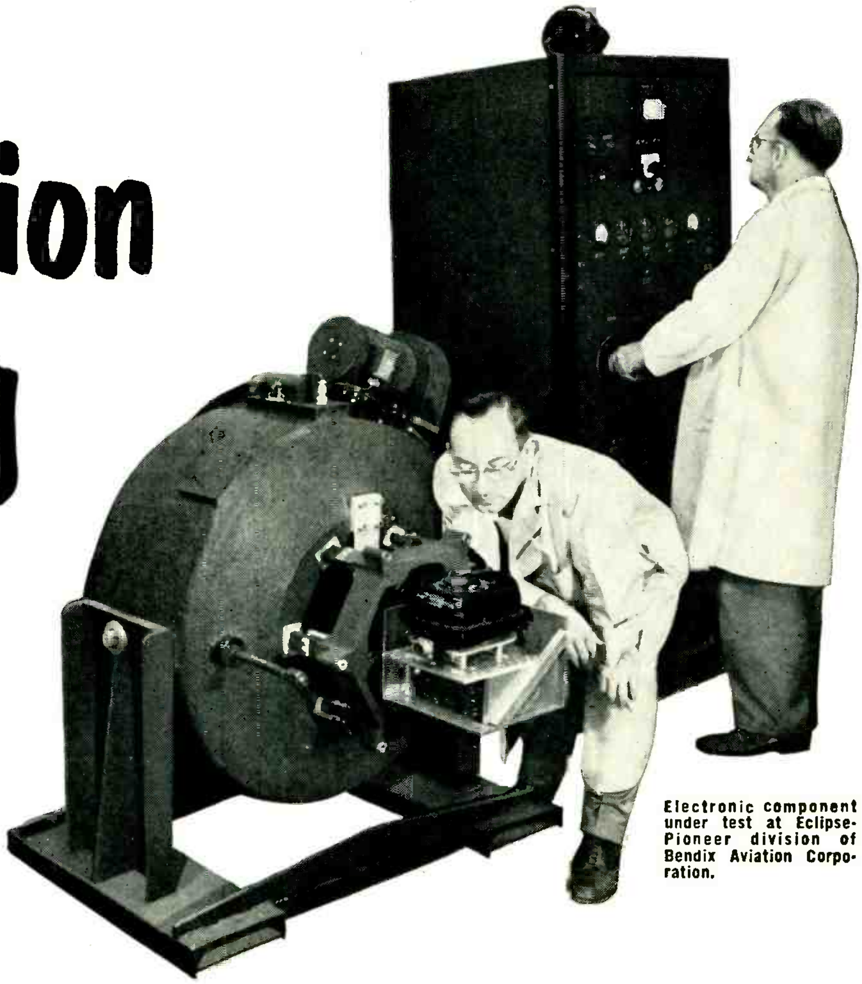
Vibration testing made easier



Electronic component under test at Eclipse-Pioneer division of Bendix Aviation Corporation.

with the help of MB equipment like this

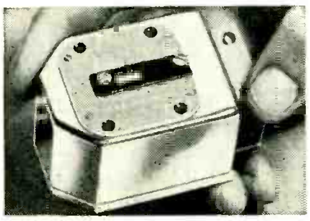
Do you have to vibration-test your product to meet military specifications? Want to apply shake-testing to improve product design or to control quality? If so, do what many leading companies have done – enlist the help of MB.

First, you get the right equipment. MB offers a *complete* line of vibration exciters from 10 pounds force all the way to the largest developed today – 10,000 pounds! All are quality built to stand up and do the job right to specifications. Electromagnetic in operation, they're easily and quickly adjusted for force and frequency. And, second, you get the benefit of MB's wide experience in applying this relatively new and valuable technique for product improvement.

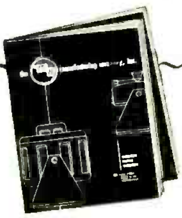
Among the well known companies working with MB products, Bendix Aviation Corporation's Eclipse-Pioneer division is outstandingly equipped with *several* MB Vibration Exciters. The photograph shows one – MB Model C-25, rated at 2500 pounds of force – vibrating an electronic component to insure dependability under severest conditions. Such testing can uncover, in minutes, trouble that might take months to develop.

VIBRATION PICKUP ANOTHER USEFUL TESTING TOOL

When you want to detect vibration and determine its nature, you'll want an MB Vibration Pickup. While the pickup detects even slightest vibratory motion, it was built for grueling service as well. Model 122 withstands temperatures up to 500°F.



Control panels for all MB shakers, as in the photo above, can be furnished with MB Vibration Meter for use with pickup. This meter gives direct velocity, acceleration and amplitudes of the picked-up vibration.



Bulletins you'll welcome

How to calibrate vibration pickups to 2000 cps – Bulletin C-11-5 reviews the subject comprehensively. Bulletin 1-VE-5 tells all about MB Vibration Exciters. Write for them.

THE MB MANUFACTURING COMPANY, INC.
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HEADQUARTERS FOR PRODUCTS TO INDUCE VIBRATION...TO MEASURE IT...TO ISOLATE IT

. . . Here's all the latest design and engineering data on

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Write for the new 56-page Stackpole Catalog RC-9 for complete charts, graphs, formulas, and detailed specifications on these dependable components.

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

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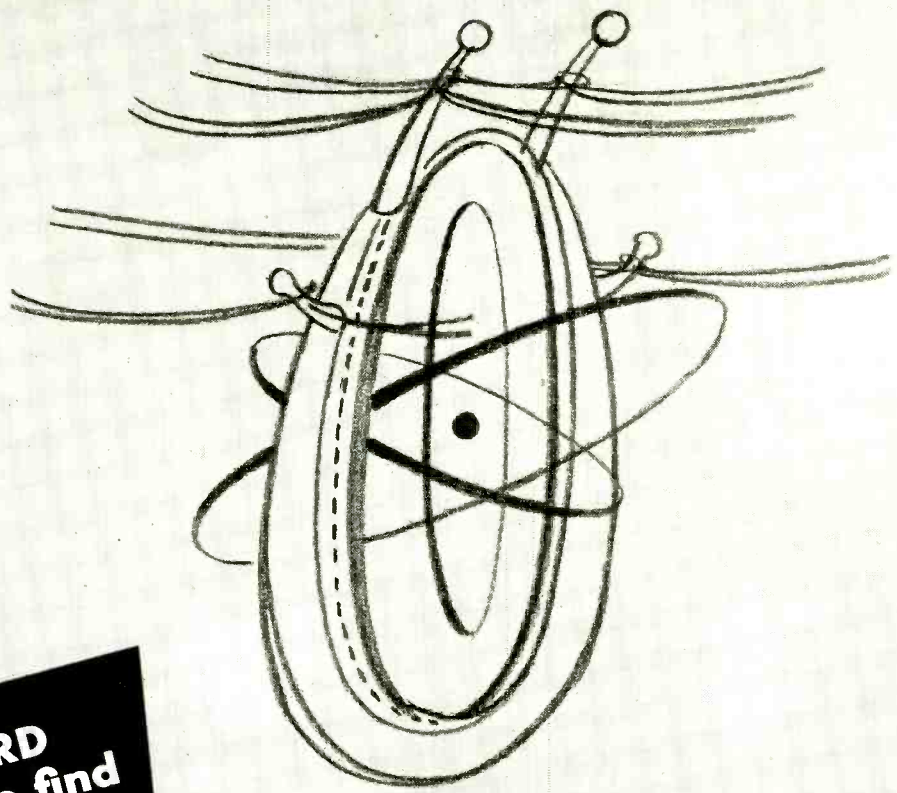
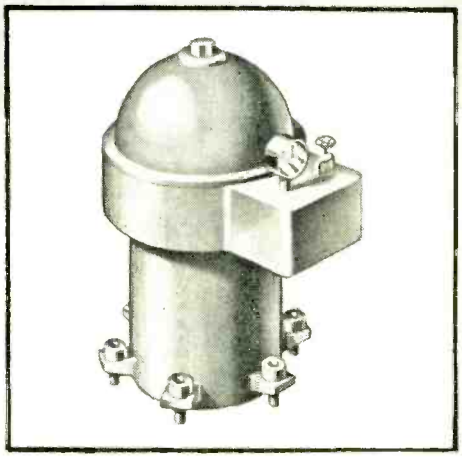
HOW TO MAKE A HARNESS
for an Atom



. . . and FORD was asked to find the answer



Taming the monster power of a nuclear reactor requires precision control of all the elements. Ford Instrument is designing controls that seek and hold the optimum power level of the pile . . . and keep the rods so exactly set that the reactor's energy is harnessed . . . safely, securely.

This is typical of the problems that Ford has been given by the Armed Forces since 1915. For from the vast engineering and production facilities of the Ford Instrument Company, come the mechanical, hydraulic, electric, magnetic and electronic instruments that bring us our "tomorrows" today. Control problems of both Industry and the Military are Ford specialties.

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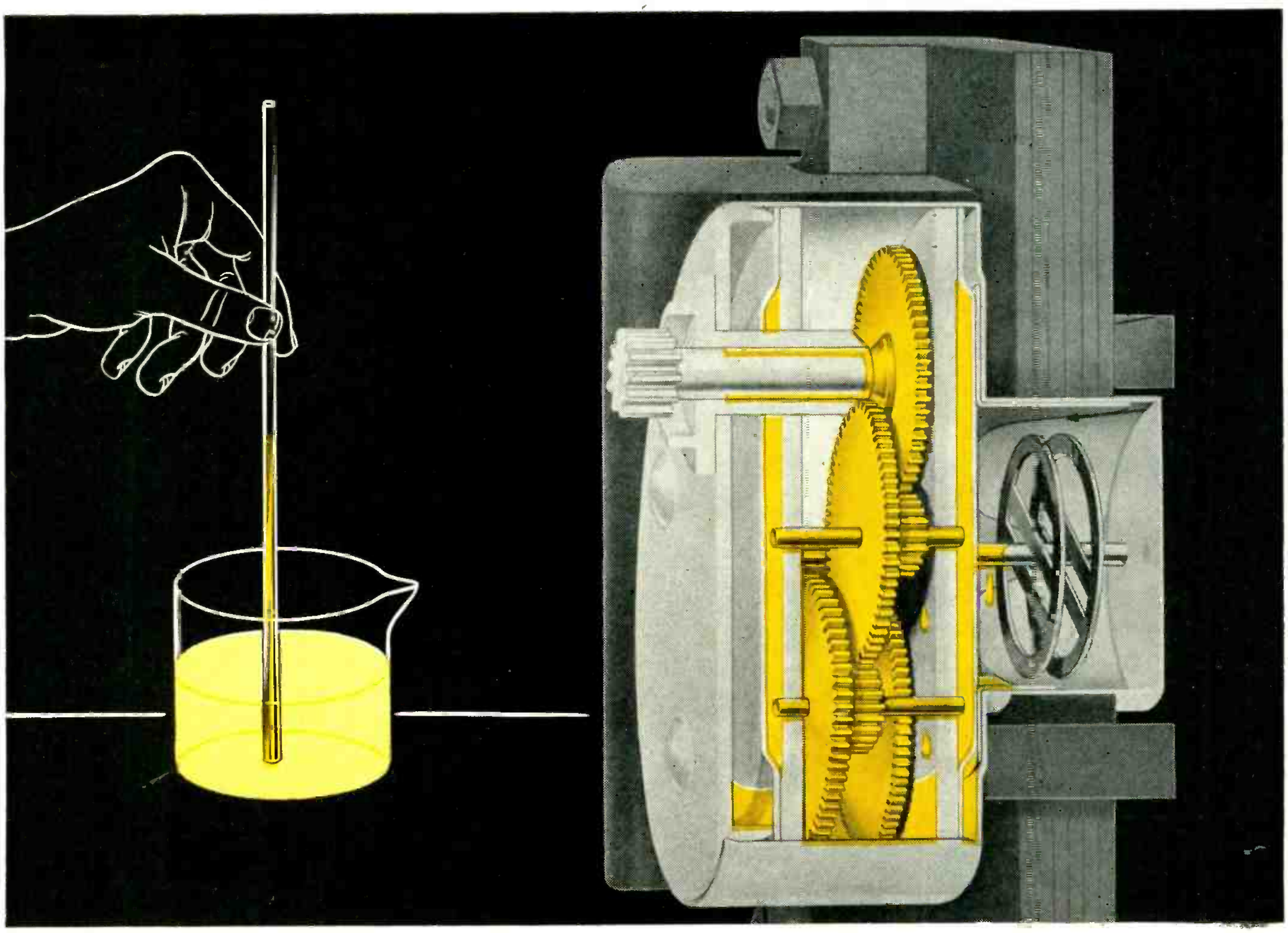
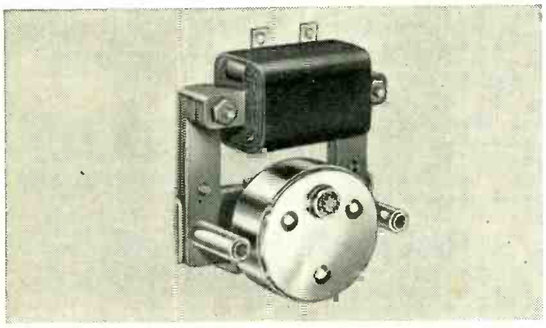


MORE evidence of the extra VALUE in TELECHRON timing motors . . .



Lubrication is only part of the Telechron motor story. Lightweight rotors assure quick starting. Gears are hobbed for quiet operation. Power-line accuracy means true synchronous performance. Separation of the field from the rotor results in cooler operation and longer life.

The accurate, dependable, inexpensive Telechron Synchronous Motor is the heart of timing you see everywhere . . . in clock-radios, washers and dryers; in heating controls, refrigerator defrosters and air conditioners . . . in industrial time switches, recorders and instrumentation.

CAPILLARY ACTION FEEDS OIL TO MOVING PARTS

One secret of the lasting accuracy of a Telechron timing motor is its exclusive sealed-in system of lubrication.

Each Telechron motor carries just the right amount of oil, locked-in against dirt and dust. The oil is drawn up the spaces between bearings and capillary plates by the same free-flowing process that pulls water up the hollow stem of a plant—or a glass tube. Bearings are constantly covered with a thin coating of oil.

This way the oil lasts the life of the motor—which, with a Telechron timing motor, can be for years and years.

Write for complete catalog and full information on our Application Engineering Service. Telechron Department, General Electric Company, 45 Homer Avenue, Ashland, Mass.

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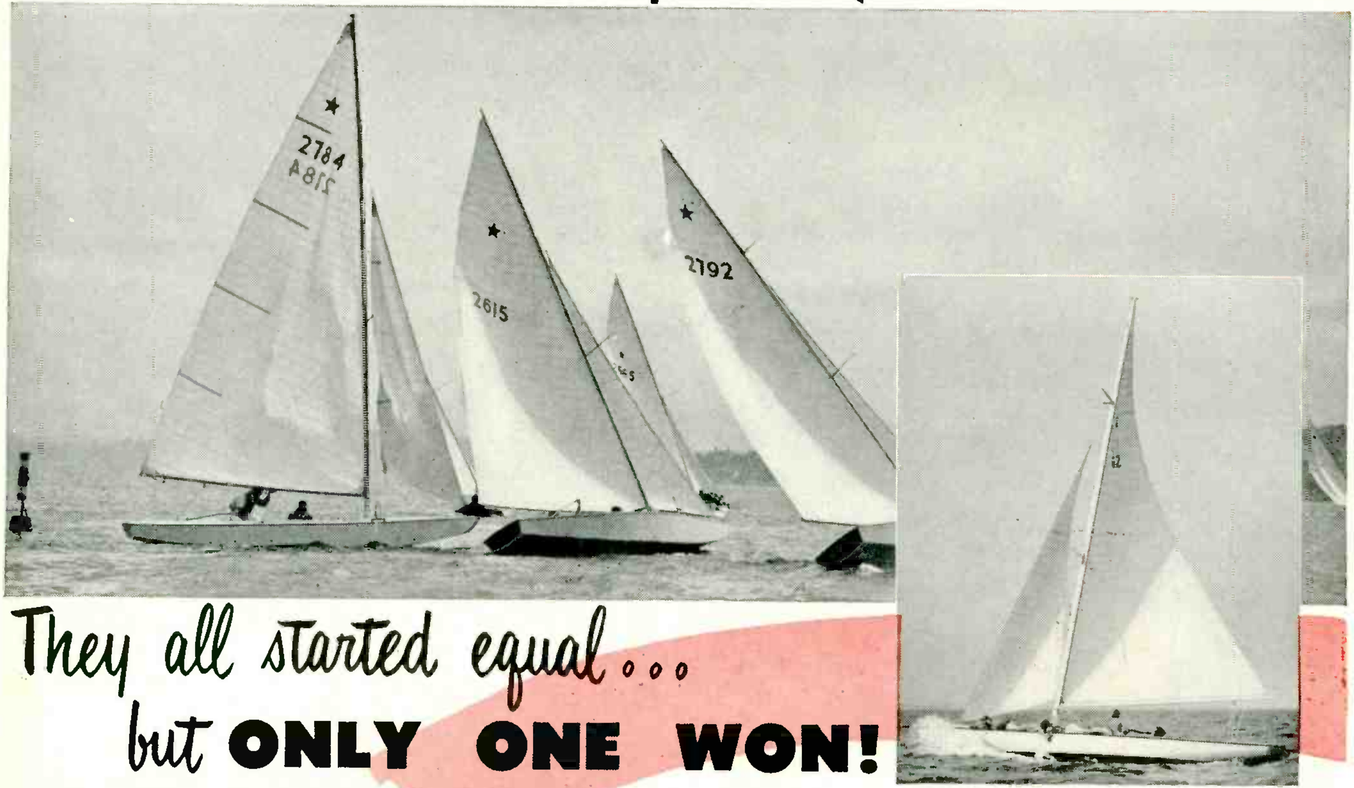
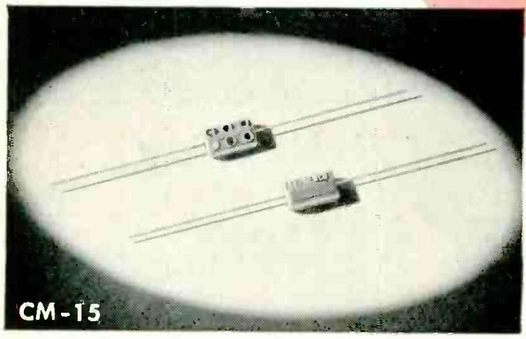
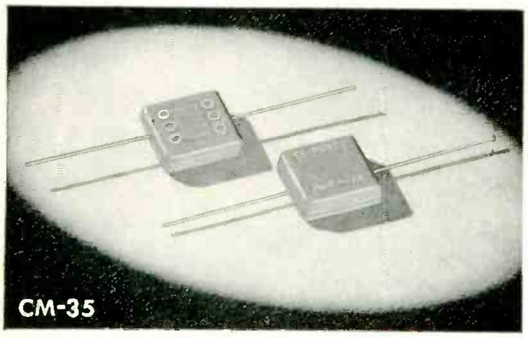
ONLY ONE—out of many—IS FIRST



They all started equal...
but ONLY ONE WON!





A spanking breeze across the bay . . . the echoing boom of the race steward's deck cannon . . . ropes and sails straining for advantage of position. Each boat, sleek and ship-shape, is out to win — but only *one* will come in first.

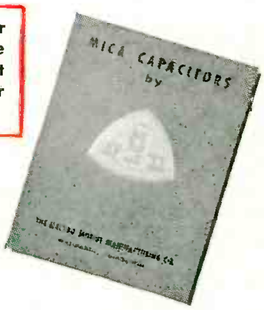
...most capacitors start even, too

. . . but EL MENCO Capacitors always win first place in specification requirements because their superiority and dependability have been *proven*. They're factory-tested at more than double their working voltage . . . they're guaranteed stable under the most adverse conditions of application.

No matter what your requirements — from the mighty high-capacity CM-35 (5-10,000 mmf) to the midget low-capacity CM-15 (2-525 mmf) — EL MENCO gives you superior job-rated, job-tested performance. They're built to win!

Electro Motive is now supplying special silvered mica films for the electronic and communication industries in any quantity — just send us your specifications.

Jobbers and Distributors are requested to write for information to Arco Electronics, Inc., 103 Lafayette St., New York, N. Y. — large stocks on hand — spot shipments for immediate delivery. Sole Agent for Jobbers and Distributors in U. S. and Canada.



WRITE FOR FREE SAMPLES AND CATALOG ON YOUR FIRM'S LETTERHEAD

El-Menco

MOLDED MICA — **CAPACITORS** — **MICA TRIMMER**

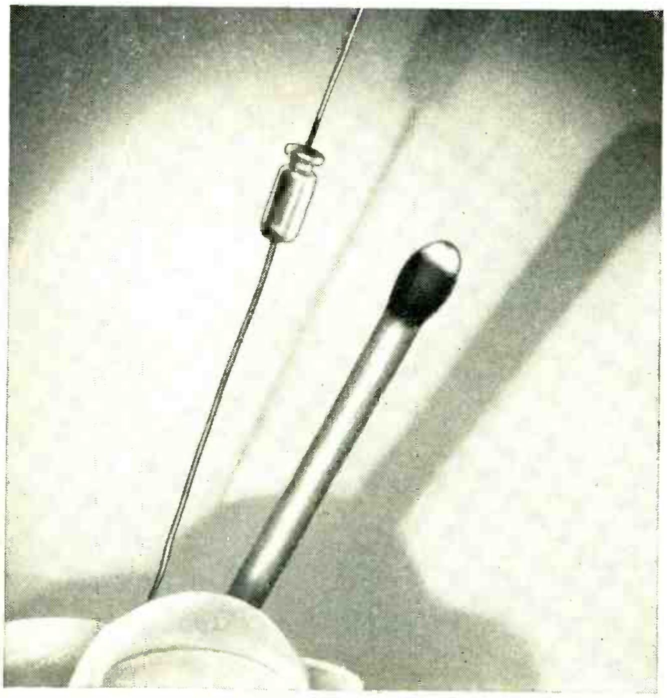
Foreign Electronic Manufacturers Get Information Direct from our Export Dept. at Willimantic, Conn.

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

Want more information? Use post card on last page.

DESIGNER'S

Micro-miniature Tantalytic capacitors give new design flexibility

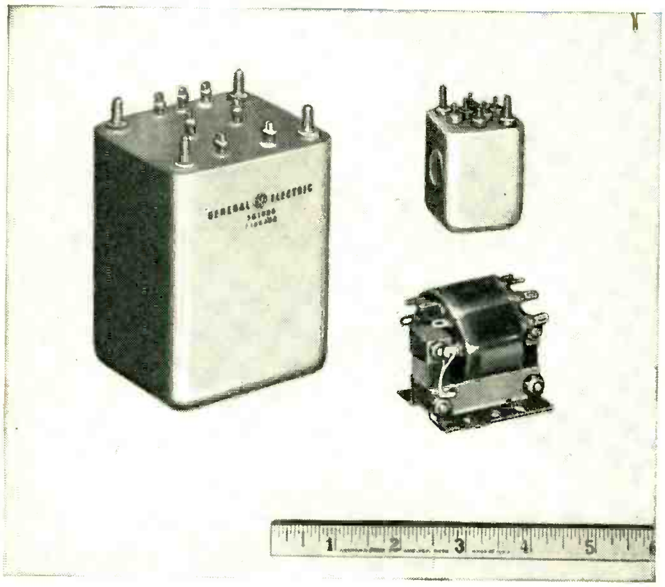


Smallest electrolytic capacitors commercially available

Micro-miniature Tantalytic capacitors can now be supplied in ratings up to 20 volts, or, up to 8 microfarads in the $\frac{5}{16}''$ long case—higher capacitance in a $\frac{1}{2}''$ case size . . . with -0% to $+100\%$ capacitance tolerance. They give you new design flexibility in low-voltage, d-c circuits—particularly transistorized subminiature assemblies where space is at a premium.

Designed especially for nonresonant, noncritical applications such as coupling, by-pass and filtering, G-E micro-miniature Tantalytic capacitors outperform aluminum electrolytics in electrical stability, operating and shelf life because of the inert characteristics of tantalum metal. They operate over a -20C to $+50$C range and may be stored at -65C. With some capacitance derating, Tantalytic capacitors perform well below -20C—with some life limitations they will also perform satisfactorily above $+50$C.

You may obtain samples 2 to 3 weeks after your order is received at the factory. Production lots are supplied 6 to 8 weeks after the order is received. For more information see your G-E Apparatus Sales representative, or write for Bulletin GEA-6065.



G.E. builds dependability into electronic transformers—3 ways

From laboratory samples to the last production model, dependability is built into G-E electronic transformers. Here's how:

1. INTEGRATED FACILITIES: G-E labs, testing facilities, and materials sources are co-ordinated to help get you the transformers you want—when you want them.

2. MECHANIZATION: The G-E plant is mechanized and staffed to handle large-quantity production, while maintaining laboratory sample quality.

3. EXPERIENCE: G-E personnel have worked hand-in-hand with electronics manufacturers for years and consequently keep *your* problems in mind as they produce transformers for your particular, specialized applications. See your G-E Apparatus Sales representative for more information.

GENERAL ELECTRIC

DIGEST

TIMELY HIGHLIGHTS ON G-E COMPONENTS

New electronic relays have high sensitivity

This new electronic resistance-sensitive relay is able to amplify minute currents carried by very delicate contacts. Even a wet thread will provide enough signal for it to operate.

Sensitivity level is set by adjusting dial, which can be locked in place. The relay may be remotely controlled from as far away as 500 feet. Each can be set for either "normal" (relay "drops-out") or "reverse" (relay "picks-up") operation of the magnetic relay included in the device.

Built for long life, its enclosure is weather-resistant and dust-tight. Terminals are easily accessible; all components of this G-E relay are open for ease in servicing. For further information send for Bulletin GEA-5893.

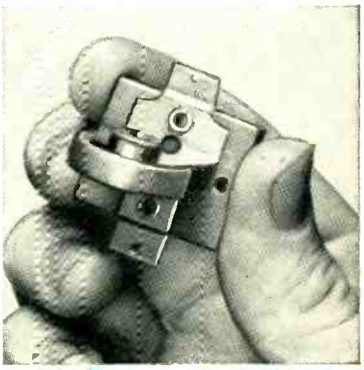
Fast, accurate circuit analysis

This self-contained, highly stable G-E self-balancing potentiometer rapidly converts small d-c voltages to measureable currents—*without* loading the measured circuit—for analysis of electronic circuits. It is consistently accurate because simple controls, and automatic, rapid circuit balance minimize operator errors. Easily changed resistor permits selection of input ranges from 100 microvolts to one volt d-c full scale with 5-milliampere d-c output. See Bulletin GEC-367.

Tiny signals amplified

Combining amplifying and rectifying elements in a unit, G-E amplistats (self-saturating magnetic amplifiers) "sense" small signal changes, amplify them greatly, and impart the amplified signal to a system to obtain the desired control. They give you the practical advantages of virtually instantaneous response, low power consumption, long life, and electrical signal isolation. Obtain assistance in applying G-E amplistats at your G-E Apparatus Sales Office. See Bulletin GEA-5950.

Small rectifier has high output



G-E germanium rectifiers offer the highest output in the smallest of rectifiers. For example, the dime-sized, sealed, air-cooled type is available in ratings up to 50 volts, 0.4 amperes d-c. Germanium rectifiers have these advantages: ***high efficiency***—operate 98% to 99% efficient; ***compactness***—small size and weight per watt output means you can build more compact assemblies; and ***long life***—two-year life tests show no detectable aging. Write for Bulletin GEA-5773.

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 A667–28, Schenectady 5, New York

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

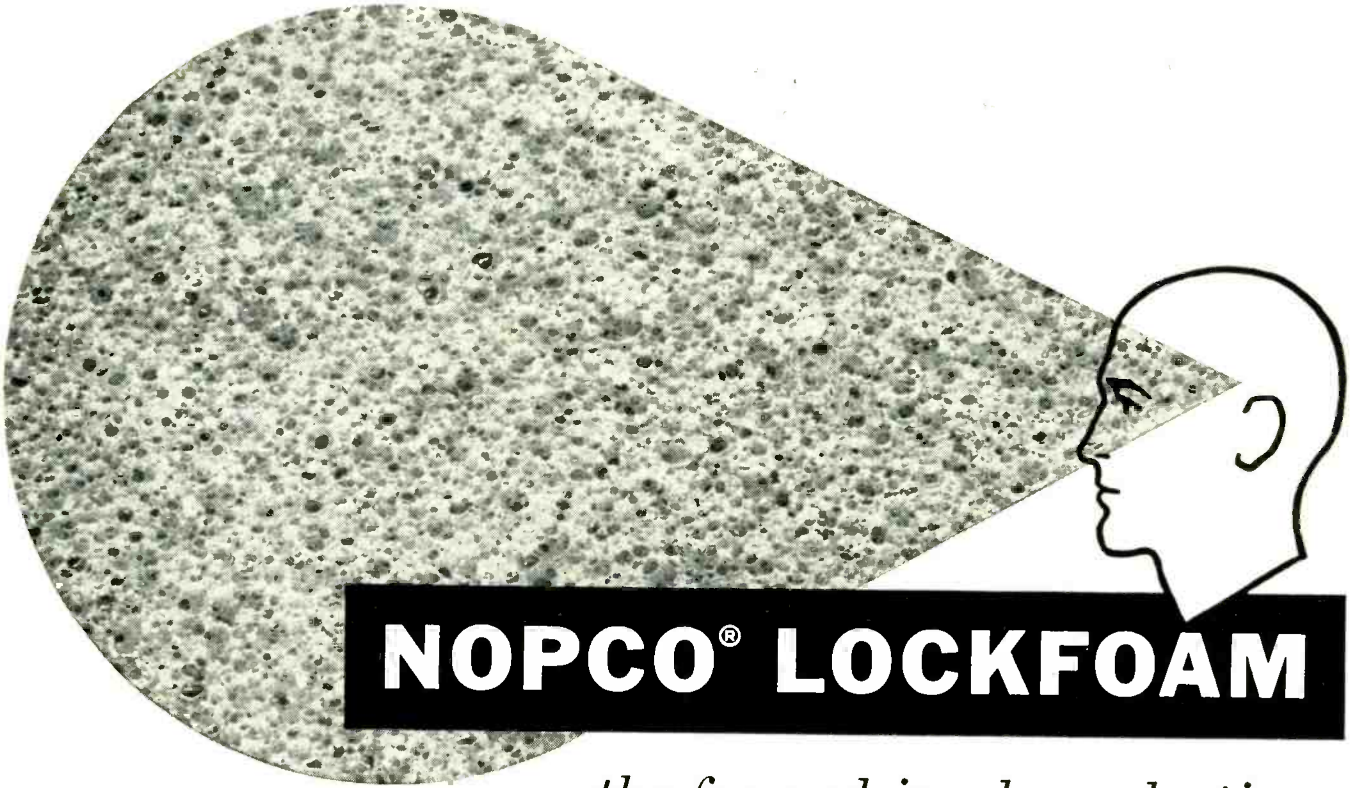
- ☐ **GEA-5773 Germanium Rectifiers**
- ☐ **GEA-5893 Electronic Resistance Sensitive Relay**
- ☐ **GEA-5950 Amplistats**
- ☐ **GEA-6065 Micro-miniature Tantalytic Capacitors**
- ☐ **GEC-367 Self-balancing Potentiometer**

Name ....

Company ....

City .... State ....

Want more information? Use post card on last page.



NOPCO® LOCKFOAM

...the foamed-in-place plastic that places no limits on your ingenuity!

Where Can YOU Best Use These Properties?

Near-perfect
Radar Transmission

Ease of Fabrication
It's "poured-in-place"

Great Strength
with Light Weight

Excellent Electrical Properties
6 lb/cu ft Lockfoam tested
at 9.375 KMC
Dielectric Constant 1.05
Loss Tangent .0005

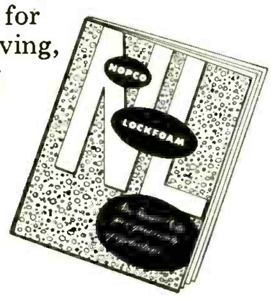
Good Thermal Insulation
"K" Factors
.018 at 8 lb/cu ft
to .025 at 11 lb/cu ft

Wide Range of Densities
From 2 to 35 lb/cu ft

Great Versatility
50 different formulations
available

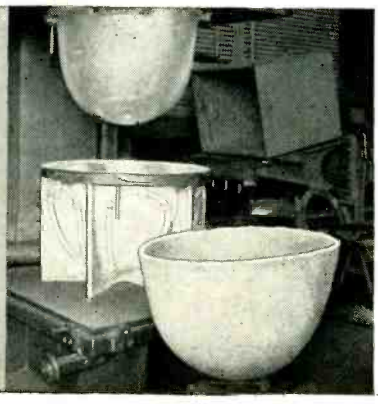
The magnificent range of physical and electrical properties of Nopco Lockfoam—plus its unique pour-in-place versatility and convenience—is rapidly finding many applications in electrical and electronic manufacturing, as well as in aviation.

For Nopco Lockfoam literally "goes where you want it"—fills exactly the configurations of any cavity into which it is poured. It is ideal for fabricating lenses for electronic devices. It is ideal as a space-saving, vibration-free potting material for holding electrical components of circuits in a fixed position. It is sure to find many other practical uses.



You'll surely want the full story. Write today for the Nopco Lockfoam booklet.

AIRPLANE RADOMES, for both military and civilian planes, are but one of the first conspicuous uses which have taken advantage of Nopco Lockfoam's excellent electrical properties, its strength/weight ratios, and the simplicity and economy resulting from its pour-in-place technique.



Plastics Division
NOPCO
CHEMICAL COMPANY
Harrison, New Jersey
Cedartown, Ga. • Richmond, Calif.

NOPCO TRADEMARK EVOLVED THRU RESEARCH

NEW LOS ANGELES BRANCH. To aid West Coast manufacturers with complete field service on Nopco Lockfoam, our new office at 4858 Valley Blvd., Los Angeles 32, is now ready to serve you. Drop in and get acquainted, or write.

Want more information? Use post card on last page.

LAMBDA'S NEW "600 MA" SERIES

OF HEAVY DUTY, PRECISION REGULATED POWER SUPPLIES

FOUR VOLTAGE RANGES...WITH AND WITHOUT METERS

Rack Model 62 (without meters) $239.50
(Also illustrates Models 63, 64 and 65)

Rack Model 62M (with meters) $269.50
(Also illustrates Models 63M, 64M and 65M)

These new, compactly engineered LAMBDA models supply load currents up to 600 MA in the following voltage ranges:

Model 62 and 62M	**245-305 VDC @ 0-600 MA, regulated**
Model 63 and 63M	**195-255 VDC @ 0-600 MA, regulated**
Model 64 and 64M	**100-200 VDC @ 0-600 MA, regulated**
Model 65 and 65M	**0-100 VDC @ 50-600 MA, regulated**

Equipment in the "600 MA" series is designed for standard 19" rack mounting. Efficient design has made possible a panel height of only 12¼" with a depth behind panel of only 9". Intended primarily for fixed voltage use, these models are adjustable over the voltage ranges indicated.

Models 62, 63, 64 and 65 are excellent sources of power for racks of equipment. Representative applications are for television studio and transmitter equipment, tube ageing apparatus, computer installations, and multi-channel equipment. These models are well suited to all installations where comparatively large amounts of power are required. They are rated for industrial applications, based on continuous-duty operation at maximum ratings.

SCHEDULE OF PRICES

Model 62	$239.50	Model 64	$244.50
Model 62M	269.50	Model 64M	274.50
Model 63	239.50	Model 65	249.50
Model 63M	269.50	Model 65M	279.50

Available for immediate delivery. Prices F.O.B. factory, Corona, N.Y.

SPECIFICATIONS FOR "600 MA" SERIES

Input:
105-125VAC, 50-60C, 775W (Model 62);
715W (Model 63); 675W (Model 64); 585W (Model 65)

DC Output (regulated)
Voltage and currents:

Models	Voltage range*	Current range**
62 & 62M	245-305VDC	0-600MA
63 & 63M	195-255VDC	0-600MA
64 & 64M	100-200VDC	0-600MA
65 & 65M	0-100VDC	50-600MA

**Voltage range for any given model is completely covered in four continuously variable bands.*
***Current rating applies over entire voltage range.*

Regulation (line)............Better than 0.15% or 0.3V
Regulation (load)...........Better than 0.25% or 0.3V
Impedance.........................Less than 2 ohms
Ripple and Noise.............Less than 5 millivolts rms
Polarity.....Either positive or negative may be grounded

AC Output (unregulated):
6.5VAC at 20A (at 115VAC input). Allows for voltage drop in connecting leads. Isolated and ungrounded.

Ambient Temperature and Duty Cycle:
Continuous duty at full load up to 50°C (122°F) ambient.

Controls, Terminals and Overload Protection:

DC output controls:	Band-switches and screwdriver adjusting vernier-control, rear of chassis
AC and DC switches:	Front panel
External overload protection:	AC and DC fuses, front panel
Internal failure protection:	Fuses, rear of chassis
Input and output terminals:	Barrier terminal block, rear of chassis

Meters:
3½" rectangular voltmeter and milliameter (Models 62M, 63M, 64M and 65M only).

Voltage Reference Tube:
A stable 5651 voltage reference tube is used to obtain superior long-time voltage stability.

Time-Delay Relay Circuit:
A 30-second time-delay relay circuit is provided to allow tube heaters to come to proper operating temperatures before high-voltage can be applied.

Size, Weight, Panel Finish:

Size:	Standard 19" relay-rack mounting 12¼" H x 19" W x 9" D
Weight:	70 lb. net; 140 lb., shipping
Panel Finish:	Black ripple enamel (standard)

LAMBDA ELECTRONICS CORP.
103-02 NORTHERN BOULEVARD CORONA 68, NEW YORK

Want more information? Use post card on last page.

They'll be safely across before the traffic starts

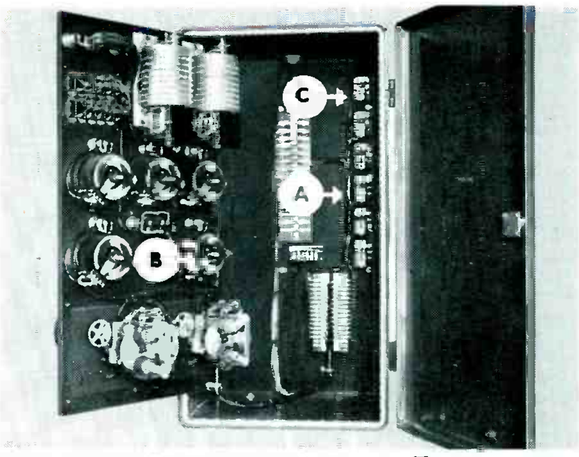
... thanks to Ward Leonard relays in Trafflex Controllers that time Buffalo's lights

• Unfailing performance twenty-four hours a day is vital in the Crouse-Hinds Trafflex control system that directs traffic in Buffalo, N.Y., and many other major cities.

The safe continuous movement of traffic is automatically regulated by predetermined timing cycles in Trafflex Master Controllers. They speed up or slow down the secondary controllers that operate the traffic lights.

Four Ward Leonard relays in each master control are used for the automatic selection of five timing cycles that control the Trafflex Secondaries and the lights themselves. Two more of these dependable relays provide for remote control of off-duty flashing amber signals and signal shut-down. Two others indicate which of three timing dials in the Trafflex Secondary Controls is operating.

If long life and thorough dependability under the most adverse operating conditions are important in your product, it will pay you to select electrical controls from Ward Leonard's complete line.

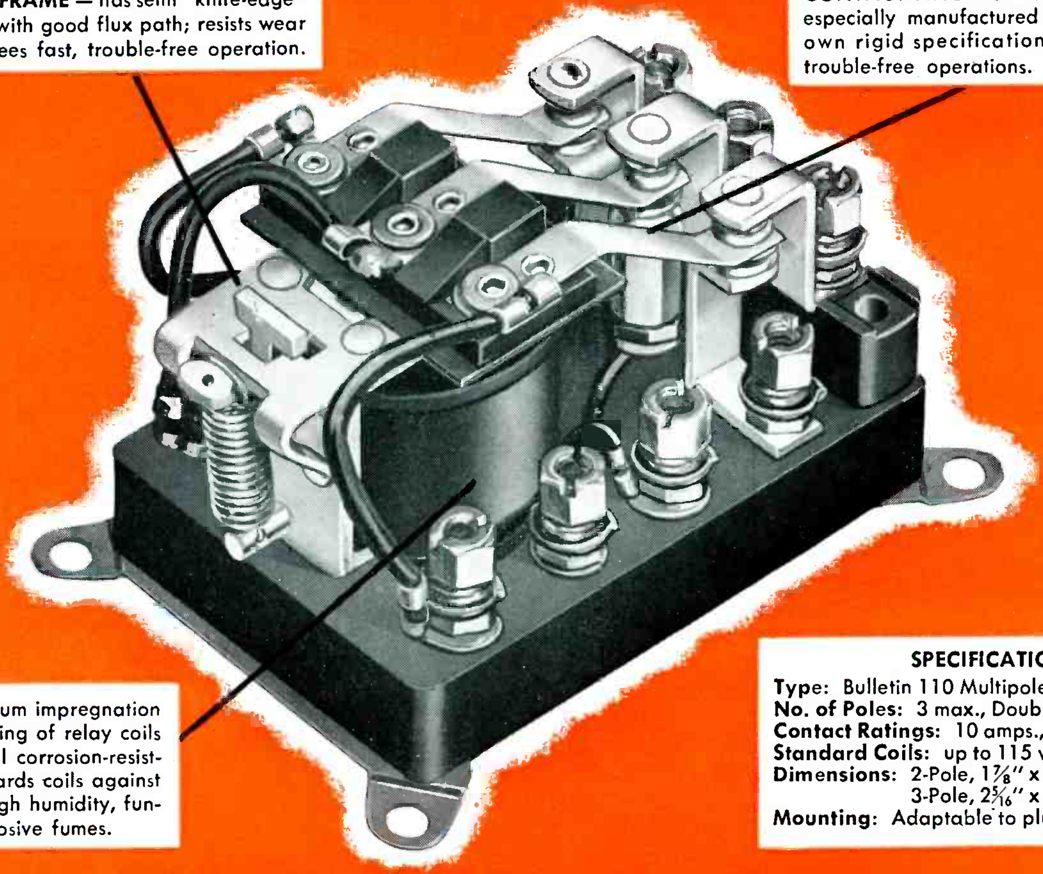


WARD LEONARD BULLETIN 110 RELAYS in Trafflex Master Controller are used for: A. Automatic selection of one of five timing cycles. B. Operation of pilot lights indicating which of three timing dials in Trafflex Secondaries is in use. C. Remote control of off-duty flashing amber and remote control of signal shut-down for entire system.

WARD LEONARD
ELECTRIC COMPANY
MOUNT VERNON, NEW YORK

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

Result-Engineered Controls Since 1892



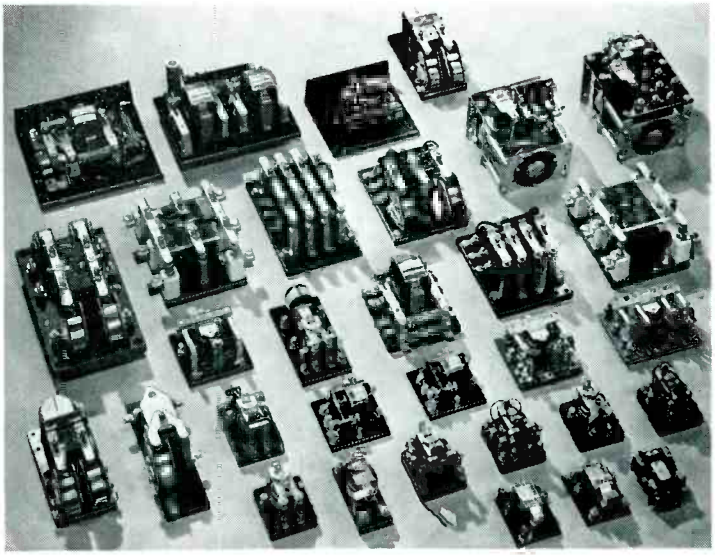
SPECIFICATIONS

Type: Bulletin 110 Multipole Midget
No. of Poles: 3 max., Double Throw
Contact Ratings: 10 amps., 115 volts, A.C. max.
Standard Coils: up to 115 volts, A.C. or D.C.
Dimensions: 2-Pole, $1\frac{7}{8}$" x 3" x $1\frac{7}{8}$" high
3-Pole, $2\frac{5}{16}$" x $3\frac{5}{16}$" x $1\frac{7}{8}$" high
Mounting: Adaptable to plug-in mounting

Here's why you get long life from Ward Leonard relays

• When applied properly and given normal care, Bulletin 110 relays, shown above, have a life expectancy of several million operations. Such exceptionally long life, typical of Ward Leonard's relay line, is made possible by: 1. Good mechanical design. 2. Quality-controlled manufacturing methods and materials. 3. Ample "safety-factor" electrically and mechanically.

Whether your product is a complex electronic instrument or a simple household gadget, our engineers will be glad to help you select the dependable electrical controls you need. Write Ward Leonard Electric Co., 200 South St., Mount Vernon, New York.



SHOWN AT RIGHT are typical Ward Leonard relays designed to meet your specific requirements in dimensions, methods of mounting, circuit connections, contact materials, coils and other features.

WARD LEONARD
ELECTRIC COMPANY
MOUNT VERNON, NEW YORK

Result-Engineered Controls Since 1892

Check these:

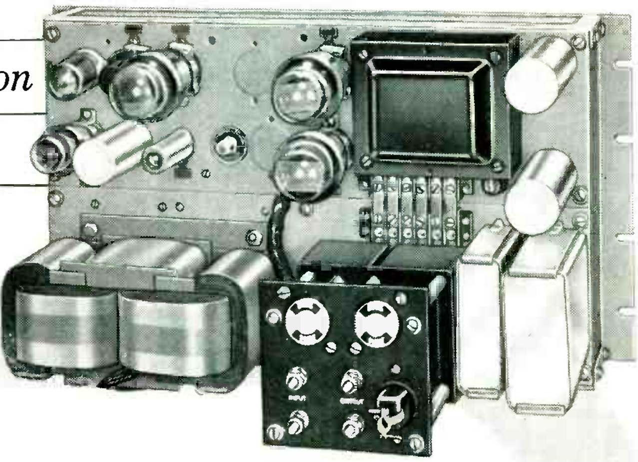
Stabilizing and Regulating Ability

Correction Speed

Waveform Distortion

Input Range

Output Range



and you will specify

STABILINE TYPE IE

Instantaneous Electronic

AUTOMATIC VOLTAGE REGULATORS

Here's how the Stabiline type IE measures up:

Stabilizing and regulating ability — For all conditions maximum variation less than ±.25 of 1%. For input voltage changes, variation less than ±0.1 of 1%. Load current change or power factor change from lagging .5 to leading .9 will vary output voltage less than ±.15 of 1%.

Correction speed — Comparatively instantaneous — 3 to 10 cycles.

Waveform distortion — Never exceeds 3%. Is generally under 2%.

Input Range—For nominal 115 volts output, input range is 95 to 135 volts. For nominal 230 volts output, input range is 195 to 255 volts.

Output Range — Output voltage on 115 volt units can be adjusted from 110 to 120 volts; on 230 volt units from 220 to 240 volts.

Furthermore, the Stabiline type IE has a circuit simplicity and mechanical ruggedness that minimizes maintenance.

Check all these characteristics against all other automatic voltage regulators and you will find Stabiline type IE is *superior* in design, construction and performance.

Stabiline automatic voltage regulators type IE are available in ratings from .25 to 5.0 KVA. Special types will be application engineered to meet specific requirements.

Send Coupon Today for Bulletin S351

THE SUPERIOR ELECTRIC COMPANY

BRISTOL, CONNECTICUT

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

Send Coupon Today

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

Please send my copy of Bulletin S351

Name ....

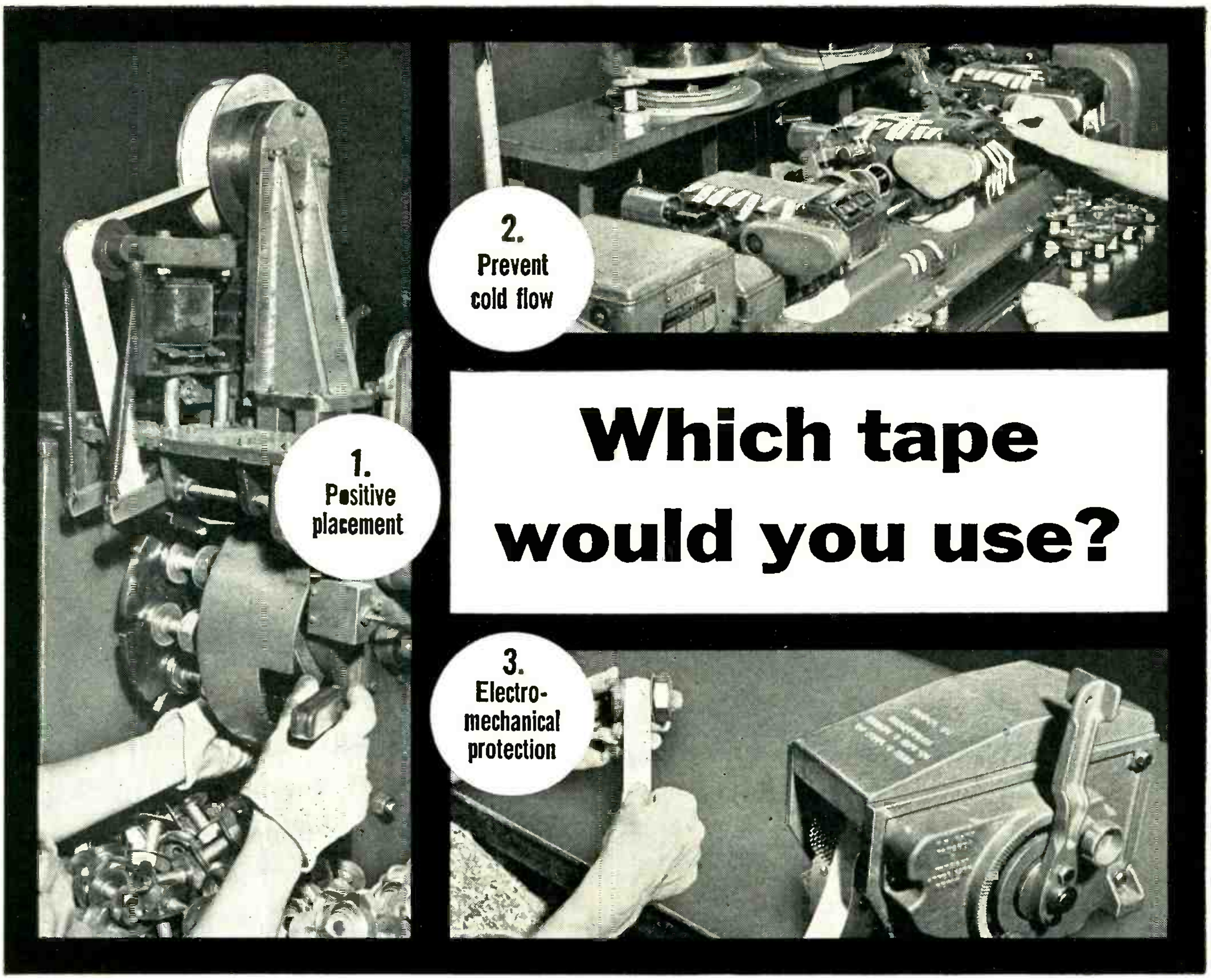
Position ....

Co. Name ....

Co. Address ....

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

Want more information? Use post card on last page.



Our tape engineers made these recommendations...

1 "Scotch" Electrical Tape No. 8 to insulate bobbin cores on solenoid gas valves. Acetate fibre backing prevents wire cutting thru to metal bobbin at 90°C. Provides a dielectric barrier.

2 "Scotch" Electrical Tape No. 38 to hold end discs in place. Thermosetting adhesive is heat-cured for powerful bond. Gives positive placement at 90°C.

3 "Scotch" Electrical Tape No. 29 to anchor valve coil leads for gas furnaces. Cloth backing and thermosetting adhesive resist 90°C. operating temperature. No. 29 has maximum conformance and holding power. Good abrasion resistance.

Our engineers got this assignment from one of the world's largest manufacturers of electronic controls. Our engineers checked the properties of over 25 pressure-sensitive tapes in the "Scotch" Brand Electrical Tape family before they chose the three best tapes for the jobs.

Our engineers can be *your* engineers whenever you have a job for tape. Just write Minnesota Mining and Manufacturing Company, Dept. ES-54, St. Paul 6, Minnesota, outlining your needs. That's the easiest way to make certain of top-quality results with no money wasted. There's no charge or obligation.

REG. U.S. PAT. OFF.
SCOTCH Electrical Tapes
BRAND

The term "Scotch" and the plaid design are registered trademarks for the more than 300 pressure-sensitive adhesive tapes made in U.S.A. by Minnesota Mining and Manufacturing Company, St. Paul 6, Minn.—also makers of "Scotch" Sound Recording Tape, "Underseal" Rubberized Coating, "Scotchlite" Reflective Sheeting, "Safety-Walk" Non-slip Surfacing, "3M" Abrasives, "3M" Adhesives. General Export: 122 E. 42nd St., New York 17, N. Y. In Canada: London, Ont., Can.

3M COMPANY

Want more information? Use post card on last page.

WHY PHELPS THE FILM

PHELPS DODGE round, square and rectangular Formvar magnet wires are the result of the finest engineering and research. They offer better space factors, outstanding forming and winding properties, excellent abrasion and solvent resistance. When used in the proper design, Phelps Dodge Formvars permit quality improvements in the insulation system that result in reduction of over-all costs.

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

First for Lasting Quality—from Mine to Market!

DODGE FORMVAR HAS BECOME

YARDSTICK FOR WIRE QUALITY!

- Leader in Application Engineering
- Pioneered Development of Square and Rectangular Formvar
- Quality Controlled for Maximum Performance
- Experience Over Complete Range

PHELPS DODGE · COPPER PRODUCTS CORPORATION · P D · MINE TO MARKET · REG. U. S. PAT. OFF.

PHELPS DODGE COPPER PRODUCTS CORPORATION

INCA MANUFACTURING DIVISION

FORT WAYNE, INDIANA

Want more information? Use post card on last page.

NOW—the modern successor to the galvanometer

the new *ElectroniK* Null Indicator

electrical characteristics

INPUT IMPEDANCE
1500 ohms

CURRENT SENSITIVITY
0.6 x 10^{-9} amperes per millimeter

VOLTAGE SENSITIVITY
1 microvolt per millimeter

OPERATING VOLTAGE
115 volts, 60 cycles

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

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

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

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

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

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

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

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

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

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.

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

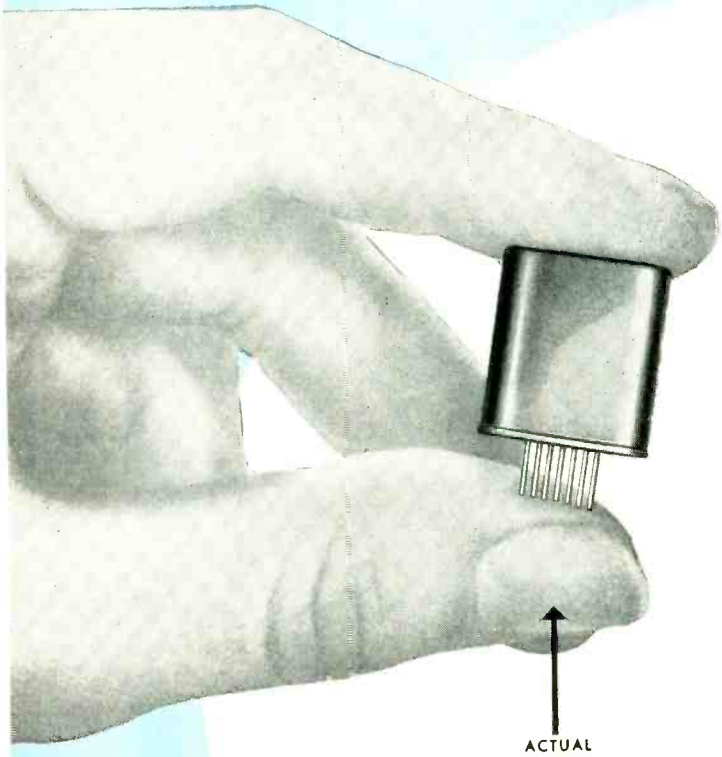
H HONEYWELL

MINNEAPOLIS
Honeywell
BROWN INSTRUMENTS

First in Controls

New Sub-Miniature Relay

APPLICABLE TO PRINTED CIRCUITS



ACTUAL SIZE

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

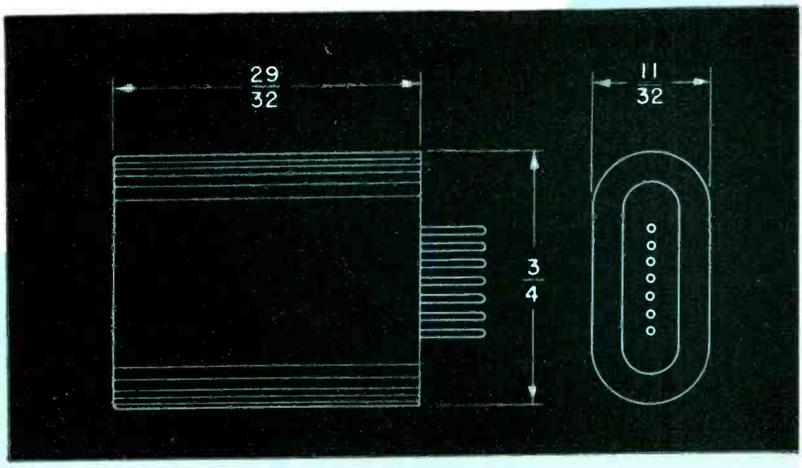
SHOCK: 50G plus (operating)

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



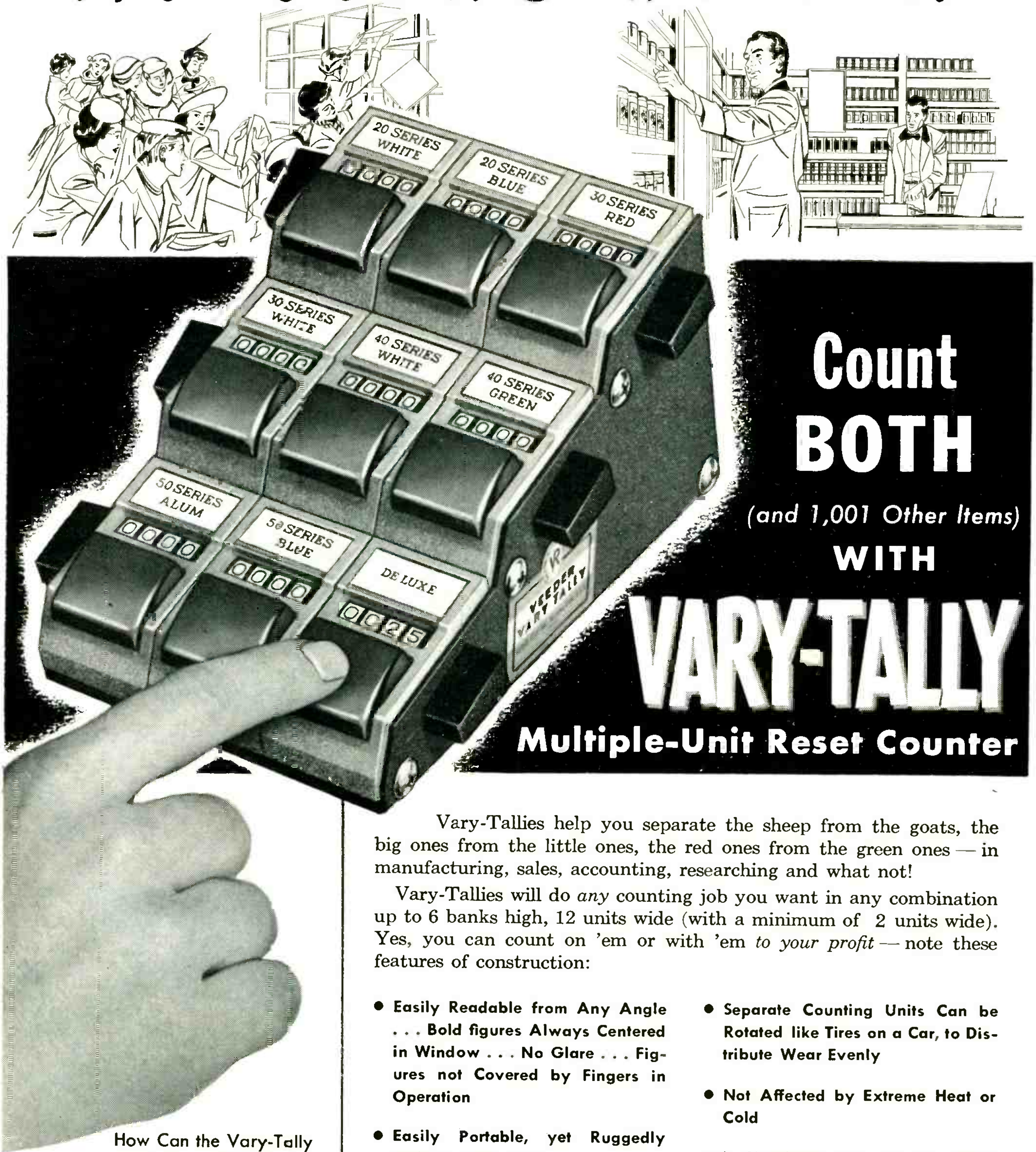
Write for catalog sheet giving complete information

ALLIED CONTROL

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

AL159

Fast Movers or Shelf Warmers?



Count BOTH

(and 1,001 Other Items)

WITH

VARY-TALLY

Multiple-Unit Reset Counter

Vary-Tallies help you separate the sheep from the goats, the big ones from the little ones, the red ones from the green ones — in manufacturing, sales, accounting, researching and what not!

Vary-Tallies will do *any* counting job you want in any combination up to 6 banks high, 12 units wide (with a minimum of 2 units wide). Yes, you can count on 'em or with 'em *to your profit* — note these features of construction:

- **Easily Readable from Any Angle . . . Bold figures Always Centered in Window . . . No Glare . . . Figures not Covered by Fingers in Operation**
- **Easily Portable, yet Ruggedly Built for Long Wear**
- **All Parts Corrosion-Resistant; Working parts of Hardened Steel**
- **Separate Counting Units Can be Rotated like Tires on a Car, to Distribute Wear Evenly**
- **Not Affected by Extreme Heat or Cold**
- **Individual Tag Above Each Counter-Window — Not Strip Tabs**
- **Veeder-Root Quality in Every Part**

How Can the Vary-Tally count for you? Write for news sheet and prices.

"The Name that Counts"®

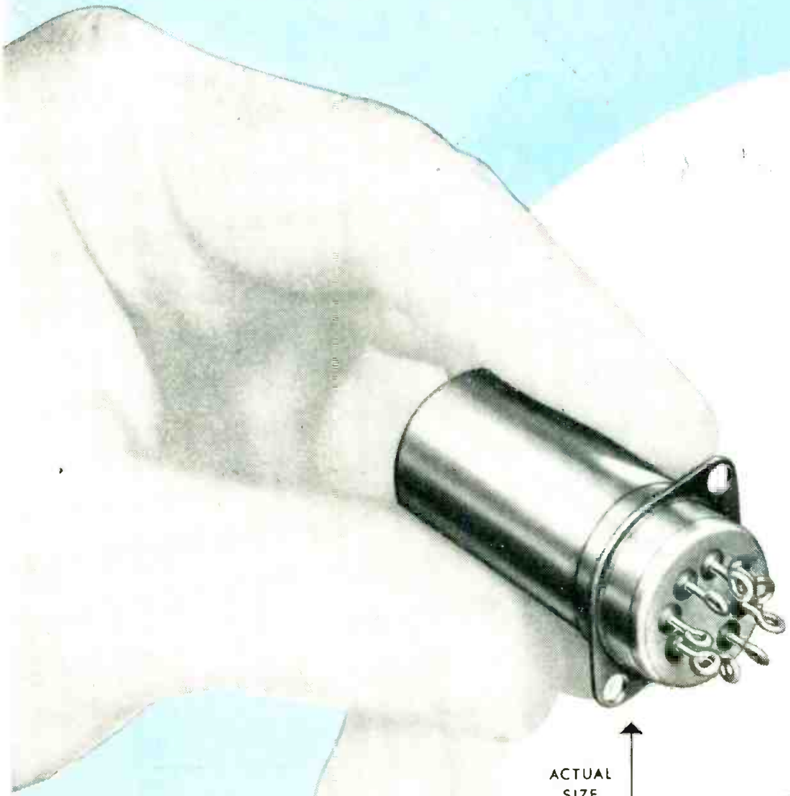
VEEDER-ROOT INC.

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

New ¾" Sensitive Relay

APPLICABLE TO PRINTED CIRCUITS



ACTUAL SIZE

ALLIED TYPE RSH has sensitivity of 40 milliwatts in D.P.D.T. and 22 milliwatts in S.P.D.T.

ELECTRICAL SPECIFICATIONS

CONTACTS: Up to D.P.D.T. rated at 2 amperes at 26.5 volts DC or 115 volts AC resistive load

COIL: Sensitivity—40 milliwatts D.P.D.T.
22 milliwatts S.P.D.T.
Resistance—up to 14,000 ohms

TEMPERATURE: Minus 60° C to plus 125° C

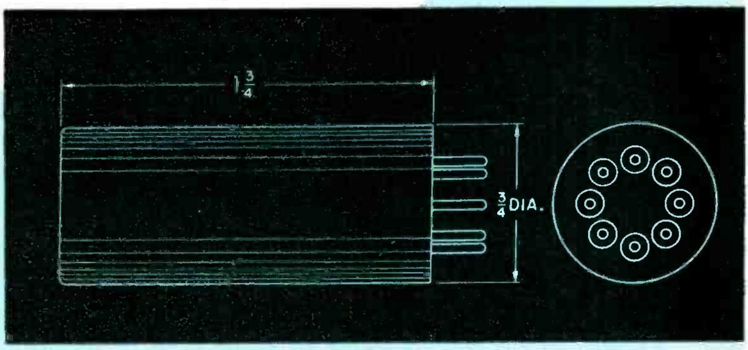
VIBRATION: 10G up to 500 cycles

SHOCK: 50G plus (operating)

ALTITUDE: 80,000 feet or 1.3 inches of mercury

TERMINAL TYPE: Solder and plug-in printed circuit.

WEIGHT: 2 ounces

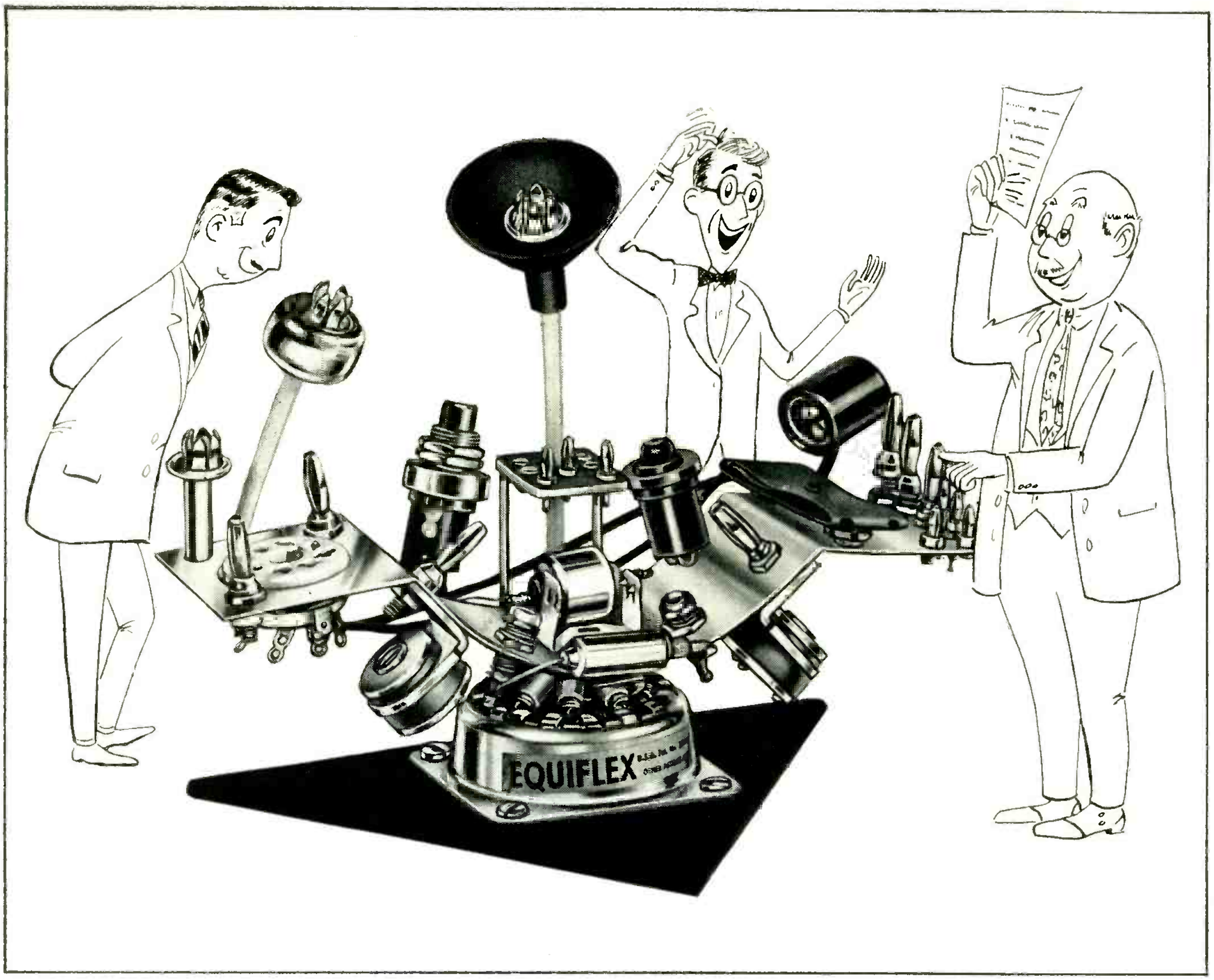


Write for catalog sheet giving complete information

ALLIED CONTROL

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

AL 136



For Weighing Important Decisions . . .

Ucinite's Judicial Gravity scale is worth its weight in paper work. It balances opinions, senses trends and shows which way the wind blows. A built-in tilting mechanism enables it to lean over backwards to be fair. Extra equipment includes a special attachment that automatically delivers weighty judgments. Though this revolutionary device has not yet been released for civilian or government use, its component parts are all available in quantity from Ucinite.

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. Call your nearest Ucinite or United-Carr representative for full information or write directly to us.

ELECTRICAL ASSEMBLIES
Ucinite
RADIO AND AUTOMOTIVE

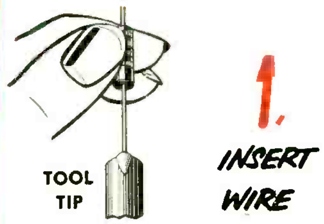
The UCINITE CO.
Newtonville 60, Mass.
Division of United-Carr Fastener Corp.

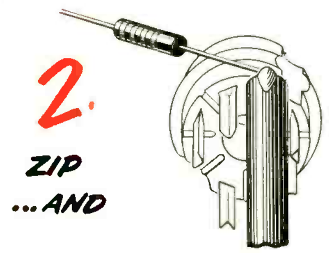
Specialists in
ELECTRICAL ASSEMBLIES, RADIO AND AUTOMOTIVE

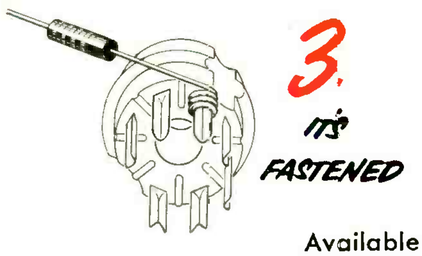
MAKE *Wire-Wrap** CONNECTIONS *in half the time!*

*Trademark

Keller "*Wire-Wrap*" Tools produce electrical connections that need no soldering







Available in air or electric models

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

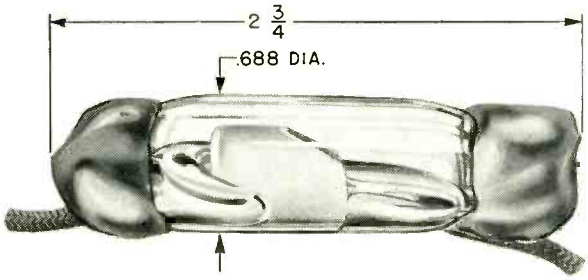
Wire-Wrap Division

KELLER TOOL COMPANY
1335 Fulton Street Grand Haven, Michigan

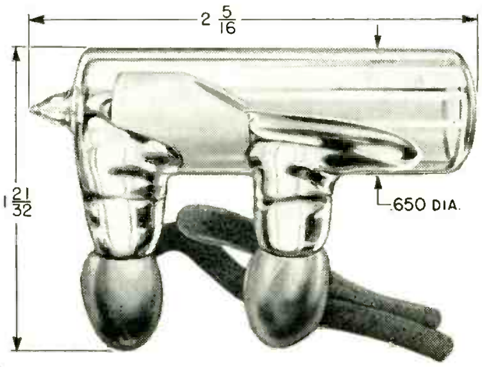
KELLER TOOLS

Want more information? Use post card on last page.

HONEYWELL Mercury Switches
A PRINCIPLE OF GOOD DESIGN



YES,
you can have
HIGH CAPACITY



in a Mercury Switch

These Heavy Duty HONEYWELL Mercury Switches combine long life and reliability with the capacity to make and break steady state currents up to 45 amperes. They will handle inrush currents as high as 144 amperes.

Whenever your design or application shows a mercury switch to be indicated, there is a HONEYWELL Mercury Switch to meet your requirement. Among these are:

- **Protected mercury switches**
- **General purpose mercury switches**
- **Small mercury switches**
- **Sensitive mercury switches**

MICRO SWITCH engineers, experienced in every type of switching problem, are located at 16 branch offices to help you select the switch for your application. Call the nearest MICRO SWITCH branch office. Ask for Mercury Switch Catalog 90.

MICRO SWITCH

A DIVISION OF MINNEAPOLIS-HONEYWELL REGULATOR COMPANY
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H HONEYWELL

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BOOTH NO. 340

BASIC MATERIALS EXPOSITION

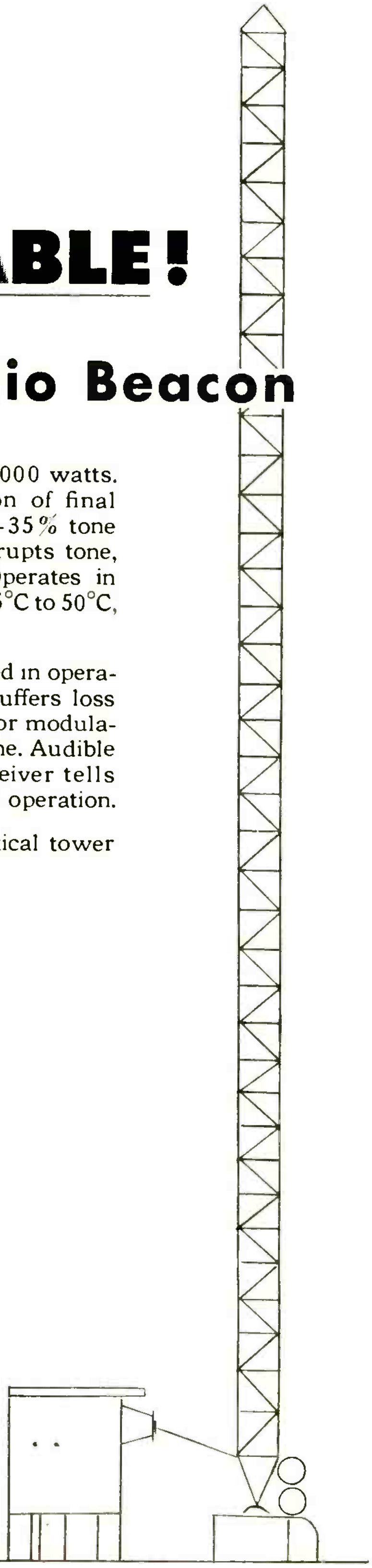
The Product Development Show

CHICAGO • MAY 17-20, 1954

AER -O- COM

DEFINITELY DEPENDABLE!

Aerocom's Dual Automatic Radio Beacon



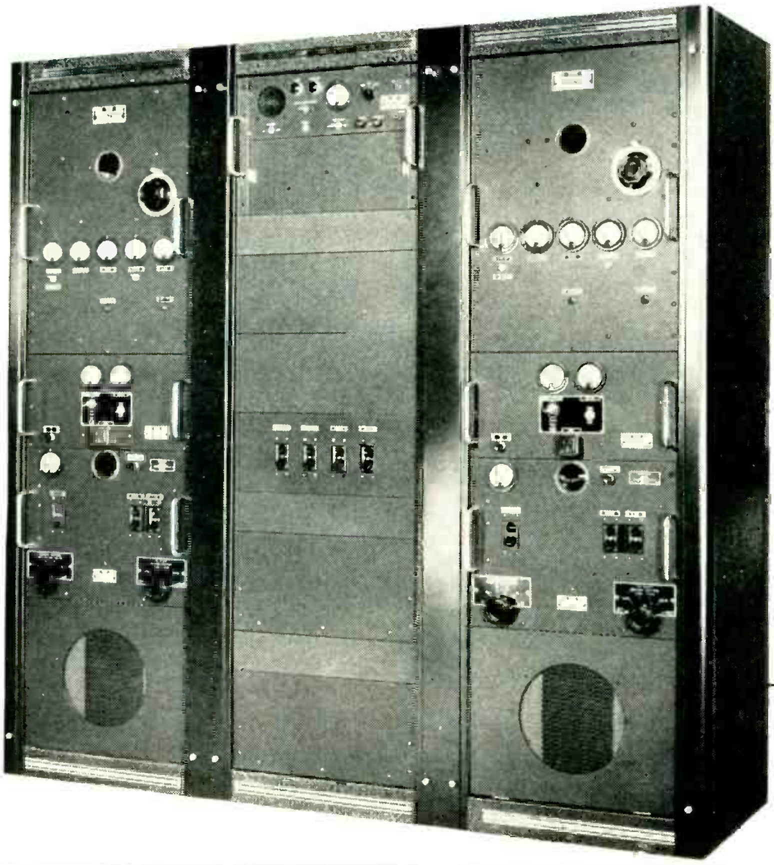
Reliability is built into every part of this dual 1000-watt aerophare unit. Ruggedly constructed and conservatively rated, it provides trouble-free unattended service, and at truly low operating and maintenance cost. It operates in the frequency range 200-415 kcs, using plug-in crystal for desired frequency.

Uses single phase power supply, nominal 220 volts, 50 or 60 cycles. Consists of two 1 kw transmitters with keyer (2 keyers if desired), automatic transfer unit and weatherproof antenna tuner. Each transmitter housed in separate standard rack cabinet, with controls in rack cabinet between the transmitters.

Nominal carrier power is 1000 watts. High level plate modulation of final amplifier is used, giving 30%-35% tone modulation. P-T switch interrupts tone, permitting voice operation. Operates in ambient temperatures from -35°C to 50°C, humidity up to 95%.

Standby transmitter is placed in operation when main transmitter suffers loss (or low level) of carrier power or modulation, or continuous (30 sec.) tone. Audible indication in monitoring receiver tells when standby transmitter is in operation.

Antenna may be either vertical tower or symmetrical T type.



A-101

AER -O- COM

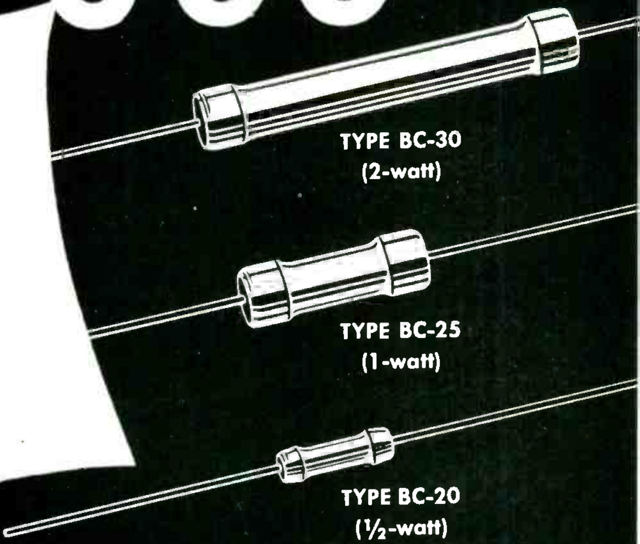
3090 S.W. 37th AVENUE • MIAMI, FLORIDA

Announcing . . .

Shallcross

Borohm®

BORO-CARBON RESISTORS



TYPE BC-30 (2-watt)

TYPE BC-25 (1-watt)

TYPE BC-20 (½-watt)

STABLE—Typical average change after 1000 hours load life test 0.2%.

ACCURATE—Within 1, 2, 5% on all standard types.

LOW T.C.—200 p.p.m. per °C above 20K. 100 p.p.m. per °C below 20K.

RUGGED—Epoxy resin coating remains elastic, cannot crack or chip.

Shallcross Borohm resistors are unusually stable, accurate, and long-lived as a result of Shallcross' basic research on carbon films and manufacturing processes. Complete control of the quality and distribution of the boro-carbon film on specially formulated ceramic rods assures minimum film variation within each unit, as well as from unit to unit.

Automatic machine handling of resistors throughout the carbon deposition process prevents contamination. Rigid automatic control of rod and gas temperatures during deposition eliminates soot formation in the carbon film. Resistance for a given size rod is therefore both predictable and reproducible.

Borohm resistors have negligible voltage coefficient, consistent temperature coefficient, and stability proven by temperature cycling, moisture resistance, and load life tests.

For detailed information as to sizes, styles, ratings, and performance test data results write for the new Shallcross Engineering Bulletin L-33.

1929—Our 25th year—1954

SHALLCROSS MANUFACTURING COMPANY

Representatives in principal U. S. cities, Toronto, Canada, and Vancouver, B. C.

522 PUSEY AVE.
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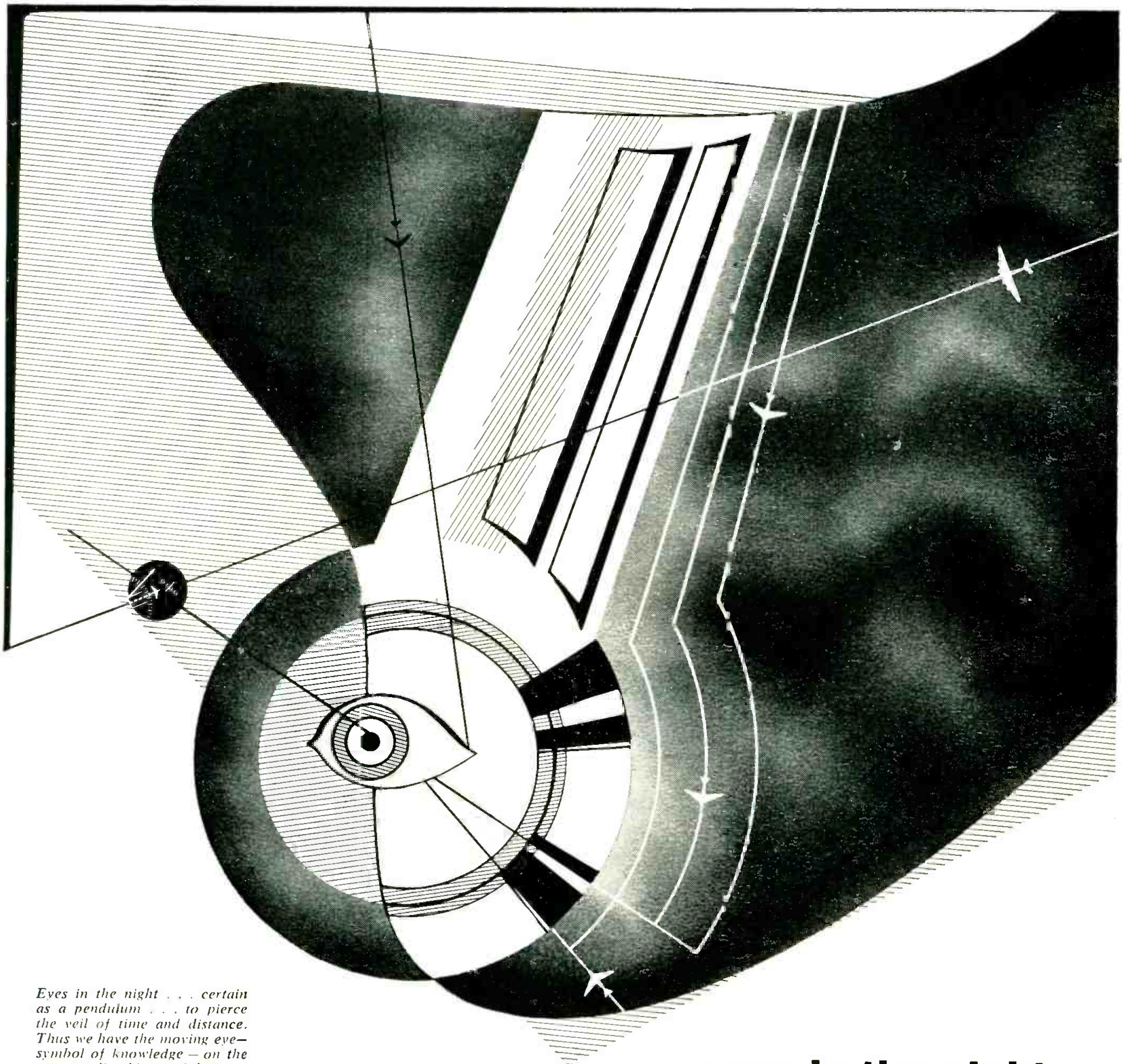

Eyes in the night . . . certain as a pendulum . . . to pierce the veil of time and distance. Thus we have the moving eye—symbol of knowledge — on the ever predictable pendulum.

eyes in the night

The victory over time and darkness is certain with Kollsman instruments. Certain because of our quarter century dedication to accuracy in controls and instrumentation.

Today our activities encompass four fields:

AIRCRAFT INSTRUMENTS AND CONTROLS
OPTICAL PARTS AND DEVICES
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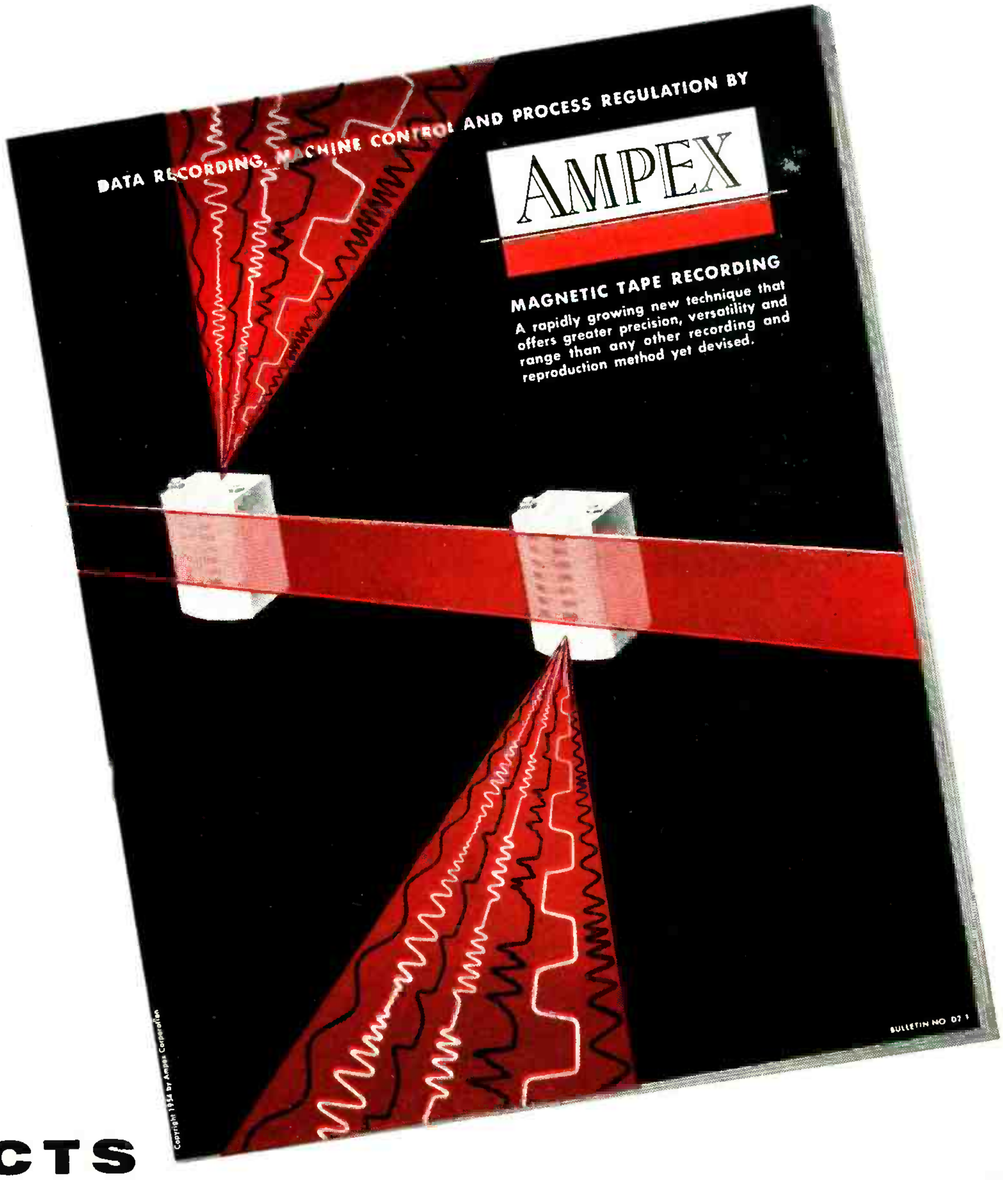
Our manufacturing and research facilities . . . our skills and talents, are available to those seeking solutions to instrumentation and control problems.

kollsman INSTRUMENT CORP.

ELMHURST, NEW YORK • GLENDALE, CALIFORNIA • SUBSIDIARY OF *Standard* COIL PRODUCTS CO. INC.



FACTS ON MAGNETIC RECORDING

the flexible "MEMORY" for science and industry

- In industry today magnetic recorders can "remember" and re-create the motions of skilled machinists, the forces encountered by a truck driving down a test road, the reflections from underground shock waves, the complex control of chemical processes.
- Magnetic recorders have long been at work recording complex data and reproducing it in its original electrical form — ready for automatic reduction and analysis.
- With greater accuracy and less cost than any other method, magnetic tape can "remember" situations encountered in your business — laboratory data, motions, processes and hundreds of kinds of information.

Get the facts in this important new bulletin from the company that has been building magnetic recorders for scientific purposes longer than any other firm. Written in clear, non-technical language, it tells what magnetic recording can do for you.

AMPEX CORPORATION

*Send for your copy today; write Dept. **E-1711***

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BRANCH OFFICES: New York, Chicago, Atlanta, San Francisco and College Park, Maryland (Washington D. C. area)

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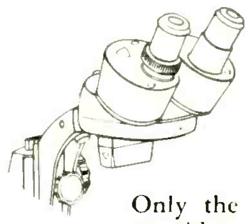
Keeps Production to Capacity . . . All Day Long!

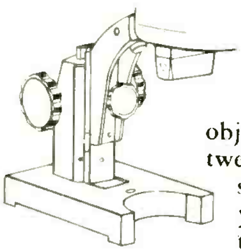
Bausch & Lomb TRANSISTOR MICROSCOPE

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



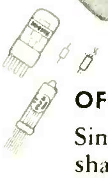
SET AT *ANY* DESIRED ANGLE FOR GREATEST COMFORT — FITS ANY WORK AREA

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.



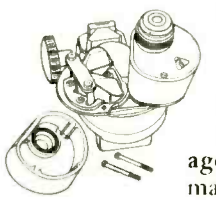
LARGE, UNOBSTRUCTED WORK SPACE PERMITS FASTER, EASIER ASSEMBLY

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.



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.



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

Clamps and gibs lock prisms into lifetime 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., 61429 St. Paul St., Rochester 2, N. Y.

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FXR PRECISION MICROWAVE TEST EQUIPMENT

SPECTRUM ANALYZER
for S-Band and X-Band
with interchangeable R-F Heads

finest in the extreme — for highest quality at lowest cost!

Large scale production usually implies units built to a price. At **FXR** quality materials and performance are the prime factors. But with its expanded facilities and specialized engineering staff, **FXR** more than doubles its volume of precision manufacture. This reflects in lower costs to you, and speedy delivery (only 3 weeks for Spectrum Analyzers). Why pay a premium? Why wait?

- **newly improved design**
- **fully engineered and field-tested units**
- **designed for use in the S-Band and X-Band Microwave Regions**
- **interchangeable R-F Heads — compactly built, stable operation, long life**

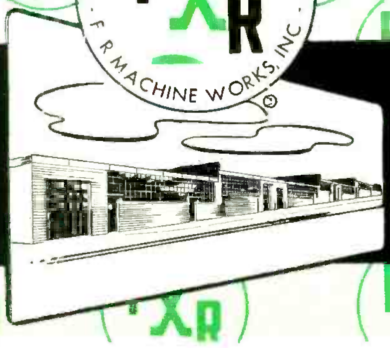
	FXR Type No.
2400 to 3400 Mc	S700A
3000 to 3700 Mc	S700B
8500 to 9600 Mc	X700A

- **only FXR precision microwave components are used in the R-F Head**

Get full details on the COMPLETE LINE of **FXR** Precision Microwave Test Equipment

Write today for Complete Catalog

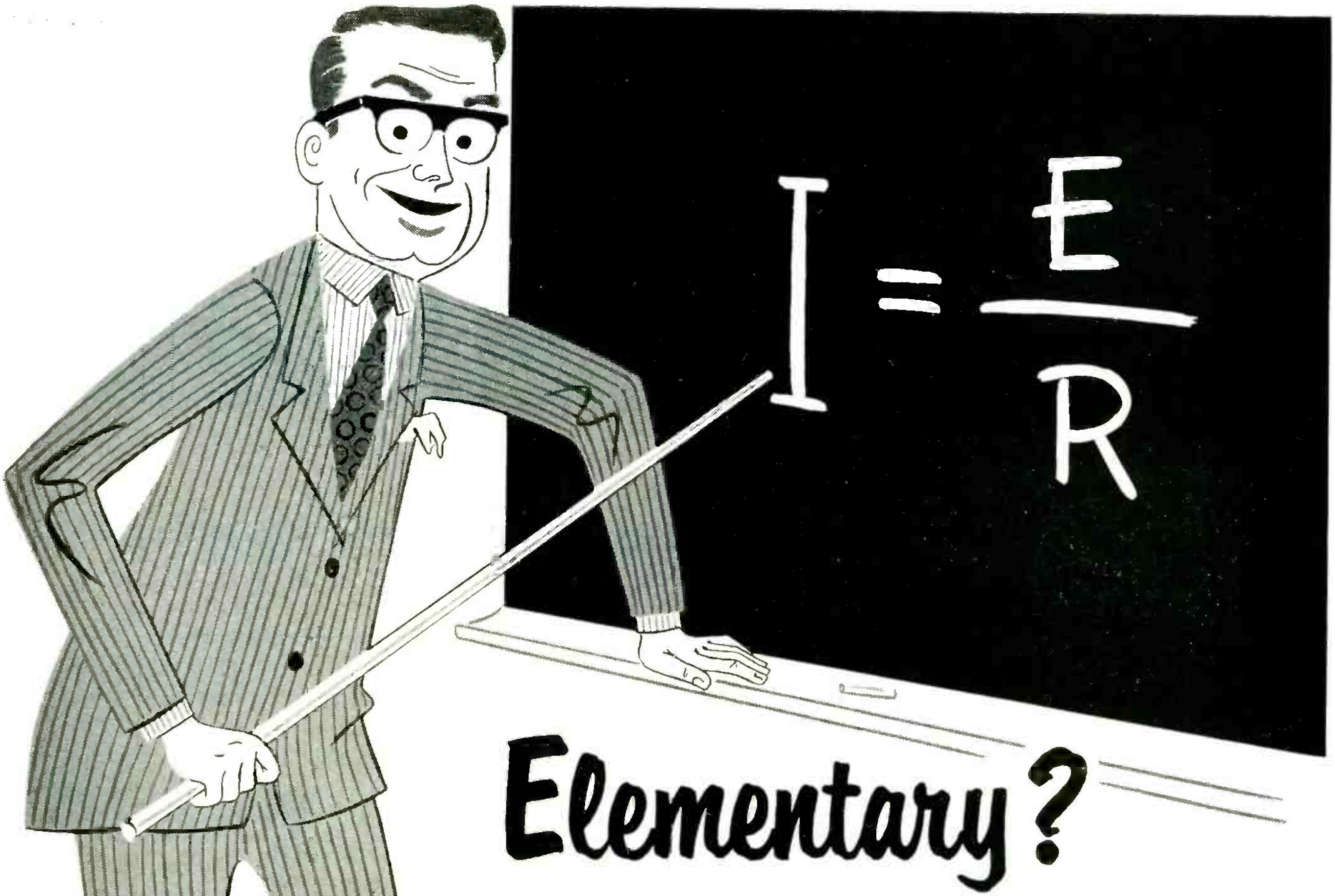
ELECTRONICS & X-RAY DIVISION · F-R MACHINE WORKS, INC. · FXR



Electronics & X-Ray Division

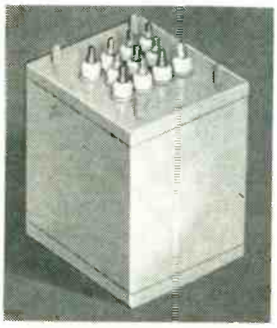
F-R MACHINE WORKS, Inc.

44-14 ASTORIA BOULEVARD, LONG ISLAND CITY 3, N. Y.

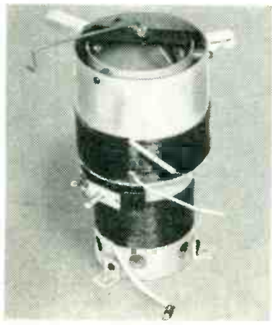


Elementary?

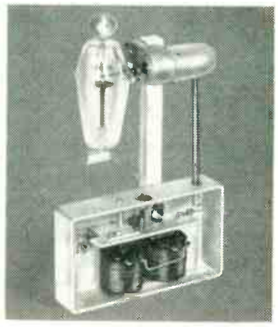
Perhaps. But the only time we won't consider a special purpose development request is when Ohm's Law says "No." Tough assignments are an Islip specialty, and our engineering staff is at YOUR service.



TRANSFORMERS

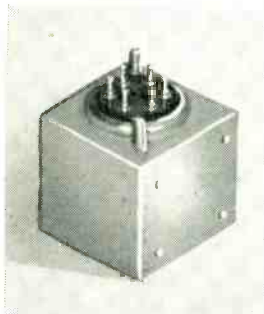


COILS



RELAYS

ISLIP SUPERIOR COMPONENTS FOR EVERY NEED
EXCEEDING COMMERCIAL AND MIL T-27 REQUIREMENTS



REACTORS

How may we help you? Write . . .

ISLIP
TRANSFORMER

ISLIP TRANSFORMER AND METAL COMPANY, INC.
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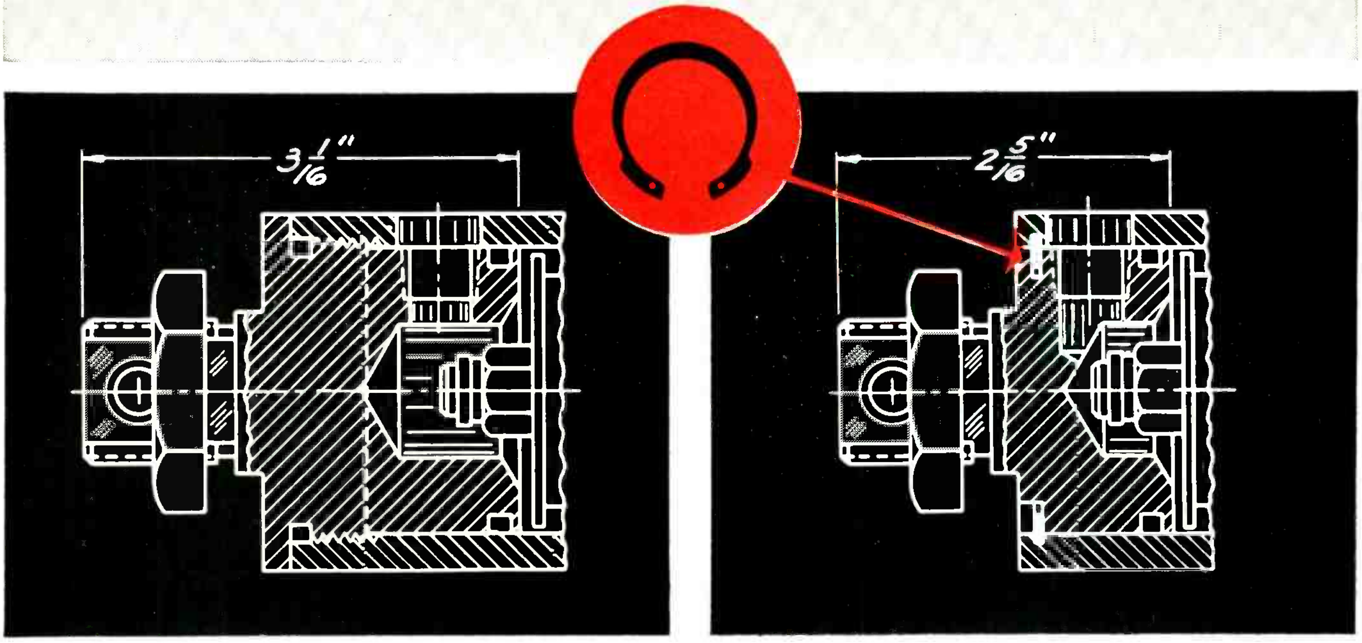
Waldes Truarc Rings Cut Costs $3.26 per Unit, Reduce Size and Weight of Air Cylinder!



OLD STYLE air cylinder, with thread-secured head, required costly tapping, chasing and assembly operations. Also, satisfactory maintenance of packing unit necessitated use of pipe wrenches on painted surfaces.

NEW cylinder head is secured with precision-ground Waldes Truarc Rings. This produces perfect alignment of head within the housing, difficult to obtain with screw-thread seating. Maintenance is quick and easy.

WALDES TRUARC RINGS PERMITTED THESE SAVINGS

Production Time Cut	17 minutes
Weight Saved	1¾ lb.
Length Shortened	1½ inches
Cost Saved	$3.26 unit

■ The A. K. Allen Company of Brooklyn, New York, maker of *AllenAir* cylinders, now uses two Waldes Truarc Inverted Rings (series 5008) to secure heads rigidly within tubes.

■ TRUARC Rings, in this application, are ground parallel by A. K. Allen to .001 tolerance. In a static hydraulic bursting test, the 3" unit (recommended for 350 p.s.i.) withstands a pressure of 2000 p.s.i. And at bursting-point, the brass groove gives way; the Truarc Ring remains intact.

■ Waldes Truarc Retaining Rings are precision-engineered . . . quick and easy to assemble and to disassemble. They can be used over and over again. There's a Waldes Truarc Ring to answer every fastening problem.

■ Find out what Waldes Truarc Retaining Rings can do for you. Send your blueprints to Waldes Truarc engineers.

For precision internal grooving and undercutting . . . Waldes Truarc Grooving Tool

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.

E056

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

Please send me the new Waldes Truarc Retaining Ring catalog.

(Please print)

Name..........

Title..........

Company..........

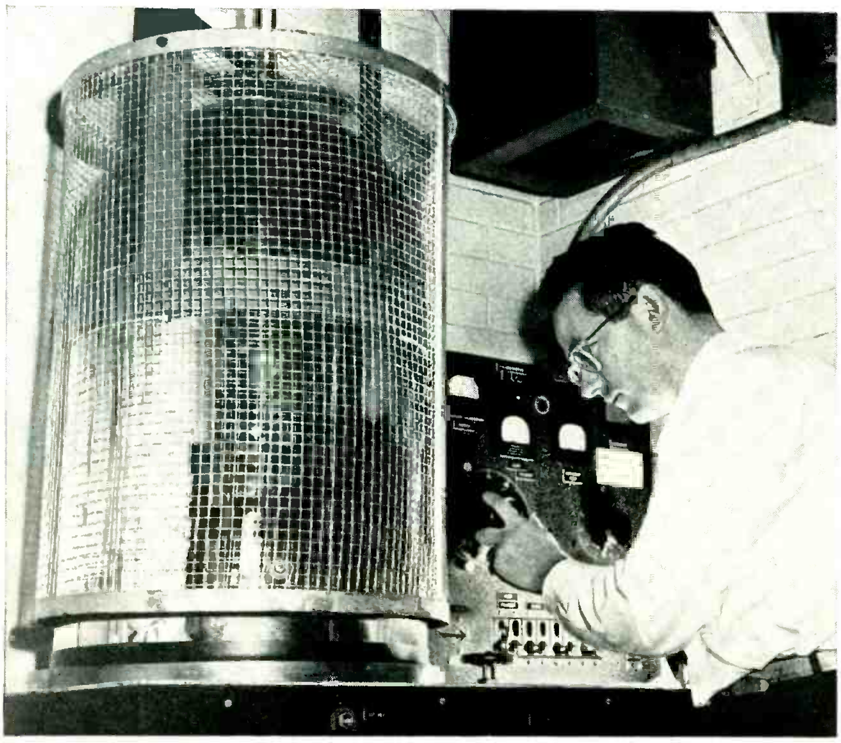
Business Address..........

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

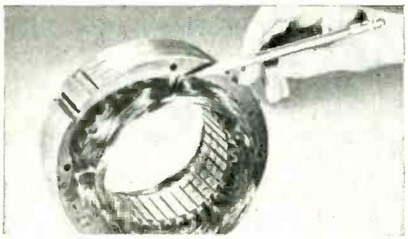
Want more information? Use post card on last page.

New Du Pont MYLAR film offers a balance of properties never before available for electrical uses!

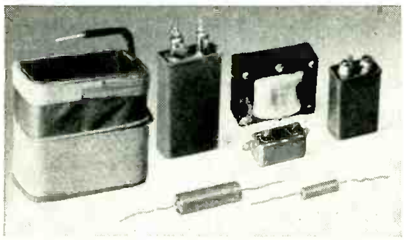
REG. U. S. PAT. OFF.



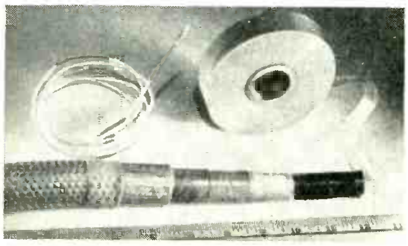
Du Pont "Mylar" polyester film has a balance of properties that make it suitable for a wide variety of electrical applications.



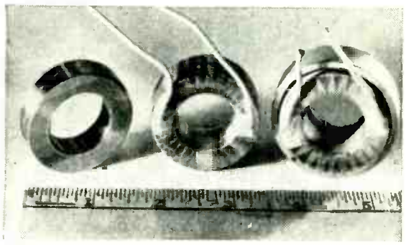
"Mylar" film used to insulate this motor stator is about half as thick as the material it replaces.



Miniaturization of capacitors, transformers and other electrical equipment is made possible by the use of "Mylar."



Flexibility and strength of new "Mylar" polyester film make it ideal for wire and cable insulation.



High dielectric strength, combined with toughness, makes "Mylar" adaptable to a variety of coil-insulation uses.

Out of Du Pont research comes a new product—"Mylar" polyester film—with a balance of electrical, mechanical and chemical properties so unusual that it opens new possibilities in the design of electrical equipment.

"Mylar" exhibits high dielectric strength, high volume resistivity and high surface resistivity. In addition to its good insulating properties, "Mylar" has outstanding mechanical properties. Its tensile strength is 17,000-25,000 p.s.i. It is tough and durable. And it retains its remarkable properties over a wide temperature range, remaining flexible and stable from -60° to 150°C.

"Mylar" is moisture insensitive... impermeable to many organic and inorganic gases. Its resistance to fungus is excellent, making it suitable for applications under a variety of climatic conditions.

These properties of "Mylar" are already being used to advantage in motors, cables, capacitors, coils and transformers. If you would like to investigate the possibilities of improving your own products with Du Pont "Mylar," write for further information to: E. I. du Pont de Nemours & Co. (Inc.), Film Dept., Room E, Wilmington 98, Delaware.

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Polyester Film

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PROGRESS OF A PROBLEM

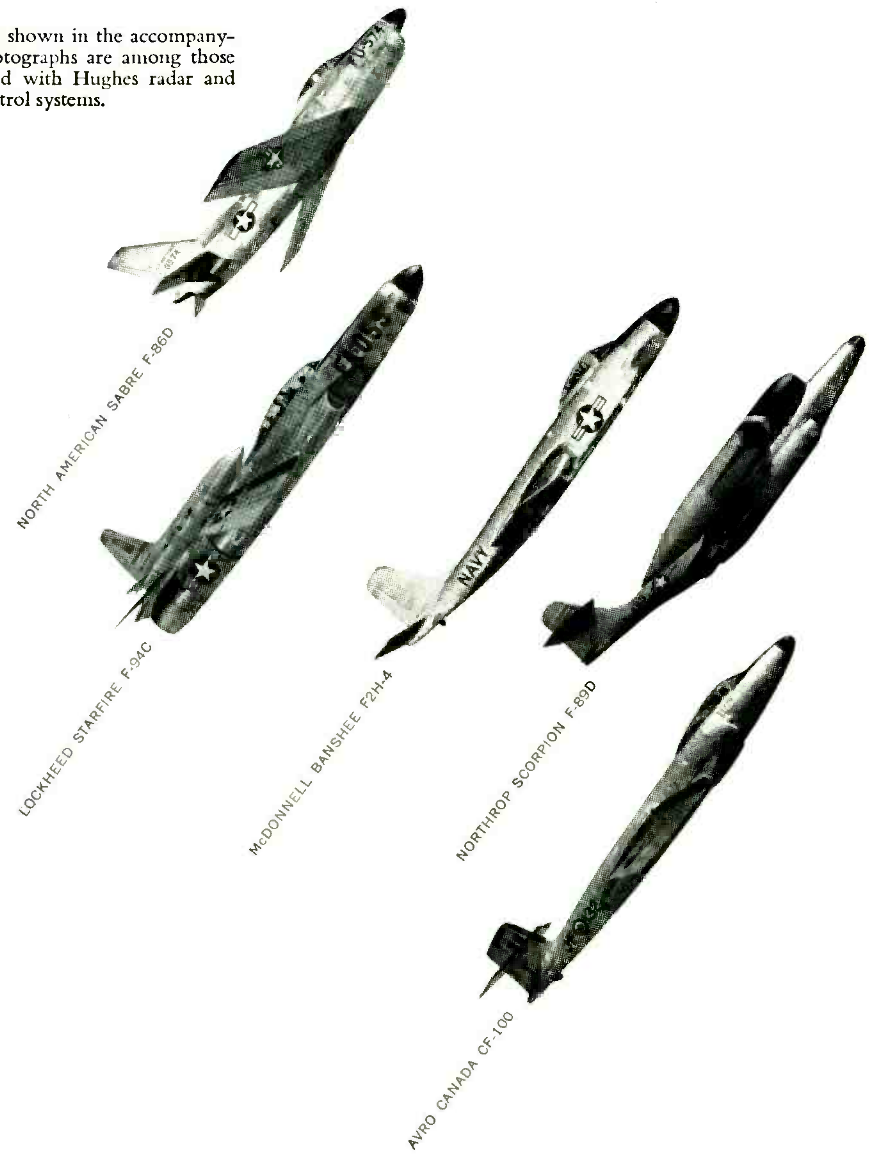
THE PROBLEM:

To design and manufacture advanced radar and fire control systems for military all-weather fighters and interceptors—equipment that must be light in weight, versatile, and capable of accurate operation day or night under extreme conditions.

At Hughes the answers to these requirements for complexly interacting systems involving advanced radar and fire control have been under continuing development from 1948 and in production since 1949. Even more advanced systems are currently in process of development for supersonic aircraft.

Beginning with systems engineering and analysis, the military studies are initially concerned with evaluation of the strategic and tactical needs of the services in order to establish design objectives. This is followed by the analysis of problems involving noise, smoothing and prediction, multi-loop nonlinear servos, aircraft dynamics and controls, and the properties peculiar to conversion of analog information to digital quantities. From the analytic stage evolve the requirements for systems design and circuitry, designs of computing sub-systems, microwave transmitting and receiving equipment, the presentation of information to an airplane pilot, and advanced testing needed to optimize over-all system performance.

Aircraft shown in the accompanying photographs are among those equipped with Hughes radar and fire control systems.



SYSTEMS ENGINEERS

CIRCUIT ENGINEERS

Further advancements in the fields of radar and fire control are creating new positions on our Staff for engineers experienced in the fields of systems engineering and circuit design, or for those interested in entering these areas.

Assurance is required that relocation of the applicant will not cause disruption of an urgent military project.

SCIENTIFIC
AND
ENGINEERING
STAFF

HUGHES

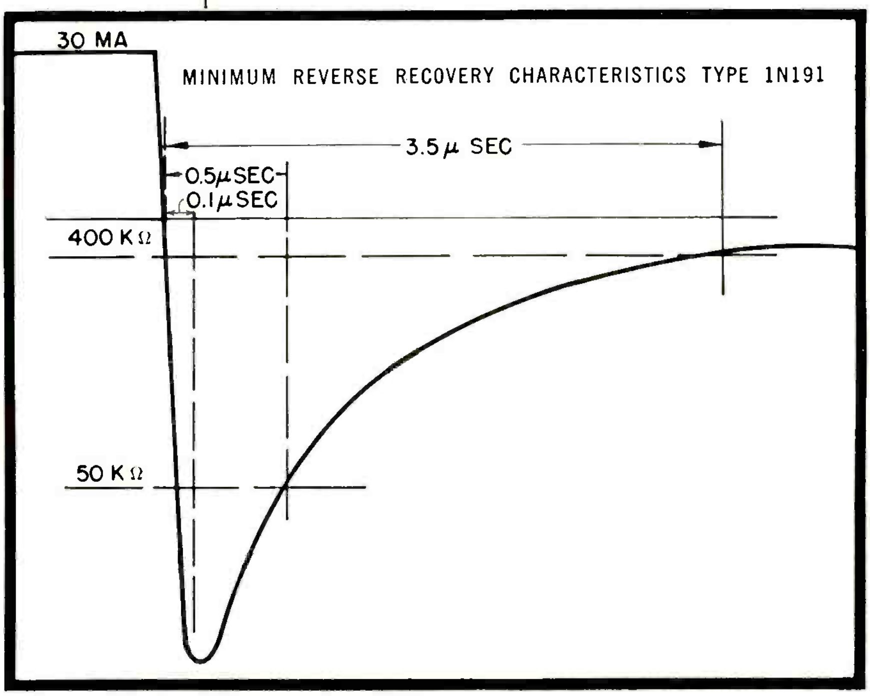
RESEARCH AND DEVELOPMENT LABORATORIES

Culver City, Los Angeles County
California

Hughes Diodes for Computer Applications

Types 1N191 and 1N192

Actual dimensions of diode body: 0.265" X 0.130"



Recovery Time Characteristics
at 25° Centigrade

Type 1N191
50 K Ω @ 0.5 µsec and 400 K Ω @ 3.5 µsec maximum

Type 1N192
50 K Ω @ 0.5 µsec and 200 K Ω @ 3.5 µsec maximum

Maximum Back Current
at 55° Centigrade

Type 1N191
400 KΩ min. between −10 and −50V

Type 1N192
200 KΩ min. between −10 and −50V

To measure pulse recovery for both types, diodes are pulsed at 30 mA in the forward direction and then a back voltage of −35 volts is applied.

Now, as part of the continuing program to meet the expanding requirements for computer components, Hughes announces the registration of *Diode Types 1N191* and *1N192*. Both are selected for their outstanding performance in computer service.

These computer type diodes, like all Hughes diodes, are designed to ensure extremely high moisture resistance...thermal stability...electrical stability...subminiature size...thorough dependability. These features mean long life with minimum maintenance.

If you need special computer type diodes, chances are that we can furnish them on a production basis—because we are constantly producing and providing *many* types to meet literally hundreds of electronics and communications applications. Among these are high forward conductance, low-voltage diodes, used for certain computer applications.

Just Off the Press

A new, eight-page descriptive brochure. Lists and describes all the more widely-used RETMA, JAN and special types in the Hughes line. Just write for your copy of Bulletin SP-2.

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Culver City
California

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VOLTAGE REGULATED POWER SUPPLY

Model 2400

MULTIPLE POWER SUPPLY

OUTPUT	VOLTS	CURRENT	REGULATION	RIPPLE
1	0-150 Bias	0-5 Ma.	*	5 Mv.
2	0-400	0-150 Ma.	0.5%	5 Mv.
3	0-400	0-150 Ma.	0.5%	5 Mv.
2 & 3 Parallel	0-400	0-300 Ma.	0.5%	5 Mv.
2 & 3 Series	0-800	0-150 Ma.	0.5%	5 Mv.
4	6.3 AC	10 Amp.	★	
5	6.3 AC	10 Amp.	★	

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

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

★All AC Voltages are unregulated.

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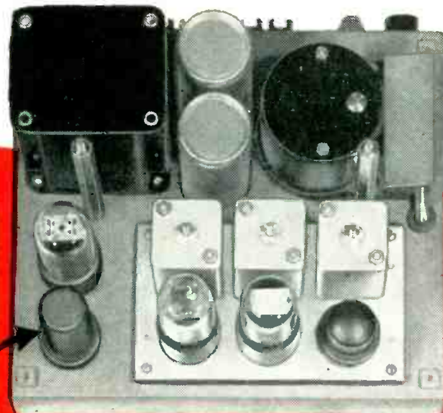
INDEPENDENCE 1-7000

NEW POWER SUPPLY CATALOG AVAILABLE ON REQUEST. WRITE DEPARTMENT 789

New WESTON
Inductronic® D-C AMPLIFIER
Measures Millivolts to 0.1%!...



The new Weston Inductronic D-C Amplifier measures both millivolts and microamperes to an accuracy previously unheard of. A product of Weston Electrical Instrument Corp., Newark, N. J.

The Weston Resistance Network (Actual size) is wound with D-H Manganin wire to achieve a high degree of stability with extreme accuracy.

Its resistor network uses D-H ALLOY *to assure* HIGH STABILITY and ACCURACY

When it's millivolts or microamperes you are measuring, you talk in terms of accuracy in the order of 0.1%. Here is the most accurate measuring instrument yet developed — the Weston Inductronic D-C Amplifier. This amazing instrument makes potential measurements down to microvolts, current measurements to fractions of a microampere.

By using this 200 kc frequency shift amplifier in connection with thermocouples, radiation receivers, bolometers, strain gages, pressure transducers, resistance thermometers, photocells, ionization gages, etc., related physical quantities can be measured with speed and accuracy far superior to any other method previously known.

The amplifying system is essentially an automatic potentiometer, wherein an output current is maintained in balance against the input through a method of accurately adjusted resistors determining the balanced ratio of output to input. With a high gain in the amplification of error unbalance, the accuracy of amplification ratio is of course dependent almost entirely upon the *stability* and *precision* of the resistor network.

For this most exacting function Weston uses Driver-Harris MANGANIN, an alloy of such fixed stability that maximum change in resistance between 15°C. and 35°C. is less than *15 parts per million per degree Centigrade.*

If fixed stability and constant resistance under normally variable operating conditions are "musts" in *your* resistor designs, let us have your specifications. We'll gladly put at your disposal 50 years of alloy manufacturing experience to help solve your problem.

SPECIAL PURPOSE ALLOYS SINCE 1899 — D H — TRADE MARK REG. U. S. PAT. OFF.

*Sole producers of world-famous Nichrome**

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HARRISON, NEW JERSEY

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

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

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

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"Specify *Heldor*

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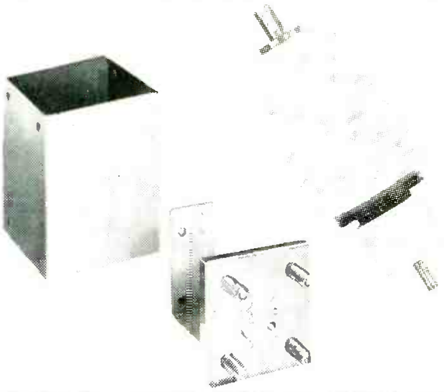
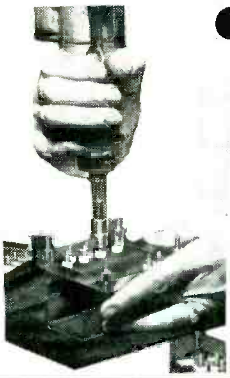
hermetic-seal, compression type

CANS & COVERS
built to meet MIL-T-27 & Commercial Specifications

ASSEMBLY SERVICE
from assembly of bushings in covers to actual hermetic sealing of your component.

YOUR electronic and nuclear equipment or components deserve HELDOR treatment. Be wise . . . time-wise, dollar-wise, quality-wise and delivery-wise — send your specifications or prints to HELDOR for "quotes". *Do it now!*





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  No tool or die costs on Standard Cans, Covers. "Know-how" provides real economies on Bushings and assembly service."

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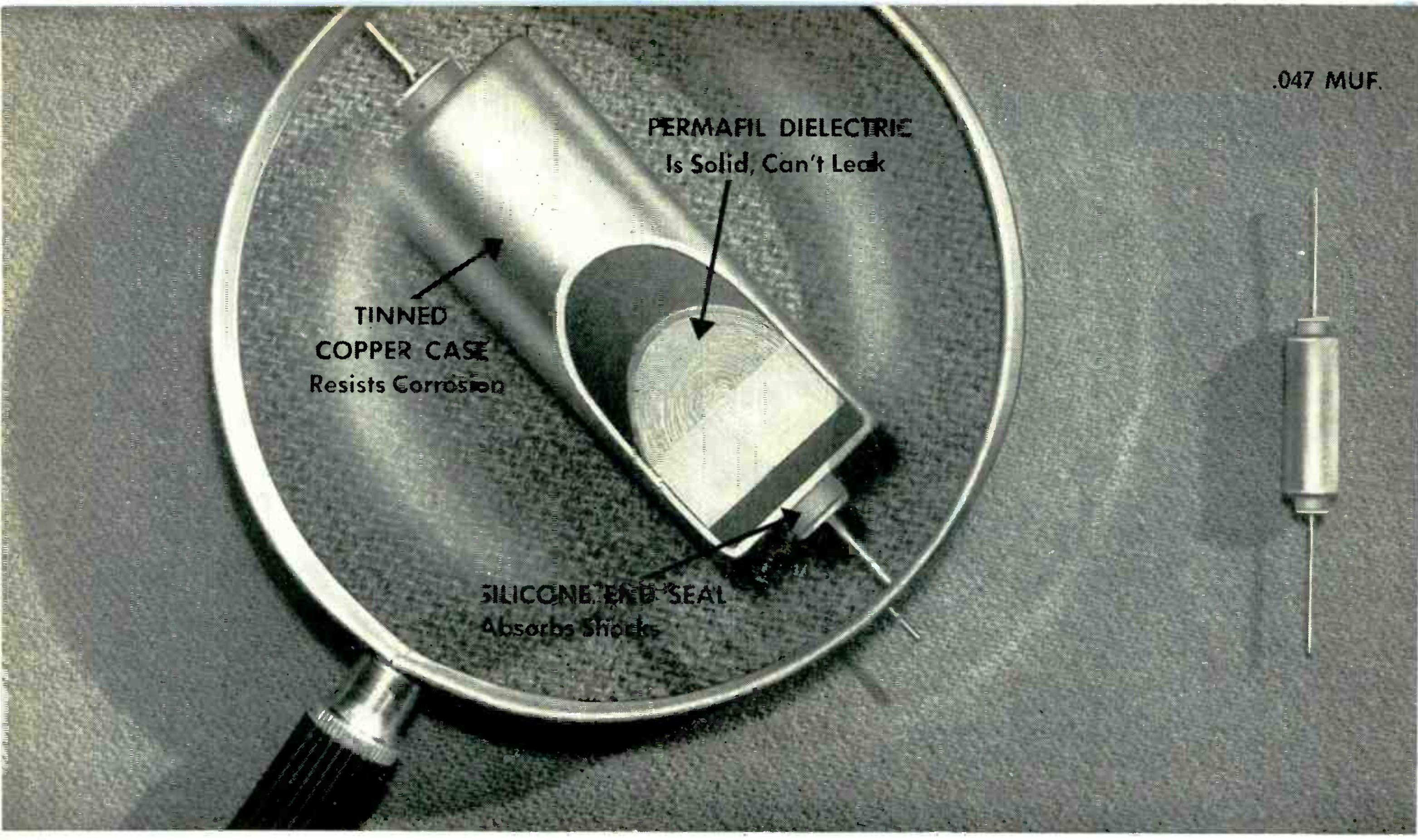

G-E SUBMINIATURE METAL-CLAD CAPACITORS

With silicone end-seals and solid dielectric operate from –55C to +125C without derating

These G-E subminiature metal-clad capacitors are specifically designed to provide the utmost reliability under severe operating conditions. For over three years, Permafil (solid) dielectric has proved its reliability in aircraft engine control, airborne radio and radar communication equipment, ground radio communication and airborne fire control systems.

G-E subminiature metal-clad capacitors offer two important, unique features:

- **Solid dielectric**—G.E.'s Permafil—provides excellent electrical characteristics and eliminates the possibility of leakage.
- **Silicone end seals**—for high thermal and physical shock resistance exceeding MIL-C-25A requirements.
- **Microfarad ratings** range from .001 to 1.0 uf in voltage ratings of 100, 200, 300, 400 and 600 volts d-c working. They can be operated at full voltage up to altitudes of 50,000 feet.

Case sizes range from .235 inches in diameter and 11/16 inches in length to 1 inch in diameter and 2⅝ inches in length.

Liquid-filled metal-clad line also available with G-E Pyranol* dielectric for operation from –55C to + 85C without derating. Lower-cost, they incorporate all the operating advantages of the solid dielectric line and are supplied in the same ratings.

For more information see your G-E Apparatus Sales Office, or write for bulletin GEC-987 to General Electric Co., Sect. 442-18, Schenectady 5, N. Y.

*Reg. trademark of General Electric Co.

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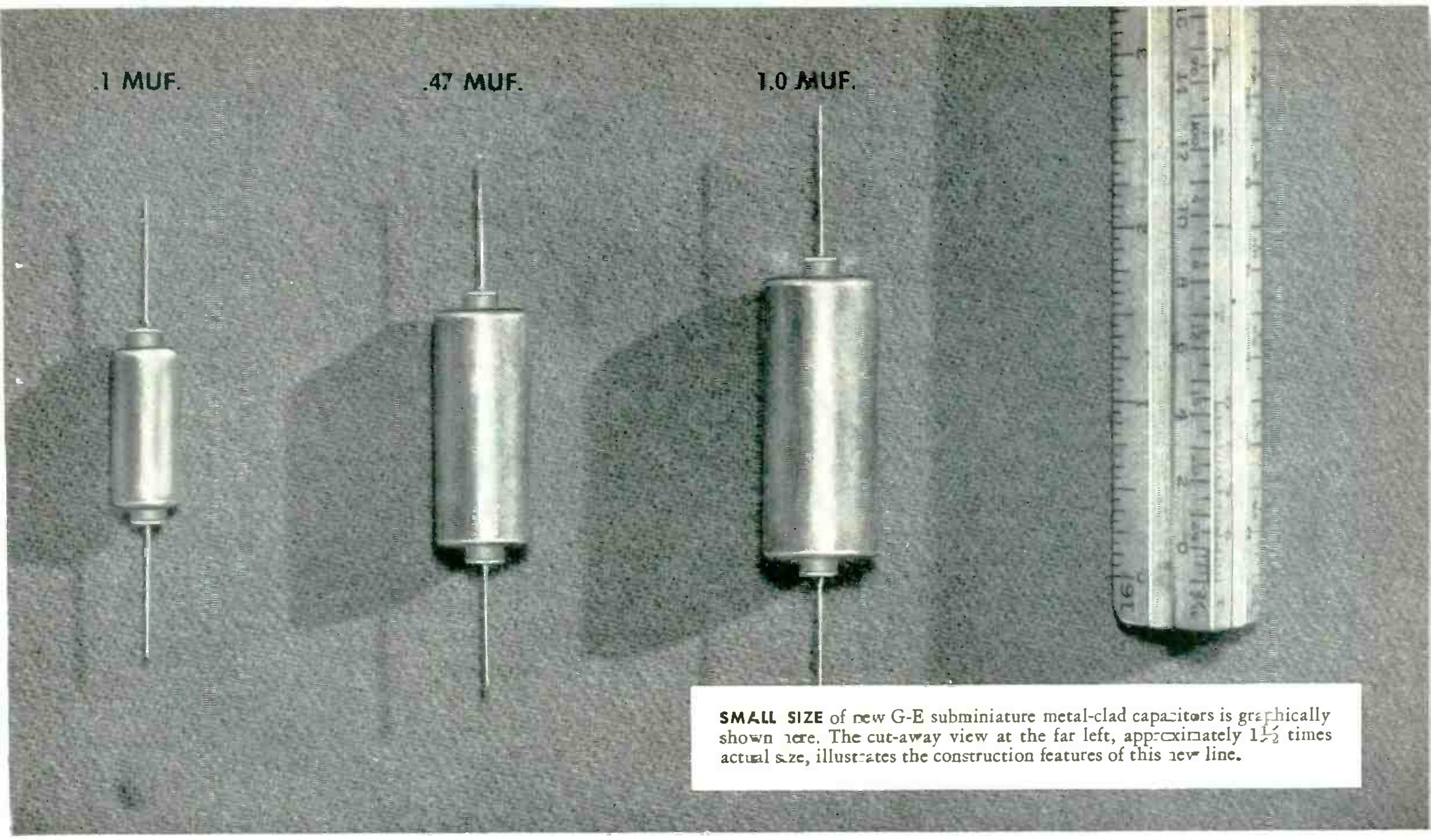
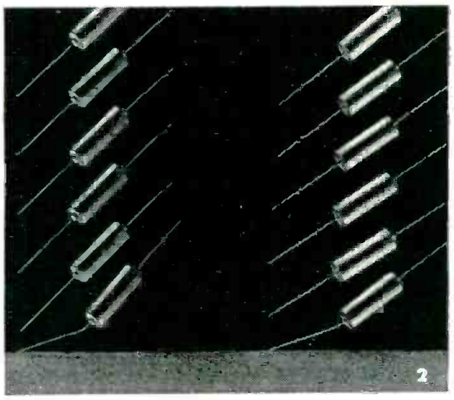
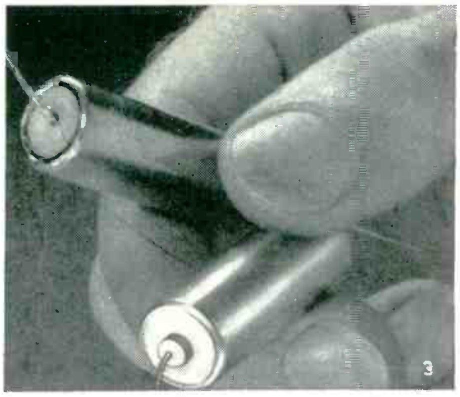


SMALL SIZE of new G-E subminiature metal-clad capacitors is graphically shown here. The cut-away view at the far left, approximately 1½ times actual size, illustrates the construction features of this new line.

1. Solder right up to the case with new G-E silicone end seal—no need to waste ¼ inch of valuable space because of danger of cracking glass.



2. Withstands vibration and rough handling. This view shows a glass-bead-sealed capacitor and a silicone-sealed capacitor being dropped.

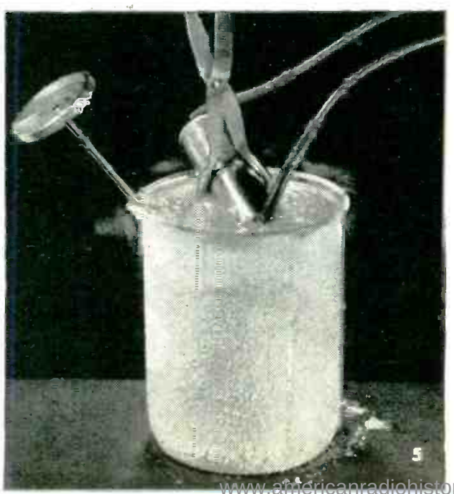


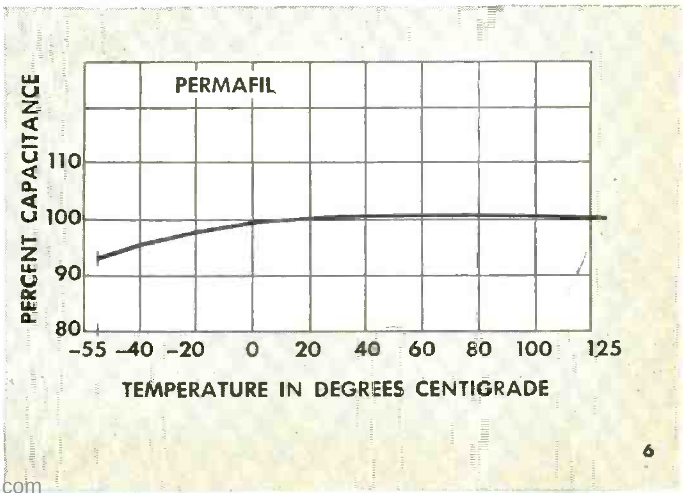
3. Undamaged by dropping, the two capacitors are shown here—note that there are no cracks in the G-E silicone-sealed unit.

4. At +125 degrees centigrade, the capacitor consistently maintains 100 percent capacitance.

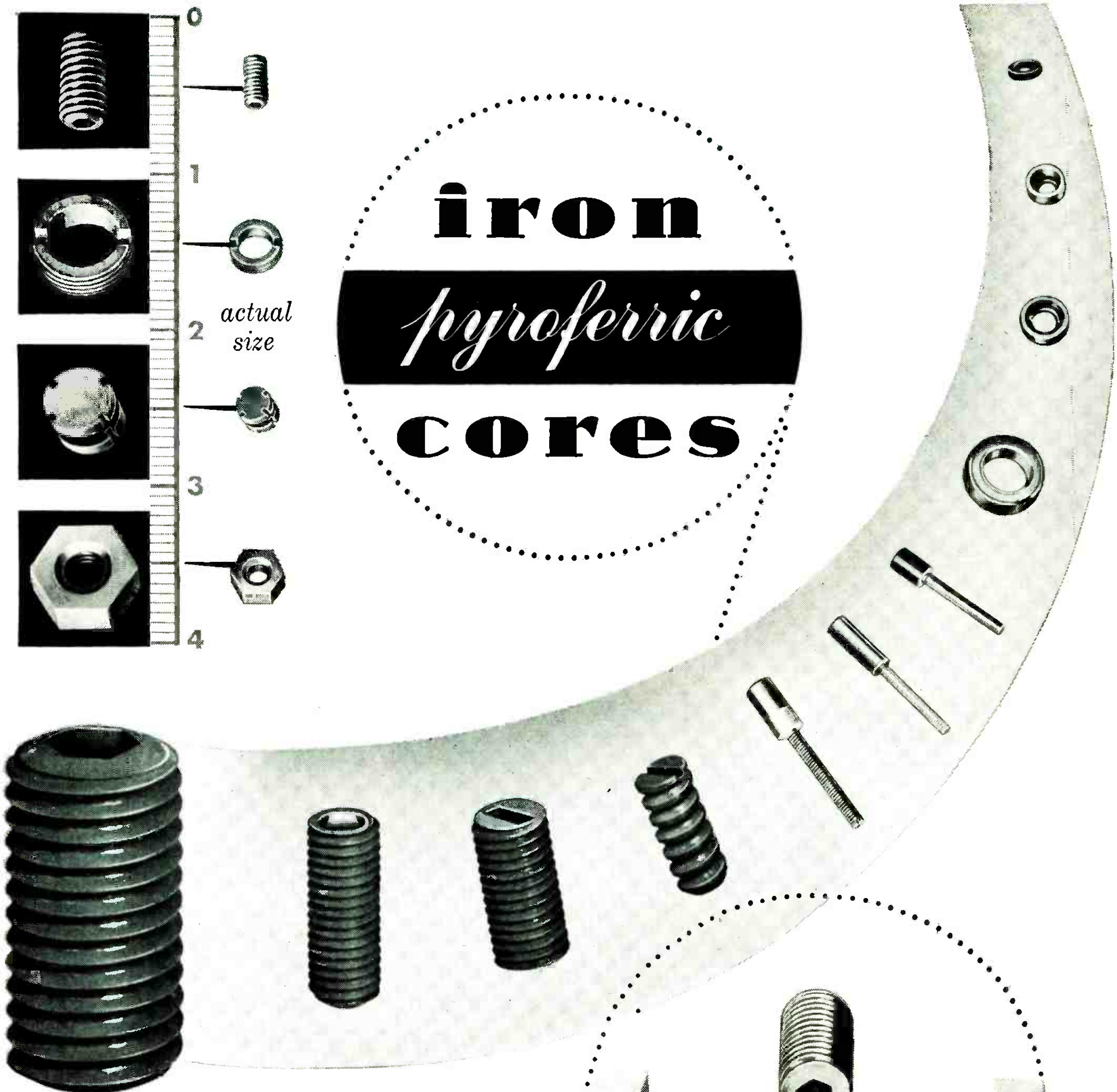
5. At −55 degrees centigrade, the subminiature G-E metal-clad capacitor with Permafil dielectric shows less than 7 percent loss in capacitance.

6. Capacitance vs. temperature is shown by this typical curve. G-E capacitors with Permafil dielectric have very little capacitance change throughout the entire range from −55 C to +125 C.



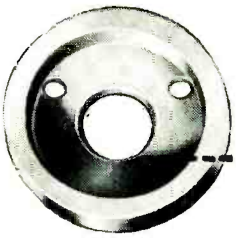


iron *pyroferric* cores



PYROFERRIC IRON CORES are scientifically manufactured, under strictest quality controls to close electrical and mechanical tolerances.

PYROFERRIC services are available for the engineering of your core production requirements . . . your letterhead request will bring you M.P.A. Data Sheets and tables which give complete information including recommended sizes and tolerances, as well as a cross-referenced index of manufacturers' material designation.



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The result is that you can look to Triplett instruments for more accurate performance, longer life and greater service value. Extra care puts extra value in your Triplett instruments.

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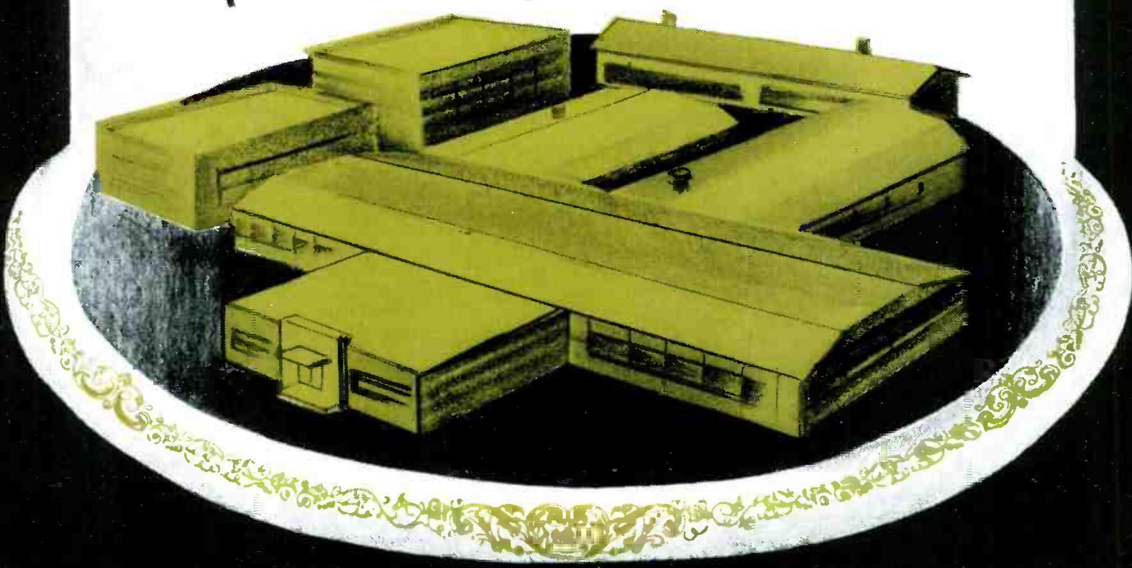
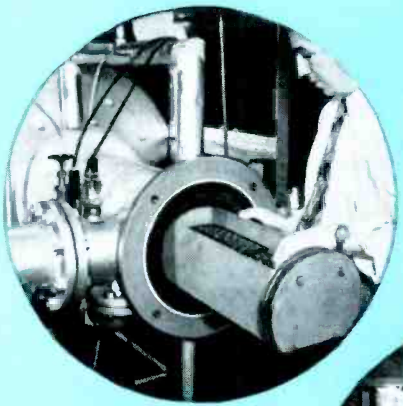


fabrication



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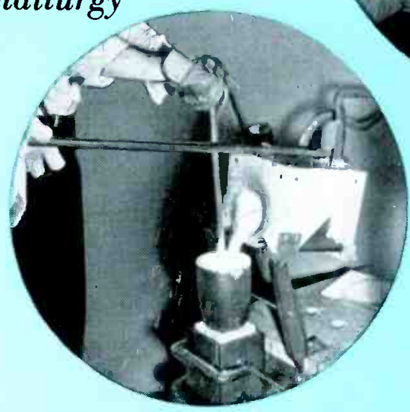
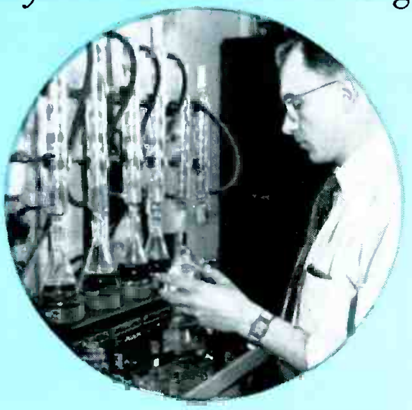


metallurgy



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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*

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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.

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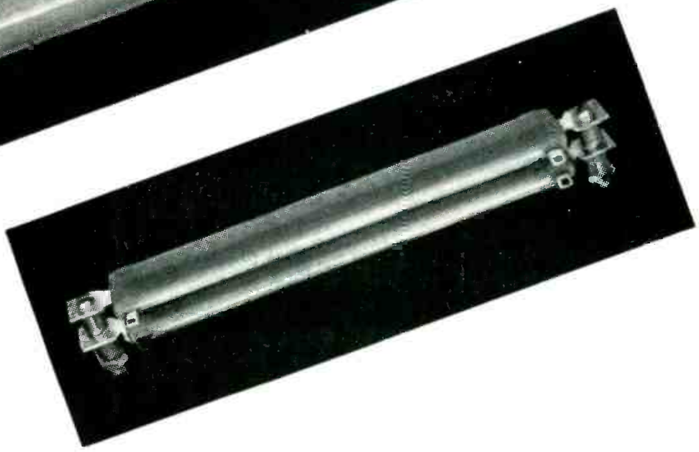
THREE YEARS FIELD EXPERIENCE WINS TITLE...
"H-H LONG-LIFE RESISTORS"



The greatly increased protection made possible by the development of our *high-temperature* gray enamel is the most important improvement of these resistors, but it is not all. True, this enamel is thermo-shock-proof and crazeless; but in addition

THESE RESISTORS OFFER . . .

- **Stronger core with higher resistance to vibration and shock.**
- **Finer resistance wire—made to H-H specifications, especially adapted to these resistors. More uniformly wound, so that failures under stress are eliminated.**
- **Special alloy terminals more securely fastened to the ceramic body by spot-welding—highly resistant to corrosion.**
- **All wire connections are protected by a positive non-corrosive bonding.**

The fixed, the ferrule and the flat types are especially designed for and manufacturd in accordance with JAN-R-26A specifications.

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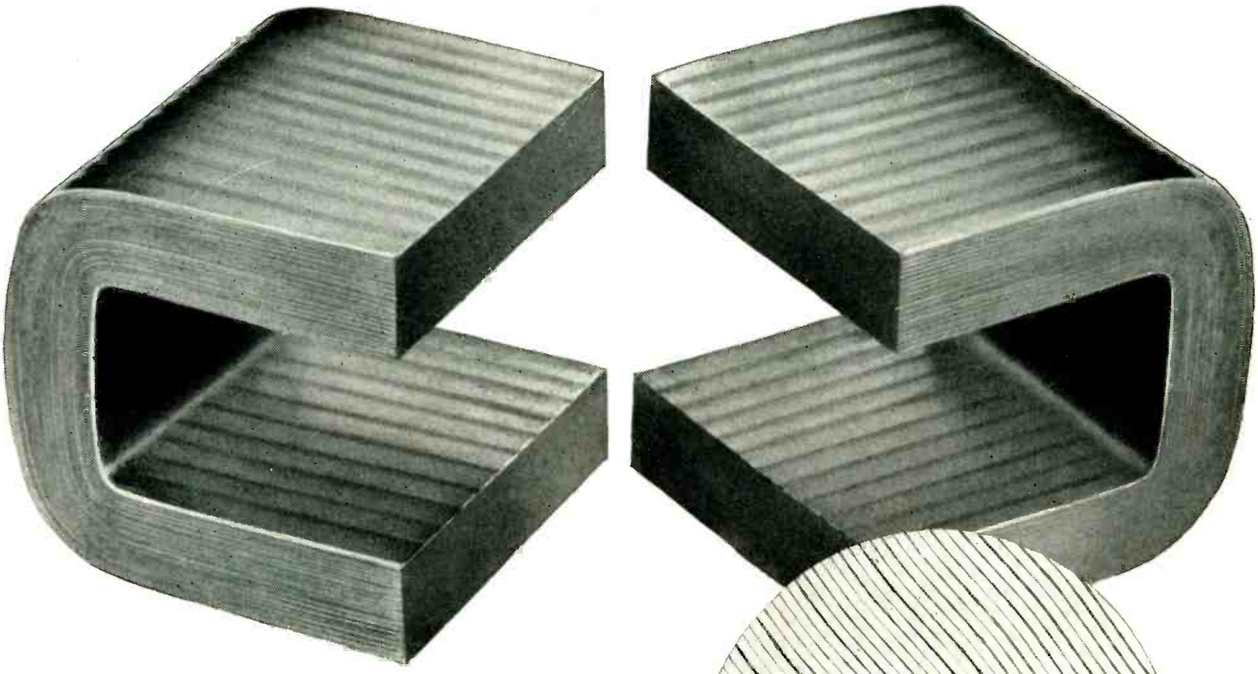

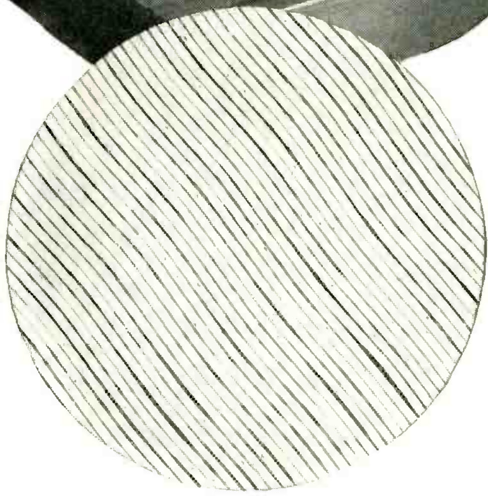

Butt joint section of 5-mil Hipersil Core, magnified 10 times. Distinct separation between the laminations channels the flux, increases core efficiency.

Hipersil® Cores now rustproof

A new process now coats a microscopic film of rustproof iron phosphate on all Westinghouse Hipersil Cores. This coating will not chip, scratch or flake, nor will it affect core performance.

Rustproofing eliminates all possibility of deterioration. This means you can safely carry samples or a stock of cores in advance of immediate production needs . . . keep your assembly lines flowing smoothly.

This thin coat prevents any loss of the inherently high flux carrying capacity . . . another reason why Hipersil Cores make it unnecessary to design excess core material, and, therefore excess size and weight, into your transformer assemblies.

Advancements like this continue to make the Westinghouse Hipersil Core the best on the market today. Because they are 100% active in carrying flux, they solve size, weight and loss problems for you. The simple, two-piece assembly helps cut your transformer fabricating costs. Get a more complete story by writing today for Booklet B-5402. Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-70694

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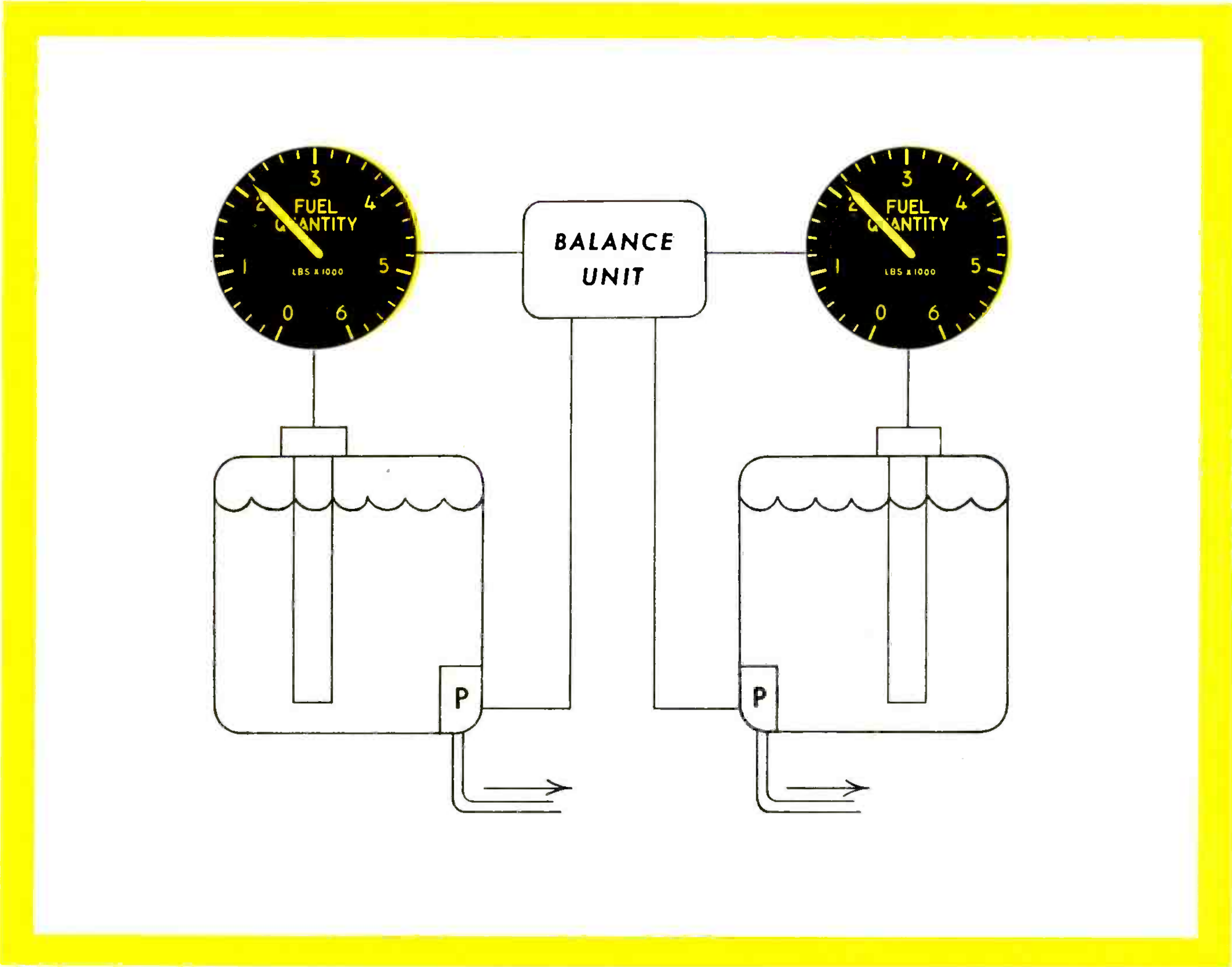

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Parts are molded by Central Molded Products Co. (Chicago); Mayfair Molded Products Corp. (Chicago); Wilcox Plastics, Inc. (Montebello, Calif.)

Electronic precision with mass production economy... thanks to PLASKON® ALKYD

World's largest producer of TV tuners is Standard Coil Products Co., Inc. Reasons for Standard Coil's leadership in this field, according to company executives, are: 1) product superiority, 2) mass production methods.

Thirty-seven vital parts of the Standard Coil tuner are made of mineral and glass fiber reinforced PLASKON Alkyds. The fast molding characteristics of PLASKON mineral-filled Alkyd facilitates mass production. And the Alkyds' excellent dielectric properties and dimensional stability assure the excellent tuner performance that keeps Standard Coil's customers happy.

Standard Coil is one of hundreds of manufacturers who have used PLASKON materials and technical assistance to increase productivity and strengthen product superiority. Perhaps one of these materials can help *you*, too. The experience and extensive modern research facilities of the PLASKON man are at your disposal.

For further information on PLASKON plastics and resins address Barrett Division, Allied Chemical & Dye Corporation, 40 Rector Street, New York 6, N.Y., Whitehall 4-0800

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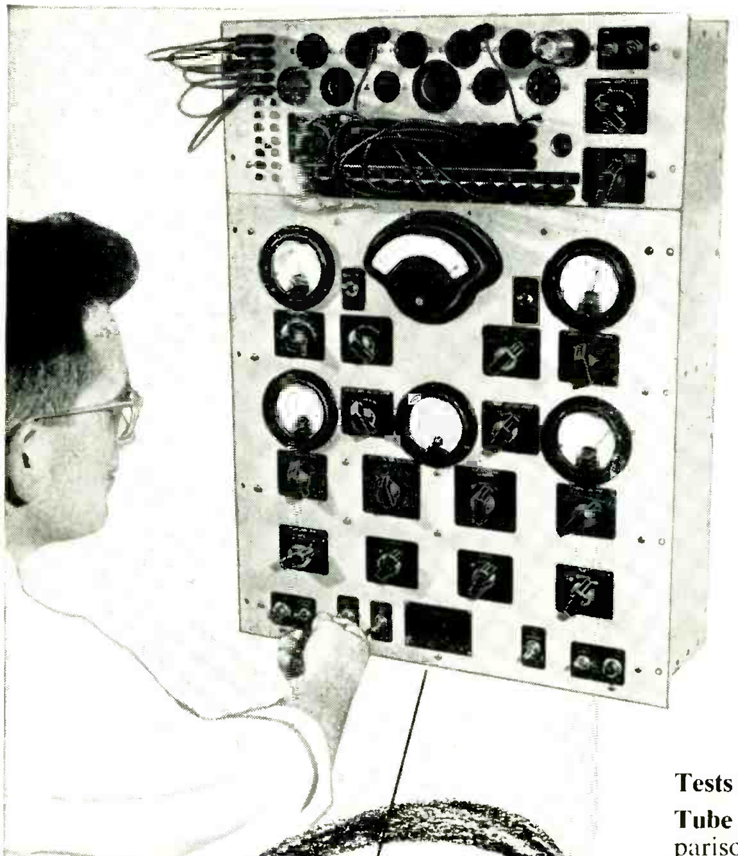

WESTON
(686 Type 10A)
true mutual conductance
ELECTRONIC TUBE ANALYZER

(over-all Gm accuracy 3% or better)

LABORATORY FOR ELECTRONIC TUBES

Tests tubes under actual circuit operating potentials.

Tube characteristic operating curves can be plotted for comparison with manufacturer's specifications.

Transconductance can be measured directly without need for null adjustments or correction factors.

Voltage Ratio method of measuring transconductance meets the IRE Standard 50 IRE 7.S2 paragraph 7.2.2.4.

Completely self-contained with all necessary power supplies, meters and switching for performing short tests, static characteristic measurements and grid to plate transconductance measurements.

A well filtered d-c power source is supplied, making it possible to test tubes with d-c potentials which can be accurately adjusted to correspond to actual circuit voltage operating conditions.

Precision meter shunts and **multipliers** are wire wound to 0.5 per cent accuracy.

Special circuitry makes meter loading effects negligible.

Regulated grid bias supply keeps this most critical voltage constant. Plate and screen supplies do not affect grid bias setting.

Wide range of measurement of transconductance provides good readings on all tubes from small subminiature types to large power control types. The true transconductance is obtained on all triodes and pentodes, including low mu control tubes having plate resistance as low as 250 ohms.

Transconductance ranges are available in the following combinations of range and grid signal voltages:

Grid Signal	1.0	0.5	0.2	0.1	Volts
Gm x 1	300	600	1500	3000	Micromhos
Gm x 10	3000	6000	15000	30000	Micromhos

The *Gm x 1* range is especially useful in the measurement of subminiature tubes having low transconductance.

Reliability, Dependability and **Accuracy** assured by sound engineering, skilled manufacture and high quality components.

7049

Descriptive literature on Model 686 gladly sent on request. WESTON Electrical Instrument Corporation, 614 Frelinghuysen Ave., Newark 5, N. J.

WESTON *Instruments*

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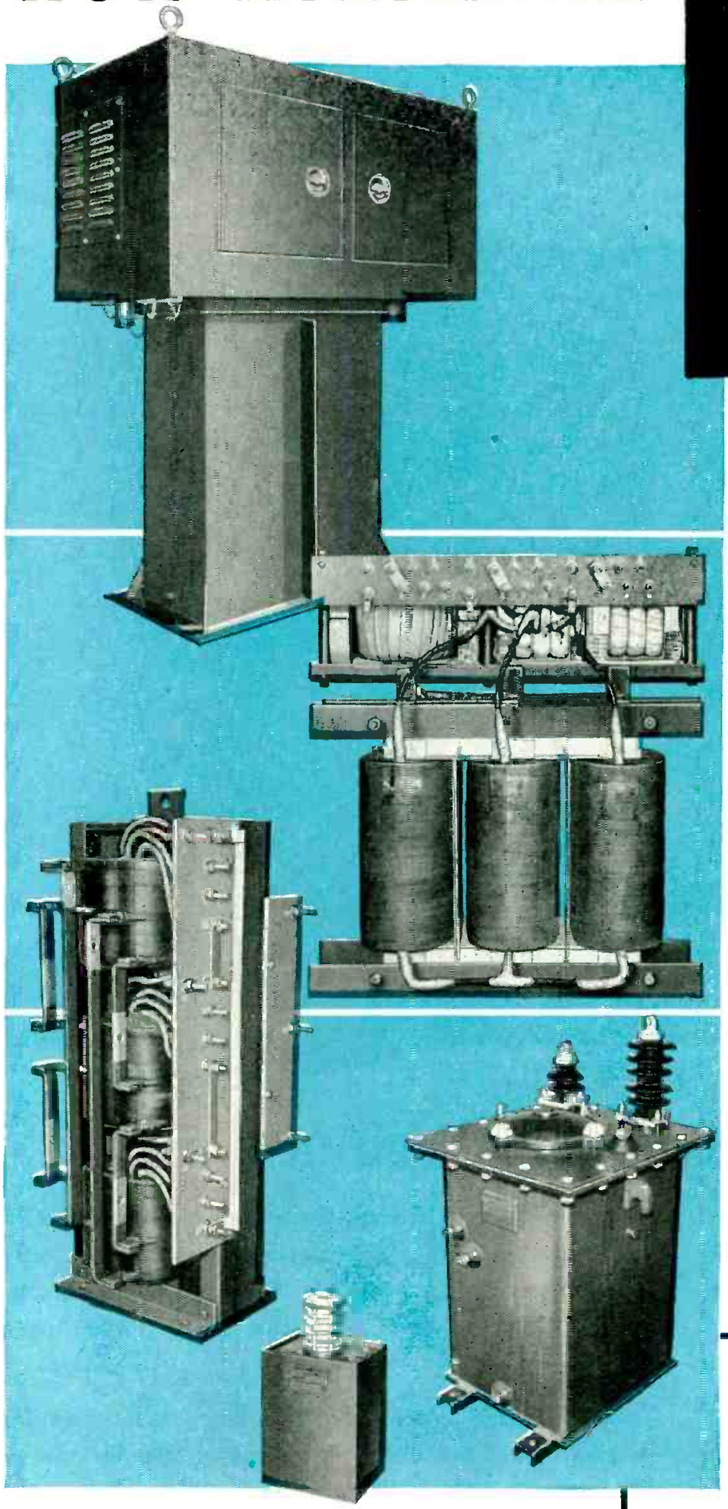

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Per { RETMA / MIL-T-27 } Standards

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DRY (Class A, B & H.)

Write today for Bulletin ST-3505 describing Specialty Transformers

ME54-13

MOLONEY ELECTRIC COMPANY

Power Transformers • Distribution Transformers • Step Voltage Regulators • Regulating Transformers • Load Ratio Control Transformers • Unit Substations • Network Transformers • Constant Current Transformers • Capacitors • Transformers For Electronics

SALES OFFICES IN ALL PRINCIPAL CITIES • FACTORIES AT ST. LOUIS 20, MO. AND TORONTO, ONT., CANADA *for* **BRASS Bridgeport CO.** *Service*

OFFICES AND WAREHOUSES IN PRINCIPAL CITIES

BRIDGEPORT WAREHOUSE SERVICE

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

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

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

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

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

Mills in Bridgeport, Conn. and Indianapolis, Ind.

In Canada: Noranda Copper and Brass Limited, Montreal

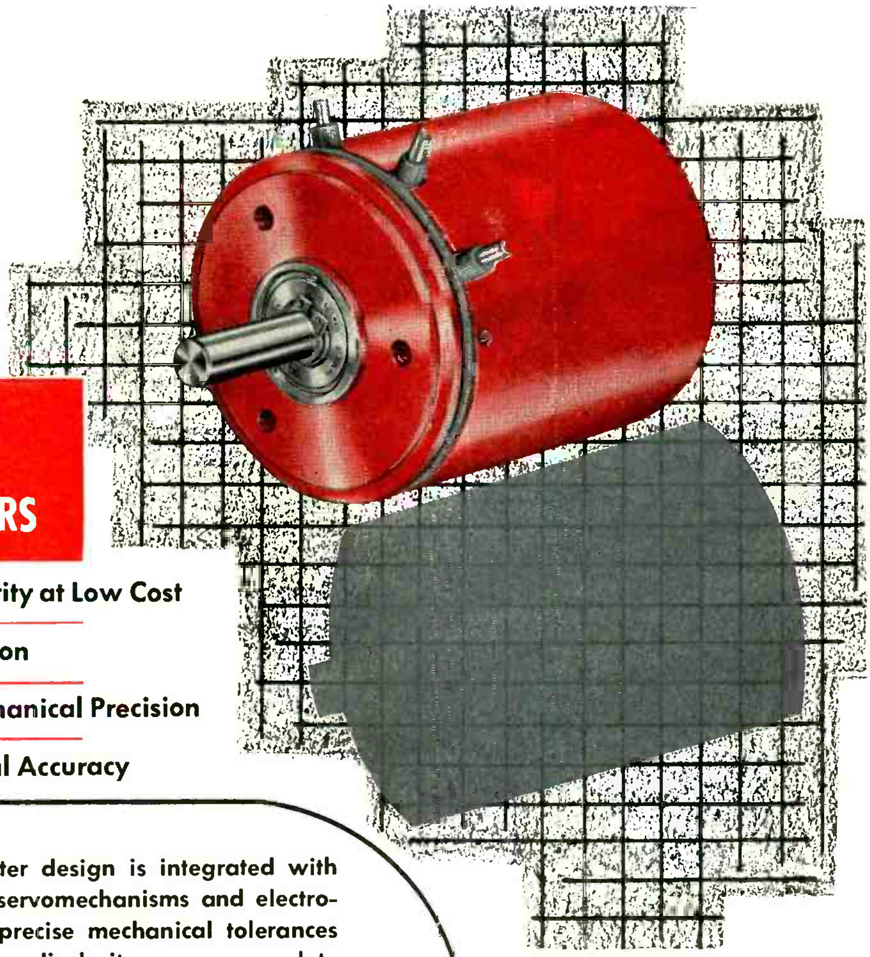
BRIDGEPORT BRASS COMPANY

30 GRAND STREET, BRIDGEPORT 2, CONNECTICUT

Want more information? Use post card on last page.

New **10 TURN**

PRECISION POTENTIOMETERS



- .025% Linearity at Low Cost
- High Resolution
- Extreme Mechanical Precision
- High Electrical Accuracy

Type M10T SERVO POTS

. . . wound coil, multiturn potentiometer design is integrated with system aspects of precision computors, servomechanisms and electromechanical instrumentation. Extremely precise mechanical tolerances shaft diameter, concentricity, and perpendicularity assure complete transfer of potentiometer accuracy to external systems.

Universal mounting surface offers a choice of servo-mount or precision pilot and tapped holes. SERVO POT resistance elements are wound under control of an electronic servo-mechanism* by a unique method based on the output accuracy of the potentiometer as the controlling factor. Gold-flashed connector-type terminals permit ease of connection where accessibility is limited.

*Based upon a method originated by IBM Corporation under U.S. Government Contract.

Electrical Specifications	
Resistance Range:	1,000 ohms to 10,000 ohms ±5%
Independent Linearity:	.05% std. .025% or better, special.
Effective Electrical Angle:	3600° +1° −0°.
Ambient Temperature Range:	−55°C., to +80°C.

Mechanical Specifications

Base and Bearings: One piece machined aluminum base houses spring-loaded ball bearings in a single through bore for greater accuracy and rigidity.

Finish: Red Alumilite, corrosion resistant per AN-QQ-A-696A.

Mounting: The stainless steel register or pilot formed by the outer race of the bearings is as accurate as the bearing with respect to concentricity and diameter. For synchro type mounting, a high precision outer register used for assembly with gears prepinned to the shaft.

Shaft: Centerless ground stainless steel .2500″ +.0000 −.0003 diameter.

Mechanical Rotation: Angle between stops 3660° ±2.5°.

Stops: Mechanical stops of lead screw type tested to withstand torques exceeding 100 inch pounds, assure reliability and ruggedness.

Dimensions: Diameter 1.820″, Length 2-[illegible]/16″.

For further details on the new advanced performance multiturn potentiometers write, wire or call

TECHNOLOGY INSTRUMENT CORP.

533 Main St., Acton, Mass. ACton 3-7711

Want more information? Use post card on last page.

AXIETTE

MADE IN ENGLAND

High FIDELITY OF SOUND

AXIETTE 101 8" Single Cone Loudspeaker

The need for a reasonably-priced and medium sized high-fidelity loudspeaker has been met by the Research Laboratories of Goodmans Industries who are constantly in touch and, indeed, in sympathy with the requirements of the high-fidelity enthusiast. To a certain extent this demand can be related to the present-day restrictions on living space and the fact that enthusiasts are seeking a loudspeaker which, when suitably housed, will occupy the minimum of space, and yet still faithfully reproduce their particular choice of music.

From the start it was decided that the new loudspeaker would be housed on an 8 in. chassis and to set a really new trend, a special hyperbolic cone was designed.

SPECIFICATION

Frequency Range	40-15,000 c/s
Fundamental Resonance	65 c/s (nominal)
Voice Coil Diameter	1 in. (2.5 cms.)
Voice Coil Impedance	15 ohms.
Flux Density	13,500 gauss
Total Flux	51,200 Maxwells
Maximum Power Handling	5 watts peak A.C.
Overall Diameter	$8\frac{1}{8}$ in. (20.63 cms.)
Overall Depth	$3\frac{15}{16}$ in. (10 cms.)
Baffle Hole Diameter	7 in. (17.8 cms.)
Mounting Holes	4 slots $\frac{3}{8}$ in. (9.5 mms.) x $\frac{7}{32}$ in. (5.5 mms.) equispaced on a $7\frac{5}{8}$ in. (19.36 cms.) P.C.D.
Nett Weight	$3\frac{1}{4}$ lbs. (1.47 kgs.)
Finish	Grey Rivelling Enamel

AUDIOPHILE NETT PRICE $21.30

Exclusively Distributed by:—

EAST:
Goody Audio Center Inc.
235 West 49th St., New York 19, N. Y.

WEST:
Hollywood Electronics,
7460 Melrose Ave., Los Angeles 46, Calif.

SOUTH & SOUTH-WEST
Hign Fidelity SSS,
606 Peachtree, N.E., Atlanta, Ga.

CANADIAN SALES OFFICE:
A. C. Simmonds & Sons Ltd.,
100 Merton Street, Toronto 12.

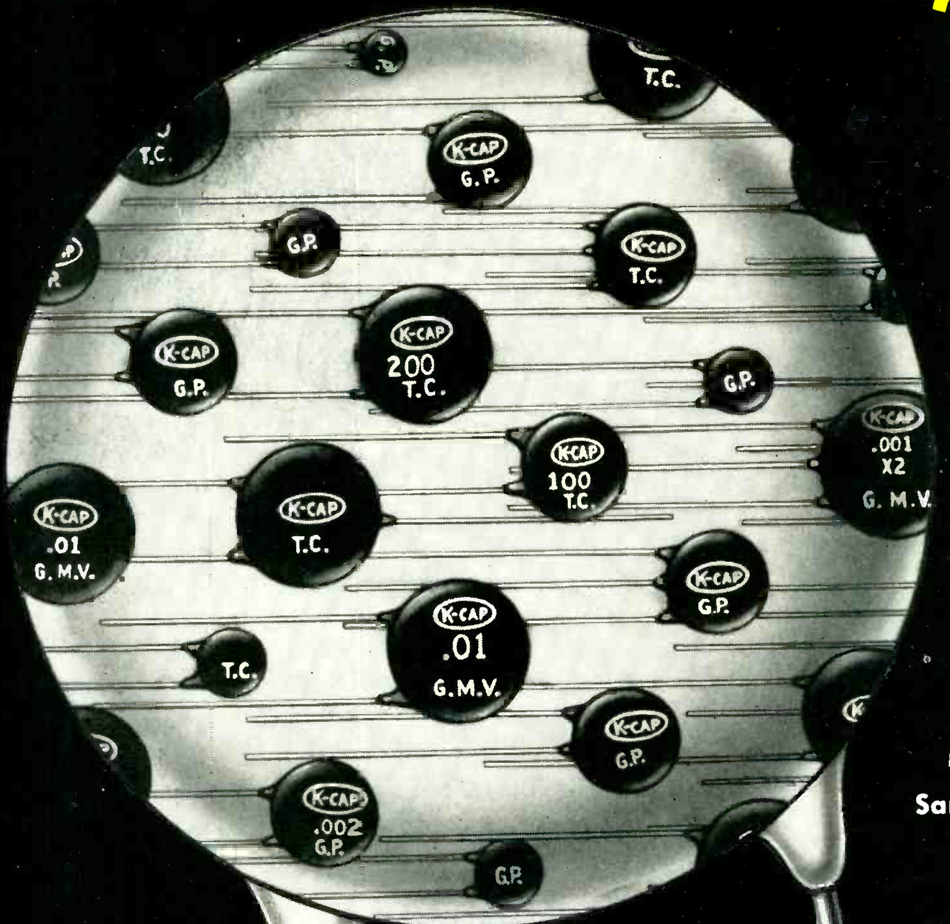
A TRADITION OF EXCELLENCE FIDELITY EFFICIENCY

GOODMANS

GOODMANS INDUSTRIES LTD., AXIOM WORKS, WEMBLEY, MIDDLESEX, ENGLAND

K-CAPS®

Made by the makers of K-TRANS



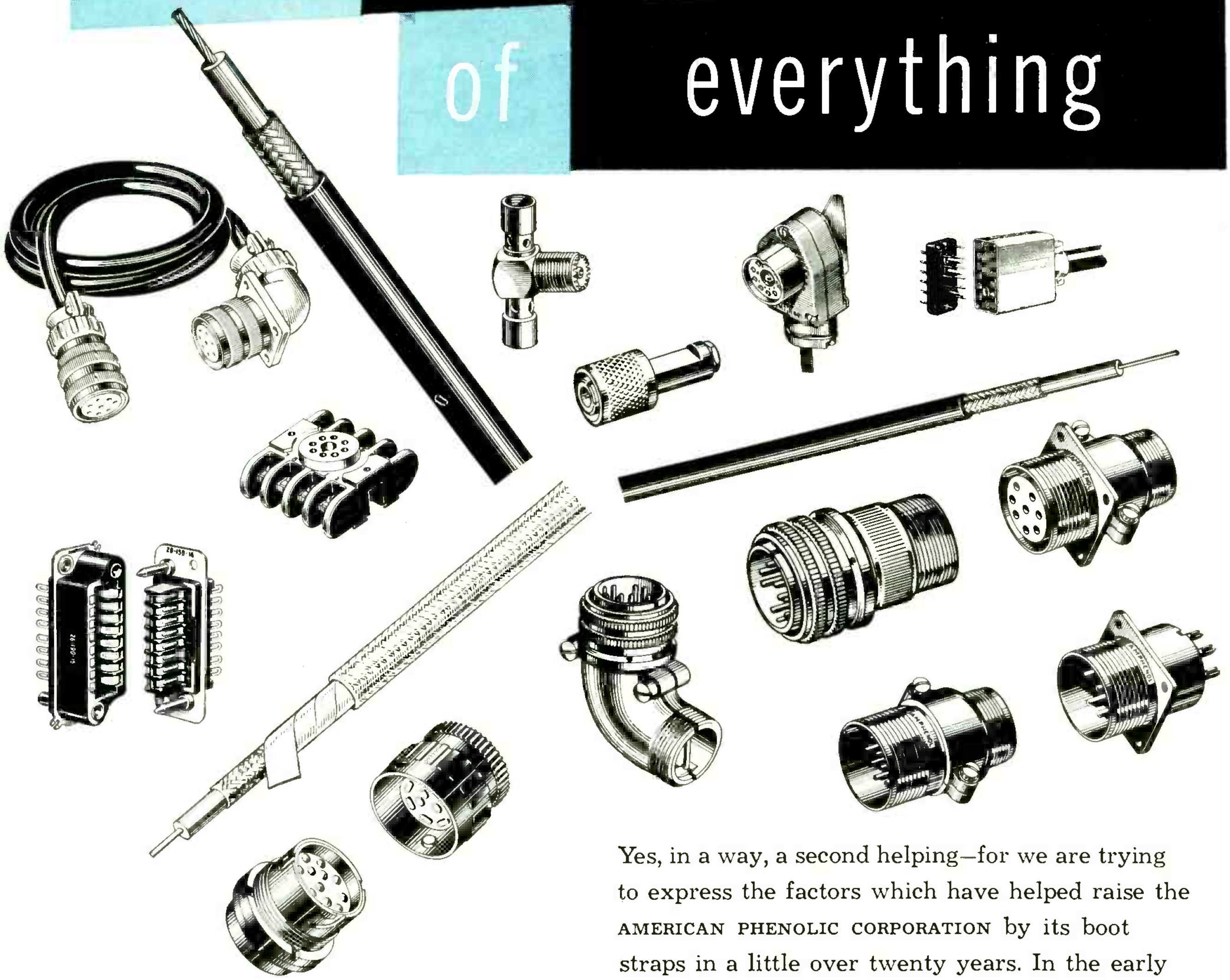
Specify the K-CAP wherever you use capacitors. Temperature Compensated, General Purpose, and Guaranteed Minimum Value. Samples available.

MASS PRODUCERS OF ELECTRONIC COMPONENTS

AUTOMATIC MANUFACTURING CORPORATION

65 GOUVERNEUR ST., NEWARK 4, N. J.

a little more of everything



Yes, in a way, a second helping—for we are trying to express the factors which have helped raise the AMERICAN PHENOLIC CORPORATION by its boot straps in a little over twenty years. In the early thirties AMPHENOL was just another struggling industrial infant in one small factory and our main concern then was radio sockets. Today there are five modern plants producing over 11,000 cataloged products ranging all the way from AN connectors to television antennas.

"A little more of everything"—we think a little more courage, a little more imagination, a little more faith have been responsible for the growth of AMPHENOL during the last two decades. And we look forward to the same "little more" qualities, a second helping of the same, to keep AMPHENOL a vital member of the electronics industry for many, many years to come.

AMPHENOL

AMERICAN PHENOLIC CORPORATION

chicago 50, illinois

THE PORTLY PICKET PLANE

and how to magnify a precision system

One typical DV Development

COST-CUTTING FIXTURES

Maintaining precision tolerances on relatively short production runs is often a difficult problem involving costly tooling.

In a recent DV development, these costs have been chopped drastically by a series of new-type master reaming fixtures which eliminate jig-boring operations combined with time-consuming pre-assembly and alignment with special tools. In a single setup, the reaming fixtures (one of which is shown in the hands of a skilled DV toolmaker) perform all the finish boring operations on a cast-magnesium radar-antenna housing.

With this straightforward, routine technique, interchangeable parts are fabricated to near-zero dimensional limits.

If an airborne radar antenna makes you think of a small, intricate mechanism, take another look at the 29 by 20 by 7 foot radome hanging under this Air Force RC-121C radar picket plane—one of the giant early-warning Lockheed Super Constellations patrolling U.S. shorelines against attack. Inside, the Dalmo-Victor-developed antenna illustrated—the largest airborne antenna ever built—plays its part in extending the range of detection beyond 200 miles, horizon to horizon.

A primary engineering requirement, of course, was integration of this antenna system into the six tons of electronic equipment aboard the high-altitude reconnaissance ship: including weather radar, relay links for transmitting radar pictures to ground-control stations, and equipment for vectoring fighters or missiles onto targets.

Dalmo Victor's contribution of this antenna to the most powerful search radar equipment yet designed for aircraft, called for an application of all the skills and techniques developed during years of engineering light-weight precision electromechanical systems.

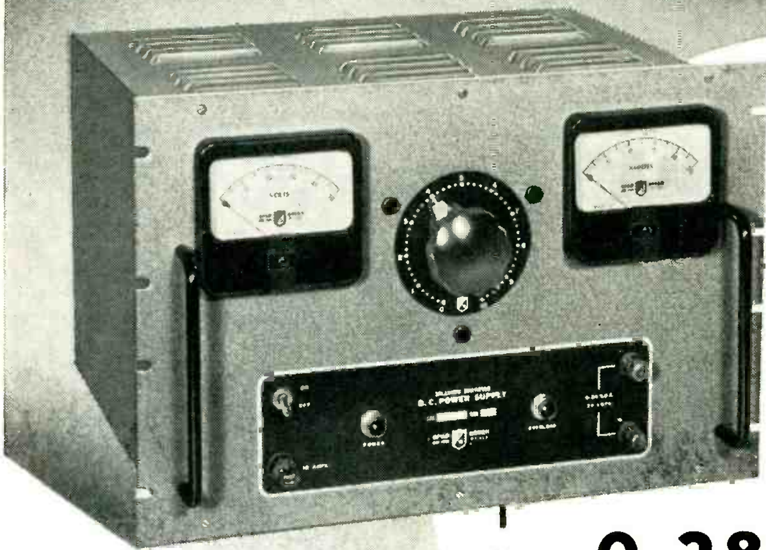
Whether your requirements call for the largest, the smallest, or something in-between; the design, development, and production facilities of Dalmo Victor's versatile organization can be put at your disposal.

DALMO VICTOR DV

SAN CARLOS · CALIFORNIA

DOWN-TO-EARTH ELECTROMECHANICAL ENGINEERING

A New low voltage POWER SUPPLY



MODEL K101F

0-28 Volts D.C.
20 Amperes
1% Ripple

$195

Designed to meet the critical D.C. power requirements of the aircraft industry, the K101F incorporates many custom engineered features, such as:

- **An automatic ammeter cutout circuit for dynamotor and inverter starting.**
- **Delay type overload protection.**
- **Permanently etched control designations.**
- **Over-current warning indicator.**
- **Stepless output control.**
- **Compact, portable design.**
- **Zero maintenance.**

SPECIFICATIONS:

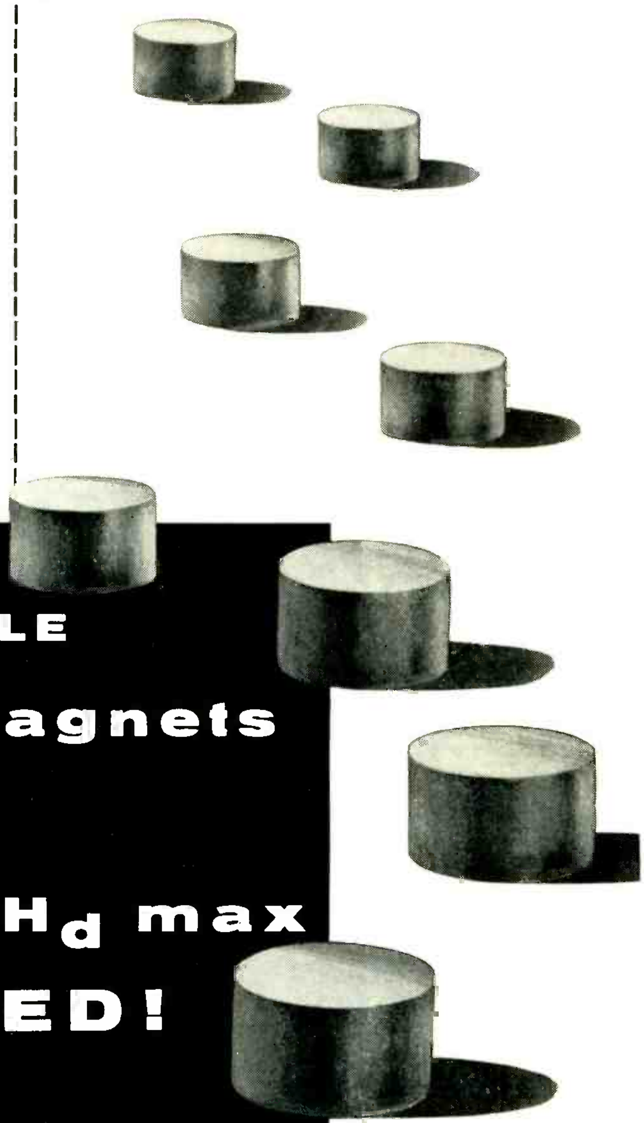
OUTPUT VOLTAGE:	0 - 28 V.D.C., continuously variable.
OUTPUT CURRENT:	20 Amperes, continuous duty at 35°C ambient
OVERLOAD:	400% for ½ minute, 200% for 2 minutes.
RIPPLE VOLTAGE:	One Percent at full load.
REGULATION:	D.C.V. at Full Load: 28.5. D.C.V. at 1/10 Load: 33.
METERS:	0-50 V.D.C., 2% accuracy, 4" rectangular. 0-25 A.D.C., 2% accuracy, 4" rectangular.
CONTROLS:	Power switch, voltage control, pilot light, overload warning light.
TERMINALS:	Panel binding posts plus rear terminal board.
INPUT:	115 V.A.C., 60 cycles, single phase.
DIMENSIONS:	19" W, x 12¼" H, x 14¼" D.
MOUNTING:	Standard Rack.

Write for Bulletin No. 150

Opad-Green COMPANY

71-2 WARREN STREET • NEW YORK 7, N. Y.

HYFLUX for HI-FI



NOW AVAILABLE

No. 9 Speaker Magnets with 6 MILLION B_dH_d max GUARANTEED!

Now... for the First Time

the RETMA Standard No. 9 Loudspeaker Magnet is available with a minimum energy product of over 6 million BH max. Made of Hyflux Alnico V HE*, it provides the highest energy product of any commercial Alnico.

The immediate advantages it offers to users of the RETMA No. 9 Magnet are:

- The highest sound level possible.
- A better transient response—resulting from the higher gap density which increases the damping factor—assures a full range of tones and overtones.
- The truest possible reproduction of sound.

* *High Energy—grain-oriented Alnico V.*

The Indiana Steel Products Company is proud to introduce this improved No. 9 speaker magnet to the audio industry. Investigate its distinct advantages for your speaker. Price and delivery information upon request.

THE INDIANA STEEL PRODUCTS COMPANY

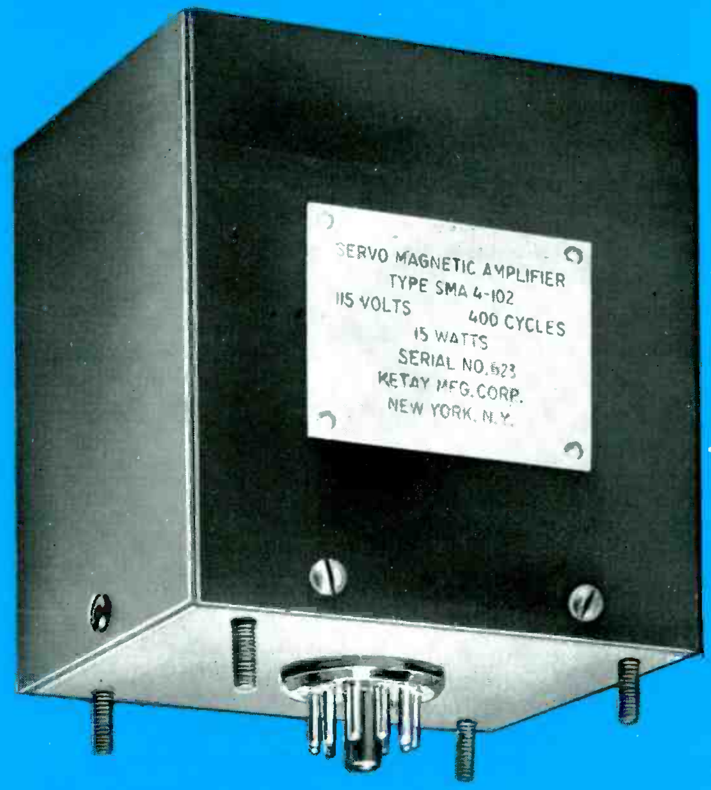
Valparaiso, Indiana

World's Largest Manufacturer of Permanent Magnets

INDIANA PERMANENT MAGNETS

Ketay

presents



... *meticulously tailored*

MAGNETIC AMPLIFIER SERVO SYSTEMS

Typical characteristics of some magnetic amplifier and two-phase servo motor combinations available from Ketay.

SPECIFY MAGNETIC AMPLIFIER (type)	FREQUENCY (cps)	LINE VOLTAGE (volts)	LENGTH (inches)	WIDTH (inches)	HEIGHT (inches)	SPECIFY SERVO MOTOR (type)	TORQUE AT STALL (oz. in.)	MOMENT OF INERTIA (oz. in. x sec^2 x 10^6)	ACCELERATION AT STALL (rad./sec^2)	NO LOAD SPEED (min. r.p.m.)	RATED VOLTAGE EXCITATION FIXED PHASE (volts) *	INPUT POWER PER PHASE AT STALL (watts)	DIAMETER (inches)	LENGTH (inches)
SMA6-102	60	115	4 ½	3 ¾	3 ⅞	K402530	2.5	49.5	50,500	3300	115	9.2	1 ¾	2
SMA6-102	60	115	4 ½	3 ¾	3 ⅞	K402380	1.45	42.8	35,000	3200	115	5.0	1 7/16	1 ⅝
SMA4-102	400	115	4 ⅛	3 5/16	4 3/16	K402550-1	2.35	49.5	47,500	4800	115	9.2	1 ¾	2
SMA4-102	400	115	4 ⅛	3 5/16	4 3/16	K402550-2	2.35	49.5	47,500	4800	115	9.2	1 ¾	2
SMA4-102	400	115	4 ⅛	3 5/16	4 3/16	K101600-6	1.45	42.8	35,000	4800	115	6.1	1 7/16	1 ⅝
SMA4-102	400	115	4 ⅛	3 5/16	4 3/16	K101660	1.45	42.8	35,000	4800	115	6.1	1 7/16	1 ⅝

BUORD DESIGNATIONS FOR SERVO MOTORS

K101600-6 = MK 7 MOD 0 K101660 = MK 7 MOD 1

K402550-2 = MK 8 MOD 1 K402550-1 = MK 8 MOD 0

* The control phase of all Servo Motors should be connected for 57.5 volt operation.

On the other side of this page are listed some of the synchros for which the combinations were specially designed.

Ketay supplies complete systems including gear trains and stabilization for given kinematic requirements.

Servo motor-tachometer generator combinations are also available.

Ketay welcomes the opportunity to design and fabricate amplifiers of both the conventional and miniaturized types to customer's specifications.

See Ketay's Exhibit at Airborne Electronics Conference
Dayton Biltmore Hotel, May 10-12

SYNCHROS • SERVO MOTORS
RESOLVERS • MAGNETIC AMPLIFIERS
AIRBORNE INSTRUMENTS
AUTOMATIC CONTROL SYSTEMS

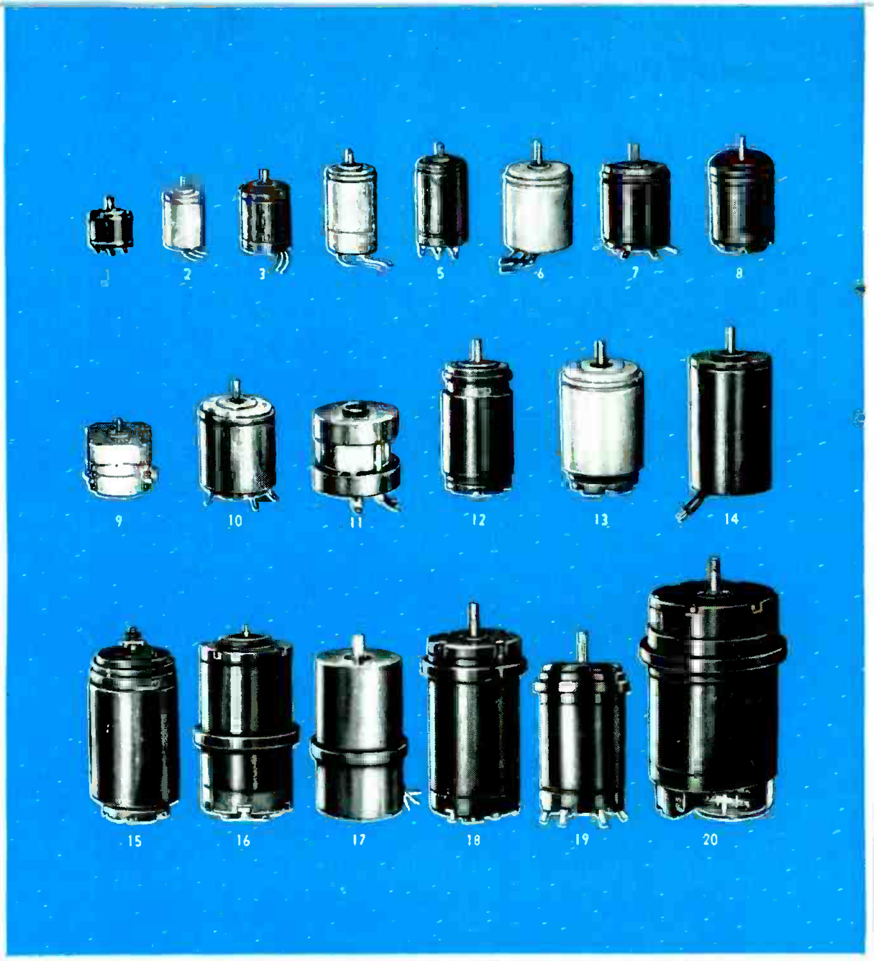
Ketay

MANUFACTURING CORP.
Executive Offices
555 Broadway, New York 12, N. Y.

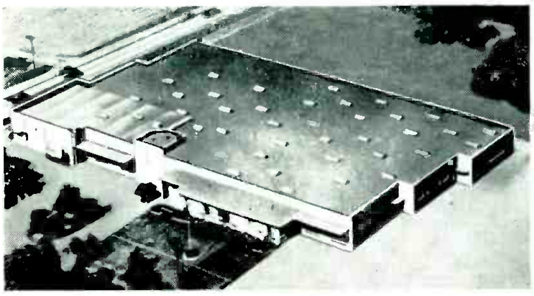
KETAY OFFERS A COMPLETE RANGE OF SIZES AND TYPES IN SYNCHROS • SERVO MOTORS RESOLVERS

1–SERVO MOTOR, Size 10 Frame, O.D. .937″
2–SYNCHRO, Size 10 Frame, O.D. .937″ (Transmitter, Receiver, Resolver, Differential Transmitter, Control Transformer)
3–SERVO MOTOR, Size 10 Frame, O.D. .937″
4–SYNCHRO, Size 11 Frame, O.D. 1.062″ (Transmitter, Resolver, Control Transformer)
5–SERVO MOTOR, Mk 14, Size 11 Frame, O.D. 1.062″
6–SYNCHRO, Size 15 Frame, O.D. 1.437″ (Transmitter, Receiver, Resolver, Differential Transmitter, Control Transformer)
7–SERVO MOTOR Mk 7, Size 15 Frame, O.D. 1.437″
8–SYNCHRO, Size 15 Frame, O.D. 1.437″ (Transmitter, Receiver, Resolver, Differential Transmitter, Control Transformer)
9–LINEAR TYPE CONTROL TRANSFORMER, O.D. 1.625″
10–SERVO MOTOR, Mk 8, Size 18 Frame, O.D. 1.75″
11–INDUCTION MOTOR, Size 20 Frame, O.D. 1.95″
12–SYNCHRO, Size 16 Frame, O.D. 1.537″ (Transmitter, Receiver, Control Transformer)
13–SYNCHRO, Size 18 Frame, O.D. 1.750″ (Transmitter, Receiver, Differential Transmitter, Control Transformer)
14–INDUCTION MOTOR, Size 18 Frame, O.D. 1.750″, 3 Phase, 2 Pole
15–SYNCHRO, Size 19 Frame, O.D. 1.90″ (Transmitter, Receiver, Control Transformer)
16–SYNCHRO, Type 1F, 1HCT, or 1HG Size 1 Frame, O.D. 2.250″ (Receiver, Transmitter, Control Transformer)
17–INDUCTION MOTOR, Size 1 Frame, O.D. 2.250″
18–SYNCHRO, Size 23 Frame, O.D. 2.250″ (Transmitter, Receiver, Resolver, Differential Transmitter, Control Transformer)
19–SERVO MOTOR, Size 23 Frame, O.D. 2.250″
20–SYNCHRO, Size 31 Frame, O.D. 3.10″ (Transmitter, Receiver, Differential Receiver, Differential Transmitter)

Typical characteristics of 116 units are available.



ADDITIONAL FACILITIES TO SERVE THE INDUSTRY



This plant, recently acquired at Commack, Long Island, adds air-conditioned work space that brings Ketay's total area to over 200,000 square feet, accommodating over 2,000 employees in the five divisions. Modern in every detail, the new plant has the latest equipment for precision volume production.

EXPERIENCE + RESEARCH + PERFORMANCE = LEADERSHIP

New developments and applications . . . increased facilities for volume production of components and complete systems . . . all the things reported on these pages are characteristic of Ketay—a firm with broad experience and specialized knowledge that adds up to leadership in the field of electrical devices and controls. This experience and knowledge is yours to command. In addition to synchros, servo motors and resolvers, it includes, but is not limited to: gyro components; aircraft engine instruments; computers; magnetic, resolver and synchro amplifiers; remote indicators and automatic control systems. Ketay's completely staffed and equipped Research and Development Division can be of greatest service during the design stage of applications involving Ketay products. You are invited to avail yourself of this service.

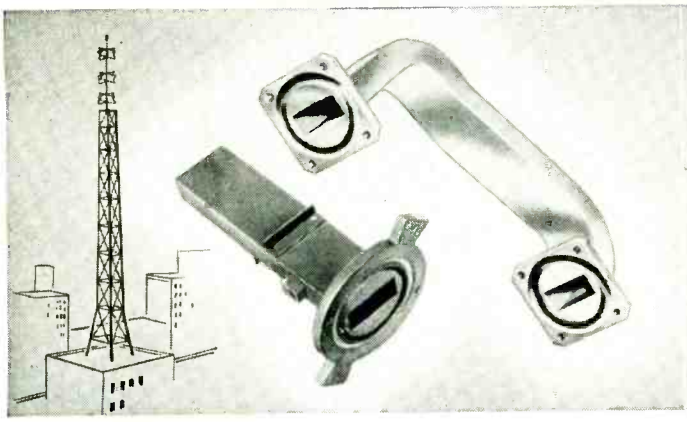
For further information or a data sheet on 116 Synchros, Servo Motors and Resolvers, write Ketay

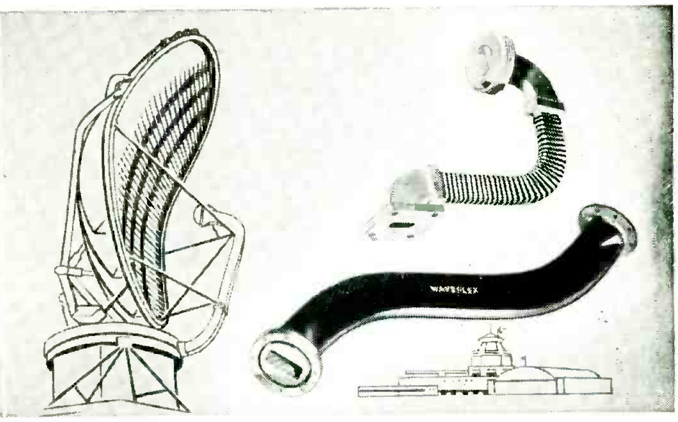
Ketay
MANUFACTURING CORP.

Executive Offices **555 Broadway, New York 12, N. Y.**
Pacific Division, 12833 Simms Avenue, Hawthorne, California

New York Division • Kinetix Instrument Division • Pacific Division
Electronic Instrument Division • Research & Development Division

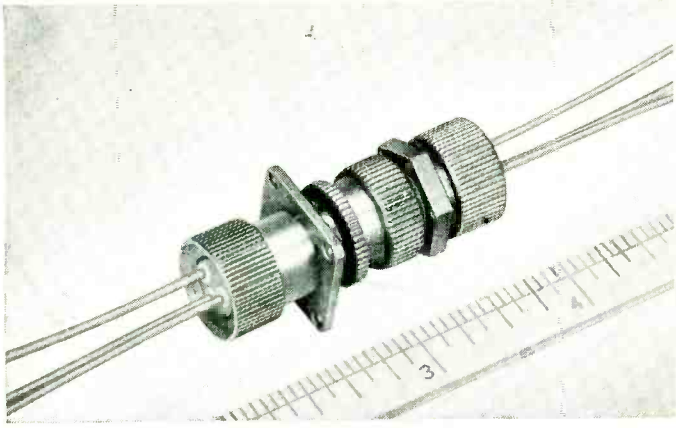
All these from one experienced source

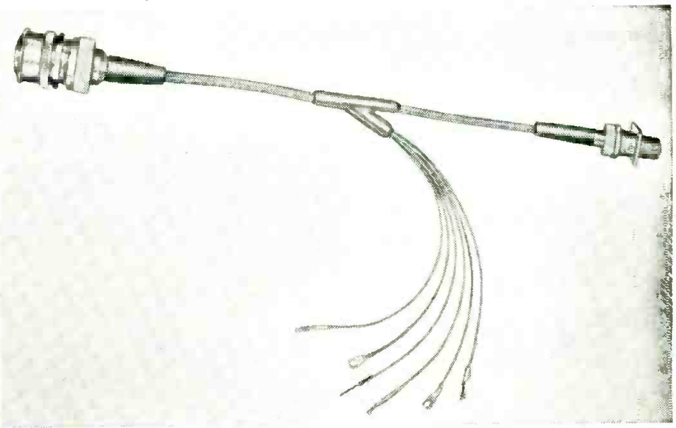




TITEFLEX DESIGNS AND MANUFACTURES— to customer specifications—rigid waveguides and combinations of rigid and flexible waveguides. Where there is, or should be, no movement, or where complicated accessories must be connected, Titeflex *rigid* waveguides are specially recommended.

WAVEFLEX® FLEXIBLE WAVEGUIDES are fabricated to retain critical dimensions — regardless of twisting or bending. Waveflex waveguides make assembly easy, improve design, compensate for expansion or movement. Rubber jacketing protects against weather, corrosion, physical abuse.





TITEFLEX CONNECTOR—lightweight, corrosion and moisture resistant with temperature ranges of —65°F. to +400°F. This connector's insulation properties will permit 3500 volts at sea level, 1200 volts at 50,000 feet altitude. Connector is available with 2 or 3 pins. 7 amperes. Weight ⅔ of ounce. Size 2" in length.

TITEFLEX CUSTOM WIRING SYSTEMS are corrosion resistant, moisture proof, pressure-tight and efficient at temperatures of — 65°F. to +400°F. Can be furnished with Titeflex or standard AN connectors for a wide range of service requirements. Can be sheathed with metal braids, fiber glass or nylon—and jacketed with silicone or other compounds.

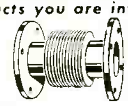
MORE THAN 37 YEARS of developmental experience make Titeflex a logical source of the components pictured on this page. We are currently in a position to supply connectors and wiring systems to makers of aviation and electronic equipment. If you have a problem requiring our unusual combination of products and engineering, let us quote on your requirements. The coupon will bring you information on our products.

Let Our Family of Products Help Yours

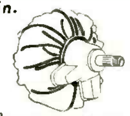
Titeflex

✓ Check products you are interested in.

☐ SEAMED AND SEAMLESS METAL HOSE

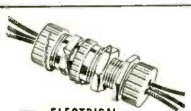


☐ PRECISION BELLOWS



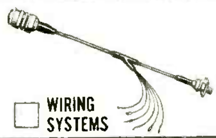
☐ IGNITION HARNESS

☐ IGNITION SHIELDING

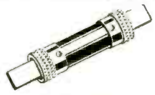


☐ ELECTRICAL CONNECTORS

☐ RIGID AND FLEXIBLE WAVE GUIDES



☐ WIRING SYSTEMS



☐ FUSES

TITEFLEX, INC.
524 Frelinghuysen Ave.
Newark 5, N.J.

MAIL COUPON TODAY

Please send me without cost information about the products checked at the left.

NAME________________________

TITLE________________________

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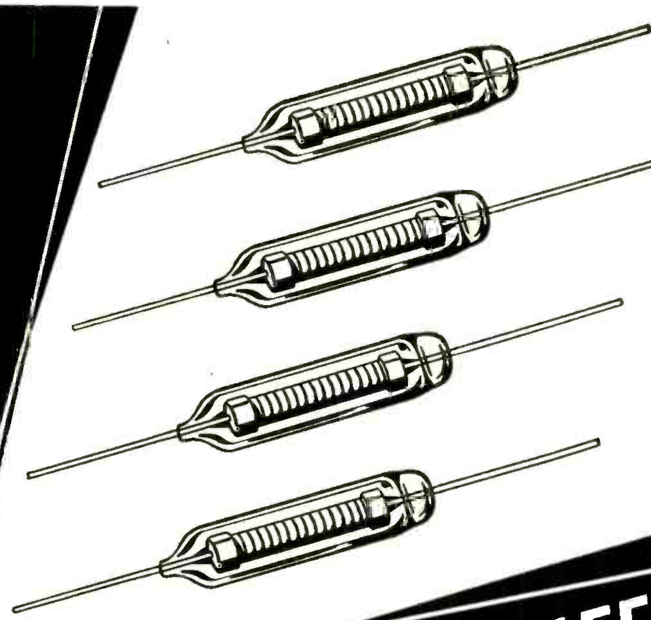
Want more information? Use post card on last page.

STABLE! ACCURATE!

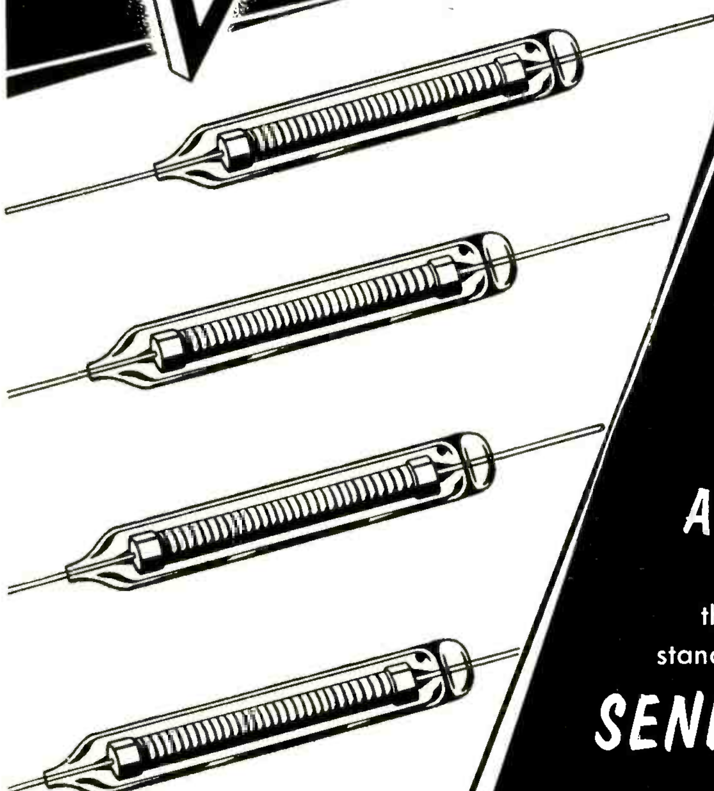
CARBON DEPOSITED RESISTORS

... GLASS SEALED FOR LIFE



STABILITY...

The ultimate in stability under any environmental conditions is obtained by hermetically sealing the element in a vacuum or an inert gas. Deterioration of the resistance element, with consequent change in resistance value, is reduced to zero. Drift during shelf life, or operating under load, is less than 1% in several thousand hours.



ACCURACY...

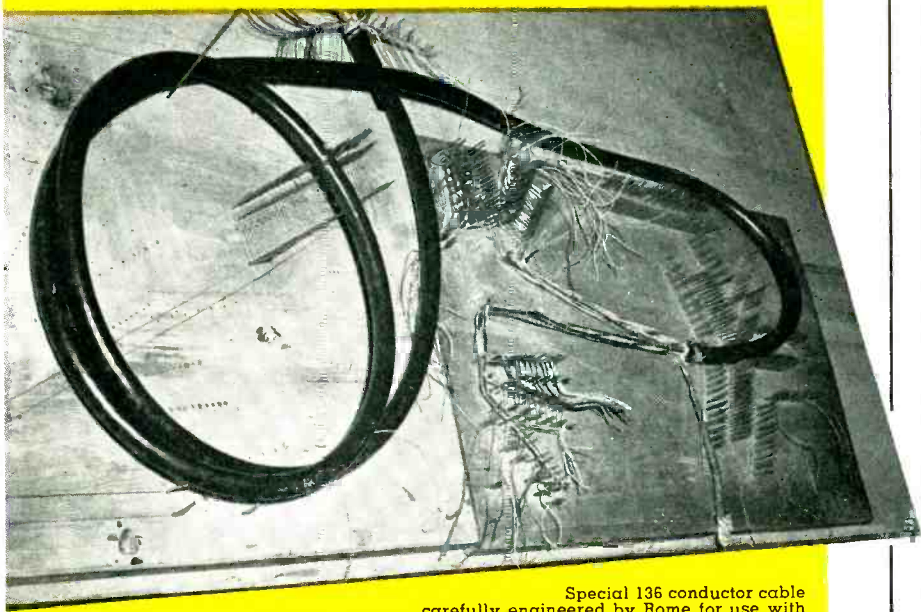
Accuracy is assured and maintained thruout life operation by Victoreen's rigid standards during the process of manufacture.

SEND *your inquiry to . . .*

COMPONENTS DIVISION

The Victoreen Instrument Co.

3800 PERKINS AVE. · CLEVELAND 14, OHIO



Special 136 conductor cable carefully engineered by Rome for use with IBM electric accounting machines, Types 402 and 403; IBM Reproducing Punch, Type 514; IBM Summary Punch, Type 523; and IBM Accumulating Reproducer, Type 528.

Carefully engineered wires and cables help keep IBM equipment "on the beam"

Equipment manufactured by International Business Machines Corporation has established a record for accuracy and service that's hard to beat.

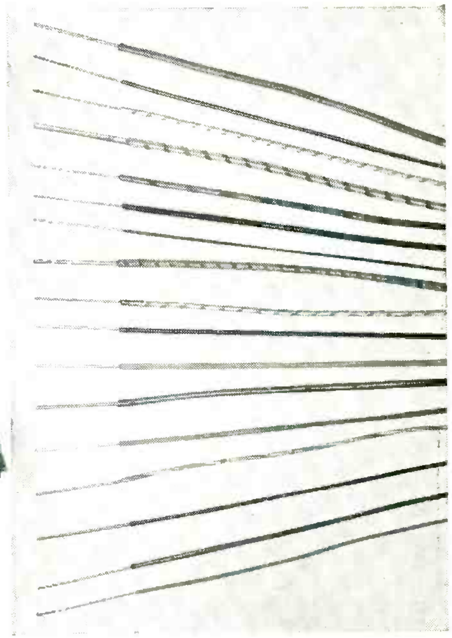
Much of the reason for this record is the fact that IBM uses only the finest components in their equipment.

This is one of the reasons IBM often comes to Rome Cable for top quality, specially engineered wires and cables. One of these is the 136 conductor cable (pictured top center) which is used in several IBM machines.

Others are various types of hook-up wire, a few of which are shown on the multiple spool rack (top left). Millions of feet of this Rome hook-up wire, manufactured to exacting specifications, are used by IBM every year.

In addition to the constructions shown, Rome manufactures a wide range of military and commercial type hook-up wires, intercommunication cables, coaxial cables, R. F. transmission line, television camera cables and other special constructions, engineered to the application involved.

Commercial type HOOK-UP WIRES



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

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

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

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

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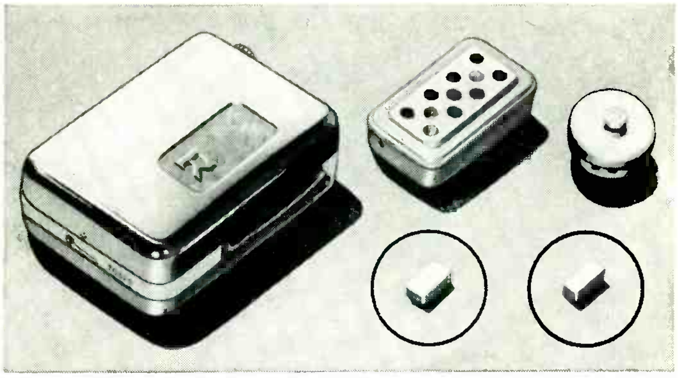
The heart of this Gibson electric guitar is the magnetic pick-up. Steel strings vibrate in the field set up by two small Carboloy permanent magnets, generating minute electrical impulses.



New all-magnetic, all-transistor hearing aid uses permanent magnets in both microphone and receiver. These tiny magnets eliminate hearing-aid failure caused by operational heat, and by humidity.

improve sound pick-up and acoustic action

They make possible simplified design, lower costs, and improved performance in communication devices and in many other important fields

Carboloy® Alnico permanent magnets are replacing electro-magnets in both the input and output elements of communication devices.

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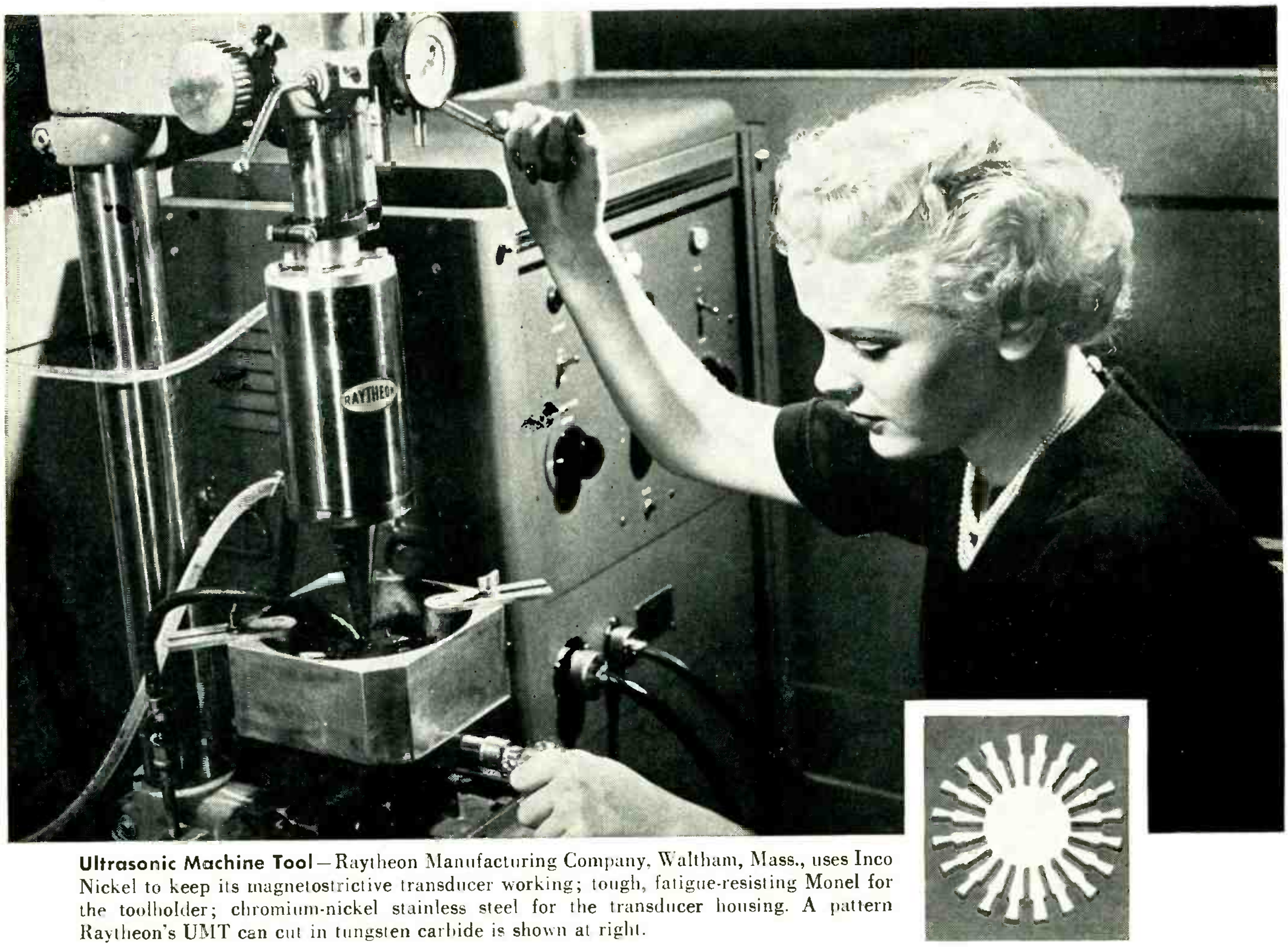

Ultrasonic Machine Tool—Raytheon Manufacturing Company, Waltham, Mass., uses Inco Nickel to keep its magnetostrictive transducer working; tough, fatigue-resisting Monel for the toolholder; chromium-nickel stainless steel for the transducer housing. A pattern Raytheon's UMT can cut in tungsten carbide is shown at right.

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This tool easily cuts a pattern as fine as lace in tungsten carbide. Yet its full potentialities in intricate machining are only beginning to be realized.

Ultrasonic waves, generated by magnetostriction, do the work in this new tool made by Raytheon Manufacturing Company, Waltham, Mass.

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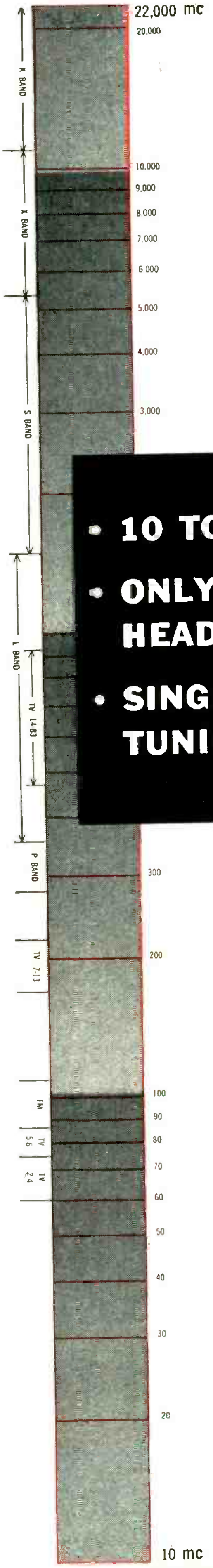

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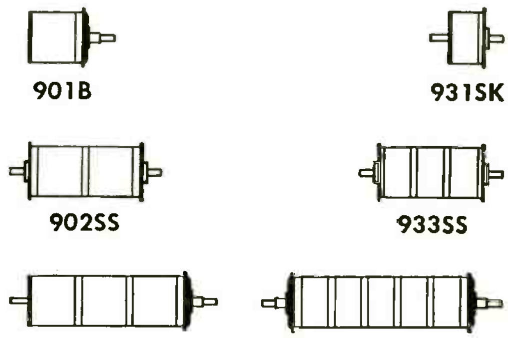

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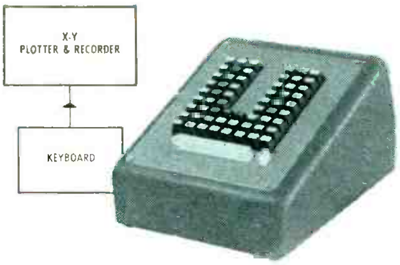

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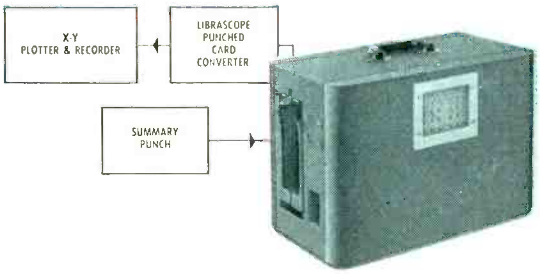

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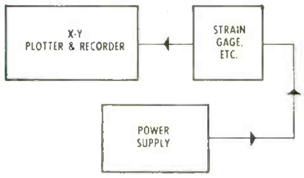

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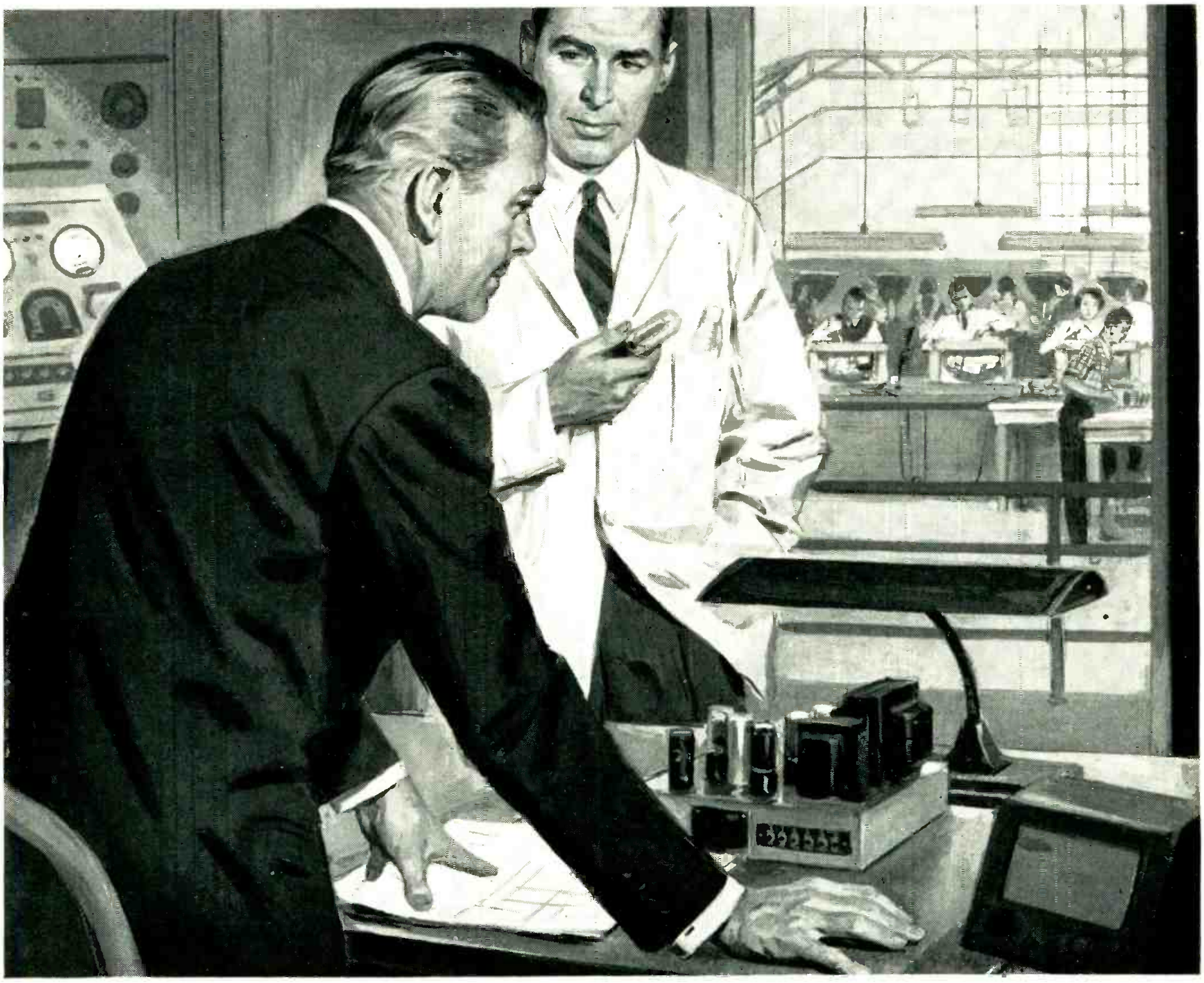

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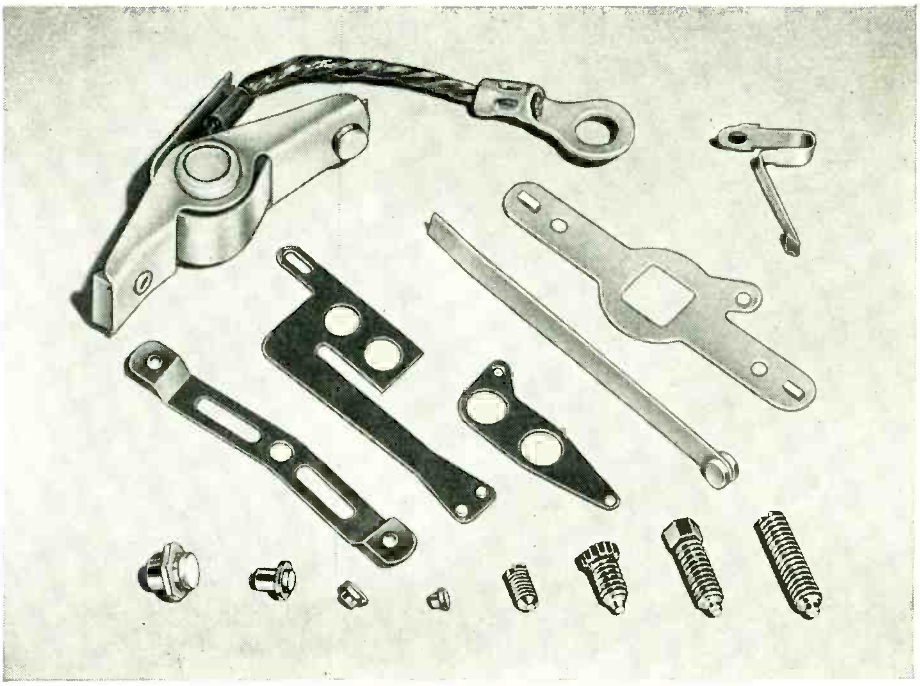

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electronics

W. W. MacDONALD, Editor

MAY • 1954

CROSS TALK

▶ **TRENDS** . . . A month of intensive field work leads to the conclusion that the electronics industry is well aware of current conditions in our economy and is adapting itself to the market.

Curtailment of television receiver production last fall hit component parts manufacturers hard. But they are now building back volume by effecting production economies and selling at lower prices. They realize that more, rather than less, business will be required in 1954 if they are to take in as many dollars.

Shifting of the military program from mass production of relatively simple and inexpensive items required by a large army to more carefully controlled production of sophisticated and expensive items needed by a highly specialized but smaller striking force has led manufacturers to shift in either one of two directions: (1) greater concentration upon military design and development as well as production contracts or (2) return to the civilian market. There is less tendency in the industry to carry water on both shoulders.

Growing realization that electronic instruments useful to all industry represent perhaps the most stable element in our entire field is leading more manufacturers in this direction. Adaptation of instruments originally designed for the military to the commercial market is proceeding at a stepped-up pace. Refinement of existing instruments will probably make this year a standout from the standpoint of new products.

▶ **RESEARCH** . . . A strong plug for scientific research in general and basic research in particular was included in President Eisenhower's recent executive order outlining the part that various government agencies are expected to play in future programs. Said the President: "Only a small fraction of the Federal funds is being used to stimulate and support the vital basic research which makes possible practical scientific progress."

Significantly, the President suggested in his budget for 1955 that the National Science Foundation receive \$14 million. It received \$8 in the '54 budget and less than \$5 million in '53. NSF is given primary responsibility for stimulating and coordinating government-supported basic research. Other agencies are urged in the direction of applied research.

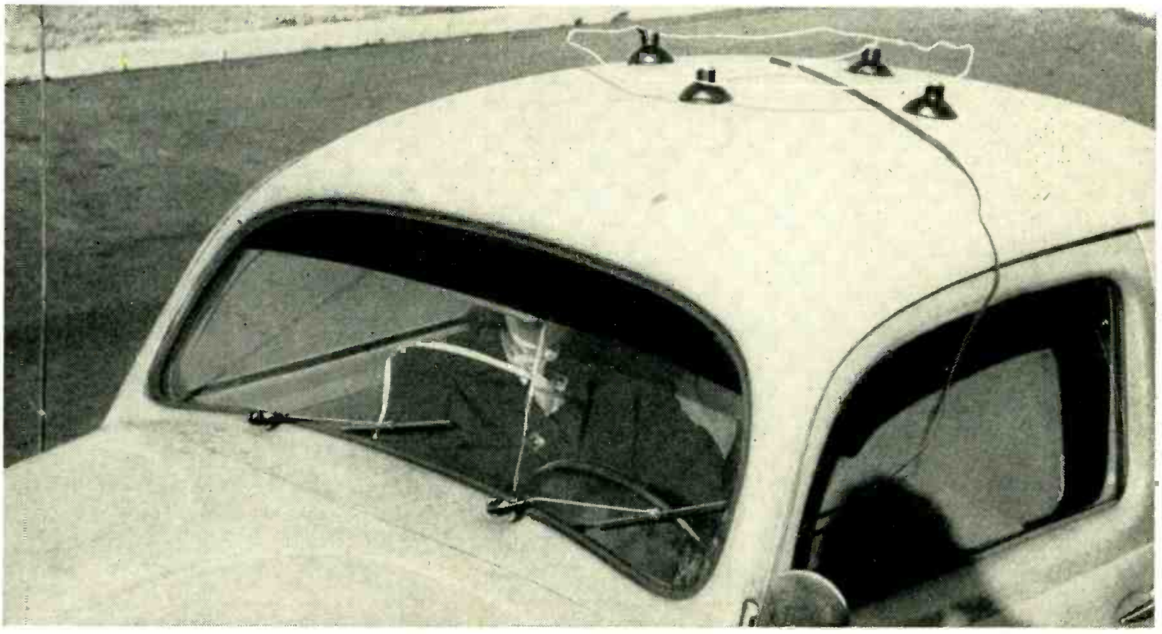
▶ **SHOWS** . . . This is the heavy season for conventions and exhibits and a good time to point out a pitfall. Let's take the recent IRE meeting in New York as an example and discuss one distressing aspect of this otherwise excellent affair:

Some 240-odd technical papers were presented in four days at 54 sessions, as many as seven running concurrently. The sessions were well planned but there were so many that it was difficult even for specialists to completely cover their own specialty.

There were 604 interesting exhibits. With the aid of our office abacus we have figured out that if a man listened to none of the papers, gave up his lunch and dinner and moved with the speed of light from booth to booth he could spend just 4 minutes 16 seconds in each before exhibitors pulled up stakes.

Maybe growth of our industry requires that shows be kingsize. If so, the amount of time devoted to them must expand too.

▶ **UTOPIA** . . . In our recent travels we met a well-heeled physicist who had just imported a swank new Mercedes automobile from Germany. Apple of his eye was the built-in shortwave receiver . . . which enables him to set the dashboard clock by WWV.



One of several car antennas giving essentially omnidirectional reception

Mobile F-M Broadcast

Simple circuits developed for f-m programs in moving vehicles or for sky-wave multipath reception use limiter and discriminator with bandwidth nearly twelve times that of normal receiver pass band. Experimental sets enhance fidelity by reducing distortion

CONVENTIONAL broadcast f-m receivers, being subject to multipath interference, cannot be used well in vehicles on the move. Even with some stationary receivers, distortion will result if the f-m signals arriving by different paths are nearly equal in amplitude. Such interference may occur at short distances owing to reflection and absorption from buildings, hills and other objects such as airplanes.

As early as 1930, Eckersley[1] reported on multipath distortion experienced during long-range a-m reception, which was found to result from incidental frequency modulation at the transmitter. Later Crosby[2,3] made a series of long-range propagation tests using f-m signals and found that severe interference was caused by multipath transmission. Thus, although f-m offers many advantages such as relative freedom from cochannel interference and noise, it suffers more from long-distance multipath distortion than a-m.

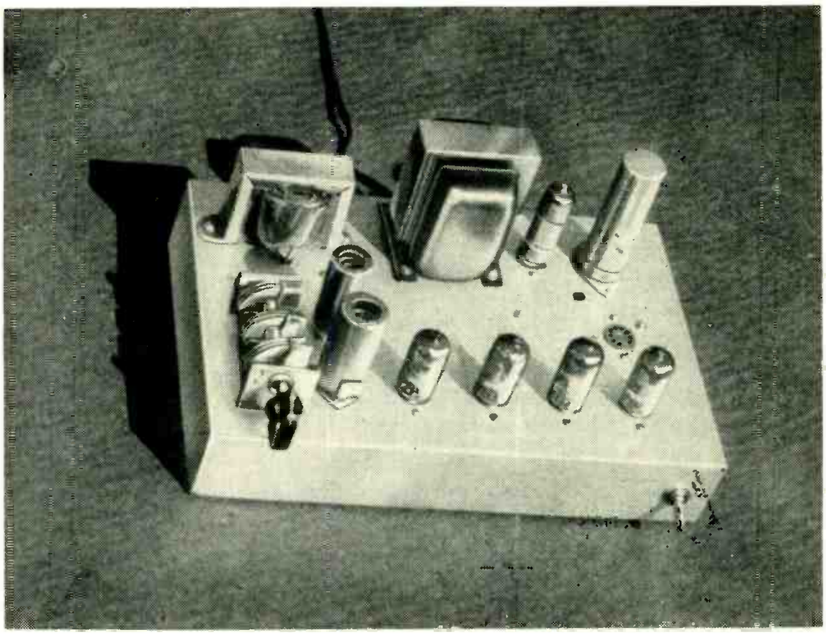
The theory of multipath distortion for f-m signals is well covered in the literature, particularly by Crosby, Corrington[4], Plusc[5], Arguimbau and Granlund. For the purpose of this paper, the following brief and simplified explanation may be helpful.

Multipath Effects

When an f-m signal arrives at the receiver by two transmission paths, there will be two signals that vary in phase and amplitude depending on the delay and absorption suffered during transmission. These two waves add in the linear circuits of an f-m receiver and their resultant can be found by combining them vectorially according to the parallelogram law.

In addition to the amplitude ratio and phase difference of the two waves, the resultant also depends on the modulation frequency and deviation. The two waves will reinforce or cancel each other depending on their instantaneous phase, thus producing undesired amplitude modulation of the resultant carrier. Furthermore, during the instant the two waves go out of phase, undesired frequency modulation is produced because of the rapid phase shift of the resultant voltage.

This effect results in spikes in the output of the discriminator. These two effects are responsible for producing distortion in f-m receivers and become worse when the amplitudes of the two signals are nearly



Complete experimental receiver occupies small chassis

Receiver Design

By KERIM ONDER
Circuit Research Laboratory
New York, N. Y.

equal. Distortion increases with both the modulation frequency and deviation.

From this oversimplified explanation it would appear that to reduce distortion, it is first necessary to check the amplitude variation of the resultant wave by passing it through an effective amplitude limiter. When this is done, the character of the original resultant wave is radically altered.

The limited resultant wave with constant amplitude now contains higher order terms that are several times the modulation bandwidth of the original f-m signal. In other words the frequency deviation is effectively widened many times. Plusc showed the extent of this widened deviation to be from $F_{cn}/(\rho + 1)$ to $F_{cn}/(\rho - 1)$ kc where F_{cn} is the beat frequency in kc between the two signals (or the frequency deviation) and ρ is their amplitude ratio > 1. In conclusion, he suggested that the bandwidth of the discriminator be widened to reduce distortion.

In a later paper, Arguimbau and Granlund[6] analyzed the whole problem of multipath interference and showed both theoretically and by experiment the advantages of the wide-band principle in reducing multipath distortion. They built an experimental receiver along conventional lines but using a wide band limiter and discriminator[7].

De-emphasis of Spikes

As regards the spikes produced in the output of the discriminator owing to undesired frequency modulation, fortunately these are predominantly ultrasonic and the de-emphasis circuits in an f-m receiver remove the higher audio frequencies. However, any interference within the lower audio range will pass through.

There are two other types of receivers claimed to reduce multipath interference, the locked-in oscillator[8,9] and the feedback type[10,11].

The problem of cochannel interference is essentially the same as multipath interference and an f-m receiver capable of separating two signals very close in amplitude will be relatively free from both kinds of distortion. However if the frequency difference between the two stations falls within the audio range, there seems to be at present nothing that can be done to improve reception.

Practical Receiver

The receiver described below is based on the wideband principle. The amount of extra bandwidth required depends on amplitude ratio of the two signals to be separated and may be determined from Fig. 1. For an f-m broadcast station using a bandwidth of 150 kc, the discriminator bandwidth should be increased by a factor of 11.5 to pick out the stronger of two signals differing by 1.5 db in amplitude.

It is necessary to widen only the bandwidth of the nonlinear circuits of the receiver, the limiter and frequency detector. The bandwidth of the r-f and the i-f stages remain 150-kc wide, since the two signals can coexist in the linear portions of the receiver. It is only required that their response be flat within the normal pass band of 150 kc. The

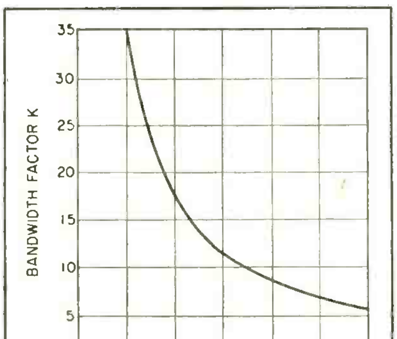


FIG. 1—Bandwidth multiplication factor for various amplitude ratios

limiter and f-m detector circuits must be fast-acting to follow rapid changes of the resultant signal within an audio cycle.

Figure 2 shows the block diagram of a simple f-m receiver using the wide-band principle. It consists essentially of a tuned r-f amplifier, an oscillating detector, an untuned amplifier and limiter, a counter-type f-m detector and combined filter and de-emphasis circuit.

The receiver circuit is shown in Fig. 3, with the exception of the audio amplifier. The detector oscillates at a frequency slightly off the carrier, the difference being equal to one half the widened bandwidth as indicated above. Only the difference frequency appears in the plate circuit of the oscillating detector, since the carrier and the sum frequencies are bypassed to ground through *C*.

This difference signal, which carries the frequency modulation, is progressively amplified and limited until it becomes a square wave of constant amplitude but varying in frequency according to the audio signal. These square waves are differentiated and rectified to emerge as small unidirectional bursts of constant amplitude and area in the output of the counter detector. The difference frequency is filtered out by the network R_2C_2 that also provides the standard de-emphasis of 75 microseconds.

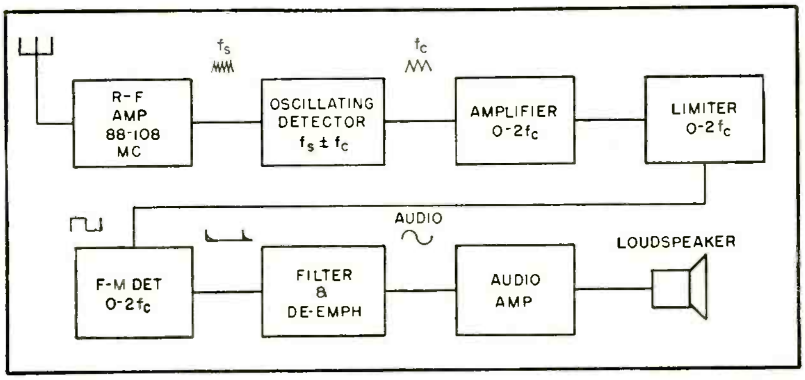


FIG. 2—Block diagram of simple receiver in which f_s is signal frequency and f_c the center frequency or half the widened bandwidth

Detector Response

The response of the limiter-detector of this receiver is shown in Fig. 4. It has a slope of 0.5 v per 100 kc, thus producing 0.7 v peak-to-peak of audio signal for 100-percent modulation. The center frequency is adjusted to approximately 500 kc. An input voltage of 2.5 mv at the amplifier is sufficient for full limiting and the output remains constant above that value.

Performance

Such a simple receiver suffers from poor adjacent selectivity and image rejection. Of two or more signals reaching the limiter, the stronger takes over when its amplitude is about 2 db above the others. Each station appears at two points on the dial separated by twice the difference frequency and severe distortion is produced in the middle region during the tuning process. This distortion occurs as the difference frequency becomes less than the deviation frequency.

A tuning device such as a meter, eye tube or a squelch circuit, should be provided to turn on the audio when the difference frequency is correctly centered. Such control is easily effected since several d-c volts are available at the center frequency. Pushbutton tuning is another possibility. With care, a station can be tuned in without these facilities or a vernier. Because the receiver has poor sensitivity, in the order of 300 μv, another r-f stage should be added for better results.

On the other hand, the performance of this simple receiver is satisfactory from several viewpoints since at least five f-m stations can be received with excellent quality in New York City. In addition to its relative freedom from multipath and cochannel interference, it is virtually free from amplitude distortion; since the nonlinearity of the diodes in the counter-type detector does not show up as distortion as in conventional discriminators.

The output of this receiver remains constant regardless of input level and it does not respond to amplitude modulation or to noise. No afc is required since the limiter-counter response is wide; hence, frequency drift in the oscillating detector will not affect the quality of reproduction. The set is free from hum and microphonics when tuned.

One feature of this receiver is its simplicity of design using a minimum of part types, rendering it suitable for miniaturization and printed circuitry. No alignment is required during production and servicing other than that of the r-f circuit. It is also adaptable for a-c/d-c operation with no hum or shock troubles since the audio output is isolated from the rest of the receiver by the differentiator capacitor and the antenna is inductively coupled.

Improved Receiver

The performance of this receiver can be greatly improved by using the front end of a conventional f-m receiver and one or more 10.7-mc i-f stages as shown in Fig. 5. An oscillating detector, similar to the circuit shown in Fig. 3, is used after the last i-f stage and the difference frequency is fed directly to the limiter. An experimental receiver based on this scheme was built and tested with good results. However, only one i-f stage was used and the first converter was likewise of the self-oscillating type but the difference frequency was tunable to 10.7 mc. The second oscillating detector was fixed at 10.2 mc.

This receiver has adequate selectivity and sensitivity and no centering device is necessary for proper tuning. In addition, it is relatively free from multipath and cochannel interference depending on how large a difference frequency is used after the second detector.

It is also possible to increase the adjacent selectivity and the sensitivity of the receiver by using a tuned amplifier between the oscillating detector and the limiter. This amplifier should have a flat bandwidth of 150 kc centered on the dif-

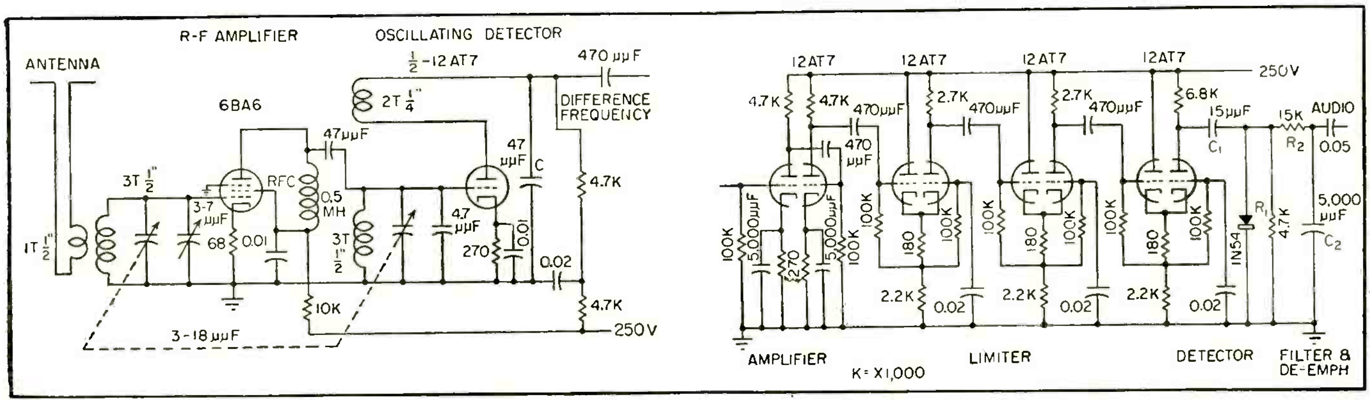


FIG. 3—Simple receiver using single r-f amplifier, oscillating detector, triple limiter and counter detector

ference frequency that is chosen.

A simplified version of this receiver is particularly suitable for tv receivers using intercarrier sound. As show in Fig. 6 it consists of a fixed oscillating detector at about 4.3 mc, an untuned limited amplifier, a counter-type f-m detector and a combined filter and de-emphasis circuit. A high center frequency is not necessary in this case, since the deviation frequency is only ±25 kc. Therefore, the differentiator time constant (R_1C_1) shown in Fig. 3 can be made longer giving higher audio output. Furthermore, the limiter will also completely remove any amplitude modulation resulting from picture signals.

This scheme can be adapted to other kinds of tv receivers by using an oscillating detector slightly off the sound carrier frequency.

Car Radio

A complete f-m broadcast receiver with audio amplifier and vibrator power supply was built to test the wide-band principle in automobiles.

With the car stationary, an f-m station was tuned in and the difference frequency adjusted to about 80 kc. When the car was driven around blocks of apartment buildings, severe distortion was caused in the form of several loud swishes of short duration. These also occurred every time a car or a bus passed by with the result that continuous reception was almost impossible.

The difference frequency was gradually increased, producing a wider bandwidth, while counting the number of swishes heard in going around the same block several times. With a center frequency of about 600 kc it was possible to reduce the number of these swishes to about two or three. Unfortunately, the poor adjacent selectivity of this experimental receiver did not permit increasing the difference frequency any further to get rid of the remaining swishes. It is also likely that two of these disturbances resulted from the directivity patterns of the antennas used.

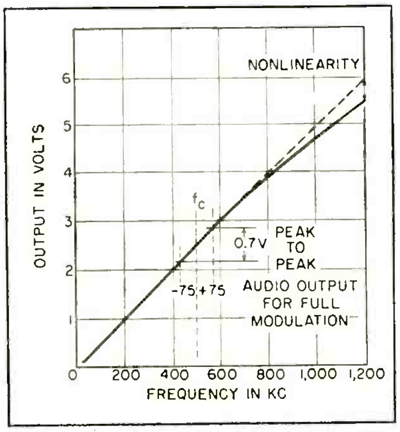


FIG. 4—Response of limiter and f-m detector showing deviation from linearity

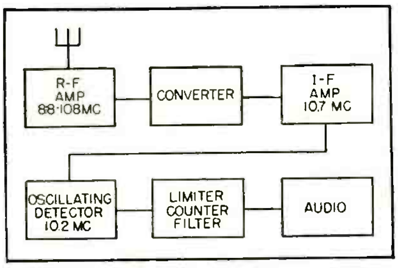


FIG. 5—Block representation of improved receiver using commercial tuner

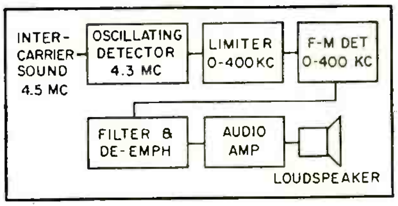


FIG. 6—Circuit can be used to improve tv sound

These experiments also showed that no ignition interference or other car noises were heard, even with the suppressors removed. However, it was found necessary to shield the early stages of the audio amplifier against direct pickup and the battery leads had to be filtered.

As a result of these experiments it can be safely concluded that satisfactory f-m reception is possible in automobiles if a wide-band f-m receiver is used. Thus, the benefits of clear f-m reception can be enjoyed in cars, particularly during summer months when ordinary a-m reception is marred with static.

It should be noted that with mobile f-m services such as taxi radio, the problem of multipath interference is not so apparent since both the audio and deviation frequencies used are low.

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Removing Tramp Iron

Pickup coil in steady magnetic field acts with electronic system to detect and reject the equivalent of a half-inch length of bailing wire in moist chopped hay traveling at up to 10,000 feet per minute through an 8-inch blower pipe

By J. B. DOBIE and F. C. JACOB

Department of Agricultural Engineering
University of California
Davis, Calif.

THE PREVALENCE of tramp iron in hay and feed annually creates significant losses for dairymen. Hardware sickness (traumatic gastritis) of cattle is caused by penetration of the stomach wall by a nail or piece of wire.

Various forms of magnets or air flotation devices successfully remove tramp iron from liquid, ground or granular feeds, but when stemmy materials such as hay or silage are handled by pneumatic conveyor, another method is needed.

The iron remover described here uses an iron detector to control a bypass or reject gate. On detection, an iron piece is rejected, along with a small wad of hay, by momentary deflection at the gate.

Several metal detectors have been described, both experimental and commercial models, that use an alternating magnetic inspection field[1,2] and operate with conveyor speeds up to several hundred feet per minute. This method is unsuitable for pneumatically conveyed chopped hay, which moves at speeds of 6,000 to 10,000 feet per minute and may have a moisture content above 30 percent. If the frequency of an alternating field is high enough to detect at this conveyor speed, the detector becomes responsive to moisture also.

Since the metal to be removed is ferromagnetic, the high conveyor speed becomes an advantage in combination with the use of a steady magnetic inspection field.[3,4] The momentary change in magnetic path reluctance created by passage of a piece of iron generates several millivolts in the associated inspection coil. This voltage is amplified by a high-μ double triode, and the positive portion operates a biased thyratron having in its plate circuit a solenoid that operates the rejection gate. The general arrangement is shown in Fig. 1.

Inspection Coil

The inspection coil has an 8½-inch aperture, for placement around an 8-inch blower pipe. The magnetizing winding of 15,000 turns carries a current of 100 ma, giving a field strength on its axis of about 100 gauss. This arrangement produces sufficient response from a length of baling wire as short as ½ inch, traveling through the least sensitive part of the aperture.

To minimize internal vibration, absorbing material that reduces transmission of vibration is used for mounting the coil assembly on a 3-foot section of aluminum pipe.

The pickup coils for the experimental model are split and wired in series opposing. This arrangement helps cancel undesired external influences, particularly ripple in the

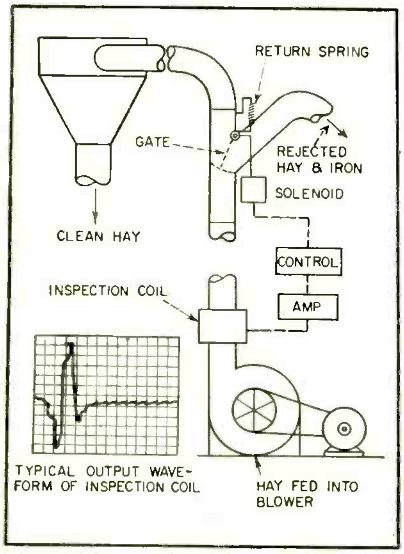

FIG. 1—Iron detector system

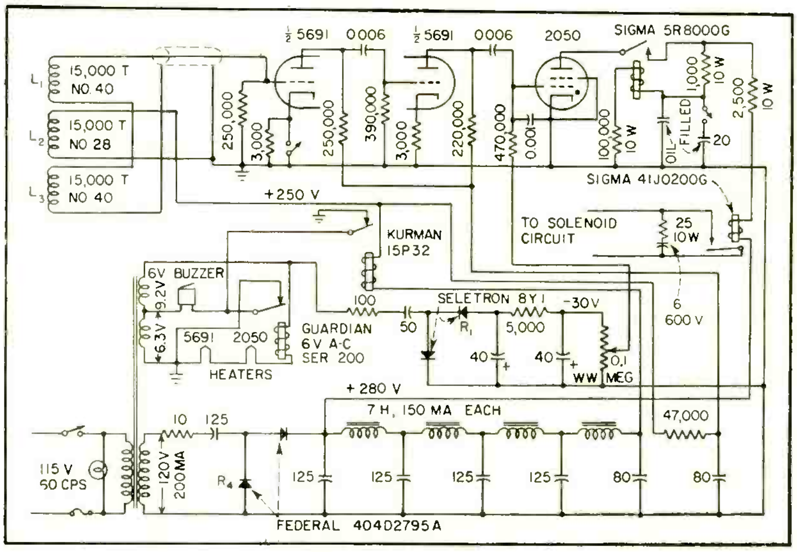

FIG. 2—Circuit of detector, amplifier and control system

from Chopped Hay

First field trial of tramp-iron remover. Total of 34 pieces of dangerous wire and nails was removed from this haystack in first pass through setup, and none on second pass

current that supplies the magnetizing winding. The desired signal is not cancelled, for the two halves of the split pickup winding are on opposite ends of the magnetizing winding. Their centers are about 6 inches apart and there is a time difference in the signal produced in the two halves. A permanent magnet for the field and a single pickup winding could be used for simplification.

The nature of the electrical signal varies with length, orientation and speed of baling wire or other iron object. In one half of the pickup winding an impulse of one polarity is induced as the wire enters the magnetic field and another impulse of opposite polarity appears as the wire leaves the field. The other half of the winding reacts the same, with the time difference mentioned above.

Each induced impulse may be likened to one half-cycle of a sine wave, but (depending on geometry and speed of the wire) the two half-cycles are not necessarily adjacent. Taking the length of the pickup coil assembly as ½ foot and the wire speed as 100 feet per second, the wire traverses the coil in 1/200 second and the coil output therefore has a fundamental frequency of 200 cycles per second.

Amplifier and Control

The complete circuit of the amplifier and control is given in Fig. 2. The amplifier gain is 54 db, with pass band centered at 200 to 300 cps. Response below 100 cps or above 1,000 cps not only contributes little to the desired information but offers more opportunity for interference from irrelevant signals, such as those produced by vibration of the inspection coil.

The extra cost of an industrial type of tube is well justified by its longer life and freedom from influence by vibration. Since the heater currents of this tube and the thyratron are the same, the coil of an a-c relay and the heaters can be connected in series so that interruption of current by a tube burnout will operate a warning buzzer. Another relay, in the line carrying the inspection coil magnetizing current, and a test button in the input stage cathode circuit offer further service reliability; otherwise the iron detector would not give warning in the event of equipment failure. The test button produces a signal by momentarily removing the bias on the first stage.

In the quiescent state the thyratron is nonconducting, the oil-filled hold-time capacitor in its plate circuit is charged to about 275 volts, and the thyratron relay is energized, thus keeping the circuit in readiness. A signal large enough to overcome the bias on the thyratron grid causes that tube to conduct, discharging the hold-time capacitor. When the capacitor voltage has fallen, the thyratron relay releases, opening the plate circuit and extinguishing the thyratron. The current flowing to recharge the hold-time capacitor passes through the coil of the solenoid-circuit power relay, operating the reject gate.

The reject gate is held in the operated position until the voltage on the hold-time capacitor rises, thereby reducing the charging current below the drop-out current for the power relay. Earlier in the cycle the voltage on the capacitor is sufficiently high to reclose the thyratron relay. This makes the device ready for a second operation even before the cycle for the first operation is complete.

The thyratron plate circuit components do more, then, than just provide a hold-open time for the reject gate. If additional signals occur during the hold time, the hold-time capacitor is repeatedly discharged, keeping the reject gate open until the last iron piece has cleared. This is essential for a detector operating with farm blower equipment. It is not unusual for a length of wire picked up with hay in the field to be cut into many small pieces when the hay is chopped, and these pieces may arrive at the detector in rapid sequence.

Much of the speed and accuracy of operation of the tramp iron remover depends on the reject gate, and special attention has been given to its construction.[5] Several factors establish 100 milliseconds as a desirable maximum operating time for the gate. These factors include the position of the iron-removing equipment in the pneumatic conveyor, the influences that give variability to the time of travel of a particle between the detector coil and reject gate and the need to keep rejected hay at a minimum.

Reject Gate

A gate of relatively simple unbalanced construction as in Fig. 3A has performed well on 6-inch pipe, but its use is precluded on 8-inch pipe by the effect of static air pressure on the larger vane. It is therefore desirable, although the inertia is doubled, to use the balanced construction of Fig. 3B where half the vane serves no function except counteraction of air pressure, thereby making the operation independent of static pressure in the pneumatic system.

From the first, the possibility has been recognized that the blower system may become plugged at the reject gate. Every effort has been made to maintain a smooth and uninterrupted flow-path for the hay in both the normal and reject positions of the gate. Results with dry hay have been satisfactory; with hay of 30-percent moisture content or above, the system is encouraging but not yet foolproof. Further development is needed to eliminate occasional plugging by such stickier material.

A Cutler-Hammer d-c solenoid, size D-3, rated for 230 volts and $\frac{1}{4}$ time duty, has been used effectively to operate the gate. The rated pull at a $1\frac{1}{2}$-inch stroke is $27\frac{1}{2}$ pounds for 85 percent voltage. A voltage-tripling selenium rectifier operating from 115 volts 60 cycles charges a 160-μf capacitor to 450 volts at no load; this power supply and the solenoid coil in series comprise the solenoid circuit, as indicated in Fig. 2. Soon after the solenoid coil is energized this voltage falls to 230 volts because of regulation, but the momentary impulse provides additional acceleration to the gate vane. The spark-suppressing components are required to protect the relay contacts from the inductive surge when the contacts are broken.

Field Tests

Thirty-four pieces of wire and nails were removed from about 3 tons of a farmer's hay, restoring it from a condemned condition to usable hay. In another field test, the equipment was exposed to rain and fog and operated intermittently over a five-month period. About 200 tons of hay were inspected, from which 472 pieces of iron—mostly nails and wire, ranging from $\frac{1}{2}$ inch to 12 inches in length—were removed. No electronic maintenance problems developed during these tests.

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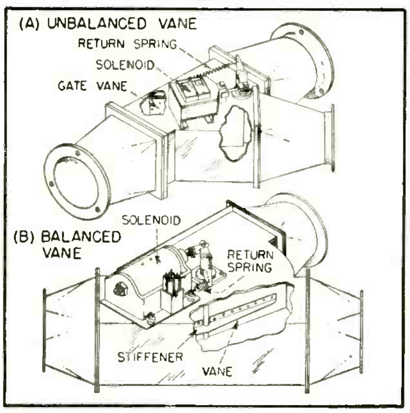
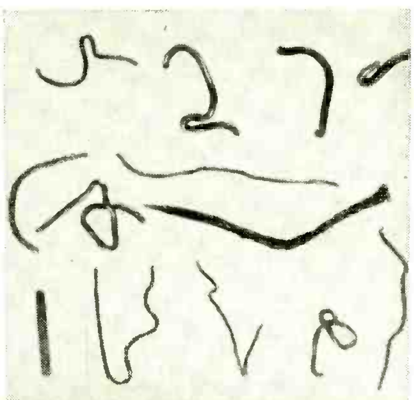
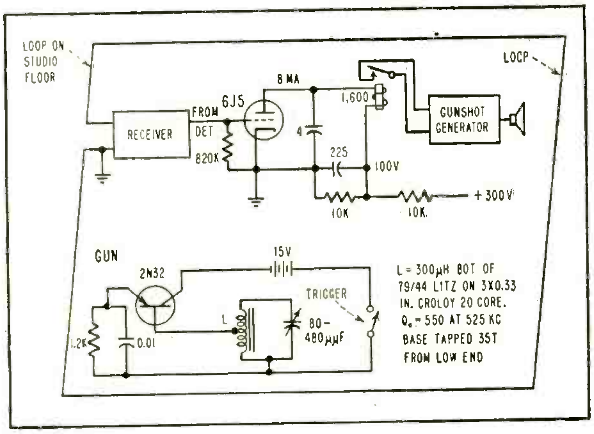


FIG. 3—Two types of reject gates used to divert contaminated hay



Iron eaten with hay, found in cow by veterinarian

Amplifier and control unit, with coil and gate sockets at front



Circuit of gun (below) and relay actuator for gunshot generator in receiver detector output, surrounded by loop

Transistor gun, showing snap-switch, transistor and battery together with inductor and capacitor in handle

Transistor Gun for TV

By RAYMOND E. LAFFERTY

Engineering Development Group
National Broadcasting Co.
New York, N. Y.

Single-transistor oscillator in dummy gun shoots medium-frequency radio wave to brass-ribbon pickup loop on floor of studio. Impulse picked up on broadcast-type receiver actuates relay in detector circuit to operate electronic sound-effects generator at exact instant that actor presses trigger

EVEN BEFORE the development and construction of the NBC electronic shot generator,[1,2] it was apparent that a gun capable of activating a gunshot sound-effects device, without connecting wires, would be useful for television.

Once several shot effects generators were built and made available in television studios, the need for such a gun became increasingly evident. Perfect synchronization between trigger action and the sound of the report is difficult, if not impossible, for sound-effects technicians. To the discriminating viewer, the delayed, or anticipatory report, is ludicrous.

Accordingly, a simple but effective application of transistors was employed to build an electronic gun. Located in the interior of the gun, which was built by the NBC Special Effects Department, is an oscillator with its associated coil and capacitor. The magnetic field established in this coil couples energy to a nearby receiving loop. The voltage induced in the loop, after amplification and detection, closes a relay that fires the gunshot generator. The actor with the gun is free to turn in any direction and may fire the gun any place within the receiving loop (taped to the studio floor and camouflaged, if necessary, with paint). The gun can be fired outside the loop if special circumstances dictate, but best results are achieved inside the confines of the loop.

Choice of Weapons

The circuit of the system is shown, as is a typical gun with its battery, transistor, coil and capacitor. The flexibility of the electronic shot effects generator permits the use of pistols, rifles or machine guns. The latter weapon will fire for as long as the trigger is held. Ricochets can be incorporated with either pistols or rifles by properly presetting the generator.

Legal Requirement

The frequency of operation has been tentatively set at 525 kc. At this frequency, FCC Rule 15.2 (c) allows 300 feet between the gun (oscillator) and the 15 microvolt-per-meter contour. Measured distances to this contour show it to be only about 50 feet.

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Balloon-Borne Radiation

By G. M. BURGWALD and L. REIFFEL

Armour Research Foundation
Illinois Institute of Technology
Technology Center, Chicago, Ill.

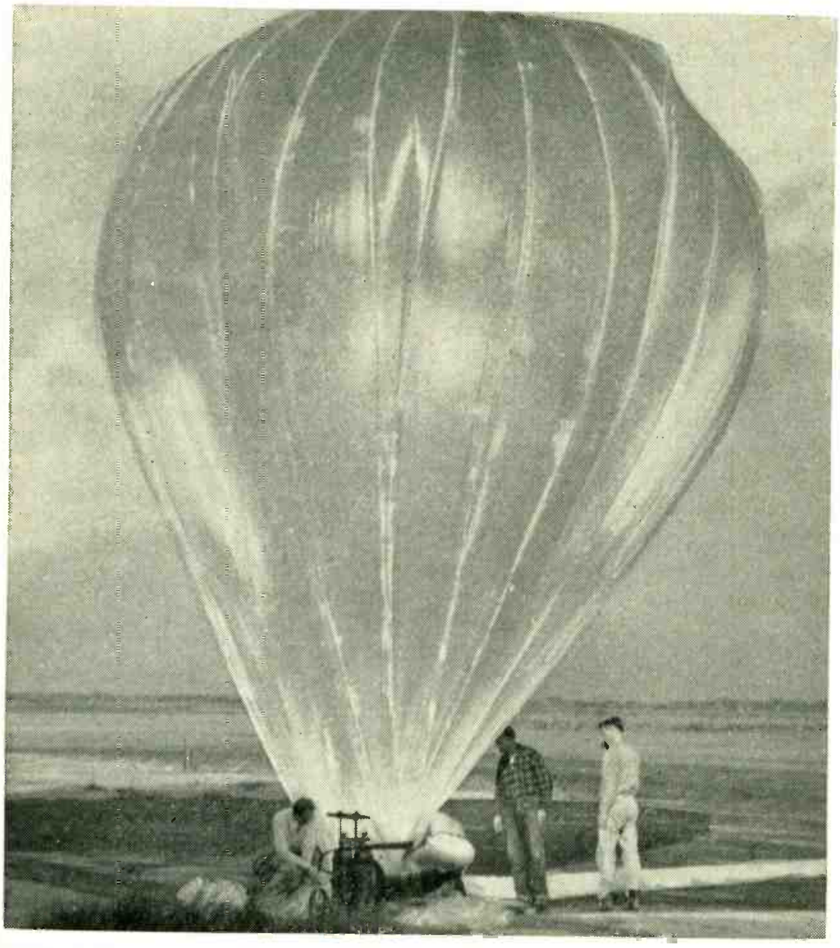
TELEMETERING SYSTEMS for high-altitude research with rocket-borne equipment have received considerable attention. Corresponding systems for balloon-borne apparatus have not undergone comparable development. While many of the problems are similar, there are sufficient basic differences to make a direct carry-over from well-engineered rocket systems to balloon-borne devices impractical.

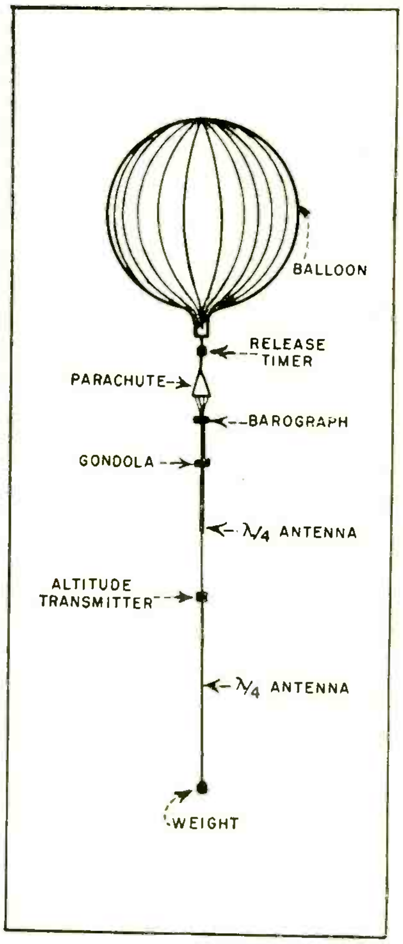
A balloon-borne radiation detection and telemetering system based on a scintillation counter is described which is capable of measuring the low-energy gamma-ray component of cosmic rays to altitudes as high as 115,000 feet.

Use of a scintillation counter as the radiation detector offers advantages not attainable with Geiger counters, although the circuitry required is somewhat more complex and necessarily heavier. Scintillation counter pulses are channeled to a differential pulse-height discriminator and then to a pulse-scaling circuit. The output pulse of the scaling circuit is used to interrupt the carrier of a crystal-controlled r-f transmitter.

Altitude information is obtained by varying the carrier frequency of a transmitter as a function of altitude and measuring the frequency shift at the ground station. Low-frequency transmitters for counting rate and altitude information permit use of crystal-controlled oscillators and nondirectional receiving antenna at the ground station.

A circuit diagram of the balloon-borne unit is shown in Fig. 1. The





Plastic balloon used to carry telemetering equipment being inflated. Diagram at right shows balloon rigging

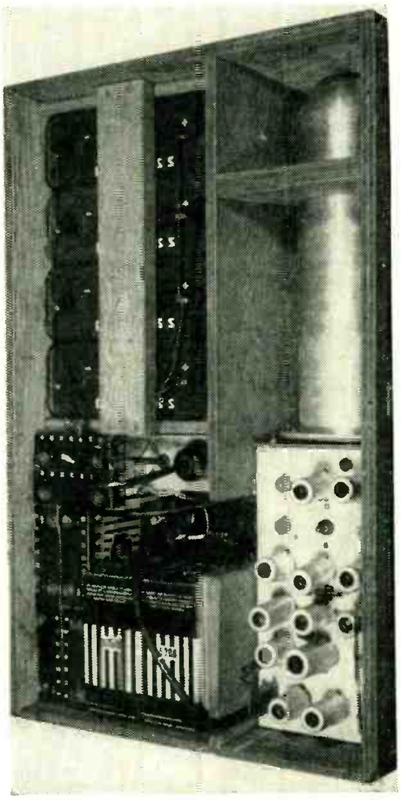
Telemetering System

Phototube scintillation counter measures low-energy gamma radiation at altitudes up to 22 miles. Pulse-modulated f-m transmitter used to convey data to ground station. At maximum altitude signal level is down only 15 to 20 db from ground reference

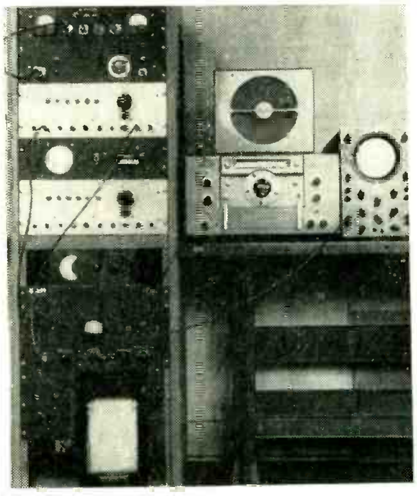
radiation detector consists of a 5819 multiplier phototube, V_1, viewing the light given off by a thallium-activated sodium-iodide crystal. The crystal responds to radiation by emitting a flash of light whose intensity is related to the energy of the radiation. Lucite as a light pipe is placed between the crystal and the window of the phototube to improve the optical light coupling. Mineral oil is used to fill small air spaces between the mating surfaces.

Detection of gamma rays in the energy range of 0.1 to 2.0 mev is principally by photoelectric and Compton absorption in the crystal. The output of the multiplier phototube is a series of random pulses whose amplitude is proportional to the energy given up by the electrons ejected by the gamma rays.

High voltage for the dynode network is supplied by a regulated supply consisting of a CK 1038, 900-volt corona regulator tube supplied from four 300-volt batteries in series. The regulated voltage varies by only a few volts as the current through the CK 1038 varies from 0 to 50 microamperes. This is important since the gain of the multiplier phototube changes as about the 9th power of applied voltage. The voltage across the dynode network may be set at from 650 to 900 volts so that the output pulse height of different tubes can be standardized. The detector and the high-voltage regulator circuit are enclosed in a light and pressure sealed container, the regulator circuit being maintained at atmospheric pressure to eliminate the problem of corona at high altitudes.



Complete gondola with radiation detector. High-voltage supply is located behind detector unit



Ground station for receiving count data

Pulse-Height Discriminator

Pulses from the multiplier phototube are amplified by V_2 and V_3 and are then coupled to the upper and lower gate circuit by the dual diode, V_4. The lower gate consists of an amplifier V_5, and a monostable multivibrator, V_6 and V_7. When the pulse height of V_3 exceeds the bias on the diode, V_4, the pulse is amplified, and triggers the multivibrator. Resistor R_1 adjusts the bias on the diode to determine the triggering level. The upper gate circuit consists of V_8 and V_9 and its operation is similar to that of the lower gate.

The output pulses from the upper gate are coupled to the suppressor grid of the output tube in the lower gate circuit, V_7. When the input pulse height is at an intermediate value between the two gate settings, only the lower gate will trigger and the output pulse is counted by the counting circuit. If the pulse exceeds the bias setting of the upper gate, both multivibrators start to trigger, but the pulse from the upper gate paralyzes the output stage of the lower gate, so that no pulse appears in its output.

The width of the upper-gate pulse is somewhat wider than that of the lower gate to insure proper anticoincidence action, at least for counting rates for which the recovery time of the circuits are negligible. The triggering levels are set to correspond to 0.1 and 2.0 million electron volts to insure a 20-to-1 ratio in levels.

Pulse Counter and Modulator Circuit

Output pulses from the lower gate circuit are coupled to a step-charge counting circuit having an adjustable scaling factor variable from eight to thirteen. The energy-storage capacitor is located in the cathode circuit of a monostable multivibrator circuit, V_{12}. Each pulse reduces the voltage on the

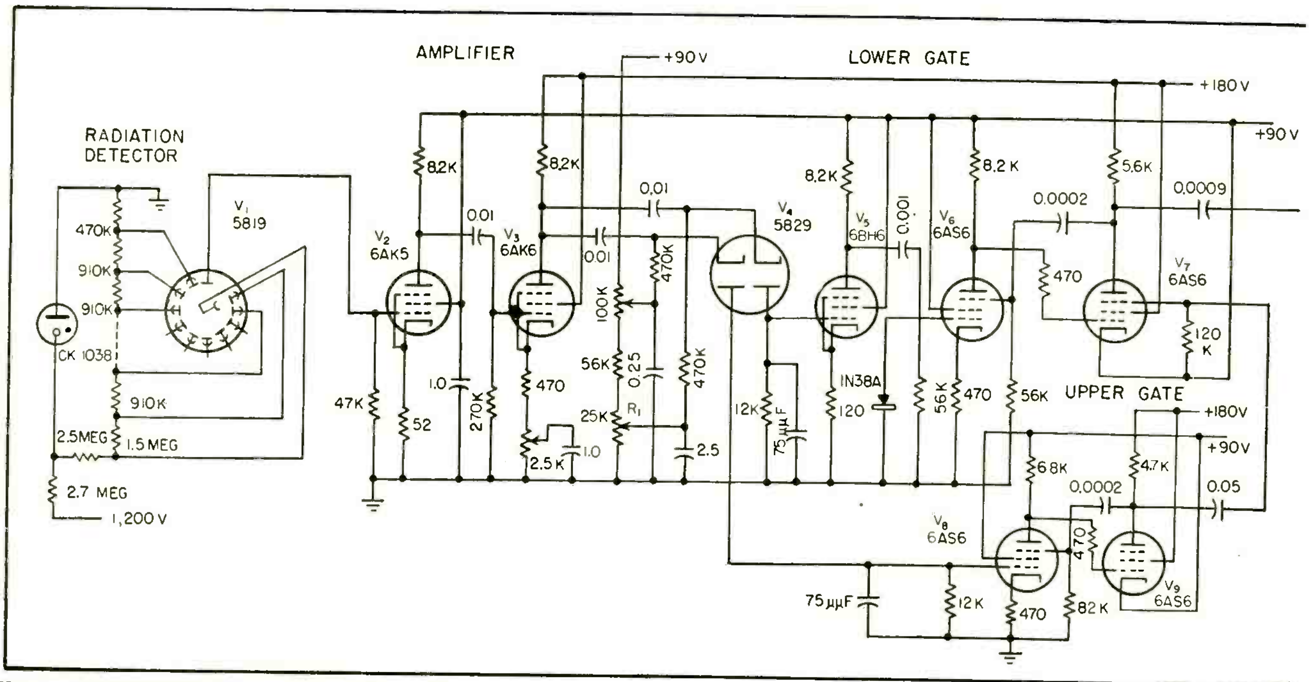


FIG. 1—Balloon-borne unit employs sodium-iodide crystal as radiation detector. High-voltage regula tor circuit is maintained at

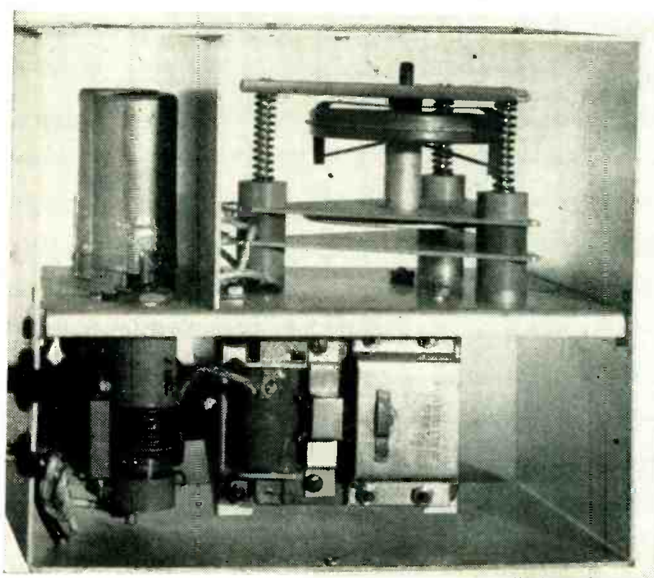
storage capacitor until the grid-cathode voltage of the normally cut-off section reaches the conduction value and then the multivibrator triggers, supplying an output pulse to the modulator circuit and recharging the storage capacitor to its original value. Triode V_{11} allows the storage capacitor to be charged in linear steps permitting the use of somewhat higher scaling factors. The modulator circuit consists of a thyratron, V_{13}, which is normally cut off. The output pulse from the scaling circuit triggers the thyratron and its output pulse is used to modulate the carrier of the transmitter. Capacitor C_1 is normally charged to the B+ voltage and quenches the thyratron.

The transmitter consists of an oscillator and a power-amplifier stage. Tube V_{14} is a crystal-controlled Pierce oscillator which requires no tuned circuits in its operation. The output of the power-amplifier stage, V_{15}, drives a center-fed half-wave antenna. The power output of the unit is approximately $1\frac{1}{4}$ watts.

The negative pulses from the modulator circuit are coupled to the grid of the oscillator stage, and cut off the carrier for approximately 600 microseconds. It is necessary to transmit pulses of at least this width because of the high selectivity of the receiver amplifier. Carrier frequency is in the 6-mc region.

The signal containing pulse data is received at the ground station by a communications receiver. The pulses appearing in the detected output of the receiver are amplified so that they will drive a scaler and count-rate meter. A recorder may be used to give a permanent record of counting-rate as a function of time.

Best reception has been obtained using a vertical center-fed half-wave antenna approximately 75 feet in length. An end-fed vertical antenna connected to a small captive balloon is also effective, but can be used only during periods of relatively low wind velocity.



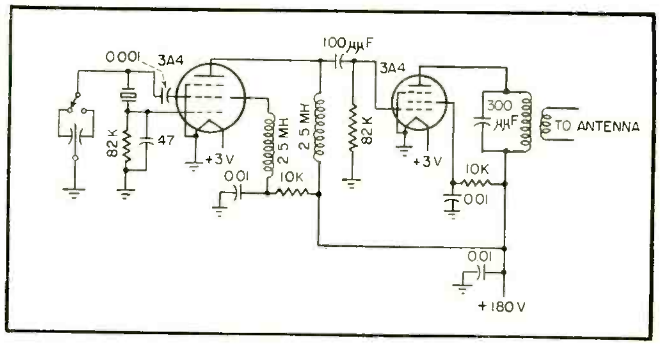
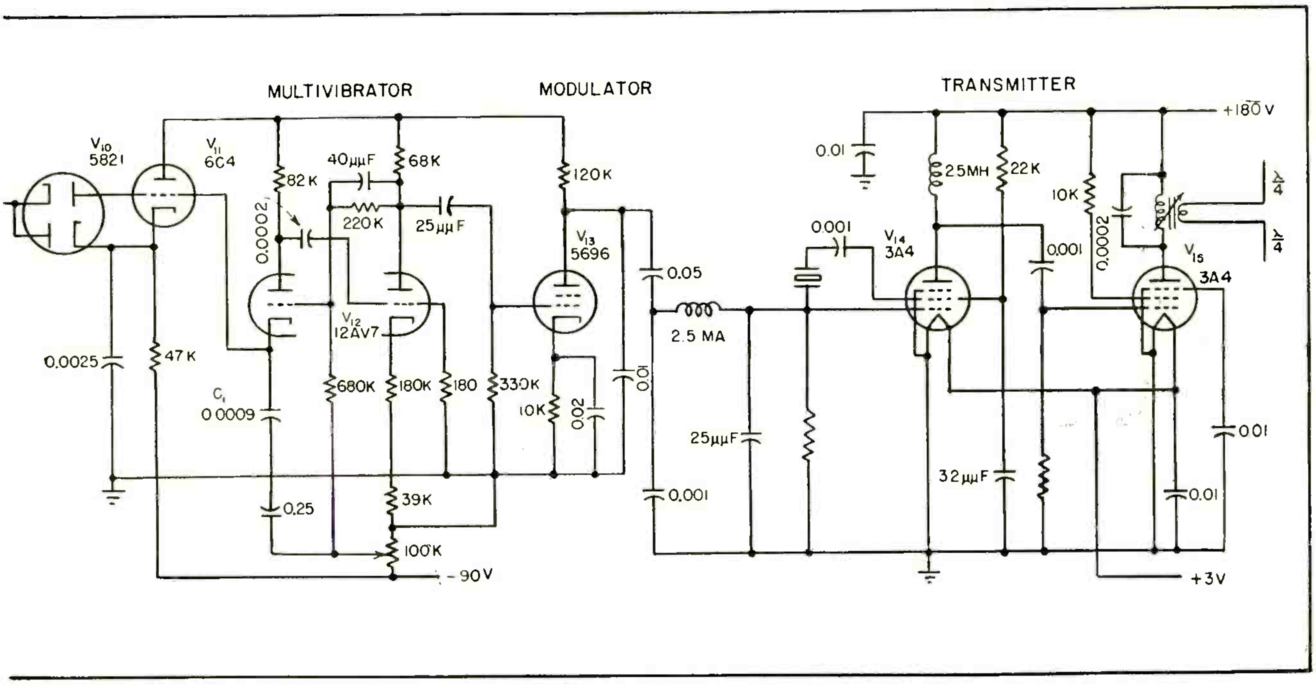


FIG. 2—Schematic and picture of altitude transmitter. Pressure sensitive capacitors at input are alternately switched to created frequency difference indicating altitude



atmospheric pressure in sealed container to eliminate corona problems at high altitude

With the receiver r-f gain set at maximum the indicated signal strength on the S-meter at the time of balloon launching is approximately 40 db above S-9. When the balloon reaches maximum altitude, the signal level is usually between 20 and 25 db above S-9. During the parachute descent, the signal level varies between S-9 and 10 db above S-9; reception is not as good during the descent because of swinging of the transmitting antenna. In general, when the signal strength is less than S-9, the signal to noise ratio makes it difficult to obtain good data.

Altitude Transmitter

A separate transmitter and receiver are used to obtain altitude data. A circuit diagram of the altitude transmitter is shown in Fig. 2 with a photograph of the unit. A variable capacitor, connected to an aneroid element, is shunted across the crystal in the oscillator circuit. The capacitance changes with altitude and shifts the carrier frequency by a small amount. For a carrier frequency of 1.75 mc, the frequency shifts approximately 500 cps as the altitude changes from zero to 100,000 feet.

The variable capacitor consists of a movable plate positioned between two fixed plates. A motor-driven set of contacts alternately switches from one fixed plate to the other so that the capacitance between the movable plate and one of the fixed plates appears across the crystal. Switching occurs at approximately 30-second intervals and the frequency difference obtained due to capacitance switching is used as a measure of altitude. The transmitter employs a crystal oscillator and a power amplifier stage delivering a power output of approximately $1\frac{1}{4}$ watts.

At the ground receiving station the input signal is mixed with a local oscillator operating at the transmitter frequency and the frequency difference at the receiver output is measured with a frequency meter and plotted on a recorder. A typical frequency-altitude curve is shown in Fig. 3.

Balloon Data

The balloons used on all flights were of a plastic, nonexpansible type about 85 feet in diameter. A release timer located at the bottom of the balloon cuts it loose from the equipment after a predetermined interval. Upon release, the equipment is lowered to the ground by a 28-foot parachute. The average rate of rise of the balloon is about 600 feet per minute. During the first part of the descent the velocity approaches the free-fall rate until 60,000 feet is reached.

To insure a successful launching, surface wind must be less than 15 mph and it is desirable to have a wind screen, such as a hangar, to shield the balloon during inflation.

The aid rendered by General Mills personnel, in particular C. P. Merrill is hereby acknowledged. The authors are indebted to J. C. Beynon, C. A. Stone and F. G. Rest of Armour Research Foundation for important and valuable contributions.

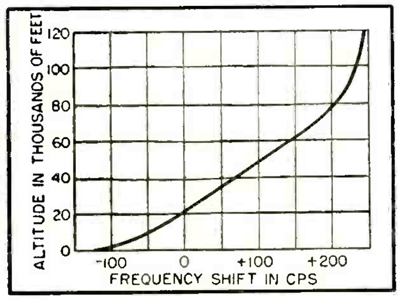


FIG. 3—Altitude-transmitter frequency shift as a function of altitude

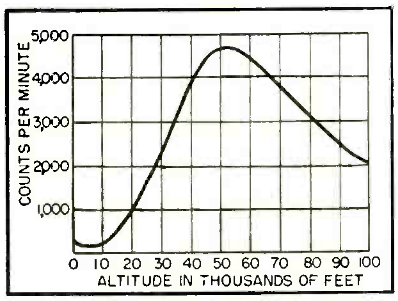
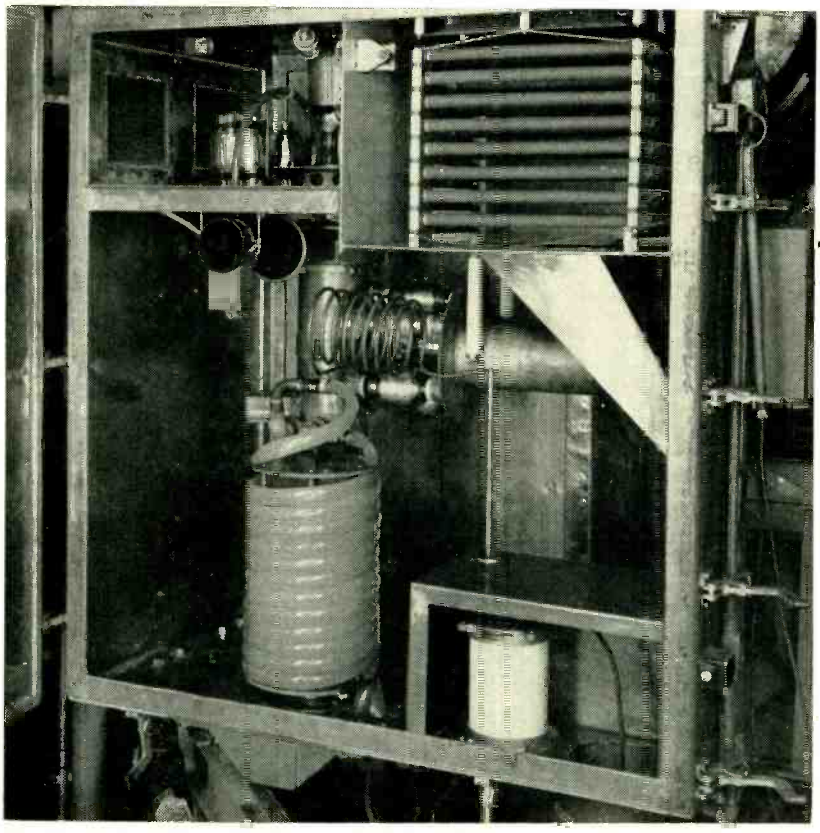


FIG. 4—Representative radiation curve obtained in flights at a latitude of 28-deg north

An R-F Generator for

By **LESTER KORNBLITH, JR.**
Institute for Nuclear Studies
University of Chicago
Chicago, Ill.



Oscillator tube with cooling system consisting of water coils and air blowers housed in movable compartment to facilitate servicing

LARGE SYNCHROCYCLOTRONS require radio-frequency supplies that can deliver large amounts of power and can be modulated over a wide frequency range.[1] In some machines it is also desirable to pulse the r-f system on during the desired part of the frequency-modulation cycle and to control the pulsing intervals. This article describes the equipment used for these purposes in the 170-inch synchrocyclotron at the University of Chicago.

The basic design of the r-f system is identical with that developed by MacKenzie for the same use at the University of California.[2] The system is inherently capable of covering both proton and deuteron ranges with minor adjustments. The rotary tuning capacitor is located at a point of low magnetic field and d-c bias for the dee is easily provided to avoid ion loading.

Protons start at a magnetic field of 18,600 gauss and reach a final energy of 450 million electron volts at a radius of 76 inches and a field of 17,600 gauss. The frequency range required is 28.4 to 18.2 mc.

The accelerating voltage is applied between a single dee and a grounded dummy dee. The dee, which is approximately semicircular, is 164 in. in diameter and has the characteristics of a transmission line of about 6 ohms. The dee voltage is of the order of 10 to 15 kv, sufficient for a repetition rate of about 60 pulses per second.

General Design

In this system the dee is connected to a rotating capacitor through a section of transmission line. The other side of the capacitor is connected to ground through a transmission-line stub. It is possible to proportion the dimensions of the system so that it behaves like a uniform transmission line shorted at one end and open at the other with the rotating capacitor at a point about one-third of the way from the shorted end.

The minimum frequency is approached as the capacitance is made very large and the system behaves as a resonant quarter-wave line. As the capacitance approaches zero the system behaves as a three-quarter wave line with a 180-degree phase shift at the capacitor. The theoretical ratio of maximum to minimum frequency is three.

In practice, the attainable ratio is appreciably less than three because of the finite capacitance limits of the rotating capacitor and the difficulty of arranging an efficient coupling to the oscillator tube over a wide frequency range. The coupling for the tube is designed to avoid undesired modes of oscillation. A particularly troublesome parasitic mode is a three-quarter wave mode that places no voltage across the capacitor. In this mode the capacitor has no control over the frequency at which the system resonates. Since the capacitor losses do not appear, this mode has a higher Q than the proper operating mode.

If the capacitor losses are excessive, the capacitor can behave as a mode selector tending to favor the incorrect mode. For this reason the capacitor must be designed to have as small a loss as possible.

Oscillator Tube

The oscillator tube is coupled across the capacitor through long high-impedance lines, as shown in Fig. 1, designed so that the excitation phase is incorrect for the $\frac{3}{4}$-wave untunable mode. The tube is operated grounded-grid, to take advantage of the inherent freedom from oscillator parasitics that this type of operation can afford. The oscillator excitation is supplied to the cathode, which must be driven

Nuclear Energy Studies

Accelerating voltage for 450-mev synchrocyclotron is supplied by 40-kw sweep-frequency generator. Motor driven capacitor tunes oscillator from 18.2 to 28.4 mc. Output is keyed by phototube circuit actuated from mirrors on capacitor shaft

in phase with the plate.

The cathode is indirectly coupled by a loop suspended inside the dee to induce a voltage which, transformed through a long line, drives the cathode with enough amplitude in the proper phase. Because of the resistive component of the drive impedance, the actual phase must be corrected by capacitive loading of the cathode. The plate is coupled directly by a long line connected in parallel with the stub line.

The resonant system, consisting of the dee and its line and capacitor stator, the rotor, and the grounded stub line and its stator, is suspended and operated in a vacuum. To dissipate the heat produced in the system, all parts in the vacuum as well as the support rods are water cooled. The rotor of the capacitor, which is 18½ inches in diameter and about 4 feet long, has 6 rows of blades with 85 blades in each row. It was machined from a solid steel forging and copper plated. The rotor blades mesh with stator blades to leave a minimum gap of 0.110 inch. This gives a total capacitance of 3,600 μμf.

The oscillator tube is mounted in a compartment shown in photograph. Since the tube is operated with the grid grounded, the box is divided into an upper cathode section and a lower anode section to minimize coupling between these electrodes. The box is mounted on wheels and tracks to facilitate servicing other parts of the machine.

The tube is a 5770 thoriated-tungsten filament, water and air-cooled triode especially designed for grounded-grid operation. It has a plate dissipation rating of 40-kw at 30 mc. It is mounted in a ½-inch mild-steel jacket to provide shielding against the stray field of the cyclotron magnet, which is about 300 gauss at this point. Cooling is provided by a water coil made from two 20-foot lengths of 1-inch nylon-jacketed Tygon tubing wound on an insulating support. Blowers cool plate, filament and grid seals.

Vacuum capacitors were originally used for plate blocking, grid grounding and cathode phasing. When trouble was experienced with voltage breakdown of the plate blocking capacitor, the vacuum units were replaced with ceramic capacitors. Eight 500-μμf, 15,000-volt units are used in parallel. The vacuum capacitors used for grid grounding were replaced by a paral-

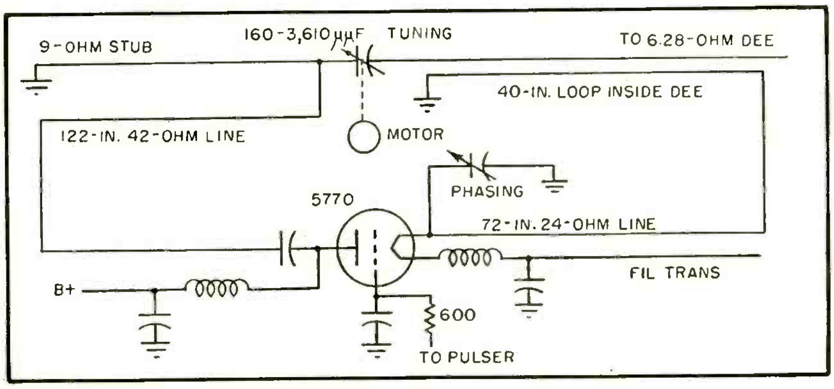


FIG. 1—Sweep-frequency oscillator generates 40-kw r-f signal

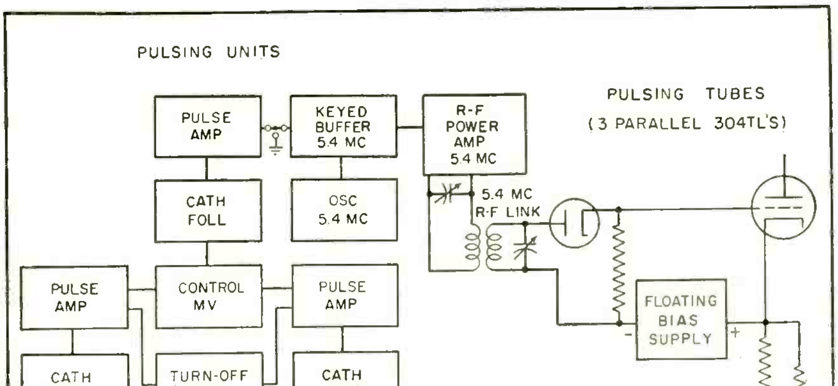


FIG. 2—Pulser circuit turns oscillator on and off to accelerate particles during descending part of the f-m cycle

lel-plate capacitor using Teflon insulation to eliminate resonances. The photograph was taken before these changes were made.

The oscillator power supply is rated at 200 kw and can deliver 11.5 amperes at 17.4 kv. The voltage is continuously variable from about 1 kv to maximum at rated current. The rectifier output is filtered through a choke-input filter with a 58-μf output capacitance to reduce supply droop during pulsed operation. A 70-ohm resistor in series with the output protects the oscillator from flash-arc damage by limiting the arc current until the supply breaker trips.

Oscillator Pulser

Since acceleration takes place only during the descending part of the frequency-modulation cycle, a pulser has been constructed to turn the oscillator on and off at appropriate times. A block diagram of the system is shown in Fig. 2.

Timing signals for operating the pulser are obtained from two multiplier phototubes receiving light from a mirror mounted on the rotary capacitor shaft. The mirror has six sides, corresponding to the six sets of blades on the rotor, and is fixed with respect to the blades. The phototube housings are mounted on carriages that move on a semicircular track concentric with the rotor shaft. The carriages are driven by selsyns operated from the control room.

The output of the multiplier phototubes is sent through two cathode followers to the control room. There the two pulses are used after amplification and shaping to start and end a control-multivibrator pulse. The automatic turn-off multivibrator puts out a pulse at an adjustable time after the on phototube pulse. This pulse will turn off the control multivibrator in the absence of a pulse from the off phototube. The output of the control multivibrator is fed through a cathode follower to the pulsing unit. The pulser uses a 6V6 as a 5.4-mc oscillator feeding an 807 power amplifier through a 6L6 keyed buffer. The control-multivibrator pulse is fed through a 6V6 amplifier to the cathode of the keyed buffer. A switch is provided to ground the buffer cathode permitting it to operate continuously.

The grid of the main oscillator tube is normally held at about −1,200 volts by a separate bias supply. During the pulse, this bias is overcome by the voltage developed across the cathode resistor of the pulsing tube. Three parallel 304TL pulsing tubes are used, driven by the rectified voltage from a tuned circuit inductively coupled to the 807 power amplifier.

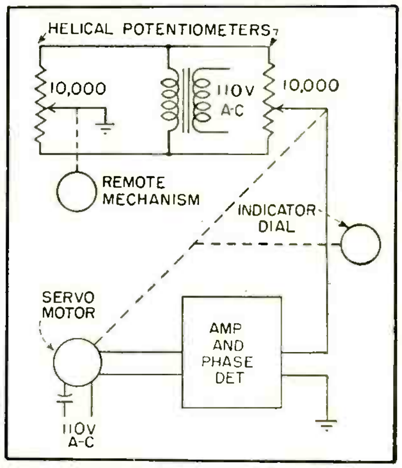


FIG. 4—Null-type servo system indicates position of pulser phototubes

This arrangement is used so that the low-level stages are not required to operate at oscillator bias potential. Suitably insulated power supplies are required and interlocks provided to insure that plate voltage cannot be supplied to the cyclotron oscillator unless all required voltages are present in the pulser.

Pulser Control

It is sometimes desirable to operate under conditions other than the normal 50 or 60 pulses per second. Plug-in units are inserted between the on multiplier phototube and the pulser to provide several modes of operation. The arrangement is shown in Fig. 3. The modes selected include normal continuous operation, n pulses per control pulse and 1 pulse for each n control pulses, where n is any power of two from zero to five.

In addition, a time clock is provided to determine the length of operating time under the first and third modes. Control pulses may be supplied from an external source such as a piece of experimental apparatus or a one-second pulser available in the cyclotron. The cyclotron cannot be operated directly from the control pulses because the pulses must come at the proper point in the capacitor-rotation cycle. It is however pulsed at the proper time in the first cycle following the control pulse. Two output channels are provided, one for triggering the cyclotron and one for

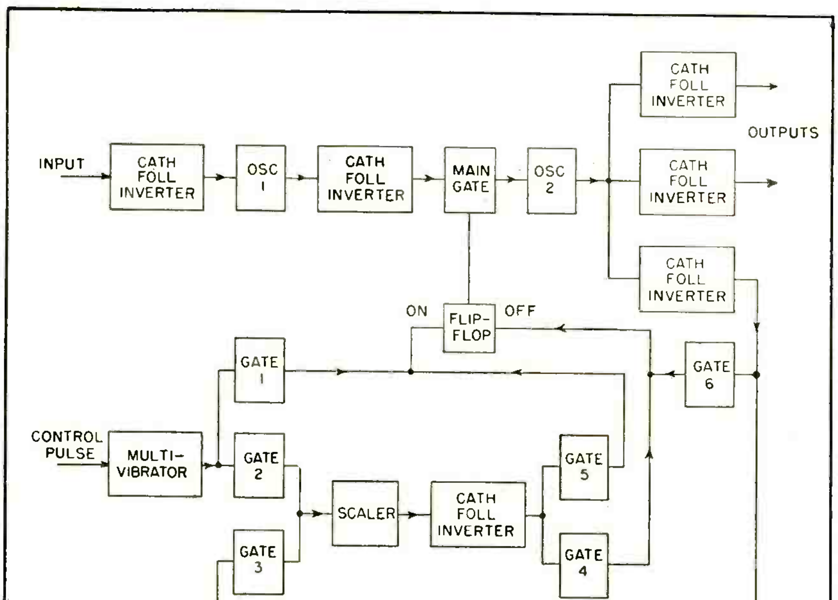
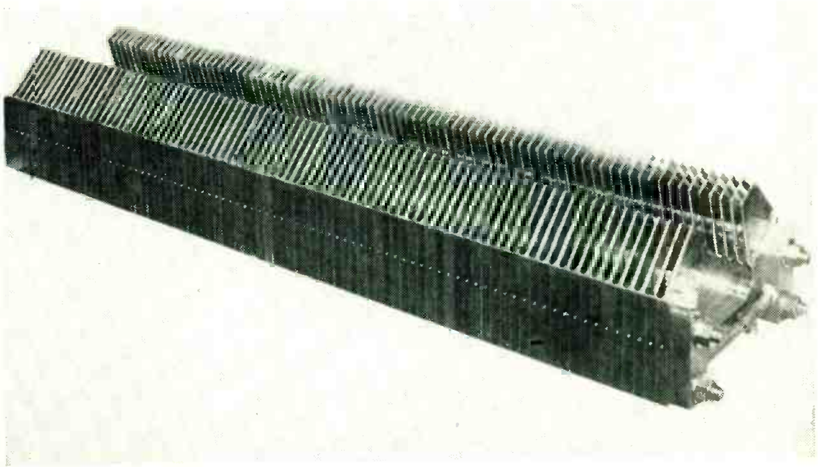


FIG. 3—Control system provides for several modes of operation including normal continuous operation, series of pulses per control pulse and 1 pulse for a group of control pulses

triggering experimental apparatus.

The on phototube pulse is amplified and inverted in a cathode follower-inverter and used to trigger blocking oscillator 1. The blocking-oscillator pulse is fed through a cathode follower to the main gate. Pulses passed by the main gate trigger another blocking oscillator that drives the output cathode followers. Control pulses are formed in a one-shot multivibrator and applied to two gates. For continuous operation gate 1 is opened, turning on the control flip-flop. For the second type of operation, n pulses per control pulse, gate 1 is again opened. Gates 3 and 4 are also opened. Pulses from oscillator 2 are now fed through a cathode follower and gate 3 into the scaler unit. The scaler counts to n and sends a pulse through a cathode follower-inverter and gate 4 to turn off the control flip-flop. This cycle is repeated for each control pulse. For the third mode of operation, one pulse for each n control pulses, gates 2, 5 and 6 are opened. Control pulses go through gate 2 to the scaler which counts n of them and then sends a pulse through gate 5 to turn on the control flip-flop. The output pulse from blocking oscillator 2 is then fed through the cathode follower and gate 6 back to the control flip-flop to turn it off.


Water-cooled stator of 3,600-$\mu\mu$f capacitor is mounted in a vacuum with other parts of cyclotron r-f system

Position Indicator

A device is required in the control room to indicate the position of the pulser phototubes and other remotely controlled units. The indicator consists of two separate channels each of which has a ten-position switch for selecting the unit whose position is to be indicated.

A block diagram of one channel is shown in Fig. 4. The system is a null-type servo system employing two helical potentiometers, one mechanically driven by the component to be indicated and one driven by a servomotor. Both potentiometers are energized through a transformer from the 110-v 60-cycle line. The movable arm of the remote potentiometer is grounded and an amplifier connected between that of the local potentiometer and ground. The amplifier output is fed to a phase-sensitive power amplifier and then to the control field of the servomotor. The local potentiometer has double shaft extensions coupling on one end to the motor and on the other end to an indicator dial. The position is readable to one part in 1,000 or 2,500, depending upon the channel and may be estimated to twice this accuracy. The sensitivity of the system is great enough so that the reproducibility is limited primarily by the number of turns of wire on the potentiometer. Accuracy is limited by the linearity of the potentiometers, which is one percent for the two units.

Operating Characteristics

Radio-frequency systems of this sort have operating difficulties at practical vacuum levels due to ion loading. These troubles are caused by ions between the high-voltage components and grounded surfaces oscillating under the influence of the electric field. In oscillating they ionize additional gas molecules until the loading on the oscillator is so severe that it stops oscillating. This condition can be prevented by biasing the components of the system to eliminate the ions.

This is done in the case of the dee and the capacitor rotor. The grounded stub line cannot be biased, however, so an arrangement of clearing wires and skins is provided in the region between the stub line and the ground skin. The clearing wires are isolated from both stub and ground and are biased. Care must be exercised to avoid resonances in the clearing wires at frequencies covered by the oscillator as such a resonance could destroy a set of mounting insulators. The biases for the rotor, dee and clearing wires are supplied from 300-ma rectifiers adjustable from 0-3 kv negative and are applied through 7,000-ohm resistors. In addition, each clearing wire is decoupled from the set of clearing wires by an individual 5,000-ohm resistor. This leaves voltage on the rest of the wires if one is shorted or grounded. Bias voltages are supplied to the rotor and dee through choke coils, which are grounded at r-f by large capacitors.

The oscillator normally operates with a plate voltage of about 10 kv. At this voltage there is an average plate current of about 1.5 amperes and about a half ampere of grid current. The input to the oscillator during the pulse is approximately 40 kw. About five percent of the power appears in the ions that strike the target.

Most of the equipment described in this paper is the result of the cooperation of a group working under the direction and guidance of H. L. Anderson. The project has been supported in large part by the Office of Naval Research, the Atomic Energy Commission and the University of Chicago.

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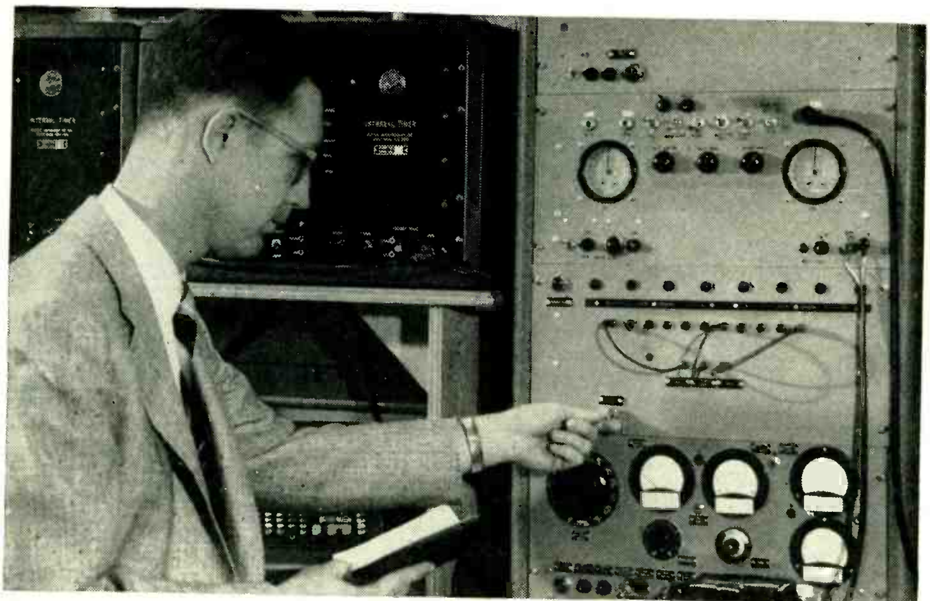
Equipment for generating pulses indicating shaft position uses flip-flop circuit which is immune to false triggering

Marker Pulse Shows Shaft Position

Synchro-triggered circuit produces pulse indication when shaft reaches reference position. Angular position of reference can be varied by use of differential synchro. System is useful in operation and testing of control systems and automatic equipment

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By F. B. WOESTEMEYER

Aeronautic and Ordnance Systems Division
General Electric Company
Schenectady, N. Y.

CONTROL SYSTEMS and automatic equipment operation or testing frequently make it necessary to produce a marker or signal indicating when a shaft has reached a given reference position. The shaft in question may be inaccessible, or the equipment may have originally been built without provision for attaching a reference position indicator.

As originally built, the circuit operated from a small synchro in the remote equipment, however, induction resolvers, potentiometer resolvers, and center-tapped potentiometers can also be used.

The circuit for generating marker pulses consists basically of a flip-flop triggered by two polarized gates, with clipping, biasing, and phase shifting circuits.

Operation

The amplifier input stages are biased so that the synchro signal reaches the gates whenever it exceeds a predetermined magnitude. The gates are polarized so that gate *A* passes the synchro signal when it is in phase with the carrier and gate *B* passes it when it is 180 deg out of phase, Fig. 1.

A signal through gate *A* triggers the flip-flop circuit to the flip position and a signal through gate *B* triggers it to flop. The flip-flop gives out a negative pulse on each flip. The flop is a reset operation.

The synchro is connected as a generator and the line to line output of one phase is used.

The signal envelope starting

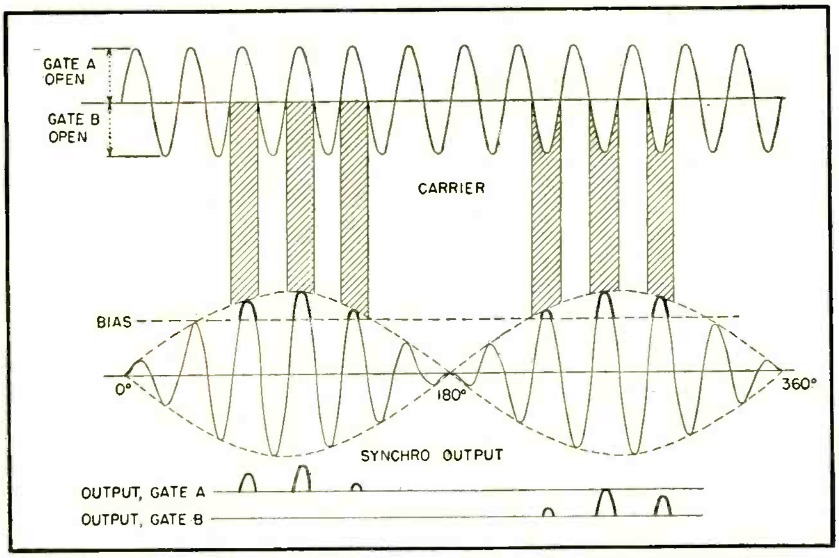


FIG. 1—Synchro output exceeds bias during part of each half revolution producing pulse to trigger flip-flop

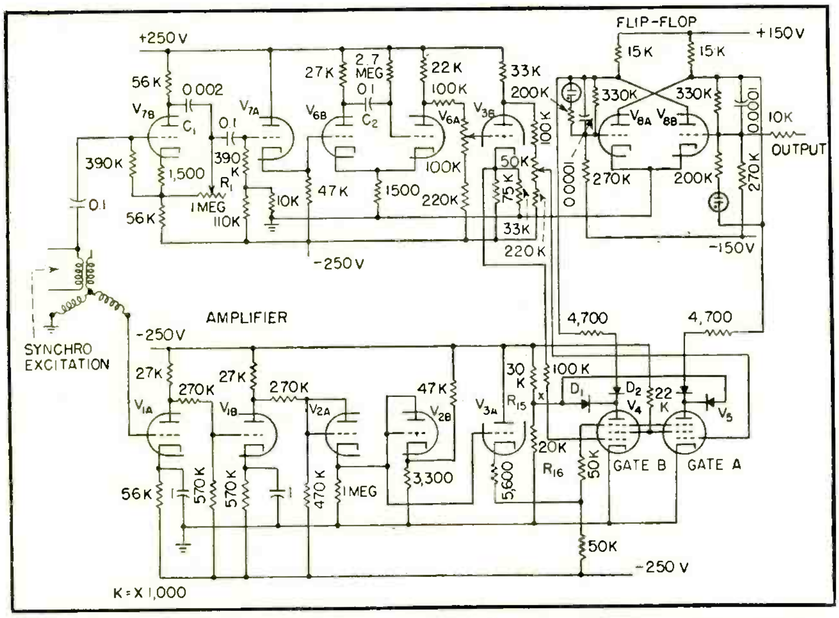


FIG. 2—Flip-flop triggered through two polarized gates generate marker pulses indicating shaft position

from null proceeds sinusoidally to null again at 180 deg during a half revolution in which the signal is in phase with the carrier. During the other half revolution, the amplitude also follows a sinusoidal envelope but the signal is shifted in phase 180 deg from the carrier.

The gates are operated by the carrier, gate *A* opening during the positive half cycle and *B* during the negative half cycle. When the synchro signal exceeds the bias level, it is fed to the gate tube grids.

Three cycles of the synchro output exceed the bias during each half revolution, and are applied to both gates. During the first half revolution, they occur when gate *A* is open. In the second half revolution they coincide with gate *B*.

The first pulse through gate *A* flips the flip-flop which in turn produces a pulse indicating that the variable reference position has been reached. Succeeding pulses through gate *A* produce no response.

The first pulse through gate *B* resets the flip-flop. Succeeding pulses again are ignored. On the next half revolution, the first cycle that exceeds the bias level will again flip the flip-flop. Hence, the marker pulse is generated within one cycle of the carrier after the synchro reaches the reference position, the position where its output exceeds the bias level. For accuracy the bias is set above the noise level, but low enough to be on the steep portion of the sine-wave envelope. Increasing the frequency of the synchro excitation also increases the accuracy, especially at high shaft speeds.

Circuit Description

In the circuit shown in Fig. 2, the carrier signal is fed to the grid of V_{7B}, a phase splitter which, with C_1 and R_1 produces a phase shift adjusted to compensate for phase shift in the synchro.

Tube V_{7A}, a cathode follower, drives a one-shot multivibrator, V_{6A} and V_{6B}. Capacitor C_2 is so chosen that the multivibrator does not reset itself but is controlled by V_{7A}. This multivibrator converts the carrier to a square wave.

Phase splitter, V_{3B} has a gain such that equal control signals of opposite phase are applied to the gates V_5, gate *A* and V_4, gate B.

The output of the synchro is fed to amplifier stages V_{1A} and V_{1B}. Tube V_{2A} is connected as a diode and produces the bias and negative clipping. Positive clipping to avoid overdriving cathode follower V_{3A} and the gates is furnished by V_{2B} also connected as a diode.

The plates of gates V_4 and V_5 are coupled to the flip-flop V_{8A} and V_{8B}. A cycle of signal through V_4 flips the flip-flop, dropping the plate potential of V_{8B}, and producing an output pulse. The plate voltage of V_{8B} is now lower than the voltage at point *X*, the junction of R_{15} and R_{16}. Because of the diodes D_1 and D_2, V_4 now has the voltage at *X* as its plate supply. Tube V_5 has the same action. Any further cycles of signal passing through either gate after the flip-flop has been operated are thus diverted from the flip-flop avoiding the possibility of false triggering.

Two levels of B+ and B— are not strictly necessary. The positive and negative 150 volt buses are obtained from a tie into associated circuits in this installation.

As shown, the reference position of the synchro is fixed. If it is desired to make this variable, a differential synchro can be used to shift the reference angle.

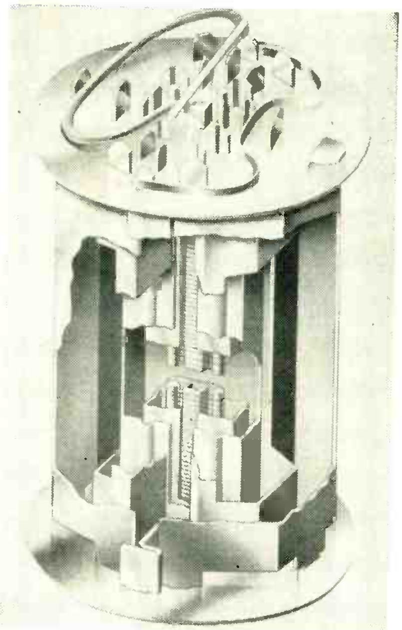
Beam-Deflection Tube

By ROBERT ADLER and CHARLES HEUER
*Zenith Radio Corporation
Chicago, Illinois*

COLOR INFORMATION appears in NTSC color receivers in the form of amplitude and phase modulation of a suppressed subcarrier. Two synchronous detectors to which reconstituted subcarrier signals are supplied in phase quadrature extract the color difference signals.

The synchronous detection process requires multiplying the incoming chrominance signal with a locally generated reference signal. This process is akin to frequency conversion and in principle any tube or device which is suitable as a frequency converter may be used, including diodes, triodes, crystals and other nonlinear circuit elements. Multigrid tubes are most commonly used because they permit separation of the two signal inputs.

A beam tube, in which a control grid is used for one input signal and a pair of deflectors for the other, appears to have advantages over the multigrid-converter. Figure 1 shows how such a tube is used. The chrominance signal S is applied between a conventional control grid and the cathode. Reference signal R, the locally reconstituted subcarrier, is applied in push-pull between a pair of balanced deflectors. The intensity-modulated beam is thus swept back and forth at reference frequency between the two anodes. The desired output appears across the two load resistors as two equal and opposite signals.



Cut-away view of General Electric 6AR8 beam-deflection tube

Tube Construction

The tube uses elements of conventional length and is mounted in a 9-pin miniature envelope.

The cross section of a practical tube is shown in Fig. 2. A solid accelerator box, having one narrow slot on each side of the cathode, is substituted for the wire screen grid shown in Fig. 1. Between control grid and accelerator there is a grounded focusing electrode which has wider slots.

Electrons attracted by the accelerator pass through the control grid at right angles to the grid wires. Later, in the lens field of the focusing electrode, they are forced to converge so that they pass through the accelerator slot; less than one percent get caught on the edges of the slot.

The regions between the accelerator and the leading edges of the deflectors form final projection lenses for the two sheet beams emerging from the accelerator slots. The greater the spacing between the deflectors, the lower is the d-c potential which must be applied to them to focus the beams.

Initial circuit work was carried out with tubes which focused at plus 50 volts, with 250 volts on the accelerator. Recently, tubes have been built which focus at zero volts,

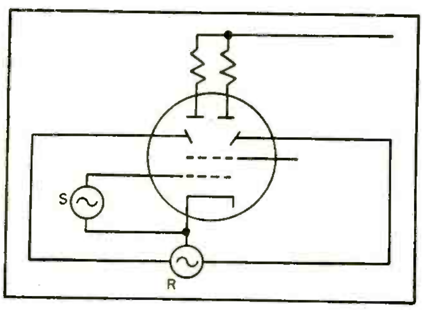


FIG. 1—Schematic representation of beam-deflection tube

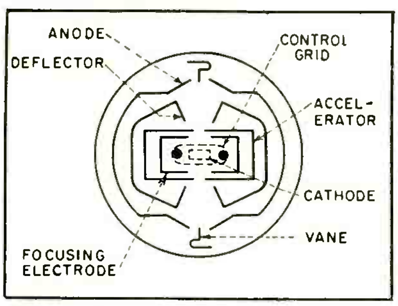


FIG. 2—Cross section showing location of beam-tube elements

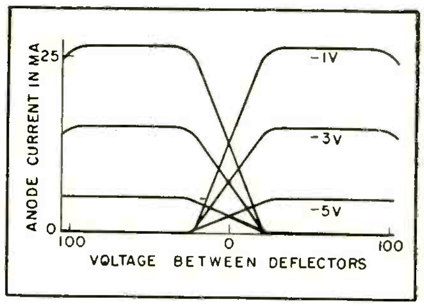


FIG. 3—Deflector characteristics for —1, —3 and —5 volts control-grid bias

Simplifies Color Decoders

Sheet-beam synchronous detector eliminates color-difference phase-splitting stages in color receivers. Low injection-power requirement permits both *I* and *Q* demodulators to be driven directly by subcarrier reference oscillator

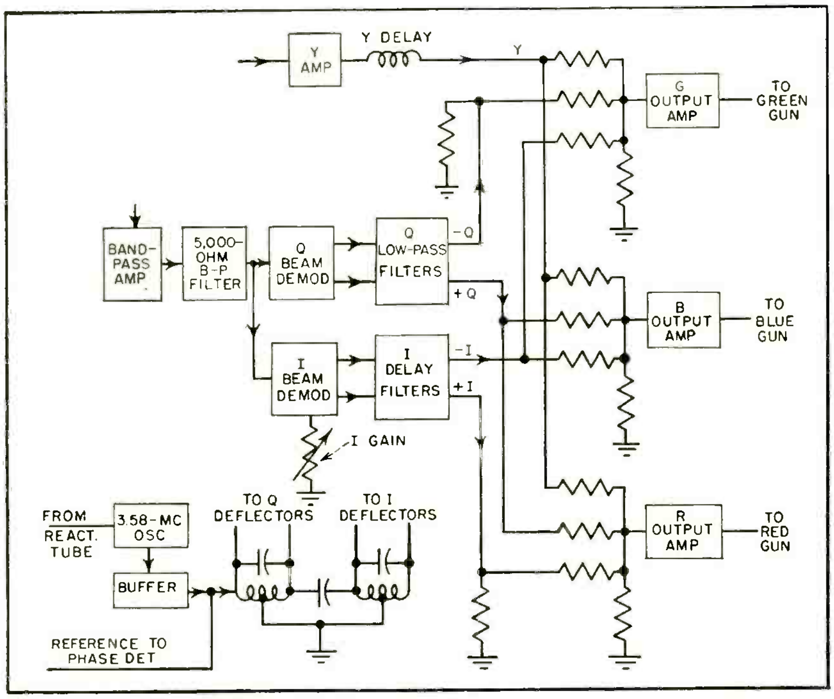


FIG. 4—Color decoder using 6AS6 demodulator tubes and low-level matrixing

regardless of accelerator potential. Focusing potentials are not critical; deflection sensitivity merely reaches a broad maximum in the vicinity of correct focus.

Deflector Characteristics

The deflectors, operating near ground potential, do double duty as suppressors. An additional grounded vane prevents the interchange of secondary electrons between anodes. The relative positions of anodes, deflectors and vane determine the quality of suppression. An effort has been made to keep this quality high to permit use of high anode-load impedances.

Figure 3 shows plots of the two anode currents against the voltage applied between deflectors for three different grid bias potentials. At minimum bias, the current exceeds 25 ma. A potential of about 25 volts between deflectors is sufficient to direct all current to one set of anodes, yet more than 100 volts may be applied before overload effects are encountered. Thus the reference signal amplitude may vary over a wide range.

Total deflector current is only a small fraction of one ma and loading of the reference oscillator is negligible. There is no noticeable stray coupling between signal grid and deflectors.

Conventional Decoder

Figure 4 is a block diagram of a typical decoder using conventional 6AS6 synchronous detectors or demodulators.[1] This diagram shows *I-Q* demodulation and low-level matrixing to *R*, *B* and *G*, the signals required for a three-gun color tube. Several points should be mentioned:

(1) Both polarities of *I* and *Q* are needed in the matrix; additional tubes provide the phase inversion and amplification, at the same time adding stability problems and increasing current drain.

(2) Space charge coupling and suppressor to signal grid capacitance can cause excessive local oscillator voltage to appear at the signal

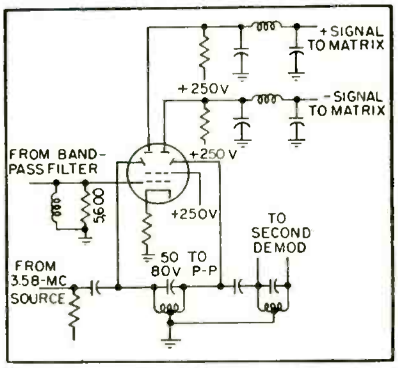


FIG. 5—Demodulator circuit using beam-deflection tube

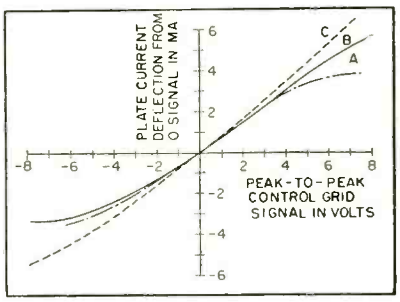


FIG. 6—Demodulator characteristics of 6AS6 (A) and beam-deflection tube with 0-signal cathode current of 10 ma (B) and 16 ma (C)

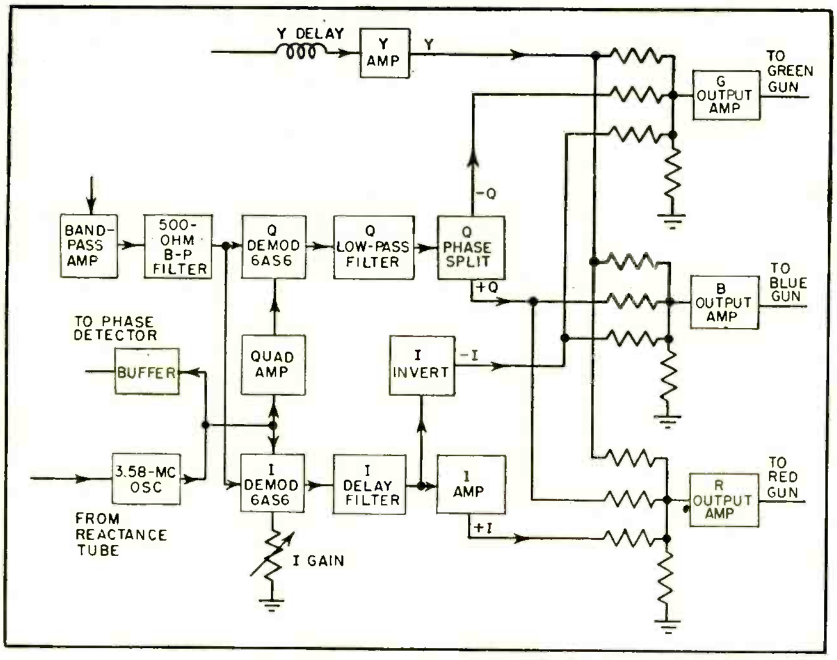


FIG. 7—Color decoder with 6AS6 demodulators replaced by beam-deflection tubes

grid unless the grid is driven from a low-impedance source. The 500-ohm source used represents a compromise.

(3) To make most effective use of the 6AS6 the suppressor grids must be driven positive and consume power. Space-charge coupling and grid current cause modulation of the injection by video and the 6AS6 is somewhat sensitive to injection amplitude variations. In some designs this has led to additional injection circuitry to provide decoupling and power.

In tubes like the 6AS6 and 6BE6 the primary role played by the local oscillator injection is to switch a part of the total cathode current periodically between plate and screen grid. Thus the a-c plate and screen currents in a 6AS6 are essentially equal and 180 degrees out of phase. In a demodulator whose plate output is the color difference signal I, the screen current is a potential source of a $-I$ signal, but unfortunately is inconvenient to use.

Beam-Tube Decoder Design

Injection to the beam tube of Fig. 5 still switches current from one tube element to another. Here it is from plate to plate and each plate can drive a video load. The beam deflection tube features which are of interest in decoder design are as follows:

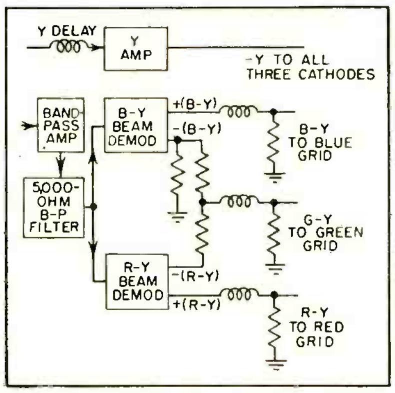


FIG. 8—Beam-deflection tubes supplying chrominance information from color decoder directly to picture tube

(1) No color-difference phase-splitting tubes are necessary since each demodulator supplies plus and minus outputs of equal peak-to-peak current swing.

(2) Deflection voltages of the order of 50 volts peak-to-peak between deflectors are required to approach maximum demodulation efficiency. When 60 to 80 volts nominal injection is used the demodulator is very insensitive to changes in injection amplitude.

(3) The deflectors draw negligible current, hence very little injection power is required. Both demodulators can be driven by one tube, with a suitable 90-degree phase-shifting network. It is likely that the driving tube can be the oscillator itself. No modulation of injection by video has been observed.

(4) There is no space-charge coupling between the deflectors and signal grid. Moreover, interelectrode capacitances, small to begin with, tend to be balanced. A high 3.58-mc impedance can be used in the signal-grid circuit without developing appreciable local oscillator voltage on this grid.

(5) Screen or accelerator current is less than 5 percent of cathode current at operating bias, compared to 30 percent in the 6AS6.

Comparative Characteristics

Typical operating characteristics of beam deflection and 6AS6 demodulators are given in Fig. 6. The ordinate shows plate current swing per plate from the no-signal value. Peak-to-peak 3.58-mc c-w input to the signal grid is given by the abscissa; plus values indicate signal-grid inputs in phase with injection, minus values are inputs 180 degrees out of phase with injection.

Curve *A* is a replot of data given by Pritchard and Rhodes[2] as optimum operation of a 6AS6. Curve *B* was taken on a developmental beam tube with cathode bias and accelerator voltage adjusted for zero-signal cathode current of 10 ma. Curve *C* is for the same beam tube with voltages set for 16 ma zero-signal cathode current.

All three curves are with no degeneration. As in conventional tubes, cathode degeneration is helpful in improving beam-tube linearity at a given cathode current. Required increased drive is more readily obtained in the beam-tube circuit because the signal-grid driving impedance can be several times that used with the 6AS6.

Typical Beam-Tube Decoders

Figure 7 is the block diagram which results when the 6AS6's of Fig. 4 are replaced by beam-deflection demodulators. A 5,000-ohm band-pass circuit supplies the chrominance drive required by degenerative I and Q demodulators. A variable cathode resistor in one demodulator serves to adjust relative gains. The demodulator outputs (balanced $\pm I$ and $\pm Q$ currents) and the Y-amplifier output (Y current) feed a passive matrix containing no tubes and no adjustments. The matrix need not be a lossy one to minimize crosstalk between output channels; a proper matrix can be calculated where the impedance at the grids of the output tubes is of the same order of magnitude as the impedance presented to the driving plates.

A decoder using $(R - Y)$ and $(B - Y)$ demodulators and matrixing in the picture tube is shown in Fig. 8. The $(-Y)$, $(R - Y)$, and $(B - Y)$ outputs are applied directly to the reproducer while $-(R - Y)$ and $-(B - Y)$ currents are passively matrixed so that $(G - Y)$ voltage appears across the output resistor and at the green grid.

Of the conventional converter and mixer tube types, only the 7AK7 (30 ma cathode current at operating bias) has adequate output to drive the picture tube directly; all such tubes require phase inversion in the $(G - Y)$ channel. A deflection tube having about 11 ma operating cathode current supplied direct drive in an equal-bandwidth receiver used on NTSC field tests from April to June 1953. Although this receiver did not lack drive, to handle all picture tubes with a reasonable safety factor, a tube having 15 to 16 ma cathode current at operating bias seems desirable.

Direct drive with I-Q demodulators and matrixing would require considerably more current than this. The equivalent of I-Q operation can be achieved by Q bandwidth limitation and matrixing to $(R - Y)$ and $(B - Y)$ before demodulation.

When high output currents are desired, it appears advantageous to interchange the signal inputs to the demodulator, using the chrominance signal for push-pull deflection and putting the reference carrier on the control grid. This type of operation requires additional video drive and makes the demodulator somewhat more sensitive to injection amplitude variations.

On the other hand, using the substantially linear deflection characteristic for chrominance results in a worthwhile improvement in output linearity. High-level operation is illustrated in Fig. 9: outputs of 180 volts peak-to-peak on each of the two anodes of the Q demodulator show excellent symmetry.

The NTSC field-test receiver also used a beam-deflection tube to perform the burst-gating function. In a color receiver, it is necessary to have a gate which accepts the color-synchronizing burst and rejects the rest of the chrominance signal. It is also desirable to turn off the chrominance channel at a horizontal rate during burst time, especially if d-c restorers are used at the display. These two operations have been performed separately, by turning on and off separate amplifiers or diode gates.

Functionally the beam-deflection tube is a spdt switch and can perform both operations at once. In Fig. 10 the full chrominance signal is put on the signal grid and the beam is statically deflected to the left plate by putting plus 30 volts d-c on the left deflector. This plate is connected to the chrominance channel.

A positive gating pulse derived from horizontal flyback pulls the entire beam to the burst-output plate during retrace time, so that the burst is reproduced only in this channel. The tube performs the additional function of double clipping of the gating pulse, since only a thin slice of the pulse (shown shaded in the figure) is actually effective in moving the beam from plate to plate.

The burst plate load is normally a high impedance and neutralization of plate-to-plate capacitance is necessary if the burst channel is to be completely free of chrominance information. Burst gate input and both output waveforms are shown in Fig. 11.

Experience with beam-deflection tubes in color-television receivers has shown them to be well suited to the applications described here. A fundamental asset of such a tube as a demodulator is the actual elimination of decoder functions, primarily matrix inversion. The resulting decoders are stable and are as straightforward as their block diagrams.

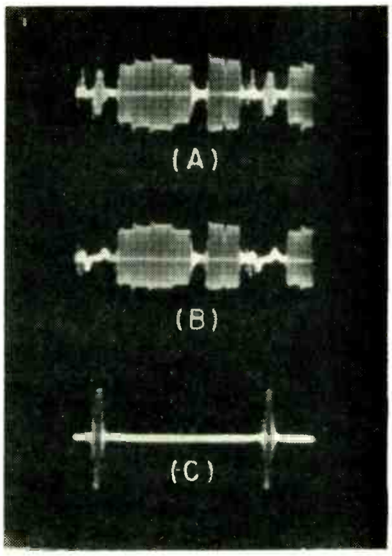


FIG. 11—Burst-gate input chrominance signal (A), gated output to chrominance channel (B) and gated output to burst channel (C)

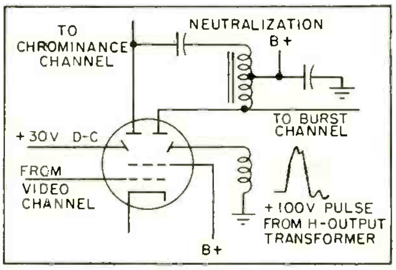


FIG. 10—Beam-deflection burst gate circuit. Only shaded portion of input pulse is effective in deflecting beam from plate to plate

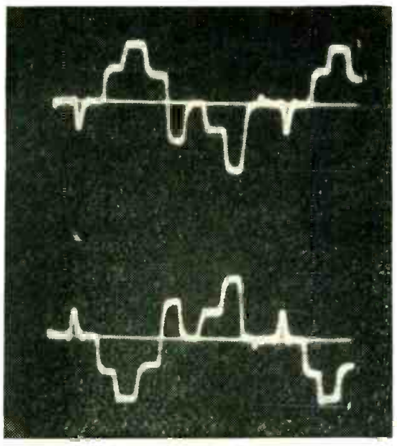


Fig. 9—Waveforms of +Q and −Q outputs on bar pattern signal with chrominance signal applied to deflectors. Peak-to-peak voltages are 180 volts across 15,000-ohm plate loads

REFERENCES

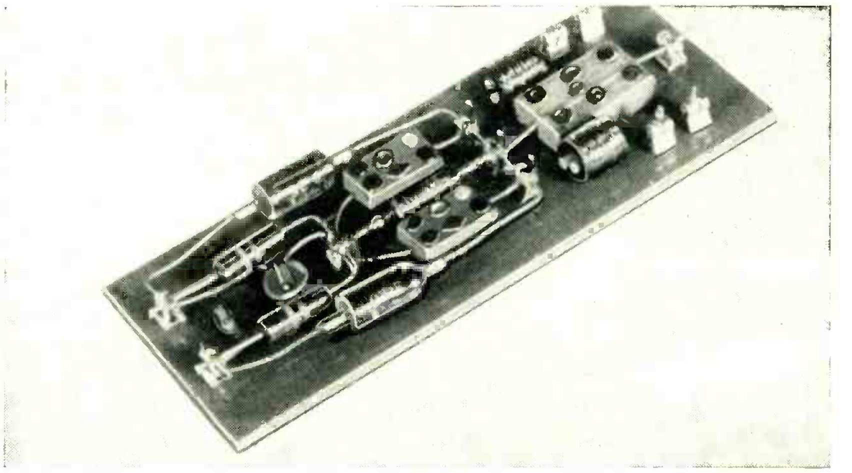
(1) Petition of RCA-NBC before the FCC, p 359, June 25, 1953.

(2) D. H. Pritchard and R. N. Rhodes, Color-Television-Signal Receiver Demodulators, *RCA Rev*, 14, p 221, June 1953.

BISTABLE UNITS for use in high-speed computers employ the magnetic-saturation characteristics of iron-cored solenoids to produce two stable output conditions.

The basic circuit of a ferro-resonant flip-flop is shown in Fig. 1A. Two solenoid inductors are alternately caused to saturate forming a resonant circuit with their series capacitors. Saturation of the core material allows the effective inductance of the solenoid to remain at its low resonant value. The resonant operating condition is not at true resonance but at a point on the capacitive side of resonance.

Flipping is produced by a d-c signal applied to the trigger winding. When current flows through the trigger winding associated with the side that is not in resonance, it will cause the impedance of that inductor to be lowered and allow it to go into resonance. This will lower the voltage across the other leg of the circuit so that the other side no longer can remain in resonance. The current through the trigger winding can be in either direction. Detailed operation has been previously described[1] and this article will deal with physical and practical application of the units.



Complete ferroresonant flip-flop unit with coupling capacitor and diodes

Ferroresonant

By RUDOLPH W. RUTISHAUSER
Computer Research Corp.
Hawthorne, Calif.

Triggering Methods

Several schemes have been employed for alternately triggering one side and then the other, one of these is shown in Fig. 1B. An r-f choke has been added as a d-c return path for the rectified output current.

The rectified output voltage will cause a small bias current to flow through the trigger winding in the side to be triggered next. Resistor R_b is chosen large enough so that the bias current is insufficient to trigger the flip-flop. A negative pulse on the order of 1 to 4 microseconds through the trigger capacitor C_t will cause enough additional current to flow in the trigger winding to change the state of the flip-flop. No current flows in the other trigger winding because there is a back voltage across the diode connected to the other trigger coil.

By having many turns on the trigger winding, the current requirement for triggering can be made extremely small, but the time constant of the circuit will be increased. Units have been built that can be triggered with as little as 2 ampere-turns. With 10,000 turns of small wire in the trigger coil, only about 200 microamperes are required.

A flip-flop is a ring of two stages. These ferroresonant units can be connected into larger rings as shown in Fig. 1C. A ring of 32 stages has operated satisfactorily. Indications are that about 50 stages would be the upper limit.

Practical flip-flop design is accomplished by graphical means based on an experimentally obtained plot of effective inductance versus a-c current through the inductor.

The resonant voltage across C_s is considered as the output voltage. The ratio of resonant to nonresonant voltage may vary from 4-to-1 to 16-to-1 with a ratio of about 8-to-1 generally being used.

The output voltage is designed to be compatible with the output requirement.

Output power is related to input, therefore, the manner in which the input is expressed will first be explained.

Assume that in the design of a particular unit, the series capacitor C_s is 500 μμf, the operating frequency is 1.3 mc and rectified output is about 25 volts peak. A capacitance of 500 μμf at 1.3 mc is about 250 ohms. Peak current is about 100 ma or about 70 ma rms. Generator voltage for this unit would probably be about 7 volts. The in-

Table I—Design Variations of Ferroresonant Flip-Flop

Output voltage	5 to 100 v
Output power	up to 2 watts
Resonant to nonresonant voltage ratio	4:1 to 16:1
Generator frequency	200 kc to 2 mc
Generator output	3 to 30 v rms
Flip-flop input	0.05 to 5.0 v-a
Voltage variation	± 20 percent
Frequency variation	± 10 percent
Flipping rate	up to 100 kc

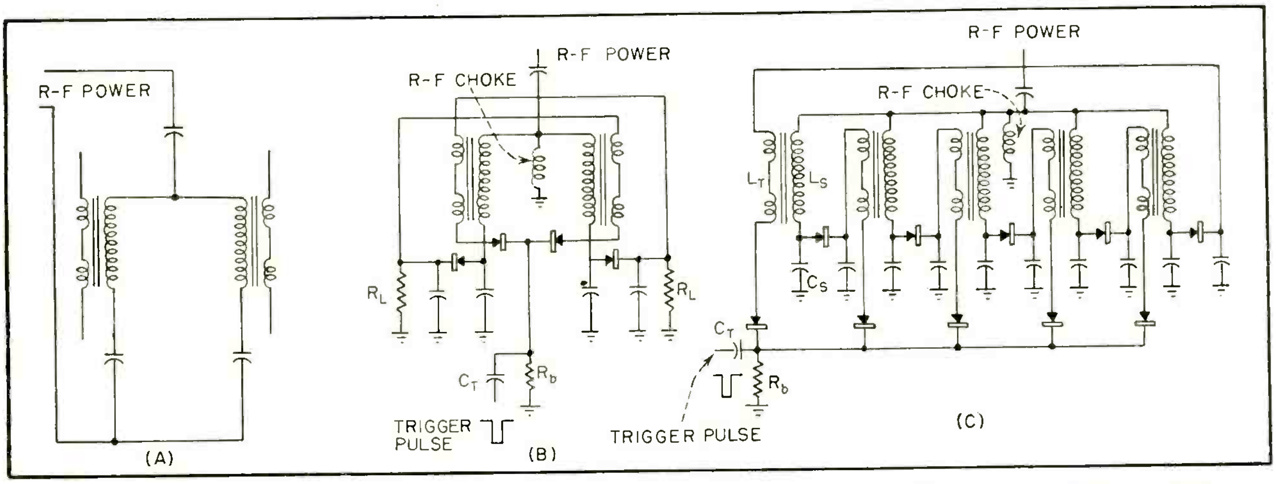


FIG. 1—Basic flip-flop unit (A) can be triggered as shown in (B). Five stage ring counter (C) shows simplicity of circuit

Flip-Flop Design

Application of ferroresonant switching units made to replace tubes in high-speed computer systems. Triggering and counting circuits are given with input and output requirements, switching rates and tolerances

put power, therefore, is about 0.5 volt-ampere.

Since the units draw reactive power, the magnitude in volt-amperes that the generator must be able to supply can be calculated. Units have been built having input requirements from 0.05 v-a to 5.0 v-a.

The maximum output power in watts that can be obtained without impairing the bistability of the unit is approximately 1/3 the v-a rating of the unit. In the example mentioned, the maximum d-c output current probably would be about 7 ma since 0.007 ma × 25 v = 0.175 watts which is about ⅓ × 0.5 v-a.

Operating Characteristics

The a-c frequency requirement have been based on several factors. Since it requires about 3 to 4 cycles of the generator frequency for a flip-flop to change its state, it would be desirable to use as high a flipping frequency as possible. To keep a constant output impedance the physical size of both the capacitor and the inductor decrease as the frequency increases. Core losses increase with frequency. The core material will determine the upper range of frequency. Using 1/8 mil 4–79 MO-Permalloy, a frequency of 1 to 2 mc can be used.

The input voltage is determined by the design of the flip-flop, however, it is generally of the order of 5 to 10 volts rms. If low v-a flip-flops are used, it is easy to drive 10 units from a single 6C4 Colpitts oscillator or 25 to 50 units from a single 6AQ5 oscillator.

One of the desirable features of ferroresonant flip-flops is their operational tolerances. They maintain their bistability and generally can be operated within at least a ±20 percent in a-c supply voltage. Frequency can vary about ±10 percent without changing basic operating characteristics.

The rate at which the flip-flops can be triggered depends on the type of triggering. However, units using a nominal a-c generator frequency of about 1.3 mc, have been made to flip with triggering pulses at somewhat greater than a 100 kc rate. In general the lower the power, the slower will be the flipping rate since less power is available for opening and closing of gates. An R-C or R/L time constant will generally appear and determine minimum gating time.

The author acknowledges the cooperation of Carl Isborn and the Computer Research Corporation.

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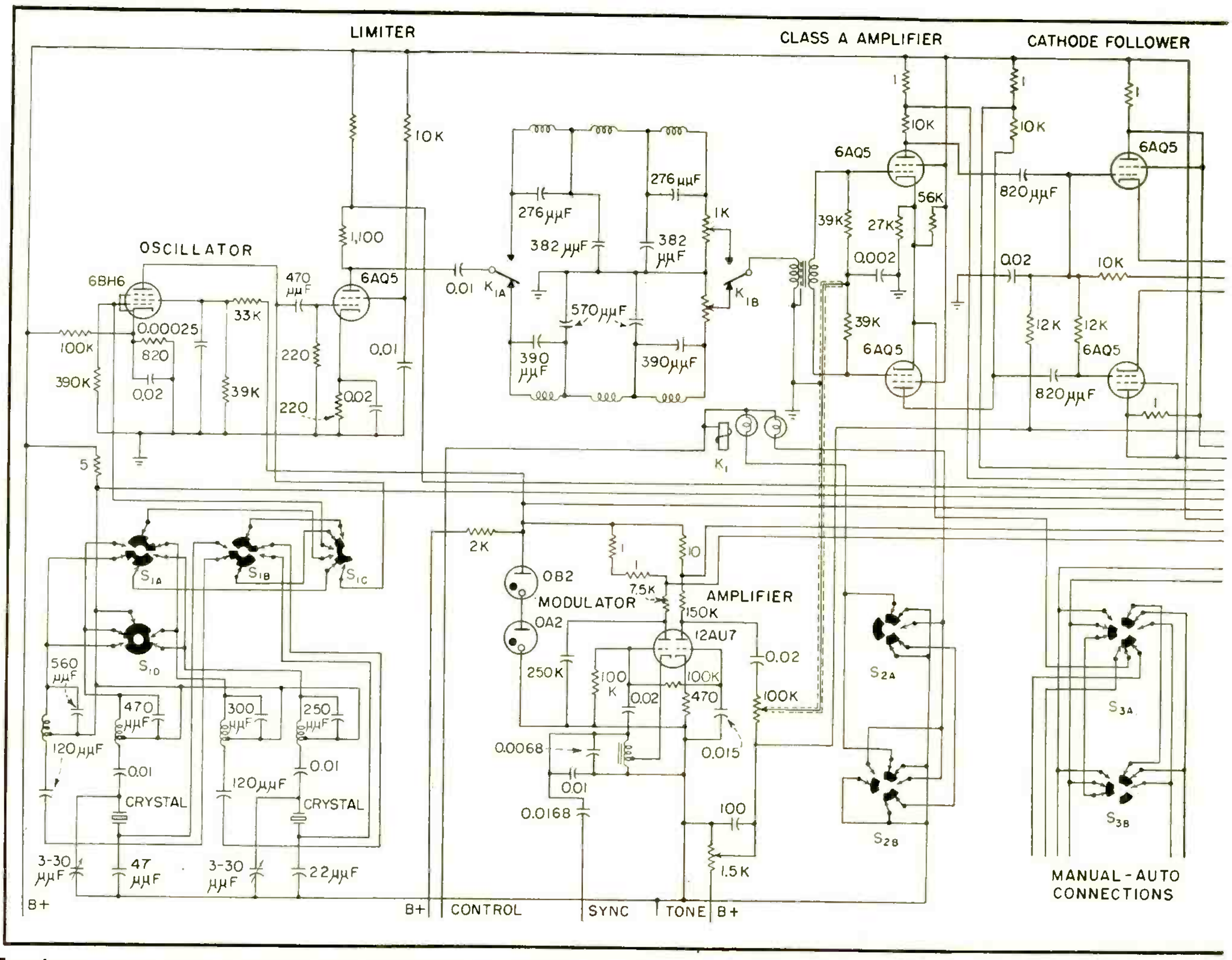
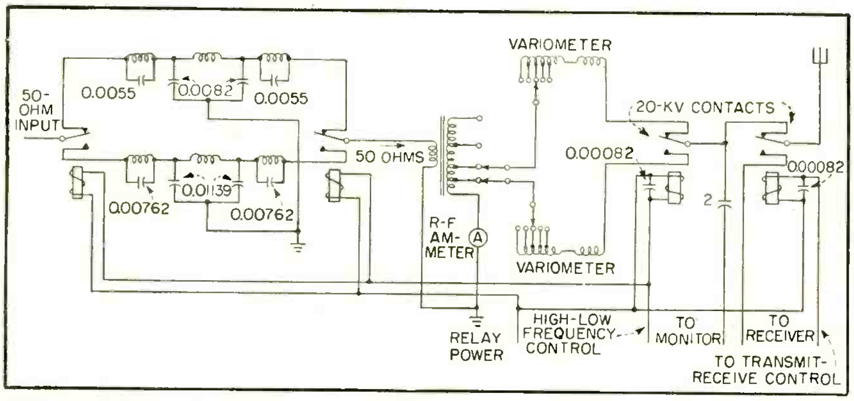


Low-frequency transmitter complete with band-switching and other controls

Tankless Low-Frequency

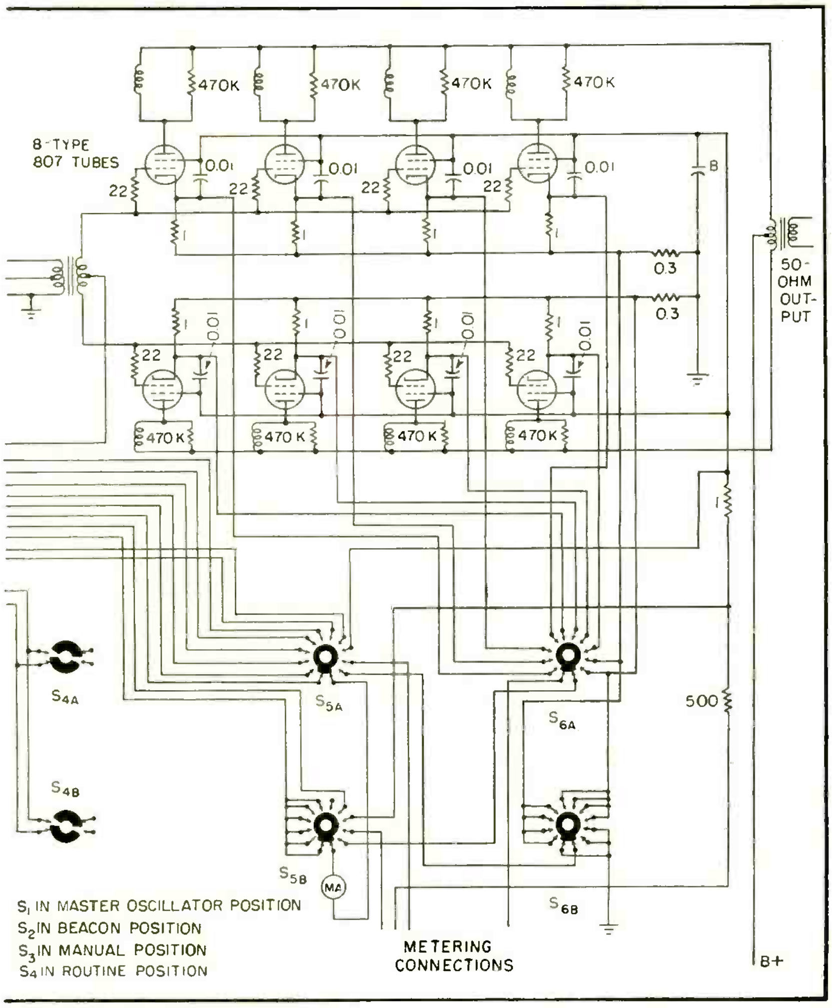
Equipment in use by Canadian Department of Transport avoids expense of large capacitors and inductors by novel design employing transformers wound on ferrite cores. Broad-band amplifier is driven by oscillator coupled through a low-pass filter



Antenna tuning unit includes low-pass filter, variometer and tap tuning as well as relay controls to change frequency

TRANSMITTERS operating in the region of 200 to 500 kc are usually equipped with one or more class-C stages employing tuned plate circuits. The bulk and cost of both coil and capacitor in such circuits grow quickly with increasing transmitter power. In an effort to provide more compact and economical designs, Westinghouse Corp.[1] and lately Canadian Westinghouse

*The work described herein was done while the author was employed by Canadian Westinghouse Co., Ltd.



Final stage uses eight type 807 tubes in push-pull parallel

Transmitter

By PREBEN GOMARD*

T. S. Farley, Ltd.
Hamilton, Ontario
Canada

have built transmitters without tank circuits in the usual sense.

The transmitter is built as a straight broadband amplifier with interstage coupling transformers wound on ferrite cores. Figure 1 is a block diagram of the transmitter panel. This particular transmitter covers two bands, 280 to 330 kc and 400 to 510 kc. The oscillator is conventional, with a number of fixed frequencies in each band. The output is R-C coupled to the limiter, which uses a 6AQ5 with a resistive 2,000-ohm plate load.

The following low-pass filter is an m-derived constant-k type and is shown in Fig. 2A. It will be seen that the filter consists of 2 L's and one π. Each L section gives the response shown on Fig. 2B. When combined with the response of the π section on Fig. 2C, an overall response like that of Fig. 2D is obtained. The filter is terminated in a 2,000-ohm potentiometer and the harmonic content at this point is 2 percent or less at any frequency in both bands.

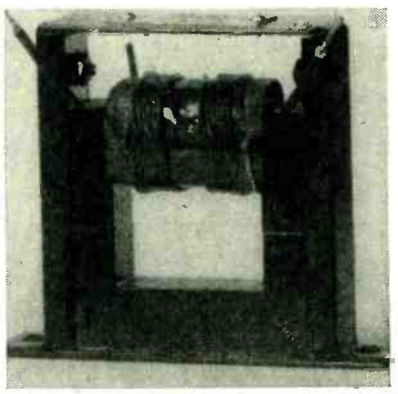
Since the second harmonic of the lowest frequency (2×280 kc $=$ 560 kc) is close to the highest transmitter frequency (510 kc) it is desirable to have a separate filter for each band.

From the potentiometer marked DRIVE LEVEL in Fig. 1, the signal goes to a transformer with center-tapped secondary, which in turn applies voltage to a class-A push-pull stage using sharp-cutoff pentodes. These are R-C coupled to two 6AQ5 cathode followers. The cathode load is a stepdown transformer so that a low drive impedance for the output stage is ensured.

The output stage comprises eight 807's in push-pull parallel and works with 600 volts into a push-pull transformer with a secondary impedance of 50 ohms. The plate efficiency of this stage is approximately 60 percent with full modulation.

A modulating 1,000-cycle note is generated by an LC audio oscillator and is applied through an amplifier to the grids of the push-pull class-A stage. A certain amount of distortion is desirable to avoid the monotonous sound of a sine wave. This is obtained in the stage following the audio oscillator. It is feasible to grid-modulate a class-A stage up to 90 or 95 percent. If the tubes have nearly parabolic $E_g - I_p$ characteristics, the intelligibility of speech remains excellent up to the modulation level specified.

The ideal way to key a transmitter is to stop the oscillator in the key-up position. In this way no



Push-pull output transformer couples type 807 amplifier into unbalanced 50-ohm impedance

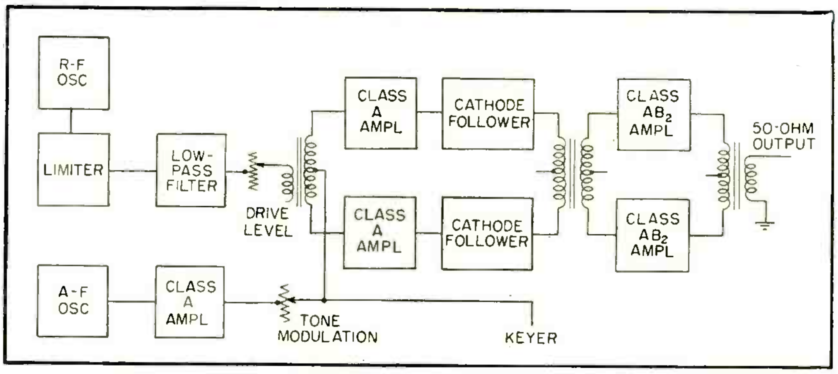


FIG. 1—Layout of low-frequency transmitter employing tone modulation

signal is generated and nothing is transmitted. It has been found by long experience that on-off keying of low-frequency oscillators often results in greatly decreased crystal life. To ensure dependability in this respect, keying is obtained by blocking the class-A push-pull stage. With this arrangement the radiated signal with the key up is 50 db or more below the transmitting level.

The modulated r-f is thus applied to the grids of the output tubes and the characteristics of this stage must be such as to handle the signal without excessive grid current or cutoff. A conventional class-C transmitter would have only four tubes in the output stage, but an additional four together with a transformer are required to give high-level modulation. The expensive modulation transformer is avoided in this design.

Antenna Matching Panel

The harmonic content at the 50-ohm output terminals of the transmitter is approximately 5 percent or —26 db. To decrease the level further a low-pass filter of the type shown in Fig. 2A is introduced. An extra attenuation of 40 db or more brings the total harmonic content to −66 db or better. This filter is terminated in a transformer that brings the impedance of the tuned antenna up to the 50-ohm level.

The Q of the shortest specified antenna at the lowest frequency was 292 and the resistive component 3 ohms. By using 96-strand Litz wire and a welded aluminum cabinet a variometer was built with a Q of slightly over 300 at this frequency. If the loss in the matching transformer is neglected, the total Q of the antenna circuit becomes

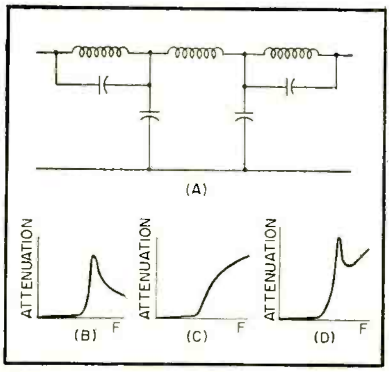


FIG. 2—Low pass filter (A) gives *L*-section response as in (B), π-section response as in (C) and combined characteristic (D)

150. The response is thus 3 db down at 0.93 kc off resonance and an original modulation depth of 95 percent is consequently reduced to approximately 67 percent. At higher frequencies and with longer antennas this effect decreases.

A variometer is used for each band. The antenna is switched by a vacuum relay.

Transformer Design

As an example of ferrite transformer design the power output transformer will be considered in detail. Two type 807 tubes in class AB_2 with 600-volts on the plates need a plate-to-plate load impedance of 6,400 ohms. The c-w power that can be expected is 80 watts. For eight tubes the figures become 1,600 ohms and 320 watts. The rms voltage is 715 volts, giving $BAN = 5.75 \times 10^4$ at 280 kc when B is induction in gauss, A is core area in sq cm and N is number of turns.

A core with $A = 2$ sq cm and a volume of 45 cu cm was chosen. According to information published by Rogers Majestic in Toronto, the temperature rise in a ferrite core approximates $\Delta T = 400\ w/v\ \sqrt{A}$ deg C, where w/v is the loss per cu cm. If 40 C is specified, $w/v = 0.07$ watts per cu cm. A value of $B = 350$ gauss at 280 kc will, according to this information, result in approximately such a loss.

The actual primary consists of 75 turns, giving $B = 384$ gauss.

In the actual transmitter a total of 170 watts is measured at the secondary terminals owing to the modulation being less than 100 percent. The temperature rise over the ambient was found to be 37 to 39 C for eight transformers. The agreement with the data is thus fair.

The inductance of the primary in henrys is $L = 4\ \pi\ 10^{-9}\ n^2\ \mu\ (A/l)$ or approximately 6 mh.

The leakage between the two halves of the primary together with the distributed capacitance gives a resonance that can be measured. It proves to be approximately 1.5 mc. No radiation on this frequency is detectable when the transmitter operates. The primary-to-secondary leakage is approximately 5 percent, giving a 3-db cutoff frequency of approximately 900 kc for the transformer alone.

Since ferrite is a good insulator it is possible to wind directly on the core after the sharp corners have been taped. This results in an extremely inexpensive component. The cost of materials does not exceed two dollars.

It has been found that these transformers stand up well in service. If the antenna load is removed while full drive is applied to the output stage, no damage is done to the equipment. This is in contrast to the voltage breakdown a class-C transmitter would suffer if sufficient overvoltage protection is lacking.

The writer is indebted to H. Rice of Canadian Westinghouse for permission to publish this article, to B. P. Jacobsen for his variometer design and to J. O. Nielsen at the Royal Technical High School of Denmark for his lectures on transformers.

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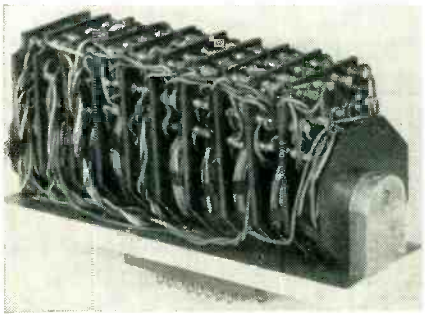


Magnetic-matrix switch before potting illustrates details. Top of chassis view of binary counter shows how switch clamps in place

Magnetic-Matrix Switch Reads Binary Output

Saturable-core magnetic matrix functions as fast-operating eight-position stepping switch to read numbers stored in electronic binary counter. Switch and counter form part of flight-test instrumentation for airborne fire-control equipment

By JOHN W. BREAN

Servomechanisms Laboratory
Massachusetts Institute of Technology
Cambridge, Mass.

BINARY NUMBERS stored in an electronic counter can be read rapidly by an eight-position stepping switch that uses a saturable-core magnetic matrix. The switch and its counter are components of a system for flight-testing airborne fire-control equipment.

The equipment simultaneously records data by means of two synchronized movie cameras and a multichannel recording oscillograph. Time synchronization is provided from a time code generated by the binary counter and magnetic-matrix switch.

The matrix is composed of eight magnetic-switch elements arranged to sense the last eight stages of an eleven-stage-counter singly and in a predetermined, repeated sequence. The idealized matrix output is a modulated 400-cps carrier (Fig. 1A) and represents consecutive eight-digit binary numbers produced one digit at a time. One digit is produced for each rotation of the master camera shutter and the code is transferred to the films with small neon lamps.

Physically, the switch is a bank

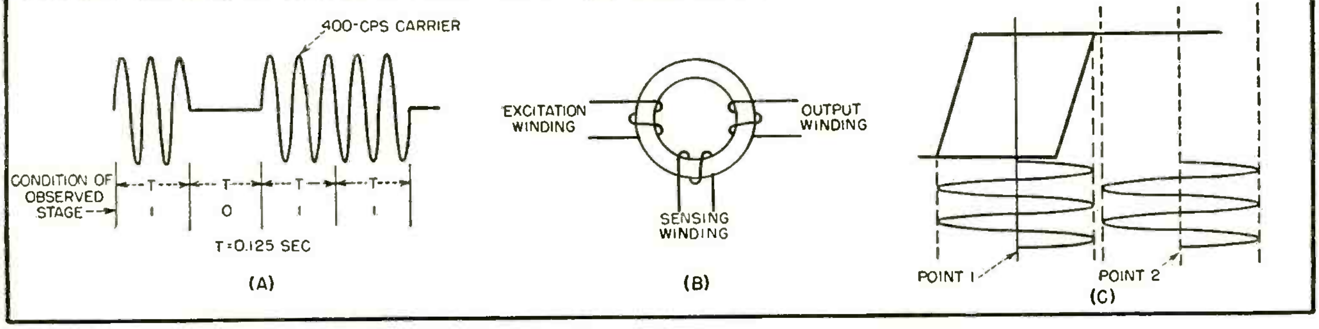


FIG. 1—Idealized switch output (A) with schematic of important core windings (B) and operating characteristics of magnetic circuit (C)

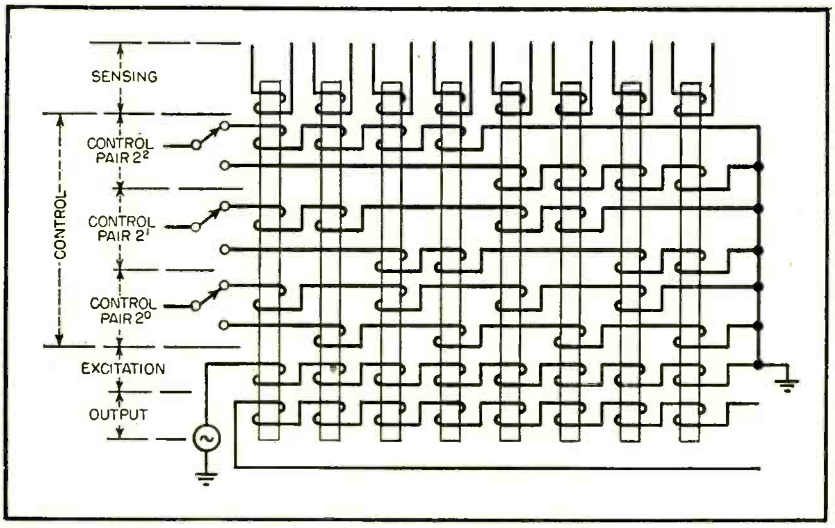


FIG. 2—Basic circuit of magnetic-matrix stepping switch illustrates how the principle of core saturation can be utilized in a switching operation

of ten matrix-connected toroidal transformers stacked horizontally on an aluminum plate. Eight of the transformers have five windings each and two have three windings each. The finished assembly is plastic encapsulated with the connecting leads brought out through a 32-pin connector. Overall dimensions are $5\frac{1}{2} \times 1\frac{7}{8} \times 2\frac{5}{8}$ in.

The magnetic-matrix switch's step-delay time is 0.1 millisecond. The stepping rate is limited by the reaction of the matrix transformers on the associated electronic flip-flops in the binary counter. The switch operates satisfactorily up to 30 steps per second; the actual upper limit on the stepping rate has not been determined.

Switch Principle

The principle of operation of the matrix switch is illustrated in Fig. 1B. This saturable-core transformer has windings for excitation, sensing and output. The idealized hysteresis curve of a typical core is shown in Fig. 1C. Switching is accomplished by passing through the sensing winding a direct current of sufficient magnitude to saturate the core. When a sinusoidal voltage is impressed on the excitation winding and the sensing winding current is zero, normal transformer action takes place and a voltage appears at the output winding.

The operating point about which the sinusoidal magnetomotive force varies is shown in Fig. 1C as point 1. If a direct current is now caused to flow through the sensing winding, a constant magnetizing force is superposed on the sinusoidal one and the operating point is forced into the region of saturation, point 2. During operation about point 2 the core permeability is reduced to unity, negligible coupling exists between the excitation and output windings and essentially zero voltage appears at the output.

Matrix Configuration

The principle of core saturation for switching is used in the matrix shown in Fig. 2. Each toroidal transformer core and its windings is called an element. The circuits into which the windings are connected are divided into control, sensing and output groups. The control group determines which of the eight sensing windings is allowed to control the transmission of the 400-cps carrier at a given time. Each sensing winding when chosen by the control group is capable of blocking or allowing the transmission of the carrier depending upon the sensing-winding current. A single output is obtained by connecting the eight windings of the output group in series.

Each element has six windings. Three correspond to the sensing, excitation and output windings. The additional windings are interconnected in the control group. The six circuits of the control group are divided into three control pairs called the 2^0, 2^1 and 2^2 pairs. When d-c flows through one circuit in each control pair, control winding mmf appears in all but one of the element cores and forces them into saturation. The one element not subjected to saturation is the selected element. Some cores in the matrix will have current in two or three control windings at the same time increasing the saturation.

The matrix control-group windings select the elements in order by causing d-c to flow alternately through the circuits of each control pair according to a prescribed binary pattern. The binary pattern is developed by the number of switching operations of the 2^0 pair as the counting reference and switching the second and third pairs after every 2^1 and 2^2 counts.

Number Generation

To obtain the desired series of consecutive eight-digit binary numbers, it is necessary to read the last eight stages of the eleven-stage counter in order and in a repeated sequence. The binary number represented by the eight counting stages increases by one for every eight camera pulses entering the counter; it is therefore necessary to read one counting stage for each camera pulse.

A convenient method of reading a counting stage is to insert the sensing winding of a matrix element in series with one flip-flop cathode of that stage as illustrated in Fig. 3. The cathode current and the saturated condition of the element indicate the binary digit.

The matrix selects the elements corresponding to the eight counting stages in the desired order by connecting the 2^0, 2^1 and 2^2 circuits of the control group to the 2^0, 2^1 and 2^2 stages of the counter. For every eight pulses entering the counter the matrix selects and reads in sequence the eight digits of the binary number stored in the last eight stages.

Winding Modification

The number of windings required on each element can be reduced from six to five by replacing the direct current in the 2^0 control pair by sinusoidal excitation eliminating the separate excitation winding. The element-selecting ability of the matrix control circuits is not affected by this simplification. The circuit of Fig. 3 employs this simplified matrix.

Introduction of a-c excitation throughout the 2^0 control pair requires d-c control of the excitation. This is provided by adding two three-winding elements to the 2^0 control circuits. The two control elements receive their excitation from a common a-c source.

The sensing windings of the matrix elements are connected in series with one cathode of each counting stage. When the state of the flip-flop is such that no current flows in the sensing winding of a selected element a voltage appears at the output winding of that element and a 1 is indicated. If current does flow the element is saturated so no voltage appears at the output and a 0 is indicated.

Control Circuits

The control pairs are operated by the flip-flop action of the first three stages of the counter. The 2^0 control pair is connected by the d-c control elements to the first stage of the counter that provides the reference count and alternates the excitation between the circuits of the pair at every count. The 2^1 control pair operates directly from the cathode currents of the second stage This stage alternates the control currents between the circuits of this pair after every two control reference counts. The 2^2 control pair operates from the cathode currents of the third stage of the counter. This stage alternates the control currents between the circuits of this pair after every fourth control reference count.

Stages 1, 2 and 3 of the counter and their associated control circuits change the binary number in the counting stages at every eighth control-reference count, select the elements in sequence and sense and represent as output voltages the conditions of the counting stages.

Output Circuits

The output circuits rectify and clip the matrix a-c output signals to form pulses of uniform amplitudes that are sent to two neon camera indicating lamps and the recording oscillograph. Some leakage exists under the saturated conditions. The leakage voltages are not always the same magnitude and together with nonuniform 1 or on-signals cause nonuniform switching ratios. To obtain uniformly effective 1 voltages and improve the switching ratio a high-gain triode amplifier and a clipper are used.

The first stage is a 12AX7 amplifier. The second stage, a 12AX7 cathode follower, is a low-impedance source that drives the two 12AT7 clippers. These clippers are biased below cutoff by an amount equal to the largest leakage-voltage peaks and operate only on positive grid-signal peaks corresponding to true 1 signals. The neon indicating lamps operate directly from the voltages developed across the plate-load resistors of the 12AT7 tubes.

Before reaching the oscillograph, carried is removed by a low-pass R-C network R_3 and C_1 of Fig. 3.

This research was made possible through the support extended the Massachusetts Institute of Technology Servo-mechanisms Laboratory by the USAF Armament Laboratory, Wright Air Development Center under Contract No. W33-038ac-13969. The initial design of the binary register with a solenoid-operated stepping switch was done by J. B. Harper at M.I.T. Instrumentation Laboratory.

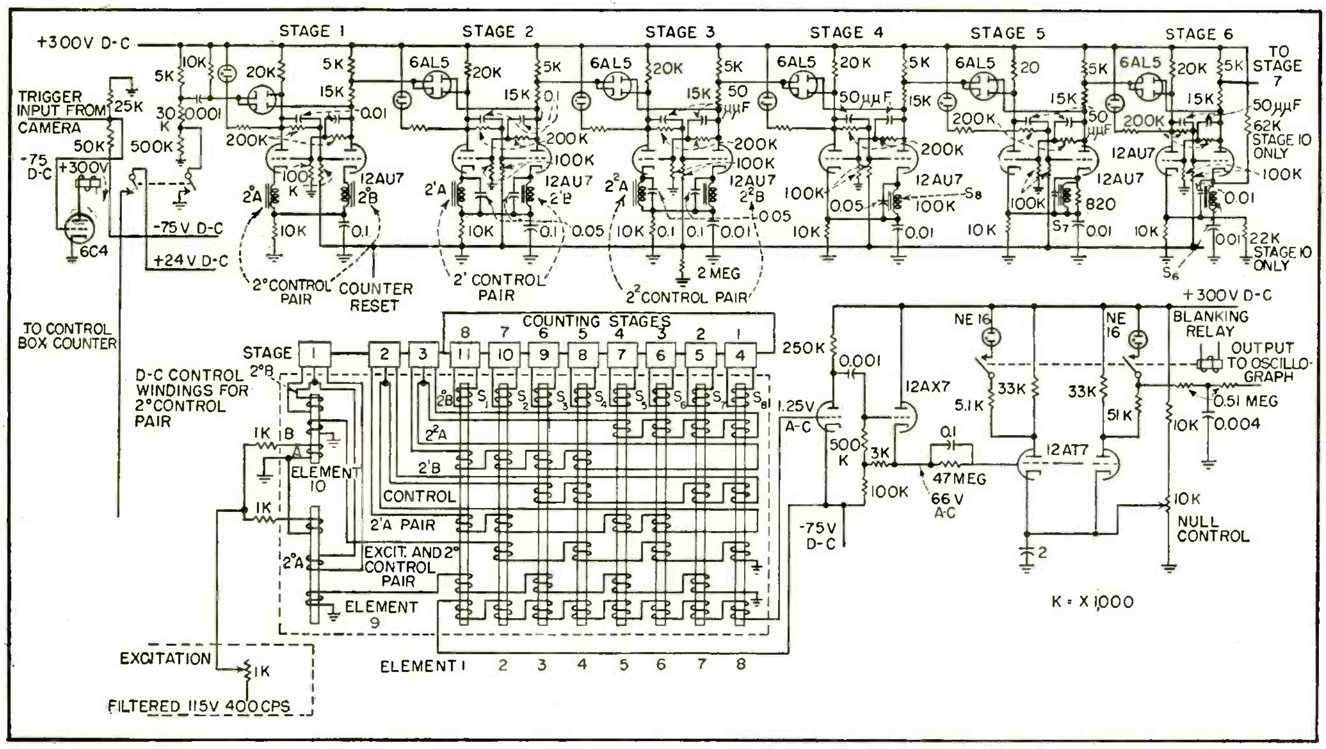
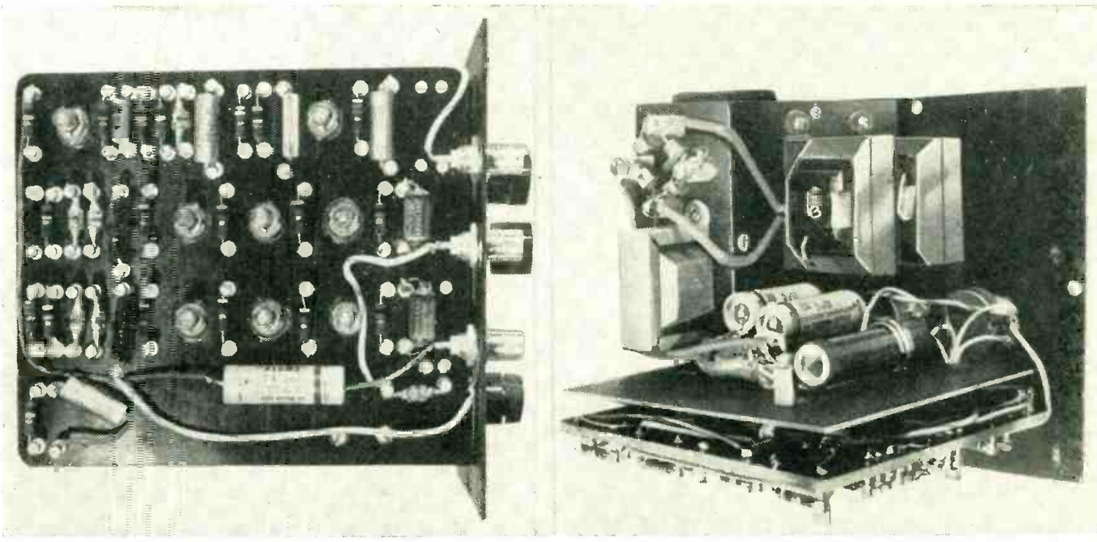


FIG. 3—Schematic diagram of electronic binary counter with magnetic-matrix switch readout. Unit is used in flight-testing airborne fire-control equipment

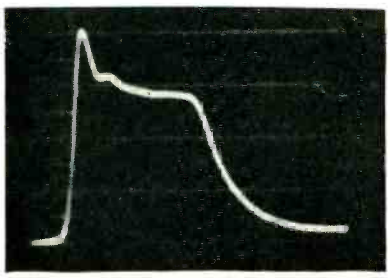


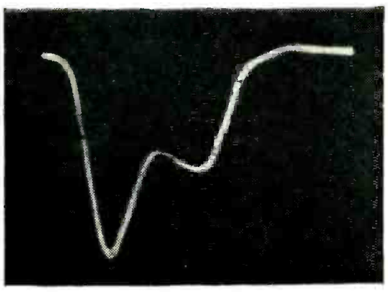
Bottom and rear views of complete pulser. Power supply with diode bridge is mounted on back of panel

Transistors Convert

Circuit uses eight point-contact transistors to amplify, square and differentiate sine-wave input to give fast-rise positive and negative pulses. Power supply uses junction diodes in bridge circuit to make completely tubeless unit

By R. E. McMAHON, I. L. LEBOW and R. H. BAKER
Project Lincoln
Massachusetts Institute of Technology
Cambridge, Mass.





Positive, top, and negative, bottom, outputs of transistor pulse converter

A TRANSISTORIZED pulser for converting a sine wave or pulse input to a large pulse output of low impedance has been built and displays useful characteristics.

The block diagram, Fig. 1, shows the four sections of the pulser. The sine-wave clipper shapes the input into a flat-topped positive pulse which is differentiated and fed to the one-shot multivibrator. The multivibrator output is inverted and coupled to the power stages through a pulse transformer. Shaping and differentiating the input insures that the multivibrator will trigger only once for each positive cycle of the sine wave.

The diagram of Fig. 2 shows the complete circuit. All the transistors are point-contact types. There are two power stages, one for positive and one for negative output. Each have three transistors effectively in parallel. This parallel connection not only increases the power capabilities and reduces the output impedance of the stage but increases regeneration, so that extremely fast rise times are obtained. Measured rise times of the pulses are of the order of 0.05 μsec.

Power Supply

The power supply uses 4JA1A1 junction diodes in a bridge network. The diodes are capable of handling currents of the order of 200 ma and above, depending on the duty cycle. They were used experimentally to reduce the size of the power supply, which is the largest part of the unit.

To determine the power dissipa-

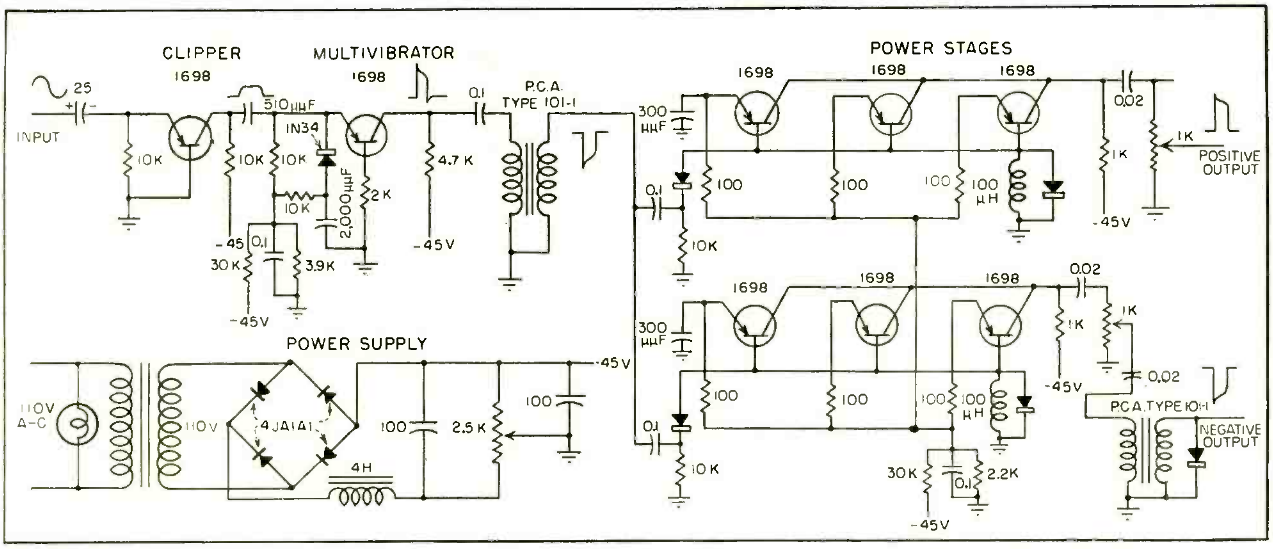


FIG. 2—Sine-wave-to-pulse converter uses diode bridge power supply. Pulse transformer in negative output inverts pulse

Sine Waves to Pulses

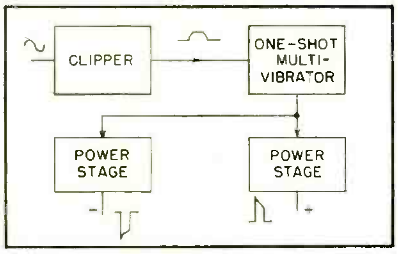


FIG. 1—Positive and negative output stages are separate in pulsing unit

Table I—Characteristics of Sine Wave-to-Pulse Converter

Frequency range, 10 cps to 200 kc
Minimum sine-wave input, 5 v
Pulse output, 35 v max
Pulse rise time, $<.05$ μsec
Pulse width (adjustable from 0.3 to 1 μsec), ≈ 0.3 to 1 μsec
Output impedance, ≈ 300 to 400 ohms

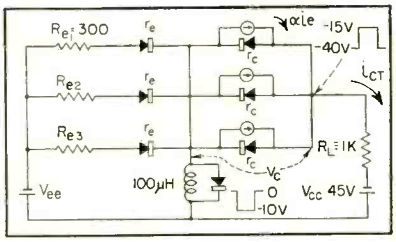


FIG. 3—Equivalent circuit used in calculating power requirements

tion required of the transistors Adler's equivalent circuit is used to represent the three parallel stages. Resistance R_e is the external emitter resistance, r_e and r_c are internal emitter and collector resistances respectively.

From Fig. 3 it can be seen that the collector current of each transistor will be one third of the load current i_{ct}. Experimentally it is found that v_c, the collector to base voltage, is -5 volts when the stages are on, and i_{ct} is the voltage across the load (30 v) divided by the load resistance, (1K) giving 30 ma. This means each stage has a peak current of 10 ma and a peak power of 50 mw. If the unit is operated at 200 kc with a pulse width of 0.5 μsec, then the average peak power (peak power $\times$ duty cycle) is 5 mw per transistor. For lower repetition rates peak power will be less.

The value of v_c when the power stage is off is -40 volts, giving as a d-c power 67 mw for each transistor. Total average power, then, is the average peak power and the average d-c standby power which, in this case, totals 72 mw.

The transistors used were originally rated at 120 mw, but recently some transistor manufacturers have lowered the maximum collector dissipation to about 50 mw. However, most failures of transistors in circuits of this type seem to be a function of the average peak power and peak currents. The value of 10 ma peak current for the power stages is large but average peak power is low and justification for operating the stages at these ratings is found in the fact that after several hundred hours of operation no failures have occurred.

The oscillograms show positive and negative outputs of the transistorized converter. Sweep speed in both cases is 0.1 μsec per cm. Use of pulse transformer reduces rise time of negative pulse.

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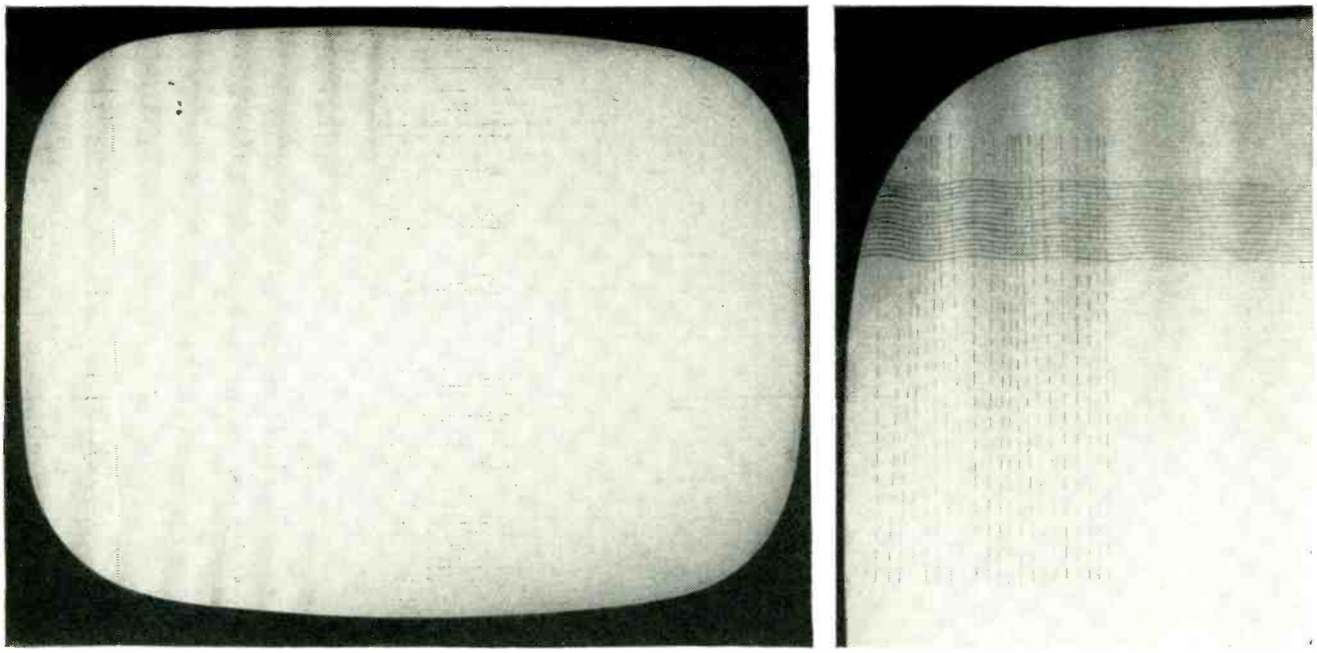


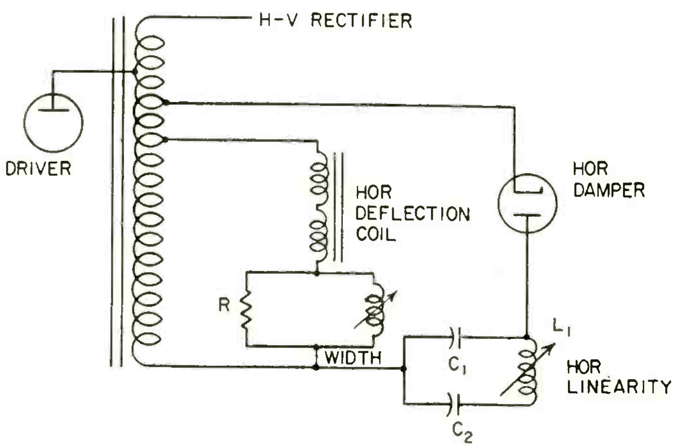
Television raster (left) displays unique appearance of horizontal deflection coil unbalance. Enlarged section of same raster (right) has scan lines emphasized and shows magnetic field lines

How to Handle Ringing

By LEO BEISER

CBS-Columbia Division of Columbia Broadcasting System
Long Island City, New York

RINGING IN HORIZONTAL WIDTH AND LINEARITY COILS



Distinctive Appearance

Velocity and intensity modulation at relatively low frequency—up to 100 kc

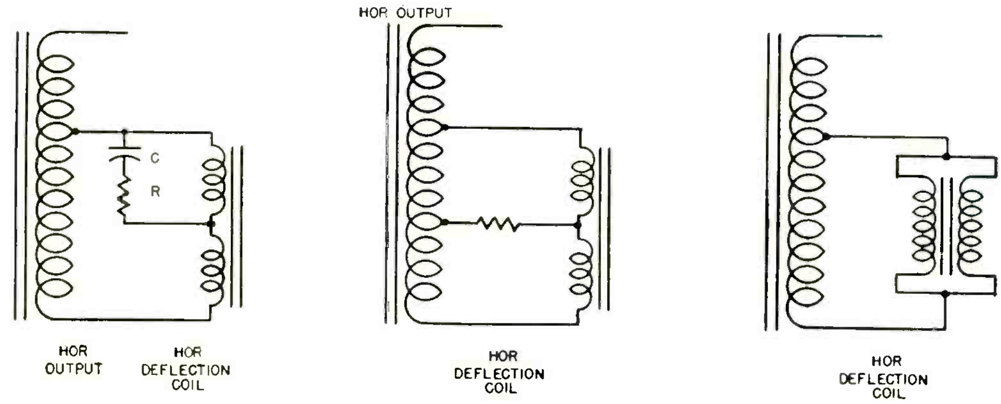
Corrective Measures

1. Resistive damping *R* across width coil
2. Resistive damping across linearity coil and proper choice of components L_1, C_1 and C_2

Modern television receiver design provides an extra measure of performance with improved picture fidelity under adverse conditions and at reduced cost. Yet, there exists a lack of information regarding a picture fault capable of detracting from that extra measure of performance. Observers call it shading, vertical bars or horizontal ringing.

Deflection system ringing is a series of transient oscillations in the output circuits. It is displayed as vertical bars, starting at the left edge of the raster and decaying gradually to the right, sometimes extending completely across the screen. Many television receivers suffer from this defect. In color receivers the effect is not only one of varying picture brightness, but since the magnetic field within the

RINGING DUE TO HORIZONTAL DEFLECTION COIL UNBALANCE



Distinctive Appearance

Velocity modulation with synchronous vertical ripples; most severe at top and bottom of raster; modulation apparently cancelled near center of raster; frequency range 100–150 kc

Corrective Measures

1. Balancing capacitor C placed across top half of deflection coil—Circuit (A)
2. Deflection coil center top returned to electrical center of horizontal output transformer—Circuit (B)
3. Both halves of horizontal deflection coil connected in parallel—Circuit (C)

in Television Design

Proper design of horizontal and vertical coils, output transformers and other receiver deflection system components avoids undesired vertical bar pattern on raster caused by transient oscillations in the output circuits

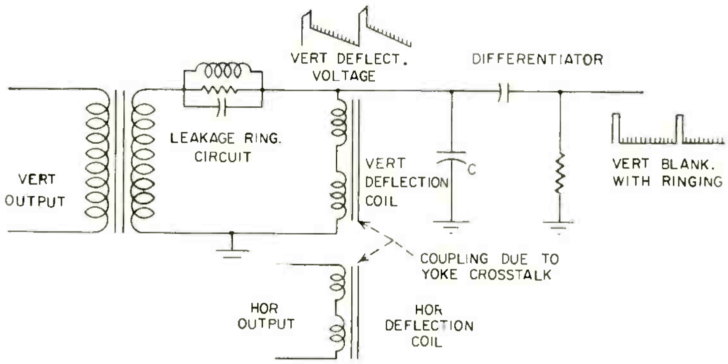
deflection yoke is distorted, color misconvergence may result in shadow-mask picture tubes. Most of the treatments described here are applicable to both monochrome and color television.

The steep wave fronts associated with horizontal deflection circuits excite the horizontal output transformer, yoke, width coil and horizontal linearity coil into transient oscillations. Ringing can therefore be considered as a train of transient oscillations, decaying exponentially after excitation by the sharp flyback waveform. The decrement or rapidity of decay is determined by the Q of the ringing circuit.

Effects of Ringing

Ringing can affect the picture in two ways. The first is by velocity

RINGING IN VERTICAL DEFLECTION COIL AND OUTPUT



Distinctive Appearance

Intensity modulation only (result of vertical blanking) at relatively low frequency—up to 100 kc

Corrective Measures

1. Obtaining vertical-blanking voltage from source other than vertical-deflection coil
2. Reducing yoke crosstalk by quadrature orientation of yoke coils; by-passing vertical output circuit, C, and choice of low-impedance vertical-deflection coil

modulation of the electron beam causing successive localized bunches of beam current at the screen. The resulting brightness variation is more discernible than the resulting geometric distortion.

The second effect is intensity modulation of the picture tube, either by undesired pickup in video circuits or as a result of blanking. Both vertical and horizontal blanking waveforms often have the undesired ringing superimposed upon them. Velocity and intensity modulation can occur simultaneously since they are both often a direct result of the same cause.

Horizontal Width and Linearity Coils

In many modern television receivers, the horizontal width and linearity coils are connected in series with the horizontal deflection coil and damper tube respectively. In these circuits, they form isolated appendages to the horizontal output circuit and can easily resonate with their physical and stray capacitances upon shock excitation by the steep flyback pulses. This is particularly true of the width coil for unlike the correctly adjusted linearity coil, the width can be resonant at almost any frequency. Since this ringing will be transmitted throughout the horizontal circuit, it can best manifest itself in both velocity modulation and intensity modulation. Adequate resistive damping across the width coil and correct linearity adjustment will minimize these sources of trouble.

Yoke Crosstalk

Leakage inductance in the vertical components would be of little consequence to the horizontal deflection circuit were it not for yoke crosstalk and vertical blanking.

A deflection yoke with high crosstalk will show appreciable horizontal energy transfer to the vertical deflection coil. This energy will set into oscillation the resonant circuit formed by the vertical output circuit leakage inductance and physical plus stray capacitance. By the vertical blanking, this transient oscillation is impressed on the picture tube resulting in intensity modulation.

If vertical blanking from the yoke circuit must be used, there are three approaches to the reduction of crosstalk. First, the yoke coils may be oriented to approach magnetic quadrature between horizontal and vertical coils and means provided to maintain this relationship. A crosstalk voltage ratio of at least 250 to 1 is a practical and necessary deflection yoke requirement. A second solution is to by-pass the vertical circuit leakage inductance thus reducing the ringing voltage and frequency. This is best accomplished by shunting an 0.02-0.1 μf capacitor directly across the vertical output transformer secondary. The vertical blanking waveform and vertical circuit performance will remain relatively unaffected.

Finally, lower impedance vertical-deflection coils will reduce crosstalk.

Yoke Unbalance

Ringing due to horizontal deflection coil unbalance can be identified by the symptoms shown in the photographs. Methods for minimizing this disturbance include use of a balancing network across the top half of deflection coil; center tap return to the horizontal output transformer and parallel connection of the halves of the horizontal deflection coil.

Figure 1A shows a horizontal deflection coil and its associated circuits. Since each half of the deflection coil, L_T, and L_B, is a physical mass above ground potential, there exists from each half distributed and stray capacitances, C_B and C_0. Across L_T, the top half of the deflection coil, there exists a distributed capacitance C_T. Capacitances C_T and C_B are unequal since C_B includes both distributed and stray capacitance. Figure 1B is a more complete representation of the horizontal deflection coil circuit.

Transfer of energy from one half of the deflection coil to the other is such that an increase of leakage current in one half causes a decrease in the other. This 180-deg phase relationship is illustrated in Fig. 1C where the output transformer is omitted for convenience.

Voltages e_T and e_B are indicated

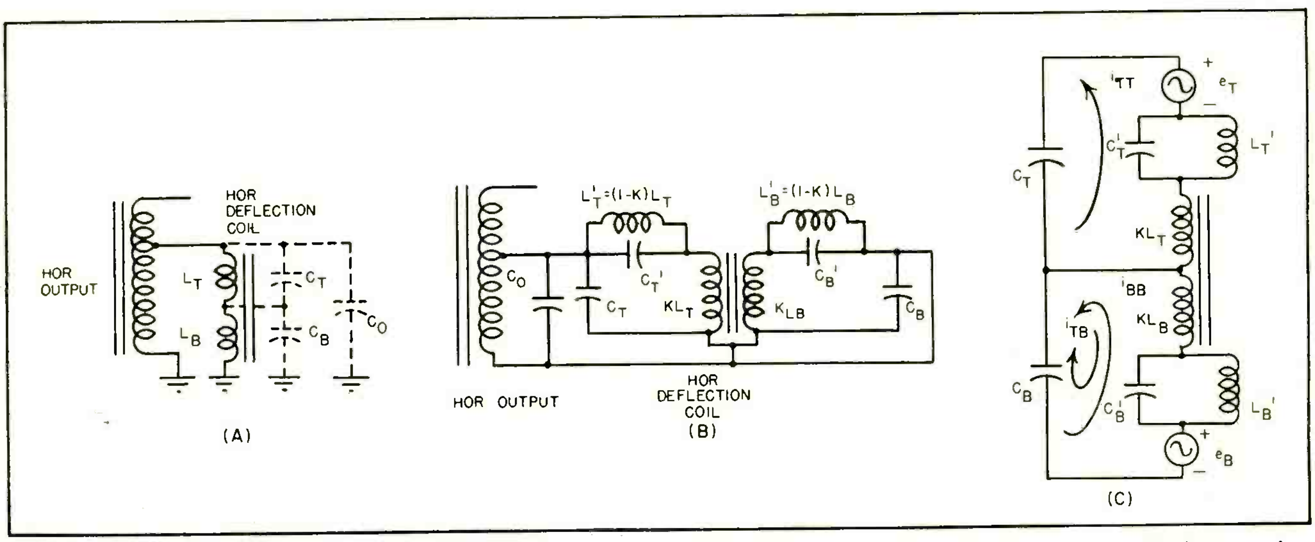


FIG. 1—Simple circuit of horizontal-deflection coil (A) is redrawn (B) to show leakage tuned circuits. Equivalent circuit (C) illustrates how coil balancing cancels ringing currents

to denote the polarities at the start of the rings, since these voltages exist only during the time driving energy is transferred to the leakage tuned circuits. The polarities of e_T and e_B must be as shown since the driving pulse initiating the ring is unipotential with respect to ground and hence passes through all coils in the same direction.

With e_T as indicated a current i_{TT} will flow through the top loop and up through L_T'.

Current i_{TT} will produce a current i_{TB} in the secondary loop, both currents being opposite in polarity with respect to ground. By transformer action, current i_{TB} is opposite in phase to current i_{BB}.

Balancing Capacitor

By adjusting capacitance C_T so that the top ringing frequency is identical to that at the bottom, any tendency towards yoke ringing is suppressed. As i_{BB} tends to increase due to initial bottom shock excitation e_B, an opposing current i_{TB} tends to decrease due to initial top shock excitation e_T. The result is complete cancellation in both top and bottom loops.

With dissimilar resonant frequencies of the leakage circuits, when i_{BB} tends to increase it is opposed by a current i_{TB}, which decreases either too rapidly or too slowly. Thus the ringing current never cancels during that first impulse and energy transfer continues with the top modifying the bottom and vice versa; the two halves always maintain their characteristic out-of-phase condition.

This interacting condition is seen as opposite shading of the top and bottom of the raster when capacitive balance is not attained. Current balance is most favorable when the Q's as well as the frequencies of the ringing circuits are identical. A small resistance is often added in series with the balancing capacitor, since the Q of stray and distributed capacitances is lower than that of a physical component.

Deflection Coil Center Tap

The deflection coil center tap connection to the electrical center of the horizontal output transformer, shown in Fig. 2A, achieves almost perfect capacitive balance. This is accomplished not only by the swamping action of the added transformer capacitances, but by the equalizing action of improved top-to-bottom coupling that reflects more nearly equal capacitances across each half of the circuit.

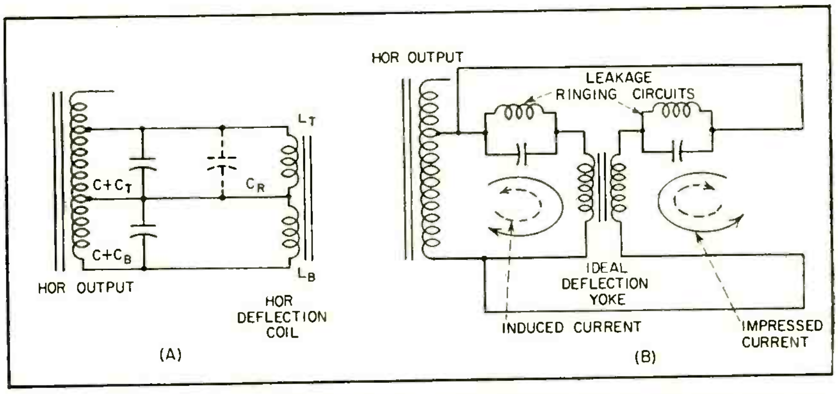


FIG. 2—Other means to combat deflection yoke ringing: connecting deflection coil center tap to center of output transformer (A) and connecting deflection coil windings in parallel (B)

Parallel Windings

Connecting the halves of the horizontal deflection coil in parallel as in Fig. 2B eliminates capacitance inequality across each half of the coil and lumps coil capacitance with transformer capacitance. Although coil leakage inductances still exist, ringing cancellation will be maintained so long as the coil halves are sufficiently similar in construction. Deflection coil inductances, leakage inductances and distributed capacitances will be the same, thus generating the same ringing frequencies to effect cancellation.

To understand the vertical displacement of the horizontal line structure coincident with brightness variation, visualize the horizontal deflection coil suspended in space; the top half above, and the bottom half below the neck of the picture tube. To generate brightness variations similar to those in the right-hand photograph, the magnetic field developed by the coil arrangement must be such that there exist compressions and rarefactions of the magnetic lines of force. This field distortion must vary with time as shown in the left-hand photo to accomplish the varying beam velocity. Any tilting of the field indicates an undesirable horizontal direction field component. It is this horizontal field component that deflects the beam vertically in synchronism with the raster shading.

A complication in yoke ringing is the effect of the vertical deflection coil upon the vertical ripple of the scan lines. Omission of the 560-ohm resistors across each half of the vertical-deflection coil will accentuate this ripple. The vertical deflection coil affects the vertical ripple through transformer action. The vertical deflection coil is energized by the undesirable horizontal direction component. The loading on the horizontal-deflection coil through reflected impedances thus influences the magnitude and damping of the horizontal component.

No degree of quadrature yoke adjustment can reduce this interaction.

Horizontal Transformer

Ringing originating in the horizontal output transformer is generally the most difficult to cope with. Horizontal output transformer ringing manifests itself in the two basic forms: intensity modulation of the picture tube through the blanking waveform and brightness variation due to velocity modulation of the raster. These effects can be controlled individually or mutually to accomplish ringing reduction.

The most important ringing sources are plate leakage and h-v tertiary leakage. Plate or primary ringing is generally at a higher frequency than tertiary ringing, the former ranging from 300 to 500 kc; the latter from 100 to 200 kc. Identification of the ringing portion is relatively simple. Since stray capacitance determines the ringing frequency, addition of small physical capacitance across the portion in question will be most effectively applied across the related leakage inductance and the ringing frequency reduced. Another technique in substantiating tertiary ringing is to remove the tertiary winding completely and to supply high voltage from another source. Ringing resulting from tertiary leakage inductance will be eliminated.

Four methods of flyback ringing reduction are: (1) increasing the transformer coefficient of coupling —a basic requirement with many complications; (2) carefully choosing the yoke-damper relationship—utilizing damper action to suppress ringing; (3) connecting deflection coil with low side above a-c ground —balancing arrangement for cancellation; and (4) choosing blanking amplitude and phase to accomplish cancellation through intensity modulation.

Coefficient of Coupling

One of the most complex requirements of a horizontal output transformer is its coefficient of coupling. At present leakage inductance reduction is a compromise with several other factors such as voltage breakdown, temperature rise and retrace time.

Leakage may be reduced by reducing the physical size of the coil. Most important is the reduction of the mean turn diameter of that portion containing all but the h-v tertiary—the primary, as it would be in an autotransformer. Within the primary winding is the damper tap, yoke tap and driver plate tap. Increasing coupling between the damper and deflection coil provides the most pronounced improvement for the damper effectively shunts any ringing appearing across the deflection coil. Reduction of leakage inductance in series with the driver plate will reduce the ringing contribution from that source.

Another technique is to reduce coil-form diameter. Coupling is increased by proximity between core and coil. Increase of coil widths also accomplishes decrease of coil diameter. However, excessive increase of coil width may reduce tertiary ringing at the expense of increasing primary ringing. There is a narrow range of optimum coil width for a given yoke and damper connection.

Tertiary diameter and width, important in tertiary ringing, are found to be the most unpredictable factors. Each transformer design must be handled individually.

The wire sizes and density of windings are important mainly in contributing to the above dimensions.

Yoke-Damper Circuit

After the geometric considerations described above have reached their compromise point, other approaches are available. The most important of these depends upon more effective use of the damper tube. If a deflection coil impedance is chosen which when connected across the damper presents the correct tube loading, advantage is taken of the vastly reduced ringing appearing at the damper. The correct deflection-coil impedance varies between 18 and 30 mh as opposed to the 8.3 mh impedance long maintained as standard. This effect is a desirable by-product of the trend to higher yoke impedances for improved efficiency. With higher yoke impedances come higher voltage pulses and the yoke must be built with this extra stress in mind.

Yoke Connections

Another transformer-yoke damper relationship results in successful cancellation of the ringing component. This is accomplished, even with the standard low-impedance yokes, by moving the horizontal deflection winding of the yoke from its customary connection, Fig. 3A, to a new connection, Fig. 3B, while maintaining the number of turns across the winding constant. This new balanced position is found to be one where the top of the coil is much closer to the damper than the bottom of the coil is to ground.

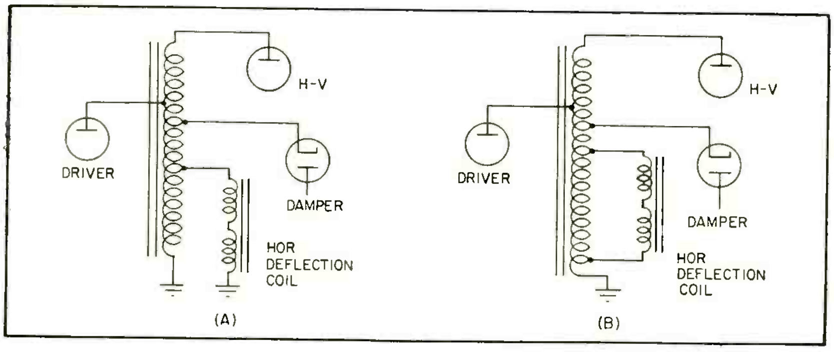


FIG. 3—Cancellation of ringing results when deflection coil is raised electrically from its normal position (A) to new balanced position (B)

In Fig. 4A the low side of the coil is at a-c ground and the high side is at some potential below that of the damper. The most important leakage inductance is that appearing between the damper tube and the transformer. This inductance L isolates the desired damping action from the rest of the transformer. The voltage appearing between 1 and ground is the desired driving pulse plus the undesired ringing component. The voltage appearing at 2 is the driving voltage minus the ringing component, the ringing component remaining across the hypothetical leakage inductance L. Inductance L is not necessarily generating the ringing. The voltage at 3 is identical to 1 but smaller in amplitude. Across the deflection coil, then, is the voltage E_y, identical to 3 and containing the ringing component.

In Fig. 4B one end of the deflection coil is connected to the damper and the other end to 4, some point above ground potential. The voltage at 2 is again the clean pulse, while the voltages at 1 and 4 are

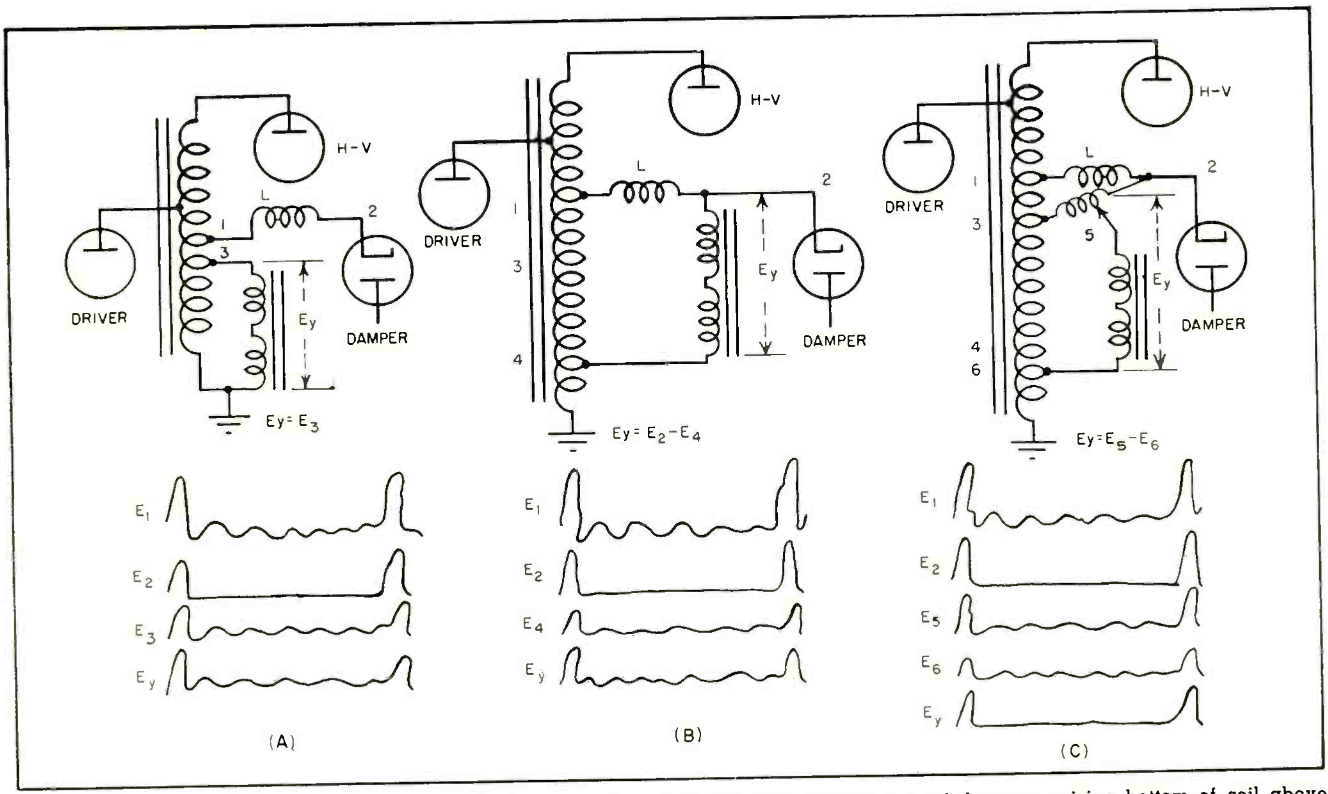


FIG. 4—How deflection coil connections cancel ringing: normal position (A) fails to make use of damper; raising bottom of coil above ground is intermediate step (B); clean waveform results when balance is achieved (C)

the same in form and different in amplitude. The voltage across the deflection coil E_y shows the ringing superimposed upon the driving pulse and inverted due to the subtraction of voltage 4 from voltage 2.

The next step, Fig. 4C, requires a nonconventional representation where a new hypothetical inductance has been added. Voltage 5 is now a cross between 2 and 3 where the ringing voltage has been vastly reduced. Voltage 6 also represents a vastly reduced ringing voltage. If the ringing voltage at 5 is made equal to that at 6, then all ringing across the deflection coil is cancelled since the voltage across the coil E_y is now $E_5 - E_6$.

Horizontal Blanking

If the use of horizontal blanking, care must be exercised not to insert excessive blanking when employing the last two methods of ringing reduction. Although the ringing voltage has been eliminated from the deflection coil, it will still exist superimposed upon the blanking waveform.

Another approach to transformer ringing reduction is to circumvent the transformer entirely. Brightness variation due to horizontal blanking is opposite in phase to brightness variation due to velocity modulation. The two basic symptoms of ringing can therefore be used to cancel each other. Unfortunately, this cancellation occurs at one setting of background brightness. The designer must choose the amount of blanking voltage that satisfies blanking requirements and provides ringing cancellation over the most important brightness range. He must also deliver this blanking waveform to the picture tube without destroying the desirable 180 deg phase relationship.

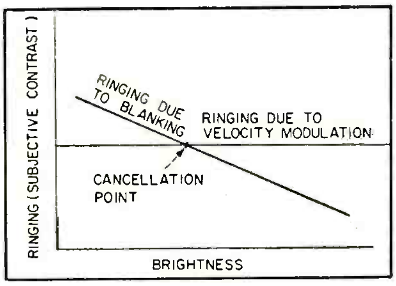


FIG. 5—Two basic ringing systems cancel one another

The reason for this single cancellation point is one of subjective contrast ratios. The ringing superimposed upon the blanking voltage is assumed fixed in amplitude and hence will appear as low contrast at high brightness and high contrast at low brightness, shown in Fig. 5. The ringing resulting from velocity modulation, however, varies in intensity with the background brightness, thus maintaining a uniform subjective contrast ratio with brightness. The cancellation point occurs at the intersection of the curves; this point subject to adjustment by setting the blanking amplitude.

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Low-Frequency Switch

By HARRY B. CORDES

Electric Boat Division
General Dynamics Corp.
Groton, Conn.

A COMMON METHOD of recording transients is to feed the output voltage of the circuit under study to a graphic recorder while applying a step-function input with a manual or motor-driven switch. However, most pen or stylus recorders have poor frequency response above 80 or 100 cps and transients containing higher frequency components are distorted by such recordings.

An oscilloscope with a low-frequency sweep circuit and d-c amplifiers is an ideal tool for the observation and recording of such transients. The major problem is then one of synchronizing the transient-initiating switch with the oscilloscope sweep to obtain identical recurring patterns on the screen.

Operation

The circuit described here was originally designed to study the delay times in magnetic-amplifier circuits operating on supply voltages of 60 and 400 cps. Heart of the circuit is a relay that operates in synchronism with the oscilloscope sweep over a wide range of frequencies and with two different modes of operation.

The electronic switch is connected to an oscilloscope and the circuit under study as shown in Fig. 1. The sawtooth sweep voltage from the oscilloscope sweep oscillator is fed into the switch circuit and triggers the relay. The relay in turn introduces a step function in the observed circuit and its output voltage is applied to the vertical amplifier of the oscilloscope.

In one mode of operation, the relay coil is energized at the beginning of one sweep and remains energized throughout that sweep. At the beginning of the next sweep, the relay coil is de-energized and remains so until the next consecutive sweep. As a result, the relay contacts alternate with each sweep. Therefore two sweeps are necessary to complete one operational cycle and hence two traces are recorded. This mode of operation was used to obtain the trace in Fig. 2A, the position response of a servo output member to a step-function input.

When two overlapping sweeps tend to obliterate each other, a second mode of operation can be used. In this mode, the relay coil is energized for the first part of a sweep and de-energized for the remainder of the sweep. This action produces two step functions, one at the start of the sweep and another near the center of the sweep. The cycle is accurately repeated for all subsequent sweeps.

This mode was used in photographing the traces of Fig. 2B and 2C. The trace in Fig. 2B is the output voltage of a magnetic amplifier as the input control current is switched between two different values by the relay. Figure 2C is a plot of the instantaneous speed of a motor as the power to the motor is switched between zero and maximum. The vertical voltage in this case was taken from a d-c tachometer generator geared to the motor shaft.

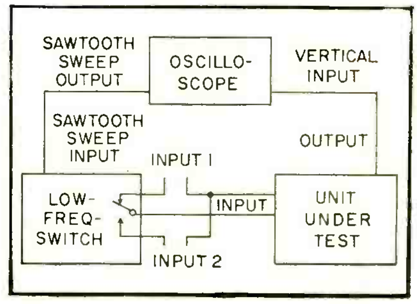

FIG. 1—Switch setup for operation as synchronous step-function producer. Sawtooth sweep input triggers relay

Circuit Details

Figure 3 is a schematic diagram of the circuit. The sawtooth voltage from the oscilloscope sweep generator is fed into coupling circuit R_1C_1. The time constant of this coupling is small with respect to the shortest sweep time used. Consequently the sawtooth is differentiated and a narrow negative pulse impressed on the grid of V_{1A} immediately preceding each sweep. Tube V_{1A} produces an amplified positive pulse that triggers single-shot multivibrator V_4 and is also applied to V_{1B} for further amplification. The negative pulse taken from V_{1B} triggers the flip-flop circuit consisting of V_2 and V_3.

Modes

Switch S_2 selects the mode of operation of the relay by connecting the grid of the relay control tube V_5 either to the flip-flop (mode 1) or to the multivibrator (mode 2).

Mode 1

Thus, during mode 1 operation, the initiation of a new sweep triggers the flip-flop into one of its stable states and the relay contacts assume a corresponding position. At the start of the next sweep, the flip-flop is triggered to its other stable state and the relay contacts move to the alternate position and remain there.

Mode 2

If switch S_2 connects the grid of the relay driving tube to the multivibrator, the following sequence of events takes place. The trigger pulse causes the multivibrator to assume its short-time stable state and the relay coil is energized. After a period of time during the same sweep, the multivibrator reverts to its normal state and the relay coil is de-energized. The next sweep again triggers the multivibrator and the cycle is repeated.

Potentiometer R_2 and selector switch S_1, with the three capacitors, allow the dwell time of the contacts in either position to be varied over a fairly wide range. With the values for R_2, C_2, C_3 and C_4 shown, the

for Recording Transients

Relay initiates step-function test voltage for analysis of transient response of low-frequency circuits and various electromechanical devices. Oscilloscope sweep synchronizes relay to produce identical recurring transient waveforms for recording

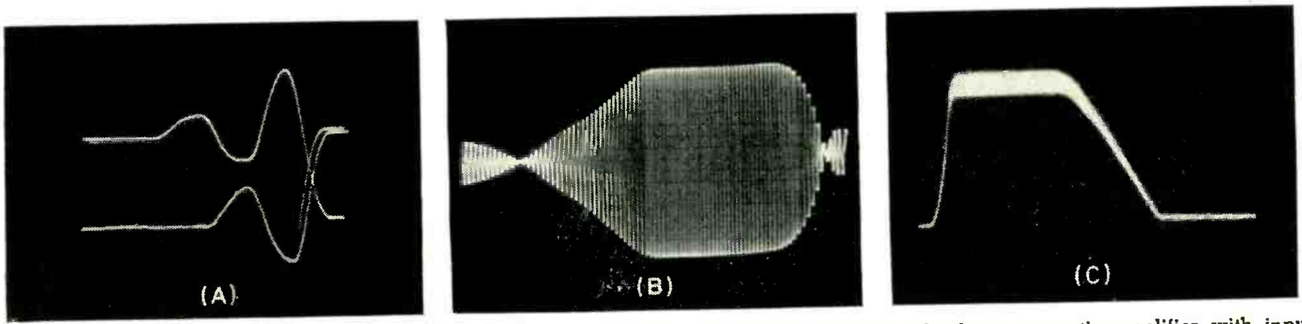

FIG. 2—Step-function response of servo system in mode 1 operation (A). Output of reversible-phase magnetic amplifier with input switched between two different values in mode 2 operation (B). Instantaneous speed of low-inertia servo motor under load with input switched between zero and maximum in mode 2 operation (C)

dwell times can be varied from 5 seconds to 16 milliseconds. Thus, the second transient can be placed in the center of the sweep over a sweep-frequency range of 0.1 to 30 sweeps per second. By varying R_2, the second transient can be moved along the sweep to provide the best observable pattern.

Switch S_2 is provided with two additional positions, one grounding the grid of V_5 and the other connecting grid and cathode. These are provided so the relay contacts may be switched to either position, facilitating adjustment of the circuit under study without disconnecting and reconnecting leads.

The relay used in this unit is a Sigma type 4F-8000-S. With proper adjustment of contact spacing and spring tension, this relay will respond up to frequencies of 30 cps. Beyond this frequency, contact bounce and pull-in times become appreciable and affect the transient trace.

Initial Adjustments

In mode 1 operation, pulse gain control R_1 is advanced until positive triggering occurs. This is easily perceived by listening to the relay contacts click at the initiation of the sweep. The sweep of the oscilloscope can then be adjusted to any desired frequency.

Mode 2 operation requires a few additional adjustments. The sweep frequency of the oscilloscope is first adjusted to the desired value. The corresponding gate capacitor is selected by S_1 and R_2 is adjusted to give zero resistance. Pulse gain control R_1 is then advanced until positive triggering occurs. The desired gating is adjusted by R_2.

The multivibrator tends to become unstable if greatly overdriven. For this reason it is desirable to set the pulse gain control just above the point where triggering occurs. Both modes will trigger on sweep voltages as low as two volts peak to peak. If very large sweep voltages are used, it would be desirable to use additional attenuation at the input of the pulse amplifier.

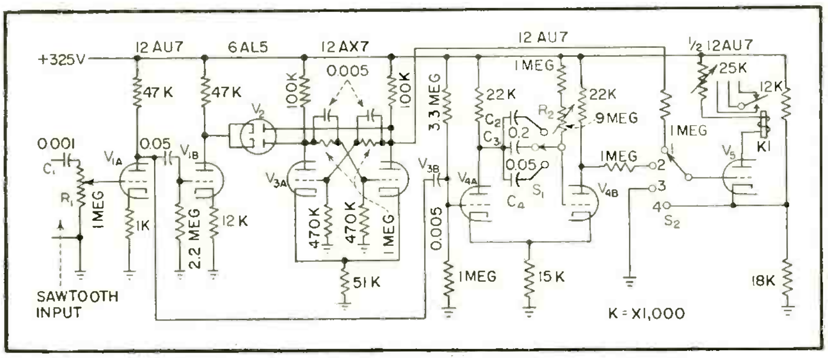

FIG. 3—Swith S_2 provides mode 1 operation in position 1 and mode 2 in position 2. Potentiometer R_2 and S_1 with C_2, C_3, C_4 (2 0.2, 0.05 μF respectively) permit the dwell time of the contacts to be varied from 5 sec to 16 millisec

Oscilloscope

This circuit may be used with any oscilloscope with good low-frequency response, but in some cases minor modifications are necessary. When the oscilloscope is not provided with external sawtooth output connections, the voltage may be taken directly from the horizontal plates. Proper polarity must be observed since a negative sawtooth will not trigger the circuits. Additional capacitors can usually be added to the sweep circuits to provide longer sweep times.

Output Windows for

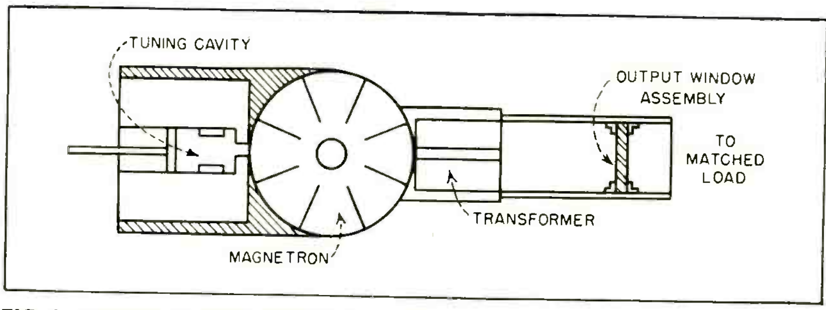

FIG. 1—Location of output window in magnetron output waveguide

By T. S. CHEN

Tube Department
Radio Corporation of America
Harrison, N. J.

OUTPUT SEAL of several types of magnetrons consists of a resonant iris and a rectangular plate of thin ceramic which fills the iris opening. The entire structure is brazed across the transverse section of the waveguide and serves as an air-tight seal for the magnetron output while allowing power to be supplied to the load. Figure 1 shows the location of a window in the output waveguide of a magnetron.

Equivalent Circuit

The resonant iris shown in Fig. 2A is a combination of inductive and capacitive diaphragms. Both inductive and capacitive susceptances, therefore, act across the waveguide at the plane of the iris.

In the equivalent circuit Fig. 2B, the inductance and capacitance are placed in parallel across the transmission line. At resonance, the circuit has zero admittance. Consequently, the principal wave passes over the resonant obstacle without reflection. Provided the dimensions are chosen correctly, the local magnetic and electric fields of the inductive and capacitive portions of the iris can be made to store equal amounts of energy. During oscillation, the stored energy is exchanged between these fields and no energy is drawn from, and returned to, the incident TE_{10} (H_{10}) wave.

Resonant Dimensions

A method for determining the resonant dimensions of such an iris has been given by J. C. Slater.[1]

Figure 3 shows a rectangular waveguide having a as the longer and b as the shorter internal dimension of the cross section. If the TE_{10} mode is transmitted along the waveguide, the characteristic impedance of the guide may be defined as the ratio of the voltage between the top and bottom plates to the longitudinal current in one plate. This impedance Z may be expressed as

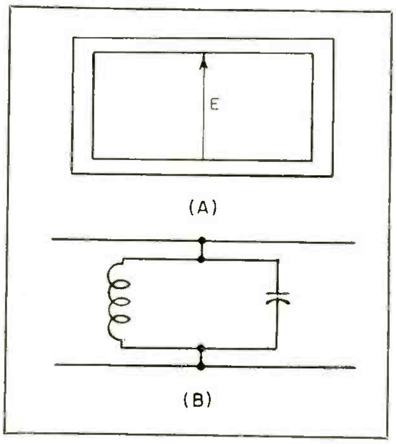

FIG. 2—Cross section (A) and equivalent circuit (B) of typical resonant iris

$$Z = \frac{\pi}{2}\sqrt{\frac{\mu_0}{\epsilon_0}}\,\frac{b}{a}\,\frac{1}{\sqrt{1-\left(\frac{\lambda}{2a}\right)^2}} \quad (1)$$

where μ_0 and ϵ_0 are respectively the permeability and permittivity of free space and λ is the free-space wavelength.[2] In this expression, the same unit of measurement is used for a, b and λ.

The iris diaphragm may be considered as a short section of waveguide having dimensions different from those of the main waveguide. If a' and b' are the longer and shorter sides respectively of the iris opening, the characteristic impedance Z' of this short section of waveguide is

$$Z' = \frac{\pi}{2}\sqrt{\frac{\mu_0}{\epsilon_0}}\,\frac{b'}{a'}\,\frac{1}{\sqrt{1-\left(\frac{\lambda}{2a'}\right)^2}} \quad (2)$$

At resonance, the characteristic impedance of the iris opening should match that of the main waveguide to eliminate reflection. Equations 1 and 2 may therefore be equated to obtain

$$\frac{a}{b}\sqrt{1-\left(\frac{\lambda}{2a}\right)^2} = \frac{a'}{b'}\sqrt{1-\left(\frac{\lambda}{2a'}\right)^2} \quad (3)$$

Equation 3 gives the resonant free-space wavelength of an iris having an opening $a' \times b'$ in a waveguide of cross section $a \times b$ when the dominant mode is propagating. In this simplified derivation, the local waves (or evanescent modes) set up at the diaphragm have been neglected.

Equation 3 reveals that a' should be greater than $\lambda/2$. The corners of the possible composite irises, shown as the dotted rectangle in Fig. 3, fall on a hyperbola having vertices $\lambda/2$ apart. The equation of the hyperbola may be written

$$(x^2/m^2) - (y^2/n^2) = 1 \quad (4)$$

where x and y are the coordinates of the upper right-hand corner of the iris as shown in Fig. 3 and m and n are parameters to be determined.

When $x = \pm\lambda/4$, $y = 0$ and $m =$

Tunable Magnetrons

Ceramic plate set in resonant iris provides air-tight seal in X-band waveguide; replaces probe for coupling magnetron power output to transmission line. Nomographs aid determination of window and resonant iris parameters

$\pm\lambda/4$. If this value of m is substituted in Eq. 4, and the values $x = a/2$ and $y = b/2$ used

$$n^2 = \left(\frac{b}{2}\right)^2 \left(\frac{\lambda}{4}\right)^2 \Big/ \left[\left(\frac{a}{2}\right)^2 - \left(\frac{\lambda}{4}\right)^2\right] \quad (5)$$

Substitution of the values of m^2 and n^2 in Eq. 4 gives

$$x^2\left(\frac{b}{2}\right)^2 - y^2\left[\left(\frac{a}{2}\right)^2 - \left(\frac{\lambda}{4}\right)^2\right] = \left(\frac{b}{2}\right)^2\left(\frac{\lambda}{4}\right)^2 \quad (6)$$

When x and y are replaced by $a'/2$ and $b'/2$ respectively, Eq. 6 reduces to the form of Eq. 3.

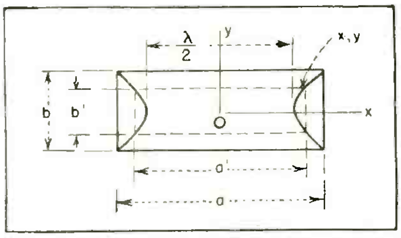

FIG. 3—Sectional view of rectangular waveguide

Substitution of the empirical factor $\lambda/0.985$ for λ in Eq. 3 results in the corrected formula for resonant wavelength.

$$\frac{a}{b}\sqrt{1-\left(\frac{\lambda}{1.97a}\right)^2} = \frac{a'}{b'}\sqrt{1-\left(\frac{\lambda}{1.97a'}\right)^2} \quad (7)$$

When the iris dimensions shown in Table I are substituted in Eq. 7, the resonant frequencies listed in the last column of the table are obtained. These values are sufficiently close to the measured frequencies. Because the iris is a highly frequency-sensitive element, minor irregularities in material, or the use of large tolerances, can cause great disparity between the calculated and measured values of resonant frequency.

Iris Q

There are an infinite number of resonant structures corresponding to different combinations of a' and b' for any given waveguide and wavelength. The dimensions of the opening, however, are also chosen to produce the desired sharpness of the resonant curve of the iris and the required power-handling capability. Although the design of these irises may be such that the section of the waveguide is almost completely occupied by metal, in one case the only opening being a 0.014-inch slit, power is transmitted through the slot without substantial reflection at the resonant frequency of the iris.

Iris Nomograph

A nomograph, Fig. 4, has been constructed to determine iris dimensions for a waveguide 0.900 × 0.400 inch. When a' and b' are known, the wavelength λ, can easily be found. Conversely, if the wavelength λ is given, a reasonable value may be assumed for either a' or b' and the other dimension found from the chart.

Example 1—A symmetrical resonant iris having an opening for which $a' = 0.706$ inch (1.793 cm) and $b' = 0.140$ inch (0.356 cm) is

Table I—Resonant Frequencies of Rectangular Irises (TE_{10} Mode) for X-Band Waveguide With Internal Dimensions 0.900 × 0.400 in.

Iris Dimensions a' (inches)	Iris Dimensions b' (inches)	Resonant Frequency Calculated from Eq. 3 (mc)	Measured Resonant Frequency (mc)	Frequency Calculated from Corrected Eq. 7 (mc)
0.706	0.140	8,760	8,900	8,900
		8,760	8,900	8,900
		8,760	8,980	8,900
		8,760	8,900	8,900
0.698	0.140	8,900	9,100	9,040
		8,900	9,050	9,040
0.721	0.140	8,510	8,700	8,700
		8,510	8,700	8,700
0.680	0.125	9,060	9,120	9,180
		9,060	9,130	9,180
		9,060	9,220	9,180

stamped out of oxygen-free high conductivity copper sheet 20 mils thick. The internal dimensions of the waveguide in which the iris is to be placed are $a = 0.900$ inch (2.286 cm) and $b = 0.400$ inch (1.016 cm). The resonant wavelength of this iris diaphragm can be found either by Eq. 7 or the nomograph, **Fig. 4.**

To use the nomograph, a straight line is drawn from 0.356 on the right-hand b' scale through the point 1.793 on the a' scale to intersect the center scale. The point of intersection on the center scale is then joined with the point 0.356 on the left-hand b' scale by a second straight line which intersects the λ scale at the point 3.36 cm.

Single-Frame

The first type of ceramic window consists of a single metallic frame into the opening of which a rectangular ceramic plate 0.040-inch thick is fitted.[3] Figure 5A illustrates the construction details of this type of window. This ceramic window has sharper resonant characteristics than an open iris. The approximate relationship between the wavelength and the resonant dimensions is

$$\frac{a}{b}\sqrt{1-\left(\frac{\lambda}{2a}\right)^2} = \frac{a'}{b'}\sqrt{1-\left(\frac{\lambda}{2a'\sqrt{\ }}\right)^2} \qquad (8)$$

where ϵ_r is the dielectric constant of the ceramic. No adequate theoretical basis can be given for this relationship. The dielectric constant of the ceramic enters into Eq. 7 to affect the phase velocity, but it does not appear in the intrinsic-impedance factor $\sqrt{\mu_o/\epsilon_o}$, in Eq. 2.

Table II—Resonant Frequencies of Sandwich-Type Ceramic Windows. Waveguide: 0.900 × 0.400 in.; Ceramic: AlSiMag 243, $\epsilon_r = 6$

Window Dimensions		Measured Resonant Frequency (mc)	Resonant Frequency Calculated from Eq. 9 (mc)
a′ (inches)	b′ (inches)		
0.474	0.250	7,800	7,750
0.474	0.250	7,800	7,750
0.474	0.250	7,670	7,750
0.490	0.250	8,600	8,500
0.498	0.250	8,900	8,990

Sandwich Type Windows

The second type of output window for magnetrons consists of a 0.040-inch ceramic plate which fills the entire section of the waveguide and two resonant iris frames, one on each side of the plate. The details of this structure are shown in **Fig. 5B.**

During the construction of the sandwich-type window, the four edges of the ceramic plate and the area which makes contact with the iris frames are metalized. This metalizing process insures a more intimate bond between the ceramic and metal parts, thus improving vacuum seal at the window. The construction of the iris frames shown in Fig. 5B is mechanically superior to that of the iris frame shown in Fig. 5A because several bends have been omitted. The omission of the bends also reduces the variation of the internal dimensions a' and b' in the finished window.

Although the sandwich-type structure contains more frequency-sensitive elements than the single-frame window, it acts essentially as a resonant iris but has a much higher reflection off resonance. The resonant wavelength of this type of window can be predicted from

$$\frac{a}{b}\sqrt{1-\left(\frac{\lambda}{2.38a}\right)^2} = \frac{a'}{b'}\sqrt{1-\left(\frac{\lambda}{2.38\sqrt{\epsilon_r}\,a'}\right)^2} \qquad (9)$$

Table II shows both the measured and the calculated resonant frequencies for ceramic windows having various dimensions.

The amount of inaccuracy observed in frequency prediction based on Eq. 9 is not serious because this difference can be compensated by broadbanding techniques which provide a bandwidth of 1,500 mc having low vswr.

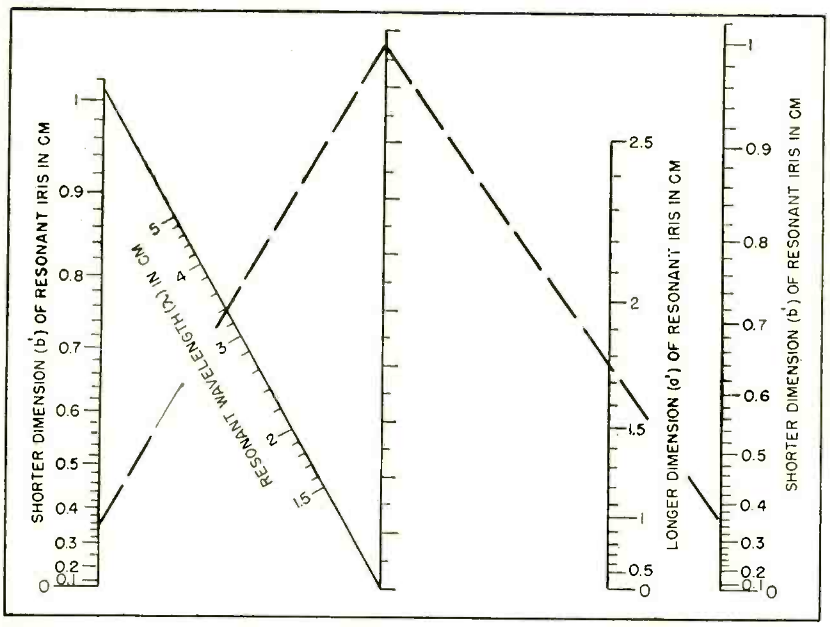

FIG. 4—Nomograph for determining iris dimensions for a waveguide 0.900 × 0.400 inch (2.286 × 1.016 cm)

Nomograph

Figure 6 is a nomograph to determine the unknown parameters in Eq. 9. The dielectric constant ϵ_r of the ceramic has a fixed value of 6 in this nomograph. The chart shows that the value of b' equal to 0.414 cm (0.163 inch) cannot be used for the combination in which the waveguide is 0.900 × 0.400 inch in cross section and the ceramic material has a dielectric constant of 6. This value of b' renders Eq. 9 independent of wavelength.

Caution should be exercised in applying Eq. 9 to the calculation of resonant wavelengths for windows made of ceramic material different from that used for these experiments. The resonant wavelength is affected by a change in dielectric constant of the ceramic and to a lesser extent, by a change in thickness of the plate.

Example 2—A sandwich-type ceramic window is to be designed for use in a magnetron-output waveguide having dimensions 0.900 × 0.400 inch (2.286 × 1.016 cm). The ceramic plate is 40 mils thick and has a dielectric constant of 6. The window frames are made of 5-mil, No. 52 alloy (52 percent nickel and 48 percent iron). The required size of the frame opening for a resonant frequency of 8,900 mc (3.369 cm) can be determined by substitution in Eq. 9 or by the nomograph given in Fig. 6.

If maximum power-handling capability is to be obtained, the height of the frame opening should be as large as the manufacturing process permits. A suitable value for b' is 0.250 inch (0.635 cm).

In using Fig. 6, a straight line is drawn from the point 0.635 on the left-hand b' scale through the point 3.369 on the λ scale to intersect the center scale. The point of intersection on the center scale is then joined with the point 0.635 on the right-hand b' scale by a second straight line which intersects the a' scale at the correct value of 1.26 cm.

The author wishes to express appreciation to B. B. Brown for valuable guidance during this development, to H. K. Jenny who initiated the program and contributed much at its inception and to K. Kovach for constant help and advice during the course of the work.

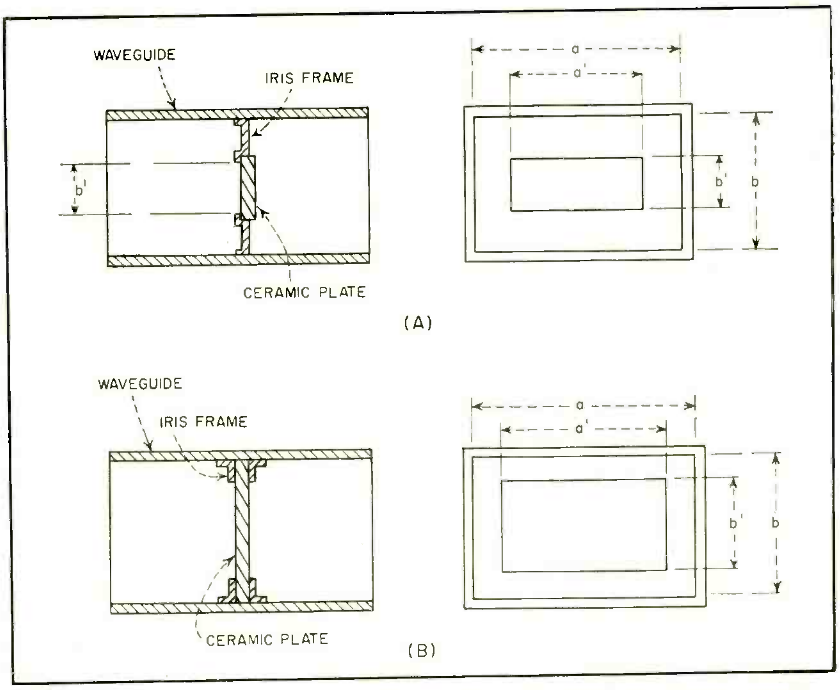

FIG. 5—Ceramic output windows with ceramic plate fitted into single metallic frame—single-frame type (A) and between two metallic frames—sandwich type (B)

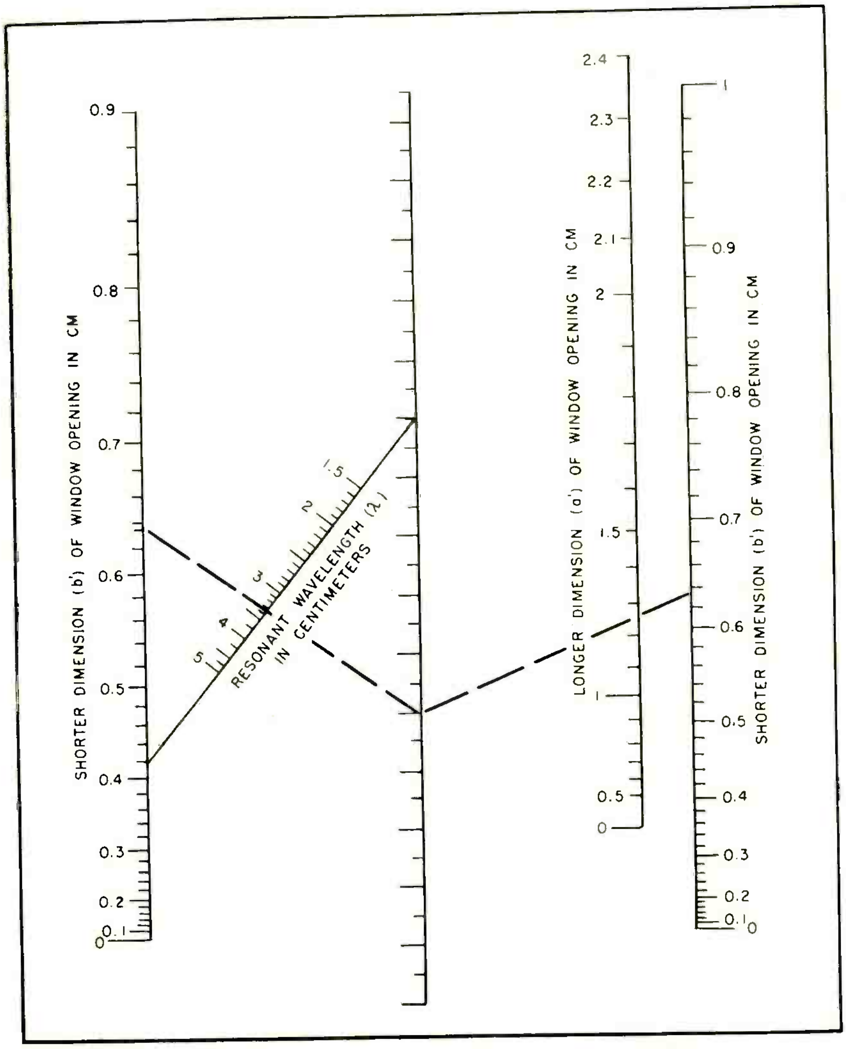

FIG. 6—Nomograph for determining resonant wavelength of sandwich-type ceramic output windows for a waveguide 0.900 × 0.400 inch with $\epsilon_r = 6$

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Arc-Lamp Tachistoscope Improves Reading Speed

Printed cards in light-tight box are illuminated for predetermined fraction of second by concentrated-arc tube controlled by pulse from univibrator circuit, for improving perception of vision by training eye to read more characters in less time

By WILLIAM J. SPAVEN

Fada Radio & Electric Co., Inc. Belleville, N. J.

MOST PEOPLE read at only 20 percent of their capacity, but it is possible to improve reading skill by suitable training. Following the completion of a speed-reading course, a group of fifty executives had improved their reading speed from an average of 275 to an average of 420 words per minute and, equally important, comprehension increased 85 percent.

The key to speedier reading lies in increasing perception—how much can be seen at one glance. Everyone reads across a line in steps, a good reader taking fewer steps than a poor reader. The eyes are not focused when they are in motion; if fewer steps are needed to read a line, reading speed will increase.

Tachistoscope Training Aid

The tachistoscope is a training aid used to improve the reading speed and comprehension of a reader. Figure 1A is a diagram of the basic tachistoscope. Essentially this device consists of a card having several digits or letters printed upon it, a means of illuminating the card for a predetermined short period of time, a means of controlling the duration of the illumination period from 0.01 to 0.10 second and a light-tight box to reduce the effect of ambient room light.

The observer is able to see the card only during the illumination period. Starting with an illumination period of 0.1 second and a card having four digits, the observer views the card and records the digits viewed. A second card, with a different combination of four digits, is inserted in the machine, and the digits are again recorded. Several cards are viewed and then the recorded digits are compared with the actual digits on the cards for accuracy. When a desirable accuracy is attained, the illumination period is reduced and cards containing more digits are employed. It is possible for an observer with 15 hours of training to see and remember as many as 8 digits or 23 letters viewed during a 0.01 second interval.

In a mechanical type of tachistoscope, an incandescent lamp serves as the light source and a spring-loaded shutter as the timing device. The shutter is necessary because of the inherently high thermal mass in this type of lamp.

A lamp that has a short response time and can be turned on and off electrically makes possible the elimination of the shutter mechanism. The enclosed high-intensity concentrated-arc lamp meets this requirement. It consists of two electrodes, an anode and a specially prepared cathode, sealed into a glass envelope filled with argon gas. The light-emitting surface may be as small as 0.003 inch in diameter and have a brightness of up to 65,000 candles per square inch. Of the sixteen different types of lamps available, the type K-2 2-watt lamp was selected for its short response time, low power supply requirements, small physical size and low price.

Arc Lamp Power Supply

The concentrated-arc lamp used operates from a direct current supply of 200 volts or more and requires a pulse of 1,000 volts to start the arc. Figure 1B is a simple schematic diagram of the circuit required to start and operate the lamp.

Initially, the arc lamp in nonconducting, and a current is flowing through the coil, resistor and normally closed switch. The magnitude of the current is limited by the resistor. To operate the lamp, the momentary-contact switch is opened, causing a voltage pulse to be developed across the inductance. By selecting the proper value of inductance, it is possible to develop a voltage pulse in excess of the 1,000 volts as required to start the arc. Once the arc is started, a normal current flows through the lamp.

The lamp is extinguished by permitting the momentary-contact switch to close, shorting the lamp. Thus the illumination period duration can be controlled by the length of time the switch is held open.

Electronic Switch

Unfortunately, it is not possible to control the switch manually so it will remain open for the short

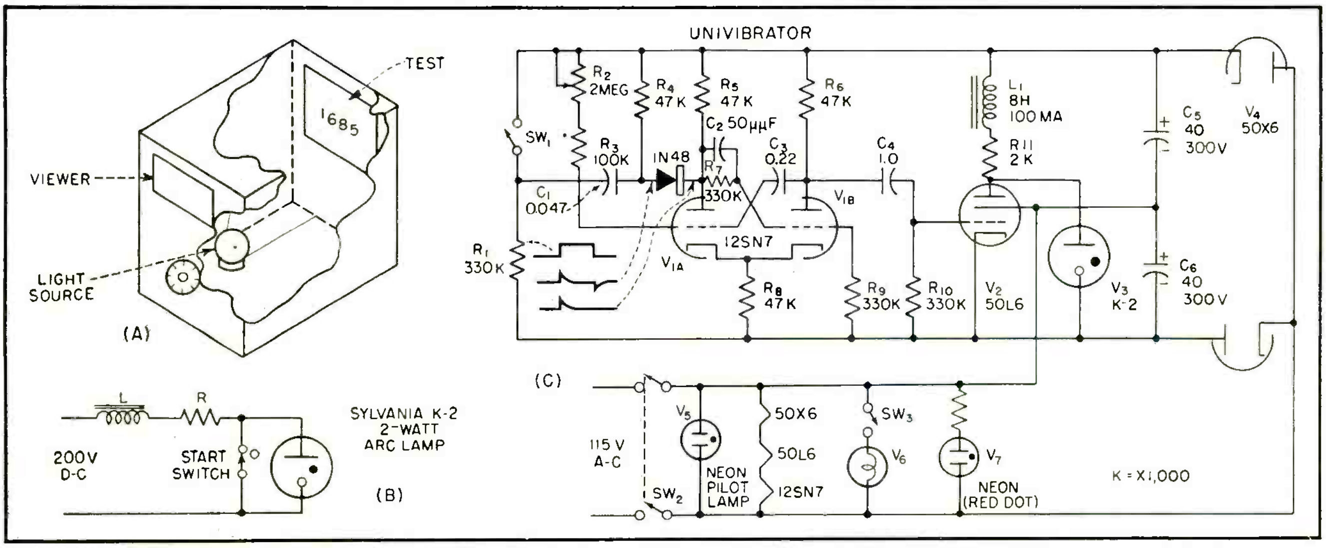


FIG. 1—Example of tachistoscope construction, simplified diagram of arc-lamp control system and complete control circuit

periods of time required; however, it is possible to utilize an electron tube as the switch. By placing a heavily conducting tube in parallel with the arc lamp, it is possible to maintain a relatively low voltage across the arc lamp, preventing the lamp from conducting. The application of a negative-going pulse to the grid of the switch tube causes the tube to be nonconducting, analogous to the open position of the manually-operated switch. The duration of the negative-going pulse can be accurately controlled by developing the pulse electronically.

Circuit Design

The complete circuit consists of a means of developing a trigger pulse, a univibrator circuit, a switching tube and an arc lamp, as shown in Fig. 1C.

A trigger pulse of indeterminate duration is developed by closing and releasing momentary-contact switch SW_1. This causes a positive-going square-wave pulse to be developed across resistor R_1. The pulse is differentiated in the R-C circuit made up of R_4 and C_1. To insure the generation of only one pulse for each operation of the momentary-contact switch, a type 1N48 germanium diode is employed, causing only the positive-going spike of the waveform to appear as the trigger pulse for the univibrator.

The univibrator circuit consists of two triode sections (V_1), two plate load resistors (R_5 and R_6), a common cathode resistor R_8 to provide bias voltage, a direct-coupled positive feedback circuit (R_7 and R_9) that causes V_{1B} to be nonconducting and a capacitor-coupled positive feedback path that establishes the duration of the pulse (R_2, R_3 and C_3).

Initially V_{1A} is conducting heavily since the grid leak resistors return to a high positive potential. The d-c voltage measured at the plate of V_{1A} is relatively low. Because of the voltage divider action of resistors R_7 and R_9, the grid voltage of V_{1B} is such that it is nonconducting. The circuit is stable.

When a positive-going trigger pulse is applied at the plate of V_{1A}, V_{1B} is made to conduct by virtue of the positive feedback loops. The circuit then becomes regenerative and is quickly transferred to a second state, which is temporarily stable. In this state the voltage at the plate of V_{1B} drops. The grid of V_{1A} is driven beyond cutoff. The sloping waveform at the grid of V_{1A} is part of an exponential curve having a time constant $T = (R_2 + R_3) C_3$. When the voltage reaches a point where the grid-to-cathode voltage is equal to the cutoff voltage, V_{1A} starts conducting and the univibrator rapidly returns to the first stable state.

The circuit remains in this state until the trigger pulse is applied again. The duration of the output pulse is controlled by varying potentiometer R_2. It is possible to vary the pulse duration from 0.01 to 0.10 second.

The negative-going waveform is coupled to the grid of V_2, which is normally conducting heavily. When the negative-going pulse is applied, V_2 is cut off, causing a high voltage to be developed across L_1 which ignites arc lamp V_3.

The arc lamp conducts for the duration of the pulse. When the pulse is removed, V_2 conducts again and the plate voltage is reduced so that the arc cannot be maintained by the circuit.

The circuit consisting of V_4 and capacitors C_5 and C_6 comprises a full-wave voltage-doubler d-c power supply.

Neon lamp V_7 is included to aid the operator in focusing his eyes to the point where the letters appear on the test card.

A second lamp, V_6, is operated by switch SW_2 and permits comparing the correct digits from the test card with the digits recorded during the short-duration illumination period.

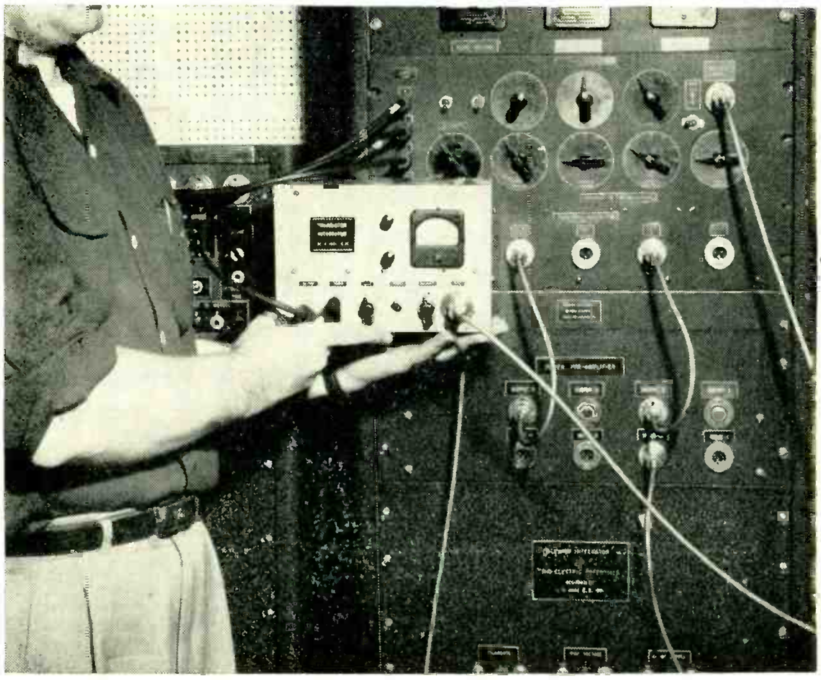
Conclusions

It is conceivable that the electronic circuit could be included as a modification to the existing tachistoscope training device (made by Stereo-Optical Co., Chicago) by replacing the mechanical shutter. It is believed that the all-electronic tachistoscope presents a reliable equipment that offers the advantage of ease of operation.

Acknowledgement is made to Dr. Harold Wiener for his kind assistance and advice.

Bioelectric Integrator

By **ADELBERT FORD**
Department of Psychology
Lehigh University
Bethlehem, Pa.



Compact transistor integrator (left) replaces bulky electron-tube unit mounted in rack at right

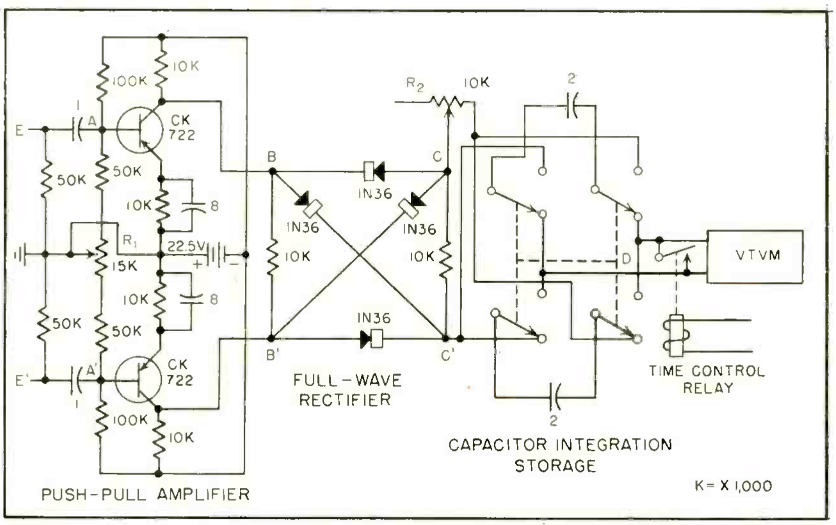


FIG. 1—Bioelectric integrator includes push-pull voltage amplifier using two pnp junction transistors with base input

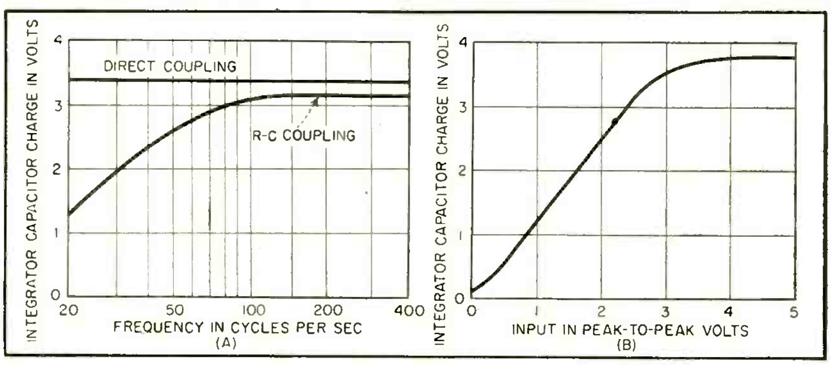


FIG. 2—Characteristics of direct and R-C coupling to transistor amplifier (A) and integrator capacitor charging characteristic (B)

Electronic integration of bioelectric potentials[1] has lead to the discovery of new facts concerning human work, strain and effort. Recent work has disclosed evidence relating severe mental effort to the bioelectric output of the heart and the frontal lobes of the brain.[2,3] Current investigations are expected to show extensive ramifications of muscular potentials with pure mental work.

Meanwhile, use of transistors for voltage amplification[4] has provided considerable simplification of the electronic equipment employed. Electronic integration involves summing the area under an irregular curve representing the energy output from a particular spot of live human tissue. This is done by measuring the charge stored on a capacitor.

The equipment used comprises a balanced voltage amplifier, full-wave rectifier and storage capacitors with their associated switching circuits. Figure 1 shows the final design of the transistor bioelectric integrator.

The equipment employs a balanced three-wire input so that it will work with bioelectric instruments such as the electroencephalograph (eeg), electromyograph (emg) and electrocardiograph (ecg). The integrator works directly from a Grass P-4 battery-powered preamplifier with a gain setting of 20,000 and an output impedance of 6,000 ohms. Coupling values are chosen to favor low frequencies.

Circuit Design

Use of transistors in a three-wire system was successful only because

Uses Two Transistors

Effects of human strain and effort are measured by bioelectric integrator that employs two *pnp* junction transistors in a push-pull voltage amplifier. Performance is comparable to electron-tube unit but size is much reduced and circuit simplified

of luck in matching. Four CK-722 *pnp* junction transistors were tested to find two that would match. Out of six possible combinations only one pair exhibited amplification characteristics different by only seven percent.

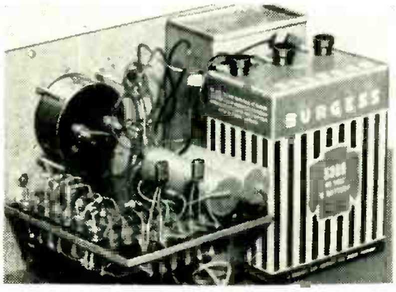
Critical test points in Fig. 1 are labeled *E-E′*, *A-A′*, *B-B′* and *C-C′*. Matching is done by measuring peak-to-peak voltage from points *B* and *B′* to ground with all resistors at matched values. The match is considered usable if there is less than a ten-percent mismatch.

Balance is achieved by potentiometer R_1 that alters the ratios of resistance values for each transistor bringing the better one down to the level of the poorer one. A d-c vtvm is placed across *A-A′* and a 20-cps signal admitted at *E-E′*. The input should be such as to produce about 0.5-volt peak to peak from *A* and *A′* to ground. If the system is out of balance there will be a d-c bias across *A-A′*. Adjusting R_1 should remove this bias and result in zero d-c voltage. A similar test can be made by connecting the vtvm across *B-B′*. Again adjustment of R_1 will remove the d-c potential.

When a good balance is achieved, the reading of the voltmeter across *B-B′* at its most sensitive setting shows a tendency to wobble back and forth across zero. This is the result of inherent instability of the transistor system and will be integrated as a small error of unbalance. This undesired output has been reduced to 0.03 volt with a total signal of 3.0 volts. It was fairly constant on successive samples and is simply subtracted from each of the research integrations. Balance and instability are measured before and after each research session.

Frequency Characteristics

Figure 2A shows the integration capacitor charge after constant time periods of 7.5 seconds when the input is direct coupled to the bases of the pair of transistors and when the R-C coupling shown in Fig. 1 is used.



Integrator permits quick change of resistors to match transistor characteristics

The direct-coupled input is constant for all usable frequencies and would be highly desirable if the input were not really the output of a cascade of preamplifiers and almost certain to have a d-c bias superimposed on the a-c waveform. Theoretically, push-pull amplifiers are balanced, but actually this is not always true. The R-C coupling is a protection against heavy integrations of d-c bias errors.

Possibly use of a Barber-Coleman micropositioner on the output of the preamplifiers can correct the balance against gradual shifts that throw unexpected d-c bias on the a-c waveforms but this will require more research in automatic controls.

Figure 2B shows the integrator capacitor charges plotted against input voltages for a constant frequency after a constant time interval of 7.5 seconds. The integrator capacitor charge is never quite zero for zero input. This is due to a small instability of the transistors and slight failures to achieve a perfect balance. The region is small, however, and electron-tube integrators usually have shown a similar defect.

There is, however, an upper limit to the allowable voltage in the integrator capacitors—3.5 volts. For this reason R_2 is inserted between the rectifying network and the capacitor integration storage. Whenever the voltmeter approaches current 3.5 volts, resistance is added to reduce the charging.

Comparisons

The electron-tube system used previously was generally operated with 285 volts on the amplifier plate and used 50μf storage capacitors. It was permissible to allow voltages in the storage capacitors to rise as high as 35 volts before encountering serious nonlinearity.

With the transistor model using battery power at 22.5 volts, it is possible to allow a maximum voltage in the 2-μf storage capacitors of only 3.5 volts before nonlinearity becomes a serious error.

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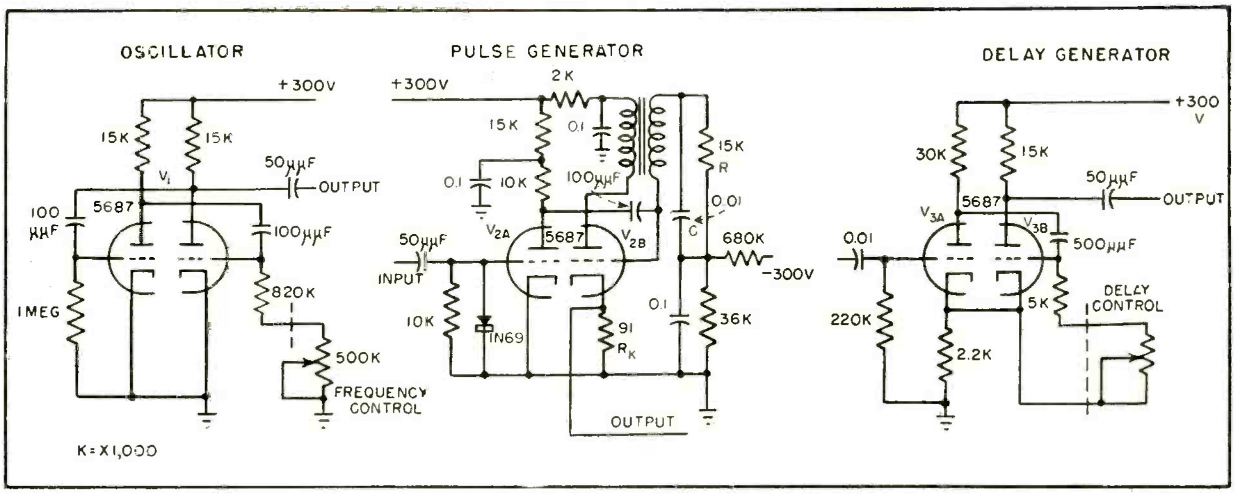
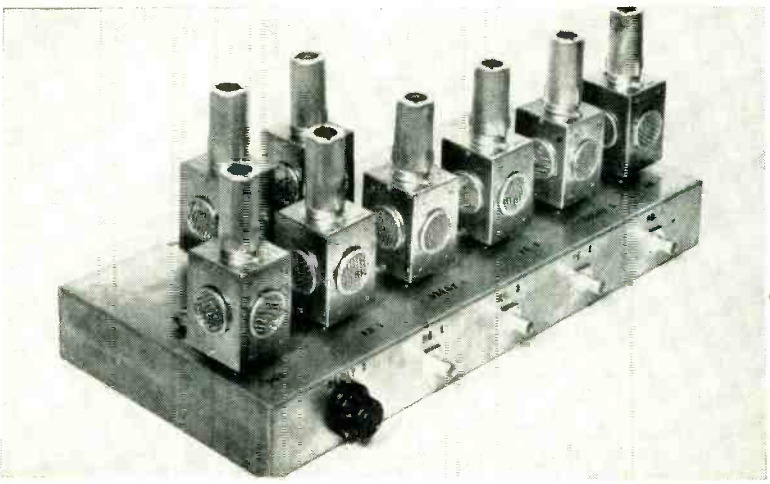


FIG. 1—Oscillator, pulse generator and delay generator circuits have power supply, input and output leads connected to pins of plug-in socket. Frequency and delay-time control potentiometers are mounted on main chassis

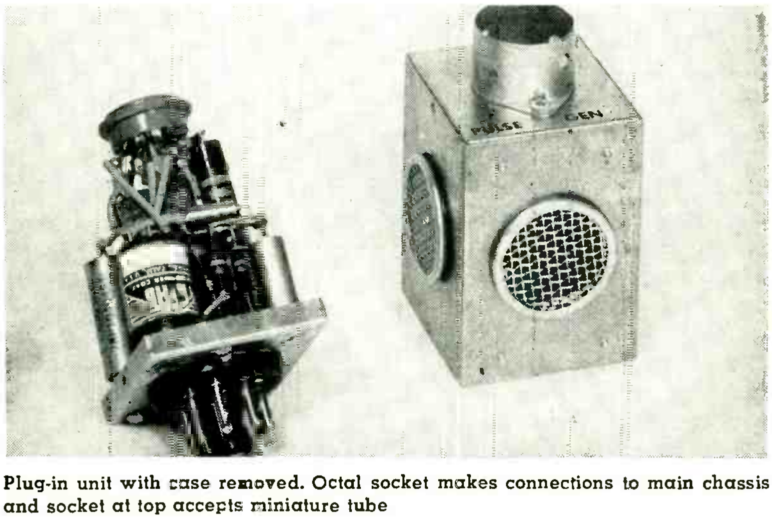
Multipulse Generator



Multipulse generator using eight plug-in units. Controls for all units are brought out to main chassis

By A. J. STRASSMAN

Research and Development Laboratories
Hughes Aircraft Co.
Culver City, Calif.



Plug-in unit with case removed. Octal socket makes connections to main chassis and socket at top accepts miniature tube

Using only two different circuits, a pulse-generating system has been designed that will provide three independently variable pulses. These pulses can be used for range-tracking tests, gating, counting and as crt markers.

The pulses are generated by low-impedance sources—making it possible to cascade generating units to obtain a wider variety of output pulses. Another advantage of this circuit is that it is adaptable to remote operation.

The usual method utilizes three complete synchronized pulse generators. In the method described here, a free-running, symmetrical multivibrator is used as a source of variable frequency. Each pulse-generator circuit and each delay circuit is identical. The circuits are

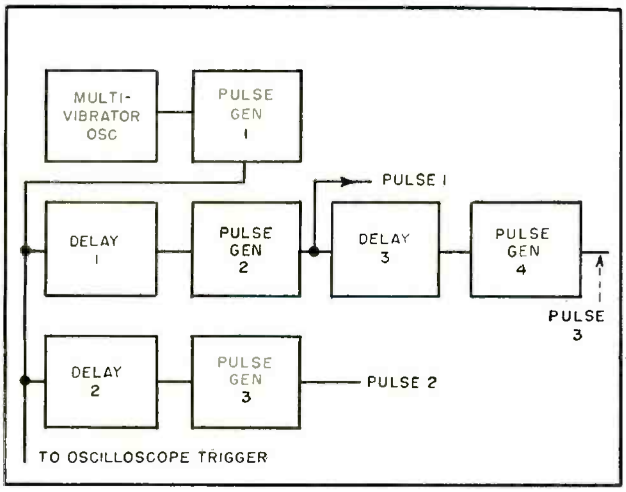


FIG. 2—Block diagram of typical delay-generator system made up of plug-in units described in text

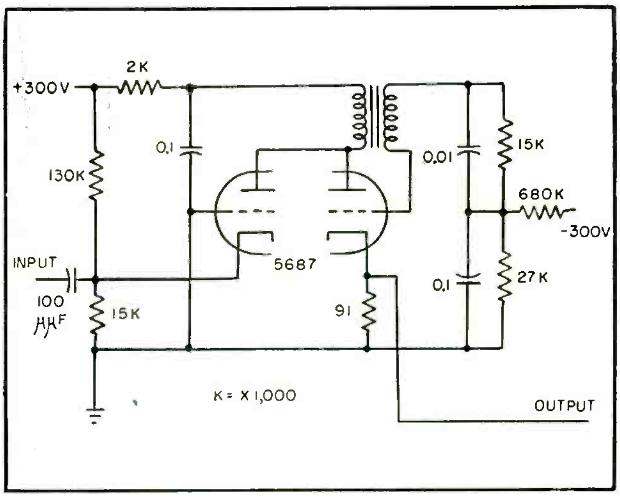


FIG. 3—Alternate plug-in pulse-generator circuit can be used when low power consumption is important

Has Variable Delay

Interchangeable plug-in units of multipulse generator provide three independently variable pulses. Pulse width can be varied with delay times up to 100 microseconds between pulses. Applications include radar tracking tests, gating and counting systems and crt marker generation

shown in Fig. 1. Plug-in type construction permits rapid interchangeability of complete circuits. This approach makes it possible to obtain a number of time-delay pulse-width combinations. Figure 2 is a block diagram of one possible combination.

Pulses at the output of each pulse generator are of fixed amplitude and width and are established by selecting proper values for C, R, and R_K in the pulse generator circuit.

If a pulse of variable width be needed, it can be obtained from the output of any one of the delay circuits.

Unit Construction

Each unit is housed in a $1\frac{3}{4} \times 1\frac{3}{4} \times 2\frac{7}{16}$ inch metal case. An octal plug on the base is used to connect the unit to the main chassis. Parts are mounted circumferentially about a rod extending the full height of the case. A noval tube socket on the upper end of the rod accepts the tube.

Circuit Operation

Operating requirements for each pulse generator are identical. The input must be a minimum of 20 volts negative. The circuit is designed to accept the output of any one of the delay-generator units. The output of each unit is a positive pulse of approximately 70 volts amplitude and 0.5 μsec wide.

Each delay generator requires a minimum of 30-volts positive input, and will accept the output of any pulse-generator unit. The output of the delay generator is a variable-width pulse with an amplitude of approximately 100 volts.

Repetition rate is determined by the frequency of the free-running multivibrator shown in Fig. 1. Frequency is controlled by a potentiometer in the grid circuit. The range can be further extended by selection of different coupling capacitors.

Zero Time Pulse

The output of the multivibrator is differentiated and fed to the grid of a trigger tube in the pulse generator. The positive peak of the differentiated pulse is clipped by a germanium diode and the negative pulse is amplified by V_{2A} and inverted to provide a positive pulse for triggering a blocking oscillator, V_{2B}.

The output of the blocking oscillator is taken from the 91-ohm cathode resistor and is used to trigger the oscilloscope and two separate variable delays. This is the zero-time reference pulse.

The delay circuit is a cathode-coupled multivibrator. The input is a positive pulse from the previous pulse generator to the grid of V_{3A}, which is normally cut off. The output pulse is derived from the plate of V_{3B} which is normally on.

When a triggering pulse is received from the previous unit the output tube produces a positive-going voltage and remains off until the circuit returns to its original condition. This period is determined by the time constant of the coupling capacitor and grid resistor.

Delay Pulse

The delay is achieved by utilizing the trailing edge of the pulse to trigger the next pulse generator. When the output pulse is differentiated, this trailing edge produces a negative-going pulse that is applied to the grid of the next pulse-generator trigger tube at a time determined by the setting of the potentiometer in the grid circuit. Delay times up to 100 μsec can be obtained with the values shown. The output of the second pulse generator is applied to another identical delay unit and this is used to produce a third pulse delayed from zero time by the sum of the two delays.

The second pulse can be varied independently about either pulse, the lower limit being the time of the original pulse. By varying the parameters of the blocking-oscillator circuit, frequency division can be obtained to provide for more than one repetition-rate frequency.

The natural recurrence period of a biased blocking oscillator is $T = t + RC \ln \frac{E_c + E}{E_c - E_o}$, where T is the period, t the length of conducting period, E_c the bias voltage, E_o the cutoff voltage and E the supply voltage.

Alternate Pulse Generator

To decrease power consumption, an alternate triggering circuit, shown in Fig. 3, can be employed with the blocking oscillator.

In this circuit the trigger tube is normally cut off by fixed cathode bias. The negative pulse developed by the trailing edge of the delay-multivibrator pulse applied to the cathode of the first section causes this tube to conduct.

The tube acts as a grounded-grid amplifier and the output pulse is of the same polarity as the input. Parallel triggering is used with the pulse transformer to produce a positive triggering pulse on the grid of the blocking-oscillator section.

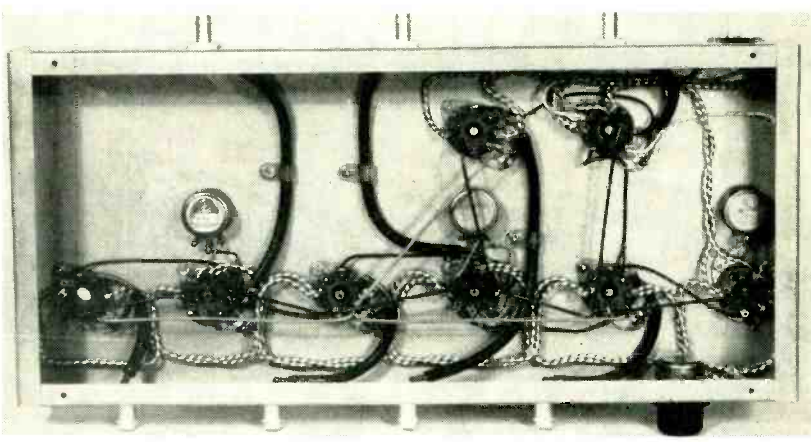
This isolates the oscillator from its trigger source. Because of the low impedence of the cathode circuit of the trigger tube when it conducts, it is helpful to keep the source of the delay pulse as low as possible.

Power Requirements

A well-regulated supply for both positive and negative voltages is recommended. Both supplies can be 300 volts. Current requirements are 14 ma for the delay generator and 12 ma for the pulse generator. Filament current for the 5687, the only tube type used, is 0.9 ampere.

The oscilloscope waveforms shown in the picture are obtained from the unit described. The photograph of the main chassis shows the simplicity of wiring obtained by use of packaged units.

Acknowledgement is made to Jerome Steinberg who performed the construction work and aided in testing the completed unit.



Wiring of main chassis is simplified by plug-in construction. Potentiometers control delay time

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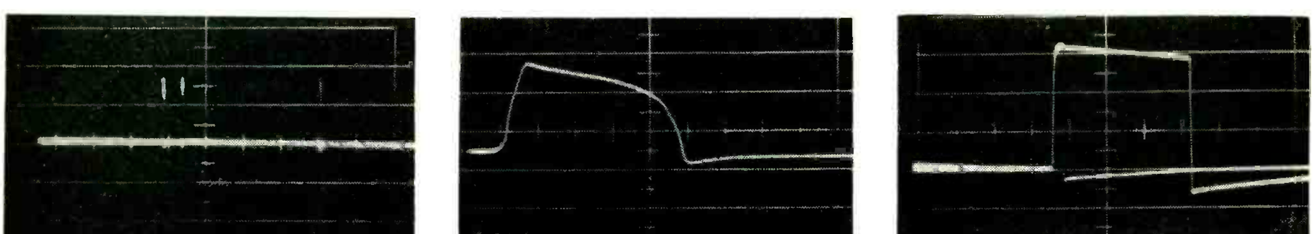


Output waveform of multipulse generator, left, with maximum delay time. Oscilloscope sweep speed was 20 microseconds per cm. Trace of pulse-generator output, center, was made with 0.1 microsecond-per-cm sweep. Output of delay generator, right, shows maximum and minimum pulse widths obtainable. Sweep speed in this oscillogram was 20 microseconds per cm

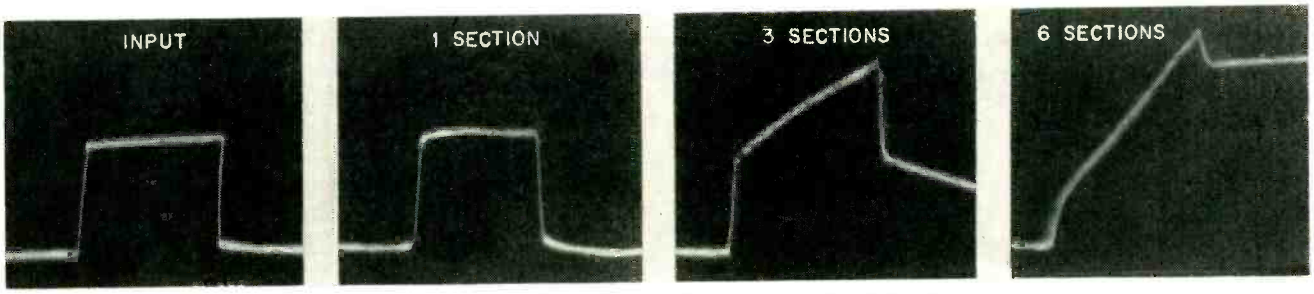


FIG. 1—Distortion of pulse shape after passing through various sections of cascaded delay line

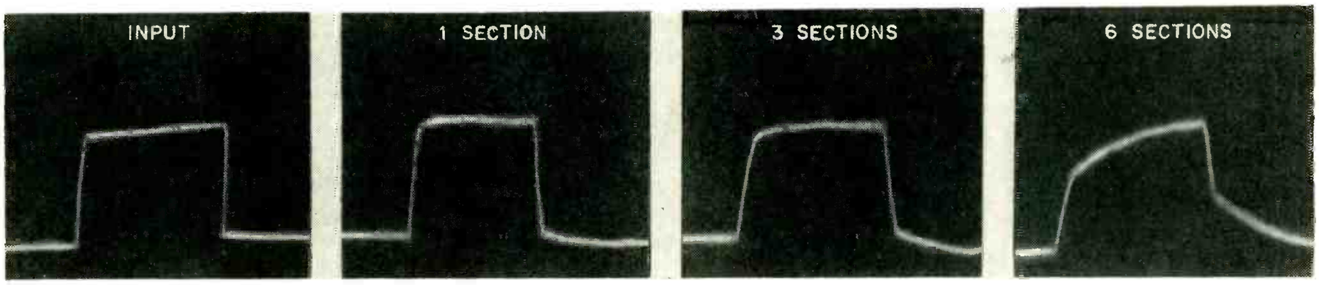


FIG. 2—Pulse distortion is reduced by inserting parallel resistance between delay line sections

Transistor Amplifiers Reduce Delay Line Attenuation

Attenuation of nine-section 70-μsec delay line is reduced from 110 db to 0 db by transistor amplifiers. Pulse distortion through cascaded distributed-constant delay sections is minimized by parallel resistors between sections

By ALLEN H. SCHOOLEY
*Naval Research Laboratory
Washington, D. C.*

DELAY and storage devices are employed in pulsed radar, electronic computers and other equipment requiring control and measurement of the time interval between series of pulses.

Video delay lines are useful for delays up to a few microseconds. For greater delays it is difficult to design lines that have small dispersion and low loss. If a line is made too long attenuation ultimately reduces the signal below the noise level. Repeater amplifiers can be used at intervals along the line to keep the signal appreciably above the noise level.

Distributed-parameter delay lines are usually practicable for impedances ranging from about 200 ohms to 3,000 ohms[1]. This range is suitable for application of transistor amplifiers. This article reports the results of an experimental study of the characteristics of a 70-μsec delay line composed of a series of nine commercially available delay sections.

Line Characteristics

The individual delay-line sections are distributed-constant lines hermetically sealed in metal containers. These sections have a characteristic impedance of 1,000 ohms, time delay of 7.8 μsec and band-pass of 0 to 2 mc. A comparison is made of the performance of the line with no amplifiers and the performance of the same line with uniformly spaced simple point-contact transistor amplifiers.

Figure 1 shows the output response to a rectangular 10-μsec pulse with the pulse generator connected directly to the matched termination and through 1, 3 and 6 delay sections. The slight displacement of the top of the pulse at far right in Fig. 1 indicates some vertical signal feeding into the horizontal sweep.

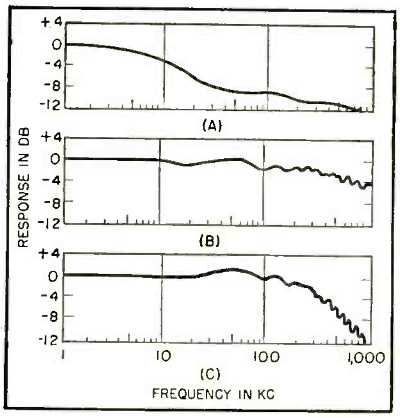


FIG. 3—Frequency response curves for three sections of delay line (A), with parallel resistors inserted (B), and with transistor amplifiers added (C)

The buildup time plus decay time was measured to be less than 0.1 μsec by decreasing the input pulse width to the point where the pulse amplitude on the oscillograph was down 6 db and then reading the pulse width setting on the pulse generator. Thus, the buildup time and decay time are approximately one-half of this figure, or 0.05 μsec each. The pulse shape after passing through nine sections of the delay line was so distorted that it was impossible to show it adequately without changing the scale of the pictures.

Distortion

After passing through three or more sections of line the waveform shows a buildup in amplitude during the time represented by the top of the pulse. This type of integration distortion is characteristic of a filter that has a relatively large low-frequency response with a lesser response at medium and high frequencies. This distortion limits the usefulness of the cascaded delay line for many applications.

It is possible to minimize this difficulty by inserting a parallel resistor of proper value between each section of the line. A suitable resistor value was determined experimentally by connecting the pulse generator through four sections of the delay line and observing the pulse shape across the input to the oscilloscope as the resistances of four ganged rheostats were varied. The resistance value that gave the best delayed reproduction of the input pulse was approximately 1,000 ohms.

Figure 2 shows the pulse shape with parallel 1,000 ohm resistors after passing through 0, 1, 3 and 6 filter sections. Comparison of the shape of the pulses in Fig. 2 with those in Fig. 1 indicates that frequency response has been improved by the addition of resistance across the line at each section.

This agrees with the experimental frequency-response curves shown in Fig. 3. The frequency-response curves were measured using three sections of the delay line. Experimental phase-versus-frequency characteristics were found to be straight and identical for the conditions being considered.

Insertion of parallel resistances across the line improves frequency response, however it also increases attenuation. The nine-section line at 20,000 cps has a total attenuation of about 60 db without parallel resistors and an attenuation of over 110 db if 1,000 ohm resistors are used. The latter attenuation figure was obtained by extrapolation because of gain and noise limitations of the experimental equipment.

The circuit of the nine-section delay line with transistor amplifiers inserted between each section is shown in Fig. 4. Type 1698 transistors were used because they have sufficient high-frequency response and were readily available.

No selection process or preferred placement of the transistors was used. The emitter and collector circuit resistances were optimized experimentally for class A operation by observing the shape of both positive and negative input pulses after passing through four sections of the transistorized line. Two four-gang rheostats were initially used for varying these resistances independently. Optimum values of emitter and collector supply voltages were found in a similar manner.

Figure 5 shows the output pulse shape when a 10 μsec positive input pulse had traveled through 1, 3, 6 and 9 delay sections connected as shown in Fig. 4. Similar oscillograms of negative input pulses showed output pulses having substantially similar shapes. Comparing these waveforms with Fig. 2, it can be seen that use of transistor amplifiers has caused deterioration of the high-frequency response.

When six sections of the filter were used the buildup-plus-decay time was found to be 0.8 μsec for the transistorized delay line as compared with 0.4 μsec for the non-transistorized line. The buildup-plus-decay time was found to be about 1.8 μsec for the transistor-

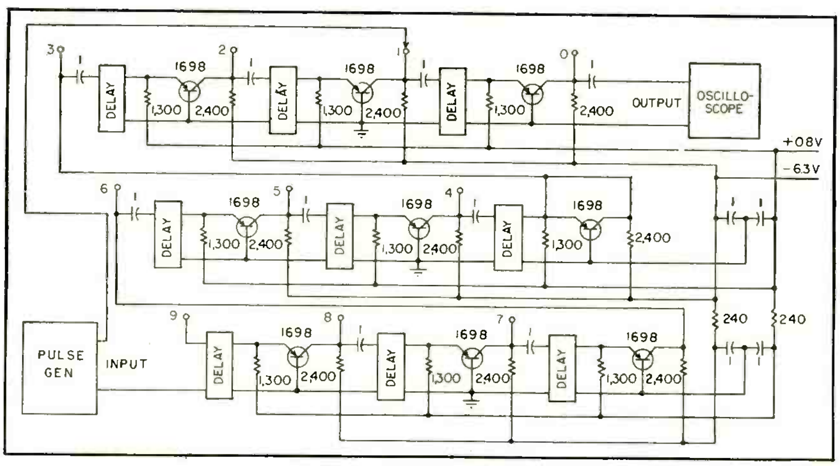
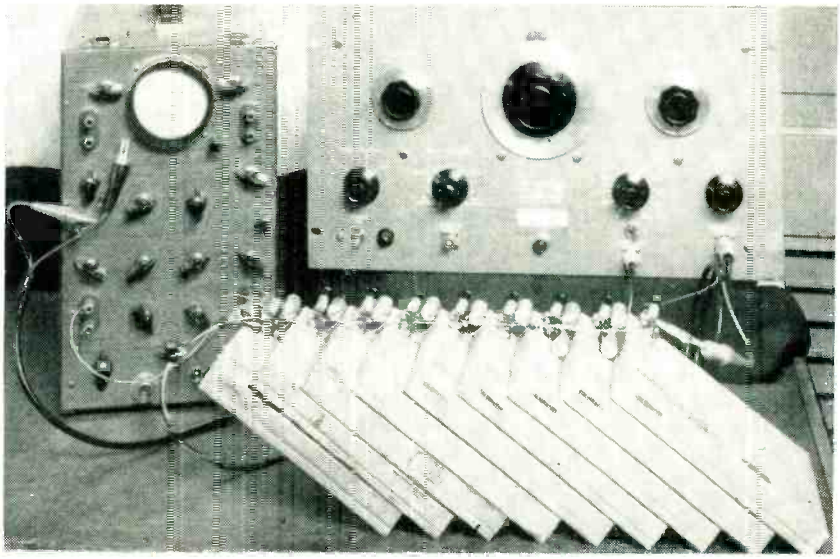


FIG. 4—Nine-section transistorized delay line using cascaded distributed-constant sections of 7.8-μsec delay each



Test setup of 70-μsec delay line with transistors and coupling capacitors mounted on top of delay-line sections

ized unit, or approximately 0.9 μsec for the individual sections.

The frequency-response characteristic of three sections of the transistorized line is shown in Fig. 3C. The phase response is linear over the frequency range of 100 cps to 1 mc.

The top of the pulse in Fig. 5 shows irregularity that is not evident in Fig. 2. This may be caused by spurious pickup in the oscilloscope amplifiers from the pulse generator since Fig. 5 was photographed at a lower signal level than was Fig. 2.

There is also evidence of a small response delayed by about twice the delay time of a single section indicating that the transistor amplifiers do not match the delay line. A confirmation of this was obtained by measuring the input and output impedances of each of the nine transistor amplifiers. Average input impedance was 120 ohms with a maximum of 245 and a minimum of 60 ohms. Average output impedance was 1,400 ohms with a maximum of 1,770 and a minimum of 635 ohms. The wide spread of impedance value is due to the nonuniformity of the operating characteristics of the transistors under the operating conditions employed.

These measurements indicate that the output of each delay-line section is terminated with approximately 120 ohms and the input of the next section represents about 1,400 ohms. The pulse is less distorted, except for buildup and decay time, after going through 6 sections of the transistorized line than after traversing 6 sections of the line without transistor amplifiers.

Overall attenuation of the nine-section line has been reduced to zero by the transistor amplifiers. The actual voltage gain of each amplifier averaged about 21 db indicating that the nine-section line had about 190 db loss with the transistor amplifiers in place. A considerable part of this attenuation is due to the low input impedance of the amplifiers.

Power Consumption

An emitter supply of 0.8 volt and a collector supply of 6.3 volts was used. Total current drawn from the emitter supply was 3.6 ma and the current drawn from the collector supply was 12.4 ma. Thus the total power taken from both supplies was about 0.08 watt.

The gain versus number-of-sections curve can be made to slope up or down by changing the supply voltages. The gain at the ninth section will increase about 1.7 db per one-tenth volt decrease in emitter supply voltage, and increase about 0.9 db per one-tenth volt increase in collector supply voltage.

In cases where it is desirable to keep amplitude distortion to a minimum it is desirable to keep the attenuation along the line substantially zero. If the gain is greatly different from this, there will be overloading of the first or last transistor amplifier stages, depending on whether the gain increases or decreases along the line. Where the overall attenuation is zero, a 20-kc sinusoidal signal will start to show some amplitude distortion when the input amplitude is over one volt peak-to-peak.

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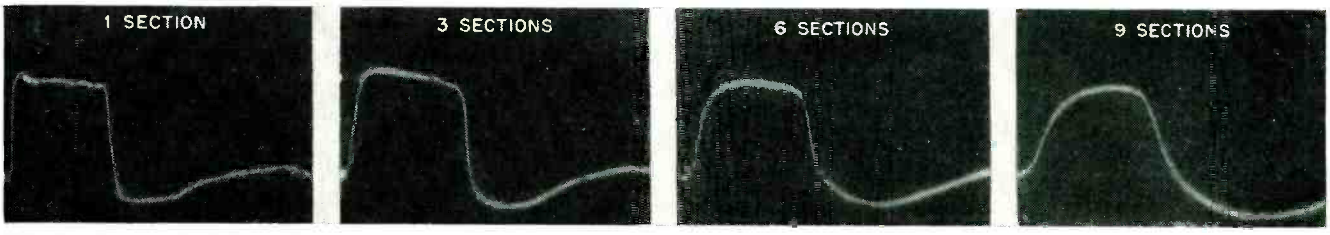

FIG. 5—Transistorized delay line output pulse shape after passing through 1, 3, 6 and 9 sections

Signal-Operated

By ED C. MILLER

Chief Engineer and Technical Director
Radio Station WKEI
Weiser, Idaho

TONE-COMPENSATION controls which vary bass response and volume usually do not adequately compensate for the reduced response of the ear to high frequencies. A separate tone control is usually required.

The circuit to be described boosts high and low frequencies simultaneously without affecting apparent volume; the amount of boost varies automatically with the input level.

Circuit Description

The basic bass and treble boost circuits of Fig. 1A and 1B respectively can be combined to obtain the combination boost circuit Fig. 1C. In this circuit, R_1, R_2 and R_3 form a T-pad, with R_1 as the variable. Replacing R_1 in Fig. 1C with the plate resistance of a triode, as in Fig. 1D, will allow automatic tone compression—increasing high and low-frequency response as volume diminishes. The circuit will however introduce sufficient loss to require another triode stage of amplification.

In Fig. 1C, when the resistance of R_1 is a maximum, the high and low boosts will also be maximum. It is not necessary to reduce R_1 to zero to obtain a nearly flat response. The range of R_1 can vary from slightly less than 1,000 ohms to approximately 50,000 ohms to give a 6 db boost at 100 and 10,000 cycles with a 1,000-cycle reference.

Figure 2 shows an arrangement which will cause the 1,000-cycle output to be slightly greater than the input. The amount of bass and treble boost is inversely proportional to the input signal level.

Design Considerations

In designing the boost networks, it is necessary to think of them removed from the final circuit and plan them around Fig. 1C.

The effective input impedance of the low-frequency portion is controlled primarily by R_4 and should be relatively constant. This requires that R_4 be at least ten times the total series impedance of R_5, R_6 and C_1. Capacitor C_2 should have a very high impedance at frequencies below 1,000 cycles. The total impedance of the circuit at 1,000 cycles is used to determine the source impedance.

Component values can be determined accurately by disregarding the combined impedance and phase and working only from the reactance of the capacitors at specific frequencies. The bass and treble boost sections can be designed separately as long as a terminal is provided where the degree of boost can be controlled with a single variable resistance. However, they can be designed more simply by using the formulas $R_4 = 2.5\ Z_i$, $R_5 + R_6 = R_s = 0.03\ Z_i$, $R_6 = R_5/2$, $R_2 = 2R_3$, $C_1 = 1/4{,}140\ R_4$ and $C_2 = 1/75\ R_4$ where Z_i is input impedance, resistance is in ohms and capacitance in microfarads.

Considerable deviation from design values will not adversely affect

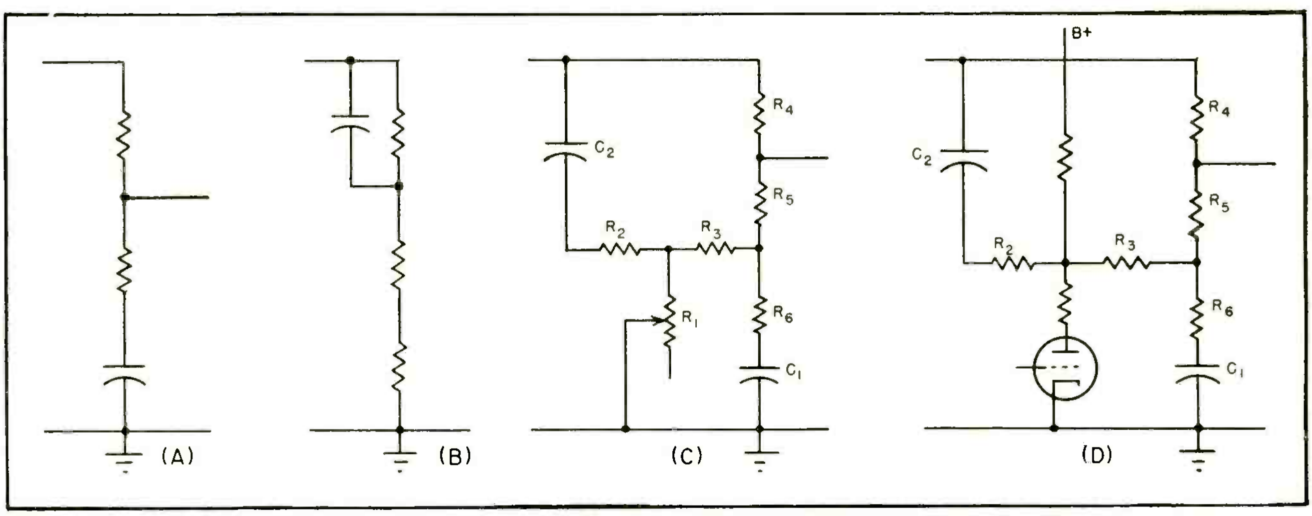

FIG. 1—Low-frequency (A) and high-frequency (B) boost circuits are combined to obtain combination boost circuit (C). Basic tone-compensation control (D) uses triode plate resistance as arm of T-pad

Tone Compensation

Triode operates as variable element of T-pad which automatically varies frequency response of audio amplifier to compensate for frequency characteristics of human ear. Circuit boosts high and low frequencies up to 6 db

operation, making it possible to use the nearest standard value for each component. The formulas above will provide an attenuation characteristic closely following that shown in Fig. 3. When greater boost at the frequency extremes is desired, two or more circuits may be connected in cascade, with intervening amplifiers, or the bass and treble may be controlled separately and phased to approach cancellation at 1,000 cycles at maximum boost. The latter method is preferable when more than 12 or 15 db boost at either or both ends of the frequency passband is desired.

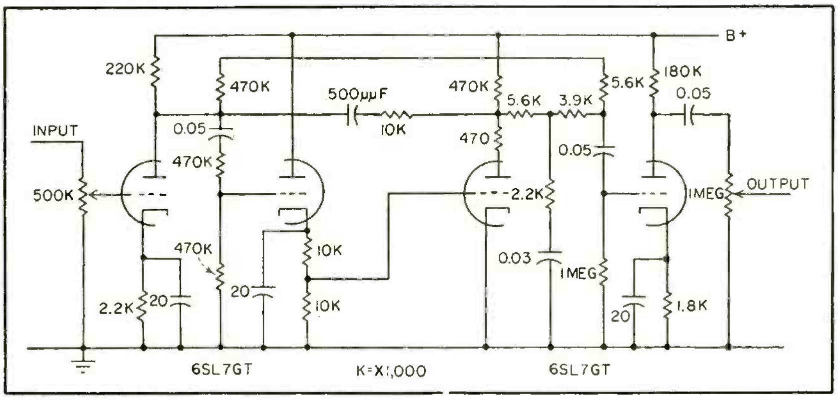

FIG. 2—Audio-frequency voltage amplifier incorporating tone-compensation control

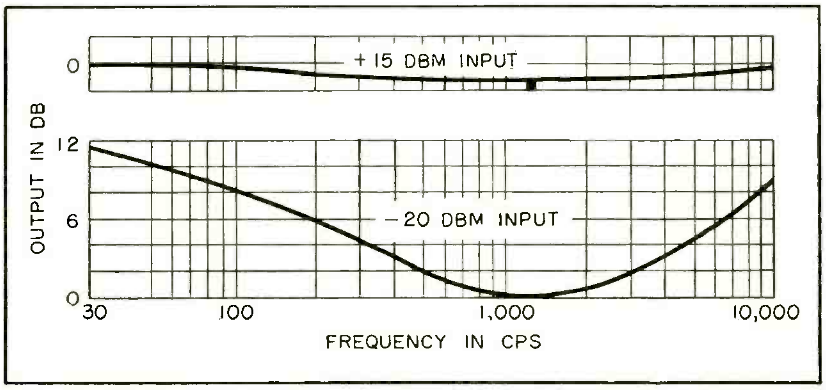

FIG. 3—Response of amplifier to different input signal levels

Adjustment

The output potentiometer in Fig. 2 is adjusted for full room volume with the input potentiometer set at maximum. Thereafter, only the input potentiometer should be used to adjust program level. With this setting, only when volume drops, or is adjusted to the point where the average human ear does not adequately reproduce high and low frequencies, will tone compensation take effect. The amount of compensation is dependent upon the plate resistance of the control tube, which varies inversely with the input signal strength. There is no sudden change in response, but rather a gradual change reaching a maximum at the lowest audible level of sound. The input voltage present at the arm of the input potentiometer determines the response curve, therefore compensation will be introduced in equal amounts, whether to compensate for a low-level passage of recorded sound, or for turning down input control.

Construction

Any triode may be used for the control and rectifier portions of this circuit. The circuit of Fig. 2 uses two 6SL7GT tubes. Use of these tubes permits operation from the power supply of the associated amplifier, since their plate current drain is small. Only usual precautions need be observed in wiring. When the output impedance of the first stage is between 50,000 and 250,000 ohms, wiring capacitance will have insignificant effect on circuit operation.

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Cavity-Resonator

Physical dimensions and tuning range free from spurious mode interference can be determined for cavity resonators by use of mode charts. Design data for cavities of both square and circular cross section can be obtained graphically

By NED A. SPENCER

Wheeler Laboratories, Inc.
Great Neck, N. Y.

SEVERAL graphical presentations have been developed to display the resonant conditions of a cavity. These displays and mode charts relate the physical dimensions of the cavity to its resonant wavelength and modes of resonance. The mode charts described by I. G. Wilson, display resonance in each mode as a straight line on a rectangular graph.[1] Another presentation can be done on nomograms as described by R. N. Bracewell.[2] To extend the utility of straight-line charts the coordinates have been normalized to provide dimensionless quantities.

The types of cavities to be treated are simple right cylinders having a cross-sectional shape of either a square or a circle. Straight-line mode charts of the square cylinder have not been previously published. However, square cylinders are preferable to circular cylinders for some purposes. Both types of cylinders provide matched crossed modes, two identical uncoupled modes in the same volume with the same tuning characteristics.

Mode Charts

The typical resonant cavity is a section of hollow cylindrical waveguide short circuited at both ends and having a length equal to an integral number of half-wavelengths in the guide. The wavelength in the guide is related to the free-space wavelength by

$$\left(\frac{1}{\lambda}\right)^2 = \left(\frac{1}{\lambda_c}\right)^2 + \left(\frac{1}{\lambda_g}\right)^2 \quad (1)$$

where λ = free-space wavelength, λ_c = cutoff wavelength and λ_g = guide wavelength.

The free-space wavelength is the desired resonant wavelength of the cavity. Cutoff wavelength is that free-space wavelength above which the waveguide will not propagate energy. This wavelength is different for each mode of propagation and is determined by the size and shape of the waveguide cross section.

The cavity length must be an integral number of half-wavelengths in the guide for resonance to occur. This can be incorporated into Eq. 1 to obtain

$$\left(\frac{1}{\lambda}\right)^2 = \left(\frac{1}{\lambda_c}\right)^2 + \left(\frac{n}{2L}\right)^2 \quad (2)$$

where n is the number of half-wavelengths in the guide and L is the length of guide forming the cavity.

This expression can be multiplied by the perimeter of the cross section to obtain the general formula

$$\left(\frac{P}{\lambda}\right)^2 = \left(\frac{P}{\lambda_c}\right)^2 + n^2\left(\frac{P}{2L}\right)^2 \quad (3)$$

where P is the perimeter.

This is a general dimensionless form of the resonance equation for a cavity resonator. The middle ratio squared assumes a significant numerical value which, in the square cylinder, is an integer and, in the circular cylinder, is the value of some root of a Bessel function. The desired family of straight lines is obtained by plotting the first squared ratio as ordinate against the last squared ratio as abscissa so the slope of each line is n^2.

Figures 1A and 1B are plots of the normalized equations. They are the straight-line mode charts for square and circular cavities. The region for which these charts are drawn is chosen arbitrarily. However, a chart for any particular region may easily

Table I—Relation of Field Pattern to Mode Index Numbers

General Mode Description	Index Designation	Mode Designation
Circular cylinder		
Noncircular E or H	l = number of axial planes where E is normal m = number of coaxial cylinders, including boundary, where E is normal	TE_{lm}, TM_{lm}
Circular E	l = 0 m = number of cylinders, including boundary, where E vanishes	TE_{0m}
Circular H	l = 0 m = number of cylinders, including boundary, where E is normal	TM_{0m}
Square cylinder	l = number of half period variations of field along one axis of square m = number of half period variations of field along other axis of square	TE_{lm}, TM_{lm}

Design Charts

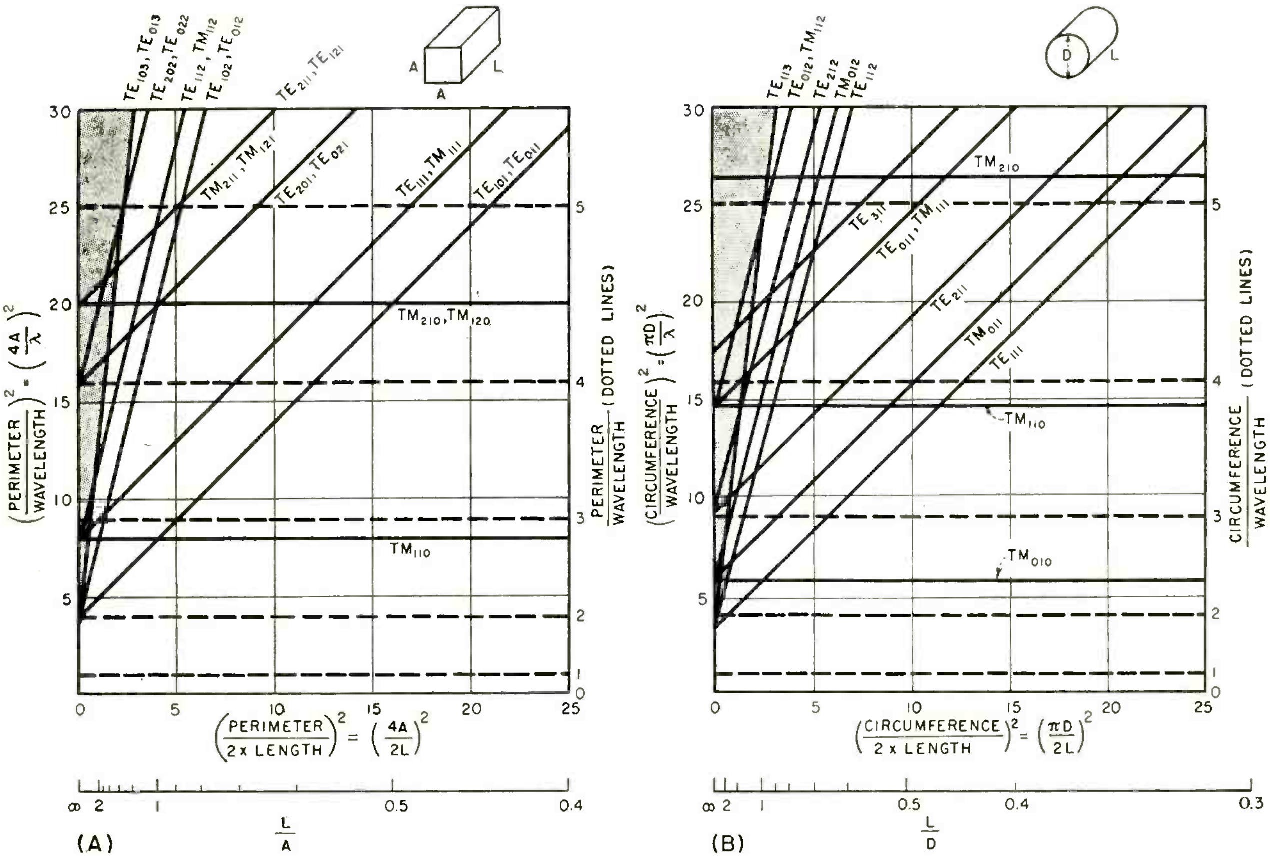

FIG. 1—Mode charts for square (A) and circular (B) cross sections. Shaded areas are incomplete. In *B*, every mode has a pair of crossed orientations unless the first index is zero

be constructed from the equations.

Modes of resonance in the cylinders are classified as TE_{lmn} or TM_{lmn}. The first two indices (l, m) describe the mode of propagation in the cylinder. These are defined in the same manner as given in the IRE Standards.[3] The third index (n) states the number of half guide-wavelengths along the axis of the cylinder. Table I correlates the mode indices with the field configuration.

Solving for λ_c and substituting in Eq. 3, the following equations are obtained: for square cylinders

$$\left(\frac{4A}{\lambda}\right)^2 = 4(l^2 + m^2) + n^2\left(\frac{4A}{2L}\right)^2 \qquad (4A)$$

and for circular cylinders

$$\left(\frac{\pi D}{\lambda}\right)^2 = (x_{lm})^2 + n^2\left(\frac{\pi D}{2L}\right)^2 \qquad (4B)$$

where $x_{lm} = m^{th}$ root of $J_l'(x) = 0$ for TE modes and $x_{lm} = m^{th}$ root of $J_l(x) = 0$ for TM modes.

Values of x_{lm} are given in Table II for the first 10 modes.

The intersection of the mode lines with the vertical axis, in Fig. 1 and 2, is cutoff for that particular family of modes. For example, in the square cylinder, the cutoff for the TE_{20} family of modes is at $(4A/\lambda)^2 = 16$.

The dashed lines in Fig. 1A and 1B are of special interest when the cavity is to be tuned by a movable noncontact short-circuit plunger. With this type of tuning plunger, a thin clearance gap separates the plunger from the walls of the cavity. A ring resonance occurs in this gap whenever the frequency is such that the perimeter of the gap is approximately an integral number of wavelengths in free space.[4] The dashed lines in Fig. 1A and 1B are drawn at each place that this condition occurs (each integer-squared on the scale of ordinates). If the tuning curve avoids these lines, the operation will be free of interference with such resonances.

Any particular ring resonance may be either coupled or uncoupled to the mode in the cavity. If coupled, the ring resonance must be avoided, as the tuning plunger would be ineffective over an appreciable frequency band. If the ring resonance is uncoupled, it may be permissible to let the region of operation include this resonance. In this case, some damping of the resonance may be desirable and effective in

(continued on page 188)

(Continued from p. 187)

removing any effects excited by accidental asymmetries.

Two-Mode Tuner

The mode chart for square cylinders was prepared especially to aid in the development of a tunable band-pass selector utilizing two crossed modes.[5]

The tunable filter is patterned after a Radiation Laboratory design for a fixed-tuned filter.[6] That design proved the feasibility of using two crossed modes to provide a doubly resonant circuit. The filter consists of a circular cylinder resonating in the two crossed TE_{11} modes. More recent work has been done on this principle.[7]

The main advantage of a two-mode resonator over two one-mode resonators is the simultaneous tuning of both resonances by one plunger so their tracking is automatic. A further practical advantage is the saving in space obtained by requiring only one cavity and one drive mechanism.

The square cylinder was chosen for the cavity of the tuner, because interference-free tuning ranges are greater than those of the circular cylinder. Comparison of Fig. 1A and 1B shows this to be a general rule. This is a consequence of the square cylinder having more coincidences of various modes, so the undesired modes contaminate less of the area on the chart.

It is in this stage of the design that the mode chart proves most useful. It is quite possible that a number of regions on the mode chart would appear to be acceptable. With the aid of the mode chart, the relative advantages of each potential design may be quickly evaluated. The various objectives in the design can then be weighed and the best compromise selected.

Design Procedure

In Fig. 2, a portion of the mode chart is drawn to show the procedure followed in the design of this tuner. An area on the mode chart is chosen which includes the desired crossed modes but no other modes, over the required tuning range of frequencies. The shaded rectangle shows the excursions of the final cavity over the tuning range. Only the desired modes are in this rectangle and the rectangle is approximately centered between two plunger resonances (dashed lines).

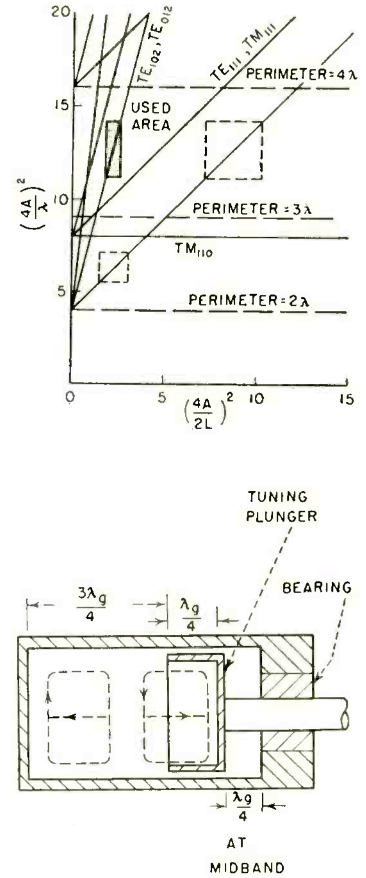

FIG. 2—Region of mode chart (above) chosen for crossed-mode tuner of square cross section (below)

Another factor in the choice of modes is the desire for a cavity one wavelength long. A shorter (half-wave) cavity will have a smaller resonance ratio (Q), and will provide insufficient space for coupling holes and a cup-shaped plunger. A longer cavity will reduce the clear spaces available on the chart. The dotted rectangles of Fig. 2 show other acceptable cavity designs but because of the shorter cavity (one-half wavelength) these designs are not chosen.

An elementary sketch of the tuner is shown in Fig. 2. The magnetic fields of the two desired modes are also depicted. Coupling with the respective modes is accomplished by holes in the walls of the cylinder. Tuning is accomplished by moving the quarter-wave cup axially in the cylinder.

The author acknowledges the effort of H. A. Wheeler, under whose direction this work was performed and who suggested the normalized presentation for the mode charts.

Table II—Roots of $J_l(x)$ and $J_l'(x)$

Mode Order	TE modes	TM modes	x_{lm}
1	11		1.841
2		01	2.405
3	21		3.054
4, 5	01	11	3.832
6	31		4.201
7		21	5.136
8	41		5.318
9	12		5.331
10		02	5.520

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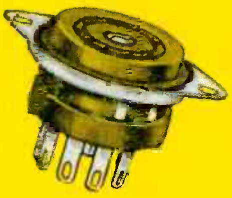

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Shielding Nomograph

Attenuation chart simplifies design calculations for shielded rooms, filter enclosures, coaxial cables and chassis construction materials. Effectiveness of shielding can be determined for both magnetic and nonmagnetic materials

By **JOSEPH F. SODARO**

Registered Engineer
Los Angeles, Calif.

ATTENUATION of a metal surface depends upon resistivity, permeability and thickness of the material. A pure copper partition presents an attenuation in db per 0.001-inch thickness of

$$A = 3.338 \sqrt{f} \qquad (1)$$

where f is frequency in mc.

For other materials attenuation in db per mil is

$$L = A \sqrt{\frac{1.72\,\mu}{R}} \qquad (2)$$

where R is resistivity in microhms per cubic centimeter, μ is magnetic permeability and A is attenuation from Eq. 1.

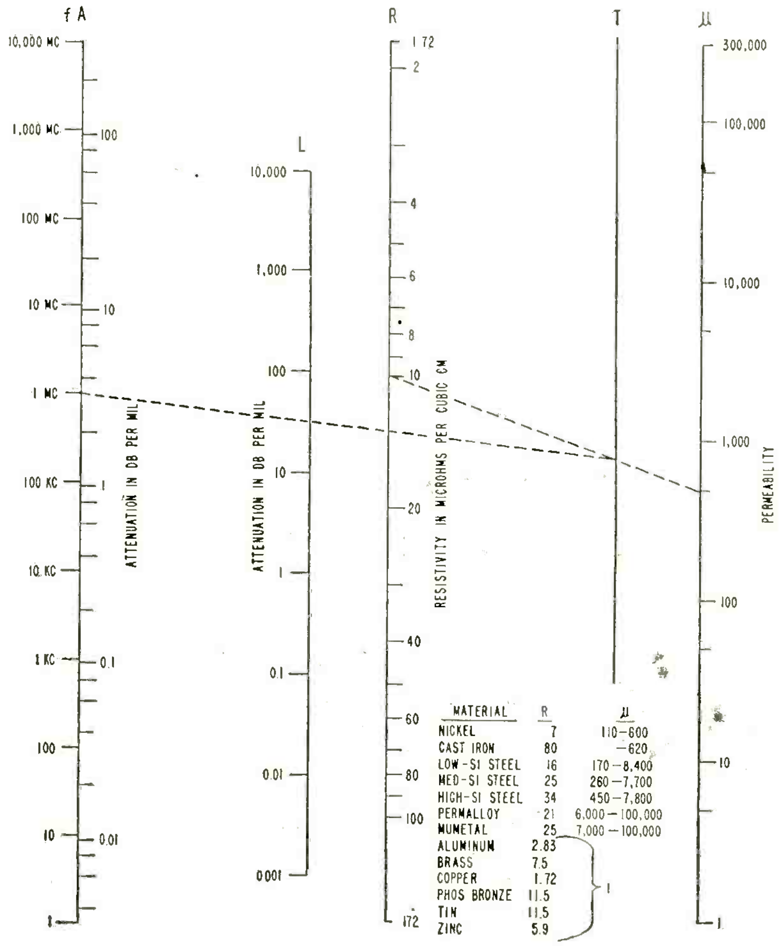
Magnetic permeability is essentially unity for all nonmagnetic materials. The permeability of magnetic materials depends on magnetic-flux density and previous magnetic history of the material. Typical values for commonly used metals are given in the table. Initial and maximum permeabilities are given.

For a material such as high-conductivity copper, select the frequency on the f scale and read attenuation on scale A in db per mil. Multiply by thickness in mils to obtain total attenuation.

For other metals locate resistivity on the R scale and permeability on the μ scale and join these points by a line. At the intersection of this line with the T scale, locate a turning point. Construct a line from the turning point to the frequency value on the f scale. Read attenuation per mil on the L scale.

As an example, determine attenuation at 1 mc for a chassis partition 10 mils thick if the material is steel having a resistivity of 10 microhms per cu cm and a permeability of 500.

Locate 10 on the R scale and 500 on the μ scale and join these points with a straight line. From the intersection point of this line with the T scale draw a line to 1 mc on the f scale. Where this line intersects the L scale estimate 30 db per mil. Multiply by 10 to obtain total attenuation of 300 db.



MATERIAL	R	μ
NICKEL	7	110–600
CAST IRON	80	–620
LOW-SI STEEL	16	170–8,400
MED-SI STEEL	25	260–7,700
HIGH-SI STEEL	34	450–7,800
PERMALLOY	21	6,000–100,000
MUMETAL	25	7,000–100,000
ALUMINUM	2.83	
BRASS	7.5	
COPPER	1.72	1
PHOS BRONZE	11.5	
TIN	11.5	
ZINC	5.9	

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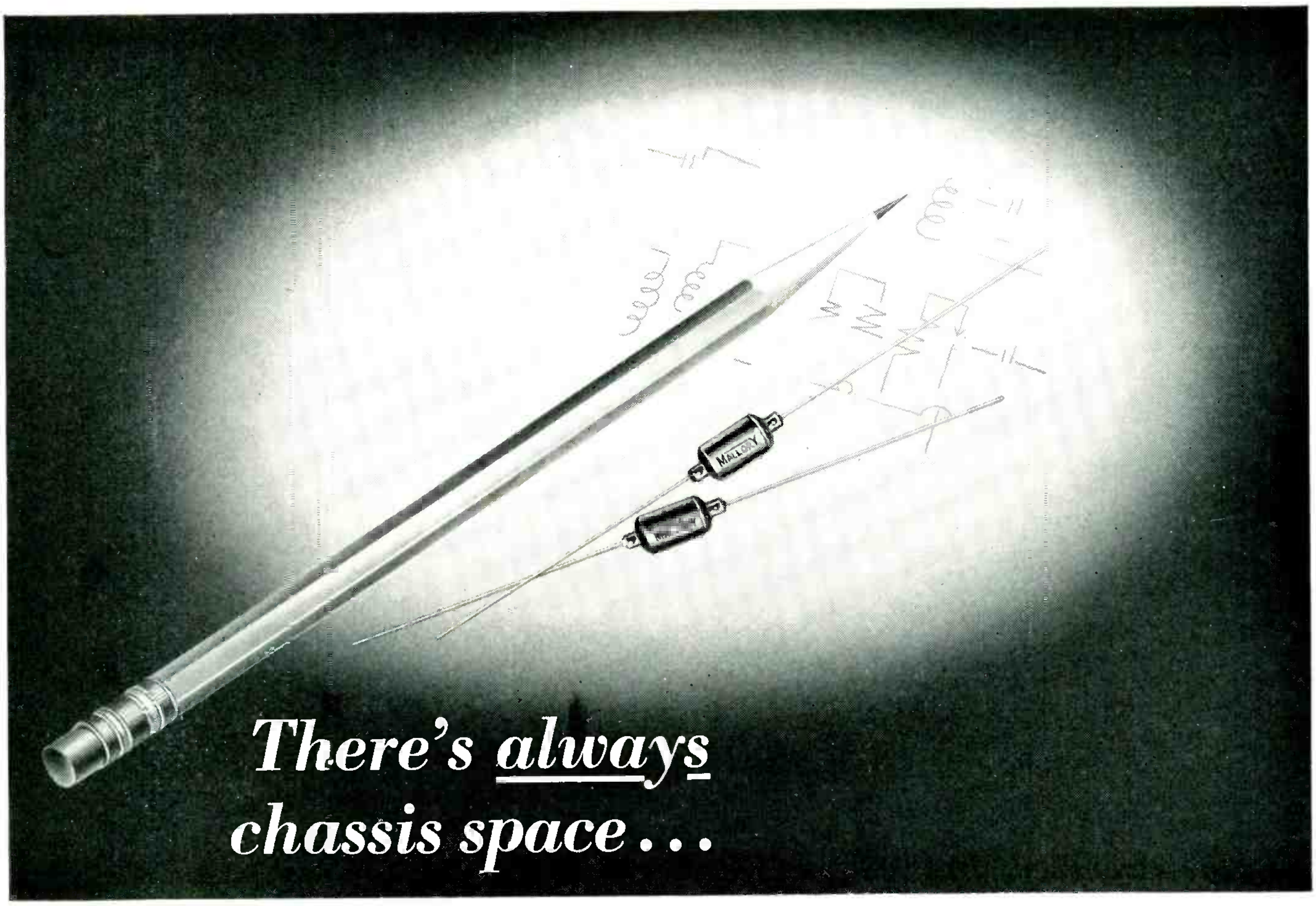

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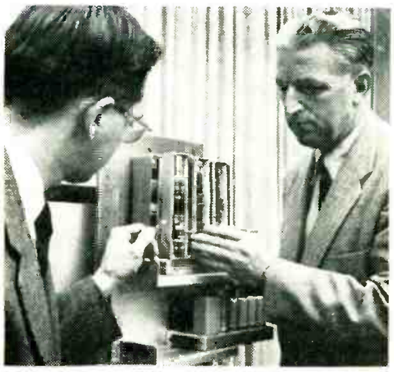
ELECTRONS AT WORK

Edited by ALEXANDER A. McKENZIE

OTHER DEPARTMENTS featured in this issue:

Transistors Simplify Telephone Plant



Model of a carrier-frequency telephone terminal suitable for rural lines. More than 300 transistors of the type held by man at the left are used in experimental equipment

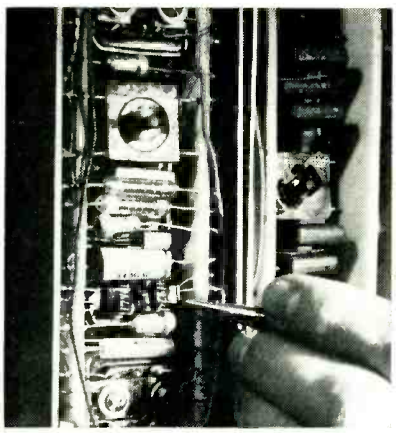
TWO MEANS are generally available for the extension of wire communications. More pairs of wires can be added for connecting additional simple terminal equipment to a central switching point. Alternatively, it is possible to make more effective use of existing outside plant facilities by employing carrier techniques.

Superimposing several modulated radio-frequency carriers on the same pair of conductors is not a new idea. It is often economically unfeasible because of the required complexity of terminal equipment. This shortcoming is particularly notable with short-haul circuits.

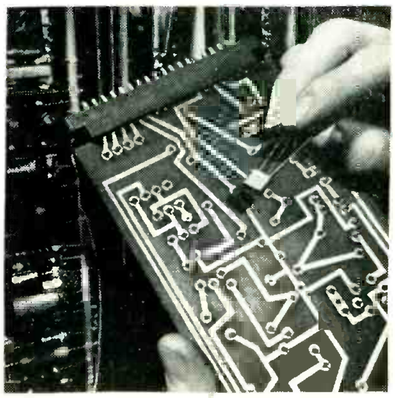
The significance of recently publicized experiments by Bell Telephone Laboratories, working with Southern Bell Telephone Co. near Americus, Ga., is very great. Here, experimental carrier circuits in the order of 10 to 15 miles long are being tested that could enhance subscriber service in rural areas.

Terminal equipment and repeaters, while more complex than conventional subscriber's-line equipment, become economical by use of printed wiring techniques and transistors.

Full technical details of the experiment are not yet available, but Bell Labs indicates that many conversations will share the same pair of telephone wires and that the system can operate economically over distances as short as five miles.



Two transistors are used in each oscillator subassembly for rural carrier telephone system



Phenolic plates with circuits etched in advance eliminate elaborate wiring and permit cheaper soldering methods for new rural-line carrier equipment that also includes transistors of the type shown

The new system is being tried over one line $11\frac{1}{2}$ miles long and over another 15 miles in length, both extending from the central office in Americus, which is about 135 miles south of Atlanta. Outward terminals of the carrier systems are mounted on telephone poles. Beyond the terminals, conventional wire circuits are employed, one for each carrier circuit.

Between central office and outward terminals are repeaters or amplifiers to compensate losses in the wires. Because the transistor requires little power, small batteries can be used, mounted directly on the poles that carry the electronic equipment. Each terminal requires only a twentieth of an ampere at 20 volts as compared with some 20 to 30 times as much

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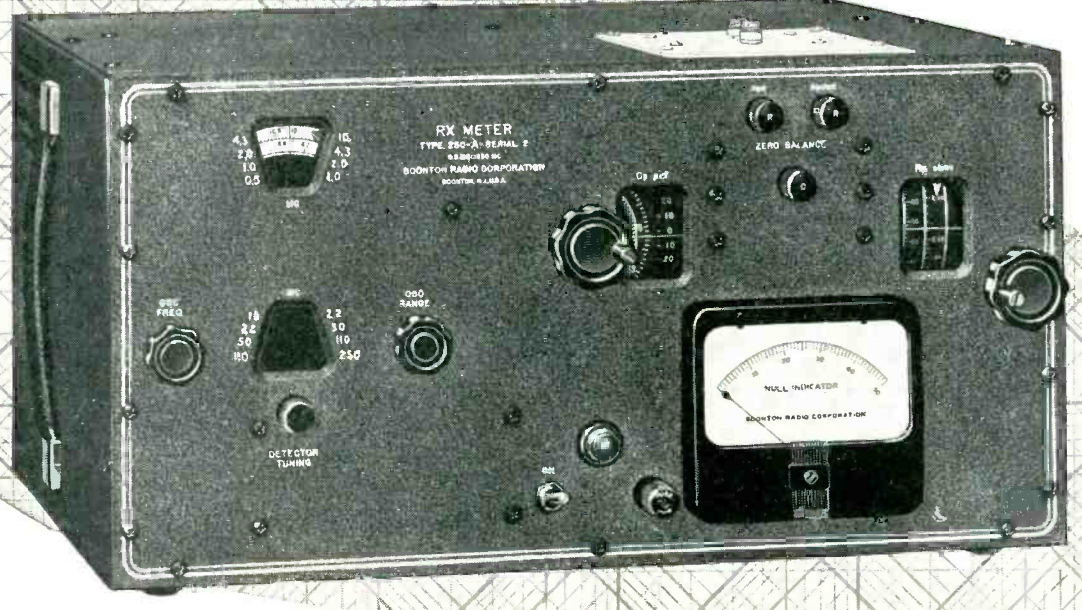

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FREQUENCY ACCURACY: $\pm 1\%$.

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RESISTANCE ACCURACY (Rp): $\pm \left\{ 2+\frac{Fmc}{200}+\frac{Rp}{5000}+\frac{Q}{20} \right\} \% \pm 0.2$ ohms.

CAPACITANCE RANGE (Cp): -100 mmf to $+20$ mmf.

CAPACITANCE ACCURACY (Cp): $\pm \left\{ 0.5+0.0002\,F^2\,mc \right\} \% \pm 0.15$ mmf.

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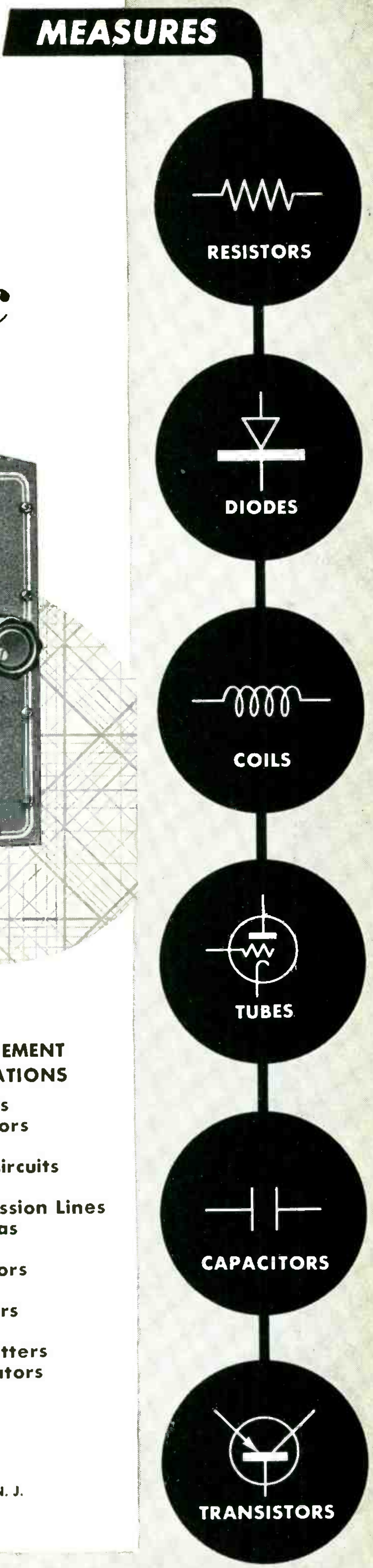

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power for comparable vacuum-tube equipments.

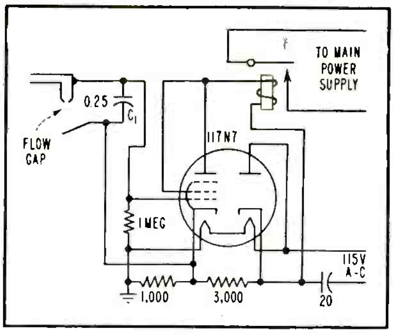
Mass-production of similar carrier equipment, after more field experience has been obtained, will reflect more compact packaging than equipment now undergoing field trials. All the illustrations shown here are merely preproduction prototypes.

Water Flow Safety Interlock

By ROBERT W. WOODS
Biophysicist
College of Medical Evangelists
Los Angeles, Calif.

UNCERTAINTIES IN THE supply of cooling water for the diffusion pump in an electron microscope required a safety interlock that would operate on 3-cc-per-sec flow. Interlocks are supplied commercially for large flow applications but nothing is available for such small flow. The circuit shown solved the problem.

A 3-amp, 110-v d-c relay operates positively on the plate and screen current of a 117N7 tube. Resistance of the stream of tap water flowing from the diffusion pump was measured and found to be constant at 0.1 megohm. By using this resistance and a 1-megohm grid resistor as a voltage divider across the bias section of the power-supply bleeder, the grid remains below cutoff in the absence of flow and operates at small bias with the flow present.

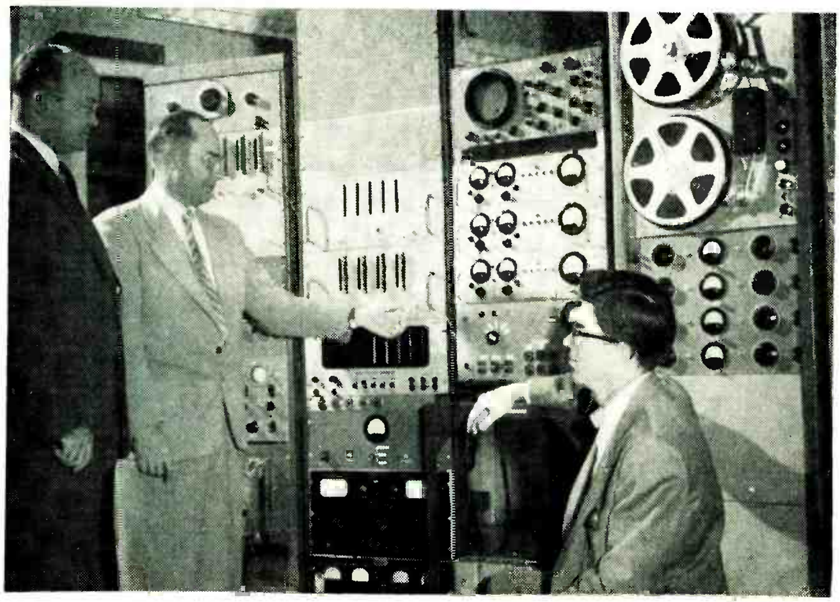


Safety interlock disconnects main power supply when water flow falls below 3 cc per sec

This circuit is capable of providing flow-interlock service with extremely small flow. It is only necessary to make the orifice small enough and the gap short enough that a continuous stream of water will span the gap, thus providing positive contact. The gap must be constructed to prevent the retention of a drop of water in the gap by surface tension in the absence of flow. This condition was accomplished by causing the stream to fall vertically and strike the terminal side of the gap at an angle. Leakage paths owing to moisture must also be avoided, since the resistance of the stream is in the order of 100,000 ohms.

When constructed and placed in operation, this circuit gave perfect control. It was necessary to introduce C_1 across the flow gap to provide a longer time constant. Without C_1 the relay chatters at every bubble of air that passes with the flowing water. The time constant of 0.25 second was sufficient to make it insensitive to such transient interruptions of service, without affecting its operation as a safety device against flow failure.

While this unit was designed for an electron microscope, it can be used with practically any vacuum or cooling system.



Threshing Machine for Missile Data

As many as 30,000 readings per minute received from guided-missile test instruments are recorded on tape at upper right. The electronic data-separator winnows out individual instrument reports and presents flight conditions in usable form for Lockheed electronics engineers

Silicon Surface-Barrier Transistors

TRANSISTOR RESEARCHERS are unanimous in their desire to escape from the high-temperature limitations of germanium. Much industry effort is being concentrated on the use of silicon as the semiconductor. This month's cover shows a jet-etched silicon wafer, enlarged 60 times (diameter of pit is 0.013 in.) which has been through the first phase of the surface-barrier transistor process (ELECTRONICS, p 6, Feb. 1954.)

A wafer of high-lifetime silicon is positioned between the pair of axially aligned glass nozzles as shown in the illustration. For the etching phase, the silicon is the anode of an electrolytic system in which the jets of an appropriate

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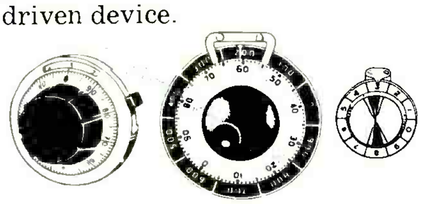

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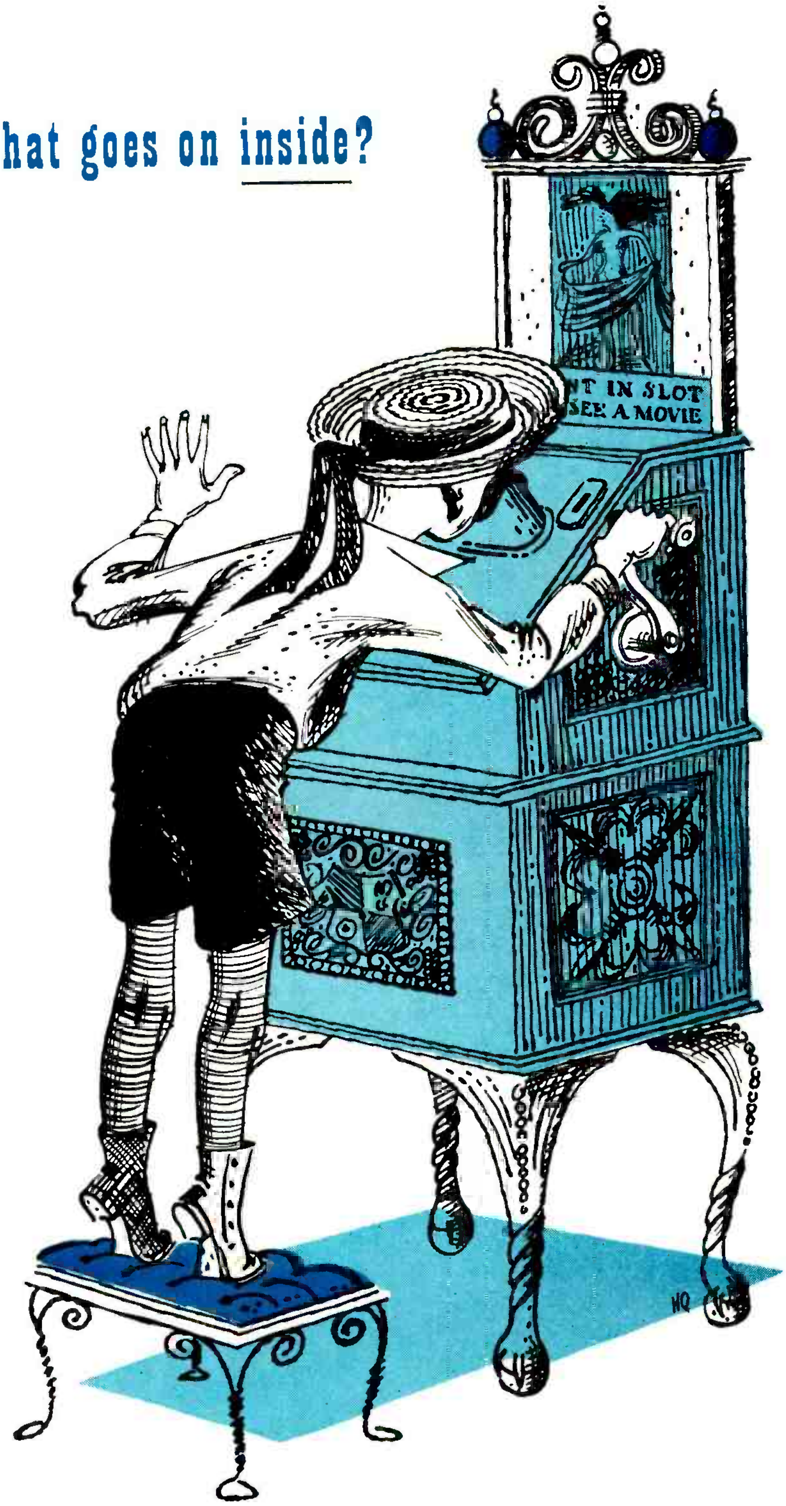

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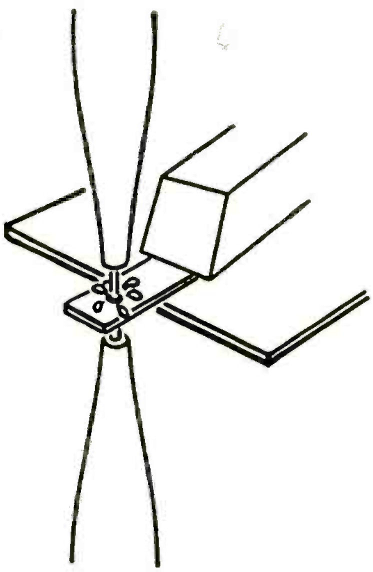


Glass nozzles direct jets of salt solution onto silicon wafer. Jets are negative for etching cycle, positive for plating phase

metal salt serve as the cathodes. The silicon atoms under the jets go into solution as atomic sawdust.

Crystalline silicon several mils thick is opaque in the visible spectrum, but efficiently transmits infrared of wavelengths longer than about 1.2 millimicrons. As the etching jets drill into opposite sides of the silicon wafer, the thickness of the silicon window is reduced ultimately to a few ten-thousandths of an inch. As the window becomes thinner, the silicon begins to transmit visible light. The etch pit shows a dull red glow, which changes to bright red, then orange and yellow and finally white as the jets break through.

In the language of an electronics engineer, the visible spectrum falls on the high-frequency sharp-cutoff portion of the silicon passband characteristic. The eye, as the detector, monitors only the visible light transmission. In the visible spectrum the silicon acts as a frequency-selective attenuator.

Decreasing the thickness decreases the attenuation. The attenuator first passes a detectable amount of the long wavelength red and then extends the transmission through the orange and yellow to all colors—white.

When the window has reached the proper thickness, metal electrodes are deposited in the etch pits to form the emitter and collector surface barriers.

Tones Provide Private Line

Recently approved by Civil Aeronautics Administration is selective-calling equipment for use in ground-to-air transmissions. Each aircraft is equipped with a selective-calling (Selcal) decoder for each radio channel to be monitored. Upon reception of a code created from 12 basic tones, the decoder rings a bell or lights a lamp to show the call. In the photograph, a Pan American dispatcher in Auckland, N. Z. signals aircraft with a Motorola tone selector

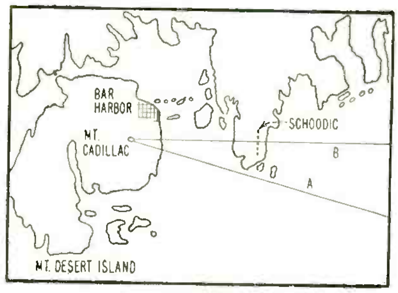


FIG. 1—Unobstructed path *A* compared with path *B* over knife-edge used for diffraction observations

Diffraction-Gain Transmission

RECENTLY REPORTED experiments with long-range vhf transmission in mountainous regions confirm theory and earlier observations as to the possible efficacy of diffraction in extending communications. Material from various sources, such as National Bureau of Standards, Signal Corps and Radio Corporation of America indicates that in the region from 30 to 100 mc so-called obstacle-gain techniques can be effective.

Based upon the optical phenomenon of light waves passing across a knife-edge in a homogenous medium, the radio application was published by Schelleng, Burrows and Ferrell in 1933. In brief, they postulated that if a transmitter and receiver were separated by a mountain, radio waves would be received by these mechanisms:

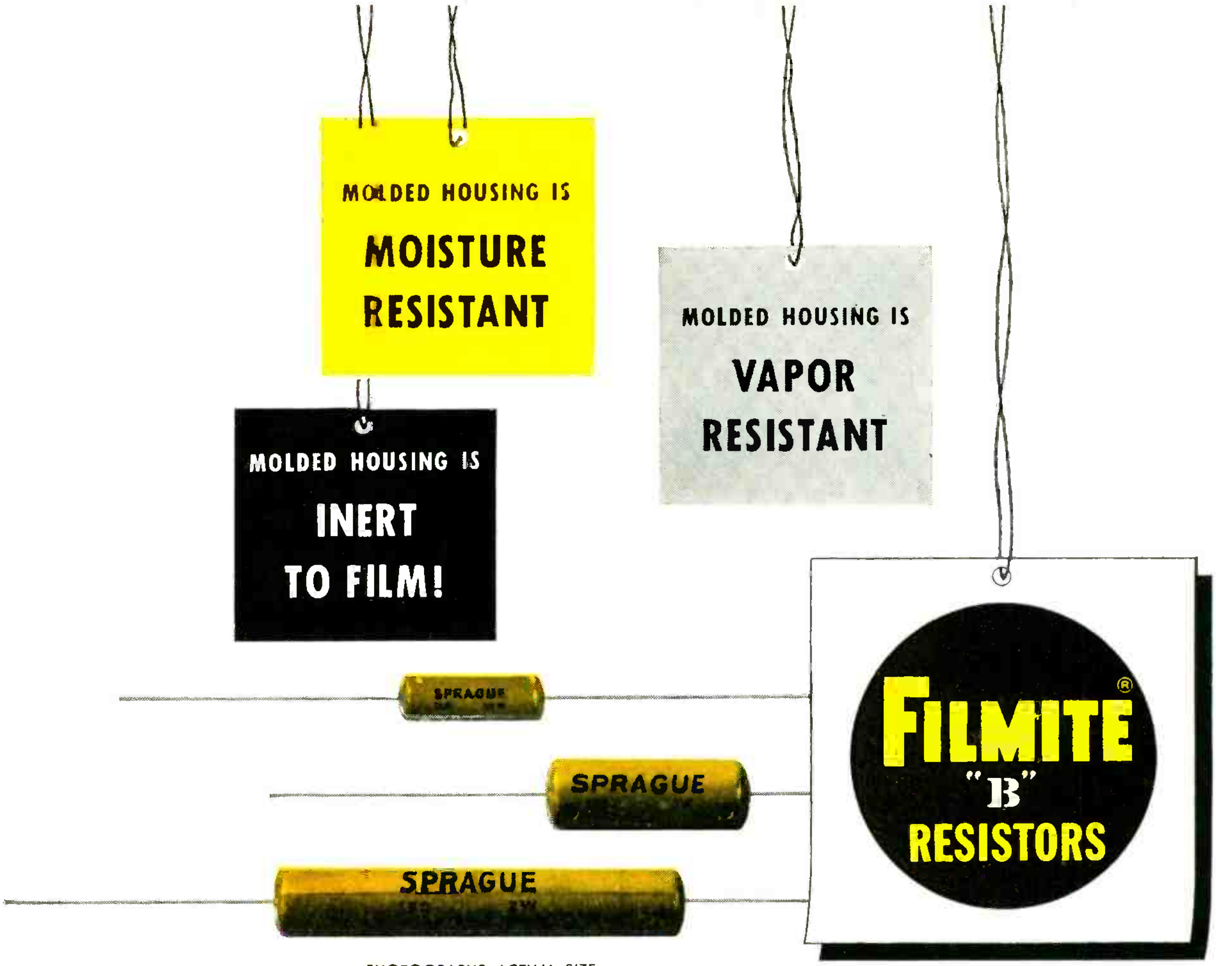
(1) Diffraction at the top of the obstacle,

(2) Reflection from the ground between the transmitter and the obstacle and then diffraction over the obstacle,

(3) Diffraction over the obstacle and reflection from the ground between the obstacle and the receiver,

(4) Combination of the two ground reflections with diffraction over the obstacle.

A requirement for increased signal strength is that the height of the obstruction must be greater than the elevation of the common horizon. For example, losses will be considerably reduced at 100 mc if a knife-edge obstacle for a 150-mile circuit is at the midpoint of the



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Other practical experiments carried out in the mid-1930's by J. A. Pierce and H. Selvidge, both of Cruft Laboratory, Harvard University, showed, among other phenomena, that horizontally polarized waves were diffracted more than those vertically polarized when propagated over a horizontal knife-edge.

Making ingenious use of natural topography, the Harvard experimenters set up transmitting equipment atop Mt. Cadillac, Maine. By carrying receiving equipment in a boat, they were able to observe along paths A and B shown in Fig. 1. Mount Cadillac is 1,532 above sea level and the knife-edge formed by Schoodic Peninsula is 437 feet high for a length of a quarter mile.

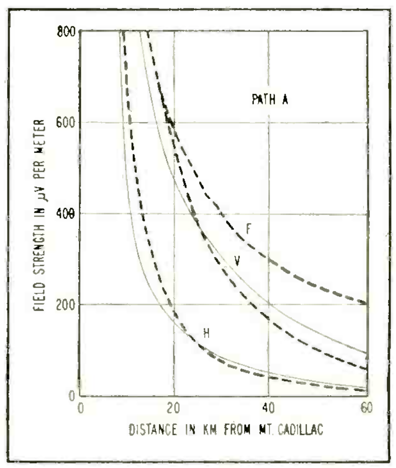

FIG. 2—Path A propagation at 55 mc over sea water. Dashed lines show computed values; free-space (F), horizontal (H) and vertical (V) polarization

Tests were made using 55 and 110 mc. Propagation for 55 mc over path A is shown in Fig. 2 and that for path B in Fig. 3. Unexplained are the sharp peaks in the deep shadow region although continued observations showed them to be reproducible.

In the more-recently reported observations is a 38-mc, 160-mile circuit in Alaska, passing over Mt. Fairweather. Calculations show that the obstacle-gain transmission loss should be 80 db above the

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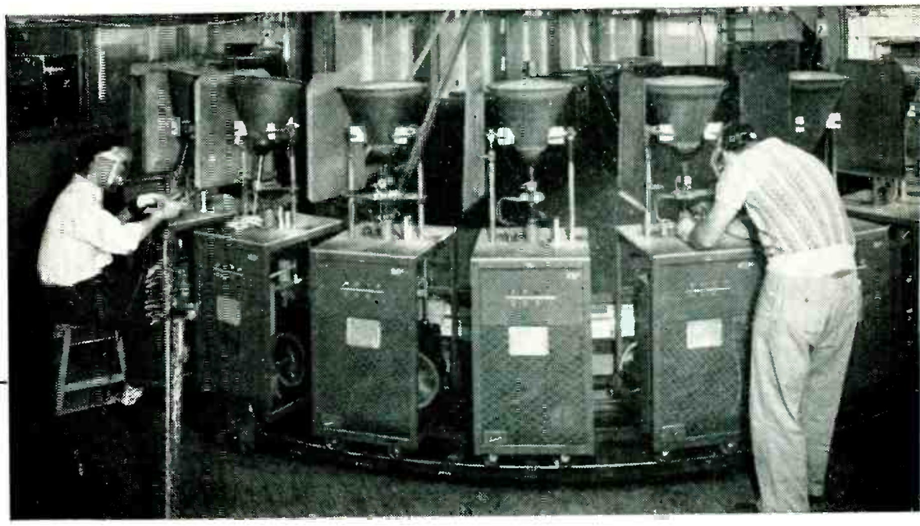

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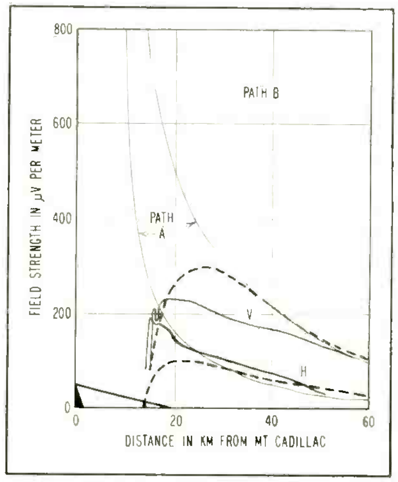


FIG. 3—Diffraction over knife edge (with path A curves shown for comparison). Horizontal (H) and vertical (V) polarization. Frequency is 55 mc

smooth-earth calculated loss. Measurements show a gain of 73 db, which is in close agreement. The actual loss over the circuit is approximately 134 db. This loss varied by less than ±2 db from a mean value, indicating that tropospheric propagation effects must have been very slight.

Some engineers have predicted that although tv broadcast listeners may benefit from the phenomenon, it will be principally useful for point-to-point communications services.—A. A. McK.

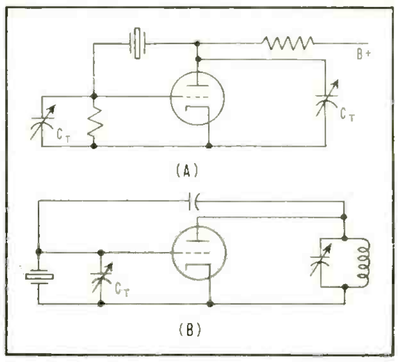
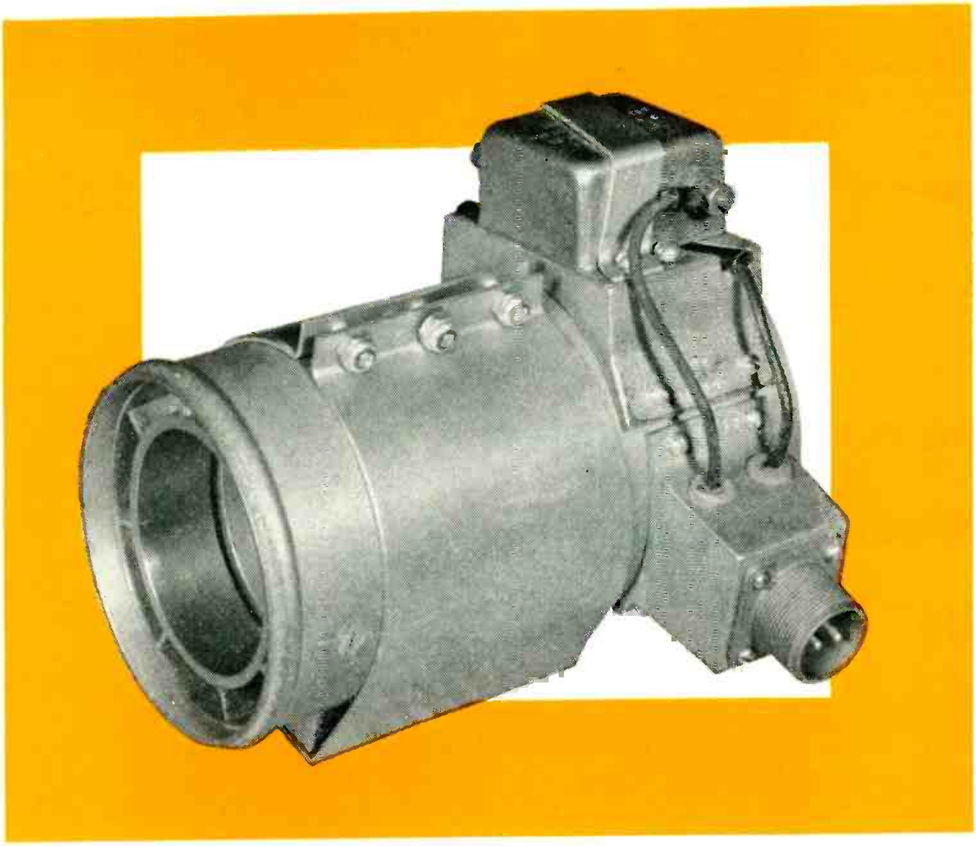


FIG. 1—Pierce oscillator circuit (A) and Miller circuit (B)

Crystal Oscillator Circuits

OSCILLATORS of the Pierce (Fig. 1A) and Miller (Fig. 1B) types operate the crystal as a reactance and normally as an inductance. The Pierce circuit has the advantage



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that no tuning is required and frequency selection is accomplished on a plug-in basis.

In the parallel-resonant circuits of Fig. 1, frequency is adjusted by a variable capacitor in shunt with the crystal. Long-term stability of the frequency of oscillation will increase as C_T (the circuit capacitance) is made large with respect to stray circuit and tube capacitances, but output will decrease because of lower operating impedance. In general, frequency instability not greater than 0.003 percent can be expected from this type of circuit.

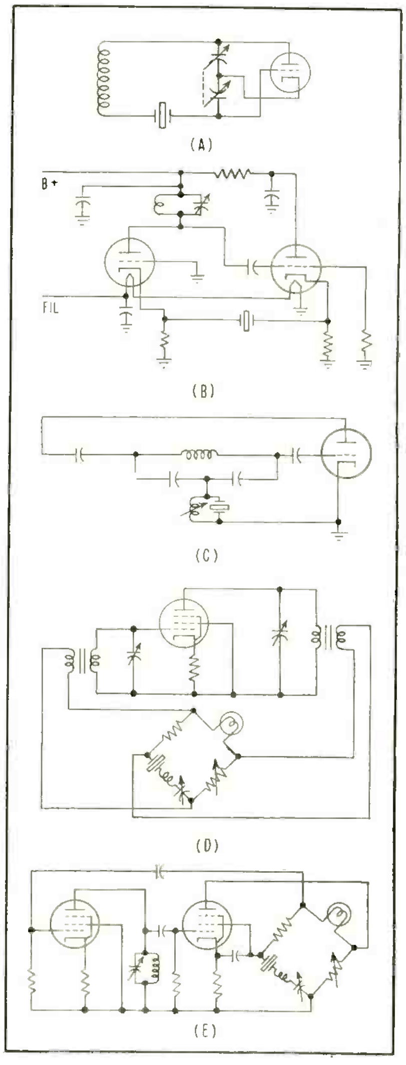

FIG. 2—Simple series oscillator (A), cathode-coupled (B), Bridged-T (C), Meacham bridge, transformer coupled (D) and Meacham oscillator with R-C feedback (E)

Series-resonant oscillators of the types shown in Fig. 2, with the crystal used as a low resistance, are most suitable for practical applica-

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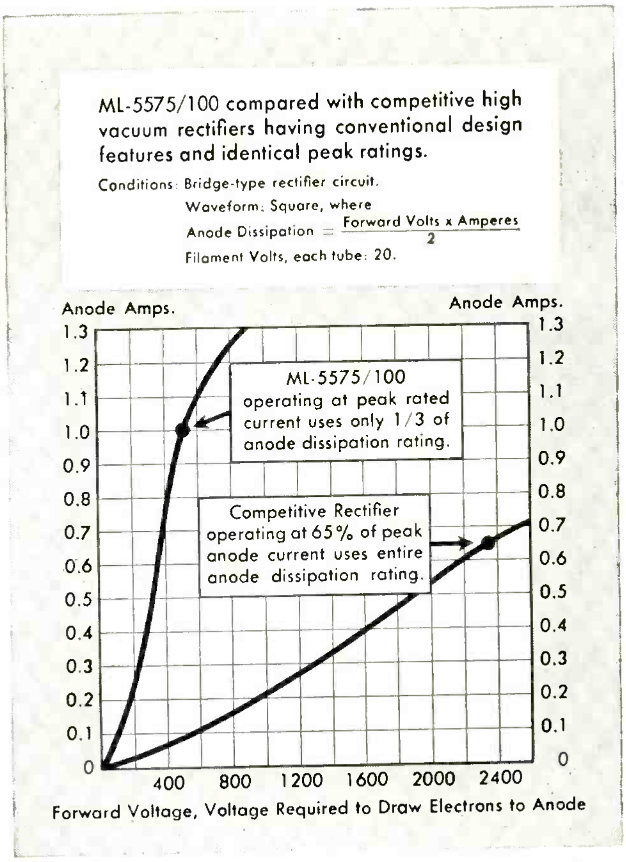

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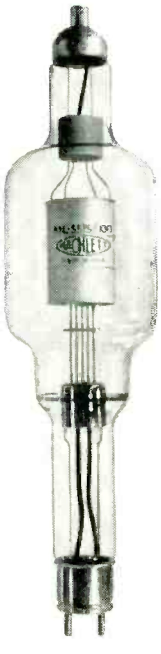

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tion when it is desired to reduce frequency instability below 0.002 percent.

Frequency can be adjusted above or below the resonant frequency of the crystal unit by connecting a variable capacitor or inductor in series. This has the disadvantage of operating the crystal as an inductance or a capacitance, thereby increasing impedance of the crystal network and decreasing stability.

The fundamental cathode-coupled circuit widely used in vhf and uhf communications equipment and shown in Fig. 2B is satisfactory up to about 50 mc.

Advantage of the bridge-T oscillator (Fig. 2C) over other vhf circuits is that one side of the crystal unit can be grounded, power output is high and frequency stability as a function of plate voltage is excellent.

The Meacham bridge circuit (Fig. 2D and 2E) is enhanced at low and medium frequencies. Its great stability results from control of the level of oscillation in the feedback circuit.

Circuits and information abstracted here are taken from "Current Status of Quartz Crystal Units and Circuitry for Frequency Control", by Douglas A. Venn, an interim report of the Naval Research Laboratory.

Portable Transceiver

By H. S. Knaack

Project Engineer
Stewart-Warner Electric
Chicago, Ill.

Portable transceiver intended for short-range communication in the class B Citizens Radio band extending from 462 to 468 mc provides reliable communication along a true line of sight for considerable distances. Its ability to work through obstructions is limited because of low power output and because of the character of the frequency at which it operates.

A hand-held instrument combining the functions of both receiver and transmitter in a single unit, it has an external power supply and a removable folding dipole antenna. Each unit may be operated from a every TV station needs

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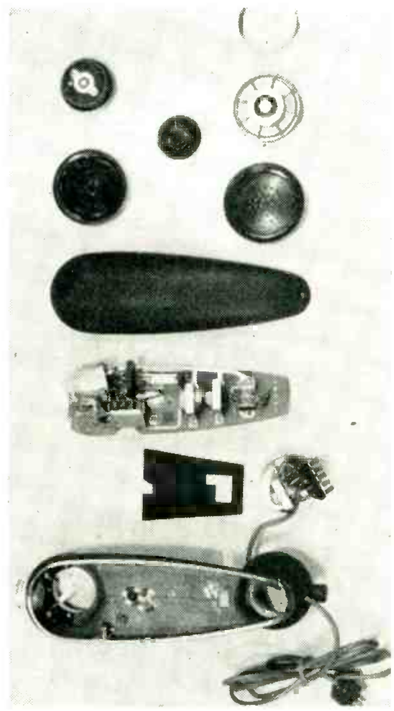
battery pack that fits into a carrying case or by a 110-volt a-c power supply. Six volt d-c and 12 volt d-c power packs are also available for use with mobile equipment.

The microphone and earphone are positioned in the case by bakelite covers and as these covers are screwed on, connections are made to pressure type contacts mounted on sub-assemblies within the case. Microphone contacts are mounted on a bakelite board that also holds the microphone transformer and



Exploded view of portable transceiver

the battery-cable contacts. The assembly is indexed with a pin forced directly into the casting, which makes it impossible to misalign the battery contacts bearing against a row of circuit contacts on the chassis itself.

The chassis contains all working parts of the circuit with the exception of the antenna matching coils and the microphone transformer. No circuit adjustments are used except in the oscillator section and the chassis employs printed circuits for speed in assembly, to reduce the room required for the wiring and to eliminate errors in wiring. Working contacts are silver plated to eliminate the effects of corrosion and to provide low resistance.

The antenna is a broad-band fold-

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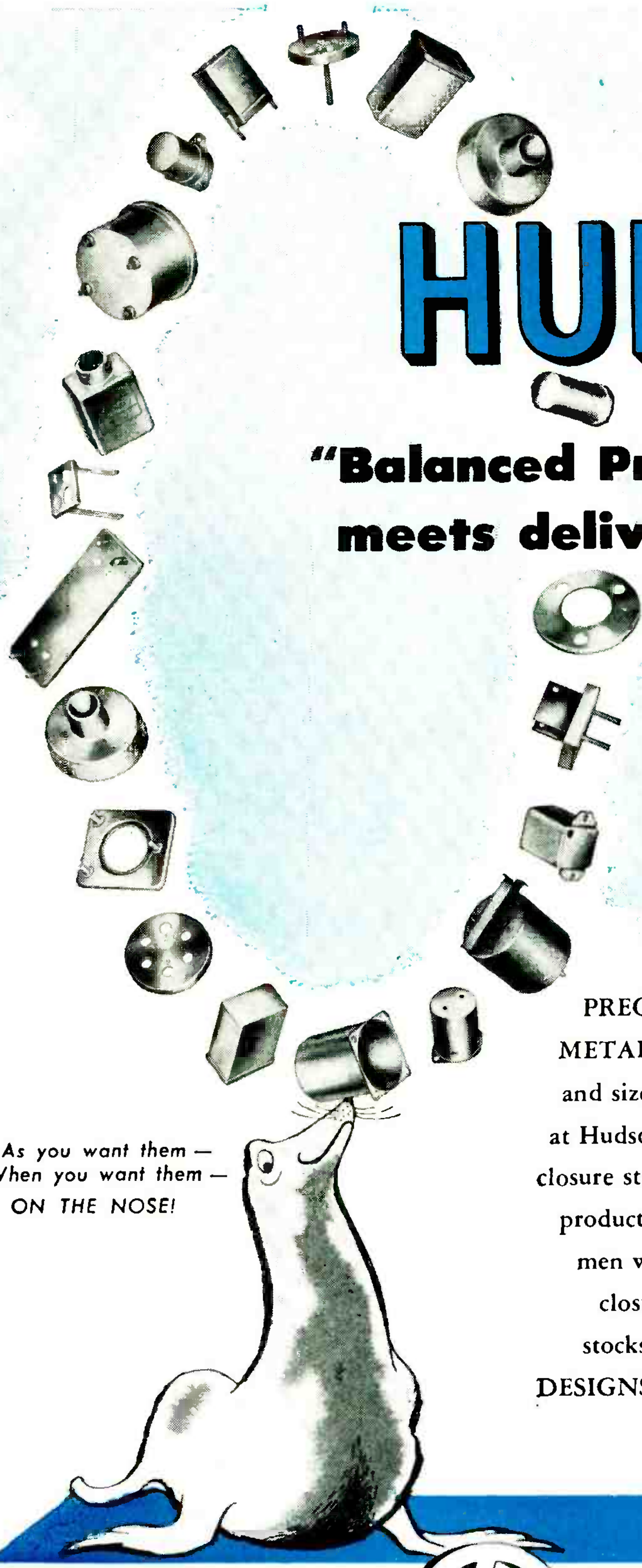

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ing dipole with integral matching section approximately a quarter wavelength long and is plugged into a pair of contacts at the top of the unit. It is roughly directional with a figure-eight pattern that does not have zero nulls. The effect of the directivity is not acutely felt until the units are approximately at their extreme range of usefulness.

The transceiver has FCC type-approval making it possible for the owner to transmit without an operator's license, although a station license is needed.

The oscillator is a Colpitts type using a 6AK4 subminiature tube and a miniature 3A4 as the modulator, with its input connected to the microphone circuit. Tuning is accomplished by a small variable capacitor integral with the oscillator plate, or by adjustment of the position of the tuning loop. The antenna is inductively coupled to the tank by means of a single-turn hairpin loop on the rear, tube side, of the ceramic plate on which the tank coil is plated.

Coupling Compensator

Thus the physical relation of the tank and antenna coils is fixed permanently is such manner that changes in coupling cannot be made except by deformation of the plate itself. This deformation is carefully controlled, becoming part of the temperature-compensating mechanism. Other elements of this temperature compensation are the grid capacitor and tuning capacitor insulator materials. With this type of frequency control, it is possible to design the oscillator to be subject to less than 200 kc variation at 465 megacycles owing to temperature effects.

Humidity effects are reduced to a minimum by fusing the ceramic plate so that it is impervious to moisture short of submersion. Humidity effects on frequency are reduced to less than 500 kc for humidities varying from 30 to 95 percent. Frequency deviations from changes in battery voltages are somewhat offset by the temperature compensation, which is in the other direction. When the power input is reduced and the tempera-

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"Imagine the stands filled," says Spalding's Arthur Wiley, "the major league teams in their dug-outs, the mounting expectation — and no baseballs!

"It sounded like an 'emergency.' The balls used in all major league games are specially tested for perfection. The club was half-way across the country from our Chicopee, Mass. plant and a double-header scheduled.

"But we're used to delivering fast. We solve situations like this week-in and week-out by relying on Air Express.

"So, we just called Air Express on this job. The balls were flown west, were delivered and actually in play on the field a few hours later.

"We use Air Express throughout the year to ship all kinds of sports equipment throughout the country.

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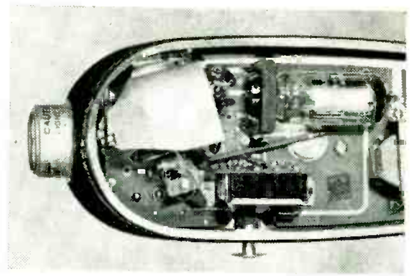
ture of the oscillator decreases the two effects tend to cancel. Overall drift from temperature, humidity and changes in battery voltage over the recommended range are less than plus or minus 1.2 mc.

Battery voltage is controlled by using a special battery pack that contains A, B and C batteries for the unit. These cells are designed so they run down in a specified manner, with the A cells going last. The existence of reasonable B-battery voltage is indicated by a small neon lamp under the antenna socket that illuminates the base of the antenna as long as the B-battery voltage is over 90 volts. When the lamp no longer lights, or when its degree of illumination changes as the press-to-talk button is pushed, the battery is replaced since frequency deviation beyond the tolerance authorized by the FCC may exist.

Movement of the tuning knob has been deliberately restricted since the oscillator does not have any degree of drift that would require a greater movement of the tuning knob.



Switching assembly detail, tuning control and tuning loop

In the receive position, the 6AK4 is a self-blocking superregenerative oscillator and the 3A4 tube acts as an audio amplifier. Sensitivity in this position for a readable signal is approximately 12 microvolts. Variation of the position of the short-circuited loop adjacent to the oscillator tank is used to tune the receiver to the desired frequency. This is accomplished by moving the receiver tuning knob. Total tuning range of the loop is approximately 7 megacycles. As noted, actual tuning is provided over a lesser range.

Switching from receive to transmit involves shorting part of the oscillator grid lead, switching the

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input of the 3A4 from the circuit of the oscillator to the microphone and connecting the modulation transformer to the earphone instead of the plate circuit of the oscillator. All this is accomplished by four spdt snap-action switches that are operated in an almost simultaneous pattern by a leaf actuated directly by the transmit button. Depressing this button also returns the tuning loop to the correct position so the oscillator will operate on 465 mc.

Power output of the transmitter is approximately 300 milliwatts with a maximum power input of 2.6 watts to the oscillator. Range varies from very short distances under adverse conditions to many miles where suitable line of sight exists, as from air to ground.

Range under average conditions of terrain and obstructions in open country is line of sight plus the distance in which the signal can be expected to have useful value after single or multiple reflections from structures or terrain. Range within steel structures is surprisingly good. Exact tuning is more critical near the limit of operating range and exact positioning of the listener or transmitter may be critical in some structures where standing-wave patterns exist.

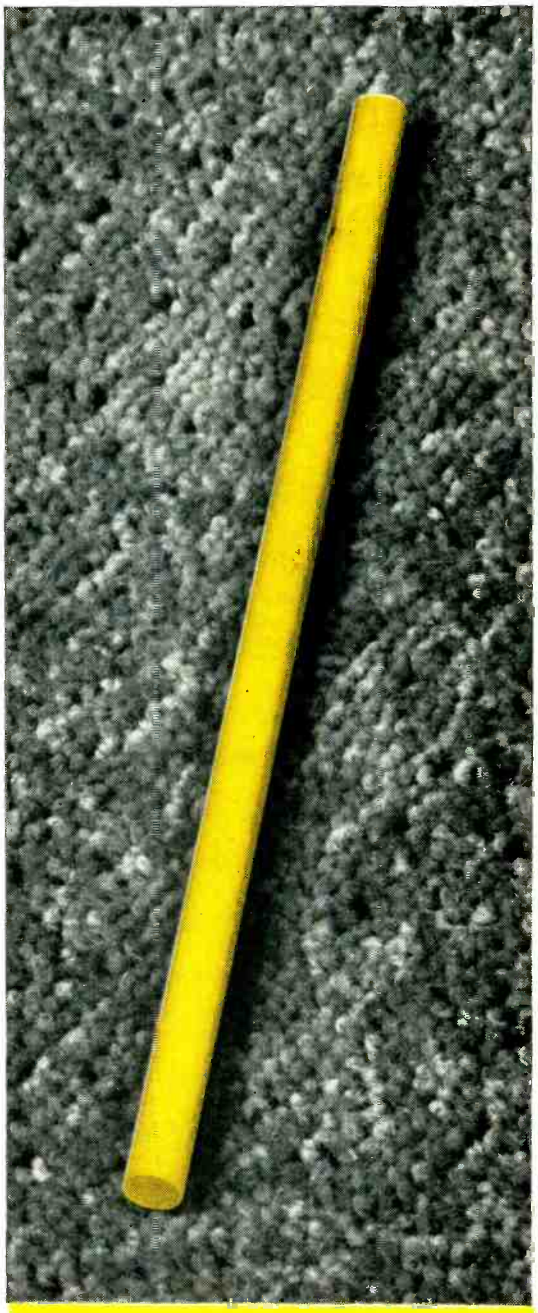
Starlings Scare Starlings

MAGNETIC-TAPE RECORDING is the latest weapon in the electronics arsenal to be leveled against superabundance of feathered friends. When the city of State College, Pa. was recently troubled by too many starlings, members of the department of zoology and entomology devised an effective antidote.

A captured bird was held by its legs near a microphone. Its startled chirp, identified as a distress call, was recorded and a continuous, hour-long tape fabricated.

The recording, amplified to a level of 120 db, was played an hour and a half for three nights from a sound truck that toured the city. It was estimated that only about 200 birds remained, the others being frightened away.

Although the recording was dis-



Colors available in production quantities include:

Natural . . . white . . . yellow (two shades) **. . . buff . . . orange . . . pastel red . . . red . . . dark red . . . brown . . . green . . . blue . . . black.**

SPECIFICATIONS: GPG Rod

Flexural strength	65,000—85,000 psi.
Compressive strength (radial)	950—1,100 psi.
Arc resistance	120 sec.
Water absorption	0.10—0.20%
Resin content	50%
Specific gravity	1.60
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Standard lengths	24" to 84"

Also available Chalk-Filled (GPG-C) and Flame-Retardant (GPF). Inquiries invited for larger diameters, longer lengths and special shapes.

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Although this new material weighs only one-fifth as much, it possesses flexural and tensile strength equal to that of low carbon steel. It's non-corrosive, and resists deformation from bending. Picture how you can use its color for decoration, identification, or coding . . . its high strength-to-weight ratio for structural parts . . . its excellent electrical properties in shafts for electronic components.

Taylor specialists will be glad to talk over the ways you can put this material to work. They'll be glad to discuss, too, the improvements in production and product quality that you can realize through the use of Taylor Vulcanized Fibre and Taylor Melamine, Phenolic and Silicone Laminates.

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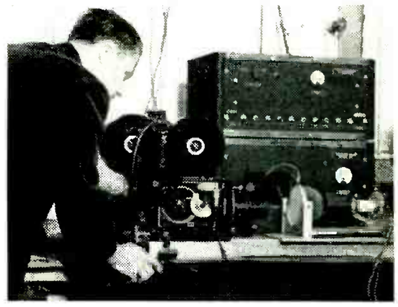
tressing to human beings, they wêre spared some discomfort by aiming the loudspeakers upwards into the trees. The sound affected only the starlings and had no effect upon common grackles or American robins.



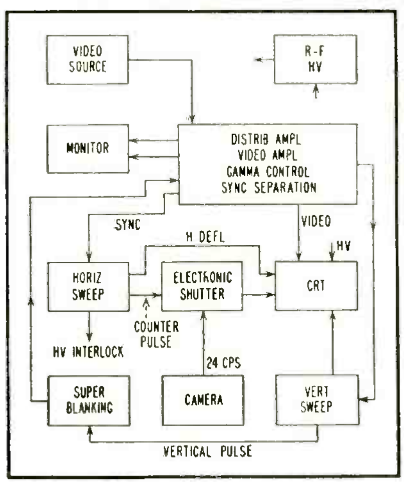
Television recording system designed for military operation comprises special film camera focused on kinescope. Ancillary electronic equipment enclosed in relay-rack cabinet is not shown

Video Recorder Uses Shutterless Camera

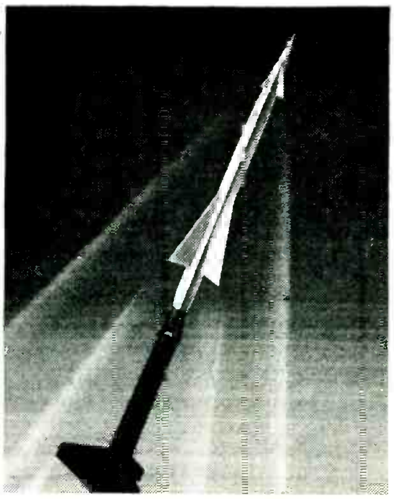
AN EXPERIMENTAL VIDEO recording system using a free-running, shutterless camera and an electronic shutter that provides a variety of television line and frame rates has been constructed at the Naval Research Laboratory.

The electronic shutter, replacing the more familiar mechanical shutter, operates by blanking and unblanking the recording kinescope.

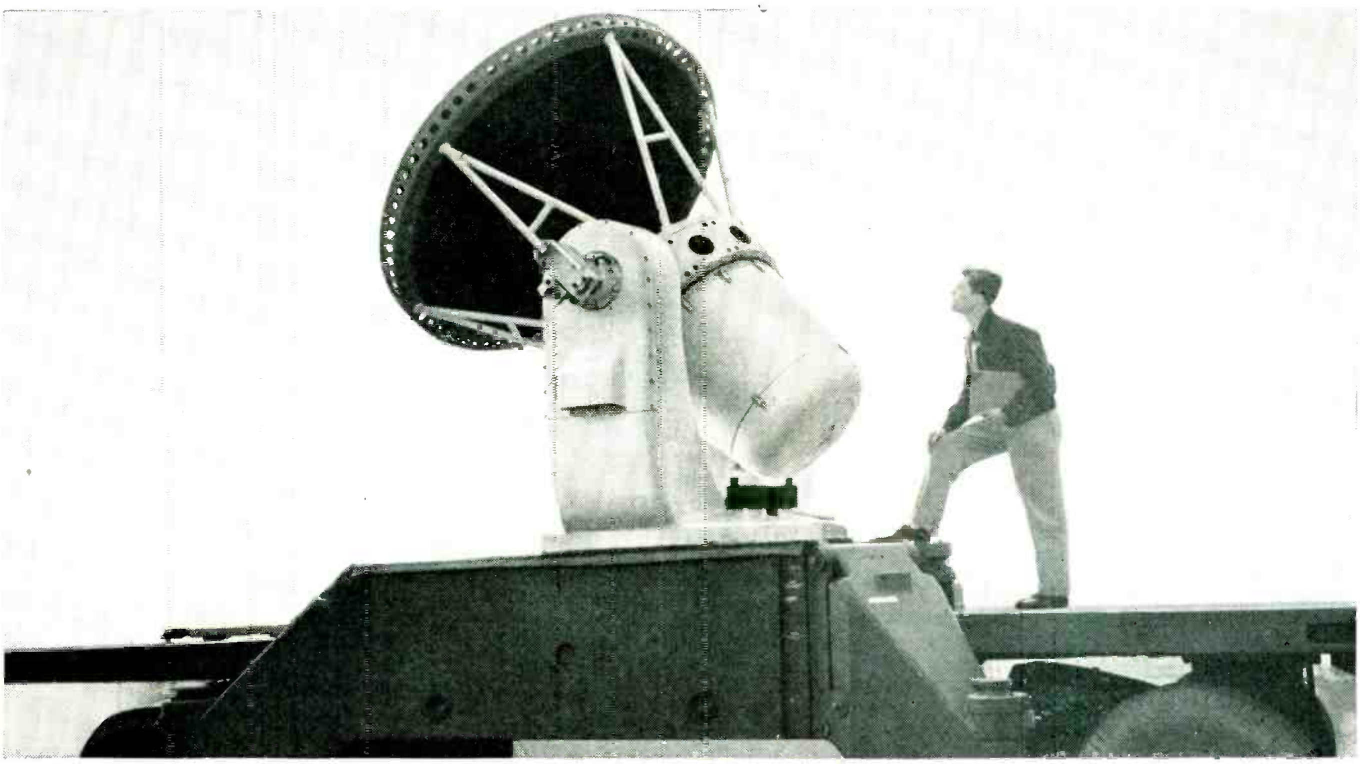
Used in a 525-line system with a camera having a pull-down time of 72 degrees or less, 80 percent of



Block diagram shows interconnection of special tv recording system developed at Naval Research Laboratory



TELEPHONE SCIENCE GUIDES A PUNCH NO ENEMY CAN DODGE



(Upper left) — Nike's missile climbs to destroy an enemy, under guidance of complex electronic controls. A radar is shown at right. Nike (pronounced Ny'kee) is named after the Greek goddess of Victory.

BELL TELEPHONE LABORATORIES

Is it possible to guide an anti-aircraft missile so that it will track down and destroy a rapidly maneuvering target? No one knew the answer for sure when the U. S. Army put this question to Bell Telephone Laboratories in 1945.

The special skills and techniques developed to create the nation's communications network uniquely fitted Bell scientists to answer this question. They recommended a new system, Nike, and then worked to bring it into being with engineers from Army Ordnance, Western Electric Company and Douglas Aircraft Company.

The first Nike installation has been made, and more will follow. Thus, America's defenses grow stronger through a new extension of frontiers in the communications art. It is a proud achievement of the knowledge and skills first developed at Bell Telephone Laboratories to make the nation's telephone service ever better.

Improving telephone service for America provides careers for creative men in scientific and technical fields

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the televised information can be recorded, with a 24 frame per second recording rate. This system, applicable to military operations, does not include simultaneous sound recording.

Britain Uses Industrial Controls

By John H. Jupe
Rogart, Hillside Road
Chorleywood, Herts
England

Increased productivity results from use of machinery, which is often dependent upon development of industrial control mechanisms. Several of the devices described below have recently been put to work in Great Britain.

Elongation Gage

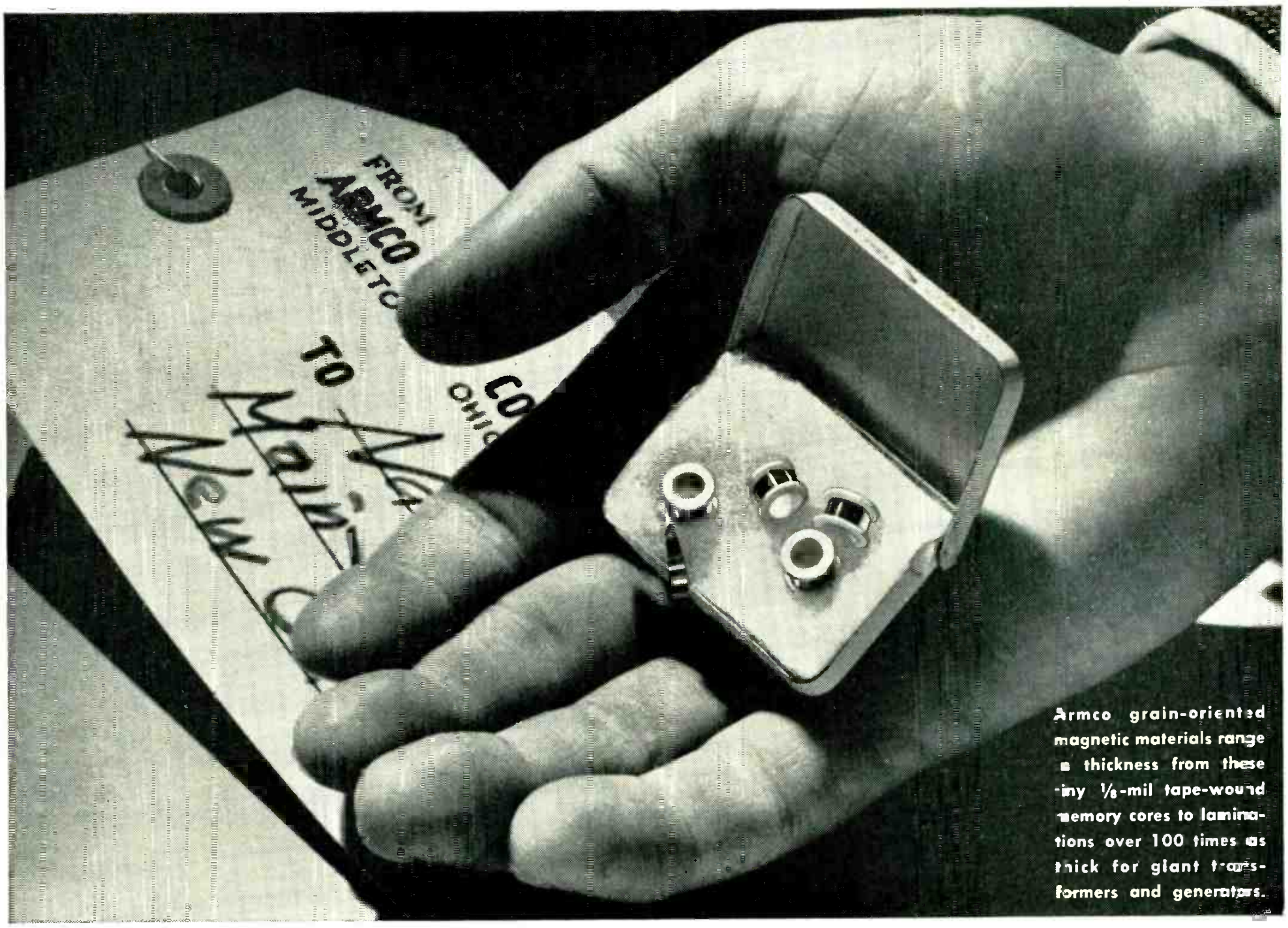
A technique that has been developed in Britain for the accurate measurement of the elongation occurring when steel or other ferrous strip is rolled, depends in principle on the measurement of the wavelength of a magnetic pattern. This is printed on the strip before rolling and is subsequently redetermined after rolling. During the passage of the metal through the mill, the peaks of the pattern will become separated, that is, their wavelength will increase and therefore the time interval between peaks before and after rolling can be a measure of the elongation that has taken place.

Level Indicator

A new type of level indicator that can be used for liquids, powders or granular solids, incorporates an arrangement that makes it independent of all reasonable changes of tube characteristics, supply voltage or general loading of the apparatus.

The indication of level of the desired material is given on a meter that measures the out-of-balance voltage of a capacitance bridge, one arm of which is composed of the capacitance to ground of a vertically mounted probe.

Constancy of output from the oscillator that supplies the bridge



Armco grain-oriented magnetic materials range in thickness from these tiny 1/8-mil tape-wound memory cores to laminations over 100 times as thick for giant transformers and generators.

For Grain-Oriented Magnetic Material, Come To Armco!

ORTHONIK

Ultra-thin (1 to 1/8-mil) Armco 48 ORTHONIK is highly grain-oriented. Its extreme thinness and rectangular hysteresis loop make it especially useful in memory cores of digital computers and reactors in other servo-networks requiring a high rate of change of flux with respect to time.

THIN SILICON STEELS

Armco Thin Oriented Silicon Steels are made in thicknesses of 4, 2 and 1 mil. Used for frequencies of 400 to 200,000 cycles per second for radio, television and other electric devices. They have exceptionally high permeabilities, low hysteresis losses for such thin material and excellent lamination factors.

STANDARD GAGE ORIENTED

In 14-mil thickness, Armco Oriented silicon steels are ideal in power and distribution transformers and generators. These steels, known as Armco ORIENTED M-8X and M-7X, are supplied in coils or cut lengths, usually CARLITE Insulated. They are ideal for stacked cores so designed that flux passage is predominantly in the rolling direction of the sheet.

For wound cores, there are Armco ORIENTED M-7W and M-6W, supplied only in coils 12 mils thick to wind more readily than 14-mil material, into compact cores.

For further information on these oriented magnetic materials, just fill out the coupon and mail it to us.

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is obtained in a unique way. An auxiliary output circuit on the oscillator takes off a proportion of the output and passes it via a metal rectifier to a moving-coil meter element. This element has the conventional pointer replaced by a light metal vane. The capacitance between this vane and another fixed vane is connected into a feedback circuit in the oscillator in such sense that if there is any tendency for the oscillator output to drift, for any reason at all, the change will move the vane on the meter element in such a direction as to secure compensation.

Photoelectric Leveling Device

A device has been developed for automatically controlling the tilt of a platform. The arrangement consists of a light source and a photocell, with the bubble of a spirit level between them, mounted in such a way that movements of the bubble cause the illumination on the cell to vary.

Between the cell and the bubble is a vane with a narrow slot in it, so that the slot covers a portion of the width of the bubble and in such a way that when the light passes through the liquid alone, the illumination on the cell is at a maximum. When the platform is tilted the bubble moves and causes the focus of the light rays to move away from the slot in the vane and so decreases the amount of light falling on the photocell. The output of this cell is compared with that from a twin cell that is in the direct beam of the light and thus a difference signal is obtained.

This signal provides a correcting force to restore the platform to a level position. If desired, two leveling units can be placed at right angles.

Accelerometer

In an accelerometer instrument, the moving system used is the same as the moving system employed in electrical indicating instruments. It is adapted as a sensing element by deliberately upsetting the balance of the system by means of a small weight attached to the coil. When the instrument is subjected to an accelerating force in the right direction, the inertia of the moving-

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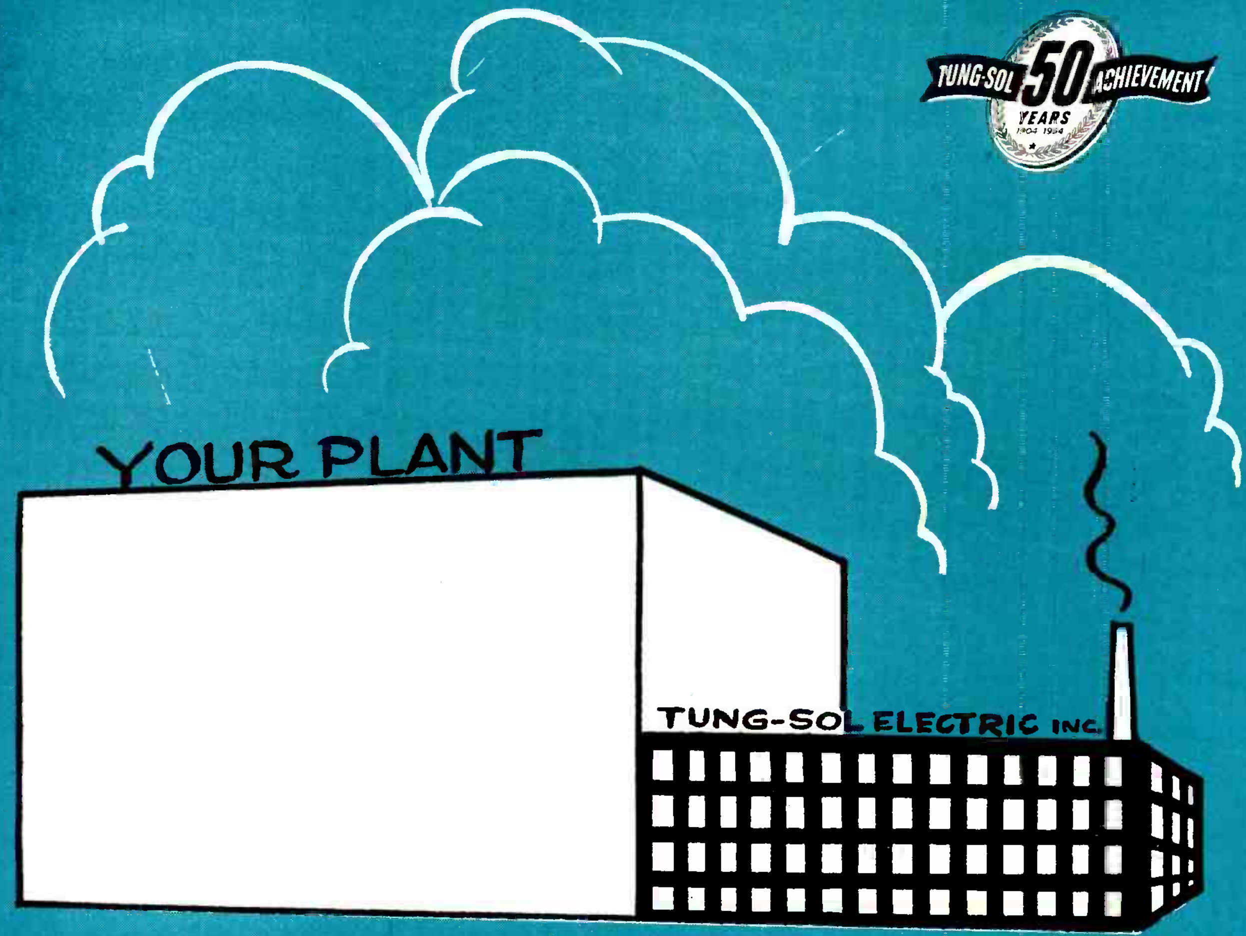

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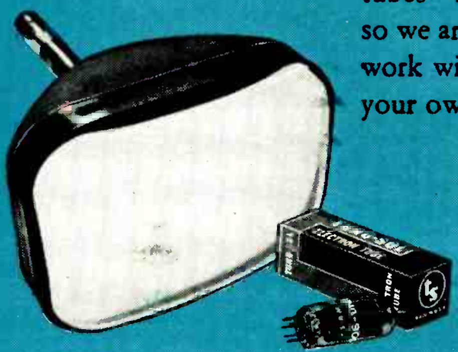

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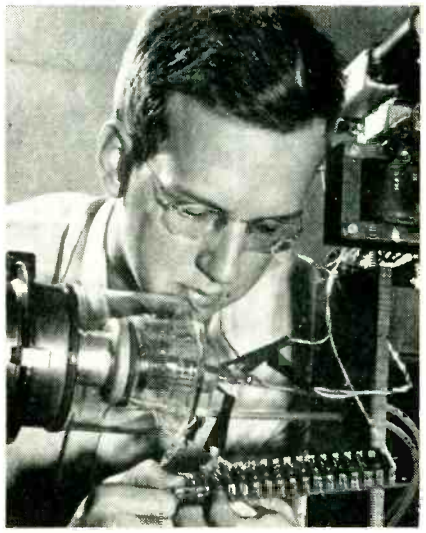
coil system causes the coil to rotate in the permanent-magnet field system and so generates a small direct current. This can be displayed on a suitable galvanometer or can be amplified by electronic means for transmission to a distant point.



Junior Linear Accelerator Fights Cancer

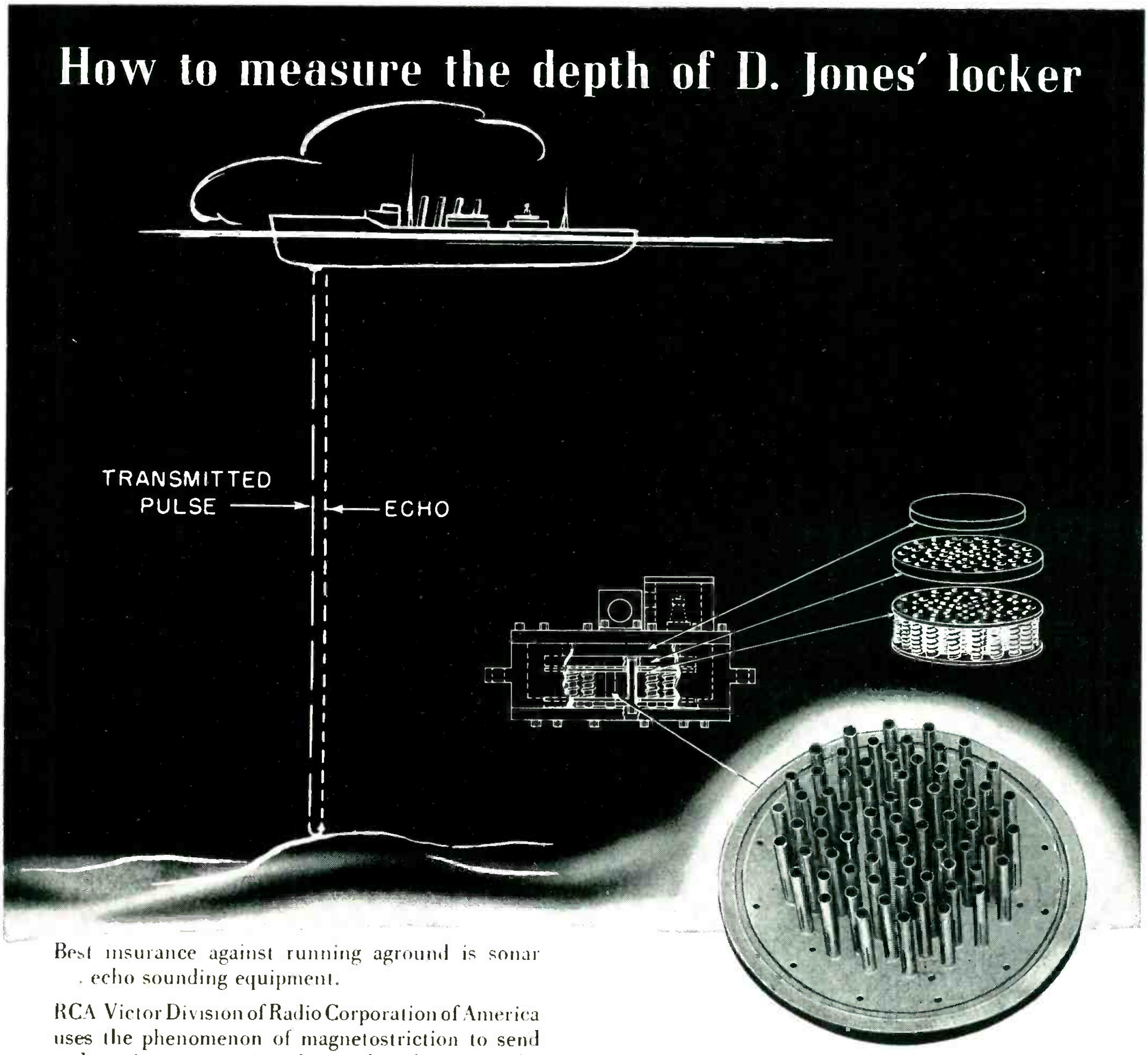
Six-million-volt electron bullets will be fired at cancerous laboratory animals from a small linear accelerator of which the prototype gun is shown in the photograph above. The gun will be attached to a 6-foot copper tube. Electrons, accelerated by superhigh-frequency radio waves from a klystron tube, will fly towards their target at nearly the speed of light. Stanford University scientists are completing a 1,000,000,000-volt, 200-foot electron linear accelerator using the same principles

High-Power Visual Amplifier for TV

By John Ruston
Allen B. DuMont Laboratories, Inc.
Clifton, N. J.

Extended power range of low-band tv transmitters is accomplished with the high-power visual amplifier shown in Fig. 1. A single type 4W20000A tetrode is used in a quasi-grounded cathode circuit and is operated at a power gain of 50. This enables the high-power ampli-

How to measure the depth of D. Jones' locker



Best insurance against running aground is sonar . echo sounding equipment.

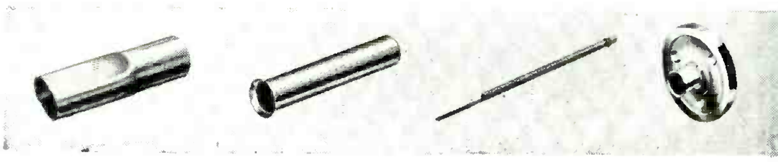
RCA Victor Division of Radio Corporation of America uses the phenomenon of magnetostriction to send and receive supersonic pulses and so determine the distance to a submerged object on the ocean's floor.

Magnetostriction—the familiar "Joule Effect" of your textbook days—is the ability of a ferromagnetic metal to change dimensions when magnetized. The metal of RCA echo sounding equipment is Superior Grade "A" nickel tubing.

70 pieces of Superior seamless nickel tubing, cold drawn to 3/8" O.D. x .020" wall thickness and cut to 1/4 of the wave length of the alternating current signal, are soldered to a plate. Each length is enclosed by a coil.

Energizing the coil with alternating current, the tube expands and contracts, creating a piston effect on plate and diaphragm, sending out a supersonic wave. Likewise, reception of the echo wave by the diaphragm again causes the nickel tubes to pulsate and induce a current in the coil.

RCA Victor looks to Superior for accuracy and uniformity of analysis, precision drawing and cutting in large quantities. For cathodes, anodes, or tubing specialties, and tubing technology—ask Superior. Superior Tube Company, 2500 Germantown Avenue, Norristown, Pa.



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Lockseam* Nickel Cathode. Round, tabbed, single bead, .045" O.D. x .0021" Wall. 27 mm long.

Disc Cathode .121" O.D. .312" long.

Many types of nickel cathodes—made in Lockseam* from nickel strip, disc cathodes, and a wide variety of anodes, grip cups and other tubular fabricated parts are available from Superior. For information and Free Bulletin, address Superior Tube Company, Electronics Division, 2500 Germantown Avenue, Norristown, Pa.

*Manufactured under U.S. Patents.

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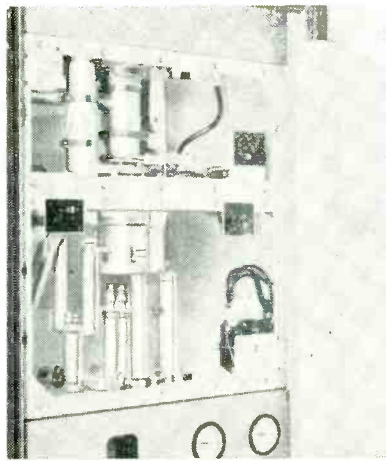

Cabinet mounting of vhf amplifier. Anode bypass capacitor is at left of tube

fier to be driven by a 500-watt transmitter without an intermediate amplifier. Rated peak power output is 25 kw. With an antenna of reasonable power gain, the amplifier provides the maximum permissible erp of 100 kw on channels 2 through 6.

The circuit differs from the conventional grounded-cathode type by the inclusion of a small variable inductor between cathode and ground. This provides adjustable degeneration that effectively loads the input circuit[1] to give the desired bandwidth and counteracts the reinsertion of lower sideband voltages removed by a filter in the driver. No sideband and filter external to the transmitter is then required.

The amplifier input circuit is connected to the double-tuned output circuit of the driver with a short length of coaxial cable. The complete coupling system is virtually a triple-tuned circuit and is aligned by using the conventional procedure for such circuits. The amplifier output is a double-tuned circuit capacitively coupled to the coaxial output transmission line.

Construction

The r-f circuit is contained in a shielded compartment divided into input and output sections by a horizontal grounded partition. The 4W20000A tube is mounted with the anode downwards. Spring fingers connect the screen terminal ring to a plate forming a bypass capacitor with the underside of the partition; the plate and partition

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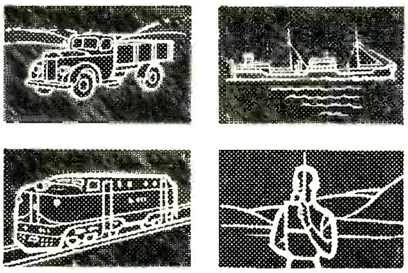

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are separated by sheets of Teflon. The anode tuning inductor, consisting of two pieces of tubing joined by a movable shorting bar, is connected between the anode terminal and another plate that forms a bypass capacitor with the underside of the screen plate (Fig. 2).

The output inductor is of similar type and is resonated by an air-dielectric capacitor on the underside of the partition. Coupling between anode and output circuits is adjusted by swinging the output inductor as indicated by the arrows.

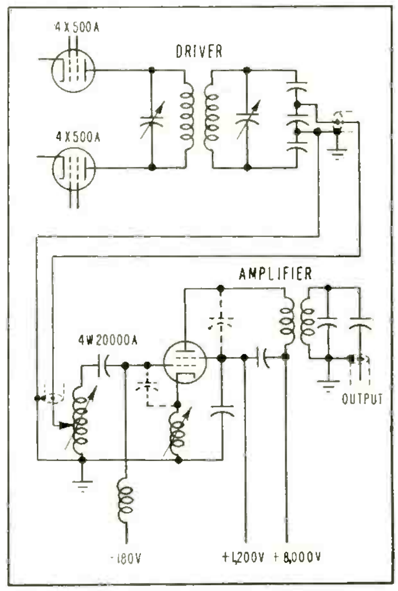
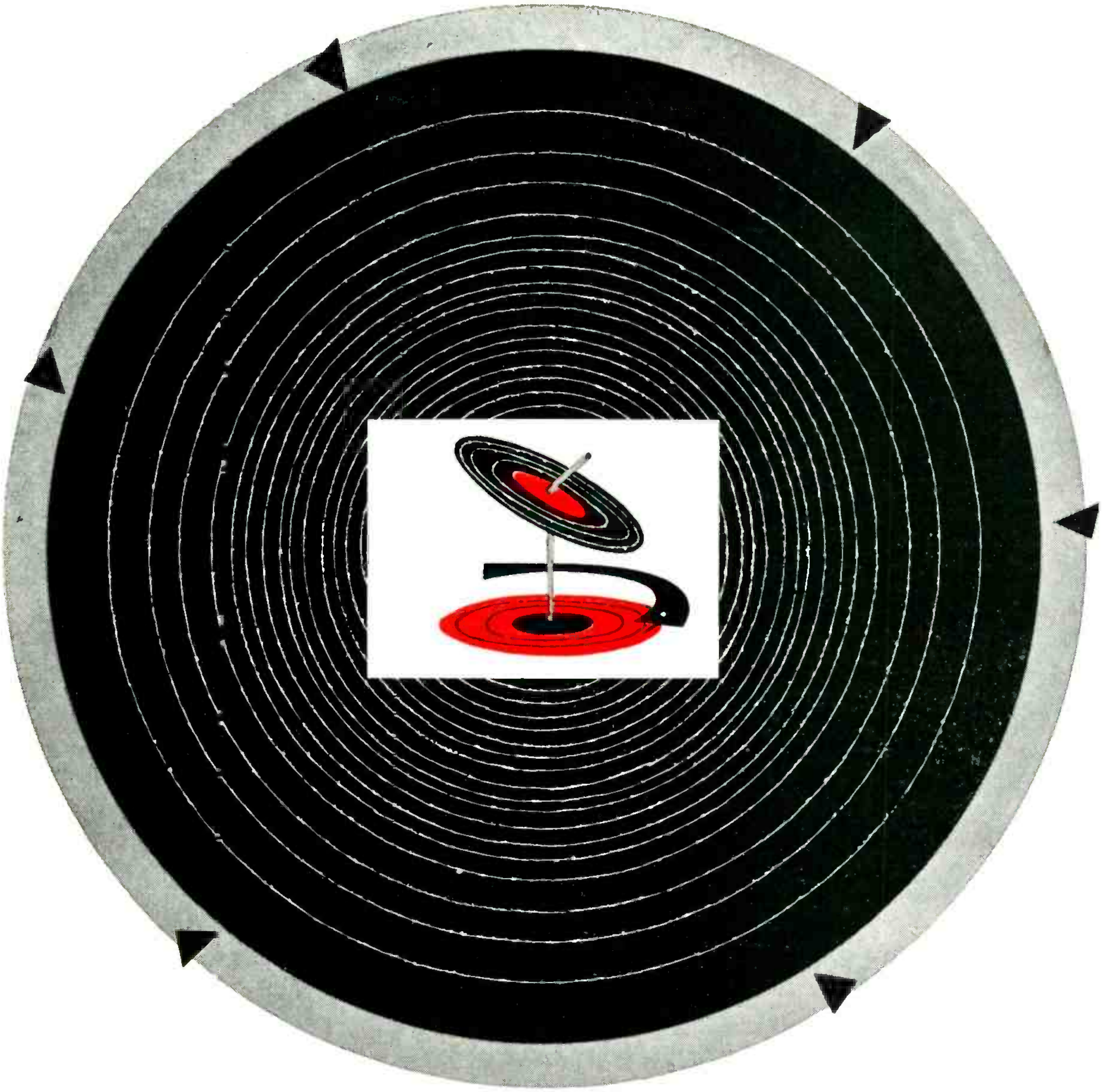


FIG. 1—Circuit of 25-kw amplifier showing coupling methods used

The circuits are aligned as a pair of slightly overcoupled tuned circuits to give a substantially uniform response, adequate bandwidth and optimum load impedance for the tube.

In the upper section of the shielded compartment, the grid ring terminal is connected by spring fingers to a circular plate supported on insulators from a grounded bracket. The input tuning inductor connected between grid and ground consists of two parallel strips joined by a movable shorting block. A d-c isolating capacitor is built into the lower strip and bias voltage is applied through an r-f choke. The coaxial cable from the driver is tapped onto the input inductor as shown. Spring fingers connect the cathode terminal of the tube to a plate supported on insulators above the grounded bracket. This plate is connected to ground through an



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adjustable inductor consisting of another pair of parallel strips joined by a movable shorting block.

The inductors all have sufficient range of adjustment to cover low-band tv channels 2 to 6, the shorting bars being preset for the desired channel. Fine tuning of the input, anode and output cricuits is obtained by small variable capacitors operated by control knobs on the front of the unit.

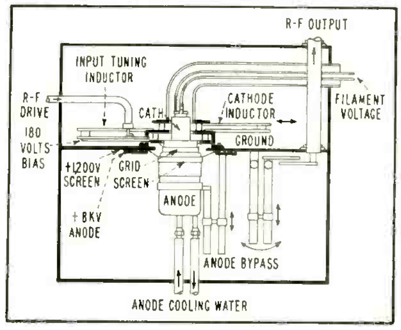

FIG. 2—Mounting of tube and tuning capacitors in 25-kw visual amplifier

The r-f compartment, as shown in the photograph, is mounted in a cabinet having the same size and styling as those used for the driver. The lower part of the cabinet contains voltage-dropping coils, Flowrator for anode cooling water and the upper part houses a blower for tube-seal cooling. All power supplies and control circuits for the amplifier are contained in a separate cabinet. The only component external to the cabinets is the plate-supply transformer.

Measured performance approaches the maximum theoretically possible with this tube type[2], it being possible to obtain a peak power output somewhat greater than 30 kw at a power gain of more than 100. Normal operation at 25 kw peak power and a power gain of 50 thus provides an adequate safety factor. If operation at less than the rated output is desired, power gain can be reduced by means of the adjustable cathode inductor. The amplifier is very stable with no tendency to self-oscillation even when operated at maximum power gain of which it is capable. This can be attributed to the effective shielding between input and output circuits made possible by ring-seal type of tube construction and the self-neutralizing characteristic of

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the tetrode tube in the vhf band[3]. As a result of the isolation of input and output circuits, they can be tuned independently with negligible interaction thus simplfying their alignment for broadband operation.

REFERENCES

(1) F. E. Terman, "Radio Engineer's Handbook," p 472, McGraw-Hill Book Co. Inc., New York, N. Y., 1943.
(2) J. Ruston, High Gain Amplifiers for High Power TV Transmitters, *Convention Record of the IRE*, Part 4, 1953 National Convention.
(3) W. G. Wagener, 500-MC Transmitting Tetrode Design Considerations, *Proc IRE*, 36, No. 5, May 1948.

Photographs Changed to Line Drawings

THE EXPERIMENTAL opticoelectronic system shown in Fig. 1 was developed by H. M. Joseph of the National Bureau of Standards in consultation with L. S. G. Kovasznay of Johns Hopkins University to produce outline pictures from halftone photographs. It may find use in automatic recognition of patterns such as fingerprints or biological specimens.

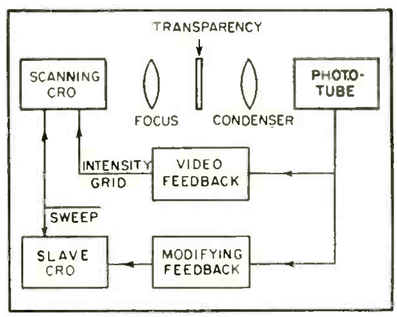

FIG. 1—Image feedback system produces desired type pattern on slave oscilloscope

The system uses patterns in the form of photographic transparencies placed between a cathode-ray tube moving-spot scanner and a multiplier phototube. Signals resulting from scanning the picture are amplified and fed back to the crt intensity control such that a picture is produced upon its screen.

Negative feedback thus obtained improves tonal rendition of the picture. The same signals are also applied to another amplifier and the resulting signal is used to control a monitor crt tube that reproduces the same picture. Modifying cir-

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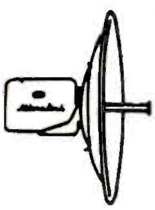

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cuits between phototube and monitor alter the image.

Any scanning pattern may be used, but the electronic circuits are simplest when the scanning velocity is the same in two orthogonal directions. Triangular waves are applied to the horizontal deflection of the scanner and a slightly different-frequency wave to the vertical deflection. The result is a Lissajous figure of rectangular shape that changes its proportions with the instantaneous phase between the two waves. The same waves are applied to the monitor for identical scanning.

This system has been employed in the enhancement of contours in photographs and for production of outline pictures from halftone photographs as shown in Fig. 2. The process of contour enhancement is essentially that of increasing the abruptness of tone transition at contour lines.

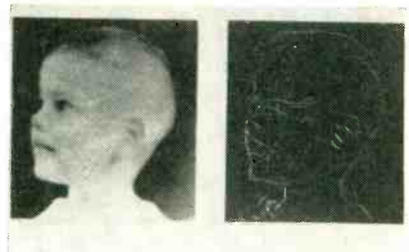

FIG. 2—Video picture (left) produced from original photo negative. At right, outline resulting from singly differentiated and rectified video signals that were then amplified and clipped at constant level

Sharpening of tone transitions for contour enhancement is accomplished by electrically adding the negative of the second derivative from the original signal. Mathematical analysis of the process indicates that a first approximation to a correctly focused picture is obtained when this process is applied to an incorrectly focused picture. Used in this way, the system is a two-dimensional visual analogue of a high-frequency compensated audio system.

When signals from a differentiating network are rectified, a positive pulse is obtained as the light spot passes over a region of sharp tone gradient. The application of such signals to the intensity control of the monitor results in pictures

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5.0 MH	MP-206-1 –	2.0 MH	MP-848 1 –	5.0 MH	MP-930-1 –	5.0 MH	MP-395-1 –	20 MH	MP-254-1 –
6.0 MH	MP-206-2 –	2.4 MH	MP-848 2 –	6.0 MH	MP-930-2 –	6.0 MH	MP-395-2 –	24 MH	MP-254-2 –
7.2 MH	MP-206-3 –	3.0 MH	MP-848 3 –	7.2 MH	MP-930-3 –	7.2 MH	MP-395-3 –	30 MH	MP-254-3 –
8.6 MH	MP-206-4 –	3.6 MH	MP-848 4 –	8.6 MH	MP-930-4 –	8.6 MH	MP-395-4 –	36 MH	MP-254-4 –
10 MH	MP-206-5 –	4.3 MH	MP-848 5 –	10 MH	MP-930-5 –	10 MH	MP-395-5 –	43 MH	MP-254-5 –
12 MH	MP-206-6 –	5.0 MH	MP-848 6 –	12 MH	MP-930-6 –	12 MH	MP-395-6 –	50 MH	MP-254-6 –
15 MH	MP-206-7 –	6.0 MH	MP-848 7 –	15 MH	MP-930-7 –	15 MH	MP-395-7 –	60 MH	MP-254-7 –
17.5 MH	MP-206-8 –	7.2 MH	MP-848 8 –	17.5 MH	MP-930-8 –	17.5 MH	MP-395-8 –	72 MH	MP-254-8 –
20 MH	MP-206-9 –	8.6 MH	MP-848 9 –	20 MH	MP-930-9 –	20 MH	MP-395-9 –	86 MH	MP-254-9 –
24 MH	MP-206-10 –	10 MH	MP-848-10 –	24 MH	MP-930-10 –	24 MH	MP-395-10 –	100 MH	MP-254-10 –
30 MH	MP-206-11 –	12 MH	MP-848-11 –	30 MH	MP-930-11 –	30 MH	MP-395-11 –	120 MH	MP-254-11 –
36 MH	MP-206-12 –	15 MH	MP-848-12 –	36 MH	MP-930-12 –	36 MH	MP-395-12 –	150 MH	MP-254-12 –
43 MH	MP-206-13 –	17.5 MH	MP-848-13 –	43 MH	MP-930-13 –	43 MH	MP-395-13 –	175 MH	MP-254-13 –
50 MH	MP-206-14 –	20 MH	MP-848 14 –	50 MH	MP-930-14 –	50 MH	MP-395-14 –	200 MH	MP-254-14 –
60 MH	MP-206-15 –	24 MH	MP-848-15 –	60 MH	MP-930-15 –	60 MH	MP-395-15 –	240 MH	MP-254-15 –
72 MH	MP-206-16 –	30 MH	MP-848-16 –	72 MH	MP-930-16 –	72 MH	MP-395-16 –	300 MH	MP-254-16 –
86 MH	MP-206-17 –	36 MH	MP-206 17 –	86 MH	MP-930-17 –	86 MH	MP-395-17 –	360 MH	MP-254-17 –
100 MH	MP-206-18 –	43 MH	MP-848 18 –	100 MH	MP-930-18 –	100 MH	MP-395-18 –	430 MH	MP-254-18 –
120 MH	MP-206-19 –	50 MH	MP-848 19 –	120 MH	MP-930-19 –	120 MH	MP-395-19 –	500 MH	MP-254-19 –
150 MH	MP-206-20 –	60 MH	MP-848 20 –	150 MH	MP-930-20 –	150 MH	MP-395-20 –	600 MH	MP-254-20 –
175 MH	MP-206-21 –	72 MH	MP-848 21 –	175 MH	MP-930-21 –	175 MH	MP-395-21 –	720 MH	MP-254-21 –
200 MH	MP-206-22 –	86 MH	MP-848 22 –	200 MH	MP-930-22 –	200 MH	MP-395-22 –	860 MH	MP-254-22 –
240 MH	MP-206-23 –	100 MH	MP-848 23 –	240 MH	MP-930-23 –	240 MH	MP-395-23 –	1.00 HY	MP-254-23 –
300 MH	MP-206-24 –	120 MH	MP-848 24 –	300 MH	MP-930-24 –	300 MH	MP-395-24 –	1.20 HY	MP-254-24 –
360 MH	MP-206-25 –	150 MH	MP-848 25 –	360 MH	MP-930-25 –	360 MH	MP-395-25 –	1.50 HY	MP-254-25 –
430 MH	MP-206-26 –	175 MH	MP-848 26 –	430 MH	MP-930-26 –	430 MH	MP-395-26 –	1.75 HY	MP-254-26 –
500 MH	MP-206-27 –	200 MH	MP-848 27 –	500 MH	MP-930-27 –	500 MH	MP-395-27 –	2.00 HY	MP-254-27 –
600 MH	MP-206-28 –	240 MH	MP-848 28 –	600 MH	MP-930-28 –			2.40 HY	MP-254-28 –
720 MH	MP-206-29 –	300 MH	MP-848 29 –	720 MH	MP-930-29 –			3.00 HY	MP-254-29 –
860 MH	MP-206-30 –	360 MH	MP-848 30 –	860 MH	MP-930-30 –			3.60 HY	MP-254-30 –
1.00 HY	MP-206-31 –	430 MH	MP-848-31 –	1.00 HY	MP-930-31 –			4.30 HY	MP-254-31 –
1.20 HY	MP-206-32 –	500 MH	MP-848-32 –	1.20 HY	MP-930-32 –			5.00 HY	MP-254-32 –
1.50 HY	MP-206-33 –			1.50 HY	MP-930-33 –			6.00 HY	MP-254-33 –
1.75 HY	MP-206-34 –			1.75 HY	MP-930-34 –			7.20 HY	MP-254-34 –
2.00 HY	MP-206-35 –			2.00 HY	MP-930-35 –			8.60 HY	MP-254-35 –
2.40 HY	MP-206-36 –			2.40 HY	MP-930-36 –			10.0 HY	MP-254-36 –
3.00 HY	MP-206-37 –			3.00 HY	MP-930-37 –			12.0 HY	MP-254-37 –
				3.60 HY	MP-930-38 –			15.0 HY	MP-254-38 –
				4.30 HY	MP-930-39 –			17.5 HY	MP-254-39 –
				5.00 HY	MP-930-40 –			20.0 HY	MP-254-40 –
				6.00 HY	MP-930-41 –			24.0 HY	MP-254-41 –
				7.20 HY	MP-930-42 –			30.0 HY	MP-254-42 –
				8.6 HY	MP-930-43 –			36.0 HY	MP-254-43 –
				10.0 HY	MP-930-44 –				
				12.0 HY	MP-930-45 –				
				15.0 HY	MP-930-46 –				
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that show only the contour lines, like line drawings.

This process may be used for automatic production of sketch maps from terrain photographs or the display of contours on x-ray pictures or coronagraphs. In picture transmission where line drawings are acceptable, economies in bandwidth are possible through reduction in the information that must be transmitted. Also, contrast enhancement may be used in television to reduce the effects of low transmission bandwidth.

The convenience and rapidity with which the position of the picture on the tube screen can be manipulated, as well as the possibility of scale changes in any direction, may permit automatic recognition of patterns by auto-correlation techniques. Among the patterns that might be recognized or compared in this way are military targets, fingerprints, printed or written matter, pathological blood cells or various types of crystals.

Magnetic Recording of PWM Signals

By Max L. Van Doren
Research Engineer
Douglas Aircraft Co.
Santa Monica, Calif.

A TELEMETERING SYSTEM suitable for the flight testing of piloted aircraft transmits to ground recording equipment information from 88 input devices having d-c outputs in the millivolt range. A high-speed switch is used to commutate the input devices to a common amplifying system. The information is then converted to pulse-width form and transmitted to the receiving station on a single, frequency-modulated r-f carrier. The rate of commutation is approximately 16 rps, thus, each input device is sampled and recorded 16 times per second for the duration of the flight. Since there are 88 input instruments, there are approximately 1,400 discrete data points recorded each second. About eight of the input channels are used to carry calibration, linearity checks and time-correlation information leaving 80

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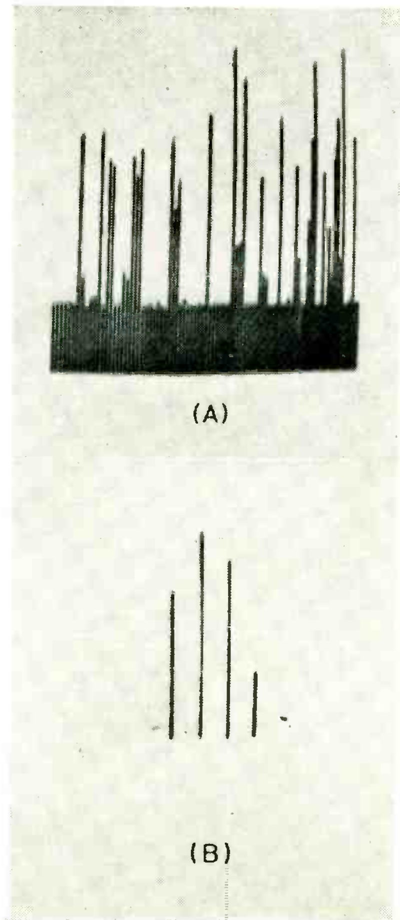


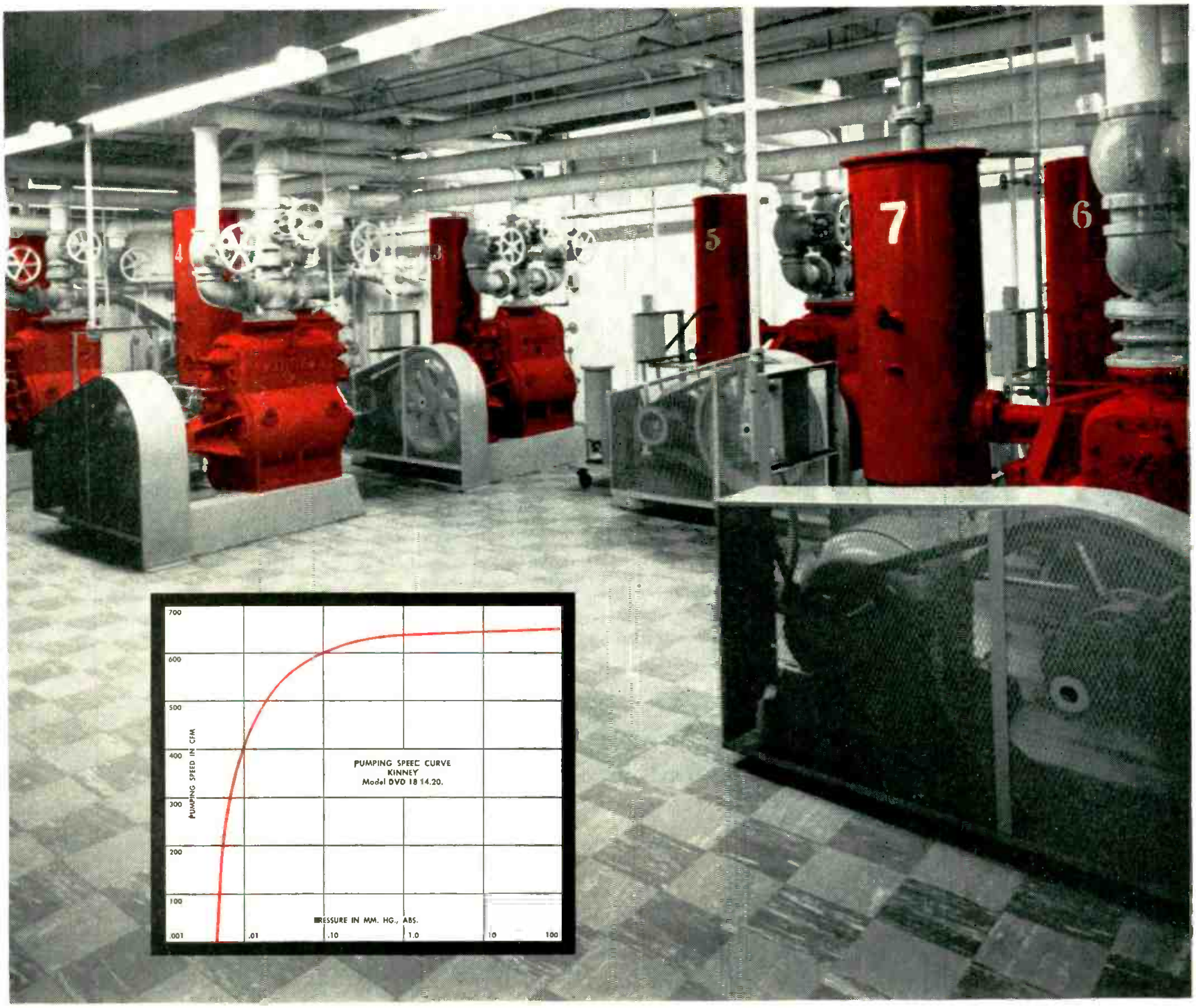
FIG. 1—Scope presentation of 88 pwm channels (A). Commutation system permits viewing selected groups of channels (B)

channels to carry flight test data.

At the ground station, the signal is received and presented in a lines raster form on the monitor scope as shown in Fig. 1 and is simultaneously recorded on magnetic tape. All of the test-data channels may be surveyed on the scope or by electronic decommutation any one channel or group of channels may be observed independently. By feeding the tape output to the automatic data reduction system, data from any given channel or group of channels may be reduced to the desired form.

The output of any channel may be continuously compared to the calibration channels, either visually or electrically, to determine applicable scale value. Since the calibration information originates at the input to the airborne system, any transmission errors are automatically compensated.

Basically, the information from each input device is commutated in



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sequence forming a chain of 88 pulses with the 89th and 90th pulses omitted for synchronization purposes. Each pulse varies in width as a function of the commutated input voltage. The transfer function expressing this relation is

$$PW_n = 44.44E_n \times 10^3 + 120 \ \mu\text{sec}$$

E_n = input voltage of channel n in volts

PW_n = resultant pulse width of pulse n in μsec

The minimum input voltage for any channel is zero and the maximum 9 mv. This results in minimum and maximum pulse widths of 120 and 520 μsec respectively. The commutation rate is 90 channels in 60 milliseconds, therefore, the pulse spacing is approximately 666 μsec. Under maximum pulse width conditions there will be a minimum space between adjacent pulses of 146 μsec.

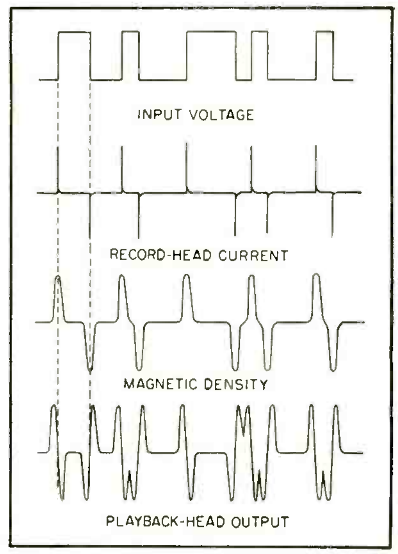
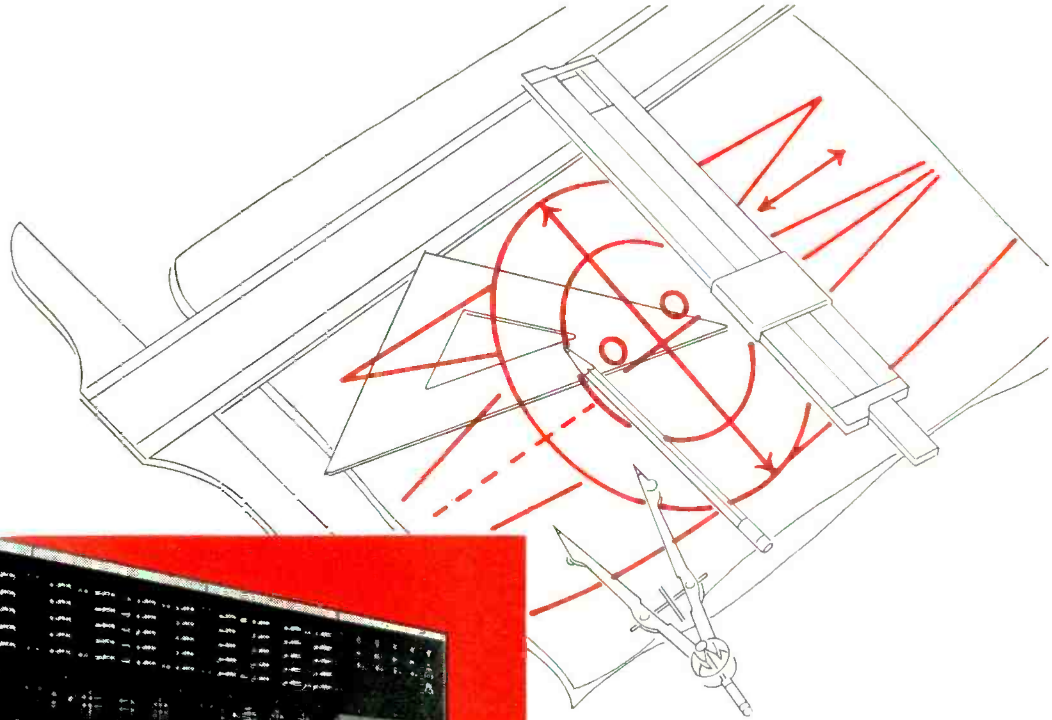
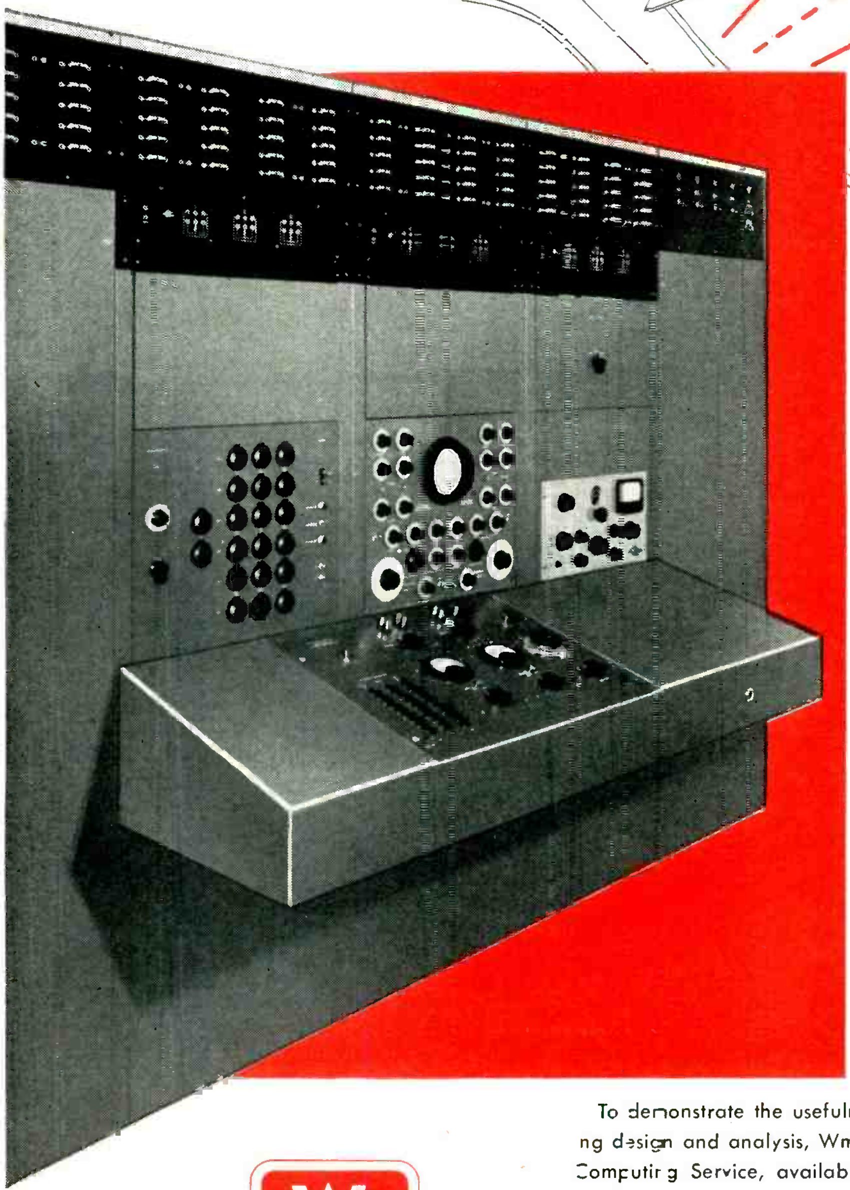


FIG. 2—Waveforms in pwm recorder. Trailing edge of output pulses coincide with leading edge of input pulses

With this recording rate a one-hour flight requires the recording of over 5 million data points. Recording this photographically would require 12,000 feet of film and would be a costly operation. For this reason use of magnetic tape recording was investigated.

With the development of recording heads employing air gaps of 0.00025 inch and improved magnetic instrumentation tape, the main problem to be solved was the design of a suitable integrator. Basically, the problem is simple, a





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near continuous train of rectangular pulses is to be recorded on tape and reproduced on playback with no change in pulse width. When recording the pulse, it is desirable to reduce the magnetic diffusion on the tape so that the magnetized area will be as small as possible. This will provide a sharply defined leading and trailing edge for each recorded pulse. To accomplish this the record head current was made the differential of the input voltage resulting in a current spike of approximately 2 μsec pulse width.

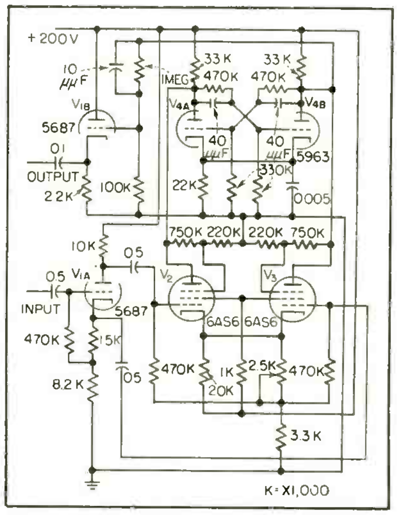
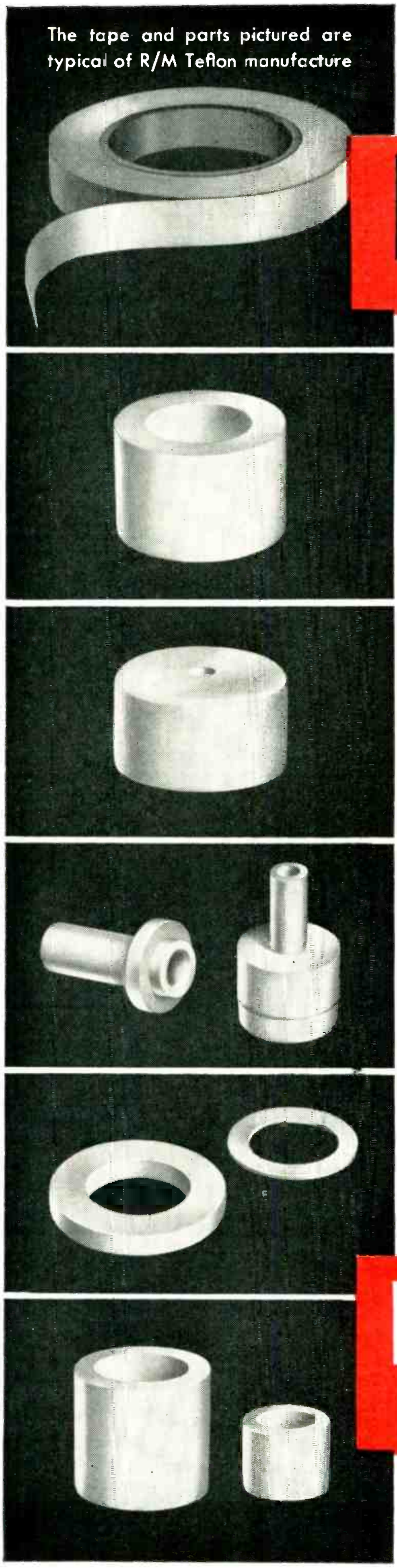


FIG. 3—Integrator circuit sensitive to amplitude and rate polarities near zero

In reproducing this pulse the output of the playback head will be the differential of the magnetic density recorded on the tape. The net result of the record and playback operation is that the output on playback will approximate the second derivative of the recorded waveform. In the process of recording and playback, magnetic-tape and tape-head diffusion will cause pulse distortion and smoothing such that the results will appear approximately as shown in Fig. 2.

In Fig. 2, when the output voltage crosses the zero axis at maximum negative rate it is coincident with the leading edge of the recorded pulse. Conversely, if it crosses while a maximum positive rate it corresponds to the trailing edge of the input pulse. From these observations it is determined that any integrating device should be sensitive to rate polarity and amplitudes near zero. Such a device is shown in Fig. 3.

The pulse reformer has an input



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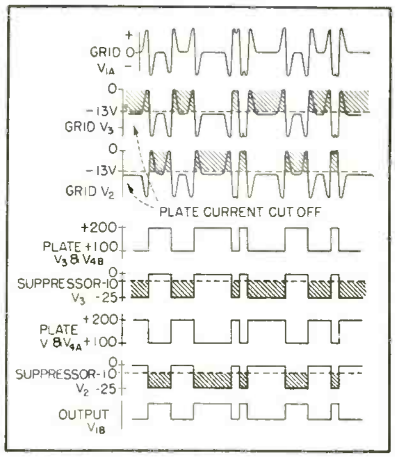

FIG. 4—Pulse sequence in integrator circuit. Shaded area indicates plate current is cut off by suppressor grid

phase inverter, V_{1A}, feeding two gated trigger tubes, V_2 ON and V_3 OFF. Tube V_4 is a bistable multivibrator forming the output pulse and gate signals for the trigger tubes. Tube V_{1B} is a cathode follower with an output impedance of approximately 300 ohms.

Operation and Design

If the integrator is to have no greater ambiguity than one microsecond, a control-voltage amplitude no greater than 3 volts should be considered. To do this a 6AS6 was chosen. The necessity of gating the trigger signal is obvious when both leading and trailing edge signals have positive components. One of these should be eliminated to avoid ambiguity. The positive component of the leading-edge signal and the negative component of the trailing-edge signal are removed by gating so that the only effective portions remaining are the trigger pulses themselves. This gating is accomplished in the suppressor circuit of the trigger tubes.

With the cathodes of the 6AS6's held at +45 volts, the suppressor divider is connected such that the suppressor voltage is 9/40 of the plate to ground voltage minus 45 volts. With +200 volts at the plate, suppressor voltage would be zero. In this condition V_2 could conduct when V_{4B} is cut off if its control grid were above cutoff. When V_{4B} conducts, its plate voltage falls to approximately 100 volts. This results in a suppressor voltage at V_2 of —25 volts and it cannot conduct. The same is true for V_{4A} and V_3. When V_2 conducts it pulls down the

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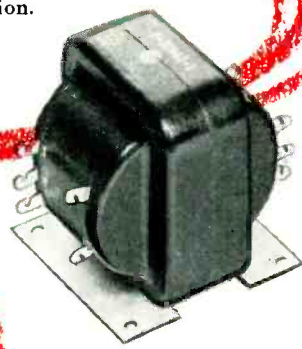

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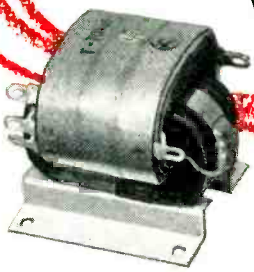

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PRECISION ELECTRONIC EQUIPMENT • OSCILLOSCOPES • MAGNETOMETERS • COMPUTERS • SOLID DELAY LINES plate voltage of V_{4B} and locks itself out of operation while enabling V_3 to conduct when its control grid signal is greater than cutoff. The grid bias for the trigger tubes is held at approximately -13 volts since the 6AS6 under these conditions cuts off at about -10 volts.

The results of this design may be seen by reference to Fig. 4. The entire sequence of operation is interrupted if there is an added extraneous pulse or a missing desirable one. For this reason dropouts due to magnetic tape imperfections are highly undesirable.

Mobile Receiver Speeds Police

Foot patrolmen in Atlantic City, N. J. are scheduled soon to obtain the benefits of police radio. A four-tube, two-cubic-inch receiver shown at left fits into the standard peaked cap. The five-ounce device uses a short antenna attached to the hat shield as modeled by the sergeant at the right

PERTINENT PATENTS

By Norman L. Chalfin
Hughes Aircraft Co.
Culver City, Calif.

Vapor detection and video-amplifier design are included in this month's abstracts of devices interesting to electronics engineers.

Vapor Detector

An interesting application of electronic vacuum-tube technique to detection of the presence of certain compounds in vapors is the subject of patent 2,652,532 issued to P. D. Zemany for an "Electrical Vapor Detector". The patent is assigned

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Only C-D-F, the Continental-Diamond Fibre Company, makes Dilecto laminated plastic, just as only Cadillac makes a Cadillac. Dilecto is 50 different materials with more combinations and variations in desired properties than we can tell you here.

But Dilecto has three important qualities that you should think about if you buy, design, or machine laminated plastics.

DILECTO HAS HIGH MECHANICAL STRENGTH

Mechanical strength is frequently an important determining factor in the selection of an insulating material. Insulating parts used in large electrical power equipment are frequently bulky. The high mechanical strength of Dilecto helps reduce size-dimensions of insulating parts without danger of failure. Instruments, meters and small motors frequently require very small insulating parts which must withstand comparatively large mechanical stresses. Insulation for use in high frequency circuits should have a minimum bulk factor for minimum dielectric losses. Dilecto fulfills these requirements with a combination of high mechanical strength and low loss factor, characteristic of the better C-D-F electrical grades.

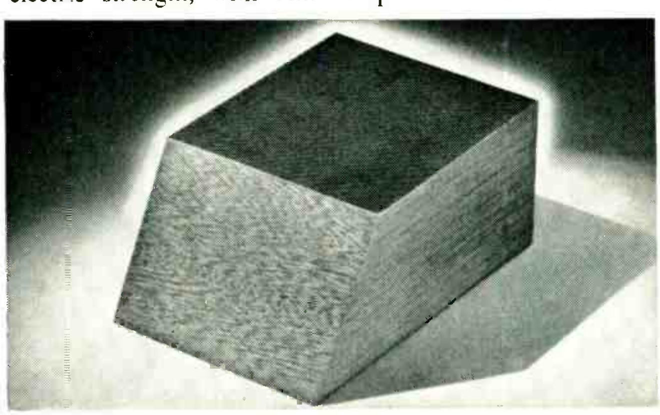
So C-D-F selects for your Dilecto insulation grade the correct, highest quality base material, paper, cotton, nylon, glass. These are used in combination with improved penetrating resins: Improved Phenolic, New Melamine, New Silicone, New Teflon, all synthetic, well polymerized resins.

Both the base and the resin are good insulators by themselves. But C-D-F sells them to you in an improved, practical form . . . Dilecto. Uniform sheets, tight tubes, strong rods, close tolerance machined and formed specialties, high bond strength metal clads.

Why does Dilecto combine so well mechanical strength with dielectric strength and dimensional stability? Because Dilecto is almost homogeneous, a true blend of resin and base.

DILECTO IS ALMOST HOMOGENEOUS

A poor laminate absorbs moisture at its edges, loses its insulating properties fast. Entrapped moisture and other volatiles within the cured structure causes inconsistent dielectric strength, with ultimate puncture and breakdown.



Punch press and bench saw operators know how much time and material is saved when the laminated plastic is *uniform* and *homogeneous* in nature like Dilecto.

DILECTO IS IMPROVED

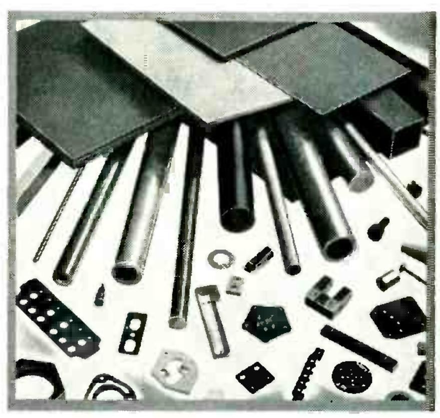
Yes, C-D-F Dilecto is an improved laminated plastic, due to high standards and advances in resin and manufacturing techniques. It is watched by skilled workers in our modern plants, checked against rigid standards . . . C-D-F standards . . . by our quality control people. It is easy to machine, and the C-D-F shops are doing a booming business in specialties.

Table I—Typical Improved Phenolic Laminates

Commercial designation[a]	Resin	Filler	Improved properties	Improvement due to:
MEC-5	Phenolic	Nylon fabric	Insulation resistance; moisture resistance	Filler
XXHV-2[b]	Phenolic	Paper	High dielectric strength parallel to laminations	Resin and manufacturing technique
CRD	Phenolic	Cotton mat	Better machining	Filler
XXXP-26[b]	Phenolic	Paper	Insulation resistance; moisture resistance	Resin and manufacturing technique
C-92	Xylenol[c]	Cotton fabric	Alkali resistance	Resin
CF	Modified phenolic	Cotton fabric	Postforming	Resin

[a] All grades are Continental-Diamond Fibre Company.
[b] Resins have improved penetrating properties and the manufacturing techniques use these properties to provide better impregnation of the filler. Since thorough impregnation eliminates entrapped moisture and air, greater moisture resistance and better dielectric properties are attained. Manufacturing techniques also provide suitable temperature control during the curing stage to assure uniform quality and optimum property values in the finished laminate.
[c] Xylenol is essentially a dimethyl phenol.

—from Electrical Manufacturing Article "Wider Design Opportunities with the NEW Phenolics", Part II.



The next time you think of laminated plastics, the name to remember is C-D-F Dilecto. The improved, high strength, uniform material that makes insulation buying and using more a science, less a puzzle. New grades, new applications, new savings are just part of the Dilecto success story. Look up the facts in Sweet's Design File, or write for catalog. Send us your blueprint for quotation . . . tell us your design dream . . . C-D-F wants to work with you.

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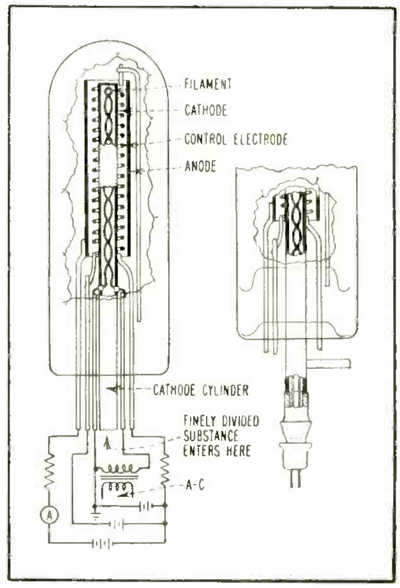

FIG. 1—Vapor detector tube (left) and alternative embodiment (right)

to General Electric Company.

Structure of the tube of Zemany's invention is shown in Fig. 1. The tube is in essence a triode of the indirectly heated cathode type. The cathode sleeve is hollow and has an external input connection for insertion of a vapor or other finely divided substance.

Contact of the finely divided substance with the filament causes ions to be formed that are attracted to the cathode sleeve surface and vary the cathode emission. The resulting variation in plate current will be an indication of the presence of the finely divided substance and the amount thereof.

The present invention has the particular advantage over existing vapor detection devices in that the ion current is amplified by the triode structure. In the other equipments used additional sensitive amplifiers are necessary to provide indication of the vapor presence on suitably rugged instruments.

Video Amplifier

Wide-band amplifiers such as those in video circuits require tricky arrangements in order that negative feedback may be applied to them. The reason is that phase shifts generally result for frequencies at one end of the band. Those at the other end are differentially shifted in phase so as to make for a positive feedback at, for example, the high end rather than negative as used at the low end

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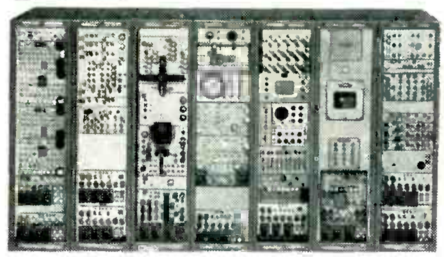

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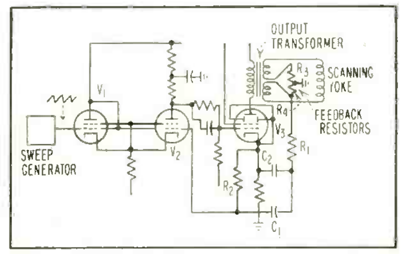


FIG. 2—Circuit of the broadband video amplifier employing feedback

when the same feedback circuit is applied to the video amplifier. Oscillation then results at the higher frequencies.

A way around this problem is proposed in the invention of E. L. C. White of Iver, England who was granted U. S. patent 2,652,459. The patent is asssigned to Electric and Musical Industries Ltd., Hayes, England.

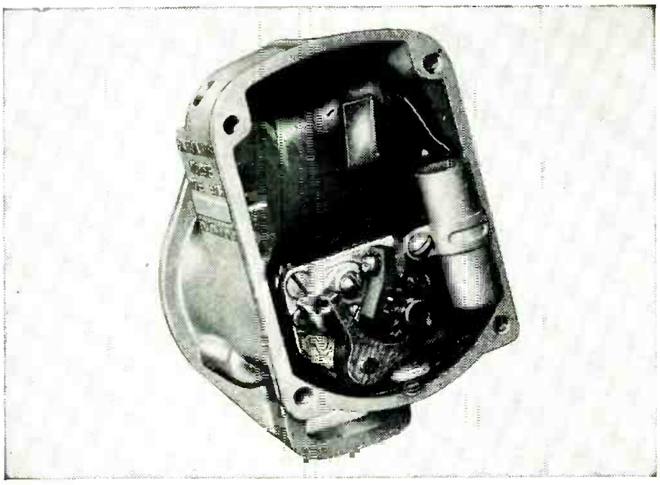
The circuit of White's invention is shown in Fig. 2. Sweep frequencies of a sawtooth character are applied to V_1, which is cathode-coupled to V_2. Tube V_3 is the output amplifier. The output transformer has a split secondary that feeds a scanning yoke. A resistor is placed in each return leg of the split secondary. From one of these through R_1 and C_1 feedback voltage is applied to the grid of V_2. Capacitor C_1 is of fairly large value. A small capacitor C_2 feeds some of the feedback voltage to the cathode of V_3. The cathode of V_3 is also connected to the grid of V_2 through R_2, a large resistance.

Low-frequency components are phased properly in the feedback resistor R_4 for negative feedback but owing to transformer characteristics high frequency components would be of a positive phase. At the cathode of V_1 the low frequencies are in phase with those at the resistor R_4 while the high frequencies are at least partly out of phase at the cathode of V_1 with respect to resistor R_4.

The small capacitor C_2 has a high impedance to low frequencies and low impedance to high frequencies thereby providing an out-of-phase high-frequency component to counteract the phase shift noted above.

Thus the tendency of such an amplifier to oscillation owing to a nonuniform phase shift is overcome and it will have a very wide band of linear operation.

How many of these electrical insulation problems do you have?



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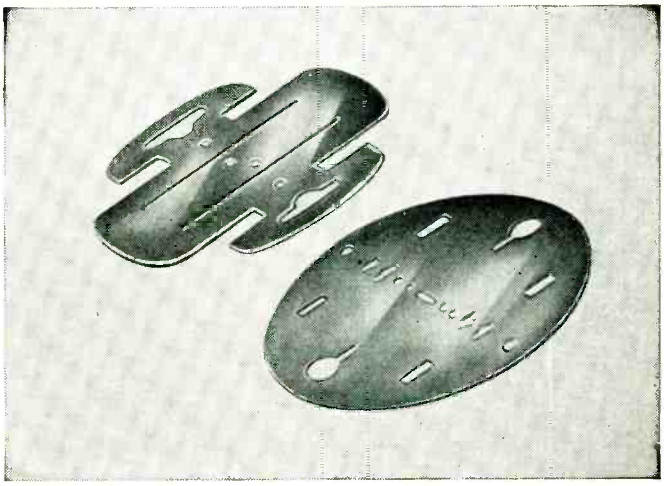

2. Need accurately punched mica stampings for filament, grid and plate supports? MICO produces mica stampings to extremely fine tolerances. Whenever you need precision-fabricated mica parts of the highest quality, call on MICO.

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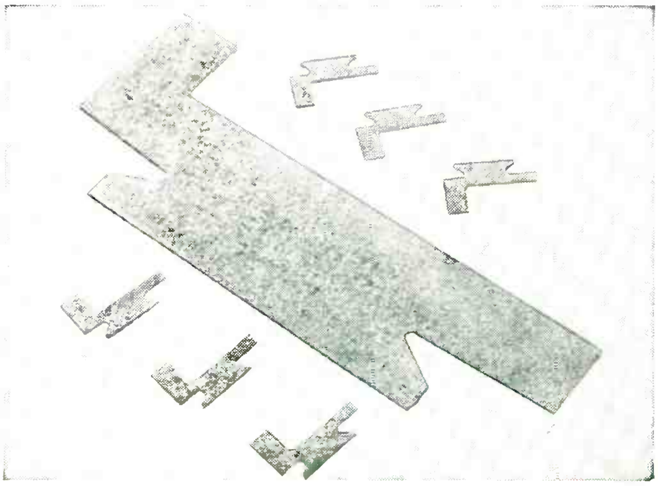

4. Need a class H segment plate that's easy to work with? ISOMICA* Segment Plate — made of built-up continuous mica sheet — shows no tendency to split or flake. Small segments of heavy thickness may be punched, and larger segments can be accurately sawed, milled, punched, etc.

Whatever electrical insulation material you need — standard or special — 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.

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Production Techniques

Edited by JOHN MARKUS

OTHER DEPARTMENTS

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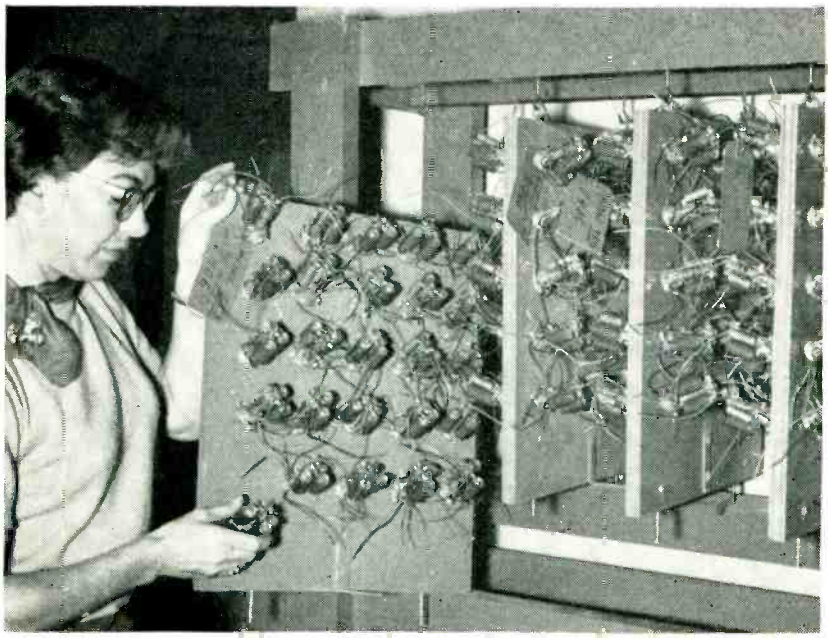


Storage Racks Protect Turret Assemblies

PLYWOOD boards containing turret assemblies are stored conveniently in a clothes closet type of rack until needed by final assembly in the Redwood City, Calif. plant of Ampex Electric Corp. Each board has two screw eyes in its upper edge. These fit over hooks screwed into the under sides of the top horizontal members of the rack.

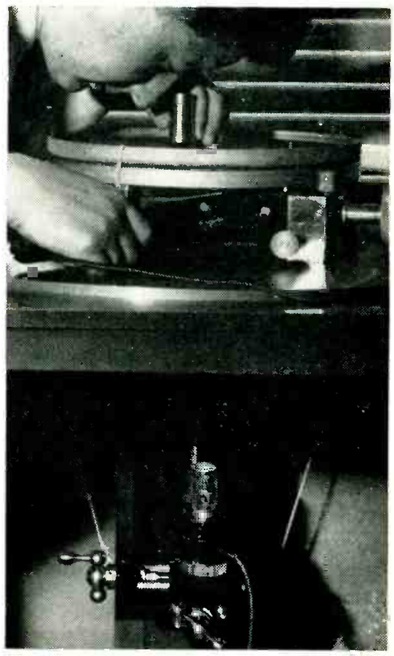
Metal pegs projecting down from the bottom edge of each rack fit into holes drilled in the work bench at each operator's position, to hold the rack upright while loading the finished turrets on it one by one. The turrets slip over long finishing nails driven into the rack at an upward angle.

The metal pegs are bolted to the racks in such a way that they can be swung up at right angles when not desired. Angle brackets bolted to opposite faces of each rack at the bottom then serve to hold the rack upright on a bench that does not have drilled holes for the pegs.

The storage rack itself has slots in the bottom member to accommodate the downward projecting pegs. This prevents the racks from swinging sideways on their hooks and bumping each other. Ordinary ore-inch lumber is used.

Color Tube Alignment

A POINT-SOURCE arc light and an ultraviolet lamp are used in conjunction with a low-power microscope to achieve exact alignment of the color picture tube shadow mask with the phosphor screen, in a pilot-plant technique used in the picture-tube development laboratory at Electronics Park, Syracuse, N. Y. Each of the 200,000 tiny holes in the metal mask must exactly match its corresponding



Color mask alignment setup, showing crater lamp mounted on cross-feed screws under bench. Operator is holding portable ultraviolet light source in right hand to activate phosphors

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Pulling a rabbit out of a hat is fine for entertainment, we agree. But not even a magician can make good on the fantastic claims attributed to cheaper solders, *the mystery alloys with a secret ingredient,* that are supposed to equal the performance of higher tin content solders. Today, as always, Kester believes, the quality of the soldered connection is what counts . . . *not* an infinitesimal saving. That's why Kester Solder has been a "star performer" for more than 50 years!

For your specific solder requirements, remember Kester "44" Resin, "Resin-Five" or Plastic Rosin-Core Solder . . . with exact core size or flux-content "tailored" to every job.

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cluster of three dots (red, blue, green) on the screen.

A concentrated arc light below the platform simulates the electron beam, to cast a shadow of the aperture plate on the phosphor screen above it.

An ultraviolet light in the operator's right hand excites phosphor dots so the aperture plate and phosphor plate can be aligned visually over the entire area. Three knobs control vertical and horizontal alignment of the aperture plate and phosphor screen.

Three-Position Turntable Speeds Induction Soldering

AN INDUCTION HEATER is used in place of a soldering iron in many instances at the Lenkurt Electric Co., San Carlos, Calif. By interchanging work coils, soldering can be done quickly and efficiently on fabricated cans, hermetic-seal terminals and can tops. The induction heater is a standard model supplied by Induction Heating Corp. of Brooklyn, N. Y.

In soldering headers to tops of filter cans, the operator first places the top in a jig and positions the header, then rotates the turntable to place the assembly under the work coil. Heating time is controlled by a timer on the machine or a foot switch. The operator determines the correct time initially by watching how the heat affects the color of the metal.

When the proper amount of heat has been applied, the operator lowers and spins the turntable to bring the heated top close to her. She then applies solder wire in a fast sweeping motion. The solder spreads over the desired area.

Three stages of processing go on at the same time. While one top is being heated, another is being soldered and a third is loaded.

Applying solder to heated header, while second unit is being heated by work coil and third unit is cooling

Standardized Plastic Containers Protect Precision Parts

Typical use of hinged-cover containers at work bench. Only one subassembly is removed at a time from the protective tray, to minimize chances of damage

TRANSPARENT plastic containers and trays for electronic components and sub-assemblies have reduced rejects appreciably in the Teterboro, N. J. plant of the Eclipse-Pioneer Division of Bendix Aviation Corp. In addition, standardization on 22 different styles of inserts for the containers provides flexibility at a lower cost per container and an overall economy of space.

Introduction of the new containers throughout the plant was achieved by setting up a centralized control over all phases of material handling operations, headed by a materials handling administrator. His responsibilities include approval of container design and construction, cleaning and maintenance of equipment and containers, the placement, replacement and disposal of containers, the choice of containers for particular parts going through process, and the general methods and procedures used in the modernized material handling operations.

The tote containers and insert trays are produced from a thermo-

FREED A.C. BRIDGES & ACCESSORIES

PRODUCTS OF EXTENSIVE RESEARCH

No. 1110A — INCREMENTAL INDUCTANCE BRIDGE

This bridge has an impedance range of one millihenry to 1000 henries in five ranges and can be extended to 10,000 henries through the use of external resistance. The inductance values are read directly from a four dial decade and multiplier switch.

The inductance accuracy is within plus or minus 1% through the frequency range from 60 to 1000 cycles. For the largest multiplier at 1000 cyles, the accuracy of the bridge is decreased to 2%.

On the 1000 henries range, the D.C. is limited to 20 MA. On the 10 henries range the D.C. is limited to 200 MA. On all lower ranges, one ampere D.C can be used.

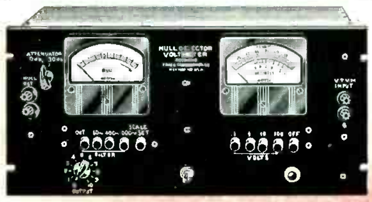
No. 1150—UNIVERSAL BRIDGE

Offers a variety of five possible bridge circuits. A range of capacitance, inductance, impedance, and phase angle measurement can be made throughout the frequency spectrum from 20 cycles to 20,000 cycles. By using decade resistors in the variable arms the unknown can be measured to four significant figures. Operation is simple with terminals and controls arranged for convenience and ease of measurements.

Frequency range 20 cycles to 20,000 cycles. Inductor Range: 100 microhenries to 1000 henries. Capacitor Range: 1 micromicrofarad to 1 microfarad. Accuracy: 0.5% @ 1000 cycles. Condensers smaller than 0.001 mf should be measured by the substitution method.

No. 1180 — A.C. SUPPLY

A valuable laboratory instrument with continuous variable output from .1 volt to 100 volts at 60 cycles.



No. 1210A—NULL DETECTOR & VACUUM TUBE VOLTMETER

Provides simultaneous measurement of the voltage across the unknown and the balance of the bridge. Vacuum tube volt meter Sensitivity .1, 1, 10, 100 volts. Frequency range 20 — 20,000 cycles. Null Detector part of instrument same as Type 1140A.

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No. 1170 — D.C. POWER SUPPLY

A stabilized Power supply primarily intended to be used as a D.C. supply for Incremental Inductance Bridge Type 1110A. Provides 4 continuously variable current ranges: 5 milliamps, 25 milliamps, 100 milliamperes, and 500 milliamperes. Maximum Output voltage 270 V.D.C. Noise level — 92 Db.

No. 1140-A NULL DETECTOR AMPLIFIER MODEL

A high gain null indicator for bridge measurements, providing visual null indications or aural indications when used in conjunction with headphones. The unit may also be used as a high gain amplifier for general laboratory work.

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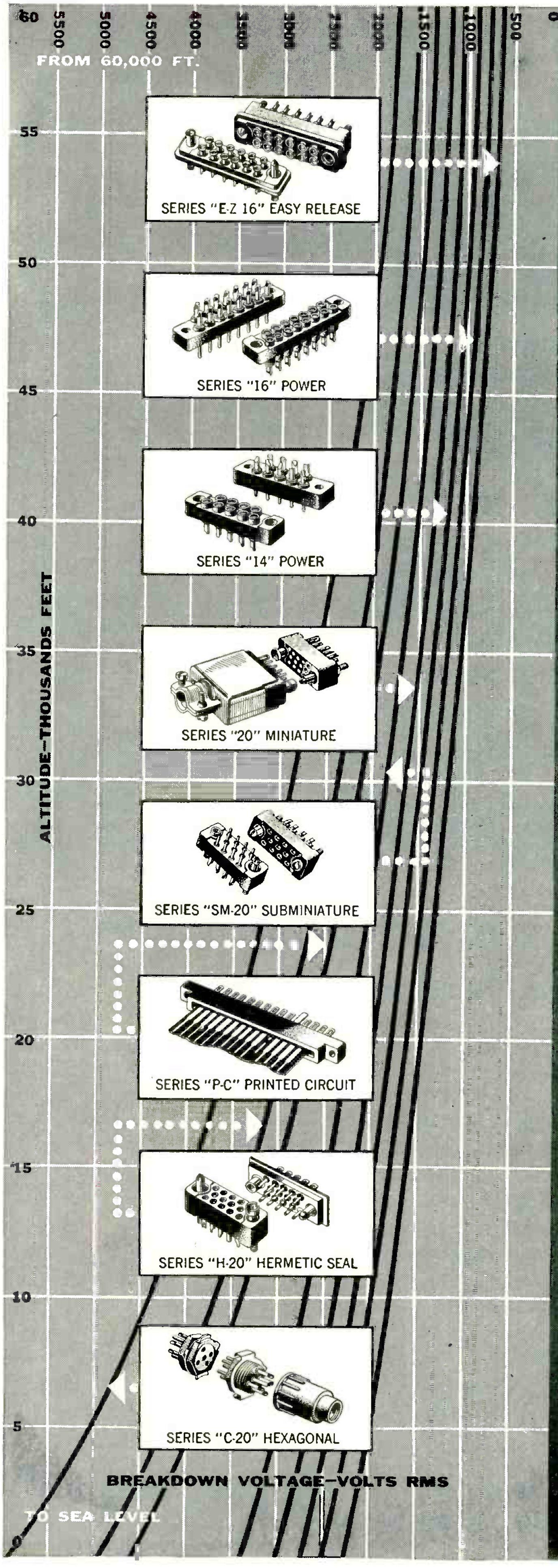
Examples of molded plastic inserts used with containers. Standardized styles were carefully selected to accommodate future components as well as those now in production

plastic material having high impact resistance, such as U. S. Royalite or Boltaron. These materials permit use of wood dies for molding from sheets, thereby reducing the cost of producing relatively small quantities of special trays and inserts. Container sizes were standardized

Hinged container with six-compartment insert for large components

Molded feet on containers and molded recesses in covers permit stacking without risk of slippage



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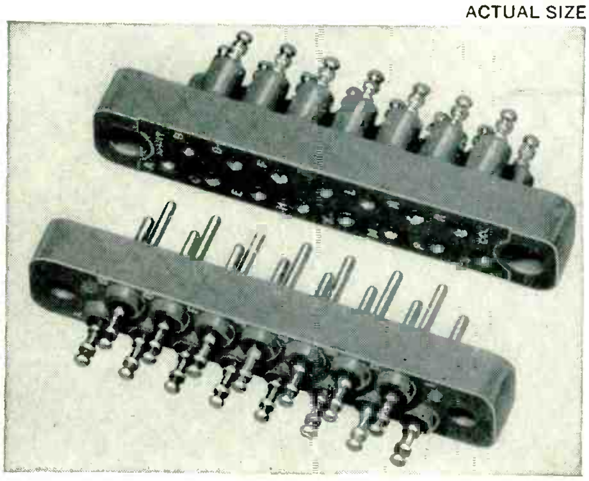

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with turret terminals or solderless taper pin wiring

Heavy-duty types for applications requiring larger current capacities of #14 and #16 AWG wire. Available with 7, 10, 15, 18 or 20 contacts, and insulating material in choice of Melamine, Plaskon-Alkyd, or Diallyl Phthalate. Turrets on the socket and pin contacts permit easy wrap-around wiring. No soldering is necessary with the taper pin wiring type.

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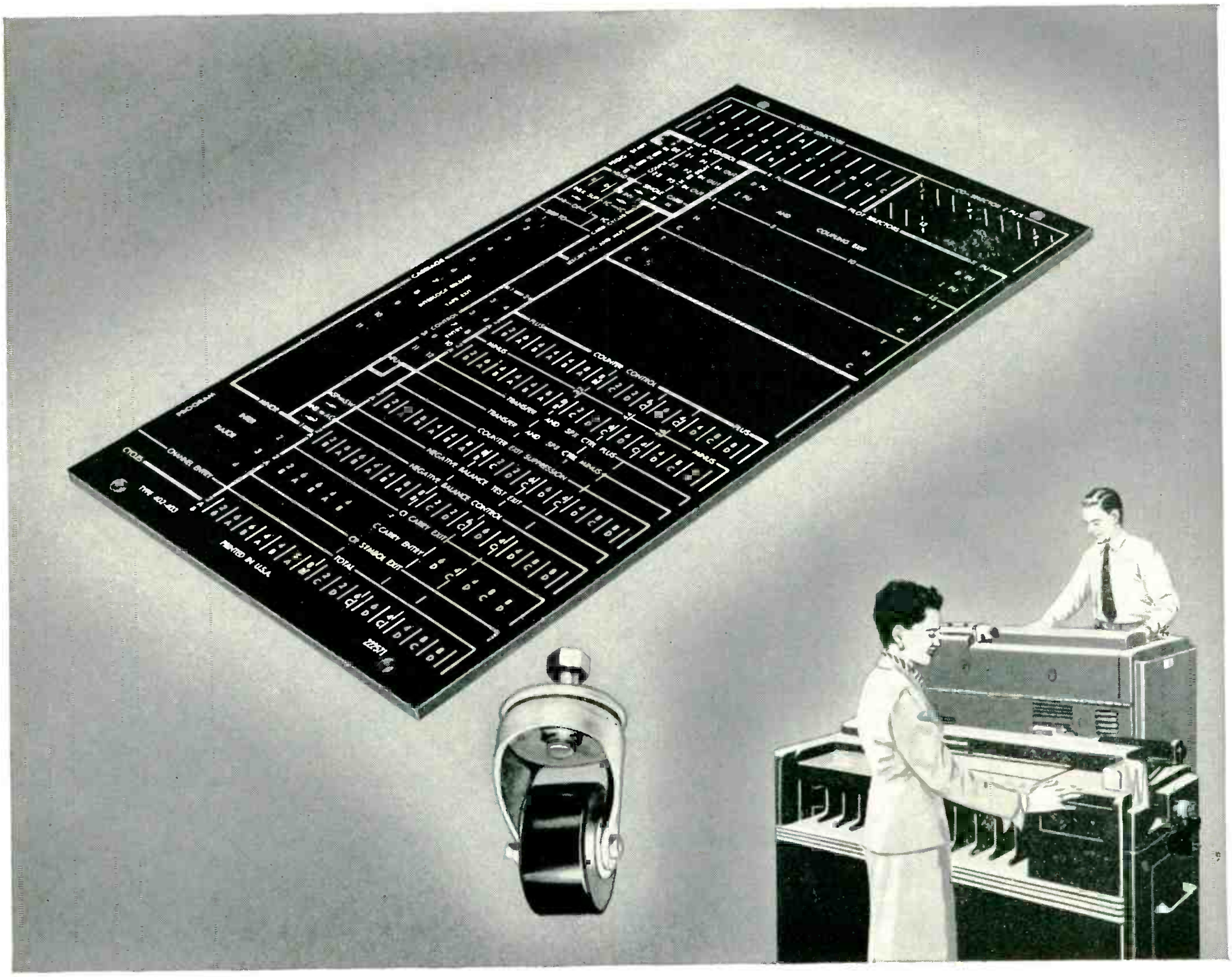
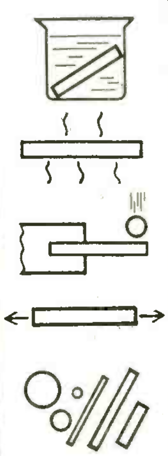


Head and feet for an office worker who neither errs nor tires

Properties of Synthane

In addition to those mentioned in the text, Synthane has the following important properties:



Chemical resistance. Synthane resists most acids and alkalis in moderate solutions, and corrosive atmospheres.

Temperature resistance. Synthane is thermosetting, will not flow under elevated temperatures. Grades resisting up to 400° F are available.

High impact strength. Synthane stands up well in applications where it is subject to vibration, pounding and shock loads.

Mechanical strength. Synthane exhibits excellent strength under tension, compression, and other loads. It will not delaminate.

Availability. Synthane is supplied in more than 33 grades of sheets, also in rods, tubes and molded-laminated or molded-macerated parts. A complete fabricating service is available.

• The uncanny ability of tabulating machines to do complicated jobs quickly and accurately is famous. One of the materials which helps to make this possible is *Synthane*—a laminated plastic.

Synthane serves as the base for the brains of the machines—the plug boards upon which the control circuits are set up. *Synthane* is excellent for the purpose because of its combination of high dielectric strength, resistance to moisture, dimensional stability and ease of machining. *Synthane* is printable, too—circuit designations are readily printed on its surface.

On tabulating machines, casters that are friendly to office-type flooring are needed. Casters of molded-macerated *Synthane* fill the bill. *Synthane* caster wheels are strong, do not flatten by constant pressure, and do not mar office floors.

Should you require a versatile material—one with many properties in combination—*Synthane* may be your answer. Our catalog tells the full story. To receive yours, drop us a note on your letter-head. Synthane Corporation, 12 River Road, Oaks, Pa.

Our 25th Year

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SYNTHANE

LAMINATED S PLASTIC

in five different depths—2, 3, 4, 5 and 6 inches. All are the same dimensions—12 inches wide and 16 inches long. Some containers are made without covers, while others have transparent plastic hinged covers with attached metal locking latches. Manufacturer of the containers and trays is Product Engineering Labs. Co., Inc., Newark, N. J.

All 22 styles of inserts fit in any container. Some inserts have rectangular or round recesses for individual subassemblies, while others have molded studs on which tubular components are supported.

The trays are self stacking either with or without covers. Normally, trays are stacked only while on workbenches, and at other times are stored on special racks that are open on all sides and have runners for supporting individual trays.

Roller-rack dolly for transporting plastic containers. Runners eliminate dust-catching drawbacks of conventional shelves. Runners can be moved up or down on vertical slides by loosening screws to accommodate different depths of containers used for various sizes of parts

Lamps Call Supervisor

AT THE Lenkurt Electric Co. in San Carlos, Calif., a worker doesn't need to leave her work position when she wants additional materials or requires advice or assistance from her supervisor. Within easy reach of each assembler or toroidal-machine operator is a switch that turns on a small colored light at the top of her workbench and at the same time turns on a light at the desk of her supervisor, who may be as far as 30 feet away.

Signal lamp and stepdown transformer are mounted in small metal box at supervisor's position. At assembly benches in rear, lamps and switch are on small metal plate fastened to bench

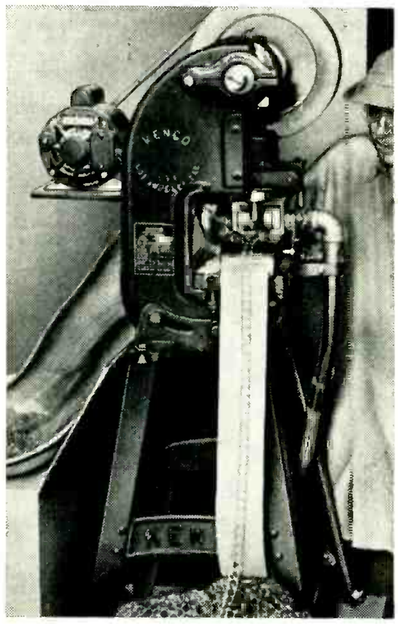
When the supervisor sees her desk light go on, she knows her assistance is needed somewhere on the production line. By looking to see which bench light was turned on, she can tell immediately where to go.

Colored series-type Christmas tree bulbs are used for the lights. The entire installation is both simple and inexpensive, since voltage is under 20 volts and ordinary bell wire or hookup wire can be used.

Neoprene Gasket Cutter

ACCURATE cutting of extremely thin neoprene or rubber washers at high production rates was accomplished by adding Stoner roll feed to a standard four-ton Kenco press made by Kenco Mfg. Co., 5211 Telegraph Road, Los Angeles 22, Calif. With this combination it proved possible to produce 24,000 washers per hour from material which is 0.019 inch in thickness. Although Navy requirements permitted 1½ percent rejects, spot checking showed the reject rate to be only 0.0133 percent.

Three additional units are now being completed by Stoner Engineering Co., 1924 Harcourt Ave.,



Precision gasket-punching machine in operation. Air blast from vacuum cleaner, acting through pipe at front of press, blows finished washers into hopper at rear of machine

Los Angeles for the gasket manufacturer, West American Rubber Co., 410 North Ave., Los Angeles, Calif. The four machines will then be placed in a circle, so the scrap materials will be ejected into a central container. This setup will allow one man to operate all four presses and produce 96,000 washers per hour.

One of the production problems involved getting the material to roll in without distortion. The unique roll feed accomplished this satisfactorily. The cutting die is so designed that washers within the 0.005 inch tolerance of the specified thickness are blown out of the die into the hopper in the rear of the press by an air blast. Washers which are too thick or too thin stay in the die. This automatically prevents defective washers from getting into the hopper.

Air-Operated Guillotine Cuts Sleeving for Leads

FOUR DIFFERENT lengths of sleeving are cut simultaneously at one location on the production line in the television receiver plant of E. K. Cole Ltd., Southend-on-Sea, England, for use as needed in insulating leads of r-f and i-f coils. This

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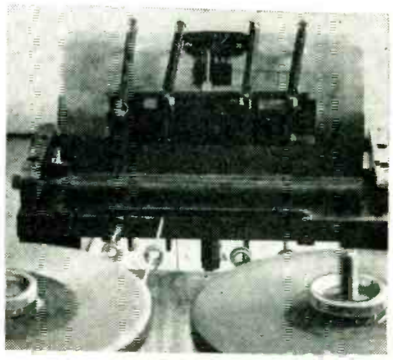
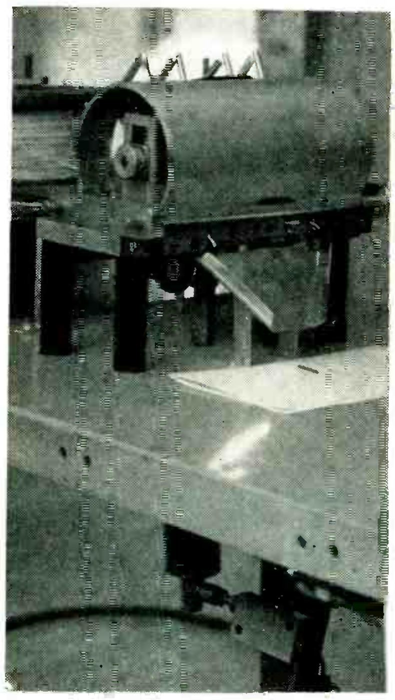


Input end of sleeving chopper, showing two reels in foreground. Other two are off to left and right. The four springs pull back the levers on the knurled wheels after each operation. Five-position pointer, fixed in position, can be seen between the springs

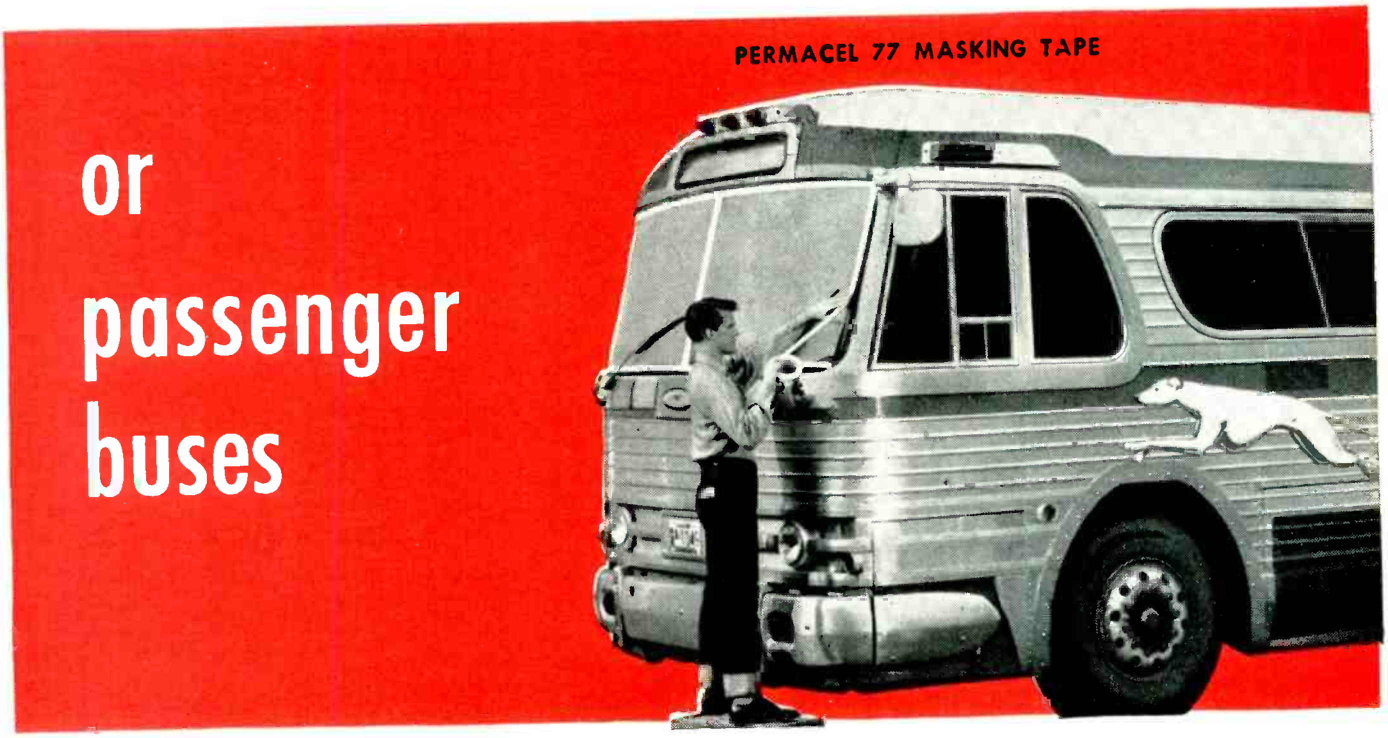
machine arrangement reduces waste by eliminating overproduction of odd sleeving lengths. There are five settings on the machine, each giving a different combination of four sleeve lengths required for lead insulation and identification. The four reels that feed the machine each contain a different color of sleeving.

Feed and cutoff are achieved with a single air cylinder mounted under the bench, with its actuating rod coming up through the bench. The first portion of the cylinder movement serves to rotate four knurled



Rear view of sleeving machine, showing output chute. Drum housing slides on two horizontal bars to give choice of five different combinations of sleeve lengths

Whatever the job...



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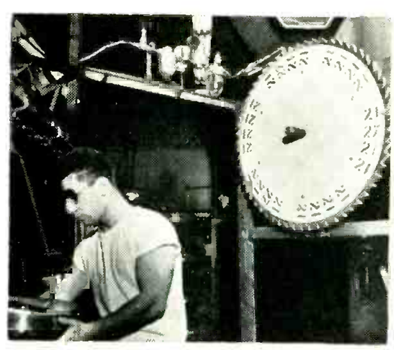
feed-wheels. The amount of rotation of each wheel determines the length to which its sleeving will be cut. This rotation in turn is controlled by the distance that levers attached to the wheels are allowed to rotate before hitting a stop. The wheels are friction-mounted on the drive shaft so they can rotate independently.

The levers of the feed wheels project outward through an aperture in the drum-shaped housing of the machine. The upper edge of this aperture is stepped, and the housing can be slid horizontally so that different steps of the aperture line up with the four levers. A stationary pointer positioned over a scale on the sliding drum identifies which one of the five possible combinations of four sleeve lengths is being produced.

After sleeves have been advanced the varying correct amounts by the feed wheels, the remaining movement of the cylinder serves to pull down a guillotine blade for chopping the sleeving. Each operation of the foot valve repeats the sequence of rotating the knurled feed wheels and operating the guillotine.

Number Wheel Shows Picture Tube Sequence

MAINTAINING desired flow of proper bulb sizes is vital to maximum utilization of machine capacity at General Electric's picture tube plant in Electronics Park, Syracuse, N. Y. A pointer on a large wood pattern wheel indicates at a glance the size of tube which should next be placed on the conveyor so the tube will arrive at the subsequent



Pattern wheel at conveyor loading position, with air-actuated pawl on shelf at left rear of wheel

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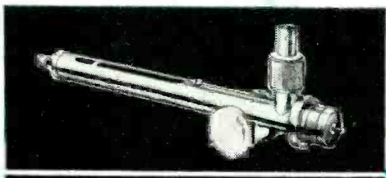
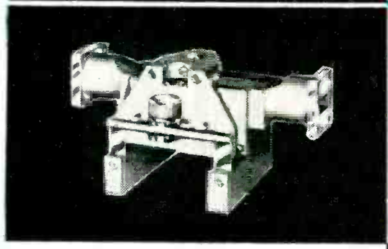


TYPE 250-A BROADBAND PROBE – Frequency range of 1 to 12.4 Kmc/s; two tuning knobs permit precise adjustment for maximum power transfer from the probe tip to the crystal or bolometer detector; third knob controls depth of probe tip insertion.



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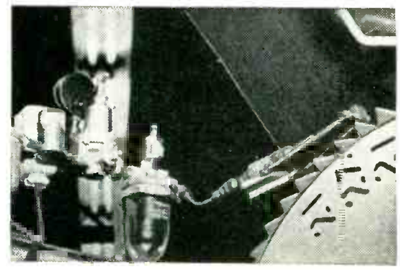


Details of pawl

processing stations at the correct time.

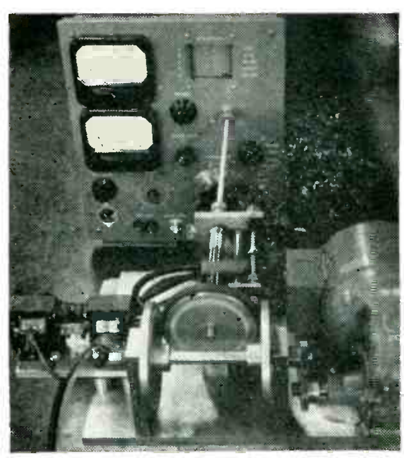
Each passing conveyor trolley closes an electrical switch, which in turn actuates an air cylinder that moves a pawl against the teeth cut into the circumference of the plywood wheel. This advances the wheel to the next number. Blanks between numbers mean that a trolley should be left empty.

Patterns on the wheel may be changed at any time to meet production demands. Several different bulb sizes may be patterned effectively.

Running In Oscillators

A SOLENOID-OPERATED clutch actuated by a limit switch arrangement on a feed screw serves to turn the dial of a precision signal generator back and forth through its entire tuning range of 20 revolutions automatically for running in the bearings and mechanical linkages.

In the arrangement used for this purpose by Hewlett-Packard Co., Palo Alto, Calif., an electric motor drives the two metal disks of a disk



Setup for running in the tuning mechanism of a five-band oscillator by rotating the tuning dial 20 turns in each direction alternately. Clutch-reversing solenoids are at left

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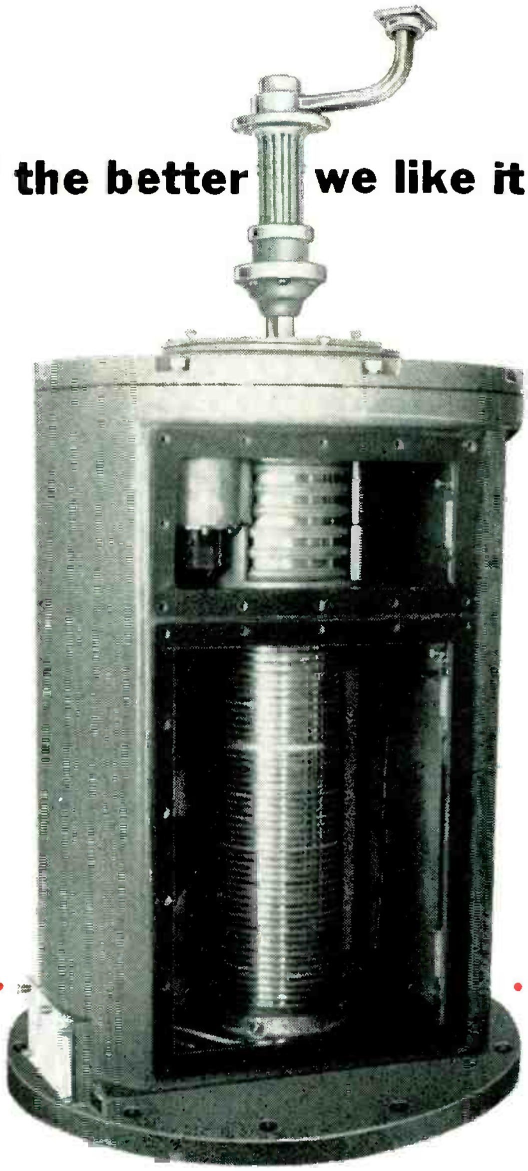

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In addition to the rings and brushes themselves, Makepeace has utilized its experience in this field in the design and manufacture of complete self contained ring and brush assemblies. The design of such a unit often poses unusual problems. The Makepeace 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.

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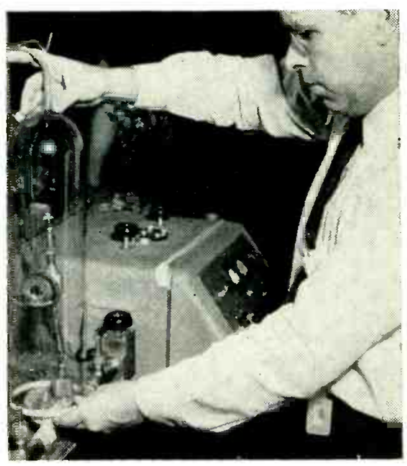
clutch continuously through reduction gears. A rubber-tired wheel mounted at right angles between the disks takes power from one or the other by friction. Two solenoids with armatures bolted together to operate in tandem move the pair of metal disks against spring loading to achieve reversal. The shaft of the rubber-tired wheel drives the tuning dial of the oscillator. On this shaft is a machined spiral on which rides a follower block. Adjustable stops on an adjacent sliding shaft can be set so that the block strikes one of them after any desired number of revolutions in one direction, to move the shaft and actuate a snap-action switch which energizes or deenergizes the solenoids to give reversal. The block then moves in the other direction until it hits the other stop on the sliding shaft and causes another reversal.

Leak Detector for Magnetrons

PUMPING-DOWN time during routine production inspection of type 4J57 magnetrons for leaks is appreciably reduced by an arrangement for checking four tubes at a



Placing helium-filled bell jar over magnetron sealed into vacuum line of mass spectrometer type of leak detector

time in the Hicksville, Long Island plant of Amperex Electronic Corp. The vacuum tubulations of the tubes are sealed to the vacuum system of a model 24-101A Leak Detector made by Consolidated Engineering Corp., Pasadena, Calif. After the vacuum has been pulled down suffi-

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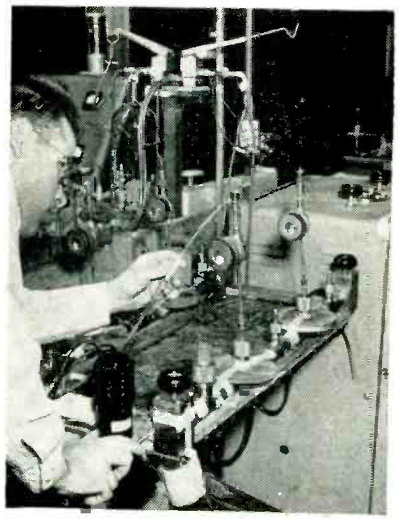

Using helium probe to find exact location of leak in magnetron after bell jar indicated that leak was present

ciently to meet the requirements of the mass spectrometer, a bell jar is placed over each tube in turn. This jar is filled with helium, which is lighter than air and hence stays inside. Any helium entering the tube through minute leaks actuates the audio alarm of the leak detector. The operator then removes the bell jar and moves a helium probe around the tube to find the exact location of the leak.

When not in use, the helium probe is hung on the hook of an economizer valve. The weight of the probe on the valve arm cuts off the helium supply, thereby preventing wastage.

Tenth-of-Hour Clock

TIME spent on various work projects is recorded hourly in tenths at the Lenkurt Electric Co., San Carlos, Calif. For example, a production worker who begins a certain assignment at 9:37 a.m. and completes it at 11:04 a.m. would mark on his time card that he begin the job at 9.7 and finished it at 11.1.

Conversion of minutes into hourly tenths is facilitated by having wall clock dials throughout the company divided into tenths of hours. This is done by painting each alternate six-minute segment in a light gray shade. Each of these segments is numbered near the center of the clock. Thus at a glance any worker can tell in which tenth of

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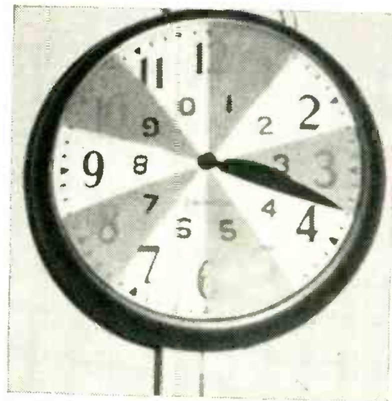

Method of marking clock to read in tenths of hours

the hour a certain job was begun and in which tenth it was finished.

This system of time recording gives a uniformity not possible if various other fractions of hours are used. The painted clock faces enable workers with little or no mathematical training to record their time accurately.

Pipe Nipples Hold Pots and Wafer Switches

PIPE nipples of various standard sizes are used as jigs for holding potentiometers and wafer switches during subassembly work in the Redwood City, Calif. plant of Ampex Electric Corp. The assembly is

To load switch in pipe-nipple holding jig, operator inserts the assembly and gives it a clockwise spin

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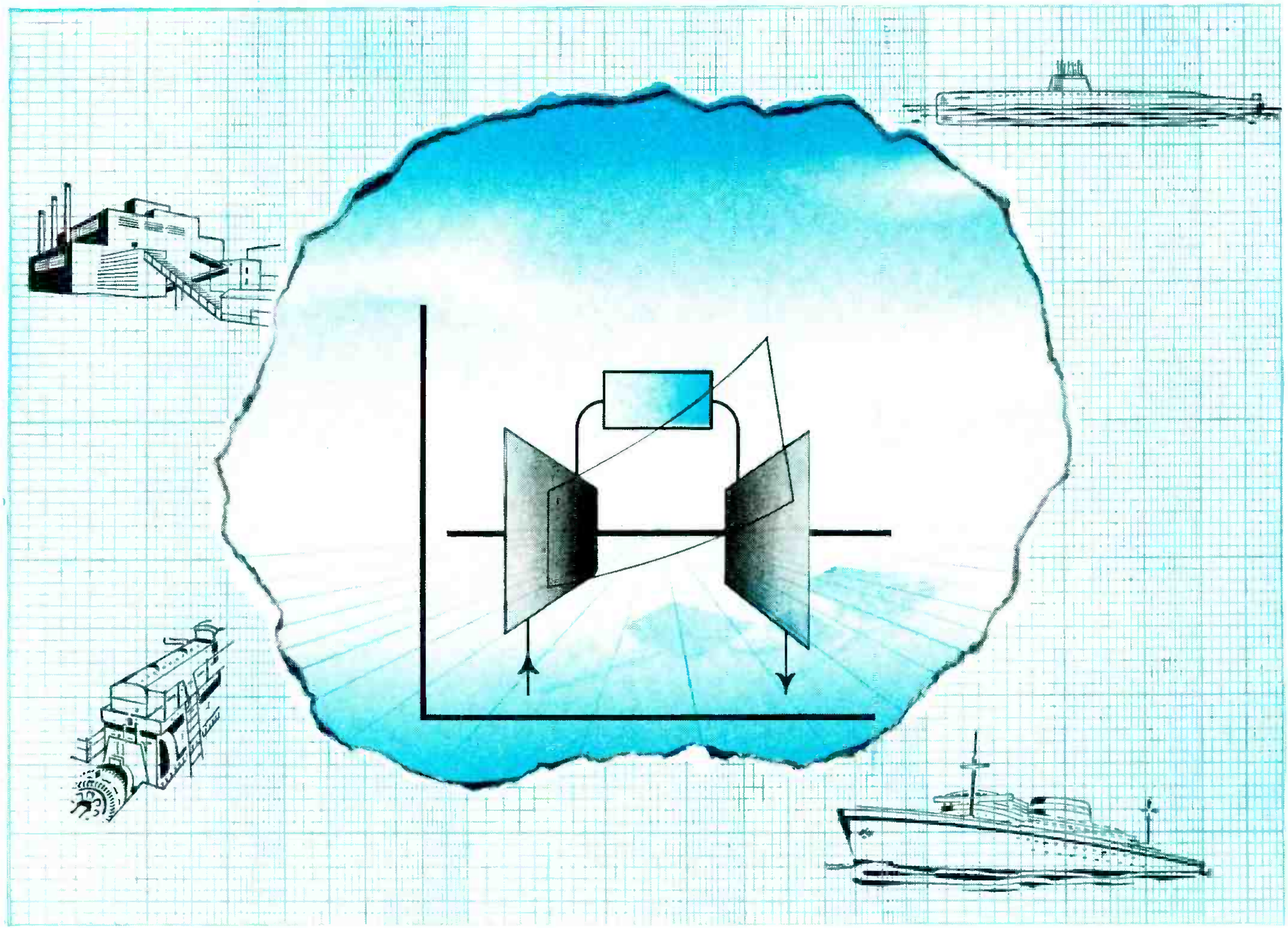
Method of using jig

screwed into the smallest nipple. The larger nipple is heavy enough to provide rigidity while inserting, crimping and soldering the leads of small parts, yet can easily be rotated or moved around on the bench for maximum convenience. The nipples also serve as holders for storing the subassemblies or for passing them down the bench to the next working position. When a unit is completed, a quick spin unscrews the subassembly.

Cutting and Bending Tube Stem Wires

THE NINE wires sealed into the glass stem of a miniature tube are cut to precisely the correct lengths

Wire-cutting setup, located at output of conveyor coming from stem machine. Bending machine is on same bench, in background



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in one operation of special foot-actuated shears developed and used in the Bloomfield, N. J. tube plant of Tung-Sol Electric Inc. The stems come down a small fabric conveyor from the automatic stem machine and drop into a box under the right hand of the operator.

While taking a sheared stem out, she picks up and orients the next stem, then inserts it in the shearing tool and operates the foot pedal which actuates the shearing dies. The individual dies for the nine wires can be set to cut leads to the different heights required for supporting the tube electrodes.

Sheared stems are dropped into drilled holes in a plywood tray that sets into a framework slanted at a convenient working angle. A filled tray is lifted out and passed along the bench to the next position, where another air-powered tool bends some of the wires to precisely the correct specifications for a particular type of miniature receiving tube.

Miniature stem die bends some or all of the nine wires to correct specifications in one operation

Grooving Recorder Heads With Abrasive Wire

STAINLESS steel wire is used as an abrasive to form highly accurate short-radius grooves in metal blocks for magnetic wire recording heads. By oxidizing the surface of the wire to varying degrees, abrasive properties are imparted. When the wire is drawn across the metal block, a groove is formed having the same accurate radius originally

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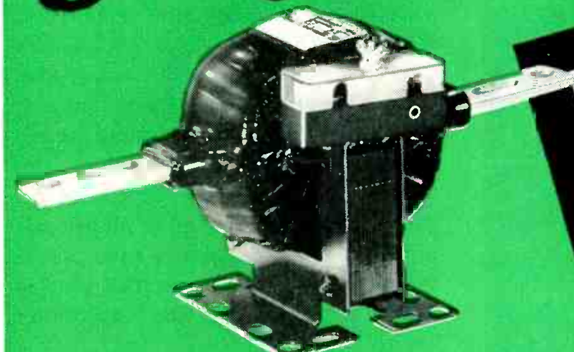
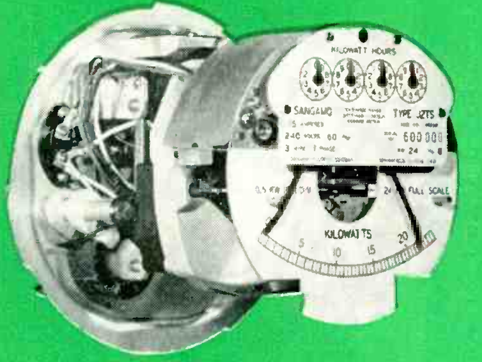


Sangamo Type MA-25 Current Transformers are designed for indoor service on metering applications. They are wound type with single primary and single secondary, and meet A.S.A. 2.5 KV insulation class test requirements—15 KV at 60 cycles and 45 KV full wave impulse. Natvar 400 Extruded Vinyl Tape is used "because of high insulation value, resistance to heat and ability to form itself to the shape of parts being insulated."



Sangamo Single phase combination Watthour and Demand Meters like the Type J2TS illustrated are built and tested for sustained accuracy under varying temperatures, ease of calibration and repair, resistance to corrosive atmosphere, and ample capacity to measure heavy loads. Natvar 400 Extruded Vinyl Tubing is used for insulation because it meets the requirements with plenty to spare.

Sangamo is one of the most respected names in the electrical industry. For more than fifty years Sangamo meters have measured electricity with great accuracy, have required little maintenance, and have been easy to test and repair. Meters and associated equipment are made in the Sangamo Electric Company plant in Springfield, Illinois.

They safeguard performance through good design for each requirement, individual tests at various stages of manufacture, and careful selection of materials. Natvar 400 Extruded Vinyl Tubing and Tape are used because of their uniformly good electrical and physical properties—particularly the ability to resist heat, oil, corrosive atmosphere and abrasion.

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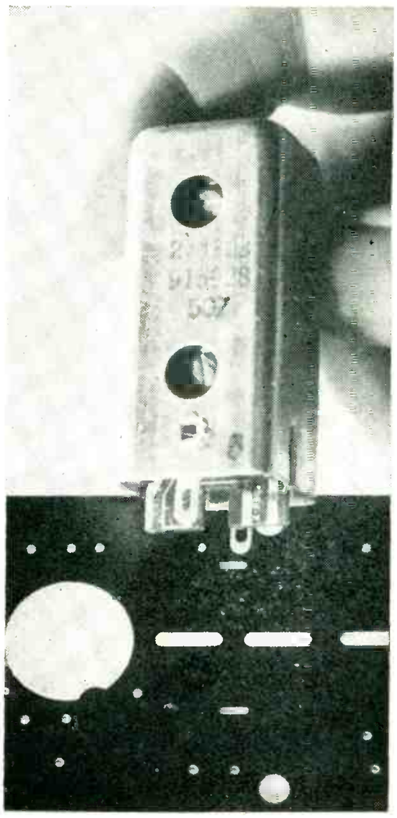
provided in the abrasive wire. The technique was developed by Fort Wayne Metals, Inc., 3211 MacArthur Drive, Fort Wayne, Ind.

Dip-Soldering Printed Video I-F Amplifier

A SINGLE immersion in a pool of molten solder simultaneously serves to mount all parts and make all connections for a three-tube video i-f amplifier designed for use in intercarrier-sound television receivers. The amplifier employs etched-circuit i-f transformers, coils and traps arranged in tandem, as well as etched wiring on the main panel.

In the assembly procedure developed for these new printed components in one parts plant, all components are pushed into previously punched holes in the plastic panel, working from the rear of the strip.

Coil components have small rectangular punched holes for their etched terminals and for the grounding lugs of the shield can. Special sockets are pushed into keyed round holes with fingers, so



Method of inserting etched i-f transformer in etched video amplifier panel. Wiring is on other side of panel

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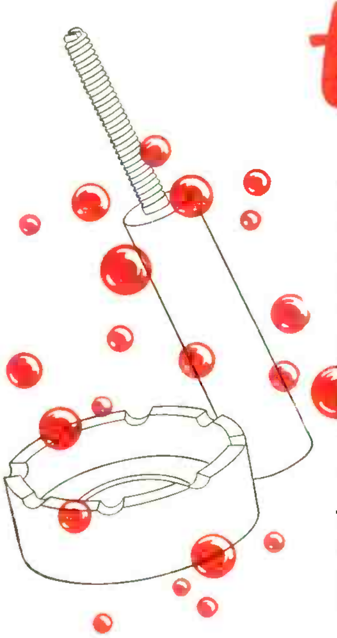

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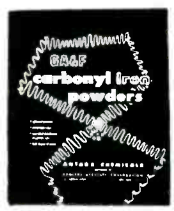

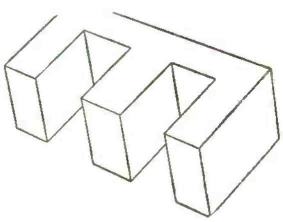

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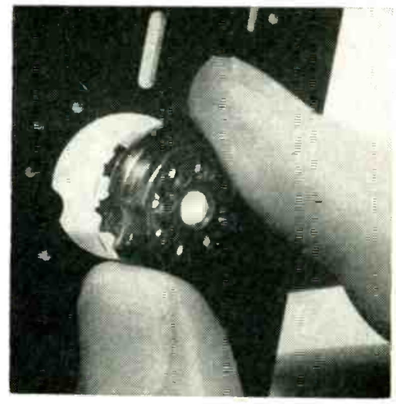
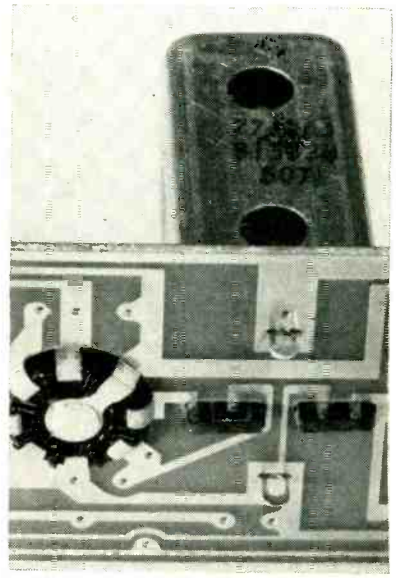


Inserting special snap-in socket into keyed hole in panel



Appearance of etched video i-f panel after socket and i-f coil have been pushed in from other side. Solder will bridge gaps between inserted terminals and wiring on panel

that the curled-over socket terminals abut the ends of etched wiring on the other side.

Preformed leads of resistors, capacitors and a crystal diode are pushed into punched round holes 0.040 inch in diameter. The smallest of these leads is 0.025 inch, and experience has shown that solder easily bridges the resulting space. To keep in position the heavier parts having pigtail leads, the ends are bent over with pliers on the etched wiring side in some cases. This must be done carefully so that bent-over leads do not short to adjacent etched wiring. Dip soldering completes the assembly work. Sometimes this is followed by cleaning, drying and dipping in hot beeswax or a similar wax for mois-

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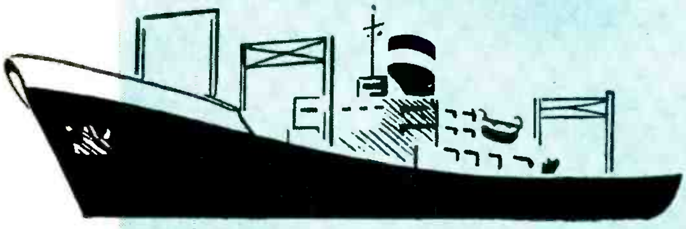

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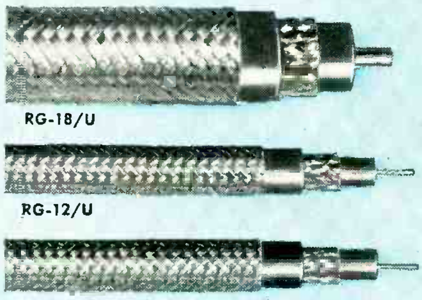

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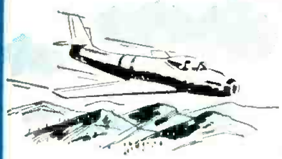

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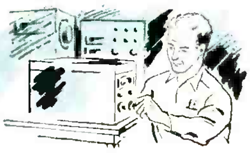

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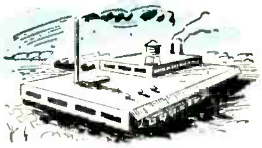

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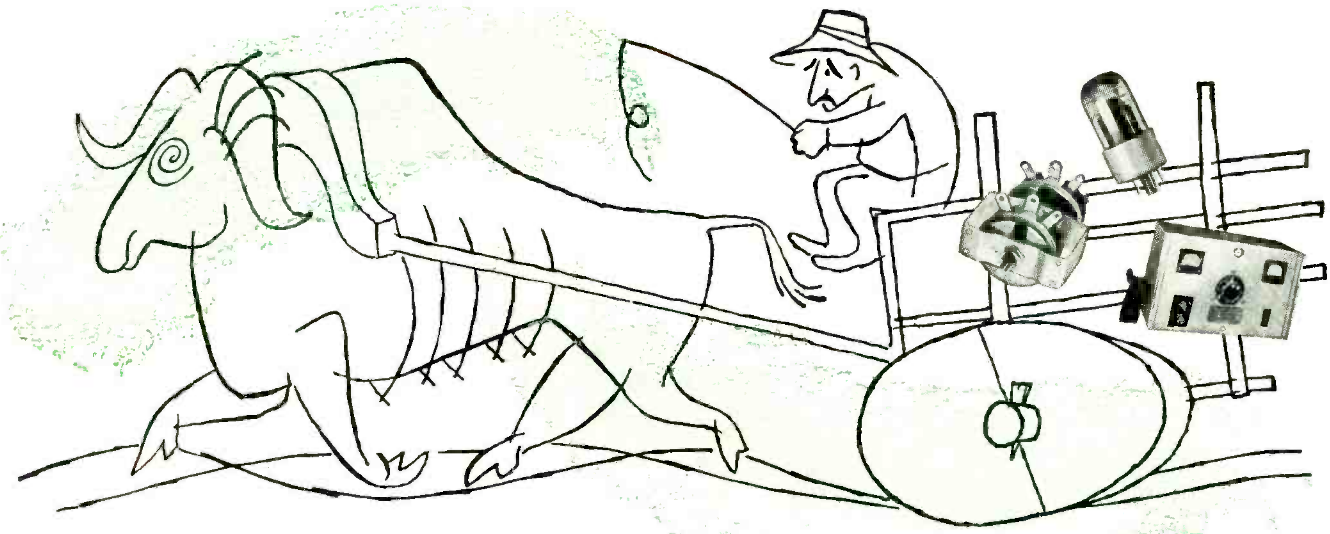

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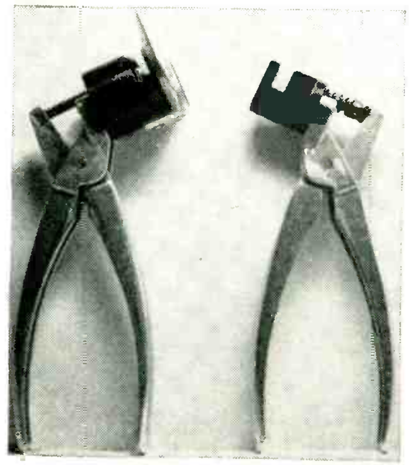

Half-circle punch (left) and small round punch for making gasket holes in moisture-proofing material

with microchanges in moisture content. The resistance of this element is measured with the portable instrument, using alternating current in order to avoid polarization of the hygroscopic film and consequent destruction of the element. The a-c power for measuring is obtained from a vibrator power supply operating from a 3-volt dry battery.

Installation takes only about 3 minutes using special tools developed for the purpose. One of these tools is a half-circle punch which cuts the round hole for inserting the sensing element gaskets into the package. The moistureproof packaging material is doubled and inserted in the jaws of the punch,

Sensing element, feed-through gasket and terminal plug (in hands) and example of hole required in moistureproof wrapping material for installation of feed-through gasket

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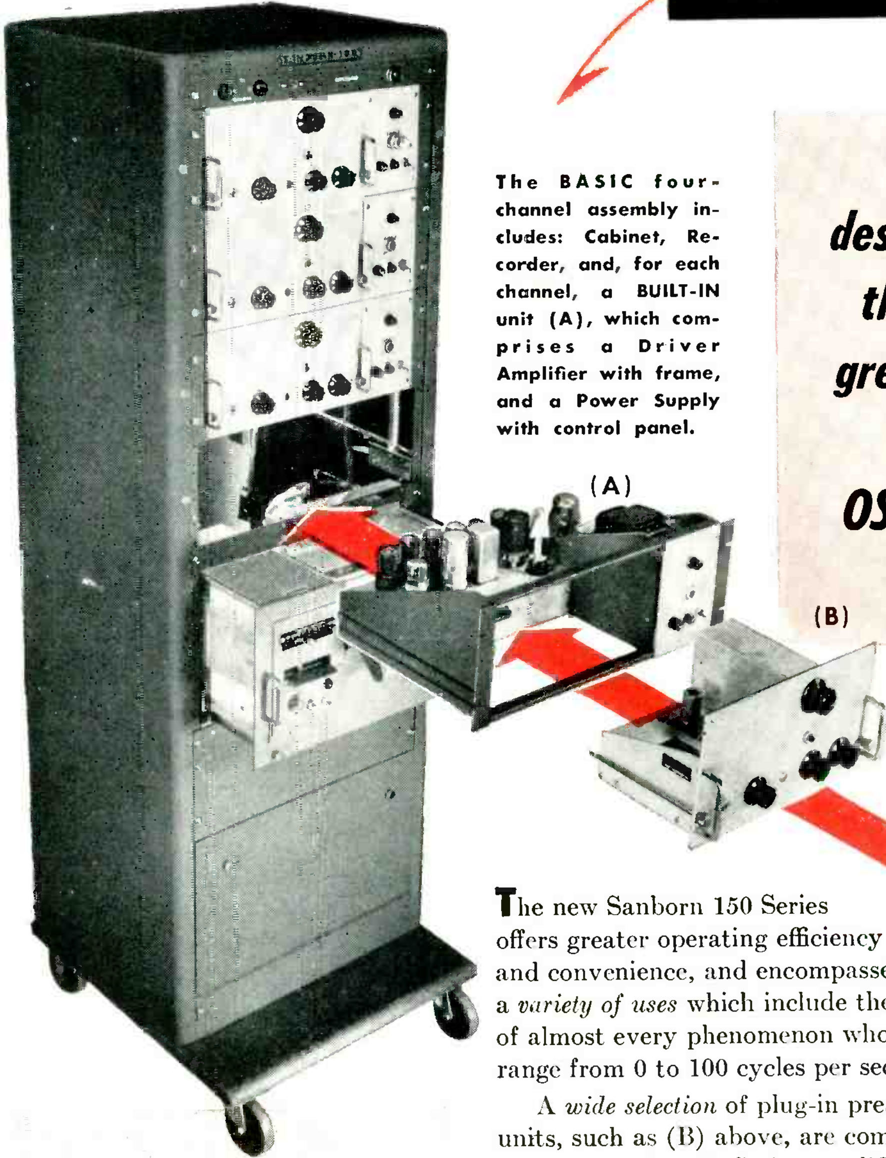

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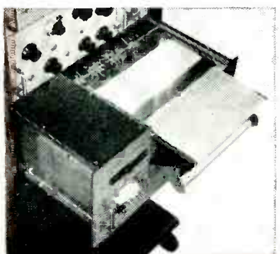

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against the plastic limit notch. Operation of the tool then cuts a half-circle through the folded material to give the required round hole. Another punch with a plastic limit step is then used to punch the two small round holes outside this circle, through which the gasket is bolted to the moisture barrier material.

The sensing element can be reclaimed when the package is finally opened for use by the military unit. Even without the reusable feature, cost of a 2-percent destructive sampling inspection pays for 100-percent inspection with this Hydrotector system, with the result that only packages found to be faulty are repackaged.

Coining Cuts Costs of Magnetron Anodes

BY L. J. CAPRAROLA

Tube Department
Radio Corporation of America
Harrison, N. J.

THE FABRICATION of intricate precision copper parts for magnetrons has always been a challenge to electron-tube manufacturers. When such parts are to be produced in large quantities, costs may often be reduced by the use of a coining technique in place of conventional machining methods. Although coining requires expensive tooling and is limited in flexibility and application, it offers such advantages as low cost in large quantity, uniformity of product, use of semiskilled operators and good control with a minimum of supervision.

Coining denotes the process of metal working by which a metal

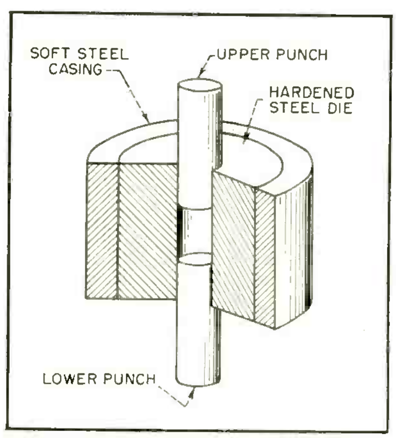

FIG. 1—Small coining die used in preliminary experiments with this technique

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D.C. Grid No. 1 Voltage	−150	volts
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Synchronization Level	850	volts
Pedestal Level	700	volts
D.C. Plate Current		
Synchronization Level	2.75	amps
Pedestal Level	2.1	amps
D.C. Grid No. 2 Current		
Synchronization Level	110	ma
Pedestal Level	50	ma
D.C. Grid No. 1 Current		
Synchronization Level	100	ma
Pedestal Level	50	ma
Driving Power at Synchronization Level*	300-400	watts
Power Output		
Synchronization Level	5	kw
Pedestal Level	2.8	kw

*Driving power is accounted for largely by circuit losses. The indicated driving power is required to take care of losses in loading resistors, circuit losses and tube driving power.

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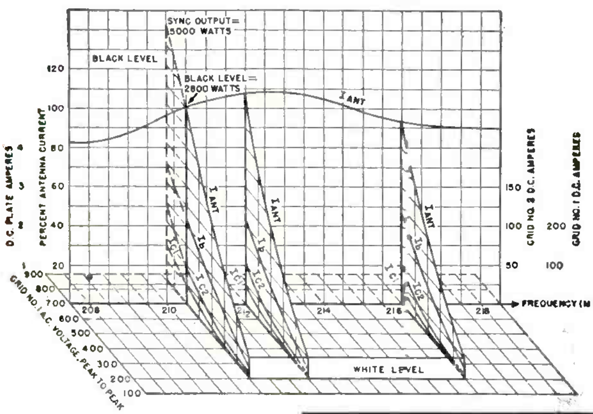

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D.C. Grid No. 2 Voltage	800	volts
D.C. Grid No. 1 Voltage	−250	volts
D.C. Plate Current	1.1	amp
D.C. Grid No. 2 Current	100	ma
D.C. Grid No. 1 Current	70	ma
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shape having approximately the dimensions desired is cold-worked in the confines of a hardened-steel cavity made to the precise dimensions. A small coining die, shown in Fig. 1, was used to acquire some general information and to determine some of the limitations of coining. The cavity of this die is a circular cylinder having a ½-inch diameter and a height dependent upon the amount of copper used. Pressure from the ram is applied to the copper in the cavity by means of the upper and lower punches. All of the parts which form the cavity are made of tool steel having a Rockwell C hardness of approximately 60 to 62. The soft-steel casing surrounding the coining die is principally a safety precaution.

A number of annealed copper cylinders were cold-worked in the cavity under different pressures to determine the smallest working stress for coining. Pressures between 60,000 pounds per square inch and 100,000 pounds per square inch gave satisfactory coining action. At pressures above 100,000 pounds per square inch, the slug, when removed from the cavity would be as much as 0.002 inch larger than the cavity in diameter. Because it is advantageous from the standpoint of tool life to operate at the lowest possible stress, a value of 60,000 pounds per square inch is used.

Experience with this die indicated that a very light film of castor oil prevents metal pickup on the tool. If oil is applied in excess, however, a void results in the finished cylinder. The original punch-and-die clearance of 0.0005 inch on the diameter produced a large burr or flash at the edges of the slug. This burr or flash was eliminated by two changes. The clearance was reduced to 0.0002 inch, and the

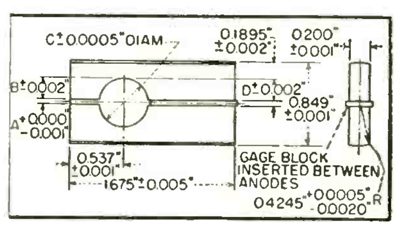

FIG. 2—Dimensions and tolerances required for copper anode blocks of a magnetron

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rough cylinder was chamfered slightly at the points where flash normally occurred. The effect of the chamfer was to provide room for the metal to cold-work sufficiently before it filled the cavity. Experiments with this coining die showed that the diameter of annealed copper slugs could be controlled within plus or minus 0.00025 inch.

Magnetron Anode Dies

The magnetron anode blocks which were to be made by the coining process are shown in Fig. 2. Although the part may look relatively easy to make, the tolerances on each individual block for dimensions *A* and *C* are half the values indicated on the assembly drawing. The radius, therefore, must be held to a tolerance of plus or minus 0.00025 inch and the step to a tolerance of plus zero, minus 0.0005 inch.

The anode block is, in general, a rectangular prism having sharp edges and corners. Because it was desirable to make fabrication of the tools as easy as possible, the die was made in four sections. A problem with this type of construction is to hold each section of the die in its proper position when the large forces used during coining are exerted. The construction used is shown in Fig. 3. When assembled, the four sections of the die provide an opening having the same length and thickness as the anode block.

The outer surface of the die forms a circular cylinder having a two-degree taper. This taper mates with an identical taper cut into a barrel of Elastuff 44, a strong tough material. The die sections are

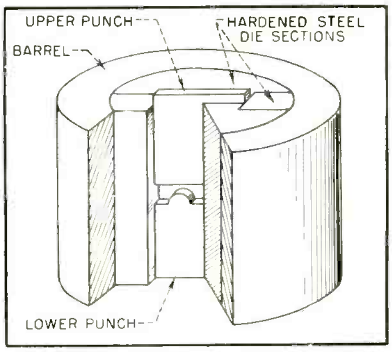
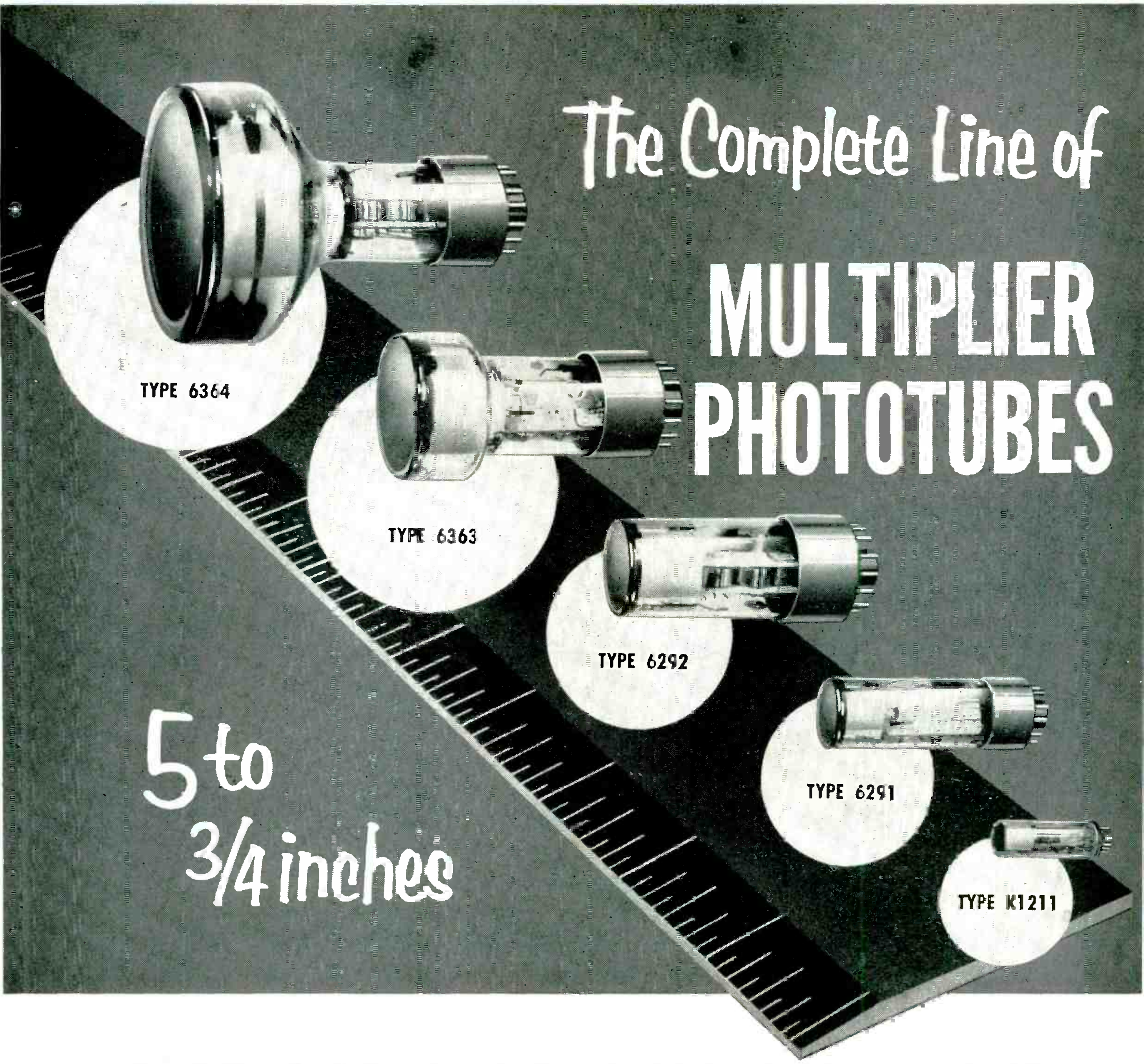


FIG. 3—Coining die used for anode blocks



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pressed into the barrel with approximately 65 tons of force. The two remaining surfaces of the cavity are formed by an upper and a lower punch. The upper punch contains the less critical contour and the lower punch all of the critical dimensions. This arrangement, which is very favorable, is possible because of the design of the parts to be made and not because of the design of the tools.

The lower punch was originally made to correspond exactly to the dimensions of the part to be coined. When sample parts were made and removed from the cavity, however, they no longer conformed to the dimensions of the punch. Figure 4 shows the outline of the punch used and the outline of the resulting part. The variations were due to the springback of the material. Although these variations were small, they were nevertheless objectionable. A new punch was made which compensated for the material springback. When this punch was used, the parts matched the contour of the original punch within a tolerance of plus or minus 0.00025 inch.

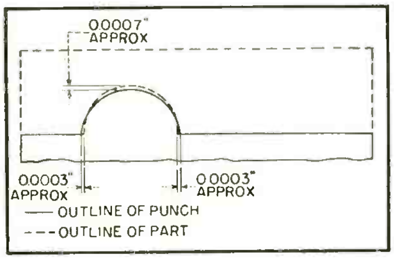

FIG. 4—Effect of springback of copper Steps in coining an anode block

Fabrication of Anode Blocks

The raw material used for the magnetron anode blocks is standard ¼-inch by ¾-inch oxygen-free, high-conductivity copper bar stock. The bar is fed into a blanking die which shears it to approximately the desired outline. The copper blanks are then flattened to a thickness of 0.197 inch; this flattening operation produces an outline larger than the original and reduces the thickness to approximately the finished size.

The flattened parts are then reblanked in the original blanking die set. This operation is actually a shaving process because little ma-

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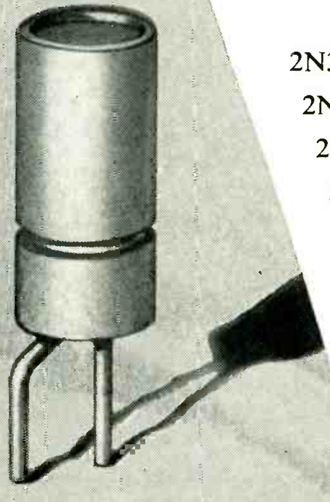

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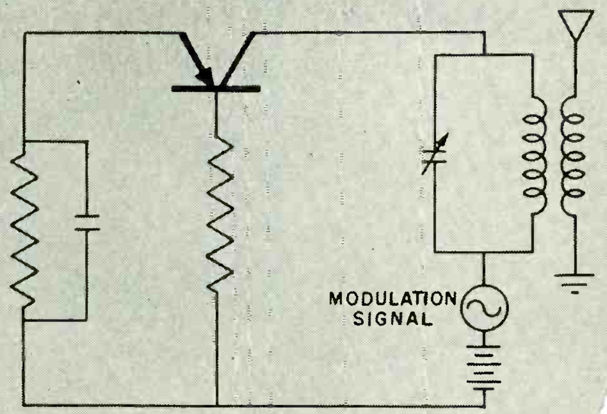

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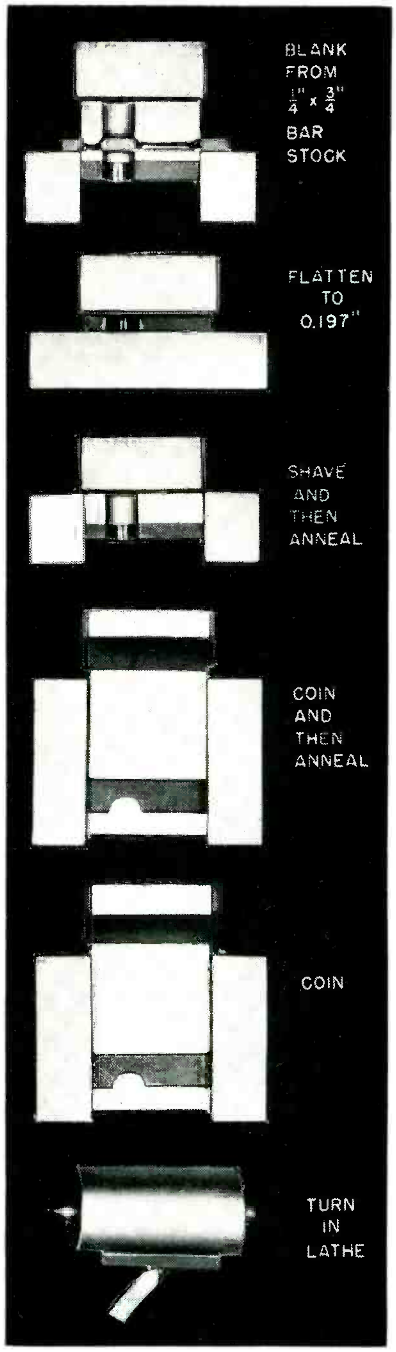

Steps in coining anode

terial is removed from the parts. During the shaving operation, the flattened part is nested in the die set so that a minimum amount of material is removed from the critical contour. The object of this shaving operation is to reduce the curvature which occurs on the under side of any blanked part and, therefore, to minimize the amount of cold-working necessary during the coining

After the shaving operation, the parts are annealed at 750 C in hydrogen for 20 minutes. The parts

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are then coined, deburred, annealed, finish coined and deburred. Because of width requirements on the anode block, it is necessary to turn the less critical side in a lathe.

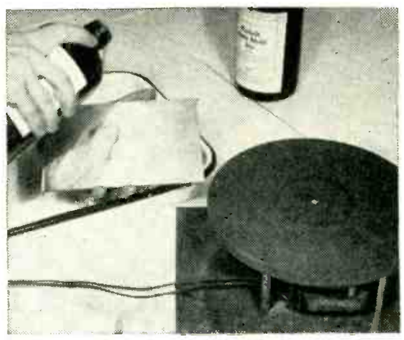
The factory cost of fabricating these magnetron anode blocks has been reduced by as much as 80 percent by the use of this coining technique. When the cost of the tools is considered, the break-even point for this process is 378 parts; that is, the savings realized in the fabrication costs for 378 anode blocks is sufficient to cover the cost of the tooling.

The author expresses his appreciation to Lloyd P. Garner and his group of the RCA Tube Department at Lancaster, Pennsylvania for recommending the use of Elastuff as the die-barrel material, the general construction of the anode-coining tools and use of a chamfer.

The author also expresses his appreciation to William J. Bachman of the RCA Tube Department at Harrison, N. J. for his suggestion to investigate the coining technique as well as the direct contributions that he made.

Phonograph Spreads Photo Resist on Copper-Clad Phenolic

LABORATORY production of etched circuitry in experimental quantities is expedited by using an ordinary 78-rpm phonograph motor and turntable as a whirler. The sheet of copper-clad phenolic is sensitized by pouring a quantity of photo resist solution on the surface, then placing the sheet on the turntable and starting the motor. A few seconds



Pouring photo resist solution on copper-clad phenolic sheet

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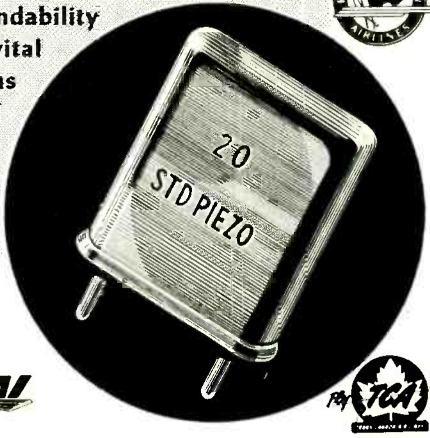

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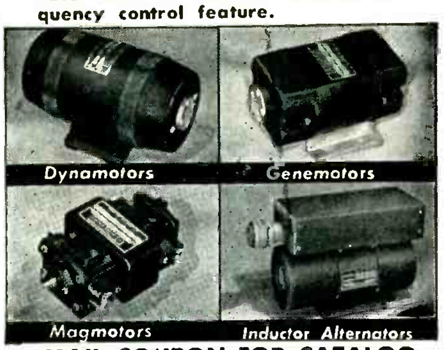

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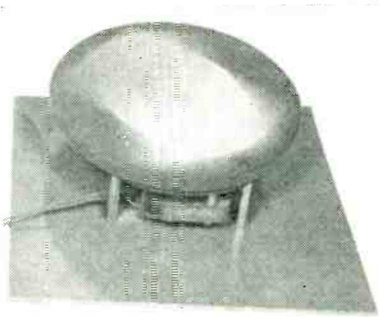
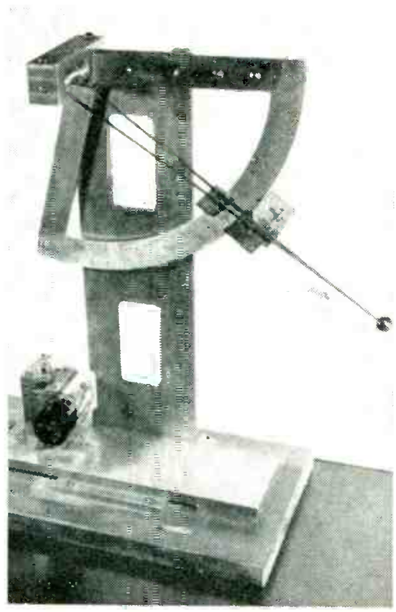


Spinning sheet on turntable to distribute solution evenly

of whirling distributes the solution uniformly over the sheet. This prepares the sheet for exposure conventionally with the negative made from the drawing of the wiring layout. The turntable technique is used by Electronic Engineering Co. of Calif., Los Angeles.



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ENVELOPES of glass tubes are checked for structural strength on a sampling basis at Tung-Sol with a gravity-type impact tester patterned after a corresponding instrument developed by the Naval Material Laboratory in the form of a pendulum tapper for checking microphonism in vacuum tubes. The amount of impact can be accurately controlled by adjusting the angle from which the pendulum is released. The tube to be tested let **WILLIAMS** help you apply

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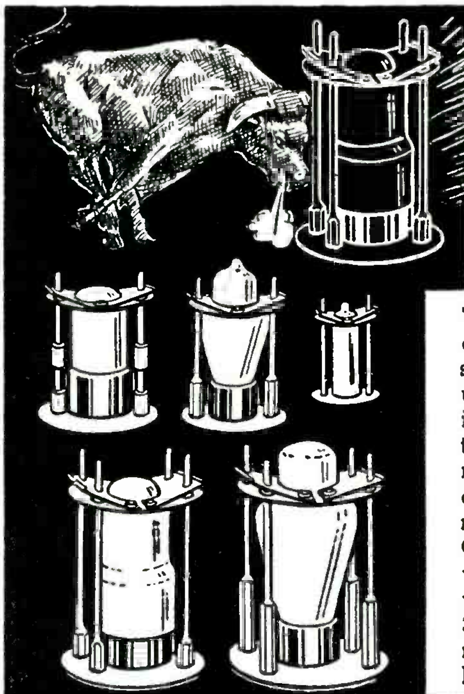

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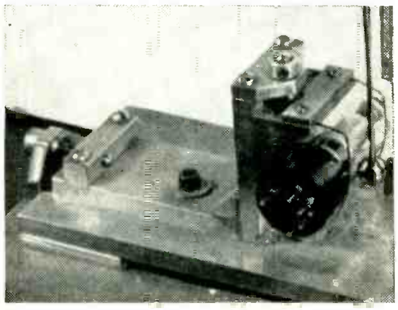
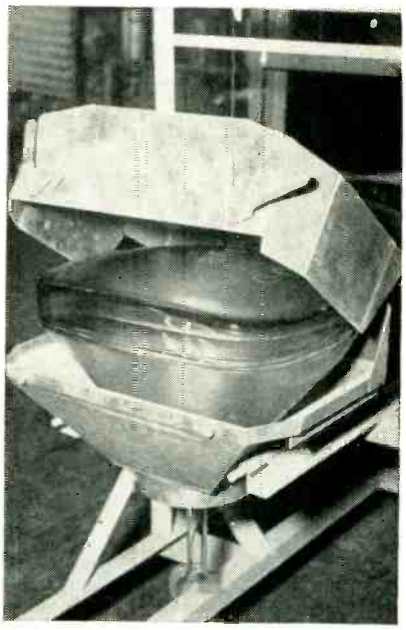


Close-up of tube holder, with pendulum resting at point of impact

is held in position on the anvil with a spring wire clip. The position of this anvil is adjustable on the base of the tester, to permit locating the point of impact directly under zero of the overhead quadrant scale regardless of the size and shape of the tube. On this quadrant scale is the pendulum-holding slide that can be set and locked at any desired angular position away from the vertical. When ready for a test, a button on the holding slide is pushed to release the pendulum.

Clam Shell Housing Speeds Cooling of Picture Tubes

A METAL enclosure that somewhat resembles a clam shell has been developed by Corning Glass Works to protect glass picture tubes from drafts while they are being ex-



Clam shell metal housing for picture tube. The two latches lock over studs on the lower part when the cover is down

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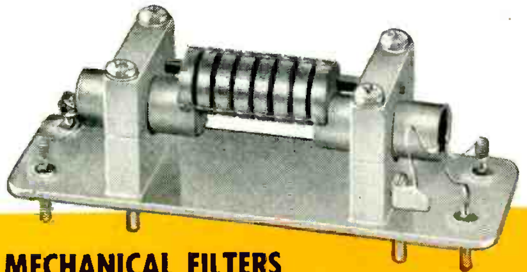

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(Fig. 1) *Type F455B-31* — Center frequency, 455 kc; band-width, 3.1 kc; plug-in terminal arrangement.

(Fig. 2) *Type F250Z-2* — Center frequency, 248.2 kc; band-width, 3.2 kc; solder terminal arrangement.

Fig. 1

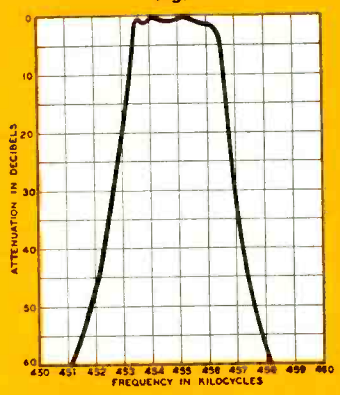
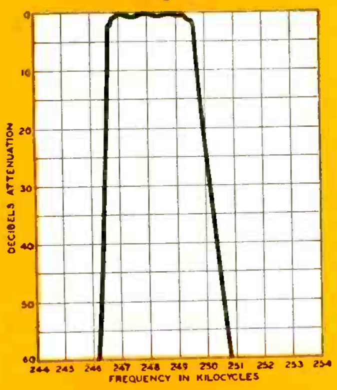
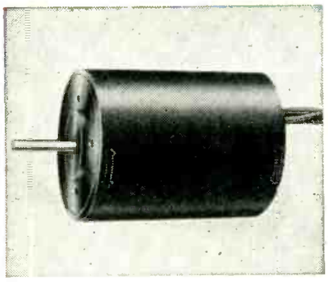
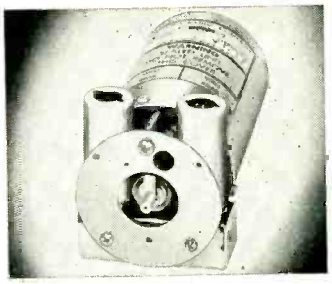
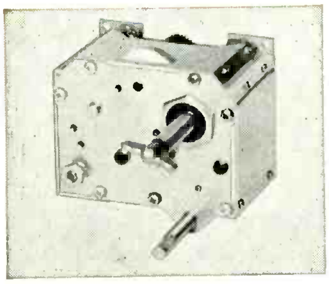


Fig. 2









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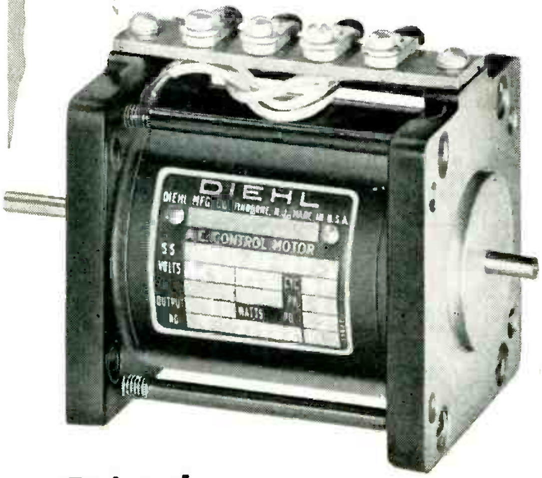
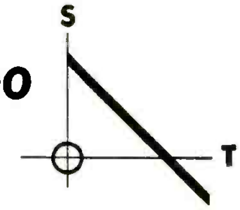
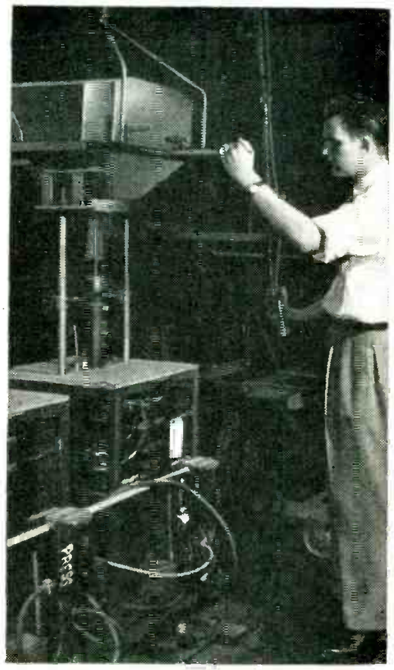




hausted and cooled. This technique permits cooling down the tubes from their pumping temperature of 400C much more rapidly than was heretofore possible. The time required for a safe cooling schedule that did not introduce strains in the glass had been the bottleneck

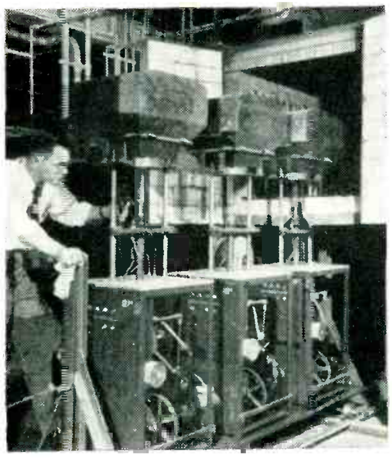


Lowering protected picture tube onto exhaust cart with overhead hoist having a fork-type lift

before in television picture tube production plants.

If the metal shells are blackened on all surfaces to absorb heat radiation, a glass tube placed in the clam on an exhaust cart can be thrust immediately into the heating oven and brought up to adequate exhausting temperature in about 19 minutes. The exhausted tubes can be pulled out of the oven into an open room and safely cooled without breakage even when giant fans are used to force the cooling.

Use of the metal shells permits final closure or tipping out very shortly after the tube is brought out into room temperature. This is desirable because maximum evacuation occurs when the tube is very hot. A second and more important advantage lies in being able to take the tube and its metal enclosure off the valuable exhaust equipment about 25 minutes after it has been put on, as compared to the 65 to 90 minutes previously required. Ex-



Tipping off picture tubes as they emerge from exhaust oven. Metal clam shells protect tubes from plant drafts that might cause strains in glass walls

haust oven temperature need not be regulated as precisely as before, it being necessary only to maintain a uniform temperature in the whole oven rather than a carefully calculated heating and cooling cycle.

The metal clans of individual tubes also serve to prevent a chain reaction by broken pieces of glass hitting neighboring tubes if one does break. Operating personnel are completely protected against injury during the most critical phases of the operation.

Finally, the clam shell makes it easier to handle the heavier tubes mechanically without risking breakage, since the shell need not be handled as carefully as an unprotected tube. Hooks or projections can easily be placed on the shells for engaging a hoist or lifting aid.

Optical Methods Speed Tube Components Inspection

By W. F. Wiebach

Westinghouse Electric Corp.

ADAPTION of optical inspection techniques to checking electronic-tube components has played an important part in helping attain desired quality levels at the Westinghouse Electric Corporation's new tube plant at Bath, N. Y. Contour projection has largely replaced conventional gages and micrometers for checking grids, measuring mica spacers, and gaging stem assemblies. Parts which fail to meet required specifications are thereby

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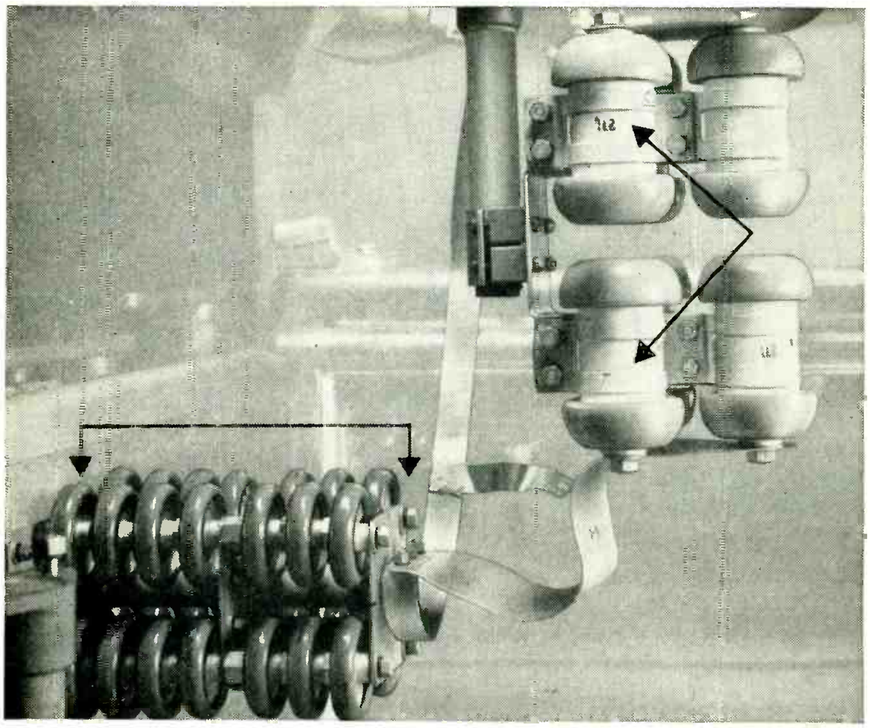
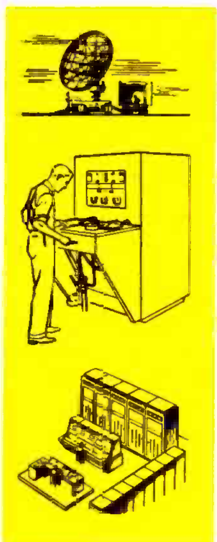




detected prior to investment of assembly time. The method has also proved applicable in final inspection of finished tubes.

The magnitude of the inspection problem indicated use of statistical methods of quality control and standard sampling procedures. Using these methods, go-no go gaging alone was insufficient. Where parts failed to fall within tolerance limits, measurement was required so deviations might be plotted and adjustments made to production machinery.

Since the plant represented a new facility, choice of contour projection as the preferred method of inspection was unhampered by considerations of existing gage inventories. The choice was based on the following factors:

(1) The necessity of holding size and spacings to measurements in tenths of thousandths. Such tolerances can be readily checked where parts are magnified by the optical system of a contour projector.

(2) The necessity of avoiding distortion of delicate components during inspection, pointing up the advantage of using light as a gaging medium.

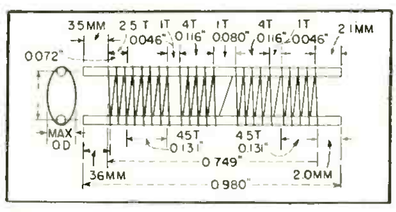
(3) The ease with which inspectors may be trained to use visual methods.

(4) The speed with which complex parts may be gaged optically on a go-no go basis, and the ease with which measurements may be made to supplement go-no go readings.

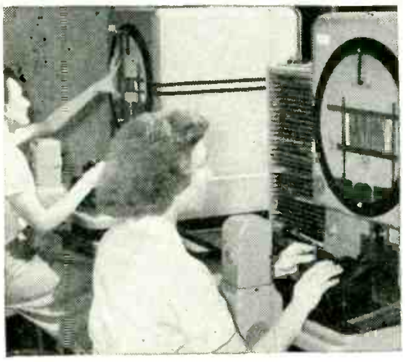
(5) The chance afforded production personnel to actually see errors in components on the contour projector screen, reducing possible misunderstandings between the inspection and production groups.

Inspecting Grids

Inspection of a typical grid involves checking the length of the supporting side rods, the length of



Example of wound grid, showing dimensions and profiles requiring inspection

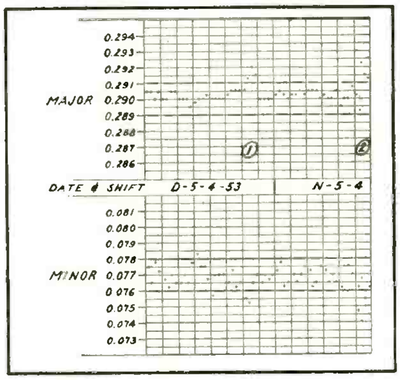


Checking grids with contour projectors. Operator at left is using calibrated enlarged glass scale to measure departure of grid from tolerance on minor diameter. Screen charts for other types of grids are stored in rack between the two projectors

grid windings themselves and their relation to the overall length, the major and minor diameters and the characteristic profile shape. In the course of this inspection the operator may also pick up any bowing of the side rods and irregularities in the spacing between the turns, called windows.

Using a simple staging fixture, an operator may quickly check length of both side rods and windings and the major diameter of the grid by comparing its enlarged shadow with the master chart mounted on the contour-projector screen. Rotating the fixture 90 degrees gives a profile image of its shape . With the grid held in place magnetically, minor diameter can be checked over its entire length by flopping the fixture on its horizontal axis.

Sample grids are checked each hour from each grid lathe in oper-



Portion of typical plot of grid-lathe performance when winding 6CB6 control grids. Major diameter was over specifications at 1 and immediately corrected. At 2, major was over specification and minor was under specification

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ation. Formed grids, which are stretched on removal from the lathe, are checked after stretching; those not formed are checked directly as they come from the lathe. Whenever two sample grids fail to meet specifications, sampling is repeated. If the second sample bears out the findings of the first, the inspector makes a failure report slip which is immediately delivered to the foreman concerned. Copies of the report slip go to the superintendent of manufacture and the supervisor of quality control. A quality control stop may be placed on the machine itself.

Since most grid tolerances are in thousandths, departures from tolerance may be measured by using a glass rule scaled to the magnification in use on the projector, in this case 20X. This scale provides a quick reading of sufficient accuracy to indicate the amount by which grids may exceed tolerance. This information is of value to the production department in making required adjustments to the grid lathes, and also enables the quality-control group to keep a running record of lathe performance on grids with troublesome histories.

Since the grid-holding fixture accommodates a number of grids of different types, the operator may switch from checking one type of grid to another merely by changing the chart on the screen. Charts are stored alongside the contour projector and the changeover time is not excessive. With comparatively little training an operator can handle the hourly checks, including the measurement and paper work, for as many as 15 lathes—each winding a different type grid.

Inspecting Micas

More critical tolerances are encountered in the inspection of mica spacers, which serve for insulating and locating component parts in electronic tubes. Sequential sampling methods are employed in receiving inspection to hold a 1 percent average quality level. A typical mica may call for checking upwards of 20 pierced holes for size, location and shape or concentricity, with the diameters held to ± 0.0005 inch and location to ± 0.00075 inch.

The advantages of contour pro-

Checking locations and diameters of holes in mica spacers. Light from vertical illuminator at top projects shadow of mica resting on glass staging table

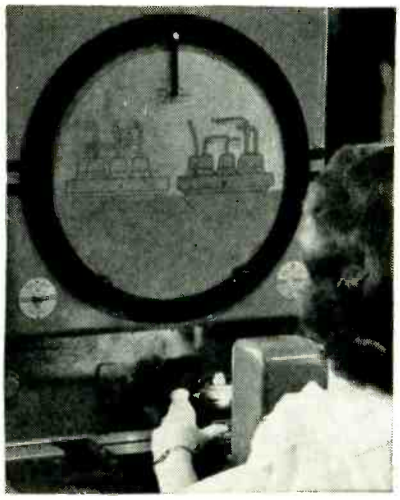
jection here, as contrasted with mechanical gaging, are both economic and operational. From the economic standpoint, a single chart for the projector replaces numerous mechanical gages, many of which would of necessity be complex since mica piercings are often non-symmetrical. In operation, the chart provides a means of determining, literally at a glance, what dimensions may be in error as the location of an individual hole in the mica is shown in relationship to all other holes.

Sequential sampling of micas is done on a go-no go basis, usually at 20 or 31.25 magnifications. Fixturing is avoided by using the projector's vertical light source and a glass staging table. The mica is simply positioned on the stage and aligned with the master chart.

The same light source and stage are used in the even more critical task of measuring dimensions when new dies are placed in production. In such cases, as a check on the dies, first-run micas are magnified 50 times and all dimensions measured using the instrument's micrometer attachments. Such dimensions may include linear measurements, measurements of radii and angles.

Inspecting Tube Stems

Optical methods are particularly helpful where angularity must be measured. This is of major importance in checking the molded stems used for different tube types, where



Checking length and angularity of leads in tube stems with contour projector, using screen chart having two views of stem and staging table that rotates and moves stem 90 deg for comparison with each view in turn

the length and form of the lead wires must be gaged.

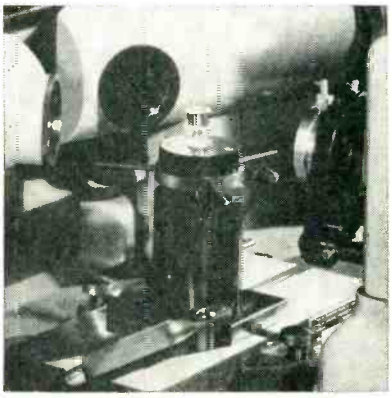
To inspect stems on the contour projector, a two-position staging fixture is used. The screen chart includes two views of the stems, opposed by 90 degrees. Working at 10 magnifications, the operator places the stem on the fixture and aligns it in the first position. By shifting the fixture to the right and rotating it to a fixed stop, the stem is aligned in the second position. The opposing views provide a measure of angle and length. The shadow image is quickly compared with the tolerance lines scribed on the screen chart.

Using this method, an operator can inspect as many as 200 stems per hour, a number sufficient to provide an adequate sample from the output of more than 15 forming machines. Where stems are malformed, the setup man can determine from the screen image the information needed to adjust the former for acceptable production. Changeover time for inspecting various types of stems is short.

Inspecting Tube Assemblies

Reliability standards have also led to use of a special projector for inspection of tube assemblies prior to evacuation. This instrument is equipped with additional light sources supplementing the conventional surface and shadow sources on the standard projector. These

Special multiple-lamp contour projector used for inspecting tube assemblies prior to evacuation



Details of multiple-lamp projector, showing rotatable staging table

provide a brilliant screen image of the part and enable the operator to detect any windows, non-uniformity of spacing between grids and cathode and the condition of numerous welds as the tube is rotated on its fixture. Magnification is changed by the use of a hand lever. Various planes of the tube are imaged successively by changing focus. Rejection rates on completed assemblies, tested functionally, have decreased by 5 percent since this special projector has been in use.

Save for this special projector, the contour projectors used at the Bath plant are all stock models made by Eastman Kodak Co., Rochester, N. Y. Since many of the holding fixtures on which components are staged are universal in nature, little gaging cost is encountered. When new tube types are put in production, new screen charts showing required specifications are prepared by the plant's own engineering department.

NEW PRODUCTS

Edited by WILLIAM P. O'BRIEN

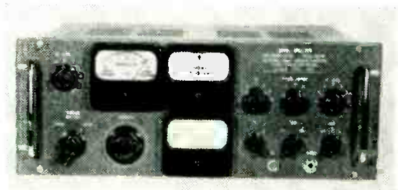
53 New Products and 55 Manufacturers' Bulletins Are Reviewed . . . Control, Testing and Measuring Equipment Described and Illustrated . . . Recent Tubes and Components Are Covered

OTHER DEPARTMENTS featured in this issue:

SIGNAL SPLITTER

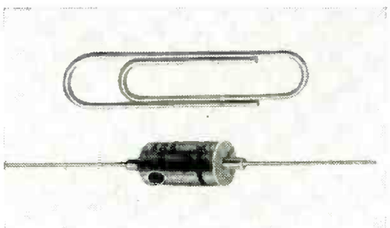
provides jam-free bandwidth

J. L. A. MCLAUGHLIN CORP., La Jolla, Calif., announces production of the type MCL-50/50 series signal splitter, a complete variable bandwidth single-sideband converter. It provides the exact realistic jam-free bandwidth for all long-range reception of short-wave single-sideband transmissions. The unit is a complete variable bandwidth s-s converter and is used with general purpose communications receivers to provide the ultimate in reception of double or single-sideband, program, voice or fsk transmissions. It provides exalted carrier reception for full and reduced carrier transmissions. Jamming attenuation is 60 db, 500 cps outside passband.



GERMANIUM DIODES

for high temperature use

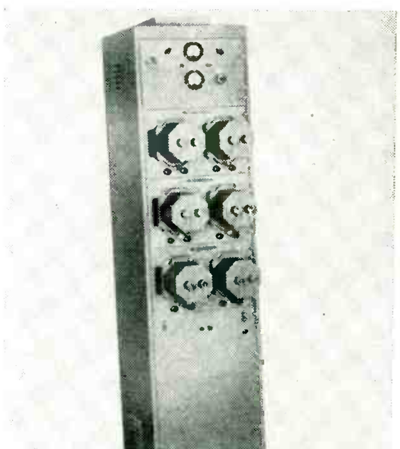


INTERNATIONAL RECTIFIER CORP., 1521 E. Grand Ave., El Segundo, Calif., is producing a Red-Dot series of germanium diodes for high temperature applications. Each unit is so well sealed that exposure to 95 plus percent relative humidity for 500-hours at temperatures from 0 to 85 C will not appreciably change back resistance or cause appearance of hysteresis. Type G44 has a minimum of 100,000-ohms resistance at —30 v and 100 C. Other types are available to customer specifications. The Red-Dot series is designed for either clip-in or solder-in application, measuring $\frac{5}{32}$ in. in diameter and $\frac{3}{8}$ in. in length with $\frac{3}{16}$ in. clip pins.

FUNCTION GENERATOR

is six-channel unit

MID-CENTURY INSTRUMATIC CORP., 611 Broadway, New York 12, N. Y. The MC-600 six-channel function generator is designed as a valuable tool in analog computer applications. It is a self-contained unit consisting of 6 c-r tubes for the generation of arbitrary functions. A camera unit is provided for transforming the given curves onto $3\frac{1}{4}$ in. × $4\frac{1}{4}$ in. slides which are inserted between the face of the tube and the photocell. Among the features are its ability to handle functions whose slope does not exceed 80 deg, a maximum noise output of less than 0.1 v, an amplitude response which is essentially flat to 30 cps at which frequency the phase shift is less than 2 deg, a transient response which for a step input gives a rise time of less than 3 milliseconds with an overshoot of less than 10 percent. Accuracy in the output waveform is 0.5 v or better, and total drift is less than 0.25 v over an 8-hour period for a straight line input of unity slope. Bandwidth may be broadened to 400 cps at the expense of increased noise.

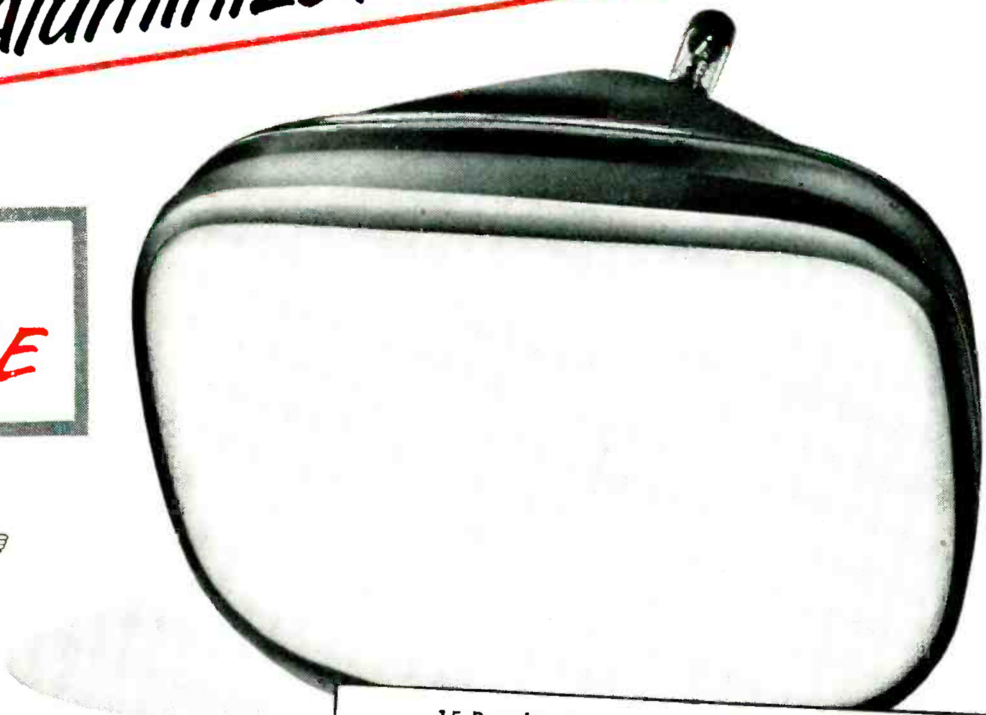


TINY CONNECTOR

is single-pin type

DEJUR-AMSCO CORP., 45-01 Northern Blvd., Long Island City, N. Y. Miniature precision connector series FHL is a tiny round-shaped connector that provides easy means for passing a single lead through a rack and panel arrangement. It may

AT LAST... super dependable Aluminized Picture Tubes



The name SYLVANIA on an Aluminized Picture Tube is an *endorsement of dependability!* It signifies that the tube has passed 781 quality-control tests, plus a series of final inspections after a 48-hour hold period.

Sylvania Aluminized Picture Tubes offer all these Advantages

1. *More Usable Light Output* resulting from reflection of wanted light from back of screen.
2. *Better Picture Contrast and Increased Contrast Range* due to elimination of reflected unwanted light from inside the tube.
3. *More Uniform Screen Color Tube for Tube* because of tighter screen color quality limits.
4. *Longer Screen Life* due to the protection of aluminum film on back of screen.
5. *Greater Picture Brightness and Sharpness* result from the elimination of electron "sticking."
6. *Longer Tube Life* due to a controlled degree of getter action in the aluminum film.

Lower Aluminized Picture Tube Prices!

Sylvania aluminized picture tube prices have now been reduced to slightly above regular television picture tube prices. Now you can offer your sets with 50% brighter pictures at practically no additional cost. For detailed data sheets drop a line to Dept. 4R-1605, Sylvania, today!

15 Popular Sylvania Aluminized Tube Types
AVAILABLE NOW

Type	Focus	Deflection Type	Deflection Hor. Angle	Ion Trap Magnet	Length
17HP4	Lo Es	Mag	65°	S	19 3/16″
21ALP4A	Lo Es	Mag	85°	S	20 7/16″
21AMP4A	Mag	Mag	85°	S	20 7/16″
21EP4B*	Mag	Mag	65°	S	23″
21FP4C*	Lo Es	Mag	65°	S	23″
21WP4A	Mag	Mag	66°	S	22 1/4″
21XP4A	Lo Es	Mag	65°	S	22 1/4″
21YP4A	Lo Es	Mag	65°	S	23″
21ZP4B	Mag	Mag	65°	S	23 1/32″
24CP4A	Mag	Mag	85°	S	21 1/8″
24DP4A	Lo Es	Mag	85°	S	21 1/8″
24VP4A	Mag	Mag	85°	S	21 1/8″
27EP4	Mag	Mag	85°	S	23 1/16″
27LP4	Mag	Mag	85°	S	24 23/64″
27RP4	Mag	Mag	85°	S	23 1/16″

*Cylindrical Face. All others have Spherical Face Plates

Lo Es—Low Voltage Electrostatic
Mag—Magnetic
S—Single Ion Trap

SYLVANIA

Sylvania Electric Products Inc., 1740 Broadway, New York 19, New York
In Canada: Sylvania Electric (Canada) Ltd.
University Tower Bldg., St. Catherine St., Montreal, P. Q.

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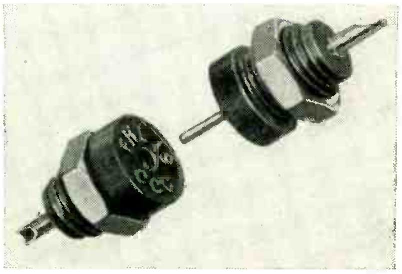
also be applied as a feed-through disconnect. It has high dielectric characteristics and features the use of one-piece molding available in three insulating materials: mineral (asbestos) filled Melamine for high dielectric and mechanical strength; Plaskon reinforced (glass) Alkyd type 440A for unusually high im-



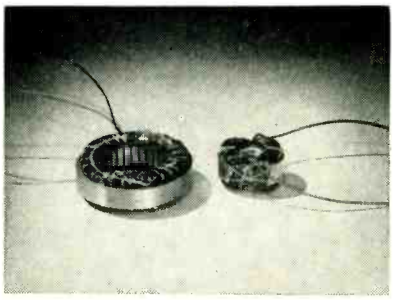
pact strength and arc resistance; and Diallyl Phthalate (blue) with high dimensional stability plus excellent dielectric properties. Precision-machined socket and pin contacts are of spring temper phosphor bronze and brass respectively, gold plate over silver giving low contact resistance and ease of soldering.

P-M GENERATOR
for instrument indicating

DALMOTOR CO., 1329 Clay St., Santa Clara, Calif. Rated for continuous duty with an output frequency of 20 cps and a maximum of 3-percent harmonic distortion, type 44A generator is recommended for instrument indicating and other similar applications. Voltage is linear with speed, and the unit develops 33 v of 2-phase a-c at 4,500 rpm. Internal winding resistance is 30,000 ohms per phase. Weighing a total of 8 oz, it is 1$\frac{3}{4}$ in. in outside diameter by 2$\frac{1}{8}$ in. long, and has a $\frac{5}{32}$-in. shaft extending 0.340 in. Special shaft arrangements including splines, keyways and gears can be supplied. The generator is pressure-sealed and has permanently-lubricated bearings. Electrical leads or terminations can be supplied in a number of different types as may be required.

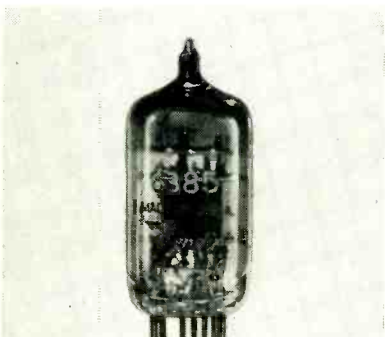
SYNCHRO
for airborne mounting

CLIFTON PRECISION PRODUCTS CO., INC., Marple at Broadway, Clifton Heights, Pa., has developed type SG-17-1-A synchro designed for gimbal mounting in airborne gyroscopic instruments. Maximum error spread when used as a transmitter is less than 6 minutes. Maximum depth is less than 0.500 in. Overall diameter is 1.625 in. Rotor



input to the synchro is 26 v, 400 cps. Stator output is 11.8 v. Input power when loaded with one control transformer is 0.973 w and sensitivity at control transformer output is 397 mv per deg. The synchro reflects to its shaft no measurable cogging effects or mechanical loading. Outline drawings, mounting information, complete characteristic basic data and typical error curves will be mailed on request to the company.

TWIN TRIODE
for aircraft and industry



BENDIX AVIATION CORP., Red Bank Division, Eatontown, N. J. The 6385 twin triode amplifier incorporates features that promote long life and is designed to replace the 2C51/5670 and other such tube types. Each 6385 is run-in tested and aged under vibration with all operating voltages applied for 45 hours to indicate that it will withstand extreme shock and vibration. These tubes have a cathode type structure with extruded ceramic heater insulator and a coil type heater instead of a filament structure. This construction, along with the ruggedized mount structure, virtually eliminates heater failures, shorts and other adverse effects of shock and vibration. The tube has a 9-pin miniature button base and can operate at altitudes up to 80,000 ft.

POWER MEGAPHONE
is all-electronic device

AUDIO EQUIPMENT CO., INC., 805 Middle Neck Road, Great Neck, N. Y., has developed a powerful single-unit electronic megaphone. With an acoustic output of 112 to 115 db at 5 ft it permits effective speech transmission up to 3,000 ft, depending on atmospheric and sur-

WHAT'S *new* IN TAPE RECORDING

Here's a professional magnetic sound recording tape that offers a new high in *permanence* and durability. It can be used and stored under the most extreme conditions of temperature and humidity without any ill effects. For all practical purposes, it is virtually *unbreakable*. Now available on 1, 1½ and 2 mil Mylar*, in standard sizes from 600 to 2,500 ft. Write for Bulletin No. 201.

The new EP Audiotape provides the *extra precision* that is so important to *dependable* magnetic data recording and reproduction. It is especially produced to meet the most exacting requirements for uniformity and freedom from microscopic imperfections. Available in ¼″ to 2″ widths, 1,225 to 5,000 feet. Write for Bulletin No. 207.

Audiotape, now available on green, blue or brown plastic base — and Audiotape reels in red, yellow, green, blue and clear plastic — provide *instant identification* that can simplify your cueing, filing, recording and playback problems. Write for Bulletin No. 209.

AUDIO DEVICES, Inc.

Dept. A3, 444 Madison Ave., New York, 22, N. Y.
Export Dept., 13 East 40th St., New York 16, N. Y. Cables "ARLAB"

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rounding noise conditions. Outstanding feature is the virtual elimination of acoustic feedback. The present unit is completely self-contained with batteries and 3-stage vacuum-tube amplifier in the main housing. It is small and light, only weighing slightly over 5 lb, and being just over a foot long. The form-fitting handle incorporates a press-to-talk trigger switch.

A-C VOLTMETER features expanded scale

ARGA DIVISION, BECKMAN INSTRUMENTS, INC., 220 Pasadena Ave., South Pasadena, Calif. An advanced a-c voltmeter featuring both scale expansion and recording over the 100 to 500-v range has been announced. The instrument covers the voltage range in 39 easy-to-read 10-v steps, full scale. True rms readings are obtained with accuracies better than ±0.25 percent of input voltage. Frequency response is uniform between 50 and 2,000 cps. The new voltmeter offers built-in recorder connections for continuous recording of line voltage fluctu-


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Specify Instrument Corporation of America Slip Ring and Commutator Assemblies for closer tolerances, absolute uniformity and the ultimate in miniaturization. Wherever extreme dimensional precision, accurate concentricity and high dielectric qualities, are required, Instrument Corporation of America assemblies are specified with confidence. One-piece, unitized construction eliminates dimensional variation due to accumulated errors, provides jewel-like finish, uniform ring hardness and reduced weight. Engineering "know-how" resulting from years of specialization and continuous collaboration with leading manufacturers all over the world is at your immediate service.
Proven for performance in precision instruments and equipment including SYNCHROS, GYROS, RADAR, FIRE CONTROL, TEST TABLES and other CRITICAL APPLICATIONS
TYPICAL SPECIFICATIONS
SIZES: .035" to 24" Diameter, Cylindrical or Flat
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FINISH: 4 Micro-Inches or Better
BREAKDOWN: 1000 V or More Hi-Pot Inter-Circuit
RING HARDNESS: 75 to 90 Brinell
SURFACE PROTECTION: Palladium and Rhodium, or Gold Prevent Tarnish, Minimize Wear & Noise
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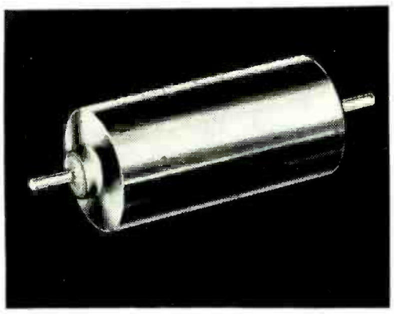
ations with a 1-ma d-c recorder, greatly simplifying problems of voltage regulation or stabilization in any a-c system.

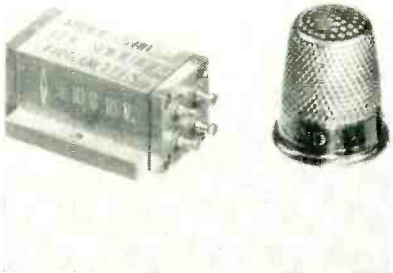


DELAY LINES are solid ultrasonic type

BLILEY ELECTRIC CO., Union Station Building, Erie, Pa. Solid ultrasonic delay lines provide precise delay intervals for electronic equipment. Type SDL-15 has the equivalent of 1,000 yards or 3.051 microseconds. Type SDL-16 has the equivalent of 2,000 yards or 6.102 micro-seconds. Each unit is in an hermetically sealed case. Carrier frequency is 30 mc. Attenuation is 26 db into 1,000 ohms; and bandwidth, 8 mc.

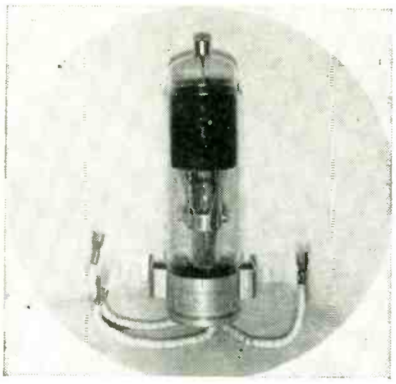
MARKER OSCILLATOR tunes 400 to 930-mc range

TELONIC INDUSTRIES, 444 South Rural St., Indianapolis, Ind., announce their new uhf marker oscillator that tunes the range of from 400 to 930 mc. The compact unit with built-in, regulated power supply measures 5 in. × 7 in. × 5 in. The black anodized, 4-in. aluminum dial is individually calibrated and is carefully engraved to maintain an accuracy of ±0.25 percent. A smooth action, 5 to 1 vernier is used for easy tuning. The 50-ohm output is attenuated by 0, 20 and 40 db.



TINY ACCELEROMETER
is strain wire type

GENERAL SCIENTIFIC CORP., Los Angeles, Calif., has available a sub-subminiature accelerometer (strain wire type) with a maximum length of 1 in. and a weight of 14 grams. It offers a range of ±0.5 to 100 g and accuracy of 1.0 percent full scale. Natural frequency is 30 to 250 cps, with damping factor of 0.7 of critical. Used for acceleration measurements, flutter analysis, vibration investigations, impact research and guided missile telemetering, the accelerometer minimizes space and weight requirements, disturbances and distortion.



THYRATRON TUBE
for industrial equipment

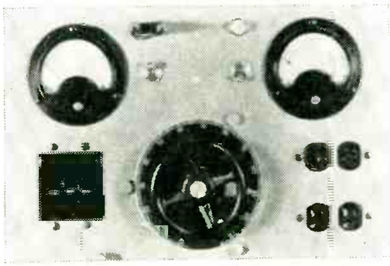
NATIONAL ELECTRONICS, INC., Geneva, Ill., has announced a new high-current thyratron with bracket base for panel mounting. Type NL-760P has a 6.4-ampere d-c and 77-ampere peak rating. It is designed for motor speed control, welding control, and regulated rectifier applications. The tube is gas and mercury filled for quick starting and constancy of characteristics within wide temperature limits. Other rating details are: filament voltage, 2.5 v; filament current, 21 amperes; and peak inverse voltage, 1,250 v.

TERMINAL BOARDS
are custom fabricated

DEJUR-AMSCO CORP., 45–01 Northern Blvd., Long Island City, N. Y., can supply a wide variety of custom fabricated terminal boards to government and civilian users. Many different terminals and base materials make possible a proper design for every application. The boards can be finished or impregnated, and coding is accomplished by silk screening. In addition, Continental terminal boards can be made with any number of contacts and in any size or contact arrangement.

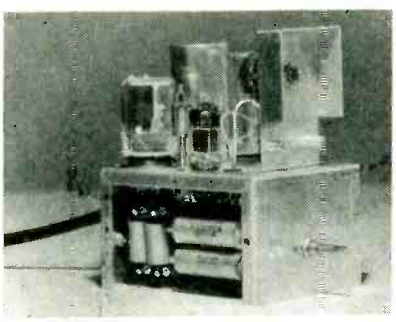
RECEIVER-CONVERTER
weighs only 22 lb.

SERVO CORP. OF AMERICA, 20–20 Jericho Turnpike, New Hyde Park, N. Y. This unit extends the frequency range of a standard h-f receiver into the vhf range of 50 to 200 mc. It has a self-contained power supply which facilitates installation. No modification of the receiver is required. The vhf antenna is connected to the converter which is connected to the h-f receiver. Power input is 35 w from nominal 115 v, 50/60 cycles. Small and compact, the unit weighs only 22 lb.



POWER SUPPLY
has industry and lab uses

SUMMIT ELECTRONICS, INC., 7 Industrial Place, Summit, N. J. A new adjustable a-c regulated power supply is designed to operate from a 60-cycle a-c line. The supply is particularly suitable for application in industrial production and inspection operations as well as in laboratory work. Several models are available for varying output requirements, ranging from a minimum of 0.1 ampere to a maximum of 100 amperes. Output voltages are readily variable by a simple front-panel control, while easily read meters make possible rapid adjustment to desired voltage and current. Intended for rack mounting, the equipment measures 12¼ × 19 × 6½ in.



ELECTRONIC TIMER
is continuously variable

MT. SOPRIS INSTRUMENT CORP., 1320 Pearl St., Boulder, Colorado. Percent-on time from 25 to 75 percent

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feature increases the usefulness of this electronic timer in such timing operations as product life testing, energizing solenoids and feeding machines. Both cycles-per-minute and percent-on time are continuously variable. Either may be changed without disturbing the other and may be adjusted with the equipment in operation. Model T-1 covers a frequency range of from 10 to 50 cycles per minute and T-2 is a dual range model with a total frequency coverage from 2 to 100 cycles per minute. Standard accuracy including line voltage variation ±10 percent is within 10 percent. The timers are operable from 115 v, 50-60 cycles.

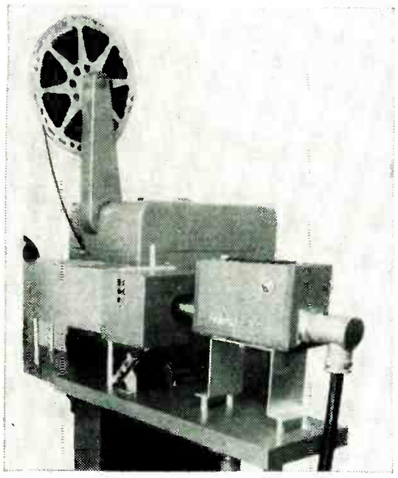
CRT CHECKER
tests 5 tubes at once

RESEARCH ELECTRONICS, Roslyn, Pa. Model 404 c-r intermittent checker tests up to five tubes at once for intermittent shorts and opens of all elements of any standard tv picture tube. By a unique cycling action it forces intermittents to show very quickly, announces any failure by an alarm bell, and the type of short or open is indicated by lamps. The unit measures 12 × 12 × 18 in.

RESISTANCE ANALYZER
is a high precision unit

THE KULJIAN CORP., Philadelphia, Pa., announces a resistance analyzer designed to measure accurately the voltage coefficient of a wide range of resistances. Primarily a high precision, general purpose, resistance measuring laboratory instrument, it measures resistances ranging from 1,000 ohms to 111 megohms to within 0.1 percent. The voltage coefficient of any

resistor up to a power rating of 1.5 w can be determined down as low as 0.0002 percent per volt. Voltage across the measured resistance is continuously variable in two ranges from 0 to 500 v by a self-contained regulated power supply. Sensitivity of balance is within 0.04 percent on all ranges. It is designed for 115-v, 60-cycle operation.



CAMERA CHAIN
for televising film

FEDERAL TELECOMMUNICATION LABORATORIES, Nutley, N. J., announces a newly developed camera for televising film. Using a small photoconductive camera tube, the camera chain (FTL-105A) features high definition and excellent contrast range in addition to low initial and operating cost. Consisting of a very small camera head weighing only 7½ lb, a control monitor, and a rack-mounted power supply, this camera may be used in a number of flexible operating arrangements, none of which requires a shading operator. When used with this camera, an ingenious optical multiplexer (FTL-287A) provides pictures from two film projectors, a 2-in. × 2-in. slide projector, and a 4-in. × 5-in. opaque

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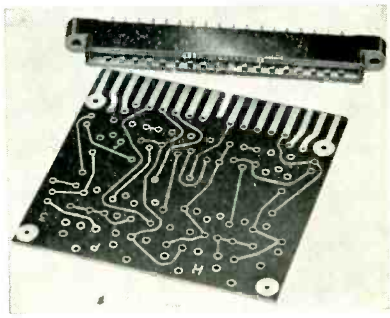
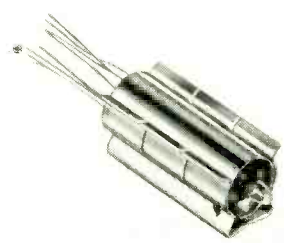
projector—all automatically controlled and providing for the ultimate in operating smoothness.



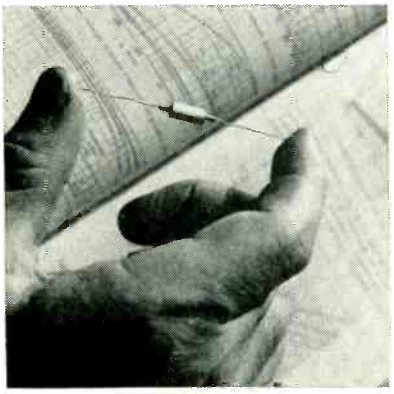
CONNECTOR
for printed circuits

Gorn Electric Co., 857 Main St., Stamford, Conn., has available a new receptacle connector with 6, 8, 10, 12, 15, 18 or 22 contacts to receive printed circuit cards. The body is compression molded Melamine for high dielectric and mechanical strength. Contacts are of spring tempered beryllium copper, gold plated over silver for ease of soldering and prevention of corrosion. Design of the contacts provides positive mating of the connector with printed circuit cards of from 0.061 in. to 0.071 in. thickness. Voltage breakdown at sea level is 2,500 volts rms, and at 60,000 ft is 700 volts rms. Minimum creepage is $\frac{5}{64}$ in.; minimum air space is $\frac{1}{8}$ in.; mechanical spacing is $\frac{5}{32}$ in. It is designed for use with wire size No. 16.



TINY TUBE HOLDER
features light weight

Atlas E-E Corp., Bedford Airport, Bedford, Mass. A new lightweight subminiature tube holder made of cadmium-plated spring steel with silver-plated brass tube shield provides space saving, economical and convenient methods for firm holding in fixed positions in relation to a mounting surface. Subminiature tubes, held in place by the holders, withstand high shock and vibration encountered in mobile electronics such as guided missiles. Equipment using this construction technique has withstood tests of 10 to 500 cps from 5 to 20 g for 8 hours without resonance. The holders provide ready removability of the tube should replacement of the component be needed; efficient conduction of heat from the component to the body on which the holder is mounted; and automatic adaptation to thermally caused dimensional changes, thus minimizing thermal stress between component and holder.



GERMANIUM DIODES
are hermetically-sealed

GENERAL ELECTRIC Co., Syracuse, N. Y. Three JAN types (1N69, 1N70 and 1N81) and some commercial computer types of hermetically-sealed ceramic germanium diodes are now available. As in the past, the platinum-ruthenium whisker is welded to the germanium pellet. The hermetic seal is metal to ceramic. Gas-tight ceramic cases with metalized ends permit solder seal to nickel pins. The diodes exceed the requirements of JAN humidity specifications.

PRINTING MACHINES
for wire lead components

MARKEM MACHINE Co., Keene 41, N. H. A printing machine that

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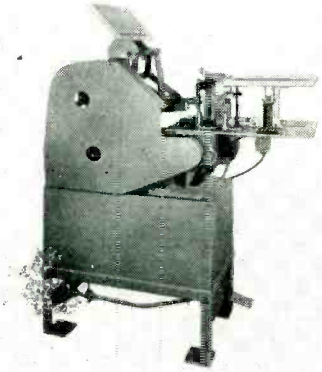
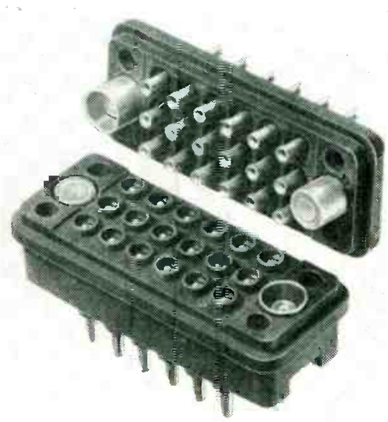


automatically feeds, prints and ejects small cylindrical objects with wire leads is available for in-plant printing. It prints trade name, trade mark, specifications, etc., on items such as resistors, capacitors, diodes, triodes, transistors and subminiature electronic tubes or other cylindrical objects when a special feed adapter is used. The machine incorporates a chute feed which easily adjusts to handle items up to 2½ in. long by ¾ in. o.d. The unit, powered by a ¼-hp motor equipped with a variable speed drive, is mounted on a floor stand and occupies space 45 in. deep, 15½ in. wide and 56 in. high.



POWER CONNECTORS with coaxial contacts

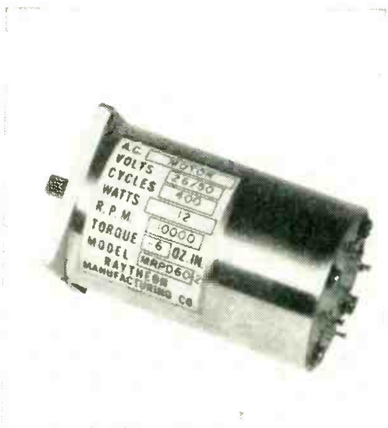
DEJUR-AMSCO CORP., 45-01 Northern Blvd., Long Island City, N. Y. A new type of "Easy-Release" connector designed for use with small r-f cables where nonconstant impedance is required, has been added to the Continental connector line. This connector uses coaxial contacts instead of the standard guide pins to minimize electrical discontinuity in a coax line. Electrically they are similar to the BNC type connector. Polarization is positive with the two coaxial contacts serving not only as a means for polarization, but also as a self-aligning guide pin and socket. Plugs and receptacles may be used with cables RG-55, 58, 59 and 71/U.

SWEEP GENERATOR
is a high-speed unit

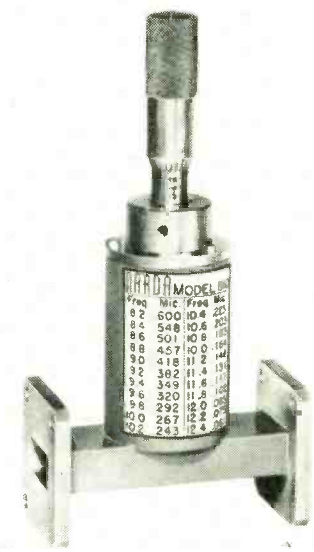
SPENCER-KENNEDY LABORATORIES, INC., 186 Massachusetts Ave., Cambridge 39, Mass. Model 610 high-speed sweep generator was designed to supply extremely fast sweeps for cathode-ray indicators or other applicators or other applications requiring a rapidly rising linear voltage. It will provide continuously adjustable sweep speeds of from 0.05 to 500 cm per μsec. The unit can be triggered for single or repetitive sweeps. It will also provide a brightening pulse and gate outputs. All controls and connectors are conveniently grouped on the front panel and include sweep-speed controls, trigger input, gate output and external horizontal-deflection-input jacks. All power connections are made to the rear of the chassis.

SERVO MOTOR
for high acceleration

RAYTHEON MFG. CO., 148 California St Newton 58, Mass.. The motor illustrated was designed for an application requiring high acceleration. Minimum starting torque is 0.6 oz-in. and the measured average acceleration is 26,500 radians per second. A tachometer generator is incorporated in this design for applications where tachometric



feedback is required. The no-load speed is 10,500 rpm, and the motor will accelerate to full speed, no load, in 0.03 sec. For complete technical information, write for bulletin DL-Y-14.

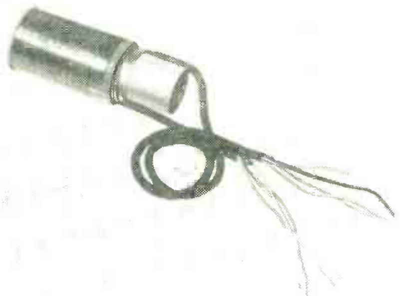


FREQUENCY METER for 8,200-12,400 mc range

NARDA-NASSAU RESEARCH & DEVELOPMENT ASSOCIATES, INC., 66 Main St., Mineola, N. Y., has developed a frequency meter for the 8,200 to 12,400-mc range for use by microwave laboratories in the X-band region. It features high Q, accuracy of 0.1 percent, ease of tuning, calibration chart mounted on cavity and large reactive dip for rapid location of resonance. The meter consists of a resonant cavity in the TE_{111} mode, which is tunable by varying the cavity length with a noncontacting shorting plunger. The cavity is mounted on a short length of $1 \times \frac{1}{2}$ in. waveguide, which is terminated in UG-39/U cover flanges.

RECTIFIER
is tiny double-bridge type

RAYTHEON MFG. CO., 148 California St., Newton 58, Mass. This unit contains two full-wave selenium bridge rectifiers and associated resistors, designed to operate as a phase comparator and packaged to withstand high shock and vibration. The package is completely sealed. Overall dimensions are 1 in. × $\frac{7}{8}$ in. × $\frac{7}{8}$ in. Weight is slightly over $\frac{1}{2}$ oz. For complete details write for bulletin DL-Y-19.



DEFLECTION YOKE
for tv camera tube

I-T-E CIRCUIT BREAKER CO., 1924 Hamilton St., Philadelphia 30, Pa. Function of the camera deflection yoke illustrated is to control the electron scanning beam as it moves vertically and horizontally. Each raster is scanned at the rate of 525 lines per second, the same as commercial broadcast tv camera and home receivers. The yoke, weighing approximately 4 oz, measures 1$\frac{5}{8}$ in. in diameter by 4 in. in length. Hori-

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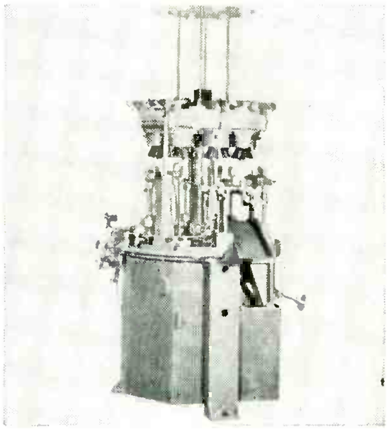
zontal resistance is 3.59 ohms; vertical resistance, 161 ohms. Horizontal inductance is 0.92 mh; vertical inductance, 53.2 mh.

TINY C-W MAGNETRON
for 9,800 to 10,000 mc

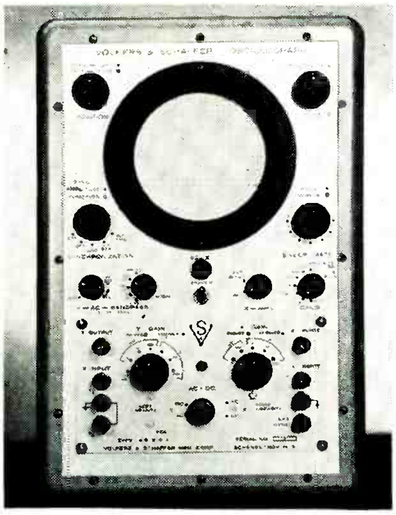
MICROWAVE ASSOCIATES, INC., 22 Cummington St., Boston 15, Mass. A new c-w magnetron resembling physically a standard receiving tube and operating from a plate supply of 450 to 500 v and a heater supply of 6 v is now available for use at a range from 9,800 to 10,000 mc. The 6444 is fixed-tuned, incorporates the new long-life Philips dispenser-type cathode and delivers 1 w of c-w energy in a standard klystron octal socket. The magnet is an integral part of the tube package. The 6444 is extremely rugged, nonmicrophonic and is exceptionally suited for Doppler-type radar and other field and laboratory use.



FLARE MACHINE
operates automatically

KAHLE ENGINEERING CO., 1307 Seventh St., North Bergen, N. J. Model

2310 automatic flare machine combines two production operations in one unit to save labor costs and reduce the percentage of breakage. It produces flared necks at rates of approximately 800 each hour for c-r tubes from standard lengths of tubing. The machine feeds, cuts and flares automatically. Cutting is by the hot-chill technique. The machine can also be used as a tubing cutter by locking out the flaring mechanism.



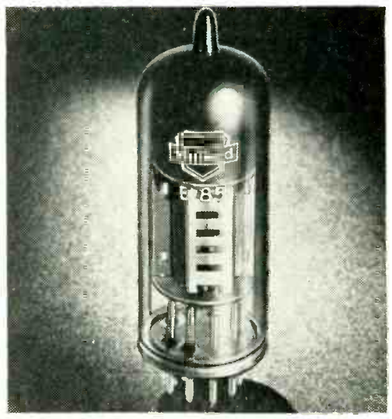
D-C SCOPES
are very highly sensitive

VOLKERS & SCHAFFER MFG. CORP., 1679 Broadway, Schenectady 6, N. Y. The VS-900 series of oscillographs sets a new standard for sensitivity and stability in d-c scopes. They have an exceptionally high a-c sensitivity and unusual freedom from distortion. Their d-c sensitivity is 700 μv per cm, and a-c sensitivity, 10 μv per cm. Direct current drifts, after a 5-minute warm-up period, seldom exceed 1 mv. Four distinctive design features are: heavy overall feedback (including d-c), d-c heated electronically regulated filaments, the starved amplifier circuit, and gas-diode coupling in a new circuit. Frequency range has an upper limit of 500 kc (3 db down).

SEALED RELAYS
for small space

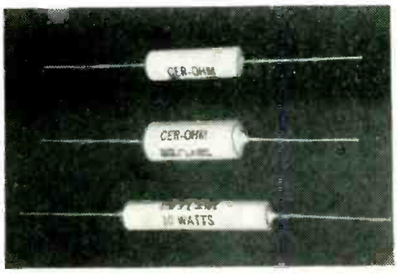
MAGNECRAFT ELECTRIC CO., 1442 W. Van Buren St., Chicago 7, Ill. Developed to meet application requirements where space is limited, these

small d-c relays are hermetically sealed in metal containers $1\frac{1}{8} \times 1\frac{9}{16} \times 1\frac{13}{16}$ in. high. They are available with 14-pin miniature plug or solder terminals. Relay and container interlock so weight of the relay puts no strain on the solder seals. They are furnished for any voltage to 115 v d-c, and with contact combinations up to 4-pole, double throw. Added contact combinations are available in larger containers. Resistance range is 0.12 to 11,000 ohms. Weight is approximately 5 oz.



OUTPUT PENTODE
for mobile radio use

MULLARD LTD., Century House, Shaftesbury Ave., London, WC2, England. The EL-85 a-f and r-f output pentode is a noval-based tube intended for a-c power line operation. Heater rating is 6.3 v, 0.2 ampere, which is low in view of the maximum cathode current rating of 35 ma. The EL85, which has an anode dissipation of 6 w, may be used as an a-f output tube or as an r-f amplifier up to 120 mc. As a class-A audio amplifier it gives an output of 2.8 w when operated with a h-v supply of 225 v and an anode current of 26 ma. As an r-f amplifier it will deliver 2 w at 100 mc. It should be useful for equipments requiring moderate power output and where low voltage drain is important. It is particularly suitable for mobile transmitters and receivers, where it may be used as a driver, modulator or audio output tube.



RESISTORS
are high-voltage insulated

BRADFORD COMPONENTS, INC., 33-35 Bishop St., Bradford, Pa., is manufacturing a high-voltage insulated precision wire-wound resistor called the Cer-Ohm. Its h-v ceramic insulation plus conservative power ratings make this COP type unit ideal where cost is a large factor. Cer-Ohm units are fabricated with 2 w, 3 w, 5 w, 7 w, 10 w, 15 w and 20 w ratings using Tophet C, Evanohm or other recognized good resistance wire. They are produced with standard 5 percent and 10 percent tolerances but are made to close tolerances with special characteristics when so specified.

SHEET-BEAM TUBE
for synchronous detecting

GENERAL ELECTRIC CO., Schenectady 5, N. Y. The 6AR8 is a miniature double-plate sheet-beam tube which incorporates a pair of balanced deflectors to direct the electron beam to either of the two plates and a control grid to vary the intensity of the beam. The tube is especially suited for service as a synchronous detector in color tv receivers. In this application, relatively large, balanced output signals of both positive and negative polarities are developed which eliminate the need for phase-inversion functions in the matrix circuits. Other features of the 6AR8 syn-

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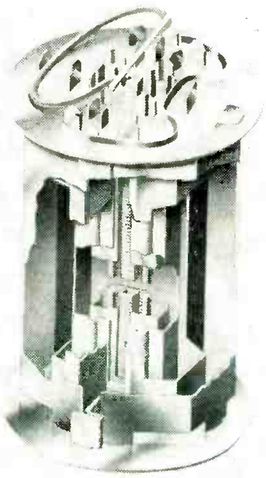
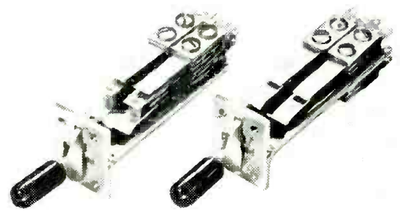


chronous detector circuit include low oscillator injection power requirements freedom from the space-charge coupled effects which are present in dual-control pentodes and heptodes, linear output voltages, insensitiveness to variations in oscillator amplitude over a wide range, and a high ratio of plate to accelerator current. Complete technical information is given in six catalog pages designated ET-T840.

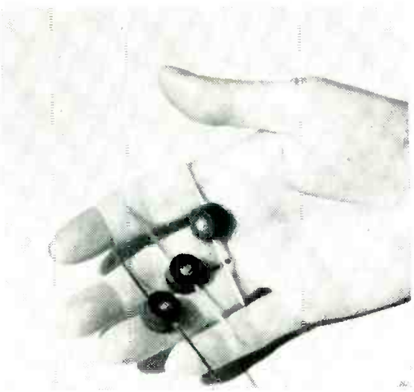


NEW SWITCH features rugged frame

SWITCHCRAFT, INC., 1328 N. Halsted St., Chicago 22, Ill., has announced a telephone type switch called Telever that features an unusual T-beam, rugged frame construction. It is available in many contact arrangements in 2 and 3-position types. Size is $4\frac{1}{2}$ in. long overall by approximately $1\frac{7}{32}$ in. $\times$ $\frac{15}{16}$ in. It features a welded cross bar palladium contact rated at 3 amperes, 120 v a-c noninductive load. Insulation is natural paper base phenolic spacers and tubing in stack assembly. The switch is designed for applications requiring light weight but sturdy construction.

RESIN BOBBIN
for resistor sealing

THOR CERAMICS, INC., 225 Belleville Ave., Bloomfield, N. J. A new type Epoxide resin bobbin has been developed especially for use in hermetically sealing wire-wound resistors. The new bobbin, featuring outstanding adhesion quality, is fabricated from a thermosetting resin with excellent physical and electrical characteristics — high tensile strength, low water absorption, a dielectric constant of 3.70 at 60 cycles, and a low loss factor of 0.009 at 60 cycles.



TINY INDUCTORS
weighing ½ oz

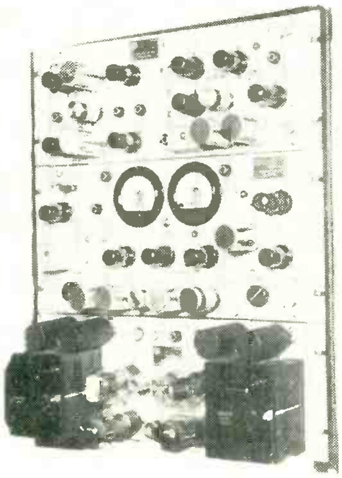
MICO INSTRUMENT CO., 80 Trowbridge St., Cambridge 38, Mass., has available a line of miniature inductors particularly suited for use as inductor elements in tuned circuits and filter networks and as chokes in receiving, telemetering and navigational systems. They are also ideal for chokes in the low power sections of transmitters where a compact, stable and durable inductor is required. Full description, chief features, specifications and ordering data are given in a single-page bulletin now available.

CRO SWEEP
operates automatically

AUDIO INSTRUMENT CO., INC., 133 W. 14th St., New York 11, N. Y., announces a device that halves the time required to use a cro. Model 54 automatic oscilloscope sweep locks onto a signal of 0.1 to 50 v, in the frequency range of 20 to 30,000 cps, and automatically generates a saw-tooth sweep voltage of constant amplitude, perfectly synchronized. This saw-tooth voltage may be fed to the X-axis amplifier of any oscilloscope. Both positive and negative sweep polarities are available. Input impedance is 1 megohm. Sweep frequency is always one-half the signal frequency, so that two cycles of the signal are displayed on the oscilloscope screen.

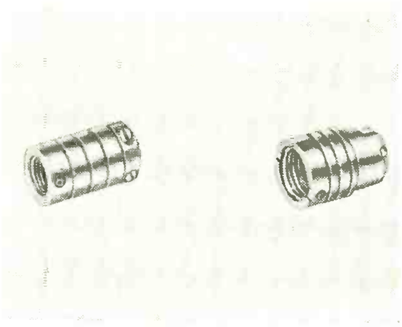
UHF-VHF STAND-OFF
is easily installed

ARGYLE ELECTRONIC CO., 8 W. 18th St., New York 11, N. Y. The new universal stand-off eliminates the metal ring from around the transmission line and thus completely overcomes the problems of standing waves and voltage losses. It permits the closest approach possible to running a transmission line in free space. The gromet is of pure polyethelene, heavy construction, which accommodates all types of transmission line without the need to thread. The installation time is reduced to about one-fifth that of the ring type stand-offs. The new standoffs are available in wood screw and mast types, singles, duals and triples.



CURVE TRACER
determines envelope delay

TELECHROME, INC., 88 Merrick Road, Amityville, L. I., N. Y. Model 1603-AR envelope delay curve tracer provides rapid determination of the envelope delay and amplitude characteristics of any network, video amplifier or system. It saves time and provides accurate performance checks for leading research laboratories, manufacturers and broadcasters. Measurements can be made to an accuracy of 0.01 μsec in absolute value, and to even greater accuracy in terms of relative values.



ALUMINUM HOODS
for electrical connectors

WINCHESTER ELECTRONICS, INC., Glenbrook, Conn. New hoods for the series M miniature electrical connectors offer greater protection, sturdier support and strain relief for the cable. Hood bodies with cable clamps are machined from top

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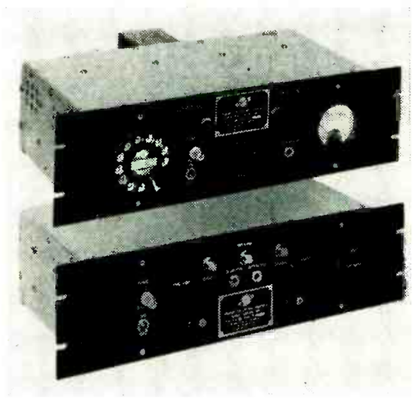
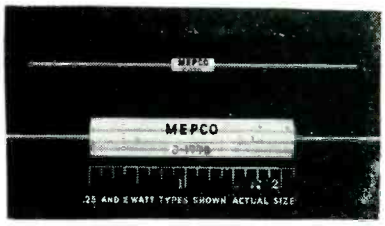
quality aluminum bar stock, thus providing greater strength than is possible to obtain when die cast methods are employed. Weight is kept to a minimum. Cadmium plating with clear iridite finish assures maximum resistance against corrosion. The compact, lightweight series M connectors are available in arrangements of 4, 5, 7 and 9 contacts for No. 20 Awg cable wires. Molded mineral-filled Melemine insulator bodies provide high dielectric and mechanical strength. Mating plugs and receptacles are positively polarized and locking mechanisms prevent accidental disconnection.



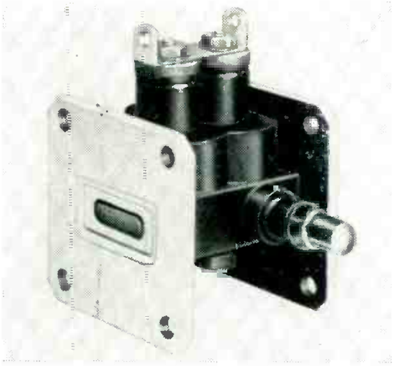
REMOTE CONTROL for unattended stations

SCHUTTIG AND CO., INC., 9th and Kearny St., N. S., Washington 17, D. C., has announced a new remote control system for unattended communications stations. Because only a single telephone line is required to turn a transmitter on and off, select operating frequency, carry the outgoing voice signal to the transmitter and return a receiver signal to the control center, the savings in toll charges for the average installation will soon offset the initial cost. Provisions are included for operating six separate circuits with a single operator's control unit. No d-c is used on the line, permitting use over any ordinary speech telephone line or radio link, regardless of the number of repeaters used. Plug-in subassemblies provide flexibility and easy maintenance. The equipment is designed for airways radio communications control, but is adaptable for use with any equipment using on-off switching and dial selection for control.



RESISTORS
sealed in steatite housing

MEPCO, INC., Morristown, N. J., announces a complete line of hermetically sealed deposited carbon resistors with ratings from 0.25 w to 2 w. Unlike the usual varnish-coated types, they are completely sealed in steatite housing, assuring positive protection against moisture. Available also are resin-coated types manufactured to MIL-R-10509A, glass enclosed and helium filled high stability types, and high-frequency rod and disk units.



TR SHUTTER TUBE
offers waveguide shorting

BOMAC LABORATORIES, INC., Salem Road, Beverly, Mass. The BL-58 TR shutter tube offers waveguide shorting plus t-r tube action. It has continuous crystal protection, all in one complete package. When equipment is not in use, or is in standby condition with t-r keep-alive voltage off, an automatic, fail-safe shutter provides a minimum of 40 db insertion loss ahead of the crystal. When equipment is in operation with voltage applied, the shutter action is automatically removed and the t-r tube functions normally. The complete package

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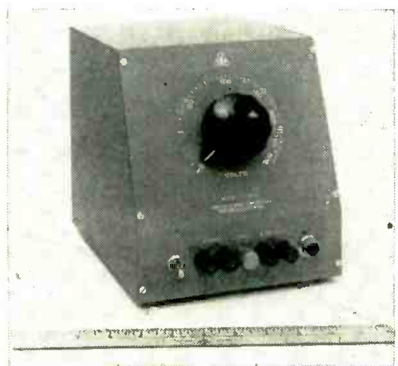
protection affords the user substantial savings in both size and weight.

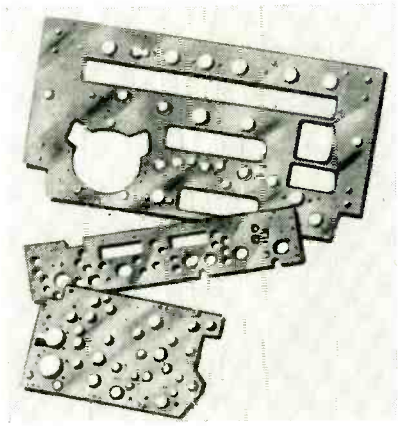
BEAM TRIODE
is high-voltage regulator

RADIO CORP. OF AMERICA, Harrison, N. J. The 6BD4 is a low-current beam triode of the sharp-cutoff type designed specifically for the voltage regulation of high-voltage, low-current d-c power supplies, such as the power supply with the 15GP22 tricolor kinescope. The 6BD4 has a maximum d-c plate-voltage rating of 20,000 v, a maximum d-c plate-current rating of 1.5 ma, and a maximum plate-dissipation rating of 20 w.



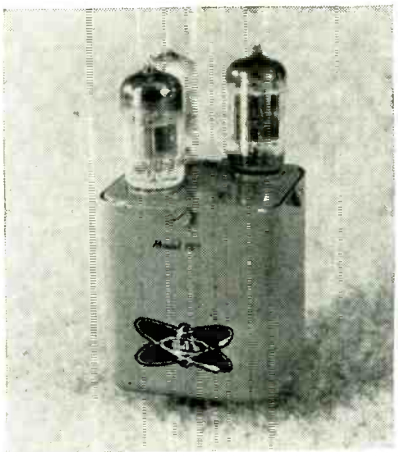
D-C POWER SUPPLIES
are low-cost units

DRESSEN-BARNES CORP., 250 N. Vinedo Ave., Pasadena 8, Calif., announces a new line of low-priced d-c power supplies for laboratory and experimental applications. The units come in two types: model 3-150-L, a cabinet-mounted unit with an output voltage range up to 300; and a series of subchassis mounting type packages with d-c voltages ranging from 150 to 500. Ripple on all units is below 0.01 v, peak to peak at full load. Regulation ranges from 0.5 percent to 1 percent from no load to full load with 10 percent plus or minus line voltage variation.



GEAR TRAINS
for electronic computers

UNIVERSAL MFG. CO., 402 Hillside Ave., Hillside, N. J., has available jig bored gear trains to tolerances of ±0.0005 between holes, and ±0.0002 on the holes themselves, with interiors of holes finished to 4 to 6 microinches. Material used is 24 ST aluminum sheets. The jig boring machine used for this operation employs an optical measuring system instead of the usual threaded spindle, and attains an accuracy not found in other machines.



WIDE-BAND AMPLIFIER
features very high gain

C. J. APPLEGATE & CO., 1816 Grove St., Boulder, Colorado. The Uniplug illustrated is a wide-band gen-

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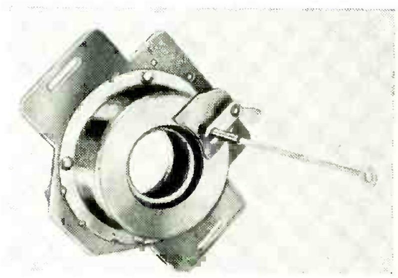
eral-purpose amplifier featuring high gain, low noise, high input and low output impedance, high stability, 3 feedback loops, uniplug convenience, small size and low price. The company has available a data sheet giving complete technical specifications.

CONTROL PANEL
for-h-v breakdown testing

INDUSTRIAL INSTRUMENTS, INC., 89 Commerce Road, Cedar Grove, N. J., announce the series CP control panel for the control of high-voltage power supplies in breakdown test equipment. It is available as a standard RETMA rack-mounted unit or as a self-contained cabinet model. A motor-actuated Variac uniformly increases voltage at a rate of either 500 v or 1,000 v per second. An electromagnetic clutch is employed as driving mechanism, permitting instantaneous disengagement at any point in the cycle. Variac operates from 0 to a maximum of 130 v a-c, 60 cps.



FOCUSING MAGNET
uses sintered ferrite

HEPPNER MFG. CO., Round Lake, Ill., has available the new economical Focomag for accurately focusing tv tubes up to 27 in. The compact design requires only one ferrite magnet instead of the usual two. As the sintered ferrite is extremely uniform throughout, the magnetic field is more uniform, resulting in superior focusing. Other new features are an extended focus range with a very fine adjustment to exact focus and a built-in centering device. There is no harmful external field because the entire unit is completely shielded. The flexible nylon adjusting shaft eliminates any possibility of breakage. A convenient lever accurately positions the tv picture. A variety of mounting arrangements are available to suit any requirement.

Literature

Magnetic Separators. Basco Mfg. Co., 5 Woodside St. Stamford, Conn. Complete information on the construction and uses of magnetic separators for fast and easy handling of steel sheets and plates is included in a new 4-page catalog. The booklet also describes how these units speed up production, reduce damage to machinery and eliminate injuries to operators. The booklet also contains handy magnet performance charts and a table of U. S. standard gages for sheet and plate steel.

Ultrasensitive Oscillographs. Volkers & Schaffer Mfg. Corp., Box 996, Schenectady, N. Y. An 8-page illustrated brochure covers the VS-900 series ultrasensitive oscillographs. Outstanding performance of the d-c scopes described is made possible by the combination of four distinctive design features: heavy overall feedback (including d-c); d-c heated electronically regulated filaments; the starved amplifier circuit; and gas-diode coupling in a new circuit. One of the most important features of the scopes discussed is that enough amplification is provided in them to extend their sensitivity to the limit of visible tube noise. A price list and information on scope preamplifiers are inserted in the booklet.

Multiturn Potentiometers. The George W. Borg Corp., 120 South Main St., Janesville, Wisc. A new 8-page folder, covering the 900 series micropots, deals with the new standard of precision multiturn potentiometers. It discusses models 901–903 ten turn and models 931–935 three-turn units. Included are cutaway photographs showing advantages of construction, dimensional drawings showing special

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lengths available and complete technical specifications. Also given are ordering information and data on standard features and optional features.

Oil-Filled Capacitors. Industrial Condenser Corp., 3243 N. California Ave., Chicago 18, Ill. A 4-page brochure covers a complete line of tubular oil-filled capacitors. The G and H type capacitors illustrated and described fill a definite need where chassis space and ease of mounting are prime factors. Complete technical data are given.

Power Connectors. DeJUR-AMSCO Corp., 45-01 Northern Blvd., Long Island City, N. Y. A 1-sheet bulletin in color deals with the Continental series E-Z 16 precision power connectors with coaxial contacts. It includes schematic drawings, special features and suitable cable types that can be used. The reverse side of the bulletin gives complete information on the series E-Z 16 connectors with bayonet locks.

Printed Circuit Controls. Chicago Telephone Supply Corp., Elkhart, Ind. Data sheet 168 illustrates and completely describes the new type YGC-B45 variable resistor with unique self-supporting snap-in bracket and a complete line of other controls for printed circuit applications. Electrical and mechanical specifications and 17 diagrams are given.

Electronic Package Element. Sanders Associates Inc., Nashua, N. H. A pocket-size six-page folder covers the Reliacube, a compact electronic package element containing all components in a complete circuit, and featuring repeatibility, reliability and reduced cost. Included are photographs, circuit diagrams, price information and an outline of the company's services.

Capacitor Manual. Astron Corp., 255 Grant Ave., East Newark, N. J., has available a new capacitor manual, AC-4, containing detailed engineering data and specification information on a complete line of capacitors and filters for radio, tv and electronic application. Capacitors are grouped into three broad categories: electrolytic, paper and metalized paper, bringing together in one volume the Astron Metalite, Hy-Met, Meteor, Blue Point and Safety Margin, electrolytic and paper tubular capacitors. Within each category, capacitor types are grouped according to operating temperature range and the construction styles and ratings that are available as standard.

Parts Catalog. Clum Mfg. Co., 611 W. National, Milwaukee 4, Wisc. Form 3547 is an 8-page catalog illustrating and describing a line of electronic parts. Items covered include antennas, tv coils, video clears, r-f chokes, lock switches, terminal strips and oscillator coils. Prices are given.

Modular Tools for Industry. Sanders Associates, Inc., Nashua, N. H. A small folder illustrates such modular tools as the silk screener, module dip, resistor stick-down gun, rotary drying oven and module assembly jig. Basic components and a circuit are shown. The folder also gives an approximate price for a complete semi-mechanized module production line in a plant.

Transistor Reference Guide. General Electric Co., Syracuse 1, N. Y., has available a 16-page booklet containing excerpts from "Principles of Transistor Circuits." Included are information on equivalent circuits, desirable values for the parameters of junction transistors, a large signal equivalent circuit, bias connections, audio amplifiers, transformer coupling, output stages, oscillators, h-f operation, noise in transistors and basic measurement circuits.

Subminiature Ceramic Capacitors. Mucon Corp., 9 St. Francis St., Newark 5, N. J. A 4-page folder covers a line of tiny capacitors that are used extensively in military equipment such as the handie-talkie, walkie-talkie and airborne equipment, as well as commercial equipment such as hearing aids, tv tuners, filters and radar. Included are general specifications for this line of subminiature ceramic capacitors, as well as information on area, multiple plate units, thickness, leads, coating, insulation resistance and the company's engineering service. Also given are maximum capacitance values for uhf subminiature ceramic capacitors.

Color TV Test Equipment. Philco Corp., Philadelphia, Pa. Three units of test equipment for color television are illustrated and described in a recent single-sheet bulletin. Applications specifications are given for model 7200 color convergence generator, model 6300 anode current meter and model 7100 color bar generator.

Video Line Amplifier. Linear Equipment Laboratories, Inc., Brightwater Place, Massapequa, L. I., N. Y., has available a single-page bulletin illustrating and describing the model LA-2 video line amplifier designed for color tv. Included are a listing of specifications, tube complement data and chief features.

Environment Resistant Connector. Scintilla Division, Bendix Aviation Corp., Sidney, N. Y., has published a brochure covering the type E environment resisting connector. Illustrations and specifications are given for the AN3100E wall mounting receptacle, the AN3102E box mounting receptacle, the AN3101E cable connecting receptacle, the AN-3106E straight plug assembly and the AN3108E 90-deg elbow assembly. The units described are moisture-proof, vibration proof, corrosion resistant, pressurized and easily serviced.

Polyethylene. Bakelite Corp., 300 Madison Ave., New York 17, N. Y. Information about molding, extruding, and other ways to use Bakelite polyethylene as well as properties of resins is presented in a new 8-page folder. Entitled "Bakelite Polyethylene", the folder also contains photographs showing principal applications of the material for packaging, wire covering, housewares, pipe and industrial products. Three tables list properties of various Bakelite polyethylene resins available in commercial and experimental quantities and also of compounds that are blended with suitable colorants, and antioxidants and made available as molding, extrusion and electrical compounds.

Precision Electrical Instruments. Muirhead & Co., Ltd., Beckenham, Kent, England, has published a well illustrated catalog over 175 pages long, dealing with a wide line of equipment. Contents include: resistors and resistance networks; capacitors and inductors, a-c bridges; oscillators, tuning forks and phonic motors; d-c laboratory equipment; components; Magslips (synchros) and servo components; and specialized testing equipment.

Engineering Services. The International Testing Service, 321 North Hamilton St., Saginaw, Mich., has issued a 28-page brochure listing services available in research, development, consulting engineering, automatic process control, special instrumentation, field testing and laboratory testing. The organization specializes in providing engineering and scientific talent to handle unusual problems. Instruments will be custom designed to customer specifications. The brochure contains a partial roster of key personnel and other information pertinent to its qualifications. Laboratory facilities are illustrated.

Time Delay Relay. Elastic Stop Nut Corp. of America, 1027 Newark Ave., Elizabeth, N. J. Model SF Agastat hermetically sealed time delay is described in bulletin SR5. Extremely compact, the unit described measures only $2\frac{1}{8} \times 2\frac{5}{32} \times 3\frac{7}{8}$ in., and weighs only 1.2 lb. It meets requirements of MIL-R-6106 and MIL-R-5757B for vibration, shock, acceleration, temperature resistance, and it is unaffected by voltage variations. Sealing against dust, moisture and effect of altitude on accuracy is proven by mass spectrometer tests of the equivalent of 80,000 ft. Length of time delay is externally adjustable over a range from 0.030 to 120 seconds. The 4-page bulletin, illustrated in color, includes complete mechanical

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and electrical specifications, wiring diagrams and mounting dimensions.

Reflection Coefficient Meter. Sierra Electronic Corp., San Carlos 2, Calif. Bulletin 106 describes operation, application and circuitry of the new model 136A reflection coefficient meter. The meter discussed is a compact, 92 to 1,125-mc instrument for rapid, simple measurement of reflection coefficient, vswr, matching loads to lines, or wide-range laboratory receiver use.

Reducing Circuit Loading Errors. Keithley Instruments, 3868 Carnegie Ave., Cleveland 15, Ohio. "A Way to Reduce Circuit Loading Errors" is the subject of a recent edition of the company's *Engineering Notes*. The paper discusses the size of errors which can be expected when a measuring instrument, such as a vtvm, affects the circuit being tested. Included are charts comparing actual output of a typical circuit with output as indicated by different instruments. Also discussed is the Phantom Repeater, a decade amplifier that increases the working accuracy of vtvm's and oscilloscopes in high impedance measurements.

Analog Computer. Mid-Century Instrumatic Corp., 611 Broadway, New York 12, N. Y. A 24-page folder illustrates and describes the MC-400, a small analog computer designed to meet the requirements of a desk side computer, training device, dynamic tester, laboratory tool, or a building block which can be readily expanded or appended to other equipment. Included are a listing of components and specifications, problems, schematics and solutions.

Frequency-Selective Voltmeters. Sierra Electronic Corp., 1050 Brittan Ave., San Carlos 2, Calif. Technical bulletin 107 describes circuitry, range, application and operating techniques for four frequency-selective voltmeters. It contains detailed information on model 101A voltmeter, 20 to 500 kc; model 103A, 3 to 40 kc; model 104, 5 to 150 kc and model 108A, 15 to 500 kc. The bulletin also contains information on other carrier-frequency measuring equipment, including model 121 wave analyzer (15 to 500 kc) and model 122 line bridging transformer.

Beryllium Copper Tubing. Superior Tube Co., 1523 Germantown Ave., Norristown, Pa. Properties, applications and advantages of seamless and Weldrawn beryllium copper tubing are presented completely in data memorandum No. 7-2. This alloy, 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.

Measuring, Indicating and Controlling Devices. Schaevitz Engineering, P. O. Box 505, Camden 1, N. J. An 8-page, illustrated, 2-color folder shows measuring, indicating, recording and controlling devices for use in many different industries. Included in the folder are descriptions and illustrations of linear and angular accelerometers; linear variable differential transformers; rotary variable differential transformers; rotary accelerators for acceleration testing and one-to-five channel recorder systems for recording related information on a single recorder chart. Technical data accompany product descriptions and line drawings show applications in many instances.

Coil Catalog. Thordarson-Meissner, Mt. Carmel, Ill. Eighty-three schematics covering approximately 300 coils, cross references to competitors' numbers, 62 new tv coils, a new r-f heater supply and complete listing of its hi-fi components and kits are contained in catalog 54-A.

Electrical Insulation. Insulation Manufacturers Corp., 565 W. Washington Blvd., Chicago 6, Ill., has published a 32-page catalog that gives complete technical data, descriptions and information on applications, sizes, stocks, and use of

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silicone materials for high temperature class H electrical insulation. The illustrated catalog covers silicone laminated glass cloth plastics; silicone bonded mica products; silicone rubber and varnish treated glass tubings and sleevings; silicone rubber and resin coated glass cloth and tape; silicone treated glass cord; Silastic pastes and Silastic R tape and cloth; and silicone varnishes, resins, adhesives, compounds and grease.

Plastics. Emerson and Cuming, Inc., 869 Washington St., Canton, Mass., makes available a series of bulletins describing its lines of casting resins, plastic foam, and other r-f and microwave insulation materials. Detailed information on the physical and electrical properties of each material is given, together with recommended procedures for their use. Price lists and illustrated descriptions of typical applications are included.

Coaxial Transmission Lines and Waveguide. Prodelin Inc., 307 Bergen Ave., Kearny, N. J., announces its new catalog entitled "Coaxial Transmission Lines and Waveguide." The 20-page 2-color catalog contains pictures, descriptions and roughing-in dimensions of coax lines and waveguide for tv and microwave systems. Typical tower layouts and bills of material based on actual installations illustrate the positioning of components and simplify planning and ordering.

Vacuum Metallurgy. National Research Corp., 70 Memorial Drive, Cambridge 42, Mass., has available reprints of recently published articles on vacuum metallurgy. They are entitled "Development of Commercial Vacuum Furnaces for Metals and Alloys" and "Some Aspects of Vacuum Melted Metals." The reprints may be had for the asking.

Speaker Catalog. Utah Radio Products Co., Inc., 1123 E. Franklin St., Huntington, Ind., has announced a catalog listing the correct replacement speaker for most auto radio speakers in use today. The new publication is indexed by make of auto, receiver manufacturer, receiver model number and speaker part number. In each instance the proper company replacement is designated. Catalog AR100 makes it unnecessary to compare either physical or electrical measurements—the correct Utah speaker is automatically indicated.

Precision Wire-Wound Resistors. International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa. Catalog data bulletin D-1 gives comprehensive data on characteristics, applications, construction, ranges, ratings, tolerances, terminals, insulation, temperature coefficient and derating. It contains four pages with photographs, charts and graphs.

Tape Recording Accessories. Audio & Video Products Corp., 730 Fifth Ave., New York 19, N. Y., has just released its new 6-page tape recording accessories catalog. The catalog includes specification and descriptive material on recommended accessory items for use with magnetic tape recording equipment. Prices are included.

Radiation Measuring Equipment. The Victoreen Instrument Co., 5806 Hough Ave., Cleveland 3, Ohio, announces the availability of a new catalog of radiation measuring equipment. The 20-page booklet contains descriptive data, illustrations and technical specifications for medical x-ray control, personnel dosimeters, health survey and isotope laboratory instruments and accessories. Specify form 3017-A.

Tiny Single Pin Connector. DeJUR-AMSCO Corp., 45-01 Northern Blvd., Long Island City, N. Y. Bulletin series FHL is a 1-page color treatment of a new subminiature single-pin connector. It includes schematic drawings, features and materials available. The reverse side of the bulletin gives complete information on Continental's series C-20 high-voltage single-contact cable and panel connectors.

Choppers. Stevens-Arnold, Inc., 22 Elkins St., South Boston, Mass. Catalog 370 describes a completely redesigned line of 60-cycle choppers for low level operation at noise levels under 1 mv. Twenty-two different models are now available to meet every requirement. They are offered both in single-pole and double-pole for use in computers, business machines, recording potentiometers, servomechanisms, regulated power supplies and microvolt meters.

TV Replacement Catalog. Rogers Electronic Corp., 43 Bleecker St., New York, N. Y., has available a 16-page catalog, reproduced in two colors, that gives a complete list of every tv set model with its full-focus deflection yoke and flyback transformer replacement. The $8\frac{1}{2} \times 11$ in. catalog also includes diagrams and other useful data.

Standby Electric Plants. D. W. Onan & Sons Inc., Minneapolis, Minn. A 4-panel 2-color folder describes the wide selection of special emergency electric generating plants that meet the rigid code of approval of the Pennsylvania Industrial Board. Both gas and gasoline driven models are illustrated in sizes ranging from 1,000 w a-c to 30,000 w a-c. Specially designed line transfer controls which make operation of the plants completely automatic are shown. Several installations are pictured in the folder.

Directional Coupler Design. Airtron, Inc., Linden, N. J. Technical bulletin T-2400 is a 6-page publication that provides much of the basic theoretical and design information needed by the engineer in choosing the proper directional coupler for use with reflectometers, test equipment, power splitters, in local oscillator coupling and similar radar and microwave applications. Among the couplers discussed are (1) the narrow wall to narrow wall (sidewall) coupler, (2) the cross-guide coupler, (3) the broad wall to narrow wall coupler, and (4) the broad wall to broad wall coupler. Each is fully described as to construction, theory of operation, electrical characteristics and typical applications. Other types of available couplers for special applications are illustrated in a range to fit waveguide sizes from 6.50×3.25 in. down to 0.280 in. $\times$ 0.140 in. i.d., with couplings from 0.5 to 100 db, in a frequency range from 400 to 40,000 mc.

Wiring Device Catalog. Slater Electric & Mfg. Co., Inc., Woodside, N. Y. Wiring device catalog No. 1-54 features large, clear, actual photographs of each product and a new style of tabular listings that are particularly easy to read and identify. The new catalog contains approximately 250 devices. Some of the new items shown are a complete line of 20-ampere T-rated switches, 3-wire crowfoot receptacles, and a complete grounding line that fills the new NEC code requirements.

Tiny Toroidal Coils and Coil Meters. Burnell & Co., Yonkers 2, N. Y., has available a 16-page catalog introducing a new line of subminiature toroidal coils and toroidal coil meters. It also includes valuable and complete information on toroids, high-quality coils and various audio filter networks. The catalog gives complete descriptions, attenuation and Q curves that will prove valuable for equipment design engineers. Write for catalog 102-A.

Snap-Action Switches. Acro Mfg. Co., Columbus 16, Ohio, has issued a new 36-page catalog on precision snap-action switches that gives detail specifications, dimensions and operating characteristics for two lines of switches. The lines described are Acro switches, which operate by the rolling spring principle, and Mu switches, which employ the single, prestressed blade principle. A feature designed to simplify use is the Quick-Finder index. By using this illustrated, comprehensive index engineers can quickly locate the proper switch for any application by type, size and rating.

Panel Meters. International Instruments Inc., P.O. Box 2954, New Haven 15, Conn. A newly revised and reprinted engineering data sheet gives complete information on 1½-in. db panel meters for commercial and military applications. Weighing less than 3 oz, the instruments described are constructed to meet applicable Government specifications and are housed in metal

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cases with watertight seals. The data sheet lists the accuracy as being ±5 percent of full scale voltage; scale length, 1.3 in.; dielectric strength, 1,500 v a-c; and the instrument resistance at zero reading, 4,000 ohms minimum.

Equipment Brochure. Rollins Corp., Lewes, Del., has available a 6-page brochure describing its facilities engaged in the development, design and production of electronic equipment. The brochure covers the operation and the type of products manufactured by the company. Included in the corporation's product line are all types of transformers, filters, cable harnesses, control units and subassemblies.

Cord Sets. Cords Limited Division, Essex Wire Corp., 121 Dodge Ave., DeKalb, Ill. A new 30-page, two-color catalog combines the company's comprehensive wire cordage types and cord set components within the covers of one book. It contains 64 photographs of facilities and some typical production cord sets. A special engineering section contains 118 separate dimensional engineering drawings. There are also simplified tables showing maximum ampere and voltage ratings for various portable cordage and wire gages, with typical appliance and industrial cordage and cord sets listed.

Terminal Boards. DeJUR-AMSCO Corp., 45-01 Northern Blvd., Long Island City, N. Y. A recent single-sheet color bulletin deals with terminal boards. It gives a schematic drawing and information about available base materials and pin arrangements. Also included is illustrated information on special-design hermetic plugs.

Instruments and Controls. Electro Tech Equipment Co., 308 Canal St., New York 13, N. Y. Catalog No. 54 is a 190-page comprehensive buyers' guide of instruments and controls. Every item is presented in a manner purposely designed to simplify the selection of instrument needs in terms of economy, utility, manufacture and quality. Table of contents includes laboratory and portable test instruments; bridges, decades and recording instruments; panel and switchboard instruments; pyrometers, thermometers and associated equipment; service instruments; transformers, voltage regulators, rectifiers and controls; timers, counters and photoelectric controls; heaters, furnaces and accessories; switches, relays, solenoids and solenoid valves; and miscellaneous equipment.

Sound Products. Radio Corp. of America, Camden, N. J. A new 20-page illustrated sound products catalog lists the company's latest line of sound equipment. The booklet is divided into sections dealing with such products as microphones, amplifiers, speakers, intercommunications equipment, tv Antenaplex systems and unit-built cabinets and racks. Each section in turn presents a list of products designed to meet needs from portable systems to large sound installations. Descriptions of each model include such information as special features, uses, specifications and photographs.

Casting Alloy. The International Nickel Co., Inc., 67 Wall St., New York 5, N. Y., has issued a new technical booklet on the engineering properties of "S" Monel, an age-hardenable casting alloy that provides unusual strength, hardness and anti-galling properties at temperatures up to 1,100 F in addition to the general corrosion resistance of Monel.

Potentiometer Noise. Helipot Corp., 916 Meridian Ave., South Pasadena, Calif. "Electrical Noise in Wire-Wound Potentiometers," a 12-page illustrated technical paper by Irving J. Hogan, examines several aspects of potentiometer noise. It describes the kinds of noise which can originate in a precision potentiometer; discusses methods of observing and measuring noise; and sets up a system of units in which noise can be expressed.

High Resistance Measurement. Keithley Instruments, 3868 Carnegie Ave., Cleveland 15, Ohio. Two accurate ways to measure high resistance are discussed in a recent issue of *Engineering Notes*. The

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first method, involving a v-t electrometer and shunt, permits measurements to 124,000 megohms full scale, at an absolute accuracy of within 5 percent. The second method employs an electrometer and low-leakage capacitor, and achieves similarly high sensitivity. Both methods permit the measurement of resistances far beyond the reach of bridges, megohmeters and wall galvanometers.

Servo Motors. Ketay Mfg. Corp., 555 Broadway, New York 12, N. Y. A recent 4-page folder covers a complete range of sizes and types of synchros, servo motors and resolvers. Tabular data give typical characteristics of two-phase servo motors, synchro control transformers, synchro receivers, synchro resolvers, induction motors and synchro transmitters.

Controls and Resistors. Clarostat Mfg. Co., Inc., Dover, N. H. Catalog No. 54 features standard controls and resistors for radio and electronic equipment, as well as the new C-line and other industrial controls. In a new format and printed in two colors, this catalog is distinguished by its concise descriptions, informative pictures, dimensional drawings, listings, prices and standard packings.

Cathode-Ray Oscillograph. Allen B. Du Mont Laboratories, Inc., 760 Bloomfield Ave., Clifton, N. J. A new 12-page bulletin describes the type 323 wide-band cathode-ray oscillograph. The new booklet gives complete specifications about the instrument and also contains illustrations and circuit diagrams.

Balancing Machines. Tinius Olsen Testing Machine Co., 3030 Easton Road, Willow Grove, Pa. The Electodyne, a new principle for automatically measuring the amount and indicating the angular location of unbalance by means of electronics, is comprehensively described in bulletin 49. In addition, the bulletin describes features of the complete line of Electodyne dynamic and static balancing machines including the horizontal and vertical models as well as the automatic crankshaft balancer.

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PLANTS AND PEOPLE

Edited by WILLIAM G. ARNOLD

Industry associations name new officers . . . Manufacturers announce further plant expansions . . . Engineers and executives are promoted . . .

OTHER DEPARTMENTS
featured in this issue:

Sylvania Begins Operations At New Facilities

SYLVANIA dedicated its new defense laboratory, began production in its new tv set plant and laid plans for a new tv plant in Canada.

At the dedication of the new defense lab were, left to right, Don G. Mitchell, chairman of the board of Sylvania, Maj. Gen. James D. O'Connell, deputy chief signal officer and Henry Lehne, director of the lab, shown examining a traveling-wave tube.

According to O'Connell, the new lab will help defense planners develop electronic countermeasures. The structure will provide 61,000 sq ft of space and will house 300 to 400 scientists and engineers doing research for the Signal Corps. Cost of the building, not including equipment, was set at $500,000. Key scientists and engineers have been transferred to the lab from the firm's eastern labs.

Sylvania commenced manufacturing operations at its new 422,000 sq ft tv set assembly plant in Batavia, N. Y. The first of four separate assembly lines began producing sets. Present plans call for the other three assembly lines to start operations consecutively by the end of June. When all four lines are in operation, the plant's total employment will be approximately 1,500.

The Batavia plant initially will produce only black-and-white receivers, but will ultimately manufacture color tv sets as well. The radio and tv division is now producing very limited quantities of color sets at its Buffalo plant.

In Canada, Sylvania plans to construct a new plant in Dunnville, Ontario, where tv sets will be manufactured. Production is scheduled to begin in the new facility about August 1, 1954. Present plans call for the employment of 150 to 200 persons initially and about 350 to 400 when in full operation in 1955.

Regis R. Forbes, former divisional purchasing agent of the parent company's radio and tv division, has been appointed manager of the plant. With completion of the plant, Sylvania in Canada will have three manufacturing facilities in operation.

Virgil Graham Named RETMA Chief Engineer

VIRGIL M. GRAHAM has been placed in charge of the RETMA engineering department. He succeeds Ralph R. Batcher, who has resigned after nearly four years of service as the association's chief engineer. Graham will retain the title of associate director of the department, which he formerly held in an honorary capacity, and will continue to perform the duties of that office as well as of chief engineer.

Associated with RETMA's engineering activities since 1929, Graham comes to the association on a full-time basis from Sylvania, where he has been director of technical relations since 1946.

Beginning his standardization work about 1925 while serving on a number of standardization committees of the Institute of Radio Engineers, Graham's major activities and contributions were in industrial standardization in the radio and electronics field. In 1929 he became editor of the Radio Manufacturers Association Stand-

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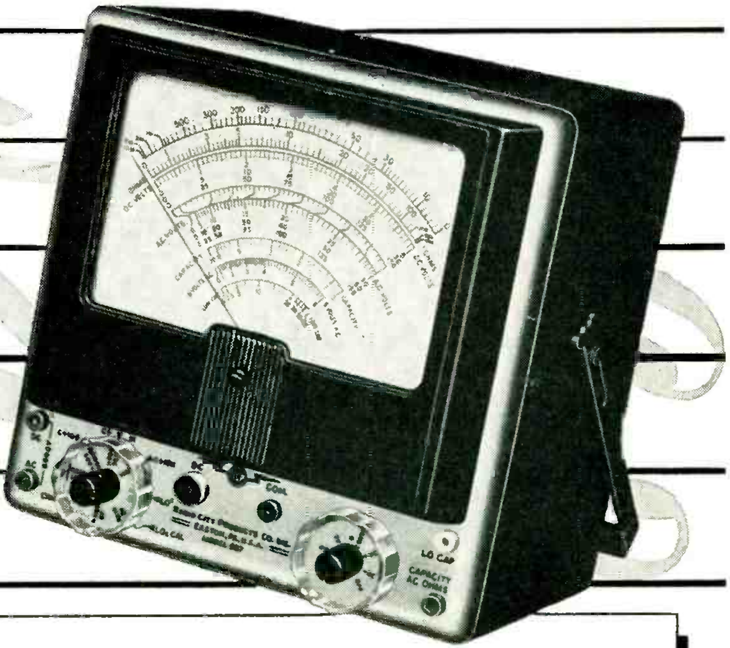
SIXTY-TWO INDIVIDUAL ELECTRONIC RANGE MEASUREMENTS

RCP

Electronic "DO-ALL" MODEL 657



CAPACITY METER

HIGH RANGE OHMMETER

R.M.S.
R.M.S. V.T. VOLTMETER

P-P
PEAK-TO-PEAK V.T. VOLTMETER

INDUCTANCE METER
(By Reference To Charts)

Never before has there been engineered one instrument to sell for under $100 that can possibly match the versatility, efficiency and speed of measurement built into this latest RCP design. Here are combined in one instrument five independent instruments essential in service—production—development. Outstanding in performance, measuring low frequency sinusoidal and both low and high repetition rate non-sinusoidal waveform.

Years Ahead In Design—

- **8½" Easy-To-View Meter provides instant measurement recognition of the several scales.**
- **Simplified Controls save time. Illuminated individual settings of function and range.**
- **Carrying Handle serves as inclinable rest—tilts the instrument for maximum readability.**

$99.85 NET

D.C. Voltage:	16 Ranges 0±1.5±3±6±30±150±600±1500±6000
D.C. Voltage:	Zero center 14 ranges±.75±1.5±3±15±75±300±750
A.C. Voltage:	Peak-to-Peak 7 Ranges 0—4.2—8.5—17—85—420—1700—4200
A.C. Voltage:	RMS—7 ranges 0—1.5—3—6—30—150—600—1500
A.C. High Voltage:	RMS—Range 0-6000 Volts.
Ohmmeter:	8 ranges 0—1, 000—10, 000—100,000 ohms, 0—1—10—100—1,000—10,000 megohms. Center Scale 10.
Capacity meter:	6 ranges 1 micro-microfarad to 1,000 microfarads; 1-10 uuf; .00001-.001 mfd.; .0001-.01 mfd.; 001-0.1 mfd.; .1-10 mfd.; 10-1000 mfd.

RCP VTVM Model 655 Reads Peak-To-Peak Voltages Directly

Quickly, accurately, the DO-ALL Model 655 gives a true reading measurement of complex and sinusoidal voltages with necessary peak-to-peak or RMS value read directly, for the analysis of waveforms in video, sync and deflection circuits.

Versatility of measurement, built into each Model 655, serves a variety of industrial applications in the service of vibrator power supplies, AC generators and all equipment utilizing any type of waveform or DC.

$59.50 NET

RCP Midgetscope Model 533M

A 3" scope with high sensitivity and wide band response—weighs only 9 pounds. Meets the highest standards of quality, dependability and accuracy.

$99.50 NET

See your local parts distributor, or write to Dept. E-5 for illustrated catalog.

RADIO CITY PRODUCTS COMPANY
EASTON, PENNSYLVANIA

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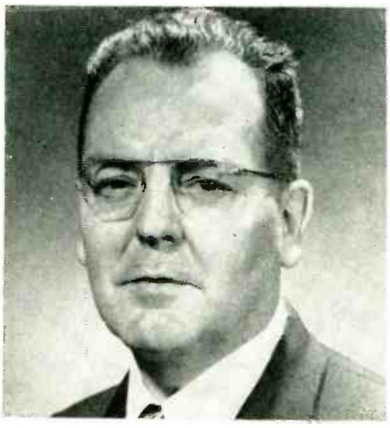


ards and Engineering Information.

In 1931 he assumed the chairmanship of the standards section of the RMA engineering committee which was the predecessor of the RETMA engineering department.

He was largely responsible for the development and adoption of a standardized electron tube designation system and the formalization of the central registration system for tube types.

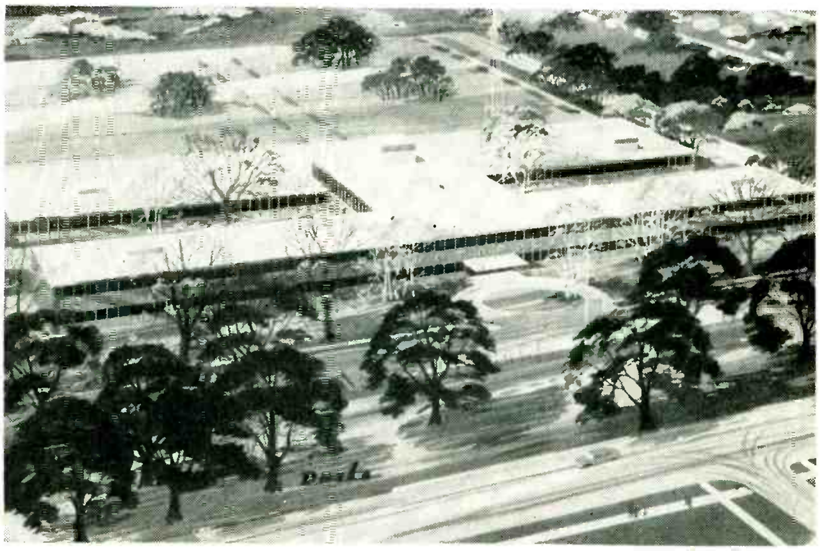
Graham became assistant director of the RMA enginering department in 1934 and shortly thereafter associate director. At that time he introduced the standardization system which is still used by RETMA and from then until 1946 served as chairman of its general standards committee.

In 1936 he helped establish the RMA Data Bureau (now the RETMA Engineering Office).

Early in 1947 he was appointed to the Joint Electron Tube Engineering Council (JETEC) of RTMA and NEMA.

Motorola Plans Headquarters Expansion Near Chicago

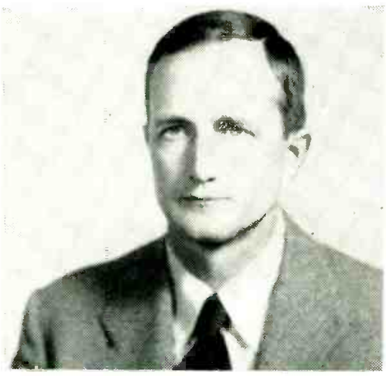
A 40-ACRE tract in Niles, Ill. bordering Chicago is to be purchased by Motorola. President Paul V. Galvin said that the move was part of a long-term policy of decentralization. "The use of this particular parcel of land is an important factor in our overall planning for the progressive realignment of various operations to achieve greater efficiency and permit further orderly growth. Ultimately we expect to relocate our engineering laboratories and our administrative offices on this site comprising a headquarters campus," he said.



"In the course of the next few years it is likely our investment in the development of this property, including the land, building, utilities, laboratory and office equipment will exceed $5 million. At the moment preliminary plans are being drawn for an initial engineering structure of some 200,000 sq ft.

"We have no plans calling for the construction of any manufacturing facilities on this site. It will serve our objectives best to confine the use of the Touhy property to laboratories and offices," he stated.

Initial excavation on the site is scheduled for the spring months of the current year.

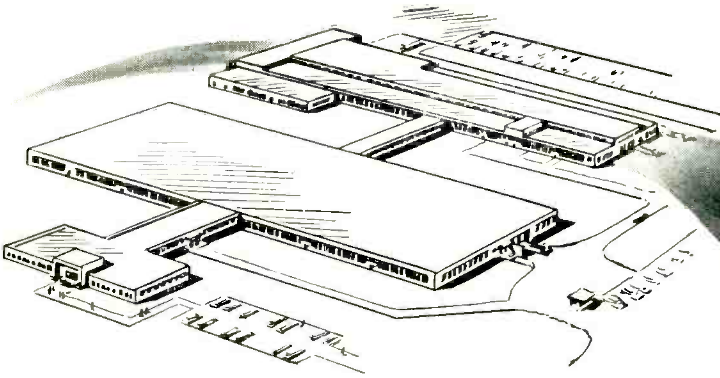


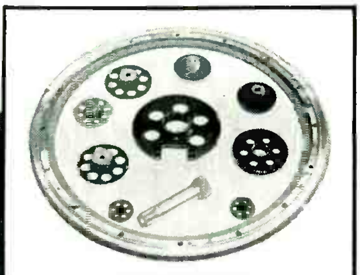
James B. Fisk

Ralph Bown

Bell Labs Promotes Fisk And Bown

JAMES B. FISK, director of research in physical sciences at Bell Telephone Laboratories, has been elected vice-president in charge of research. He succeeds Ralph Bown, who continues as a vice-president with a new assignment in charge of the long-range planning of programs. He will continue his present responsibilities in connection with





PRECISION GEARS

WHAT DAYSTROM HAS TO OFFER YOU . . .

UNDER ONE ROOF Daystrom Instrument can meet every one of your engineering and manufacturing needs—in their modern 350,000 sq. ft. plant, where a full range of up-to-date equipment is available for manufacturing from raw materials to finished assemblies and systems . . . for complete electro-mechanical and electronic parts and assembly in any quantity . . . for internal, external, surface and centerless grinding; low to high precision turning; jig boring and milling; welding, heat treatment and finishing; precision spur and helical gear shaping, hobbing and shaving; straight and spiral beveled gearing; test and inspection for entire range of gear production.

Daystrom's Research and Development Engineers have special skills in mathematics, radar circuitry, electronic computor design and instrumentations of a similar nature . . . Daystrom's Production Engineers are specialists in the mechanical, electronic and electromechanical fields . . . Daystrom's Manufacturing Engineers are experts in tool design, processing and tooling—with a new, complete toolroom for producing jigs, dies and fixtures.

Write today for

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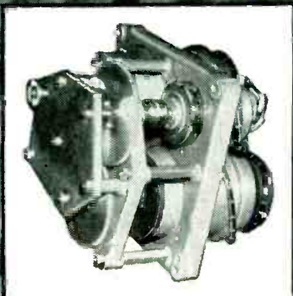
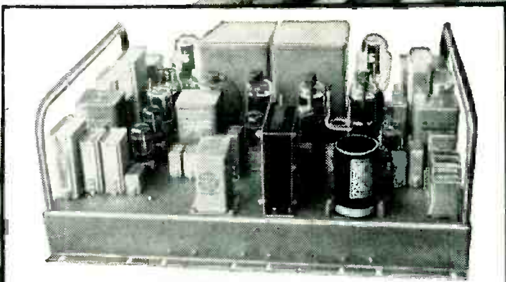


ANGULAR POSITION TRANSMITTER

DIVISION OF DAYSTROM

INCORPORATED



PRECISION VOLTAGE SUPPLY

DAYSTROM
INSTRUMENT

ARCHBALD, PENNA.

Affiliates:

American Type Founders, Inc., Elizabeth, N.J.; Daystrom Furniture Div., Olean, N.Y.; Daystrom Electric Corp., Poughkeepsie, N.Y

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the patent department.

Dr. Fisk, who joined Bell Laboratories in 1939, was for two years director of research of the Atomic Energy Commission and simultaneously Gordon McKay professor of applied physics at Harvard University. He is currently a member of the general advisory committee of the Atomic Energy Commission as well as the science advisory committee of the Office of Defense Mobilization.

During World War II he was selected to head the Magnetron development group at Bell. After the war, he was placed in charge of electronics and solid state research. It was work in this area that resulted in the invention at the Laboratories of the transistor. In 1949 when he returned to the Laboratories from the Atomic Energy Commission and Harvard, he was placed in charge of research in the physical sciences.

Dr. Bown has served for 35 years with the Bell System. Before his appointment as vice-president in charge of research of Bell Laboratories in 1952, he had served as director of research since 1946, in which post he succeeded M. J. Kelly.

Awards

Dr. Bown was awarded the Morris Liebmann Memorial Prize by the IRE for 1926. He was a division member and consultant of the National Defense Research Committee, specializing in radar. He also served as expert consultant to the Secretary of War. In 1949 he received the Institute's Annual Medal of Honor. In 1927 he served as president of the IRE. He served as a captain in the Signal Corps in World War I, prior to joining the Research and Development Department of the American Telephone and Telegraph Company.

He was named assistant director of radio research of the Laboratories in 1934, director of radio and television research in 1936, and in 1944 was appointed assistant director of research.

Thompson Products Keeps Expanding

NEGOTIATIONS for the purchase of Dage Electronics Corp. by Thompson Products have taken place. The

Dage assembly plant, near Indianapolis, will continue in its present location, operating as a decentralized unit of Thompson's electronics division.

Founded in 1952, Dage is headed by George Fathauer, chairman, and James Lahey, president. No changes in personnel are contemplated.

Thompson electronics division, founded three and a half years ago with headquarters and manufacturing facilities in Cleveland, has expanded in several directions. It first entered the electronics field in 1950 in the development of high-frequency electronic components.

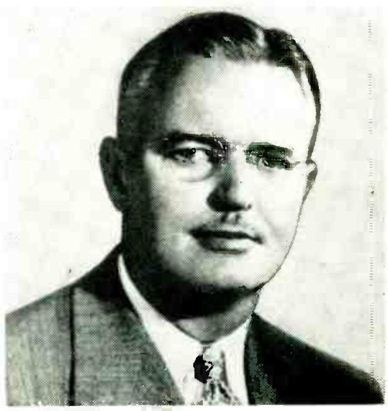
A year later the company acquired the Antenna Research Laboratory of Columbus. In September, 1953 Thompson provided financial backing for the formation of the Ramo-Wooldridge Corp. of Los Angeles, organized to specialize basically in new advanced systems developments. A month later the firm purchased Bell Sound Systems.

Consolidated Forms Computer Subsidiary

CONSOLIDATED ENGINEERING has established the ElectroData Corp. as a new wholly-owned subsidiary.

ElectroData of Pasadena, Calif. will continue engineering, manufacturing and sales activities formerly conducted by Consolidated's computer division.

President of the new corporation is Philip S. Fogg. He will continue as president and chairman of the board of the parent company. Other officers of Electro Data are: James R. Bradburn, executive vice-presi-



Philip S. Fogg

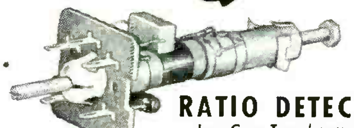
R. F. AND I. F. COILS

OPEN TYPES OR SHIELDED

for Television, Radio, Communications Applications

LOWER PRICE
QUICKER DELIVERY
HIGHEST QUALITY

1.



RATIO DETECTOR
Iron Core Tuned complete with Shield Can.

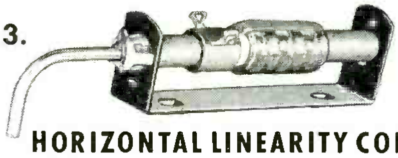
Coil is carefully impregnated for stability. Built to withstand drastic temperature changes. Mechanically stable. It has excellent linearity. Once set—remains in adjustment—vibration-resistant. Has room for additional tie-lug on terminal base.

2.

WIDTH CONTROL COIL.

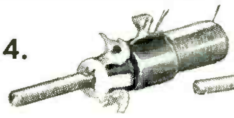
Mechanically stable winding structure. Iron core tuned. Single hole mounting. Machine staked terminals.

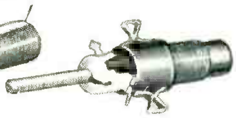
3.



HORIZONTAL LINEARITY CONTROL COIL—Very stable winding structure. Instantly adjustable with pullout shaft. Clip mounted. A favorite with leading T-V set manufacturers. Sturdy. Vibration resistant. Trouble free.

4.





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Bifiler Winding. Iron Core Tuned. Excellent electrical and mechanical ability. Carefully controlled "Q". Single hole mounting.

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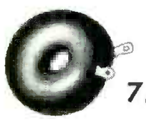

7.

Above units are specified as standard equipment by leading manufacturers.

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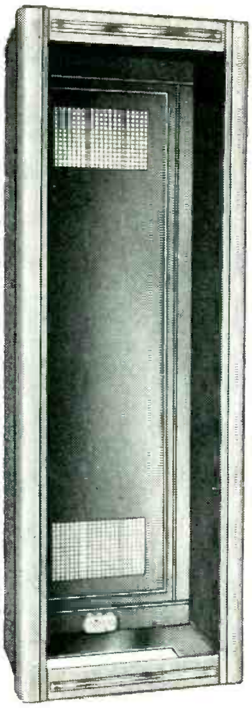


"P" SERIES RACKS

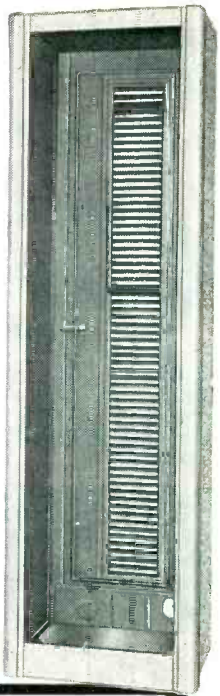
No. P-3618: Overall: 42⅞" x 22" x 18"
Panel Space: 36¾" x 19"
No. P-6618: Overall: 67⅜" x 22" x 18"
Panel Space: 61¼" x 19"
No. P-8318: Overall: 83⅛" x 22" x 18"
Panel Space: 77" x 19"

Par-Metal "P" Series Racks are available on special request up to 28" deep.

"G" SERIES TRANSMITTER RACKS

No. G-2218: Overall: 76⅛" x 22" x 18"
Panel Space: 70" x 19"
No. G-2219: Overall: 83⅛" x 22" x 18"
Panel Space: 77" x 19"
No. G-3024: Overall: 76⅛" x 33" x 24"
Panel Space: 70" x 30"

"P" and "G" Series RACKS have standard finishes of black ripple, slate grey ripple (or prime coat only).



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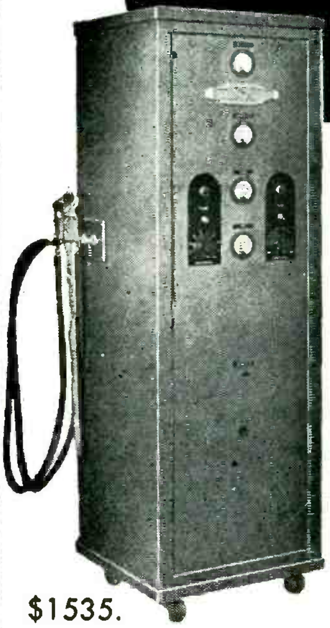

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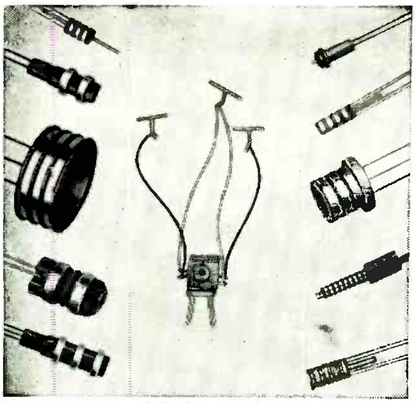
James R. Bradburn

dent; L. P. Robinson, vice-president; Victor J. Pollock, secretary-treasurer and Joseph B. Rice, assistant secretary-treasurer.

"The high degree of specialization required in computer design and manufacture and continual and anticipated future growth of the electronic computing industry are factors which contributed to Consolidated's decision to establish its computer operations as a separate organization," Fogg said.

James R. Bradburn, executive vice-president, served in a variety of engineering and administrative posts with GE and Eastman Kodak before joining Consolidated Engineering in 1945 as treasurer and assistant to the president. He is both a registered electrical and mechanical engineer in California. In 1946, he was named director of sales and vice-president in charge of commercial engineering at Consolidated and subsequently served as vice-president and director of engineering. In December 1953, he was made vice-president and director of the computer division.

L. P. Robinson, vice-president, was also associated with the firm's computer division and directed much of the original research and engineering work of the company's computer group. Pollock serves as secretary-treasurer of the parent corporation in addition to his new financial post. The new firm has already received orders for a number of its electronic computing instruments and expects to make



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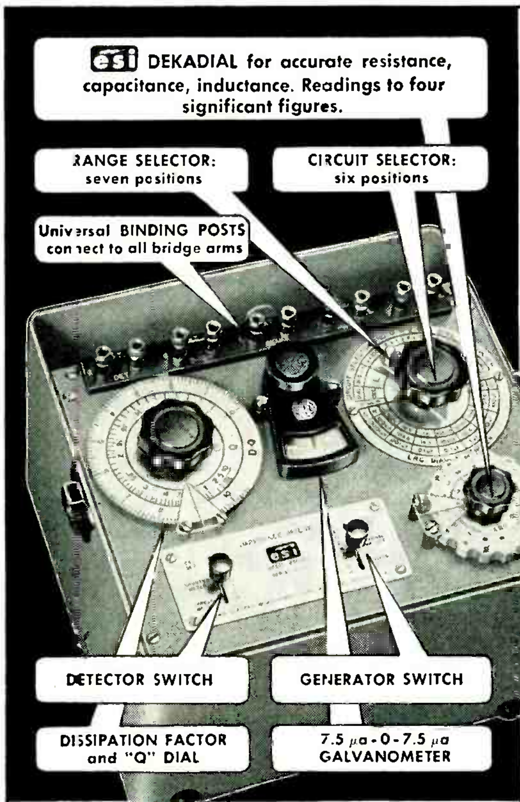

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Exceptional Accuracy

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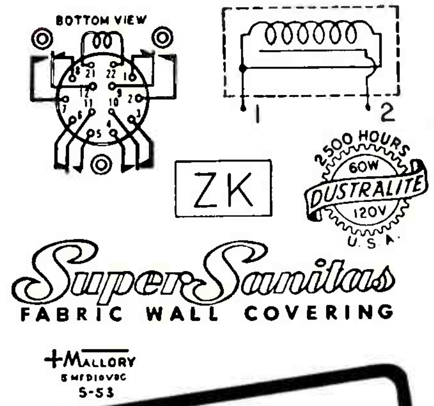

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deliveries at the rate of one a month during the last six months of 1954.

AT&T Engineer Awarded Lamme Medal

FRANK A. COWAN, assistant director of operations, Long Lines Department of AT&T, has been awarded the 1953 Lamme Gold Medal by AIEE.

It will be presented at the opening session of the five-day Summer and Pacific General Meeting of the Institute at Los Angeles on June 21, by Elgin B. Robertson, president of AIEE.

Cowan was cited "For his outstanding contributions to long-distance communication and the development of modulating and transmission measuring apparatus of original design and application." He joined AT&T in 1919 and is the holder of 17 patents in the communications field.

Sanders Associates Names Best

ETHRIDGE C. BEST, formerly director of the electronics division, Navy Bureau of Aeronautics, was appointed assistant to Royden C. Sanders, Jr., president of Sanders Associates. He will be chiefly concerned with contract and program coordination with government agencies.

Best is a Colonel in the U. S. Marine Corps Reserve and comes directly to the company from nearly 27 years of service with the Navy and Marine Corps. The last 3 years of this service was spent as deputy director and director of the Bureau

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CROSSBAR SWITCH
for Automatic Control Systems and Computers

FAST!

LOW INITIAL COST!

MANY CIRCUIT APPLICATIONS!

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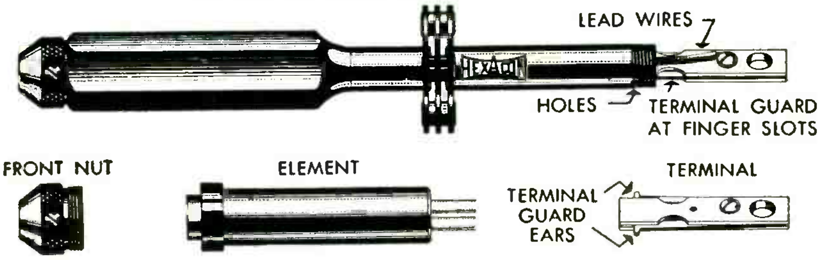
Readily Removable Terminal* does the trick!



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BRASS-SHEATHED ELEMENTS
Easier to replace—Better Protection

Write for catalog showing 40 industrial soldering irons of every type and size; there is no obligation.

Quick-change terminal can be removed in a second or two, permitting replacement of element in a fraction of the usual time. By simply depressing terminal guard at the finger slots, the terminal comes out in a jiffy — no longer necessary to fish element lead wires around terminal.

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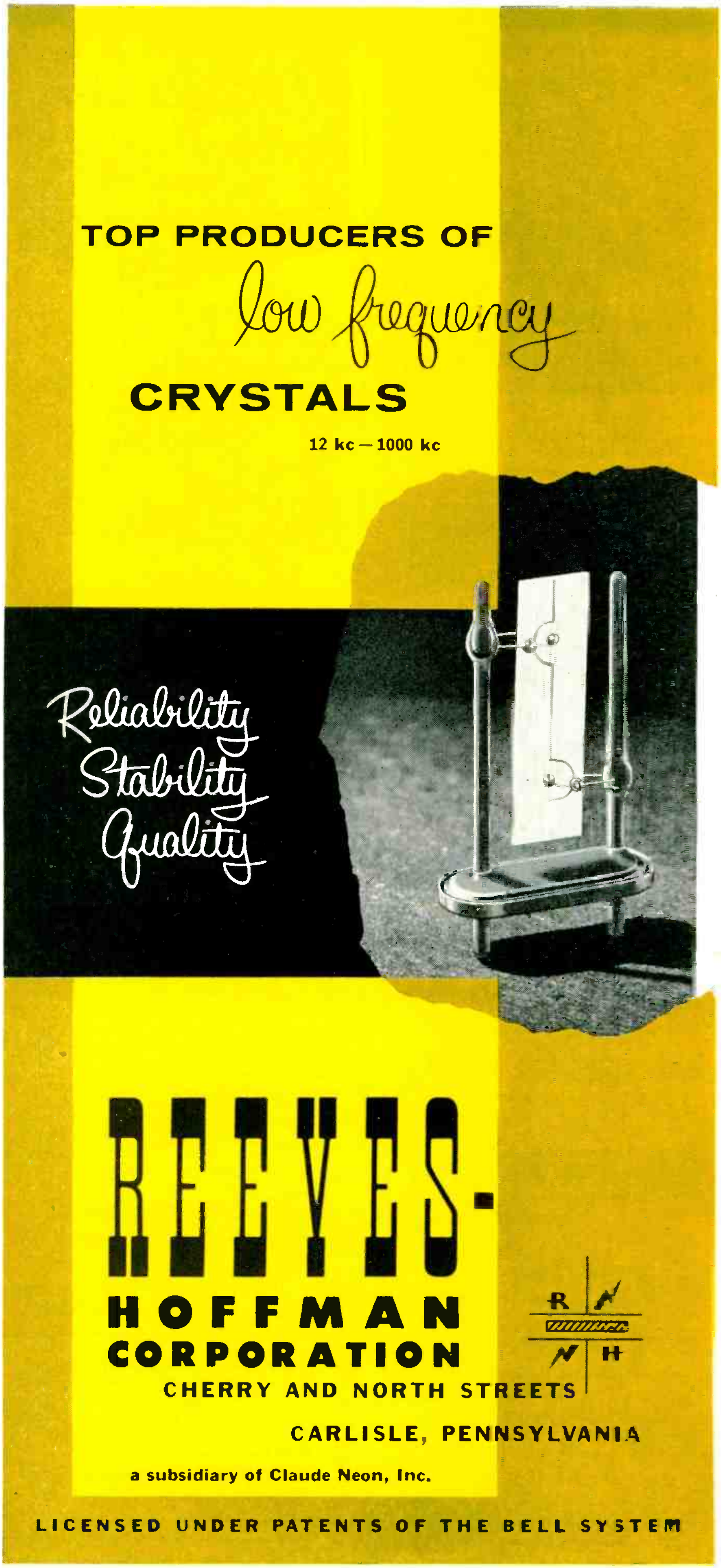

Ethridge C. Best

of Aeronautics' electronics division.

A graduate of the U. S. Naval Academy and a Marine Corps pilot, he has served as Assistant Naval Attache and Assistant Naval Attache For Air at the United States Embassy, London. During World War II, he served in the Pacific.

Brown To Head NBS Boulder Labs

FREDERICK W. BROWN has been appointed director of the Boulder (Colorado) Laboratories of the National Bureau of Standards. Currently technical director of the Naval Ordnance Test Station, China Lake, California, he will assume his new responsibilities near the end of the current fiscal year. He will direct the research, development and standards programs of the NBS Central Radio Propagation Laboratory and the NBS-AEC Cryogenics Engineering Laboratory, both of which are in Boulder.

Although only a portion of the Bureau's radio division is now in the Boulder area, the total transfer of personnel and equipment from Washington to a multimillion-dollar research center in Boulder is expected to be completed during the coming summer. The cryogenic laboratory, which conducts a research program for the Atomic Energy Commission and the U. S. Air Force, is located on the same site as the radio research center; it has been staffed and functioning since 1952.

From 1935 to 1938, Dr. Brown

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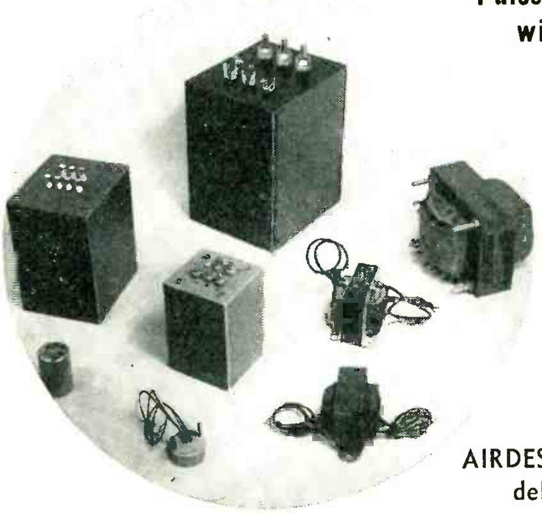
Pulse & Filter Networks with Ferrite Cores



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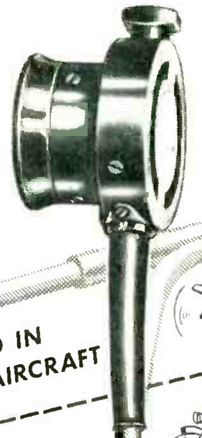
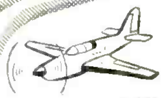
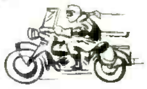


Style #044



USED IN SMALL AIRCRAFT



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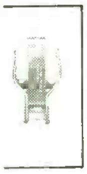
Beginning May, 1954

Designed to rigid Navy specifications, this dependable, lightweight microphone features long-life, high output, and all-position response. Incorporates use of long-life detent switch. Cord is reinforced by a rubber protector for maximum flexure life. Available also with coil cord—on made-to-order basis.

HANGER STYLE 035



Designed for use with Style #044 Roanwell hand-held microphone. Made of hardened steel, finished in cadmium plate. Resilient heat-treated spring grip holds microphone securely, prevents vibration.

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taught physics at the University of Illinois and the University of Kansas City, and then became a research associate at the California Institute of Technology. In 1940 he joined the U. S. Bureau of Mines Central Experiment Station as a research physicist in the field of high explosives and explosions, and in 1946 he worked on nuclear reactor designs and effects of radiation on materials for North American Aviation. While at North American he was also concerned with the analysis of guidance systems for long-range missiles. He joined the staff of the Naval Ordnance Test Station in 1949, and in 1951 was appointed technical director.

Fischer & Porter Acquire Two Firms

FISCHER AND PORTER have acquired the patents and engineering personnel of the Electrical Development Company and the Digi-Coder Corp. The company is now able to engineer, produce and install completely automatic control systems from the sensing element at the machine or process to the coded or tabulated digital data output. The two newly acquired corporations have been integrated into the firm as the data reduction and automation division. Robert K. Stern, formerly president of Electrical Development is manager of the new division and has retained his entire engineering staff. The company expects to develop other automation equipment such as remote data logs, temperature and pressure scanners, sequential data recorders, remote pressure and thermocouple readout systems, and voltage-to-digital converters.

Capehart Announces Wright Resignation

ANTONY WRIGHT resigned as vice-president of the commercial products division of Capehart-Farnsworth and has joined CBS-Columbia as vice-president of engineering.

J. F. Conway, Jr., chief engineer of the Capehart commercial products division will continue to be responsible for television and radio engineering and will direct the activities of the firm's color and

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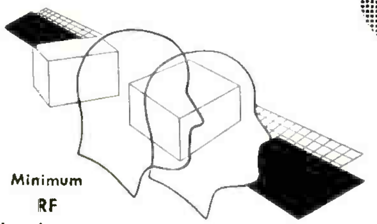
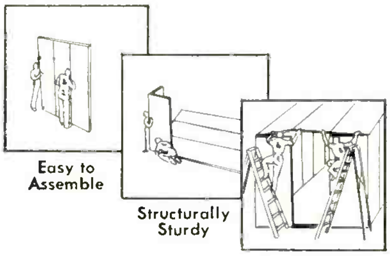
Lindgren SCREEN ROOMS



Minimum RF Interference



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LINDGREN screen rooms are economically manufactured at the factory. They consist of pre-fabricated units, easily assembled where you want them . . . conveniently portable to *any location*. More than 30 standard sizes available.

Used by leading manufacturers of electrical and electronic equipment . . . and more than meets government specifications.

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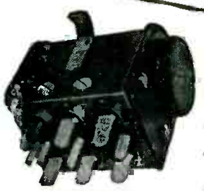

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Proven Quality

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Socket with deep Bracket

For 5,000 Volts, 25 Amperes per Contact Alterable by circuit Characteristics.

Socket contacts phosphor bronze, knife-switch type, cadmium plated. Plug contacts hard brass, cadmium plated. 2, 4, 6, 8, 10, and 12 contacts. Plugs and sockets polarized. Long leakage path from terminal, and terminal to ground. Caps and brackets, steel parkerized (*rust-proofed*). Plug and socket blocks interchangeable in caps and brackets. Terminal connections most accessible. Cap insulated with canvas bakelite.

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NEW! UHF TELEVISION

Standard Signal Generator

MODEL 84-TV
300—1000Mc.

SPECIFICATIONS

FREQUENCY RANGE: 300-1000 megacycles.
OUTPUT: .1 Microvolt to 1 Volt, across 50 Ohms.
OUTPUT IMPEDANCE: 50 Ohms coaxial.
MODULATION: Internal 400 cycle, continuously variable from 0 to 30%. Provision for external modulation of 50 to 20,000 cycles.
LEAKAGE: Negligible.
SIZE: Overall Dimensions: 11¾ inches high, 19 inches wide, 11 inches deep.
WEIGHT: Approximately 40 pounds.
POWER: 115 volts, 60 cycles, 120 watts.

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Standard Signal Generators
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TV & FM Test Equipment

MEASUREMENTS CORPORATION
BOONTON NEW JERSEY

black-and-white television and high-fidelity programs. Capehart has a research and development staff of 600 people.

Production Begins At Hoffman In Kansas City

THE FIRST tv sets were produced in March in the new million-dollar Kansas City, Mo. factory of Hoffman Radio.

The plant manager, Leonard L. Roberts, said two chassis lines, now being installed, would be ready in about sixty days to begin full assembly of sets in the plant. Until then the operation will consist of final assembly work, using components supplied from company plants in Los Angeles.

With 250 employees at work, Roberts said he had scheduled production of 150 sets a day, while continuing to produce on other assembly lines 350 table model and clock radios each day and 350 hi-fi record players.

At full capacity the 8,500 sq ft plant can produce 1,000 television sets a day with an employment of 1,000 men and women.

The Kansas City plant will supply Hoffman distributors in the Midwest, South, Southwest and East.

McCrae Named Du Mont Development Manager

HAROLD W. MCCRAE, has been named manager of the development engineering department at Allen B. Du Mont Laboratories, communica-

Star Performers

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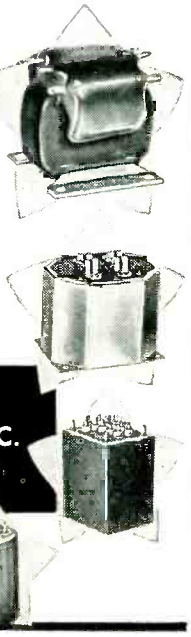

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In the never-ending conquest of the vast barriers of space and time, Douglas goes ever forward meeting every challenge that men and machines must face. The newest — and brightest — star in the aviation firmament, the Douglas DC-7, is truly a miracle 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.

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.
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when timing poses a problem — consult

(Catalog sent on request)

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Design and Manufacture of Electro-Mechanical Timing Devices

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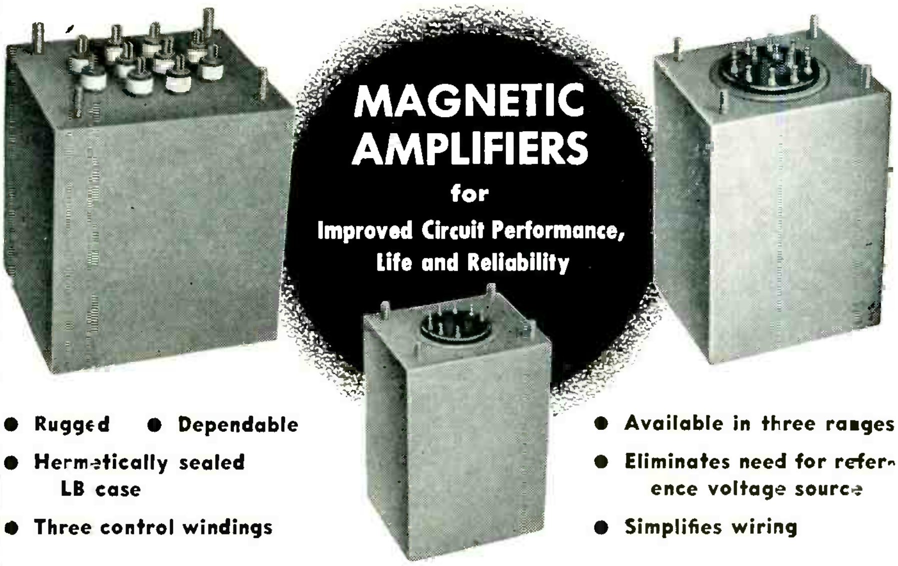

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for Improved Circuit Performance, Life and Reliability

- Rugged
- Dependable
- Hermetically sealed LB case
- Three control windings
- Available in three ranges
- Eliminates need for reference voltage source
- Simplifies wiring

These outstanding Series RG-60-D Magnetic Amplifiers by ATLAS provide extreme ruggedness and unfailing dependability for many voltage control applications. By improving the performance and life of circuits in which they are used, costly maintenance and repairs can be reduced. Competitive in price with other voltage control methods, ATLAS Magnetic Amplifiers have *all* the features you have always desired.

***WRITE** to Dept. **AD** for Bulletins for complete specifications.*

ATLAS

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Want more information? Use post card on last page.

Harold W. McCrae

tion products division.

In his new post he will have direct responsibility for the engineering development of all of the electronic communication products made by the division, including transmitters, cameras and studio equipment, industrial closed-circuit television systems and mobile radio transmitting and receiving systems. McCrae first joined the company in 1951, and has been the project head in charge of its bright-screen radar program.

In 1940, McCrae joined the National Research Council of Canada, doing special circuit research. He was engaged in top-secret radar development for Canadian and U. S. Armed Forces.

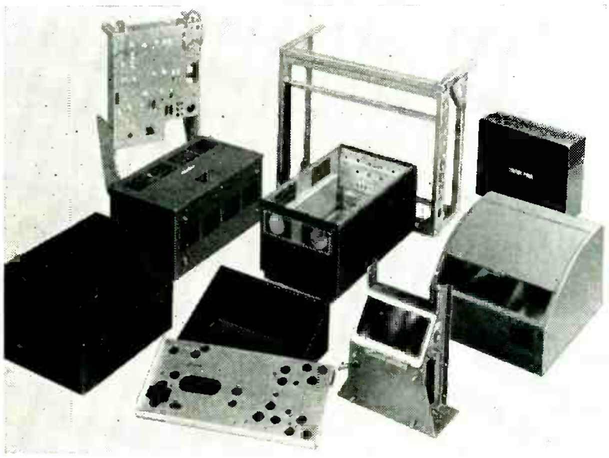
In 1946, he joined the transmission and development department of the Canadian Broadcasting Corporation, Montreal, where he worked on am, fm & tv projects, including the initial planning for a Canadian tv system.

In 1949, he joined Canadian-Marconi as chief television engineer, handling all details of the recently awarded contract for television equipment for the Canadian Broadcasting Corp.

Carroll Named Chief Engineer of Hallicrafters

CHARLES T. CARROLL, chief of government engineering for Hallicrafters since 1951, has been named director of engineering for the firm.

From 1948 to 1951 he was chief



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KOOL KLAMPS

BIRTCHER KOOL KLAMPS *will* help keep your subminiature tubes COOL... and hold them firm and secure, regardless of how they are shaken, or vibrated.

KOOL KLAMPS are made of a specially developed heat treatable alloy *99½% pure silver* of high thermal conductivity.

KOOL KLAMPS under certain conditions are able to reduce bulb temperatures as much as 40° C.

KOOL KLAMPS have proved of particular value in miniaturized electronic equipment.

Where heat conditions are less critical, beryllium copper KOOL KLAMPS are available.

The BIRTCHER CORPORATION
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Dept. E-5-4

Please send Bulletin which describes and illustrates Kool Klamps in detail.

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television engineer for Trav-Ler Radio and from 1945 until 1948 was an advanced development engineer for Hallicrafters.

In 1938 he joined the engineering staff of Hazeltine Research. In 1943 he became associated for two years with Hamilton Radio. He replaces Harold Adler, former director of engineering, who resigned.

McElroy Appointed FCC Engineer

FCC COMMISSIONER John C. Doerfer announced the appointment of James B. McElroy of Ventura, Calif., as his engineering assistant.

From 1937 to 1945, McElroy was employed by the government of Guatemala as chief engineer of government-owned commercial radio stations, and from 1945 to 1949 he privately owned and operated a commercial radio station in Guatemala. Since 1950, he has been employed as an electronic engineer by the U. S. Navy.

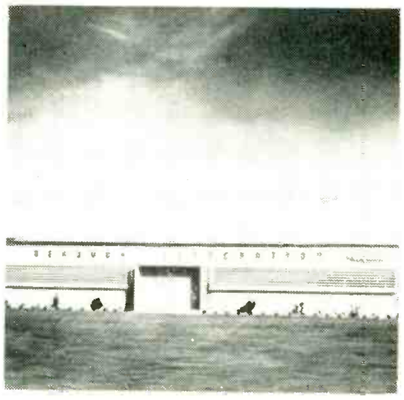
Aerovox Officially Opens Two Plants

AEROVOX Corp. announced the formal opening of two new plants in California. One will house Cinema Engineering in Burbank, and the other will house both Acme Electronics and the pacific coast division of the firm in Monrovia.

Aerovox purchased Cinema and

Acme during the past year, and has increased the productive ability of each by the erection of the new plants.

The Monrovia plant is being



equipped to manufacture most types of Aerovox capacitors. Cinema Engineering, with national distribution, brings diversification in some eight product lines, all within the scientific instrument, electronic and sound fields.

The combined areas of the two plants is over 70,000 square feet, 20,000 at Cinema and 51,000 at Acme-Aerovox.

The two plants presently house over 400 employees, and it is estimated that the total will exceed that amount many times as production is expanded.

Triple Transmitter Building Completed

THE JOHN POOLE Broadcasting Company's new television transmission center atop Mt. Wilson in California houses three transmitters.

In addition to Poole's new 12-kw uhf transmitter for KBIC on channel 22, the building houses the 1-kw uhf transmitter serving KTHE over channel 28. The latter is the educational station operated

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Precision Work to .0003" Tolerances

Capacity Up to 1" Dia.

Specializing In Electronic Parts and Materials

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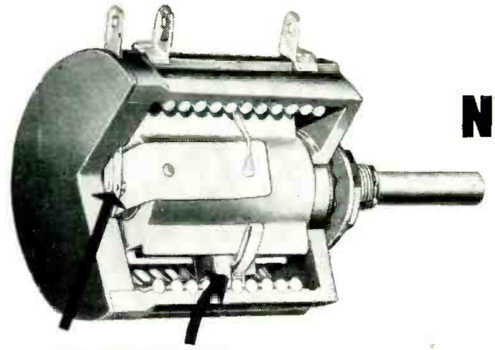

NEY PRECIOUS METAL ALLOY CONTACTS

NEY'S SMALL PARTS PLAY A BIG PART IN PRECISION INSTRUMENTS

The output of any potentiometer is dependent upon the contacts. Illustrated above is a Helipot 10-turn Potentiometer (Model A) using Ney Precious Metal Contacts between the slider and the resistance winding and for the slip ring pick-off, assuring the utmost in linearity and electrical transmission.

The J. M. Ney Company has developed a number of precious Metal Alloys and fabricates these into contacts, wipers, brushes, slip rings, commutator segments and similar components for use in electrical instruments. Ney Precious Metal Alloys have just about ideal physical and electrical properties, high resistance to tarnish, and are unaffected by corrosive atmospheres. Consult the Ney Engineering Department for assistance in selecting the right Ney Precious Metal Alloy which will improve the electrical characteristics, prolong the life and accuracy of your instrument.

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Specialists in Precious Metal Metallurgy Since 1812

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- Helium
- Argon
- Neon
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In radar electronic equipment, nuclear radiation counters, cosmic ray cloud chambers, and thyratrons, where the purest rare gases are demanded, LINDE M.S.C. Grade gases meet the specifications. They are produced under continuous mass spectrometer control to assure you of gases of *known* purity and consistently high quality. LINDE, the world's largest producer of gases from the atmosphere, can meet your individual needs of volume, mixture, and container.

For information on the physical, chemical, and electrical properties of these gases, send for the booklet, "LINDE Rare Gases."

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HIGH POTENTIAL TESTING INSTRUMENTS

Write for Bulletin 4A

- **ONLY ONE** instrument necessary to make high potential tests for leakage, breakdown or shorts!
- **PORTABLE,** with rugged steel case . . . Operates in any position!
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- **VISUAL INDICATIONS** from neon lights give positive test results. Audible test indication for leakage also available.
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"Precision Instruments Since 1936"

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by the Allen Hancock Foundation of the University of Southern California.

The ground floor is occupied by radio station KFWB-FM, which has a 10,000-watt transmitter.

Adoption of the chalet type design was dictated by the desire to provide for heavy snow loads sometimes encountered at the 5,700-foot elevation at which the three-story reinforced concrete and masonry structure is located.

Sprague Electric Reelects Officers

ALL DIRECTORS of Sprague Electric Co. were reelected, and Robert C. Sprague, founder and chairman of the board, was elected to the additional post of treasurer, succeeding George B. Flood. Flood remains as a member of the Board of Directors, and will make available his long experience in the company's affairs as a director-consultant.

Other officers and directors who were reelected are: Julian K. Sprague, president and director; Ernest L. Ward, executive vice-president and director; William J. Nolan, vice-president, secretary and director; Wilbur A. Lazier, vice-president and technical director; Neal W. Welch, vice-president in charge of sales; Preston Robinson, director-consultant; Frank A. Bond, director; Gordon W. Phelps, director; Harry C. Robbins, director and Robert C. Sprague, Jr., director.

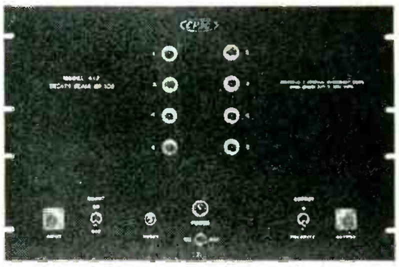
Burroughs Organizes Special Products Division

THE RESEARCH CENTER of the Burroughs Corp. of Philadelphia has formed a new special products division.

It will be concerned with applications of magnetics and electronics in industrial equipment and the development of defense equipment. Initial concentration will be in the fields of systems engineering, data processing systems, weapons control and other applications for digital techniques in industrial applications.

It will also conduct research and development work in telemetering, servomechanisms, process control and various applications of elec-

10 mc DECADE Scaler



0.1 Microsecond Resolution

SPECIFICATIONS **Model 412**

INPUT CIRCUIT:
- POLARITY: Positive pulses only.
- AMPLITUDE: Minimum amplitude of 5 Volts required at low counting rates, increasing to 10 volts minimum at the maximum counting rate.
- REQUIRED RATE OF RISE: Minimum of 10 volts per μsec.
- INPUT IMPEDANCE: Greater than 5000 ohms.

RESOLVING TIME: 0.1 μsec.

MAXIMUM ACCEPTABLE UNIFORM RATE: 10mc or 10^7 counts/second, no lower limit on counting rate.

SCALING FACTOR: Decade Scale of 100 Neon light interpolation.

OUTPUT:
- POLARITY: Positive or Negative pulse selected by front panel switch.

PULSE CHARACTERISTICS: Triangular pulse of approximately 1 μsec. rise time, 4 μsec. width and 50-60 volt amplitude.

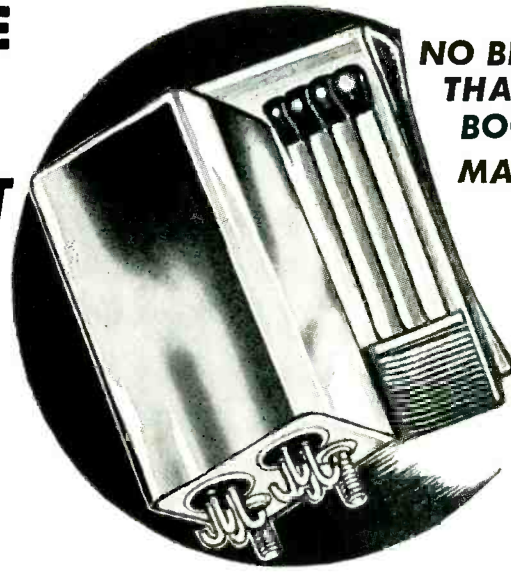
POWER REQUIREMENTS: 105-125 volts, 50-60 cycles, approximately 300 watts.

SIZE: 10-½" x 19" x 13" deep

Complete literature on request Dept. LD-4

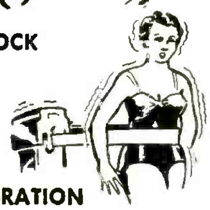
EPIC ELECTRICAL & PHYSICAL INSTRUMENT CORP.
42-19 27th Street, L.I.C. 1, N. Y

SENSITIVE RELAYS *that* R-E-S-I-S-T



NO BIGGER THAN A BOOK OF MATCHES

SHOCK



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TEMPERATURE

Here are miniature sensitive relays—single or double-pole types—which fullfill the most rigid requirements of space, shock, temperature and vibration in both commercial and military applications. The Series 100—105—106 relays are hermetically sealed and have a long life expectancy. *Write for Bulletin* **SR— 6**

Engineering representatives in principal cities.

Wheelock RELAYS
SIGNAL ENGINEERING & MFG. CO.
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BE SAFE WITH Q-max A-27

LOW-LOSS LACQUER & CEMENT

- Q-Max is widely accepted as the standard for R-F circuit components because it is chemically engineered for this sole purpose.
- Q-Max provides a clear, practically loss-free covering, penetrates deeply, seals out moisture, imparts rigidity and promotes electrical stability.
- Q-Max is easy to apply, dries quickly and adheres to practically all materials. It is useful over a wide temperature range and serves as a mild flux on tinned surfaces.
- Q-Max is an ideal impregnant for "high" Q coils. Coil "Q" remains nearly constant from wet application to dry finish. In 1, 5 and 55 gallon containers.

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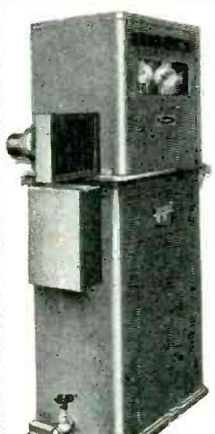

34 KW 17,000 V.D.C.

MAGNATRAN — Our years of experience gives you MAGNATRAN Heavy Duty High Voltage products . . . built for longer life and rugged performance

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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.

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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

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MAGNATRAN INCORPORATED
TRANSFORMERS AND ELECTRICAL EQUIPMENT
WALTER GARLICK, JR., PRESIDENT
246 SCHUYLER AVE., KEARNY, NEW JERSEY

tronic, magnetic and electromechanical techniques.

Isaac L. Auerbach has been named manager of the new division. Before its organization he was manager of the research center's magnetics department.

Auerbach, who was a radar officer with the U. S. Navy during World War II, is a registered professional engineer in Pennsylvania.

Link To Affiliate With General Precision

LINK AVIATION plans to affiliate with General Precision Equipment Corp. The operation of Link Aviation would continue under its present management. The affiliation is expected to provide a strengthening of the Link Aviation product base and to lead to expansion of operations.

Link reports that sales in recent years have shown a steady increase due to the broadening demand for electronic trainers. Its present backlog of orders is substantial.

Bendix-Scintilla Plant Nears Completion

A NEW FACTORY addition at the Scintilla division of Bendix, now nearing completion, will increase plant floor area from 500,000 sq ft to 533,000 sq ft.

The new addition is to be devoted to the precision manufacture of coils, capacitors, electronic devices and ignition components for the aircraft, automotive, agriculture, marine and petroleum fields.

Chromatic TV Adds Engineers

IN ANTICIPATION of an upswing in color set production schedules by manufacturers, Chromatic Television has increased its staff at the West Coast Development Laboratories by more than a third.

Executive personnel changes have been necessitated by this expansion. Earl Sargent, who has been working with Chromatic at Oakland, has been made head of manufacturing at the Emeryville plant. Louis Silverman joins Sargent at Emery-

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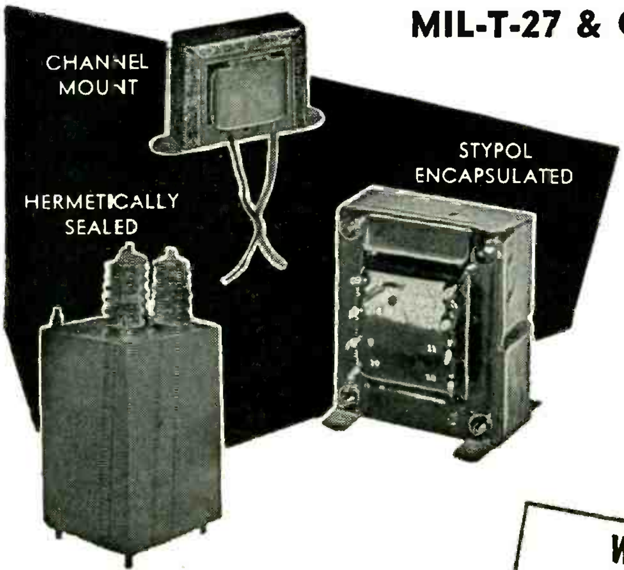

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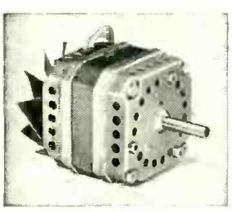
DC MOTOR OR GENERATOR
This small permanent magnet, ball-bearing unit—As a motor: 1/125 H.P. at 6000 RPM continuous duty. As a generator: output 4 watts at 6000 RPM—5 volts per 1000 RPM. Dimensions: 1-29/32" x 1-1/2" x 1-15/100".

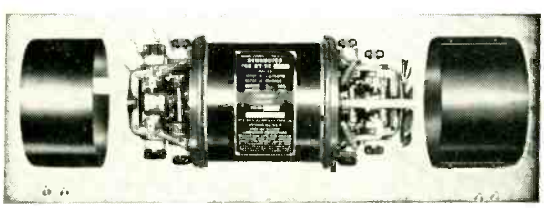


SHADED POLE MOTOR— for sound recorders, air circulators, many other applications. 4-pole, 2 or 4 coil construction. Will operate from 115 volts, 60 cycle a.c.

The RIGHT power supply for mobile equipment is an EEPCO specialty

Outstanding experience in producing rotary electrical equipment to meet rigid specifications is an integral part of every EEPCO product.

Whether your problem involves an industrial or highly developed military unit, EEPCO's complete research and engineering facilities are at your disposal. Contact EEPCO today for special design assistance that can provide you with the best solution.



DYNAMOTOR OPERATES FROM 12-24-32 VOLTS
Output of this remarkably compact unit is 500 volts at .100 amperes. Dynamically balanced armature has 4 windings.

ELECTRO ENGINEERING PRODUCTS CO.
609 W. LAKE STREET, CHICAGO 6, ILLINOIS

• P-M DC MOTORS & GENERATORS • CAPACITOR TYPE MOTORS • UNIVERSAL MOTORS
• DC MOTORS & GENERATORS • SHADED POLE MOTORS (2-4-6 Pole) • P-M AC GENERATORS

VERSATILE SIGNAL SOURCE speeds electro-acoustical measurements

Bruel & Kjaer Beat Frequency Oscillator, Model BL-1012

This Beat Frequency Oscillator is designed to incorporate the many features required in a complete and flexible signal source such as — continuously tuned frequency range, metered output, frequency modulating circuit, variable compression and noiseless oscillator stop switch.

When coupled with the Bruel & Kjaer Level Recorder, the Oscillator automatically sweeps through the audio frequency range. This permits fast, accurate recording of frequency response, sound insulation properties, reverberation times, energy decay, etc. The Oscillator has a high frequency accuracy; 1%± one cycle per second. An incremental tuning adjustment and scale permit very accurate frequency setting. An automatic gain control circuit is utilized to maintain the desired output voltage for constant current, voltage, or sound pressure.

For complete specifications on this and other Bruel & Kjaer instruments, write Brush Electronics Company, Dept. K-5B, 3405 Perkins Avenue, Cleveland 14, Ohio.

ACOUSTIC AND TEST INSTRUMENTS

Bruel & Kjaer instruments, world famous for their precision and workmanship, are distributed exclusively in the United States and Canada by Brush Electronics Company.

BL-1012	Beat Frequency Oscillator
BL-1502	Deviation Test Bridge
BL-1604	Integration Network for Vibration Pickup, BL-4304
BL-4304	Vibration Pickup
BL-2002	Heterodyne Voltmeter
BL-2105	Frequency Analyzer
BL-2109	Audio Frequency Spectrometer
BL-2304	Level Recorder
BL-2423	Megohmmeter and D. C. Voltmeter
BL-3423	Megohmmeter High Tension Accessory
BL-4002	Standing Wave Apparatus
BL-4111	Condenser Microphone
BL-4120	Microphone Calibration Apparatus and Accessory
BL-4708	Automatic Frequency Response Tracer

BRUSH ELECTRONICS COMPANY

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

BRUSH ELECTRONICS

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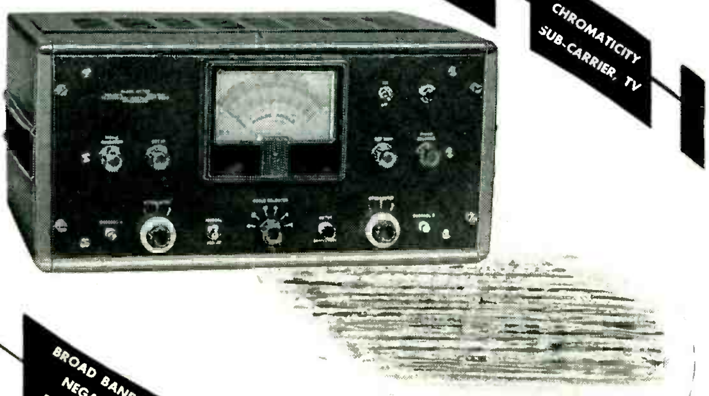


ville as chief manufacturing engineer.

Edward J. Davenport, formerly with National Union Radio Corp. for eight years, has joined Chromatic as chief commercial engineer. Davenport came to Chromatic after a survey of tube possibilities in the color tv field. He has some 15 years of electronics and television engineering training.

Textile Firm Moves Into Electronics

STOCKHOLDERS of the H & B American Machine Co. and Susquehanna Mills approved a merger of H & B into Susquehanna to form the H & B American Machine Co.

Victor Nemeroff, president of H & B, was elected president of the surviving corporation. Arnold H. Maremont and David E. Bright were elected vice-presidents. The merger is subject to the formal approval of the creditors of Susquehanna.

H & B currently conducts operations through three divisions including the Karp Metal Products division, Brooklyn.

Color TV Clinics Draw Technicians

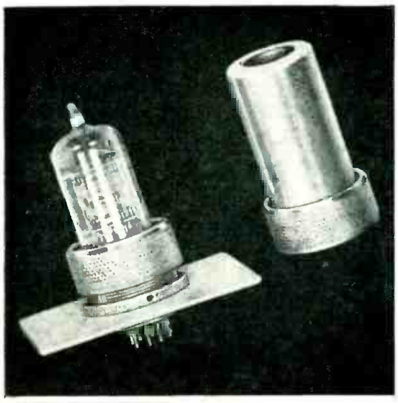
MORE THAN 27,000 television servicemen have attended the first 35 sessions in RCA's series of technical clinics on installation and maintenance of color television receivers. In New York, 2,775 technicians turned out for the meetings, in Philadelphia, 1,660, and in Newark, N. J., 1,475. In Buffalo, N. Y., 635 servicemen attended.

Similar clinics in a total of 65 major cities are scheduled in the series. More than 80,000 copies of RCA's color servicing book have been distributed.

Kay Lab Appoints Chief Engineer

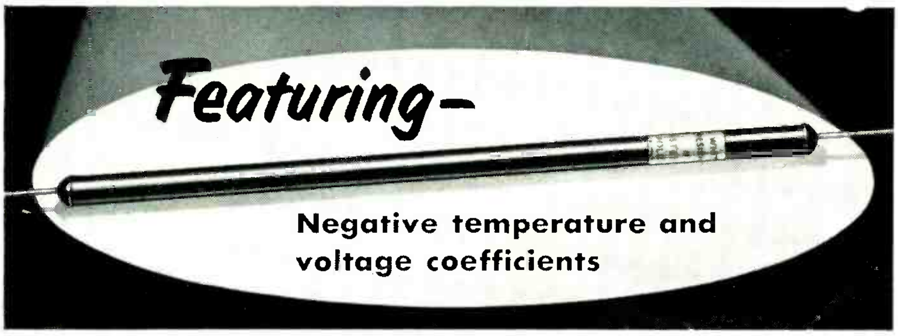
JOHN DAY, recently appointed chief television engineer for Kalbfell Laboratories of San Diego, now assumes responsibility for all development and engineering work on the new Kay Lab television camera

IF IT'S NEW . . . IF IT'S NEWS . . . IT'S FROM ELCO



News that is bound to make headlines again for Elco Corporation is its new hermetically-sealed socket for use at high altitudes; and to give complete protection against moisture conditions. Floating contacts of heat-treated beryllium-copper assure complete relief of strain from glass of tubes. The Kel-F body is retained in an aluminum or brass housing, terminating with hermetic-seal on chassis end. A retainer ring lined inside with silicon rubber screws on to the housing, forming a complete seal around the tube; and also acts as tube retainer. Water absorption: 0. Condensation inside socket: practically 0. Contact resistance .001 Ω Silicon seal withstands temperature up to 525° F. Complete contact float; excellent tube retention under pressure. Available in 7- and 9-pin miniature tube class, with or without shields. Drawings and prices are yours upon request.

For Catalog Sheets, Call GArfield 6-6620 or Write ELCO Corp., 190 W. Glenwood, Phila. 40, Pa.



S.S.WHITE 80X Molded Resistors

3 watts — 100 to 100,000 megohms

S.S.White 80X Resistors have been developed to meet the exacting needs of high voltage equipment, such as electrostatic generators, X-Ray units, and specialized equipment used in atomic energy work. Their design and construction assures an unusually fine combination of characteristics for this work, chief among which are:

- Negative temperature coefficients.
- Negative voltage coefficients.
- Excellent stability, durability and mechanical strength.
- Non-deterioration of values due to age.
- Moisture resistant, non-hygroscopic base material specially processed to insure full protection against humidity.
- Space-saving compactness.

WRITE FOR BULLETIN 4906 — It contains full information on S.S.White 80X resistors. Copy sent on request.

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DENTAL MFG. CO.
Dept. R 10 East 40th St.
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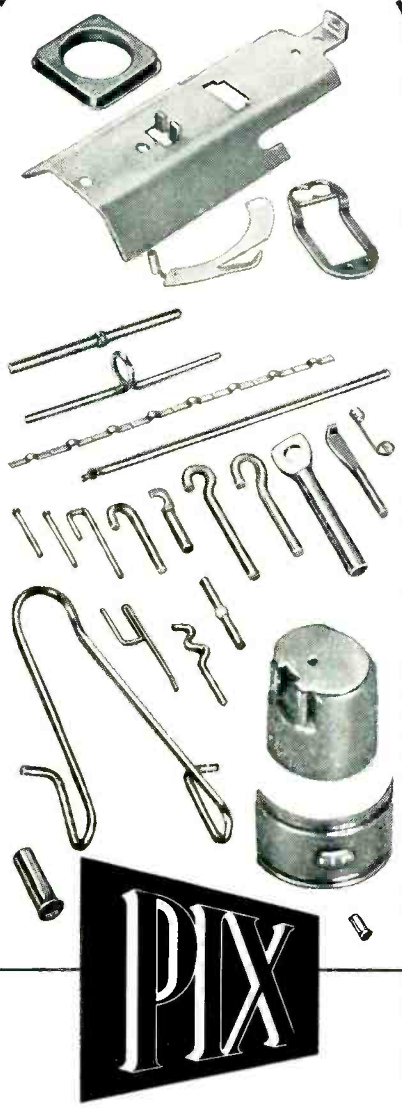

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systems and associated equipment.

He has been employed by Paramount Pictures as an electronics engineer. At the Naval Research Laboratory in Washington, he was associated with the early work by the Navy on radar equipment. He also was engaged in the design of receivers and test equipment. He participated in early work in electronics counter-measures for aircraft radar.

Day worked in the field of high-frequency propagation at the Naval Electronics Laboratory in San Diego. He developed standard procedures employed in propagation instrumentation.

At Kalbfell Laboratories, Day will be directly associated in a supervisory capacity with Kay TV, the television intercommunications systems for industry and commercial broadcasting.

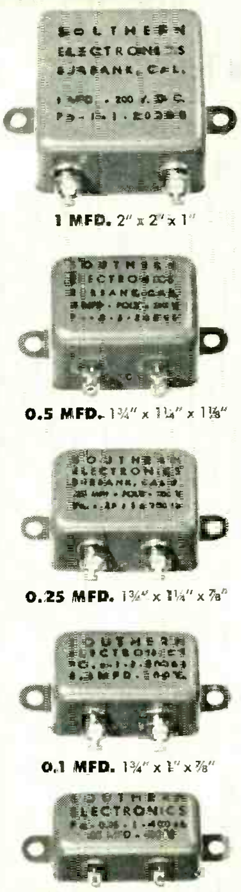
General Instrument Names Valliere

B. F. VALLIERE has been named vice-president and general manager of the F. W. Sickles division of General Instrument.

In his new capacity, Valliere will have over-all responsibility in the Sickles division and its three plants. He joined the firm as an executive in January, 1946, after serving with Sylvania and American Bosch.

Crucible Steel Acquires Interest In Vacuum Metals

CRUCIBLE STEEL has acquired a 50 percent interest in Vacuum Metals



1 MFD. 2" x 2" x 1"

0.5 MFD. 1¾" x 1¼" x 1⅝"

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as low as 0.1% tolerance in most values

CAPACITANCE AVAILABLE—0.05 to 10.0 MFD.
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INSULATION RESISTANCE—10^6 MEG./MFD.
TEMP. COEFF.—100 P.P.M. per °C (—20° to 140°F)
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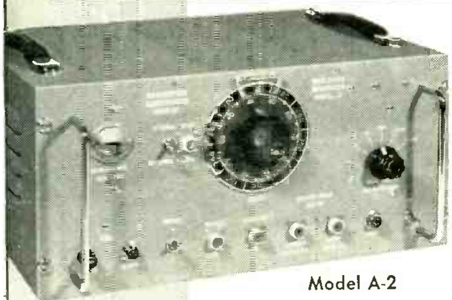
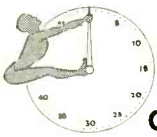


Model A-2



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Each provides accurate and variable time intervals in five ranges. They feature low jitter (.008%), linear scales, built-in calibration indicator, 1,000-division dial, small repetition rate effects, blocking oscillator output and wide pulse output.

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Get complete data: our Bulletin E-A-2

A-4 — Range: .00001 to 10 secs.
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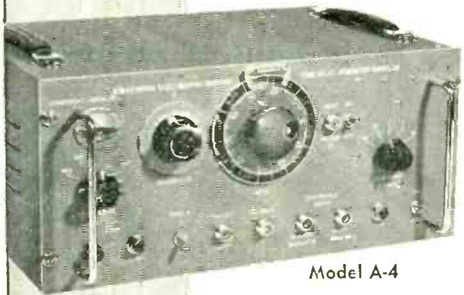

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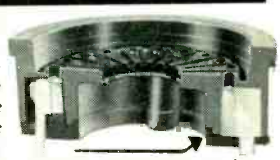
New components, designs and techniques for HIGH VOLTAGE and CORONA SUPPRESSION

Here's a brand new technique . . . makes possible connectors and cables wherein insulation is molded right around contact and lead . . . to give you an integral unit that licks the problems of high voltage and corona suppression at new low cost, by —

1 Eliminating need of leakage paths at wire holes.
2 Utilizing materials more inert to ozone attack than conventional materials.
3 Sealing high voltage potential sources from air except at the point of contact mating, where there is a natural damping of corona.

This new technique just worked out for Color TV can give you connectors and cables for solving many problems involving high voltage and corona suppression.

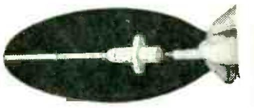
NEW SOCKET TECHNIQUE



As illustrated in this Alden 220FTSC Color TV Tube Connector, the new technique permits a jacket of high voltage insulation to be integrally molded around each high voltage contact and lead, while the low voltage leads take the resilient "figure 8" clips in the regular isolated pockets providing air space leakage.

NEW CABLE TECHNIQUE

This new technique makes possible completely molded cables having all connectors and wire insulation sealed into an integral unit that licks the problems of high voltage and corona suppression. For example, the 30,000-volt anode cable illustrated has in-line tube cap, high voltage disconnect and anode clip all molded together as one integrated unit tailored for a Color TV set.



8101FP/M High Voltage Disconnect for 20,000 volt anode cable.

8111FP/M High Voltage Disconnect for 30,000 volt anode cable.

911SL Molded in-line Tube Cap.

ADDITIONAL ADVANTAGE—this new technique gives a solidly molded unit that eliminates common cable problems of: wire fatigue under vibration; insulation pullback; strain relief for leads.

TO GET STARTED

write for Spec Sheets on Color TV—and let us plan these techniques to your special needs in ANY field involving high voltages and corona suppression.

NA-ALD ALDEN PRODUCTS CO.
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Corp., formerly a wholly-owned subsidiary of National Research.

Arrangements have been completed for construction of new vacuum melting facilities to be located in Syracuse, New York, in an expansion program that is expected to increase Vacuum Metals' capacity by more than 500 percent in the next twelve months.

Vacuum Metals is currently producing vacuum-melted metals and alloys in its plant in Cambridge, Mass. Present production facilities permit production at a rate in excess of $1 million annually.

Directors of Vacuum Metals, under the joint ownership, will be:

(Representing Crucible) Joel Hunter, executive vice-president of Crucible; R. S. Poister, vice-president in charge of operations of Crucible; W. H. Wiewel, vice-president in charge of sales of Crucible; L. L. Ferrall, assistant vice-president in charge of operations of Crucible.

(Representing National Research) Richard S. Morse, president of National Research, Kenneth G. Donald, vice-president and treasurer of National Research, Robert A. Stauffer, vice-president and director of research of National Research and Richard M. Nichols, secretary of National Research.

Officers of Vacuum Metals will be: Joel Hunter, chairman of the board; Richard S. Morse, president; L. L. Ferrall, vice-president; Robert A. Stauffer, vice-president; George F. Groff, treasurer; Kenneth G. Donald, assistant treasurer; Richard M. Nichols, clerk and secretary and K. R. Vogel, assistant secretary.

General Manager in charge of operations of Vacuum Metals Corporation is James H. Moore.

Wendt-Squires Firm Formed In Buffalo

THE COMPANY of Wendt-Squires of Buffalo, N. Y. has been organized to engage in research, development and limited volume production in the electronics field. Approximately 2,000 sq ft of lab space are available. Total personnel number seven, with additions expected.

President of the new firm is Karl R. Wendt, formerly manager of the

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The only portable fluxmeter available which returns rapidly to zero when a single button is depressed. Simple and fast in operation. Convenient and light in weight.

Not limited to a single type of measurement. Has universal application for laboratories or production. Measures strength of magnets and electromagnets, permeability and hysteresis loops for iron and steel, total flux lines in circuit, flux lines developed in air gap, etc.

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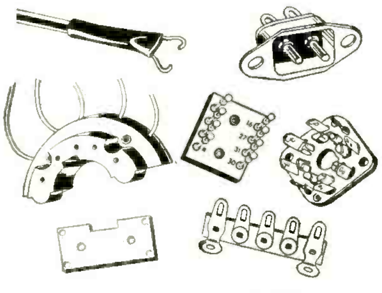

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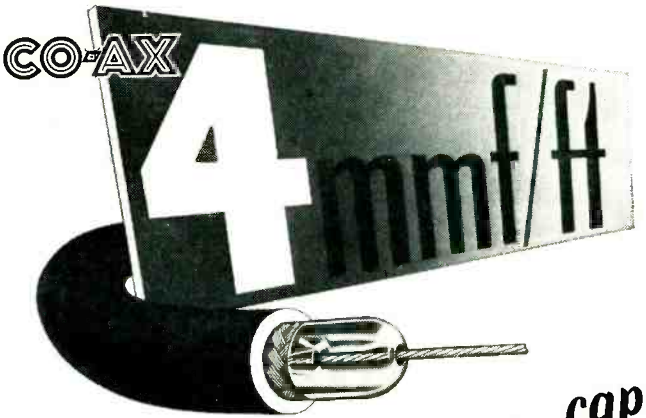

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C 1	7.3	150	.36"
C 11	6.3	173	.36"
C 2	6.3	171	.44"
C 22	5.5	184	.44"
C 3	5.4	197	.64"
C 33	4.8	220	.64"
C 4	4.6	229	1.03"
C 44	4.1	252	1.03"

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NEW 'MX and SM' SUBMINIATURE CONNECTORS Constant 50Ω–63Ω–70Ω impedances

TRANSRADIO LTD. 138A Cromwell Rd. London SW7 ENGLAND CABLES: TRANSRAD, LONDON advance development department of Sylvania's radio and tv division since 1948. William K. Squires is vice-president of the company. He was formerly with Sylvania as uhf tv engineering specialist and supervisor in the advance development department.

Chief engineer of the new company is LaVerne H. Hardy. Previously he was a senior engineer at Sylvania and had also worked at GE's general engineering and consulting laboratory.

GE Shifts Midwest Tube Facility

A CONSOLIDATION of GE's Indiana receiving tube manufacturing at its Tell City plant will result in closing of a feeder operation, the G-E tube mount assembly plant at Huntingsburg.

Processing done formerly at Huntingburg will be shifted to a 42,000 sq ft addition completed last autumn at the Tell City plant.

Firth Sterling Elects Porterfield

C. PAUL PORTERFIELD has been elected vice-president and general manager of The Method X Co., an affiliate of Firth Sterling of Pittsburgh. He was previously chief engineer of the firm.

Porterfield has served as electronic engineer for the Chesapeake & Ohio Railroad, chief engineer for Air Transport Maintenance Co. and radio engineer in the 7th Naval District in Miami.

Hyman Heads Brach TV Antenna Development

ABRAHAM HYMAN has been appointed head of the recently expanded tv antenna development section of Brach Manufacturing division of General Bronze Corp. He will report to Ira Kamen, vice-president in charge of sales and tv development.

In addition to having served as a consulting engineer in the tv antenna industry, Hyman is a former employee of the CAA and FTL.

His first assignment at Brach is

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- Other Features -

- **Reads 10 to 30,000 Gauss Flux Fields**
- **Probe is only .025" thick**
- **Active area .01 square inches**
- **Overall size 13" x 6-3/4" x 10-1/2"**
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- **Power supply 105-125 volts, 50-60 cycles**

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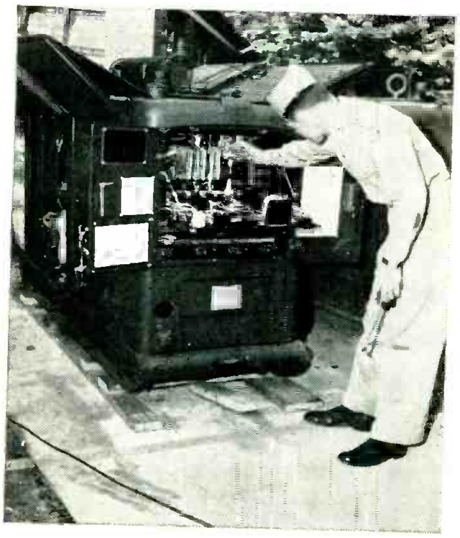

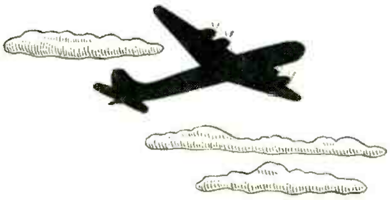

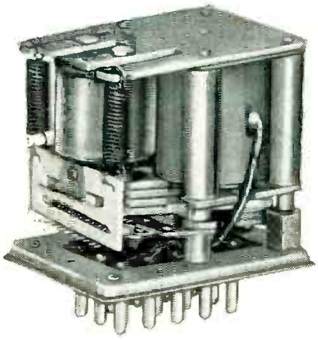

the development of a new type fringe antenna for vhf and uhf for introduction at the May Parts Show.

Bross Leaves MIT

R. B. BROSS, for the past 7 years manager of MIT's electromagnetic engineering section of the instrumentation laboratory, resigned from the MIT staff in order to devote full time to consulting. He will cover problems associated with design, development, production, testing and application of special electric and electromagnetic components.

Tel-Instrument Appoints Silver TV Manager

MARTIN SILVER has been named manager of the new broadcast equipment division of Tel-Instrument. He was formerly manager of the tv division of Federal Telecommunications Laboratories.

During 1953, Silver served as manager of WTVU in Scranton, Pa. From 1941 until 1953 he was employed at Federal. He headed the tv development laboratory there until his promotion to manager of the tv division.

Electronics Plant To Rise In India

THE PROPOSED construction of the Bharat Electronics factory, the first enterprise of its kind for the Indian government, was scheduled to begin in March. The plant will be built on 500 acres of land near Bangalore, India.

At peak production, about 5,000 people will be employed.

El Mec Moves To New Location

EL MEC LABORATORIES moved their plant and office to Kenilworth, N. J. The firm is engaged in the design and manufacture of special electronic and electromechanical equipments and devices, including custom-designed production-testing automatic machinery.

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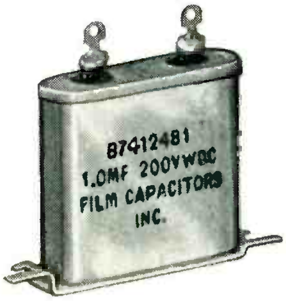

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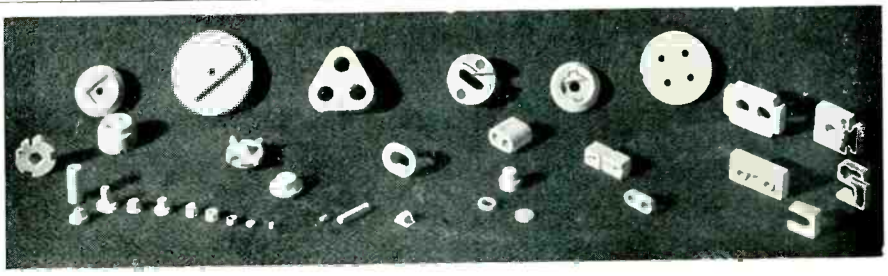

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cent more effective space for engineering and development work and manufacturing.

Plating Company Doubles Capacity

AMERICAN ELECTRO PRODUCTS, Waterbury, Conn., has completed construction of a wing which more than doubles the production capacity of its former plant.

According to the company, the expansion was made necessary by the increase in business which followed the perfection of the firm's "Cantavone" processes.

Norden Labs Elects Officials

NORDEN LABORATORIES' stockholders elected eight directors, including Carl F. Schaefer, Norden's technical director.

The newly-elected directors, at their meeting following the election, reappointed the corporation's officers for the coming year. They are: Paul W. Adams, president; R. M. Adams, Jr. and Dr. L. T. E. Thompson, vice-presidents; M. V. Lane, treasurer and W. W. Sisbower, secretary.

Norden, which designs, develops and produces electronic and mechanical precision instrumentation and controls, is comprised of three divisions and now has 898 employees.

Mossman Completes Move To New Plant

DONALD P. MOSSMAN, manufacturers of multiple-circuit lever, push and turn switches, are now occupying a recently completed plant at Brewster, New York.

Management, engineering and sales offices are located at the new plant. In addition, the company has manufacturing facilities at Joliet, Ill.

Chief engineer at the new plant is George C. Hills, Jr. Prior to joining the company Hills served as industrial specialist with the Dept. of Defense and had been assistant to

G. C. Hills, Jr.

the chief engineer of Celanese Corp., plastics division.

Jahns Named To Head Wilcox-Gay Production

EDWARD JAHNS has been appointed vice-president in charge of production at the Recordio plants of Wilcox-Gay. He was formerly chief development and research engineer for the Majestic Radio & Television division for several years before becoming chief engineer of the Recordio division in June 1953. Prior to that, he served as chief engineer for several large firms.

Orville Gans has left his position of plant manager to become regional representative for all divisions.

Decker Expands Transducer Research

DECKER AVIATION is expanding research and development on a new transducer element. Toward this end, Theodore Kaslow, recently an instructor in aircraft instrumentation at MIT, has been named director of research and development.

Research and development will be performed in 8,000 square feet of laboratory space recently acquired adjacent to the company.

UK Firm To Open Canadian Factory

VICOM AND COMPANY, a British firm which specializes in radio and radar for aircraft, plans to open a factory in Kingston, Ontario.

Future plans include an overhaul installation base for marine radar and direction-finding equipment on

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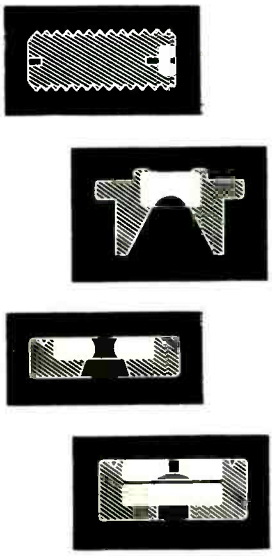

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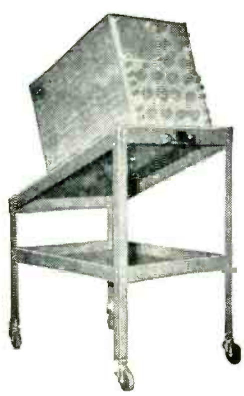

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Small in size (only 4″ x 4″ x 4″) with gravity erection system and precision potentiometer takeoffs. D.C. torque motors actuated by mercury switches. Caging optional using same simple, reliable features as in free gyros.

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These small precision rate gyros are ideal for stabilization and control of autopilots, computers, radar antenna systems and fire control systems used under severe environmental conditions. Dry inert gas damping, pressure sealed case and patented low hysteresis spring system.

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lake vessels, manufacture and servicing of two-way communication equipment for vehicles, and a motor overhaul base.

Brettell Appointed By Ampex Loud Speaker

GEORGE A. BRETTELL has been named chief loudspeaker engineer for the Ampex Loud Speaker Corp. of North Hollywood, Calif.

Prior to joining the company in 1953, he was in the sound engineering department of 20th Century Fox and during World War II was with the U. S. Navy Radio and Sound Laboratory at San Diego.

New Resistor Firm Formed

W. M. KOHRING has formed a new manufacturing company, Wilrite Products, Cleveland, Ohio. It produces a new type of high-precision metallic film resistor for low and high-wattage use to fit requirements of color television and other highly sensitive industrial electronic equipment.

Kohring formerly owned Wilkor Products, which he sold to Aerovox in 1951.

Computer Research Names Engineers

THE APPLICATIONS department of Computer Research Corp., manufacturer of digital electronic computers, has recently been expanded. Arnold D. Hestenes, formerly of the Institute for Numerical Analysis of the National Bureau of Standards, at University of California, Los Angeles, heads the department. Everett C. Yowell, also formerly with the Institute for Numerical Analysis, joined the applications department as an applications specialist.

Radio Craftsmen Promotes Engineers

RADIO CRAFTSMEN promoted Edward S. Miller to vice-president and John Narrace to chief engineer. Miller has been chief engineer for the past six years in charge of development of high-fidelity products. Narrace, formerly with Wells-Gardner, has been recently in charge of tv design for the firm.

Trio Acquires Falcon Electronics

FALCON ELECTRONICS of Quincy, Ill. and its line of antennas was purchased by Trio Manufacturing Co. of Griggsville, Ill.

Roy Wade, formerly general manager of Falcon, has been appointed general sales manager for Trio.

The entire Falcon operations will be moved to the new Trio plant in Griggsville. All Falcon representatives have been retained and will work with Trio representatives. Trio recently installed a tube mill to process its tubing.

International Testing Adds Electronics Section

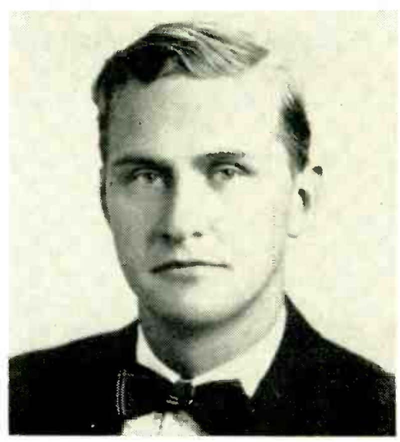
INTERNATIONAL Testing Service of Saginaw, Mich. has added a specialized electronics section devoted to development and research services. Electronics work was previously conducted by the instrumentation department. The electronics section is also being supplemented by a theoretical physics section under the direction of Robert L. Echols, formerly consulting physicist for the Applied Physics Laboratory of Johns Hopkins University, and head theoretical physicist for the Fairchild Aircraft NEPA Atomic Project. Experimental services are currently under the direction of Warren J. Deshotels, formerly chairman of the physics department at Xavier University.

MIT Sets Up Course On Automation

PLANS have been announced for a two-week special summer program in the Automatic Control of Machine Tools, to be held from August 23 to September 3 in the servomechanisms laboratory at the Massachusetts Institute of Technology. The program will be under the direction of Professor J. Francis Reintjes, director of the MIT servomechanisms laboratory in the department of electrical engineering, who will be assisted by other members of the laboratory staff.

Morning sessions of the two-week program will be devoted to studies of systems and components, including the following topics: principles of information processing as applied to the use of machine tools; numerical control systems and their machine tool applications; equipment design for numerical control systems, including data input and storage devices, computational equipment and servomechanisms for machine tool control; design considerations for system reliability; management, operation and maintenance of numerically controlled machine tools.

In addition, there will be less formal afternoon sessions devoted to programming techniques, using the numerically controlled milling machine developed in the Servomechanisms Laboratory under U. S. Air Force sponsorship. Topics in these sessions will include the mathematics of programming, practical procedures and machine aids.



Overlakes Appoints Kindquist Vice-President

ERIC B. T. KINDQUIST, former wire mill superintendent and assistant works manager for the Eastwood Nealley Corp., has been appointed vice-president and general manager for the Garfield Wire Division of the Overlakes Corp.

He began his metallurgical career in the research laboratory of the International Nickel Co. at Bayonne, N. J., later becoming research engineer for RCA at Harri-

RELAYS

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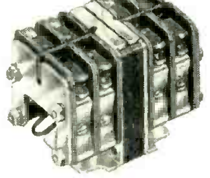

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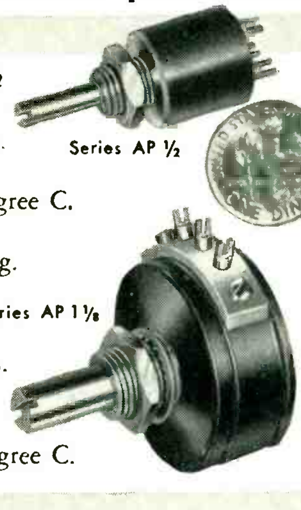

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TRANSFORMERS

son, N. J. For several years he was associated with the Battelle Memorial Institute at Columbus, Ohio, as a research engineer specializing in the physical metallurgy of nonferrous metals.

Thomas & Betts Promotes Engineers

MARTIN D. BERGAN has been appointed engineering technical director of the Thomas & Betts Co. He was formerly director of research and will guide, review and approve proposals for new product designs

Martin D. Bergan

prior to their submission to the company's development executive committee.

Bergan will explore the electrical field for new product ideas and will serve as technical consultant to all company departments.

L. M. Curtiss, formerly executive, engineer was named assistant chief engineer in charge of development. Curtiss will supervise product investigation, research and development. As head of the company's laboratory he will oversee the planning of test programs, reporting to C. A. Badeau, chief engineer.

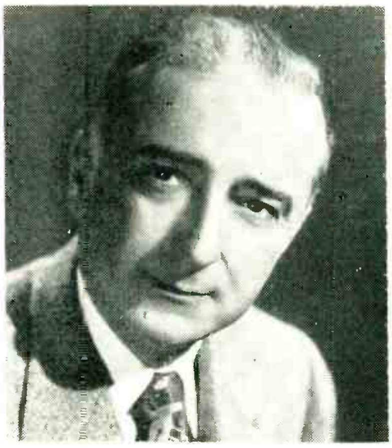
Brown Joins Statham Labs

S. LEROY BROWN, developer of one of the first mechanical brains, has joined Statham Laboratories, Los Angeles scientific instrument manufacturer, as director of research. His former post was at the University of Texas, where he was chairman of the physics department. Prior to that, he taught physics at the University of California, Purdue University and Lehigh University. His mechanical brain, developed in 1938, was called the multiharmonograph. Brown has been with the University of Texas for 42 years.

Columbia Establishes Plastics Division

CRYTON Precision Products, a new division for manufacturing a general line of precision molded plastic products, will be formed by Columbia Records.

James Hunter will be vice-president and general manager of the new division. He has directed Co-



James E. Hunter

lumbia's recent new developments in the record manufacturing industry.

Columbia intends through its new division to divert some of its facilities to products other than discs. The company recently completed a million-dollar plant expansion program which involves installation of injection molding equipment.

Columbia is equipped to manufacture the original precision molds by electrodeposition, as well as the finished plastic product.

Precision Potentiometer Company Formed

PRECISION POTENTIOMETERS CORP. of Los Angeles, Calif., has been organized as a majority-owned subsidiary of Master Mobile Mounts. It will manufacture high-precision potentiometers and precision windings, according to Samuel E. Goldstein, president of the two companies.

Other officers of the new firm are Walter H. Donaldson, potentiometer design engineer, and Karl A. Kopetzky.

Onondaga Appoints Electronics Director

ONONDAGA POTTERY Co. appointed Conan A. Priest as director of the electronics division. He formerly was manager of the transmitter division of GE.

Struthers-Dunn Moves To New Plant

STRUTHERS-DUNN, relay manufacturer, moved from Philadelphia to Pitman, N. J. New office and factory buildings comprising more than 54,000 square feet of space and specifically designed for relay engineering and production have been completed in Pitman.

WCEMA Begins Scholarship Drive

MEMBERS of WCEMA (West Coast Electronic Manufacturer's Association have begun their 1954 scholarship fund drive. As in past years, all money raised in the drive will go toward helping outstanding prospective electronic engineers com-

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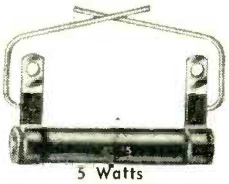

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1 to 100,000 Ohms

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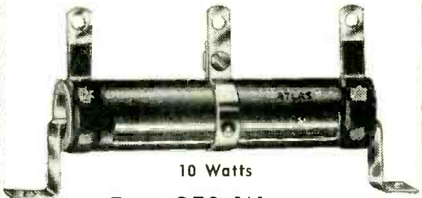

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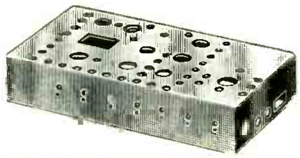

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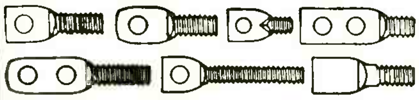

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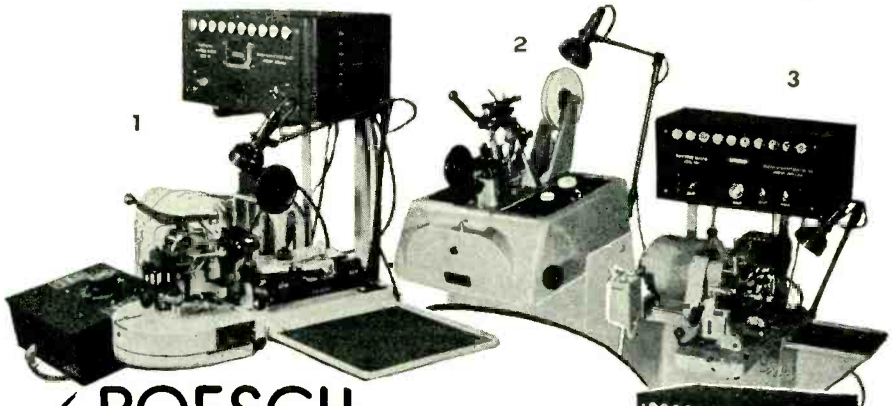

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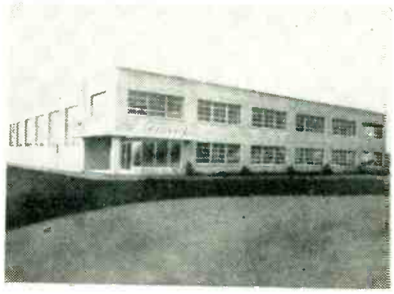
plete their college educations. Last year, WCEMA distributed $6,400 to students of nine west coast schools, as a result of contributions from 56 electronic firms.

The scholarship program was first set up in 1952, under the chairmanship of E. P. Gertsch of Gertsch Products, to help solve the problem of attracting more qualified men into the electronics field. Only about 15 out of every 100 graduates of western engineering schools are headed for electronics, according to WCEMA.

Precision To Occupy New Plant By Mid-Summer

PRECISION APPARATUS CO., manufacturers of test equipment, plans to move from Elmhurst to a new plant in Glendale, Long Island, by mid-summer of 1954.

It will provide expanded facilities for the concern and its wholly-owned meter manufacturing subsidiary.



Tenney Engineering Moves Into New Plant

TENNY ENGINEERING is carrying on full-scale operations in its new environmental equipment plant in Union, N. J.

The current expansion marks the third in recent years.

The new Union plant is a one-story, 30,000 sq ft building. It will employ some 300 people and is situated on a 7-acre site to allow for future expansion.

Barkley Joins General Mills Research

John E. Barkley, formerly head of physical-chemistry research at Armour Research Foundation, where he directed a number of research projects, has been named manager of physics and chemistry research for the mechanical division of General Mills. He will have responsibility for applied research in physical and chemical analysis and measurements applicable to instrumentation for automatic control of processes in petroleum, chemical, food and other fields.

A specialist in the study of infrared rays, Dr. Barkley has played an important role in the interchange of knowledge and ideas between British and American scientists. Both groups have been experimenting with the possible military and civilian uses of infrared photocells and photoconductors. Recently, he has been concerned with the possibilities of extending the spectral range of infrared photocells.

Edison Makes Patent Agreement

Thomas A. Edison Company and International Electronics Co. have made an agreement under which Edison acquires the license to operate under all the patent rights of International and has the power to grant licenses under this right to others.

Commenting on the agreement, Henry G. Riter, III, president of Edison, said, "In some magnetic fields we expect to follow a policy of granting licenses to others under these patent rights. In certain other fields, especially that of office dictation in which Edison is engaged in active research of its own, we plan to maintain our license as an exclusive one."

Avien Names Engineer; Forms New Firm

AVIEN of Woodside, N. Y., manufacturers of aircraft fuel management systems, appointed Everett M. Patterson as director of engineering.

He was associated with Bell Labs for twelve years, during which time he was active in the development of anti-aircraft fire control systems and sonar. As director of research and engineering of U. S. Time Corp., he was responsible for work in the navigational and engine instrumentation fields.

Patterson was more recently president of Patterson, Moos & Co., engaged in chemical, electronic and nuclear research for the military.

The company also established Avien Service Corp. in Los Angeles. The new corp., headed by L. A. Weiss, president of Avien, will handle the firm's sales and engineering services in California areas.

The new firm will be under the direction of Anthony G. Brown, vice-president.

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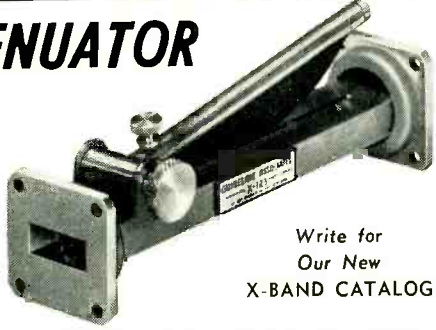

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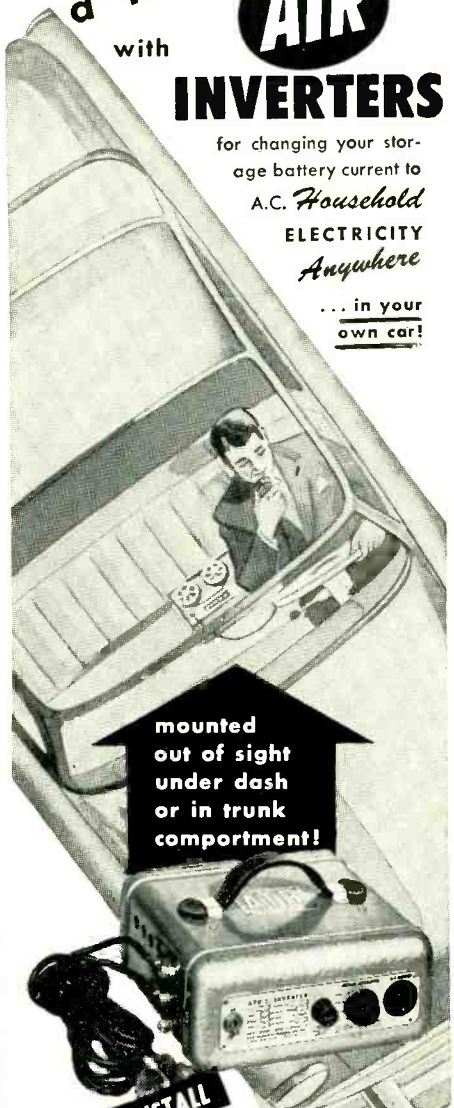

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NEW BOOKS

Advances in Electronics Volume 5

EDITED BY L. MARTON. *Academic Press, Inc., New York, N. Y.*, 1953, 398 *pages*, $9.50.

THE NEW VOLUME of "Advances in Electronics" is among the best to date in achieving the original goal, that of providing monographs serving both as reviews of progress and introductions to special topics in the field of electronics. Contents are:

Performance of Detectors for Visible and Infrared Radiation, by R. Clark Jones, Research Laboratory, Polaroid Corporation, Cambridge, Mass.

Beta-Ray Spectrometers, by R. W. Hayward, National Bureau of Standards, Washington, D. C.

Solid-State Luminescence, by F. E. Williams, General Electric Research Laboratory, Schenectady, N. Y.

Thorium Oxide and Electronics, by W. E. Danforth, The Bartol Research Foundation of the Franklin Institute, Swarthmore, Pa.

A Review of Modern Vacuum Pumps in Electronics Manufacturing, by H. C. Weingartner and S. W. Kennedy, National Research Corporation, Cambridge, Mass.

On the Steady-State Theory of the Magnetron, by R. Q. Twiss, Services Electronics Research Laboratory, Baldock, Herts, England.

A Review of Recent Work in Color Television, by C. J. Hirsch, Research Division, Hazeltine Corporation, Little Neck, N. Y.

Junction Transistor Applications, by J. S. Schaffner, General Electric Company Electronics Laboratory, Syracuse, N. Y.

Some of these papers are of interest mostly to research workers, especially the first two, while the magnetron paper is somewhat mathematical for most persons interested in making, testing, or using magnetrons.

Although solid-state luminescence and electron emission from thorium oxide are still somewhat specialized topics, the articles by Williams and Danforth are both timely and useful.

The rapidly expanding activity

in color television and growth of interest in such fields as electroluminescence, have increased greatly the number of people whose work will be materially aided by a better understanding of solid-state luminescence.

While the sintered thoria cathode has not yet succeded in becoming of major commercial importance in the electronics industry, there are many who believe this will eventually be a reality. The work done during and since the war has served to emphasize the practical difficulties encountered while, at the same time, holding the promise for successful application. Mr. Danforth's paper will, therefore, be of special interest to many readers whose activities are in electron-tube design or research.

The Weingartner and Kennedy article gives a description of pump operation. It does not go deeply into the effects of cold traps on pumping speed or ultimate vacuum.

Transistors-Television

Of particular interest to readers of ELECTRONICS are the last two monographs, by Hirsch and Schaffner, respectively. They are both excellent and deserve special mention.

Mr. Hirsch's contribution, while requiring some knowledge of television and optical principles for complete understanding, provides a fairly comprehensive description of the color-television system evolved and standardized by the National Television System Committee of which he was an active member until the work was completed and the Committee disbanded early this year. Readers will recall his article in ELECTRONICS on the NTSC system about two years ago. The present monograph is 75 pages in length and presents the facts as they are understood in the first year of regularly scheduled color telecasting; it is very well done and worthy of being placed on the required-reading list for engineers entering this exciting field.

In "Junction Transistor Applications" Mr. Schaffner develops this topic somewhat farther than it was carried in "Principles of Transistor Circuits" of which he was coauthor[1].* The general approach is the same, but newer material, such as the papers in the Transistor Issue of the *Proceedings of the Institute of Radio Engineers* (November 1952), has been digested and incorporated into a unified presentation. The author stated in his concluding remarks that he hopes "that this article will not become obsolete too fast in view of this rapid development"; as of the moment, it is by all odds the clearest and most useful review of this topic available.

As usual, all reviews are appended with carefully selected bibliographies and are excellent starting points for more intensive study.—GEORGE D. O'NEILL, *Sylvania Electric Products Inc., Bayside, New York*

(1) "Principles of Transistor Circuits," edited by Richard F .Shea ; John Wiley & Sons, Inc., New York, N. Y.

Practical Television Engineering

BY SCOTT HELT. *Rinehart Books, Inc., second edition, 744 pages,* 1953, $7.50.

THIS is a book on the principles of television engineering, and its scope embraces the entire system. Its greatest usefulness would appear to be as a textbook for a student entering the field, but the practicing engineer will find it of considerable value as a reference book also. For the student, review questions are included at the end of each chapter. It deals primarly with equipment design and treats this subject in detail.

Much information is given on the techniques of broadcasting, and to this extent its scope overlaps that of "Television Broadcasting" by Howard Chinn. It seems to this reviewer, however, that the two books are largely complementary, and most engineers will find use for both as references. Mr. Helt's book contains much of the fundamental knowledge considered prerequisite to a proper understanding of the book by Mr. Chinn. With regard to those areas of broadcasting technique in which the two books overlap, it is believed that Mr. Chinn has given a more comprehensive treatment of the subject.

The present text is a second edition of a book originally published in 1950. It contains 36 pages more

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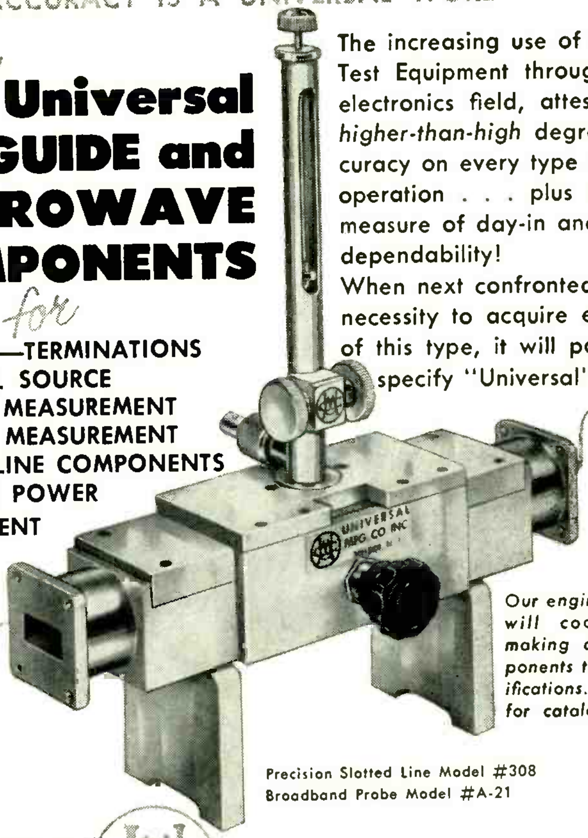

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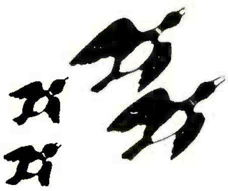

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than the original edition, due mainly to the addition of a chapter on uhf and color television. The treatment given to uhf includes much sound material on fundamentals which will continue to be useful. On the other hand, the few paragraphs on color television which have been added to this edition are of little value today. They merely constitute an acknowledgment by the author that important activity was taking place in this field at the time he revised the text.

Some new material also has been added on television transmitters and kinescopes of more recent design. It is regrettable that the opportunity was not taken to update the book in other important areas. To be sure, fundamentals, if well presented, do not go out of date and there is a great deal of sound material in this category which is of enduring value. Nevertheless, this art is progressing at a swift pace, and it is a little disconcerting to find references in this most recent edition to image orthicon tubes of the type 2P23, and other types which have long since been discontinued.

This reviewer would quarrel with the confusing presentation of certain subjects, such as the following statement on page 433 concerning transmission of the d-c component:

> "The result is that it has been found necessary to amplify the video and d-c brightness components of the signal separately. After being separately amplified, the d-c component is introduced directly into the radio-frequency modulated amplifier grid bias without having passed through any of the coupling capacitors of the video amplifier system. It is seen therefore, that the carrier is not only amplitude-modulated by the video and sync components of signal, but the transmitted picture carrier level is made to vary slowly as changes in average picture brightness take place. It follows that a d-c amplifier is required to provide the average d-c brightness component before picture carrier modulation takes place."

It seems that a textbook of this type is hardly the place to crusade against the widespread use of incandescent light sources in television studio lighting. The space devoted to this might better have been given to a complete listing of the FCC Technical Standards, for example, or to a brief treatment of factors affecting propagation of vhf and uhf waves and the FCC criteria for allocation of tv stations. Many operating engineers are likely to take issue with the recommendation in the section under maintenance procedures which calls for checking every tube used in video amplifiers at least once a week.

A thorough and useful exposition of the cathode-ray oscilloscope is given, but there is relatively little information on other test equipment. Most experienced television broadcasters will note the lack of any treatment on the subject of set-up in the video signal.

Despite the shortcomings noted here, and a few others, the book is a good one on the whole, particularly the sections which treat of basic fundamentals of engineering which do not go out of date.—ROBERT E. SHELBY, *National Broadcasting Co.*

Fields and Waves in Modern Radio

BY SIMON RAMO AND JOHN R. WHINNERY, *2nd Edition, John Wiley and Sons*, 1953, 576 *pages*, $8.75.

THIS BOOK is a somewhat revised version of a text which first appeared ten years ago. Although a number of other texts on the same general subject have appeared in the interim, the book under review remains one of the better treatments of electromagnetic theory as applied to high-frequency problems. The book is intermediate in difficulty between the introductory text by Skilling and the more advanced texts by Stratton and by Schelkunoff.

The book starts off with some introductory material on wave fundamentals and then goes into the subject of static-field problems. This is followed by a chapter on Maxwell's equations and one on circuit concepts. This material, which makes up the first 40-percent of the book, constitutes an excellent introduction to electromagnetic theory. Such vector analysis as the student needs is worked into the text as the need for it arises in connection with problems of physical interest.

The latter part of the book is concerned with the development of field theory as it pertains to the numerous problems which are of everyday concern to the microwave engineer. The topics which are treated include skin effect, propagation, guided waves, waveguides and transmission lines, cavities, microwave networks and radiation. Although not all of the topics are treated exhaustively, they are treated in sufficient detail to give the reader a thorough grounding in basic principles and some idea of how the theory may be applied in actual engineering problems.

Some new material of interest has been added to the chapters on waveguides and on radiation. One of the more important additions to the book has been a chapter on microwave networks. The network representation of microwave circuits has found increasing use, and the chapter referred to gives a good introduction to this topic. However, there is no mention of the important work in this field which has recently been done by Deschamps.

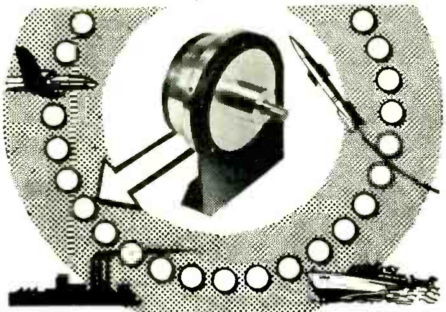
One very worth-while change in the second edition has been the use of MKS units throughout the entire book. This is in line with the present universal use of this system in the engineering field. A number of new problems have also been added to the book.

All in all, the second edition represents a distinct improvement over the first edition and, like its predecessor, it should find wide application not only for classroom use but also as a handy reference source for the practicing engineer.—HENRY JASIK, *Consulting Engineer, Mineola, New York*

Applied Electronics

BY TRUMAN S. GRAY, *Associate Professor of Engineering Electronics, MIT. John Wiley & Sons, Inc., New York, N. Y., Second Edition*, 1954, 881 *pages*, $9.00.

THIS is a major revision of an important text first published in 1943. Since that time "electronics has come of age" as the author states. And since that time a tremendous expansion has taken place in the concepts on which the whole science of electrical engineering is founded. For new students, these concepts are of vastly greater importance than the machines erected upon them. At MIT, at least, an overhaul of the whole department will result in primary emphasis on these principles and the facts that all the



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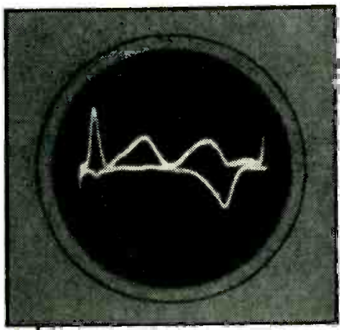

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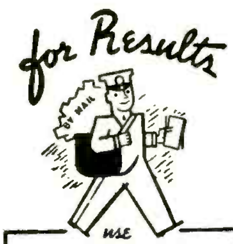

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machines—generators, transformers, tubes, waveguides— obey fundamentally the same laws. We need only remember how new are such matters as feedback, the new information theory, data collection and transmission, or servomechanisms to realize how rapidly this art changes and grows.

The new Applied Electronics is part and parcel of the "new look" at electrical engineering taking place at MIT. The changes in it from the earlier edition are vast and basic. It is now in the hands of Professor Gray who accepts the job of organizing, synthesizing and correlating the material so that it is a unified whole.

While there are 13 chapters, several appendices and a bibliography there are really four parts to the book, first a discussion of the physical phenomena involved in electronic tubes; then an explanation of the way in which the phenomena combine to produce the characteristics and possibilities of the devices; then the applications of tubes to the several branches of electrical engineering, and finally, a considerable amount of material on those new prodigies, the transistor and other semiconductor devices.

A further description of the contents would only reveal what one knows intuitively—this is a complete course in electronics and a very good one. While it is aimed for use by students, there is no doubt that it will be very valuable to anyone who is long out of school.—K. H.

Dislocations In Crystals

BY W. T. READ, JR. *McGraw-Hill Book Company, Inc., New York*, 1953, 228 *pages*, $5.00.

BEFORE 1946, the field of dislocations in crystals was remote to the interests of the electrical engineer. However, with the discovery of the point-contact transistor, germanium and other semiconducting solids have attained a key position in the future of the electronics industry. Recent research on germanium has shown the tremendous importance of dislocations as the sites for impurities, as scattering centers for the electrons and holes, and as lifetime killers.

To the novice seeking to get a toehold into dislocation theory, Dr. Read offers a book which presents primarily the better established aspects of dislocation theory. There are exercises and examples at the end of each chapter as aids to those using the book for individual study. The book would also serve well as a text for college seniors or graduate students in science or engineering.

Dr. Read's book is concerned primarily with the production, geometry, and motion of dislocations, their interactions with each other, and their relation to crystal growth and to grain boundaries. The interaction of dislocations with impurities and lattice defects are discussed only briefly and the reader is referred to Cottrell[1]* for details on this important phase of dislocation theory.

Dr. Read is a member of the Technical Staff of the Bell Telephone Laboratories and is an expert on semiconductor physics as well as dislocation theory. His book is strongly recommended as a competent presentation of the role of dislocations in crystals.—SUMNER MAYBURG, *Sylvania Electric Products Inc., Bayside, New York.*

(1) A. H. Cottrell, Dislocations and Plastic Flow in Crystals, Oxford, 1953.

THUMBNAIL REVIEWS

How To Use Meters. By John F. Rider. John F. Rider Publisher, Inc., New York, N. Y., 1954, 140 pages, paper-covered, $2.40. Description of meters, their several characteristics and uses. Applications are given for measurements in tv and radio servicing, transmitter installation and repair, laboratory practice and industrial applications.

The Mechanism of Economic Systems. By Arnold Tustin. Harvard University Press, Cambridge, Mass., 1954, 161 pages, $5.00. Application of control-systems technique to manipulation of economic quantities such as income and investment. Of interest to economists because it suggests new tools, it likewise discusses business problems in terms with which the engineer is familiar.

Dial Cord Stringing Guide, DC-3 and 4. Howard W. Sams & Co., Inc., Indianapolis 5, Ind., 96 pages each, 5½ x 8½, 1954, $1.00. Continuation of the dial stringing series.

BACKTALK

Teacher vs Engineer

DEAR SIRS:

I HAVE JUST read the letter in the March issue from Lawrence Fleming concerning engineers in industry and in teaching.

Having taught in two large state universities, a larger A & M college, and worked in the research laboratories of two leading concerns, I cannot agree with the tentative belief set forth by Mr. Fleming to the effect that the standards of educational institutions must be higher because of the emigration of engineers from schools to industry.

The faculty standards of schools today are related in direct proportion to annual salaries. No fewer than 35 former university and college teachers of Electrical Engineering, Physics, and Mathematics are within my range of vision while writing this reply. Their present annual salaries are from 2 to 4 times their former teaching annual incomes.

The trend should be obvious.

A. W. McMURTREY, JR.
Senior Aerophysics Engineer
Consolidated Vultee Aircraft Corp.
Fort Worth, Texas

(Editor's Note: As Mr. Fleming suggested, more information and discussion do indeed seem desirable. The editors would welcome more correspondence on this subject, especially from engineers who have gone into teaching.)

Current-Step Waveform Generator

PRINT-SHOP gremlins were at work last month when an extraneous drawing was substituted for Fig. 7 of Dr. Babits' article, "Current-Step Waveform Generator" (ELECTRONICS, p 167, March 1954). The correct drawing and its caption appear here. For the convenience of readers a portion of the text is reprinted below:

The details of driver and output are shown in Fig. 7.

The basic voltage-step waveform is fed to the grids of a parallel-6L6 cathode follower that has its

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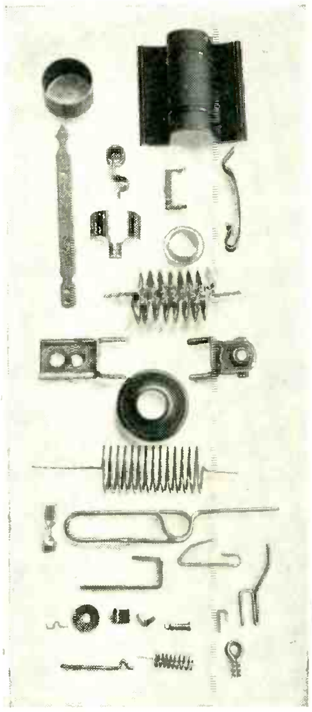

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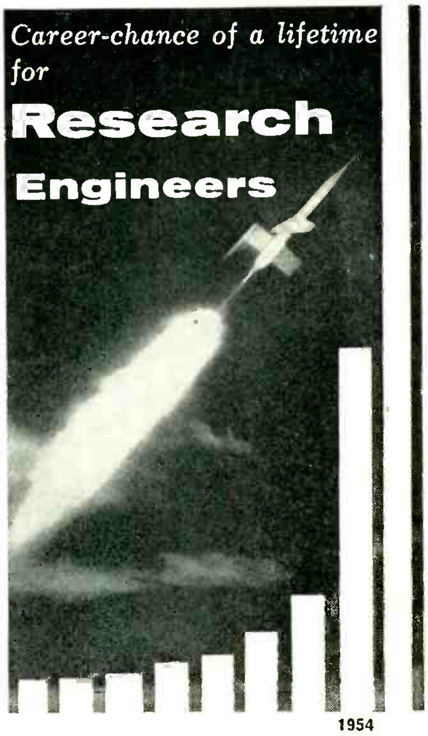

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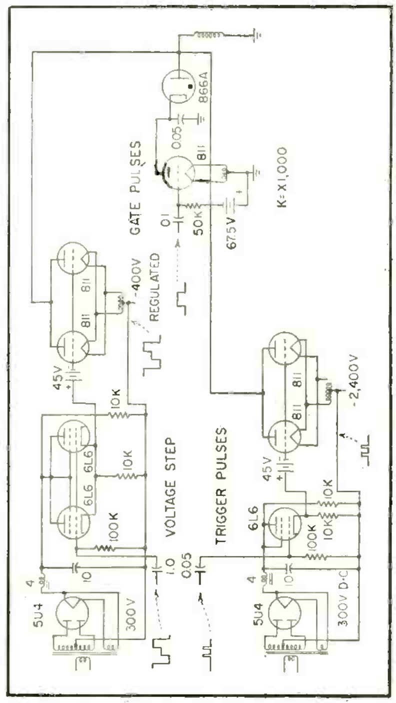

FIG. 7—Driver and output circuits provide high-voltage pulses and couple combined waveform to coil

own isolated 300-volt power supply, the negative terminal of which is 400 volts below ground potential. The final stage, which provides the steady-state current in the current-step waveform, consists of two 811's in parallel, their cathodes being 400 volts below ground potential.

The swing of the grid voltage of this output stage is from 45-volts negative to 60-volts positive. The plates of the 811's are connected through the output coil to ground.

Transistor Mechanics

DEAR SIRS:

THE ACCOUNT of Philco's surface-barrier transistor on page 10 of the January issue of ELECTRONICS described accurately the fabrication techniques and the improvement which has been obtained in high-frequency performance compared with that of commercially available junction transistors.

We would, however, like to point out that the following statement quoted from your article is incorrect: "The indium deposits formed become emitter and collector of a junction transistor by virtue of an effect which causes the germanium near the surface of the deposited indium to take on an impurity character opposite to that of the germanium base."

We have found evidence that there is no diffusion of the metal into the germanium. Thus, the metal tin forms an excellent surface barrier rectifier when deposited electrolytically at room temperature upon n-type germanium in strong contrast to its operation when allowed to diffuse into the germanium at high temperature.

Again, the mechanism of rectification is different from that of a junction.

In the p-n junction, both the hole and electron currents are limited by diffusion, whereas in the surface barrier transistor only the minority carrier current is diffusion limited. The majority carrier current is limited by the potential barrier at the interface between metal and semiconductor.

W. E. BRADLEY
Director of Research—Technical
Philco Corporation
Philadelphia, Pa.

Staircase Generator

DEAR SIRS:

IN MY ARTICLE, "Staircase Generator Counts Pulses", published in your March 1954 issue, there are several errors.

The values of minimum deviation from linearity in Table I on page 188 are in percent and should read from top to bottom: $\pm 0.7\ V_{max}/E_B$; $\pm 0.2\ V_{max}/E_B$; $\pm 0.1\ V_{max}/E_B$.

In Table II, page 189, the SM5LS relay has a 10,000-ohm coil. The second, fourth, and sixth columns refer to both halves of the tube connected in parallel.

The equation at the top of the second column on page 188 should read:

$$\%\ \text{Deviation} =$$

$$\pm 100 \times \tfrac{1}{8}\left(\frac{E_{co}}{E_B} + \frac{C_2}{C_3}\right)\frac{V_{max}}{E_B} \text{ if } R_K \gg \frac{1}{g_m}$$

The comment in the next-to-last paragraph of the text regarding the heater-to-cathode voltage of V_1 applies also to V_2.

NATHAN SOKAL
Lincoln Laboratory, MIT
Cambridge, Mass.

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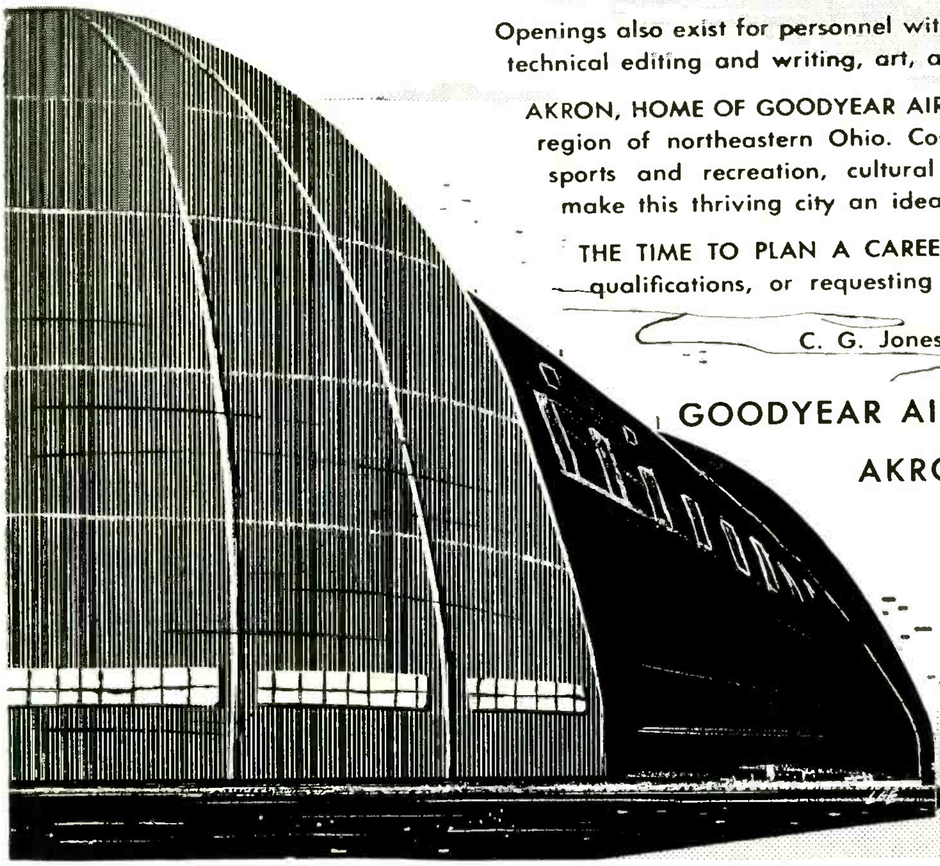

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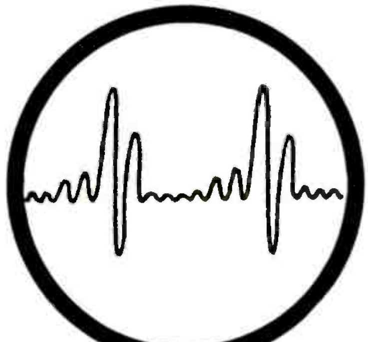

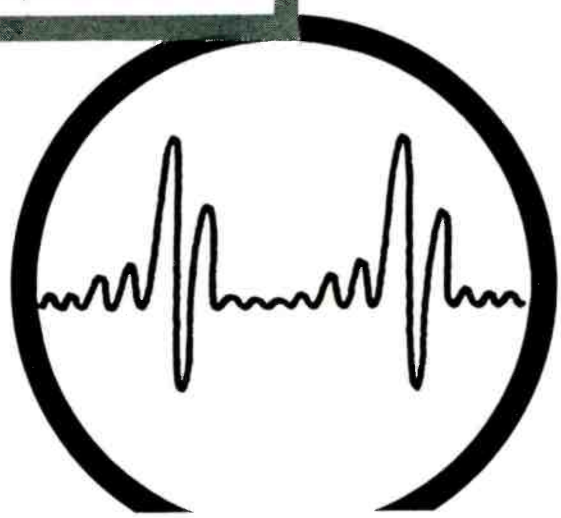

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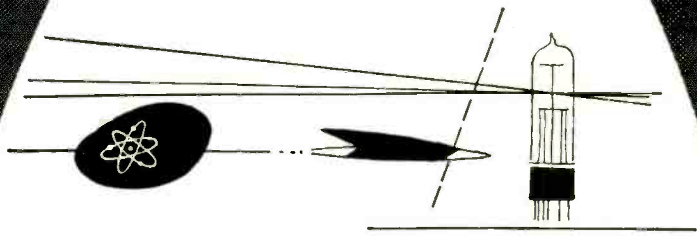

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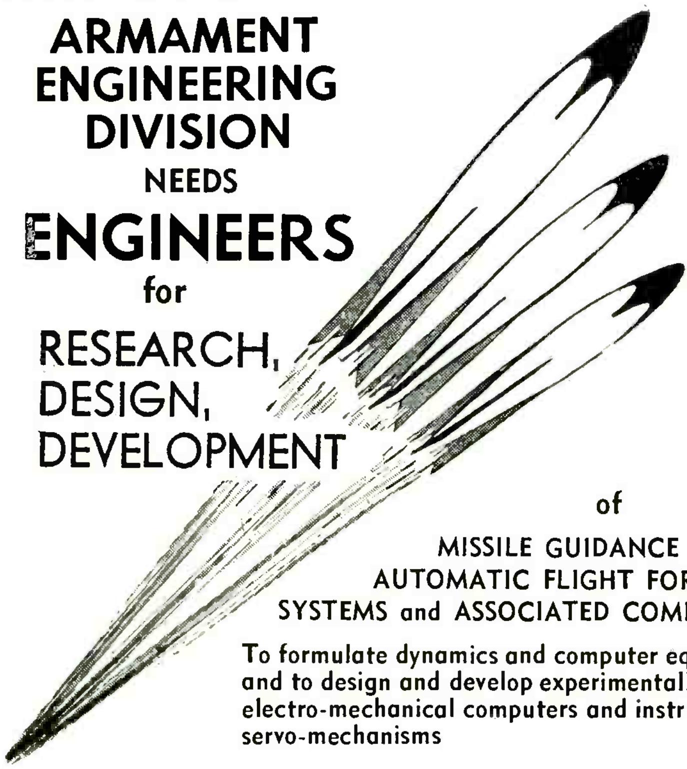

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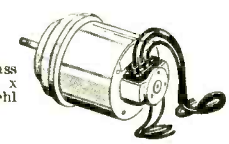

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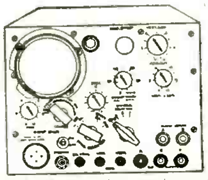

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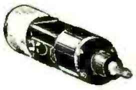

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General Electric Type 5AB10AJ37: 27 volts, DC; 5 amps. 8 oz. inches torque; 250 RPM, shunt wound; 4 leads; reversible $12.50
General Electric. Mod. 5BA10FJ33: 12 oz. inches torque. 12 DC 56 RPM. 1.02 amp .... **$15.00 ea.**
General Electric Type 5BA10AJ52C: 27 volts DC; 5 amps. 8 oz. inches torque; 145 RPM; shunt wound; 4 leads; reversible $12.50
GENERAL ELECTRIC DC MOTOR Mod. 5BA10AJ-64. 160 r.p.m.; 65 amp; 12-oz.-in. torque 27V DC. $12.50
2¼ H.P. MOTOR—Mfg. LEECE-NEVILLE Co; Type 1454-MO; 24VDC; 4000 RPM; 100 amp $35.00

115 VOLT GENERATORS

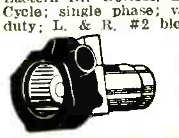
Brand new Eclipse generators; 115 VAC; 9.4 amp; 1000 watts; single phase; 800 cycles, 2400-4200 rpm. DC output is 30 volts at 25 amp. Unit has spline drive shaft and is self-excited. $29.95

MICROPOSITIONER

Barber Colman AYLZ 2133-1 Polarized D.C. Relay: Double Coil Differential sensitive. Alnico P.M. Polarized field. 24V contact: .5 amps; 28 V. Used for remote positioning, synchronizing, control, etc. **$12.50 ea.**

BLOWER

Eastern Air Devices, Type J31B: 115 volt: 400-1200 Cycle; single phase; variable frequency; continuous duty; L. & R. #2 blower; approx. 22 cu. ft./min. **$15.00**



BLOWER: Mfg. John Oster; Type C2A-1B; 27 VDC; 63 amps; 1/100 H.P.; 7000 RPM; Series Wound .... **$9.95 ea.**

BLOWER ASSEMBLY

115 Volt, 400 Cycle, Westinghouse Type FL. 17CFM, complete with capacitor. New .... **$12.50 ea.**

TEST EQUIPMENT TS-45/APM

For measuring relative output power and transmitted freq. of radars and adjusting receivers. Components of the set are a thermistor-type power meter, coaxial line-type freq. meter, a 723A oscillator, attenuator, and a choke coupling. Set is designed for continuous wave operation, with jack provided for external pulsing.
Electrical Characteristics: Freq. Range . . . Airborne X Band. **Accuracy**: Freq. Meter plus or minus 5 mc; Power Meter plus or minus 1.5 db. (relative only).
Signal input: rf power; minus 10 to plus 37 dbm.
Signal Output: C. W. av. power 10 mw (plus 10 dbm).
Attenuator: Calibrated, adjustable 0-30 db loss. Power: 110-130 volts, 60-2400 cycles, 55 watts.
TUBES: 1-723, 1-6V6, 2-6ZY5G, 1-6SL7GT, 1-VR-150-30. Batteries: None. Mechanical Characteristics: 10" x 9½" x 8". Weight: 18 lbs. **PRICE** . . $250.00
TEST SETS . . . TS-13-AP; 3 cm. Signal Generator, X-Band $650.00
TS-35 A/AP; X-Band Signal Generator, pulsed, calibrated power meter, frequency meter, calibrated attenuator, 110 V., 60-800 cps $395.00

Immediate Delivery

ALL EQUIPMENT FULLY GUARANTEED

All prices net FOB Pasadena, Calif.

C & H SALES CO

2176 East Colorado Street • Pasadena 8, California • RYan 1-7393

HERSHEL RADIO CO.

LOWEST PRICES ON ALL ELECTRONIC NEEDS

BUTTERFLY CONDENSERS

TYPE A
106 to 330 MC Can Use 955 Type Tube

CHOICE **$4.95**

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

MODULATION and DRIVER TRANSFORMERS

Both Units Only
Modulation trans. 815 class AB2-56 Watt Driver, 6SN7 to Modulator. **$4.95**

SQUIRREL CAGE BLOWERS

R.E.L. V.D.C. 12 or 24-40 Watt Max.
$4.95

TYPE FL
115V—400 Cycle 6700 R.P.M. Westinghouse Electric.
$3.95

BK 22K RELAY

Only **$3.95**

Used with SCR-269F-Change Over. Contains 28 Volt Step Relay, 5 Deck, 6 Position Switch, 12V D.P.S.T.

IGNITION COILS

PRI. 3 Volts, SEC. 15,000 Volt. **$1.29**

ANT. SPECIALS

AS-217 APG 15	$19.95
AS-27 ARN-5	9.95
AN-APS-3	39.50
CU 43/APT	9.50
AT-5/ARR-1	95¢

DRAKE F-15U FILTER

75 MC Cut-Off Freq. . . . $3.50

GEAR REDUCTION MOTOR

1/8 H. P.
$5.75
24 VDC 8500 RPM 7 Amps Reel 12-B Aircraft Ant. Wind

$3.95
1/35 H.P. 28 VDC 1.8 Amp 2200 RPM

DIRECTIONAL GYRO

For A-5 Automatic Pilot

Only **$24.50**

M-1 Directional Gyro. Made by Sperry Mfg. Brand New!

CABLE SPECIALS

CD-501 . . . . 4.50
CD-510 . . . . 2.75
CG 151A/PPNIA RG 58U FOR BEACON TRANS AND REC 25' LONG 1.49
CD-4013 . . . . 4.75
COAXIAL RF CABLE FOR SCR 270-B 27' LONG 2.95
CD-604 WITH C-410 TRANSFORMER . . . . 69¢

VACUUM SWITCH

Magnetic Type
$1.95
15000 V Contacts 30 Amp Operates with DC Coil Spdt

DONUT ANTENNA
$9.95
CTZ 66-AFJ 144 MC TO 156 MC

GUN CAMERA MOTOR $2.75

7500 RPM Will Run Series or Shunt 28 V.D.C. Size 2½"x1½"x2"

Permeability TUNER $4.95

From BC-728 Contains: RF-1st Det. and OSC. Coils 2 MC to 5 MC If. Freq 456 KC

DIRECTION FINDER

RECEIVER ADF-8	$95.00
JUNCTION BOX J-41 WITH CABLES	$ 4.50
LOOP ANT ADF-8	$24.50
ANT HI-FREQ. ADF-8	$ 4.50

OIL CONDENSERS

MFD	VDC	Price
.01	8000	4.95
.01	3000	1.15
1	3600	2.45
1	5000	4.95
2000	50	2.95
2000	15	1.29
*525	450	12.00

* Photo Flash Condenser

CONTRACTOR UNIT

$9.50
BC 608A TIMER RADIUM DIAL

WILLARD BATTERY
$2.65
2 Volt Wet 20 AH

VARIABLE CONDENSERS

TYPE A From BC 604 6 Gang 350 MMFD: 60 MMFD; 60 MMFD; 80 MMFD; 60 MMFD; 60 MMFD; $1.95

TYPE B
200 MMFD—Shielded Can ¼" Shaft
95¢

RHEOSTATS

49¢
Ultra Violet Inst Control 25 Watts 30 Ohms To 145 Ohms

95¢
Aircraft Power Unit AN 3155 30 Ohms 50 Watts

RCA OUTPUT TRANSFORMER

P.P. 6L6's 25 Watt
PRI 5000 Ohms Output. Sec. #1 500 Ohms Sec. #2 600 Ohms sidetone 15 to 15,000 cy. Flat Hi Fi special.

ONLY $1.95

BC 604 FM TRANS.

W / Tubes Less Dyn.	$69.00
Radar Trans. T-30 / APQ9	$49.00

HI FREQ. ANTENNA

$4.50
From ADF-8 Mfg. General Electric

TRANSMITTING & RECEIVING TUBES

814	$2.69	931A	$3.95
VT127A	$3.95	3C24	.89
15E	$1.50	872A	$2.69
304TL	$6.50	8020	$1.19

Volt. Regulator

TYPE 4 coil current .105 to .115 Amp. Reg. Voltage 60 Volts MFD Leland **95¢**

BE-74 CHEST UNIT

Uses Two 1½V. Batts. $1.95

HERSHEL RADIO CO.

5245 GRAND RIVER
Detroit 8, Michigan
Phone TYler 8-9400

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Merchandise Subject to Prior Sale

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COMMUNICATIONS EQUIPMENT CO.

MICROWAVE COMPONENTS

"S Band," 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. Fed 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" connectors ...$22.50 EACH

DIRECTIONAL COUPLER. Broadband type "N" Coupling, 20 db. with std flanges, Navy #CABV47A-AN-2 ...$37.50

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 APX 2400-2700 MCS. Silver Plated ...$32.50

BEACON LIGHTHOUSE cavity p/o UPN-2 Beacon 10 cm. Mfg. Bernard Rice, each ...$32.50

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 ...$4.00

WAVEGUIDE TO 7/8" Rigid Coax "Doorknob" Adapter Choke Flange Silver Plated Broad Band ...$32.50

AS14A AP-10 CM Pick up Dipole with "N" Cables ...$4.50

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—with video detector, A.F.C. 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

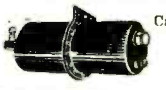
"E" PLANE BENDS, 90 deg. less flanges ...$7.50

X Band— RG 52/U Waveguide

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

3CM Motor-Driven Echo Box



Cavity Q is 30,000. Tuning range 80 mc Motor operates from 24 VDC Type, "N" INPUT ...$32.50

HORN FEED, Mounted at end of 1' run. Designed to be used with dish reflector ...$15.00

VSWR Measuring Section. Consisting of 6" straight section, with 2 pick-up, Type "N" Output Jacks. Mounted ½ Wave apart ...$8.50

1" ½" waveguide in 5' lengths, fitted with UG 39 flange & UG40 choke ...per length $7.50

Rotating-joints supplied either with or without deck mounting. With UG40 flanges ...each, $17.50

Bulkhead Feed-thru Assembly ...$15.00

Pressure Gauge Section 15 lb. gauge and press nipple ...$10.00

Pressure Gauge, 0-15 lbs. ...$2.50

Directional Coupler, UG-40/U Take off 20db ...$17.50

Rotary Joint choke to choke with deck mounting ...$17.50

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 DV 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.

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. 75c

Slug Tuner Attenuator W.E. guide, gold plated ..$6.50

Bi-Directional Coupler. Type "N" Takeoff 25 db. coupling ...$27.95

Bi-Directional Coupler, UG-52. Takeoff 25 db. coupling ...$24.95

Waveguide-to-Type "N" Adapter. Broadband ...$22.50

I. F. AMPLIFIER STRIPS

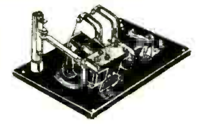
MODEL SO: 30 McGain figure is 120 db. Bandwidth: 2MC. Uses 6 stages of 6AC7 Plus one video detector. Less Tubes ...$24.50

Model 15: 30 Mc center frequency. Bandwidth 2.5 Mc. gain figure: 65 db. Uses 5 stages of 6AC7's. Has D. C. Restorer and Video Detector. A.F.C. Strip included. Input impedance: 50 Ohms. Less tubes. ...$27.50

Model APS-4: Miniature IF strip, using 6AK5's 60 Mc center Freq. Gain: 95 db at Bandwidth of 2.7 Mc. Less tubes ...$45.00

15 KV CONTACTOR

Rugged contactor assembly: Coil: 115V 60 cps, 1 phase Contacts: **SPST NO.** 15,000 V., 1.0 amp. plus- **2-SPST NO** contacts in parallel rated 100 amp per contact. Contactor has 2 auxiliary contact assy's. For operating accessory pilot equipment. Equipped with flash barriers. Size 19" x 14" x Overall **$37.50**



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

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

—IN STOCK—

AIA	APS-4	APT-4	SJ-1
APA-9	APS-6	MKIV	TAJ
APA-10	ASD	MKX	TBK
APN-3	ASH	RC145	TBL
APN-7	BG	RC148	SCR520*
APN-9*	DAS†	SO-1	SCR521
APS-2	DBS†	SO-8	SCR518
APS-3	APT-2	SG-1	

*COMPONENTS. †LORAN EQUIPMENT

—TEST SETS—

TS-10	TS-12	TS-159
TS-36	TS-56	TS-268
TS-47	TS-34	TS-270

MAGNETRONS

Type	Freq. Range (MC)	Peak Power Out (KW)	Duty Ratio	Price
2J21A	3345–9405	50		$8.75
2J22	3267–3333	265		7.50
2J27	2965–2992	275	.002	19.95
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
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	Write
730-A	9345–9405	50	.001	24.50
4J38	3550–3600	750	.001	169.45

*—Packaged with magnet.
†—Tunable over indicated range

KLYSTRONS

723A	$12.50	2K25/723A/B	$27.50
237A/B	19.50	417-A (Sperry)	17.50

70 WATT MAGNETRONS

These tubes provide a simple, rugged, inexpensive source of C.W. energy. An inexpensive power supply is all that's required.

CHARACTERISTICS:

Heater: 6.3 V, 3.8 A.	Power out: 70 W. Cw
Anode V. 1250 V.	Anode current: 125 ma.
Pk. Input: 200 Watts	Av. input: 100 W

Each tube is packaged with an integral magnet, and is tunable over the range shown below.

TYPE	RANGE (MC.)	TYPE	RANGE (MC.)
QK 60	2840-3005	QK 61	2975-3170
QK 62	3135-3330		

Price $85 ea.

MICROWAVE ANTENNAS

AT49/APR—Broadband Conical. 300-3300 MC. Type N Feed ...$8.95

AS-31/APN-7: 10 cm Polyrod in Lucite Ball. Type N Fitting Coax Feed ...$22.50

Relay System Parabolic reflectors approx. range 2000 to 6000 Mc. Dimensions 4½" x 3'. New ...$100.00

Dipole for above ...$12.00

Cone Antenna. AS 125 APR. 1000-3200 mc. Stub supported with type "N" connector ...$14.50

AS14A/AP, 10 CM pick up dipole assy, complete w/length of coax and "N" connectors ...$4.50

AS46A/APG-4 Yagi Antenna, 5 element array ...$22.50

30" Parabolic Reflector Spun Aluminum dish ...$4.85

APS-34 Pillbox Antenna, waveguide input: 24,000-27,000 MC ...$22.50

SCR 584, Dishes Perforated, Metal Construction $185.00

PULSE NETWORKS

15A—1-400-50: 15 KV. "A" CKT. 1 microsec. 400 PPS. 50 ohms imp. ...$37.50

G.E. #3E (3-84-810) (8-2.24-405) 50P4T; 3KV "E" CKT Dual Unit; Unit 1, 3 sections, 0.84 Microsec. 810 PPS, 50 ohms imp.; Unit 2, 8 Sections, 2.24 microsec. 405 PPS 50 ohms imp. ...$6.50

7-5E3-1-200-67P. 7.5 KV "E" Circuit, 1 microsec. 200 PPS. 67 ohms impedance 3 sections ...$7.50

7-5E4-16-60, 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

#755: 10KV. 2.2usec., 375 PPS. 50 ohms imp. ...$27.50

#754: 10KV. 0.85 usec., 750 PPS. 50 ohms imp. ...$27.50

KS8865 CHARGING CHOKE: 115-150 H @ .02A, 32—10H @ .08A. 30.700V Corona Test. 21KV Test ...$37.50

G.E. 25E5-1-350-50 P2T. "E" SKT. 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 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

TPS-3 PULSE MODULATOR. Pk. power 50 amp. 21 KW (1200 KW pk): pulse rate 200 PPS. 1.5 microsec. pulse line impdance 50 ohms. Circuit series charging version of DC Resonance type. Uses two 705-A's as rectifiers. 115 v. 400 cycle input. New with all tubes ...$49.50

PULSE TRANSFORMERS

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: 18 KV. Part of APQ-13 ...$12.50

GE #K-2449A TRANS.

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 Bifilar: 1.5 amps (as shown) ..$62.50

GE #K-2748-A. 0.5 usec @ 2000 Pps. Pk. Pwr. out is 32 KW impedance 40:100 ohm output. Pri. volts 2.3 KV Pk. Sec. volts 11.5 KV Pk. Bifilar rated at 1.3 Amp. Fitted with magnetron well ...$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. Bifilar: 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. Bifilar: 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 ...$7.50

UTAH X-150T-1: Two sections, 3 Wdgs. per section. 1:1:1 Ratio, 3 MH, 6 ohms DCR per Wdg. ...$7.50

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 ...$5 ea.

W.E.: D-166310, D-166638, KS9800, KS9948.

UTAH #9262, with Cracked Beads, but will operate at full rated capacity ...$5.00

UX 8693 (SCS #2Z9627-54); 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

JAN WAVEGUIDE FLANGES

UG 39/U	$1.10	UG 54/U	$1.85
UG 40/U	$1.25	UG 52/U	$3.40
UG 40A/U	$1.65	UG 52A/U	$3.40

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-5 Chas. Rosen Phone: Digby 9-4124

POWER TRANSFORMERS

COMB. TRANSFORMERS 115V/50-60 CPS INPUT

CT-479 7000V/.018A/14 KV Test 2.5 V/5A, 17,800 V. Test........e........$37.50
CT-138 520-0-520V/500 MA, 6.3V/3A, 6.3V/17A, 2 X 5V/3A........14.75
CT-013 450-0-450V @ 200 MA, 10V/1.5A, 2.5V 3.5A 5V/3A........6.95
CT-341 1050V/10MA,—625V @ 5MA, 26V @ 4.5A 2x2.5V/3A, 6.3V @ 3A........9.95
CT-071 110V .200A 33/.200, 5V/10, 2.5/10........4.95
CT-403 350VCT .026 A 5V/3A........2.75
CT-931 585VCT .086 A 5V/3A, 6.3V/6A........4.25
CT-442 525VCT 75 MA 5V/2A, 1CT/2A, 50V/200 MA........3.85
CT-43A 600-0-600V/.08A,2.5VCT/6A,6.3VCT/1A........6.49

FILAMENT TRANSFORMERS 115V/50-60 CPS INPUT

Item	Rating	Each
FT-140	5VCT @ 10A 25KV Test	$22.50
FT-157	4V/16A, 2.5V/2.75A	2.95
FT-924	5.25A/21A, 2x7.75V/6.5A	14.95
FT-824	2x26V/2.5A, 16V/1A, 7.2V/7A, 6.4V/10A 6.4V/2A.	8.95
FT-463	6.3VCT/1A, 5VCT/3A, 5VCT/3A	5.49
FT-55-2	7.2V/21.5A, 6.5V/6.85A, 5V/6A, 5V/3A	8.95
FT-38A	6.3/2.5A,2x2.5V/7A	2.79
FT 650	2.5V/10A-3KV TEST LO-CAP	7.50

PLATE TRANSFORMERS, 115V 60 CY INPUT

PT 175 550-0-550VAC (400VDC) @ 150MA........$6.30
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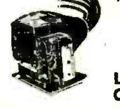
PT 158 1080-0-1080V (1000VDC) at 125MA Plus 500-0-500VAC (400VDC) at 150MADC Simult. Ratings........10.80
PT 159 900-0-900 VAC (750VDC) or 800-0-800 VAC (600VDC) at 225 MADC........10.35
PT 167 400-0-1400 VAC (300MADC) or 1175-0-1175 VAC (1000VDC) at 300MADC........25.50
PT 168 2100-0-2100 VAC (1750VDC) or 1800-0-1800 VAC (1500VDC) at 300 MADC........33.00
PT 133 3140/1570V, 2.36 KVA........$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 579 3100-0-3100V/2KVA, 15KV.INS. C. T. Grounded (case)........$135.00



GE #M-7470689 Input: 115 V, 60 Cycle, Single Phase
1 WDG 3700V Tapped at 710V
1 WDG 1700V Primary
Rated .0377KVA
Lo-Cap Donut Construction **$24.75**

FILTER CHOKES

Stock	Description	Price
CH-187	Swing, 4-16H, 150MA, 210 ohms, 3KV Test	$3.90
CH-189	Swing, 4-16H, 250MA, 125 ohms, 3KV Test	6.60
CH-190	Swing. 3-14H, 300MA, 80 ohms, 3KV Test	6.90
CH-CEC117:	9-60H/.05-400MA, 10KV Test	14.95
CH-366	20H/.3A	6.95
CH-322	.35H/350MA—10 Ohms DCR	2.75
CH-141	Dual 7H/75 MA. 11H/60 MA 5KV DC Test	4.69
CH-119	8.5H/125 MA	2.79
CH-69-1	Dual 120H/17 MA	2.35
CH-8-35	2/.5H/380 MA/25 Ohms	1.79
CH-776	1.28H/130 MA/75 ohms	2.25
CH-344	1.5H/145MA/1200V Test	2.35
CH-43A	10HY/15MA—850 ohms DCR	1.75
CH-366	20H/300MA	6.95
CH-999	15HY/15MA—400 ohms DCR	1.95
CH-445	0.5 HY/200 MA, 32.2 OHMS, 3000 V.T.	1.39
CH-170	2x0.5H/380 MA, 25 OHMS	2.79
CH-533	13.5H, 1.0 AMP DC, 13.5 KV INS	29.95

DYNAMOTORS

TYPE	INPUT VOLTS	INPUT AMPS	OUTPUT VOLTS	OUTPUT AMPS	Price
DM 416	14	6.2	330	.170	$6.75
DM33A	28	7	540	.250	3.95
BD AR 93	28	3.25	375	.150	7.50
23350	27	1.75	285	.075	3.95
B-19 Pack	12	9.4	275	.110	8.95
			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	12.95
D-402†	13.5	12.2	300	.200	
			8.8VAC		12.50
SP 175	18	3.2	450	.06	4.49
DM 25†	12	2.3	250	.0	6.95

‡ Less Filter * Replacement for PE 94.
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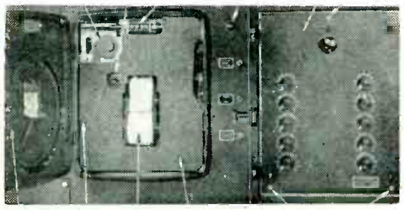

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115 Volt 60 cycle BLOWER (pictured) — approx. 100 CFM Dis. 2¼" intake; 2" outlet. Quiet running. Motor size: 2½"x3¼". NEW — Not Gov't. surplus.
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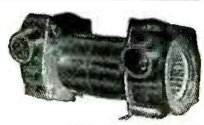

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2) 6500 ohms	1B-1C	3.5 MA	2.75 ea.
3) 6500 ohms	2A	4 MA	3.00 ea.
4) 6500 ohms	2A-1B	4 MA	3.00 ea.
5) 6500 ohms	5A	5 MA	3.25 ea.
6) 6500 ohms	5A-2D	5 MA	3.50 ea.

CLARE TYPE "G" HALF SIZE SENSITIVE TELEPHONE RELAYS

Coil	Contacts	Will Close at	Price
1) 6500 ohms	2A	5 MA	$2.50 ea.
2) 5800 ohms	3A	4 MA	2.50 ea.
3) 5800 ohms	2B-1C	5 MA	2.50 ea.
4) 4850 ohms	1C	4 MA	2.50 ea.
4) 3600 ohms	1C	6 MA	2.00 ea.
5) 4850 ohms	1A	5 MA	2.00 ea.
6) 3300 ohms	(None)	ACTUATOR	1.50 ea.

All above Relays may be used for continuous duty operation on 110V. D.C.

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1) 1300 ohms	1A-1C	24 or 48V	$2.50 ea.
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3) 500 ohms	1D	24V	1.65 ea.
4) 200 ohms	1A	24V	1.50 ea.

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D=Make Before Break

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1) 24V.	260 ohms	DPDT	$1.25 ea.
2) 24V.	100 ohms	DPST NO	1.00 ea.

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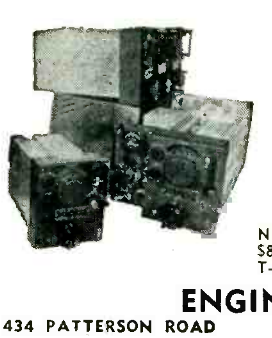

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OZ4	.55
1B3GT	.90
1B22	1.20
1B23	4.96
1B24	6.75
1B26	1.50
1B27	9.95
1B32/532-A	1 25
1B35	7.50
1B42	7.00
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1L6	1.35
1N21-B	1.88
1N23-B	1.90
1N34-A	.55
1N38-A	1.25
1N44/400B	1.10
1N45/400C	1.20
1N48	.45
1N54	.75
1N54-A	.83
1N69	.75
1N70	.80
1P23	2.50
1P28	7.75
1P40	1.50
1R5	.75
1S5	.75
1T4	.70
1U4	.75
1U5	.70
1V	.80
1X2-B	.90
1Z2	2.75
2B22	2.00
2C39-(JAN)	12.50
2C39-A(JAN)	17.50
2C40(RCA)	9.55
2C43	write
2C44	.98
2C51/396-A	3.75
2C52	3.75
2D21	1.00
2E22	1.70
2E24	2.75
2E25	3.70
2E26	3.40
2E30	2.20
2J21/2J21A	3.99
2J22	3.50
2J26	6.99
2J27	9.00
2J31	18.75
2J32	19.75
2J33	20.00
2J34	17.75
2J37	12.00
2J39	8.69
2J50	18.35
2J51	250.00
2J54	62.95
2J54-B	95.00
2J55	65.50
2J61	22.00
2J62	18.50
2K22	17.50
2K23	15.50
2K25	24.50
2K28	25.00
2K29	23.00
2K30/410R	185.00
2K33-A	125.00
2K34	123.00
2K41	139.50
2K45	92.50
2X2	.38
2X2-A	write
3A5	.90
3B24	4.50
3B25	3.40
3B26	2.75
3B28	3.79
3BP1	3.50
3BP11	7.00
3C23(GE)	6.75
3C24/24G	1.00
3C27	3.25
3C31/C1B	2.25
3C45	11.75
3CP1	2.50
3D21A	6.95
3D22	8.95
3D24	8.95
3DP1/3DP1-S2	2.25
3DP1-A	5.25
3EP1	3.50
3FP7	1.25
3GP1	2.30
3HP14	6.60
3J30	85.00
3J31	write
3S4	.65
4A1	1.15
4B22	7.50
4B24	4.50
4B25/EL6CF	7.95
4B28/CE-225	3.95
4B32	9.50
4C27	10.00
4C35	17.50
4-65-A	20.00
4-125-A	30.25
4-250-A	41.25
4E27/257B	13.75
4J32	220.00
4J36	125.00
4J37	195.00
4J63	195.00
5AW4	1.50
5BP4	3.00
5CP1	3.75
5D21	11.00
5FP7	1.00
5J29	10.00
5J30	23.50
5J33	11.00
5JP1	10.00
5JP2	11.50
5JP7	20.00
5R4GY	1.45
5TP4	30.00
5U4-G	.59
5V4-G	.97
5X4-G	.63
5Y3-GT	.48
C6J	7.25
C6L	5.00
6AB4	.70
6AC7	1.14
6AF4	1.39
6AG5	.78
6AH4GT	.89
6AH6	.93
6AK5	.80
6A65	.60
6AN4	1.60
6AN5	3.65
6AQ5	.72
6AS5	.75
6AS6	2.65
6AS7G	3.75
6AT6	.58
6AU4GT	1.00
6AU5GT	1.15
6AU6	.65
6AV5GT	1.10
6AV6	.57
6AX4GT	.84
6AX5GT	1.25
6BA6	.70
6BC5	.74
6BE6	.72
6BG6-G	1.89
6BH6	.85
6BK5	.95
6BK7-A	1.15
6BL7GT	1.20
6BN6	1.20
6BQ6-GT	1.27
6BQ7-A	1.23
6BX7GT	1.25
6BY5-G	1.75
6B27	1.28
6C4	.56
6C21(JAN)	22.00
6CB6	.75
6CD6G	1.80
6CL6	1.10
6CS6/5915	1.10
6F4	3.20
6H6	.52
6J4	4.95
6J5	.55
6J6	.80
6K6GT	.65
6S4	.63
6SA7GT	.69
6SK7GT	.69
6SN7GT	.79
6SQ7GT	.63
6T8	.99
6U8	1.05
6V3	1.30
6V6GT	.67
6W4GT	.65
6W6GT	.82
7C25	95.00
7C30	85.00
9JP1	12.50
12AT6	.55
12AT7	1.05
12AU7	.84
12AV6	.55
12AV7	1.00
12AX7	.80
12AY7	1.75
12AZ7	.92
12B4	.98
12BA6	.70
12BD6	.75
12BE6	.72
12BH7	1.00
12BY7	1.05
12BZ7	1.10
12SA7GT	.69
12SK7GT	.69
12SN7GT	.85
12SQ7GT	.63
FG/DR-17	4.00
19BG6G	2.05
KY21A	13.25
RX21A	9.00
25BQ6GT	1.35
25L6GT	.70
25W4GT	.70
25Z5	.75
25Z6GT	.64
FG27A	7.00
28D7	1.35
35A5	.72
35B5	.70
35C5	.72
35L6GT	.70
35W4	.45
35Z5GT	.50
FG-41	127.50
50A5	.75
50B5	.70
50C5	.72
50L6GT	.70
QK60	60.50
QK61	60.50
QK72	250.00
81	.95
82	.85
83	1.11
83-V	.98
100-E(Collins)	2.50
100-TH(JAN)	5.95
FG-104	25.00
FG-105	17.75
F-128A	70.00
VXR-130	1.50
117Z3	.75
117Z6GT	1.00
CV-172	25.00
HF-200	13.50
211	.88
RX215	7.00
GL-218	22.50
CE225	3.95
227/227A	3.00
231-D	2.00
QK-249	120.00
253-C	12.50
250-TH(JAN)	19.95
271-A	6.00
FG-271/5551	55.00
275-A(WE)	5.50
HF-300	17.50
304-TH(JAN)	7.75
304-TL(JAN)	7.75
305-A	4.50
306-A	4.95
310-A	3.75
311-A	5.25
316-A	.85
328-A	4.00
350-A	4.00
355-A	12.00
359-A	3.50
369-B	20.50
371-B	.95
373-A(WE)	2.00
374-A(WE)	2.00
F-375-A	12.50
387-A(WE)	2.72
388-A(WE)	1.49
393-A	5.95
394-A	2.00
403-A(WE)	1.50
403-B	3.45
404-A/5847	write
407-A(WE)	3.50
408-A(WE)	2.50
416-A(WE)	write
417-A/5842	write
417-A KLYSTRON	11.20
418-A(WE)	18.00
421-A(WE)	5.00
422-A(WE)	5.00
423-A(WE)	5.80
GL-434-A	12.00
GL-446A	.99
450-TH	77.00
GL-451	3.00
464-A	7.00
GL-471-A	2.20
WL-481-A	4.30
CK-501LX	1.25
WL-502A	1.65
WL-531	4.75
WL-532	3.50
GL-559	1.00
GL-562	75.00
WL-575-A	20.50
WL-579-B	14.70
WL-KU627	19.80
WL-629	11.70
WL-632-B	26.00
WL-635	11.00
WL-651	65.00
ZP-653	19.50
WL-672-A	34.30
WL-KU676	52.25
WL-677	52.25
WL-678	47.00
700A, B, C, D	8.50
701-A	6.60
703-A	4.00
704-A	.85
706-B	17.50
706-EY	27.50
707-A	5.00
707-B	8.50
708-A	2.50
709-A	2.00
CK-710	.95
7H12	2.00
713-A	.90
715A	3.00
715B	4.00
715C	16.00
717-A	.85
719-A	1.95
721-A	1.95
722-A	1.50
723A/B	15.75
724-B	1.75
725A	7.50
726-A	7.50
726-C	55.00
728AY, BY, CY, DY, EY, & FY	$13.00
801-A	.35
WL-802	3.30
805	2.95
807	1.55
807W/5933	4.95
809	3.50
WL-810	15.95
811	2.90
811A	3.25
812	2.95
812A	3.65
WL-813	17.75
813	9.95
814	3.30
816	1.40
826	.39
829	6.65
829B	9.95
830B	2.75
WL-833A	49.00
834	8.00
837	.95
838	2.50
WL-845	13.50
851	34.00
860	2.00
861	13.50
865	.95
866A	1.25
869B	55.00
872A	2.65
874	.85
884	1.10
885	1.50
WL-891	237.00
892R	225.00
918	2.00
921	1.85
922	1.60
927	1.75
931A	4.95
954	.24
955	.45
956	.40
957	.40
958A	.65
959	1.50
991	.47
1000T(JAN)	95.00
CK1005	.65
CK1027	2.75
1201	.55
1203A	.30
1612	2.00
1613	.75
1616	.85
1619	.29
1620	4.50
1622/6L6M	1.95
1624	1.50
1625	.30
1626	.20
1629	.24
1960	.60
1961	1.25
2050	1.20
5516	7.65
WL-5550	44.10
WL-5552	110.00
WL-5553	236.20
5636	5.75
5639	7.95
5642	1.00
5643/SN949	8.00
5645	7.50
5646	7.75
5651	2.30
5654	1.65
5670	3.25
5676	1.15
5693	4.25
5694	2.25
5719/SN980D	5.50
5725	4.10
5726	1.50
5732	3.95
CK5744	1.25
5749	1.90
5750	2.00
5751	2.85
5780(WE)	350.00
5784	5.00
5795(WE)	350.00
5803	4.75
5812	1.50
5814	1.75
5819	45.00
5829	2.75
5840	6.00
5844	1.50
5879	1.40
5948	395.00
6021	7.75
6080	3.50
6082	5.10
6090	2.00
6095	1.50
6096	1.85
6097	1.75
6098	1.90
6099	1.90
6101	1.90
6136	1.80
6146	4.65
6201	5.00
8011	.75
8012	2.20
8013	2.13
8014A	write
8020	2.50
9002	.95
9003	1.45
9004	.30
9006	.25

ANDMANYOTHERS, including a complete line of receiving tubes:

Remember! We Ship No Seconds or Rehashed "Bargains." You Can Place Your Confidence in Our Dependable *NEW* Tubes. We Ship the Best—First Quality RCA, GE, SYLVANIA, WESTINGHOUSE, HYTRON and RAYTHEON TUBES Insure Repeat Orders From You—Our Customers.

AUTHORIZED FACTORY DISTRIBUTORS FOR EIMAC, WESTINGHOUSE (WL), CBS-HYTRON (CBS), CETRON and LEWIS & KAUFMAN TUBES

SELENIUM RECTIFIERS

FULL-WAVE BRIDGE TYPE

Current (Continuous)	18/14 Vol	36/28 Volts	54/42 Volts	130/100 Volts
1 Amp	$1.35	$2.15	$3.70	$8.50
2 Amps	2.20	3.60		10.50
2½ Amps	3.10	4.20	6.00	13.00
4 Amps	4.25	7.95	12.95	25.25
6 Amps	4.75	9.00	13.50	33.00
10 Amps	6.75	12.75	20.00	44.95
12 Amps	8.50	16.25	20.50	49.00
20 Amps	13.25	25.50	38.00	87.50
24 Amps	16.25	32.50	45.00	95.00
30 Amps	20.00	38.05	......	......
36 Amps	25.00	48.50	......	......

NEW RECTIFIER CHOKES

4 Amps......07 Hy.....6 ohm $7.95
12 Amps.......01 Hy......1 ohm 14.95
24 Amps......004 Hy......025 ohm 29.95

NEW RECTIFIER TRANSFORMERS

PRI: 115 V., 60 cycles in.
SEC: 9, 12, 18, 24, and 36 Volts
Continuous Ratings

4 Amps $8.75
12 Amps 16.75
24 Amps 35.75
30 Amps 45.00
50 Amps 59.75

Rectifier & Transformer Combination

115 Volt 60 cyc Input

up to 14VDC at 12 amps $19.98
up to 28VDC at 4 amps 14.98
up to 28VDC at 12 amps 29.98
up to 28VDC at 24 amps 63.98
up to 28VDC at 50 amps 127.00

Rectifier & Transformer & Variac

up to 14VDC at 12 amps 30.98
up to 28VDC at 12 amps 45.50
up to 28VDC at 50 amps 167.00

TUBE CARTONS

Two-Colored Cartons With New Safety Partitions . . . Super-Gloss Red and Black Carton is the Most Distinctive Box Available Today.

SIZE		EACH
Miniature	(6AU6, 6ALS, etc.)	$.01
GT	(6SN7, 6W4, etc.)	.0125
LARGE GT	(1B3, 6BQ6GT, etc.)	.015
LARGE G	(5U4G, 6BG6G, etc.)	.02

"QUANTITY USERS—BUY THESE CARTONS BY THE CASE. WRITE FOR QUANTITY DISCOUNTS.—"

FILTER CAPACITORS

Capacity	W. Voltage	Ea.
500 MFD.	50 V.	.85
1000 MFD.	15 V.	.35
2000 MFD.	50 V.	2.25
6000 MFD.	15 V.	1.50

"Turn Your Excess Tube Inventory into Cash!—or Perhaps a "Swap" Can Be Arranged to Your Benefit—For Quick Action and a Fair Deal, Write, Wire, or Call."

We Build other Selenium Rectifiers, Transformers and Chokes to your specifications.

Buy from the Direct Source for Quick Delivery.

ALL MERCHANDISE FULLY GUARANTEED.

PHONE: REctor 2-2562

Terms: F O B N Y C—25% Deposit with order—or send full remittance to save C O D charges—Well-Rated Firms (D. & B.) Net 10 days—CABLE BARRYLECT. N. Y.

BARRY ELECTRONICS CORP.
136-C LIBERTY ST. N. Y. 6, N. Y.

Want more information? Use post card on last page.

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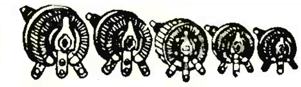
POWER RHEOSTATS



"Be Right with" MODELS H-J-G-K-L-N-P-R
FAMOUS MAKE

Ohm	Watt	Mod	Each	Ohm	Watt	Mod	Each	Ohm	Watt	Mod	Each
.1	150	L	5.34	40	225	P	6.99	500	300	N	8.42
.5	150	L	5.34	50	50	J	2.10	585	150	L	5.05
1	50	J	2.34	75	25	H	1.86	750	25	H	1.86
2	25	H	1.86	75	75	G	3.15	780	100	K	3.55
2	100	K	3.79	80	50	J	2.10	1000	25	H	2.10
2	300	N	8.42	80	500	R	12.18	1000	50	J	2.22
3	100	K	3.79	100	25	H	1.86	1200	225	P	6.99
3	225	P	6.99	100	100	K	3.55	1250	50	J	2.22
5	50	J	2.10	100	150	L	5.05	1250	150	L	5.34
5	100	K	3.79	125	25	H	1.86	1500	25	H	2.10
6	25	H	1.86	150	50	J	2.10	1500	50	J	2.22
6	50	J	2.10	175	25	H	1.86	1600	50	J	2.22
6	75	G	3.15	175	500	R	12.18	1800	50	J	2 22
7.5	75	G	3.15	200	25	H	1.86	1800	150	L	5.62
7.5	225	P	6.99	200	100	K	3.55	2000	25	H	2.10
8	50	J	2.10	200	150	L	5.05	2250	150	L	5.62
8	500	R	12.18	250	25	H	1.86	2500	50	J	2.22
10	25	H	1.86	300	50	J	2.10	2500	100	K	3.71
12	25	H	1.86	300	75	G	3.15	2500	150	L	5.62
12.5	500	R	12.18	300	100	K	3.55	3000	100	K	3.79
13	100	K	3.55	350	25	H	1.86	5000	25	H	2.22
15	25	H	1.86	350	150	L	5.05	5000	50	J	2.34
15	75	G	3.15	378	150	L	5.05	5000	100	K	4.04
20	25	H	1.86	400	75	G	3.15	7500	50	J	2.34
20	50	J	2.10	500	25	H	1.85	7500	100	K	4.30
25	25	H	1.86	500	75	G	3.15	10K	50	J	2.50
25	300	N	8.42	500	100	K	3.55	10K	100	K	4.54
25	500	R	12.18	500	150	L	5.05	20K	150	L	6.98

SPECIAL DISCOUNT TO QUANTITY USERS

PRODUCTION QUANTITIES AVAILABLE

OTHER STANDARD BRANDS

Ohm	Watt	Ea.	Ohm	Watt	Ea.
1	50	1.64	185	25	1.30
1.1	50	1.64	200	25	1.30
5	25	1.30	200	50	1.47
7	25	1.30	250	50	1.47
8	50	1.47	300	50	1.47
10	50	1.47	350	25	1.30
10	100	2.97	370	25	1.30
12	50	1.47	400	25	1.30
15	25	1.30	500	25	1.30
15	100	2.97	500	50	1.47
16	50	1.47	500	150	4.20
30	50	1.47	750	150	4.20
37.5	50	1.47	800	25	1.30
50	25	1.30	1000	25	1.47
50	50	1.47	1200	300	6.30
60	25	1.30	1500	25	1.47
75	25	1.30	2000	50	1.55
75	50	1.47	2500	25	1.47
75	300	6.30	3000	25	1.47
100	25	1.30	10K	50	1.75
100	50	1.47	15K	25	1.93
125	25	1.30	20K	4	.75

AVAILABLE IN ALL SHAFT SIZES—Knob Type or 1/8" Screwdriver. Specify type shaft required.

HIGH POWER TRANSMITTING MICAS

G-1 TYPE

.0001	6 KV	12.18	.0008	6 KV	14.00
.00015	6 KV	12.18	.001	6 KV	14.00
.00015	6 KV	12.18	.0015	6 KV	14.67
.0002	6 KV	12.18	.02	3 KV	15.44
00024	6 KV	12.76	.032	2 KV	15.44
.00025	6 KV	12.76	.04	1 KV	17.55
.0004	6 KV	13.31	.051	1.5 KV	18.21
.0005	6 KV	14.00	.08	1.5 KV	19.72
.00075	6 KV	14.00	.09	1.5 KV	20.25

G-2 TYPE

.0001	10 KV	19.67	.0005	10 KV	19.67
.00015	10 KV	19.67	.00065	10 KV	19.67
.0002	10 KV	19.67	.0008	10 KV	19.67
.00027	12 KV	19.67	.001	10 KV	19.67
.0003	10 KV	19.67	.01	5 KV	20.75
.000375	10 KV	19 67	.03	2 KV	21.00
.0004	5 KV	19.67	.045	2 KV	21.00

G-3 TYPE

.00005	20 KV	33.27	.0011	20 KV	43.50
.0001	20 KV	36.30	.0012	20 KV	44.62
.0001	25 KV	37.80	.00124	15 KV	44.75
.00015	20 KV	37.80	.0015	20 KV	45.38
.00025	20 KV	39.33	.0016	15 KV	42.96
.0003	20 KV	39.33	.002	12 KV	42.35
.0004	20 KV	41.15	.0025	12 KV	45.00
.00045	15 KV	41.15	.004	12 KV	45.38
.00047	20 KV	41.15	.005	5.5 KV	28.50
.0005	20 KV	41.15	.006	10 KV	45.38
.0008	20 KV	41.15	.015	3 KV	45.38
.00095	5 KV	42.35	.015	7 KV	45.33
.001	15 KV	42.35	.05	3 KV	45.81
.001	20 KV	42.35	.25	1.6 KV	45.81

G-4 TYPE

.00025	30 KV	66.35	.0025	25 KV	68.73
.0003	25 KV	66.35	.005	20 KV	75.68
.00032	25 KV	66.35	.006	15 KV	75.68
.00032	30 KV	66.35	.0066	15 KV	75.68
.0005	30 KV	66.35	.0075	12.5 KV	78.00
.0006	35 KV	67.50	.01	15 KV	81.73
.00062	30 KV	66.35	.01083	12 KV	81.73
.00065	35 KV	67.50	.01163	5 KV	30.60
.0008	30 KV	66.35	.03	8 KV	81.73
.001	25 KV	68.73	.056	6 KV	83.17
.0015	25 KV	68.73	.05668	2 KV	30.75

G-5 TYPE

.000155	30 KV	139.20	.000533	30 KV	151.25
.0004	30 KV	139.20	.001	30 KV	163.20

Many other sizes and types in stock — All Perfect.

OIL CONDENSERS

NEW LOW PRICES

MFD	VOLTS	EACH	MFD	VOLTS	EACH
.3	600	.98	2	600	.75
.5	600	1.19	3	240AC	1.95
1	250AC	.70	3	600	2.09
1	330AC	.79	4	220AC	1.85
1	500	.65	4	400	1.75
1	600	.68	4	600	1.95
1.25	220AC	.75	4	700	2.25
1.25	330AC	.80	5	50	1.25
1.5	400AC	.87	5	600	2.35
2	200	.49	6	400	2.49
2	220AC	.69	6	600	2.85
2	250AC	.79	8	600	3.38
2	330AC	.89	10	600	3.75
2	400	.65	15	600	2.79
2	500	.69	30	90AC	4.75

SPECIAL SALE

15 MFD 600 VOLTS D.C.

Famous Make Oil Filled Condenser
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.0025	1500	1.59	.5	7500	8.95
.004	10 KV	2.25	75	1 KV	1.25
.0075	7 KV	2.95	1	1 KV	1.59
.0075	10 KV	3.75	1	1500	1.85
.02	7500	5.30	1	2 KV	2.35
.05	2500	1.65	1	2500	3.49
.1	2 KV	1.65	1	3 KV	4.95
.1	3 KV	3.49	1	6 KV	12.95
.1	3500	3 90	2	1 KV	1.98
.1	6 KV	7.95	2	1500	2.49
.1	7500	11.25	2	2 KV	2.75
.1	20 KV	39.50	2	2500	5.49
.25	1500	1.40	2	4 KV	10.95
.25	2 KV	1.80	4	800AC	3.75
.25	3 KV	3.49	4	1 KV	2.50
.25	3500	3.95	4	1500	3.49
.25	4 KV	6.50	6	440AC	3.75
.25	5 KV	7.49	8	440AC	3 90
.3	2 KV	1.85	8	1 KV	3.95
.5	1500	1.59	10	1 KV	4.25
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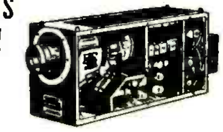

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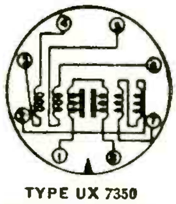
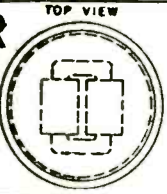
PULSE TRANSFORMER

Tube base plug in type



TOP VIEW



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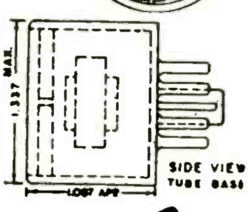

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2E22	1.50	3GP1	2.00	RK-21	1.25	310A	3.00	708A	2.00	861	10.00
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2J22	4.75	4B27	5.00	HK-54	3.50	313C	3.00	715A	2.50	869B	50.00
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2J62	17.00	5JP4	9.00	250R	4.50	446A	1.00	808	1.50	1904	12.00
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2K55	50.00	5R4GY	1.00	257A	3.00	WL-468	15.00	826	1.00	8012	1.50
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1B47	12.00	811A	3.25
1P21	49.50	813	12.50
1P40	1.55	814	3.75
1P42	5.00	866A	1.50
2D21	1.17	872A	3.50
2D21W	2.50	884	1.50
2J21	5.50	955	.45
2J31	20.00	1000T (JAN)	98.50
2J32	22.00	1619	.35
2J51	250.00	2050	1.40
2J54B	95.00	5560	28.00
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2X2A	1.50	5654	1.65
3B24W	11.75	5670	3.25
3BP1	3.70	5687	2.75
3C23	6.75	5692	8.25
3C24	.95	5720	23.00
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3GP1	2.70	5837	110.00
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807	1.49
808	1.99
809	3.49
810	9.69
811	2.85
813	9.91
814	3.49
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849	19.69
851	34.99
860	2.49
861	14.99
864	.19
865	.89
866A	1.22
869B	54.50
872A	2.49
874	.96
878	1.29
884	1.29
9-3	.19
902	5.75
902P1	7.49
918	2.18
927	2.18
931A	4.24
954	.22
955	.34
956	.34
957	.35
958	.59
1500-T/750TH	86.50
CK-1005	.59
1608	.99
1611	1.70
1613	1.70
1616	.69
1619	.29
1624	1.24
1625	.29
1626	.19
1629	.21
1630	.69
1632	.42
1639	.89
1642	.89
1806/P1	3.66
2050	1.21
2051	.89
1A3	.69
1A7	.64
1B3/GT	.89
1G6/GT	.59
1LC5	.59
1LD5	.79
1LN5	.69
1L4	.49
1L6	1.09
1H5	.59
1N5	.69
1R5	.65
1S4	.62
1S5	.62
1T4	.48
1X2A	.89
1V2	.79
2A3	.89
2X2/879	.24
2X2A	1.61
3A4	.64
3B7/1291	.35
3D6/1299	.34
3S4	.62
3Q4	.62
3Q5	.79
3V4	.66
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6BH6	.89
6BN6	1.19
6BJ6	.69
6CS6	1.04
6C4	.49
6C6	.54
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6P6	3.19
6F5	.49
6D4	2.70
6J4	4.91
6J5	.45
6J6	.72
6J7-M	.69
6J7G	.59
6K4A	4.69
6K6	.59
6K7	.44
6L5	.54
6L6M	1.39
6L6G	.92
6L7G	.41
6L7M	.86
6SC7	.72
6SF5	.69
6SF7	.79
6SS7	.78
6N7GT	.46
6N7	.76
6S4	.66
6SA7	.48
6SG7	.59
6SH7	.58
6SK7	.58
6SL7	.58
6SN7	.81
6SR7	.59
65Q7	.51
6U4	.89
6Y6	.92
6W4	.61
6X4	.49
6X5	.52
6T8	.86
7A5	.89
7A6	.69
7A7	.69
7B6	.69
7B7	.69
7C4	.28
7C5	.86
7C6	.69
7F7	.79
7F8	.81
7H7	.59
7N7	.79
7G7	.69
7Q7	.69
7Y4	.49
7Z4	.49
12A6	.53
12AU7	.79
12AT7	.88
12AV7	.89
12AX7	.71
12AY7	1.44
12BA7	.79
12BH7	.86
12SC7	.71
12SQ7	.54
12SR7	.56
12SF5	.44
12SG7	.69
12SH7	.62
12SJ7	.46
12SK7	.51
12SN7	.74
12SL7	.66
14A7	.63
14B6	.64
14B8	.66
14N7	.76
14R7	.69
14W7	.69
25L6	.69
25Z6	.56
28D7	1.49
35L6	.76
35Z5	.51
35Y4	.49
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50B5	.69
50C5	.79
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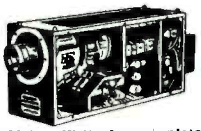

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6B6G	.55
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6H6	.49
6K7	.45
6SC7	75
6SH7GT	.59
6SH7	.59
7C4/1203A	39
7E5/1201	.69
7E6	.45
10Y	79
12A6	.69
12C8	.59
12J5GT	.40
12SF7	.40
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14H7	.49
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15R	.55
CE22	.69
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805	2.50
807	1.35
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813	8.95
814	2.25
815	3.00
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954	.29
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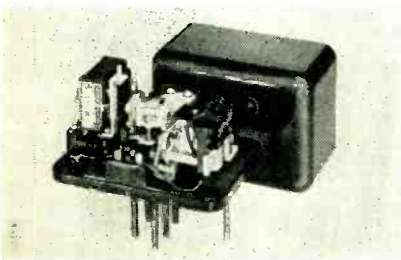

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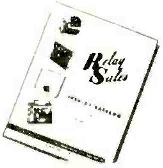

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28 VOLTS


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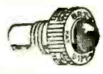

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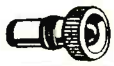

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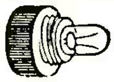

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BC-604	BC-1000	SCR-510	TRC-1
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OA2	$1.00
OA3	1.10
OB2	.99
OB3	1.10
OC3	.96
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C1B	2.95
1B21	1.50
1B22	1.50
1B23	6.95
1B24	12.00
1B26	1.75
1B27	12.50
1B32	2.95
1B38	35.00
1B50	23.00
1B51	7.50
1B56	35.00
1B60	35.00
1N21	1.25
1N21A	1.75
1N21B	2.75
1N21C	19.50
1N22	1.00
1N23	1.95
1N23A	2.75
1N23B	2.75
1N23C	7.50
1N25	4.50
1N26	6.75
1N27	3.50
1N34A	.79
1N43	2.25
2B4	1.25
2B22	1.75
2C34	.15
2C40	9.00
2C42	12.00
2C43	14.50
2C44	.60
2C46	7.50
2E22	2.25
2J21A	12.00
2J22	9.00
2J26	15.00
2J27	15.00

TYPE	PRICE	TYPE	PRICE	TYPE	PRICE	TYPE	PRICE	TYPE	PRICE	TYPE	PRICE
2J31	24.00	3C24	1.50	5BP1	3.95	203A	7.50	464A	7.50	802	3.95
2J32	29.00	3C31	2.95	5BP2A	12.00	211	.95	471A	1.25	803	5.95
2J33	32.00	3DP1	7.50	5BP4	3.95	217C	12.00	527	18.00	805	4.95
2J34	36.00	3DP1A	10.00	5CP1	7.50	242C	10.00	WL530	23.00	807	1.50
2J36	90.00	3DP1A-52	10.00	5CP7	6.95	244A	9.50	WL531	22.50	808	1.95
2J38	8.95	3EP1	5.00	5CP7A	14.00	249C	4.25	WL532	1.75	809	2.95
2J39	8.95	3E29	15.50	5D21	18.00	250TH	19.95	WL533	15.00	810	10.50
2J40	29.00	3FP7	5.00	5FP7	1.95	250TL	12.00	HK654	35.00	811A	3.75
2J42	135.00	3HP7	5.00	5JP1	27.50	274B	2.75	700A/D	10.00	812A	3.95
2J49	60.00	4A21	2.75	5JP2	19.50	304TH	10.00	701A	4.50	813	13.75
2J50	55.00	3GP1	5.00	5JP4	27.50	304TL	10.00	703A	3.95	814	3.75

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TYPE	PRICE	TYPE	PRICE	TYPE	PRICE	TYPE	PRICE	TYPE	PRICE	TYPE	PRICE
2J55	150.00	4B26	5.40	C5A	11.00	307A	3.50	704A	1.95	815	6.25
2J56	110.00	4C27	22.50	C5J	7.50	310A	4.50	705A	21.75	816	1.45
2J61	35.00	4C28	35.00	7BP7	5.00	310B	4.95	706AY/FY	5.00	829	11.00
2J62	35.00	4E27	16.00	7DP4	9.00	311A	6.50	707A	9.75	829A	12.00
2K22	15.00	4J25	150.00	12AP4	50.00	312A	3.50	707B	15.00	829B	15.00
2K23	15.00	4J26	150.00	12DP7	24.00	323A	15.00	714AY	18.00	830B	2.00
2K25	27.50	4J27	150.00	LM15	225.00	327A	3.75	715A	4.50	832A	9.95
2K26	68.00	4J28	150.00	15E	1.75	328A	6.75	715B	9.00	833A	45.00
2K28	35.00	4K29	150.00	15R	.75	350A	10.00	715C	22.50	834	7.50
2K29	35.00	5J30	150.00	NE16	.59	350B	5.95	717A	1.50	836	3.95
2K33A	95.00	4J31	150.00	2C-4	.75	352A	3.00	718AY/EY	30.00	837	2.75
2K39	140.00	4J32	150.00	KY21A	8.25	HK354C	15.00	719A	22.50	838	5.95
2K41	135.00	4J33	150.00	RX21	8.00	357A	15.00	720AY/GY	150.00	849	35.00
2K45	80.00	4J34	100.00	HK24G	1.50	368AS	4.95	721A	3.50	860	3.50
2K50	275.00	4J35	150.00	25T	2.95	371B	1.50	722A	3.50	861	25.00
2K54	125.00	4J36	150.00	45 Special	.35	385A	4.50	723A/B	18.00	866A	1.50
2K55	125.00	4J37	150.00	RK39	2.75	388A	1.80	724A	1.95	869B	67.50
2K56	72.00	4J38	150.00	HF50	1.75	393A	7.50	724B	2.25	869BX	50.00
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3B24	4.50	4J41	150.00	RK72	1.00	417A	15.00	726B	45.00	879	.50
3B25	5.50	4J42	190.00	RK73	1.00	434A	15.00	726C	45.00	880	250.00
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3B28	8.00	4J52	225.00	100TH	7.95	446B	3.95	730A	22.50	885	1.50
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TYPE	PRICE
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955	.50
956	.75
957	.25
958A	.60
959	2.25
E114A	.25
1280	.95
1500T	135.00
HK1554	75.00
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1612	1.50
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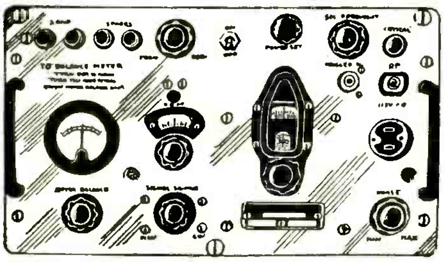

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- TS1C0 Scope
- TS102A/AP Range Calibrator
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- TS270 S Band Echo Box
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- TS175/AP Signal Generator
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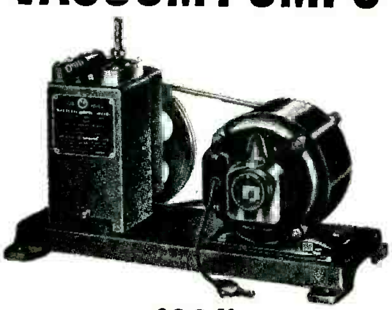

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2C43	14.50	CE309	4.75	5654	1.75
2C46	7.50	W.E. 310A	4.25	5691	6.75
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2C52	3.50	446A	1.00	9001	.85
2D21	.95	WL460	12.00	9002	.80
2J54	47.50	702A	1.50	Scope Tubes	
2J62	32.50	703A	2.95	2AP1	6.95
2K22	19.50	706B	18.50	3AP1	4.95
2K23	11.25	715C	15.00	3AP1A	8.95
2K28	25.00	717A	.65	3BP1	3.50
2K33A	99.50	801A	.35	3DP1	2.75
2K54	99.00	807	1.45	3GP1	2.75
2K55	99.00	811A	2.95	3JP1	9.75
C3J	3.75	813	9.25	5BP1A	9.00
C6J	8.75	814	2.50	5HP1	4.25
6C21	18.00	815	4.50	5HP4	4.25
10Y	.45	832A	7.50	7BP7	4.25
28D7	1.45	845	6.75	9GP7	4.25
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MAY, 1954

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Varistor W.E. 40A........$1.50 @, 3 for $4
Varistor W.E. 41A........$1.50 @, 3 for $4
Varistor W.E. D87966.....$2.49 @, 3 for $7
Varistor W.E. D163906.....95 @, 3 for $2.00
Varistor W.E. D178220.....$1.79 @, 3 for $4.50
Write For Details

MICROWAVE FLANGES and WAVE GUIDE

UG39 to UG40 "X" Band Adapter Flange to Choke. Sperry Dsgn. ....85 @, 6 for $4
UG40A/U Choke Broad Band $1.25 @, 6 for $6.00
UG51/U Choke.......95 @, 6 for $5.00
UG52A/U Choketo Plain Flange $1.80 @, 6 for $10.00
UG52A/U Round 2¼" OD...$1.50 @, 6 for $8.00

FLEXIBLE WAVE GUIDE

CG166/U (42") (E165003) Terminates UG52/U Stock #WGF-3.........$15 @, 3 for $39
CG166/U (12") (E137858) Terminates UG52/U Stock #WGF-1.......$4.00 @, 3 for $10.00
CG166/U (24") Terminates UG52/U Stock #WGF-2.........$9 @, 3 for $23
Technicraft (2½") Rigid to Flex X-Band, E-Plane Wave Guide. UG40 to Rigid W.G. Ending in UG40. Round Threaded Keyed Choke Pt #D154124 W.E. & Z1305 Philco. Stock #WGF/R-1.........$3.00; 3 for $8.00
Technicraft (3") W.G. (X-Band) to UG39 Plain Flanges. Stock #WGF-4......$2.50; 3 for $6.00
X-Band Rigid Wave Guide per ft.........$1.50

TRANSFORMER SPECIAL!!

6.3 Volt 3¾ Amp.
CONTINUOUS DTY
115VAC Input
SIZE 2 5/16"H/2L/1½" W
HVY DTY CHANNEL MTG
8 INCH WIRE LEADS RM.
MFGRS, JOBBERS, DLRS
ORDER THIS $1.98 VALUE
Special $1.00; 12 for $10; 50 for $36

FILAMENT TRANS.

115 Volt 60CY Input
2.5V/2A @ 79c, 2 for $1.49; 10 for.......6.49
2.5VCT/10A 5KVINS.......3.59
2.5VCT/10A 12.5 KVINS.......$5.50; 3 for $14.
5VCT/13A 5 KVINS UTC S-59.......3.95
7.5VCT/12A CSD 15 KVINS...10.95; 2 for 17.50
24V/1.25A CSD @ $1.98 Two for.......3.49
42.5V/2A Sel. Rect. Xfmr.......$2.95; 2 for $5.50
64V/1A Hmeld.......$3.49; 2 for $5.
PRI/220/440V Sec 3x2.5V/5A, 2.5V/15A.......4.95
2X12V/2A or 24V/2A.......$4.00; 3 for $11.00

NEW RELAY LIST

Tremendous Bargain Prices

R1ST1 Stevens Arnold Resonant Relay #189 Freq 240cy.......$5.98; 3 for $15.
R2WE1 Western Elect Mercury Relay D-171584, Plug-in SPDT Transfer Cont 36VDC/4500 Ohm/8MADC.......$7.75; 3 for $21
R3WE2 Western Elect D-163781 SPST/10VDC/2500 Ohm/4MA Plug-in Sig #2Z7587-17 P/O SCR 545A. Mercury Hi-spd.......$16.95; 3 for $48.
R4KU1 SPST/MINI/115VAC/4A CTS.......$1.39
R5KU2 SPDT/MINI/115VAC/4A CTS.......$1.69
R6KU3 Kurman DPINO & INC/4MADC/700 Ohm/5A CTS.......$4.49; 3 for $12.
R7CL1 Clare SK5010 VAC SLD/DPDT/18-28 VDC/3A CTS Octal Base.......$2.98; 3 for 7.50
R8RB1 SPNO/MINI/115VAC/8A CTS.......$1.89
R9AC1 Allied-FX SPST/MINI/4MADC/3000 Ohm/3A CTS.......$1.25; 3 for 2.98
R10SD1 S'Dunn SPST/115VAC/6-30ACTS $2.00
R11AC2 Allied-BJ DPDT/115VDC/5A CTS $1.39
R12AC3 Allied-BJ DPDT/6VDC/5A CTS.......$1.49
R13LE1 Leach-DPDT/28VDC/5ACTS.......$1.98
R14AU1 DPDT & SPNO/12VDC/10A CTS $2.25
R15GE1 G.E. CR2792B117A3/SPST/28VDC/50A CTS.......$1.98; 2 for 3.50
R16GE2 G.E. K36J406/SPDT/2000 Ohm/8MA/5A CTS Plug-in.......$2.95; 2 for $5.
R17GM1 GM/SPST/24VDC/20A CTS.......$1.49
R18LE2 Leach/DPST/115VDC/10A CTS.......$1.49
R19SD2 S'Dunn-32AXX100/Reset & Overload/115VAC/10MA.......$4.95; 2 for $9.
R20CH1 C'Hammer-B8/7-24VDC/200-1200Amp.......$2.98; 2 for $5.
R21GA1 DPST/6VDC/10ACTS $1.98; 2 for $3.
R22AD1 Advance-4001B/DPDT & PNO/115 VDC/RF-Ceramic Insulation.......$4.50; 2 for $8.
R23AB1 A'Bradley-810/Magnetic Overload, Adjustable 18.1-15.2-12-9-6.3 Amp. 600V/Max. $3.98
R24EC1 Eclipse 515-M2/SPST/12 VDC Hvy Dty Solenoid.......$2.98; 2 for $5.00
Selium Rectifier-FW 115VAC/40MA.......79c
WRITE FOR QUANTITY PRICE

SOCKET ASSEMBLIES

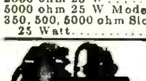
⅝" Jewel Bayonet Socket Light Dimmer (Shutter) Regular 97c Less Than (3) Ea....39c Lots of 5 **33¢ EA.**
Dialco 31101 Pilot Light 1" Jewel 115V. High Polish Finish. Reg. $1.03 "TAB" Price.......85c @ 10 for $6.00
Neon Panel Lite Dialco 95408 in Red, Amber & Clear Spec 79c; 12/$6

NEW RHEOSTAT LIST

Priced Below Manufacturer

15 ohm 25W w/knob.......$1.10; 10 for $7.00
60 ohm 50W w/knob.......1.98; 10 for 14.00
100 ohm 50 W.......1.50; 10 for 9.00
125 ohm 25W Model H.......1.10; 10 for 7.00
225 ohm 50 W.......1.98; 10 for 15.00
250 ohm 25 W.......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

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

CRYSTAL DIODES

1N21 Lots of 50.......@ 30¢ ea.
Smaller Qty. 49c@; 10 for $3.98

KEMTRON—W.E.—SYLVANIA
1N23B $2.10; 5 for $9.50
1N21A $1.55; 5 for $7.00
1N21B $2.10; 5 for $9.50
1N41 $8.95; 2 for $16.00
1N42 $16.95; 2 for $28.00
1N34 Each 64c
1N34A Each 88c
1N39 Each $4.49

METER SALE

0-1 MADC Wstghs 3½" Sq RA35.......$6.49; @, 2/$11
1 MADC Miniature 1½"...2 for $7
0-500MADC/2¾"; Rnd Triplett MODEL 221T.......4.98
0-120 MA RF 3½" ROUND WESTON 301.......11.98
0-800 MADC/3½" Rnd.......$4.49; 2 for $8
300-0-300 Micro Amimeter Galvanometer, 50 Div Scale, Hi-Torque 3½ Rnd Hickok Sealed $4.49; 2 for $8.00

"TAB" THAT'S A BUY

WATCH! THIS SECTION

For Tremendous Bargain Prices

HI-MEG HI-VOLT RESISTORS

.75 MEG "MVP" 10W 10KV.... .79 10 for 5.00
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
12 MEG 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

TRANSFORMERS

All 115 V 60 Cyc Input TV & CR Pwr Xmfr up to 20" tubes. Hi VOLTS to 20 KV (w/quadrupler ckt.) ALL tubes, PL & Fil wndgs 300 VDC 275Ma Full-Wave; 6.4V/10.3A, 5.4V/8A, 2.5V/3A Hypersil Core, Oil Impreg. $4.98 @, 2 for $8.50; 6 for $22
2500V/20 MA 6.3 V/.6 A. 2.5 V/1.75 A 4/BC412 Scope Replmnt.......$7.98
1600VCT/5Ma, 6.3VCT/3A, 6.3VCT/10A, 2.5 VCT/5A.......$7.95; 2 for $14.00
1000VCT/45MA, 795VCT/80MA, 360VCT/55MA 3X5V/3A, 6.3VCT/1A, 6.3VCT/3A CSD...$4.00
950VCT/100MA, 5V/2.5A, 5V/5A, 45V/1A, 10V/1.5A WESTERN ELECT.......$4.98; 3 for $13
900V/35MA, 2X2.5V/2AXCLENT 1800V DBLER TWO 2X2 FIL WNDGS.......$2.25
850VCT/148MA, 5V/3A, 6.3V/5A, 6.3V/3A DOUBLER Half Shell.......$4.98; 2 for $9.00
778VCT/200MA, 5V/3A, 6.3VCT/5A THORDASON.......$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/120MA, 2X6.3V/3A, 6.3V/1A Price.......$3.98; Two for.......$7.25
700VCT/70MA, 5VCT/3A, 6.3VCT/2.5A.......$3.95
680VCT/200MA, 5V/3.5A, 6.3V/4A, 78V/1A.......$4.39; 3 for $12
600VCT/50MA, 6V/3A, 6V/1.5A, 5V/1A HALF SHELL.......$2.49; 2 for $4.50; 10 for $20.00
500VCT/60MA, 6.3V/4A HMSLD.......$2.98
420VCT/90MA, 6.3V/1.9A, W/INPUTS 6, 12, 24, 115VDC & 115 & 230 VAC @.......$1.49

FILTER CHOKES

12Hy/80ma/8KVins.......2.25
10Hy/75ma.......1.25
10Hy/125ma/UTC/Csd/H'sld/1 KVins.......1.98
50Hy/125ma/Csd/H'Sld.......2.89
20Hy/300ma or 15Hy/400ma/12KVins Kenyon.......8.95
13.5Hy/1 Amp/17KVins/Raytheon.......35.00
Dual 2 Hy/300ma USN.......95c; 2 for 1.49
6 Hy 175ma 250 Ohm.......$1.49; 2 for 2.49
10 Hy 100ma Freed.......1.39
5-30 Hy 500MA Swinging.......6.49

Industrials Write on Your Letterhead for Power Rectifier Catalog

SELENIUM RECTIFIERS

We specialize in Rectifiers and Power supplies to your specifications. Immediate delivery.

Current Cont.	18/14 Volts	36/28 Volts	54/40 Volts	130/100 Volts
1 Amp	$1.35	$2.15	$3.70	$8.50
2 Amp	2.20	3.60	6.00	10.50
4 Amp	4.25	7.95	12.95	25.25
6 Amp	4.75	9.00	13.50	33.00
10 Amp	6.75	12.75	20.00	44.95
12 Amp	8.50	16.25	25.50	49.00
20 Amp	13.25	25.50	39.00	87.50
24 Amp	16.25	32.50	45.00	95.00

2000 V. PK INVERSE SELENIUM Rectifier 1600VDC 1.5MA/½ Wave Pigtail Type ¾" Dia 2" Lgth. for SCOPES, TV, Photoflash Series for Higher Voltages...$3.00; 2 for $5; 12 for $25

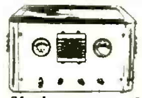
Rectifier & Transformer Combination 115 Volt 60 cyc Input

up to 14VDC at 12 amps.......$19.98
up to 28VDC at 4 amps.......14.98
up to 28VDC at 12 amps.......29.98
up to 28VDC at 24 amps.......63.98
up to 28VDC at 50 amps.......127.00

Rectifier & Transformer & Variac

up to 14VDC at 12 amps.......30.98
up to 28VDC at 12 amps.......45.50
up to 28VDC at 50 amps.......167.00
C "TAB" fast delivery SPECIALS

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 Input 115V or 230V 60cy

Stock Number	Continuous Rating	With Meters
T28V4A	0-28VDC at 4 Amp	$43.00
T28V12A	0-28VDC at 12 Amp	89.00
T28V24A	0-28VDC at 24 Amp	129.50
T28V50A	0-28VDC at 50 Amp	239.50

RECTIFIER XFMRS

PRIMARY 115V 60 cyc
SECONDARY 0-9-12-18-24-36V
CONT. CURRENT 4 amp.......$8.75
12 amp.......16.75
24 amp.......35.75
30-32-34-36V/48A.......59.50
18 Volt 2 amp.......1.98

RECTIFIER CHOKES

4 Amp	.07 Hy	.6 Ohm	$7.95
12 Amp	.01 Hy	1 Ohm	14.95
24 Amp	.004 Hy	.025 Ohm	29.95

BATTERY CHARGER RECTIFIER

13-0-13 Volts (CT) 100 Amp (Fan-Cooled) Replace Your Old inefficient Sulphide Rect. with the NewSeleniumTypes. **SPECIAL**...$11.98

TUBES

"TAB" TESTED & GUARANTEED

PRICES SUBJECT TO CHANGE
WRITE FOR COMPLETE TUBE LISTING

OA2	$0.88
OA3/VR75	1.04
OB2	1.37
OB3/VR90	.96
OC3/VR105	.92
OD3/VR150	.92
1B3/8016	.80
1B22	1.82
1B23	8.87
1B24	8.98
1B26	2.24
1B27	11.98
1B32/532A	2.48
1B35	9.15
1B37	14.87
1B38	29.45
1B41	49.95
1B42	17.48
1B46	1.98
1B63	45.00
1L4	.48
1L6	1.35
1LD5	.98
1LN5	.78
1P5	.78
1U4	.52
1U5	.54
1V2	.70
1X2A	.98
2C36	27.00
2C39A	26.98
2C40	4.98
2C43	17.48
2C44	1.15
2C51	3.88
2D21	1.18
2E43	1.49
2J31	27.00
2J32	29.48
2J33	27.00
2J34	24.98
2J37	12.70
2J38	69.98
2J39	6.98
2J42	148.98
2J4[illegible]	24.25
2J49	84.00
2J50	99.98
2J51	238.98
2J56	149.00
2J62	49.45
2K22	23.48
2K23	11.48
2K25	28.49
2K25/723AB	23.88
2K28	27.48
2K33	219.48
2K39	134.99
2K41	126.00
2K42	145.00
2K45	129.48
2K48	99.48
2P23	298.00
2X2	.42
3B22	2.48
3B23/RK22	4.95
3B24	4.70
3B25	3.70
3B28	7.90
3C22	85.00
3C23	8.67
3C31/C1B	3.45
3C33	9.51
3C45	9.98
3D6/1299	.69
3D21A	8.15
3D22	13.97
3D23	4.90
3E29	14.49
4C35	21.49
4D21	18.99
4E27	22.49
4J22	129.51

4J31	99.51
4J52	199.99
EL5BHD	15.99
5C21/C6J	9.89
5C22	39.95
5D21	14.98
5J29	11.92
5R4GY	1.20
5R4GYW	1.75
5T4	1.48
5U4G	.55
5V4G	.95
5Z3	.99
5Z4	1.49
6A3	.90
6A7	.85
6A8GT	.90
6AC7	.80
6AG5	.71
6AG7	1.14
6AH6	1.21
6AJ5	1.40
6AK5	.87
6AK5W	2.79
6AK6	.92
6AL5	.48
6AL7GT	.98
6AN5	3.27
6AQ5	.52
6AQ5W	2.78
6AQ6	.81
6AQ7GT	1.29
6AR6	3.27
6AS5	.79
6AS6	2.22
6AS7G	3.48
6AT6	.54
6AU5GT	1.10
6AU6	.56
6AV5GT	.98
6AV6	.49
6B4G	1.18
6B8G	.60
6BA6	.54
6BA7	1.09
6BC5	.63
6BC7	1.23
6BD6	.83
6BE6	.54
6BF5	.98
6BG6G	1.58
6BH6	.63
6BJ6	.69
6BK7	1.58
6BL7GT	1.19
6BN7	2.69
6BQ6GT	1.20
6BQ7	1.65
6C4	.52
6C21	24.50
6CB6	.59
6CD6G	1.69
6D4	2.70
6D6	.84
6F4	6.20
6F6	.79
C6J/5C21	9.89
6J4	6.66
6J5	.54
6J6	.58
6K6GT	.54
6K7	.58
6K8	1.08
6L6	1.48
6L6G	1.09
6L6GA	1.08
6L6GAY	1.98
6SA7GT	.66
6SC7	.90
6SF5	.78
6SF7	.73
6SG7	.64
6SH7	.61

6SJ7	.58
6SK7GT	.56
6SL7GT	.64
6SN7GT	.68
6SQ7GT	.62
6SR7	.62
6SS7	.88
6T8	.96
6U4	.74
6U8	.99
6V6	1.39
6V6GT	.59
6W4GT	.52
6X4	.49
6X5GT	.54
6Y6G	.88
7A8	.68
7C7	.76
7F7	.82
7F8	1.24
7H7	.72
7N7	.92
7V7	1.06
7Y4	.68
8D21	298.00
12AL5	.54
12AT6	.54
12AT7	.89
12AU6	.72
12AU7	.69
12AV6	.52
12AV7	.98
12AW6	1.18
12AX7	.98
12AY7	1.69
12BA6	.59
12BA7	.94
12BD6	.59
12BE6	.59
12BF6	.85
12BH7	1.29
12SA7GT	.68
12SC7	1.08
12SF5GT	.54
12SF7GT	.84
12SG7	.80
12SH7	.63
12SJ7GT	.54
12SK7	.66
12SL7GT	.62
12SN7GT	.68
12SQ7GT	.54
12SR7	.66
FG17	3.90
24G/3C24	1.32
25BQ6GT	.98
25L6GT	.67
25Z5	.78
25Z6GT	.58
FG-27A	8.24
35Z5GT	.54
35T	4.88
35L6	.67
35Y4	.68
45Z3	.88
48	1.98
50A5	.76
50C5	.54
50L6GT	.62
RK61/XFG1	2.65
FG67	14.68
HY69	4.98
71A	.74
78	.78
80	.58
81	1.38
83	1.12
83V	1.22
84/6Z4	.62
100TH	9.88
FG104	24.58
FG105	19.48
VXR130	4.50

CV148	7.98
FG166	48.49
FG172	29.00
211/VT4C	.86
RX215	7.98
RX233A	3.49
250TH	18.97
250TL	17.75
304TH	12.49
304TL	12.49
371B	.88
388A	1.48
GL434A	12.69
446A	1.05
466B	3.48
450TH	49.97
450TL	52.00
460/HF200	15.95
CK502AX	1.49
CK503AX	1.49
CK505AX	1.79
CK512AX	1.45
CK531DX	1.89
531	5.72
CK532DX	1.89
WL532A	3.68
CK536AX	.99
CK538DX	.98
CK539DX	2.19
CK541DX	1.99
CK543DX	.99
CK544DX	.99
CK546DX	1.99
CK571AX/5886	2.49
CK573AX/6029	3.49
WL652	65.00
WL676	34.98
703A	4.72
705A	1.88
707A	7.90
707B	14.88
715A	4.96
715B	7.94
715C	17.98
717A	.88
719A	24.48
721A	3.92
722A/287	1.94
723A/B	16.98
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

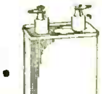
927/CE25	1.7
CK1005	.6
1613	.8
1614	1.95
1625	.3[illegible]
1632	.68
1633	.98
1636	3.08
1642	.62
1644	.92
2050	1.48
2050W	2.48
5618	3.50
5635	11.57
5637	6.53
5640	11.57
5641	7.52
5643	11.57
5644	11.57
5646	11.57
5651	2.24
5654	1.72
5656	12.08
RK5657	298.48
5663	1.06
5670	3.44
CK5672	1.20
CK5678	1.28
5687	3.74
5691	7.54
5692	8.52
5693	6.24
5694	3.65
CK5702	2.90
CK5703	1.29
5713	120.00
WL5736	130.00
5749	1.72
5751	2.88
5769	298.00
5812	2.99
5814	2.03
5820	148.00
5840	7.98
5844	2.98
5881	2.70
8012	2.58
8013	3.92

Xtal Diodes

1N21A	$1.55
1N21B	2.10
1N22	1.22
1N23	1.35
1N23A	1.89
1N23B	2.10
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

OIL CONDENSER SPECIAL



10 MFD 600 VDC **$1.75 ea.** LOTS OF 3
Case Dimensions, Not Including Insulators, 4⅞H—3¼W—1¼"D
Quantities Less Than 3, Ea.......$1.98

OIL CONDENSERS

NEW WAREHOUSE LIST
.00025MFD/25KV.......$4.00; 2 for $7.00
.0016MFD/15KV.......$7.00; 2 for $12.00
2X.1MFD/2000V.......$1.39; 2 for $2.00
.5MFD/600V.......25c; 6 for $1.00
.5MFD/1500V.......85c; 6 for $2.00
1MFD/600V.......33c; 4 for $1.00
1MFD/600V.......39c; 3 for $1.00
1MFD/1000V.......39c; 3 for $1.00
2MFD/600V.......59c; 5 for $2.00
4MFD/3000V.......$7.98; 2 for $14.00
4MFD/5000V.......$19.95; 2 for $35.00
8MFD/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

VARIABLE VOLTAGE TRANSFORMERS

SUPERIOR-GR-STACO
0-135V/3A.......$11.25
Cased/0-135V/7.5A.......20.70
Uncased/0-135V/7.5A 16.20
Cased 0-270V/3A.......23.40
Uncased/0-270V/3A.......18.00
Cased/0-135V/15A.......41.98
Cased/0-270V/9A.......41.98
GR50A/0-135V/45A/LN.......100.00
GR50B/0-270V/31A/LN.......115.00
3000BU/0-135V/30A Uncased.......49.00
3000B/0-135V/30A Cased.......55.00
3020BU/0-270V/18A Uncased.......49.00
3020B/0-270V/18A Cased.......55.00
Staco LRL-5 Metered/140V/5A.......41.50
Staco PAL-7/Metered/135V/7.5A.......40.50
Write for Catalogue & Quantity Prices

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SEE IN DARK TUBE
Image-Converter Tube Hi-Sensitivity simplified design 2" dia Willemite screen—Resolution up to 350 lin/in. Complete data & tube.......ea. $7.98; 2 for $13.98
Snooperscope Pwr Supply 1800VDC/35MA. Using Doubler Crkt, Transformer, Rectifiers, Sockets, Resistors, Capacitors and Diagram 115V/60cy Oper...$6.98

CIRCUIT BREAKERS

Heinmann Magn Bkrs. **Amps:** .220, 3, 7, 9, 12, 20, 30, 35, 40, 80, 180 $1.98@, 12 for $20.
Sq. D & CH Toggle Sw Brks. **Amps:** 5, 10, 15, 20, 25 98c.......10 for $8.98
Klixon Therma Push Button Brkrs **Amps:** 5, 10, 15, 20, 25, 30 89c.......10 for $7.98

TYPE-J POTENTIOMETERS

10 ohm.......85c; 12 for $8.00
200 ohm.......85c; 12 for $8.00
1000 ohm.......85c; 12 for $8.00
2000 ohm.......85c; 12 for $8.00
3500 ohm.......85c; 12 for $8.00
5000 ohm.......85c; 12 for $8.00
25K ohm.......85c; 12 for $8.00
50K ohm.......85c; 12 for $8.00
100K ohm.......85c; 12 for $8.00
1 meg. Type JJJ (Triple) 1¾" shaft $2.98; 10 for $25.00

TUBE SOCKETS

CINCH—NATCO—JOHNSON—AMPH EQUIV TO JOHNSON AS INDICATED
#122-244 (866A).......30c; 4 for $1.00
#123-209 (866A).......35c; 2 for 1.49
#122-247 (829B).......55c; 3 for 1.00
#123-211 (872A).......1.30; 4 for 4.80
#122-237 (813).......50c; 3 for 1.00
#122-234 (5D21-715).......1.25; 4 for 3.98
#122-101(4-65A).......1.50; 4 for 5.00
#124-213 (304TL).......1.30; 2 for 2.49
#124-214 (1500TH).......1.65; 2 for 3.00
#122-227 (1625).......30c; 4 for 1.00
#122-225 (807).......35c; 4 for 1.20
#49-SS11L (Magnal).......59c; 2 for 1.00
5 prong (Acorn).......35c; 4 for 1.00
4 prong (5C22-8008).......1.20; 4 for 4.00
Octal (low-loss mica) ring mtg.......10 for 1.00
Octal (mica) ring mtg.......12 for 1.00
Octal (steatite) ring mtg.......12 for 1.00
Octal (bakelite) ring mtg.......15 for 1.00
Octal (bakelite) saddle mtg.......15 for 1.00
Octal (mica) saddle mtg.......12 for 1.00
Octal (steatite) saddle mtg.......12 for 2.00
Loktal (steatite) ring mtg.......10 for 2.00
Loktal (mica) saddle mtg.......12 for 1.00
7 pin min (mica) base shld.......20c; 12 for 2.00
7 pin min (mica) bottom mtg...12c; 10 for 1.00
7 pin min (blkt) rubber shock mtg 20c; 12 for 2.00
7 pin min waffer.......9c; 15 for 1.00
9 pin min (mica) bottom mtg...20c; 12 for 2.00
9 pin min (bklt) bottom mtg...18c; 7 for 1.00
9 pin min (bklt) base shld.......28c; 5 for 1.00
Write for qty price and other types

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FOUR MILLION IN STOCK
All 1% Accuracy Gtd
ORDER ANY VALUE WE HAVE IT; REGULARLY SOLD FOR 69c AND UP
"TAB" SPECIAL 35c EACH; 10 OF ONE VALUE **25¢ EA.**
100 OF ONE VALUE.......$20.00
10 ASSORTED VALUES (U-SELECT).......$3.00
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NOTE. 1 MEG & UP ADD 25c EA RESISTOR

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RF-P1-Choke 20MH/200MA.......6 for $2.00
RF-P1-Choke 20MH/500MA.......12 for $7.00
5" Dynamic Speaker & Tranf-Pent 3000 Ohm Field.......$1.19; 6 for $5.00
Helipot 50,000/Ohm 10/Turn/0.5%.......$7.98
Helipot 30,000/Ohm 10/Turn 0.5%.......$7.98
Micropot 20,000/Ohm 10/Turn/0.1%.......$7.98

TYPE "G" MICA CONDENSERS

HIGH CURRENT TRANSMITTING

MFD	KILO-VOLTS	FREQ. CURR.	LIST PRICE	"TAB" PRICE
.00035	20		$134.	$18.00
.0004	20	4.5A/.3MC	135.	18.00
.0005	20	6A/.3MC	135.	18.00
.0012	20	14A/1MC	142.	30.00
.0025	25	22A/3MC	325.	39.00
.01	10	27A/1MC	151.	39.00
.09	1.5	40A/1MC	78.	9.00

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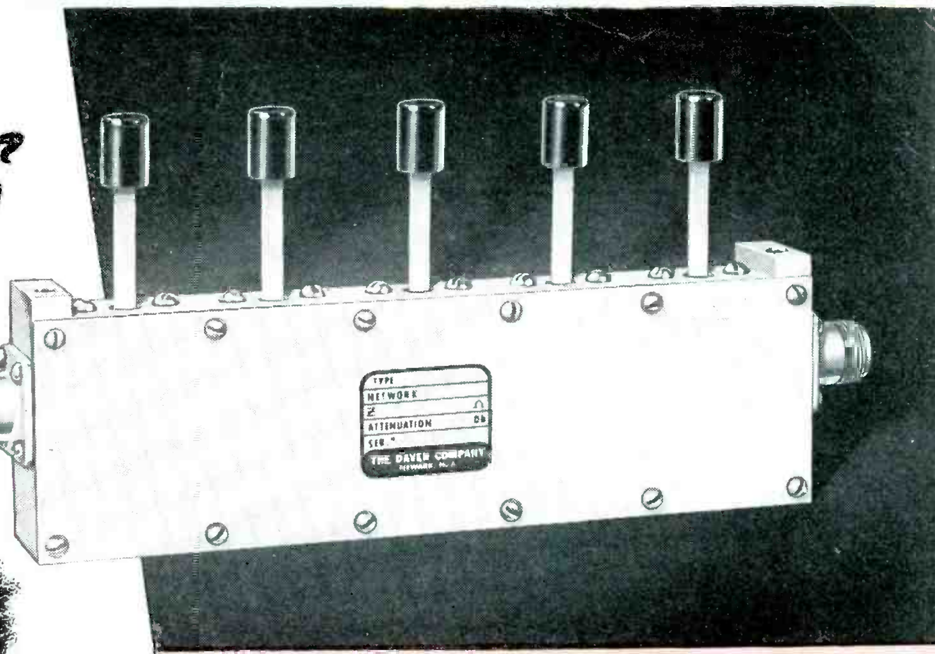
IN *Attenuators* WHY DOES ONE NAME.. DAVEN STAND OUT?



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Standard impedances are 50 and 73 ohms, with special impedances available on request. Resistor accuracy is within ± 2% at DC. An unbalanced circuit is used which provides constant input and output impedance. The units are supplied with either UG-58/U* or UG-185/U** receptacles.

TYPE	LOSS	TOTAL DB	STANDARD IMPEDANCES
RFA* & RFB 540**	1, 2, 3, 4 DB	10	50/50Ω and 73/73Ω
RFA & RFB 541	10, 20, 20, 20 DB	70	50/50Ω and 73/73Ω
RFA & RFB 542	2, 4, 6, 8 DB	20	50/50Ω and 73/73Ω
RFA & RFB 543	20, 20, 20, 20 DB	80	50/50Ω and 73/73Ω
RFA & RFB 550	1, 2, 3, 4, 10 DB	20	50/50Ω and 73/73Ω
RFA & RFB 551	10, 10, 20, 20, 20 DB	80	50/50Ω and 73/73Ω
RFA & RFB 552	2, 4, 6, 8, 20 DB	40	50/50Ω and 73/73Ω

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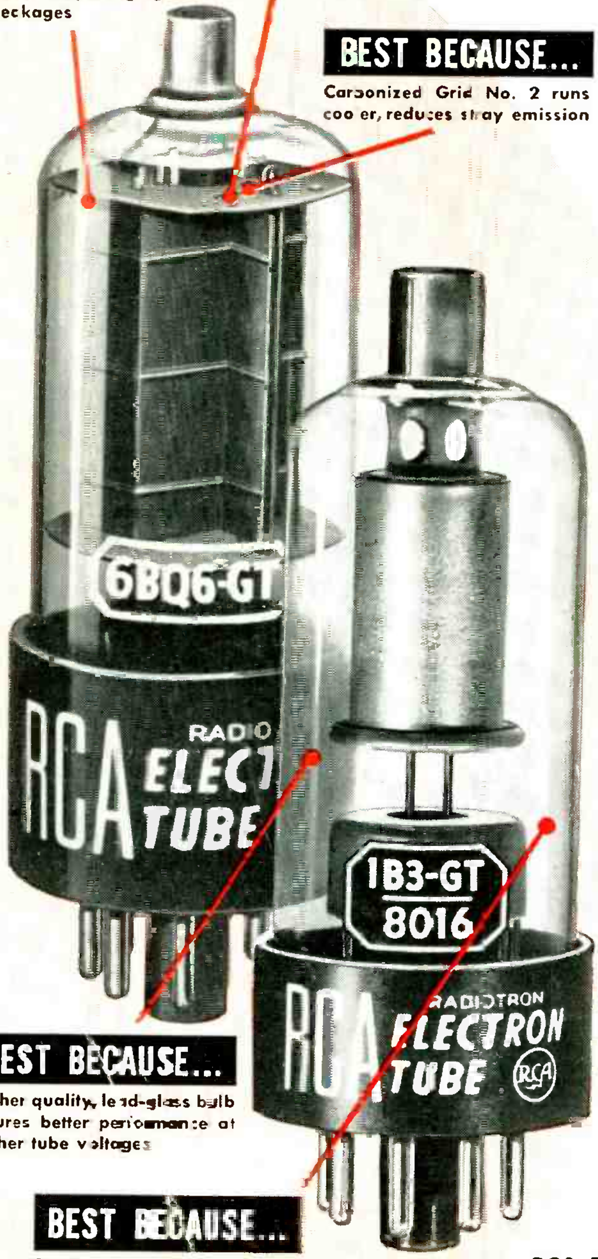

You get more for your money when you buy RCA receiving tubes because RCA makes extra effort to keep pace with new requirements for tube applications. For instance, the 1B3-GT and 6BQ6-GT illustrate how RCA makes improvements in tube type designs . . . makes RCA receiving tubes best for top performance in your TV-receiver designs.

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The RCA-6BQ6-GT horizontal output tube is another improved tube. Its improvements minimize grid emission, stray emission, and TV picture "jitters."

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