OCTOBER · 1950

electronics

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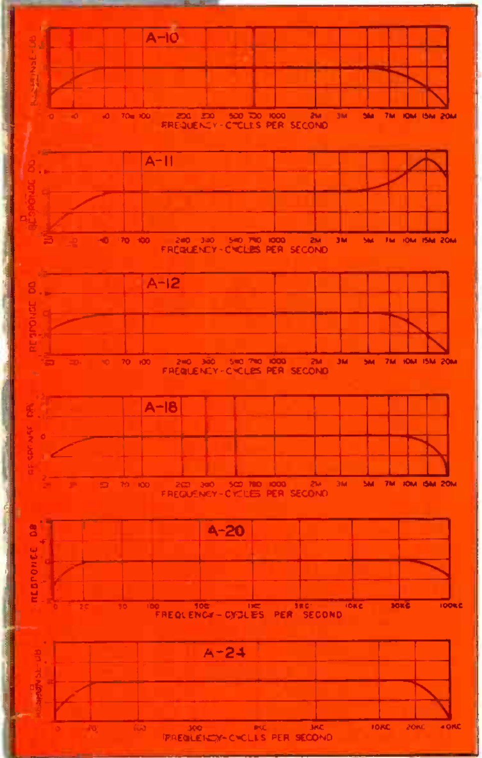
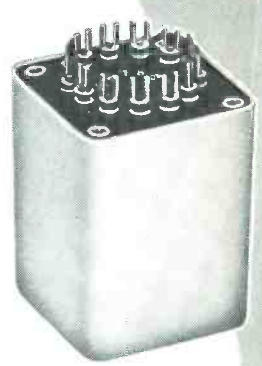
UTC Ultra compact audio units are small and light in weight, ideally suited to remote amplifier and similar compact equipment. High fidelity is obtainable in all individual units, the frequency response being ± 2 DB from 30 to 20,000 cycles.

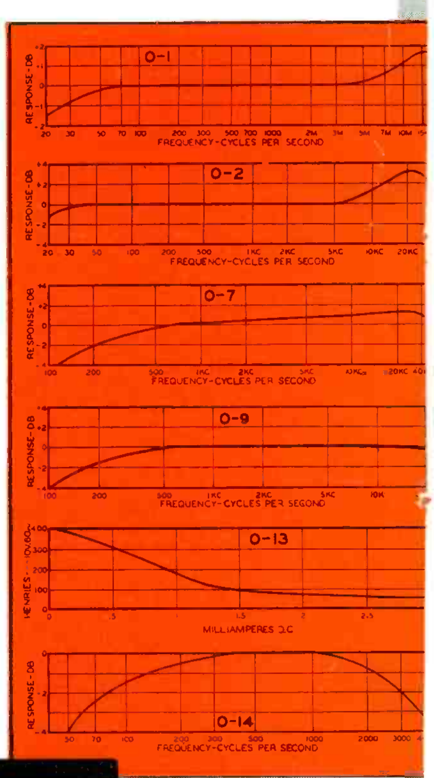
True hum balancing coil structure combined with a high conductivity die cast outer case, effects good inductive shielding.



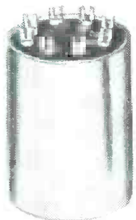
Type No.	Application	Primary Impedance	Secondary Impedance	List Price
A-10	Low impedance mike, pickup, or multiple line to grid	50, 125/150, 200/250, 333, 500/600 ohms	50 ohms	$15.00
A-11	Low impedance mike, pickup, or line to 1 or 2 grids (multiple alloy shields for low hum pickup)	50, 200, 500	50,000 ohms	16.00
A-12	Low impedance mike, pickup, or multiple line to grids	50, 125/150, 200/250, 333, 500/600 ohms	80,000 ohms overall, in two sections	15.00
A-14	Dynamic microphone to one or two grids	30 ohms	50,000 ohms overall, in two sections	14.00
A-20	Mixing, mike, pickup, or multiple line to line	50, 125/150, 200/250, 333, 500/600 ohms	50, 125/150, 200/250, 333, 500/600 ohms	15.00
A-21	mixing, low impedance mike, pickup, or line to line (multiple alloy shields for low hum pickup)	50, 200/250, 500/600	50, 200/250, 500/600	16.00
A-16	Single plate to single grid	15,000 ohms	60,000 ohms, 2:1 ratio	13.00
A-17	Single plate to single grid 8 MA unbalanced D.C.	As above	As above	15.00
A-18	Single plate to two grids. Split primary	15,000 ohms	80,000 ohms overall, 2.3:1 turn ratio	14.00
A-19	Single plate to two grids 8 MA unbalanced D.C.	15,000 ohms	80,000 ohms overall, 2.3:1 turn ratio	18.00
A-24	Single plate to multiple line	15,000 ohms	50, 125/150, 200/250, 333, 500/600 ohms	15.00
A-25	Single plate to multiple line 8 MA unbalanced D.C.	15,000 ohms	50, 125/150, 200/250, 333, 500/600 ohms	14.00
A-26	Push pull low level plates to multiple line	30,000 ohms plate to plate	50, 125/150, 200/250, 333, 500/600 ohms	15.00
A-27	Crystal microphone to multiple line	100,000 ohms	50, 125/150, 200/250, 333, 500/600 ohms	15.00
A-30	Audio choke, 250 henrys @ 5 MA 6000 ohms D.C., 65 henrys @ 10 MA 1500 ohms D.C.			10.00
A-32	Filter choke 60 henrys @ 15 MA 2000 ohms D.C., 15 henrys @ 30 MA 500 ohms D.C.			9.00



TYPE A CASE
1½" x 1½" x 2" high



UTC OUNCER components represent the acme in compact quality transformers. These units, which weigh one ounce, are fully impregnated and sealed in a drawn aluminum housing ⅞" diameter . . . mounting opposite terminal board. High fidelity characteristics are provided, uniform from 40 to 15,000 cycles, except for 0-14, 0-15, and units carrying DC which are intended for voice frequencies from 150 to 4,000 cycles. Maximum level 0 DB.



OUNCER CASE
⅞" Dia. x 1⅛" high

Type No.	Application	Pri. Imp.	Sec. Imp.	List Price
0-1	Mike, pickup or line to 1 grid	50, 200/250 500/600	50,000	$13.25
0-2	Mike, pickup or line to 2 grids	50, 200/250 500/600	50,000	13.25
0-3	Dynamic mike to 1 grid	7.5/30	50,000	12.00
0-4	Single plate to 1 grid	15,000	60,000	10.50
0-5	Plate to grid, D.C. in Pri.	15,000	60,000	10.50
0-6	Single plate to 2 grids	15,000	95,000	12.00
0-7	Plate to 2 grids, D.C. in Pri.	15,000	95,000	12.00
0-8	Single plate to line	15,000	50, 200/250, 500/600	13.25
0-9	Plate to line, D.C. in Pri.	15,000	50, 200/250, 500/600	13.25
0-10	Push pull plates to line	30,000 ohms plate to plate	50, 200/250, 500/600	13.25
0-11	Crystal mike to line	50,000	50, 200/250, 500/600	13.25
0-12	Mixing and matching	50, 200/250	50, 200/250, 500/600	12.00
0-13	Reactor, 300 Hys.—no D.C.; 50 Hys.—3 MA. D.C.,		6000 ohms	9.50
0-14	50:1 mike or line to grid	200	½ megohm	13.25
0-15	10:1 single plate to grid	15,000	1 megohm	13.25

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OCTOBER • 1950

MICROWAVE OMNIRANGE LENS .... COVER
New Sperry 5,000-mc omnirange antenna lens eliminates ground reflections (see p 118)

NEW IDEAS IN TELEVISION STUDIO DESIGN, by N. F. Smith 66
Separation of programming and technical control increases flexibility

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Phototube-controlled servo-drive motors track sun in upper-atmosphere research

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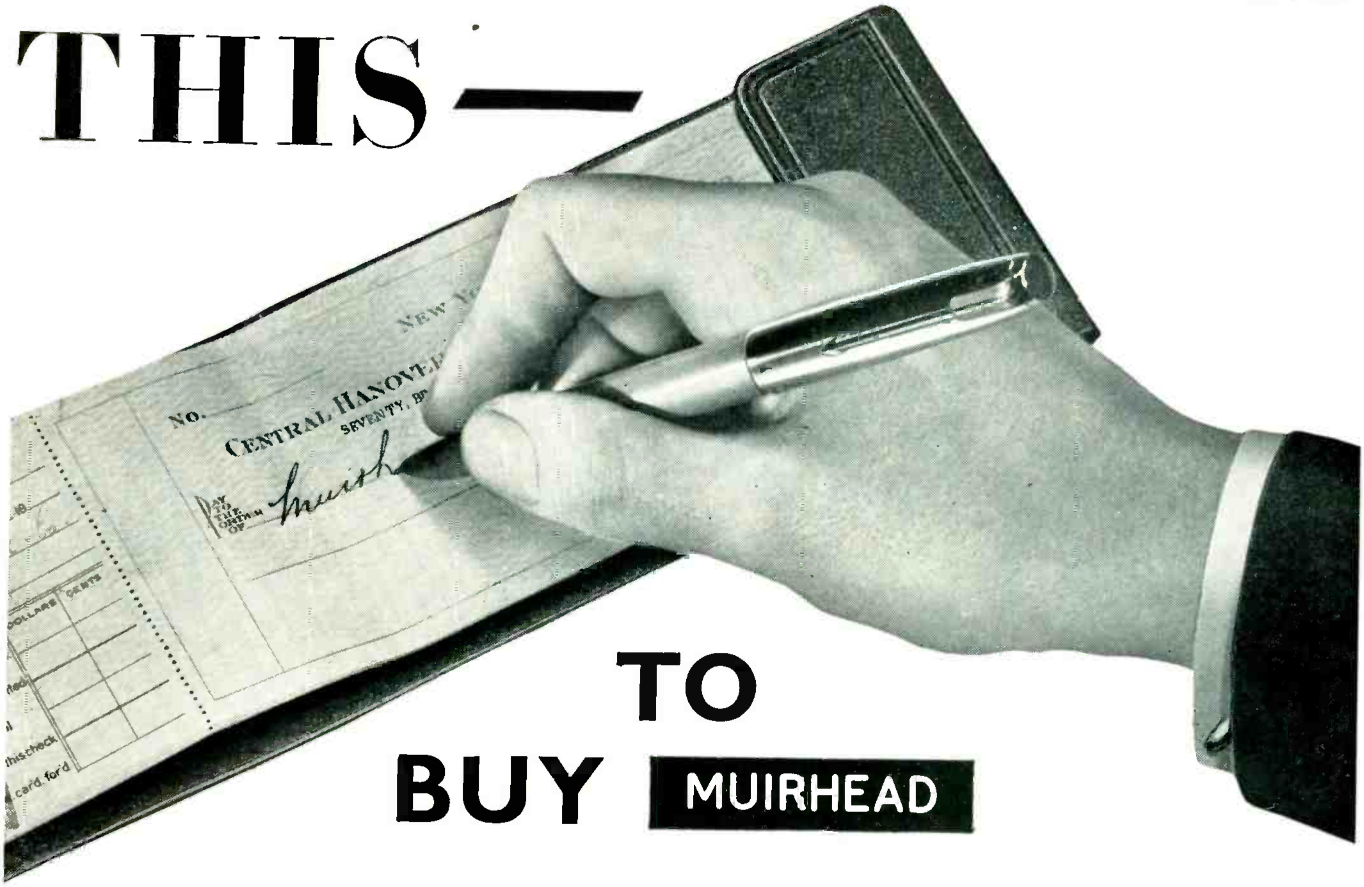

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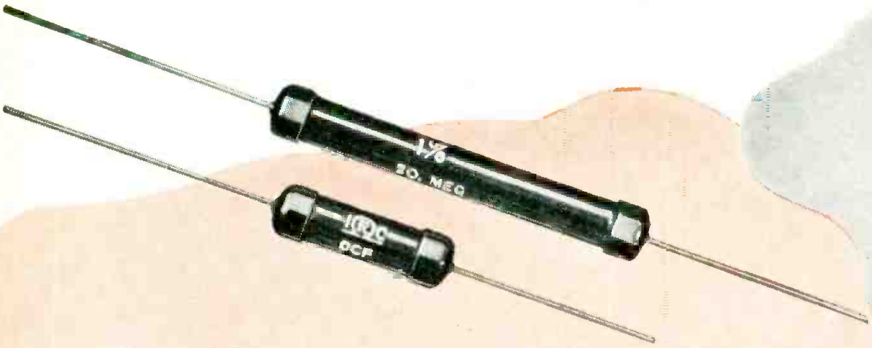

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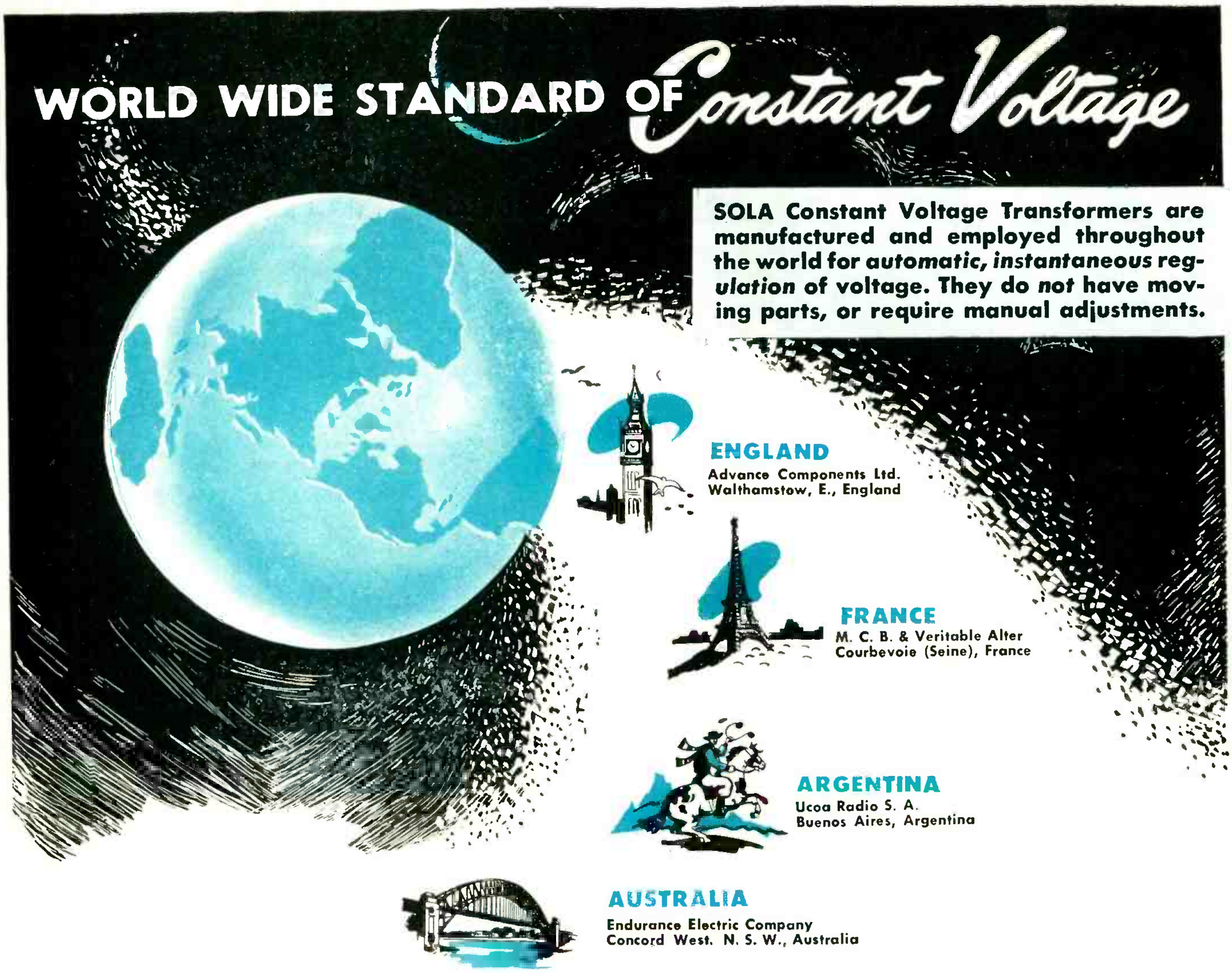

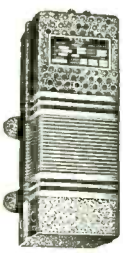

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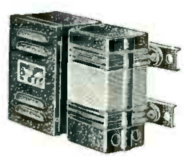

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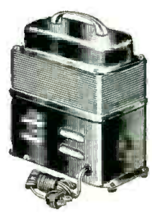

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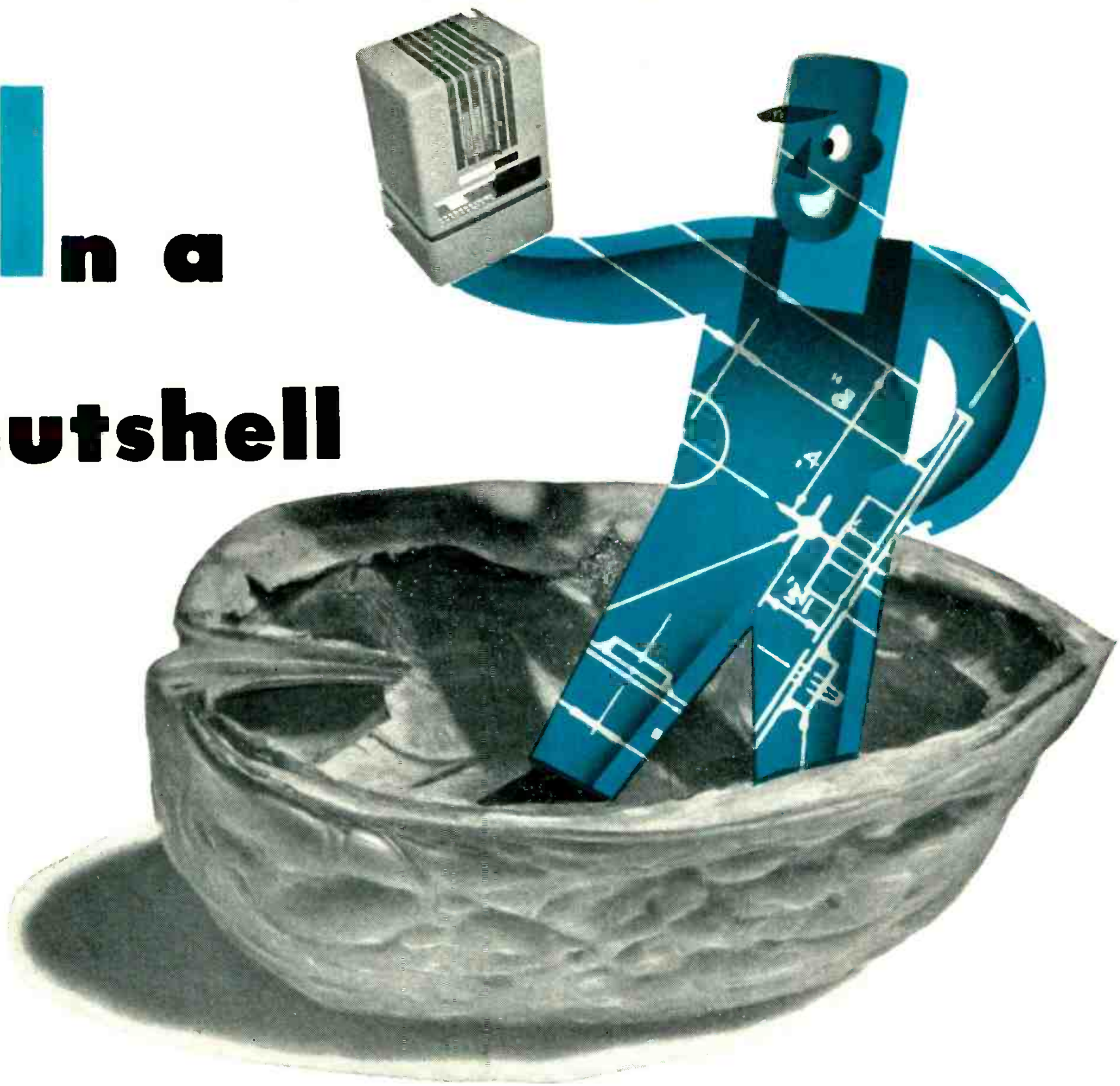
In a nutshell



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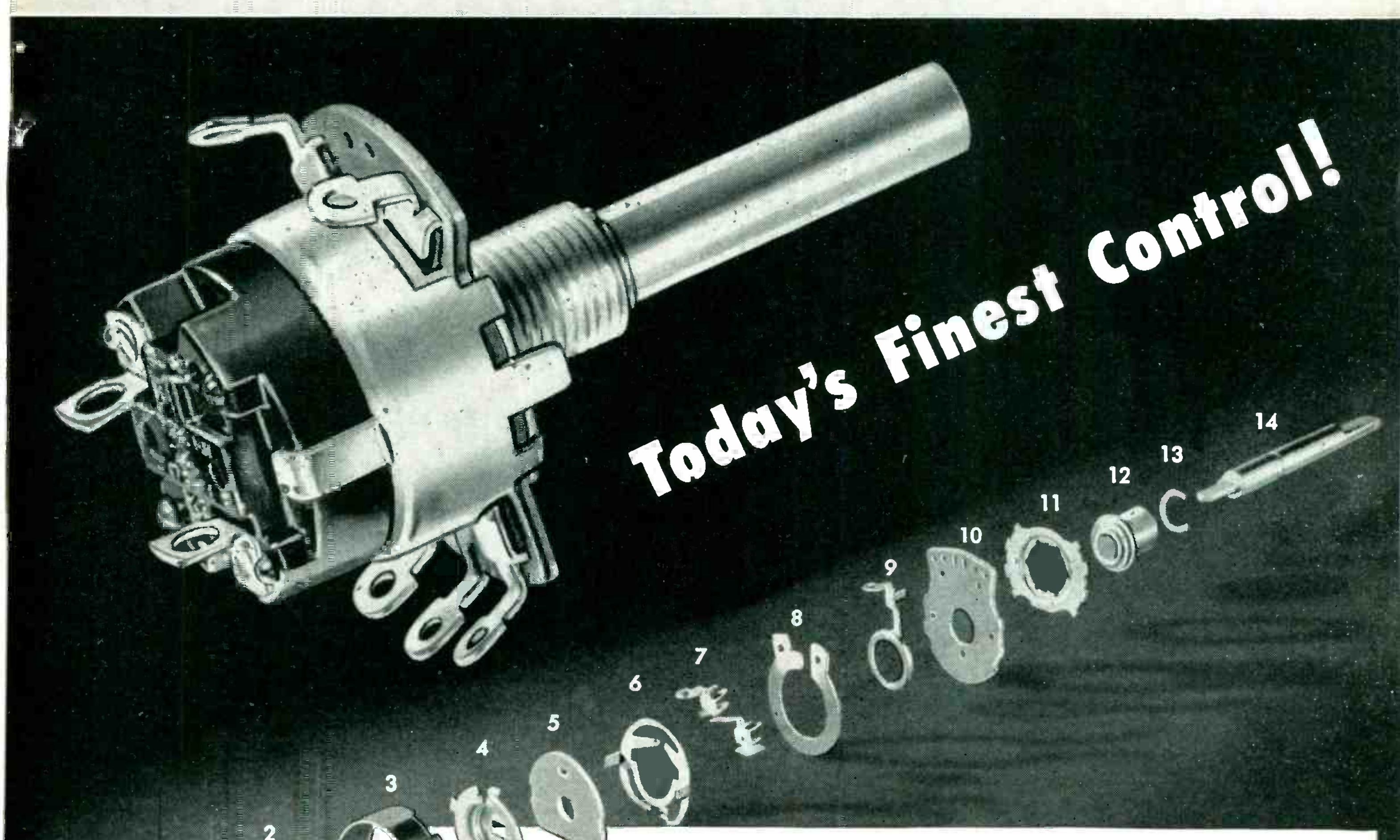

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3. *Insulator's* high dielectric strength permits breakdown test at 1000 volts R. M. S. Dust and dirt can't get in.

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6. Contact Spring gives you double wiping contacts on both resistor and center terminal ring . . . is accurately formed to maintain uniform pressures and minimize noise.

7. Electro tin-plated *terminals* provide soldering ease. Tightly crimped terminals give you direct contact to resistor . . . assure constant contact under humidity and soldering conditions.

8. *Resistor* is made of special resistance material bonded to high quality phenolic for smooth operation, low noise level, outstanding humidity characteristics.

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11. Cadmium-plated steel *ground plate* assures positive grounded cover.

12. Cadmium-plated steel *bushing* is accurately finished and fit to shaft for smooth rotation.

13. *Retaining ring.*

14. *Shaft,* Unlimited variations available to meet your specifications.

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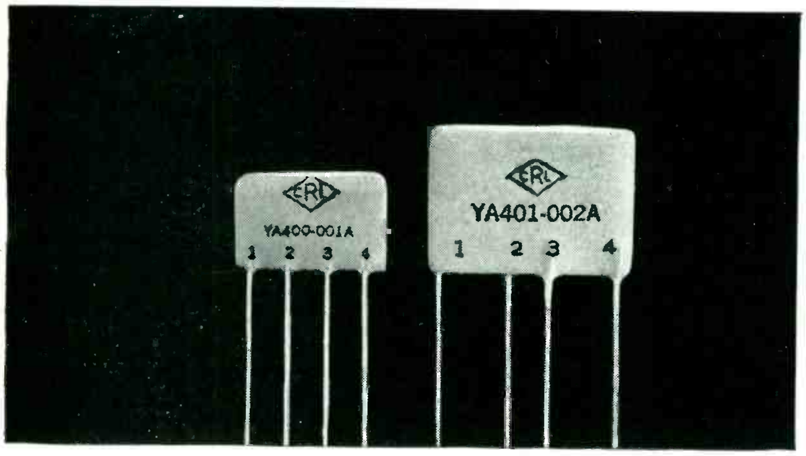
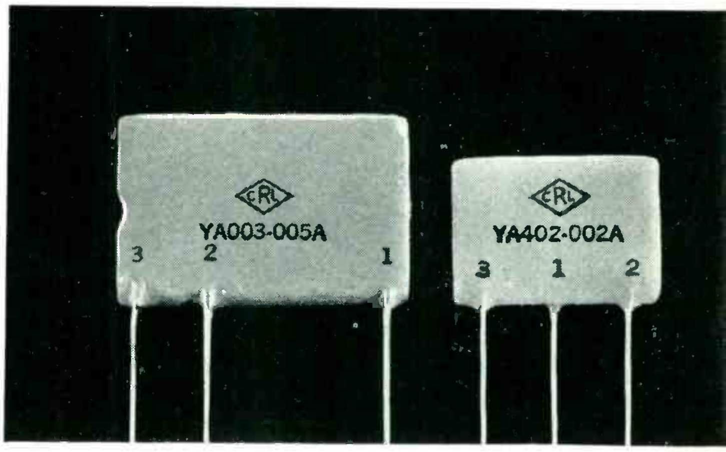
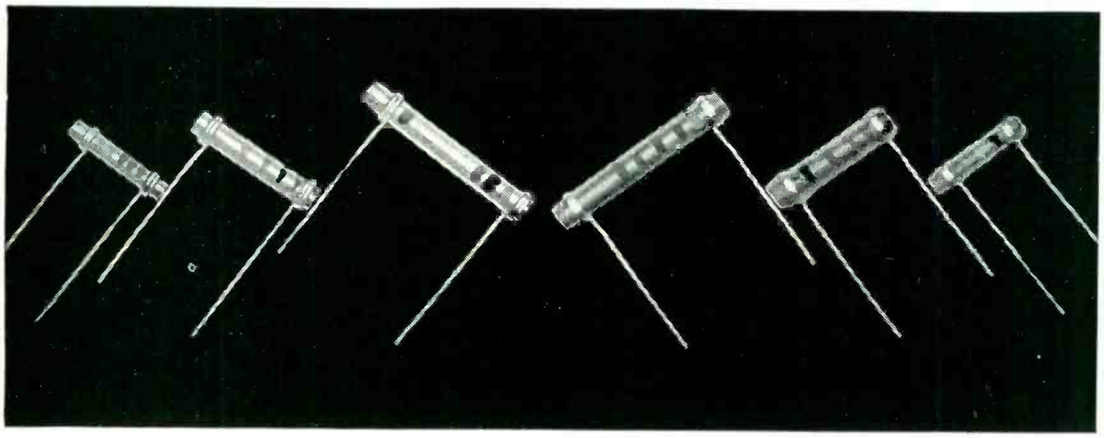


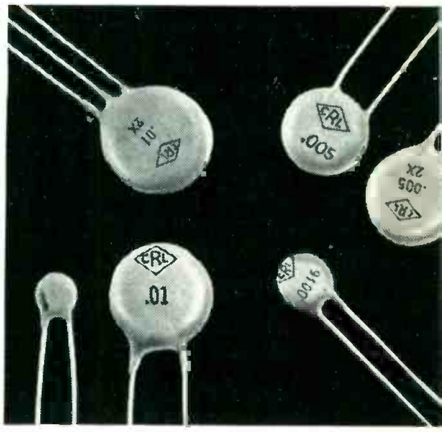
Centralab Triode Couplates save space and weight. They actually replace 5 components normally used in audio circuits. Triode Couplates are complete assemblies of 3 capacitors and 2 resistors bonded to a dielectric ceramic plate. Available in a variety of resistor and capacitor values.



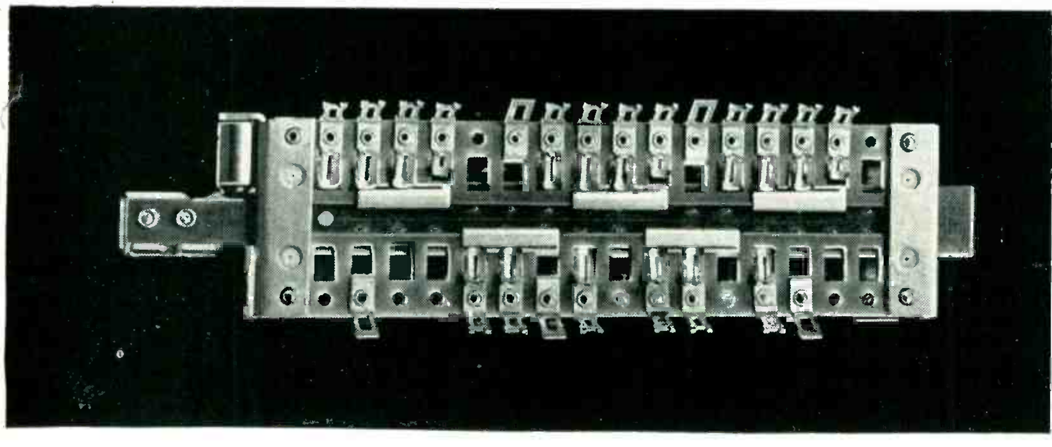
Centralab Vertical Integrators give you big savings in assembly costs, particularly in TV vertical integrator networks. One type consists of 4 resistors and 4 capacitors brought out to 3 leads . . . reducing the formerly required 16 soldered connections to only 3! There's a big saving in the number of parts handled, too!



Centralab's TC (Temperature Compensating) Tubular Hi-Kaps, left, are the most stable capacitors available. With TC Hi-Kaps, there's practically no variation due to aging or changes in temperature or humidity. For applications where temperature compensation is unimportant, use Tubular BC Hi-Kaps, right.



Disc: The original miniature ceramic disc capacitors combining utmost reliability with small size and low mass weight. Diameter 5/8", 9/16", 3/8" and 1/4". Single shielded and non-shielded units available.



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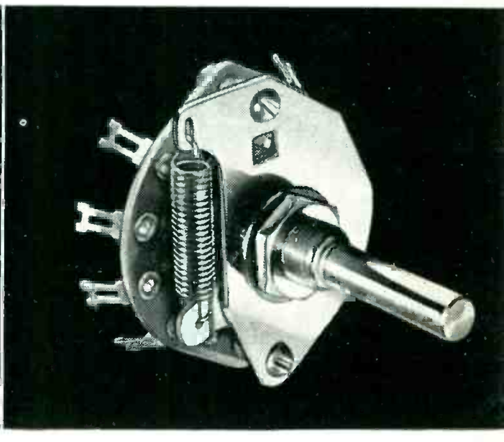

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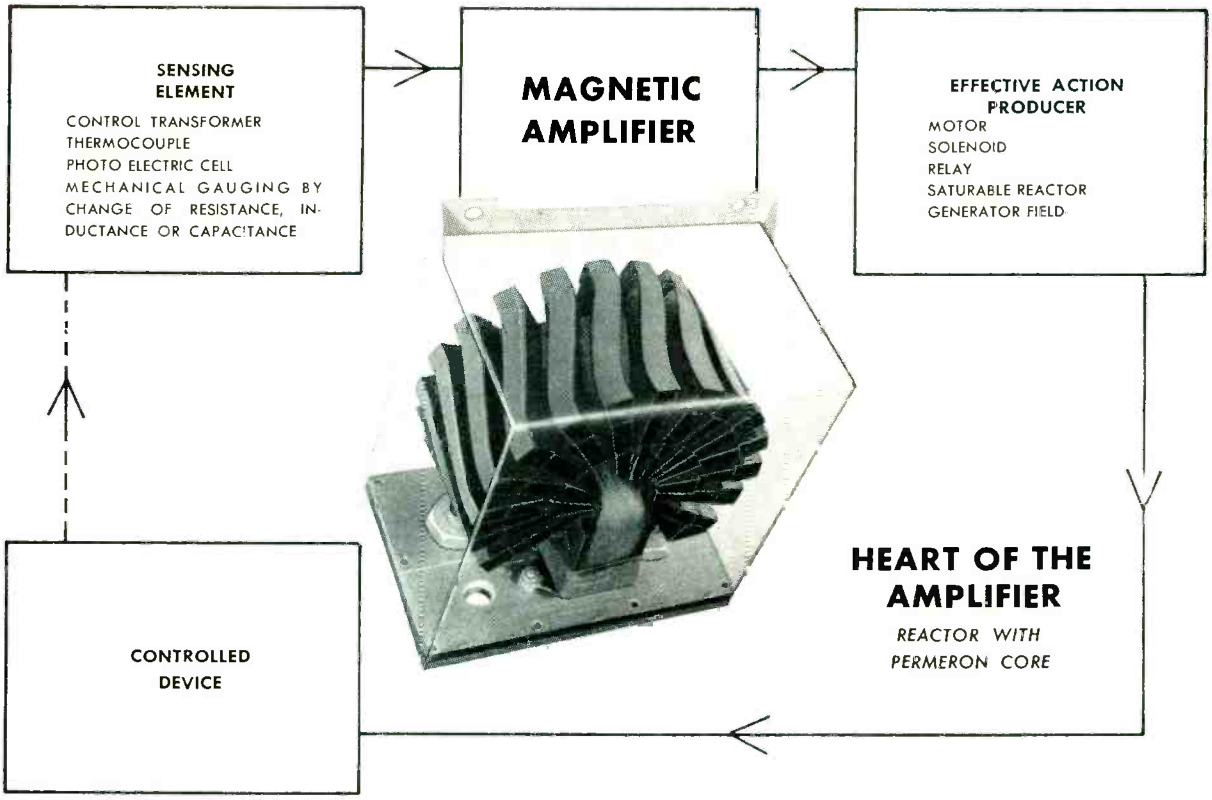

Why? Well, for one thing it's a *magnetic* amplifier. The advantages are obvious: there are no moving parts — hence, there's nothing to wear out. It's shock-proof and vibration-proof.

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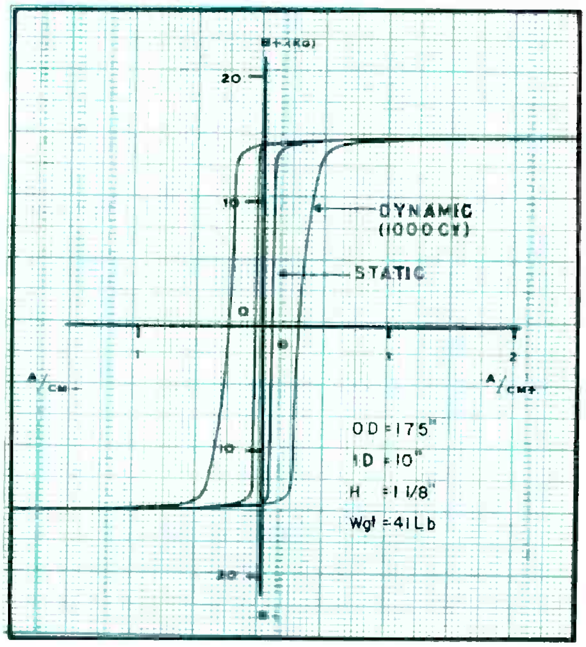
Magnetic amplifiers with PERMERON cores are now being produced by several large electrical manufacturers for an ever-expanding field of uses. These cores, with their amazing characteristics, have helped make magnetic amplifiers practical for many new uses and better for many old ones.

If *your* business is amplifiers, or controls, it will pay you to take another look at PERMERON!



For additional information write—I-T-E Rectifier Division, or consult your local I-T-E Representative

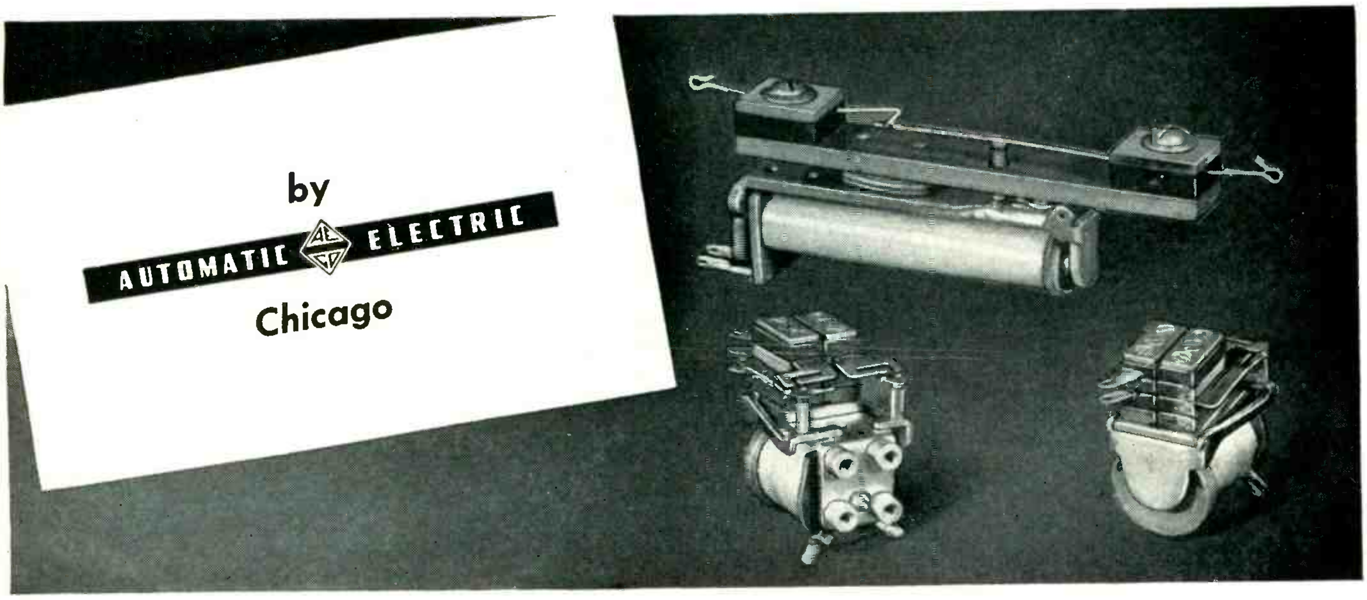
I-T-E PERMERON

A product of Rectifier Division, I-T-E CIRCUIT BREAKER COMPANY,
19th & Hamilton Streets, Philadelphia 30, Pa.

MECHANICAL RECTIFIERS • SWITCHGEAR • UNIT SUBSTATIONS • ISOLATED PHASE BUS STRUCTURES • RESISTORS • SPECIAL PRODUCTS

to control high frequencies

USE LOW-CAPACITANCE RELAYS...



For smooth, chatter-free control of microwave circuits . . . switch them with Automatic Electric relays. Automatic Electric made its first low-capacitance relay more than ten years ago, and today offers two types, each providing exceptionally low capacitance between contact springs, and between springs and ground (frame, mounting, etc.)

In addition to these low-capacitance characteristics, Automatic Electric relays provide the dependability of "twin" contacts and the small size you need for compact mounting. The Class "C" relay (background above) is especially suitable for strip mounting; it is only 0.687″ wide and $2\frac{1}{8}$″ high and is $5\frac{15}{32}$″ in over-all length. The Class "S" relay (two views in foreground) is 1″ wide, $1\frac{3}{8}$″ high and $1\frac{19}{32}$″ long, over-all. Operating mechanisms are basically standard Automatic Electric designs, thus assuring the high operating efficiency for which Automatic Electric controls are famous.

To receive complete information, simply let us know your specific needs. Address AUTOMATIC ELECTRIC SALES CORPORATION, Chicago 7, Ill. In Canada: Automatic Electric (Canada) Ltd., Toronto. *Offices in Principal Cities.*

RELAYS SWITCHES

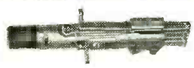
AUTOMATIC ELECTRIC

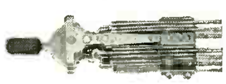
CHICAGO

OTHER AUTOMATIC ELECTRIC TELEPHONE-TYPE CONTROLS


Stepping Switches


Relays

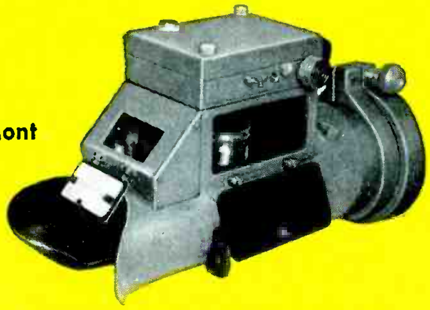

Turn Keys


Lever Keys

Efficient, dependable Automatic Electric controls are available also for many other uses. Lever, turn and push-type keys; telephone-type dials; stepping switches; lamp jacks and caps—as well as a complete range of telephone-type relays carrying the Automatic Electric name—are now in service in hundreds of industrial applications.

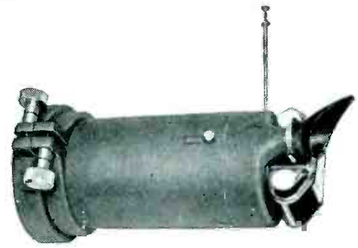
A new and complete line of oscillograph-record cameras.

The Du Mont Type 295



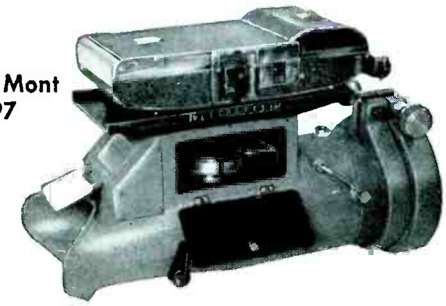
Transient phenomena representing writing rates as high as 180 inches per microsecond are recorded effectively with the Du Mont Type 295. The high-writing-rate capabilities of the Type 295 are obtained by the use of an f/1.5, 50mm, coated lens having excellent resolution and a minimum of rectilinear distortion. The camera accommodates plain or perforated 35mm film or paper and will make 40 exposures from a standard 36-exposure cassette Film may be removed from the camera as it is exposed by use of a cut-off knife and a detachable, light-tight, film take-up cassette. Thus, a portion of the film may be developed while subsequent exposures are being made. Comfortable binocular viewing is possible while recording. An illuminated data card records pertinent hand-written information directly below the exposed trace. The housing has a side-access door through which the lens aperture is accessible. The aperture control has "click" settings. Both Time and Bulb exposures may be taken. The camera may be adapted for remote control of film advance and shutter release.

The Du Mont Type 296



Single-frame recording provided by the Type 296 represents the most versatile and inexpensive general-purpose technique. Oscillograph-record application of the Type 296 is unlimited except by the specialized needs of moving-film recording and ultra-high writing speeds. Compact in design, light in weight, and sturdy in construction, the Type 296 is easy to handle and is mounted quickly to all 5-inch cathode-ray oscillographs equipped with the Du Mont Type 2501 Bezel. A high-quality, f/2.8, 41.5mm, coated lens increases the writing-rate capabilities of the Type 296 approximately 57% over the Type 271-A, which it supersedes. Shorter focal length shortens the over-all length of the Type 296. A self-winding shutter has speeds of 1/200, 1/100, 1/50, 1/25, 1/10 sec., Time and Bulb. A comfortable, soft-rubber eyepiece permits simultaneous viewing and recording. The Type 296 weighs only 5 lbs.

The Du Mont Type 297



For applications where minute-to-minute comparison of waveforms is required, the Du Mont Type 297 furnishes a finished print in a minute, by the Polaroid-Land Process. The Polaroid-Land camera-back is attached to the mirror housing by means of a slide adaptor which has three snap stops making it possible to record one, two, or three traces on a single print. The camera may be set at any point along the slide so that adjustment may also be continuous where more than three traces are desired on a single print. An illuminated data card permits recording information photographically on the print. All possible confusion between similar prints is eliminated. The camera is positioned so that the operator pulls the film toward him. Thus, the quick, smooth motion necessary to obtain clean prints is achieved with ease and comfort. The Type 297 incorporates a special, f/2.8 coated lens. Exposures may be taken at shutter speeds of 1/200, 1/100, 1/50, 1/25, 1/10 sec., Time, and Bulb. The recorded image is reduced to one-third the object size. The Type 297 is mountable on any 5-inch cathode-ray oscillograph and is supported completely by clamping it to the Du Mont Type 2501 Bezel.

The Du Mont Type 321

The moving-film camera makes possible the presentation of waveforms upon an unusually long time-base, and augments the performance of the cathode-ray oscillograph.

Many improvements from the standpoints of performance and operation have been incorporated in the Type 321 to simplify moving-film recording. The camera accommodates 400 feet of perforated or unperforated 35mm film or recording paper. Both the load and take-up magazines may be detached from the camera in a few seconds. Film-loading is amazingly simple — there is no threading necessary, no complicated path to follow. Film speed is variable in eighteen steps from approximately one inch per minute to 10,800 inches per minute (15 feet per second).

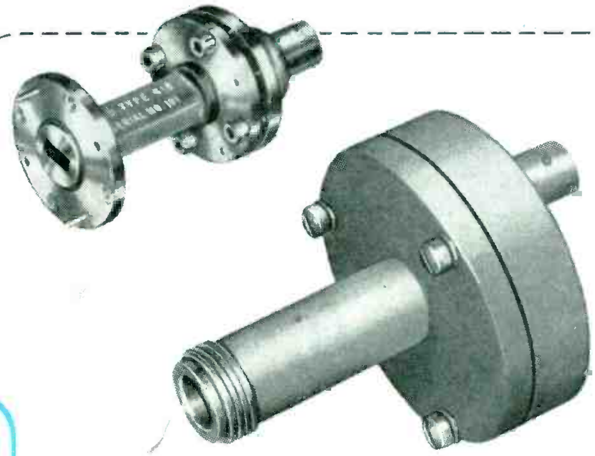
Full speed is attained almost instantly. Less than one inch of film is wasted in stopping the motion of the film even when the camera is operating at the highest speed. Specially designed film-braking minimizes the possibility of clogging, jamming, or breaking of the film. A film-supply indicator gives positive indication when the recording film is exhausted.

The camera may be rotated 90 degrees, permitting either vertical or horizontal recordings to be made without rotating the cathode-ray tube or reversing deflection-plate leads. Single-frame records may also be made with the Type 321. Film travel may be time-calibrated by a flashing glow lamp. The light shield permits simultaneous viewing and recording. An illuminated data-card transfers pertinent information to the film. The Type 321 uses an f/1.5, 50mm, coated lens. Focus is fixed for general oscillographic applications but may be adjusted where required. Any desired length of exposed film may be removed from the camera by means of a cut-off knife. The take-up magazine may be removed quickly and carried to the darkroom. Additional magazines are relatively inexpensive. Stand mounting makes the Type 321 highly mobile. It can be mounted either from the floor or bench top. There is no mechanical connection between the camera and the oscillograph. A sponge-rubber sleeve makes the mounting light-tight and vibration proof.

ALLEN B. DU MONT LABORATORIES, INC.
INSTRUMENT DIVISION
1000 MAIN AVE., CLIFTON, N. J.

WHAT is a MILLIWATT?

–for the correct answer from VHF to EHF, ask PRD

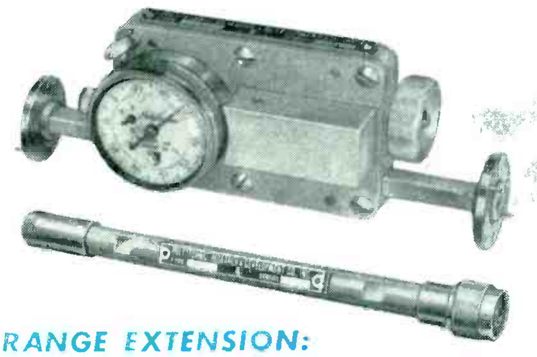


DETECTION:

PRD now offers a complete series of Broadband Coaxial Bolometer Mounts covering in three bands the range from 20 to 10,000 megacycles per second. Both 1 mw and 100 mw units are available for direct operation with the PRD Type 650 Universal Power Bridge. Additional wave-guide detectors provide coverage of the 12.4-40 kilo-megacycle band.

INDICATION:

Direct reading power measurement in four ranges of 0.1, 1, 10, and 100 milliwatts full scale is provided by the Type 650 Universal Power Bridge. This instrument may be used with positive or negative temperature coefficient bolometers operating from 50 to 250 ohms with bias currents of 3 to 40 milliamperes.



RANGE EXTENSION:

A full complement of fixed and variable attenuators permits extension of the power range of bolometer elements to higher input levels. Directional couplers are also available for this purpose.

PRD now provides the instrumentation to permit accurate power measurement over broad frequency bands with great precision and comforting ease of operation. Thus, another parameter is erased from the realm of the unknown by PRD's continuing program aimed at providing the r-f engineer with the best in test equipment. For full information concerning our complete list of products write Dept. E-9 today.

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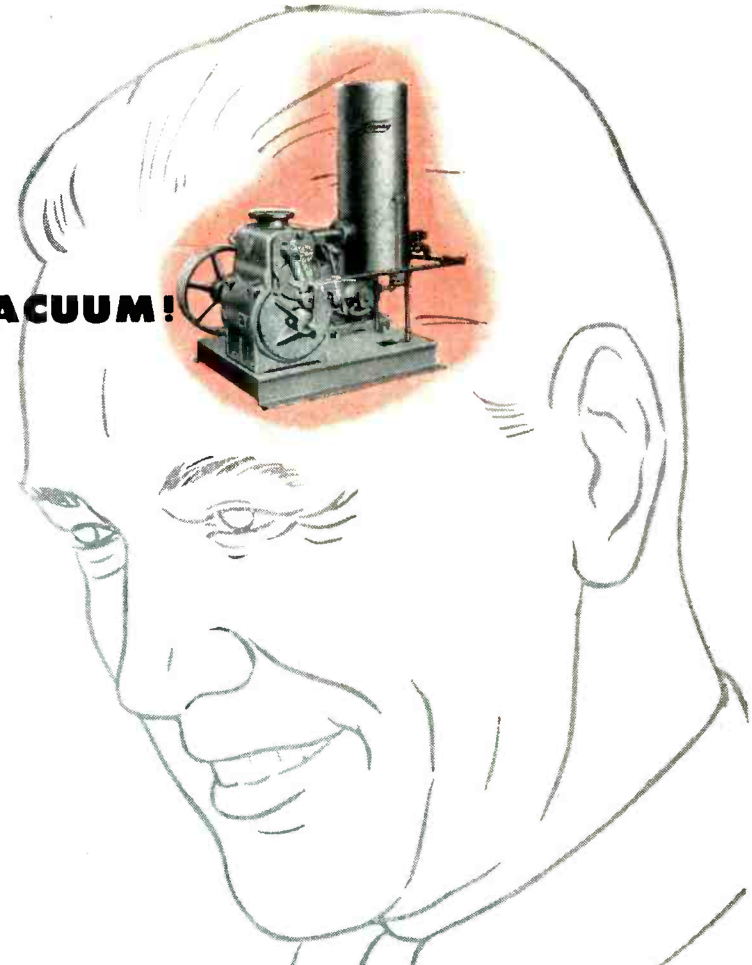
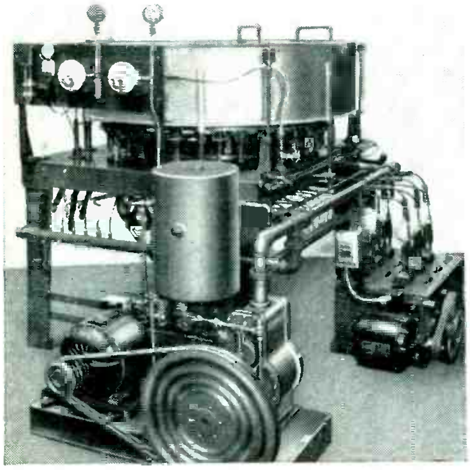
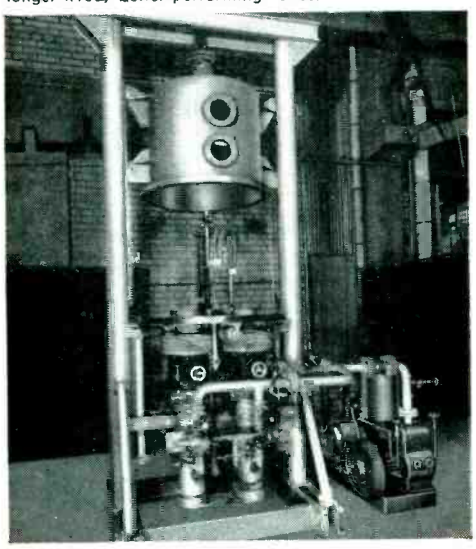




Eisler Radio Tube Machine showing Kinney Single Stage Pump used for initial pump-down and for backing Eisler Pump. The vacuum exhausting process is fast, sure, and extremely complete . . . making possible longer-lived, better performing tubes.



National Research Corporation high vacuum metallurgical furnace. Kinney Pump used for roughing and for backing diffusion pumps. In high vacuum furnaces metals like Titanium, Zirconium and Molybdenum are being cast or treated in the pure gas-free state. These vacuum-processed metals display new qualities of ductility and conductivity . . . new advantages made possible by Kinney-created low absolute pressures.

When the job calls for vacuum processing, keep *Kinney High Vacuum Pumps* in mind. Thousands and thousands of successful installations prove beyond doubt that it's wise to make Kinney Pumps your first thought for vacuum!

Why do so many modern vacuum processing systems employ Kinney Vacuum Pumps? Because these Pumps save processing time, because they conserve operating costs, and because they can be trusted on the job. If you want fast pump-down and minimum equipment "down-time", the Kinney Pump is the pump you need. Write for Bulletin V45, the complete story on Kinney High Vacuum Pumps and Equipment.

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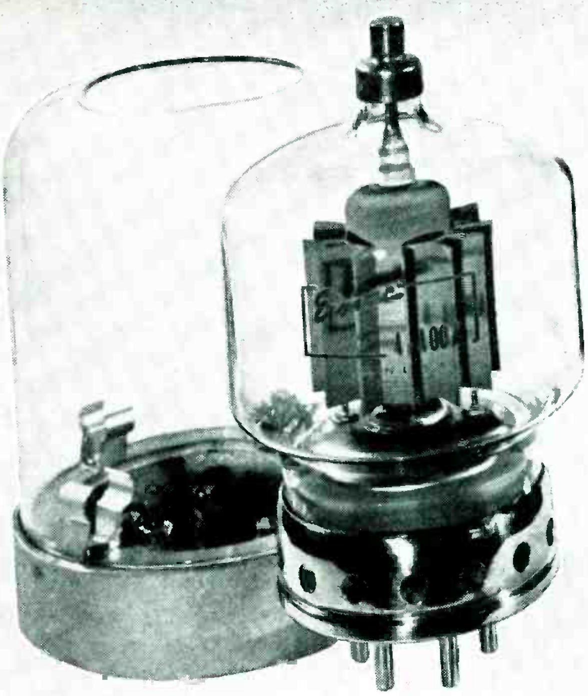
Making old things better
Making new things possible

KINNEY Vacuum Pumps

the 4-400A



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★ Audio Amplifier

★ Simplified Cooling

★ Pyrovac Plate

★ Non-Emitting Grids

★ And . . . thoroughly proved in service.

EIMAC 4-400A POWER TETRODE
TYPICAL OPERATION
AUDIO FREQUENCY POWER AMPLIFIER AND MODULATOR

Class AB₁ (Sinusoidal wave, two tubes, unless otherwise specified)

DC PLATE VOLTAGE	3000	4000	Volts
DC SCREEN VOLTAGE - - -	750	600	Volts
DC GRID VOLTAGE (approx.)* - - -	−136	−116	Volts
ZERO SIGNAL DC PLATE CURRENT -	160	130	Ma
MAX. SIGNAL DC PLATE CURRENT -	620	510	Amp
ZERO SIGNAL DC SCREEN CURRENT	0	0	Ma
MAX. SIGNAL DC SCREEN CURRENT	28	10	Ma
EFFECTIVE LOAD PLATE TO PLATE -	9200	16,000	Ohms
PEAK AF GRID INPUT VOLTAGE (per tube) - - -	136	116	Volts
DRIVING POWER -	0	0	Watts
MAX. SIGNAL PLATE POWER OUTPUT -	1100	1280	Watts

*Adjust to give stated zero-signal plate current.

A pair of Eimac 4-400A tetrodes provides the ideal answer for a one-kilowatt AM or FM broadcast power amplifier stage. The 400-watt plate dissipation rating of these tubes allows extremely conservative operation at the 1-kw level, thus assuring long, trouble-free tube operation.

In AM service, the 4-400A is FCC rated for 500 watts output per tube in high level modulated amplifiers. In FM applications, the superlative performance of the 4-400A at VHF allows an easy 1-kw of useful power output from a pair of tubes.

The low driving-power requirement of these tetrodes allows the driving equipment to be reduced to simple low power stages employing low cost tubes. The rugged construction of the 4-400A, plus a Pyrovac plate and the use of other time-proven materials and manufacturing processes, contributes to the tube's long life and ability to withstand both physical and electrical abuse.

To simplify transmitter design, an Eimac air system socket and chimney assembly is available for the 4-400A. This assembly provides a balanced flow of cooling air to the tube with minimum air waste, as well as completing the shielding between input and output circuits.

The low driving-power required by the 4-400A makes it an ideal choice for audio as well as r-f application. High audio power at low distortion can easily be obtained with zero driving power. (See accompanying data.)

For tube economy in one-kilowatt equipment, consider the service-proven 4-400A developed by America's foremost tetrode manufacturer . . . Eimac. Complete technical data are available . . . write today.

Follow the Leaders to Eimac TUBES The Power for R-F

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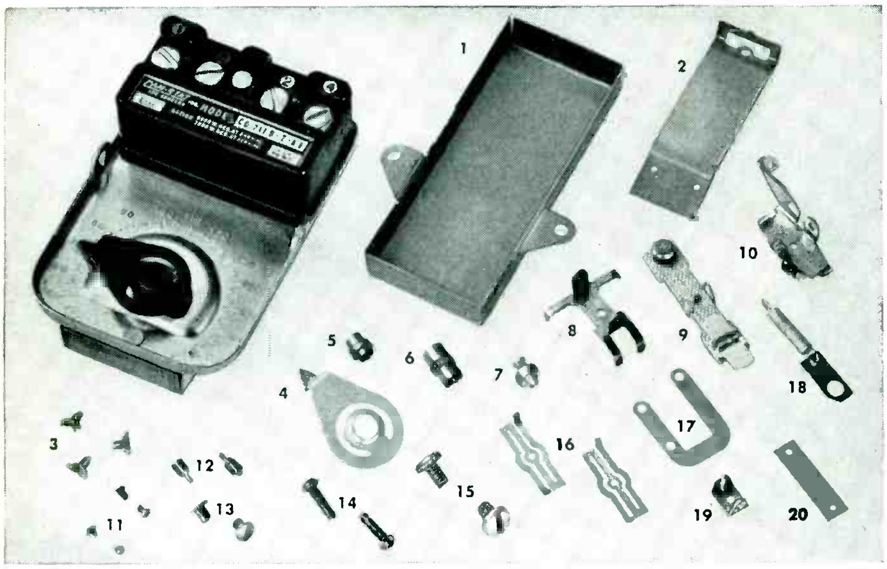
COPPER ALLOY BULLETIN

REPORTING NEWS AND TECHNICAL DEVELOPMENTS OF COPPER AND COPPER-BASE ALLOYS

Prepared Each Month by BRIDGEPORT BRASS COMPANY "Bridgeport" Headquarters for BRASS, BRONZE and COPPER



Hot water thermostat and component parts—Courtesy Camstat, Inc., Los Angeles, Calif.

Seven Copper Alloys Resist Corrosion in Bi-Metal Switch

Rusting and other forms of corrosion change the electrical characteristics of parts, decrease strength of springs and jam bearing points in small control instruments.

To combat such conditions, copper-base alloys were primarily selected for all functional parts in the illustrated water heater thermostat. This unit operates with a bi-metal actuator which curves forward as the result of one metal expanding more rapidly than another.

Since each copper alloy has different mechanical and physical characteristics, seven were used in this unit, and, in some cases, several tempers for each alloy.

Cartridge brass, 70% copper and 30% zinc, because of its ability to withstand heavy working better than high brass, is used for the cover (1), bracket (2), pointer (4), yoke (9), and staple (3). Half hard metal was necessary to permit drawing, forming and bending of the cover, pointer and yoke, and in the staple to permit the prongs to be bent at assembly. The bracket is spring hard (8 numbers) as it acts as a flat spring.

Phosphor bronze Grade A, 95% copper, 5% tin, 0.15 phosphor, produces flat springs in light gages (0.006 and up) due to its excellent spring properties and resistance to fatigue. This alloy is used for the contact springs (16), push button spring (17), spring link (18) and flat spring (20). All have spring temper.

Nickel Silver Grades A, B

Two grades of Nickel silver find use in this unit. In the pivot bracket (8) grade B, 55% copper, 18% nickel and the remainder zinc, gives the part fine spring characteristics, high strength (better than 90,000 psi in its extra hard temper), and the ductility in this hard state to permit heavy bending and forming.

Grade A, 65% copper, 18% nickel and remainder zinc, has greater ductility than B which permits dimpling, bending and forming on the actuating lever (10). The base metal is hard (4 numbers) and has a tensile strength of 85,000. The coldworking done on this lever increases its strength to around 90,000.

Several Parts Machined

Free machining brass rod, with the highest machinability of the copper alloys, can be accurately machined with good finishes at high speeds. For these reasons, it is used for the counterweight (shown on assembly 9), adjusting nut (5), terminal (6), stub (7), and calibrating screw (12). This alloy also has a conductivity 26% that of copper.

The hollow rivets (11) and (13) are produced in cold headers from 70-30 (cartridge brass) wire. When the hollow rivets are such that drilling is required rather than extrusion in the header, a light leaded wire is used (65% copper, 0.3% lead and remainder zinc) to facilitate the drilling.

The cold headed and roll threaded screws (14) and (15) are made from high brass, 65% copper, 35% zinc. Although not as ductile as the cartridge brass used in the hollow rivets, it is sufficiently ductile for medium-sized heads and roll threading.

Silver Rivets

The hollow rivets used for electrical contacts in the switch under the silver links are also of silver to eliminate danger of arcing.

Bridgeport's laboratory can be of help to product engineers in the selecting of the best alloy from a functional as well as fabricating standpoint. Write the nearest district office or contact Bridgeport directly.

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Measuring Split Seconds . . .
with the help of Holtzer-Cabot motors!

This ingenious electronic device, made by American Time Products, Inc., tells in 30 seconds exactly how fast or how slow any watch is running per 24 hours (a job that used to require weeks of checking). Here's how it works: — the ticks of a watch, picked up by a sensitive crystal microphone, activate a stylus which prints a dot for each tick on a revolving chart drum. The pattern made by these dots indicates the slightest variation of time-keeping accuracy, and also indicates the cause of any irregularity.

Designing a suitable motor for this high-precision instrument presented a difficult problem, due to the demanding specifications of the application:

- The motor must rotate the drum with an accuracy of one part in one hundred thousand.
- The motor must be exactly synchronous.
- It must have the necessary torques to operate the mechanical system with a margin of safety.
- The velocity of rotation must be perfectly smooth and uniform.
- The motor must be free from all electrical and mechanical noises which might be picked up by the microphone.

Holtzer-Cabot engineers were called in at the prototype stage and, working with American Time Products' engineers, met all requirements by designing a modification of the Holtzer-Cabot RWC 2505 synchronous motor. Result — years of trouble-free performance in the field.

This is just another example of Holtzer-Cabot's ability to meet the most demanding specifications in small-motor applications. Holtzer-Cabot motors range from 1/2000 up through 1½ H.P.; from 24,000 RPM to 1 revolution per day!

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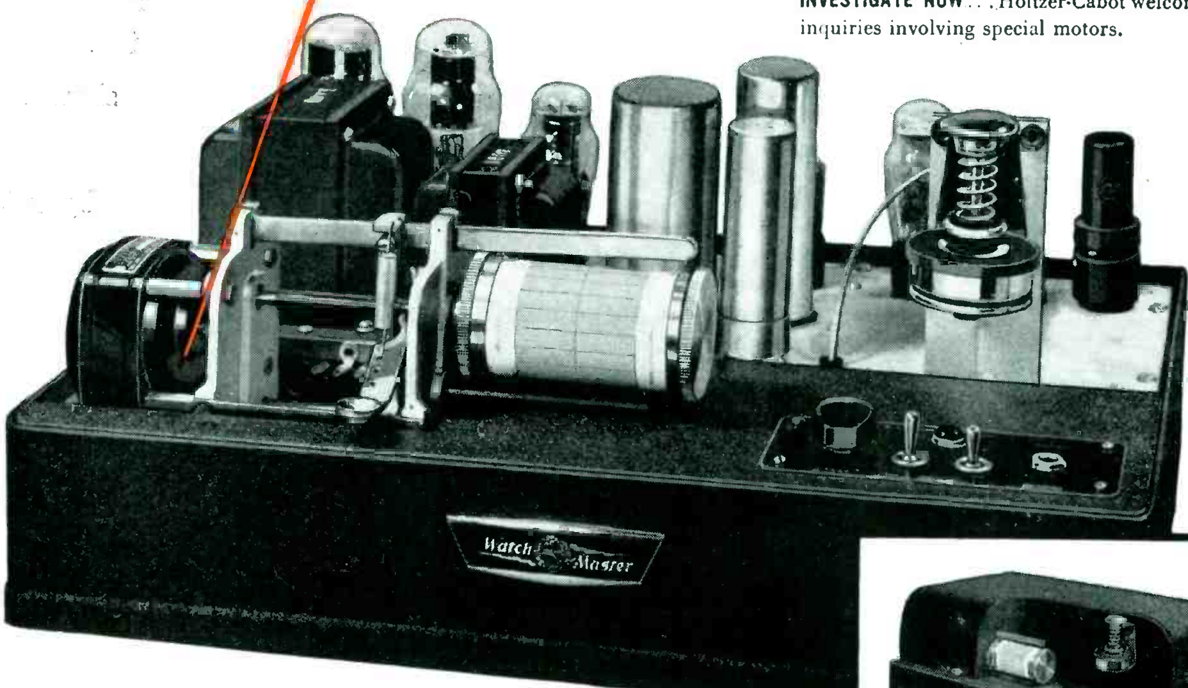
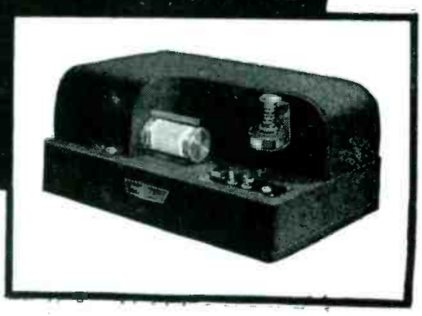
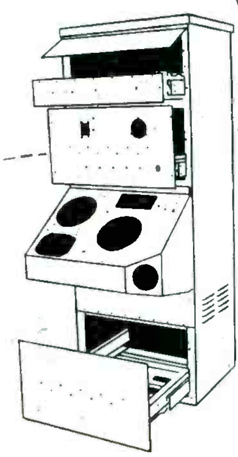
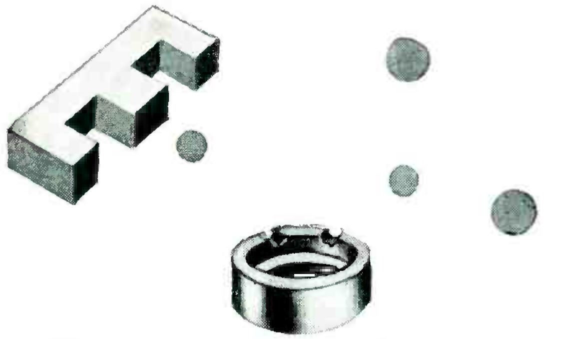




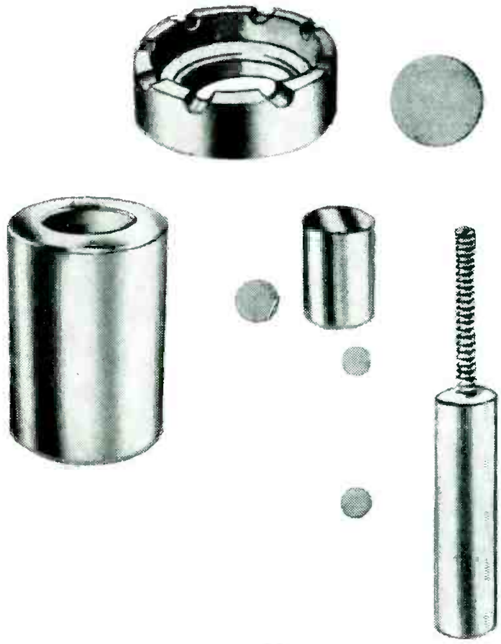
This is the WatchMaster . . . Watchmakers, watch manufacturers and jewelers everywhere use it to measure the accuracy of timepieces.

Photos Courtesy of American Time Products, Inc.





to all users of powdered iron cores...



Core users—here's a tip that will guarantee you cores made of the highest quality materials on the market. Ask your core maker for cores made with Carbonyl Iron Powders. You will guarantee yourself high quality cores because Carbonyl Iron Powders are high quality products with low loss characteristics. They are manufactured and tested for quality under the most rigid conditions.

It costs no more to secure Carbonyl Iron Powder cores. On a performance basis, they offer savings not possible with other magnetic powder.

Your core maker knows about these high Q materials. He is familiar with their stability, their ease of insulation, and the controlled particle size distribution. That's why we say, next time you order, insist on Carbonyl Iron Powders for best results!

THIS FREE BOOK — fully illustrated, with performance charts and application data — will help any radio engineer or electronics manufacturer to step up quality, while saving real money. Kindly address your request to Dept. 56.

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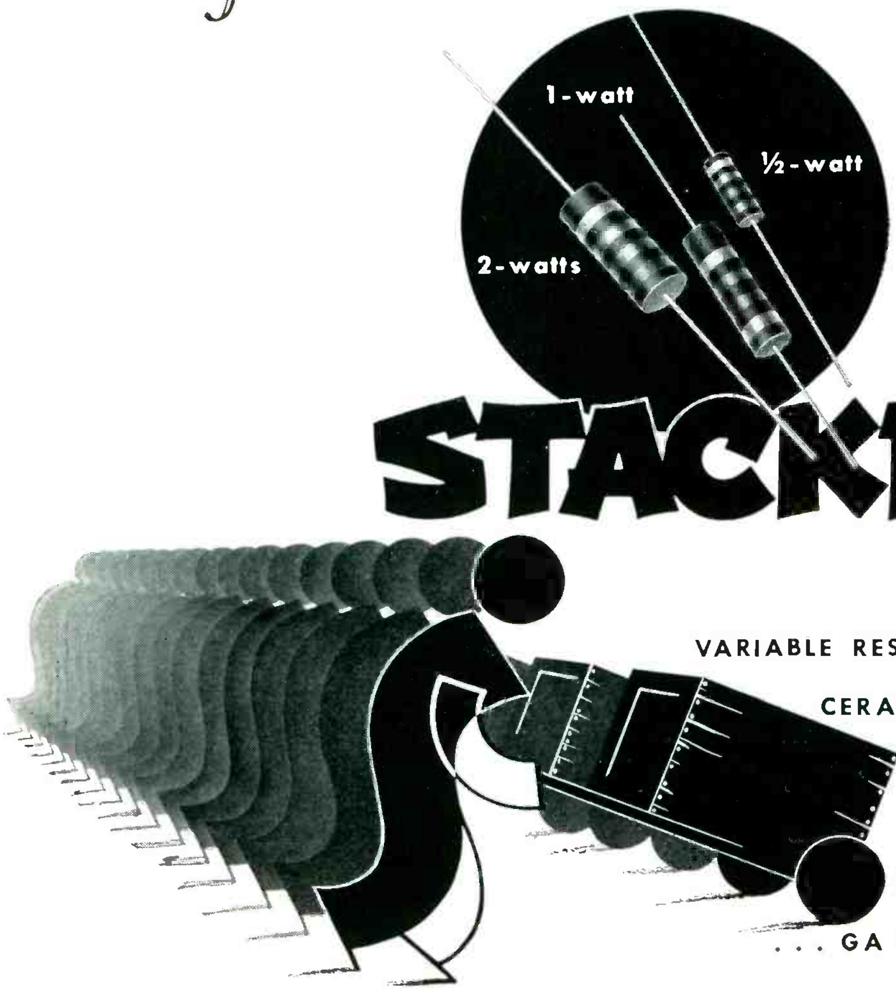

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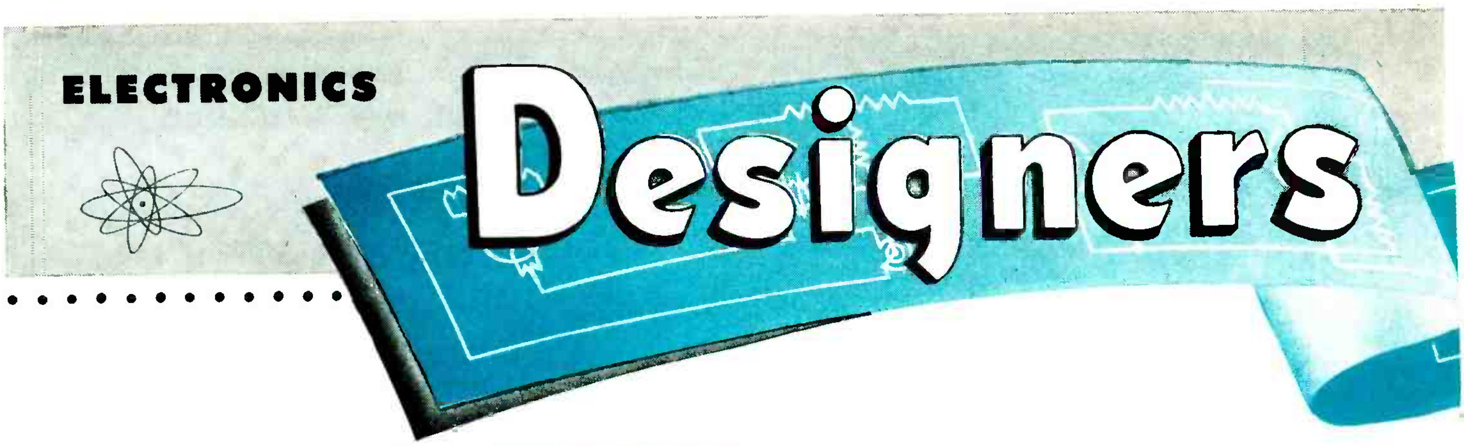
From 2 cycles to 700 megacycles, there's an accurate, easy-to-operate -*hp*- voltmeter to fit every voltage measurement requirement. You can choose from 5 precision voltmeters (including a battery-operated instrument) the ones which precisely fill your measuring need. Each has the familiar -*hp*- characteristics of high sensitivity, wide range, versatility, compact size, and time-saving ease of operation. These -*hp*- precision voltmeters are used by radio stations, manufacturers, research laboratories and scientific men throughout the world.

INSTRUMENT	FREQ. RANGE	VOLTAGE RANGE	ACCURACY	INPUT IMPEDANCE	PRICE
-hp- 400A	10 cps to 1 mc	.005 to 300 v 9 ranges	Within 3%	1 meg., 16 μμfd shunt	$185.00
-hp- 400B	2 cps to 100 kc	.005 to 300 v 9 ranges	Within 3%	10 meg., 20 μμfd shunt	195.00
-hp- 400C	20 cps to 2 mc	.0001 v to 300 v 12 ranges	Within 3%	10 meg., 15 μμfd shunt	200.00
-hp- 404A (Battery Op'd.)	2 cps to 50 kc	.0005 v to 300 v 11 ranges	Within 5%	10 meg., 20 μμfd shunt	185.00
-hp- 410A	20 cps to 700 mc	0.1 v to 300 v 7 ranges	Within 3%	10 meg., 1.3 μμfd shunt	245.00

For complete data on any -hp- instrument, write direct to factory or contact the nearest -hp- technical representative.

HEWLETT-PACKARD CO.
1876-A PAGE MILL ROAD • PALO ALTO, CALIF.
Export Agents: Frazar & Hansen, Ltd.
301 Clay Street, San Francisco 11, California, U.S.A.

hp laboratory instruments
FOR SPEED AND ACCURACY



PANEL INSTRUMENTS—A COMPLETE LINE

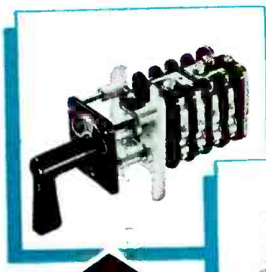
Accurate and Reliable

FOR MEASURING D-C, A-C, RF, AF, VU

General Electric panel instruments have long been known for their reliability and accuracy. Recent design changes provide for better performance, readability, durability, and appearance. G-E voltmeters, kilovoltmeters, ammeters, milliameters, microammeters, and vu volume-level indicators; thermocouple types and rectifier types; round or square, with conventional or long 250-degree scales—all will give your measurements the accuracy required and your panel that smooth, modern appearance. To bring you up to date on the latest improvements in cases, faces, and mechanisms, G.E. offers a comprehensive 24-page bulletin containing all information necessary for ordering. Write for Bulletin GEC-368. For vu indicators, see Bulletin GEC-369.

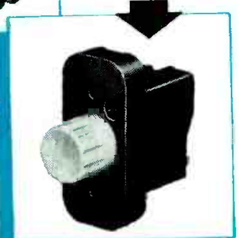
SOLVE DESIGN PROBLEMS WITH THE SWITCH OF 10,000 USES

A member of the well known SB-1 switch family can find a useful place on almost any large electronic control panel. The precision-built parts of this all-purpose switch permit as many as 40 stages—four banks of ten stages each—to be operated in tandem. Switches with up to 16 stages and 12 positions are commonly furnished. Over 10,000 circuit-sequence combinations are possible. Ratings go to 20 amperes at 600 volts a-c or d-c. See Bulletin GEC-270.



SB-1 switch, cover-removed

Illuminated push button

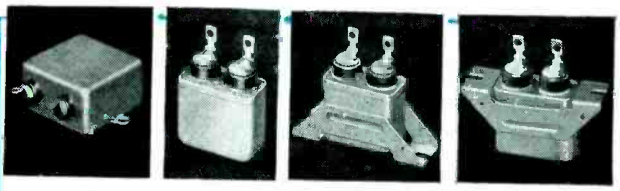


SAVE PANEL SPACE WITH ONE-UNIT PUSH-BUTTON AND INDICATING LIGHT

This space-saving pilot-circuit switch consists of a sturdy push-button unit, 2⅝ inches high, with a hollow translucent cap and 6-volt lamp. The switch is the momentary contact type, single-pole, with one normally open and one normally closed circuit. It uses movable-disk type contacts. Buttons are supplied in clear, red, green, blue, amber, and white. For more data on this and other G-E push-button units, see Bulletin GEA-4254.

GENERAL ELECTRIC

TIMELY HIGHLIGHTS ON G-E COMPONENTS

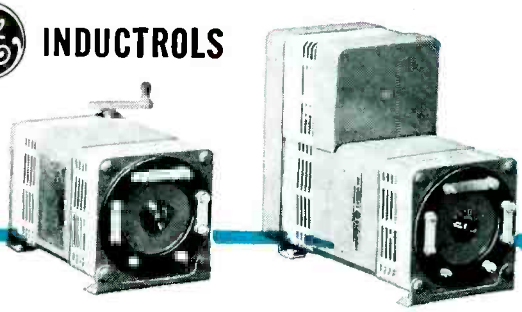


PERMAFIL CAPACITORS

NO DERATING AT 125° C OPERATION

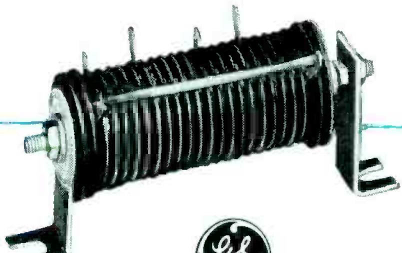
For operation at high ambient temperatures, these standard-line G-E Permafil capacitors are naturals. They're paper dielectric units and can be used at temperatures up to 125° C without derating. All are metal encased, compression-sealed, and have long-life silicone bushings. Ratings: up to 2 muf for operation at 400 volts d-c and below. Case styles: 53, 61, 63, and 65 (JAN-C-25 specifications). For more data, write Capacitor Sales Div., General Electric Co., Pittsfield, Mass.

INDUCTROLS



STEPLESS VOLTAGE VARIATION

Inductrols are G-E dry-type induction voltage regulators for 120 and 240-volt operation. Hand-operated models provide smooth and extremely precise voltage adjustment for such uses as instrument calibration and rectifier control. Motor-operated models are used with automatic control to maintain voltage within narrow limits, irrespective of supply variations. Sizes range from 10¼ x 6⅛ x 7⅞ inches for the smallest hand-operated unit to 14 x 6 x 10⅞ for the largest motor-operated unit. One unit provides a voltage range of 10% raise and lower on 3 and 6-kva circuits, another gives 100% raise and lower for 2.4 and 3.6 kva circuits. Complete information in Bulletin GEA-4508.



HIGH-VOLTAGE SELENIUM RECTIFIERS

WITH LIFE EXPECTANCY OF 60,000 HOURS!

Now available from G.E. are 26-volt RMS selenium rectifier cells with a continuous-service life expectancy of over 60,000 hours. Their initial forward resistance is very low and samples show an average increase in resistance of less than 6% after 10,000 hours of operation. General Electric knows of no other high-voltage selenium cell on the market that can even approach their performance.

The high output voltage permits the design of smaller stacks while the low resistance means cooler operation and the space saving that goes with it.

Stacks made with the new G-E cells may be obtained with rated outputs from 18 to 126 volts d-c at .15 to 3.75 amps. Write now for Bulletin GEA-5280.

General Electric Company, Section E667-7
Apparatus Department, Schenectady 5, N. Y.

Please send me the following bulletins:

Indicate for reference only (V)
for planning an immediate project (X)

- ☐ **GEA—4254 Push-button units**
- ☐ **GEA—4508 Inductrols**
- ☐ **GEA—5280 Selenium rectifiers**
- ☐ **GEC—270 SB-1 switch**
- ☐ **GEC—368 Panel instruments**
- ☐ **GEC—369 Vu volume-level indicators**

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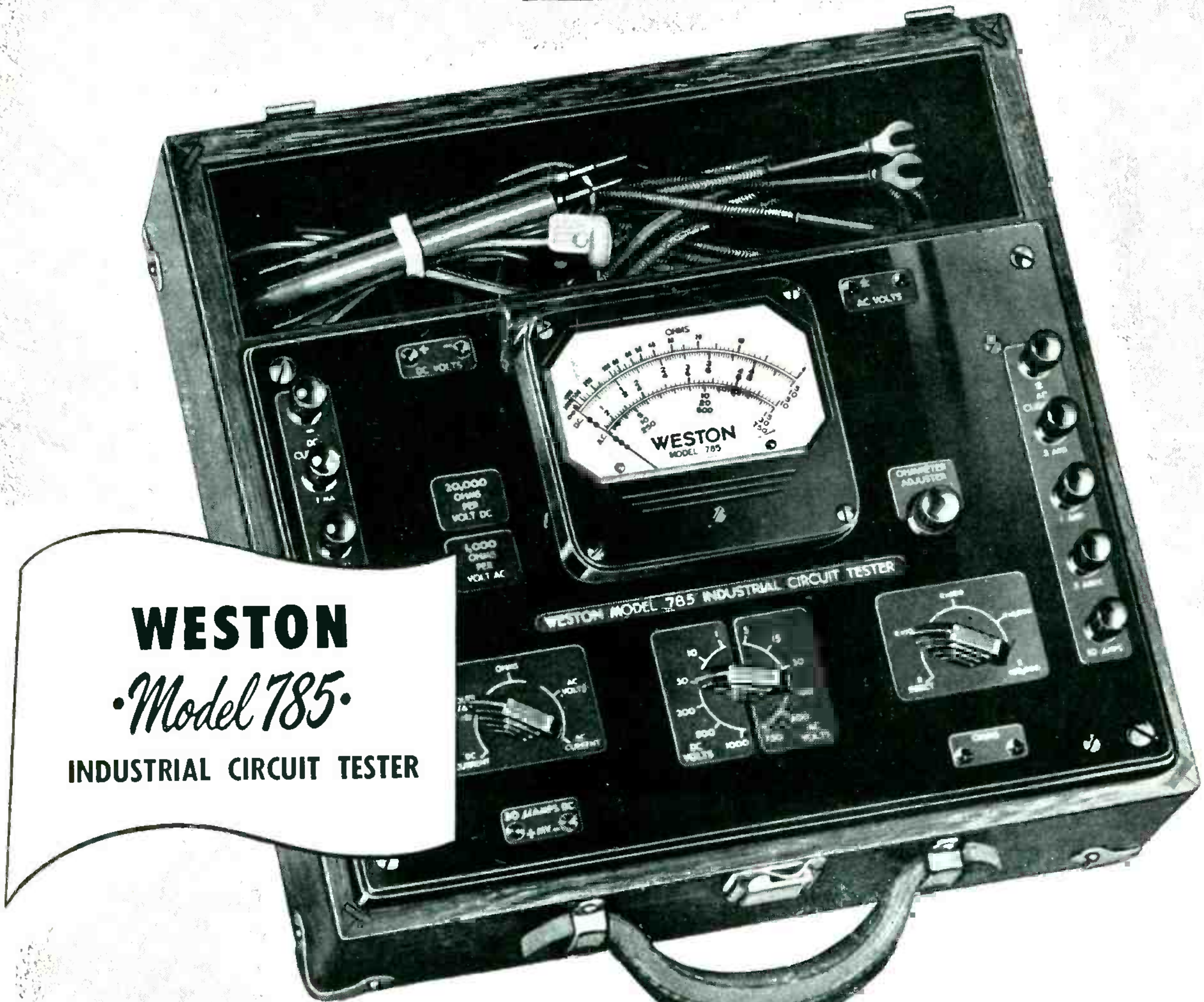
COMPANY____________________

ADDRESS____________________

CITY__________ STATE__________

NO OTHER TESTER

does so much...so well!



In the shop . . . 28 ranges *in one case* to locate circuit troubles on production equipment.
On the bench . . . 28 ranges *in one case* for checking electrical equipment during manufacture.
In the lab . . . 28 ranges *in one case* immediately available for research and development work.

28 Instrument Ranges

D-C VOLTS: 100 mv, 1/10/50/200/500/1000 volts (20,000 ohms per volt).
A-C VOLTS: 5/15/30/150/300/750 volts.
D-C CURRENT: 50 microamps; 1/10/100 milliamps; 1/10 amps.
A-C CURRENT: .5/1/5/10 amps.
RESISTANCE: 3000/30,000/300,000 ohms; 3/30 megohms.

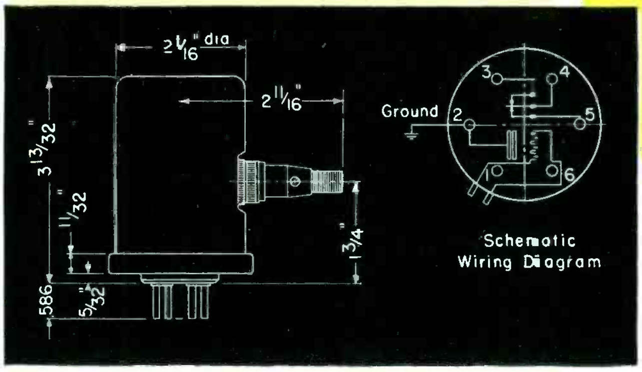
Stock Accessories Available for Extending Above Ranges

It does *so* much, *so* well, for *so* little. Check your Weston Representative for full details or see your local jobber. Weston Electrical Instrument Corporation, 618 Frelinghuysen Avenue, Newark 5, New Jersey . . . manufacturers of Weston and Tagliabue Instruments.

WESTON *Instruments*

Albany • Atlanta • Boston • Buffalo • Charlotte • Chicago • Cincinnati • Cleveland • Dallas • Denver • Detroit • Houston • Jacksonville • Knoxville • Little Rock • Los Angeles • Meriden • Minneapolis • Newark • New Orleans New York • Orlando • Philadelphia • Phoenix • Pittsburgh • Rochester • San Francisco • Seattle • St. Louis • Syracuse • Tulsa • Washington, D. C. • In Canada, Northern Electric Company, Ltd., Powerlite Devices, Ltd.

BROWN INSTRUMENTS ACCELERATE RESEARCH



Combines Longevity and Dependability

...The Brown 400 Cycle Converter

ELECTRICAL CHARACTERISTICS

DRIVING COIL REQUIREMENTS—18 volts, 94 milliamperes, 400 cycles ± 10 per cent.

CONTACT RATING—SPDT switching. Nominal rating, 28 volts to one microvolt, 1.0 milliampere; maximum power, 100 microwatts.

SWITCHING ACTION—Each contact closed 55 per cent of each cycle, closed simultaneously 5 per cent of the time.

SYMMETRY—Within 5 per cent.

LOAD CHARACTERISTICS—Resistive or inductive.

SHIELDING—Shell and coil shields, both grounded through pin No. 2.

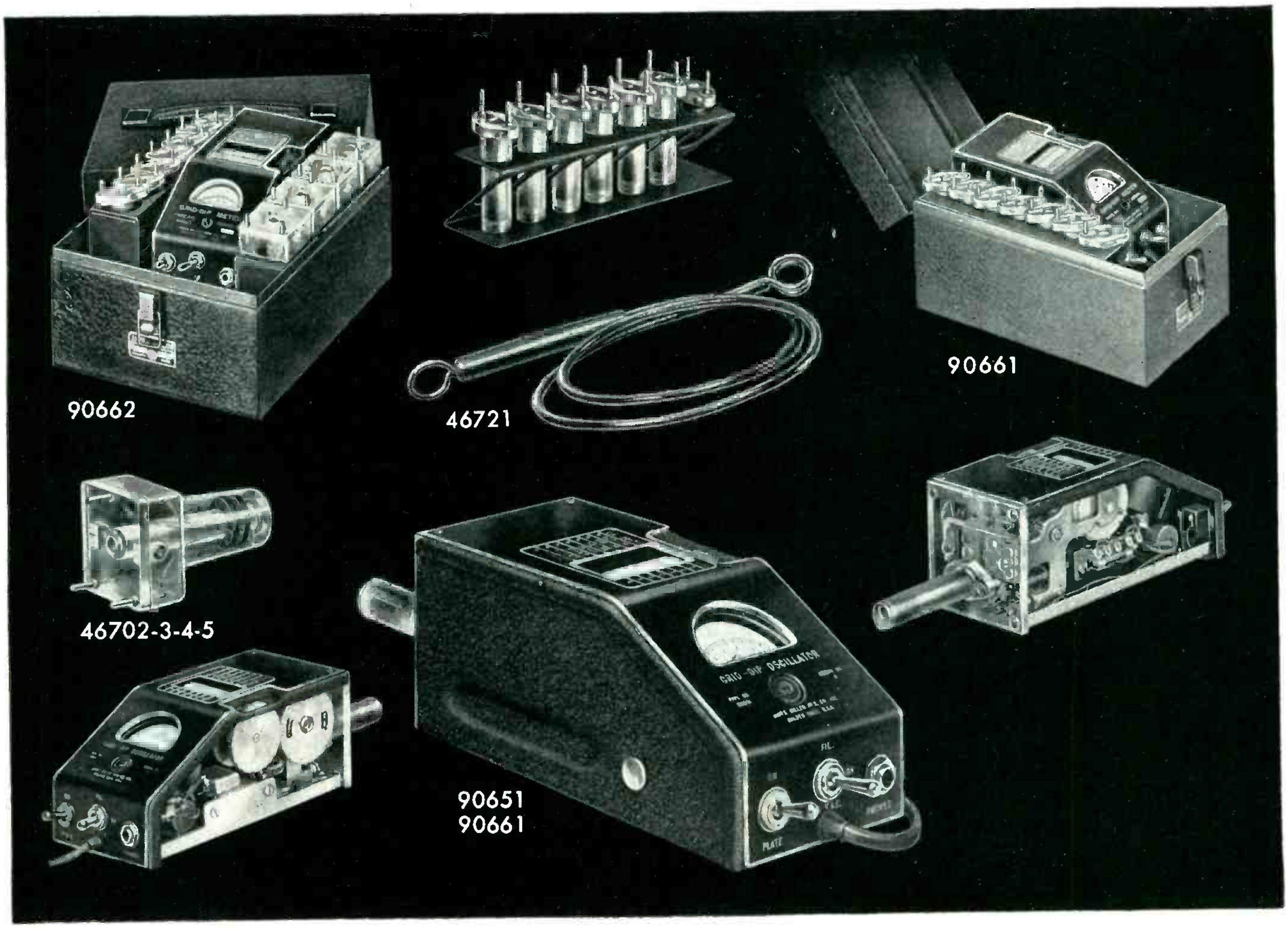
VIBRATION RESISTANCE—Output voltage will vary less than 2 per cent, with rates of vibration from 0 to 10 g.

PHASE SHIFT—Output voltage differs from that of driving voltage by 45 to 50 degrees.

STRAY PICK-UP—Sufficiently low for the measurement of a one microvolt d-c signal after amplification by a suitable audio frequency amplifier.

Practically identical to the service-proved 60 cycle converter used in the Brown line of *ElectroniK* precision instruments, this component is ideal for use with any system involving the conversion of low-power direct voltage signals of the order of 100 microvolts to 400 cycle alternating voltages. It is particularly useful for applications requiring error voltage measurements or null detection. The design and arrangement of its contacts practically eliminate electrostatic stray potential pick-up. For detailed information, write for a copy of Data Sheet 10.20-1. MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4428 Wayne Ave., Phila. 44, Pa. Offices in more than 80 principal cities of the United States, Canada and throughout the world.

MINNEAPOLIS Honeywell
BROWN INSTRUMENTS



Designed for Application

GRID DIP METERS

Millen Grid Dip Meters are available to meet all various laboratory and servicing requirements.

The 90662 Industrial Grid Dip Meter completely calibrated for laboratory use with a range from 220 kc. to 300 mc. incorporates features desired for both industrial and laboratory application, including three wire grounding type power cord and suitable carrying case.

The 90661 Industrial Grid Dip Meter is similar to the 90662 except for a reduced range of 1.7 to 300 mc. It likewise incorporates the three wire grounding type cord and metal carrying case.

The 90651 Standard Grid Dip Meter is a somewhat less expensive version of the grid dip meter. The calibration while adequate for general usage is not as complete as in the case of the industrial model. It is supplied without grounding lead and without carrying case. The range is 1.7 to 300 mc. Extra inductors available extends range to 220 kc.

The Millen Grid Dip Meter is a calibrated stable RF oscillator unit with a meter to read grid current. The frequency determining coil is plugged into the unit so that it may be used as a probe.

These instruments are complete with a built-in transformer type A.C. power supply and interminal terminal board to provide connections for battery operation where it is desirable to use the unit on antenna measurements and other usages where A.C. power is not available. Compactness has been achieved without loss of performance or convenience of usage. The incorporation of the power supply, oscillator and probe into a single unit provides a convenient device for checking all types of circuits. The indicating instrument is a standard 2 inch General Electric instrument with an easy to read scale. The calibrated dial is a large 270° drum dial which provides seven direct reading scales, plus an additional universal scale, all with the same length and readability. Each range has its individual plug-in probe completely enclosed in a contour fitting polystyrene case for assurance of permanence of calibration as well as to prevent any possibility of mechanical damage or of unintentional contact with the components of the circuit being tested.

The Grid Dip Meters may be used as:

1. A Grid Dip Oscillator
2. An Oscillating Detector
3. A Signal Generator
4. An Indicating Absorption Wavemeter

The most common usage of the Grid Dip Meter is as an oscillating frequency meter to determine the resonant frequencies of de-energized tuned circuits.

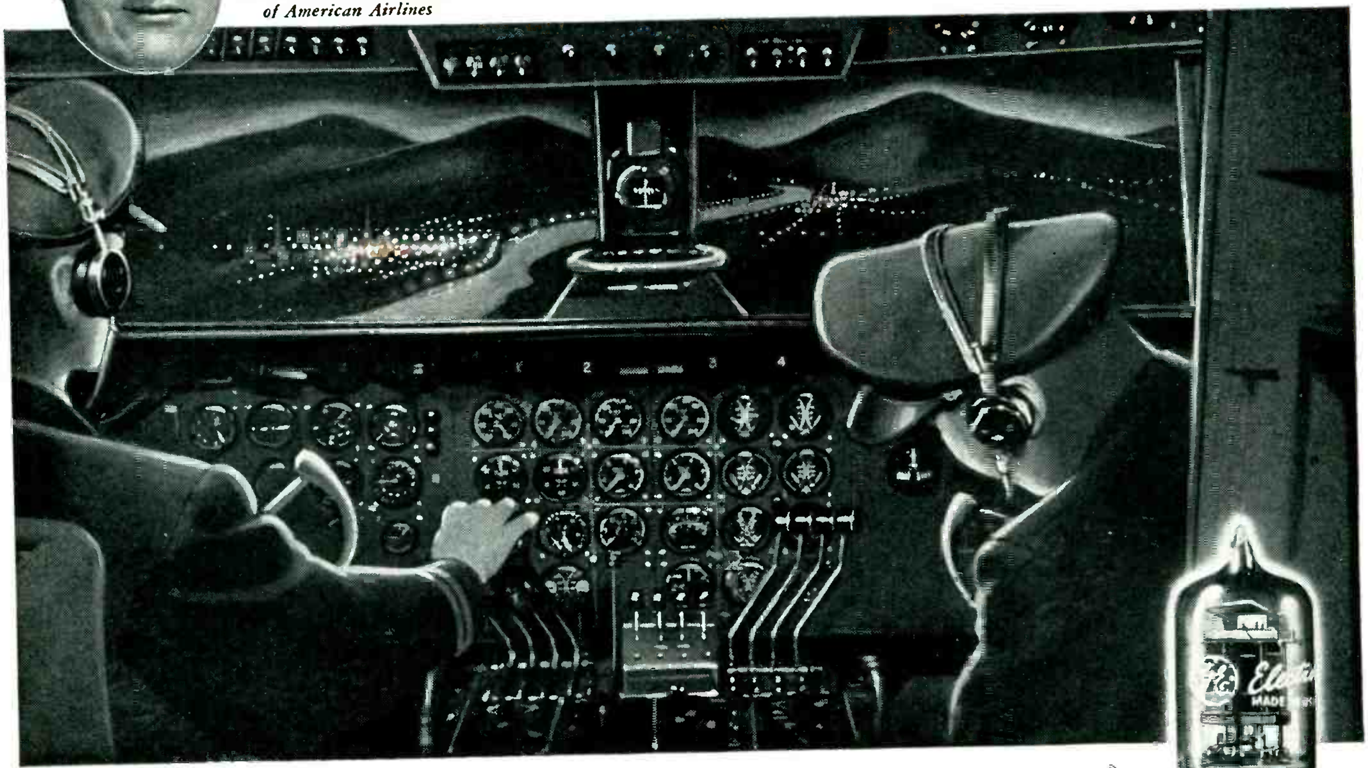
Size of Grid Dip Meter only (less probe): 7 in. x 3 3/16 in. x 3⅜ in.

Millen Laboratory Instruments are illustrated and described in our Laboratory Equipment catalogue, a copy of which will be mailed upon request.

JAMES MILLEN MFG. CO., INC.
MAIN OFFICE AND FACTORY
MALDEN, MASSACHUSETTS, U. S. A.

"with AMERICAN AA AIRLINES EXTRA SAFETY IS A MUST..."

States HERSCHEL WOLF
of American Airlines



"...G-E High-Reliability Tubes Lift SAFETY and SAVINGS, Too!"

SAYS Herschel Wolf, in charge of aircraft radio communications for American Airlines: "You can trust G-E High-reliability Tubes to do their job *all* the time. They've helped us lift our high safety standards still higher."

You can't beat these special G-E miniatures for steady performance "under fire"—the kind of day-in, day-out job you can count on. So take a tip from American and other enthusiastic users, and specify G-E High-reliability Tubes in the equipment now on your drawing-boards! You'll lower upkeep costs, increase safety factor, widen your product's acceptance.

Altimeters, radio compasses, radio control apparatus, h-f aircraft receivers—all are employing G-E High-reliability miniatures with marked success. Every tube gets 50 hours' service at the factory under Class A conditions. Also, frequent samples are chosen for life tests, during which the tube is operated normally but intermittently by turning the heater on and off at one-minute intervals.

Communications . . . industry . . . along with aviation, find numerous applications for G-E High-reliability miniatures—the *better* tubes for *better* service where conditions are exacting! Write for further information. Learn more about what these tubes are; what they will do; how they can serve *your* needs more efficiently. *Electronics Department, General Electric Co., Schenectady 5, N. Y.*

GL-5654	Sharp-cutoff r-f pentode
GL-5670	H-f twin triode
GL-5686	Power-amplifier pentode
GL-5725	Semi-remote-cutoff r-f pentode
GL-5726	Twin diode
GL-5749	Remote-cutoff r-f pentode
GL-5750	Pentagrid converter
GL-5751	High-mu twin triode
GL-5814	Medium-mu twin triode

GENERAL ELECTRIC

180-J8

TRANSFORMERS AT WORK—KENYON

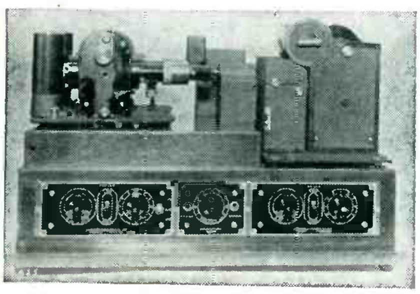
pH Meter

CAMBRIDGE INSTRUMENT CO., INC., Grand Central Terminal, New York City. The industrial model pH Meter is a precision instrument for the determination of acidity and alkalinity of fluids, which finds wide application in medicine, science and industry.

For many years, Cambridge has used KENYON Transformers in various industrial, research, laboratory and medical instruments.

Electrocardiograph

Another example of Cambridge pioneering is the Simpli-Trol Portable Electrocardiograph-Stethograph, a diagnostic instrument used by prominent cardiologists, hospitals and medical schools throughout the world for the study of heart disease.



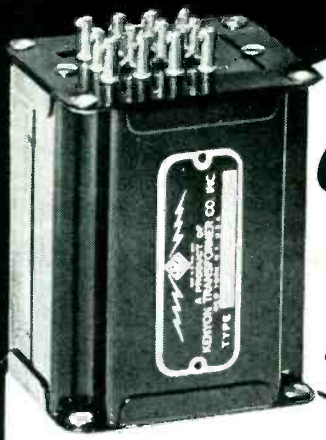
Many important developments in science and industry have been furthered by instruments designed and manufactured with KENYON Transformers by the Cambridge Instrument Co.

For over 25 years, leading manufacturers and engineers in all fields have specified KENYON Transformers for industrial, communication, sound, electronic and scientific applications. Cambridge, too, specifies KENYON Transformers for quality, dependability and sound construction!

Advertisement

Here's the "Q" in Transformers

It's KENYON Quality



Custom-built to your Specifications

KENYON one of the oldest names in transformers, offers you high quality specification transformers custom-built to your requirements — *practically at catalog prices!* For over 25 years the KENYON "K" has been a sign of skillful engineering, progressive design and sound construction.

KENYON *"Specials" Are Designed For:*

- JAN APPLICATIONS
- BROADCAST
- INDUSTRIAL MACHINERY
- RADAR
- AUTOMATIC CONTROLS
- AUDIO AMPLIFIERS
- EXPERIMENTAL LABORATORIES
- ATOMIC ENERGY EQUIPMENT

Among many others

Consult our engineering staff on any of your "special" problems at no obligation to you. Call or write *now* for our representative.

KENYON "T's"— famous line of high quality, uniform transformers are ready for immediate delivery from stock. Our standard line can save you much time and expense. For a complete story about specific ratings on all transformers, send for your copy of the latest KENYON Catalog edition *now!*

KENYON TRANSFORMER CO., Inc.

840 BARRY STREET **NEW YORK 59, N. Y.**

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We need "special" transformers —
☐ Please have your representative call

electronic voltage regulators

by sorensen

- MAXIMUM ACCURACY
- MINIMUM DISTORTION
- FREQUENCY INSENSITIVITY

Standard DC

*Output voltage	6	12	28	48	125
**Load in amperes	5-15-40-100	5-15-50	5-10-30	15	5-10
Input voltage	95-130 VAC single phase 50-60 cycles: adapter available for 230 VAC operation				
Regulation Accuracy	±0.2% from 1/10 to full load				
Ripple voltage RMS Max.	1%				
Recovery time	0.2 seconds — value includes charging time of filter circuit for the most severe change in load or input conditions				

*Adjustable +10%, —25%
**Individual models identified by indicating output voltage first then amperes. Example: E-6-5 6 VDC @ 5 amperes

Standard AC

Model in VA Capacity	150S 500S	250S 1000S	2000S 3000S	5000S 10000S 15000S
Regulation Accuracy	±0.1%	0.1%	0.1%	0.1%
Harmonic Distortion	3% max.	2% max.	3% max.	3% max.
Input voltage	95-130 VAC also available for 190-260 VAC single phase 50-60 cycles			
Output voltage	Adjustable between 110-120; 220-240 in 230 VAC models			
Load range	O — Full load			
P.F. range	Down to 0.7 P.F.			

NOTES: Regulators can be hermetically sealed.
All models temperature compensated.

SPECIALS Your particular requirements can be met by employing the ORIGINAL SORENSEN CIRCUIT in your product or application.
SORENSEN REGULATORS can be designed to meet JAN specifications.
SORENSEN engineers are always available for consultation about unusual regulators to meet special needs not handled by *THE STANDARD SORENSEN LINE.*

Write for Complete Literature

Sorensen and company, inc.
375 Fairfield Avenue, Stamford, Conn.

PRODUCED FOR YOUR REQUIREMENTS

- by the top specialists in the ceramic field

HI-Q

CERAMIC PLATE CAPACITORS

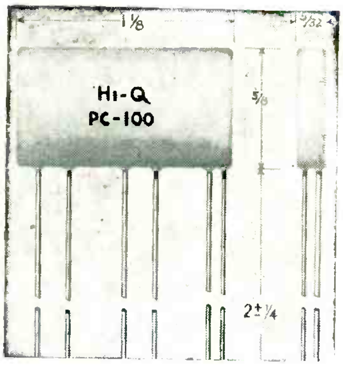
Essentially similar, except in shape, to **HI-Q** Disk Capacitors except that in the multiple units they do NOT have to have a common ground as is the case with disks. These **HI-Q** Plates can be produced in an unlimited range of capacities, the number on a plate being limited only by the K of the material and the physical size of the unit. They offer the greatest available capacity per unit volume of any type condenser on the market.

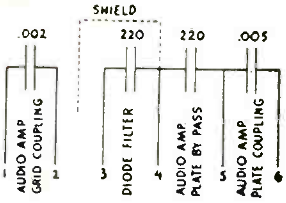
Guaranteed minimum values of capacity up to 33,000 mmf per sq. in. are available. This is based on the use of Body 41 ceramic having 3000 as a dielectric constant "K" and .020 in. thickness and the formula:

$$C\ (\text{mmf}) = \frac{.224\ K\ A\ (\text{Sq. in.})}{D\ \text{in.}}$$

If temperature compensating ceramics are used, the capacity will be considerably lower. Typical circuits are shown here, but almost any combination can be produced for your specific needs. Consult our engineers for complete details. Write for new **HI-Q** datalog.

PC-100



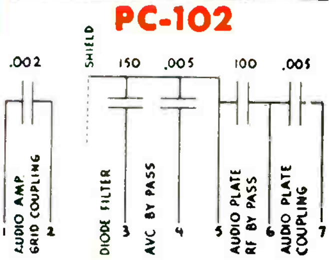


1-2	.002	+75 −25	%	mf
3-4	220	+50 −50	%	mmf
4-5	220	+50 −50	%	mmf
5-6	.005	+75 −25	%	mf

PC-101

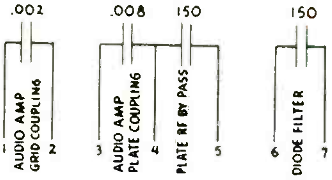
1-2	.002	+75 −25	%	mf
2-3	100	+50 −50	%	mmf
3-4	.005	+75 −25	%	mf
4-5	150	+50 −50	%	mmf
5-6	.005	+75 −25	%	mf

PC-102



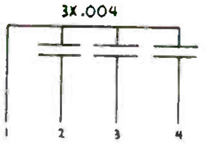
1-2	.002	+75 −25	%	mf
3-5	150	+100 −0	%	mmf
4-5	.005	+100 −0	%	mf
5-6	100	+75 −25	%	mmf
6-7	.005	+75 −25	%	mf

PC-103



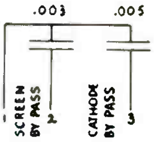
1-2	.002	+75 −25	%	mf
3-4	.008	Min	%	mf
4-5	150	+50 −50	%	mmf
6-7	150	+50 −50	%	mmf

PC-104

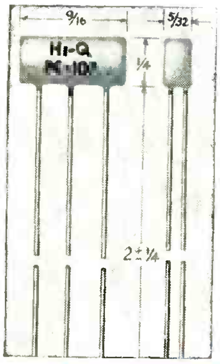


3X .004 Min mf

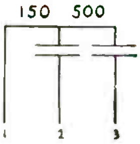
PC-105



1-2	.003	+75 −25	%	mf
1-3	.005	+75 −25	%	mf



PC-107



1-2	150	+75 −25	%	mmf
1-3	500	+75 −25	%	mmf

HI-Q COMPONENTS

Capacitors
Trimmers • Choke Coils
Wire Wound Resistors

BETTER 4 WAYS

- PRECISION
- UNIFORMITY
- DEPENDABILITY
- MINIATURIZATION

JOBBERS—ADDRESS: 740 Belleville Ave., New Bedford, Mass.

HI-Q

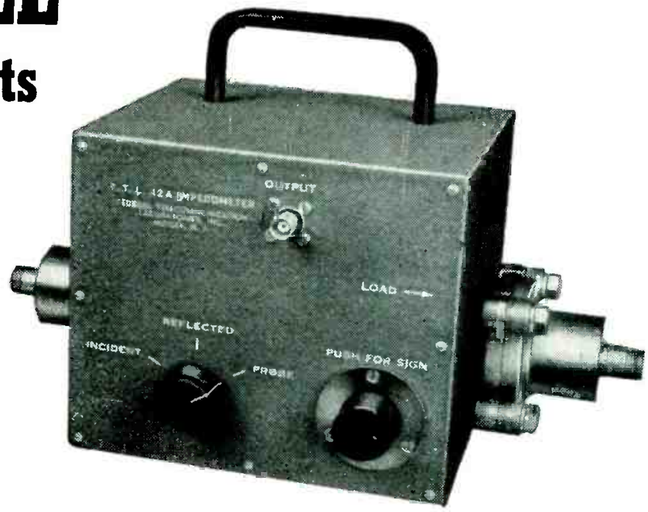
Electrical Reactance Corp.

OLEAN, N. Y.

SALES OFFICES: New York, Philadelphia
Detroit, Chicago, Los Angeles

PLANTS: Olean, N. Y., Franklinville, N. Y.
Jessup, Pa., Myrtle Beach, S. C.

QUICK, RELIABLE
impedance measurements up to 500 megacycles



FTL-42A IMPEDOMETER

Any signal generator with 0.1 volt maximum into 51.5 ohms output furnishes sufficient power for operation.

Crystal detector and audio amplifier with output meter have sufficient sensitivity as a detector above 100 megacycles.

Compact, simple, accurate instrument for the measurement of impedance, attenuation, reflection coefficient and standing-wave ratio at frequencies up to 500 megacycles.

Read relative voltages of incident wave, reflected wave and resultant. Plot diagram of voltages on Smith Chart and impedance can be determined to $\pm 5\%$.

Requires no unusual accessories – only those found in every laboratory and test shop working in the frequency range of the instrument: signal generator with 0.1 volt maximum output, crystal detector, audio amplifier, and output meter. Below 100 megacycles a radio receiver is desirable for its greater sensitivity.

In addition, the FTL-42A Impedometer can be operated with input power up to several hundred watts when it is desired to drive the load in this manner.

Adapters for 1⅝ inch line to type N are furnished so that the instrument can be used with flexible cables.

The FTL-42A Impedometer can be used directly with 1⅝ inch line, or with other sizes of lines or cables by use of various adapters that are available.

It can be built for other impedances such as 72 ohms coaxial, according to requirements of user.

Dimensions of cabinet: 6 13/16 inches long by 5 9/16 inches wide by 5⅞ inches high. Net weight including adapters is 7 pounds.

Price – $400.00

Write for complete FTL-42A brochure.

INTERNATIONAL TELEPHONE AND TELEGRAPH — FTL

Federal Telecommunication Laboratories, Inc.

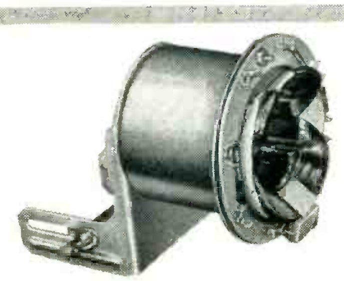
500 Washington Avenue — Nutley 10, New Jersey

A NEW SERVICE TO TV MANUFACTURERS

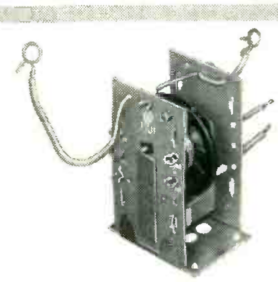
A NEW MARKET FOR TV SERVICEMEN

with General Electric TV Components

EM-PM FOCUS COIL—These units combine the effects of Alnico 6 permanent magnet and an electromagnet to provide uniform focus with a minimum of circuit power.



NEW DEFLECTION YOKE—Sweeps 70° with only 20 watts of power from a 260-volt supply. Ferrite core units available for high efficiency applications.



HORIZONTAL SWEEP TRANSFORMER—When used with high efficiency yokes, these ferrite core transformers provide 70° deflection at 13 kv.

You can put your confidence in—

GENERAL ELECTRIC

RECEIVER MANUFACTURERS

You can cut replacement parts servicing problems to a minimum...keep your sets in the field with the assurance of ready serviceability . . . reduce material and handling costs...by designing General Electric TV components into your product.

More than twenty TV receiver manufacturers are now using G-E components. Big makers like them because they're expertly fabricated, dependable, backed by a name you can depend on.

Smaller manufacturers turn to G.E. for components specially adapted to fit particular designs. Remember—when you use G-E parts, duplicates are stocked by G-E distributors and dealers everywhere —automatic assurance that your sets will be repaired in the field, not returned to the factory.

SERVICEMEN

Estimates peg the TV market at ten million sets in use by the end of 1950...*that's your opportunity!*

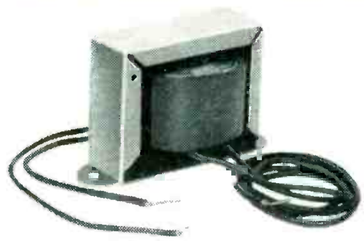
Millions of G-E parts are now in receivers everywhere...and more manufacturers are turning to General Electric every day...Be sure you get your share of the skyrocketing replacement business that supports these receiver sales...*that's your market!*

Now—*for the first time*—dealers and servicemen can stock the complete line of General Electric components shown here! They're available through parts jobbers and distributors in your area.

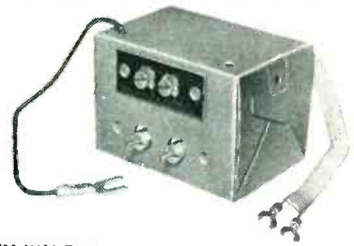
Put yourself in the replacement business for keeps—and for profit. Call your jobber or distributor for full details. Meanwhile, send for the complete G-E Parts Catalog, just off the press. Mail the coupon and the catalog will be rushed to you—free!

WIDTH & LINEARITY CONTROLS—Provide convenient control of picture and linearity by screwdriver adjustment.

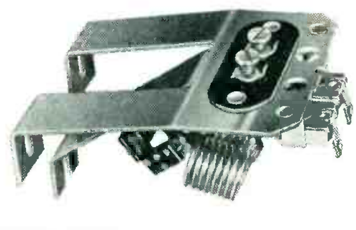
ION TRAP MAGNET—Available in two sizes, 35 and 42 gauss.



VERTICAL SWEEP TRANSFORMER—For use in magnetic deflection circuits from 50°-70°. Designed to match vertical output tube to deflection yoke.



FM WAVE TRAP—Reduces or eliminates interference caused by FM broadcasting stations operating in 88 to 108 mc channels.



IF WAVE TRAP—Designed to reduce or eliminate interference on TV receivers caused by signals at IF frequencies of 41-47 mc.

ARE YOU READY? MAIL THIS COUPON TODAY!

General Electric Company, Section 4100, Electronics Park, Syracuse, N. Y.

I want my share of the new TV replacement market. Send me complete catalog of TV components and facts on service sales.

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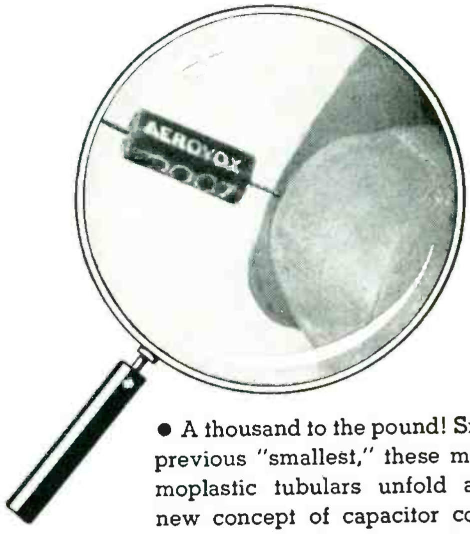
Miniaturization Specialist Capacitors—

1000 to the Pound!

AEROVOX MICRO-MINIATURES

(TYPE P83Z AEROLITE* CAPACITORS)



• Try Aerovox Micro-miniatures in your miniaturized assemblies. Write Dept. MM-83 for engineering data, samples, quotations and application-engineering aid.

• A thousand to the pound! Smaller than previous "smallest," these molded thermoplastic tubulars unfold an entirely new concept of capacitor construction. The smaller physical sizes are directly attributed to the latest metallized-paper technique which combines both dielectric and electrodes in a single winding strip. Unusually strong lead connections to capacitor section. Since capacitance is predetermined mechanically in the initial processing, it is no longer necessary to rely on the human element for capacitance control.

Type P83Z Micro-miniatures are particularly applicable to that portion of the electronic field where low capacitance paper capacitors and high-capacity disk capacitors are now being used.

*Trade-mark

Featuring . . .

Two sizes: 3/16" d. x 7/16" l.; 1/4" d. x 9/16" l.

200, 400 and 600 rated voltage; 300, 600 and 900 test voltage.

Hyvol K impregnated in humidity-resistant molded thermoplastic case.

Operating temperature from −15°C. to +85°C. without derating.

Power factor less than 1% when measured at or referred to frequency of 1000 cps and ambient temperature of 25°C.

Life test: 1000 hours at 1.25 times rated voltage in ambient temperature at 85°C.

Insulation resistance of 25,000 megohms or greater, measured at or referred to temperature of 25°C. Insulation resistance at 85°C., 500 megohms or greater.

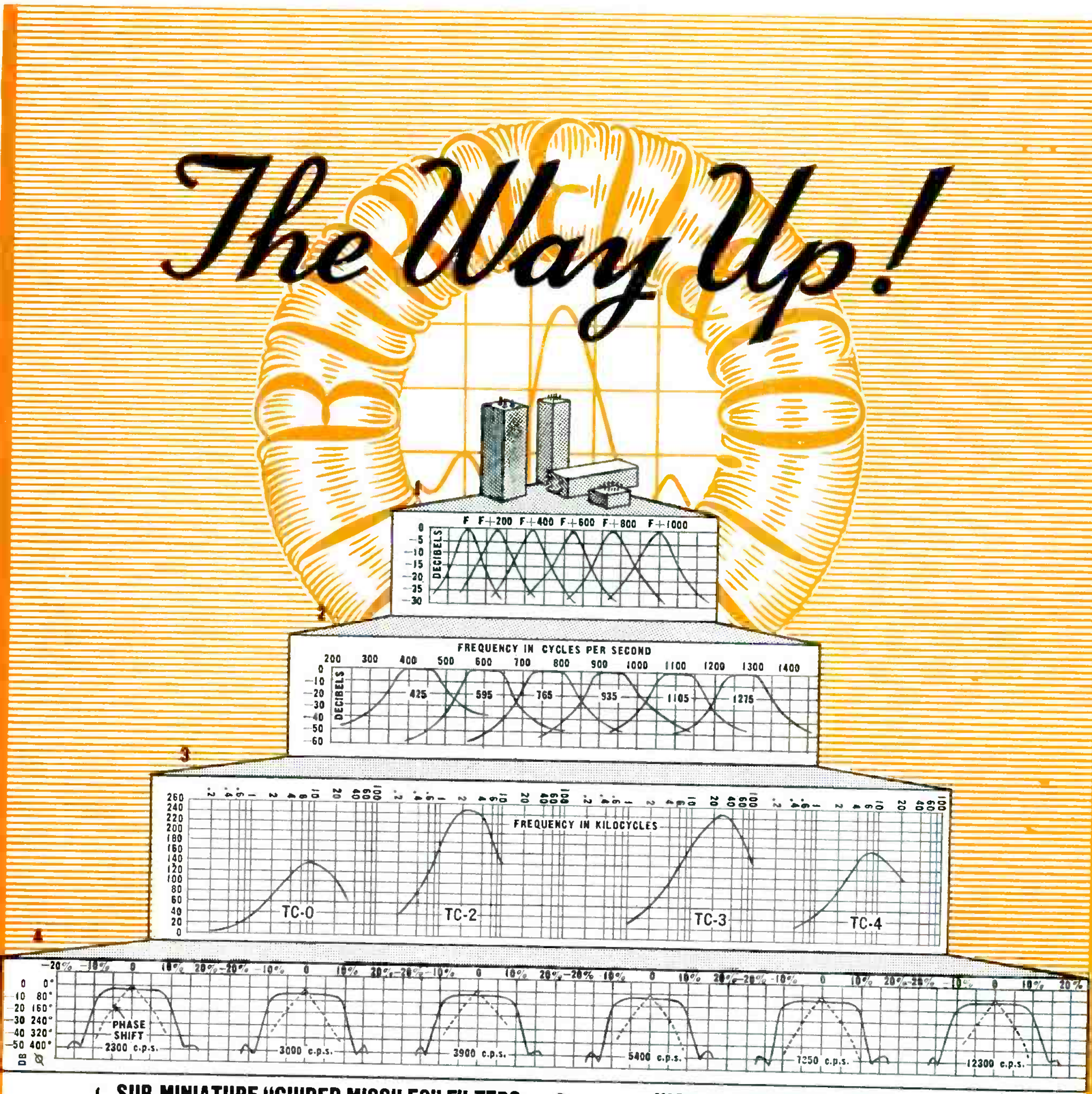
AEROVOX capacitors

FOR RADIO-ELECTRONIC AND INDUSTRIAL APPLICATIONS

AEROVOX CORPORATION, NEW BEDFORD, MASS., U. S. A.

Sales Offices in All Principal Cities • Export: 41 E. 42nd St., New York 17, N. Y.

Cable: AEROCAP, N. Y. • In Canada: AEROVOX CANADA LTD., Hamilton, Ont.



1 SUB-MINIATURE "GUIDED MISSILES" FILTERS

For security reasons details of this development in miniaturization must be omitted. It can be told, however, that all six channels are contained in a total volume of 18 cubic inches or 3 cubic inches per channel.

2 TONE CHANNEL FILTERS *

Available for either 170 or 340 cycles spacing between channels. These filters have received wide acceptance and are extremely popular among manufacturers of carrier telegraph equipment. In addition to the many standard types of tone filters we are supplying, special characteristics can readily be incorporated into designs to suit your application.

3 HIGH Q TOROIDAL COILS

"Actually the first essential requirement in the design and manufacture of high quality audio filters, these toroids wound on molybdenum permalloy cores have provided the almost impossible solution for many network problems. As the leading independent manufacturer of toroids, our products are backed by years of experience and specialized knowledge."

4 TELEMETERING FILTERS *

Among the earliest to be employed in the improved telemetering system now in general use. Particular attention has been paid to linearity of phase shift and good transient suppression as well as high interchannel attenuation in order to eliminate distortion in telemetering reception.

*"*Filters such as these are included in a wide variety of types which we are now producing for manufacturers and users of microwave communications and relay equipment. We would be pleased to discuss your application for filters in this field and bring you up to date on the latest developments in the application and design of filters which have resulted from our close association with the carrier communications industry.*"

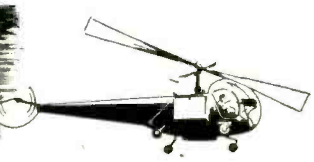
Burnell & Company
YONKERS 2, NEW YORK
CABLE ADDRESS "BURNELL"

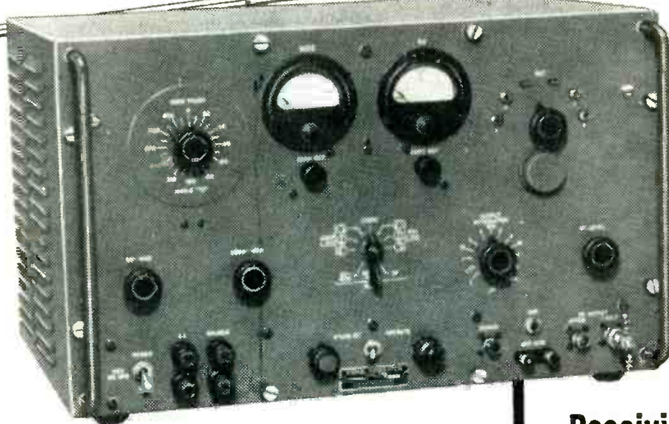
Exclusive Manufacturers of Communications Network Components

Announcing the H-14 SIGNAL GENERATOR

108-118 megacycles

Newest in ARC's Line of Signal Generators





Checks on...

- 24 Omni courses
- Left-center-right on Phase-localizer
- Left-center-right on Amplitude-localizer
- Omni course sensitivity
- To-From and Flag-alarm operation
- All necessary quantitative bench tests

Use the H-14 for Testing Omni Receiving Units in Aircraft ...... or on the Bench.

The Type H-14 Signal Generator, 108-118 megacycles provides a standard signal source for the complete testing of VHF airborne omnirange and localizer receivers in aircraft or on the bench. It provides for testing 24 omni courses, plus left-center-right checks on both amplitude and phase localizers. Aircraft may be checked out quickly and accurately just before take-off. RF output for ramp checks, 1 volt into 52 ohm line and for bench checks, 0-10,000 microvolts. Provision for external voice or other modulation. AF output available for bench maintenance and trouble shooting.

PRICE: $885.00 net, f.o.b. Boonton, N. J.

MICROWAVE TEST SET . . . TYPE H-10

23,500-24,500 MEGACYCLES

Provides source of cw or pulse frequency-modulated RF, power level —37 to —90 dbm. RF power meter measures levels from +7 to +30 dbm. Frequency meter for measuring output or input RF accurate to better than 20 mc. Primary purpose of the H-10 is to measure receiver sensitivity, bandwidth, frequency, recovery time, and overload characteristics, plus transmitter power and frequency. Recommended as a standard source of RF for research or production testing. Equal to military TS-223/AP.

PRICE: $1692.00 net, f.o.b. Boonton, N. J.

UHF SIGNAL GENERATOR . . . TYPE H-12

900-2100 MEGACYCLES

Provides source of cw or pulse amplitude-modulated RF, power level 0 to —120 dbm. Internal pulse circuits with controls for width, delay, and rate, and provision for external pulsing. Single dial tuning, frequency calibration accurate to better than 1%. Built to Navy specifications for research and production testing. Equal to military TS-419/U.

PRICE: $1950.00 net, f.o.b. Boonton, N. J.

ARC COMMUNICATION AND NAVIGATION EQUIPMENT

Aircraft Radio Corporation also manufactures LF and VHF airborne communication and navigation equipments — all CAA-Type-Certificated for scheduled air-carrier use or for those whose type of flying requires a high degree of reliability and performance. Equipment consists of light, small units which can be combined to provide the required operation, whether it be the 1 Receiver/1 Transmitter (15-pound) installation in a 2-place helicopter, or a 3 Receiver/2 Transmitter/VHF Omni installation (70 pounds) in larger 2-engine aircraft.

ARC

Aircraft Radio Corporation

Boonton, N. J.

Dependable Electronic Equipment Since 1928

WRITE TODAY for descriptive bulletins on any of these instruments

Only One

In medieval times, a coat-of-arms had an importance that could not be overestimated. It was granted as a personal badge, signifying the attributes and accomplishments of its proprietor—and as such was respected thruout the civilized world. It had no duplicate.

In turn, the emblem imposed upon its owner a responsibility for maintaining an enviable reputation—a condition which stimulated general confidence in him.

Times have changed, but not all *things*. The sense of sanctity of an emblem is prevalent today as it was hundreds of years ago. That is why we take such pride in our trademark: NICHROME.

It is evidence of our accomplishment; our unique, personal badge — respected everywhere. Granted solely and wholly to us by the United States Patent Office over forty years ago, it symbolizes a series of superb electrical heat and corrosion-resistant alloys (developed and produced *only* by Driver-Harris Company) which today is serving industry all over the world.

Yes, there are other excellent heat and corrosion-resistant alloys, but *only one* NICHROME—the product of exclusive Driver-Harris knowledge and techniques.

We are well aware of our obligation to maintain its reputation, both here and abroad. In fact, such obligation is an inspiration to give of our best—now, tomorrow, and always.

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

Nichrome* is manufactured only by

Driver-Harris Company

HARRISON, NEW JERSEY

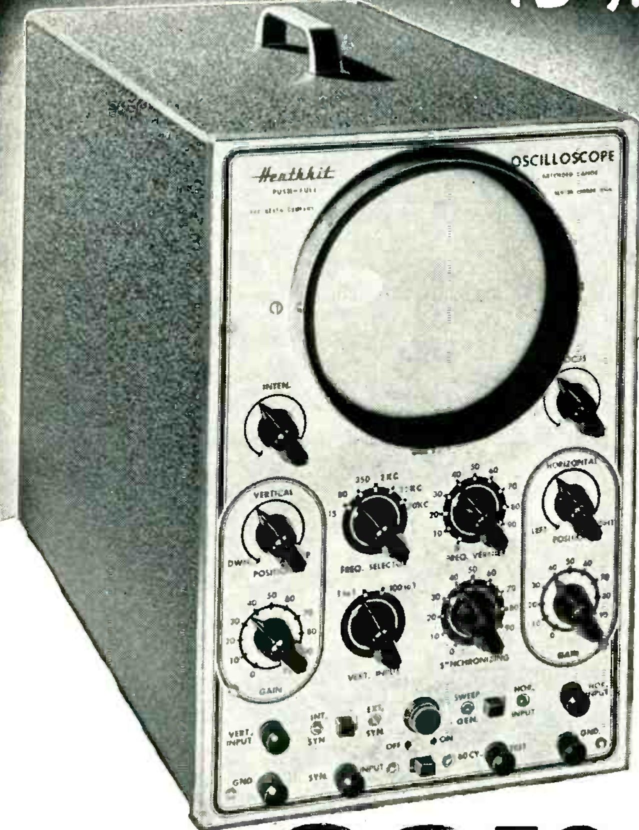
BRANCHES: Chicago, Detroit, Cleveland, Los Angeles, San Francisco,
Manufactured and sold in Canada by
The B. GREENING WIRE COMPANY, LTD., Hamilton, Ontario, Canada

**T.M. Registered in United States Patent Office by Driver-Harris Company August, 1908*

12 Improvements IN NEW 1951

MODEL O-6 PUSH-PULL

Heathkit OSCILLOSCOPE KIT



- ★ New AC and DC push-pull amplifier.
- ★ New step attenuator frequency compensated input.
- ★ New non frequency discriminating input control.
- ★ New heavy duty power transformer has 68% less magnetic field.
- ★ New filter condenser has separate vertical and horizontal sections.
- ★ New intensity circuit gives greater brilliance.
- ★ Improved amplifiers for better response useful to 2 megacycles.
- ★ High gain amplifiers .04 Volts RMS per inch deflection.
- ★ Improved Allegheny Ludlum magnetic metal CR tube shield.
- ★ New synchronization circuit works with either positive or negative peaks of signal.
- ★ New extended range sweep circuit 15 cycles to over 100,000 cycles.
- ★ Both vertical and horizontal amplifier use push-pull pentodes for maximum gain.

Only **$39.50**

The new 1951 Heathkit Push-Pull Oscilloscope Kit is again the best buy. No other kit offers half the features — check them.

Measure either AC or DC on this new scope — the first oscilloscope under $100.00 with a DC amplifier

The vertical amplifier has frequency compensated step attenuator input into a cathode follower stage The gain control is of the non frequency discriminating type — accurate response at any setting. A push-pull pentode stage feeds the C.R. tube. New type positioning control has wide range for observing any portion of the trace.

The horizontal amplifiers are direct coupled to the C.R. tube and may be used as either AC or DC amplifiers. Separate binding posts are provided for AC or DC.

The multivibrator type sweep generator has new frequency compensation for the high range it covers; 15 cycles to cover 100,000 cycles.

The new model 0-6 Scope uses 10 tubes in all — several more than any other. Only Heathkit Scopes have all the features.

New husky heavy duty power transformer has 50% more laminations. It runs cool and has the lowest possible magnetic field. A complete electrostatic shield covers primary and other necessary windings and has lead brought out for proper grounding.

The new filter condenser has separate filters for the vertical and horizontal screen grids and prevents interaction between them.

An improved intensity circuit provides almost double previous brilliance and better intensity modulation.

A new synchronization circuit allows the trace to be synchronized with either the positive or negative pulse, an important feature in observing the complex pulses encountered in television servicing.

The magnetic alloy shield supplied for the C.R. tube is of new design and uses a special metal developed by Allegheny Ludlum for such applications.

The Heathkit scope cabinet is of aluminum alloy for lightness of portability.

The kit is complete, all tubes, cabinet, transformer, controls, grid screen, tube shield, etc. The instruction manual has complete step-by-step assembly and pictorials of every section. Compare it with all others and you will buy a Heathkit. Model 0-6. Shipping Wt., 30 lbs.

New INEXPENSIVE MODEL S-2

ELECTRONIC SWITCH KIT

Twice as much fun with your oscilloscope — observe two traces at once — see both the input and output traces of an amplifier, and amazingly you can control the size and position of each trace separately — superimpose them for comparison or separate for observation — no connections inside scope. All operation electronic, nothing mechanical — ideal for classroom demonstrations — checking for intermittents, etc. Distortion, phase shift and other defects show up instantly. Can be used with any type or make of oscilloscope. So inexpensive you can't afford to be without one.

Has individual gain controls, positioning control and coarse and fine switching rate controls — can also be used as square wave generator over limited range. 110 Volt transformer operated comes complete with tubes, cabinet and all parts. Occupies very little space beside the scope. Better get one. You'll enjoy it immensely. Model S-2. Shipping Wt., 11 lbs.

Only **$19.50**

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13 East 40th St.
NEW YORK CITY (16)
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The **HEATH COMPANY**

. . . BENTON HARBOR 14, MICHIGAN

HOW TO STOP TROUBLE BEFORE IT STARTS!

It's no accident that AlSiMag components give you the plus performance and the smooth assembly that they should. It's planned that way.

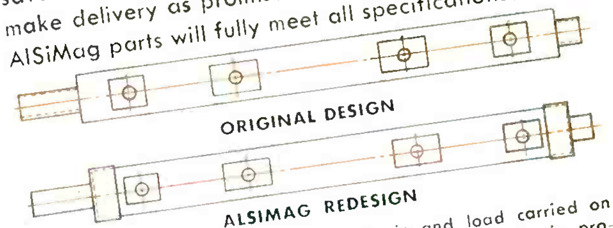
Every new design goes through two groups of engineers at the AlSiMag plant. The first group studies the design to see if it can be made to do its job more effectively or if it can be modified for more efficient production.

Production engineers in the second group study the design to adapt it to the most efficient production methods in our plant. On complex designs, both groups study the prints, then get together for final discussions. Thus the men who are directly responsible for production see the design before the order is accepted. They point out any design features that might lead to trouble or unnecessary expense.

These engineering recommendations are sent to the customer. Specialized experience and intimate knowledge of available production methods thus give you better AlSiMag components at a saving.

In many instances, our engineering groups recommend hand made test samples of the original design and of modified designs. These can be made promptly and at reasonable cost. Once the proper design is found, production orders can be entered with assurance that the design does the job and that it is practical to produce.

When production orders are entered, Quality Control takes over. If the job gets off specification at any point, the trouble is corrected immediately. This saves a lot of time and a lot of money and helps us make delivery as promised. And it assures that your AlSiMag parts will fully meet all specifications.



Weak points removed from the ceramic and load carried on metal caps. Overall strength greatly increased. Losses in production and in use greatly reduced. Precision manufacture at minimum cost obtained through redesign.

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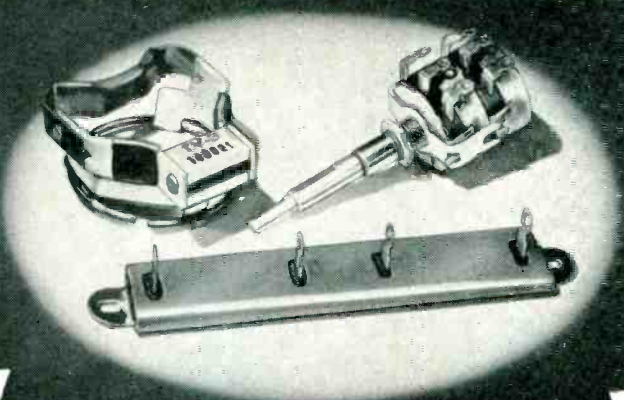
the best picture in **Television** is . . .

CLAROSTAT

FOR CONTROLS, RESISTORS, BEAM-BENDERS



As "Big Business," television came suddenly. Just as suddenly, Clarostat was ready. Three decades of pioneering and specialization, backed by a plant second to none, assured TV designers and manufacturers of an outstanding selection of resistors, controls and resistance devices.

And when ion spot blemishes became a major problem, again Clarostat was ready with simpler and cheaper beam-benders.

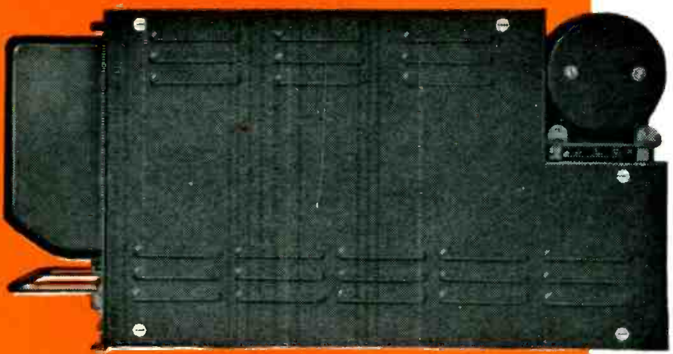
Thus Clarostat products are already represented in over 5,000,000 sets and in countless radios in daily use. All because, for quality, uniformity, dependability, economy, it's CLAROSTAT.

WRITE FOR Engineering Bulletins on resistors, controls and resistance devices. Let us collaborate on your control and resistance problems and requirements.

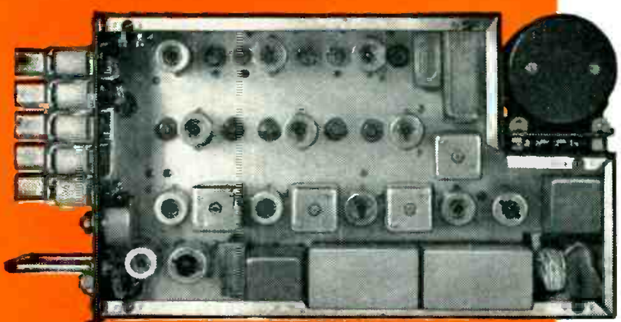
Controls and Resistors

CLAROSTAT MFG. CO., INC. • DOVER, NEW HAMPSHIRE
IN CANADA: CANADIAN MARCONI CO. LTD., MONTREAL, P. Q., AND BRANCHES

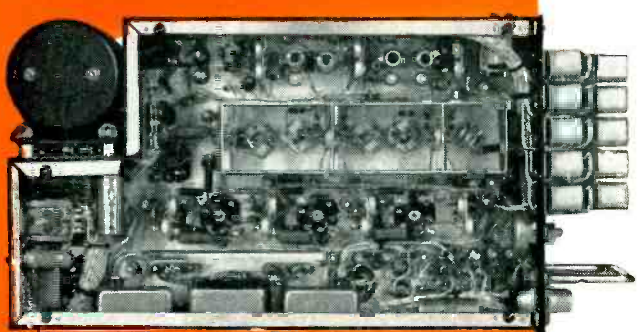
CLAROSTAT



51V-1 glideslope receiver, covers in place



Collins 51V-1 chassis (right side)



Collins 51V-1 chassis (left side)

Glideslope Receiver

51V-1

...inside and out

THIS is the new Collins 51V-1 glideslope receiver for aircraft. Note the orderly design, and the accessibility of all tubes, components, and wiring.

The 51V-1 provides reception of 90/150 cps tone modulated glideslope signals on any of the twenty channels in the uhf range of 329-335 mc. This receiver together with Collins 51R navigation equipment will fulfill ILS receiving requirements for military, commercial and private aircraft. The design of the 51V-1 is based on "Glideslope Receiver Characteristics" issued by Aeronautical Radio, Inc., and on U. S. Airforce specifications.

Output circuits of the 51V-1 receiver feed standard ID-48ARN deviation indicators including flag alarm. By means of the flag alarm the pilot has a positive indication of the reliability of the glideslope signals and instrumentation.

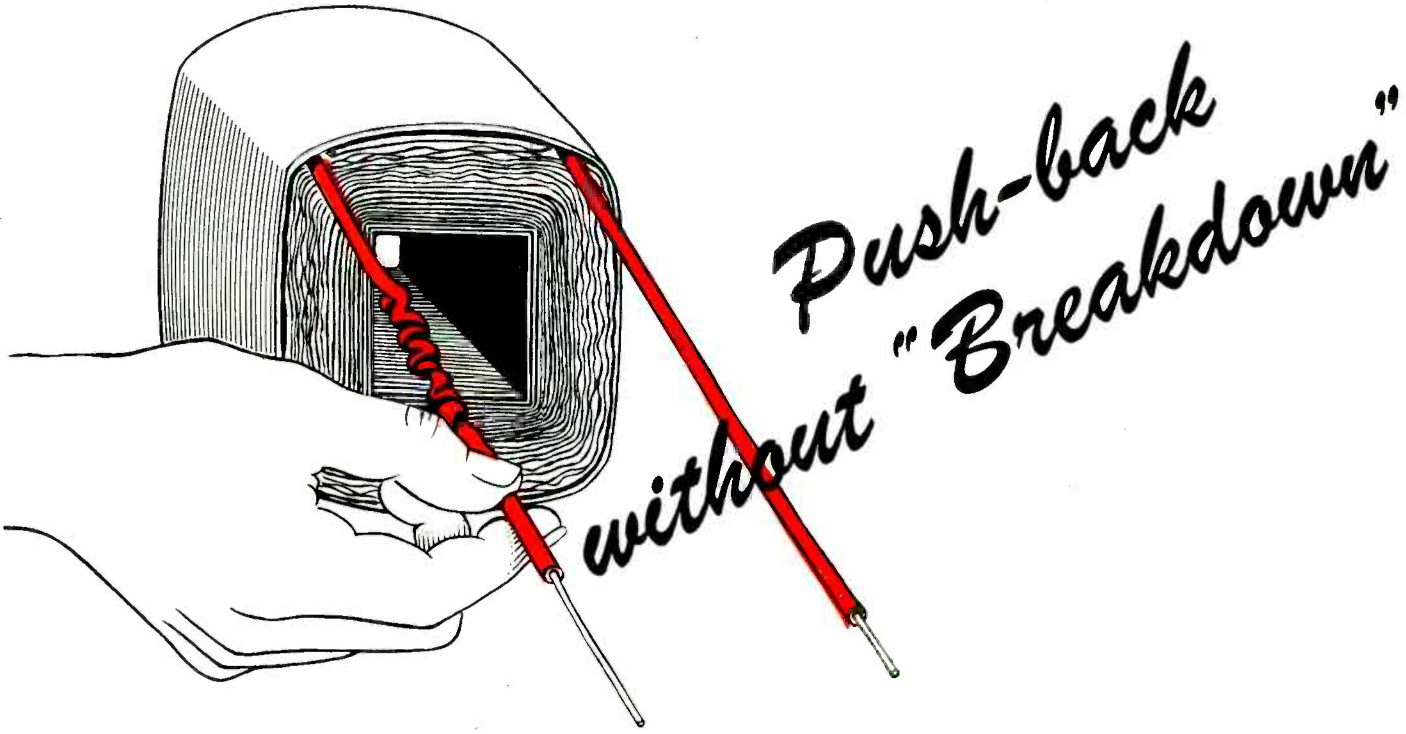
The 51V-1 control circuits are integrated with the standardized R/θ channeling system with channel selection provided by means of a Collins 314U remote control unit.

More complete information, in the form of an illustrated bulletin, is yours on request.

IN AVIATION RADIO, IT'S... COLLINS

COLLINS RADIO COMPANY, Cedar Rapids, Iowa

11 West 42nd Street, New York 18, N. Y. 2700 West Olive Ave., Burbank, Calif.



New Tough Insulation Speeds Coil Production

In coil manufacture, the amazing flexibility of BH "649" Fiberglas Tubing and Sleeving permits ease of push-back with no loss of physical or dielectric properties. Saves valuable production time. Cuts down rejects. BH "649" can be twisted, compressed, folded — with no cracking or rupture of the film.

BH "649" has a smooth bore, handles easily during production with no snagging. Will not support combustion. Resists moisture, oils, grease or ordinary chemicals. Remains supple after baking at 302°F. for 24 hours. Unaffected at temperatures as low as −67°F. Suitable for use with most impregnants—for complete test data, see our Technical Data Folder. BH "649" is made in Grades A-1, B-1, C-1 and C-2—in all sizes from No. 24 to ⅝" inclusive. Write for production samples.

BENTLEY, HARRIS MANUFACTURING COMPANY
CONSHOHOCKEN, PA.

BH *Fiberglas** SLEEVINGS

USE COUPON NOW

Bentley, Harris Mfg. Co., Dept. E-42, Conshohocken, Pa.

I am interested in BH "649" Fiberglas Tubing and Sleeving. Send samples for production testing of Grade______ in sizes as follows______ (size or I.D.) for______ (product) operating at temperatures of______°F. at______volts.

NAME________________________

ADDRESS________________________

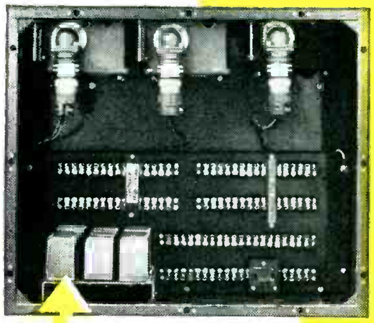
Send samples, pamphlets and prices on other BH Products as follows:

- ☐ BH non-fraying Fiberglas Sleeving
- ☐ Cotton or Rayon-base Sleeving and Tubing

Airborne Instruments Laboratory *Specifies*

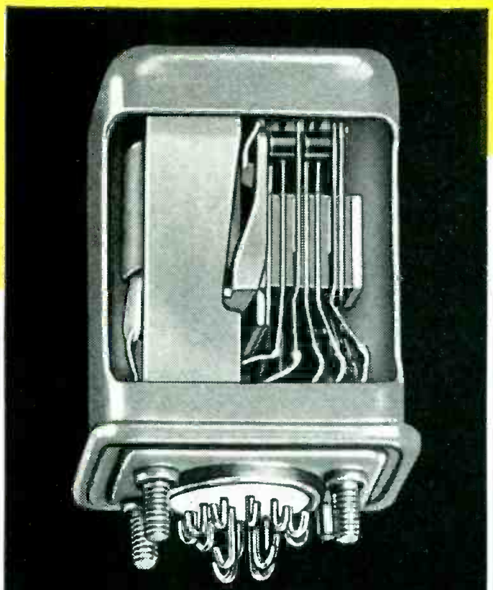
CLARE SEALED RELAYS

For Aircraft, Ship and Submarine Control Equipment

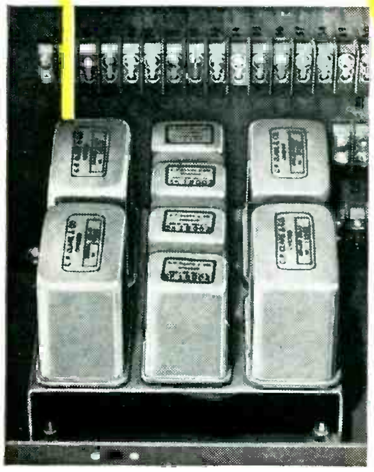


Front view of Airborne Instruments Laboratory control panel, with cover removed, showing group of eight CLARE hermetically sealed relays which perform important circuit control functions.

Cutaway view of typical CLARE Type "K" d-c Relay which is hermetically sealed in a permanent atmosphere of dry, inert gas to give maximum performance under the most extreme conditions of dust, moisture, air pressure and combustible gases.



CLARE Type "K" Hermetically Sealed Relay



Close-up view of the CLARE relay installation which demonstrates the economical use of space which use of CLARE sealed relays makes possible.

Airborne Instruments Laboratory of Mineola, N. Y. uses CLARE Type "J" and Type "K" sealed relays as components of ruggedly designed but delicately operated control equipment for aircraft, ship and submarine.

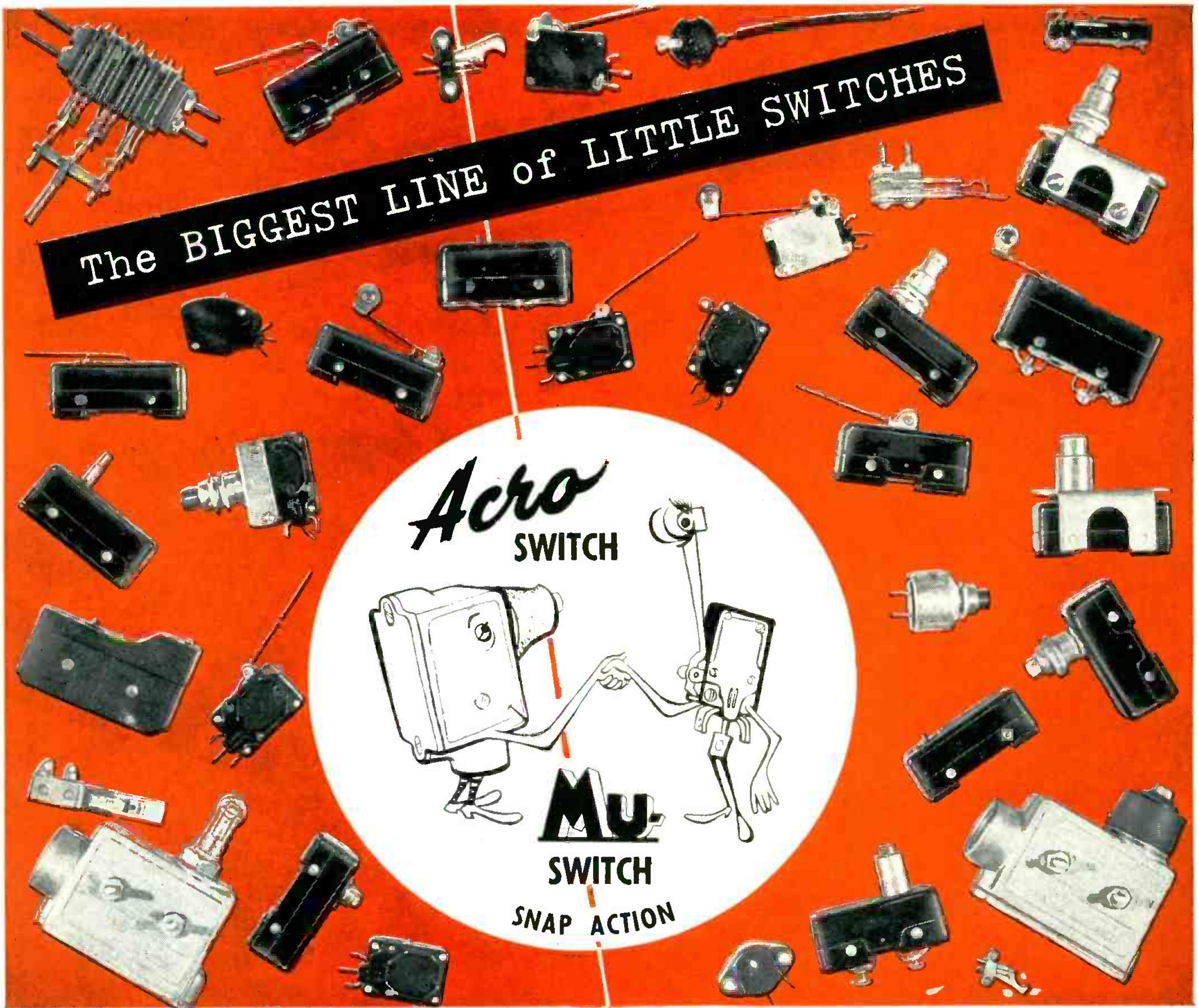
These small, compact, space-saving relays are used in circuit applications that cover the broad field of low and high current, a-c and d-c switching and video switching. CLARE Type "J" and Type "K" Relays were selected for their outstanding speed of operation, dependable performance, resistance to vibration and very small size. Hermetically sealed in dry, inert gas, they are immune to changes in atmospheric pressure, humidity, dust or dirt . . . will operate as required over a long period.

CLARE relays have long been first choice of manufacturers whose products must not fail. Selection of highest quality materials, precise manufacture and ability to "custom-build" just the relay for a specific requirement have made CLARE relays first choice with engineers who insist on . . . and get . . . the best.

Sales engineers are located in principal cities to cooperate with you in the development of a CLARE "custom-built" relay that will meet your most difficult relay need. Look in your classified telephone directory or write: C. P. Clare & Co., 4719 West Sunnyside Ave., Chicago 30, Illinois. In Canada: Canadian Line Materials Ltd., Toronto 13, Ontario. Cable Address: CLARELAY.

CLARE RELAYS...

First in the Industrial Field



Now United under the strong ownership-management of Acro Manufacturing Company, Mu and Acro snap-action switches comprise the finest and most complete line obtainable. The combined plants, with enlarged engineering and research facilities, are equipped to precisely manufacture (or develop, if required) the style switch which best suits your needs. To old or new Acro and Mu customers our expanded facilities will bring even better products and service. Design engineers are invited to submit their switch problems to us for speedy, economical solution. Write either location.

THE BIG NAME IN ELECTRICAL SWITCHES

ACRO MANUFACTURING COMPANY

MU SWITCH DIVISION
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COIN SWITCHES, OPEN BLADES, PHENOLIC ENCLOSED, METAL CLAD, MINIATURES, HIGH VOLTAGE, D. C., PUSH BUTTON, PANEL MOUNTS the

PRESTO PT-900

America's finest portable tape recorder

Look at these features:

- Three heads for recording, playback, erasing.
- Separate recording and monitoring amplifiers.
- Three microphone input.
- Speeds: 15" and 7½"/sec.
- Frequency response: 50-15,000 cps.
- Power supply and amplifier in separate, leatherette covered cases.

The PRESTO PT-900 has been chosen by discriminating engineers, educators and broadcasters throughout the country as the best constructed, best performing, most durable, portable tape recorder available today. Combining the features of machines costing hundreds of dollars more, the PT-900 answers the need for a recorder of ultra-high fidelity in a completely portable, compactly designed unit. Built by the world's largest manufacturer of recording equipment and discs, the PRESTO PT-900 is precision engineered for years of satisfying service.

PRESTO RECORDING CORPORATION
Paramus, New Jersey

In Canada: Walter P. Downs, Ltd., Dominion Square Bldg., Montreal, Canada
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BUSINESS BRIEFS

By W. W. MacDONALD

Better Men than this *Business Briefs* editor, in government and industry, are reshaping our economy to meet the requirements of peace, part-time police action or full-scale war. We are glad they are doing such planning, for the transition from the first condition to the second has already occurred and the third step seems probable. The only real uncertainty appears to be one of terminology and timing.

We think that no matter which way the bear jumps the devotion of American men and materials to purely military projects will eventually be at least equal to that which applied at the close of World War II. We think the electronics industry will ultimately face a greater manpower shortage, receive more military equipment orders, and have to suspend more civilian business than most people believe at this time. We think this will be more apparent after the November elections.

Having said all this, we can now report current news out of Washington, without further editorial comment. . . . . .

Mobilization Plans already being implemented as this item goes to press lead Washington officials to believe that military orders for electronic items through the remainder of 1950 and fiscal year 1951 will total between $2 billion and $2.4 billion, with equipment actually shipped totalling about $1.5 billion.

Electronic industry spokesmen say that if this is so military business will require about 25 percent of their plant capacity and manpower to handle. This might permit an industry goal of 6 million television sets and 10 million radio receivers to be reached in 1950, despite an anticipated sharp drop in December. A reduction in civilian business of from 20 to 25 percent would be sufficient in 1951. Military people think this is overoptimistic.

Some raw materials are already in short supply due to military needs. Some component parts are in short supply due to heavy television receiver production and protective stockpiling. Allocations in some categories seem likely.

Three Major Groups have been set up by the electronics industry to work closely with the military. They are: (1) the National Electronics Mobilization Committee, which is a joint undertaking of RTMA and NSIA; (2) the Electronics Industry Advisory Committee, appointed in 1948 by the Munitions Board and NSRB; and (3) the Army Signal Corps Advisory Council.

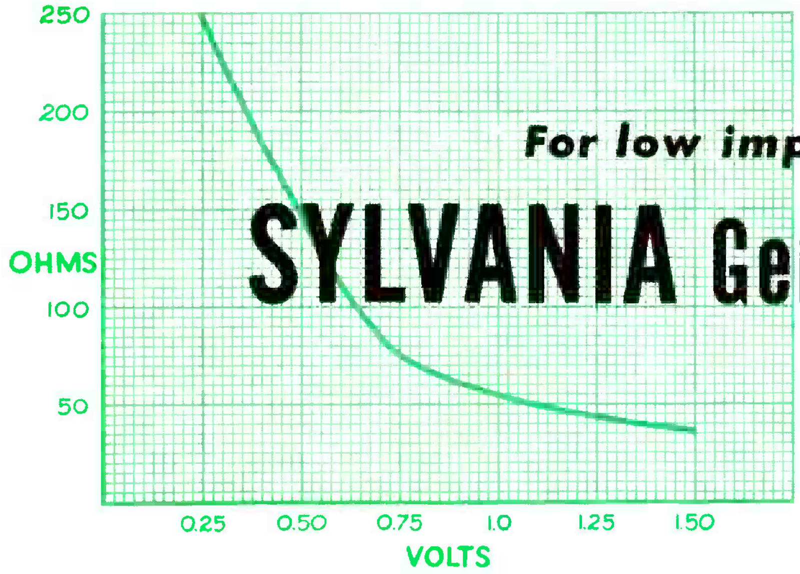
Navy has set up a new Electronics Office, part of the Office of Navy Materiel located in the Executive Office of the Secretary of Navy. It will serve as a central point of contact for contractors formerly dealing individually with BuShips, BuAer, BuOrd, BuSupplies and Accounts.

Training Servicemen capable of handling electronic equipment to the satisfaction of the Navy Department in time of war costs from 10 to 100 times the value of the equipment these men maintain, according to L. V. Berkner of Carnegie Institute. It takes from two to four years, plus an additional four to ten weeks on each new highly specialized piece of equipment.

Editorial Assistant Jack Carroll went on ELECTRONICS' masthead last month. This month he is back in his Ensign's uniform and Somewhere in the Pacific.

Fascinating Fact of the month is the granting of permission to remain silent for one day to radio stations KFGQ and KFGQ-FM by the FCC. It seems that the stations are run by a biblical college and the staff needed a day off to attend graduation exercises in Iowa City.

Puerto Rico, because of a very lenient corporation and personal



For low impedance applications...

SYLVANIA Germanium Diodes

Typical 1N56 Resistance Characteristic

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

For Carrier Communications

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

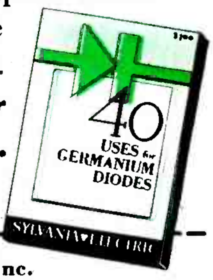
All Germanium Diodes are notable for their low forward impedance. But the 1N56 is specially engineered to make the most of this quality.

Use this diode for high efficiency circuits with low input and output impedances. Use it for relay activation, heavy current and surge applications with low impedance coils, transformers and condensers.

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

Both the 1N56 Germanium Diode and 1N71 Varistor are available from Your Sylvania Distributor. Also ask him for a copy of the new book "40 Uses for Germanium Diodes." Priced at only $1.00, it is the most complete collection of germanium diode applications yet published.

Call him today . . . or mail the coupon below.



ELECTRONIC DEVICES; RADIO TUBES; TELEVISION PICTURE TUBES; ELECTRONIC TEST EQUIPMENT; FLUORESCENT LAMPS, FIXTURES, SIGN TUBING, WIRING DEVICES; LIGHT BULBS; PHOTOLAMPS; TELEVISION SETS

SYLVANIA ELECTRIC

Sylvania Electric Products Inc.
Dept. E-1010, Emporium, Pa.

*Name*____________________

*Street*____________________

*City*__________ *Zone*____ *State*________ tax policy that is unique in the U. S., is being eyed as a plant location by a number of manufacturers. Already several people in our business have set up shop in the unincorporated territory and one or two others appear to be on the verge.

First Six Months of 1950 saw production of the following receiver totals by RTMA members:

	TV	*Home Radios (inc. portables)*	*Car Sets*
Jan	335,588	470,715	189,480
Feb	367,065	529,254	221,139
Mar	525,277	724,691	255,673
Apr	420,026	648,352	234,354
May	376,227	693,592	206,464
Jun	388,962	784,108	270,348

The 2,413,145 tv sets produced in the first half of 1950 compared with 913,071 made in the corresponding period of 1949. The 5,228,170 radio sets made compared with 3,481,858 made in the preceding comparable period.

F-M and F-M—A-M radios included in the figures above totalled 539,852 in the first six months of 1950, an increase of 115,000 over the first six months of 1949. In addition, 225,673 of the television sets made from January through June this year had f-m reception facilities.

Receiving Tube Sales by manufacturers totalled 170,375,921 in the first half of 1950 as against 81,663,213 in the first half of 1949.

Electrons, Inc. says Detroit is still number one market for industrial thyratrons of its manufacture, but that Milwaukee and Cleveland are running a close second and third. We wonder how these and other cities stack up as industrial electronic equipment markets for others.

Heard In A Lab, and applicable in many other walks of life: *"He has an unerring instinct for the unimportant."*

Mexican XHTV is now transmitting television programs on a commercial basis two hours nightly, transmits music and a test pattern two additional hours each day. At least three major U. S. television receiver brands are being sold in quantity in Mexico City.

In July we mentioned a 700-outlet master television antenna system installed in New York and invited correspondence from anyone who knew of a bigger job. Curtis Pierce of RCA Victor Distributing now tells us that Roberts-Stage Electric is completing a 740-unit installation suitable for both television and f-m on Chicago's Lake Shore Drive.

New Product Ideas are always interesting to manufacturers. If you have one tell us about it. Maybe we can help.

Advertising Copywriters are indeed ingenious in the matter of artwork. Looking through the ads in one of our recent issues we note the presence of such widely assorted eye catchers as flying saucers, Indians, tight-wire artists, ghosts, magicians, elephants and butterflies.

September Issue Ads:

Just two pieces of copy make a direct bid for military business. However, several makers of temperature, pressure and humidity test chambers, and vibration testers, are back in print for the first time since World War II.

Three tube makers feature special long-life industrial types.

We are intrigued by the terms "mush-wound" coils and "ground worms (hard or soft)".

Quality of editorial material is the thing we strive for on ELECTRONICS, but you get quantity too. The average issue weighs 23 ounces.

Self-Hypnosis may be accomplished with a photoelectric relay controlling a 10-watt lamp, according to the Photobell Company. "The lamp is placed near the phototube, causing rapid oscillations controllable by varying the adjusting knob. Adjust the frequency by trial to match your eye requirements, look closely, and . . . ."

And what wakes you up, a power failure?

CROSS TALK

► **BLOOPERS** . . . Major Armstrong has reminded the industry that local oscillator radiation, now so troublesome in the f-m and tv bands, is an old problem, licked long ago in regenerative and superhet sets for the broadcast band. In a strong letter read before the RTMA f-m receiver committee he cites measurements on a particularly bad f-m receiver, with no r-f stage, that developed a full volt of local oscillator voltage across the antenna terminals, and compares it with a better receiver developing 20 millivolts.

We agree with the Major that keeping the radiation voltage down to 20 millivolts is good engineering, but unfortunately it's not good enough. If it were, the tv band would not be in the trouble it's in today. Measurements on tv receivers of twelve manufacturers, recently conducted under RTMA auspices, showed that the voltage across the antenna on channels 2 through 6, adjacent to the f-m band, was under 20 millivolts in 12 models of the 14 tested. The majority were below 10 millivolts on channels 2 through 6.

The mark to shoot at is one millivolt across 300 ohms for these channels. Such a radiated voltage represents only 3 billionths of a watt radiated, and produces a field of 15 microvolts per meter at 100 feet. Even on the low-band channels, achieving this low level is difficult. On the higher channels, thus far, it has proved almost impossible to meet this mark, because radiation direct from the chassis comes into play when the wavelength is only a few times the maximum dimension of the chassis.

The development that licked the problem on the broadcast band, so far as we are able to determine, is the built-in loop antenna. The majority of a-m sets now made use loops, and no r-f stage. But the loop is such a poor radiator that the radiation is held to an acceptable level. We wish that some equally simple solution were available to f-m and tv designers.

► **TV NATIONS** . . . A checkup reveals that as of September 1, public television service of one sort or another is being rendered in eight countries. In the Americas, stations are operating on 525 lines in the U. S. A., Mexico City and Sao Paulo (Brazil). A second Brazilian station, in Rio de Janeiro, is scheduled to start on 625 lines, the difference in scanning being predicated (wrongly!) on the power supply frequency. Equipment for 525-line service has been shipped to Cuba and should be on the air this fall. In Europe stations are on the air in London and Birmingham, Paris, Eindhoven (Holland) Milan, and in Russia. Experimental transmissions, without public participation, are reported to be under way in Denmark and Sweden.

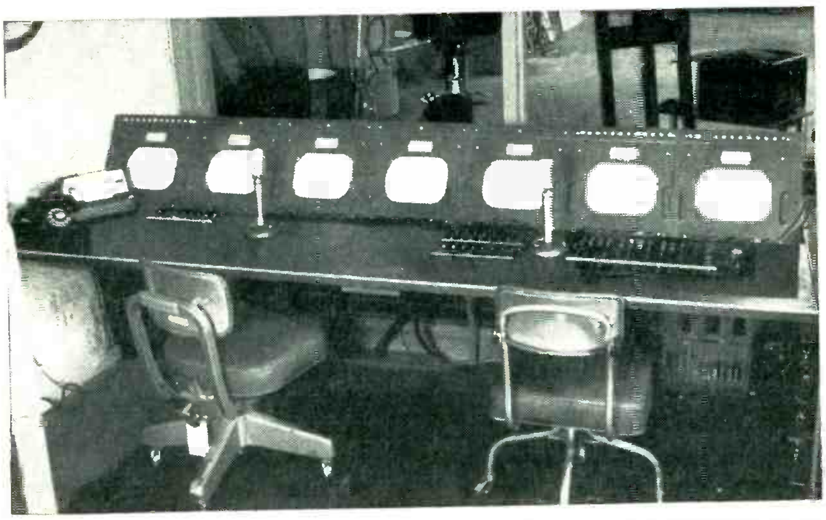
Many new stations can be expected in Europe, now that the European standards have been agreed on. Word from Geneva has it that the European nations (except France and England) have definitely settled on 625-line, 25-frame scanning, as anticipated in our last report (August issue, p 70). Negative modulation and f-m sound, following U. S. A. practice and opposed to the British recommendations, have been adopted. The channel width is 7 mc. Except for the adoption of 25-frame scanning, which will put the European system at a disadvantage from the flicker standpoint, the choices made at Geneva are a sound basis for television service, and reflect a careful study of alternatives.

► **RED FEATHER** . . . The symbol on our cover this month is a reminder that October is Community Chest month. Two of our leading industrialists, whose names are 100 percent correlated (Charles E. Wilson, president of General Electric and Charles E. Wilson, president of General Motors) are national campaign chairman and vice-chairman respectively. The Wilsons point out that the one-campaign method is a very sound way of raising money, from a business standpoint, because the production costs drop as the volume increases. The campaign is not only sound in method, it is free-enterprise humanitarianism at its best. Give enough!

NEW IDEAS In

By NEWLAND F. SMITH
Engineer in Charge of Television
WOR—TV
New York, N. Y.

General view of studio A. Each studio has its own program control room from which program director, video switcher and audio operator watch action. Cameras are controlled from central control room which views both main studios from second floor

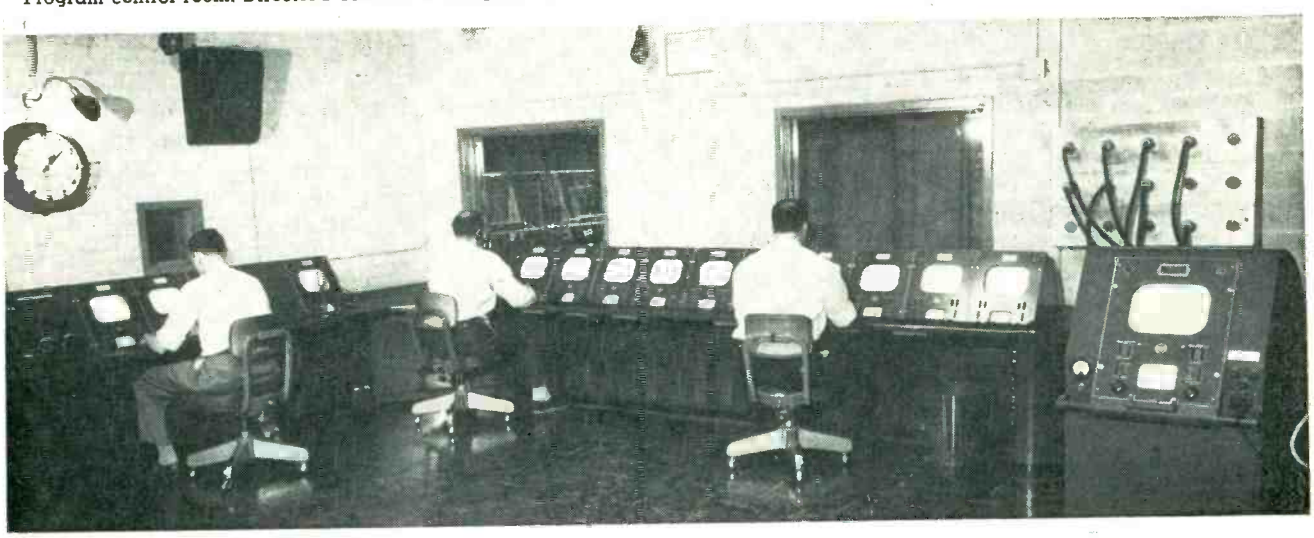


Program control room. Director's console is designed for unobstructed view of studio

DEMANDS ON TECHNICAL FACILITIES at television studios vary from program to program and from day to day as new techniques and ideas are developed. In order to keep up with constantly-changing requirements, the arrangement of equipment must be extremely flexible.

A new approach to the problem of television studio design has been made at WOR-TV. A maximum of attention has been directed toward getting the most out of available technical equipment. Facilities are provided for rapid and effortless interchange of equipment from scene to scene and from studio to studio. Careful planning has reduced the number of camera chains required, while at the same time production problems have been eased.

The setup includes two large studios, two announce studios, three program control rooms, film



Camera control center. Here operators set outgoing video levels and maintain electrical focus on all cameras. Camera cable patch panel is visible at extreme right

Television Studio Design

Separation of program direction and technical control solves many problems and enables station to get more out of available facilities. Central camera control provides increased flexibility and efficiency with less confusion and complication

projection facilities and a camera control center. The space is divided as shown in Fig. 1.

All camera-control facilities for all studios are centrally located in the camera control center. Thus, camera-control operation is removed from the actual studio control rooms which are called the program control rooms.

Program director, video switcher, and audio operator are located in these program control rooms. The program director's console has seven 10-inch picture monitors. These monitors are directly in front of the director, enabling him to have a close view of each camera and signal available for his program make-up. The console has a lower top than is normally used in television consoles, providing a good view through the studio window onto the studio floor. Here the program director finds no distraction from the camera control operators being between him and his monitors, as in the usual setup, making concentration on his production that much easier.

Video Switching

To the right of the program director, who normally sits in the center of the console desk, sits the video switcher. He has, in front of him on the desk top, a sixty-button control panel, which enables him to do the necessary camera switching as called for by the director.

The panel uses d-c voltages to energize video-switching relays which are centrally located for all studios in the camera control center. The control panel consists of five rows of buttons. It may be seen on the right-hand end of the desk in the program control room photograph. The lower row of controls provides for the switching of any one of the twelve inputs to the outgoing program line, and represents, therefore, the program output of this studio. The next two rows select inputs for the effects mixer amplifier. The gain of each section of the mixer amplifier can be controlled independently or simultaneously by a fader lever located to the right of the buttons. The output of the effects mixer is brought back into the main switching bank in the number twelve position, thus providing for the switching of a super-position or a lap dissolve directly onto the program line by pressing the number twelve button in this row.

Two additional rows of buttons on the top of the panel enable either of the two preview monitors located in the console to be switched at will to any one of the twelve inputs to this switching system.

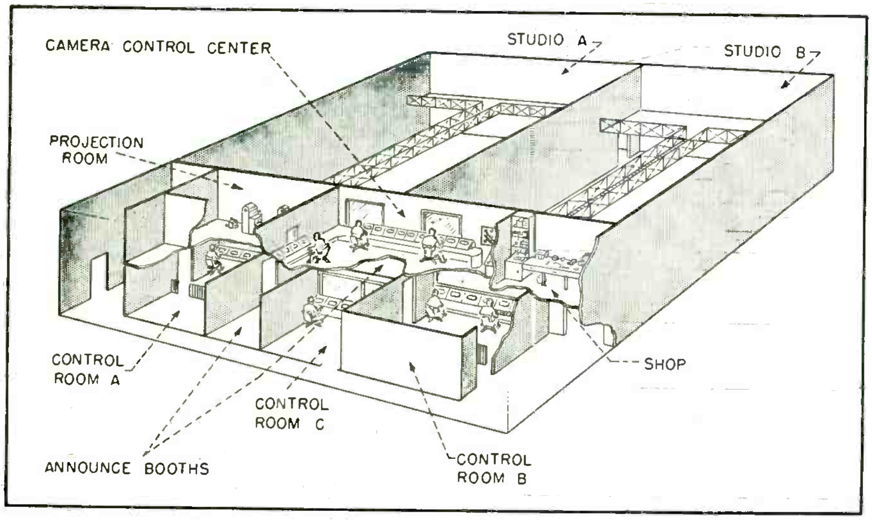


FIG. 1—WOR-TV's new 67th Street studio building is designed to afford most efficient use of technical facilities

Program Patching

All required signals for a particular program are sent to the program-control-room switchboard through a coax patch panel located in the camera control center. With the normal arrangement, the first eight positions on each studio-control switching system are reserved for camera inputs, that is, signals with video and blanking only. The next three positions are reserved for composite video signals. This enables a remote signal to be switched in as part of a studio program in any of the studio control rooms where it is required.

The video switching relays used in the system are the standard RCA TS-20A switching relays. In these, the timing is dependent on only one relay for each outgoing channel, thus simplifying adjustment. In switching a television signal, time delay is very important and has been reduced in these relays to approximately one millisecond. In the case of the program bank of relays, the transfer relay is set to produce an overlap in the switching. That is, the two cameras are momentarily on together at the time of switchover. This gives a smoother appearance on the outgoing signal than a gap between the two cameras. It does, however, momentarily parallel the output of the camera control units during the one-millisecond switchover. This does not reflect back in any other outgoing signal.

In the case of the effects and preview switching relays the timing has to be set for a gap in switching. It is necessary to use gap switching here in order that switching of cameras on the preview or effects busses will not disturb cameras that may be feeding the outgoing program line.

The camera switching system, which is identical for all studios, is shown in block form in Fig. 2. The switching relays incorporate in each outgoing bank a cathode follower which isolates the capacitance of the outgoing line from the incoming camera circuit. In this manner a uniform frequency characteristic through the video bank is obtained out to seven megacycles. It is necessary, however, to keep the cable to the isolation amplifier as short as possible.

Camera Control Center

All control units for both film and studio cameras are located in the one central control room as shown in Fig. 3. Central camera control operators merely set levels on the outgoing video signals and maintain proper background and electrical focus on each of the cameras. A line monitor is incorporated in the camera control console for each of the studio control rooms. Thus, the camera control operator can readily check his levels after being switched onto the program line.

The camera cable patch panel on the wall of the camera control center enables any of the eight studio camera control units to be patched into any of fifteen outgoing cables. These cables are routed to the different studios and announce booths. Any combination of the eight studio cameras can be distributed to the studios as required for a given program. In addition to distributing the cameras to the various studios as required, it is, of course, necessary to patch the video output of the camera chain to the proper camera-switching control position, where the show is to be directed.

A tally-and-intercom patch panel enables the tally light signals that are furnished by the switching relays to energize the corresponding camera control monitors and cameras when they are switched on the air. The same patch cord also carries order wire and program audio to the headsets of the camera control operators and the cameramen. Thus, at each of the camera control positions the operator can plug in a headset which will give him communication with the video switcher in the appropriate program control room, and also with the cameras that he is controlling. In addition, the program audio is fed to the camera operator from his studio.

The film camera controls located to the left of the studio camera controls are operated in a similar manner, with the exception that the camera cable is connected directly from the film cameras in the projection room to their corresponding camera control units. The video outputs of the film camera controls may be patched at the video patch panel into any of the three studio control rooms for switching as required. Thus we have the provision in any one of three studio control rooms to switch in film inserts or

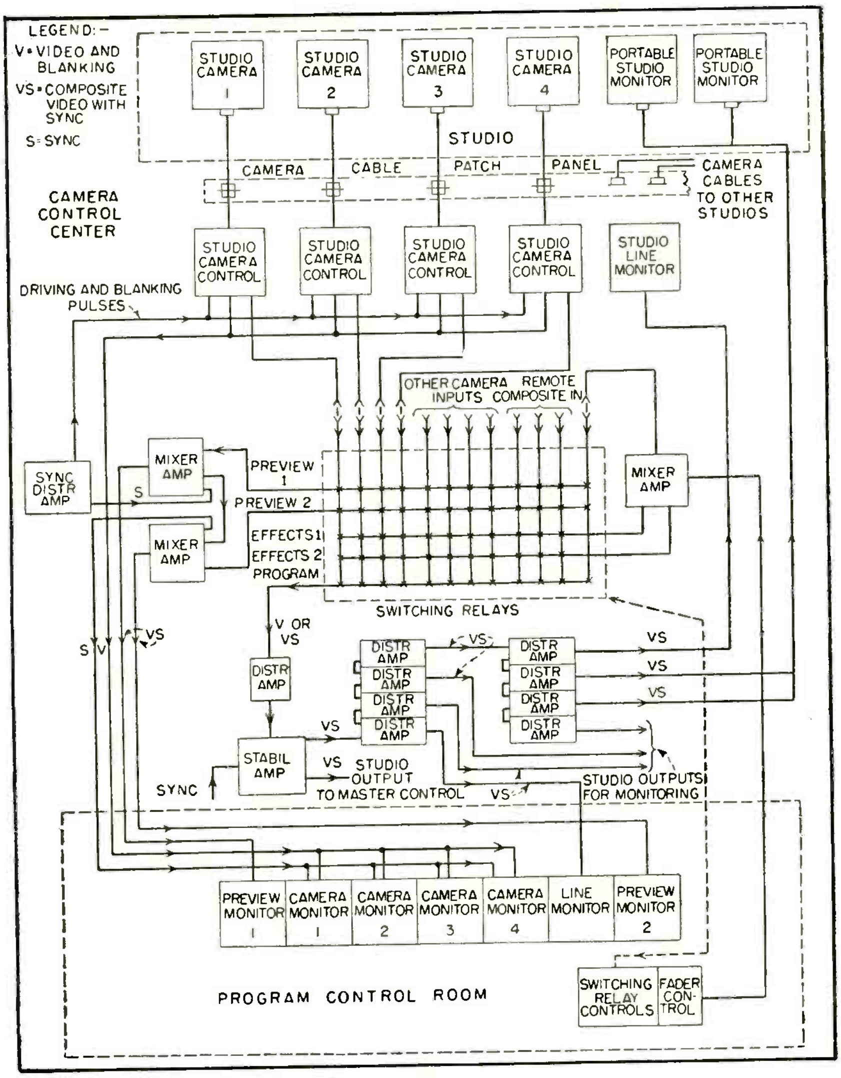


FIG. 2—Video switching is accomplished by remotely-controlled relays located in the camera control room

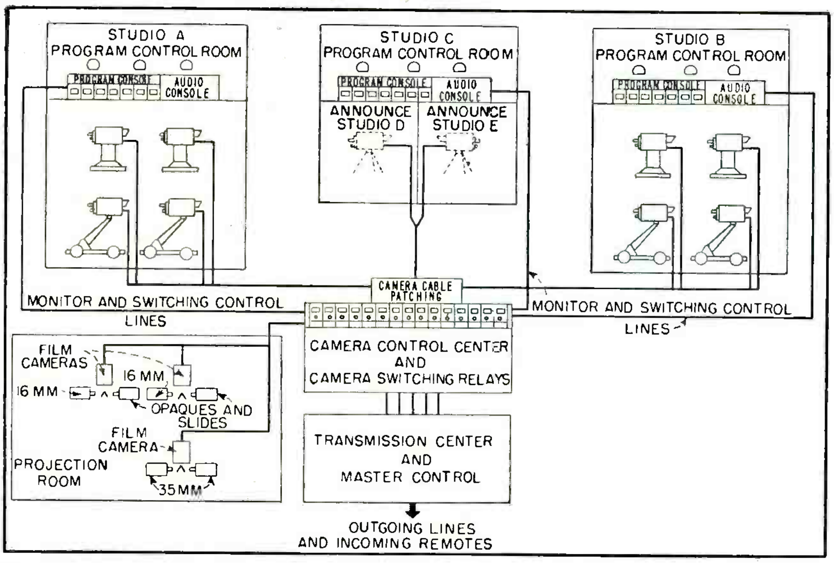


FIG. 3—Complete equipment diagram shows wide variety of combinations available through the use of separate program and camera control rooms

slides, as well as any of a number of studio cameras, depending upon the size of the production.

Advantages

By centralizing the camera control units some of the control operators who have been working with one studio can switch immediately to a program from a second studio, since it requires no physical movement from one room to another. It is possible to realize a saving in operating personnel. Also, the quick interchange of camera control sections, by use of the camera cable patch panel, makes it possible to replace defective units quickly in case of trouble during a rehearsal or actual program.

An additional advantage of the centralized control room is a simplification of the cable-delay problem which normally occurs when several studios are operated at different distances from a central master control room. In this case it is customary to delay the horizontal driving and blanking pulses of the nearer studio control rooms, so that the time delay is equal to that of the studio control room having the greatest cable distance to the master control room. By having all of the camera control units for all studios located at one point the same delay between synchronizing and blanking pulses holds, regardless of which studio control room is used.

By centralizing the camera-control equipment and the camera-switching equipment for all studios in one place, the actual program signal does not appear in nor is it routed through any of the studio control rooms. The monitors in the individual studio control rooms are fed by lines from the camera control center, which merely bridge the program circuits in the camera control center.

Power Supplies

In addition to the switching relays and associated amplifiers, the camera control center contains the necessary power supplies for all of the studio equipment, including monitors in the individual program control rooms. There are approximately 150 power supplies which occupy 20 cabinet-type racks. All of these power supplies are of either of two standard types. They are all of the plug-in type, which means that spare units can be quickly substituted in case of failure of any individual power supply. A power-cable extension cord with suitable connectors is always kept available for patching in the d-c outputs of the spare supplies when required.

Centralizing all power supplies simplifies the power distribution problem and eliminates much of the heat from the studio control rooms. Furthermore, a reduction can be made in the number of spare units required to take care of several studios.

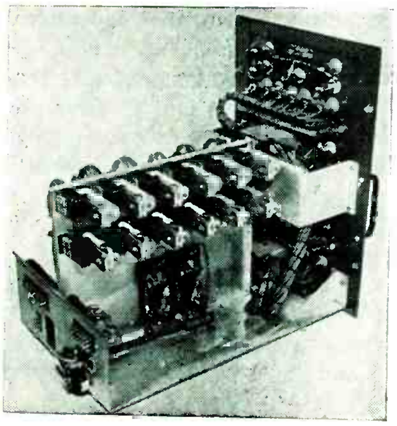
Projection Room

The projection room, located adjacent to the camera control center, contains three TK-20A iconoscope film cameras. Each of these is multiplexed by means of a mirror system to provide three sources of film or slides for each film camera. Two 16-mm projectors, two 35-mm projectors, opaque projectors, and slide projectors comprise the projection equipment.

Cabinet racks contain picture monitors for each of the film camera chains as well as space for audio and intercom amplifiers. An intercom system consisting of a microphone and talk-back speaker is suspended over each film camera assembly. The intercom system can be tied in individually with any of the studio control rooms that the film camera should be associated with on a given program. In this way one film camera chain can be used for a rehearsal with one studio control room, while another film camera chain is being used with a second control room to produce a show on the air. In the same way that tally lights indicate studio cameras are on the air, tally lights on the individual film cameras show when each is placed on the air by a studio control room. The tally signals are fed through the tally patch panel in the same way that the studio camera tallies are fed.

Master Control

The master control facilities are located in the same room as the



Video switching relays like these are energized by d-c from program control rooms

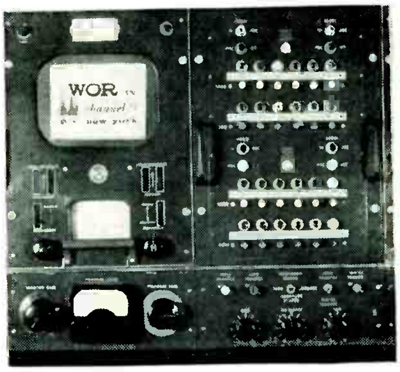
camera control center, and actually are one half of the large U-shaped console. The switching facilities consist of equipment to switch six incoming studios to four outgoing channels. Both audio and video are switched here, and individual picture and audio monitors are provided on each outgoing channel. All switching is done by relays. The switching relays set for gap timing are used for the video switching and a special audio-relay switching system has been built up to accompany this.

All switching can be preset and provision is made for either simultaneous audio-video switching or independent audio and video switching if required. Normally, only simultaneous audio-video switching is used, since only complete programs are switched at the master control point. However, if required to hold over the audio from one studio to another, and switch only the video, this can be accomplished, and the audio switched at a later moment. Provision is also made for tripping all four outgoing channels simultaneously when required, or for switching them in groups or individually.

At this point in the system only composite signals are handled, and no provision is made for lap dissolving or fading. Fading is always a program function, and should be handled when so required at the direction of a program man in one of the studio control rooms. Each outgoing channel is provided with a stabilizing amplifier in its output, so that the picture level and synchronizing level may be set independently on that particular channel. Corresponding audio-gain controls are also provided on each outgoing channel.

The transmission center is really a part of master control. Two additional console sections are provided with TM-5A picture monitors, which can be fed from any of the six inputs to master control. The inputs to these monitors are switched by control buttons directly in front of the monitor. Any of the inputs to master control can be previewed here before actual switching.

Adjacent to the monitors are located remote controls on six stabilizing amplifiers. The controls enable the operator to match the levels on all of the studio outputs as well as any remote outputs which may be patched in for checking.



Master control switching console

Phase Comparison

A means is provided for comparing the phase of an incoming remote signal with that of the local synchronizing system. This is done by switching the vertical driving pulses of the local sync generator onto the grid of the cathode-ray oscilloscope in one of the preview monitors. This blanks out the period of the local vertical synchronizing signal, and when a remote signal is switched up on this monitor a portion of its synchronizing will be blanked out. When the blank period is phased so that the vertical disappears, then the two synchronizing generators are properly phased as regards vertical synchronizing. Normally, the phase of the remote sync generator is changed to bring it in with that of the local studio sync generator. Thus, the studio sync generator is kept as a standard.

Remote controls on the phasing of the local sync generators are brought over to this console section also, so that when required the phase of these generators can be changed conveniently. In addition, a remote-control switch is provided so that a stand-by sync generator can be switched in in place of the regular generator as an emergency. It is important that the two local generators be previously phased.

Provision has been made for utilizing the new RCA Genlock unit. This will enable remote signals coming in to control the phase of the studio sync generator line-by-line. A remote signal coming in can be treated as a local camera, and when patched into any of the studio control rooms can be faded and lap dissolved with local cameras. To treat the signal this way it is necessary to wipe off the synchronizing component on the incoming remote by means of one of the TA-5C stabilizing amplifiers. The synchronizing thus removed is fed into the Genlock unit to provide afc control on the local sync generator. Synchronizing from the local generator is then finally mixed with the output of the studio control room to provide a composite signal for both local cameras and remotes.

Remote signals come into the building through Telco video lines. Approximately twenty-four circuits are available from different points within the city where remotes are handled. One circuit comes from the microwave receiving location on the Empire State Building, where many remotes are received, and is then routed to the master control.

Results

This studio system has been in use since the first of the year, and has worked out very well. On some of the larger productions both studios have been used for one show. In this case as many as seven camera signals have been switched in one studio control room to make up a given production. On other occasions rehearsals have been conducted in one studio concurrent with an on the air show from another studio control room. The flexibility of the system has been very apparent in the rearranging of camera facilities to meet the individual requirements of different types of productions.

With the present setup, only three program control rooms are used. Undoubtedly, the future of television will require many more studios. In such a system the same basic principles that have been used in the WOR-TV studios could be extended to provide the same advantages. It may be that a practical limit, as to the number of camera control units that might be located in one center, would be reached. In that case, two or more camera control centers might be provided for, say, six or eight studios, to form a practical arrangement.

SUN FOLLOWER for V-2 Rockets

Automatic tracking device keeps spectrograph in nose of V-2 rocket pointed at sun for making intensity measurements at wavelengths as low as 500 angstroms. Servo-drive system resembles SCR 584 auto-track principle, except that error signal is derived from photocell mounted in rocket

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KEEPING a spectrograph in a spinning V-2 rocket pointed at the sun is accomplished by a photocell-controlled servo-drive mechanism called the sun follower. By lengthening the available exposure time, measurement of radiation intensities down to 500 angstroms has been made possible. Hitherto observation of solar spectra from photographs taken by ultraviolet spectrographs in the nose or tail of V-2 rockets passing through the ozone layer has been limited to wavelengths above 2,000 A.

To overcome the effects of the rocket's angular motion, a two-axis tracker was developed for stabilizing the spectrograph and keeping it pointed at the sun regardless of the spin and precession of the rocket. Automatic detachment and descent by parachute are provided to facilitate recovery of the sun follower and spectrograph.

Requirements

The behavior of the rocket in flight is depicted in Fig. 1. During the burning period, axial-spin and precessional velocities are imparted to the rocket and remain approximately unchanged from a few seconds after burn-out until the denser atmosphere is encountered on descent. A typical rocket assumes axial-spin velocities up to 50 rpm in either direction, and precessional velocities up to 10 rpm in either direction at angles up to 20 degrees to a precessional axis which may be inclined up to 20 degrees from the vertical.

Built into the nose of the rocket, as shown in Fig. 2, and timed to operate above the denser portion of the earth's atmosphere after doors in the rocket's nose have opened, the sun follower stabilizes by means of error signals derived from the sun. This is accomplished with a photocell error-signal generator and two independent servo-drive units. The azimuth axis is collinear with the longitudinal axis of the rocket. The elevation axis is perpendicular to the axis of the rocket and rotates about it. By tracking with an error of less than one-half degree in both azimuth and elevation, the sun follower permits the use of a spectrograph capable of recording wavelengths as short as 500 A.

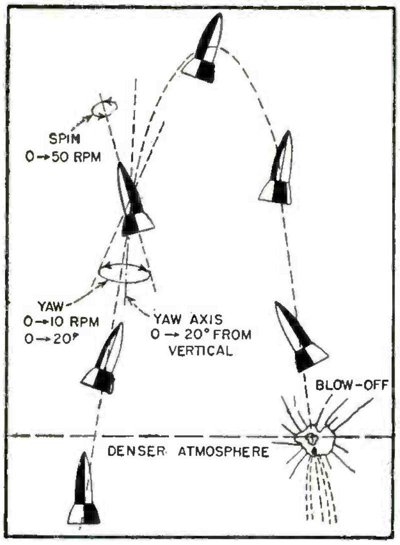

FIG. 1—Typical V-2 flight pattern shows precession and spin that limit spectrograph exposure time

Stabilization

The principle of the stabilization system is similar to that of the tracking unit employed in the SCR-584 radar, except that the photocell error-signal generator and low-frequency amplifier replace the radar's r-f transceiver. A block diagram is shown in Fig. 3. A real image of the sun is focused by a lens onto a rotating shutter situated in the focal plane with its center on the optical axis. The shutter (Fig. 4) is constructed of transparent material upon which is placed a number of equally-spaced, radial, opaque spokes. Superimposed on the spoke design is a pattern of linear shading. The spokes chop the sun's radiation at 400 cps producing a 400-cps carrier. The linear shading modulates the carrier at 40 cps. The degree and phase of modulation of the 400-cps carrier are determined by the position of the sun's image on the shutter. A photovoltaic cell placed immediately behind the shutter intercepts the 40-cps-modulated, 400-cps light signal and converts it into a proportional electrical signal which is amplified, maintained at constant level with avc, and demodulated.

The resulting 40-cps signal is then fed into a two-channel phase-comparator circuit. In the azimuth

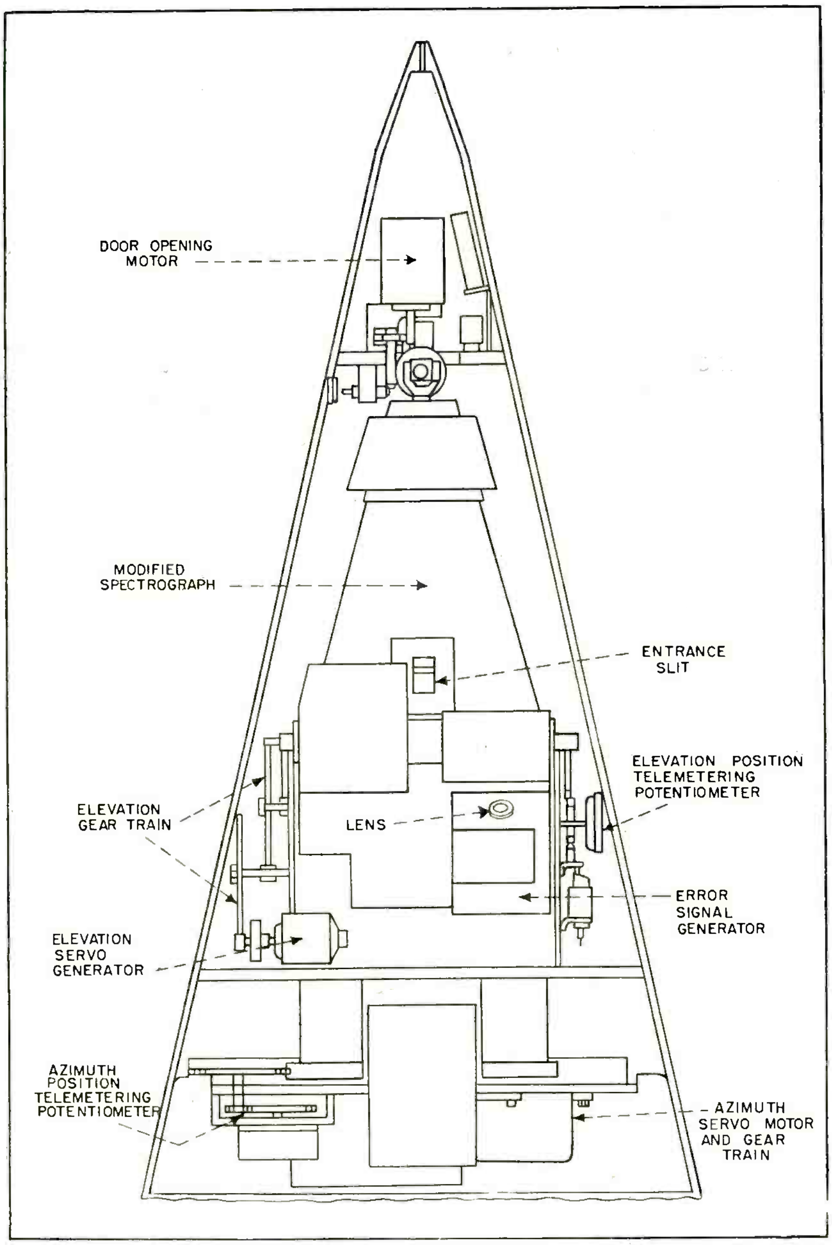

FIG. 2—Rotating nose of rocket compensates for spin while spectrograph is elevated to overcome precession

channel the phase of the signal is compared with the phase of a fixed 40-cps voltage from a reference generator which rotates in synchronism with the shutter. In the elevation channel, the phase of the signal is compared with that of a second fixed 40-cps voltage which is in quadrature with the fixed voltage of the first channel. The results of the phase comparisons in both channels are two independent d-c voltages whose magnitudes are functions of the differences in phase between the respective signals and fixed voltages which produced them and are proportional to the magnitudes of the respective demodulated signals.

This dual relationship makes the respective d-c output voltages directly proportional to the horizontal and vertical displacement of sun from the center of the shutter and hence the optical axis.

Displacement Voltages

For example, if the sun's image is positioned on the optical shutter at a distance R from the optical axis and the resulting differences in phase angle between the 40-cps modulation on the 400-cps carrier and the azimuth and elevation reference voltages are α and β respectively, then the following proportionalities hold for the d-c voltage swings, ΔV_{az} and ΔV_{el} in the azimuth and elevation channels

$$\Delta V_{az} \propto \cos \alpha$$
$$\Delta V_{az} \propto R$$

and

$$\Delta V_{el} \propto \cos \beta$$
$$\Delta V_{el} \propto R$$

combining

$$\Delta V_{az} \propto R \cos \alpha$$
$$\Delta V_{el} \propto R \cos \beta$$

therefore

$$R \cos \alpha = X$$
$$R \cos \beta = Y$$

In other words, the d-c voltage swing in the azimuth channel is directly proportional to the right-left displacement, X, of the sun's image and the d-c voltage swing in the elevation channel is directly proportional to the up-down displacement, Y, of the image. This is true for image displacements up to 25 degrees off the optical axis and is determined by the extent of the linear portion of the shading on the optical shutter. Beyond 25 degrees to the edge of the shutter the shading is a maximum and constant.

After amplification the two d-c voltages are employed to control, individually, the outputs of the azimuth and elevation amplidynes. These in turn control the azimuth and elevation servo motors. Portions of the amplidyne outputs are fed back into the last stages of the amplifiers for antihunt control.

The only stable condition for the system exists when the image of the sun is on the optical axis of the error-signal generator. Other positions of the sun's image result in the generation of restoring torques in the azimuth and elevation channels which are directly proportional to the magnitudes of the respective horizontal and vertical displacements of the image. Since the optical axis of the ultraviolet spectrograph is mechanically aligned with the optical axis of the error-signal generator; and, since the error-signal generator tends to line up with the sun, the spectrograph is brought into alignment with the sun.

Automatic Search

In addition to the simple tracking function, the sun follower automatically searches for the sun in the azimuth plane when energized at the start of the rocket's flight and will do so automatically if it loses the sun during the flight. The search rate is 70 rpm relative to the rocket in a clockwise direction.

Since the rate of search must be greater than any anticipated rocket spin velocity, the rotational velocity of the sun follower relative to the sun may be high under some conditions. The stopping and locking-on requirements are severe. Under the worst possible condition, when the direction of search and the direction of spin are the same, net search velocities up to 120 rpm can be expected. Because of the limited field of view of the error-signal generator, it is necessary to stop the sun follower in less than an 80-degree sector so the tracking unit can take over. This amounts to a deceleration of approximately 600 rpm per second. A velocity-sensitive unit providing for such deceleration has been incorporated in the sun follower.

Since the vertical coverage of the error-signal generator includes the sun in its field of view under normal conditions, no added provision for rapid acceleration and deceleration is required in the elevation plane.

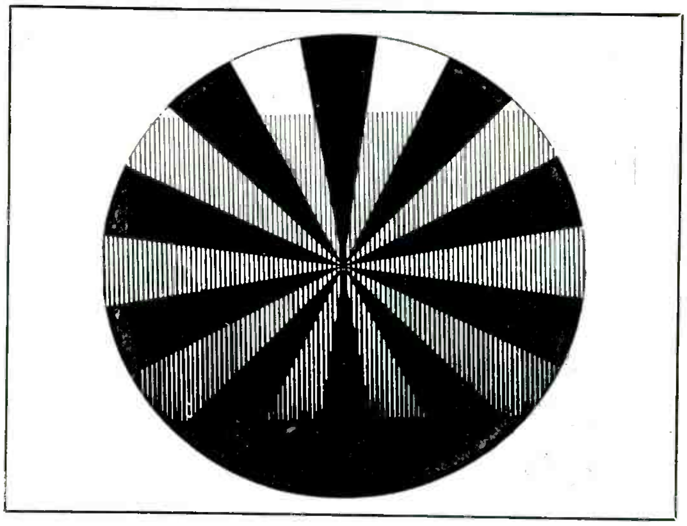

FIG. 4—Spokes of shutter provide 400-cps optical carrier as wedge shading modulates at 40 cps

The sun follower also provides rocket-aspect data for telemetering. Since the error-signal generator tracks the sun in both azimuth and elevation, its instantaneous position with respect to the main body of the rocket is the same as the rocket's instantaneous position with respect to the sun. Potentiometers attached to the sun follower provide d-c voltages for telemetering the rocket's attitude. In addition, the sun follower's tracking errors in azimuth and elevation are telemetered.

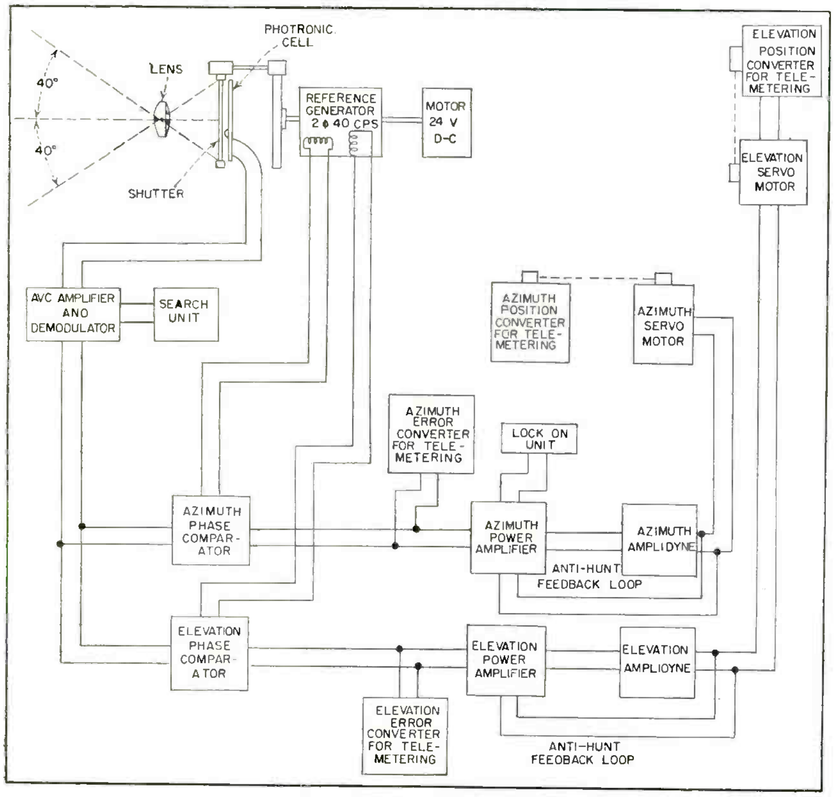

FIG. 3—Block diagram traces error signal from phototube generator to servo-drive motors

Rocket Installation

The first sun follower was installed in V-2 rocket No. 38 which was fired on April 19, 1948. The rocket's flight was off course and had to be terminated at an altitude of eighteen miles. The cycle of operation of the sun follower had not begun at that time. In hope of saving the sun follower, the ejection mechanism was actuated immediately following radio-fuel cutoff. Signal Corps motion pictures taken with the aid of a tracking telescope show that the sun follower was ejected properly. However, at the time of the ejection the rocket's velocity was 3,830 ft per sec and it is doubtful if the parachute withstood the shock of opening in the earth's atmosphere. No part of the sun follower has been recovered.

A simplified version of the sun follower is now being prepared for installation in the Venus and Viking rockets as well as in some of the few remaining V-2 rockets.

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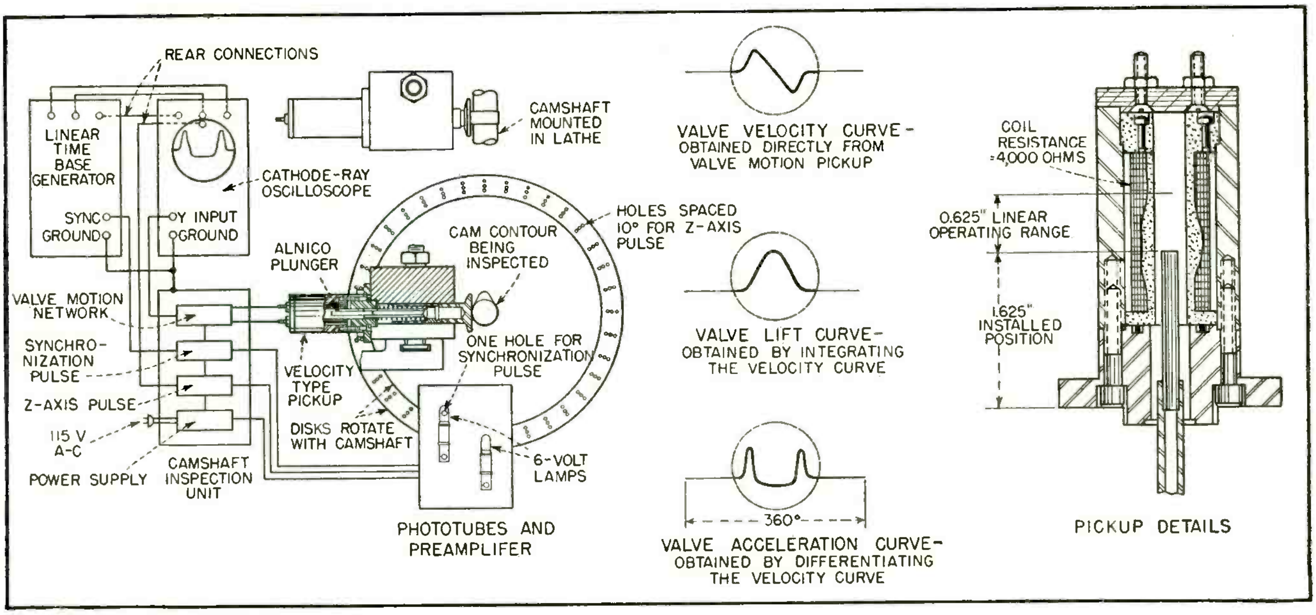

FIG. 1—Inspection fixture, associated electronic equipment, examples of the three types of curves obtained, and details of pickup coil whose output voltage varies linearly with velocity of the plunger inside

Electronic Inspection of ENGINE CAM CONTOURS

Cam pushes rod-shaped permanent magnet back and forth inside pickup coil to generate voltage proportional to velocity, for viewing on cathode-ray screen to reveal contour errors. System can also be used directly on engines to study valve motion at high speeds

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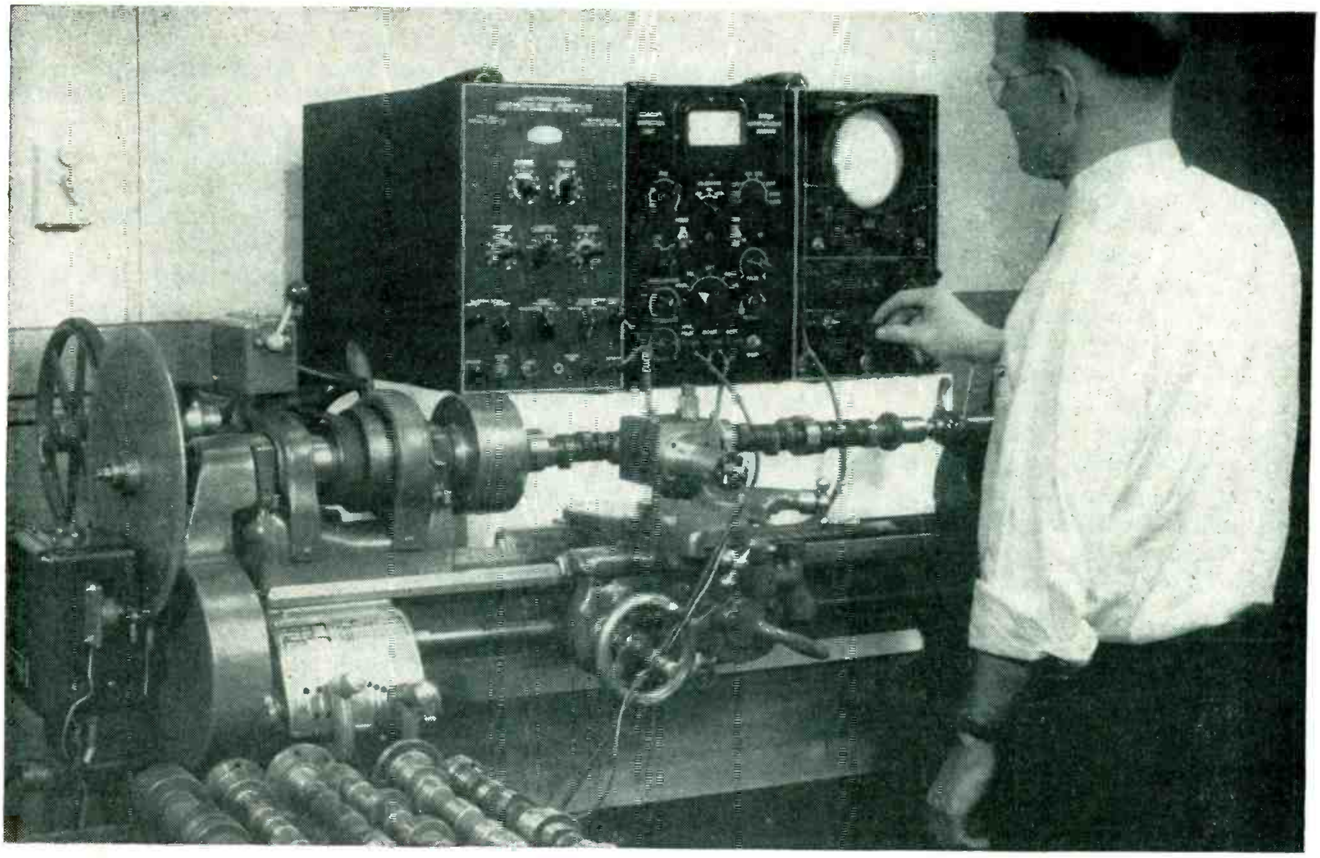
THE CAMSHAFT LOBES that lift the valves of internal combustion engines must be accurately ground if good engine performance is to be obtained. In the production of camshafts, errors in profile can arise from factors such as wear in master cams and machinery, uneven grinding operations, lash and inertia. A cam lobe possessing a contour deviating noticeably from the theoretical can affect engine performance and cause failure of parts in the valve gear. This points to the need for cam contour inspection.

Inspection Methods

The conventional method of inspection involves using a suitable fixture to record the cam contour lift at intervals of one or two degrees. This method is sufficiently accurate for most inspection purposes as it provides data comparable to the design lift figures. However, small contour errors are not easily found without plotting a lift curve several times size or taking differences between adjacent lift figures and plotting the resulting data which will resemble a velocity curve. Also, differences of these difference figures can be taken to secure data which will resemble that of an acceleration curve.

Using inspection data in this manner gives erratic results since the fifth decimal place greatly affects the acceleration curve. Furthermore, this method of checking a cam contour is time-consuming and is impractical for production testing except when done in rather infrequent intervals. When each lobe is to be inspected on a sixteen-lobe camshaft for an eight-cylinder engine, the inspection time can require from eight to thirty hours unless the fixture is suitably designed to handle production inspection. Small errors in indexing, errors in bearing supports for the camshaft and clearance errors in the tappet follower can affect the accuracy considerably.

An alternate method is to use a template for comparative purposes; this, however, is not suitable for any real accuracy. A modified form of the template method involves



Cam contour inspection equipment installed on lathe. Operator watches curve on scope as tappet follower on lathe carriage is set on each cam lobe in turn. Disc at left end of lathe shaft has holes that pass light to phototubes in box below for generating sync pulses

using a magnifying comparator to cast an enlarged shadow of the profile on a ground glass screen. This is much more accurate, but still does not lend itself to production inspection.

In view of the shortcomings of the two established methods of inspection, the electronic method was evolved to obtain a rapid, accurate and more reliable method of determining the type of motion a particular cam will produce.

By using the electronic method of cam contour inspection it is possible to inspect each lobe in approximately one minute. All of the cam lobes of a camshaft can be inspected and photographed in only a fraction of an hour, once the equipment is set up. This method is equally suitable for supplementing production inspection and for cam contour development work.

Electronic Method

In the electronic method of inspection, the camshaft is mounted in a lathe, and each cam contour is checked by observing curves that appear on the screen of a cathode-ray oscilloscope. The general arrangement of the equipment is shown in Fig. 1, along with the lift, velocity and acceleration curves that are selected at will with a three-position switch. Individual curves can thus be studied without going through the process of plotting them from data obtained by tedious micrometer measurements.

In actual inspection work the lift curve is not of much value as small errors are not apparent. The velocity curve reveals errors more readily, and is especially useful for checking the ramps provided at each end of the cam contour. The acceleration curve is best of all for critical cam contour inspection, as it reveals local irregularities even better than by calculation from lift figures measured to 0.0001 inch.

The camshaft to be inspected is mounted in a lathe and rotated at a uniform speed somewhere in the range of 200 to 400 rpm. A tappet follower (flat, roller or shoe) is held against the cam lobe by a light spring to simulate the motion of a tappet in a valve gear. Attached to the follower is a small rod-shaped Alnico magnet that moves inside the pickup. The design of the pickup, also detailed in Fig. 1, is such as to give a high sensitivity factor along with linear response in its operating range.

The electronic equipment comprises a cam contour inspection unit, a 5-inch 208-B DuMont scope employing a blue screen for photographic purposes, and a 215 DuMont linear time-base generator. The scope has sufficient Y-axis gain to design a pickup for direct connection without an additional electronic amplifier. A more recent model of scope (DuMont 304-H) can be used without the separate generator as it has a sufficiently linear X-axis time base built-in.

The associated electronic circuit, shown in Fig. 2, provides two types of pulse voltages, one for synchronization of the scope to the rotative speed of the camshaft and the other to provide 10-degree markers on the X axis for photographic use. These pulse voltages are obtained by using a rotating disc as in Fig. 1 to trigger light to two phototubes. Two series of holes are used; one series has one hole for 360-degree rotation for synchronization purposes, while the other series has holes spaced 10 degrees apart for X-axis calibration purposes.

The upper phototube and its associated amplifier serve to produce a stationary image on the screen by injecting into the X-axis sweep generator circuit a voltage pulse directly related to camshaft speed. Good results are obtained with this method of synchronization; however, the photoelectric circuitry can be satisfactorily replaced by a magnetic type of synchronization trip actuated by a steel pin on the lathe shaft.

The lower phototube and its amplifier serve to inject positive voltage pulses onto the control grid of the c-r tube. This gives Z-axis pulses producing dots every 10 degrees on the X axis.

When the permanent magnet (attached to the tappet follower) reciprocates within the pickup coil, a voltage is generated across the pickup terminals equal to $k_1 N d\phi/dt$, where N is the number of coil turns and $d\phi/dt$ is the rate of cutting flux lines. But $d\phi/dt$ is equal to $k_2 V$, where V is the velocity of the magnet, hence the generated voltage is equal to $k_3 NV$. This shows that the output voltage from the pickup is directly proportional to the velocity curve when the output terminals from the pickup are connected directly to the c-r tube.

When the selector switch is set to give the lift curve, an R-C integrating network is connected across the pickup coil and the integrated output voltage is taken across C, as shown in Fig. 2. Values of R and C are selected to give a high ratio of resistance to capacitive reactance and a high ratio of time constant (RC) to the reciprocal of the frequency of operation ($1/f$).

When the selector switch is set to give the acceleration curve, an R-C differentiating network is placed across the pickup coil and the differentiated output voltage is taken across R. Values are chosen to give a high ratio of capacitive reactance to resistance and a low ratio of time constant (RC) to the reciprocal of the frequency of operation ($1/f$).

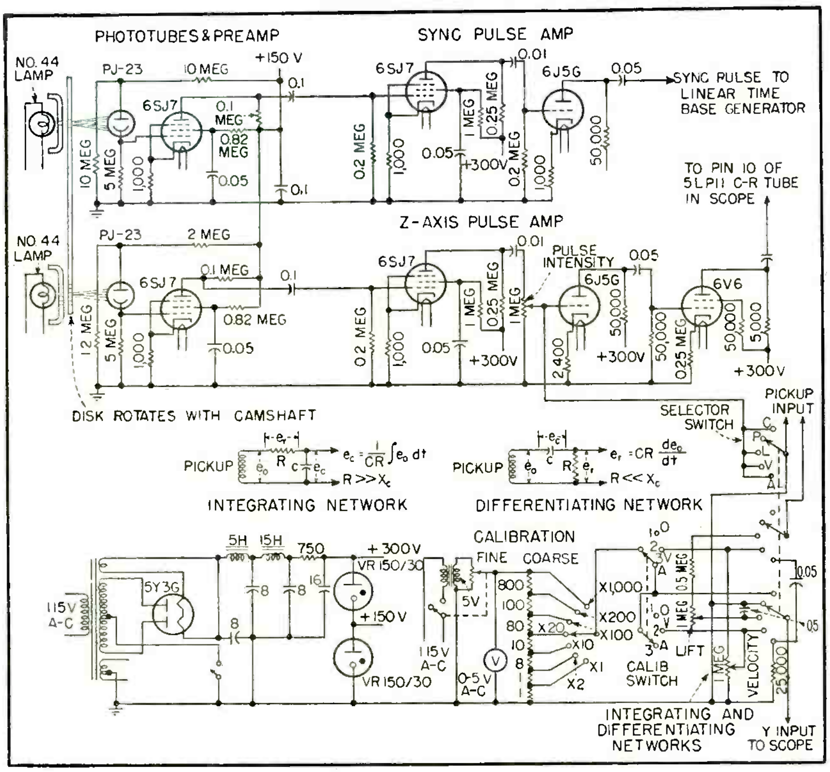


FIG. 2—Complete circuit of electronic cam contour inspection unit

Calibrating Technique

A 60-cycle calibrating voltage is used for adjusting the gain controls to predetermined settings and to secure curves on the c-r screen with calibrated ordinates. This requires that the pickup be calibrated to determine its sensitivity factor by measuring the voltage generated as related to the maximum acceleration and velocity of the small reciprocating magnet.

Calibration is accomplished by employing an eccentric to reciprocate the tappet follower. Here the actual acceleration of the tappet is known and voltage measurements

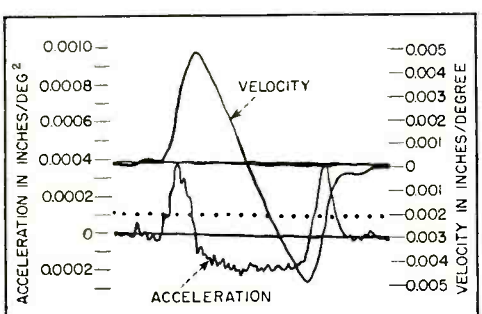


FIG. 3—Example of photographed curves. X-axis dots are 10 degrees apart

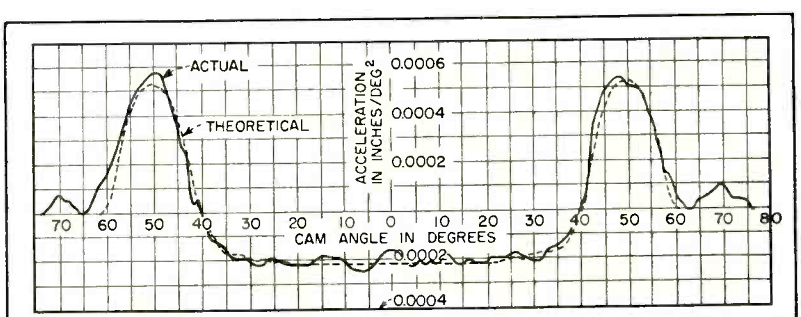


FIG. 4—Comparison of actual and theoretical acceleration curves for a new cam contour that has been accurately finished

are easily made on the screen due to the sinusoidal waveform output from the pickup. To secure adequate sensitivity a higher speed is used for calibration than for actual cam contour inspection. Low speeds are desirable during cam contour inspection to keep inertia and spring loads to a minimum.

To find the sensitivity factor of the pickup coil, its output is fed through the cam contour inspection unit to the oscilloscope. The Y-axis gain is adjusted to give a certain amplitude on the screen, such as 2 inches overall. The selector switch is then set on CALIBRATION and the calibration switch is set on ACCELERATION. Finally, fine and coarse calibration controls are adjusted to give the same height as before on the screen. The reading of the voltmeter in millivolts, multiplied by the appropriate multiplication factor given on the coarse calibration control, is then used to establish the acceleration sensitivity factor of the pickup. This factor is used for all later adjustments, providing the pickup and magnet are not altered, the test speed is held at the preselected value, and the differentiating circuit is not altered. The velocity calibration is made in the same manner.

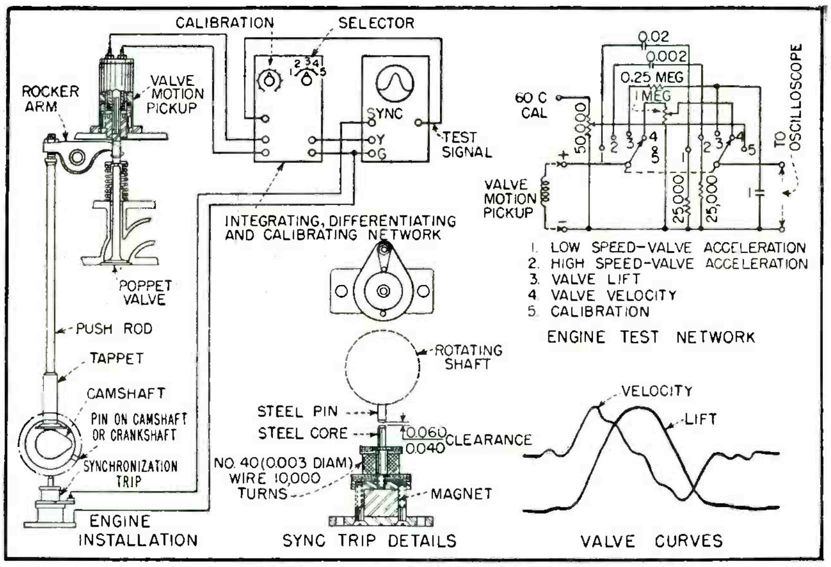


FIG. 5—Method of using equipment for checking operation of valves on an engine

Inspection Results

The inspection fixture as built up employs a conventional lathe. The tappet follower can be a flat plate, roller, or curved shoe, and should be the same as the type normally used with the cam contour being inspected if accurate data are to be obtained for comparison with a theoretical curve. For purposes of magnifying errors appearing on the nose of the cam, a small roller follower may be used on a cam contour normally requiring a flat plate or large roller follower. In this instance, the wave forms will be of value for comparative purposes only in production testing and will have no direct relationship to theoretical curves.

At the adopted test speed of 226 rpm the maximum inertia load, when inspecting a high-acceleration cam, is about one pound. During testing a light oil (about SAE-10) is continually supplied to the cam lobe to eliminate any tendency of the tappet follower to chatter. Inadequate lubrication produces rough and nonrepetitive curves.

Actual inspection is generally visual, but the curves on the screen can be photographed for closer study wherever desirable. A typical complete set of curves as photographed for study of velocity and acceleration is shown in Fig. 3. The multiple curves shown are obtained by multiple exposure, one for each line or pattern across the film. The film may be projected onto graph paper and traced for accurate comparison with a theoretical design curve, as shown in Fig. 4.

Engine Test Work

It is frequently desirable to observe valve motion directly on an internal combustion engine at relatively high speeds. Due to the flexibility of the various component parts, to a possible surge of the spring and perhaps to false motion in the valve gear, the resulting valve motion departs measurably from the theoretical motion which the cam is designed to produce. The same electronic instrumentation used for camshaft inspection may be advantageously used to observe valve motion at high speeds.

Arrangement of the equipment on an engine with overhead valves is shown in Fig. 5. Observations may be made with the engine motored with a dynamometer or under engine firing conditions. Typical valve lift and velocity curves obtained with the engine delivering power at 3,600 rpm are also shown.

Due to the increased frequency of operation on an actual engine, it is necessary to alter the integrating and differentiating networks to secure accurate results. For this type of work the networks shown in Fig. 5 are used.

Synchronization of the oscilloscope may be obtained by using the simplified magnetic synchronization trip shown in detail in Fig. 5. This device consists of a coil of fine wire wound on a steel core and mounted on a permanent magnet. The motion of a steel pin past the core disturbs the magnetic flux passing through the coil for a short time interval to generate sufficient voltage to give synchronization. The high speed of operation produces a rapid change in flux so that a sufficiently high voltage is produced and no additional voltage amplification is required in the electronic equipment.

The use of this type of electronic test equipment for inspection purposes will assure that more manufactured cam contours will be closer to the preferred design. Its use on engine test work will reveal to the engine designer exactly how the valve gear is performing in an engine. The results will be longer life to the component parts of the valve gear and improved engine performance.

Curtain-Rod F-M Antenna

Body forms part of tunable horizontal loop exhibiting nearly omnidirectional characteristics. Design is easy to manufacture, install and adjust and withstands rough handling on the road and in the shop

FIG. 1—Antenna mounted on front of bus between windshield and destination window

THE CURTAIN-ROD f-m antenna to be described is one component of a complete bus f-m receiver system which was developed for Transit Radio, Inc., Cincinnati, Ohio.[1]

A satisfactory antenna for this application must meet the following requirements:

(1) Receive horizontally-polarized waves.

(2) The pattern in the horizontal plane should be reasonably omnidirectional.

(3) A vswr on 50-ohm coaxial cable of 5 to 1 or better over a frequency band several times greater than the f-m channel width of 200 kc.

(4) Mechanically strong to withstand the pressure of the large rotary brushes used to wash the bus, and to withstand the shocks caused by striking low-hanging tree branches during a run.

(5) Easy to install, tune-up, and maintain by semi-skilled personnel.

Description

The antenna developed for this application is called a curtain-rod because of its physical appearance. Fig. 1 shows the antenna installed on the front of a bus between the windshield and destination window. It is a type of long, narrow, horizontal loop which is adaptable for mounting on the front or back of the bus. The loop is supported in the center by a metal U. This supporting U also serves as part of the tuned circuit that matches the balanced high impedance of the loop to the 50-ohm unbalanced coaxial cable which carries the signal to the receiver.

The antenna has five principal parts, four of which are shown in Fig. 2. The two long end elements are made of soft aluminum tubing which can easily be bent, flattened and drilled. The center U has a mounting base and connecting lugs and is cast of brass. The tuning capacitor which is mounted and connected between the top ends of the U, is a 7-to-45 $\mu\mu$f ceramic variable of the disc type. A Plexiglas cover for the center part of the U keeps rain, dust and tree branches away from the tuning capacitor and feed wires. An access hole is provided in the bottom of the cover so that the capacitor can be adjusted during routine maintenance without removing the cover. This hole is normally closed up with a metal snap-in button.

The cable that carries the signal from the antenna to the receiver is 50-ohm RG-58/U coaxial. It terminates at taps on the inner sides near the bottom of the U to provide a shunt-fed configuration.

Figure 3 shows how the optimum

for Buses

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vswr and frequency bandwidth for 5-to-1 vswr of the antenna installation shown in Fig. 1 vary throughout the frequency band 88 to 108 mc. (It is a conventional specification for receiving antennas that the mis-match loss may be as much as 2.5 db, corresponding to a vswr of 5 to 1). These curves show that the antenna can be adjusted for a vswr of less than 3 to 1 at any frequency in the band and that the bandwidth is more than 2 mc. Actual experience with a number of bus installations has indicated that this bandwidth provides a safe margin for reliable operation.

The first horizontal-plane patterns were measured using an actual bus installation tuned to f-m station WMLL on 94.7 mc. The bus was driven around in a small circle at a location in the middle of a level, clear field six miles from the station. The effective radiated power of the station was 4 kw and substantially line-of-sight propagation conditions prevailed. The strength of the input signal to the receiver was measured using a microammeter to indicate limiter-grid current for every 10-degree change of bus heading. The receiver meter had been previously calibrated in the laboratory with a signal generator. The measured pattern of receiver input signal voltage in millivolts versus bus heading is shown in Fig. 4. The strongest signal was received when the bus was headed toward the station but the extreme variation in the signal strength was only 7 db.

The same type of bus receiving antenna has also been used in several cities where the f-m station is still in the low band of 42–50 mc. In these cases, the antenna was modified by the addition of a 25-$\mu\mu$f fixed capacitor in parallel with the variable tuning capacitor in the center U. The resulting antenna is not quite as well matched, but it still has a vswr of less than 5 to 1 throughout the band and gives very acceptable performance.

General Design Aspects

The length of the loop is nearly a half-wavelength and the loop is center-fed with a balanced structure. A lumped-circuit approximation helpful in understanding the antenna is shown in Fig. 5.

Each of the two end elements is approximately a quarter-wavelength long and during reception of a signal each element provides the center U with an induced loop voltage in series with a large resistance, *R*, and reactance, *X*. Voltage is the same from both elements and therefore a balanced voltage from a high-impedance source is applied across the top ends of the U. The U acts as a parallel L-C circuit balanced to ground; the base at the center of the U is actually grounded to the bus body.

The coaxial cable is tapped across the U near its base for best match to 50 ohms. The position of the tap varies with frequency, but a satisfactory compromise tap position can always be found. This location gives the vswr characteristics shown in Fig. 3.

More than a thousand of these antennas have been in service for several years without any major changes in the design. After the curtain-rod antenna had been developed it was learned that a 75-mc marker-beacon aircraft antenna having somewhat similar radiating elements was investigated by the Germans during World War II.[2]

The author wishes to credit John B. Caraway, Jr. of Electronics Research, Inc. for several invaluable suggestions and Richard W. Anderson for performing some of the measurements reported here.

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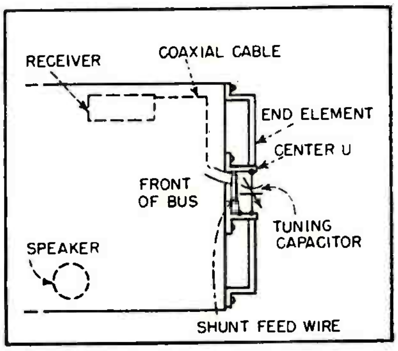


FIG. 2—Plan-view of antenna installation on front of bus

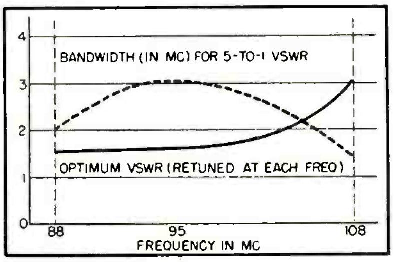


FIG. 3—Voltage-standing-wave ratio and bandwidth characteristics

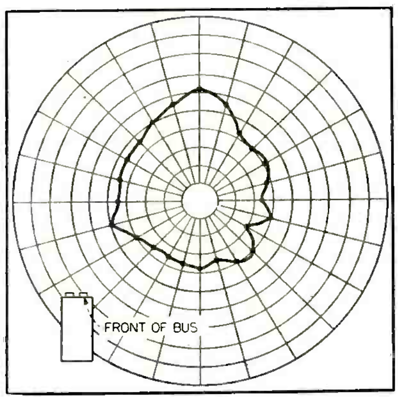


FIG. 4—Reception pattern of bus installation

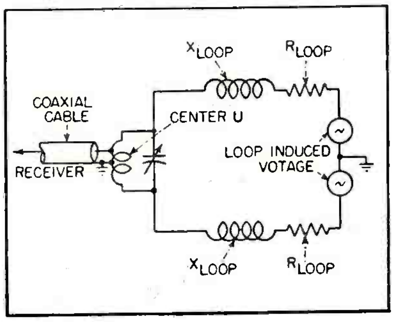
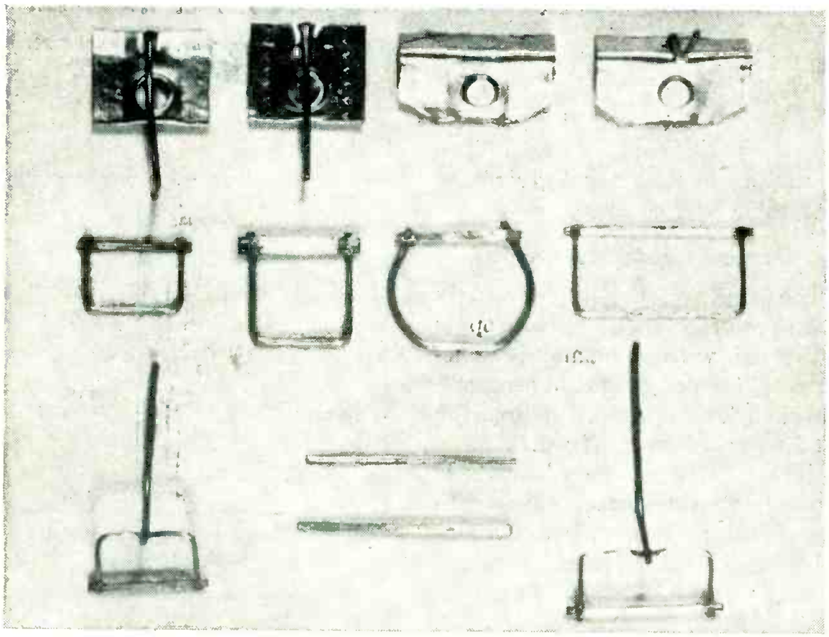


FIG. 5—Lumped circuit approximation of the antenna

GETTER MATERIALS



Typical Ba flash getters for glass bulbs (upper row) and getter strip assemblies

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THE USE of getter materials is based on the ability of certain solids to collect free gases by adsorption, absorption or occlusion. This effect is widely utilized in the field of electronics to shorten the exhaust period and to improve and maintain a high vacuum or the purity of an atmosphere of noble gases.

Bulk getters are sheets or wires of gas-absorbing metals, which usually are heated for this purpose by mounting them on hot electrodes of the tube. In some cases the heating is accomplished by a separate heating source.

Coating getters are generally applied to those electrodes of vacuum tubes, which during service are maintained continuously at temperatures between 200 and 1,200 C. Such getters usually consist of nonvolatile metal powders that are sintered upon the electrode surfaces.

In the case of flash gettering, chemically active, comparatively volatile metals—mostly metals of the alkaline earth group—are evaporated by heating their supports at the conclusion of the pumping process. The metal vapor before and during condensation reacts instantaneously with all other than noble gaseous residues and forms on all cold parts of the tube, particularly on the tube walls, the so-called getter mirror. This surface, because of its large area, is capable of binding chemically or physically gases that are liberated during the life of the tube. With respect to the mechanism of gettering and the action of gases getter materials may be divided into two groups: corrosion type and solution type. From this aspect, barium (Ba) is the typical example of chemical corrosion by gases and zirconium (Zr) an example of solution of gases in a metal. Corrosion takes place if the oxide film is porous and incoherent, thus not preventing further oxidation, which usually happens only if the volume of the oxide is smaller than that of the metal to be oxidized. In this case, the sorption of gas from the surrounding atmosphere can continue uninterruptedly. Oxides of the alkali and alkaline earth metals have less volume than the metal.

From a technical aspect the wide application of earth alkali metals for flashing getters in vacuum tubes is founded upon the fulfillment of the following requirements.

(1) During the standard degassing procedure at 400 C the getter should have low vapor pressure ($p < 10^{-2}$ mm Hg).

(2) The getter should be readily vaporized at its activation temperature. This temperature range must be high enough so that the getter may be readily degassed prior to the flashing; on the other hand, it must be sufficiently low to avoid the evaporating, melting or loosening of electrode metals. For nickel supports this establishes a temperature range of 600 to 1,000 C.

(3) After flashing, the getter deposit on the tube glass wall must have a negligibly low vapor pressure ($p < 10^{-7}$ mm Hg) assuming the operating temperature of the vacuum tube at 200 C.

(4) Between ambient and operating temperature the getter should be very active for all gases, especially oxygen. The oxide film created must be porous and incoherent in order that the gases may diffuse without hindrance into the interior of the getter mirror and may be absorbed also by getter molecules in the volume of the getter material.

for ELECTRON TUBES

The specific action and applicability of Ta, Cb, Zr, Th, Ti, Al, Mg, Ba and P as getters for vacuum tubes are shown. They can be formed as wires, sheets, tubes and tablets directly or indirectly heated; they may be powder coatings on hot electrodes; or they can be flashed

(5) The chemical compounds should be stable in order that during operating temperature or electron bombardment the absorbed gases are not expelled. For gas-filled tubes, the absorbed residual gas should not be replaced during operation by the filling gas, for example—Hg-vapor in tubes.

The first requirement is satisfied by all earth alkali metals. As seen from Fig. 1, Mg is near the border line, and cannot be used in tubes with high operating temperature because of the danger of migration of Mg atoms. Requirement 2 is met by all earth alkali metals but not by aluminum. Requirement 3 is met by all earth alkali metals with the exception of magnesium. The fourth requirement, with emphasis on activity, is met by all earth alkali metals with the exception of magnesium and aluminum. In a similar manner requirement of an incoherent oxide layer is not met by magnesium and aluminum. Requirement 5 (stable reactions) is met by all earth alkali metals but only up to a temperature of 200 C (regarding the oxides created even up to higher temperatures).

The materials Sr, Ba and Ca, are the most suitable for flash getters in high-vacuum electron tubes. Concerning the replacement of absorbed gases by mercury vapor, however, all earth alkali metals fail with the exception of magnesium, which is the reason that the latter metal is used in mercury tubes.

There are few quantitative data that permit a comparison of the getter-efficiency of different metals for different gases. Table I shows such a comparison for flashed deposits of Al, Mg, Th, U, mischmetal and Ba and the gases O_2, H_2, N_2, and CO_2. It exhibits Ba as the most efficient getter among the metals investigated. The higher efficiency of diffuse deposits is due to their much larger surface, resulting from their finely divided state. This phenomenon, known as dispersal gettering is illustrated by the black Ba deposit.

The practical choice of the proper getter material is a function of factors other than efficiency alone. The broad use of high-efficiency flash getters requires considerations of insulation, interelectrode capacitance, contact potential and secondary emission of vacuum-tube electrodes and insulators, which often suggest their avoidance. On the other hand, Ba flash getters are preferred for oxide-coated cathodes because the Ba does not poison the cathodes and in some cases will improve the BaO cathodes. Judicious use of shields and proper positioning of the flash getters avoids most of their disadvantages.

It has been known for a long time that almost all metals (after thorough degassing) are capable of adsorbing gases on their surfaces.

Table I—Comparison of Getter Efficiency for Metals and Gases

Getter	Gas	Efficiency (in microns of pressure) Bright deposit	Diffuse deposit
Al	O_2	7.5	38.6
	N_2, H_2, CO_2	——	——
Mg	O_2	20	202
	CO_2, N_2, H_2	——	——
Th	O_2	7.45	31.15
	H_2	19.45	53.7
U	O_2	10.56	9.26
	H_2	8.9	21.5
Mischmetal	O_2	21.2	50.9
	H_2	46.1	63.9
	N_2	3.18	16.1
	CO_2	2.2	44.8
Ba	O_2	15.2	45
	H_2	87.2	73
	N_2	9.5	36.1
	CO_2	5.21	59.5

Getter efficiency is determined by the product of volume (1 liter) and pressure of gas cleaned up by 1 mg getter material. Diffuse deposits were obtained by flashing the getter in argon and consist of finely divided getter material.

Tantalum

Certain metals are capable of incorporating gases, even noble gases, by solution in their bulk volume. The classical example is tantalum which, on account of this property, plays a predominant role in the construction of high-power transmitting tubes. After degassing in a high vacuum for several hours at a temperature of 1,600 to 2,000 C, tantalum is capable of absorbing gases in amounts up to several hundred times its own volume. The optimum gettering temperature for tantalum appears to be in the neighborhood of 1,000 C. At temperatures above 1,500 C, the gettering action is reversed. The maximum getter effect is secured, therefore, by dimensioning tantalum anodes so that during normal service the electrodes operate at red to yellow heat. Generally, the high price of tantalum sheets and wires limits the use of whole tantalum electrodes to particularly valuable tubes and suggests the coating of electrodes with tantalum powder. This is mostly performed by applying very fine tantalum powder on the surface of anode sheets in the finished assemblies. They are sintered together while simultaneously degassing these powders during the pumping operation by means of high-frequency heating or by electron bombardment. On account of the high degassing temperature required for tantalum, only molybdenum or tungsten is suitable as a base metal for tantalum powder. Tantalum should never be hydrogen-fired because of embrittlement and consequent destruction by this gas.

The main disadvantages of tantalum are the high material cost and the high temperature range required for proper degassing and subsequent gettering operation.

Columbium

During recent years columbium getter pellets have been introduced to the vacuum technique. These pellets are approximately three to five millimeters in diameter and one to three millimeters high, and consist of oxide-free columbium metal.

The getter pellets must occupy a position in the tube where they can be heated to a high temperature during exhaust by either high-frequency induction or electron bombardment. The position of the pellet must be such that the temperature is maintained by either radiation or electron bombardment at approximately 500 C. This temperature is not critical but must be above 400 and less than 900 C. A temperature of 1,650 C is needed to outgas columbium pellets because at this temperature occluded and absorbed gases are expelled and columbium oxide is volatilized. A temperature lower than 1,650 C will not accomplish this expulsion of columbium oxide. The outgassing time may vary from a period of five minutes to a somewhat longer time. The preferred manner for supporting the columbium getter pellet is to weld a molybdenum wire to it. The temperature of outgassing is too high for a nickel support but is in the proper range for molybdenum. Tungsten need not be used.

Zirconium

Zirconium has valuable gettering characteristics and has come into wide use during the past decade. It forms very stable solid solutions (or compounds) with such gases as O, N, CO and CO_2. Zirconium metal is cheaper than tantalum and requires somewhat lower operating temperatures. Zirconium is available either in solid metal form (sheets or wires) or it may be applied in the form of a powder to base metals (molybdenum) as described above. The proper outgassing temperature for zirconium lies between 1,000 and 1,700 C, which is attained by either direct or indirect heating of the zirconium metal or of the base metal to which zirconium metal or zirconium powder has been applied. Wherever it is deemed inadvisable to heat the getter material to this temperature range, an outgassing temperature of 700 C must be considered minimum for activating the surface of the zirconium getter. While zirconium is effective as a getter from about 400 C on, it is most active at temperatures up to 1,600 C if used, for example, on molybdenum and carbon anodes.

The solubility of H_2 in Zr at room temperature equals 1,500 times its own volume at 1 atmosphere. Sorption begins at 300 to 400 C and is completed at 500 C. As the temperature is increased, the metal frees H_2, but at 850 C the H_2 is again taken up during transition from α to β Zr. Above 850 C, H_2 is evolved. Sorption and desorption are reversible with decrease in temperature. Preliminary heating to a high temperature is a necessary condition for the sorption of H_2 at lower temperatures. During a rapid passage from a high temperature (above 1,200 C) to room temperature, a large amount of H_2 is quickly taken up.

Oxygen as well as N_2 dissolve homogeneously in Zr. When a Zr rod covered with a thick white oxide layer is heated in vacuum, the metallic luster reappears. Water vapor is cleaned up between 200 to 250 C. Care must be taken that a part of the Zr getter remains at a low temperature (approximately 400 C) during operation in order to bind the H_2, while another part must assume much higher temperatures (approximately 800 C) in order to absorb O_2, N_2 and other gases.

Zirconium metal in sheet form 0.002 to 0.005 inch thick is used on locations that can be properly outgassed and which operate in the temperature range indicated above. Very often zirconium sheets are mounted to grid shields, cathode supports, and other structures, which during operation attain a temperature of 600 to 800 C. In small tubes zirconium sheets, cylinders, or ribbons are used for cathode supports, grid supports and radiation shields. Zirconium wire of 0.005 to 0.020-inch diameter can be mounted for direct heating, being heated whenever absorption of gas is required, or it may be mounted for the same purpose by winding zirconium wire around Mo rods or other suitable structures.

Continuous gas absorbers such as that shown in Fig. 2 provide a support for the Zr wire and are operated from 350 to 1,700 C, for example, in x-ray tubes in series or in parallel with the filament (the temperature being adjusted by proper length of the wire). They have also been used for shortening the degassing time of electrode systems during pumping. Using a

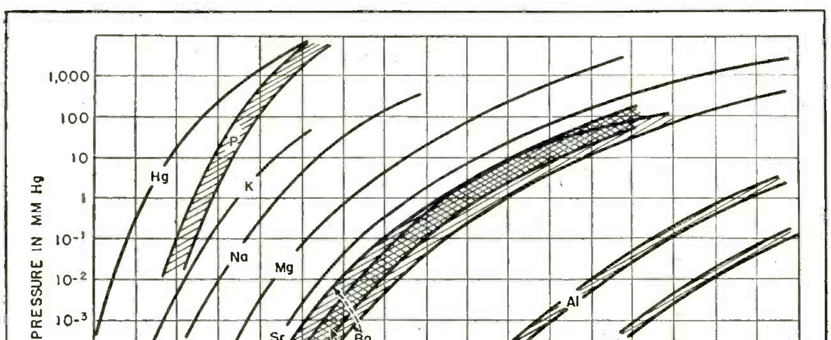

FIG. 1—Vapor pressure of metals used as flashing-type getters. Hg and Ni are included for comparison

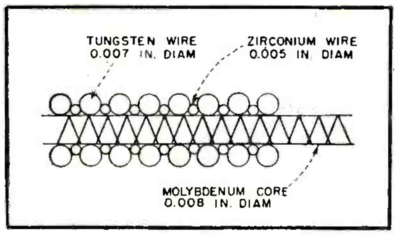

FIG. 2—Zirconium-wire assembly for continuously heated gas absorber

Zr wire spiral of fifteen turns on a 0.040-inch Mo mandrel, treated and outgassed for one hour at 1,700 C, a pressure of 5×10^{-6} mm Hg was reached in ten minutes instead of thirty minutes with the high vacuum pump alone. This auxiliary pumping getter can be used repeatedly even though exposed to atmospheric pressure between pumping cycles, no additional outgassing between cycles being required. In every case the Zr absorber maintained a higher vacuum at a considerably higher effective pumping speed than the 20-liter-per-second high-vacuum pump.

A convenient way of using zirconium is to spray the tube parts with fine zirconium powder. Such powders, of particle size between 1 and 8 microns, may be suspended in a temporary binder such as nitrocellulose dissolved in amyl acetate. For high voltage tubes a permanent binder such as colloidal silicic acid has been used with success. Such a binder has the further advantage of not giving off gaseous products during outgassing and operation. The amount of binder is usually two to five percent. This mixture is sprayed on the electrode parts, which in turn are fired in vacuum in order to remove the binder or to convert the binder to a stable compound. Nickel electrodes (preheated at 1,000 C, operating at 200 to 500 C), molybdenum electrodes (preheated at 1,300 C in vacuum and operating at 800 C) and graphite electrodes can be satisfactorily coated with such mixtures. Quantitative data on the sorption of different gases at different temperatures by powdered Zr are shown in Table II. Other methods of applying zirconium powder to electrodes have been reported, such as a suspension mixture consisting of paraffin, naphthalene, xylene and methanol or deposition of zirconium powder by cataphoresis.

Zirconium hydride (ZrH_4) may also be applied to Mo, Ni, Fe or graphite anodes or grids as a paste, by spraying or cataphoretic precipitation, and reduced to pure Zr upon heating. This compound compared with pure Zr powder presents the advantage that at lower temperatures the zirconium is tied up and protected against oxidation or poisoning during seal-in and exhaust. Then as the temperature is raised, metallic zirconium is formed, liberating its hydrogen completely in vacuum at about 800 C. Thus, for coating on carbonized plates, which liberate much adsorbed gas during exhaust, zirconium hydride may be preferable to the pure metal since not only is the combined zirconium protected from the evolved gases but furthermore the hydrogen that it liberates at higher temperatures apparently reduces the last traces of adsorbed oxygen in the carbon layer.

Zirconium has been used successfully in high-power transmitting tubes, especially tubes having thoriated tungsten filaments, small microwave tubes and gaseous discharge tubes. Zirconium is inert to mercury vapor.

Stable solutions or compounds of Zr are formed with most gases including water vapor, with the exception of hydrogen.

The chief disadvantage of zirconium as a getter is that the optimum temperature for the sorption of hydrogen is too low for the effective cleanup of oxygen, nitrogen and the oxides of carbon. If, therefore, the zirconium-coated part is to operate at a temperature much in excess of 300 C, a supplementary lower temperature Zr getter or a getter of the barium or barium-magnesium type should be added to absorb the hydrogen. Whether this precaution is necessary or not depends upon the tube and the amount of water vapor or pure hydrogen found within it.

Thorium

During World War II, thorium, thorium alloys and mixtures of these with other getter materials were developed in Germany for use in vacuum tubes. Thorium metal is manufactured by reduction of ThO_2 with Ca. Powdered Th is very pyrophoric; it is inflammable by mere friction. Electrode parts were coated with thorium powder by cataphoresis and heated for two to three hours in a vacuum furnace. For wires the coating was 5 to 10 microns thick and for sheets 1 to 2.5 mg per sq cm. The heating temperature is about 800 to 1,000 C for nickel and iron and 1,500 to 1,600 C for graphite electrodes. Considerable gas absorption is reported to occur around 200 C but especially in the range from 400 to 500 C. This getter is therefore suitable for power tubes and very small tubes with high anode temperatures. If the anode is covered with thorium powder its surface finish is rough, resulting in increased emissivity by blackening.

One alloy of thorium is the getter called Ceto, which comprises a 20-percent mischmetal, (chiefly cerium) and 80 percent thorium. This powder mixture is sintered at approximately 1,000 C, and the bars are milled to powder again. It is very inflammable. Ceto getter powder is transformed with amyl acetate into a paste that is applied to the tube electrodes in the amount of 15 to 25 mg powder per sq cm and then sintered upon the base metal in a vacuum furnace. The degassing temperature of the Ceto getter is 800 C and a marked getter action is exhibited from 80 to 130 C up, with an absorption maximum at 200 to 500 C.

Ceto getter material has a lower secondary emission than barium. It is used when it is desired to avoid or to reduce secondary emis-

Table II—Sorption of Gases by Powdered Zirconium

Gas	Temp C	Gas sorbed (cu cm $\times$ mm Hg per mg Zr)
O_2	25	0.38
	400	1.99
N_2	500	0.11–1.0
	800	1.46
CO	25	0
	500	0.43
	800	3.65
CO_2	25	0
	500	0.57
	800	3.04
H_2	25	0.09
	350	13.33

sion that might arise from the use of Ba. It cannot be used above 600 C. Ceto bridges the gap between the low-temperature flashing getter such as Ba and the high-temperature non-volatile types (Th, Ta and Zr.) Pure thorium or compounds of Th and Zr are highly pyrophoric.

Titanium

A recent addition to bulk getter materials is titanium, which can be used either as bulk or as coating getter. It is not pyrophoric and its getter properties are good, besides being easy to form and machine. Blackening of the parts can be obtained by a short heating in air. At present titanium sheet is more expensive than zirconium per unit of gas absorbed.

Aluminum

Aluminum in its pure state is not used as a flash-getter, chiefly because its vapor pressure is too low (see Fig. 1). It vaporizes sufficiently only above 1,300 C, which is much too high for the conventional base metals like Ni. On the other hand, aluminum plated on Fe to a thickness of about 15 microns shows a considerable coating-getter effect for traces of O_2 being bound by the carbon content of Fe electrodes and released only slowly during the life of the tube. After heating at 700 to 800 C in vacuum, the aluminum forms a black compound with the Fe base ($FeAl_3$ or $FeAl_6$). This blackening increases the total emissivity to a level that is equal to or greater than that of carbonized Ni anodes. Such Al-plated sheet-iron has been widely used in Europe for anodes in receiving and amplifier tubes with oxide-coated cathodes.

The trade name for sheet iron plated with aluminum on both sides is P2-iron; plated with Al on one side and with Ni on the other—PN-iron.

Magnesium

Pure magnesium possesses many desirable properties for a getter material, such as availability in suitable forms, and being comparatively stable and volatile under vacuum at convenient temperatures around 500 C. Unfortunately, the gettering power of magnesium is

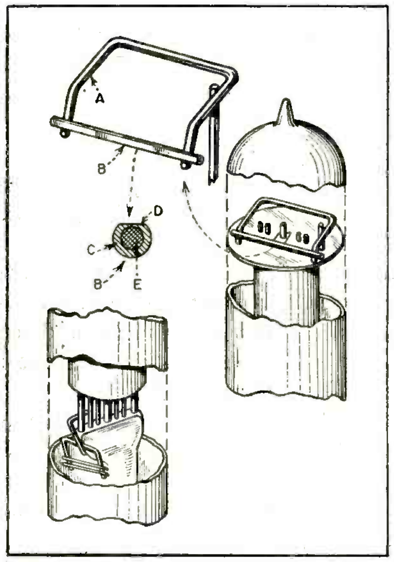

FIG. 3—Typical Kemet KIC getter mountings; *A* is nickel h-f induction loop, *B* getter strip, *C* iron sheath, *D* weakened zone to allow evaporation and *E* is 0.5 to 25-mg barium filling

not high because most gases are only physically absorbed. As a result, magnesium by itself is not used in high-vacuum tubes. The only evidence of its use is in Hg-vapor-filled rectifiers and in certain types as a grid coating powder to reduce secondary emission.

In order to obtain a material of greater stability and safety in use than pure magnesium, the so-called Formier getter was developed. It consists of aluminum-magnesium alloy powder (55 percent Al, 45 percent Mg) which is applied suspended in a nitrocellulose binder and applied to tube parts as a paint. On account of the limited gettering powers of magnesium, Formier is used only when other types of getters with higher evaporation temperatures must avoided. Magnesium getters are difficult to degas, have little gas absorption up to temperatures of 175 C and absorb only oxygen. High vapor pressure precludes use in small tubes and at high operating temperatures.

Barium

The active ingredient of most flash getters is barium, which is used in combination with aluminum, magnesium, tantalum, thorium, strontium or calcium. The getter is attached to the electrodes in the form of a pellet, or more frequently, to a special metallic support within the tube as shown in the top row of the accompanying photograph. It is mounted in such positions as to insure that the vapor stream produced is not splashed against such parts as the stem or the insulated lead-in wires. Shielding screens of metal, mica or ceramic materials are often provided to prevent this. The getter pellet must be attached to parts that during the pumping process may be readily heated to the evaporation temperature of the getter. This heating is performed by electron bombardment or, more frequently, by high-frequency induction from coils arranged outside the tube.

Flash getters of pure barium have the disadvantage that the unprotected barium reacts at room temperature with oxygen or with water vapor, thereby becoming inactive. This condition may be prevented by using: a protective layer or casing, alloys of Ba that are inert at room temperature or by generating the gettering material in the vacuum tube by a chemical reaction between stable Ba compounds and deoxidizing agents to form a reaction-type getter. Alloys of barium with magnesium and aluminum are relatively stable at room temperature and yield pure barium upon dispersal or flashing of the getter. The percentage of metals in standard alloys for getter tablets are: Ba 25, Mg 55, Al 20; Ba 37, Mg 37, Al 26; Ba 43, Mg 20, Al 37 (known by the trade name Kemet). The tablets are mounted on nickel flags of various shapes.

Barium-magnesium alloys yield very little Ba metal in the flashing and are, therefore, seldom used in modern high-vacuum tubes. Ba-Al getters provide much larger amounts of Ba metal, which accounts for their wider use. A common disadvantage of both types of alloys is their rapid rate of deterioration upon exposure to air and the necessity of vacuum packing.

Another commercial assembly is shown in Fig. 3. Other types comprise short pieces of iron, nickel and copper-clad barium wires to be mounted on a support of Ni-sheet, which can be high-frequency flashed at 900 to 1,100 C. Trade names of these materials are Feba, Niba and Cuba.

Several x-ray tubes of European

make use iron-clad barium (Feba) getter made in wire form, 2 mm diameter by 15 mm long. The getter is mounted within a miniature oven consisting of a ceramic tube into which the getter just fits. A tungsten spiral heater is wound on the outside of the ceramic tube. Care must be taken to avoid the possibility of migration of the barium to active tube elements. After sealing off the tube, the getter is flashed by heating the spiral.

Examples of the reaction type Ba getters are the reduction of BaO by Al to Ba (Alba getter) and of $BaCO_3$ or barium berylliate by Ta to Ba. In the case of $BaCO_3$, a tantalum wire heater is coated with a mixture of $BaCO_3$ and $SrCO_3$ ($SrCO_3$ prevents fusing of $BaCO_3$). At 800 to 1,100 C the carbonates dissociate to oxides and at 1,300 C the oxides react with Ta to form metallic Ba, whereby 40 percent of the theoretical Ba yield is obtained in the so-called Batalum process. Also barium berylliate ($BaBeO_2$) is stable in air and is used in a directly heated getter, shown in Fig. 4, formed in the shape of a trough from a 0.040 × 0.001 in. Ta ribbon, which holds approximately 2.5 mg of Ba and gives a Ba yield of 60 percent.

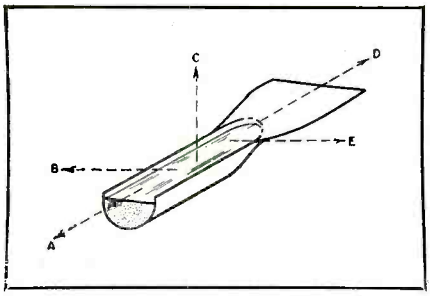

FIG. 4—Arrows indicate direction of barium metal evaporation from barium berylliate in tantalum trough

Another flashing-reaction-type getter is the so-called Bato getter, which is prepared by mixing an aluminum-barium alloy with iron oxide and thorium powder. Its purpose is to provide a source of heat in the getter pellet and in so doing aims at flashing Ba metal at a relatively low getter flag temperature. The source for the Ba is the Ba-Al alloy and the latent heat so derived forms an exothermic reaction between iron oxide and metallic thorium. The powder is formed into tablets, which are pressed into nickel cups and attached to special supporting members within the tube. Since it is important to store the Bato getter in a dry atmosphere, the getter flags are usually sealed into evacuated ampoules or cans. After the pumping process, the getter is evaporated by high-frequency.

Flash getters are outgassed at temperatures between 600 and 700 C, usually by r-f heating from the outside of the tube, and flashed at temperatures beween 900 and 1,300 C. The barium vapor condenses on the cold surface opposite the getter material, usually on the envelope of the tube. The appearance of the condensed getter deposit depends upon the vapor pressure in the tube at the time of flashing. If the getter is vaporized very slowly, the first barium atoms evaporated will absorb the gas present so that the remaining getter is deposited in a very high vacuum, exhibiting a shining mirror. If flashing is done very rapidly, however, the getter deposits in a rather high vapor pressure and the getter mirror will be discolored due to dispersion of the Ba. If vaporization is carried out in the inert atmosphere of a rare gas the condensed deposit will be black, resulting in a dispersal getter. This condition does not mean that the getter is contaminated, but merely that the deposit is finely divided and therefore absorbs light. Such deposits exhibit higher efficiency than the

Table III—Outgassing, Flashing and Operating Temperatures of Typical Getters

Material	Ta	Cb	Zr	Th	Ceto	Mg	Al-Mg	Ba And Ba Compounds	Reaction-Type Getters Bato	Batalum	Ba-Berylliate	Phosphorus
Form of Application	bulk coating	bulk	bulk coating	coating	coating	flash	flash	flash	flash	flash	flash	flash
Form of Getter	sheet powder	pellets	sheet wire powder	powder	powder	ribbon wire	powder paint	metal-clad wire pellets	Ni-clad pellets	$BaCO_3$ paint on Ta	$BaBeO_2$ paint on Ta	powder suspension
Outgassing Preheating Temperature (deg C).	1,600–2,000	1,650	700–1,300 (up to 1,700 in compound wires)	for metal base 800–1,000 for graphite 1,500–1,600	800–1,200	400	400	600–700	no ref	800–1,100	900–1,000	no ref
Flashing Temperature (deg C).	——	——	——	——	——	500	no ref	900–1,300	750–800 (900)	1,200–1,300	1,300	>200
Operating Temperature (deg C).	700–1,200	500	800 (up to 1,600 in compound wires)	400–500	200–500	absorbs gases only during flashing		20–200 max	20–200	20–200	20–200	100–200
Applications Reported	D, E, M	D, E	C, D, E, F, I, K, L, M, N	C, D	P	I, K	A, F	A, B, D, F, G, H, I, (L), N	D, M	A, F	A, F	O

A — Small receiving tubes
B — Miniature tubes
C — UHF tubes
D — Medium-size transmitting tubes
E — High-power transmitting tubes
F — Oxide-cathode tubes
G — Cathode-ray tubes
H — Phototubes
I — Gaseous-discharge tubes
K — Hg-vapor tubes
L — X-ray tubes
M — High-power vacuum tubes
N — Tubes with thoriated cathodes
O — Incandescent lamps
P — Vacuum tubes in which neither flashing getters nor the high temperatures necessary for Ta and Zr may be used

bright deposits indicated in Table I.

Barium reacts with atmospheric gases such as oxygen, nitrogen and carbon dioxide at room temperature, as well as with hydrogen and carbon monoxide. This absorption at low temperature makes flash getters particularly valuable for tubes that do not attain high operating temperatures. If the volume of the vacuum tube is large, multiple getter strips or several getter pellets are employed.

Flash getters have the disadvantage that during flashing metallic vapor is produced, which may settle on insulating parts or build up a conducting layer on the glass envelope. Such layers may become charged during operation or represent interelectrode capacitance. Usually flash getters are inadvisable in high voltage tubes or in microwave tubes, the latter type having very close spacing and only short insulating surfaces. It should also be considered that the opaque mirror interferes with the cooling of electrodes by radiation. In high-voltage types like transmitting and x-ray tubes fast stray electrons may hit the mirror and evaporate sufficient getter material to cause a gas discharge followed by a short circuit and destruction of the tube.

Phosphorus

Phosphorus has a comparatively high vapor pressure (indicated in Fig. 1) and for this reason it is not used in radio transmitting, x-ray, or other high-vacuum discharge tubes. Inexpensive and simple to handle, it is used for high-vacuum and gas-filled lamps, especially for types of below 60 watts with voltages of 90 to 250 volts.

The outgassing, flashing and operating temperatures of typical phosphorus getters are given in Table III.

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Aircraft Ignition Tester

One set of spark plugs in an engine equipped with a dual ignition system is used as ionization detector to determine if the active set is firing properly. The drop in potential across the detector plug is sensed by an amplifier and neon-lamp indicator for each cylinder to give a dynamic indication on the ground

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OPERATION of the ignition tester to be described depends upon the fact that an aircraft dual-ignition system includes two sets of spark plugs. Each cylinder has two plugs, connected to associated magnetos by a cable harness as shown in Fig. 1. When the engine is operating on one of the magnetos, the spark plugs of the other magneto system can be used as detector plugs to determine if the other spark plug in the same cylinder is firing properly.

Testing is accomplished by applying a fairly high voltage across the detector plug. When flame strikes the electrodes as the cylinder fires, ionization conductivity of the combustion gases permits current to flow and the potential across the detector plug drops.

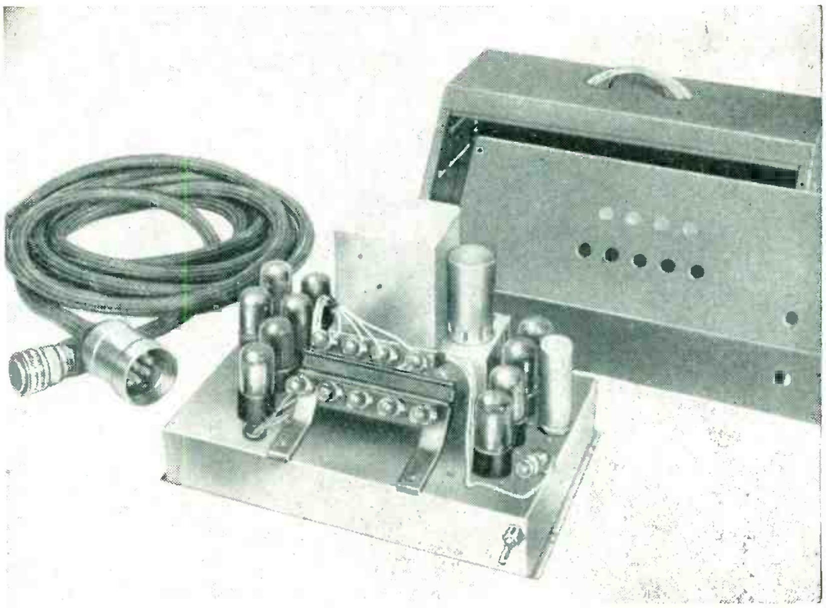
This drop in potential across the detector plug is used to flash a neon lamp by means of an electronic circuit.

The basic circuit of the ignition tester is shown in Fig. 2. A potential of about 500 volts is applied to the detector plug through R_1. The same voltage also charges C_1 through R_1 and R_2. The grid of V_1 is normally positive, grid current being limited by R_6. Neon lamp V_4 performs the double duty of voltage regulator and voltage level indicator.

The use of a spark plug as a detector of ionization has previously been used in studies of propagation of flames in cylinders. When an active plug fires, the combustion flame at the detector plug greatly reduces the dielectric strength of the gap. When the gap of the detector plug becomes sufficiently conductive, the charged capacitor C_1 discharges through the detector plug. This discharge charges C_2 in opposition to its normal polarity and makes the grid of V_1 negative. A typical oscillogram of this variation in grid voltage, measured at the junction of C_1 and C_2, is illustrated in Fig. 3. It will be noted that the grid voltage is driven from a positive value to a much greater negative value.

Swinging the grid of V_1 negative cuts off this triode with the result that its plate potential becomes much more positive, making the grid of V_2 positive. Tube V_2 is normally biased to cutoff, so the positive swing causes V_2 to conduct and to light the neon indicator lamp V_3. Flashing of V_3 indicates that the live spark plug has fired the cylinder's combustion charge.

After the voltage discharge through the detector plug, the grid voltage of V_1 relaxes toward its quiescent positive bias illustrated in Fig. 3, so that V_1 becomes conducting. It allows V_2 to return to its normally nonconducting state until the next ignition flame is detected by the detector plug. By providing suitable voltages across the detector plug and to the grid of V_1, even a weak detection signal, owing to a very lean mixture, can



Complete tester, showing connecting cable from harness disconnect block. Two voltages are obtained from vibrator supply and additional vacuum-tube rectifier

* Formerly Curtiss-Wright Corp.

be relied upon to flash the indicating lamp V_3 brightly.

Bias Tube

The unusual location of the neon indicator lamp V_3 in the plate circuit of triode V_2 may be noted since the cathode is isolated from ground except during the conduction period of the lamp V_3. By this means, a negative biasing battery or other inconvenient biasing method is avoided. Cutoff bias voltage is developed automatically by cathode emission and by electron collection by the plate. The cathode, being isolated from ground by the neon lamp, will raise itself to a positive potential by loss of electrons. With the grid grounded through R_8, cutoff bias is obtained that keeps lamp V_3 dark until the positive grid signal is transmitted through capacitor C_3.

In practical applications a separate electronic detector circuit is used for each cylinder. For a nine-cylinder engine, nine detector circuits with a total of nine firing indicator lamps and nine dual-triode tubes together with a power supply are used. This arrangement makes it possible to check all nine cylinders at once.

To connect such an ignition tester to an aircraft engine, disconnect junction blocks must be located in an accessible position somewhere along the high tension leads between the distributor and the ring manifold of the harness. In Fig. 1, the continuous ring manifold is shown with the disconnect blocks located on top of this manifold in front of the engine. To attach the tester, one disconnect is opened and the tester cable is plugged into the manifold block. The plug from the magneto has all contacts grounded for protection.

For a nine-cylinder engine, nine individually shielded wires are connected to the tester from the receptacle on the ignition harness. Shielded leads are preferred in order to prevent crosstalk between the test leads in the cable to the tester. If unshielded leads are used, the mutual capacitance between leads permits induction of the firing signal from one lead to all the others. Such capacitance causes false flashing of the indicator lamps and greatly dissipates the strength of the initiating signal.

Another difficulty encountered was the severe interference from the mutual capacitance between the live ignition leads and the test ignition leads in the same harness. Reduction of interference voltage is accomplished by the capacitor divider action of the comparatively large capacitance to ground of the test leads in the 20-foot cable connection to the tester. Further elimination of interference is accomplished by the integrator circuit defined by R_2 and C_2. Toleration of residual interference is made possible by operation of triode V_1 with positive bias that is too high for any negative interference peak to overcome.

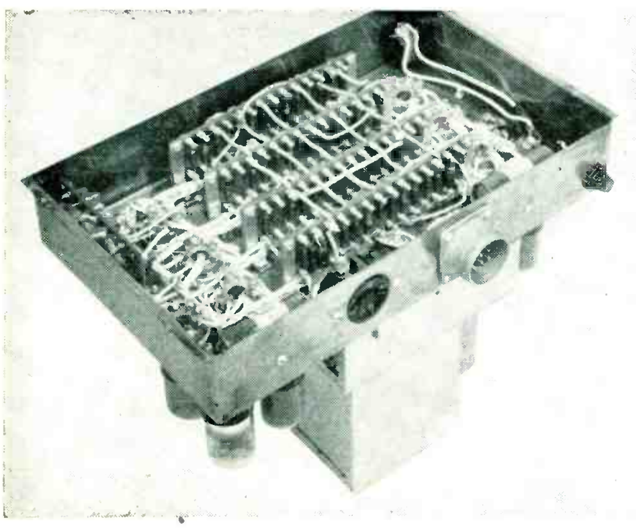
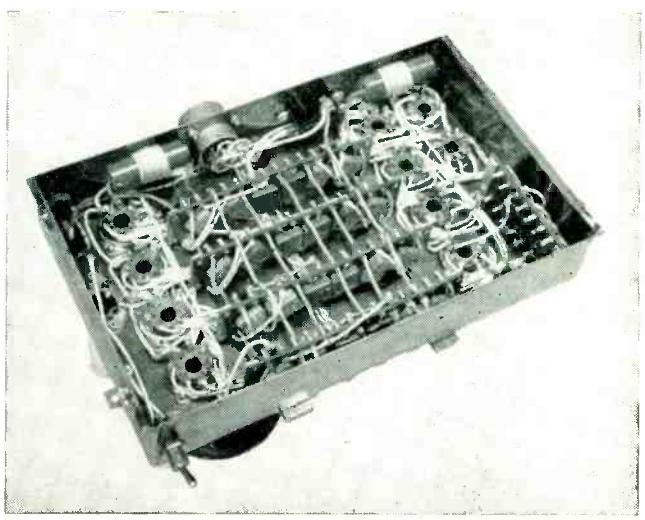
Using the Tester

To test the ignition system of an aircraft engine, the engine may be run first on magneto 1. In this case, magneto 2 is cut out and the tester cable is connected to the receptacle at the disconnect block between the magneto and ignition harness in the circuit of magneto 2. With the engine running, firing of each cylinder is indicated by the flashing of its respective neon indicator lamp. The indicator lamp indicates definitely whether the associated cylinder is or is not firing, even if there is only occasional missing. The in-

Spark Plug Faults Are Elusive

A plug that acts erratically in an engine when hot may test good when removed. Plugs that work perfectly under cruising conditions may go bad under takeoff conditions of higher compression and temperature. Many a crash has occurred that could have been avoided if ignition had been checked under load on the ground.

A conventional preventative is routine replacement of all spark plugs. However, it takes twelve man-hours to do the job on an 18-cylinder engine—with no assurance that new troubles have not been introduced. The ignition fault finder described in this article may go a long way toward improving maintenance

Underchassis views of the tester. Connection to the individual test plugs is made through the multiconductor plug shown at left

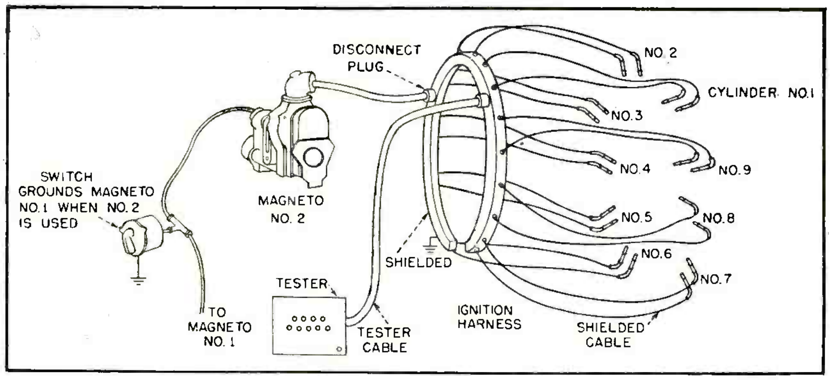


FIG. 1—Simplified detail of conventional ignition harness and method of attaching tester

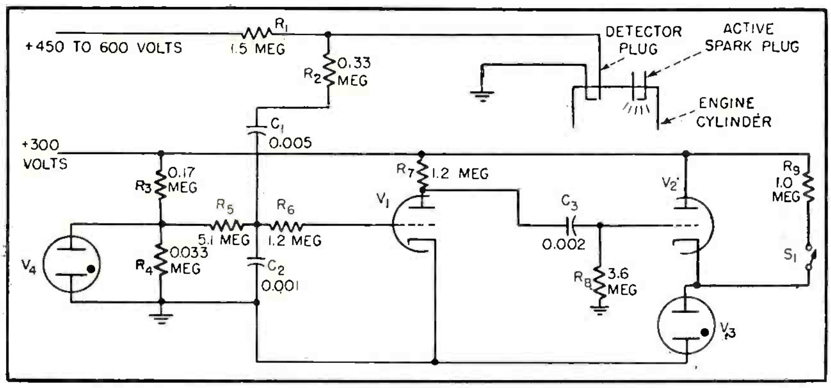


FIG. 2—Schematic of the test circuit. A similar channel is required for each cylinder

dication is simply the failure of the neon lamp to flash repeatedly so that an experienced operator is not required to interpret the lamp indications.

The ignition trouble is accordingly localized in the particular circuit which fails to fire the cylinder charge and in most cases the trouble can be cleared by replacement of the spark plug. If after such replacement, trouble still exists in this particular circuit, a standard harness and magneto tester may be used to locate the trouble in this circuit.

As a matter of convenience, the tester may be provided with a so-called memory switch (S_1 of Fig. 2) for each indicator circuit. If an indicator lamp shows faulty ignition, the memory switch may be closed so that the lamp will remain lighted after the ignition testing is completed.

Tests have shown that the detector spark plug need not itself be in perfect condition for detecting proper firing of the active plug on test. It has been found that fouled spark plugs will serve as ignition detectors until they are practically

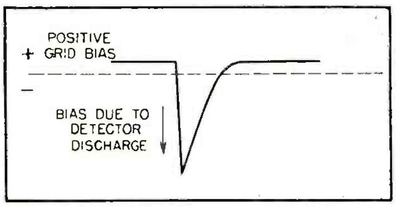


FIG. 3—Oscillogram of the voltage at the grid of tube V_1

shorted by a bridge of carbon across the electrodes of the spark plug. Even in case the testing apparatus falsely indicates faulty ignition of the active spark plug due to the detector plug being very badly fouled, the tester will still definitely indicate faulty ignition in that cylinder since the badly fouled plug would in this case fail to give satisfactory ignition.

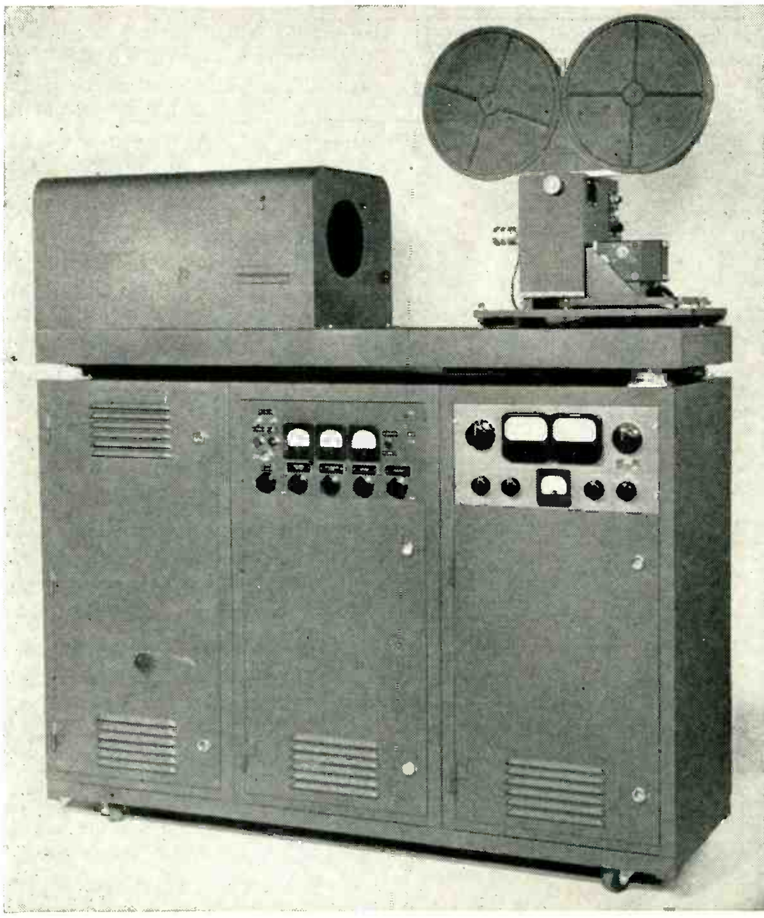
Unique Performance

During a test demonstration of the ignition tester on a Wright G-200 engine, an indication of intermittent ignition in a cylinder where a new spark plug has been installed was indicated. Examination showed a mechanic's failure to make a proper connection to that spark plug. No other existing type of tester could have found this trouble, nor could a complete replacement of an entire set of spark plugs preclude recurrence of the same trouble. The action of some questionable spark plugs was to go dead for a second or two, repeating the trouble after an interval of a few seconds to half a minute. Synchronized with the indication of the tester, there was an unmistakable change in sound and vibration of the engine. This type of an intermittently bad spark plug usually tests good on all other testers.

The presently used ignition harnesses are usually not equipped with disconnect blocks that would permit the ignition tester to be readily attached. Manufacturers have indicated a willingness to produce new harnesses with disconnects. Although this type has been developed and is being tested by airlines and engine manufacturers, present applications are confined largely to military uses.

The photograph shows an experimental model tester equipped with nine separate channels so that all cylinders of a nine-cylinder engine may be tested simultaneously. A type 6SN7GT dual-triode is used in each channel. Power is supplied from a vibrator pack and its associated rectifier tube since this particular model is intended for portable operation at an airport. The dual voltage output from the vibrator is obtained with a synchronous vibrator in addition to the novel use of a full-wave rectifier tube across the secondary of the vibrator transformer. The nine neon indicator lamps are visible through the openings in the front panel. The neon lamp to the far right is the voltage regulator V_2 referred to earlier in this paper. The glowing of this lamp indicates that the voltage applied from the power supply is sufficient for reliable operation of the ignition tester.

Test facilities for this development of the Curtiss-Wright Corporation Development Division were provided by the Wright Aeronautical Corporation ignition service and engineering departments, and by the Army School in Paterson, New Jersey. Grateful acknowledgment is also expressed for the helpful cooperation of A. C. Winter, Tony Munsell and J. G. Smith.



Complete video recording console. Hood at left covers the picture tube. Magazine of camera at right holds 1,200-foot film for 33 minutes of continuous recording

Video

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VIDEO RECORDING, the transcription of televised material onto motion picture film from a cathode-ray tube, is an essential medium for long-distance network television. Used with existing relay facilities, video recording enables program presentation at the same hour in different time zones. In the absence of relay facilities, it provides the only means for network distribution of key station programs.

Current practice is to record on 16-mm film, at the motion picture standard rate of 24 frames per second. The recording camera is driven by a synchronous motor, operating from the local power line, so that the film exposure rate is synchronized to the local power line frequency. The television picture rate, on the other hand, is necessarily synchronized to the power line frequency at the point of origin. If the camera has a conventional mechanical shutter, frequency difference between power lines causes recording difficulties in distant program pickup.

A new recording system, using an electronic shutter timed by electronic counting circuits, is entirely independent of the synchronizing frequency at the point of program origin. The equipment is self-contained in a single console. It includes picture and sound pickup circuits, the recording cathode-ray tube, a direct-reading video level monitor, a camera and a sound head.

The mechanical shutter of a conventional motion-picture camera performs the cyclic tasks of starting, stopping and timing each film exposure. The electronic shutter is an assemblage of electronic circuit blocks which performs these same tasks. It differs from a mechanical shutter in the following respects:

The exposure is started and stopped by successively applying and blanking the picture on the face of the cathode-ray tube, rather than by intervention of a mechanical shutter blade.

The exposure is timed by counting the scanning lines which compose the television picture. Exposure of each film frame is terminated on completion of the 525th scanning line, regardless of whether or not the camera and the television synchronizing generator are in synchronism with each other. To achieve the same desirable objective with a mechanical shutter, two major variables must be controlled. These variables are the operating speed of the shutter and the angular blade width. The angular blade width is fixed in the camera design so that the time of shutter opening is 525 lines when the shutter is running at nominal operating speed. Departure from nominal speed during nonsynchronous operation causes line-count errors. During synchronous operation, momentary changes in power line frequency may cause line-count errors because of the inertia associated with the camera mechanism.

With either mechanical or electronic timing, the start of exposure must be properly phased in relation to the camera mechanism. Exposure should not start until film pulldown has been completed and the film has become stationary. With a mechanical shutter, this function is performed by the trailing edge of the shutter blade (or the leading edge of the shutter opening). With an electronic shutter, it is performed by a mechanical cycling disc which generates an electrical cycling pulse suitable for actuating the counting circuits.

The circuit blocks which compose

Program Recording

Independence of synchronizing frequency at the point of program origin is established by substitution of electronic circuits for the mechanical shutter of a motion-picture camera. Tubes are also employed for phosphor persistence compensation and gray-scale correction

the electronic shutter are shown in Fig. 1 together with a timing diagram.

The scanning method commonly used with either a mechanical or electronic shutter is shown in Fig. 2. Since four film frames are to be exposed during the period of five television frames, one television frame must be dropped out of every five. By utilizing the interlace feature of the television scan, the same result is obtained by dropping one-quarter frame out of every one and one-quarter. One complete field and two complementary portions of adjoining interlaced fields are photographed during a single shutter opening, the separate portions adding up to a single television frame.

Accurate shutter timing is essential for correct operation. The shutter not only blanks the picture during the film motion interval, but also times the exposure to allow exact completion of a single television picture on each film frame. It is this additional timing function that imposes the severe accuracy requirement. With correct shutter timing, the starting line of the first field and the ending line of the third field occupy adjoining positions in the raster. If the shutter remains open a trifle too long the film records several extra scanning lines, which appear on top of a completed frame as a bright horizontal strip.

Similarly, early shutter closure causes a dark horizontal strip. This strip, either light or dark, becomes an obvious exposure defect which is sometimes called a shutter bar. The region of the picture where shutter closure occurs is known as the join-up or splice.

These conventions apply to a positive print produced from a negative film. The light values reverse for a direct positive print.

It is characteristic of the scanning method that the join-ups of alternate frames have different positions. The two join-up locations are separated from each other by one-half the picture height. In Fig. 2, the intersections of the dotted lines with the vertical sawtooths indicate the join-ups. The phasing chosen places one join-up near the top of the first and third frames, and the other join-up near the bottom of the second and fourth frames. One join-up can be removed from the picture area by phasing the camera to place the join-up at the raster edge, but the other join-up lies within the picture area. The join-up locations remain stationary when the television and camera rates are synchronized to each other. Otherwise, they travel up or down, depending on the difference between rates. An invisible join-up is a necessity in either case, and shutter timing must be correspondingly accurate. As an illustration of the degree of accuracy required, it may be noted that the edge of a mechanical shutter blade is hand-finished to almost micron dimensions in order to produce a satisfactory join-up. Even with this degree of accuracy, changes in the cyclic time base during nonsynchronous operation cause a shutter bar effect.

In the equipment illustrated, a shutter gate generator, rather than a timing circuit alone, blanks the cathode-ray tube during a portion of the film cycle. The phasing and duration of the shutter gate are established by several associated electronic circuits. One of these circuits opens the gate and starts the timing action as soon as pull-down of the preceding exposed frame has been completed. Another circuit times the exposure. A third circuit closes the gate. This combination of circuits forms an electronic shutter which replaces the

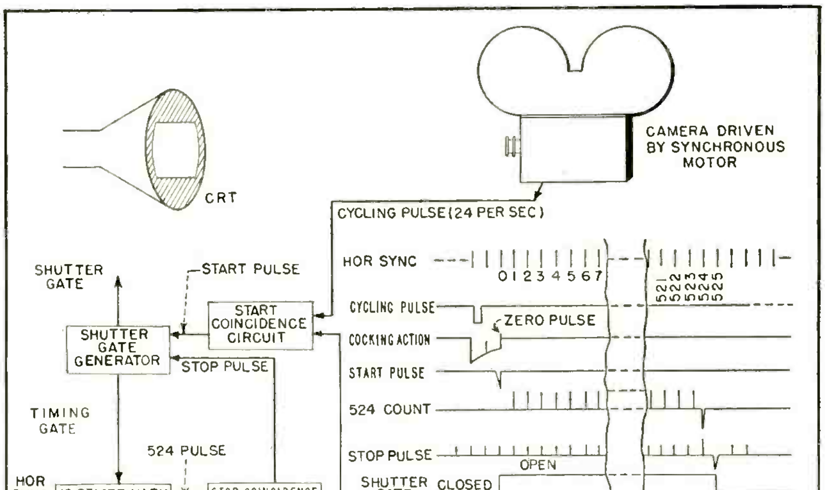

FIG. 1—Stages of the electronic shutter and illustration of line count timing. Exposure occurs when the shutter gate is open; the image on the crt is blanked when the shutter gate is closed

conventional mechanical shutter and affords greater inherent accuracy. The electronic shutter in the camera described has an inherent timing accuracy of better than one percent of a single horizontal line, or 0.5 microsecond, in either synchronous or nonsynchronous operation. The join-up reduces to a small line break in the unused margin of the raster, outside the picture area.

Since each television frame contains exactly 525 horizontal scanning lines, counting circuits may be used to time the film exposure. The counting circuits blank the recording cathode-ray tube when the correct number of horizontal lines has been scanned. Film exposure may start at any horizontal scanning line. Once started, the exposure continues to completion of the television frame, and then stops until triggered by a cycling pulse. In the camera, film pulldown starts after the exposure stops. On completion of pulldown, when the film has become stationary, the camera generates the cycling pulse and starts a new cycle.

Referring to Fig. 1, the cycling pulse, after amplification, actuates the start coincidence circuit. The pulse does not initiate the actual exposure, but merely cocks the circuit. A single horizontal synchronizing pulse then trips the circuit. This same synchronizing pulse, which may lie anywhere in the scanning cycle, becomes the start pulse which opens the shutter gate. Photography of the first scanning line commences with this pulse and continues as long as the shutter gate is open, the duration of the shutter gate opening being determined entirely by the timing gate.

The timing gate resembles the shutter gate, but the starting edge is intentionally delayed so that the gate opens during the first scanning line, after passage of the zero pulse. With the timing gate open, each pulse following the start pulse trips an appropriate stage in the binary counter circuit until the 524th pulse trips the 10th stage. This, in turn, actuates the stop coincidence circuit, effectively cocking the circuit. The 525th horizontal synchronizing pulse then trips the circuit, closing both the shutter gate and the timing gate. The gates remain closed during the blanking interval. At the conclusion of this interval, the camera generates a new cycling pulse, exposure starts and the operation repeats itself.

Start Coincidence Circuit

Figure 3 shows the start coincidence circuit. Under static conditions, triode V_{2B} is strongly conducting and V_{2A} is biased to cutoff.

The negative cycling pulse from the camera passes through diode V_{2A} and arrives at the grid of V_{2B} as a strong negative pulse, sufficiently large to stop conduction in this triode section. The voltage at the plate of V_{2B} goes positive, carrying the grid of V_{2A} with it. Conduction thus transfers to V_{2A}. Meanwhile, the negative charge on V_{2B} grid starts leaking off through the 1-meg resistor.

The time constant in the grid circuit is such that V_{2B} grid can remain negative during the period of several horizontal lines. (This is the cocking action illustrated in Fig. 1). While V_{2A} is conducting, the horizontal sync pulses are amplified in V_{2A} and appear as positive pulses on V_{2B} grid. Within the time of a few scanning lines, the negative potential on V_{2B} grid becomes so small that a particular pulse in the string of horizontal sync pulses overrides the negative potential on the grid of V_{2B}. This is the zero pulse, illustrated in Fig. 1, which causes transfer of conduction to V_{2B}. The voltage at the plate of V_{2B} falls abruptly from + 150 volts to almost ground potential, giving rise to a large negative pulse which becomes the start pulse.

The stop coincidence circuit is shown in Fig. 4. It is similar to the start coincidence circuit, except for the use of direct coupling to V_{2B} grid. The 524 count (Fig. 1) from the 10-stage binary counter replaces the cycling pulse as one of the inputs. The other input, the string of horizontal sync pulses, remains the same. The output is the stop pulse. The stop coincidence circuit contributes the 525 count.

Shutter Gate Circuit

The heart of the shutter gate generator is shown in Fig. 5. The circuit is a symmetrical version of the start coincidence circuit, and may be recognized as a form of the scale-of-two counter. It has two stable positions, characterized by conduction of one or the other of the two triodes. If triode V_{4B} is conducting, a negative pulse applied through diode V_{3B} transfers conduction to triode V_{4A}. Conversely, if triode V_{4A} is conducting a negative pulse applied through diode V_{3A} transfers conduction to triode V_{4B}.

The counter stages also employ the same basic circuit. Ten counter stages are used, but only the first and last of these stages are shown in Fig. 6. The circuit configuration within each stage is identical. The circuit is known as the Higinbotham counter circuit.

Tube V_1 of the counter group inverts incoming positive horizontal pulses, providing the negative pulses required by the design of the counter circuit.

The negative sync pulses reach

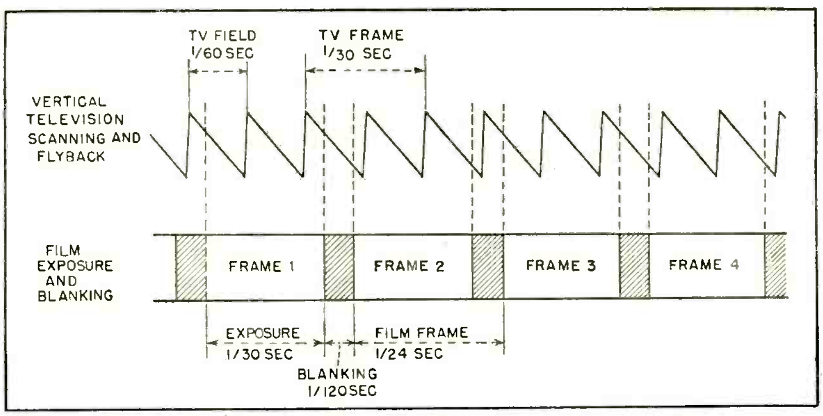

FIG. 2—Time relationships between television picture scan and film exposures

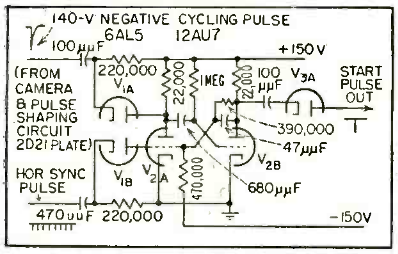

FIG. 3—Start coincidence circuit

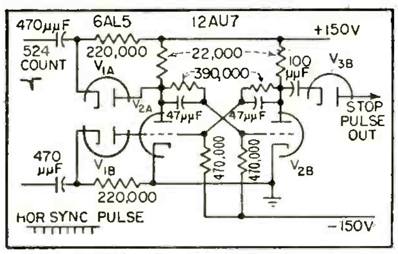

FIG. 4—Stop coincidence circuit

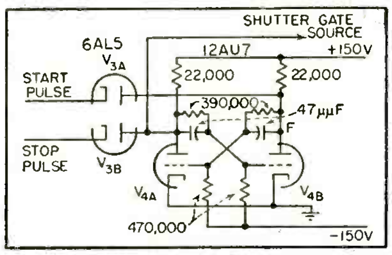

FIG. 5—Circuit of shutter gate generator

the first counter stage, V_3, through a 100 -$\mu\mu$f capacitor and the pair of diodes in V_2. The counter stage has has two stable conditions, depending on whether the *A* or *B* triode section is conducting. Each successive pulse transfers conduction from one triode section to the other. Whenever conduction transfers from the *A* triode section to the *B* triode section, a 140-volt negative pulse is produced at the plate of the *B* triode section. This negative pulse reaches the next counter stage through another 100 -$\mu\mu$f capacitor and another pair of diodes. The action continues to the tenth stage.

Each counter stage contains two diode sections, only one of which is effective during any one pulse application. The plate of the other diode section stands at a negative potential with respect to its cathode, and hence the diode section does not conduct. Conduction transfers from one diode section to the other as the counter operates.

Counter Operation

Assume each stage in the counter is on when its *A* triode section is conducting, or off when its *A* triode section is nonconducting. The stage produces a pulse when it goes from on to off. It does not produce a pulse in going from off to on. The stage goes through a single reversal on receipt of a pulse from the preceding stage.

Suppose, then, that all stages are on as an initial condition. A single pulse entering the first stage trips all stages simultaneously, including the last stage. As the last stage swings from on to off it generates an output pulse. In effect, the circuit has counted one.

Suppose, instead, that all stages are off as an initial condition. The first incoming horizontal pulse swings the first stage on. The second incoming pulse swings the first stage off; and the resulting counter pulse swings the second stage on. The second stage thus requires two incoming pulses for a single reversal. Similarly, the third stage requires 4 incoming pulses, and so on. The tenth stage swings from on to off, and generates an output pulse, only after 1,024 incoming horizontal pulses have been counted.

By turning certain stages on and the other stages off as an initial condition, any number from 1 to 1,024 can be counted. The 525 count imposed by current television standards is just beyond the limit of a 9-stage counter, and hence ten stages are used. The ten binary register switches are set to count 524 incoming pulses during each counter cycle. The 525 count is contributed by a separate stage associated with the stop coincidence circuit. In this way, the final critical count in each cycle is obtained directly from the associated horizontal pulse, with a minimum of intervening circuit elements.

The timing gate opens during the first scanning line, and remains open during the exposure cycle. Positive polarity corresponds to closed shutter. When the positive timing gate is applied to V_{21} grid, the triode conducts heavily and the voltage at the plate falls to almost ground potential. This allows conduction through the reset diodes V_{13} to V_{22} and the binary register switches. All counter stages are thus reset to their preselected on or off initial conditions during the blanking interval. The reset diodes do not conduct during the exposure interval, and hence do not affect the counter action.

A full frame of 525 lines is scanned during the exposure interval. One quarter frame is then dropped during the blanking interval to effect the 5:4 frame rate conversion. Under synchronous conditions, the average blanking interval covers 131.25 lines. However, since the counting circuits do not recognize fractional lines, the actual number of lines dropped during successive blanking intervals is 131, 131, 131, 132, 131, 131, 131, 132 and so on. The difference on the fourth count is caused by an accumulation of fractional-line increments to the point where they start the blanking interval a whole line earlier. Each picture, meanwhile, scans to completion.

On the fourth count, the scan merely starts and ends one line higher. Since the beginning of the blanking interval is tied to the end of the picture, while the end of the blanking interval is tied to the cyclic rate of the camera, the blanking interval is not subject to rigid cyclic control. It can shrink several lines, or increase by any necessary amount. Because of this flexibility, the camera need not be locked to the frequency of the television signal. A full frame of 525 lines is photographed during each locally synchronous exposure cycle, and any short or over lines are dropped out during the blanking interval.

Camera Construction

In the camera, the most noticeable differences are the absence of the conventional mechanical shutter and the substitution of a cycling disc, outside of the picture light path, which generates the cycling pulse. This disc rotates at a constant speed of 24 turns per second (1,440 rpm) and passes a single light pulse during each revolution. It is phased so that the light pulse follows immediately after completion of film pulldown. A phototube with associated amplifying and pulse shaping circuits translates the light pulse into the electrical cycling pulse.

Figure 7 shows the amplifying

and pulse-shaping circuits. Triode V_{1A} and V_{1B} are a two-stage amplifier and V_2 is a gas tetrode used as a pulse regenerator. It is biased to cutoff in the absence of an input pulse. A positive pulse applied to the grid fires the tube and produces a single negative-going pulse at the plate. This pulse is fed to the start coincidence circuit.

Film pulldown must be accomplished in a relatively short time. The blanking interval of 1/120 second establishes the maximum time allowance for film pulldown, but only a portion of this interval may be utilized. The film must remain stationary during the initial portion of the blanking interval to allow for phosphor persistence effects in the recording cathode-ray tube.

Rate changes encountered in nonsynchronous operation serve to further shorten the allowable pulldown time. During periods of increased camera rate or decreased television rate the end of the television frame intrudes on the beginning of the nominal blanking interval, and the start of film pulldown must be correspondingly delayed.

The camera uses a 3-to-1 skip movement in the intermittent mechanism. In effect, the mechanism operates at triple the normal speed and would pull the film at the rate of 72 frames per second if not for the fact that two out of three pulldown cycles are skipped. The film travels at normal rate of 24 frames per second, but pulldown is completed in ⅓ the normal time. With this fast action, pulldown can begin late in the blanking interval and can be completed before the next film exposure starts.

Practical Design Factors

It has been found that vibration, even in a small degree, may betray the location of the picture join-up. The subject for photography is a moving spot which traces successive patterns of evenly spaced lines. Vibration during film exposure displaces some lines with respect to others, causing line pairing and coarse line structure over portions of the film. Differences in line structure become particularly apparent at the join-up.

The effectiveness of vibration reduction measures employed can be gaged from the fact that close inspection of a recorded picture, projected on a 6 by 8-foot screen, reveals no evidence of vibration effects on either side of the join-up.

The deflection yoke design necessarily involves a compromise between good focus and low distortion. Perfect focus over the entire field can be attained at the expense of linearity, by accepting a certain amount of pincushion distortion. The approach used in this design was to strive for perfect focus over the field and to compensate for nonlinearity by optical means. As a result, the scanning lines are clearly resolved over the entire tube face, while the departure from linearity at any part of the picture does not exceed the width of two scanning lines. The recorded film original shows definite scanning line resolution in regions of low or medium density, at the corners as well as in the center.

A P11 phosphor is used in the recording cathode-ray tube. The major component of this phosphor's light output is in the blue region of the spectrum, where video recording films are most sensitive. This phosphor has a desirably high decay rate, the persistence illumination dropping to a very small percentage of initial illumination within the scanning time of a few lines.

Persistence illumination preserves each line for photographic exposure during an interval after scanning, and supplies an appreciable additional light contribution in relation to initial illumination. If the last line scanned in each frame is to contribute its full share of persistence illumination before film pulldown starts, the phosphor decay rate must be very high.

The P11 phosphor is almost entirely satisfactory in this respect, but has one shortcoming which seems to be common to all presently available phosphors. Complete extinction of low-level illumination requires several seconds. Residual illumination from this source causes a brightness difference between the first and last lines. Although the magnitude of the effect is small, the brightness difference can be quite apparent because these lines are adjacent in the recorded picture, and because the high contrast of the photographic film emphasizes any brightness difference.

Compensation is effected quite simply by using a sawtooth waveform which decreases the bias on the cathode-ray tube (increases brightness) as the exposure proceeds. The peak amplitude of the compensating sawtooth waveform is adjustable to meet different tube characteristics. The adjustment need be made only when a new tube is installed, and need not be repeated during the life of the tube.

Power-Law Amplifier

Gray scale rendition is improved by use of a power-law amplifier, a device which was originally developed for video recording, but which now offers promise

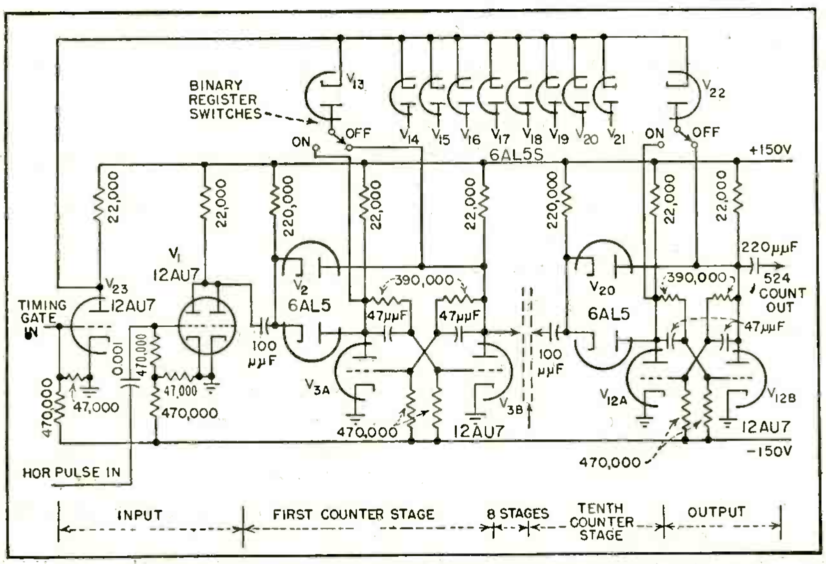

FIG. 6—Output of this counter circuit feeds the stop coincidence circuit

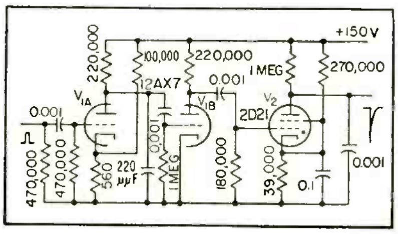

FIG. 7—Pulse amplifier, which is fed a 0.01-volt positive pulse from the cathode of the phototube. A 140-volt negative pulse is produced at the plate of the 2D21 to feed the start coincidence circuit

of general application wherever gray-scale correction is required.

The gray scale of the reproduced picture depends on the overall transfer characteristic of the system elements intervening between the scene and the picture. The transfer characteristic can often be expressed in terms of the exponent of a power-law relation, the exponent being analogous to the familiar gamma of the photographic art.

A gamma greater than unity indicates compression of the blacks and expansion of the whites; lower than unity indicates the converse effect. A very high exponent is associated with a harsh or contrasty picture; a very low exponent is associated with a flat or washed-out picture. A gamma of about 1.5 at the screen is considered to be most pleasing for motion-picture exhibition by direct projection.

Current television practice results in an exponent greater than unity, principally because of the individual transfer characteristics of the light-to-signal and signal-to-light transducers. Direct studio pickup involves only a single pair of transducers, namely, the pickup tube in the camera and the cathode-ray tube in the receiver. The resulting transfer characteristic is quite acceptable. The video recording process introduces two additional transducers, as well as the film on which the recording is made, and the cumulative effect may be far from acceptable.

Assume that a linear transfer characteristic (exponent of 1 in the reproduced picture) is the desired objective, and that the overall system response is such as to result in an exponent of 2. An amplifier is inserted in the video line and is adjusted to provide a transfer characteristic which follows a 0.5-power-law relation between its own input and output. Prior to correction, the brightness of the reproduced picture follows the square of the scene brightness. The video signal is modified by insertion of the amplifier, the amplifier output signal following the square root of the input signal. With this correction, the brightness of the reproduced picture is linearly related to the scene brightness.

The heart of the amplifier is a germanium crystal diode. The resistance of the diode varies with the crystal current. One portion of the resistance-versus-current characteristic can be closely approximated by the relation, $R = KI^{-0.5}$, where K is a proportionality constant and R and I are crystal resistance and current, respectively. The amplifier circuit which utilizes this characteristic is shown in Fig. 8.

The first 12AT7 operates as a cathode follower and delivers a voltage replica of the video waveform at point A. Video black level is at ground potential; video white level is at approximately 0.3 volt positive. The cathode load on this first tube is an essentially constant resistance. The crystal resistance, even at maximum value, is negligibly low in relation to the resistor in series with it. The cathode follower can therefore be regarded as a low-impedance source feeding a constant-resistance load. The load consists of two voltage dividers having significantly different characteristics.

The voltage divider composed of R and the germanium crystal diode delivers its voltage output at point B. Because of the relatively high constant resistance of the resistor, and the negligibly low resistance of the crystal diode, the current through the crystal diode is a replica of the video waveform. The voltage across the diode is, however, influenced by the crystal resistance characteristic. The voltage at point B is thus a power function (exponent = 0.5) of the voltage at point A.

The voltage divider composed of R_1 and R_2 delivers its voltage output at point C. The voltage at this point is a linear function (or a power law of unity exponent) of the voltage at point A. The potentiometer arm is set for equal white level voltages at points B and C.

Both voltage outputs are applied to the second 12AT7. Each half of this second tube functions as a cathode follower. Video output voltage can be obtained from point D, E, or from any intermediate point F. Point D provides maximum correction, point E provides minimum correction, and point F provides any intermediate value of correction.

Sound

The sound portion of the equipment is planned for direct positive variable density sound-on-film recording, using a recording system developed by J. A. Maurer, Inc.

The positive film stocks used in video recording are relatively insensitive in comparison to the negative film stocks which are normally

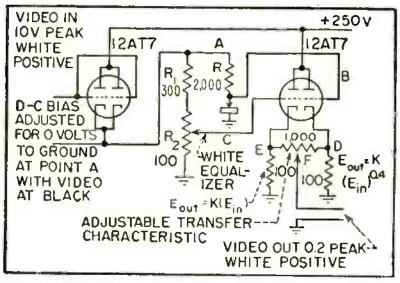

FIG. 8—Circuit of power-law amplifier for correcting gamma

used in motion picture photography. Considerably more light is required if the optimum density range of the film is to be utilized. The sound recording system uses larger than normal optical apertures to allow an approximately fourfold increase in illumination level.

A precisely-shaped mask compensates for the nonlinearity of the light-transmission-versus-exposure characteristic of the film.

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PRODUCTION TESTER

Transistor characteristics are determined quickly and accurately by a-c test apparatus. Circuit design information is furnished as well as operational test results. Includes provision for electrically forming transistors

VOLTAGE GAIN, current gain and input impedance of transistors for various emitter biases and collector load resistances are determined quickly and conveniently by the transistor testing apparatus shown in the photograph. Since no general set of curves can describe each transistor, this tester furnishes specific design information as well as operational test data.

The equipment has a built-in circuit to modify the electrical characteristics of a transistor and an oscilloscope for visual inspection of its diode characteristics.

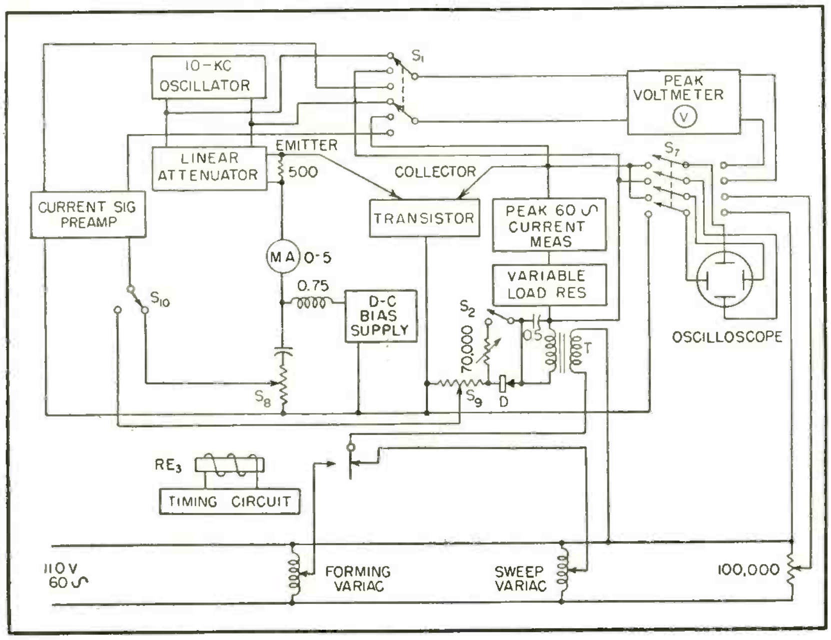

FIG. 1—Block diagram of a-c test apparatus

Figure 1 is a block diagram of the circuit. The transistor is connected in the conventional manner with 500 ohms in the emitter circuit and a 400 to 42,000-ohm variable resistor in the collector circuit. The emitter bias is supplied by a center-tapped voltage divider so that either positive or negative d-c voltage may be applied. The collector is supplied 60-cycle a-c voltage through the isolation transformer T. A crystal-diode rectifier D, in series with the collector probe, is connected in opposition to the direction of rectification of the collector probe itself. When not shorted out by S_2, it will have the positive half-cycle voltage of the 60-cycle supply developed across it, permitting the collector probe to be swept in negative polarity only. With S_2 closed, the magnitude of the forward current in the collector may be varied by the variable resistor in series with S_2. The negative peak value of the 60-cycle collector current is read on M_2 as the 20-μf capacitor shown in Fig. 3 charges through diode D'. Switch S_{12} selects the proper series resistance to read either 10 or 20 ma full

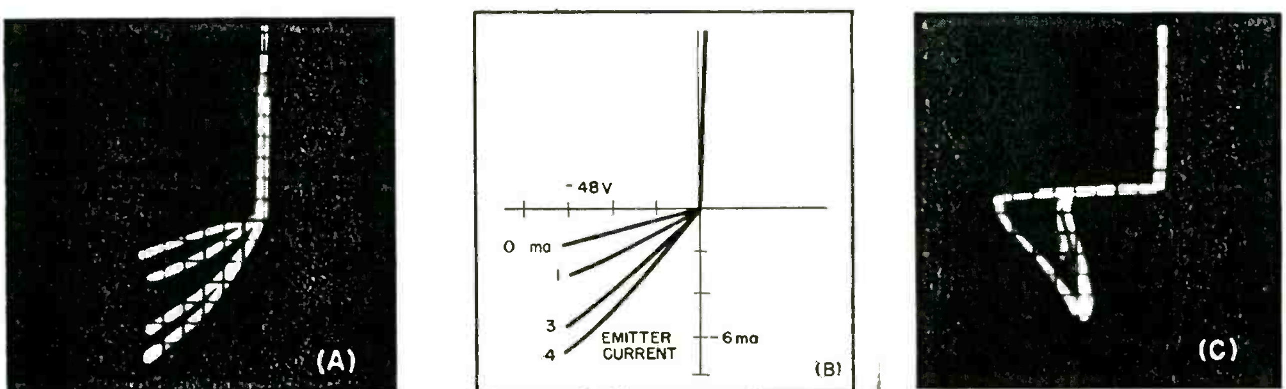

FIG. 2—Scope trace (A) shows collector volt-ampere characteristic of transistor while line diagram (B) gives typical bias conditions of emitter current and collector voltage. Back-voltage breakdown of crystal due to forming pulse is shown at (C) as seen on scope

for TRANSISTORS

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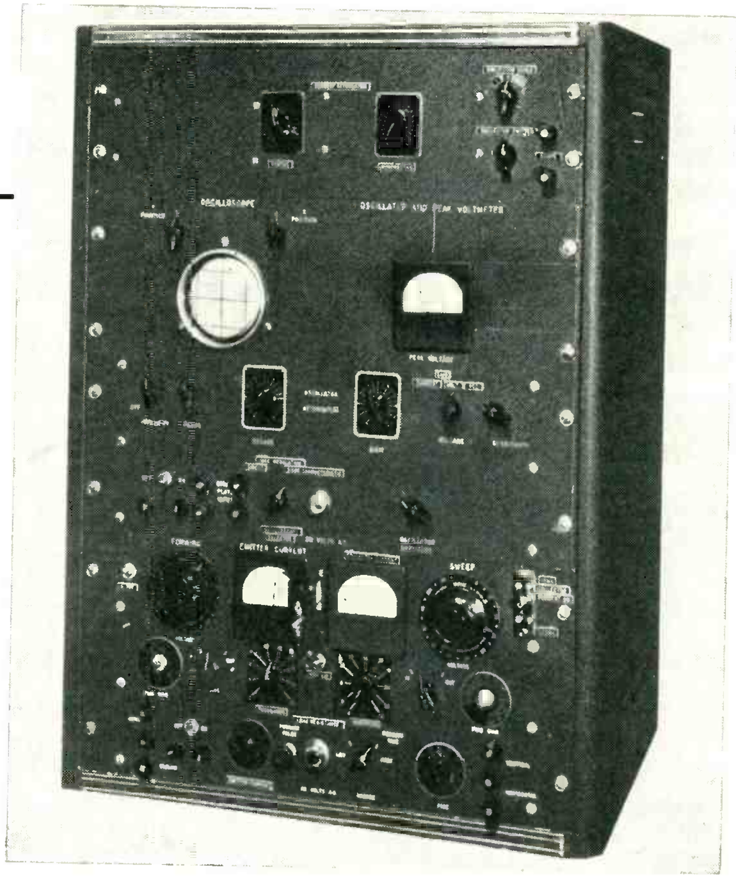

Production tester for transistors

scale. The peak collector voltage may be read directly from the trace on the calibrated oscilloscope screen.

Voltage Gain

Voltage gain of the transistor is measured at 10 kc by applying the output of the 10-kc oscillator to the emitter through the linear attenuator and comparing the 10-kc voltage developed across the load resistor with the direct output of the oscillator. Voltage comparison is made by means of the peak voltmeter and S_1, as shown in Fig. 1. If the linear attenuator is adjusted so that the two voltages are equal, the voltage drop in the linear attenuator is balanced by the gain of the transistor, and the reading of the attenuator equals the voltage gain of the transistor. The 60-cycle sweep voltage is filtered from the input to the peak voltmeter so error will not be introduced.

A similar method is employed to measure current gain. The relationship of collector and emitter currents is determined by comparing voltage drops across resistances selected by step switches S_8 and S_9. These signals cannot be fed directly into the peak voltmeter but first must be amplified as shown in Fig. 4A. Step potentiometer S_8 (Fig. 1) is adjusted to pick up the same value of 10-kc voltage as appears across the resistance selected by S_9. The current gain can be read directly from the setting of the step potentiometer. The decimal point is determined by S_9.

The input impedance may be found by measuring the voltage and current gains at a known value of load resistance, since the voltage gain is equal to the current gain multiplied by the ratio of load resistance to input impedance.

The collector volt-ampere characteristic is shown on the oscilloscope with the voltage across the collector on the horizontal plates and the voltage across the load resistor on the vertical plates. The 10-kc voltage amplitude is negligible compared to the 60-cycle sweep voltage so the trace is not broadened appreciably if voltage gain measurement is made while the collector characteristic is being examined. Figure 2A shows a typical characteristic. Figure 2B gives typical bias values of collector current and voltage.

Short-circuit current gain α may be measured by adjusting the load resistance to equal the a-c resistance of the collector-characteristic line at the desired operating point, measuring the current gain and doubling it. The collector characteristic on the oscilloscope may be used to adjust the load resistance to this value. The load resistance is varied until the voltage drop across the load is equal to the voltage drop across the transistor. To facilitate this adjustment, a diagonal line is ruled on the oscilloscope screen at the proper angle and the collector characteristic trace is made parallel to this line by varying the load resistance.

Forming Circuit

To form the collector probe of the transistor a second 60-cycle sweep voltage of large magnitude is applied momentarily to the transformer in the collector circuit. The duration of this forming pulse is determined by the timing circuit through RE_3. The ratio of forward to backward current in the collector is controlled during the forming pulse in the same manner as for the sweep. A range of forming pulse lengths from 20 cycles to one cycle is available. The forming pulse is applied by pressing the push-button switch S_5 shown in Fig. 3, and the effect of forming may be observed immediately on the oscilloscope and peak voltmeter. Figure 2C is a photograph of the back-voltage breakdown of a crystal induced by a forming pulse.

The timing circuit shown in Fig. 3 controls the length of time of application of the forming voltage. It consists of a capacitor discharging through the winding of the relay, initiating a voltage pulse in the collector circuit. The relay is in parallel with a variable resistor so that the time of capacitor discharge can be varied. One of two capacitors can be selected with S_6 and these capacitors are charged through resistors large enough to ensure that RE_3 cannot be activated more often than once in 5 seconds to prevent overloading.

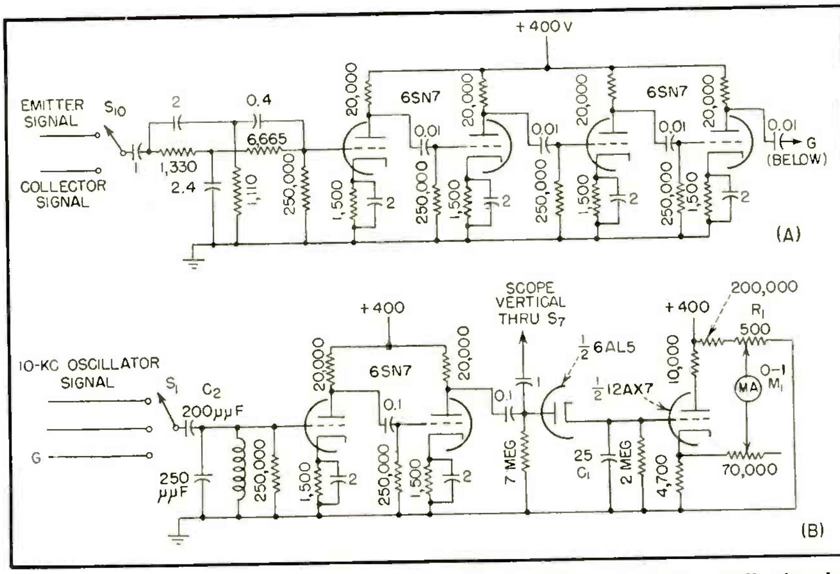

FIG. 4—Current measurement preamplifier (A) handles extremely small signals. Peak voltmeter (B) permits relative gain measurement

Peak Voltmeter

The peak voltmeter is one of two systems used to measure voltage and current gain. The output voltage of the 10-kc sine-wave oscillator is compared by the peak voltmeter with the same 10-kc signal after passing through the linear attenuator and transistor. Voltage gain is measured by balancing the gain of the transistor against the drop in the linear attenuator. A peak value voltmeter is necessary because the modulated form of the wave varies with transistor characteristics.

Circuit illustrated in Fig. 4B consists of a filter for 60 cycles, two-stage amplifier, series rectifier, storage capacitor C_1, and a low-current voltage-measuring circuit. The incoming signal passes through a network consisting of C_2 and a parallel L-C circuit. The L-C circuit is tuned to 10 kc for maximum impedance to ground. The high reactance of C_2 in combination with the low reactance of the L-C circuit at 60 cycles forms a 60-cycle filter. The 10-kc signal is then amplified 150 times in two stages to provide sufficient amplitude for linear operation of the 6AL5 rectifier. Capacitor C_1 charges through the 6AL5 to peak value of the signal.

The 12AX7 monitors this voltage, and the reading of M_1 is proportional to it. Potentiometer R_1 is a zero set for M_1; a 70,000-ohm unit controls its sensitivity.

Direct Gain Reading

The absolute magnitude of the voltages is unimportant. Meter M_1 is set on the direct 10-kc signal, then switched to the modulated 10-kc signal of the transistor output. The attenuation is varied until the meter reads the value previously set. The attenuator then gives voltage gain directly.

The second method of measuring voltage gain is to apply the output of the peak-voltmeter amplifier to the vertical plates of the oscilloscope and compare the height of the two 10-kc signals.

The use of the peak voltmeter to make current-gain measurements is essentially the same as described above for the voltage-gain measurements. Either M_1 or the oscilloscope may be used to indicate a balance between the signals originating across the step potentiometers S_8 and S_9 shown in Fig. 3.

By use of selector switches S_1, S_7 and S_{10} (Fig. 1) diode characteristics, the voltage-comparison test or the current-comparison test may be viewed on the oscilloscope. The horizontal input for the voltage-and-current comparison tests is a 60-cycle variable sweep voltage. The two methods of measuring voltage or current gain will work simultaneously. When the diode characteristic is on the scope, the peak

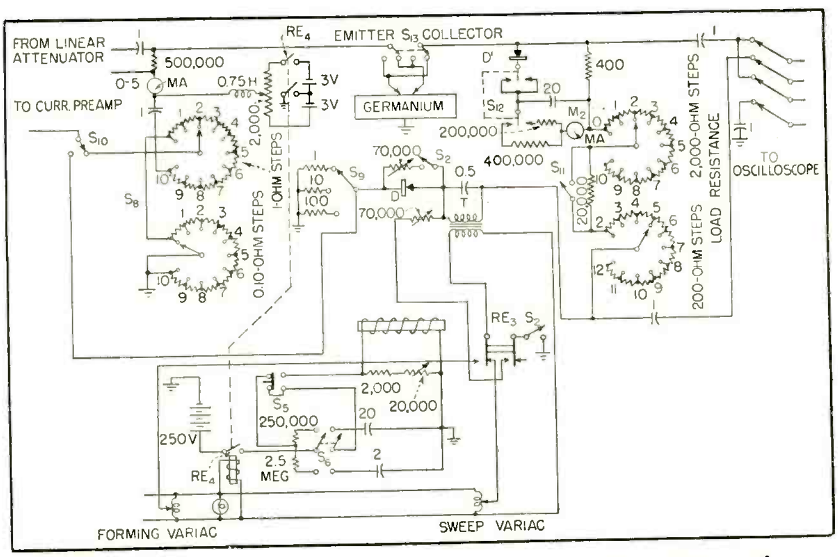

FIG. 3—Transistor bias supplies and timing circuit for transistor forming pulse

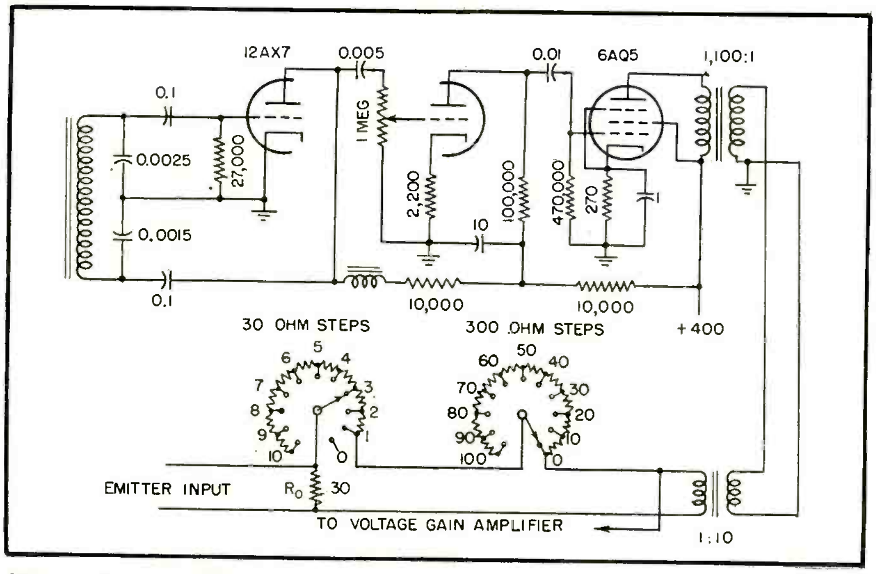

FIG. 5—Ten-kc oscillator furnishes test signal while linear attenuator gives direct gain reading

voltmeter alone will register balance.

The 10-kc attentuator in Fig. 5 consists of two 10-step potentiometers in series. The first adds 300 ohms resistance in each step. The second adds 30 ohms per step.

The output of the attenuator is always taken across the 30-ohm resistor, R_0. When the attenuator is on position 1, the 30 ohms is in parallel with the secondary of the transformer and may load the oscillator amplifier to some degree depending on the secondary impedance. This does not create an error in the measurements since all tests are of a comparison nature. Above position 3 this effect disappears. Increasing the attenuator from position 1 to position 2 drops the voltage across the output resistor by one-half. The next step drops the voltage by one-third. These fractions represent the ratio of the attenuator-output voltage to input voltage, therefore the step-position numbers indicate directly the voltage factor by which the 10-kc oscillator output is attenuated. When this attenuation is balanced by the gain of the transistor, the numbers read directly the voltage gain of the transistor.

Current Gain Measurement

The method of measuring current gain makes use of extremely small signals compared to those used in voltage-gain measurement. These signals are amplified by the circuit shown in Fig. 4A. Since the amplitude of the 60-cycle current in the collector circuit is large, and only the 10-kc current is to be measured, a 60-cycle filter is added ahead of the preamplifier to prevent saturation by 60 cycles. A twin-T filter[1] was chosen because it is possible to tune such a circuit to cancel out one frequency completely. The twin-T circuit's relatively low input impedance is no disadvantage since the original signal appears across a resistance of the order of 10 ohms. Following the preamplifier, there are terminals for an external oscilloscope, which are used if current and voltage gains are read simultaneously.

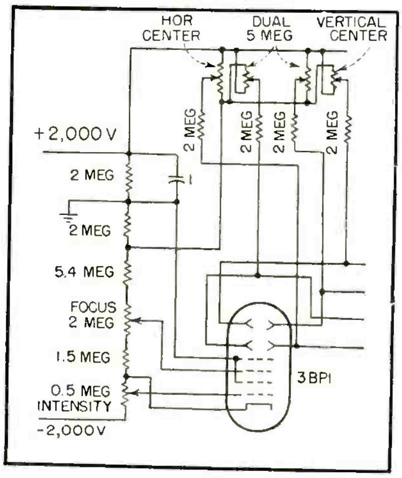

FIG. 6—Oscilloscope displays both gain measurement and transistor characteristics

The signal used to measure current gain is so small that any stray signals caused by inter-winding capacitance in the oscillator output transformer will add a constant factor to the readings. This effect is minimized with the addition of the second transformer by permitting grounding of the secondary of the first output transformer.

Oscilloscope

Through switches S_1, S_7 and S_{10}, the scope shown in Fig. 6 becomes multipurpose. The circuit consists of a 2,000-volt power supply, a potential-dividing system, centering controls for the scope traces and a system of calibrating the horizontal and vertical scope traces in volts as illustrated in Fig. 6. Horizontal and vertical deflections are varied simultaneously by varying the second-anode voltage, thus maintaining a vertical-to-horizontal deflection ratio of 7 to 10. The voltage is usually set so the horizontal sweep is 7 volts per division. The vertical calibration is 10 volts per division.

Oscillator

The Colpitts oscillator shown in Fig. 5 is tuned to 10 kc. The signal is amplified and fed to the linear attenuator and the peak voltmeter. The oscillator has proved stable in both amplitude and frequency. Binding posts on the front panel are provided for an external oscillator should measurements at another frequency be required.

This apparatus has been used in production of transistors to check the semiconductor ingots before cutting, to select the best pieces after cutting, to check the best probe adjustment, to form electrically the finished transistor, and to grade the final product. It has also been used to pick the best transistor for a given circuit application, and to give the information necessary for a proper choice of other circuit components. It has been used to check periodically the characteristics of transistors when in use, and to carry out experiments on transistors in statistical quantities.

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Selective Mixing Amplifier For Aircraft

Unit combines ten channels of communication and navigation audio information in any combination, selected separately by pilot and copilot, without mutual interference between used and unused channels. Fail-safe arrangement insures reliable operation

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WARTIME and postwar developments in the field of communications and navigation are in daily use along the airways. The opening of vhf channels for range, traffic control and ILS has increased the complexity of aircraft radio installations. Connecting headphones to one or two receivers is not difficult, but handling the various audio channels of a modern installation of several receivers and transmitters is definitely an engineering problem.

The duties of pilot and copilot are such that it would in fact be desirable for each to have entirely independent radio systems. Such an installation would be most uneconomical of space and weight. It is possible, however, to attain a high degree of efficiency from a minimum amount of equipment by running all audio signals through a multichannel dual-output isolation amplifier.

The amplifier to be described provides a means of integrating almost any composite installation into a highly efficient and practical system. Because all audio signals pass through this amplifier it has necessarily been made fail-safe. That is, in the event of partial or complete failure, it is easily disconnected from the circuit by the pilot or copilot in such a way that service is uninterrupted. Isolation of the two circuits is such that there is no crosstalk. Sufficient output power is available to drive small cabin speakers, thus eliminating the fatigue of wearing headphones. Since the amplifier is optional equipment, it has been designed to be added to existing installations.

The F-11 isolation amplifier is capable of handling ten audio input circuits. Two of these circuits are divided in such a way that the outputs of two receivers can be terminated in two range-voice filters. Pilot and copilot can then independently select any combination of range, voice or both filter outputs without mutual interference. A typical assignment of audio circuits to the various channels is as follows:

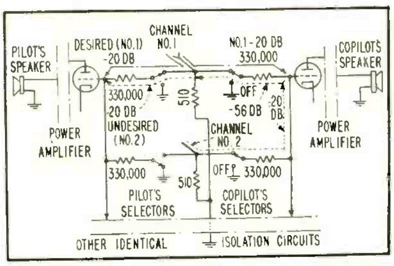


FIG. 1—Two of the ten basic isolation circuits are shown. The pilot is connected only to channel 1, while the copilot hears channel 1 and channel 2 simultaneously

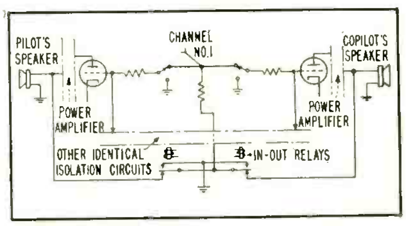


FIG. 2—Fail-safe relays (normally energized when equipment is in use) drop out and bypass amplifier in the event of component failure

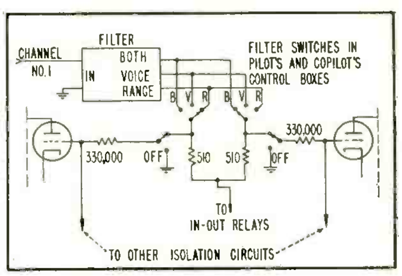


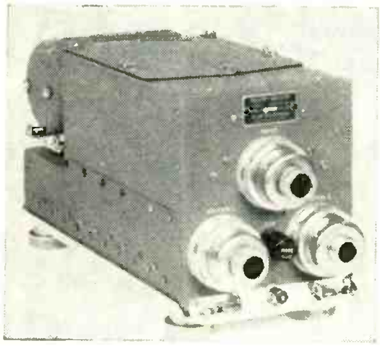
FIG. 3—With a single range filter, pilot and copilot can independently choose range, voice or both

Channel Number	*Audio Circuit*
1	ADF receiver Range-Voice-Both
2	L-F range receiver Range-Voice-Both
3	ADF receiver
4	Broadcast receiver
5	VHF navigation receiver
6	VHF communication receiver
7	Marker beacon receiver
8	H-F transmitter sidetone
9	VHF transmitter sidetone
10	Intercom

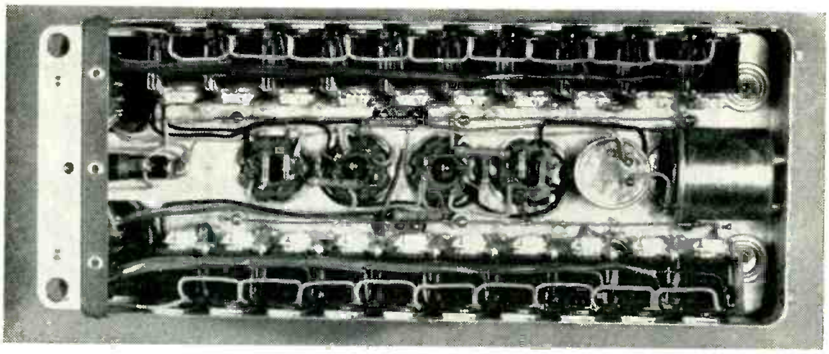
The photographs show the complete unit and the under side of the chassis, base removed. Connections are made by means of multiwire ceramic-insulated connectors plugged into receptacles mounted on the front plate.

Basic Circuit

The basic isolation circuit is shown in Fig. 1. For simplicity only two of the ten circuits are drawn in detail. Each input channel provides a 500-ohm load for the circuit connected to it. As shown, the pilot is connected to channel 1, while the copilot is connected to channels 1 and 2. In the case of the pilot, the desired signal from channel 1



Packaged design permits addition of selective isolation amplifier to existing aircraft systems



All channel switching is accomplished from the cockpit by means of d-c relays which are located underneath the amplifier chassis. Low-impedance audio lines between amplifier and cockpit are free from crosstalk

passes through the closed switch, a 300,000-ohm isolating resistor and thence to the grid of his isolation-amplifier tube. Because the nine other isolating resistors connected to this grid are grounded, the desired signal suffers a reduction of only 20 db.

The signal from channel 2, to which the copilot is also listening, reaches the grid of the pilot's amplifier by the path indicated. It can be seen that it undergoes the following losses: (1) to copilot's amplifier grid −20 db, (2) to circuit 1 input load −56 db, and (3) to pilot's amplifier grid −20 db. The undesired signal level is therefore 96 db below the input level or 76 db below the level of the desired signal at the grid of the pilot's amplifier. Actually common ground currents and cross coupling reduce this to about 60 db.

All audio switching is done by relays. The selector relays are located in the bottom portion of the chassis along the sides. The arrangement can be seen in the bottom-view photograph. Relays permit short unshielded leads between receivers and amplifier. All wiring between amplifier and cockpit is d-c and high-level low-impedance audio. These wires are not subject to cross coupling or noise pick-up.

Operation

Figure 2 shows a modification of the basic circuit to provide a means of bypassing the amplifier in the event of component failure. The two relays are connected in the common lead of the input load resistors. When energized this lead is grounded and operation is as described above. The relay coils are connected directly to the primary power circuit. When this circuit is broken by fuse failure or manual switching, the relays open and connect the common lead of the input load resistors directly to the output circuit. The loss introduced in each receiver line by the load resistors and shunting effect of other receivers is about 10 db. This loss, although noticeable, is not sufficient to impair operation of the system and the receivers can be shared by pilot and copilot as before installation of the amplifier.

Figure 3 shows a method of using a range-voice filter in one channel. The filter is the receiver load. The input load resistors are now divided and brought to separate pins of the input receptacle. These pins are connected to the arms of pilot and copilot filter switches. The pilot and copilot can now connect their input circuits to filter output range, voice or both. No crosstalk will result if both users are connected to the same circuit but there will be a noticeable reduction in output (3 db). If this cannot be tolerated, the use of separate filters is recommended.

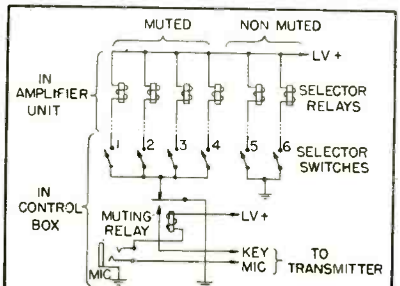


FIG. 4—Special circuit mutes incoming signals during transmission periods

It is desirable to cut off or mute all incoming signals during transmission. Isolated muting circuits are desirable because the speaker only requires perfect quiet. The use of selector relays makes possible receiver muting as desired. Figure 4 shows the muting circuit.

The selector relay circuits are energized by completing their coil circuits to ground by means of individual selector switches. Any circuit or group of circuits may be muted by breaking the common ground lead of the corresponding selector switches. This is easily done by the muting relay which is operated by the microphone key circuit when the button is pressed to talk. Muting relays are usually located in the control boxes.

Installation

A complete installation permits independent selection of 1 to 10 audio channels by pilot and copilot, independent choice of range-voice filters on two circuits and independent muting of receivers, also choice of speaker or headphone operation. The design of the amplifier unit is such that an input signal of 300 mw will produce 3 watts output for loudspeaker operation.

At this time it is felt that the 10-channel amplifier is adequate for most needs. Another such unit can be added as the number of channels increases. Thus pilot, copilot, radio operator and flight engineer can listen to any combination of the 10 facilities without mutual interference.

Precision Phasemeter

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PHASE DIFFERENCE measurements accurate to 0.1 degree are obtained by the precision phase meter shown in the photograph.

Phase comparison is accomplished by a detector bridge consisting of four 5647 diodes arranged as a ring modulator. Phase difference is read directly from a decade voltage divider which controls the amount of quadrature voltage added to a reference signal.

The instrument is self-calibrating and provides sense information to remove 180-degree ambiguity. Figure 1 shows a block diagram of the phasemeter.

Some proposed applications of the instrument are in testing polyphase systems, goniometers, wideband phase-shifting networks for single-sideband transmitters and feedback amplifiers. It may also be used in filter, transformer and network design and in measurement of residual L and C in resistor units.

Basic Method

The method developed by J. R. Ragazzini and L. A. Zadeh[1] forms the basis for design of the precision phase meter. It can be classified as a phase comparison method. The phase meter is seen in the simplified block diagram of Fig. 2 to consist of two signal channels terminating in a phase detector, which need only indicate approximate phase quadrature between its input signals. Two phase shifters, one calibrated and the other uncalibrated, are inserted in series with one or the other channel. Either phase shifter can modify the phase difference between signals at the phase-detector input as compared with those at the phase meter input.

Specifications

Frequency Range	—30 to 20,000 cps
Phase Range	—0–360 degrees
Accuracy	—0.1 degree absolute (0.01 degree for incremental angles up to two degrees)
Signal Level	—0.5 to 10 volts rms
Input Impedance	—10 megohms shunted by 25 $\mu\mu$f
Display	—decade null system
Power Supply	—105–125 volts rms, 50/60 cps
Size	—19½″ wide × 16¼″ deep × 25″ high
Weight	—110 pounds including walnut cabinet

Precision phasemeter gives phase difference of two sinusoidal voltages directly in degrees

The phase meter is calibrated by applying a single test signal to both input terminals, and setting the calibrated phase shifter to zero. The uncalibrated phase shifter is adjusted so that the phase detector indicates a condition of balance.

To measure phase difference, the input terminals of the two channels are separated and connected to the two signals whose phase difference is sought. The phase detector will then show a condition of unbalance. The indication of balance is restored by adjustment of the calibrated phase shifter.

The operation of the calibrated phase shifter is shown in Fig. 3A, B, and C. In Fig. 3B the input signal $E_1\angle 0°$ is shown. Added to this signal in exact quadrature is a vector $E_1 \tan\theta$. The resultant E_R is phase-displaced by an angle θ from the original vector. In Fig. 3A is shown the method of producing vector $E_1 \tan\theta$. The amplifier of gain A has capacitive reactance X bridged from input to output. It can be shown that for $R = X$, the overall gain is unity and the phase shift is closely equal to 90 degrees. The error in quadrature is approximately $1/A$ radians. For values of R unequal to X due to frequency variations, the accuracy of the quadrature relationship is essentially maintained with the output amplitude varying directly with frequency. The output divider can then be calibrated in terms of tan θ.

For the condition $R = X$, all values of calibrated phase shift up to 45 degrees may be obtained by properly adding the two voltages. An additional 45 degrees can be obtained by merely switching the divider to the $E_1\angle 0°$ vector before summation. The vector diagram of this relationship is shown in Fig. 3C. It can be seen that phase angle calibration is independent of frequency provided the $R = X$ condition is maintained throughout the band. Similar results are obtained if R and X are interchanged. The circuit shown is the preferred arrangement since it displays an integrating characteristic to harmonics. It does however tend to accentuate low-frequency noise which is controlled by R-C cutoff filters in the band switching.

The condition of $R = X$ or unity gain requires adjustment of R for each frequency of measurement. The balance voltmeter used for this purpose is shown in Fig. 4A. The input and output signals of the 90-degree amplifier are fed to a pair of stable feedback amplifiers which in turn feed a pair of full-wave averaging rectifiers. The d-c output of these rectifiers is applied to a microammeter through a pair of self-protecting cathode followers. The two inputs are connected to the same signal source to establish amplitude equality. The gain of one amplifier is adjusted to obtain a

for Audio Frequencies

One-tenth degree accuracy is obtained in phase-difference measurements between two sinusoidal voltages. Problems in design of a commercial instrument to this accuracy are discussed. Self-calibration procedure is outlined

balance reading on the zero-center microammeter. The inputs are then connected to the 90-degree amplifier with the meter serving as indicator for the balance condition. The required sensitivity of one part in 3,000 is obtained with amplifier gains of approximately 250. A schematic diagram of the balance voltmeter circuit is shown in Fig. 5.

Method of Display

The mechanical calibration of a continuously variable potentiometer is not feasible for a dynamic range of 360 degrees with 0.1-degree accuracy and a sensitivity of discernment of 0.01 degree. A combination of 23 precision fixed resistors is used to obtain 2-degree intervals. These intervals are chosen by means of two switches, the first selecting any 10-degree value from 0 to 80 degrees, the second selecting any of five additional two-degree intervals. The transition around the 45-degree point is accomplished automatically as the tens or units dial is rotated. The interpolation of the remaining 2-degree interval is provided by the phase comparator.

The phase comparator must have a sensitivity sufficient to resolve phase deviations of the order of 0.01 degree. It must be capable of measuring such incremental angles accurately over a range of two degrees. The comparator is shown in block form in Fig. 4B. It is an application of the classical wattmeter circuit or ring modulator. The d-c output current measured by the zero center microammeter balances when a 90-degree phase difference exists between the two channel voltages. The d-c current is a function of the signal amplitudes and the cosine of the phase-difference angle.

For plus or minus one-degree deviation from the balance condition, the d-c current is linear to within 5×10^{-5} degree, so that linear scale calibration is adequate for this interval. A deviation of plus or minus ten degrees departs from linearity by approximately 0.05 degree. This is applied in obtaining coarser phase measurements with greater rapidity by shunting the meter to obtain a plus or minus ten-degree scale.

Amplitude inaccuracy is virtually eliminated by setting the levels on the phase-detector bridge to prescribed values. Misadjustment of more than ten percent of both levels is required before impairing the 0.1-degree accuracy with the meter at full scale.

Analysis of the ring modulator disclosed that at discrete operating level ratios various orders of odd harmonics in one channel would be rendered ineffective in producing errors. Since the bridge is insensitive to even-order harmonics, levels were designed for cancelling third-harmonic effect in channel 2. The 90-degree amplifier is integrating in character and is therefore used

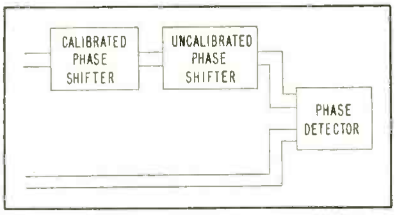


FIG. 2—Simplified block diagram illustrates phase-comparison method of measurement

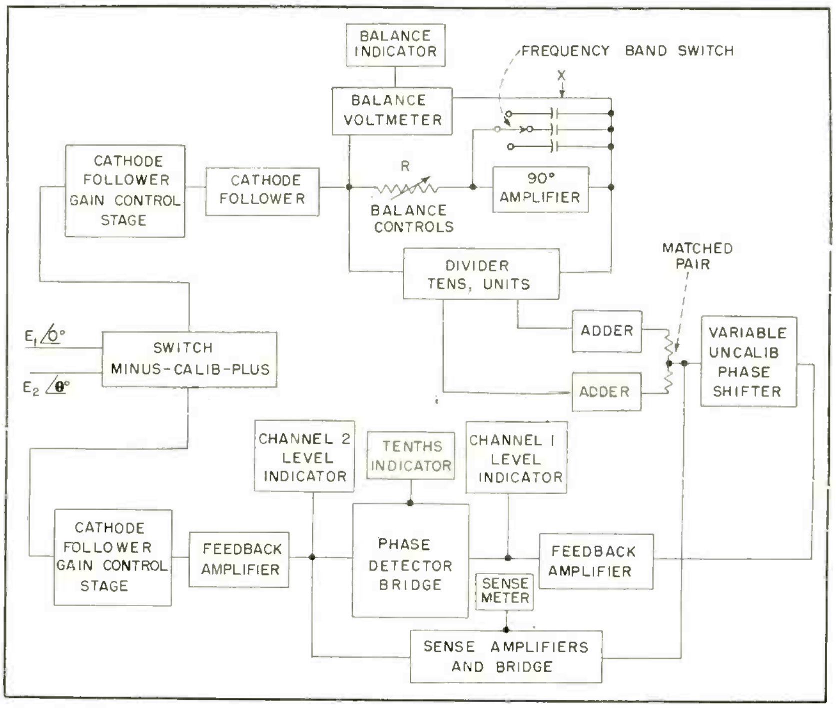


FIG. 1—Block diagram shows path of input signals to phase-detector bridge. Divider gives phase-difference reading

for feeding channel 1. The result is to preserve meter accuracy in the presence of harmonics.

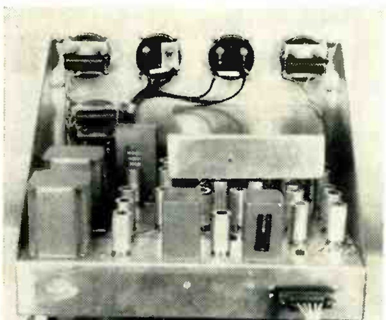
Sensing Circuit

The 90-degree amplifier and dividers are capable only of calibrated phase shift over 90 degrees. An additional 90-degree shift is obtained by interchanging the positions of the calibrated phase shifter and the uncalibrated phase shifter shown in Fig. 1. The phase comparator is however, ambiguous about 180-degree points. A sensing circuit consisting of a low-level wattmeter 90 degrees out of phase is used to indicate the quadrant. While a value between zero and 90 degrees is read on the phase meter, a switch position indicates polarity and the sense meter indicates whether or not 180 degrees must be added.

Developmental Problems

For 0.1-degree accuracy, it is necessary to limit individual known error effects to a maximum of 0.01 degree. The gain of the 90-degree amplifier contributes an error effect approximately equal to $1/A$ radians. Therefore high orders of gain must be achieved in the presence of a 0.7-feedback ratio at 45 degrees at operating frequency. The schematic of the 90-degree amplifier is shown in Fig. 6.

Stray capacitance across R (Fig. 3A) contributes error in the form R/X_{stray} radians while leakage resistance across X contributes $X/R_{leakage}$ radians. This complicates amplifier design in that a low operating-impedance level is required to minimize these errors. An amplifier with a cathode-follower output working at an impedance level of about 1,000 ohms is employed. The amplifier gain is 4,000 over the frequency band, with amplitude-phase characteristics outside the operating band controlled to insure stability. High quality polyethylene capacitors with Q's of the order of 5,000 are used.


Rear view of instrument removed from its cabinet. Three anode-voltage supplies are provided

Resistor R must be capable of stable adjustment to one part in 3,000 to achieve a settability of 0.01 degree at 45 degrees. Three series controls are used to adjust R: a coarse-control 31-position attenuator, a medium-control 31-position attenuator and a smooth low-resistance rheostat for fine control. The coarse control is calibrated in frequency to permit easy, rapid adjustment with the balance voltmeter.

Adding two signals with phase accuracy better than 0.01 degree and amplitude accuracy of one part in 3,000 is accomplished by two feed-back amplifiers with low-impedance (less than one ohm) cathode-follower outputs that feed a pair of precision-balanced 5,000-ohm resistors whose centertap is fed to the high-impedance input of the subsequent amplifier stages. Thus the effects of vacuum-tube variations and of component aging are virtually eliminated. Figure 7 shows the circuit of one of the amplifiers.

Vacuum diodes are used in the phase-detector bridge because of the linearity and consistency of diode characteristics even with heavy loading. Since contact potential and diode characteristics are critically dependent upon heater potential and vibration, stability is achieved through use of subminiature ruggedized diodes (type 5647) suspended in a sealed potted container. The heater supply is current regulated.

The output transformers feeding the diodes are designed for maximum primary inductance and minimum variation with level adjustment. Leakage reactances between

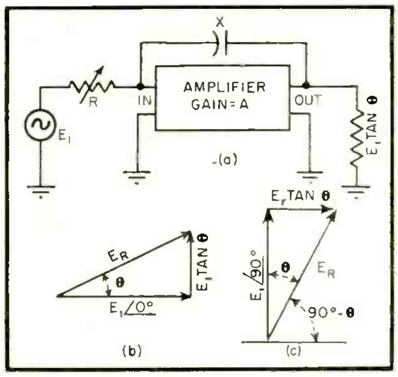


FIG. 3—Calibrated phase shift is obtained by adding quadrature voltage to input signal

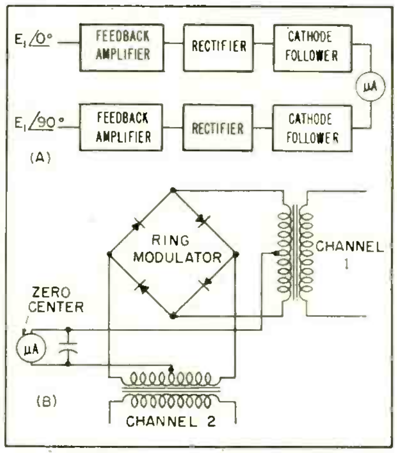


FIG. 4—Balance voltmeter (A) indicates signal amplitude equality. Phase-detector bridge (B) responds to signals in quadrature

half secondaries and primary are maintained small throughout the range.

The output stage is a push-pull Class-A amplifier with 30-db feedback, driven by direct-coupled cathode followers to eliminate phase-shift variations at low frequences due to small grid conduction. The output-level meters are specially designed rectifier types flat to within ½ db from 30 to 20,000 cps.

Due to the low operating impedance levels used throughout the design, common coupling at high frequencies presents little difficulty. Elimination of coupling at low frequencies through the common impedance of the power supply requires three separate anode sources. Their self impedances are kept below one ohm and their transfer impedances below 0.01 ohm with a combination of L-C filtering and electronic regulation. A schematic of the channel-1 output amplifier

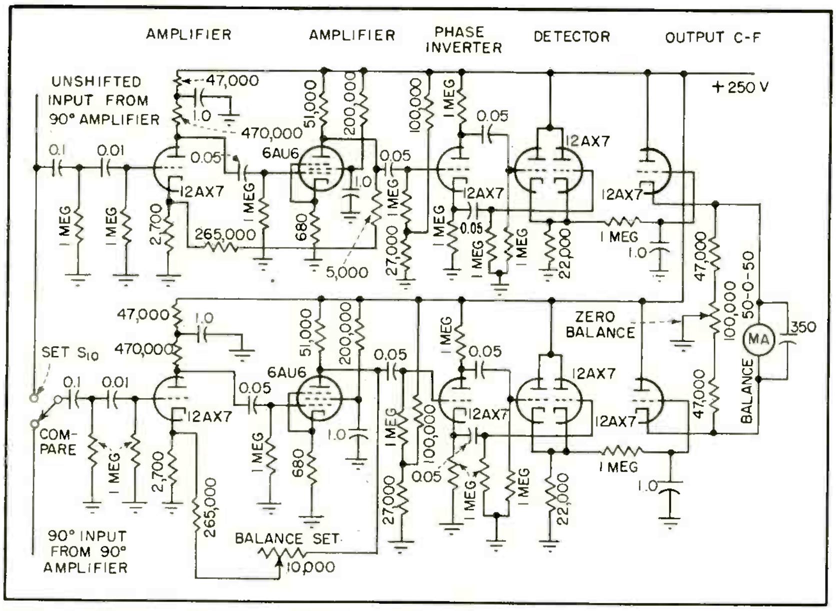


FIG. 5—Circuit of balance voltmeter used to display departure in voltage equality of one part in 3,000

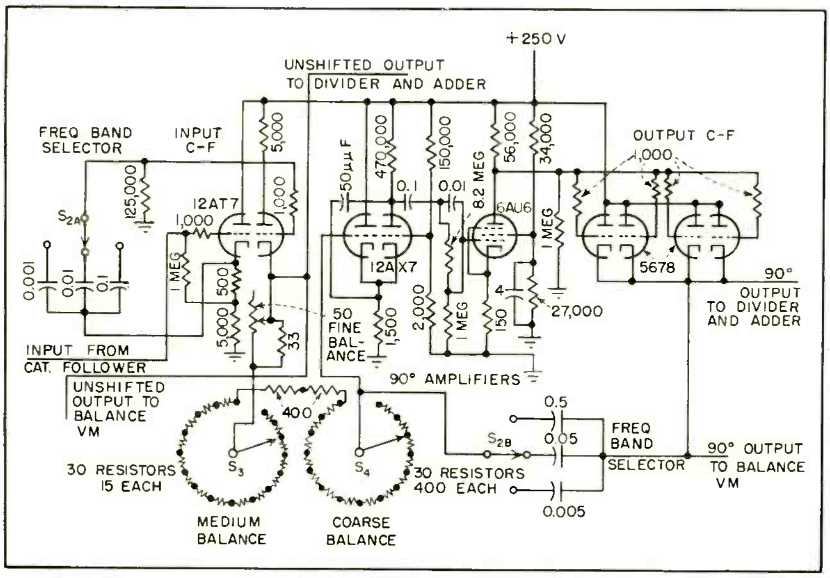


FIG. 6—Circuit of 90-degree amplifier with high-pass filter and low-impedance cathode-follower output

and uncalibrated phase shifter is shown in Fig. 8.

Test Methods

To determine performance characteristics within the specified tolerance, a test method capable of divulging 0.01-degree error is necessary. Such orders of accuracy are unobtainable in any primary standard. The use of accurately calibrated phase shifts created by resistive-reactive networks and carefully measured frequencies is unsuitable. In the most favorable case of a single 45-degree R-C network, calibration accuracies suitable at one frequency only are of the order of 1.75 parts per 10,000. This assumes basic calibration equipment of such complexity as is available only at the Bureau of Standards. The method employed uses the instrument itself to divulge its own error.

A phase standard of zero degrees implies connection to the same signal source. In addition, two variable uncalibrated phase shifters of the following characteristics are necessary. Input and output impedances must be sufficiently high and low respectively that less than 0.01-degree change is effected by loading one input on another output. The output impedance must be sufficiently low that less than 0.01-degree change is effected by loading the output with the input impedance of the phase meter.

Design of such phase shifters is readily realizable. Cathode-follower input and output stages of conventional 12AT7-type miniature triodes provide sufficient isolation. The test procedure is as follows:

With the input terminals tied to a common source, the phase meter is adjusted to its calibrating position of zero degrees. It is then connected to measure the shift of one phase shifter which is adjusted to give an exact reading of 180 degrees on the phase meter. The first phase shifter is removed, and the remaining phase shifter is similarly adjusted. The phase meter is then connected to measure the phase shift of the two shifters in tandem. For zero error in the original reading of 180 degrees, the sum should now read 360 or zero degrees. The deviation from zero degrees indicated by the phase meter is double the error at 180 degrees. This permits exact calibration of the true 180-degree point.

This procedure is then repeated with each phase shifter adjusted to 90 degrees as read on the phase meter. The deviation from the previously calibrated 180-degree point when connected in tandem is double the 90-degree error, and the true 90-degree position is evaluated. In this manner 45 degrees, 22½ degrees, etc. may be checked.

By means of the two-degree steps, it can again be shown that eleven equal phase shifts as indi-

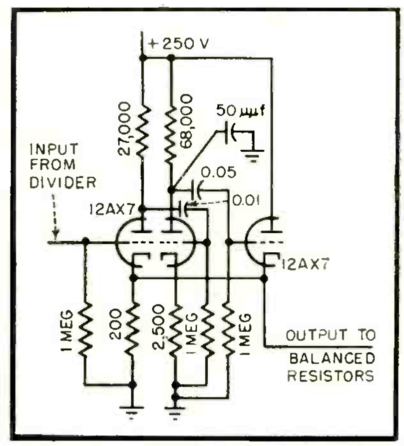


FIG. 7—Low-impedance feedback amplifier used in adder circuits

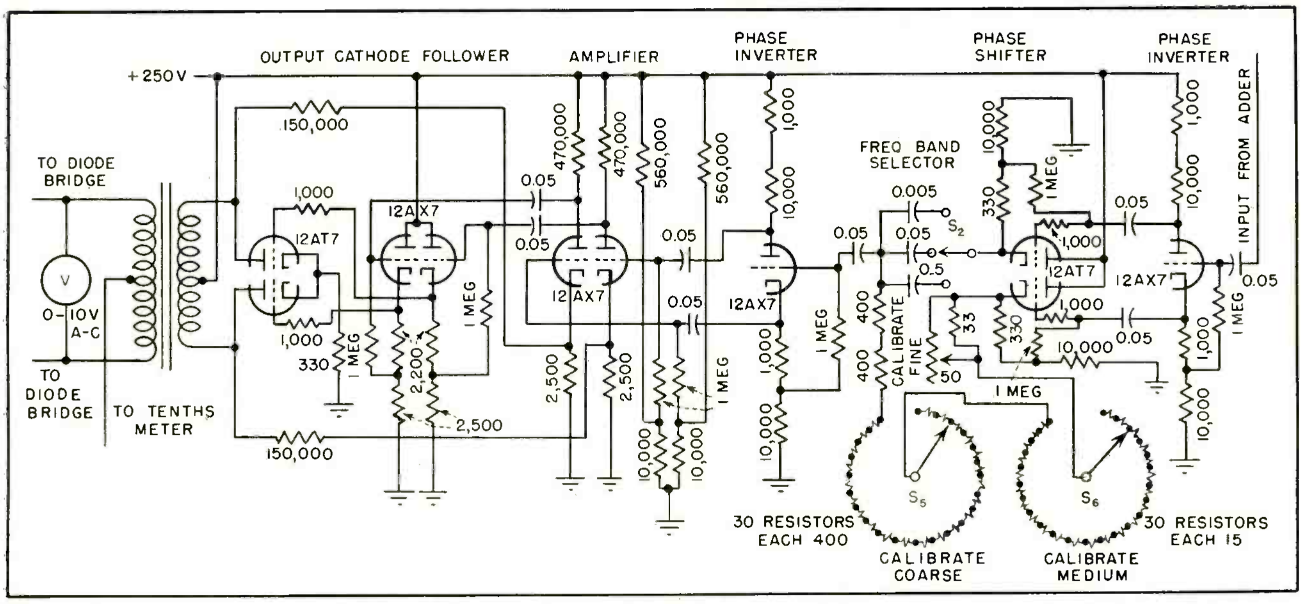


FIG. 8—Channel-one amplifier includes uncalibrated phase shifter and output amplifier. Transformer feeding bridge is designed for maximum primary inductance and low leakage reactance

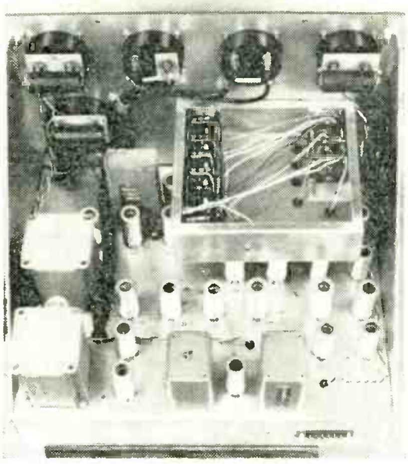
cated on the degree meter add to 22 degrees, and 22 such equal shifts add to 44 degrees, and 45 such steps add to 90 degrees. In this manner the entire region from −90 degrees to +90 degrees may be tested. The remaining angles of the complete 360 degrees can be checked by a similar process utilizing the 180-degree symmetry of the instrument.

Production Technique

For a large number of frequencies in the spectrum this complete test method is laborious and time consuming. Exhaustive tests on the prototype have borne out theoretical considerations of unobservable error at 180 degrees, and complete symmetry about 180-degree spaced values. Two-degree step tests to 46 degrees in addition to the cardinal points have proved sufficient to guarantee an instrument accuracy of 0.1 degree throughout the range, thus enabling a more rapid production technique. This technique tests the divider accuracy as a basic 45-degree calibrated phase shifter as well as the remaining circuitry which remains unaltered over the entire range.

Evaluation of Tests

The maximum error disclosed in type testing the prototype is 0.06 degree. This represents the maximum accumulation at various angles and frequencies of the calculated 0.01-degree errors in different circuits. Stability of zero calibration is such that measurements to full accuracy are possible after about 15 minutes of warm-up. Variation of vacuum tubes and components within the commercial tolerances shows no effect on performance. Evaluation of performance in terms of harmonic content of the signal source is in process and will soon be available. Preliminary observations indicate no error contributed by even-order harmonics and a tolerance of about one percent third within stated accuracy. Accuracy and calibration are not disturbed by insertion of filters in the input. Zero calibration may be set even if the filters are not matched.



View from above shows ganged degree switches and resistors of precision voltage divider

Equipment Layout

The top row of instruments on the front panel is for indications of balance, channel levels and sense. Immediately below are the major degrees dials and meter. Below these dials, on the left are the three balance controls (R of Fig. 1), with calibrated controls for the uncalibrated phase shifter on the right. The contact potential balance dials and balance voltmeter controls are located in two panel recesses. These elements require infrequent adjustment and are removed from the operating area.

A photograph shows a rear view of the instrument removed from its cabinet. The lower deck is the power supply. Also shown is a top view from the rear with the dust cover removed from the switch box. The ganged degree switches and precision divider resistors can be seen. The first production model has been delivered to the Communication and Navigation Lab., Wright-Patterson Air Force Base, whose cooperation and stimulation aided the program considerably.

REFERENCE

(1) J. R. Ragazzini and L. A. Zadeh, "A Wide Band Audio Phasemeter", National Convention IRE 1949.

A Fast Sweep Circuit

Designed for study of extremely short-duration phenomena, the oscilloscope described has a maximum sweep speed of 100 inches per microsecond, obtained from a simple thyratron circuit. Three methods of calibration are employed

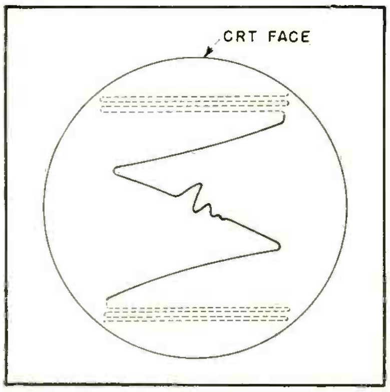


FIG. 1—Stable delayed sweep is provided by modified raster scan

By N. L. DAVIS and R. E. WHITE

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IN ATOMIC STUDIES, the scintillation counter has assumed great importance. With these counters it is now possible to detect the incidence of single alpha or beta particles or single-gamma quanta upon certain types of crystals. When particles strike the crystal, minute fluorescent light flashes are produced.

The use of a multiplier phototube makes it possible to convert these tiny flashes to voltage pulse waveforms, a much more convenient form for recording and studying. The voltage waveforms produced are, however, of extremely short duration and the problem of displaying them in sufficient detail to allow accurate study and counting presents a considerable problem in design of high-speed oscilloscopes. In the field of digital computers there is an increasing requirement for high-speed operation. Such operation demands the use of short-duration pulses. For the observation of such pulse voltages, a fast-sweep oscilloscope is required.

For use in the type of problems mentioned an oscilloscope with the following characteristics has been developed: The frequency response is uniform to 265 megacycles. It is possible to observe either single traces or recurrent traces to a repetition rate of 5,000 cycles. The unit has a maximum sweep speed of 100 inches per microsecond (0.01 μsec per inch) with several sweep ranges reaching a maximum sweep length of 25 microseconds. A low-impedance keying pulse is provided for keying external circuits under examination. A variable delay between the external keying pulse and the oscilloscope is available which may be varied from 0 to greater than 3 μsec.

Requirements

The first three specifications place severe requirements on the cathode-ray tube and its circuitry. The tube must be capable of producing traces of very high brilliance, and the transit time of the electron beam through the deflection plates must be sufficiently low to permit the required frequency response. The performance of the cathode-ray tube on both of these factors is improved by the use of very high accelerating potentials.

Two DuMont crt types are designed for high-speed oscilloscope applications. A few of the pertinent characteristics of these two tube types are compared in the accompanying box. For the oscilloscope to be described, the 5RP-A satisfies the required brilliance and frequency limits and was used because of its immediate availability.

Sweep Circuitry

With an accelerating potential of 20,000 volts on the 5RP-A tube, a deflection sensitivity of approximately 0.005 inch per volt may be expected. For five inches deflection approximately 1,000 volts of sweep voltage is required. If the fastest sweep (100 inches per μsec) is considered, a voltage slope of 20,000 volts per μsec must be developed for a sweep wave form.

Two general methods of generating suitable sweep voltages were investigated: modified raster scan using vacuum tubes, and sweeps generated by hydrogen thyratrons.

The modified raster scan produces the presentation shown in Fig. 1. To develop this scan, a two-megacycle oscillator is keyed to provide either sine-wave sweeps or a series of linear sawtooth sweeps. The cathode-ray tube is then unblanked during the interval under investigation. Coinciding

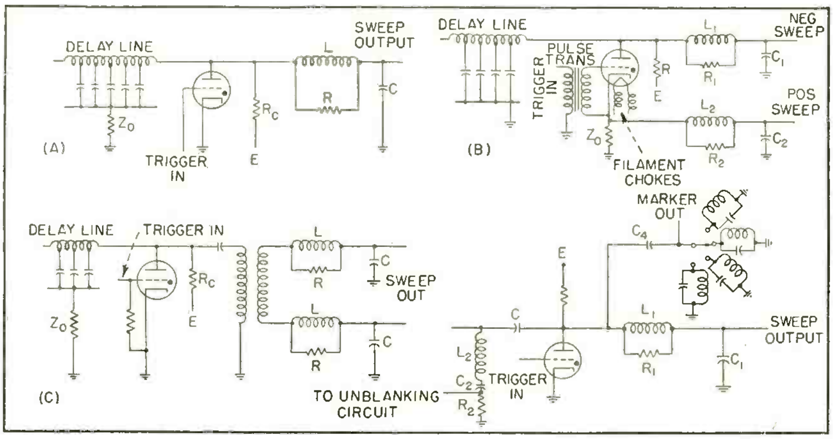

FIG. 2—Balanced and unbalanced sweep circuits for hydrogen thyratrons

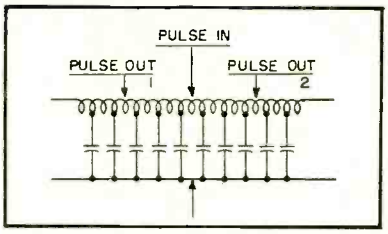

FIG. 3—Two-output delay line for initiating action observed and later, the scope sweep

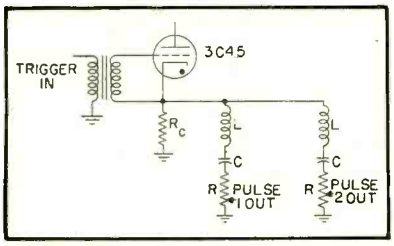

FIG. 4—Jitter is avoided by taking two outputs from cathode of thyratron

with the unblanking pulse, a small expansion sweep voltage is applied to the vertical deflection system so that several consecutive sweeps become distinguishable. This corresponds to a raster type of scan in that several sweeps may be made available at a given time.

One advantage of this type of sweep is that it provides stable delayed sweeps with no stable delay-pulse generation required. The time jitter of any sweep depends only upon the variation in the amplitude and frequency of the two-mc basic oscillator.

The jitter in the delay of the unblanking pulse used in this system does not result in time jitter in the trace itself, but is seen as fluctuations in the end of the interval being examined. This method works quite satisfactorily for sweeps longer than 0.5 μsec. Above this speed, the generation of steep voltage slopes demands higher currents than can be conveniently obtained from vacuum tubes.

The rate of rise in volts per second of voltage across a capacitor is equal to the current divided by the capacitance.

$$\frac{i}{c}\left(\frac{\text{amperes}}{\text{farads}}\right) = \frac{dV}{dT}\left(\frac{\text{volts}}{\text{seconds}}\right)$$

If the sweeps are developed over the lowest possible capacitance consisting of the output capacitance of the sweep generator tube in parallel with wiring and cathode-ray tube capacitances, the current which must be handled becomes objectionably high to be handled by a vacuum tube. For example, given a minimum capacitance of 30 $\mu\mu$f and a rate of rise of 20,000 volts per μsec, the current becomes 0.6 ampere.

In addition, the amount of cross coupling from one deflection plate to the next right-angle plate increases as the capacitance from plate to ground is lowered. This is due to the capacitance divider formed by the capacitance to ground and the plate-to-plate capacitance of the cathode-ray tube. If the capacitance from the deflection plate to ground is deliberately made as high as 100 $\mu\mu$f to minimize cross-coupling effects, the current is increased to two amperes. This magnitude of current leads to the selection of a gas-filled tube such as the thyratron as a sweep generation source.

Several variations of the basic circuit for the development of sweeps through the use of a hydrogen thyratron are possible. Figure 2A shows one form such a circuit may take. The tube may be a 2D21, 2050, 3C45, 4C35 or others.

CRT Characteristics

	K1030	5RP-A
Direct interelectrode capacitances		
Deflection plate D_1 to D_2	0.52	1.8
Deflection plate D_3 to D_4	0.39	1.5
Maximum ratings		
Anode 2 to final intensifier	30,000 v	22,000 v
Typical deflection factor	128	140±20 percent

This circuit operates as follows: with the thyratron in an unfired condition, the pulse-forming network is charged to voltage E through resistance R_c. When the trigger pulse is impressed upon the grid of the thyratron, the tube conducts and the voltage at the plate of the gas tube falls very rapidly to a voltage 20 to 50 volts above ground depending upon the tube used.

The charged line then discharges through the series circuit of Z_o and the thyratron. This produces a negative square pulse across Z_o of amplitude $E/2$ and length equal to twice the delay of the line, providing an unblanking pulse. The sharp drop at the plate is integrated by the *RLC* circuit to provide a substantially linear sweep voltage approximately equal to the supply voltage.

Associated with single-ended sweeps on electrostatic cathode-ray tubes there is an effect known as deflection defocusing which appears as progressive defocusing from start to end of the sweep. To correct this situation, two methods of producing balanced sweeps have been investigated. One method is illustrated by the circuit shown in Fig. 2B. The circuit is similar in operation to that previously described. When the thyratron is triggered, the cathode of the gas tube rises rapidly to a voltage $V/2$. In this way, C_2 charges to $V/2$ through L_2 and R_2 to provide a positive linear sweep approximately equal to $V/2$. Capacitor C discharges from V to $V/2$ to provide a negative sweep approximately equal to $V/2$. A positive square pulse of amplitude $V/2$ is developed across Z_o so that an unblanking pulse may be obtained from the circuit.

Another method of obtaining balanced sweeps employs a transformer. In this circuit, Fig. 2C, the cathode of the gas tube is grounded, eliminating the necessity of filament chokes and the pulse transformer for keying purposes. Here the unblanking pulse is obtained across Z_o and the sharp voltage step at the plate is capacitively coupled to the phase-inverting transformer. The voltage step is integrated from the secondary of the transformer to develop balanced sweeps. The linearity of these sweeps depends upon the frequency response of the transformer.

With the 5RP-A tube, deflection defocusing is not very serious and because of the possible simplification of circuitry, the single-ended sweep circuit shown in Fig. 2D is now used in this oscilloscope. The sharp voltage drop at the plate of the gas tube is integrated by $L_1R_1C_1$ to provide the sweep output.

The sharp voltage drop is also coupled by C_4, a very small capacitor, to one of several tuned circuits in the grid circuit of the cathode-ray tube where a damped train of oscillations suitable for intensity markers is generated. The L_2, R_2 and C_2 components produce a negative voltage pulse from which an unblanking pulse of sweep duration is formed.

Delay

When using an oscilloscope having high sweep speeds, the difficulty of maintaining the sweep in coincidence with the signal is considerable. To obtain a good presentation, the jitter should be kept less than one line width. This naturally applies to recurrent phenomena only since jitter from one sweep to the next is not recorded if individual sweeps are being photographed. Consider the case of the fastest sweep described, namely, 0.01 μsec per inch. Allowing for a spot size of 0.05 inch, this demands a jitter less than 500 $\mu\mu$sec for recurrent sweeps.

To obtain coincidence of sweep and signal, means must be provided to delay the sweep over the interval being examined. In the past, some variation of the circuit shown in Fig. 3 has been used. In this circuit a pulse is developed and fed into a delay line. This pulse traveling along the delay line is picked off at two points. A pulse with one delay is used to initiate the action to be observed, and a pulse at a second delay is used to initiate the oscilloscope sweep. These delays are so chosen that the transient to be observed occurs in the desired portion of the oscilloscope sweep.

An investigation of the keying characteristic of thyratrons has shown that with a d-c heater supply, a keying pulse supplied from a low-impedance source can provide stable keying of a thyratron on a comparatively slow voltage slope. By decreasing the amplitude of this low-impedance pulse, the delay in firing the thyratron is increased.

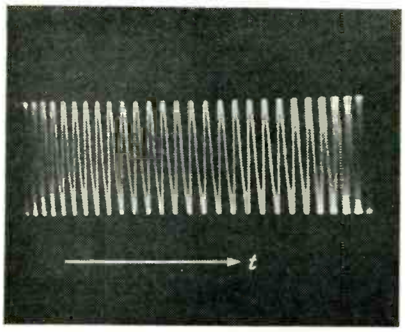

FIG. 5—Trace of a 120-mc keyed oscillator with a sweep of 0.05-μsec per inch

Figure 4 shows a suitable source of low-impedance keying pulses. In this circuit two low-impedance pulses are obtained simultaneously from the same thyratron, thus assuring that no jitter exists between them. One pulse is used to trigger the thyratron sweep tube while the other is used to trigger the thyratron to be observed.

The values of L and C can be switched to furnish a rough adjustment of the delay in firing. For fine adjustment the amplitude of the keying pulse is changed by varying R. By means of suitable adjustment, the sweep tube and the tube under observation can be keyed simultaneously.

With this general type of circuit negligible jitter delays to 10 μsec have been obtained. To do this the values of L and C are such as to produce an approximate half sine-wave pulse of length equal to 20 μsec. By suitable compensation within the gas-tube circuit as well as changes in the design of the thyratron the stable delay interval may be increased.

Calibration

The high-speed sweeps described were calibrated by several methods to find one accurate method suitable for both visual and photographic use.

Perhaps the most accurate method tried consists of using a crystal-controlled transmitter as a timing-wave source. The timing wave is applied to the vertical deflection plates and single-trace photographs taken. It has the disadvantage of not being synchronized with the sweeps and cannot be used to measure time directly when viewing recurrent phenomena.

A 120-mc oscillator was keyed and photographed, Fig. 5. This circuit is very stable and easily photographed since a considerable number of sweeps can be observed at one time.

A third method consists of ringing an inductance to produce a train of damped oscillations. This method is easiest to apply since a thyratron having high-current capabilities can be used for generating the oscillation. With the 3C45 the physical size of the tube appears to limit the frequency of oscillations to about 60 mc.

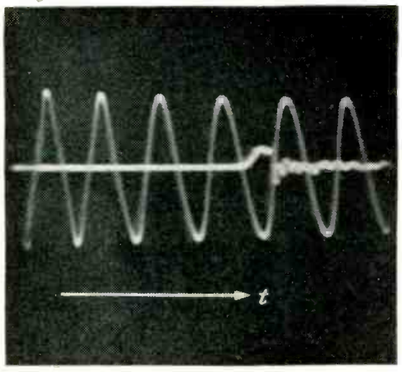

FIG. 6—Alternate keying of 0.005-μsec pulse and 50-mc timing wave

Figure 6 shows a 50-mc timing wave obtained from a ringing circuit superimposed on a 0.005 μsec pulse by alternate keying.

The oscilloscope is housed in a four-foot cabinet with component parts placed in three levels. The crt gun and deflection section are enclosed in a mu-metal shield to prevent magnetic fields from influencing the beam. The front of the tube is maintained at the final intensifier voltage by means of a copper band encircling the tube. To prevent corona and provide physical support for the tube, a Lucite collar is fastened to the front panel and supports the front of the cathode-ray tube. A sheet of $\frac{1}{8}$-inch Lucite protects the observer from the high voltage. The high-voltage bleeder for obtaining the proper voltages for the intensifier elements consists of half-watt 1.8-megohm resistors wound in a spiral groove cut into a polystyrene rod to minimize corona effects. The total resistance is 100 megohms so that a 200-microampere meter may be used with the bleeder to read 20 kilovolts at full scale.

The limits on bandwidth and sweep speeds encountered in this oscilloscope are not a function of the circuitry. The frequency limitation is imposed by the cathode-ray tube and may be extended by a factor of four with use of the K1030 type tube. The available writing rate then becomes much greater and the circuitry may be extended to provide sweeps of much higher writing rates.

Calculating UHF Field Intensities

Curves based upon accepted propagation concepts facilitate theoretical prediction of television field intensities between 470 and 890 mc until more experience is obtained. Data on nulls and maxima resulting from path differences are included to show their location in miles from the transmitter

By FREDERICK W. SMITH
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THE RECENT allocations proposals by the FCC for commercial television broadcasting in the band from 470 to 890 mc have centered attention on propagation problems at these frequencies. In order to facilitate the prediction of theoretical ground-wave field intensities in this band, the group of charts presented here has been prepared.

The methods for the calculation of field intensities employed were originally proposed by Norton[1] and have been conveniently summarized by Terman.[2]

Field Near Transmitter

The equation for field intensities in the immediate vicinity of the transmitting antenna for the ultra-high frequencies under consideration is given by Terman[3] as

$$\text{Field Intensity, } E = \frac{2\,E_o\,P^{\frac{1}{2}}}{d}\sin\frac{2\pi\,ha}{\lambda d} \quad (1)$$

where E_o is the reference field intensity produced at a distance d of one mile for an effective radiated power P of one kilowatt, and h, a and λ are the heights of the transmitting and receiving antennas and the wavelength, respectively.

The reference field intensity selected by the FCC as an f-m and tv standard is that developed in the equatorial plane of a half-wave antenna under the conditions specified above, or 137.8 millivolts per meter. Such an antenna has a power gain of 1.641 when compared to an isotropic radiator.

Using this value for E_o and substituting 186,200 miles per sec ÷ f or (c/f) for λ, with h and a in feet and f in megacycles, Eq. 1 can be reduced to

$$E = \frac{275{,}600}{d}\,P^{\frac{1}{2}}\sin\theta \text{ microvolts per meter}$$

$$\text{where } \theta = 6.92 \times 10^{-5}\,haf/d \text{ degrees} \quad (2)$$

It can be seen from Eq. 2 that for a fixed distance and receiving antenna height, a single value of field intensity will result for a given frequency-transmitting antenna height fh product. Thus, where Eq. 2 applies, a transmitting antenna height of 1,000 feet at 450 mc will produce the same field intensity as 500 feet at 900 mc, other factors being equal.

This relationship has been employed to simplify the construction of the field-intensity chart, which is similar in many respects to previous charts published by the FCC for field-intensity calculations in the vhf band. Here, the product fh serves as the independent variable, which permits the use of a single chart for the entire frequency band under consideration.

Phase Interference

Near the transmitting antenna, a series of oscillations will occur in the field intensity as a result of phase interference due to differing path lengths traversed by the space wave and ground-reflected wave components of the signal. This effect is indicated by the sine term of Eq. 2, which will oscillate between unity and zero in value as Θ reaches successive values of 90, 180, 270 degrees, and so on. The nulls and maxima thus produced will become much more frequent with decreasing distance. However, the latter will always be tangent to a curve along which the field intensity var-

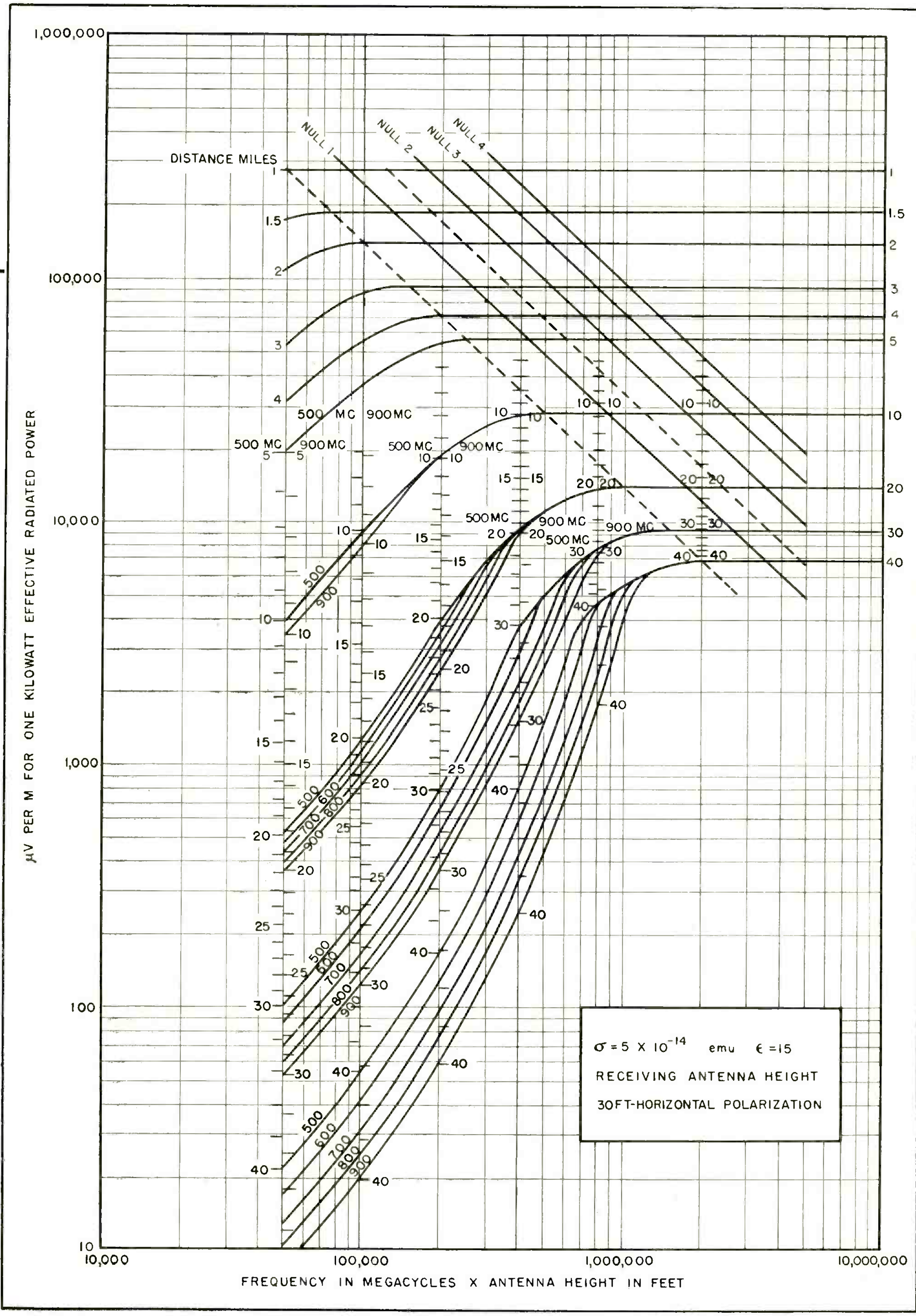

FIG. 1—Theoretical ground-wave signal range for 470 to 890 mc

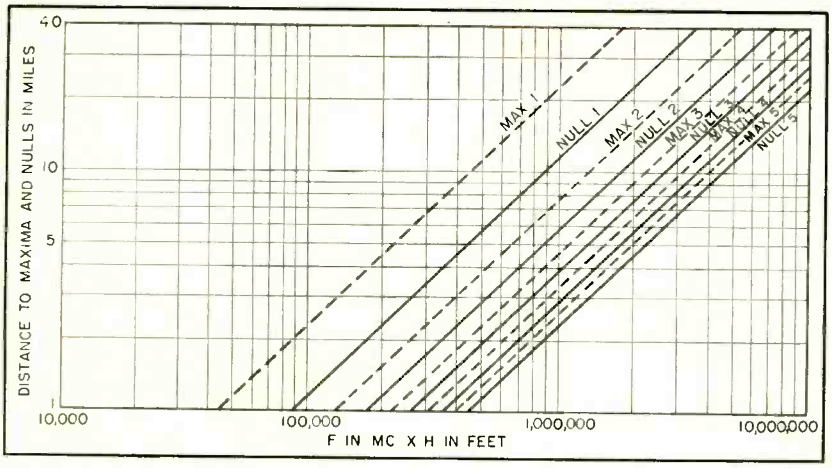

FIG. 2—Distance in miles to maxima and nulls

ies inversely with distance. Such a curve can therefore serve as a guiding upper limit when the graph is used to secure a plot of E as a function of d.

The approximate distances at which the above mentioned nulls occur for various fh products can be estimated from the null lines that have been drawn for the first five nulls. These null points may be more exactly determined from the smaller graph, Fig. 2, which represents the distance to the various maximum and null points as a function of fh. The dotted lines adjacent to the first null line in Fig. 1 serve to indicate the points at which the field intensity curves will start to fall from and return to the inverse distance curve on either side of the first null, giving some idea of the behavior of the field-intensity curves in a null region.

As the transmission distance increases, nulls cease to appear, and field intensities will progressively diminish, varying as the inverse square of the distance when Θ has decreased to 20 degrees or less. This is seen in Eq. 2 where sin Θ may be replaced by Θ itself for the values of Θ just mentioned, causing d to be squared in the denominator.

Equation 2 may be used with accuracy until Θ equals ten degrees, or until the radio line-of-sight horizon has been reached. Beyond these limits a different expression must be employed which provides field intensities in the diffraction region where the receiving antenna is below the line-of-sight. In order to obtain the continuous curves that appear in Fig. 1, smooth transition curves were drawn between the field strengths calculated for line-of-sight conditions and the field strengths calculated for the diffraction region.

It should also be noted that values shown in Fig. 1 for fh products of 10^6 or more are approximate only.

Diffraction Region Fields

Field intensities in the diffraction region where the receiving antenna is below the line-of-sight are computed by means of an expression due to Norton and given by Terman[4] as:

$$E = F_1 F_2 E_{su} \tag{3}$$

where E_{su} is the surface wave intensity at the point on the earth's surface below the receiving antenna as calculated from Eq. 10, par. 2 of the same reference[4], and F_1 and F_2 are the appropriate height factors for the transmitting and receiving antennas as given by Eq. 20, par. 3 of the source above.

It is apparent from Fig. 1, that in the diffraction region the frequency-height product relationship no longer holds, and as a result separate distance scales have been provided for 500 and 900 mc, with the addition of curves for 600, 700, and 800 mc at the 20, 30 and 40-mile points as an aid to interpolation.

Prediction Vs Measurement

Unfortunately, the theoretical calculation of field intensities at these frequencies fails to take into account various factors such as terrain irregularities, shadowing or phase differences in signals arriving at a given point by multipath propagation. Also neglected are effects important at larger distances such as fading, day-to-day variations due to changes in the refractive index of the atmosphere, and tropospheric reflections.

Initial uhf field measurement surveys in the New York[5], and Washington[6,7] areas have indicated that actual uhf field intensities observed are likely to be lower than those predicted theoretically. However, it is evident that much more investigation will be required before local deviations from the theoretical can be predicted with any accuracy.

Using the Chart

The field intensities developed at any distance up to forty miles for one kilowatt of effective radiated power may be read directly from the ordinate of Fig. 1 for any frequency-transmitting antenna height product along the abscissa. For example, an fh product of 100,000 will produce approximately 54 millivolts per meter at a distance of four miles for an erp of one kw for all frequencies in the band, and at thirty miles, 253, 212, 170, 141 and 124 microvolts per meter for 500, 600, 700, 800 and 900 mc respectively.

For other values of P, the ordinate scales must be shifted in proportion to $P^{\frac{1}{2}}$ as is done when using the charts published by the FCC for the vhf bands.

Where Eq. 2 is valid, Fig. 1 may be compared directly with the FCC curves. Citing the same example, at a distance of four miles, 54 millivolts per meter will also be obtained from the FCC curves for 82 mc at 1,220 feet, 98 mc at 1,020 feet and 195 mc at 513 feet.

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(3) Reference 2, sec. 10, par. 3, Eq. 24 (b).

(4) Reference 2, sec. 10, par. 3, Eq. 18.

(5) G. H. Brown, J. Epstein, and D. W. Peterson, Comparative Propagation Measurements; Television Transmitters at 67.25, 288, 510 and 910 megacycles. *RCA Review*, 9, No. 2, June 1949.

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(7) J. Fisher, Field Test of UHF Television, ELECTRONICS, p 106, September 1949.


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Cathode Follower Response

Chart gives permissible cathode-follower pulse drive at video frequencies in terms of low-frequency sinusoidal input. Video-frequency overloading and distortion in conventionally loaded circuits originate in output time constant

By RALPH H. BAER
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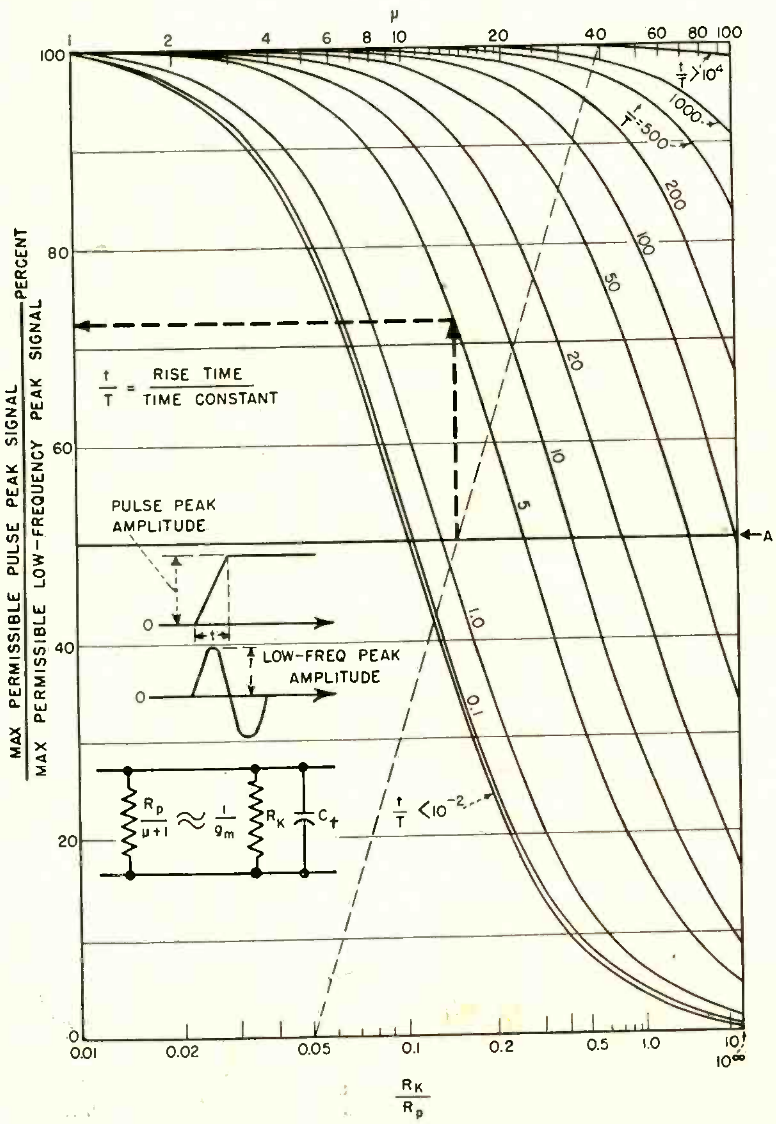
CATHODE FOLLOWERS frequently overload and distort on video signals when designed on the basis of low-frequency formulas. This behavior results from the effect of the time constant associated with the output impedance of the cathode follower and the load capacitance. The usual formula for the peak signal permissible is

$$e_{g_{\text{peak}}} = \frac{E_B}{\mu}\left[\frac{1+\frac{R_k}{R_p}(\mu+1)}{\frac{R_k}{R_p}+2}\right] \quad (1)$$

which is readily calculated. Inspection of Eq. 1 shows that medium values of μ (15-30) are desirable for maximum permissible input signal.

When a video signal with rise time t microseconds is applied to a cathode follower this permissible grid swing is reduced by a factor of

$$\frac{1}{1+\frac{\mu\frac{R_k}{R_p}}{\frac{R_k}{R_p}+1}\left(\frac{1-\epsilon^{-\frac{t}{T}}}{\frac{t}{T}}\right)} \quad (2)$$



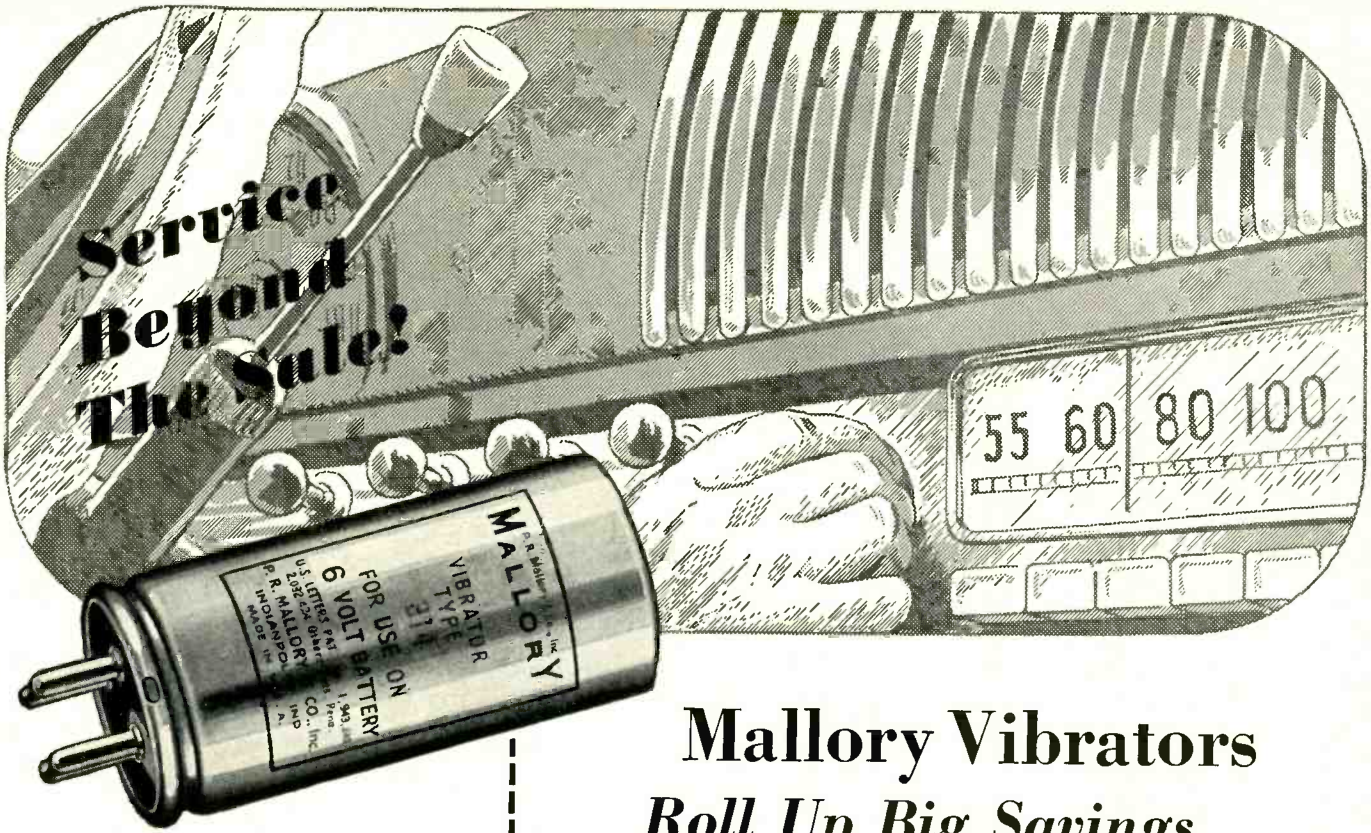
where T is the time constant. Whenever T approaches the pulse rise time in order of magnitude, the reduction in permissible grid signal can no longer be neglected and the correction factor of Eq. 2 becomes essential.

The graph is a solution of Eq. 2; the following procedure applies when a pulse waveform of rise time t is to be handled without distortion where

$$T = \frac{C_T R_k}{1 + g_m R_k}$$

(a) Determine the value of R_k/R_p and t/T. (b) On the graph, connect R_k/R_p with μ. (c) At the intersection of line A with the line drawn in step (b), read vertically up or down to the proper t/T curve. The solution is then obtained from the percent scale by reading horizontally to the left.

As an example, consider a tube with $\mu = 40$, $R_p = 20{,}000$ and a load impedance of $R_k = 1{,}000$ and $C_t = 250$ $\mu\mu$f in parallel. From Eq. 1 $e_{g_{\text{peak}}} = 5.6$ volts for $E_B = 150$ volts. Suppose a video signal with rise time $t = 0.42$ μsec is handled by the cathode follower. Then $T = 0.0834$ μsec and $t/T = 5$. From the graph the permissible peak signal is seen to be 72.3 percent of $e_{g_{\text{peak}}}$ at low frequencies, or 4 volts.



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TUBES AT WORK

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Automatic Audio Level Alarm 116
Low-Frequency Generator 116
Blocking Oscillator Time Base 118
Coaxial Feed System for Antennas 154
British Developments in Instrumentation 182

Automatic Audio Level Alarm

By N. Hagmann
Station Engineer
Radio Station WJZ
Lodi, N. J.

ONE of the many things to which a broadcast station engineer must pay careful attention is program level and quality. Because rather large variations in level are not easily detected by ear, particularly if the engineer is occupied with other allied work, an automatic alarm system becomes a practical necessity. Such a device is particularly valuable when more than one transmitter carrying the same program material must be monitored.

The audio alarm used at this station is fed through a bridging transformer from the audio source to a 6K6 amplifier stage. This tube feeds into a cascaded diode rectifier, a type 6H6, that separates the diode load circuit from the control circuit. Load resistor R_5 in the cathode of the 6H6 is used to adjust the level of audio to be rectified.

The plate of the same tube feeds the cathode of the second 6H6 section and acts as a d-c separation circuit. The plate of the second section charges a large capacitor that bleeds off through resistors R_6, R_7 and R_8 with R_{11} the controlling element. The grid of the 2050 is connected to the junction of R_6, R_7 and R_{11}. The plate circuit of the 2050 contains the a-c alarm relay. A type 6E5 tuning-eye tube facilitates adjustments for proper level and time delays R_{10} and R_{11}, respectively.

In operation, the 2050 gas tube is made conducting by the rectified signal on its grid stored by the 20-microfarad capacitor. This signal results from the charging effect of the audio input. The proper reference level is set by potentiometer R_{10} that effectively biases the gas tube. Failure of the audio signal, after an appropriate time delay set by R_{11}, results in the relay being de-energized and closing the alarm circuit through its back contacts. A disabling switch in the alarm circuit is useful during symphonic or similar programs in which wide dynamic range is encountered.

The unit can be fed from either audio program lines or the output of an r-f monitor. In the latter case, failure of either the program or the carrier will be detected.

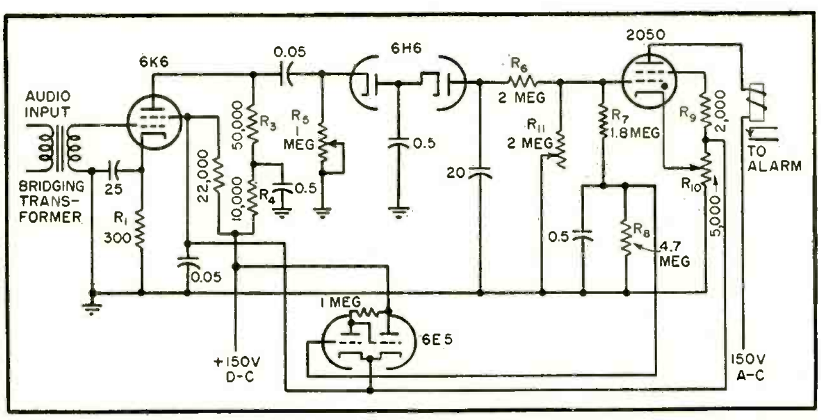

FIG. 1—Diagram of the audio failure alarm. Potentiometer R_{10} sets the level at which the gas tube fires, R_{11} controls time delay between loss of audio and sounding of alarm, and R_5 sets level of audio into the device

Low Frequency Generator

By W. G. Shepard
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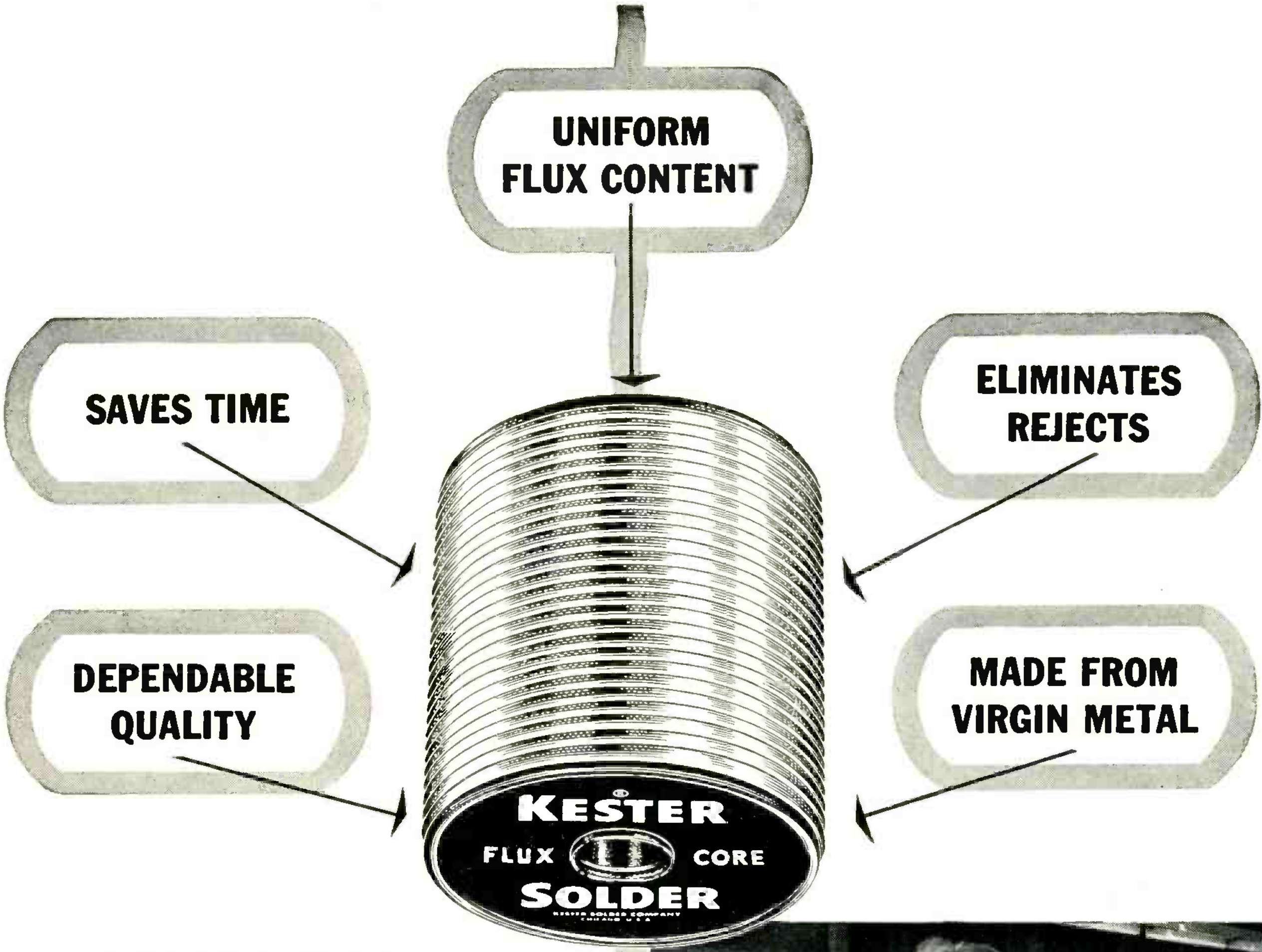
THE GENERATION of sine waves by ordinary electronic means becomes increasingly difficult as the frequency is lowered below 10 cycles. The phase-shift circuit is generally used but elaborate care in design and construction is necessary to achieve satisfactory performance. Since a multivibrator is a more dependable low-frequency oscillator, operating down to almost any slowness, it was decided to use the output wave of a multivibrator and shape it into essentially a sine wave.

First a large square-wave voltage was generated by triggering an Eccles-Jordan flip-flop circuit from the multivibrator, this being easily done because the triggering signal can be applied to both grids. By incomplete integration, essentially a triangular wave is obtained. Since this wave contains no even harmonics and only 1/9 third and even less higher harmonics,

$$Y = 8/\pi 2\ E(\cos x + 1/9 \cos 3x + 1/25 \cos 5x \ldots),$$

a simple filter system will reduce the harmonics to negligible value.

Such a sine-wave generator is most easily constructed for a single frequency and is not very well suited for continuously variable frequencies over a wide range because of the increasing attenuation of the filter as the frequency is raised. However, it is quite feasible to construct a unit covering a num-



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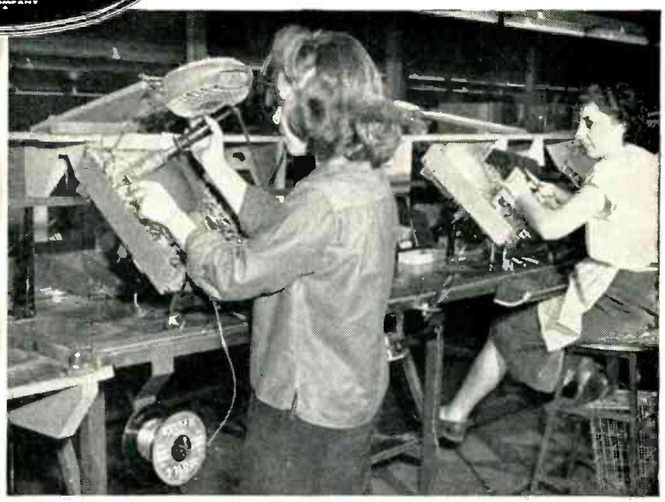

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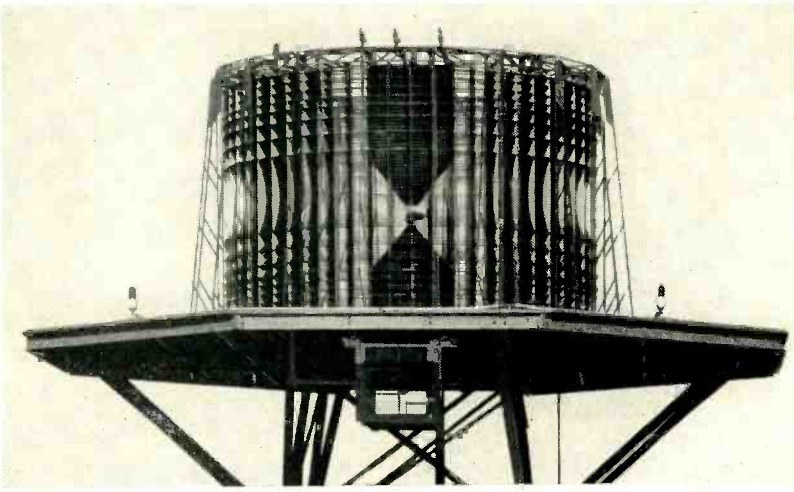
CHICAGO 39, ILL. • NEWARK, N. J. • BRANTFORD, CANADA

Kester "Resin-Five" Core Solder and Plastic Rosin-Core Solder, which are available in the usual single-core type, can now also be had in a 3-core form.

KESTER SOLDER

THE FRONT COVER

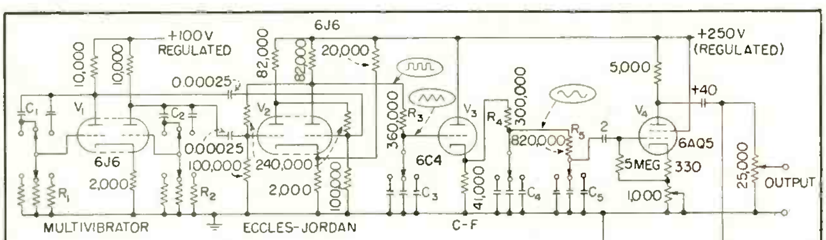


PRECISION omni-range equipment, of which the tower shown on the front cover is a part, has made possible significant increases in air terminal capacity. The new equipment, introduced by Sperry Gyroscope Co., operates in the 5,000-mc region. The photograph shows the microwave lens which performs a function similar to the Fresnel lighthouse lens. The sharp vertical pattern it forms increases accuracies to within one-half degree, by virtually eliminating ground reflections at all angles greater than approximately ½ degree above the horizontal. This represents an altitude of about 1,000 feet at the edge of the control zone. Thus the signal is free from ground reflections in the operating region.

ber of fixed frequencies selected by means of a suitable switching arrangement.

Figure 1 shows the diagram of such a circuit as constructed for calibration purposes. Type 6J6 tubes are employed in the multivibrator and flip-flop circuits, the multivibrator receiving its plate supply from a regulated source for greater frequency stability. Capacitor C_3 and R_3 form the triangular wave and V_3 is a cathode follower inserted to lower the impedance. Two filter circuits, C_4R_4 and C_5R_5, are so proportioned that the third harmonic is attenuated in each about three times as much as the fundamental, leaving about one or two percent third and practically no higher harmonics. For simplicity only three switch positions are shown in the diagram, but values are given in the table for 10 frequencies. These are the values actually used and differ somewhat from calculated values. The value of C_5 was chosen experimentally to give approximately the same voltage output for each frequency. The cathode circuit of V_4 contains a control allowing for further minor adjustments in output voltage. The output voltage, after being amplified by the 6AQ5 tube, is about 14 volts at the input to the attenuator.

Since the generator, as constructed, is used for calibration work, some method was necessary to make sure that the output voltage is approximately the same for each frequency. Since the frequency is too low for the use of a meter, a small cathode-ray tube is used as an amplitude indicator. The vertical and horizontal plates are tied together to increase the sensitivity of the tube. Since this causes the spot to move back and forth diagonally, the tube must be rotated 45 degrees to give a horizontal spot movement.



FREQUENCY	R_1 AND R_2	C_1 AND C_2	C_3 AND C_4	C_5
0.2 ∿	2 MEG	1	4	4.25
0.5	820,000	1	2	1.5
1	390,000	1	1	0.6
2	180,000	1	0.5	0.36
5	82,000	1	0.2	0.05
10	33,000	1	0.1	0.055
20	180,000	0.1	0.05	0.02
30	120,000	0.1	0.03	0.014
50	68,000	0.1	0.02	0.009
100	27,000	0.1	0.01	0.003

FIG. 1—Schematic of sine-wave generator producing frequencies from 0.2 to 100 cycles

Blocking-Oscillator Time Base

By LAWRENCE FLEMING
510 N. West St.
Falls Church, Va.

BLOCKING OSCILLATORS, commonly used for fixed-frequency time-base generators, can be used to provide very satisfactory oscilloscope time bases.

A blocking oscillator with positive grid bias is shown schematically in Fig. 1. It has an upper frequency limit higher than obtainable with gas triodes; its cost is low, the tube being an ordinary dual triode and the oscillator coil small and simple; a single variable resistor provides fine-frequency adjustment; the output waveform is

(Continued on p 150)

EXILED...

for probing the unknown!

"For practicing black magic, consorting with the devil, and spreading dangerous thoughts against the laws of man and nature, you are exiled forever!"

This was the import of the fateful words heard by Galileo Galilei, facing a court of inquisition in the 16th century. Scorned and ridiculed, the great mathematical and astronomical genius went to his exile an old and broken man; a brilliant, searching mind no longer permitted to probe the mysteries of the universe.

Today, free men of science labor under no such restriction. Analysis and proof are the tools employed in this enlightened era to obtain for them a hearing . . . an opportunity to substantiate their theories.

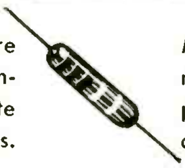
In the modern laboratories of the Sprague Electric Company, a research staff of physicists, engineers, and chemists, second to none in the electronic parts industry, is constantly striving to attain the ultimate in electronic components. Like others of their profession, they are helping to forge a level of scientific development about which Galileo, the great researcher, "born before his time", could only dream.

SPRAGUE®

SPRAGUE ELECTRIC COMPANY
North Adams, Massachusetts

PIONEERS IN ELECTRIC AND ELECTRONIC DEVELOPMENT

SUBMINIATURE PROKAR® CAPACITORS are designed especially for high-quality, minimum-size electronic equipment which must operate dependably under the most severe conditions.



Made by an exclusive Sprague process . . . molded in a mineral-filled, high temperature plastic . . . these tiny but tough capacitors are ideal for −55°C to +125°C operation.

THE ELECTRON ART

Edited by JAMES D. FAHNESTOCK

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Metallized Paper Capacitors 122

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Direct-Reading R-F Wattmeter 240

Ionosphere Winds Charted from Meteor Echoes

IONOSPHERIC WINDS, 55 to 80 miles above the earth, have been measured by analyzing the drift of meteor ion trails.

Wind velocity, which may range from 30 to 125 mph, is determined by use of the Doppler effect. Doppler recordings have been made using a 23.1-mc c-w transmitter, the beat difference between the transmitted and reflected signals being used to determine wind velocity. In addition, a 17.3-mc pulse transmitter has been used for ranging on the ion trails.

Wind direction is determined through the use of a special meteor direction finder. Four vertical antennas are spaced about a vertical reflector as shown in the photograph. Each radiates through a single quadrant. The antenna pattern is swept electronically. Presentation involves sixteen vertical A-scan traces on a horizontal trace.

This research, carried on at Stanford University and financed by the Office of Naval Research, is expected to have useful applications both in the design of long-range guided missiles and in weather forecasting.

Irregularities Noted

Although each ion trail lasts only a second or two, the average motion of the upper atmosphere air mass is determined by averaging many measurements. In addition to this average motion, evidence of irregularity in the nature of the wind has been reported.

The meteoric ion trails are usually observed to drift at speeds of 200 mph, although the air mass as a whole moves several times more slowly. It is not yet clear whether these irregularities are the result of local turbulences or of separate layer-like winds blowing in different directions at different altitudes.

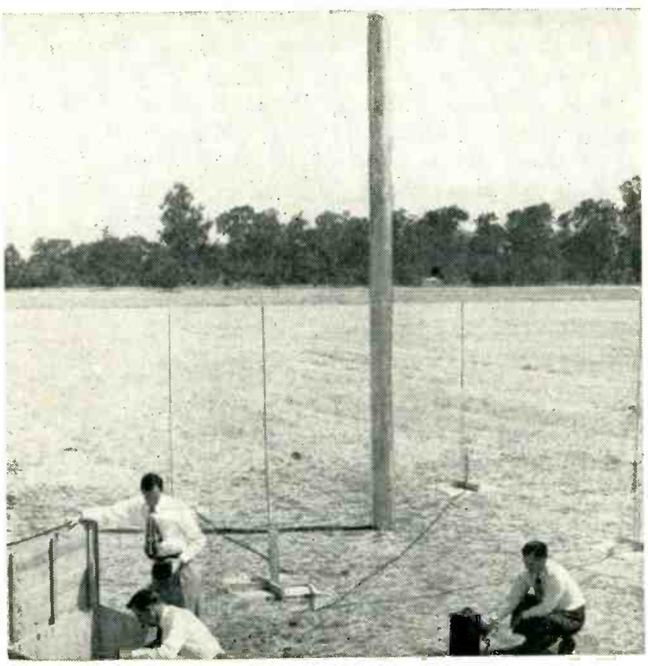
The measurements show that during July and August last year, the winds in the outer atmosphere were predominately from the south-south west, with some winds from the north, and a few weaker winds blowing west to east.

The bright flashes seen in the night sky by the naked eye are caused by particles of matter about the size of a small pea. Smaller, more numerous particles produce weaker flashes not visible to the human eye and are easily detected by electronic methods.

Continuous Readings

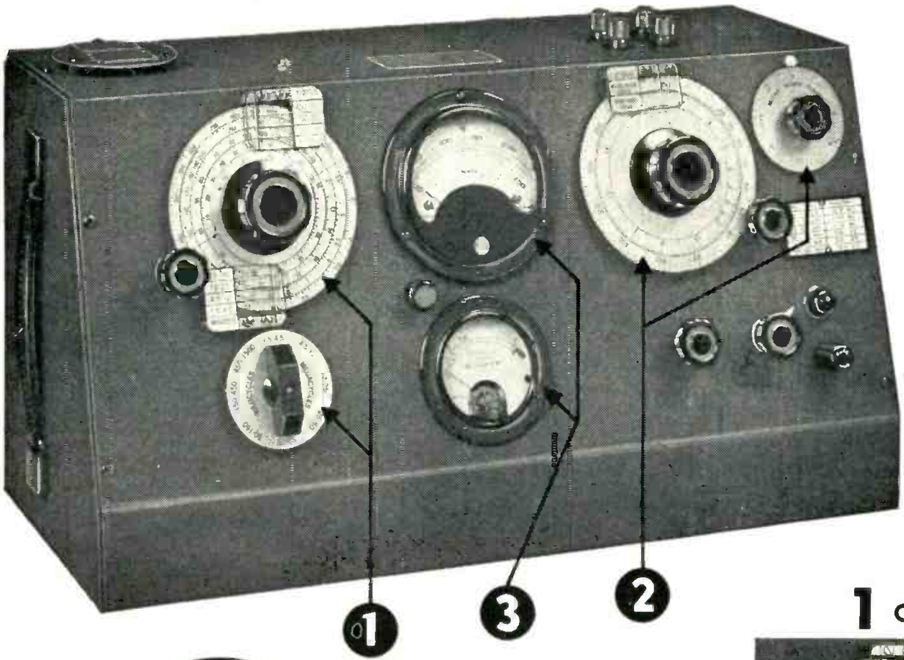
Radio equipment can detect these tiny meteors both day and night, so the ion trail method of wind measurement is potentially capable of giving continuous wind readings.

Thus far measurements have been made only during the early



Meteor direction finder uses four vertical antennas spaced around a single vertical reflector

Doppler beats between transmitted and reflected c-w signals are recorded on tape to furnish wind-velocity data



EXAMINE THESE
Direct Reading Features
WHICH SIMPLIFY ACCURATE MEASUREMENTS

The Q METER
TYPE 160-A

50 kc. to 75 mc.

Radio frequency circuit design often requires the accurate measurement of Q, inductance and capacitance values. For this application the Type 160-A Q-Meter has become the uncompromising choice of radio and electronics engineers in this country and abroad.

Each component part and assembly used in the manufacture of this instrument is designed with the utmost care and exactness. Circuit tolerances are held to values attainable only in custom built instruments.

With the 160-A Q-Meter, as with other Boonton Radio Corporation instruments, the keynote in design is to embody accurate *direct reading* features which save time and simplify operation.

SPECIFICATIONS

Oscillator Frequency Range: 50 kc. to 75 mc. in 8 ranges.

Oscillator Frequency Accuracy: ±1%, 50 kc.—50 mc.
±3%, 50 mc.—75 mc.

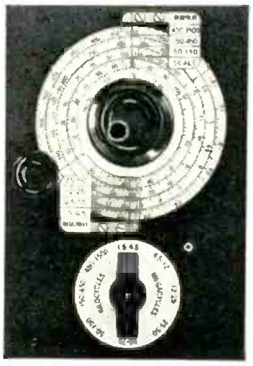
Q Measurement Range: Directly calibrated in Q, 20-250. "Multiply—Q—By" Meter calibrated at intervals from x1 to x2, and also at x2.5, extending Q range to 625.

Q Measurement Accuracy: Approximately 5% for direct reading measurement, for frequencies up to 30 mc. Accuracy less at higher frequencies.

Capacitance Calibration Range: Main capacitor section 30-450 mmf, accuracy 1% or 1 mmf whichever is greater. Vernier capacitor section +3 mmf, zero, −3 mmf, calibrated in 0.1 mmf steps. Accuracy ±0.1 mmf.

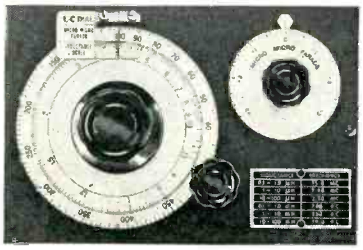
Catalog "H" containing further information available upon request.
(In Canada, direct inquiries to RCA Victor Co., Ltd., Montreal.)

1 OSCILLATOR FREQUENCY DIAL.



This large 4½" open faced dial has eight overlapping frequency ranges, each calibrated *directly* in kilocycles or megacycles, with scales conveniently divided for maximum readability. A vernier dial drive enables fine settings to be made with ease. All frequency ranges are accurate to within ±1% except the 50-75 megacycle range which is accurate to ±3%. The clearly marked range change switch located directly beneath the frequency dial facilitates rapid and positive selection of the desired frequency band.

2 Q-TUNING CAPACITANCE DIALS.



L-C dial serves twofold purpose of (1) conveniently and accurately indicating tuning capacitance *directly* in MMF, and (2) providing an effective inductance scale which also becomes *direct* reading at certain defined frequencies shown on frequency reference plate. Incremental capacitance dial at right calibrated from +3 MMF through zero to −3 MMF, accurate to ±0.1 MMF.

3 Q-VOLTMETER AND MULTIPLIER METER.

For the indication of Q values the 160-A Q-Meter employs a Weston Model 643 Meter calibrated *directly* in terms of Q over the range from 20-250. The damping of the meter movement is ideal for the rapid determination of exact resonance without sluggishness or overshoot. The lance type pointer enables Q readings to be obtained to the nearest unit. Located directly beneath the Q voltmeter is the "Multiply-Q-By" meter which provides Q multiplier factors of X1 to X1.5 in 0.1 steps, X2, and X2.5 thereby extending the useful range of Q indication to 625. This meter is carefully matched to a particular thermocouple element for maximum accuracy.

DESIGNERS AND MANUFACTURERS OF THE Q METER · QX CHECKER
FREQUENCY MODULATED SIGNAL GENERATOR · BEAT FREQUENCY
GENERATOR AND OTHER DIRECT READING INSTRUMENTS

BOONTON RADIO *Corporation*
BOONTON · N · J · U · S · A ·

morning hours when radio conditions are best. Improved equipment, which is just being put into service, is expected to extend the measurement schedule around the clock.

By a further extension of the technique it is believed, that winds at selected heights in the 55 to 80-mile altitude range may be measured.

The meteor drift method is the first to offer the possibility of continuously measuring winds at different altitudes. Other radio wind-measuring methods have recently been devised in the United States and England, but they depend on the regular ionosphere layers and so are restricted to specific heights. Wind measurements made during high-altitude rocket flights are expensive and restricted to a few minutes duration at the most.

Knowledge of the high altitude winds gives information as to the composition of the upper atmosphere. This information is of value to high-altitude aircraft designers in connection with airfoil design; and it is particularly useful to weather forecasters because weather predictions must be based on the most complete possible knowledge of the atmosphere.

Field tests carried out simultaneously with measurements at Stanford served to confirm the reality of the wind-drift effect and showed that the same meteor disturbances could be detected simultaneously at two locations as much as 50 miles apart. Valuable data on the composition of a given meteor trail at different points along its length was also obtained in these tests.

Top to bottom: Conventional 0.1-μf molded paper capacitor; corresponding metallized unit; hermetically sealed metallized unit

Metallized Paper Capacitors

By JOHN H. FISHER

Vice-President in Charge of Engineering
Astron Corporation, East Newark, N. J.

THE CONCEPTION of a metallized paper capacitor dates back to approximately 1900. However, developments at this early stage of the art were stymied mainly by the inability to obtain a uniform and continuous metal coating on thin paper. The basic principle was proven sound by Robert Bosch of Stuttgart, Germany during World War II when he developed a practical evaporation process for coating paper with a thin uniform film of zinc. The zinc is placed in a high-vacuum chamber and its temperature is raised to about 350 degrees C. The gaseous vapors given off then condense on the relatively cool paper surface in the chamber.

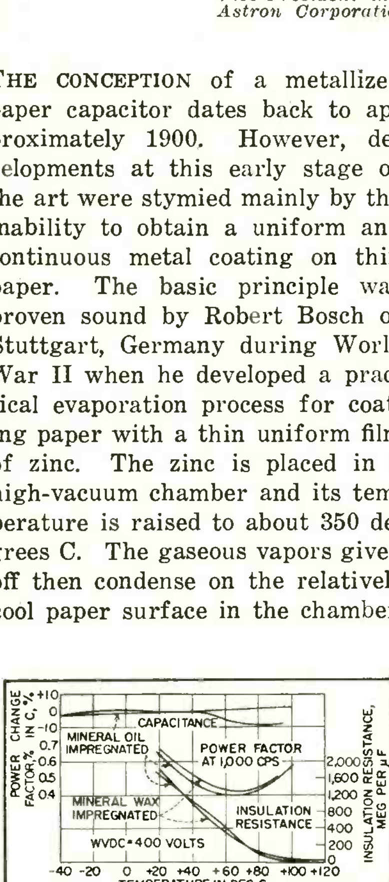


FIG. 1—Variation of electrical characteristics with temperature for metallized paper capacitors


Actual-size reproduction of metallized paper foil, showing holes left by self-healing action

Under the right conditions of vacuum and temperature the result is a homogeneous metallic coating 50 millimicrons in thickness.

Bosch found zinc most suitable for his purpose because of its low vapor pressure of 10^{-2} mm Hg at 350 C, which gave him no refractory difficulties during the process. It was found, however, that zinc is somewhat limited for capacitor applications, chiefly because of its high power factor which limits it to d-c applications. It is also difficult to obtain a strong lead connection to the zinc-coated paper section of small capacitors.

A practical method was developed in England for the vaporization of aluminum on paper, using a vacuum of 3 to 4 microns and a temperature of 1,500 C. The thin uniform coating of aluminum permits use of a single-sheet dielectric and gives a small, compact and light-weight capacitor unit with revolutionary selfhealing characteristics.

Prior to metallizing the paper is continuously coated on one side with a thin film of lacquer material consisting of a 10-percent solution by weight of cellulose acetate, to increase the dielectric strength and insulation resistance of the paper.

Selfhealing Action

Metallized paper capacitors can be subjected to intermittent overvoltages and surges without danger of failure. If surges are of short duration, the capacitors can safely stand surges of 2 to 2½ times their operating voltage. As the temperature is increased the tendency to spark increases and the breakdown point of the capacitor is lowered. When the capacitor is overstressed, any incipient weakness in the dielectric is burned out. Actually the aluminum coating on the paper is melted by the spark discharge caused by the puncture, whereupon the molten metal is blown away from the hole by the arc, leaving a metal-free area around the puncture. The area thus made has a high surface resistance so that the overall insulation resistance of the capacitor is only slightly lowered. In most circuits, reduced in-

(Continued on p 214)

The tape goes 'round and 'round...

*smoothly, swiftly—
at higher winding
machine speeds*

It's Kodapak Sheet

... choice of leading electrical manufacturers for primary wire insulation

In general: Kodapak Sheet is available in various forms including Kodapak I Sheet, cellulose acetate, gauges up to 0.060″; Kodapak II Sheet, cellulose acetate butyrate, gauges up to 0.002″. Of the two, the latter is preferred for many electrical applications because of its high dielectric strength, its superior resistance to moisture and oxidation.

Self-centered . . . Solvent-sealed. Wire wound with Kodapak tape is perfectly centered; thus permits over-all diameters to be held at a minimum. Also, when overcoating of braid is employed, lacquer and lacquer solvents tend to seal tape, forming a continuous waterproof tube around the wire.

Hard to harm it: Because it has excellent strength, stretch, and toughness characteristics, Kodapak Sheet is particularly suitable for use on winding machines. It serves well at high speeds without breaking. These same properties allow wire to be flexed or bent sharply without harming the insulation.

For further information, including other applications, write for free copy of the folder, "Kodapak Sheet for Electrical Uses."

Cellulose Products Division, EASTMAN KODAK COMPANY, Rochester 4, N. Y.

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New York, Chicago.

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Cleveland, Dallas, Philadelphia, Providence.

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Wilson & Geo. Meyer & Co., San Francisco, Los Angeles, Portland, Seattle.

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Paper Sales, Limited, Toronto, Montreal.

Kodapak Sheet ... for efficient insulation

"Kodapak" is a trade-mark

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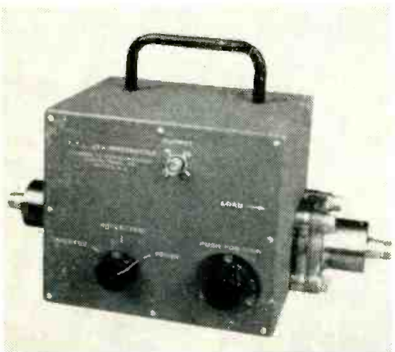
NEW PRODUCTS

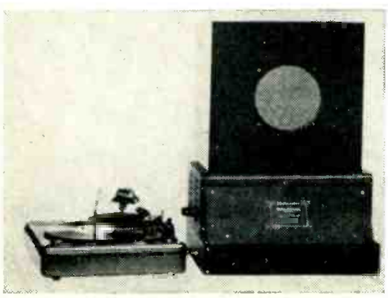
Edited by WILLIAM P. O'BRIEN

Radio and TV Equipment Vie With Nuclear Devices . . . Improved Lab Gear and Testing Equipment Are Listed . . . Twenty-Four Literature Items Are Reviewed



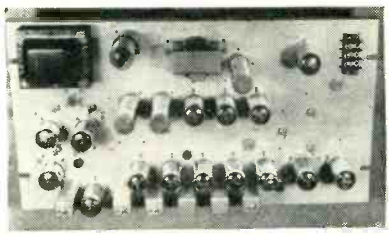
Impedance Measuring Device

FEDERAL TELECOMMUNICATION LABORATORIES, INC., 500 Washington Ave., Nutley 10, N. J. The 42A Impedometer is a compact device for the measurement of impedance in the frequency range from below 50 mc to above 500 mc. Below 500 mc its accuracy is ±5 percent. It consists of a short length of standard 1⅝-in. 52-ohm coax line on which are mounted two directional couplers, a voltage probe and a capacitance plunger. To use the unit a signal generator is connected to one end of the line and the load to be measured is connected to the other end.



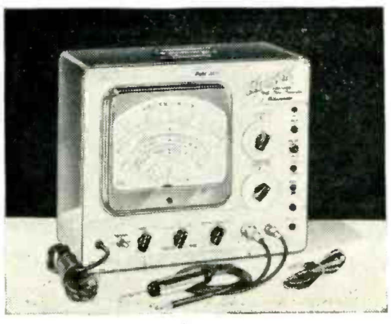
Sound Stretcher

KAY ELECTRIC CO., Maple Ave., Pine Brook, N. J., has announced the Sona-Stretcher, an instrument that lengthens the time scale of recorded sounds by a 2-to-1 ratio but does not alter the frequency distribution. It covers a sound frequency range of about 100 to 5,000 cycles. The instrument consists of three component parts: a stretching circuit and monitor amplifier; a turntable suitable for standard disc records, with variable reluctance pickup; and a monitor loudspeaker. It is useful in general studies in phonetics and language instruction.



Ultrasonic F-M Receiver

RADIO ENGINEERING LABORATORIES, INC., 36–40 Thirty-Seventh St., Long Island City 1, N. Y. The model 720 Remo receiver is particularly designed for f-m broadcast music in public places, such as restaurants and shopping centers. The audio output can either be muted or boosted by transmission from the broadcast station of a superaudible tone. Specifications are given in Article 10–31.

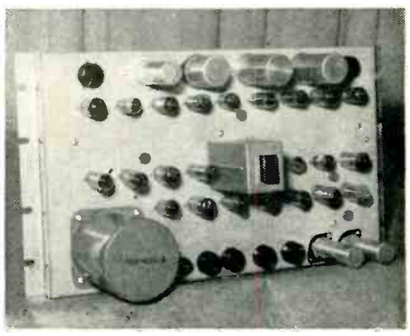


Lab VTVM

THE HICKOK ELECTRICAL INSTRUMENT CO., 10527 Dupont Ave., Cleveland 8, Ohio. Model 209-A volt-ohm-capacitance milliammeter is especially designed for increased speed and range for tv engineers and technicians. It measures resistance as low as 0.1 ohm and capacitance of 1 $\mu\mu$f. The unit has a new a-c range of 1,200 v and features flat frequency response to 300 mc. New literature is available covering full technical details.

Modulation Monitor

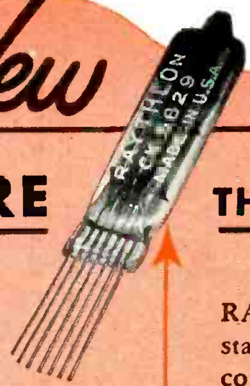
RADIO CORP. OF AMERICA, Camden, N. J. Type BW-66E amplitude modulation monitor provides continuous direct reading of modulation percentage in a-m transmitters operating in the 500 to 2,500-kc range. It will measure percentage of modulation on either positive or negative peaks, carrier shift when modulation is applied, and transmitter a-f response. It will also provide overmodulation indication and is useful in program level monitoring. The unit operates from a 75-ohm r-f transmission line, and can accommodate a range of r-f input powers from 0.35 watt to 6 watts. No tuning adjustments are required.



TV Stabilizing Amplifier

GENERAL ELECTRIC CO., Syracuse, N. Y. Type TV-16-B television stabilizing amplifier provides automatic correction of the sync and

ANOTHER *New* RAYTHEON SUBMINIATURE



THE CK5829 TWIN DIODE

TO PROVIDE YOU WITH

1. High perveance (performance compares favorably with that of the larger 6AL5)
2. Low heater current (150 ma.); half as much as the 6AL5
3. Moderate cost

RAYTHEON *Subminiature Tubes* have long been standard throughout the world. More of them are in commercial use than all other makes combined. They assure *greater product salability* due to size reduction — *greater convenience* because they fit standard sockets or can be soldered or welded into the circuit, and because over half a million are available from stock; over 300 Raytheon Tube Distributors are at your service — *greater dependability*, backed by unsurpassed technical resources and a dozen years of production and application experience with long-life Subminiature Tubes.

→ NEW TYPES

This chart gives you at a glance the characteristics of representative Raytheon Subminiature Tubes

Type No.	Remarks	Maximum Diameter Inches	Maximum Length Inches	Filament Or Heater Volts	Filament Or Heater Ma.	Mutual Conductance umhos	Power Output MW	Typical Operating Conditions: Plate Volts	Plate Ma.	Screen Volts	Screen Ma.	Grid Volts
HEATER CATHODE TYPES												
→ CK626CX	Half Wave Rectifier	0.400	1.75	6.3	300				45	Inverse peak 850 volts		
CK5702/CK605CX	Characteristics of 6AK5	0.400	1.5	6.3	200	5000		120	7.5	120	2.5	Rk=200
CK5703/CK608CX	Triode, UHF Oscillator, ¾ watts at 500 Mc	0.400	1.5	6.3	200	5000		120	9.0			Rk=220
CK5704/CK606BX	Diode, equivalent to one-half 6AL5	0.315	1.5	6.3	150			150ac	9.0			
CK5744/CK619CX	Triode, High mu.	0.400	1.5	6.3	200	4000		250	4.0			Rk=500
CK5784	Characteristics of 6AS6	0.400	1.5	6.3	200	3200		120	5.2	120	3.5	−2.0
→ CK5829	Similar to 6AL5	0.300x0.400	1.5	6.3	150			117ac	5.0 per section			
FILAMENT TYPES												
1AD4	Shielded RF Pentode	0.300x0.400	1.5	1.25	100	2000		45.0	2.8	45.0	0.8	Rg=2meg
2E31-32	Shielded RF Pentode for pocket radio	0.300x0.400	1.56	1.25	50	500		22.5	0.4	22.5	0.3	0
2E35-36	Output Pentode for pocket radio	0.290x0.390	1.56	1.25	30		6	45.0	0.45	45.0	0.11	−1.25
2E41-42	Diode Pentode for pocket radio	0.290x0.390	1.56	1.25	30	375		22.5	0.35	22.5	0.12	0
2G21-22	Triode Heptode for pocket radio	0.300x0.400	1.56	1.25	50	60 conv. cond		22.5	0.20	22.5	0.30	
RK61	Gas Triode, Exp. Radio Control	0.550	1.81	1.4	50			45.0	1.5	Special Circuit		
CK510AX	Double Space Charge Tetrode Amplifier	0.285x0.400	1.25	0.625	50	150† both units		45.0	0.06			0
CK512AX	Low microphonic voltage amplifier	0.285x0.385	1.25	0.625	20	37†		22.5	0.125	22.5	0.04	−0.625
CK522AX	Output Pentode 20 ma. filament	0.285x0.385	1.5	1.25	20	450	1.2	22.5	0.30	22.5	0.08	0
CK524AX	Output Pentode	0.285x0.385	1.5	1.25	30	300	2.2	15.0	0.45	15.0	0.125	−1.75
CK525AX	Output Pentode	0.285x0.385	1.5	1.25	20	325	2.2	22.5	0.25	22.5	0.06	−1.2
CK526AX	Output Pentode	0.285x0.385	1.5	1.25	20	400	3.75	22.5	0.45	22.5	0.12	−1.5
CK527AX	Output Pentode 15 ma. filament	0.285x0.385	1.5	1.25	15	225	0.75	22.5	0.10	22.5	0.025	0
CK529AX	Shielded Output Pentode	0.290x0.390	1.515	1.25	20	350	1.6	15.0	0.32	15.0	0.075	−1.25
CK533AX	Output Pentode	0.285x0.385	1.5	1.25	15	400	1.8	22.5	0.36	22.5	0.09	0
CK534AX	Voltage Amplifier	0.285x0.385	1.25	0.625	15	30†		15.0	0.0047	15.0	0.0014	−0.625
CK535AX	Output Pentode	0.285x0.385	1.5	1.25	20	350	1.6	15.0	0.32	15.0	0.075	−1.25
CK551AXA	Diode Pentode	0.300x0.400	1.56	1.25	30	235		22.5	0.17	22.5	0.043	0
CK553AXA	RF Pentode	0.300x0.400	1.56	1.25	50	550		22.5	0.42	22.5	0.13	0
CK571AX	10 ma. filament Electrometer Tube, Ig = 2×10^{-13} amps. max.	0.285x0.400	1.5	1.25	10	1.6†		10.5	0.20	Triode Conn.		−3.0
CK573AX	Triode, High-Freq. Osc.	0.300x0.400	1.5	1.25	200	2000		90.0	11.0			−4.0
CK574AX	Shielded Pentode RF Amplifier	0.290x0.390	1.25	0.625	20	160		22.5	0.125	22.5	0.04	−0.625
CK5672	Output Pentode	0.285x0.385	1.5	1.25	50	650	65.0	67.5	3.25	67.5	1.1	−6.5
CK5676/CK556AX	Triode, UHF Oscillator	0.300x0.400	1.5	1.25	120	1600		135.0	4.0			−5.0
CK5677/CK568AX	Triode, UHF Oscillator	0.300x0.400	1.5	1.25	60	650		135.0	1.9			−6.0
CK5678/CK569AX	Shielded RF Pentode	0.300x0.400	1.515	1.25	50	1100		67.5	1.8	67.5	0.48	0
CK5697/CK570AX	Electrometer Triode Max. grid current 5×10^{-13} amps.	0.285x0.400	1.25	0.625	20	1.5†		12.0	0.22			−3.0
CK5785	High voltage rectifier	0.300x0.400	1.5	1.25	15				0.1	Inverse peak 3500 volts		
→ CK5851	Class C. RF Beam Tetrode	0.400	1.6	1.25	110	1600		125	5.5	125	1.0	−7.5
→ CK5889	7.5 ma. filament electrometer pentode Ig = 3×10^{-15} amps. max.	0.285x0.385	1.6	1.25	7.5	14		12.0	0.005	4.5	0.005	−2.0
VOLTAGE REGULATORS												
CK5783	Voltage reference tube — like 5651	0.400	1.625	Operating voltage 87. Operating current range 1.5 to 3.5 ma.								
CK5787	Voltage regulator	0.400	2.06	Operating voltage 100. Operating current range 5 to 25 ma.								

CK ® RK ®

†Voltage Gain Ratio.

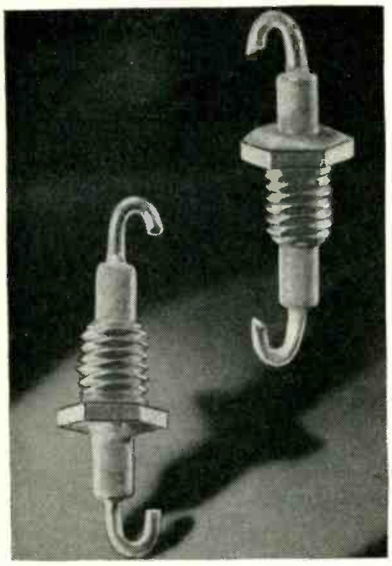
RAYTHEON

Excellence in Electronics

RAYTHEON MANUFACTURING COMPANY

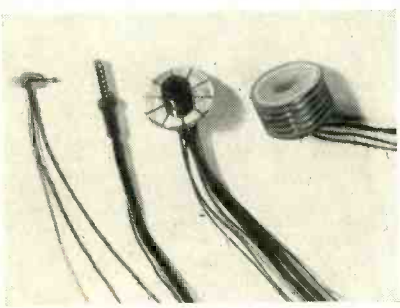
SPECIAL TUBE SECTION • Newton 58, Massachusetts

SUBMINIATURE TUBES • GERMANIUM DIODES and TRIODES • RADIATION COUNTER TUBES • RUGGED, LONG LIFE TUBES blanking portion of a tv signal. It features adjustable sync percentage, can remove noise and hum from the video signal will combine sync and video or separate sync and video, and automatically clips black and white spikes. The unit can increase the picture signal by up to 20 db.



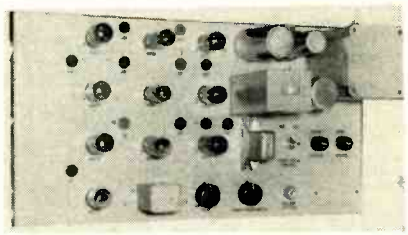
Feed-Through Capacitors

CENTRALAB, 900 E. Keefe Ave., Milwaukee 1, Wisc., now offers tiny ceramic feed-through capacitors designed for single-hole mounting where a capacitance ground to either chassis or shield is desired. They are available in 500, 1,000 and 1,500 $\mu\mu$f. Voltage rating is 600 volts d-c working, 1,000 volts d-c flash test. Both ends of the terminals are hooked to facilitate soldering.



Miniature Plated Commutators

THE ELECTRO-TEC CORP., 53 Bergen Turnpike, Little Ferry, N. J., has pioneered the use of precious metal electroplating for fabrication of all size commutators and slipring assemblies. The miniature sections illustrated are firmly anchored to withstand high centrifugal force at up to 12,000 rpm. Commutator forms are stamped out of laminated linen base bakelite sheets with the laminations running parallel to the segment faces in order to utilize the strength of the linen base. By threading wire connections prior to plating, the wires and segments are bonded so as to be impervious to heat.



Sync Lock Unit

GENERAL ELECTRIC CO., Syracuse, N. Y. Type TV-30-A television sync lock unit allows remote picture signals to be treated and handled like local studio productions. Through its use local commercials, special effects or other local program material can be inserted into the remote picture without disturbance. This is accomplished by means of automatic synchronization of the local sync generator with the remote sync signals.

TV Sweep Generator

KAY ELECTRIC CO., Maple Ave., Pine Brook, N. J., has announced the Switcha-Sweep, an all-electronic tv sweep generator with fundamental outputs on all channels as well as output in the i-f range. A rotary switch selects the desired channel, which is swept through a range of 15 mc. Sawtooth sweep eliminates phasing problems. Amplitude modulation of the sweep signal is less than 1 percent per megacycle. Both switched and continuously variable output attenuation is provided, with maximum outputs of about 0.5 volt on the 70-ohm unbalanced output and 1 volt on the 300-ohm balanced output.

Voltage-Regulated Power Supply

KEPCO LABORATORIES, INC., 149–14 41st Ave., Flushing, N. Y. Model 315 features one regulated B supply, one regulated C supply and one unregulated filament supply. The B supply is continuously variable from 0 to 300 v and delivers from 0 to 150 ma. The C supply is continuously variable from 0 to 150 v and delivers 5 ma. Ripple is less than 5 mv. The a-c output is 6.3 v, 5 amperes, center-tapped, unregulated.

Ore Detector Kit

ALLIED RADIO CORP., 833 W. Jackson Blvd., Chicago, Ill. The Scout radioactive ore detector, in addition to field survey work, may be used for

(continued on p 242)

THE FOUNTAINHEAD OF MODERN TUBE DEVELOPMENT IS RCA

...with the economy of thoriated-tungsten filaments

THESE SIX improved RCA power tubes are "musts" for designers of industrial electronic heating equipment where design and operating economies alike are important considerations.

Ranging in power input from 1.5 to 650 kw, these types successfully utilize thoriated-tungsten filaments which offer marked savings in filament power and the cost of associated power equipment.

The 5671 utilizes an effective lightweight radiator while the 5762 and 5786 have radiators designed to permit use of less-expensive blowers than have been required previously for similar tubes. The new and revolutionary RCA-5831 super-power beam triode with internal water cooling, is tested at one million watts input, and handles with high efficiency an input of 650 kilowatts in continuous commercial service.

Air jackets for the 5671 and 5762, and water jackets for the 5770 and 5771, are available from RCA.

• • •

RCA Application Engineers are ready to consult with you on the application of these improved tubes and accessories to your specific designs. For complete technical information covering the types in which you are interested, write RCA, Commercial Engineering, Section J42R, Harrison, N. J.

RCA

RADIO CORPORATION of AMERICA

ELECTRON TUBES — **HARRISON, N. J.**

NEWS OF THE INDUSTRY

Edited by WILLIAM P. O'BRIEN

AIEE-IRE Electronic Instrumentation Conference

FINAL DATES for the third annual joint AIEE-IRE Conference on Electronic Instrumentation in Nucleonics and Medicine have been set as October 23, 24, and 25, 1950. Location of this meeting which will feature technical papers and discussions on the various problems in instrumentation for the vital fields of nuclear and medical science, is the Park Sheraton Hotel, New York City.

More than 300 persons attended the highly successful three-day gathering last year at which papers were presented covering the non-nucleonic phases of electronics in medicine, nucleonics in medicine, and nucleonic developments in industry and government.

Such great interest was evoked in the papers presented that they were compiled and published in the form of a consolidated pamphlet covering the proceedings of the conference and made available by the two organizations. This year's meeting will be held along the same lines and a similar type of publication is contemplated.

Prominent among the features of the conference is a special evening meeting during which a number of prominent authorities will discuss, "Effects of Atomic Weapons"—a government publication containing recently declassified information on the subject. They will explain various parts of the book in an effort to educate the technical man in the techniques of protection from atomic weapons so that he in turn can pass on the information.

Interesting and informative exhibits of instruments and related products will be displayed by leading companies in the field. Those attending the meeting will have an opportunity to see many of the devices (some in actual operation) that will be discussed in the technical papers.

Ford's Rouge Railroad Gets Radio System

INSTALLATION of a two-way radiotelephone communication system for direction of railroad traffic over the 105 miles of track in Ford Motor Co.'s Rouge plant will be completed within a year. The Rouge railroad, largest such industrial system in the world, is one of the first private lines to adopt this method for traffic direction. As of August, the special equipment had been installed in ten of the company's 19 diesel-electric locomotives.

Ford officials expect the radio control system to improve the railroad's overall efficiency, expedite the movement of freight cars in and out of the yards, and speed execution of all switching orders. It is the result of four years of experimentation with equipment and methods by the company's communications, railroad and plant security sections. A special control tower has been constructed to serve as the brain center for the system.

Audio Fair Program

THE THIRD ANNUAL AUDIO FAIR, sponsored by the Audio Engineering Society will be held from Oct. 26 to 28, 1950, at the Hotel Commodore, N. Y. The advance program of papers for the technical sessions is as follows:

Thurs. Oct. 26

Symposium on High Fidelity Audio Systems For the Home, by N. C. Pickering of Pickering & Co., R. H. Synder of Station KJBS, San Francisco, and M. S. Corrington of RCA.

Proposed Standard Method of Calibrating Cutters & Pickups, by H. E. Roys of RCA.

RMA Standards Covering Loudspeaker Systems and Associated Equipment, by O. L. Angevine of Stromberg-Carlson Co.

Educational Audio Requirements, by W. J. Temple.

Application of Square Wave Testing to Disc Recording (speaker to be announced) of Naval Research Lab., Washington, D. C.

Fri. Oct. 27

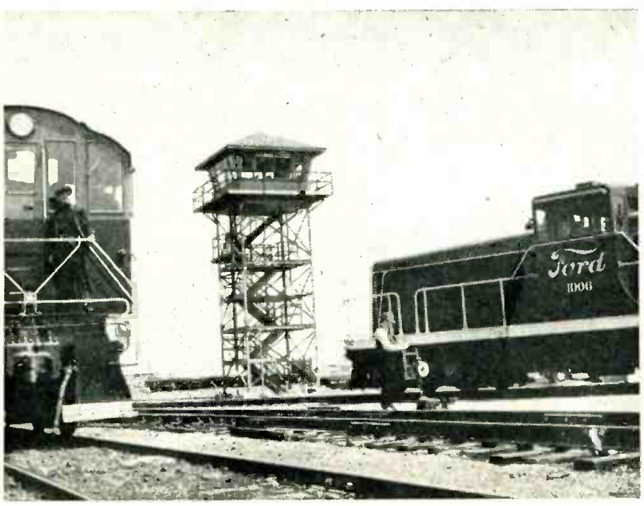
New Developments in Radio Tubes and Their Application to Audio Circuits, (speaker to be announced).

A Consideration of Intensity-Loudness Function and Its Bearing Upon the Judgment of Tonal Range and Volume Level, by S. E. Stuntz of U. S. Naval Medical Research Lab, New London, Conn.

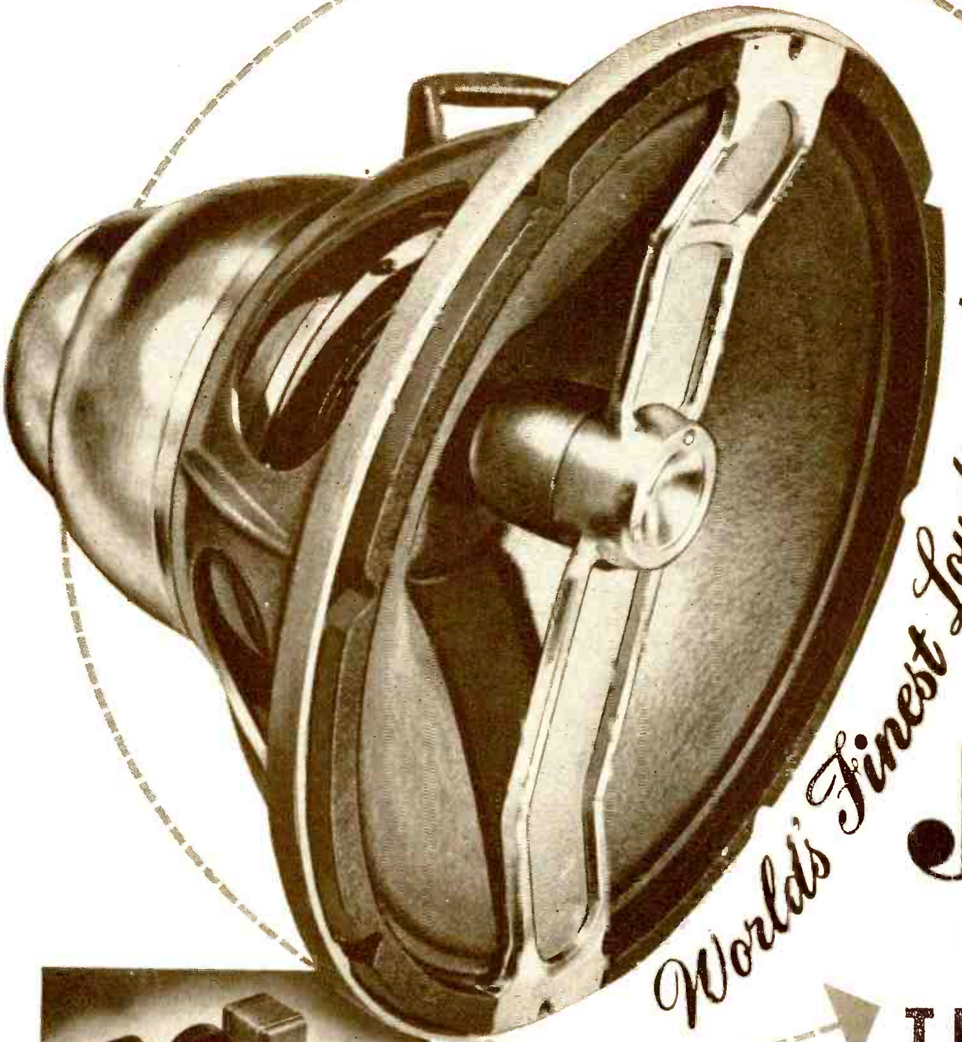
CBS Television Studio Intercommunication Facilities, by R. B. Monroe of CBS-TV.

Report of the A.E.S. Standards Committee on Playback Characteristic (speaker to be announced).

Free Field Audiometry, by R. Allison of



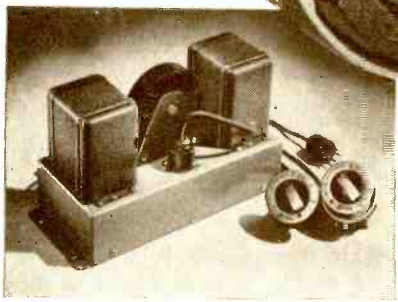
Dispatcher (right) at the mike of Ford railroad's new radiotelephone communication system relays switching orders to diesel locomotives in the 105-mile track yard. The traffic direction unit is located in a 42-foot high control tower (left)

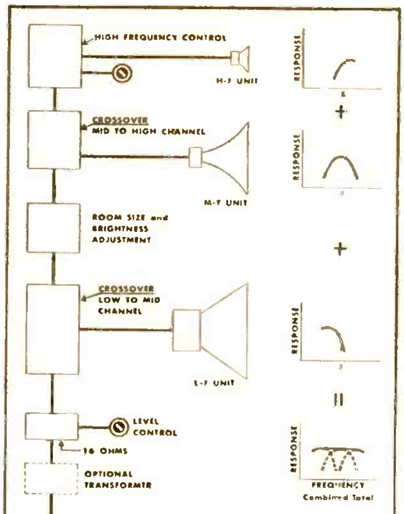


World's Finest Loudspeaker

Jensen G-610 TRIAXIAL

LOUDSPEAKER SYSTEM





SCHEMATIC of 3-WAY CROSSOVER and CONTROL SYSTEM MODEL G-610 TRIAXIAL

Never Before Reproduction Like This!

The G-610 brings a totally new meaning to high fidelity sound reproduction. Not only does this new 3-channel system reproduce the widest frequency range ever attained by a loudspeaker, but it also sets new high standards with its incomparably smooth response characteristic and very low distortion. The result is clear, clean, life-like quality, with thrilling *transport to the original* such as you have never heard before. The G-610, complete with Speaker Unit and Crossover and Control network is priced at $365.00 list. Ask for Data Sheet 160.

Jensen Manufacturing Company

Division of the Muter Company

6607 SOUTH LARAMIE AVENUE, CHICAGO 38, ILLINOIS

Microtone Co., St. Paul, Minn.
The Measurement of Audio Volume, by H. A. Chinn of CBS.
A New Low Cost Intermodulation Measurement and Analysis Technique, by C. J. Lebel, audio consultant.
Loudspeaker Damping, by A. Preisman of Capitol Radio Engineering Institute.

Sat. Oct. 28

Multi-Channel Magnetic Tape Recording, by P. Brubaker of Rangertone, Inc.
A Solution to Magnetic Tape Timing Problems, by D. R. Andrews of RCA.
Action of A-C Bias in Magnetic Tape Recording, by W. W. Wetzel of Minnesota Mining & Mfg. Co.
Sprocket Hole Magnetic Tape Recording, by A. C. Davis of Cinema Engineering Co.

MEETINGS

SEPT. 25-27: National Electronics Conference, Edgewater Beach Hotel, Chicago, Ill.

SEPT. 30-OCT. 8: Third Annual National Television & Electrical Living Show, Chicago Coliseum, Chicago, Ill.

OCT. 3-5: AIEE District No. 2 Meeting, Lord Baltimore Hotel, Baltimore, Md.

OCT. 16-20: 68th Semiannual Convention of SMPTE, Lake Placid Club, Lake Placid, N. Y.

OCT. 23-25: Third Annual Joint AIEE-IRE Conference on Electronic Instrumentation in Nucleonics and Medicine, Park Sheraton Hotel, New York City.

OCT. 23-27: AIEE Fall General Meeting, Skirvin Hotel, Oklahoma City, Okla.

OCT. 26-28: Second Audio Fair, sponsored by the Audio Engineering Society, Hotel New Yorker, New York City.

OCT. 30-NOV. 1: Radio Fall Meeting, sponsored jointly by IRE and RTMA engineering department, Hotel Syracuse, Syracuse, N. Y.

MAR. 19-22: IRE Annual Convention, Hotel Waldorf Astoria and Grand Central Palace, New York City.

IRE Emporium Seminar

A NUMBER of prominent speakers were featured at the eleventh annual seminar of the Emporium Section of the Institute of Radio Engineers, held August 18 and 19 at Emporium, Pa.

Included as speakers for the technical sessions were Norman Pickering of the Pickering Co., Oceanside, N. Y., who discussed high-quality audio reproduction; C. Wesley Carnahan of the Sandia Corporation, Albuquerque, N. M., who spoke on the application of electronics to remote control devices; R. M. Bowie of Sylvania Electric Products Inc., Bayside, N. Y., who reported on color television; and F. M. Geyer of the Corning Glass Works, who discussed the electrical characteristics of glass.

ARINC Expands Pacific Communication Services

NEW equipment installed in Hawaii by the Mackay Radio and Telegraph Co., subsidiary of the American Cable and Radio System, will permit coverage of the entire Pacific area with both radiotelephone and radiotelegraph service to aircraft and base stations, thereby expediting the increased flow of air traffic to the Far East.

This rapid expansion in available communication services in this area has been carried out under the direction of Aeronautical Radio, Inc., or ARINC as it is commonly known, the organization established and supported by the air industry to operate radio communication stations wherever required.

Mackay, under terms of a contract with ARINC, broke ground for a large extension to its radio transmitter at Kailua, Hawaii, on June 21, and before the deadline date of August 1 had completed the installation of four multichannel transmitters and associated antennas. The new equipment was manufactured by Federal Telephone and Radio Corp., a subsidiary of the International Telephone and Telegraph Corp.

N. Y. Ferries Get Radar

ALL City of New York ferries operating between Manhattan and Staten Island will be radar-equipped by the end of the year. Contracts for double-ended installations of X-band General Electric radar navigators in the eight ferries now on the run have been received by the Marine Electric Corp. of Brooklyn, N. Y., distributors for G-E equipment.

Each craft will have two radar consoles, with a scope in each pilot house. Skippers of the ferries will receive training in the use of radar during their two-week installation layups.

Disaster Communications

PROPOSED rules for providing emergency radio communications have been formulated by the FCC. They provide for "disasters and other incidents involving loss of communications facilities normally available or demanding the temporary establishment of communications facilities beyond those normally available".

The Disaster Communications Service would operate in the frequency band of 1,750-1,800 kilocycles. Any fixed, land or mobile station could qualify for participation in such emergency operation, including amateurs and commercial radio operators.

It is proposed that application for authorization to operate in the Disaster Communications Service for a radio station already licensed in a different service shall be submitted directly to the Commission. The application would detail the individual's eligibility and include a certified copy of the locally coordinated disaster communication plan.

In this proposal it is mandatory that a local network be set up under appropriate leadership with rules for self-government and operating procedure that will tend to assure an orderly and reasonably efficient service.

Radio Fall Meeting

LATEST technical developments of radio and television equipment and components will be discussed at the annual Radio Fall Meeting sponsored by the IRE and RTMA engineering department, to be held at the Hotel Syracuse, Syracuse, N. Y., Oct. 30 to Nov. 1. Following is the tentative technical program:

Mon. Oct. 30

9:30 A.M.—General Session (Ralph R. Batcher, presiding)
A Broad Range Oscillator for Television Testing, by H. A. Finke and J. Ebert of Polytechnic Research and Development Corp.
Wideband Impedance Matching Between a Resonant Antenna and a Line, by H. A. Wheeler of Wheeler Laboratories, Inc.
High Frequency Crystal Calibrator Design, by J. B. Minter of Measurements Corp.
The Determination of Amplifier Sensi-

(Continued on page 282)

These Leaders look to SYLVANIA for dependable TV Picture Tubes

Admiral
Emerson Television
Meck
PHILCO
STROMBERG-CARLSON
air-king
MIDWEST
PILOT
SYLVANIA
FADA
Tele King
Arvin
hallicrafters
Motorola
SCOTT
Tele-tone
Bendix Television
Hoffman
national
Sentinel
TRAV-LER
Calbest
INDUSTRIAL TELEVISION INC
Olympic
Silvertone
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CONRAC
Kaye-Halbert
Packard Bell
Sparton
CROSLEY
Magnavox
phaostron
Starrett
DEWALD

• The trade-marks shown here identify the television leaders now choosing and using Sylvania TV Picture Tubes in their sets.

The reasons behind today's acceptance of Sylvania tubes include greater clarity, consistent color, dependability, and longer life.

Remember, your dealers as well as set owners recognize Sylvania as a symbol of distinction—a name associated with the very finest in radio and television.

For full descriptions and ratings of all Sylvania TV Picture Tubes, write today to Sylvania Electric Products Inc., Dept. R-2110, Emporium, Pa.

SYLVANIA ELECTRIC

RADIO TUBES; TELEVISION PICTURE TUBES; ELECTRONIC PRODUCTS, ELECTRONIC TEST EQUIPMENT; FLUORESCENT TUBES, FIXTURES, SIGN TUBING, WIRING DEVICES; LIGHT BULBS; PHOTOLAMPS; TELEVISION SETS

NEW BOOKS

The Principles of Television Reception

BY A. W. KEEN. *Sir Isaac Pitman and Sons, Ltd., London,* 1949, 319 *pages,* 30 *shillings.*

THIS short book, by a well-known contributor to the British technical press, is unusual in that it treats the American and British television systems on an equal footing, and is one of the few sources of comparative data on receiver design in the two countries. Complete circuit diagrams of popular American and British receivers of the 1947 vintage are included.

The book opens with chapters on system standards, basic video signal theory and circuit operation. The following six chapters are devoted to detailed examination of typical receiver circuit functions. Chapters on aerial systems and test equipment are included. The final chapter gives an introduction to color television, describing the wideband field-sequential and simultaneous systems. Since the manuscript was prepared in 1947, no mention is made of the line-sequential or dot-sequential systems.

The treatment is non-mathematical in the text proper, but a mathematical appendix is included for those who wish to consult it. The book is not intended for design engineers, except as it reveals details of receiver practice (many of which are now unfortunately outmoded, such is the pace of tv design in both countries). The book is an excellent introduction to the subject, however, and is recommended to all who wish to compare British and American methods.—D. G. F.

RELEASED THIS MONTH

- Better Television Reception; W. Smith and R. L. Dawley; Editors and Engineers Ltd.; $2.50.
- Father of Radio—The Autobiography of Lee de Forest; Wilcox & Follett Co.; $5.00.
- Response of Physical Systems; John D. Trimmer; Wiley; $5.00.
- The Effects of Atomic Weapons; McGraw-Hill; $3.00.
- TV Installation Techniques; Samuel L. Marshall; Rider; $3.60.

Ralph 124C 41 +

BY HUGO GERNSBACK. *Second Edition,* 1950, *Frederick Fell, Inc., New York,* 207 *pages,* $2.50.

SHADES of Edward Bellamy, Jules Verne and all the more recent imaginative writers of science fiction! This book is a revival of one of the early classics of that peculiar brand of literature that is at once the dismay of those who don't like it and the bread and life of those who do. And to anyone in this field of electronics who has followed Hugo Gernsback through the years,

(Continued on p 133)

BACKTALK

This Department is Operated as an Open Forum Where Readers May Discuss Problems of the Electronics Industry or Comment Upon Articles that ELECTRONICS has Published

Why not here?

DEAR SIRS:

I READ with much interest the paper by Dr. Brueckmann which appeared in the May 1950 issue of ELECTRONICS on an antenna for the regular broadcast band used on the broadcast station in Frankfort designed to push out the rapid fading zone and increase efficiency.

My special interest is due to the fact that in the late thirties, I spent some time on the theory of such an antenna and variations of it and also on an antenna fed at more than one point, whereby the current distribution along the antenna could be controlled accurately, so as to provide the desired radiation distribution in the vertical plane. On the basis of this work I applied for patents and was in due course granted patents No. 2,283,617, No. 2,283,618, No. 2,283,619. I had thought that the clear channel stations in the United States would have been interested to have had their service improved by such antennas, but no interest has been shown by them. I was therefore very interested to find that German broadcast stations have found this antenna worth while. Dr. Brueckmann has just written me that he believes another German station, located at Muhlacker, has a similar antenna under construction.

RAYMOND M. WILMOTTE, INC.
Consulting Engineers
Washington, D. C.

ELECTRONICS Quiz

AS PROMISED in July *Crosstalk,* here is the first installment of our electronics puzzle-quiz column. To start, we will publish one problem every month and its solution the following month, along with the next problem. Readers are encouraged to submit brain-teaser problems for this department. A payment of $5.00 will be made for each acceptable entry.

This month's problem is submitted by R. W. Johnson, China Lake, California.

What is the power dissipated by the plate resistor of a class A audio amplifier when both a sinusoidal and d-c component of plate current are present?

Answer will appear next month.

Neutralizing Bifilar I-F Stages

DEAR SIRS:

IN THE PAPER "Bifilar I-F Coils", appearing in the June 1950 issue of ELECTRONICS, it is stated that a

(Continued on p 290)

who has read his stuff and wondered just how crazy he might be, this book is must reading.

For Gernsback, to those youngsters who have the misfortune to have been born recently (say since 1920) and who therefore know only modern electronics, was the publisher of a periodical called Modern Electrics back in 1908 and thereabouts, a paper which still lives gloriously in the memories of all old-timers in radio.

In 1911, when Modern Electrics had a circulation of about 100,000, the editor and publisher wound himself up into some sort of electronic stew and concocted a serial with the above title. He kept up this atrocious bit of fiction for a year, and in it he predicted a lot of things now only recently come to pass.

In 1925, our Ralph became a book, famous among the science fiction writers. Early in 1950 second-hand book stores wanted $50.00 for a copy of this first edition and there were few to sell.

With forewords by Lee deForest and Fletcher Pratt, this little book is fascinating reading and surely will prove to lots of us that its author is not as crazy as we thought.—K. H.

Electrical Communication

BY ARTHUR LEMUEL ALBERT, *Professor of Communication Engineering, Oregon State College. John Wiley & Sons, Inc., New York. Third Edition,* 1950, 593 *pages,* $6.50.

THIS new edition of Professor Albert's useful text follows the general scheme of earlier editions—to provide a concise picture of all aspects of modern communication systems as means for transmitting and receiving intelligence in the form of codes or voice or music over radio or wireless circuits.

In the first part of the new edition the author has grouped certain basic subject matter useful to any communication system; that is, acoustics and electroacoustic devices, lines, filters, cables and waveguides. Thereafter he deals with specific mechanisms.

There are chapters on telegraph

systems, telephone exchange service and systems, telephone toll service and systems, radio wave propagation, antennas, radio systems and a final useful chapter on interference and noise.

When one considers that there are many thousands of radio engineers who have only the remotest idea of how to hook up a telephone and who might sometime wish to do so without calling upon AT&T, it is clear that a book of this type is not only useful as a text but as a reference book. This is indeed the fact; and this reviewer, a radio man, enjoyed finding out what happens when you lift the hook on the telephone, or how a teletypewriter works, or what the Varioplex system is, or the basic facts concerning the numerous carrier telephone systems now in use.

Some of the early history of the communication art is most interesting and since it is not allowed to occupy much space in this book, it is distinctly worthwhile.—K. H.

Photoelectric Cells in Industry

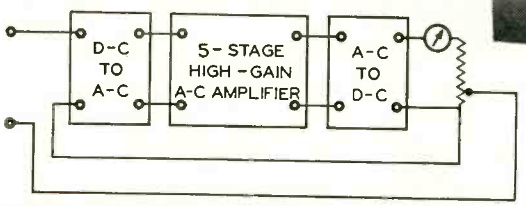
By R. C. Walker. *Pitman Publishing Corp., New York*, 1948, 510 *pages*, $8.50.

The object of this British book is best described by the author's words, ". . . to present a representative selection of the industrial uses of light-sensitive cells of the emission and rectifier types, with a very superficial explanation of the theory of operation of these devices, sufficient, it is hoped, to make the text readable to practical men whose purpose is to employ electrons rather than theorize about their internal affairs." This modest though somewhat verbose statement (as are most of the sentences in the book) pretty well tells the story.

It is difficult to imagine a capable industrial electronics engineer who could not benefit from this book. One scan through its pages, just looking at illustrations, should bring to mind some possible idea for putting photosensitive devices to work. The final solution may or may not come from the same pages, but adequate information is supplied for design and construc-

For low-level d-c measurements Use these new, triple-purpose D-C INDICATING AMPLIFIERS

stabilized for zero and gain



Voltage-balance feedback (above) and current-balance feedback stabilize gain . . . provide virtual null balance.

SPECIFICATIONS

MICROVOLT UNIT Catalog No. 9835	MICRO-MICRO-AMPERE UNIT Catalog No. 9836
FULL SCALE RANGES WITH BUILT-IN 4" METERS	
0 to 50 or —25 to +25 Microvolts; scale multipliers: 1,2,4,10, 20,40	0 to 1000 or —500 to +500 Micro-Micro-amps; scale multipliers: 1, 2, 5, 10, 20, 50, 100, 200, 500, 1000, 2000
ACCURACY	
Of amplifier: ±0.4% of reading ±0.5 Microvolt; Of meter: ±1%	Of amplifier: ±0.5 to 0.8%* of reading ±20 Micro-Micro-amps; Of meter; ±1%
STABILITY	
Zero and Gain stabilized automatically. No trimmer controls required.	
***SOURCE RESISTANCE**	
Up to 10,000 ohms.	0.1 megohm or more.
RESPONSE TIME	
2 to 3* sec.	2 to 3* sec.
OUTPUT	
For full scale input on any range: 10 millivolts at output impedance of 500 ohms for null recorder; 1 volt for 20,000-ohm external meter.	

Front panel fits standard 19" relay rack.

*Accuracy and Response Time depend on Source Resistance.

USE AS

- **DIRECT-READING MICROVOLTMETER OR MICRO-MICROAMMETER**
- **RECORDER PREAMPLIFIER**
- **NULL DETECTOR**

These new instruments are not only D-C Indicating Amplifiers but are stable, accurate measuring instruments as well. You can use them in measurements with thermocouples, strain gages, bolometers . . . bridge and potentiometer circuits . . . ionization, leakage, and phototube currents . . . almost any measurement of extremely small direct current or voltage.

Through a combination of a-c amplification and unique balanced feedback network, zero and gain stability are designed right into the instrument. Trimmer controls are designed out—eliminated.

Actually *three* instruments in one, these amplifiers can be used as—

Direct-reading instruments . . . At the turn of a scale-multiplier knob, you simply select the range in which you want to work.

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Fast and Reliable TV Receiver Testing—makes this scope particularly useful in head-end position work. Unsurpassed for stability and fine trace . . . excellent definition . . . no bounce when shifting bands. Where the sweep generator does not have a baseline, measurements can be taken on the DC amplifier. Delivers maximum sensitivity without sacrifice of frequency response. Low capacity input probe is provided for trouble shooting.

In Broadcast Stations, It Pin-points Trouble—helps you stay on the air with maximum performance. Use it to check hum, noise, distortion, modulation, phase relationships; measure gain and sweep generator output; isolate defective components; determine frequency response of audio circuits.

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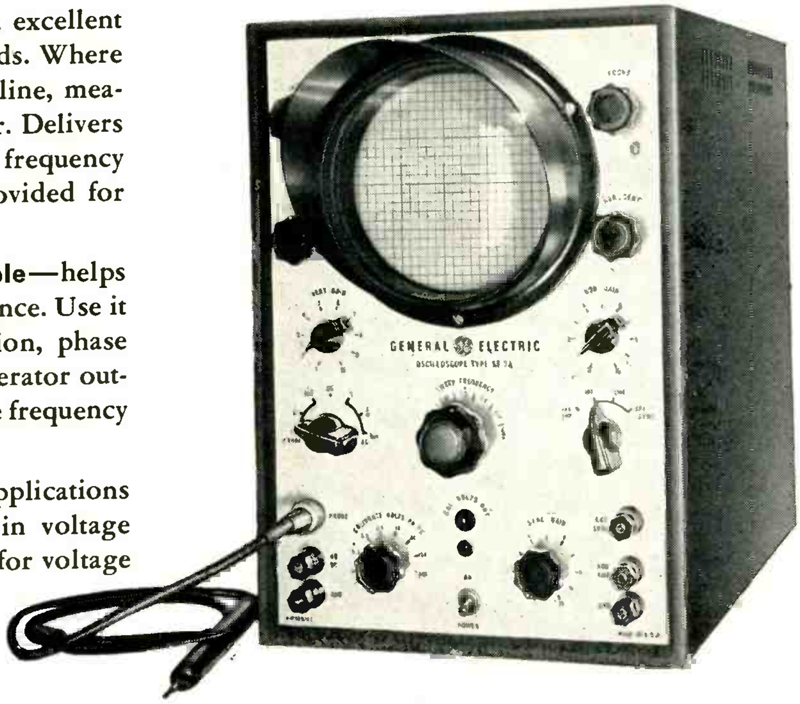


TV SCOPE ST-2A

SPECIFICATIONS

Frequency Response

Vertical Amplifier
Probe and AC—+0,—20% from 20 cycles to 500 kc (Square Wave response 60 to 40,000 cycles.)
+0,—50% from 20 cycles to 1 megacycle with gradual reduction in response beyond 1 mc.
DC—+0,—20% from 0 to 500 kc at full gain setting.

Sweep Range

10 cycles to 100 kc in six overlapping ranges.

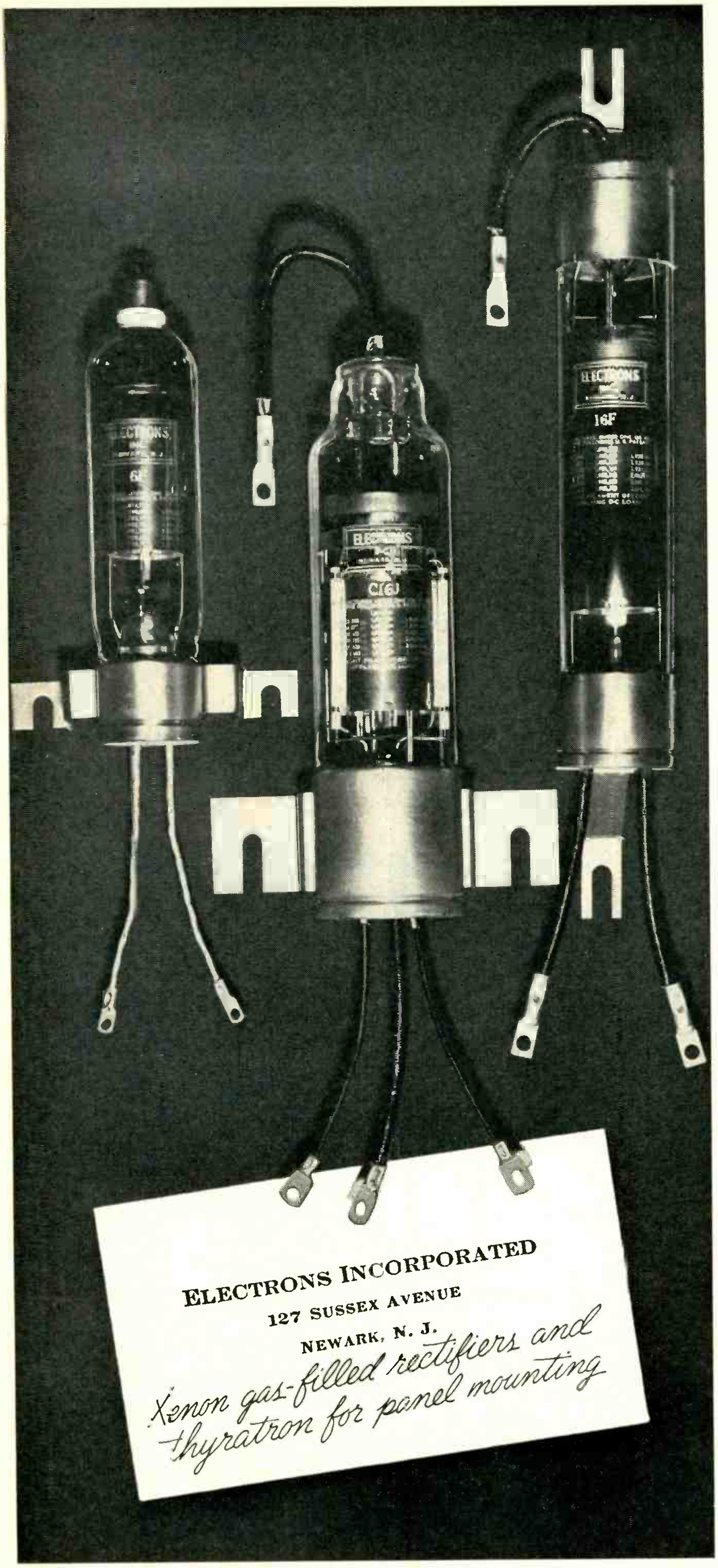
Sensitivity

Vertical
1. AC Input—.015 volts RMS per inch
2. DC Input—2.0 volts DC per inch
3. Probe—.20 volts RMS per inch

Horizontal—.4 RMS volts per inch

Calibrating Voltages

Seven AC voltages of power line frequency—.3, 1.5, 3, 15, 30, 150 and 300 volts with ±15% accuracy.



tion of even the most elaborate installations.

Many of the techniques discussed are recognized as having been in existence for quite some time. However, their value is not lessened by their age in this case.

One possible shortcoming of the book is the lack of down-to-earth what-tube-do-I-use and what-value-of-resistor information that is so important to many engineers and technicians. Both British and American light-sensitive devices are discussed.—J. F.

Better Television Reception

By Woodrow Smith and R. L. Dawley. Editors and Engineers Ltd., *Santa Barbara, Calif.*, 141 *pages paper-covered*, $2.50.

Specific recommendations are given for the best method, the best antenna and the best accessories for improving vhf television reception in fringe and low-signal locations. Techniques presented apply to difficult nearby locations behind hills or in canyons, as well as locations far beyond line-of-sight paths from transmitters. Emphasis is on practical rule-of-thumb data, with theory included only to give a general idea of the considerations involved.

Of particular interest technically is the second chapter, dealing with propagation phenomena. Subjects covered here include bending or diffraction of tv signals, picking up of ground reflection after diffraction, explanation of focusing by diffraction to give a strong-signal region directly behind a large rounded-top hill, focusing by reflection where a hill of gradually increasing slope approaches a section of a parabola, utilizing focused ground reflections and reflections from large objects, elimination of ghosts, use of ghosts, analysis of conditions leading to fading and flutter, intelligent use of boosters, and realignment of video i-f amplifiers in receivers for reception of very weak signals.

Other chapters, equally detailed, cover receiving antennas, transmission lines, mast installation and interference problems. Examples of practical data are the recom-

NEW Miniature Telephone Type Relay

NEW LK RELAY

MOUNTING: End mounting for back of panel or under-chassis wiring. Interchangeable with standard "Strowger" type mounting.

COIL POWER: From 40 milliwatts to 7 watts D.C.

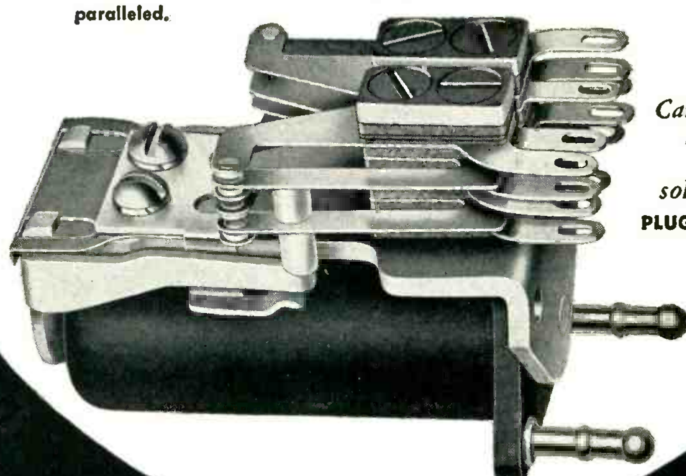
CONTACTS: Standard 2 amperes, special up to 5 amperes. 2 amperes up to 6 P.D.T. 5 ampere contacts (low voltage) up to 4 P.D.T. Special 20 ampere power contacts S.P.S.T., normally open, paralleled.

DIMENSIONS:

1⅝" HIGH, 2⁷⁄₃₂" LONG, 1³⁄₃₂" WIDE

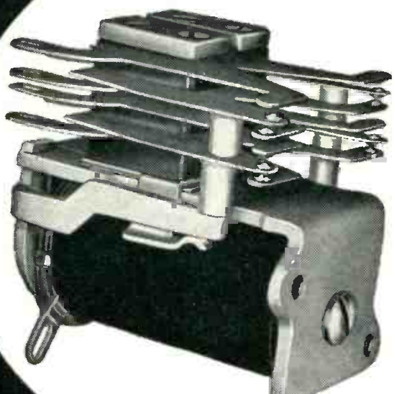
These are the dimensions for the 6 pole relay.

Will meet Army and Navy aircraft specifications as a component unit.



Can be furnished hermetically sealed with solder terminals.

PLUG-IN MOUNTING-SPECIAL.



SK RELAY

MOUNTING: Front of panel mounting and wiring.

COIL POWER: From 100 milliwatts to 4.5 watts D.C.

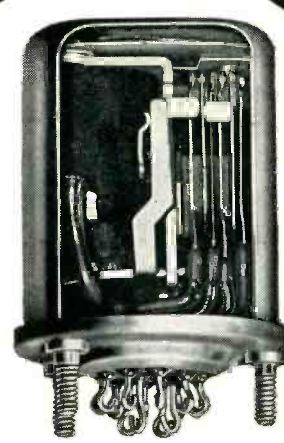
CONTACTS: Same as "LK".

DIMENSIONS: 1½" HIGH, 1⁹⁄₁₆" LONG, ³¹⁄₃₂" WIDE.

These are the dimensions for the 4 pole relay.

Will meet Army and Navy aircraft specifications as a component unit.

CAN ALSO BE FURNISHED HERMETICALLY SEALED WITH SOLDER TERMINALS. PLUG-IN—SPECIAL.



SK, HERMETICALLY SEALED

AL-132

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mendations that tubular 300-ohm line be sealed at the top but left open at the bottom to permit breathing, and that elaborate and costly antenna installations be protected against rust and corrosion with a coating such as Krylon plastic spray. Zinc-coated marine hardware is preferable for long-time weather resistance. Screw eyes for guy wires should be used only with a sidewise pull, as screw threads alone should not be relied on to take the pull.

Though intended primarily for the professional television antenna installer and the amateur experimenter, this book is also highly recommended for the engineer who wants to install or experiment with his own television antenna system in a fringe-area location.—J. M.

The Radio Manual

BY GEORGE E. STERLING AND ROBERT B. MONROE, *D. Van Nostrand Co., New York,* 1950, *Fourth edition,* 890 *pages,* $12.00.

IT IS SAFE TO SAY that this volume represents a comprehensive study of the entire field of radio communication. The field is broad and its subdivisions are diversified, but the authors seem to have had the skill, experience and initiative to weigh each phase and to collect and record a good balance of general information.

This fourth edition is a completely rewritten and reworked version of its already famous predecessors. Entirely new chapters have been added on such subjects as f-m systems, propagation, antennas and emergency equipment, and there is an especially comprehensive chapter on television. The other chapters have been revised to include the latest developments in studio and transmitter techniques. The last three chapters list the latest regulations governing radio and allied arts.

In dealing with a subject, pieces of actual equipment are discussed. Complete circuits of typical transmitters are explained in detail. Mobile and marine installations are thoroughly treated. Also included are chapters on up-to-date direction-finding and test equipment.

This book is not a radio engi-

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Here's how one perplexing problem was solved . . . a typical example of the modern engineering available at Westinghouse for all types of transformer applications.

The application: Electronic transformers on a rectifier power supply circuit with high frequency and operating voltages up to 2,465 volts. Small size and light weight were essential. Terminals required: seventeen! The transformers originally used in this application couldn't "stand the gaff" . . . the high voltages caused coil deterioration because of corona in a matter of hours.

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If you have a tough transformer problem, take advantage of the facilities of Westinghouse for quick, practical solutions. Transformers specially designed for all types of electrical and electronic circuits, as well as a wide selection of standardized designs . . . produced in quantity . . . with quality. Call your nearby Westinghouse representative, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania.

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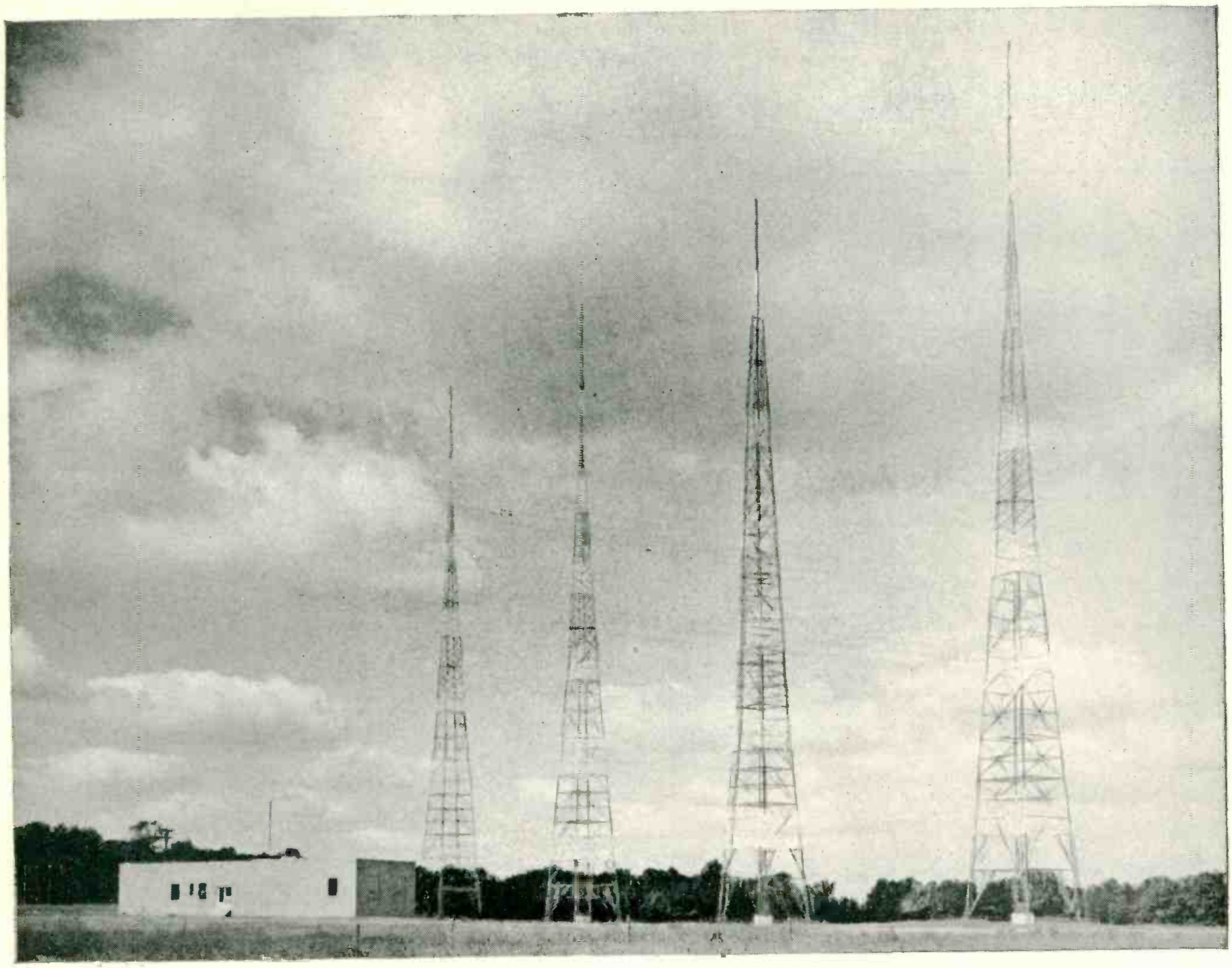

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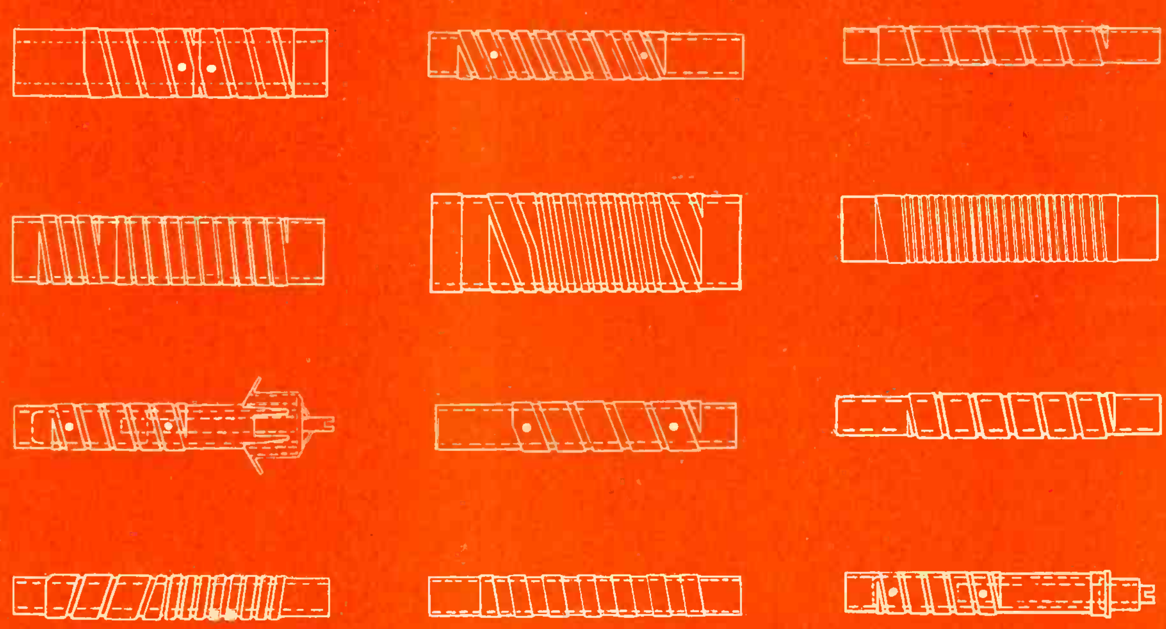

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About the only limiting factor in Corning Metallized Glass Inductances is that they cannot be designed to operate much below 30 Megacycles. Aside from that, just give us your specifications and Corning engineers will quickly design and send you samples. Once approved, they can be easily duplicated to surprisingly close tolerances on a production basis.

When special tuning characteristics or convenient terminating areas in inductances with fine turns are desired, variable pitch coils are easily supplied. Double pitch windings are available for r.f. transformer or inductive coupling purposes. The conductor width may even be modified to give you distributed parameters. Gaps between turns can vary from as little as .020″ to as much as one-eighth of an inch.

Fixed tuned, permeability tuned, or permeability tuned inductance-trimmer combinations can be supplied with appropriate powdered iron cores and convenient mounting bushings. Assembly can be made by conventional methods.

Corning Inductances offer many special advantages. High temperature stability due to low expansion coefficient of the glass coil form, and the low temperature coefficient of the dielectric, results in negligible drift characteristics. Minimum allowable Q is 150. The smooth glass form assures noiseless tuning. Rugged and durable, they can stand repeated handling. Assembly costs are lower. Whatever your inductance requirements, Corning engineers can help you. Write for further information today.

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neering education in itself. It is not the kind of book one reads cover to cover (890 large-size pages with over 800 illustrations). However, it fills the bill as a ready reference for the engineer and/or operator who needs a quick answer to routine or special questions and problems.—J. F.

THUMBNAIL REVIEWS

TELEVISION FOR RADIOMEN. By Edward M. Noll. The MacMillan Co., New York, 595 pages, $7.00. Principles of television receiver circuits, with emphasis on servicing aspects, for nonengineering readers.

TRIPLE PINDEX. Available from RCA distributors, 75 cents. Compilation of base diagrams of over 600 tube types, arranged as three identical booklets joined in single spiral-binding cover so up to three desired diagrams may be seen and studied simultaneously.

HIGH POWER PULSE TRANSFORMER DESIGN AND DEVELOPMENT. Section of report by Armour Research Foundation for Bureau of Ships. 229 pages, $8 in microfilm or $28.75 in photostat, from Library of Congress, Photoduplication Service, Publication Board Project, Washington 25, D. C. Intended to minimize use of skilled highly-trained design talent. Gives theory of pulse transformers, details of Armour interleaved winding design that places primary and secondary conductors in a single layer, and steps in electrical and mechanical design procedure for development to meet specific requirements.

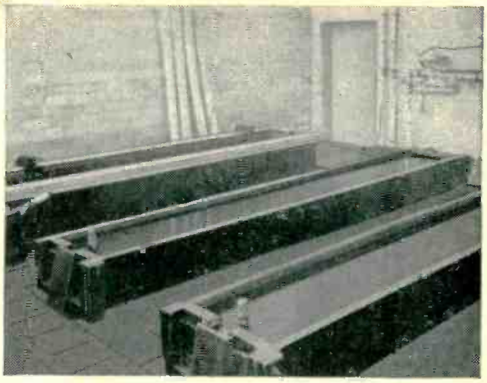
PRINCIPLES OF COLOR SENSITOMETRY. Society of Motion Picture and Television Engineers, 342 Madison Ave., New York 17, N. Y., 72 pages, $1.00. Basic text dealing with instruments available for color research and quality control in connection with commercial color processes. Contains sections on Sensitometric Exposures, The Processing of Sensitometric Tests, Quantitative Evaluation of the Image, Densitometer Design Principles, Transformations Between Integral and Analytical Densities, Interpretation of Sensitometric Results, Statistical Aspects of Color Sensitometry, and References.

THE SPECIAL THEORY OF RELATIVITY. By Herbert Dingle. Methuen's Monographs on Physical Subjects (British), published in U.S.A. by John Wiley & Sons, Inc., New York, 1950, 94 pages, $1.25. Third edition of monograph first published in 1940, based on short course of lectures given to students at Imperial College. Treatment involves development of whole form of the theory from a redefinition, along ordinary scientific lines, of the measurement of length.

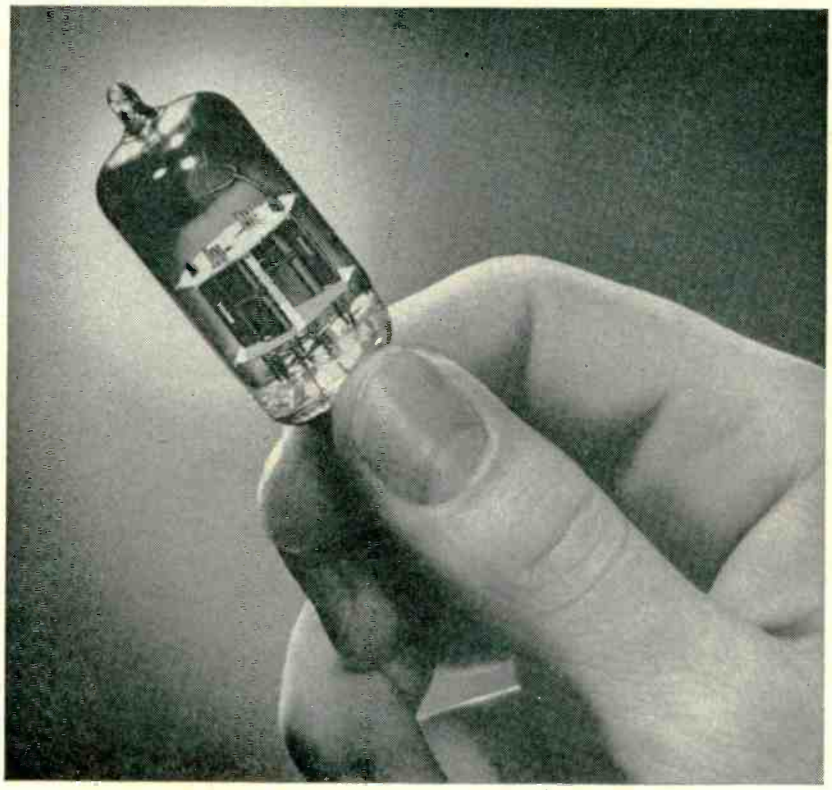
WAVE GUIDES. By H. R. L. Lamont. Methuen's Monographs on Physical Subjects (British), published in U.S.A. by John Wiley & Sons, Inc., New York, 1950, 118 pages, $1.50. Third edition of monograph first published in 1942, with a number of new sections, a new chapter and a bibliography brought up to date. Covers theory, attenuation and stability of waves, wave guides as resonators and radiators, and rectangular guide techniques.

RESISTANCE WELDING—DESIGNING, TOOLING, AND APPLICATIONS. By Wallace A. Stanley, Progressive Welder Co., Detroit. McGraw-Hill Book Co., New York, 1950, 329 pages, $7.50. Background or basic information on resistance welding, characteristics of standard equipment, design considerations for products to be assembled by resistance, spot, projection, seam or flash butt welding, evaluation of weld quality, practical data on getting the most out of resistance-welding equipment, and time-saving techniques. Highly practical book for engineers as well as production men, of real value to electronic engineers who work with welders even though by intent the author has ignored the subject of electronic welding controls.

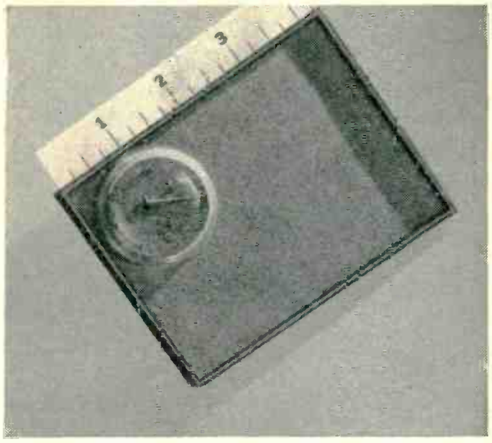
Inside Information on the Inside of a Tube



Acid House Equipment where material is cleaned and rinsed before bright annealing.



Inspection and Gaging . . . equipment for checking dimensions of Seamless and Lockseam Cathodes.



52,600 Seamless Nickel Cathodes . . . standing on end compared with a ruler, and an ordinary pin under a lens.

● The public-at-large does not know, as you do, that within nearly every electronic or television tube are other tubes. Or that these other tubes—of metal—can be as troublesome as they are tiny.

To see that they behave properly, the Electronics Division of Superior maintains excellent tubing research facilities, exercises tight control over production and product, helps you think your way out of problems in design and specification.

Superior was one of the early birds in electronics tubing—is always one of the first to come to your aid when you have tubing trouble . . . and is definitely a leader in tubing technology.

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SEAMLESS . . . ? The finest tubes that can be made. Standard production is .010″ to .121″ O.D. inclusive, with wall thicknesses of .0015″ to .005″. Cathodes with larger diameters and heavier walls will be produced to customer specification.

Or LOCKSEAM*. . . ? Produced directly from thin nickel alloy strip stock, .040″ to .100″ O.D. in standard length range of 11.5 mm to 42 mm. Round, rectangular or oval, cut to specified lengths, beaded or plain.

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All analyses .010″ to ⅝″ O.D.

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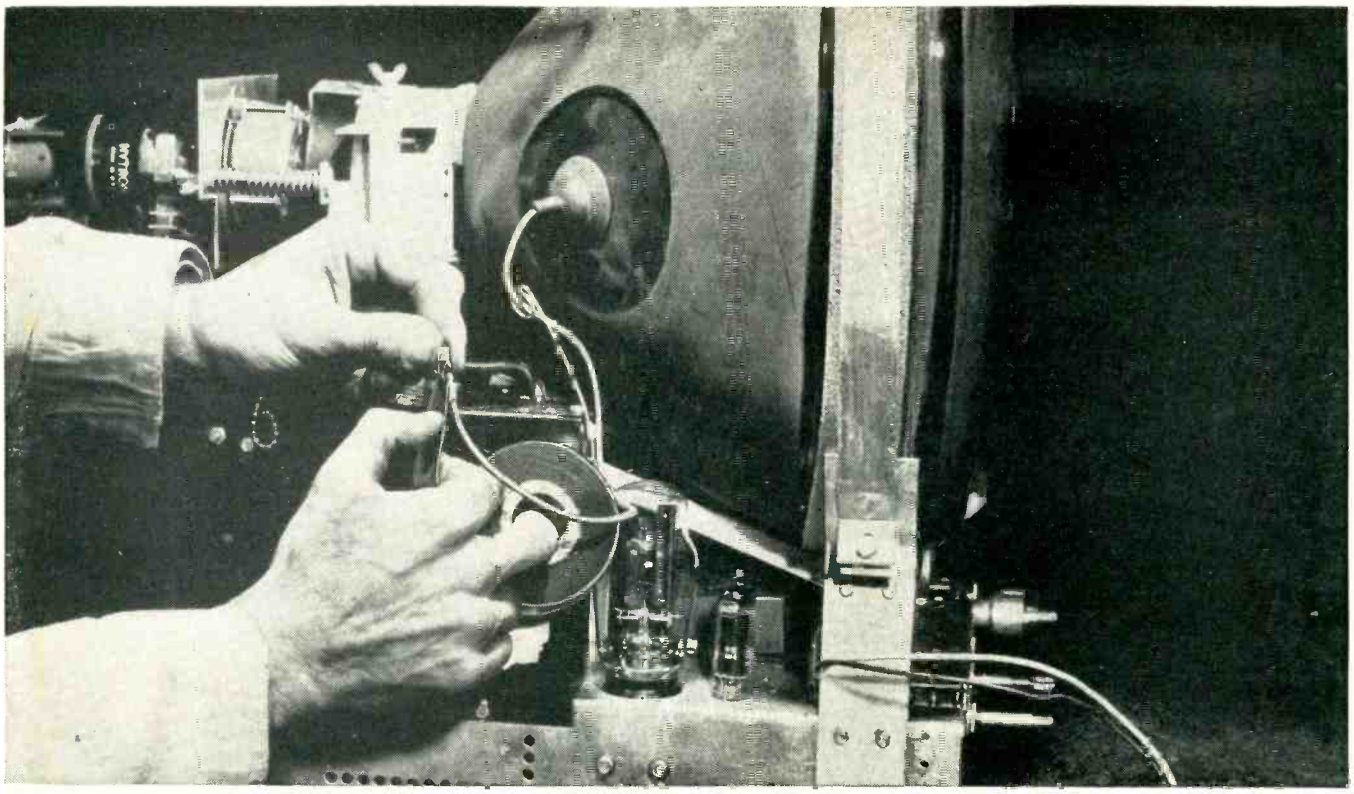


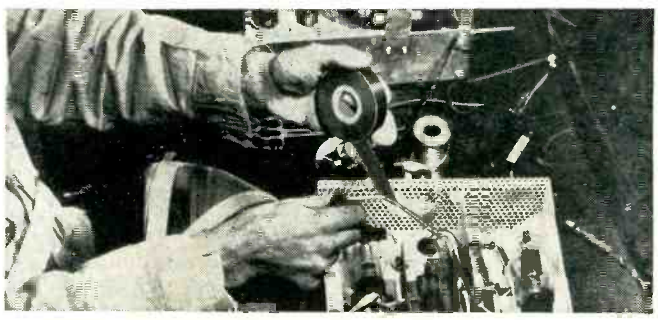
INSULATING SPLICE of high voltage lead to picture tube neatly, quickly with "Scotch" No. 33 Electrical Tape.

What's new in TV repair? Safe, speedy plastic tape!

More and more TV repairmen are saving money on service contracts with "Scotch" No. 33 Electrical Tape. This plastic-backed tape provides safe, snug protection for all wiring. Makes it easier to splice leads than to replace them! Difficult soldering is eliminated. Repair time is cut as much as 50%.

And customers are happier, too! Plastic tape in TV sets helps eliminate "snow" and "ghosts," improves signal-to-noise ratio.

Try "Scotch" No. 33 Electrical Tape on your next insulating job. Write Dept. ES-105 for complete information.



WRAPPING LEADS with "Scotch" No. 33 Electrical Tape prevents drying and cracking of original wire covering.

Quick facts about "Scotch" No. 33 Electrical Tape

- **THIN CALIPER**—only .007 inch thick, makes a neat wrap.
- **HIGH DIELECTRIC STRENGTH**—over 7,000 volts.
- **TOUGH**—plastic backing is abrasion resistant, unaffected by water, acids, alkalies, alcohols, exposure to sunlight, rain, snow, ice.
- **P.S.**—for perfect high-heat insulation try "Scotch" Electrical Tape No. 27 with thermosetting adhesive, glass-cloth backing.

Made in U.S.A. by MINNESOTA MINING & MFG. CO., St. Paul 6, Minn., also makers of other "Scotch" Brand Pressure-sensitive Tapes, "Scotch" Sound Recording Tape, "Underseal" Rubberized Coating, "Scotchlite" Reflective Sheeting, "Safety-Walk" Non-Slip Surfacing, "3M" Abrasives, "3M" Adhesives. General Export: Durex Abrasives Corp., New Rochelle, N.Y. In Canada: Canadian Durex Abrasives Ltd., Brantford, Ontario.

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Look for the orange package . . . the universally popular solder for use in electrical applications where bonding must be secure and free from corrosion.

The flux is in the solder . . . all you need is heat! Federated Rosin Core Solder is available in 1, 5, and 20-pound sizes.

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TUBES AT WORK

(continued from p 118)

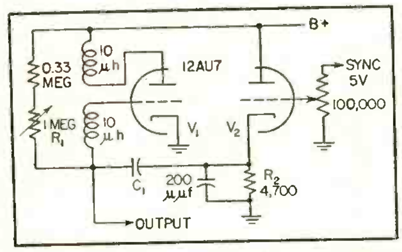


FIG. 1—Positive-grid blocking oscillator provides oscilloscope time base

inherently a good sawtooth, its shape unaffected by changes in circuit constants and voltages; frequency is substantially independent of plate supply; and sawtooth amplitude is independent of frequency.

Referring to Fig. 1, one half of a double triode is connected as a blocking oscillator, with the grid resistor returned to a high positive potential, conveniently the B+ supply. This bias linearizes the sawtooth voltage by making the total voltage across the grid or charging resistor large compared to the incremental voltage. Part of the grid resistor, R_1, is variable as fine-frequency adjustment. Coarse-frequency control is effected by switching capacitors at C_1.

The oscillator coil is not at all critical in design. Circuit in Fig. 1 uses two close-coupled windings of about 20 turns of No. 30 wire on a 3/8-inch form. Best results are obtained when both grid and plate coils are the same size with no tuning capacitors connected across them. Sawtooth amplitude increases with the Q of the coil, and is higher with low-mu tubes than with high-mu. The r-f frequency of oscillation is relatively unimportant. No attempt was made to design for "snap" operation, in which the discharge of the grid capacitor is effected in a single cycle of oscillation.

Synchronization

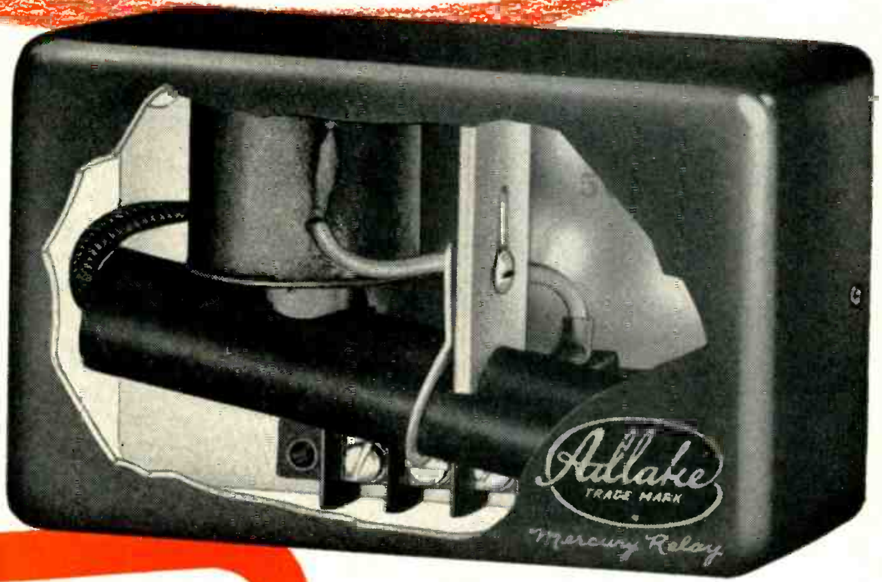
The other triode V_2 is used for the purpose of sync injection, and is connected as a cathode follower. The 200-$\mu\mu f$ capacitor across the cathode resistor provides r-f bypassing. If very high sweep frequencies are not desired, a capacitor of 22 $\mu\mu f$ or so from the grid of V_2 to ground will help improve

SPECIALLY DESIGNED FOR USE WITH

SENSITIVE

THERMO-REGULATORS

New ADLAKE No. 5000 Mercury Relay



Because of its amazingly high load-input ratio, the No. 5000 relay operates at 115 volts 60 cycles on *only 0.007* ampere—a fraction of the current consumed by any other type of mercury relay!

It is ideally suited for use in electronic tube circuits where the output of the tube is limited. With its low amperage operating the coil, the contacts will handle 5 amperes at the same voltage — and tests indicate the No. 5000's life to be over 30 million operations!

It can be used as a pilot relay operating from a very sensitive thermo-regulator—serves equally well for high and low temperature control—and functions perfectly with either mercury-and-glass or bi-metal regulators.

FOR FULL INFORMATION on this sensational relay, write The Adams & Westlake Company, 1107 N. Michigan, Elkhart, Indiana. No obligation, of course.

Every ADLAKE Mercury Relay offers these advantages:

- Hermetically sealed—(dust, dirt, moisture, oxidation and temperature changes can't interfere with operation)
- Silent and chatterless
- Requires no maintenance
- Absolutely safe

Manufacturers of
Hermetically Sealed Mercury Relays for Timing, Load and Control Circuits

THE
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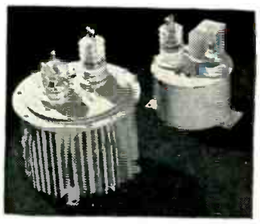
Established 1857 — ELKHART, INDIANA — New York • Chicago

a complete line of hermetically sealed oil-filled HIGH-VOLTAGE COMPONENTS

Rectifiers

Small, lightweight a-c to d-c power supply units for use with cathode-ray tubes, television camera tubes and radar indicator scopes, electron microscopes, and similar jobs. Typical outputs are 7, 9 and 13 kv. Low regulation—the 7-kv unit illustrated does not exceed 3.5% regulation per 0.1 milliampere load, holds ripple on output voltage to less than 1%. Size, only 6″ x 6″ x 7″; weight 8 lb.

Pulse Transformers



Pulse transformers for use with either hard-tube or line-type modulators. Available in voltage ratings of 10 kv or above. These units are ideal for radar applications, stepping up or down, impedance matching, phase reversing and plate-current measurements. Also suitable for nuclear physics research work, television and numerous special applications in and out of the communications fields.

Resonant Reactors

Resonant-charging reactors, accurately designed and constructed for radar service. Usually required in ratings of 40 kv and below, 1 ampere and below and 300 henries and below. Higher ratings are being built, and can be considered. When required, small- and medium-size designs can be provided with 3 to 1 range of inductance adjustment.

Filament Transformers

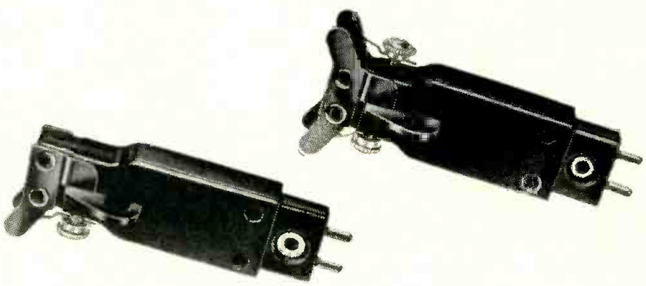
Filament transformers available with or without tube socket mounted integral with the high-voltage terminal. Low capacitance. Ratings to match any tubes; insulated to practically any required level.

Illustrated here are typical high-voltage components manufactured by General Electric. They can be built to meet Armed Services requirements. All are oil-filled and hermetically sealed—with excellent ability to withstand mechanical shocks and to operate continuously for long periods in widely varying temperatures. Apparatus Dept., General Electric Company, Schenectady, N. Y.

Your inquiries will receive prompt attention. Since these components are usually tailored to individual jobs, please include with your inquiry, functional requirements and any physical limitations. *Write to Apparatus Dept., 42-328A, General Electric Co., Pittsfield, Mass.*

GENERAL ELECTRIC

401-63



the isolation of the sync source from retrace pulses.

The sync voltage required is higher than with gas triodes, but is not excessive. Less sync input is required at lower plate-supply voltages. Otherwise the plate voltage makes no difference except in the amplitude of the output wave. Voltages from 75 to 300 have been found satisfactory.

Trials with plate-blocked oscillators indicate that they are remarkably free of high-frequency limitations. Their inherent defect is that blocking action is proper only over a comparatively small range of charging resistance—not over 2 to 1. The best tube is a medium-mu triode with a high ratio of mutual conductance to plate current at low values of plate current.

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Coaxial Feed System for Antennas

By JOHN F. CLEMENS

Project Engineer
Electronics Research Inc.
Evansville, Ind.

COAXIAL CABLE may be used to feed balanced horizontal antennas without interference, noise pickup or power loss due to unbalanced currents in the outer shield. The familiar delta match is used. The outer shield is bonded to the center of the antenna while a shorted section of cable resonates with the inductive reactance of the system.

Coaxial cable has advantages over unshielded or open-wire line in almost every transmission-line application. Generally speaking, attenuation is lower, making it particularly desirable when the line must be relatively long. For receiving applications the low noise pickup

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On a nice clear day finding an iceberg is pretty easy even though nine-tenths of its hulk remains below the surface.

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Edo has been a leader in the research and development of depth-finding instruments and sonar equipment with which to find out much more easily and clearly what's below.

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Known as the Contour Bottom Scanner, the instrument gives a continuous picture of the bottom's profile on a cathode ray tube. It has many potential uses for navigating in shallow waters and locating sunken objects.

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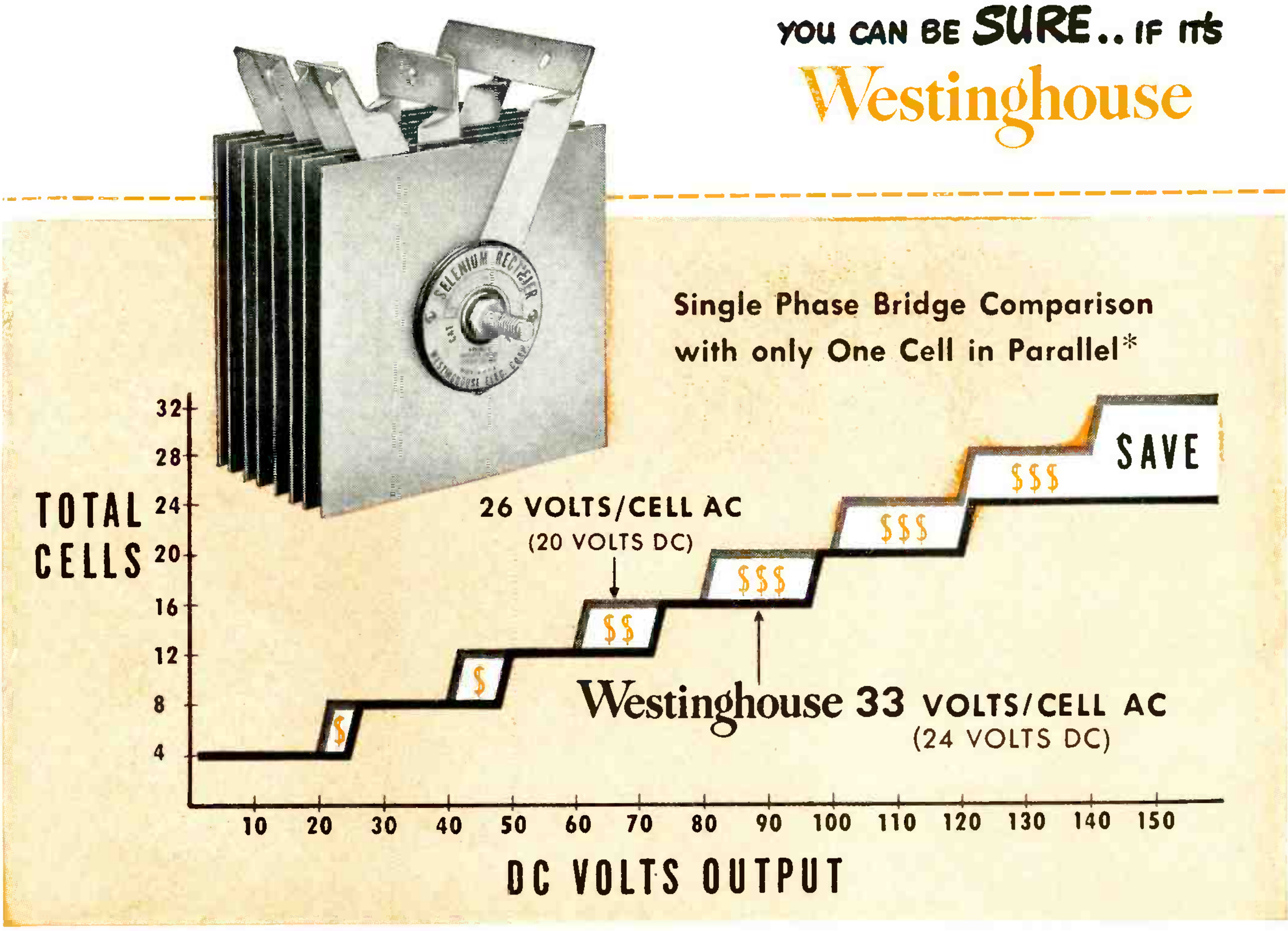

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of coaxial cable is a definite advantage. For this reason it is especially suitable for television receiving antenna leadins. Coax is entirely free from weather effects while the ribbon type of line is usually affected by rain and moisture, often deteriorating rapidly from exposure in coastal regions.

No Split Element

A system of coaxial-cable feed for balanced horizontal antennas should find wide application to television and f-m receiving antennas and transmitting antennas such as parasitic beams. The system described has a feature of prime importance in these applications: splitting the driven element is unnecessary. A feed system which necessitates breaking the antenna is difficult to fabricate since insulating materials of sufficient strength and electrical quality are not available for large self-supporting structures.

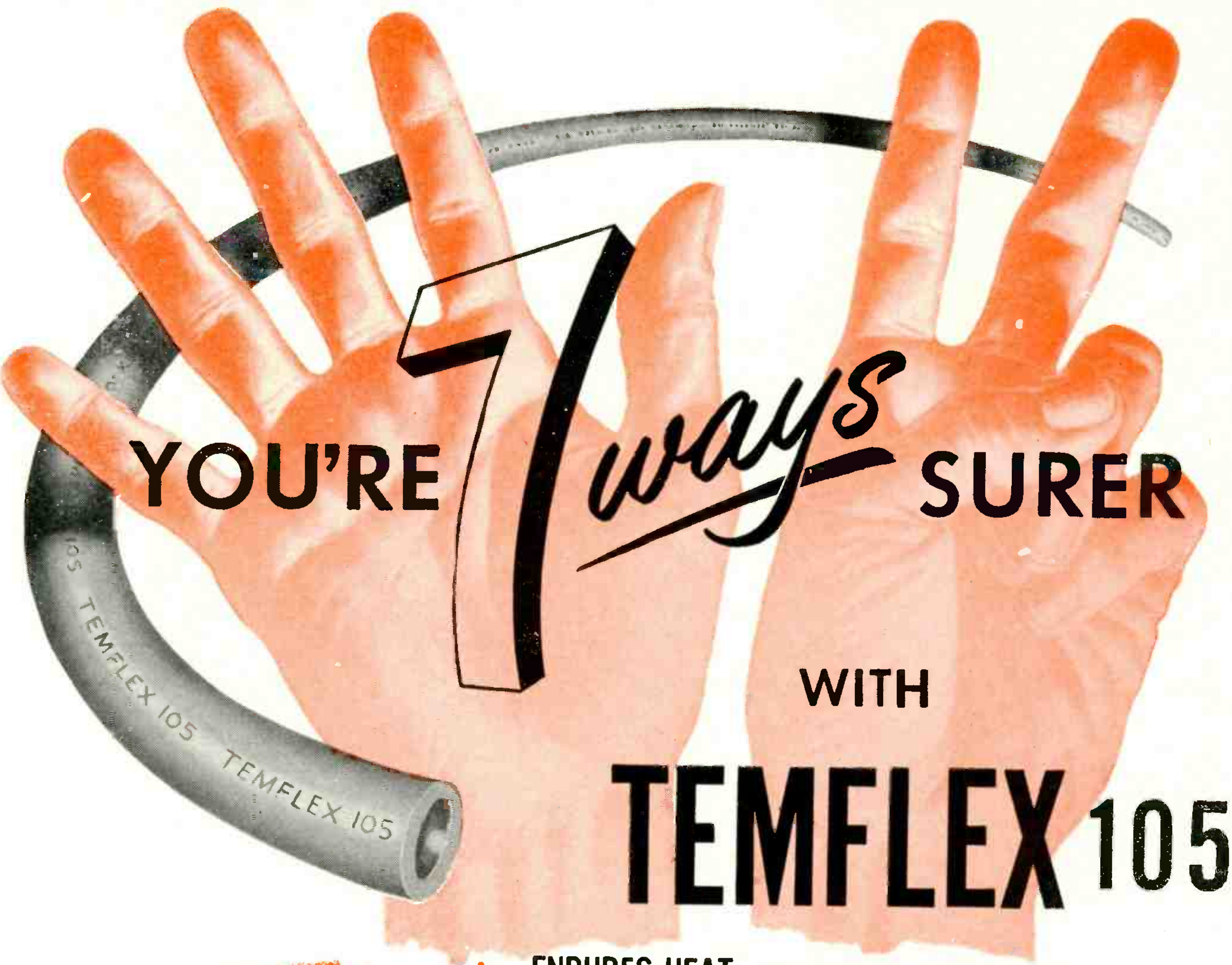
A serious problem in applying coaxial feed to a balanced antenna is that of eliminating unbalanced or antenna currents from the outer shield.[1] If present, such currents cause loss of the normal antenna pattern and the low noise pickup feature of coaxial cable. In transmitting, currents on the outer shield may cause feedback, interference or power loss.

The system described achieves balanced feedline currents as determined by test. In general, a symmetrical system can be relied upon for absence of unbalance effects. The diagram of the system, Fig. 1, discloses almost perfect symmetry.

Delta Match

The impedance between two symmetrically located points on an antenna rises from zero when the points are adjacent, to a very high value when the points are at opposite ends of the antenna. Therefore, in any type of resonant antenna, it is possible to select two points between which the resistive component of impedance is equal to the characteristic impedance of the transmission line. This is the basis for the familiar delta match.[2]

The impedance between two driving points is not purely resistive;



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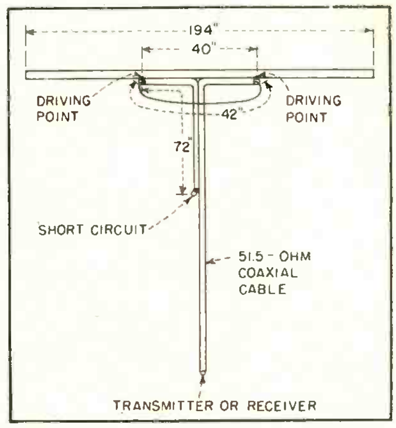


FIG. 1—Driven element of three-element close-spaced array for 29 mc using coaxial feed system

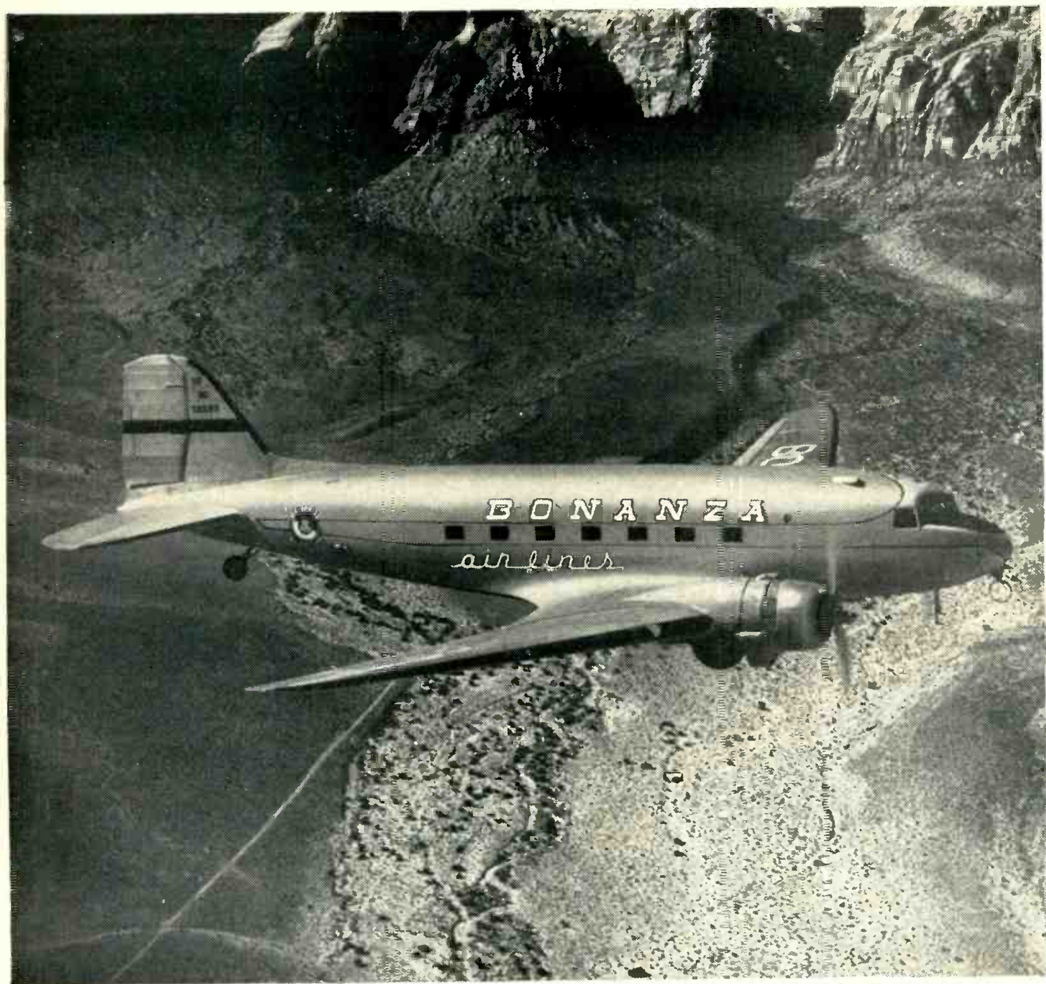
the actual impedance may always be represented by an equivalent series circuit of resistance and reactance. Prediction of the actual input impedance between two driving points is difficult in a parasitic array although approximate formulas are available for the half-wave dipole.[3]

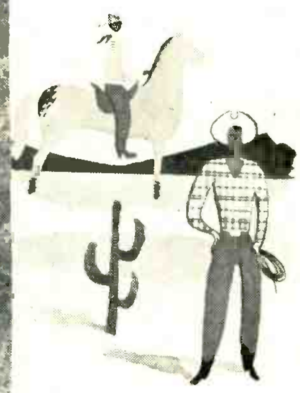
The driving points must be chosen empirically to satisfy the requirement of an equivalent series resistive component equal to the characteristic impedance of the transmission line. Once these points have been determined, the series reactive component of the impedance may be calculated.

Shield Bonded

Assume that two symmetrically-located driving points have been located on the antenna. If the shield of a coaxial cable is connected to the center of the antenna, no antenna current will flow into the cable since the voltage at the center of the antenna is negligible. The cable may also be run along the antenna since it will act merely to increase its effective diameter. If protrusion of the inner conductor is negligible, no current will flow in the cable. Accordingly, it may be extended to one of the driving points. The shield should be well bonded to the antenna at this point.

The center conductor of the cable is looped past the center of the antenna to the opposite driving point. The coax sees a load resistance paralleled by the inductance of the length of the antenna element between driving points, and in series with the inductance of the ex-





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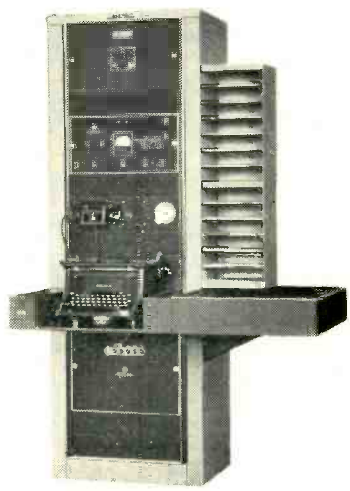

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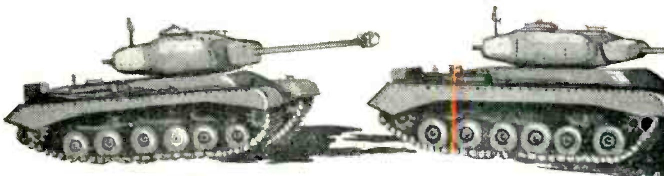

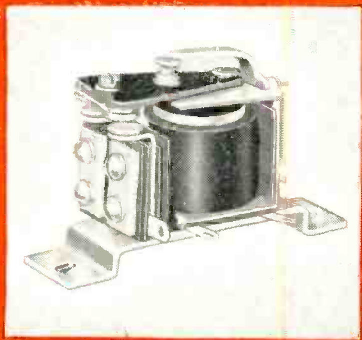

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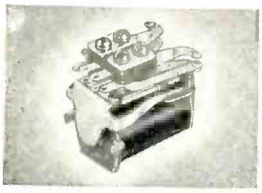

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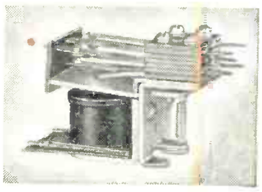

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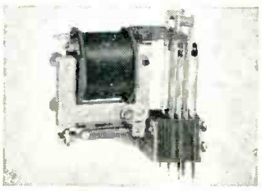

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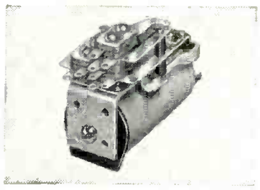

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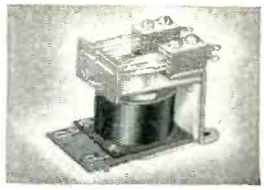

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tended center conductor. The inductance of both antenna and center conductor can be determined from[4]

$$L = 0.00508\, a \left(2.303 \log \frac{4a}{d} - 0.75\right) \quad (1)$$

where a and d represent length and diameter of each conductor in inches, and L is given in μh.

The actual equivalent circuit is shown in Fig. 2A where R_p is unknown while L_p, the inductance of the length of antenna between driving points, has been calculated.

The inductance of the extended center conductor, L_2, may likewise be calculated. In Fig. 2B the parallel circuit of R_p and L_p has been replaced by the series equivalent R_s and L_s. In this case, R_s is the characteristic impedance of the line. Inductance L_s may be calculated from

$$X_p = \frac{X_s^2 + R_s^2}{X_s} \quad (2)$$

$$R_p = \frac{X_s^2 + R_s^2}{R_s} \quad (3)$$

$$X_s = \frac{X_p + \sqrt{X_p^2 - 4 R_s^2}}{2} \quad (4)$$

Resistance R_p may be determined likewise if desired.

Resonating Load

Once X_s has been determined the next step is to combine it with the reactance of L_2 and insert a capacitance, C, of such a value to resonate

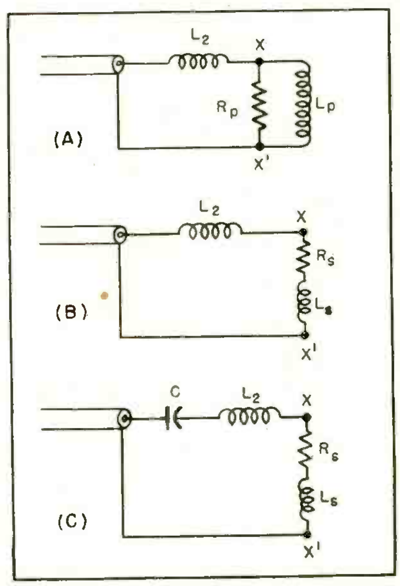
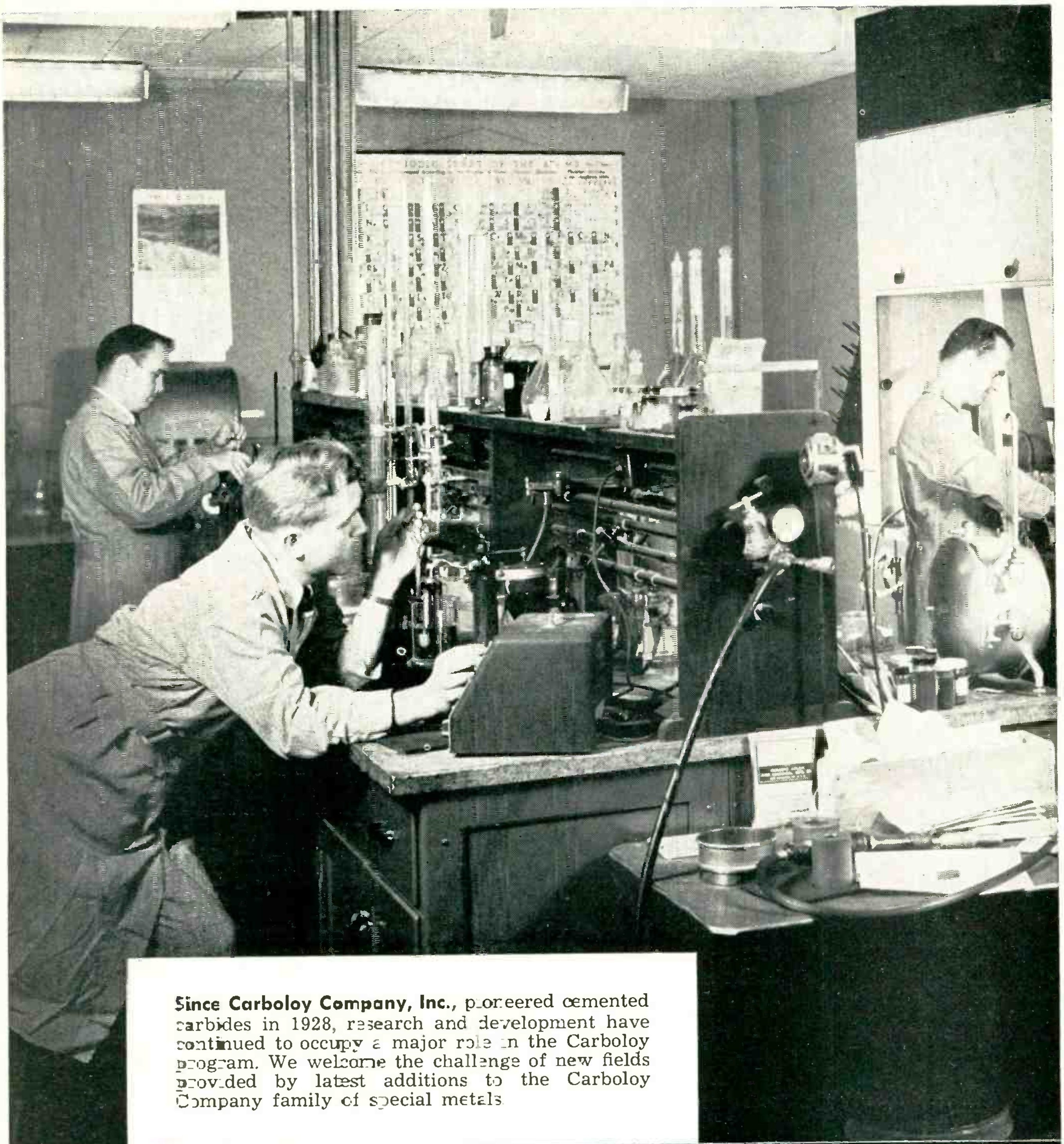


FIG. 2—Equivalent circuits of coaxial feed system show effect of shorted line and distributed inductance



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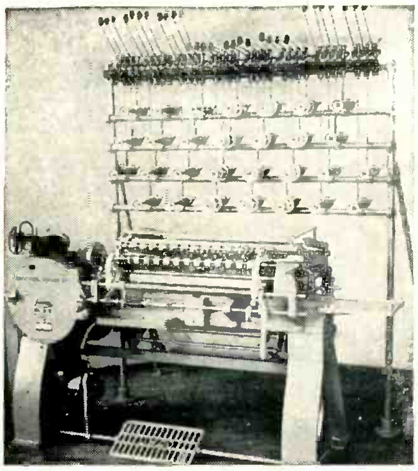

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Universal's new high speed automatic No. 107 winder produces accurately-wound paper-insulated or acetate-insulated coils at a very high rate of output.

Automatic feeding Single or laminated insulating sheets are fed into the machine automatically. Rate of feed, with either paper or acetate, can be as high as 25 inserts per minute.

Thus, on a coil containing 100 wire turns per layer, the machine can be operated at winding speeds up to and including 2500 rpm.

An entirely new type of delivery shelf has been designed to provide high accuracy. It imparts a uniform backward pull on the paper as it is fed into the coil, resulting in windings of highest possible density.

This delivery shelf will handle insulating papers, either "Kraft" or "Glassine," from .0006 in. to .003 in. in thickness, and where the machine is equipped with devices for removing static, acetate sheet is handled at high winding rates.

The machine utilizes a single width of insulating paper, and this can be 24 in. or up to 25 in. maximum if required.

Accurate wire control Wire sizes accommodated range between No. 19 and No. 42 (B&S). The creel stand is independently mounted, and holds up to 30 wire spools at a time.

The wire spool spindle is of the latest design, with solid construction. The braking device is mounted on the rear of the machine to give better balance between the wire spools and the higher winding speed.

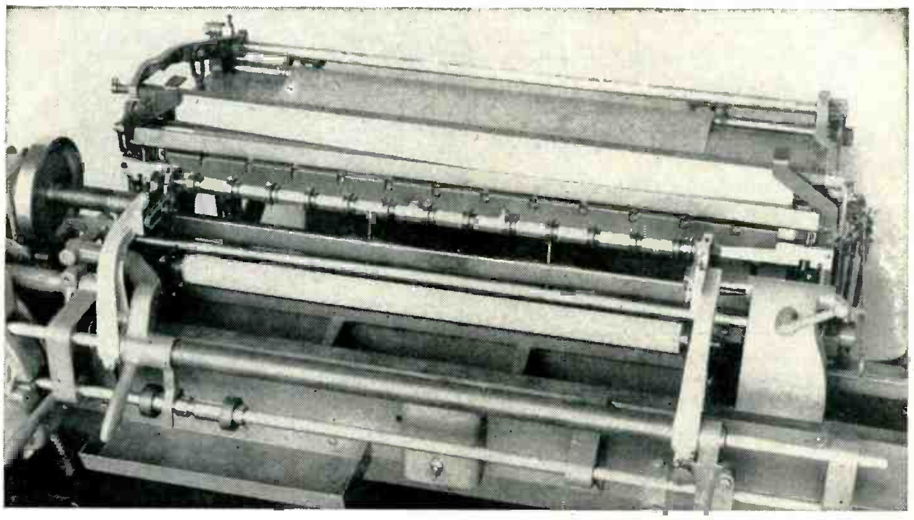
Efficient winding A quick return of the wire guides is assured at the end of each wire layer, and thus there is no possiblity of crossed turns due to delayed return, particularly where wear develops.

The same efficient traverse mechanism used in the Universal No. 105 Coil Winder has been adopted for the No. 107. No changes in cam are necessary for various lengths of wire layer.

Special attachments These include an auxiliary "space-wind" traverse for spacing the first and last layers of high-tension coils. A special "mid-tap" attachment permits shifting the wire guides at the end of a wire layer for "tap" location or to arrange for starting and finishing leads.

Where required, a "dual-counter" is available so that the machine will stop automatically for the removal of a mid-tap.

The new No. 107 Coil Winder has already demonstrated, in preliminary installations in plants of several prominent electrical manufacturing firms, its ability to turn out coils of the highest quality.



Closeup showing coil arbor in transfer position.

the total inductive reactance as shown in Fig. 2C. A capacitor of capacitance C may be inserted in the center conductor anywhere along its length to obtain an impedance match.

Usually a capacitor is not used because of weather effects. Instead, a length of cable may be used to present the same capacitive reactance. Although a length of either open or shorted cable may be used, the shorted cable is preferable because of its lower loss. If a shorted cable is used the proper electrical length may be computed from

$$X = -j Z_k \tan \theta \qquad (5)$$

where X is the desired capacitive reactance. The electrical angle θ may be converted to inches from

$$D = \frac{(32.8)(\theta)(v_p)}{f} \qquad (6)$$

where θ is expressed in degrees, f in megacycles and v_p, the propagation velocity, as a fraction.

The matching section and antenna may be bonded along their mutual length without altering the performance of either.

Allowable Mismatch

The fact that the antenna inductance, L_p, shunts the resistive component, R_p, permits the system to be used when the radiation resistance exceeds the characteristic impedance of the line. A 50-ohm coaxial cable may thus be matched to a free-space dipole having a radiation resistance of 73 ohms.

The cable may be fed inside a tubular antenna element with the center conductor emerging through a hole at one driving point and reentering the antenna tube at the other driving point.

Experimental Antennas

A test of the system was first made at 300 mc with a close-spaced three-element parasitic array. Instead of the capacitive line section, a small variable capacitor was used. A standing wave ratio of less than 1.5 to 1 was readily obtained. Antenna elements were 3/16 silver-plated brass rods and the feed line was RG-58/U.

The system was next tested on a scaled-up version of the three-element antenna at 29 mc. Spacing

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Max Continuous Inverse Voltage	60	100
Average Rectified Current (ma)	40	30
Peak Rectified Current (ma)	125	90
Surge Current (ma)	400	350
Temp. Range °C	−50 to +70	−50 to +70
Characteristics at 25°C		
Max Inverse Current at −50v(ma)	.85	.41
Max Inverse Current at −10v(ma)	.05	.01
Min Forward Current at +1v(ma)	5.0	3.0
Average Shunt Capacitance (mmfd)	0.8	0.8

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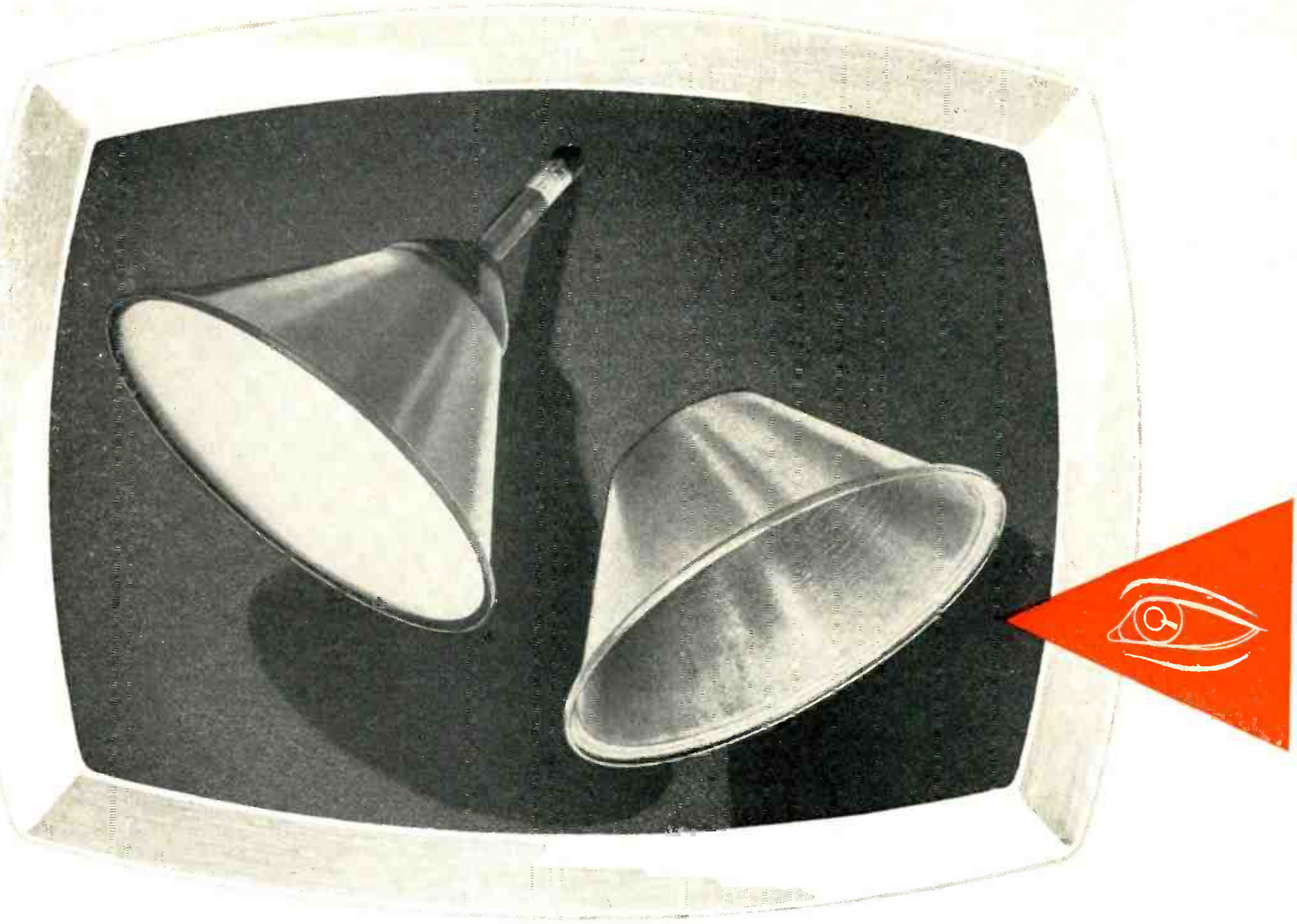

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In addition to its light weight, other inherent advantages of Stainless make important contributions here. Its strength enables the tube to withstand extreme pressures and reduces breakage hazards. Because glass area is held to a minimum, and because of the protection provided by the Stainless Steel cone, hazards of implosion are minimized—in tube manufacture, in installation and in service. The U·S·S 17-TV cone permits the use of a flawless, smooth glass face, thus resulting in cleaner, and sharper pictures.

Whether you manufacture or use cathode ray tubes, investigate the possibilities of U·S·S 17-TV Stainless Steel, developed especially for the television industry. Like all other grades of U·S·S Stainless, it is made to give you the finest possible performance.

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from antenna to director was 0.1 wavelength and from antenna to reflector, 0.15 wavelength. The antenna was 194 inches long, the reflector, 204 inches, and the director, 184 inches. All elements were 1 inch in diameter.

With a series variable capacitor and a Micro-Match, two feed points were located 20 inches each side of center. Type RG-8/U cable was then connected as described. The cross lead was formed by 42 inches of center conductor from which the shield had been removed. The cross lead was allowed to sag about three inches from the center of the antenna. The driven element is diagrammed in Fig. 1.

The inductance of 42 inches of wire with a cross-sectional area approximately equivalent to number 14 wire from Eq. 1 is 1.52 μh. The inductance of the antenna, L_p is 0.862 μh. Reactance X_p is therefore 158 ohms at 29 mc. Reactance X_s from Eq. 4 is 19 ohms. Reactance X_2 is 277 ohms, making the total inductive reactance 296 ohms.

The capacitive reactance required for resonance is 296 ohms. This capacitive reactance was obtained by a 72-inch length of RG-8/U, shorted at one end, as calculated by Eq. 5.

First tests on the antenna were made with the shield of the capacitive shorted section and the driving cable bonded to the antenna and to the metal supporting pole throughout their mutual lengths. On a second antenna the shields were bonded to the antenna at the driving points where the vinyl jacket was removed from the cable but the remainder of the cable was left with the insulation on and merely taped along the antenna and supporting pole. No difference in performance was detectable in the two systems.

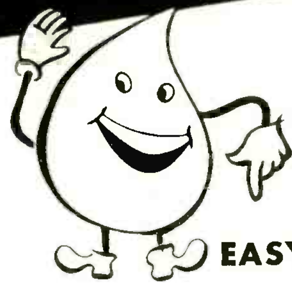
Standing-Wave Ratio

The antenna was mounted one wavelength above ground and tested with a Jones Micro-Match. The standing-wave ratio was measured as 1/1 at 29 mc, the resonant frequency of the antenna, rising to approximately 1.5/1 at 28.5 and 30.0 mc.

A question arises as to the desirability of a resonant system for im-

G.E.'s 9574 all-purpose* insulating varnish provides BETTER BONDING BETTER PENETRATION NO SLUDGING

Mr. Guy W. Probst



That's what Guy W. Probst, owner of the Lockhaven Electric Repair Co., Lockhaven, Pa., says about General Electric's 9574. Here is his statement:

> "*G-E all-purpose insulating varnish 9574 gives you a cover coat you can see and that fills up between the Formex wires. I've had very good success with it on armatures up to 2000 RPM. On formed coils I can bake before forming and the turns don't come apart when you pull the coil. I've had no trouble with sludging, and all my work is hot dipped. I find that I only use about half as much 1201 Glyptal as a cover coat on 9574 as I had to use over the varnish I had been using, and I get higher gloss and better bonding when 1201 is used over 9574.*"

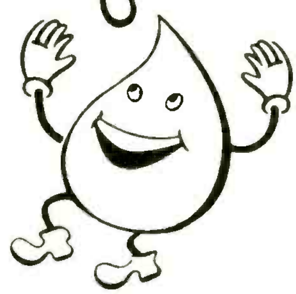
EASY TO USE

BAKES AT LOWER TEMPERATURES than is possible with most other synthetic varnishes.

PENETRATES EASILY into the deepest coils.

NO SPECIAL THINNER required (just petroleum spirits).

STABLE—will not tend to harden in the tank.



**G-E 9574 gives excellent results on all types of coils except extra-high-speed armatures. It is one of G.E.'s complete line of electrical insulating materials, including adhesives, wedges, cements, compounds, cords and twines, sleeving, wire enamels, mica, papers and fibers, permafils, tapes, tubing, varnished cloths, varnishes.*

SEND FOR BULLETIN!

If you haven't yet tried G-E 9574, get in touch with your local G-E Distributor, or write for our new bulletin to Section K-2, Chemical Department, General Electric Company, Pittsfield, Mass.

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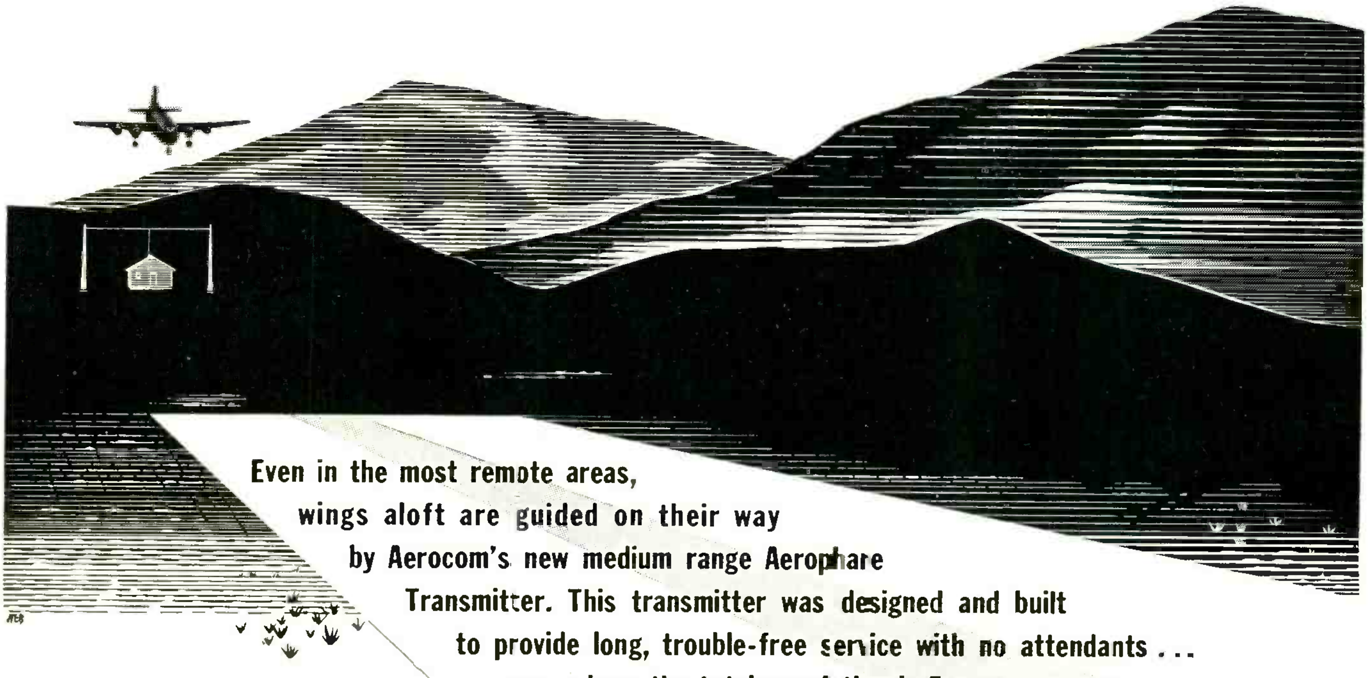
CD50-K2

POPULATION-0



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wings aloft are guided on their way
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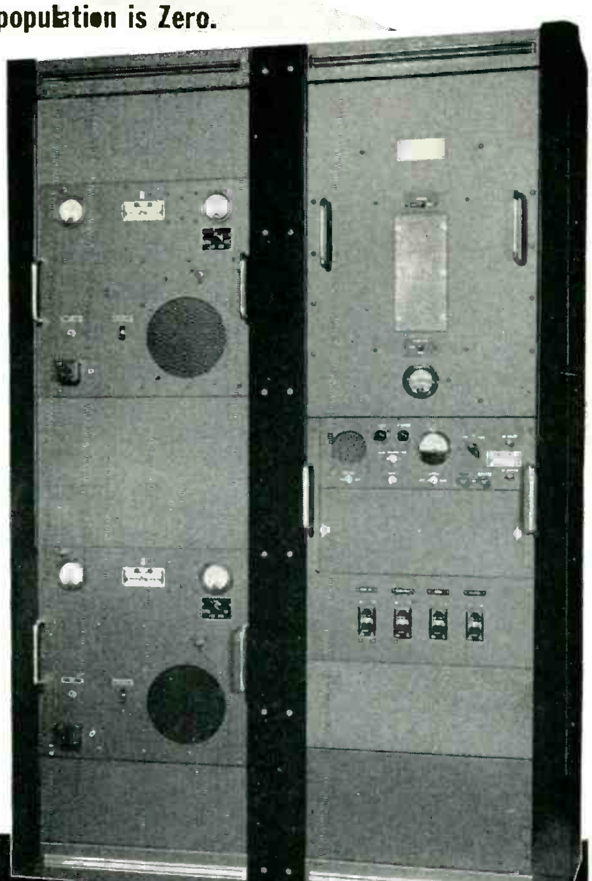
Transmitter. This transmitter was designed and built
to provide long, trouble-free service with no attendants . . .
even where the total population is Zero.

AEROCOM'S

Dual Automatic Package-Type Radio Beacon



for completely unattended service. This aerophare (illustrated) consists of two 100 watt (or 50 watt) transmitters, one AK-3B keyer, one ACA automatic transfer, and an antenna tuner. (Power needed 110 volt or 220 volt – 50/60 cycles)

Frequency range 200 – 415 Kcs.: self-contained P. A. coil covers entire range; 1 "plug-in" crystal oscillator coil covers 200 – 290 Kcs., other 290 – 415 Kcs, (Self-excited oscillator coils covering same ranges are available). High level plate modulation of final amplifier is used, giving 35% tone modulation in 100 watt transmitter and 35 – 50% in 50 watt model. Microphone P-T Switch when depressed interrupts tone, permitting voice operation.

Using 866A rectifiers, unit can be operated in air temperature range 0°c to + 45°c; using 3B25 rectifiers, – 35°c to + 45°c; humidity up to 95%.

Aerocom's Automatic Transfer unit will place the "stand-by" transmitter in operation when main transmitter suffers loss (or low level) of carrier power or modulation. The characteristics of the keyed call letters are so modified on "stand-by" that a distant monitoring station can determine whether the main or "stand-by" transmitter is operating.

Unit is ruggedly constructed and conservatively rated, providing low operating and maintenance costs. Engineering data on this unit and other Aerocom communications products are available on request.

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pedance matching such as the length of coaxial cable used to produce capacitive reactance. Reference to Fig. 2C shows that the series resonant circuit includes a resistance of 51.5 ohms. The total series inductive reactance has been calculated as 296 ohms. Thus, the Q of the series circuit is 5.75. Obviously, the feed system is a wide-band device compared to the three-element parasitic array on which it is used.

The 29-mc beam antenna was next checked for line current balance. The pattern of the antenna was first measured with a field-strength meter. Maximum radiation was found to be perpendicular to the antenna elements. An unbalanced antenna will usually show an altered pattern with the maxima occuring slightly off center. The field-strength meter was then positioned a fixed distance from each antenna-element tip in turn and the deflection of the meter was found to be the same in each case. This test indicates that the voltage at each antenna tip is the same. Small incandescent bulbs hung from each end of the antenna showed the same brilliance.

Further Tests

Next, the center conductor was broken close to the first driving point where the conductor emerged from the shield. A receiver connected to the line was now completely dead. The absence of pickup showed that the cable had no signal pickup of its own. Type RG-8/U cable may be used to carry transmitter outputs of two kw or so with the line matched. A standing wave exists in the capacitive shorted line section. Therefore care must be used to select a line of sufficient insulation capacity. For a one-kilowatt transmitter the line current which must flow through the matching section is 4.41 amperes.

The voltage drop across the capacitive section of coax is 1,310 volts. This voltage appears between the inner conductor and the shield of the capacitive matching section at the point where the inner conductor enters the shield. Since RG-8/U has a maximum voltage rating of 4,000 volts rms, it should

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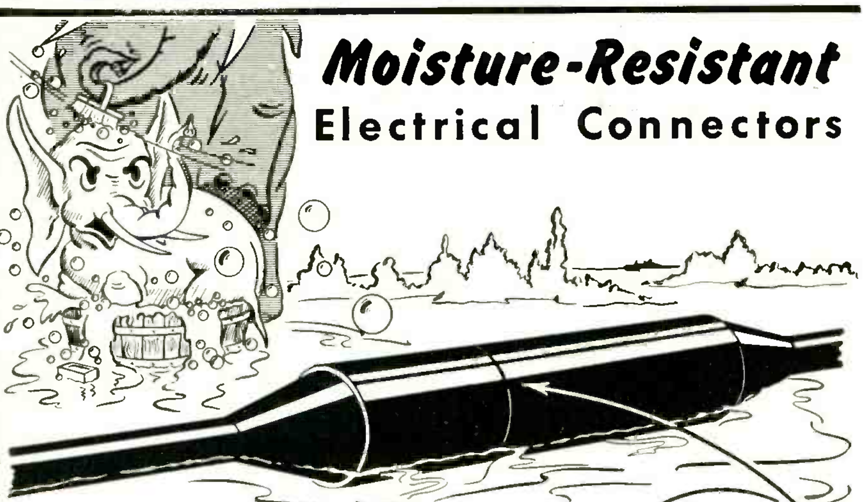
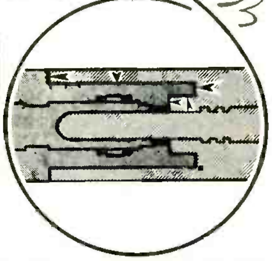
Electrical Connectors



No question about it . . . JOY plugs and sockets are today's outstanding electrical connector value! Molded as one-piece Neoprene units and factory vulcanized to cords, they won't crack or shatter under hard blows—are surprisingly immune to climatic changes—and are trim, safe and easy to handle. Whenever advantageous, JOY Connectors are equipped with the famous MINES "Water-Sealing" face. Cut-away illustration in circle shows how close fitting segments on mating Male and Female plugs positively "*Seal-out*" dirt and moisture by enclosing contacts in a resilient rubber housing. Ask for a complete description on this and other advantages that only JOY Connectors provide.

A wide variety of sizes, shapes and pin combinations are available to meet the portable power requirements of TV, FM, AM or PA Circuits. Illustrations show JOY'S No. 2C156M Portable Male Plug and No. 2C156F Portable Female.



MALE & FEMALE PLUG ENGAGED
Note 5-way WATER-SEAL (arrows)

ME-150.3

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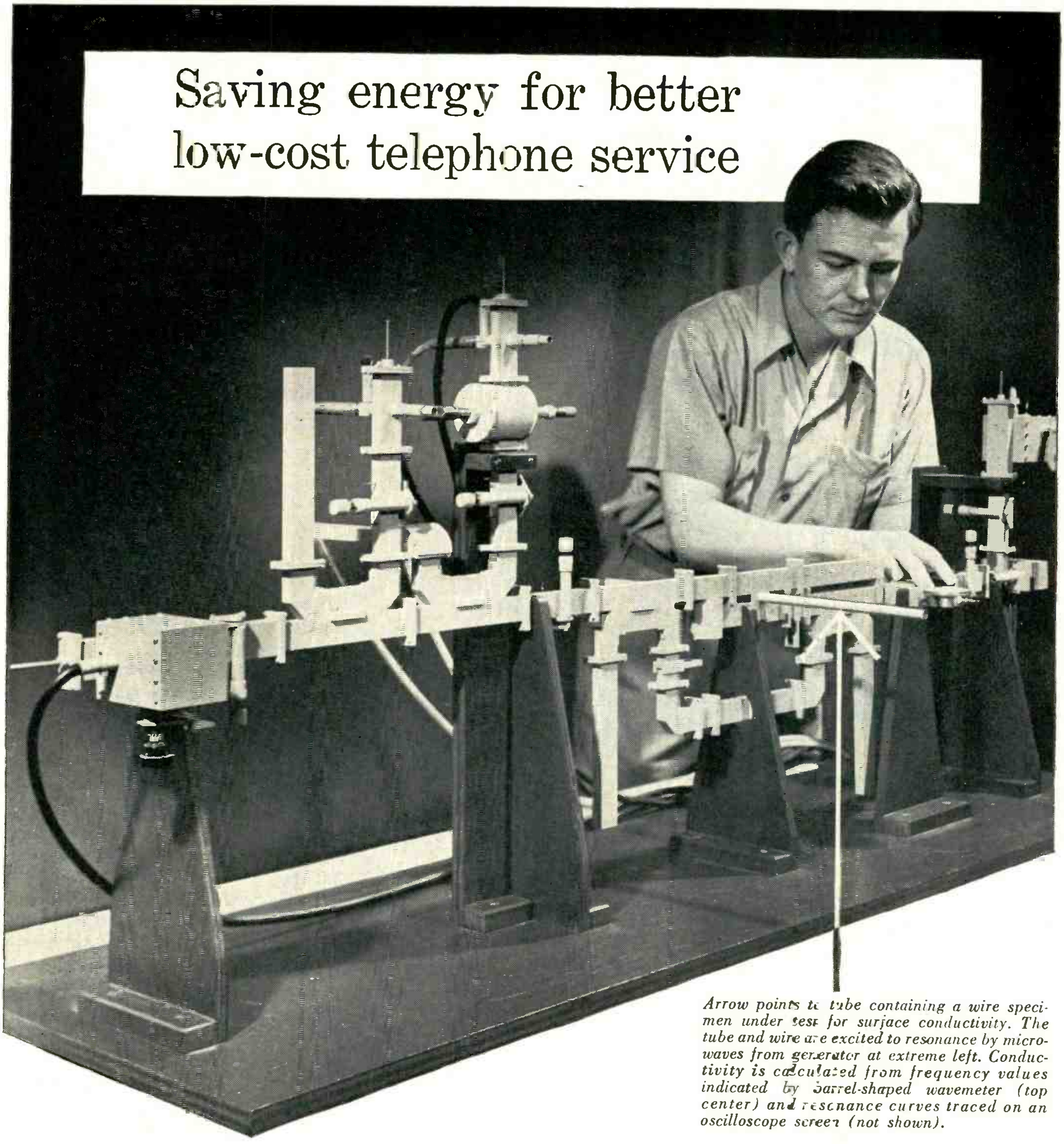

Arrow points to tube containing a wire specimen under test for surface conductivity. The tube and wire are excited to resonance by microwaves from generator at extreme left. Conductivity is calculated from frequency values indicated by barrel-shaped wavemeter (top center) and resonance curves traced on an oscilloscope screen (not shown).

In the waveguides which conduct microwaves to and from the antennas of radio relay systems, current is concentrated in a surface layer less than 1/10,000 inch thick, on the inner surface of the waveguide. When these surfaces conduct poorly, energy is lost.

To investigate, Bell radio scientists devised exact methods to explore this skin effect at microwave frequencies.

Scratches and corrosion, they found, increase losses by 50 per cent or more. Even silver plating, smooth to the eye, can more than double the losses of a polished metal. Very smooth conductors, like electropolished copper, are best. An inexpensive coat of clear lacquer preserves initial high conductivity for many months.

Energy saved *inside* a microwave station is available for use in the radio-relay path *outside*. So stations can sometimes be spaced farther apart, and there will always be more of a margin against fading. Here is another example of the practical value of research at Bell Telephone Laboratories.

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REFERENCES

(1) King, Wing and Mimno, "Transmission Lines, Antennas and Wave Guides" p 145, First Edition, McGraw-Hill, New York.
(2) King, Wing, Mimno, "Transmission Lines, Antennas and Wave Guides", p 158, First Edition, McGraw-Hill, New York.
(3) E. K. Sandeman, "Radio Engineering," 1, p 687, John Wiley & Sons, New York 1948.
(4) F. E. Terman, "Radio Engineers Handbook," p 48, First Edition, McGraw-Hill, New York.

British Developments in Instrumentation

By John H. Jupe
Middlesex, England

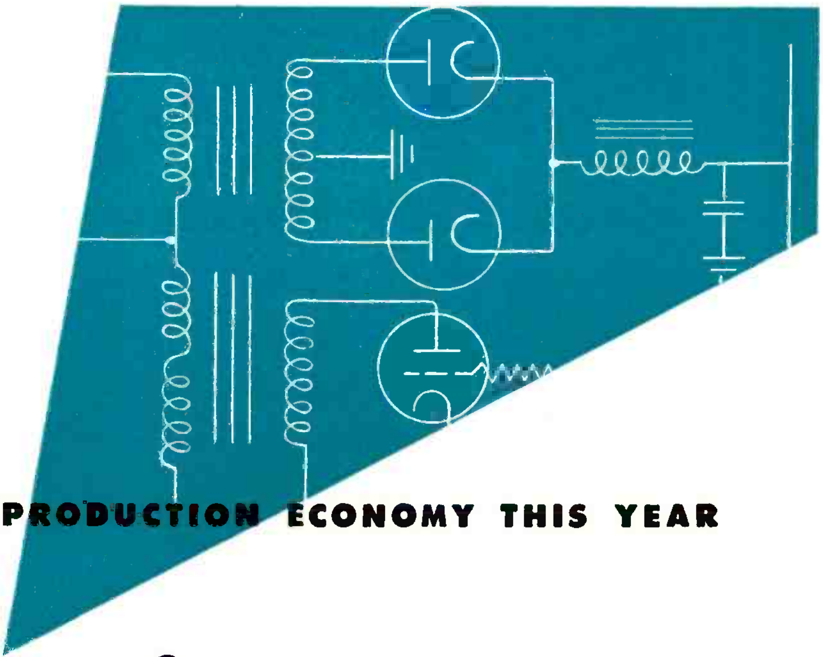
A REVIEW of recent developments in Britain discloses some novel applications of electron tubes at work, particularly in the field of scientific instrumentation.

It is sometimes required to know the size of carbon particles in luminous flames. A particle size meter has been developed by the British Iron and Steel Research Association to do this efficiently.

The instrument uses an interrupted parallel beam of ultraviolet light which is allowed to impinge on the region of the flame under examination. The cloud of luminous carbon particles in the flame will scatter the ultraviolet light which is then detected by a multiplier-type photoelectric cell and a-c amplifier. A small monochromator is interposed to select the light falling onto the photocell. By making the wavelength of the light comparable with the size of the particles, the character of the scattering is very dependent on the size, which can thus be measured in terms of the amplified photocell current.

Midget Magnetometer

It has been known for a long time that if the metal germanium is prepared with a sufficient degree of purity it exhibits a pronounced Hall effect, its electrical resistance is a measure of the magnetic field in which the metal is placed. This effect has now been used as a basis of simple, self-contained instru-



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Audio fidelity of a television receiver is tested in the echo-free room built by General Electric Co. Ltd. of England

ments for measuring and exploring magnetic fields.

A small flake of germanium $\frac{1}{8} \times \frac{1}{16} \times 0.015$-inch in thickness is mounted in a probe and is thus capable of being used to measure field strengths in very small gaps. This instrument has an overall range of 0 to 25,000 gauss, in three ranges and has a direct-reading microammeter indicator.

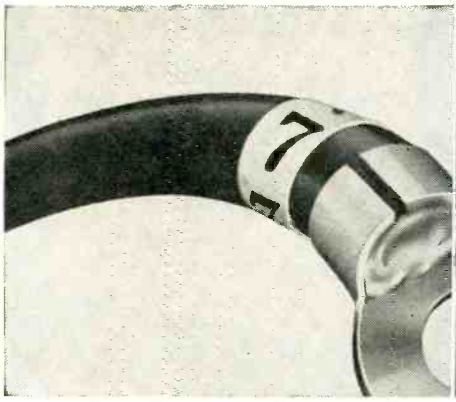
A recent pyrometer development for use at temperatures above 750 C consists of a back-silvered, heat-resisting glass hemisphere. This is so made that black-body radiation can pass out through a small unsilvered hole at the top of the hemisphere, while radiations of wavelength longer than 2.5 μ are absorbed by the glass. This prevents reflected radiation from interfering with the heat loss from the surface. A calibrated photocell with a very quick response, an alkali-metal cell, is placed behind the unsilvered hole and the cell current will then be a measure of the true temperature of the surface under examination.

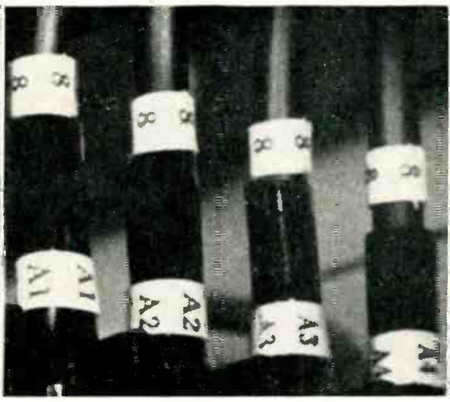
Echo-Free Room

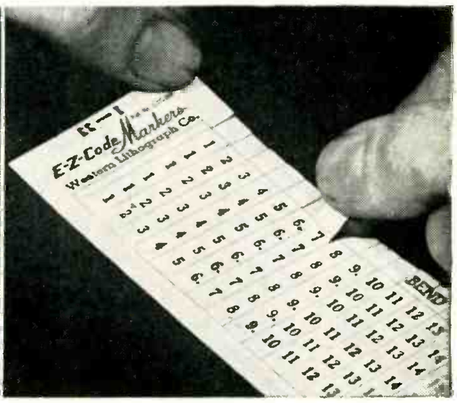
A piece of equipment which has many uses in the electronic and other electrical fields, as well as in mechanical engineering, is an echo-free room.

Such a room has recently been installed by engineers of the General

compare the speed, economy, accuracy of product marking by E-Z CODE







E-Z CODES are applied with finger-tip pressure, without moistening. They stick permanently . . . will not pop, peel or curl even in extremes of heat and humidity . . . or when pulled through conduit. E-Z Codes provide the fastest, most accurate and inexpensive method of wire marking.

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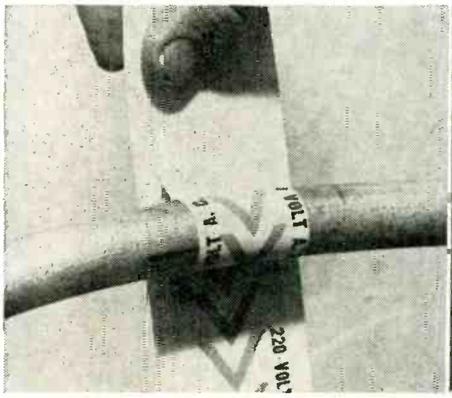
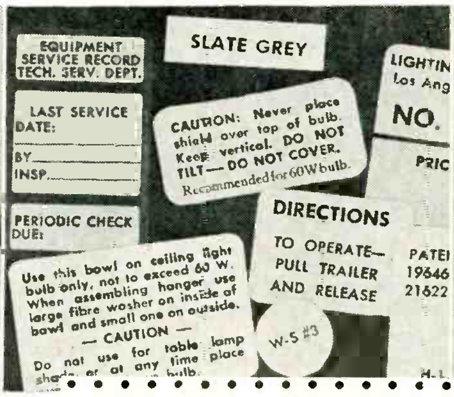
E-Z CODE PIPE, CABLE AND CONDUIT MARKERS provide a fast, accurate method of identifying pipe, cable and conduit lines at a fraction of the cost of painting or other methods. Self-adhesive strips in standard wording, or printed to your specifications, may be applied without moistening by inexperienced help in a few seconds. They last indefinitely.

USE THESE for inspection or rejection, instruction or warning labels in production, repair or service work. Westline pressure-sensitive labels are applied without moistening. They will not pop, peel or curl even under extremes of heat and humidity . . . yet are easily peeled off without harming surface.

WESTLINE SELF-BACKING, pressure sensitive tape on either cellophane, acetate film, paper or cloth stock can be furnished plain or printed with your message, and in size required. Widths from ¼" to 3". Lengths from 648" to 2592". Ideal for advertising or production installation and service data. Apply without moistening. They stick until time for removal.





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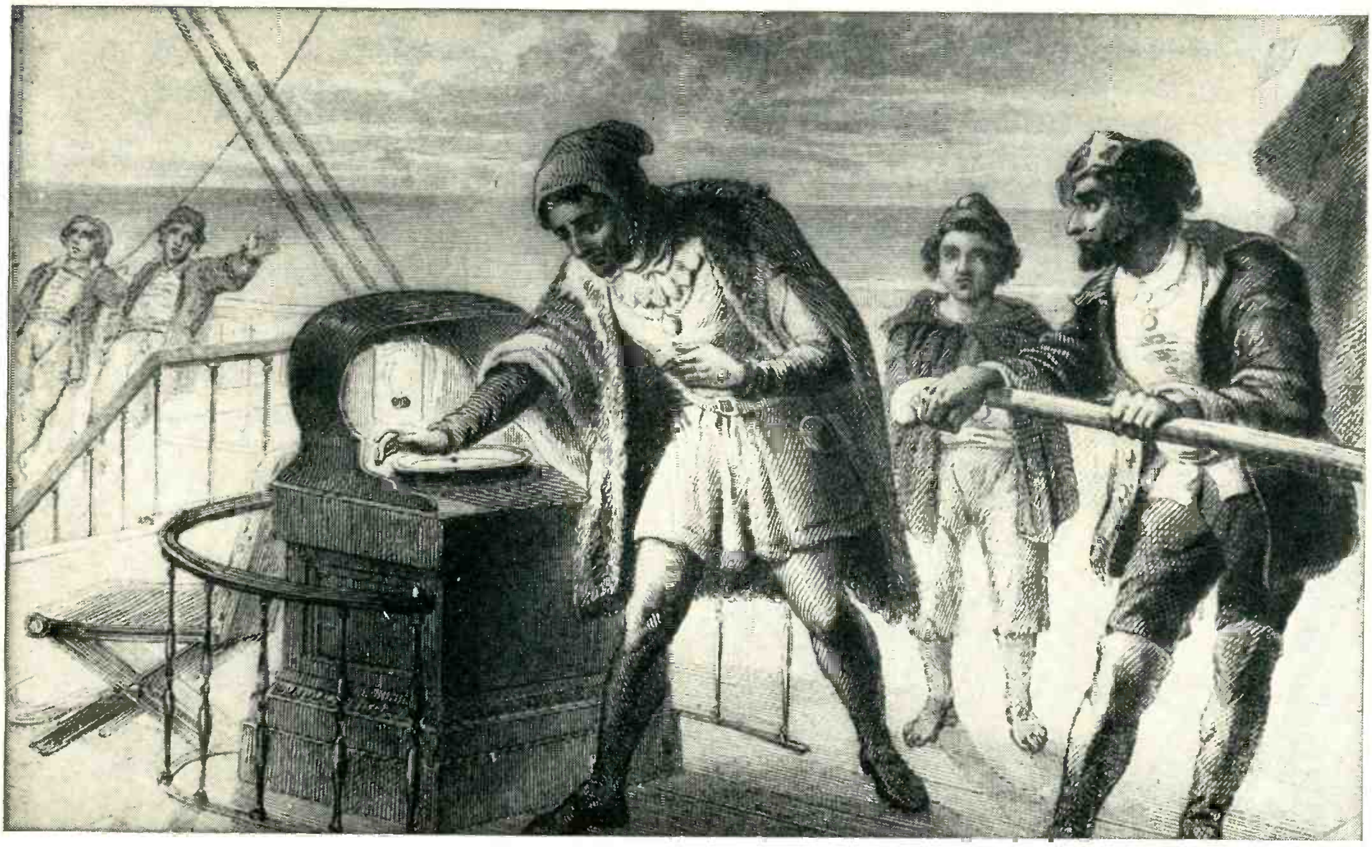

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Electric Co., Ltd. of England.

The size of the room is about 18 × 13 × 13 feet, before lining, and the walls, floor and ceiling are covered with nearly 3,000 Fibreglass wedges, each 3 feet long. These wedges are not supported by the usual eggbox construction but are in a welded wire frame arranged so as to produce the minimum sound reflection.

The door, which is also covered with wedges, presented an unusual engineering problem. Although the door opening is only 2½ feet wide the attached wedges are 3½ deep overall and so the tips would become damaged if the door were to open and shut in the usual way. To remove this difficulty the hinges of the door are designed so that it moves at right angles to the wall of the room during the final stage of closing. This is done by guiding it in tracks at right angles to the wall.

Inside the room, two overhead tracks have been fitted at right angles to each other. Their purpose is to enable the microphone carriages to be moved. An important feature of these carriages is that they have automatic brakes which ensure that a microphone cannot move during tests.

Across the floor of the room is a trolley track ending in a turntable. This enables heavy objects to be wheeled into the room on the track through the door, revolved on the turntable and suitably positioned in the room. Although the turntable is very useful for positioning equipment, it was included mainly for measuring the sound distribution round an object, for example, determining the polar response curve of a microphone. Means are provided for rotating the turntable from outside the room.

The floor of the room is lined with wedges and immediately above their tips is a wire mesh false floor which is virtually "transparent" to sound. When the greatest accuracy is required this mesh can be removed, together with most of the track and supporting posts.

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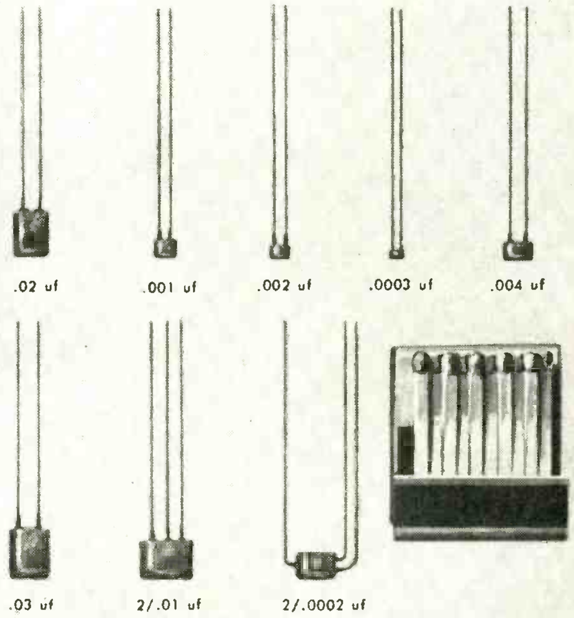

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FOR COUPLING AND BYPASS APPLICATIONS

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.25	.19	.18	.15	.001				
.50	.40	.28	.25	.005				
.70	.52	.50	.40	.01	.30	.19		
		.80	.60	.05	.61	.43	.48	.33
				.10	.88	.62	.65	.45
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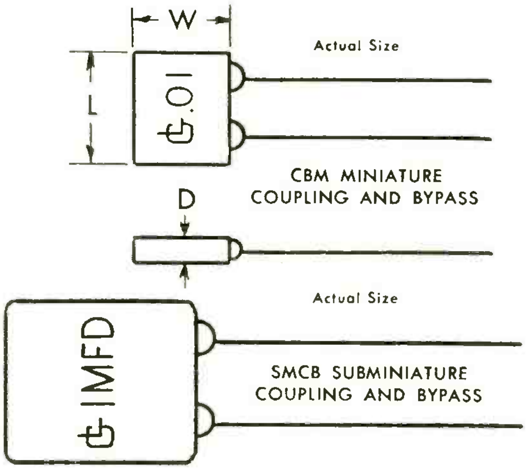
*Types CBM and SMCB are shown as typical examples of the space saving possible with GLENCO capacitors. Many more standard types, including a great variety of temperature compensating ceramic capacitors, are available. Quotations on these or types to customers' specification will be supplied promptly on request.



TYPE TC **— TEMPERATURE COMPENSATING CERAMIC PLATE CAPACITORS**

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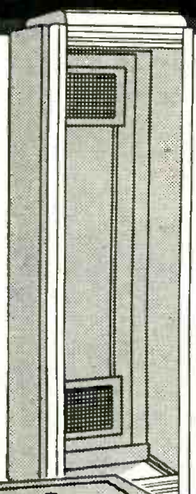
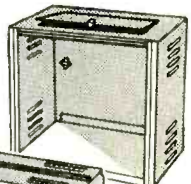
CABINETS • CHASSIS • PANELS • RACKS

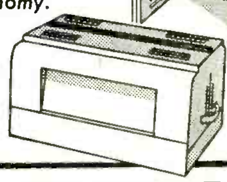
Planning ELECTRONIC EQUIPMENT ?
Investigate the ECONOMIES of PAR-METAL HOUSINGS !



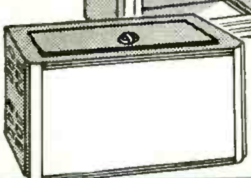
We manufacture Metal Housings for every purpose — from a *small receiver to a deluxe broadcast transmitter*. And the cost is low!

Because *we specialize in the Electronics field*, Par-Metal Products excel in *functional streamlined design, rugged construction, beautiful finish*, and economy.





Remember, Par-Metal equipment is made by *electronic specialists*, not just a sheet metal shop.



Par-Metal Electronic Housings

PAR-METAL
PRODUCTS CORPORATION
32-62 — 49th ST., LONG ISLAND CITY 3, N. Y.
Export Dept.: Rocke International Corp.
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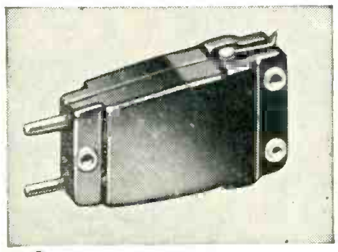
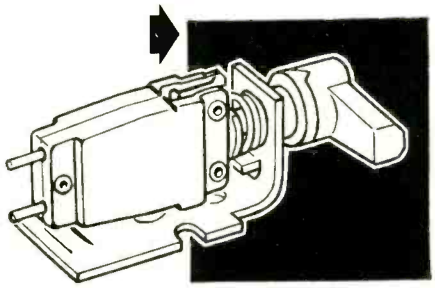
for 3 speed playing



WEBSTER ELECTRIC MODEL "A" CARTRIDGE with TWIST MECHANISM



- Outstanding performance . . . small streamline design that fits modern tone arms.
- No chance to damage leads or play in incorrect position.
- Easy installation.

The Model "A" cartridge and twist mechanism are assembled at factory ready for installation in tone arm . . . no adjustment or modification necessary. Completely assembled it gives positive tracking at all playing speeds. High vertical and lateral compliance eliminates "skating." Positive indexing eliminates the possibility of twisting and damaging leads. The cartridge rotates through a 180 degree arc for playing either 33⅓, 45 or 78 R.P.M. records. There are no parts to get out of order. Write for data sheet and prices. Webster Electric Co., Racine, Wisconsin. Established 1909.

WEBSTER ELECTRIC
RACINE • WISCONSIN
"Where Quality is a Responsibility and Fair Dealing an Obligation"

GLOBAR brand ceramic resistors offer unusual and valuable characteristics for bettering circuit performance in radio, television and industrial applications. Manufactured to meet your exact specifications, these resistors assure extreme accuracy of operation. Precision methods of control and inspection in their manufacture provide maximum uniformity and dependability.

The accompanying table lists a few different types of resistors available. GLOBAR engineers will be glad to work with you in applying any of these or other types to your designs. In the meantime, obtain more complete information by writing for Bulletins R, GR-2 and GR-3. Address Dept. V-100, The Carborundum Company, GLOBAR Division, Niagara Falls, New York.

TYPE	CHARACTERISTICS	TYPICAL APPLICATIONS
A	Low negative voltage and temperature sensitivity.	General purpose resistor for radio receivers and transmitters.
B	Medium negative voltage and temperature sensitivity.	Instrument compensation. X-Ray equipment.
BNR	High negative voltage sensitivity.	Magnetic valves. Motor governors.
CX	Low negative voltage and low positive temperature sensitivity.	Radio transmitters for dummy antenna and parasitic suppressors.
F	High negative temperature sensitivity.	AC-DC radio receivers to prevent surge currents in tube and pilot light filaments.

GLOBAR Ceramic Resistors

BY CARBORUNDUM

TRADE MARK

"Carborundum" and "Globar" are registered trademarks which indicate manufacture by The Carborundum Company

or pressures and a new and interesting development in this field is a photoelectric pressure gage by C.A.V. Ltd and Ricardo and Co. Ltd.

The principle of the device is that displacements or pressure differences are utilized to modulate a beam of light falling on to a photocell and the resulting electrical changes are ultimately applied to an oscilloscope where they are translated into direct indications of the quantities concerned.

The gaging mechanism is housed in a hollow metal cylinder and is composed of a light source, a slit of variable width and a photocell. The light beam is arranged to be parallel to the axis of the cylinder, which has the lamp and cell on either side of it. The slit, which is horizontal, is interposed in the beam.

For pressure measurements the edge of the slit shutter is linked to a horizontal circular diaphragm fixed to the base of the gage and moving with it. Pressures to be measured are applied to the diaphragm from a pipe.

For displacement measurements a different operating mechanism is used. It consists of an adaptor unit carrying a push rod which moves the slit shutter. The slit is decreased by upward displacement of the rod, which is restored to its normal position by a spring.

When the equipment is in use the current through the photocell varies directly with the width of the slit, providing that this is over 4 mils. The current change never exceeds approximately 1.9μ amp and a change of this order corresponds to variation of the slit by about 5 mils.

Generally speaking, the gage is connected to a voltage amplifier which feeds the oscilloscope, the cell output being taken from a 100,000-ohm resistor. For applications involving vibration or other rapidly-varying effects, the frequency response of the gage is important and is limited by the photocell circuit, either the cell itself or the time constant of the output circuit, which is determined by the output resistance and any stray capacitance which is effectively connected in parallel with it.

Calibration of both the pressure

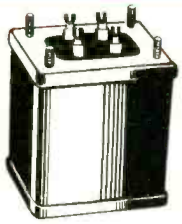
FREED

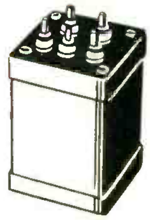
TRANSFORMERS & INSTRUMENTS

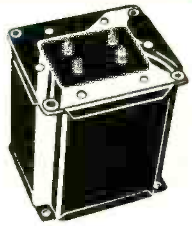
"PRODUCTS OF EXTENSIVE RESEARCH


NO. 1060 VACUUM TUBE VOLTMETER INPUT IMPEDANCE 50 MEGOHMS


NO. 1030 LOW FREQUENCY "Q" INDICATOR


HIGH FIDELITY TRANSFORMERS ½ DB 20 CPS TO 30 KC


DISCRIMINATORS 10 CPS TO 1 MC

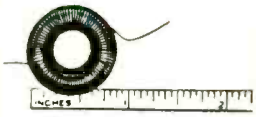

COMMERCIAL COMPONENTS QUALITY — DEPENDABILITY — PRICE


NO. 1140 NULL DETECTOR COMPLETE WITH SELECTIVE CIRCUITS


NO. 1020 MEGOHMMETER 2,000,000 MEGOHMS DIRECT READING

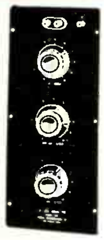

HERMETICALLY SEALED COMPONENTS TO MEET MIL-T-27 SPECS.

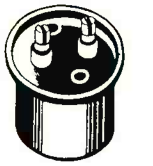

TOROIDAL INDUCTORS 60 CPS TO 1 MC

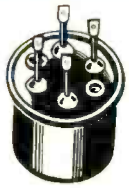


MINIATURE INDUCTORS 1000 CPS TO 100 KC

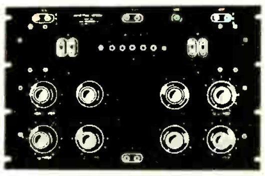

NO. 1210 NULL DETECTOR & VACUUM TUBE VOLTMETER

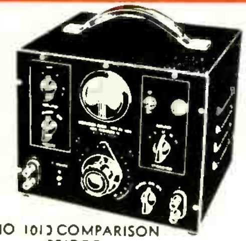

DECADE INDUCTORS 30 CPS TO 300 KC

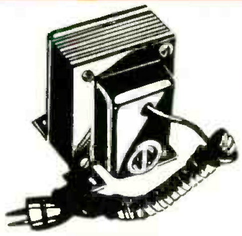

SUB MINIATURE HERMETICALLY SEALED TOROIDAL INDUCTORS

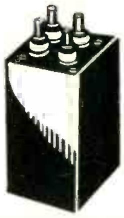

SUB MINIATURE HERMETICALLY SEALED COMMUNICATION COMPONENTS

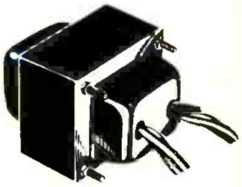

SLUG TUNED COMPONENTS 1000 CPS TO 1 MC


NO. 1150 UNIVERSAL BRIDGE 5 A.C. BRIDGES IN ONE UNIT


NO. 1010 COMPARISON BRIDGE FAST, ACCURATE, RELIABLE

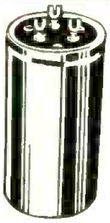

STEPDOWN TRANSFORMERS 50 WATTS TO 3 KW

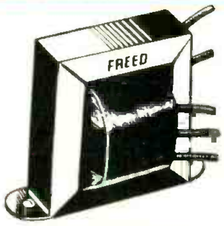

PULSE TRANSFORMERS FROM WATTS TO MEGAWATTS


POWER TRANSFORMERS RUGGED, DEPENDABLE, INEXPENSIVE.

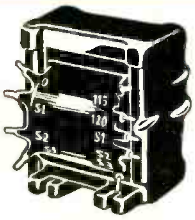

1170 D.C. SUPPLY DIRECT CURRENT UP TO 500 MA.


NO. 1110 INCREMENTAL INDUCTANCE BRIDGE A NECESSITY FOR EVERY LAB.


PRECISION FILTERS 10 CPS. TO 1 MC.



CHANNEL MOUNTING INEXPENSIVE—RELIABLE


FOSTERITE TREATMENT ANE-19 SPECS.

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FREED TRANSFORMER CO., INC.

DEPT. OE 1718-36 WEIRFIELD ST., (RIDGEWOOD) BROOKLYN 27, NEW YORK

and displacement types is done by applying known quantities and then noting the corresponding indications on the c-r tube. This method has the advantage that it can be applied quickly and it reduces to a minimum the errors which could arise owing to changes in the gage during the interval between calibrating instrument and using it.

Believed to be the first practical instrument of its kind for general use, an ionization voltage tester has been designed as a simple means of determining the threshhold voltage at which ionization occurs in a dielectric. It should prove of considerable value in researches into insulating materials.

The instrument consists of two main circuits, the first containing a generator of direct voltage, continuously adjustable up to a maximum of 5 kv by means of a single control. The positive pole of the generator is taken, via an output terminal, to the material under test, which is series-connected to the second circuit, which forms the input of a detector-amplifier. Output from the amplifier is fed into a small loudspeaker and a cathode-ray indicator is included to denote the passage of current.

As the voltage across the sample is increased, a point is reached when ionization commences and is denoted by a popping sound in the loudspeaker. A volume control is provided to enable the sound to be adjusted to a convenient level, because the intensity and frequency of the sound increases as ionization progresses. Simultaneously the miniature c-r tube indicates direct-current flow.

The instrument has a wide range of uses, testing of cables, motors, insulation on wires, high-value resistors; also the detection of ionization in gas pockets in insulation or dielectrics.

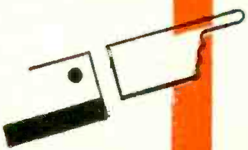
New Photocells

Developments in the field of photo-conductive cells include a miniature lead-sulphide cell of small size and simple construction for use in applications where the cell will not be cooler; a new pattern coolable lead-sulphide cell incorporating numerous improvements including interchangeable de-

Once Again

MITCHELL-RAND

Demonstrates Leadership!



Produces 2 new Wax Compounds for greater protection against extreme high heat and extreme low temperatures!

3760 HIGH MELTING POINT WAX
for Impregnating and Dip Coating

won't flow under extreme high heat
won't crack under extreme cold!

3767-A CORONA SUPPRESSING PLASTIC
for Dip Coating

won't sag or sweat under extreme heat
won't crack under extreme cold!

SPECIFICATIONS

3760

MELTING POINT (DRIP)	260/265 F
COLD FLOW (M-R)	250/255 F
PENETRATIONS	
32/200/60	15-16
77/100/5	17-19
115/50/5	20-22
COLOR	Tan
APPLICATION TEMPERATURE	300/350 F
SPECIFIC GRAVITY	0.90
VISCOSITY (SAYBLT. UNIV.) @ 325 F	40-42 seconds
FLASH POINT	500 F
ELECTRICAL PROPERTIES	
POWER FACTOR	0.023 (10^6 cycles; 77 F)
DIELECTRIC CONSTANT	2.19 (10^6 cycles; 77 F)

3767-A

COLD FLOW (M-R)	272/277 F
SOFTENING POINT (B&R)	190/195 F
DIPPING TEMPERATURE	325/375 F
MELTING POINT (DRIP)	275/285 F
COLOR	Tan
ADHESION	Good
PENETRATION 77/100/5	8-10
SPECIFIC GRAVITY	1.01
FLASH POINT	480 F
ELECTRICAL PROPERTIES (Representative Sample)	
Dielectric Strength	368 V/mil (77 F; 60 Cycles)
Dielectric Constant	2.51 (77 F; 10^6 Cycles)
Power Factor	0.0069 (77 F; 10^6 Cycles)

3760, Impregnating and Dip Coating WAX COMPOUND, was developed to meet the needs of applications which must resist flow at temperatures above the boiling point of water, and also which must resist cracking at temperatures below zero degrees F.

3760, with good electrical properties, resistance to bleeding at high temperatures, low application viscosity and high drip melting point, is recommended for moisture proofing coils, transformers, capacitors, etc.

TESTS—HIGH TEMPERATURE

Using paper tubular capacitor samples, the tubes were impregnated with, and the assembled units were flash dipped in 3760 (coating approximately 15 mils thick), the units were then subjected to oven tests at 220 F for 24 hours. NO SAGGING OR BLEEDING OF THE COATING WAS EVIDENT.

TESTS—LOW TEMPERATURE

The same units were cold tested by being placed in a cold chamber at —40 F for a period of one hour. The units were then removed and permitted to return to room temperature. INSPECTION SHOWED THAT THIS LOW TEMPERATURE TREATMENT CAUSED NO CRACKS IN THE COATING OF 3760 . . . and the surface obtained by dip coating with 3760 showed good resistance to blocking at temperatures normally encountered in shipping.

3767-A, CORONA SUPPRESSING PLASTIC, was developed to reduce or eliminate corona around certain points on television components, and similar electrical parts, which operate at high potentials. Application in the form of a corona suppressing "tire" on the periphery of "flyback" transformer coils and similar units is the primary function of 3767-A. The customary method for applying 3767-A is to dip or roll the units to be coated in a molten bath of the insulation.

Since low power factor and high dielectric strength are particularly desirable in this type of insulation, this material combines the best possible electrical properties consistent with the necessary physical properties. The surface obtained with this corona suppressing plastic is particularly smooth and free from ridges and bumps. This feature of itself reduces the evolution of corona. During the development of 3767-A particular attention was given to the physical stability of applied coatings at extremes of high and low temperatures.

FUNCTIONAL TESTS of this material applied in moderately heavy coatings on flyback transformer coils SHOWED THAT 3767-A WILL WITHSTAND A CYCLE OF 24 HOURS AT —40 C FOLLOWED BY 24 HOURS AT 125 C WITHOUT THE APPEARANCE OF CRACKS AT THE LOW TEMPERATURE OR SAGGING AND SWEATING AT THE HIGH TEMPERATURE.

Write for your laboratory test samples . . . free upon request.

MITCHELL-RAND INSULATION CO. Inc.

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A PARTIAL LIST OF M-R PRODUCTS: FIBERGLAS VARNISHED TUBING, TAPE AND CLOTH • INSULATING PAPERS AND TWINES • CABLE FILLING AND POTHEAD COMPOUNDS • FRICTION TAPE AND SPLICE • TRANSFORMER COMPOUNDS • FIBERGLAS SATURATED SLEEVING • ASBESTOS SLEEVING AND TAPE • VARNISHED CAMBRIC CLOTH AND TAPE • MICA PLATE, TAPE, PAPER, CLOTH, TUBING • FIBERGLAS BRAIDED SLEEVING • COTTON TAPES, WEBBINGS AND SLEEVINGS • IMPREGNATED VARNISH TUBING • INSULATED VARNISHES OF ALL TYPES • EXTRUDED PLASTIC TUBING

vices for use with liquid air, solid CO_2 or circulating water as constant-temperature coolants, and a window of special glass with good transmission even as far as the long wavelength limit of sensitivity attained at liquid air temperature (about 4μ); and an experimental lead-selenide cell with sensitivity (at liquid air temperature) to cover 5μ.

There has been investigation into the dependence of resistance and photosensitivity of lead-sulphide cells upon the surroundings with the cell maintained at temperatures down to that of liquid air. Screening the sensitive material from room-temperature radiation has been shown to give a ten-fold or more increase in resistance and also in sensitivity at temperatures near those of liquid air.

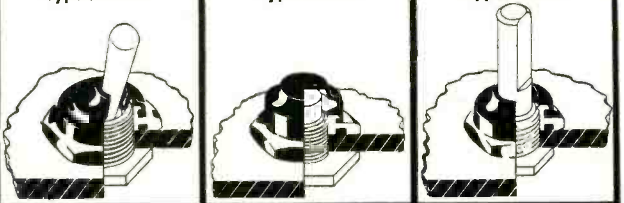
An instrument based on what is believed to be an entirely new principle in connection with the detection of smoke uses a sensitive "nose" which actuates an alarm as soon as the concentration of smoke reaches a predetermined value.

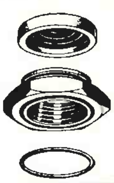
The nose contains an ionization chamber which is open to the atmosphere to be sampled. A source of radioactivity maintains the air within the chamber in an ionized condition and a potential applied across the chamber causes a small current to flow. Smoke particles entering the chamber produce a sharp variation in the current and this effect is used to actuate an electronic tube of the cold-cathode type. The alarm circuit follows conventional practice.

Modulated Photocell

In many photocell applications where the light falling on the cell is steady or only changing very slowly, it is necessary to chop the d-c signals generated so that they can be amplified by high-gain, stable a-c amplifiers. This difficulty has now been overcome by subjecting the photocell itself to an alternating magnetic field, which causes the output signal from the cell to appear as an a-c voltage, thus dispensing with mechanical aids for chopping d-c signals. Such an instrument can be made sensitive to a few microlumens and is therefore useful for the measurement of

for Toggle Switches Type H-1267 | for Push Buttons Type H-2475 | for Control Shafts Type H-1268





NOW---FOR PENNIES---YOU CAN

SEAL OUT

FUMES, DIRT AND MOISTURE AT SWITCHES AND CONTROL SHAFTS

WITH RFL SEALNUTS!

HERE'S WHY . . . MATERIALS: Cap and O-Ring of flexible, close-hugging, long-wearing Neoprene • Nut of weather-resistant, nickle-plated brass • TEMPERATURE RANGES: Standard Type (+100° C to −40° C), Low Temperature Type (+100° C to −50° C) • WEATHERING CHARACTERISTICS: Unaffected by sun or moisture, SEALNUTS keep their positive seals indefinitely • OPERATING LIFE: 10,000 cycles (minimum)

MOUNT AND SEAL YOUR SWITCHES WITH LOW-COST SEALNUTS

Write for illustrated literature, or send $2.00 for generous "Get-Acquainted Package", containing liberal assortment for control shaft, toggle and push button switches.

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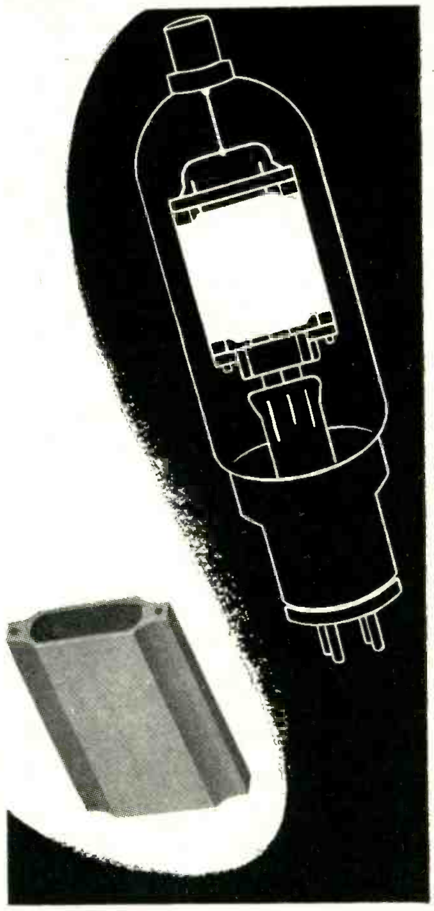
RADIO FREQUENCY LABORATORIES INC.

Boonton 1, New Jersey



GRAPHITE ANODE TUBES CUT FREQUENCY DRIFT

Frequency drift is a major problem in modern precision electronic equipment. With Speer graphite anodes, frequency drift hits *new lows!*

Here's why: Graphite anode tubes are *non-warping*. Tube characteristics will remain uniform. Interelectrode capacitances stay constant. Warping in other tube elements is inhibited. Power ratings are raised—as high as 200 to 300 percent. Thanks to their lower operating temperatures, graphite anode tubes have exceptionally long life . . . withstand hardest usage.

Whether they're used in power, rectifier, or modulator vacuum tubes, Speer graphite anodes are instrumental in bringing increased efficiency to modern electronics. Rectifiers, FM and short wave transmitters, diathermy, and many other types of equipment give better service—thanks to the tube with the graphite anode.

Speer

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Zophar Mills, Inc. has been known for its dependable service and uniformity of product since 1846.

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Get more from your test equipment with

RCA ACCESSORIES

NEW RCA High-Voltage Probes—WG-289, WG-290

Extend dc voltage range of your instrument to 50 kv.

Only $9.95 Complete with resistor. Suggested User Price.

The last word in high-voltage probes for measuring the voltage of TV power supplies and other high-voltage sources. Has *six* safety features, including anti-corona probe tip, completely insulated grip, and separate ground lead. Multiplier resistors available to adapt probes for practically all popular volt-ohm-meters. Provides high input resistance for accurate voltage readings without loading circuit. The WG-289 and WG-290 Probes are identical except for their connectors. The WG-289 has microphone-type connector; WG-290 has phone-tip connectors.

NOW... the RCA TV Isotap WP-25A—

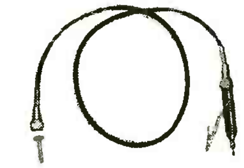
A combination Isolation-Autotransformer for Television Servicing

Only $17.95 Suggested User Price.

The answer to safe, accurate and speedy servicing of TV receivers . . . the RCA WP-25A TV Isotap provides *normal line voltage* for testing sets against manufacturer's rated specifications . . . *high line voltage* to show up all the intermittents and faulty components . . . *low line voltage* to test receivers under conditions similar to those found in some customers' homes . . . *line isolation* to prevent shorts, shocks, and damage to test equipment . . . *line matching,* from 105 to 130 volts, in 5-volt steps . . . 500 *volt-amperes continuous output* from autotransformer winding; or 275 volt-ampere load from isolated secondary winding.

AVAILABLE FROM YOUR RCA TEST EQUIPMENT DISTRIBUTOR

RCA WG-263 CRYSTAL PROBE



Converts VoltOhmyst* Meters 163, 165, 165-A, 195, 195-A, WV-65A, WV-75A, and WV-95A into VHF voltmeters for use up to 100 Mc; also used with Chanalyst* Analyzers Types 162, 162-A, 162-B, 162-C and 170-A. Can be used for relative readings to 175 Mc. Price: $8.95.

*Trade Mark, Reg. U. S. Pat. Off.

RCA WG-275 DIODE PROBE

Designed to operate with RCA Volt-Ohmyst* Electronic Meters WV-75A or WV-95A, for reading rms or peak-to-peak voltages at frequencies from 30 cycles to 250 Mc. The probe fits coaxial "T" connectors, and permits direct measurement of voltages in coaxial lines. Price: $30.00.

*Trade Mark, Reg. U. S. Pat. Off.

RCA WG-265 MINIATURE TESTPOINT ADAPTER

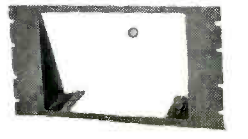
Makes your trouble-shooting faster, easier, safer by making tube-base connections accessible on the tube side of the chassis. Pins on one end of the adapter fit a 7-pin miniature socket, and socket facilities on the opposite end accommodate all types of 7-pin miniature tubes. Tabs project for easy probe contact. Price $1.50.

RCA ISOTAP WP-24A FOR RADIO SERVICING

Eliminates shock hazard between ac/dc chassis and ground, speeds detection of receiver faults with high-low line tests, and facilitates testing at 117-volt design-center value. Has six-position primary switch and three secondary receptacles. Price: $8.95.

RCA WS-18A RACK-ADAPTER PANEL

For mounting any of the matched RCA Test Instruments in standard 19-inch relay racks. Dimensions, 10½" high, 19" wide, ⅛" thick. Price: $9.50.



RADIO CORPORATION of AMERICA
TEST EQUIPMENT — HARRISON, N. J.

density of films, infrared radiation and similar applications.

A recent British patent has disclosed that a variable permittivity dielectric can be made from a mixture of barium and strontium titanates in the ratio of 95 to 5, permittivity increasing as an applied alternating voltage is increased. This property can be utilized in various ways in electronic circuits by making capacitors which are voltage-sensitive and can thus be used to secure automatic selectivity or frequency control.

For example, if the two circuits of an interstage coupling of the bandpass type are precisely in tune for a given signal level, the progressive detuning of the circuit as the signal increases above this level can be achieved by including one of these new capacitors in the circuit. The detuning will automatically widen the acceptance band of the filter and can be made to give constant selectivity.

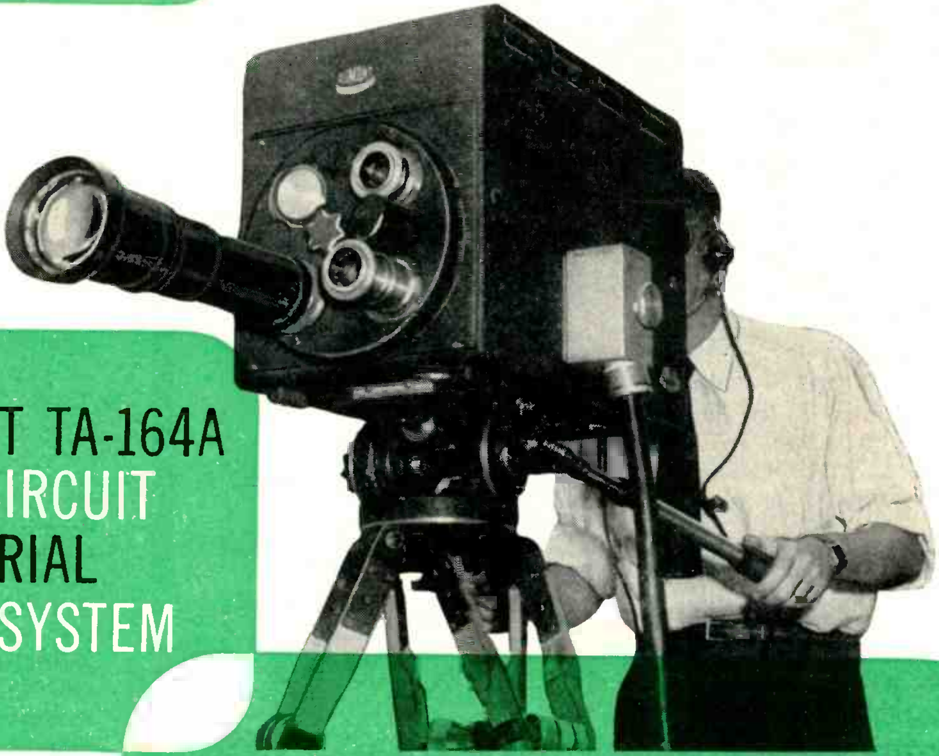
Fifteen C-R Tube Camera

A development in the cathode-ray tube field is a fifteen-channel crt camera with fifteen 1½-inch built-in tubes as an integral part of the unit. The tubes are mounted so that eight are on one side of the camera and seven on the other, with the screens of the tubes facing in the same direction as a pair of 3-inch f.2.9 lenses.

The latter are mounted at an angle of 36 degrees to each other and adjustable mirrors (one for each tube) are arranged in two batteries to reflect the traces on the fluorescent screens accurately along the axis of each lens. The traces are focused on a vertical zero line and the tubes are staggered to permit fifteen traces on a 70-mm film. Each trace is 7.5 mm wide, being reduced from one inch (25.4 mm) on the cathode ray screens and the dispositions on the film are such that the extremities of any of the traces belonging to the seven-tube group are on the midpoint of the neighboring traces of the eight-tube group.

Integral with the camera are two argon-filled discharge lamps which can be operated from an external circuit to give time marks on the film. One mark, in the form of a

now color tv for industry!



THE DU MONT TA-164A CLOSED CIRCUIT INDUSTRIAL COLOR TV SYSTEM

Now available! The Du Mont tried-and-proved industrial color television system in a complete, packaged, ready-to-operate form. Designed specifically for industrial applications, the new Du Mont TA-164A Industrial Color TV System provides bandwidth of 18 mc. and picture resolution of 525 lines. Full high-fidelity color from light pastels to deep colors.

Engineered to provide dependable day-in day-out service required by industry, research, medicine, merchandising and countless other fields. Compact, lightweight, portable units are joined by interconnecting cables utilizing the famous Du Mont "Jiffy" connectors assuring complete flexibility and the Du Mont kind of dependability. May be plugged into power line anywhere. Operates on 110-volt 60-cycle AC.

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Television Transmitter Division, Clifton, N.J.

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● Can't guarantee that the Varflex Line will solve every insulation problem. But . . . Many's the problem—large, small, unusual—that Varflex Electrical Sleeving or Tubing has solved. The Varflex range of application is vast—chances are you'll find the solution to your Electrical insulating problem somewhere in the Varflex line.

- **VARGLAS SILICONE.** That's the insulating sleeving and tubing—pioneered by Varflex—that takes temperatures ranging from 500° F above to 85° F below in its efficient, resistant stride. Lead wire and treated cord too.

- **VARGLAS TUBING IMPREGNATED WITH GENERAL ELECTRIC PERMAFIL.** Tough, flexible, heat-resistant—available in coils. Premium tubing at a reasonable price.

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

- **VARGLAS NON-FRAY SLEEVING.** Three types—may be subjected to temperatures up to 1200° F—for applications where dielectric requirements are not primary.

- **VARFLO TUBING AND SLEEVING.** New, low-priced — for applications where unusually high temperatures are not a factor. A real economy line, this.

- **VARFLEX COTTON TUBING AND SLEEVING.** Varnish or lacquer impregnants — for applications where Fiberglas products are not required.

- **SYNTHOLVAR EXTRUDED PLASTIC TUBING.** Low temperature flexibility—high dielectric and tensile strength—made from a standard formulation of vinyl polymers.

SAMPLES? All you want with our compliments. For free folder of our complete line, just clip and mail this coupon.

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VARFLEX Corporation, 308 N. Jay St., Rome, N. Y.

Please send me information as well as free samples of your electrical Sleeving and Tubing.

I am particularly interested in samples suitable for ____________

Name ____________
Company ____________
Street ____________
City ____________ Zone ______ State ______

small dot on the edge, can represent a chosen time interval and the other, a thin line across the whole film, can indicate a recurrent external event.

One particularly interesting use has been in the construction of a fault recording unit for the British Electricity Authority. This apparatus is made to record the faults on power lines and by the use of auxiliary apparatus is arranged to be normally in a quiescent state. When a fault occurs, the camera motor is started and the crt beams switched on to record all waveforms. Then after the restoration of steady conditions, it closes down again and at the same time recording the date and time of the occurence.

Low-Frequency Analyzer

For some time there has been a need for an instrument by which aircraft engines can have their vibration modes analyzed and the engine speed shown simultaneously. The difficulty has been that the range of frequencies to be examined is considerably below the range of wave analyzers which give automatic and continuous records.

A new British low-frequency analyzer is arranged to scan continuously the frequency range from 6 to 400 cps. Six modulator circuits are incorporated to cover the bands 6-12.5, 12.5-25, 25-50, 50-100, 100-200 and 200-400. Scan for the channel bands takes place in 1/25 second and to provide a continuous scan the modulator frequency for each band is varied over the octave once in 5 seconds. This results in the analysis being spread from a row of plain lines to a continuous area, the boundary of which gives the amplitude distribution of the complex wave.

To obtain a high degree of resolution it is best if the fifth and sixth bands are displayed downwards on the cathode ray tube, below the first and second bands.

In practical use, the luminous area on the screen, something like an a-c waveform in appearance, is not solid but is shown as a number of bands corresponding with the obviously limited number of frequencies present, the width of the bands being a measure of the variation of these frequencies with time.

ANNOUNCING

A NEW INDUCTION MOTOR-GENERATOR

• • • The first of its kind to be included in the wide range of "Brain Block" components now available for private industry.

ARMA Type 1A400

• • • A precision unit for high performance instrumentation and control applications.

ITS TYPICAL CHARACTERISTICS INCLUDE:

MOTOR — With 115 volt, 400 cycle excitation on both main and control fields.

Stalled	
Power Input	16.5 watts max. per phase
Impedance	210+j 380 ohms approx.
Torque	1.5 oz. in. minimum
Running — No Load	
Power Input	7 watts per phase approx.
Impedance	160+j 530 ohms approx.
Speed	8500 R.P.M. min.

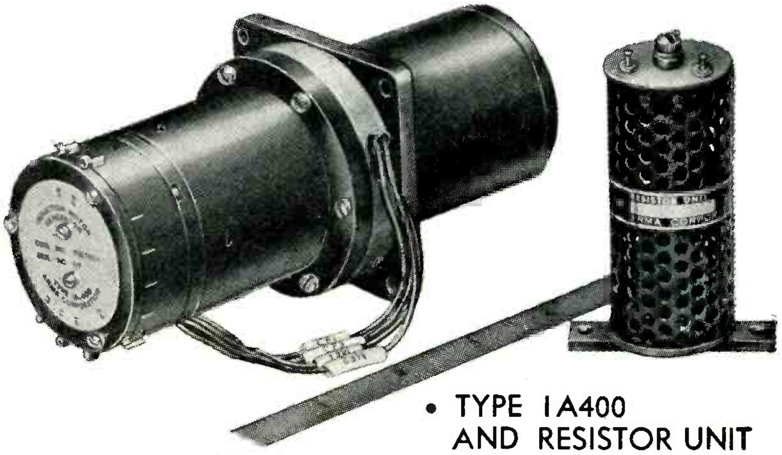
GENERATOR — With 115 ± 1 volt, 400 ± 0.1 cycle excitation.

Input current	0.065 amp.
Input power	2.8 watts
Max. speed for specified performance	6000 R.P.M.
Output — Nominal	0.1 volts per 100 R.P.M.
Output — Standardized at 25°C, 3600 R.P.M., 750 mmfd. load	
Magnitude	3.600 ± .05% volts
Phase Angle	10′ ± 5′ (lagging)
Max. Linearity Deviation	
Magnitude (in % specified max. speed)	
Over range 0-4000	0.04% (1.5 R.P.M. or 1.5 m.v.)
Over range 4000-6000	0.15% (8.5 R.P.M. or 8.5 m.v.)
Quadrature	
Over range 0-4000	1.0 m.v.
Over range 4000-6000	5.0 m.v.
Effect of ambient temperature change from 15° to 70° C.	
Variation in magnitude	approx. 0.07% max.
Variation of phase angle	approx. 0.5 min. per degree
Zero Speed-Residuals	
In-phase:	approx. 3 m.v. max.
Quadrature:	approx. 3 m.v. max.
Harmonics:	approx. 7 m.v. max.

PHYSICAL CHARACTERISTICS

Rotor inertia	0.75 oz. in. ^{2}
Weight (inc. auxiliary unit)	3¾ lbs.

Static friction — with main field excited, motor control field voltage required to start unit does not exceed 2.8 volts.



• TYPE 1A400 AND RESISTOR UNIT

OUTLINE DRAWINGS AND EXACT MEASUREMENTS ARE INCLUDED IN NEW BOOKLET JUST PRINTED— ASK FOR A COPY

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ARMA PRODUCTS RELEASED FOR PRIVATE INDUSTRY

ARMA ELECTRICAL RESOLVERS* · ARMA SYNCHROS · ARMA INDUCTION MOTORS · ARMA INDUCTION GENERATORS · ARMA MECHANICAL DIFFERENTIALS · ARMA ALTERNATING VOLTAGE COMPARATOR · COMPUTING MECHANISMS · INDUSTRIAL CONTROLS · STABILIZATION DEVICES · NAVIGATIONAL EQUIPMENT · LIMITRON AUTOMATIC INSPECTION SYSTEM

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QUALITY ARMA INSTRUMENT PRECISION

THE ELECTRON ART
(continued from p 122)

Comparison of sizes of 10-μf, 150 wvdc hermetically sealed paper capacitors with conventional (left) and metallized construction

sulation resistance does not affect performance.

When dielectric weaknesses and incipient faults develop in a metallized paper capacitor due to conducting particles or if a momentary surge of voltage should puncture the dielectric, the selfhealing action functions to clear the short, and the capacitor continues to operate normally in the circuit without interruption. This selfhealing cycle may occur thousands of times without affecting the life of the capacitor.

Design Engineering Data

The metallized paper capacitor is ideally suited for use where space is at a premium, as in equipment for military and industrial use. It is not recommended for certain special applications demanding high-impedance capacitors, such as those used in photoflash and timing circuits where the R-C curve is used to trigger electronic circuits. On the other hand, the metallized paper unit has a lower r-f impedance than an equal-value conventional paper unit since it has a lesser number of turns and shorter current path. This makes it ideally suited for r-f filters in noise suppression systems, particularly in aircraft applications and portable equipment for military use where minimum size and weight are essential prerequisites.

Typical applications for which metallized capacitors are ideally suited include, r-f and audio bypass circuits, filters, power factor cor-

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are businessmen *COLD-BLOODED?*

OF COURSE NOT! Literally, their normal body temperature is 98.6—same as laborers, engineers or any other group of people. And, figuratively, they're no more, or no less, cold-blooded—as a group.

We all know unreasonable generalizations can be dangerously false. Common sense and on-the-job experience show us the value of dealing specifically with ideas, problems—and *people*.

Let's not make the big—and costly—mistake, then, of generalizing on religious or racial groups. Adopt and *carry out* these common sense principles:

1. Accept—or reject—people on *their individual worth.*
2. Don't listen to or spread rumors against a race or a religion.
3. Speak up, wherever we are, *against* prejudice. Work for understanding.

A PUBLIC SERVICE PROJECT ★ THE ADVERTISING COUNCIL ★

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rections up to 500 cps, motor starting up to 500 cps, and noise suppression systems. They are not recommended for photoflash work, coupling circuits and timing circuits requiring constant R-C curves.

Insulation Resistance

In general, the insulation resistance of metallized paper capacitors is lower than that of the foil and paper types. To a large extent, this is due to the fact that the working stresses employed are considerably higher, since advantage is taken of the selfhealing feature. Therefore the insulation resistance cannot be considered as a criterion of quality in the same sense as applied to the foil paper capacitor. In voltage ratings up to and including 200 volts d-c, metallized capacitors have an insulation resistance value of 500 megohms per μf. On higher voltage ratings the insulation resistance is 1,000 megohms per μf.

The insulation resistance and the selfhealing voltage are to a large extent interrelated and the resultant insulation resistance is a product of these two properties. During the selfhealing cycle the surface resistance around the puncture reaches a definite value, so that with selfhealing there is a gradual reduction in the insulating resistance. The value of this resistance depends on the number of selfhealing cycles, as all of the punctured areas are in parallel.

Capacitance and Power Factor

As temperature is increased, there is a decrease of insulation resistance. This is a general phenomenon with impregnated paper, hence is not exclusive in metallized paper capacitors. Typical capacitance, power factor and insulation resistance characteristics are given in Fig. 1. Variations here are similar to those obtained with the conventional paper-impregnated capacitors. It will be noted that the mineral oil impregnated capacitors have a flatter curve than the mineral wax type and should be used in circuits demanding high capacitance stability. The mineral wax impregnated capacitor shows a definite decrease in capacitance with an increase in temperature. The decrease in capacitance with

Shooting a bird...

IN THE AIR AGE

This is "shooting a bird" at the U. S. Naval Air Missile Test Center, Point Mugu, California.

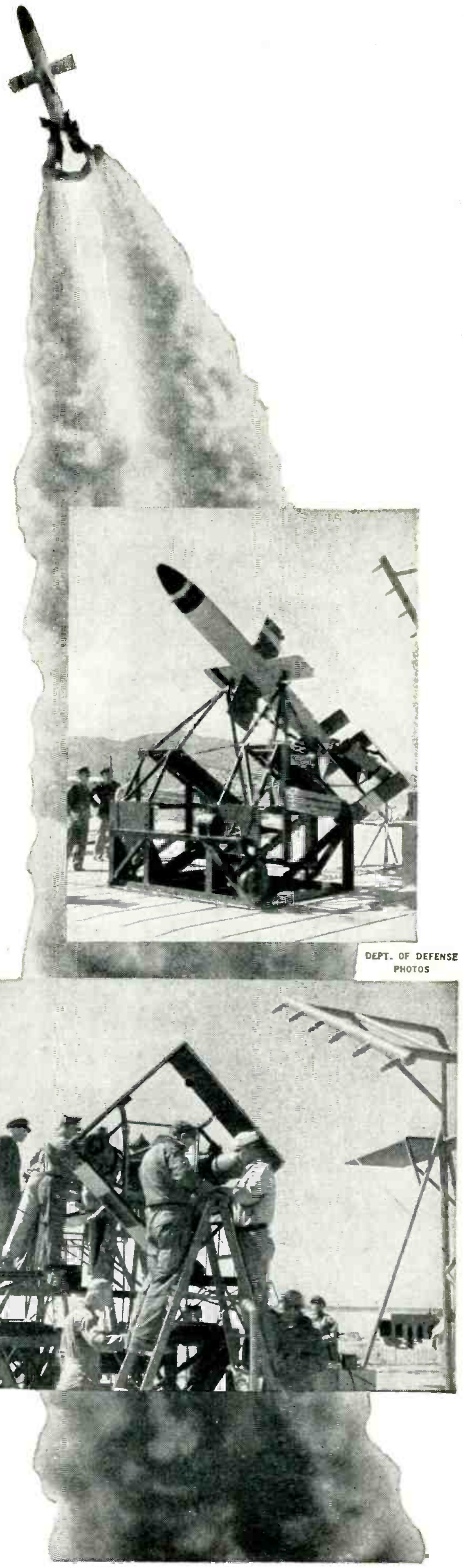
The "shoot" is the launching of a missile, while the "bird", in this particular case, is the Fairchild CTV-N-9a guided missile.

In a matter of seconds the missile is hurled high into the atmosphere with a deafening roar, propelled by its reaction type motors and auxiliary booster. Separation of the booster occurs as the missile speeds higher and higher into space, stabilized and controlled by the "intelligence" of its electronic guidance systems.

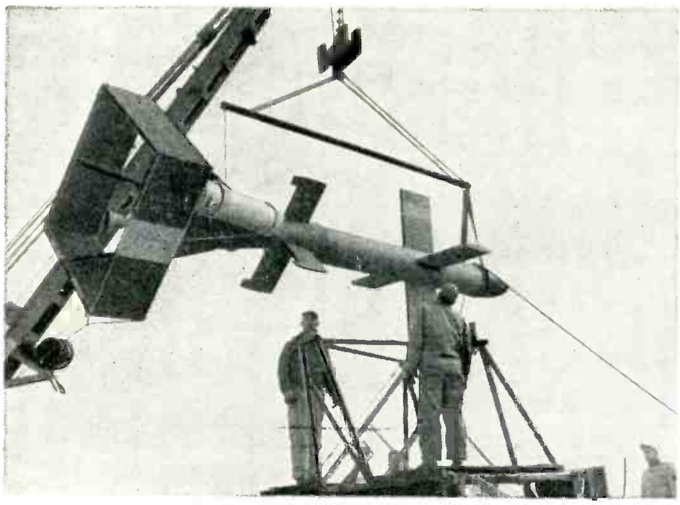
Soon the launching crews and ground observers no longer see the missile . . . but its path is being carefully plotted as it hurls toward its target . . . now under its own homing control.

This "shooting a bird" is but one phase of the Lark project. It is an operation requiring split-hair timing and perfect coordination. It is the result of teamwork between the Bureau of Aeronautics, Navy Department, the Naval Research Laboratory and Fairchild engineers and represents a combination of the best in aerodynamic design, electronic controls and precision manufacturing.

Here is another example of a Fairchild *first* and of "shooting a bird" . . . in the Air Age.



DEPT. OF DEFENSE PHOTOS



FAIRCHILD ENGINE AND AIRPLANE CORPORATION

Guided Missiles Division

FARMINGDALE, LONG ISLAND, N. Y.

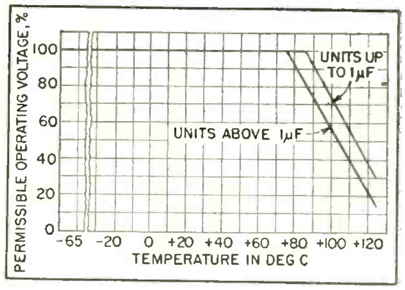


FIG. 2—Voltage derating curves for metallized capacitors operated above rated temperatures

temperature is caused by the physical change in the wax as it goes from the solid to the liquid phase; this results in a decrease of the impregnant dielectric constant.

The negative temperature coefficient of these units can be made use of in certain applications. This capacitance change is of no importance in the majority of applications. As a matter of fact, a mineral wax capacitor should be given preference because of its higher breakdown voltage except in those cases requiring a flat capacitance curve.

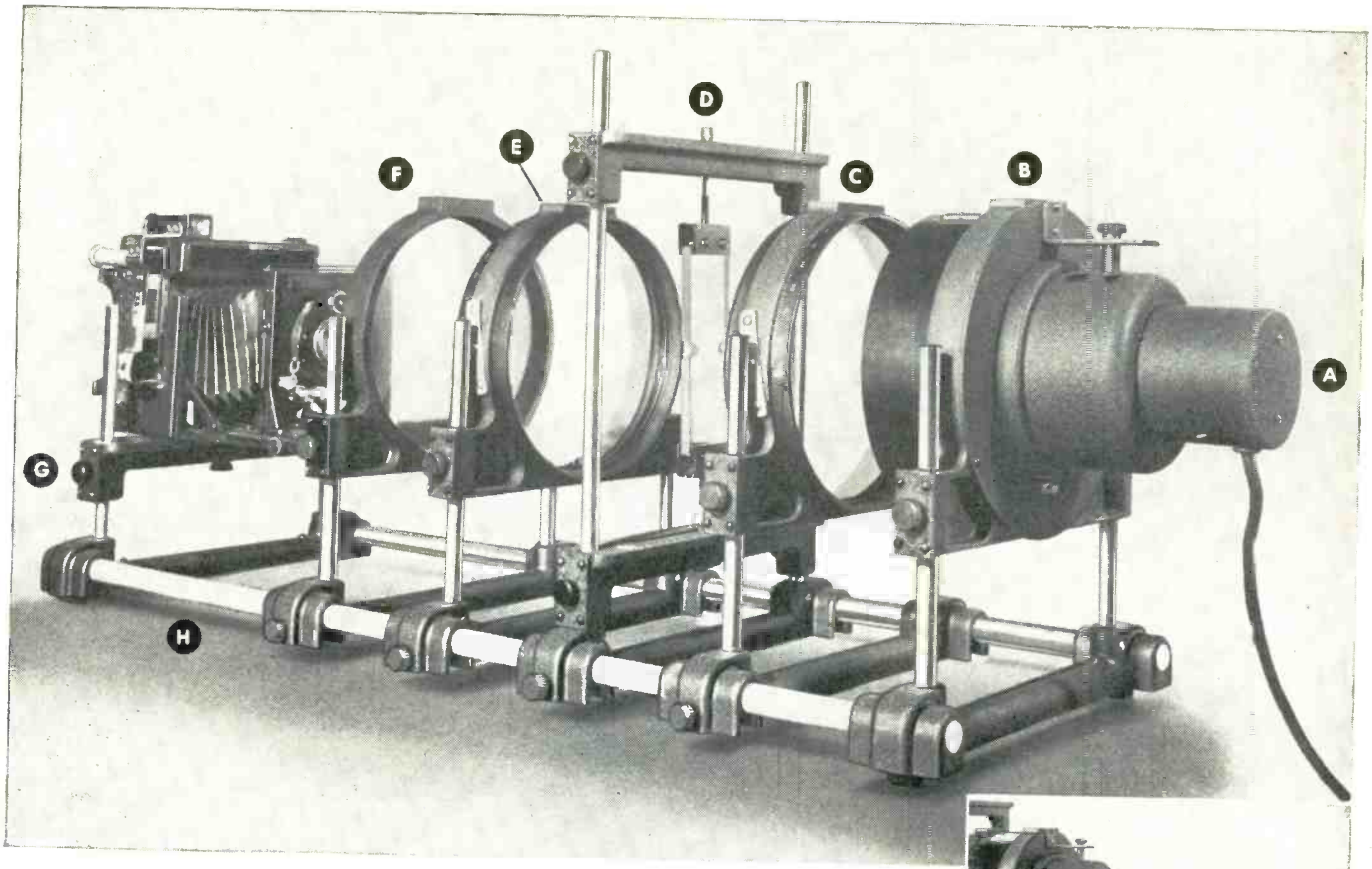
Operating Characteristics

Due to their selfhealing characteristics, metallized paper capacitors can be operated at higher temperatures than conventional paper-impregnated capacitors without danger of breakdown. The ultimate breakdown of the metallized paper capacitor is determined by the thickness of the lacquer coating and impregnated paper dielectric and is usually two to three times the rated working voltage.

As temperatures are increased, it becomes necessary for safe operation to reduce the voltage impressed across the capacitor. The amount of derating necessary for safe continuous operation on or above rated working temperatures is given in Fig. 2. In intermittent service the amount of derating is decreased proportionally.

Life Tests

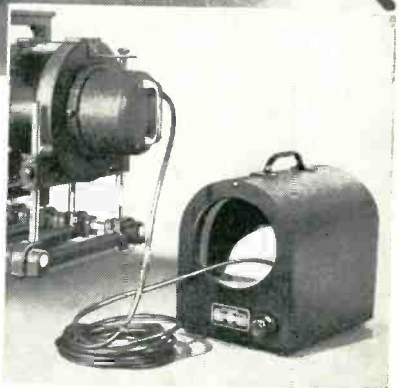
Metallized paper capacitors should be life-tested at their permissible operating voltage and maximum operating temperature, as given in Fig. 2. A suitable resistor, preferably 1,000 ohms, should be connected in series with each test specimen in order to limit



A New, Low Cost, Portable POLARISCOPE for Dynamic Stress Analysis

UNTIL now the apparatus required for either visual or photographic observation of photoelastic stress, either static or dynamic, has been cumbersome, expensive, excessively bulky and very heavy.

Through use of the G-R STROBOLUME as a very high-intensity light source for photography, all of these objections have been overcome. Formerly, photographic exposures ran into minutes; the bench set-up accordingly had to be carefully designed to minimize vibration in its many parts. The new G-R Polariscope consists of an assembly of comparatively light rods, supports and disc mounts, this lightness being possible through the extremely short 40-microsecond exposure provided by the STROBOLUME.



The Type 1532-A STROBOLUME in place, with its power supply at the right. One knurled nut readily removes the STROBOLUME lamp for substitution of the standard incandescent lamp for visual observation. **Type 1532-A Strobolume**, complete and ready to use, **$225.00**

This new Polariscope includes in its many features:

- An unusually large field — 8 inches in diameter
- Very simple means for making instantaneous photographs of dynamic stresses . . . requires only a standard camera with an f/4.5 lens
- Time exposures no longer necessary . . . the STROBOLUME flashes in 40 microseconds
- The 40-microsecond flash stops motion for dynamic stress patterns
- Unusually short wave length light . . . very high sensitivity
- Complete portability . . . weighs only 32 pounds . . . quickly assembled and dissembled . . . ideal for lectures and other demonstrations
- Easily removed quarter plates and polarizers
- Simplified replacement of damaged elements . . . snap-in assembly
- Convenient to use . . . horizontal and vertical adjustments over wide ranges . . . simpler than an optical bench
- Very low cost

SPECIFICATIONS

- **A** Type 1534-P6 Incandescent Lamp Housing
- **B** Type 1534-P2 Diffuser
- **C** Type 1534-P1 Polarizer
- **D** Type 1534-P3 Strain Bridge for Sample
- **E** Type 1534-P1 Analyzer
- **F** Type 1534-P5 Filter
- **G** Type 1534-P4 Camera Bridge (Camera not supplied)
- **H** Type 1534-P7 Shafts (furnished 36-inches long)

Accessories Required for Photography

A G-R Type 1532-A STROBOLUME

Standard camera, preferably with ground glass focusing, with f/4.5 or faster lens

Wratten No. 75 front-of-lens filter, recommended to reduce effects of normal room lighting

TYPE 1534-A POLARISCOPE . . . $490.00

GENERAL RADIO COMPANY Cambridge 39, Massachusetts

90 West St., New York 6 920 S. Michigan Ave., Chicago 5 1000 N. Seward St., Los Angeles 38

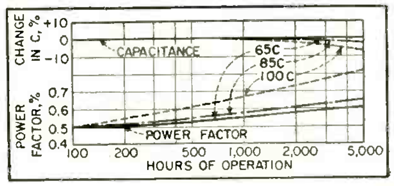


FIG. 3—Variation of capacitance and power factor with hours of operation for all d-c voltage ratings of metallized units up to and including 600 volts

the energy discharged by paralleled test specimens through a capacitor going through a selfhealing cycle. If this precaution is not taken there will be an abnormal decrease in the insulation resistance due to carbonization of the dielectric.

Metallized paper capacitors can be operated on a-c as well as d-c, can be operated at high temperatures without any serious changes in capacitance or power factor, and are practically immune to breakdown. This does not mean that their life is infinite, but rather that when metallized paper capacitors are used in a circuit there will be no early failures and the life span of the equipment will be increased. Examples of life test curves are given in Fig. 3.

Accelerated life tests can be run at 1.25 times the permissible operating voltage and maximum operating temperature, but under this test there will be a greater decrease in the insulation resistance than normally would be expected.

British Cineradiograph Apparatus

BY J. H. JUPE
Enfield, Middlesex England

AN ADVANCED TYPE of high-voltage cineradiography apparatus has recently been put in production in Britain, by Watson and Sons, which is associated with the General Electric Co. Ltd.

The new equipment incorporates several improvements over its predecessor, which was designed to take cineradiographs by the indirect method (photography of a fluorescent screen) on 16-mm movie film. A 10-kw stationary-anode x-ray tube was used and in order to minimize the exposure of

THE NEW TURNER *Aristocrat*

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The crown jewel of dynamic microphones. See it, handle it — use it on highest quality recording, public address or broadcast work. New beauty, new styling, new utility and *new performance* make the Turner *Aristocrat* the finest of the fine. Use it anywhere, indoors or out — in hand, on stand, suspended, or concealed in stage settings. The *Aristocrat* is quickly and easily detached from ball swivel coupler for hand use. Non-directional polar pattern picks up sound from any direction. Equally effective for individual or group pickups with wide range, high fidelity reproduction of voice or music. Its high output dynamic generator requires no closely associated auxiliary equipment for outstanding results. Built of finest materials with flawless workmanship, each unit is laboratory calibrated to insure specification standards. . . . Write for complete details.

SPECIFICATIONS:

FREQUENCY RESPONSE: 50 to 15,000 c.p.s. flat within ± 2½db.
OUTPUT LEVEL: 56 db below 1 volt/dyne/sq. cm.
IMPEDANCE: 15, 200, 500 ohms or high impedance.
POLAR PATTERN: Essentially non-directional in any position.
MOUNTING: Ball and swivel type, tilts in any direction. Standard ⅝" — 27 thread.
CABLE: 20 ft., high quality rubber covered, two conductor shielded cable with Cannon quick-disconnect plug.

THE TURNER COMPANY
905 17th Street N. E., • Cedar Rapids, Iowa
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TURNER *Microphones* **BY TURNER**

British cineradiograph apparatus. X-ray tube is in housing at patient's right. Fluorescent screen and 35-mm camera are on patient's left

the patient to x-rays, the voltage applied to the tube was reduced by means of a mechanical synchronous switching device, during periods when the camera shutter was closed.

Although this apparatus was used for much useful work, its design had some serious limitations. The patient could only be photographed in the upright position, the equipment was cumbersome and had to be operated in complete darkness. This was due to the long focal length of the lens used, a Zeiss Biotar, specially designed for the work and with an aperture of F/0.85.

With the x-ray tubes then available this aperture was the minimum which could practicably be used and because of its small acceptance angle, a long focal length (58 mm to cover 16-mm film) was unavoidable. This necessitated the camera and fluorescent screen being on separate stands to secure the correct reduction ratio and so led to operating in darkness. Other disadvantages were, poor definition and grainy films arising from the need to use a highly sensitive emulsion.

The new equipment, which was shown at the International Congress of Radiology in London recently, is a vast improvement on the early instrument and uses a rotating-anode x-ray tube energized at 120 kv, 400 ma, in conjunc-

tion with a specially designed 35-mm cine camera fitted with a F/1.5 Taylor-Hobson lens of 4-cm focal length.

The high voltage generator has an electronic switching device which is arranged so that the high-voltage transformer and x-ray tube are only energized during the brief period when the camera shutter is open. By adopting this plan the x-ray dose which the patient receives is reduced to a minimum and the power dissipated in the x-ray tube itself is minimized, with the result that a higher loading can be achieved without risk of tube failure.

For use at extremely slow film speeds, those for viewing slow movements of the body, the x-ray exposure can be arranged to occupy any proportion of the shutter-open period. This is done by means of subsidiary timing control in the electronic contactor circuit.

If desired, the camera, timing and synchronizing equipment can be switched out of use and radiographs can then be made on large size films by the usual still-radiography technique. In this case the synchronous timer of the equipment will determine the length of exposure.

The entire apparatus has a power consumption of about 1 kw when idling and 20 kw (average) when exposures are being made.

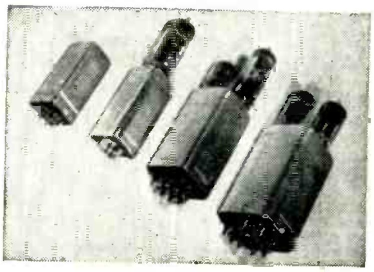
Single-Tube Audio Phasemeter

By JOSEPH A. VANOUS
Engineering Division
Collins Radio Company
Cedar Rapids, Iowa

A PHASEMETER is described, which is capable of measuring phase difference between two sinusoidal voltages from 300 cps to 100,000 cps. Angles from 1 to 180 degrees are measurable with an accuracy of better than 1 degree. No preliminary adjustments for frequency are necessary with this meter.

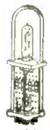
A unique property of the magnitude of the sum and differences of two alternating current voltages makes the operation of this phasemeter possible. In operation, the phasemeter is connected across the phase-shift network. After two

Modern Electronic Design Means *Plug-In Unit* Construction



ALDEN PLUG-IN BASES AND HOUSINGS

A whole series of bases and housings to meet your plug-in needs. From the miniature 7-pin to the special 20-pin non-interchangeable, Alden plug-in bases can be standardized over a wide range of plug-in design. The Non-interchangeable Series, special for plug-in construction, is designed with variable pin patterns that insure positive isolation of critical voltages or current. Strong, stubby pins and elimination of bosses on Alden bases correct the bugaboos of conventional octal or loctal design.

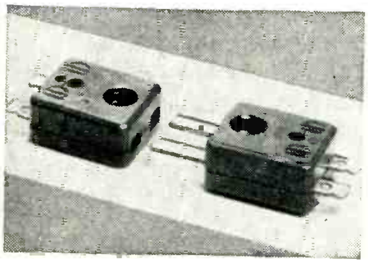


Open 20 pin plug-in assembly

Shielded 20 pin plug-in assembly

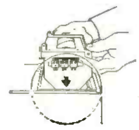
Shielded 11 pin plug-in assembly

Miniature 9 pin plug-in assembly

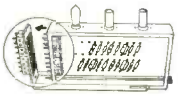


ALDEN BACK CONNECTORS

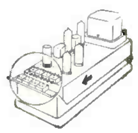
Here are back connectors that make possible slide-in chassis that go together and come apart easily. Generous bell mouthed entries and floating clip action provide wide mating tolerances — do away with critical chassis alignment problems. Wiring to color-coded back connectors instantly identifies each lead for circuit checks — makes wiring accessible for easy servicing. Can be mounted flushed or stacked to meet any space requirements.



Mechanical units



Decade units



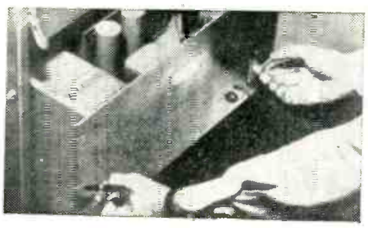
Miniature chassis

The trend in modern design is toward smaller, lighter, better looking equipment. Yet modern design demands easy servicing, rapid changeover, and fool-proof performance. To get these results, more and more modern design engineers are turning to plug-in unit construction with basic elements grouped as units that plug in, slide in, lock in, and pull out easily.

Up to now there has been no one place where components specifically designed for plug-in, unit construction were available. To get this type of construction — it has been necessary for engineers to design and have parts custom made or improvise with standard components in makeshift arrangements.

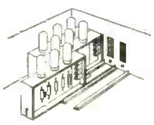
For many standard applications Alden has a whole series of plug-in components that can meet many of your unitization needs. On new or special designs, we feel we have the conception and facilities necessary to take your whole problem — to design, develop and manufacture plug-in components tailored to fit your needs — to give you the advantages of components specifically designed for plug-in, unit construction, advantages not found in standard components.

"Write for new booklet on 'Components for Plug-in Unit Construction'"

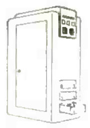


ALDEN SLIDE-IN LOCK-IN CHASSIS

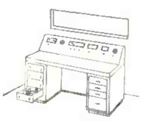
Designed for quick, positive insertion and removal, slide-in lock-in chassis utilizes bullet nosed dowels which pull in, lock, and eject chassis quickly and easily. Simple ½ twist of handles gives positive protection against vibration shock in any position. Pilot action of locking dowels eliminates critical sheet metal tolerances. Slide-in lock-in chassis are built for racks or as separate units, miniature or standard size.



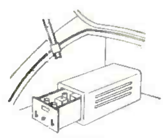
Instrumentation



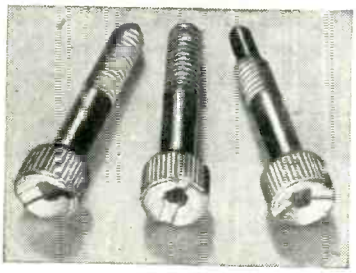
Electronic



Communication

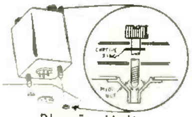


Mobile

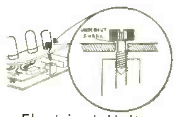


CAP-CAPTIVE CONVENIENCE SCREW

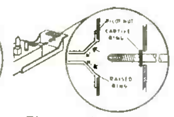
Concave surface of head and arced notch quickly center production tools on screw for rapid tightening against lockwasher. In the field, no special tools are necessary — arced slot in head is of such proportion that even a coin gives sufficient leverage to back it off lockwasher. Can readily be made captive, so it's ideal for holding detachable mechanical units, plug-in housings, miniature chassis.



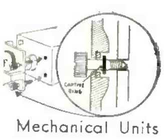
Plug-in Units



Electrical Units



Electronic Units



Mechanical Units

ALDEN PLUG-IN UNIT CABLING IS A MUST

For years cabling did not keep pace with the speed of electronic design — Manufacturers had to be satisfied with cables designed as an afterthought — cabling utilizing mongrel connectors and wire, designed for a job, yes, but not designed for a specific job. In the past this poorly designed cabling has led to malfunctions, time delays, excessive production costs and high service cost in the field.

With today's higher voltages, frequencies, and critical signals, more and more engineers are turning to Alden for the solution to their cabling problems because Alden's is the one place where specially designed connectors and large stocks of wire are obtainable under the same roof.

Here is what Alden engineers can do for you — take your prototype model, engineer to your specific requirements unit cables incorporating Alden's 20 years of technical design and development of connectors and wire services — give you economic and efficient cables of good appearance that are built as units — allow instant continuity checks and rapid replacement in the field.

Alden's series connectors enable the engineer to select, and know that he will get, the right connector for the job. For critical connections, Alden has special non-interchangeable connectors with plugs that can only mate with the correct socket and thereby absolutely prevent mismating and the costly damage of burned out sets. All connectors used have forward connected, low resistance contacts which provide individual strain relief for each lead. Production design connector bodies with well-isolated clip and wire pockets provide 100% insulation. Less material — less space, features of Alden top connected contact connectors, allow Alden to design and manufacture a cable that is more compact and more easy to handle.

Wire is supplied from stock piles that include sizes and insulation of any type. It is ready to be formed, laced, braided, or shielded — in production quantities — as needed. By pooling wire requirements, a flexible high-speed braiding department, special tools, trained operators and mingling of orders, the most exacting schedules of customers can be met at production line cost.

For quotations or suggestions about design, submit your inquiries or blueprints — Alden engineers are always ready to work with you on cabling problems.

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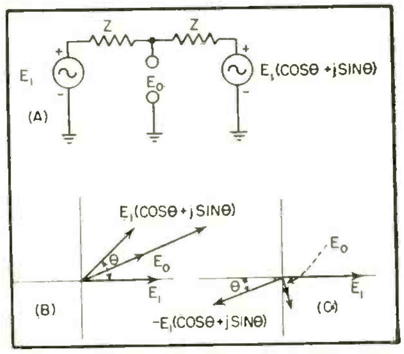

FIG. 1—Basic circuit and vector diagrams showing basis for two-tube audio-frequency phase measuring device

calibrations, the sine or cosine of half of the phase angle is measured directly. The principal value of the inverse function is found in a table of trigonometric functions. Multiplying this value by 2 will produce the phase angle in degrees.

Principle of Operation

Several other types of phasemeters employ cascaded amplifier-limiter stages which supply square waves to the indicating circuits[1, 2]. Circuit simplicity is achieved by making a comparison between two sinusoidal waves directly.

The phasemeter consists of two low-impedance generators connected by an impedance of 2Z. The voltage at the centertap of the connecting circuit is measured by an a-c voltmeter as shown in Fig. 1A. The two voltages have the polarity shown where E_1 is the voltage at generator 1, and E_1 ($\cos\theta + j\sin\theta$) is the voltage at generator 2. The two voltages have the same magnitude but differ by an angle θ which is the phase angle. Assuming the voltage E_0 is measured by a high-impedance voltmeter drawing negligible current, the following equation can be written

$$E_1 - E_1(\cos\theta + j\sin\theta) = i\,(2Z) \quad (1)$$

$$i = \frac{E_1 - E_1(\cos\theta + j\sin\theta)}{2Z}$$

$$E_0 = E_1 - iZ \quad (2)$$

Substituting Eq. 1 for i in Eq. 2

$$E_0 = E_1 - Z\left(\frac{E_1 - E_1(\cos\theta + j\sin\theta)}{2Z}\right)$$

$$= \frac{E_1}{2}(1 + \cos\theta + j\sin\theta)$$

Solving for the absolute magnitude

of the voltage measured at E_0

$$|E_0| = \frac{E_1}{2} \sqrt{(1 + \cos\theta)^2 + (\sin\theta)^2}$$

$$= \frac{E_1}{2}\left(2\sqrt{\frac{1+\cos\theta}{2}}\right)$$

$$\text{cosine } \theta/2 = \left(\frac{1+\cos\theta}{2}\right)^{\frac{1}{2}}$$

$$|E_0| = \frac{E_1}{2}(2)\cos\theta/2$$

$$|E_0| = E_1 \cos\theta/2$$

If the generator voltages are calibrated equal and unity in value, then the voltmeter will read the cosine of $\theta/2$. The vector diagram in Fig. 1B shows the relationship of the voltages for an arbitrary phase angle θ.

If generator 2 is reversed 180 degrees in phase the voltage E_0 will equal

$$|E_0| = E_1 \sin\theta/2$$

This can be proved by following a mathematical procedure identical to the one outlined above. The corresponding vector diagram is shown in Fig. 1C.

By calibrating the generator voltages at one volt, the voltmeter will read the cosine of $\theta/2$ or the sine of $\theta/2$ directly. A table of trigonometric functions will convert these readings to half of the phase angle. Multiplying this angle by two will produce the phase angle.

Equipment

The two low-impedance generators of Fig. 1A for measuring the the cosine of $\theta/2$ consist of cathode followers as shown in Fig. 2. Outputs of the cathode followers are connected in series by an impedance composed of two blocking capacitors and two resistors. The resist-

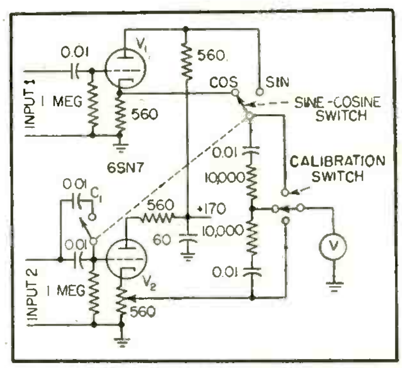

FIG. 2—Phasemeter circuit diagram shows function of sine-cosine switch

ors are identical in value to provide a center-tap. The reactances of the blocking capacitors are also equal to produce an equal impedance both sides of center-tap. Reference to the derivation will reveal this as an initial condition.

Cathode followers were employed to provide an impedance transformation from a high input impedance to a low output impedance. It is desirable to have a high input impedance to prevent the loading of the measured network, and to prevent any additional phase shift by this loading. A low output impedance allows calibration of the voltmeter without excessive cycling.

A 180-degree phase reversal for measurement of the sine of $\theta/2$ is accomplished by obtaining the output from the plate of V_1. The switch labeled SINE-COSINE performs this operation.

The input to each tube consists of a blocking capacitor and a grid-leak resistor. Identical components are used to prevent a phase difference at the grids in addition to that being measured while measuring the cosine of $\theta/2$. When the output of V_1 is taken from the plate for the measurement of the sine of $\theta/2$, the reactance of the filter capacitor becomes significant at the low frequencies, and creates a spurious phase shift. This unwanted phase shift is canceled by introducing an opposite phase shift at the grid of V_2 by decreasing the reactance of the R-C circuit.

The rate of change of the sine function with respect to the angle is greater for small angles. Therefore, to obtain maximum reading accuracy, the sine of $\theta/2$ is used for phase angles from 0 to 90 degrees. The cosine of $\theta/2$ position is used for angles between 90 and 180 degrees where the rate of change of the cosine function is greatest.

The phasemeter is used in conjunction with an audio oscillator as shown in Fig. 3. A 3-way calibration switch is used with the a-c voltmeter to allow the calibration of the tube outputs. The cathode resistor of V_2 is a potentiometer for adjusting the voltage to one volt. The cathode and plate output voltages of V_1 are calibrated by means of the audio oscillator attenuator control. This procedure eliminates

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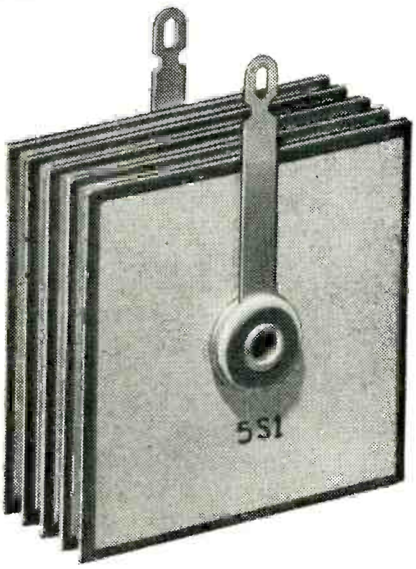

Illustrated actual size is No. 5S1, rated at 500 Mils DC, 130 Volts RMS AC input.

SELETRON "Safe Center" plates in miniature rectifiers eliminate the danger of arc-over, short circuits and excessive heating due to high leakage current at the center contact point. Assembly pressure, or pressure applied in mounting the rectifier cannot affect its performance. This SELETRON feature is accomplished by deactivating the area of the plate under the contact washer.

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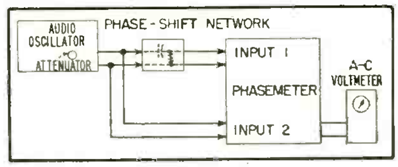


FIG. 3—In practice, the phasemeter is connected as shown here

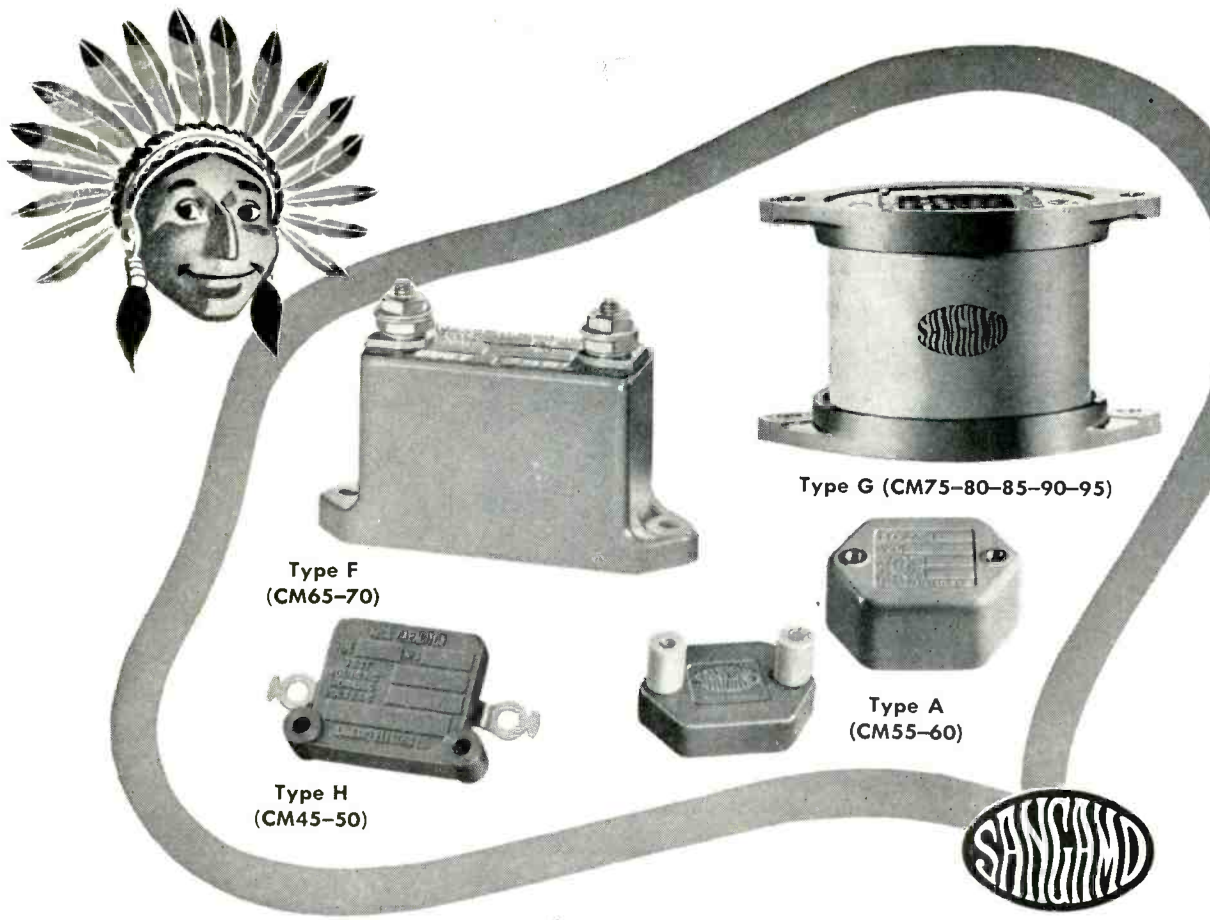
the necessity of using potentiometers in place of the cathode and plate resistors.

Performance

The phasemeter was first tested for inherent phase shift over the frequency range. The two inputs were connected together to an audio oscillator, and readings of sine $\theta/2$ versus frequency were taken. Under ideal conditions, the voltmeter reading will be zero, indicating zero phase shift, but a residual voltage caused by power supply ripple will normally be measured. This voltage amounted to 0.008 volts over the band, and, if considered a phase shift, equals approximately 1 degree. This is the smallest angle that can be measured.

The phasemeter was tested for accuracy by comparing measured phase shifts against calculated phase shifts of a R-C circuit. Values of capacitance and resistance obtained from an impedance bridge were used in the computations. The voltage across the resistance with reference to that across the series combination was first taken across the band. The voltage across the capacitor was then measured using the same reference. The error in the measured angles averaged 0.5 degrees.

Great differences in input voltages should be avoided. For greatest accuracy, both inputs should be approximately 1.7 volts corresponding to an output of one volt. The accuracy will then be within 1 degree from 1 to 180 degrees. If the input to V_2 is between 5 and 10 volts, then the 1-degree accuracy is maintained only from approximately 10 to 180 degrees. Excessive distortion creates harmonic voltages which predominate for small angles, and leads to an increasingly large error as the phase angle approaches 1 degree. Computation of the error due to the power supply ripple revealed it to



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Type G Capacitors are designed for use in medium and high power, high voltage and high current circuits. They are ceramic encased and are frequently connected in gangs to handle heavy loads.

Type F Capacitors are used in similar applications to type G's and are potted in bakelite cases.

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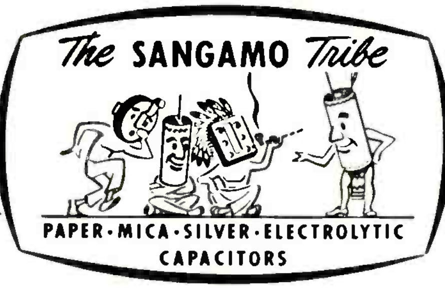

Dependable Performance

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IN CANADA: SANGAMO COMPANY LIMITED, LEASIDE, ONTARIO be negligible for angles greater than 1 degree.

The writer wishes to express his appreciation to Harry L. Sandberg for his analyses and encouragement. The writer is also indebted to Clem Arnold for his suggestions and cooperation.

REFERENCES

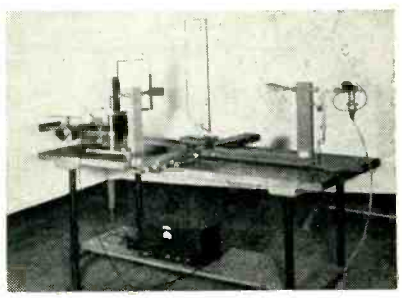
(1) Edwin F. Florman, Andrew Tait, An Electronic Phasemeter, *Proc. IRE*, 37, p 207, Feb. 1949.

(2) Edward L. Ginzton, Electronic Phase-Angle Meter, ELECTRONICS, 15, p 60, May 1942.

NRL Microwave Interferometer

ALTHOUGH ORIGINALLY intended for measurement of wavelengths in the centimeter region, a microwave interferometer constructed at the Naval Research Laboratory on the basis of Michelson's optical instrument has also proved useful in the rapid determination of the dielectric constants of materials in sheet form. It is particularly suitable for the study of laminated radome materials, of parallel-plate media of nominal dielectric constant less than one, and of metal-loaded artificial dielectric materials for microwave lenses—media which cannot readily be placed in a waveguide as required by other techniques.

In the Michelson interferometer, a beam of light is split by a half-reflecting mirror. One part of the beam is reflected from a fixed mirror, the other from a movable mirror. When the two beams are reunited, they form interference patterns. In the microwave modification, the interference is produced between a reference signal



Microwave interferometer for measuring wavelengths and dielectric constants of sheet materials

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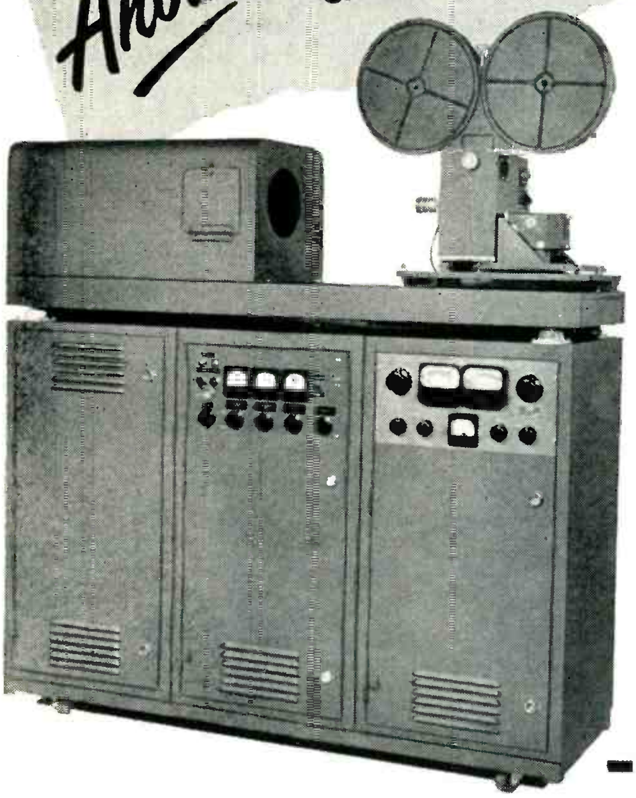

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The GPL Video Recorder may be used with the GPL rapid processor to produce finished film, positive or negative, less than a minute after the program is received either over a closed circuit or from the air.

WRITE FOR RECORDINGS made on this equipment for study by studios, advertisers, agencies.

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led through a waveguide and a signal reflected from a movable metal reflector and a fixed half-reflecting mirror. In this way, phase and amplitude of an essentially plane wave may be compared with that of a reference signal.

The instrument was developed by Radio Division One of the Naval Research Laboratory.

Ultrasonics Used In Seed Treatment

A DETAILED STUDY of the effects of high frequency sound radiation on hybrid corn is in progress at the U. S. Department of Agriculture Research Center at Beltsville, Maryland.

Using a high-intensity ultrasonic generator, government agronomists are trying to evaluate the effects of time and intensity of treatment on germination, flowering, growth and yield. Seeds exposed to the high intensity radiation have been planted recently in field test plots. The agronomists have their fingers crossed.

Based on previous experiments with other seeds they expect a faster germination, but also possible failure of some of the seeds to take root. The end object of the research, of course, is higher production.

The piezoelectric generator operates on four fixed frequencies. It is essentially a radio-frequency generator modified to match the electrical impedance of a transducer through a coaxial cable. The complete equipment is housed in a battery jar containing about 12 liters of transformer oil.

To get a constant indication of the radio-frequency volt-amperes in the high-frequency line to the transducer, a radio-frequency ammeter and a vacuum-tube voltmeter have been added.

On the top of the battery jar is a copper shield, which has in the center a copper cup of about 3 inches in diameter and 3 inches deep. A 2-inch hole in the bottom of the cup is covered by a strip of copper less than 0.002 inch thick. The cup acts as a container for a

cooling bath. Water is used in the cup as a practical liquid for both immersion and cooling of test specimen. The radiations originating at the crystal are transmitted through the oil into the test cup.

Although there are in existence about a half dozen material-testing devices that use ultrasonics, experiments in agriculture and more properly biology, have not begun until recently.

USDA's research is supervised by Truman E. Hienton, head of farm electrification studies in the Agricultural Research Administration.

Direct-Reading R-F Wattmeter

EASE OF OPERATION and excellent accuracy are combined in a direct-reading r-f wattmeter developed by the Naval Research Laboratory for measuring power from 30 to 3,000 microwatts. Instead of the a-c substitution method employed by many types of wattmeters for measurement of r-f power, the new type makes use of a d-c movement meter and precision resistors (thermistors) to achieve an accuracy of 4 percent or better over its power-measurement range.

A thermistor is placed in one arm of a bridge circuit whose other arms are usually 200 ohms each. A given amount of d-c current is passed through the bridge and an adjustable a-c voltage is connected and varied until the bridge is balanced. When r-f power is applied to the thermistor, the d-c current is automatically reduced until the bridge is again balanced. Thus with the bridge balanced, the change in d-c power in the thermistor is equal to the r-f power. A meter circuit is arranged to read this change directly.

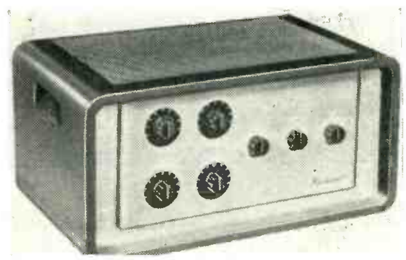
Although this instrument was first intended for use in power monitoring work, other uses for it have arisen, such as that of checking signal generator output. The instrument was developed in Radio Division Two of the Naval Research Laboratory.

NEW PRODUCTS
(continued from p 126)

school lab projects and for safety checks in radiation labs. The circuit features a G-M tube, built-in amplifier with CK522 AX subminiature tube, and regulated vibrator-type high-voltage power supply. Weight is $2\frac{1}{4}$ pounds.

Tiny Gamma Detector

THE KELLEY-KOETT MFG. CO., 117 E. Sixth St., Covington, Ky. Model K-550 pocket-sized unit for the detection and measurement of gamma radiation measures $4\frac{3}{4}$ in. $\times$ $2\frac{5}{8}$ in. $\times$ $1\frac{1}{8}$ in. The detecting element is a subminiature type 300-volt Geiger tube. Normal background response to cosmic radiation is approximately 12 counts per minute. Thus, increases in gamma radiation levels up to 8 or 10 times background are readily detectable by counting the pulses heard in the hearing-aid type receiver furnished with the instrument.



P-A Amplifier

RAULAND-BORG CORP., 3523 Addison St., Chicago 18, Ill. Model 1932 Green-Gem p-a amplifier is rated 32 watts at 5 percent or less har-

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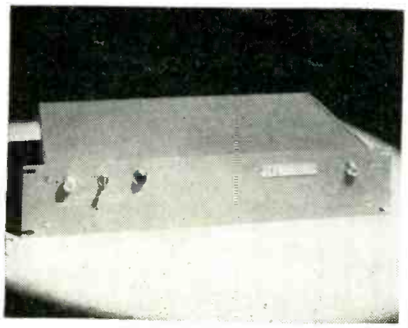
monic distortion (measured at 100, 400 and 5,000 cycles); with a 48-watt peak output. It features 3 microphone inputs (each convertible for use with a low-impedance mike by means of a plug-in transformer); 2 phono inputs with dual fader; true electronic mixing and fading on all 5 inputs; separate bass and treble tone controls. Frequency response is ±1 db, 40 to 20,000 cps. Output impedances are 4, 8, 16, 166 (70 volts), 250, 500 ohms.



TV Amplifier

SPENCER-KENNEDY LABORATORIES, INC., 186 Massachusetts Ave., Cambridge 39, Mass. Model 212TV amplifier, specifically designed for television use, is a single untuned amplifier having a bandwidth of 40 to 240 mc and a gain of 20 db into a 72-ohm unbalanced load and 25 db into a 300-ohm balanced line. Transmission characteristic is ±2 db over the bandwidth and impedance is 200 ohms.

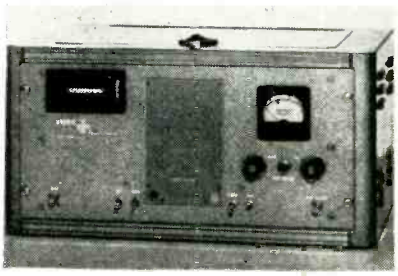
Nine-Pin Miniature

RADIO CORP. OF AMERICA, Harrison, N. J. The 5963 medium-mu twin triode of the 9-pin miniature type

is especially designed for frequency-divider circuits in electronic computers, and other on-off control applications requiring long periods of operation under cutoff conditions. A bulletin giving complete technical data is available.

Rectangular TV Tube

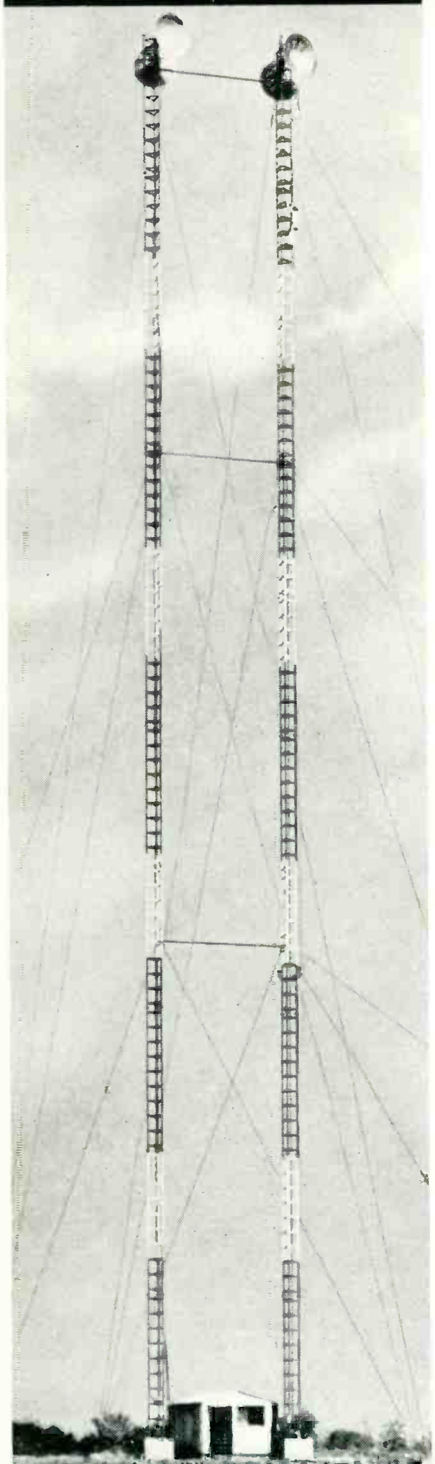
GENERAL ELECTRIC CO., Syracuse, N. Y., is now producing the 17BP-4A, a 17-inch magnetic-focus-and-deflection tube with a neutral-density faceplate. It features an electron gun designed to be used with an external, single-field ion-trap magnet for the prevention of ion-spot blemish. An external conductive coating serves as a filter capacitor when grounded. Heater voltage is 6.3 v and heater current is 0.6 ampere ±10 percent.



Scaler

ATOMIC INSTRUMENT CO., 84 Massachusetts Ave., Boston 39, Mass. Model 1010 standard scaler is furnished optionally with a scale-of-100 or scale-of-256, and added scaling assemblies to make either a scale-of-1,000 or a scale-of-4,096 may be

COMMUNICATIONS TOWERS



MICRO WAVE RELAY TOWER supports General Electric Relay Equipment between Chicago and Grand Rapids, Michigan, designed and erected by

STAINLESS, INC.
NORTH WALES, PA.
PHONE: NORTH WALES 9859

NEW! FUNGUS-PROOF *Nylon* LACING CORD

resists mold and micro-organisms

• Intensive research in the laboratories of Heminway & Bartlett has resulted in the development of a fungus-proof Nylon Lacing Cord. This new cord — with its special synthetic resin coating — resists the growth of mold and micro-organisms, factors most often responsible for the deterioration of old type linen and cotton lacing cord and the subsequent corrosion and failure of electronic equipment.

Heminway & Bartlett's new special finish Nylon Lacing Cord retains the desirable malleability of wax and yet has a melting point of over 190°F. It is non-toxic to humans.

We'll be glad to send you full information and prices . . . no obligation, of course. Why not write us today!

THE HEMINWAY & BARTLETT MFG. CO.
500 Fifth Avenue, New York 18, N. Y.

Branches: 617 Johnston Building, Charlotte 2, North Carolina; 222 West Adams Street, Chicago 6, Illinois; 77 S. Main Street, Gloversville, New York; 716-32 N. 18th Street, St. Louis, Missouri.

VSWR and RF WATTMETER

SPECIFICATIONS
Frequency Range........50 to over 1000 MCS
Impedance..................51.5 or 72 ohms
Connectors.......Standard connectors supplied are type N to accept UG-21/U attached to RG-8/U and RG-9/U cable.
The instrument is supplied on request, with UHF type connectors to accept 82-ISP attached to RG-8/U and RG-9/U cable.
Adapters are available for attaching to 7/8 inch 51.5 ohm coaxial line.

Power Ranges:

Model	Range	
MM 565	0 to 4	watts
MM 560	0 to 12	watts
MM 561	0 to 40	watts
MM 562	0 to 120	watts
MM 563	0 to 400	watts
MM 564	0 to 1200	watts

Accuracy . . . Plus or minus 5% of full scale for RF power.
Plus or minus 10% for V.S.W.R.
Reflection Coefficient . . . Less than 0.01.

MM 560 SERIES

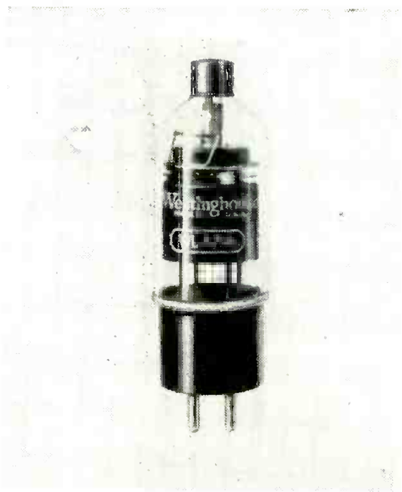
Provides instant assurance of proper functioning of entire RF portion of transmitter, antenna, and transmission line.

This new MicroMatch reads directly the incident power, reflected power, net power to load, and VSWR of the load. Complete $97.00.

M. C. JONES ELECTRONICS CO.
BRISTOL, CONNECTICUT

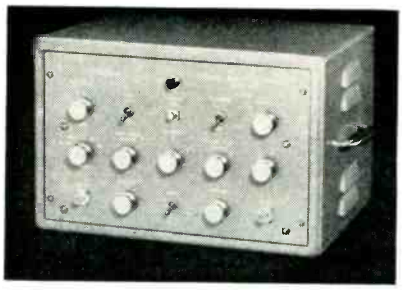
Distributed Outside of Continental U.S.A. by RCA International Div., N. Y., N. Y., U. S. A.

specified. The standard unit features a resolving time of less than 5 μsec. Inputs are as follows: G-M probe with 0.25-v sensitivity and external preamplifier; an adjustable pulse height discriminator; a 2,500-v line and load-regulated h-v supply.



Inert-Gas Thyratron

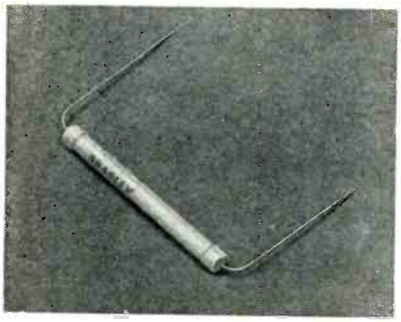
WESTINGHOUSE ELECTRIC CORP., Bloomfield, N. J. A new grid-controlled, inert-gas rectifier, the type WL-5796 thyratron, is a three-electrode, temperature-free tube designed for industrial control and ignitor firing service. Maximum peak anode voltage, both inverse and forward, is 1,500. Maximum negative control grid voltage before conduction is 250; after conduction, 10. The tube can be used in polyphase rectifiers on inductive loads with very small or no cushioning circuits. Cathode voltage is 2.5 and cathode heating time is 10 seconds.



Double-Pulse Generator

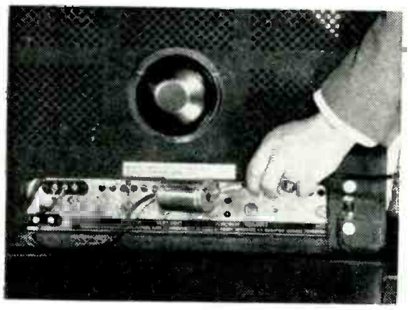
BERKELEY SCIENTIFIC CO., 6th and Nevin Sts., Richmond, Calif. Model 902 double-pulse generator pro-

duces two pulses individually controllable in width, amplitude and time relation to each other. Pulse amplitude is individually adjustable from 0 to 50 and 0 to −200 v. Pulse rise time is 0.05 μsec, decay time 0.10 μsec, and duration is individually adjustable from 0.15 to 1.5 μsec. Spacing between the two pulses is continuously variable in two ranges, −0.5 to +3 μsec. Output impedance is approximately 400 ohms; maximum output voltage, −200 v. Overall accuracy of control calibrations is ±5 percent over the entire range.



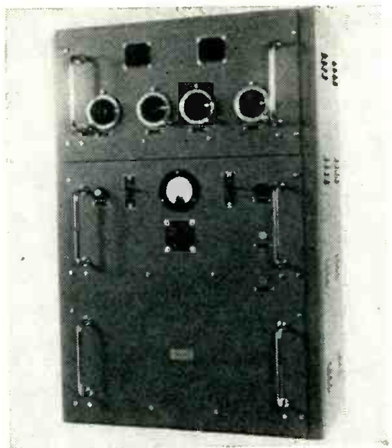
Selenium Rectifier

BRADLEY LABORATORIES, 82 Meadow St., New Haven, Conn., has introduced a new low-current selenium rectifier which features a special plate for use on direct currents in the microampere range. It was developed to provide a highly efficient selenium rectifier for very low current requirements in special equipment such as Geiger counters and c-r equipment. Model number is SE8LA. Rated up to 6,000 v peak inverse, connection series may be used for higher voltages.



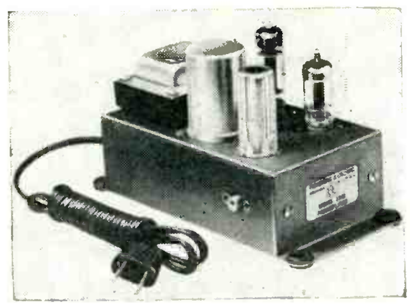
Matching Transformer

BRACH MFG. CORP., 200 Central Ave., Newark, N. J., has developed a 75 to 300-ohm matching transformer with high-pass filter action. It is designed to be a perfect termination at channels 2 to 13 but offers a serious mismatch to diathermy and short-wave interference transmissions in the i-f band. A coaxial fitting is provided to make a low-loss connection to RG59/U. The transformer has negligible loss over the complete tv band and a voltage gain of 2 to 1.



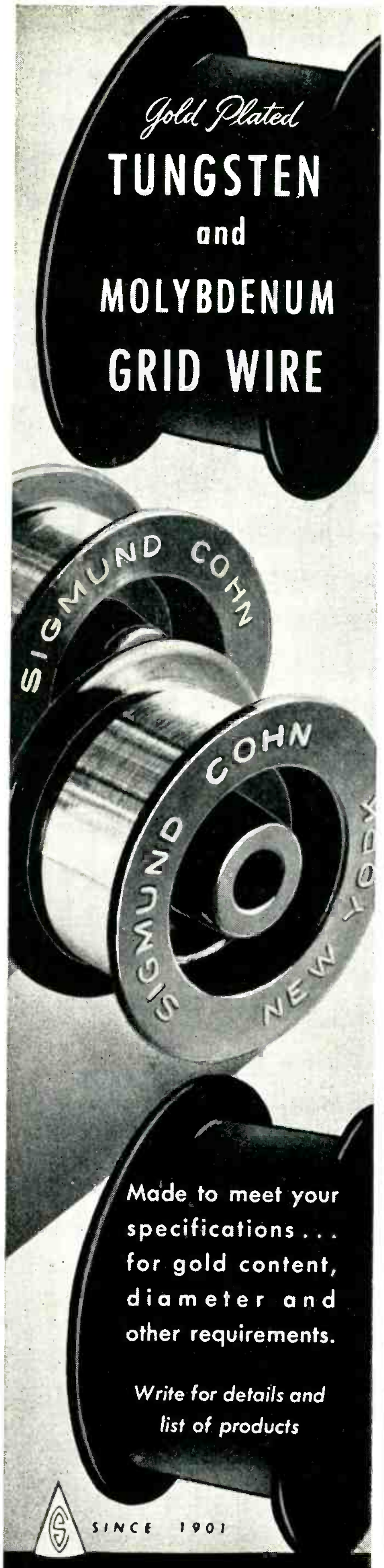
VHF Transmitter

PLESSEY CO. LTD., Ilford, Essex, England. Type PT. 15, a 50-watt vhf transmitter, has a wide field of application in providing radiotelephony communication wherever a compact fixed- station transmitter with a carrier power output of this order is required. Covering the 118 to 132-mc frequency band, the crystal-controlled operational frequency can be varied by insertion of the appropriate crystal.



Preamplifier

PICKERING AND CO., 309 Woods Ave., Oceanside, N. Y., has announced the model 230H compact, small size preamplifier to equalize low frequencies and provide neces-



SIGMUND COHN CORP.
44 GOLD ST. NEW YORK

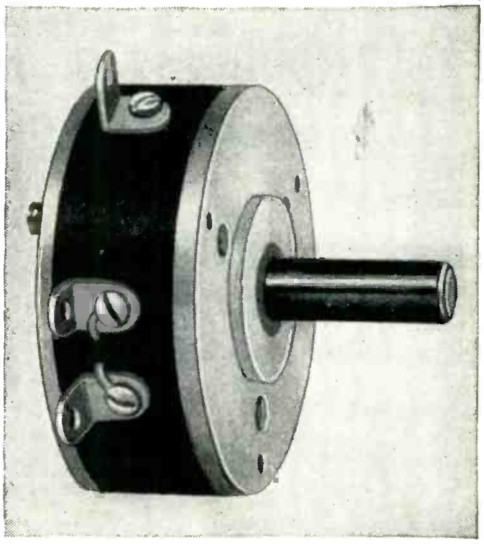
PRECISION POTENTIOMETERS

The linear Type RL-275 illustrated is one of a series ranging from 1¼" to 5" in diameter, with resistance ranges of 80 ohms to 500,000 ohms.

GAMEWELL Potentiometers are precision instruments in every respect. They feature extremely close limits in electrical characteristics and mechanical construction, low electrical noise, low torque, and long life—far in excess of 1,000,000 cycles of operation.

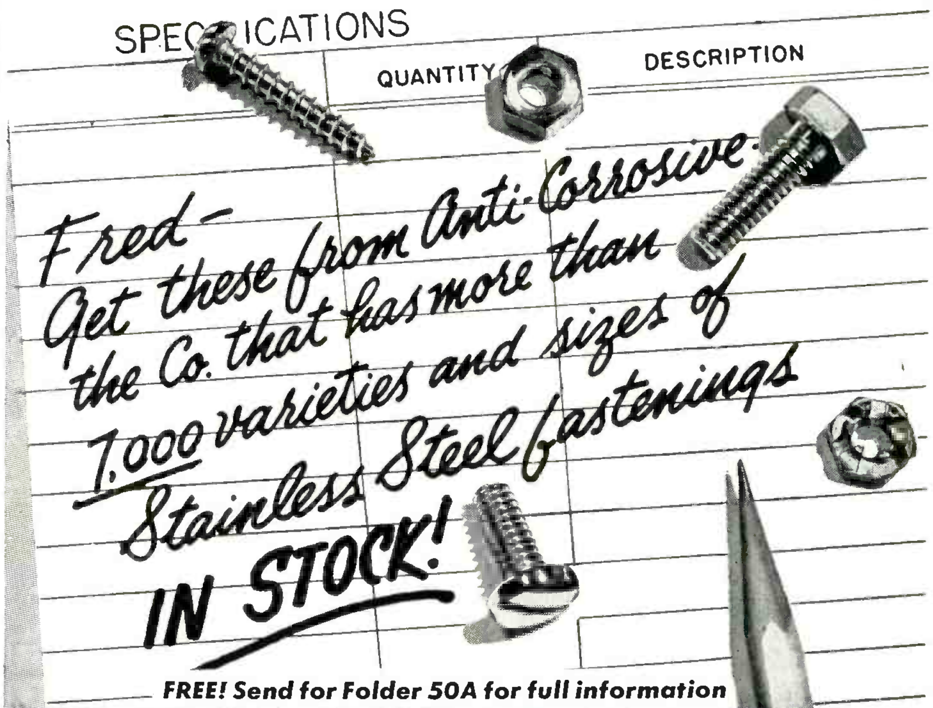
All types will operate within specified limits of performance at temperatures —55° C. to +55° C., 95% relative humidity at altitudes up to 50,000 feet. Corrosion resistant materials are used throughout and all insulating parts are fungicided. Our potentiometers meet AN-E-19 specifications.

We invite your inquiries and will gladly study and quote on special requirements.



Write for Bulletin F-68.

THE GAMEWELL COMPANY
Newton Upper Falls 64, Massachusetts



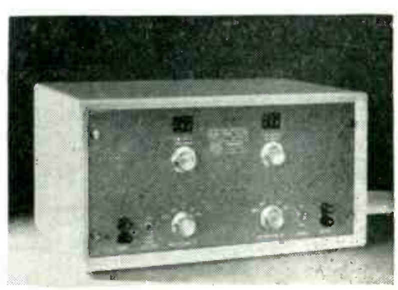
FREE! Send for Folder 50A for full information

Anti-Corrosive Metal Products Co., Inc.
SINCE 1927
Manufacturers of STAINLESS STEEL FASTENINGS
CASTLETON-ON-HUDSON, NEW YORK

sary gain for magnetic pickups. It is self-powered, operates with any high-quality, high-input impedance amplifier and installs by plugging in. The unit features low intermodulation and harmonic distortion.

TV Generator

TEL-INSTRUMENT CO., INC., 50 Paterson Ave., East Rutherford, N. J. Type 2111 tv generator is designed to provide a rapid method of production testing tv receivers on all 12 channels. When modulated by a composite video signal it will provide a standard r-f picture signal suitable for use as a final air check of receivers. The picture signal has an associated f-m sound carrier, which may be modulated at 400 cps or with music from an external source. An electronically regulated power supply assures stable performance regardless of line voltage fluctuations betwen 105 and 125 v. Picture carrier accuracy is 0.01 percent; sound carrier better than ± 4.5 kc of standard on all channels. Picture carrier output is at least 50,000 μv into a 75-ohm terminated coax cable.



ULF Band-Pass Filter

KROHN-HITE INSTRUMENT CO., 580 Massachusetts Ave., Cambridge 39, Mass., has produced the model 330-A ultralow-frequency band-pass

filter. Both the high and low cutoff frequencies are independently adjustable from 0.02 to 2,000 cps, providing maximum flexibility of adjustment of both the band center frequency and bandwidth. The gain is unity in the pass band and drops to a rate of 24 db per octave outside the pass band. The filter is especially useful for vibration studies and electromedical research, for geophysical and seismological instruments, and in conjunction with any low-frequency phenomenon involving selective amplification.

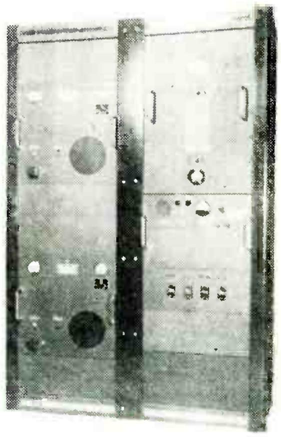
Versatile VTVM

CHICAGO INDUSTRIAL INSTRUMENT Co., 536 W. Elm St., Chicago 10, Ill. The Multitester illustrated is a vtvm featuring 7 ranges of a-c and d-c volts to 5,000; 0 to a billion ohms in 6 ranges; a capacitance scale from 50 $\mu\mu$f to 5,000 μf and 0 to 500 ma in 4 ranges. Price is $39.00 and a descriptive folder is available.

SWR Bridge

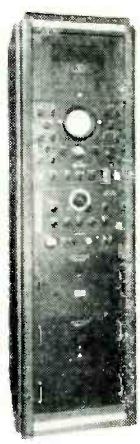
JAMES MILLER MFG. CO., INC., Malden, Mass. Catalog number 90671 standing-wave-ratio bridge is of the resistance type and is

intended for use with coax lines of either 52 or 75-ohm type. The unit measures $4\frac{1}{4}$ in. × $2\frac{1}{4}$ in. × $1\frac{5}{8}$ in. It will work with any low-range d-c instrument and makes possible an inexpensive means for making measurements of the type necessary with all modern transmitter installations.



Radio Beacon

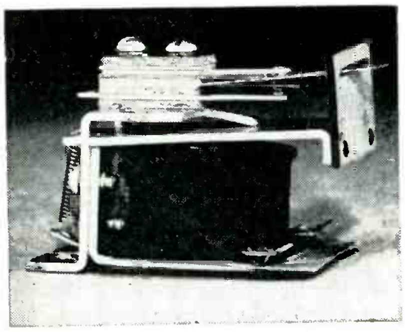
Aeronautical Communications Equipment, Inc., 3090 Douglas Road, Miami 33, Fla., has developed the package-type dual automatic beacon transmitter illustrated. Each unit consists of two 100-watt transmitters (or two 50-watt transmitters), automatic keyer, an automatic transfer unit, and an antenna tuner housed in two standard rack cabinets, especially designed for unattended service.



Oscillosynchroscope

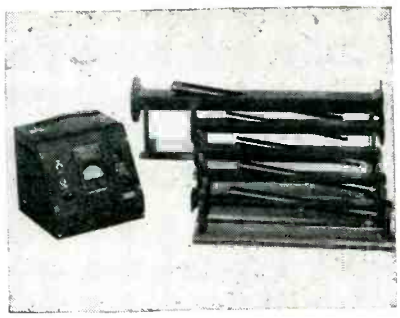
Browning Laboratories, Inc., 750 Main St., Winchester, Mass., an-

nounces the model OJ-17 oscillo-synchroscope for laboratory use. The high-gain vertical amplifier has a response flat from 5 cycles to 16 mc, extending beyond 30 mc, including the use of a 0.2-μsec signal delay line. Two completely separate sweep systems permit accurate display of repetitive phenomena with recurrence rates as high as 10 mc, or transient and recurrent pulses as short as 0.5 μsec. Accurate time measurements may be made by use of 0.1, 1.0, 10 and 100-μsec timing markers. One compartment of the five-unit cabinet is provided for permanent installation of an Oscillo-Record camera.



Sensitive Relay

ASSEMBLY PRODUCTS, INC., Chagrin Falls, Ohio. Series 1816 is a sensitive relay with heavy-duty ratings. The coil is 15,000 ohms and operates on 5 ma d-c. Contacts are snap action and will handle 15 amperes, 115 v or 7.5 amperes, 230 v a-c. Designed for high differential between pull in and drop out the relay is normally high speed in action. Contacts are spdt or dpdt.



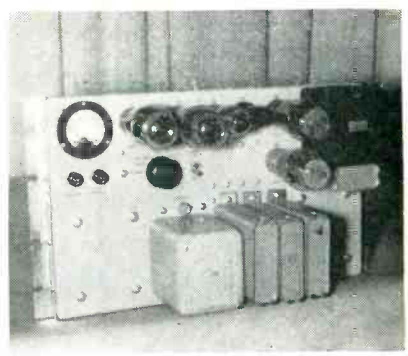
Random Noise Generators

KAY ELECTRIC CO., Maple Ave., Pine Brook, N. J., announces the microwave Mega-Nodes, a series of

random noise generators designed to produce a known output noise in the frequency range of 2,600 to 12,400 mc. The following waveguide sizes are available: RG48/U, RG49/U, RG50/U, RG51/U, RG-52/U. Over the operating range, the vswr of each generator is less than 1.1, with the exception of the RG50/U guide whose vswr goes to 1.19 over about 20 percent of the frequency range. Noise output of each generator is 15.84 db above thermal noise at a waveguide temperature of 32 C.

Low-Frequency Coils

UNITED TRANSFORMER Co., 150 Varick St., New York 13, N. Y., have developed a line of Hi-Q coils for subaudio frequencies. These coils have high Q and stable characteristics for frequencies from 0.1 to 10 cycles. A typical unit provides an inductance of 300,000 henrys with Q of 10 at 0.15 cycle and Q of 30 at 0.5 cycle. It is designed for a 1-volt a-c, 0.1-ma d-c circuit.



Regulated Power Supplies

GENERAL ELECTRIC Co., Syracuse, N. Y., has announced two new regulated power supplies for tv station when you use the *Audax* POLYPHASE...

ONE single unit plays ALL your records SUPERBLY... and at less than the cost of ordinary magnetic pick-ups

"The Standard by which Others Are Judged and Valued"

Microgroove, 78. r.p.m., etc.

- Response 20 to over 10,000 cps.
- Jewel styli replaceable individually.
- Needle talk practically nil.
- Tracking remarkable.

See it at your local distributor or write us

Send for editorial reprint on POLYPHASE principles

AUDAK COMPANY
500 5th Ave., New York 18
Fine Music Reproducers Since 1915

MEMO TO DESIGNERS

THE PATH OF MOST RESISTANCE FOR ELECTRICITY IS THE PATH OF LEAST RESISTANCE for your PURCHASING AGENT

We're Talking About

JELLIFF ALLOY 1000

This new resistance wire is almost too good to be true. Not only is the Resistivity 1000 ohms/cmf (48% higher than that of the widely-used nickel-chromiums), but it also has such outstanding mechanical and electrical properties that it can easily replace several other alloys now being used in the smallar gages for precision resistors.

★ ★ ★

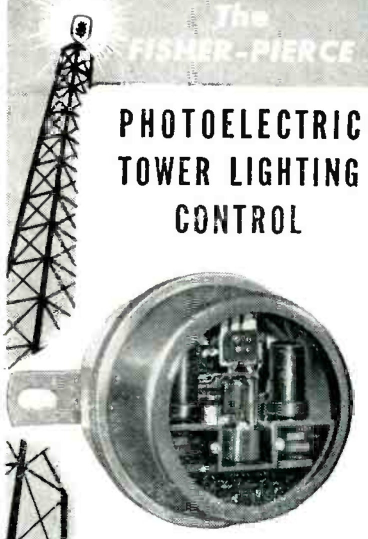
This means simplified procurement, stock and inventory procedures — more compact precision resistors — lower cost and longer life for the finished product.

For the full story of Alloy 1000, write for Bulletin 17

THE C. O. JELLIFF MANUFACTURING CORPORATION SOUTHPORT, CONN.
LEKTROMESH • RESISTANCE WIRE • FILTERS • STRAINERS • WIRE CLOTH • PARTS • WIRE MESH PARTS • DIPPING BASKETS
WIRE PRODUCTS SINCE 1880

The FISHER-PIERCE

PHOTOELECTRIC TOWER LIGHTING CONTROL



Turn-on 35 ft.-candles—off at 55 ft.-candles—independent of time of day or weather conditions.

Low first cost—negligible maintenance.

3000 watts contact capacity.

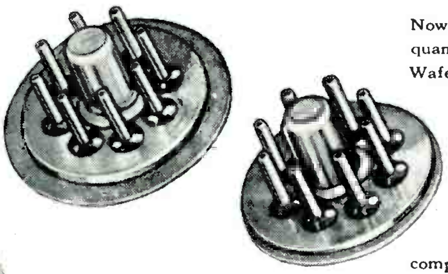
Over 20,000 in use for tower and street lighting.

Complete details available — ask for Bulletin 63305.

The FISHER-PIERCE COMPANY, Inc.
42 Ceylon St., Boston 21, Mass.

E-I HERMETIC SEALING COMPONENTS

NEW! OCTAL PLUG-IN WAFERS



Now available in production quantities, E-I Series OBS Plug-in Wafers feature several important new developments. Hollow keys are form fitting and a new hermetic sealing technique makes the seal practically indestructible, even when the pins are bent. The entire assembly is extremely rigid. For complete data, call or write for the E-I illustrated brochure.

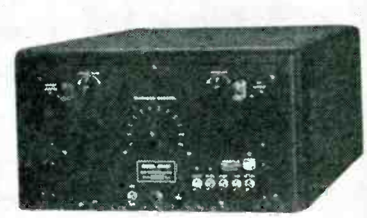
STANDARD SIZES	
MODEL	OUTSIDE DIA.
OBS 146	1.460
OBS 125	1.250
OBS 106	1.060

ELECTRICAL INDUSTRIES INCORPORATED
44 SUMMER AVENUE • NEWARK 4, N. J.

applications. Both units, types TP-12-A and TP-13-A, feature single-phase input, high current capabilities and low ripple. The TP-12-A can supply 300 to 900 ma at 275 to 300 v with a maximum ripple less than 0.01 v peak-to-peak. The TP-13-A can supply 0 to 300 ma at 275 to 400 v with a maximum ripple of less than 0.05 v peak-to-peak.

Remote-Cutoff Beam Pentode

RADIO CORP. OF AMERICA, Harrison, N. J. Type 5890 is a low-current beam pentode of the remote-cutoff type intended particularly for the voltage regulation of h-v d-c power supplies. It has a maximum d-c plate-voltage rating of 30,000 v, a maximum d-c plate-current rating of 500 μa, and a maximum plate-dissipation rating of 10 watts. The h-v insulation required for its intended service is obtained by the use of a double-ended structure using a suitably designed electron gun consisting of a thermionic cathode and three grids. The plate connection is made to a small cap at the end of the bulb.

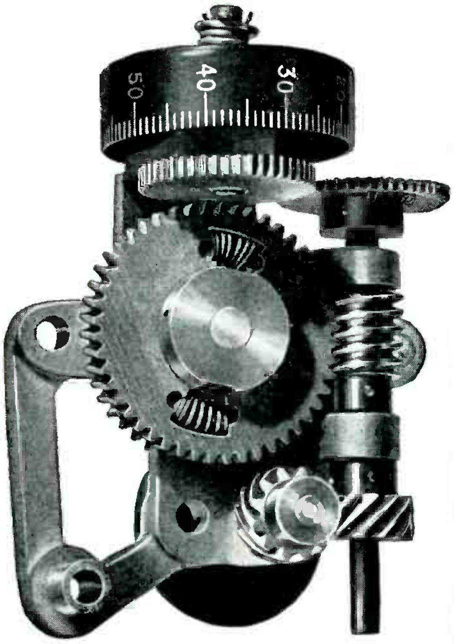


Sweep and Marker Generator

KAY ELECTRIC CO., Maple Ave., Pine Brook, N. J. Model RFP Marka-Sweep is an all-electronic sweep and marker generator espe-

SPECIALISTS IN

ELECTRONIC GEARS



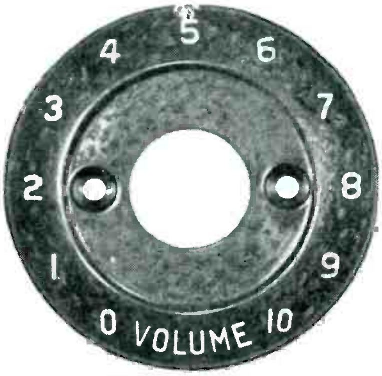
QUAKER CITY GEAR WORKS

1910 N. FRONT ST.
PHILADELPHIA 22, PA.

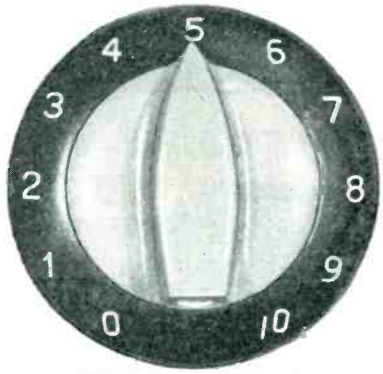
Save Time, Save Money . . . Use Rogan's Interchangeable

COMBINATION KNOBS

Wide Selection Available From Stock Molds . . . No Tool Charge . . . Fast Delivery



RB-1000 Escutcheon Branded



RB-1000 Used in Combination with RB-31 Knob

Write For New Bulletin 104 Showing How Rogan Knobs Can Help Solve Your Knob Problems

Illustration shows two of the many combination branded knobs from Rogan's huge selection. Available from stock with assorted markings readily adaptable to electronic and other related equipment. Can be furnished in matching or contrasting color combinations. Supplies from stock molds, no tool charge. Fast delivery, low cost. Send for complete details.

ROGAN BROTHERS 2504 IRVING PK. BLVD. CHICAGO, 18, ILLINOIS

Compression Molders and Branders of Plastics

VULCAN

ELECTRIC HEATING UNITS

FINNED STRIP

For use in blower type electric unit heaters, as oven or space heaters in dryers, pump rooms, switch towers, etc.

From 10½" to 42½" overall.

500 watts to 3250 watts.

for 115 and 230 volts

Steel sheath and fins (rust resisting)

For use where sheath temperature will not exceed 750° F.

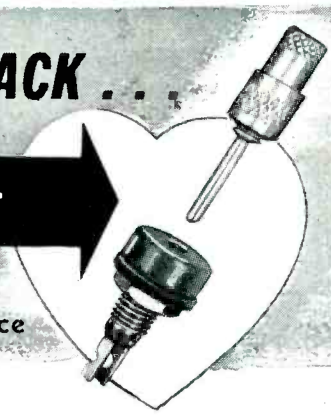
VULCAN ELECTRIC COMPANY
DANVERS 10 MASS.

TRADE VULCAN MARK

HEART OF A TIP JACK . . .

IS THE SPRING CONTACT

Johnson Design, Materials Mean Longer Life, Better Service



Next time you need Tip Jacks, remember the two important advantages JOHNSON Tip Jacks offer.

First, contact in the JOHNSON Tip Jack is made along the entire length of the phone tip or test prod, and remains unchanged despite insertion of oversize tip, excessive binding forces or long use. Second, JOHNSON uses heat treated beryllium copper contacts which remain smooth acting, have low resistance and retain high spring tension.

Although other Tip Jacks may look like those made by JOHNSON, only JOHNSON offers you heat treated beryllium copper contacts of this unique design.

The insulated style with strong molded Plaskon head, (illustrated) is available in ten attractive colors. They are also available without head for mounting directly in equipment, as well as in a variety of other types. In all of them JOHNSON machined parts are of highest quality, with close fitting threads, smooth finish, plated to comply with any specifications.

JOHNSON makes many other jacks and plugs, such as "banana" styles for military or commercial applications, as well as plug and jack board assemblies, connectors, etc. Manufacturers are invited to write for free samples and catalog information.

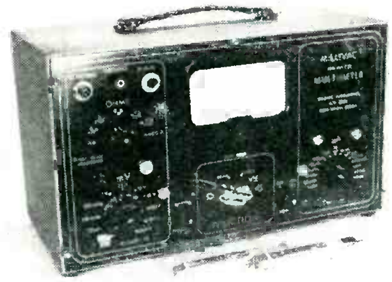
JOHNSON . . . *a famous name in Radio!*

E. F. JOHNSON CO., WASECA, MINNESOTA

cially suitable for production alignment of tv tuners and overall alignment of complete receivers. A 12-position channel switch selects extremely narrow pip-type crystal-positioned picture and sound carrier markers as well as the desired 15-mc wide swept oscillator output. Sweep outputs are from maxima of approximately 0.5 v for the 70-ohm unbalanced output and 1.0 v for the 300-ohm balanced output down to minima suitable for aligning the most sensitive receivers.

Transmitting Tube

GENERAL ELECTRIC Co., Syracuse, N. Y. Type GL-5680 transmitting tube is designed for use as a power amplifier in transmitters for long-range navigation. The tube is forced-air cooled and may be operated at maximum ratings at frequencies as high as 5 mc. In pulsed r-f power-amplifier service it can deliver a peak power output of 90,000 watts at 15,000 volts under typical operating conditions.



V-T Multimeter

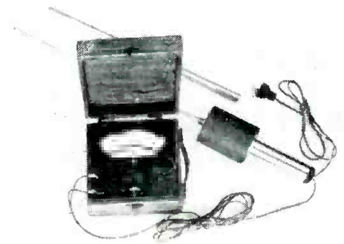
MILLIVAC INSTRUMENTS, Box 3027, New Haven, Conn. Type MV-73B

ANNOUNCING the

RAWSON-LUSH

Rotating-Coil

GAUSS METER



Tiny coil (approx 3mm diameter) rotates in the magnetic field to be measured. The voltage generated is rectified in a synchronous rectifier and deflects a Rawson high sensitivity voltmeter with scale calibrated in kilogausses.

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1) Simple operating principles, simple to maintain.
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5) Can be inserted in any gap wider than 1/4", and will reach the center of 37" diameter gap. Coil protected by stationary outer tubing.
6) Measures direction of field as well as intensity.
7) Guaranteed accuracy 1% or better.
8) Low price $325 complete with meter.

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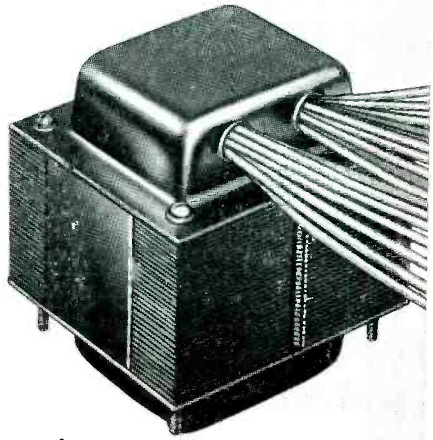

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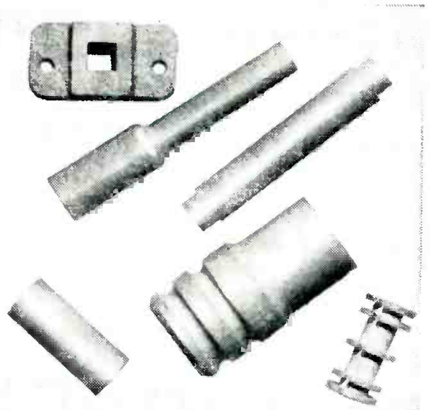

Design engineers and manufacturers in the radio, electrical and electronic fields are finding in LAVITE the precise qualities called for in their specifications . . . high compressive and dielectric strength, low moisture absorption and resistance to rot, fumes, acids, and high heat. The exceedingly low loss-factor of LAVITE plus its excellent workability makes it ideal for all high frequency applications.

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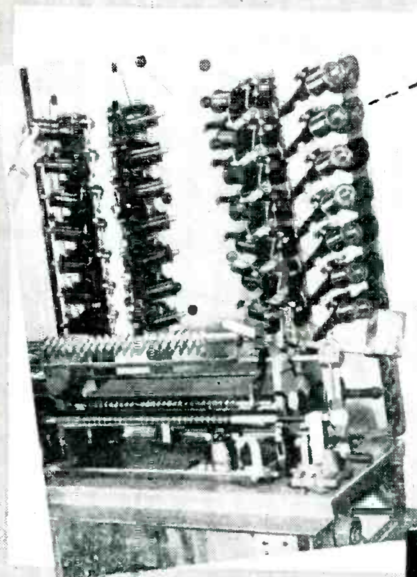

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Pamarco DeReeling Tensions increase the efficiency of coil winding departments in two important ways. Production quantity is increased because each machine accommodates more coils and can often operate at higher winding speeds. Production quality is improved because Pamarco free-running action practically eliminates wire breakage and shorted turns. No special skill or tools are required to operate Pamarco-equipped winding machines. Simple thumb screw can be set instantly for any wire gauge. For all the facts on money-saving Pamarco DeReelers, just call or write. Complete data will reach you promptly!

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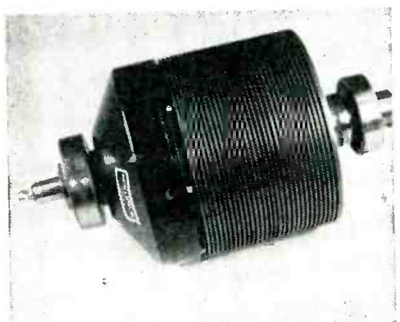
WINDING DEVICES FOR TEXTILES AND ELECTRONICS vacuum tube multimeter, which measures voltage, current and resistance, combines unusual versatility with high sensitivity. It has a full-scale sensitivity of 10 mv for d-c and a-c voltage measurements. In the high-frequency range up to 300 megacycles it has a maximum sensitivity of 25 mv. Its current range is between 1 μa and 10 amperes. As an ohmmeter it can measure from 0.5 ohm to 2,000 megohms. The instrument is equipped with three probes.

Power Frequency Amplifier

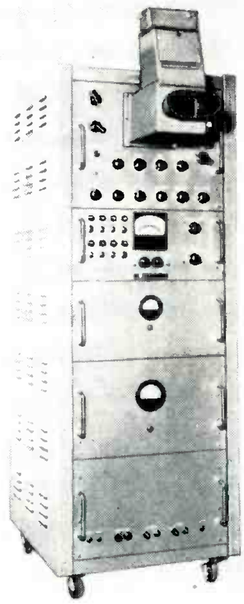
KEITHLEY INSTRUMENTS, 1507 Warrensville Center Road, Cleveland 21, Ohio. Model 105 Meter Matcher is a power frequency amplifier that will develop 150 volts rms across a 2,000-ohm resistive meter load and adds only a 0.15-percent maximum error to the measurements. Output and input voltages are in phase except for the small displacement caused by the meter current in the internal output impedance, about 0.006 degree for a 2,000-ohm resistive load at 60 cps. Detailed information is given in a recent four-page bulletin.



Hysteresis Clutch

DUNCAN AND BAYLEY, INC., 785 Hertel Ave., Buffalo 7, N. Y. New PM series hysteresis clutch is capable of synchronous operation with

zero slip. It provides a stable, long-life, proportional clutch means that can deliver desired torques continuously for given levels of control current independent of slip-heat loss. Fractional horsepower units up to ½ hp are available for industrial work such as tension control, machine tool drives, dynamometers, and various duty cycles requiring continuous high-heat dissipation as well as synchronous driving upon demand.



C-R Oscillograph

Allen B. DuMont Laboratories, Inc., Clifton, N. J. Type 293 c-r oscillograph is designed for the impulse-testing of h-v transformers, insulators, lightning arrestors, and other equipment designed to withstand surge potentials of great amplitude. Driven, logarithmic sweeps may be initiated from an external signal, internal signal, by manual pushbutton or from any point in the cycle of the 60-cycle line voltage. Sweep duration is adjustable in steps from 0.5 to 1,000 μsec. Bandwidth of both the X and Y axes is essentially uniform from d-c to 25 mc.

Literature

Coax Cable. Andrew Corp., 363 E. 75th St., Chicago, 19, Ill. Bulletin 39 treats type 738 ultralow-loss

coaxial cable that is ⅞ in. in diameter and semiflexible. Mechanical and electrical characteristics, impedance, power rating standing-wave ratio and a table of efficiency vs frequency are given. Several accessories are also described and illustrated; and a price list for all may be found in bulletin 58.

British Specifications. The Radio Industry Council, 59 Russell Square, London, W.C. 1, England, recently issued a series of private specifications for the use of the British radio industry. Specification No. RIC/111 covers fixed, wirewound, noninsulated resistors; RIC/112—fixed composition resistors, grade I; RIC/113—fixed composition resistors, grade II; RIC/131—tubular fixed capacitors (paper dielectric); and RIC/132—stacked foil mica fixed capacitors.

Reference Book. Harrison Radio Corp., 10 West Broadway, New York 7, N. Y. The Radio's Master is a 1,300-page hard-cover-bound reference book and buyer's guide for the electronics industry. It describes and illustrates the products of better than 90 percent of all manufacturers of electronic parts and equipment. Prices and specifications as well as an index are included. Copies will be sent free to any purchasing agent or chief engineer who writes on company letterhead.

Radiation-Detection Densitometer. Photovolt Corp., 95 Madison Ave., New York 16, N. Y. Bulletin 490 covers model 400-R radiation-detection densitometer which is self-contained and operates with barrier-layer photocell without amplification. The unit described is designed for the accurate measurement of density of dental-size x-ray films as employed in film badge systems for personnel monitoring in radioactivity laboratories and x-ray installations.

Receiving Tubes. Radio Corp. of America, Harrison, N. J. Form 1275-E is a 24-page booklet covering more than 450 receiving tubes and picture tubes including more than 50 new types. It provides quick and easy reference to the

characteristics and socket connections for each tube type, as well as a classification chart which groups the tubes according to their family class, their functions, and their filament or heater voltages, and thus facilitates determination of the type designation of a tube for a desired purpose. Price is 10 cents.

Variable Transformers. The Superior Electric Co., Bristol, Conn., has released bulletin P550 featuring the complete line of standard Powerstat variable transformers. Maximum display is given to product photographs, performance curves, graphs, wiring diagrams and similar descriptive illustrations. A complete rating chart occupying the back cover provides engineers and purchasing agents with a quick selector index.

Acoustical Apparatus. Audak Co., 500 Fifth Ave., New York 18, N. Y., announces its new 1950 catalog, a four-page brochure embracing its Polyphase model reproducers, also tuned ribbon and heavy duty pickups and cutting heads. All models are illustrated and list prices are given.

Contact Switches. Guardian Electric Mfg. Co., 1621 W. Walnut St., Chicago 12, Ill., recently issued a bulletin dealing with a line of contact switches. Numerous line drawings and charts are employed to give information relative to sizes, designs and materials available in standard contact blades, lug adapters and insulating separators.

Radio and TV Catalog. General Cement Mfg. Co., 919 Taylor Ave., Rockford, Ill. Catalog No. 154 features over 5,000 radio and television products and service aids. The 64 pages are well illustrated and prices of all items are included.

Electronic Calculation. International Business Machines Corp., 590 Madison Ave., New York 22, N. Y., now has available two recent publications: Electrons at Work, and Fundamentals of Electronic Calculation. The former describes briefly the operation of

the electronic tube and its application to electronic calculators and business machines; the latter discusses commercial and technical applications of the company's electronic calculating machines, and describes some of the work of the IBM technical computing bureau.

Photoelectric Colorimeter. Photovolt Corp., 95 Madison Ave., New York 16, N. Y. Bulletin 409 describes and illustrates the model 401 Lumetron photoelectric colorimeter, an instrument designed for accuracy, ease and speed of operation in colorimetric and turbidimetric analysis. The bulletin gives a list of applications, a price list and a list of available accessories and replacement parts.

Transformers and Related Components. Standard Transformer Corp., Elston, Kedzie and Addison, Chicago 18, Ill. The June 1950 edition of the company's catalog of transformers and related components for radio, sound and industrial applications is available. This 20-page illustrated booklet lists complete electrical and physical specifications of more than 400 part numbers. Also included is a complete price list and handy charts. The company's tv components are listed in a separate tv catalog and replacement guide, also available in a seventh edition.

Circuit Breakers. Heinemann Electric Co., Trenton 4, N. J. Equipment bulletin No. 3410 describes in 12 pages a line of fully magnetic nonthermal, nonenclosed, general purpose circuit breakers. Illustrations charts, diagrams, graphs and cutaway drawings portray these one-, two-, and three-pole breakers for general industrial use. Time overload curves and coil resistance curves are also included for convenience in selecting the breakers for specific needs. In addition to terminal construction, the following types of coils connections are described: series overload, calibrating tap, shunt trip and relay trip.

Solderless Connectors. Buchanan Electrical Products Corp., 1290

The Improved 1951

Concertone RECORDER

Model 1401

• Equalization conforms to NAB recommended standards • Extended frequency response—40 to 15,000 c.p.s. ± 2db • Tape noise down to random level • More powerful drive motor • Improved braking system • Monitors directly from tape while recording • Plays up to 10½" NAB reels • Write for Bulletin No. 103.

MODEL NO. 1401—Complete for console installation, with dual track heads.......... $345.00 USER'S NET COST

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NEW *Clippard* PC-4

Capacitance Comparator Checks, Grades and Sorts Condensers of Every Type —Paper, Mica, Oil Filled, Ceramic, Electrolytic.

Now....UNSKILLED OPERATOR CAN GRADE UP TO 8000 CAPACITORS DAILY!

The PC-4, companion to the well known Automatic Resistance Comparator PR-4, is a NEW high speed and extremely accurate aid in the never ending battle for higher quality and lower production costs. An unskilled operator can check, grade or sort as many as 8000 capacitors of ANY TYPE, daily, within an accuracy of 0.2%. Ease of operation reduces inspection time to an absolute minimum.

Completely self-contained, the PC-4 requires no outside attachments other than a Standard Capacitor against which the "unknowns" are to be checked. Operates on 110 Volt—60 cycle AC. Range—100 mmfd to 1000 mfd. Size 18" x 12" x 12". Weight—approximately 35 lbs. For complete details write for Catalog Sheet 4-E.

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Central Ave., Hillside, N. J. Bulletin 750 describes in four pages an improved line of connectors for solderless splicing and terminating of electrical wires. Illustrated descriptive data, installation instructions and ordering information are given. The pres-Sure tool is pictured in operation.

F-M Equipment. Collins Audio Products Co., Inc., P. O. Box 368, Westfield, N. J. Information on the T-20-A mobile receiver, the S-17-A Storecaster receiver and R-12-A industrial f-m tuner is found in a recent four-page folder. It tells how to increase the earning power of one's f-m station through use of bus radio, storecasting and industrial music. A price list is also available.

Tube-Base Reference. Radio Corp. of America, Harrison, N. J. The Triple Pindex, 2F366R, is a handy quick-reference guide to tube-base diagrams. Over 600 tube types are listed in both alphabetical and numerical sequence. Designed for workbench use, it measures 4 in. x 8 in. Price is 75 cents.

Measurements Notes. Measurements Corp., Boonton, N. J., announce the publication of the second issue of Measurements Notes. The purpose of the four-page brochure is to assist the industry in making measurements of receiver susceptibility to ignition interference.

Recorders and Amplifiers. Sanborn Co., 39 Osborn St., Cambridge 39, Mass. A recent catalog folder contains a loose-leaf-perforated series of bulletins covering a line of direct-writing recorders and instrument amplifiers. Each unit is technically described and illustrated and a price list is included. As other, or newer, models become available, descriptive pages will be sent for inclusion in the folder.

Power Frequency Amplifier. Keithley Instruments, 1507 Warrensville Center Road, Cleveland 21, Ohio. An illustration, chief uses, features and specifications of the model 105 Meter Matcher

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Weight—5½ Ounces • Watts—40 or 60 • Tip Dia.—Both 1/8" and 1/4" Tips Furnished with Each Iron • Price— $5.50

So light its weight is hardly noticeable. Outperforms any iron of equal size. Hatchet design makes it more comfortable and practical to use than a pencil iron. No transformer required. Write for complete catalog.

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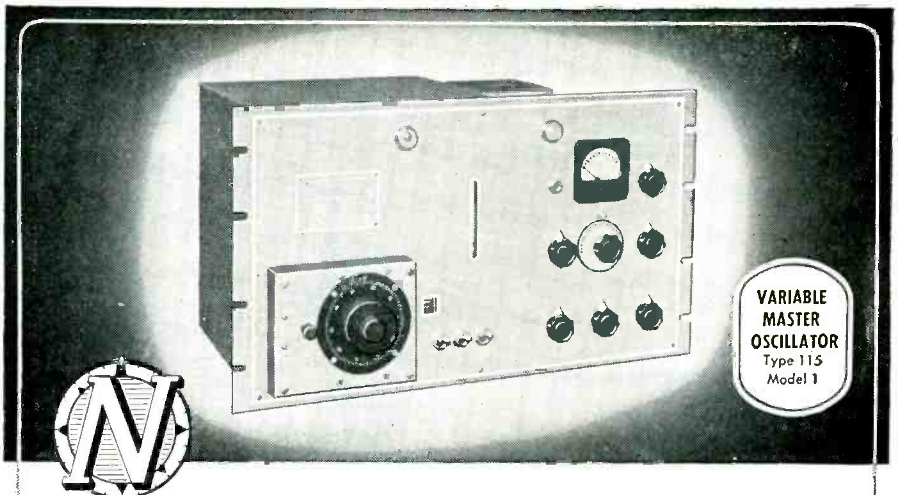

The Variable Oscillator with CRYSTAL STABILITY

High versatility, plus wide range, plus crystal stability and accuracy—that's the unbeatable combination for the best in diversity reception. You get all three with the Northern Radio VARIABLE MASTER OSCILLATOR. The HFO's stability is ± 20 cps/mc for ambient change of ± 25°C.—matching that of any non-temperature controlled crystal. Its range is 2-32 mc continuous. Crystal check points, with 40 curves supplied, permit absolute frequency setting to ± 25 cps/mc. Three crystal-controlled frequencies provide fixed frequency reception. There's a LF crystal oscillator for BFO.

And, this unit also serves as an excellent transmitter exciter and laboratory measuring standard.

See the specifications on this outstanding model in the 1950 Electronics Buyers Guide. For complete data on the precision-built Northern Radio line, write today for your free latest Catalog E-2.

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Unit mounts and mounting systems with MET-L-FLEX provide vibration isolation and true shock absorption through the widest range of operating conditions.
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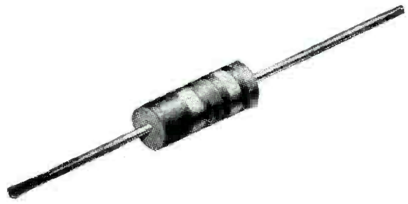

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Ideal for service replacement, especially in television receivers. Available from stock through Continental Jobbers in cooperation with Allen-Bradley.

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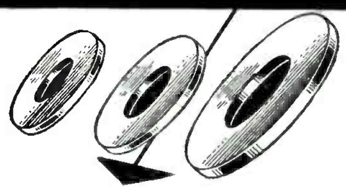

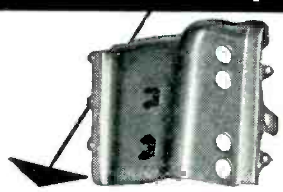

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EST. 1903 **WHITEHEAD STAMPING CO.**

1691 W. Lafayette Blvd. Detroit 16, Michigan may be found in a four-page folder. The unit described is a power frequency amplifier for greatly reducing the errors caused by measuring instrument loading of a circuit under test.

Portable D-C Recorder. Wallace & Tiernan, Belleville, N. J. Publication TP-18-A illustrates and describes a new portable d-c recorder, a direct writing recorder that is adjustable over a wide range. The unit described has a minimum full-scale range of 100 μa and a maximum full-scale range of 5,000 ma. It is particularly suited for laboratory use.

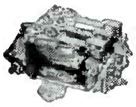
Antenna Catalog. Jerrold Electronics Corp., 121 N. Broad St., Philadelphia 7, Pa. A 12-page two-color catalog gives full information and shows diagrammatically how a Mul-TV system, including antenna, master control-amplifier unit and distribution outlets, is installed in a typical apartment house or store to provide perfect television reception on any number of television sets connected to the system.

Tube Selection Survey. Industrial Electronics, Inc., 8060 Wheeler St., Detroit 10, Mich., has available a survey form which will be sent to all companies that are interested in obtaining tubes that have superior life characteristics. The superior qualities are obtained by a preaging and selection process.

Resistors. Instrument Resistors Co., 1036 Commerce Ave., Union, N. J. A recent 28-page loose-leaf perforated folder covers a line of application-designed wire-wound resistors. Included are illustrations and specifications on each type.

Artificial Reverberation Generator. Tech Laboratories, Inc., Palisades Park, N. J., has available a single-sheet bulletin treating the type AF101 artificial reverberation generator. Technical specifications given include the unit's input impedance, input and output level, output impedance, controls, reverberation time and power requirements.

For Advanced RELAYS specify ADVANCE



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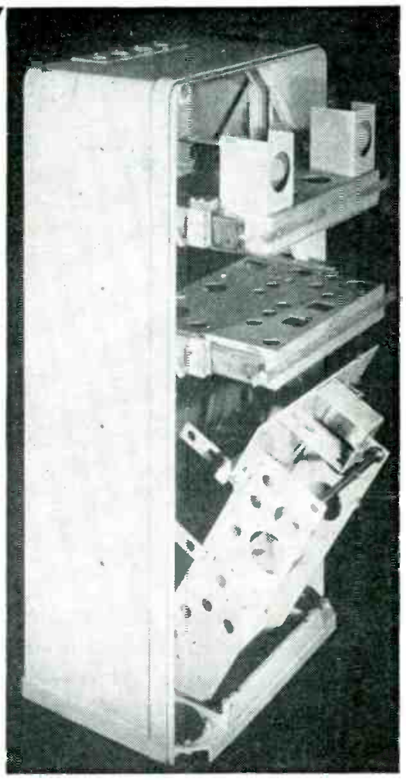

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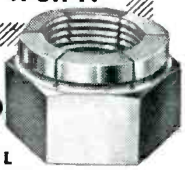
A fastener AIN'T, *if— it works loose.*

The "FLEXLOC" IS— *because it won't!*



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ONE-PIECE, ALL-METAL
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The "FLEXLOC" has plenty of tensile . . . can be re-used many times . . . has therefore a long, effective life.

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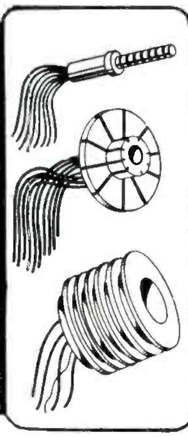

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THE DANO ELECTRIC CO.
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NEWS OF THE INDUSTRY

(continued from page 130)

tivity, With the Aid of the Noise Diode, by W. K. Squires of Sylvania Electric Products Inc.
2:00 P.M.—Quality Control Session (J. R. Steen, presiding)
Application of Statistical Quality Control in Manufacture of Electronic Products, by E. R. Ott of Rutgers U. and G. Scheel of Sonotone Corp.
The Quality Control Indicator, by C. J. Faik of General Electric Co.
The Control of Averages in Radio Tube Manufacture, by A. K. Wright of Tung-Sol Lamp Works, Inc.
The Human Aspect of Engineering Quality into the Product, by C. Gartner of Allen B. Du Mont Labs., Inc.
8:00 P.M.—Joint Session with Technology Club of Syracuse

Tues. Oct. 31

9:00 A.M.—Television Session (R. A. Hackbusch, presiding)
A Study of Permanent Magnet Focusing Devices for Television Picture Tubes, by K. James and R. T. Cappodanno of Emerson Radio & Phonograph Corp.
The Application of a New Low-Noise Double Triode as an RF and IF Amplifier in Television Receivers, by R. M. Cohen of RCA.
Consideration of Optimum Use of Picture Tubes, by W. B. Whalley of Sylvania Electric Products Inc.
Evaluation of Performance Characteristics of Cathode-Ray Tubes for Use in Television Receivers, by K. A. Hoagland of Allen B. DuMont Labs. Inc.
2:00 P.M.—Television Session (D. D. Israel, presiding)
The Technical Aspects of Phonevision, by E. M. Roschke of Zenith Radio Corp.
An Analysis of Color Television, by A. V. Loughren of Hazeltine Electronics Corp.

Wed. Nov. 1

9:00 A.M.—Audio Session (O. L. Angevine, Jr., presiding)
The Mechanics of the Phonograph Pickup, by T. E. Lynch of Brush Development Co.
Lightweight Pickup and Tone Arm, by C. R. Johnson and L. J. Anderson of RCA.
Sound Pickup in High Ambient Noise, by W. Beaverson of Electro-Voice Inc.

Radiotelephone Third

A NEW CLASS of license has been established to meet a need for nontechnical radiotelephone operation intermediate between the telephone second and the restricted radiotelephone operator permit. The latter is issued to those at certain stations employing pushbutton equipment. Among the stations that can be operated by the new class of license are noncommercial educational broadcast stations with 10 watts of power or less.

Supplement No. 6 to the FCC Study Guide has been issued for those preparing for the new examination. A new study guide, last revised in July 1948, will be available by January 1951. This booklet will bring all the examination elements up to date and include a new Element 8 covering ship radar techniques.

New Bureau

THE NEW Safety and Special Radio Services Bureau recently estab-

lished by FCC is headed by Edwin L. White, Chief. He is charged with the unification of regulations for nonbroadcast, certain common carrier (including aeronautical) radio, ship and public coastal, public safety, amateur, land transportation, industrial and citizens radio services. His assistant is Lester W. Spillane.

Heading up the five divisions are: Marine, William N. Krebs; Aviation, John R. Evans; State-Local Government and Amateur, George K. Rollins; Industry and Commerce, Glen E. Nielsen; Authorization Analysis, Charles R. Weeks. The chief of the Enforcement unit is Marshall S. Orr.

Citizens Radio

FCC HAS AMENDED its rules for the Citizens Radio Service to permit operation of such stations by any person so authorized by the station licensee as long as communication does not involve transmission of Morse code telegraphy.

BUSINESS NEWS

JOHN MECK INDUSTRIES, INC., tv receiver manufacturer, is now operating a new building providing 20,000 sq ft of additional production space at its main Plymouth, Ind., factory.

GOULD-NATIONAL BATTERIES, INC., recently became the new name of the National Battery Co., manufacturer of industrial storage batteries, when the stockholders of the latter firm approved the change proposed by the board of directors.

GENERAL ELECTRIC CO., Syracuse, N. Y., has bought the Illinois Cabinet Co. at Rockford, Ill., which will continue to produce its present line of wood products for tv home receivers.

PRODUCTION EQUIPMENT CO., 37 W. Main St., Oyster Bay, N. Y., is now functioning as two separate organizations. Production Tool & Fixture Co. will continue with the subcontract portion of the business producing aircraft and similar parts. Coil Winding Equipment

electronics

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Co. will continue with the design and manufacture of equipment for the coil-winding industry.

TETRAD CO., INC., 4921 Exposition Blvd., Los Angeles 16, Calif., is a recent entrant into the electronic components manufacturing field. It will specialize in the manufacture of miniature solenoid coils.

FIELDEN INSTRUMENT CORP., industrial control manufacturer, announces the occupation of new and larger office and factory space at 2920 North 4th St., Philadelphia 33, Pa. The name of the company has been changed from Fielden Electronics Inc.

GENERAL ELECTRIC CO., recently announced a three-million dollar expansion program for its receiving tube plants at Owensboro, Ky., and Tell City, Ind., involving the addition of 134,000 sq ft of floor space and new tube making equipment.

BETA ELECTRIC CORP. has moved to new and larger quarters at 333 E. 103 St., New York 29, N. Y. The new premises will allow about five times as much production area as was formerly available and will allow for the manufacture of power supplies up to 400 kv.

LEAR, INC. has acquired the balance of 9,600 sq ft of space in its main building in Grand Rapids, Mich., increasing the main plant area to 180,600 sq ft. The added space will be used to further increase production of such devices as automatic controls, servomechanisms, aircraft radio and other aircraft accessories.

ELECTRONCRAFT CORP. has been formed at Lakewood, Ohio, to manufacture electronic equipment under contract. Theodore C. Asad, 1578 Ridgewood Ave., is president of the firm.

NATIONAL BUREAU OF STANDARDS, Washington 25, D. C., recently established the Office of Basic Instrumentation, to coordinate a program of evaluation and improvement of instruments for measuring basic physical quantities.

ATOMIC INSTRUMENT CO., manufacturers of nuclear research equipment, have moved to new, larger, and more conveniently located quarters at 84 Massachusetts Ave., Cambridge 39, Mass.

THE FIDELITY TUBE CORP. (formerly the Allied Video Corp.) has acquired 80,000 sq ft of space at 1000 Passaic Ave., East Newark, N. J., and has set up to make tv picture tubes. Full production goal is 1,800 per day.

PERSONNEL

WALTER F. KRAM, formerly engaged in CAA omnidirectional range development work at Lavoie Laboratories, has joined the staff of Ballantine Laboratories, Inc., Boonton, N. J., as a senior engineer.

GEORGE D. HULST, at one time engaged in development work on the proximity fuse, and until recently in the General Patent Department of the Research Division of Allen B. Du Mont Laboratories, Inc., has been promoted to manager of the Special Projects Laboratory of the Electronic Parts Division.

WILLIAM J. MORLOCK has been promoted to assistant manager of the Commercial Equipment Division of the General Electric Co., Syracuse, N. Y.


W. J. Morlock


R. M. Daugherty

ROGER M. DAUGHERTY, previously associated with Colonial Radio Division of the Sylvania Electric Products Corp. as manager of government sales and engineering and chief engineer, has been elected executive vice-president of J. H. Bunnell & Co., Brooklyn, N. Y., manufacturers of railroad and radio communication equipment.

RALPH R. BATCHER, New York electronic consultant, recently succeeded L. C. F. Horle as chief engineer of the engineering department of the RTMA and manager of the

RTMA Data Bureau, New York City.

V. K. ZWORYKIN, Director of Electronic Research, RCA Laboratories Div., Princeton, N. J. was awarded the 1951 Medal of Honor by IRE.

ROBERT G. SCOTT, senior engineer for Allen B. Du Mont Laboratories, Inc., has been named head of the company's Commercial Engineering Department.

DUNDAS P. TUCKER, former director of electronics design and development for the Navy's Bureau of Ships, is the new director of the Naval Electronics Laboratory at Point Loma, San Diego, Calif.

J. GRAYSON JONES, former chief engineer of Conrac, Inc., Glendora, Calif., tv receiver manufacturers, has been elected vice-president of the company.

J. A. HUTCHESON, director of research at Westinghouse Electric Corp., Pittsburgh, Pa., has been named chairman of the Committee on Ordnance, Research and Development Board.

ARTHUR GREEN, formerly vice-president and chief engineer of Thomas Electronics Inc., Passaic, N. J., is now vice-president and chief engineer of the new Fidelity Tube Corp., East Newark, N. J., tv picture tube manufacturers.

DAVID B. SMITH, vice-president of Philco Corp., has been named vice-director of the RTMA engineering department.

B. V. K. FRENCH has joined Allen B. DuMont Labs., Inc., East Paterson, N. J., as application engineer in the Electronic Parts Division.

E. H. ULM, previously with Western Electric Co. as field engineer, and until recently sales engineer for the Electronics Division, Sylvania Electric Products Inc., has been appointed Sylvania's merchandising manager.

HARALD SCHUTZ, formerly electronics research specialist and consultant on microwave problems, now heads radio-frequency engineering in the electronics department of The Glenn L. Martin Co.

CONTACTS
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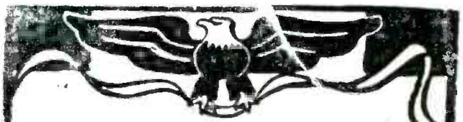

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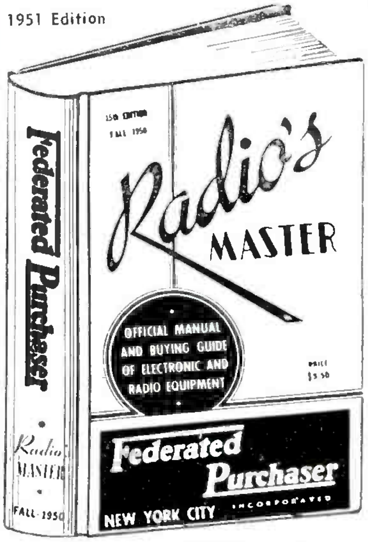

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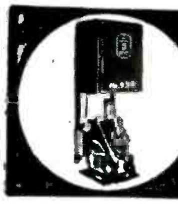

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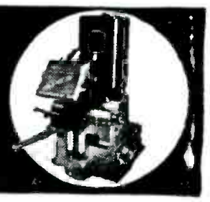

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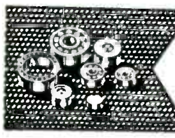

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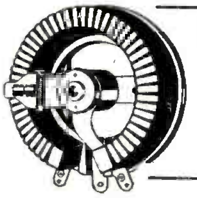

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limitation of the use of bifilar coils is the fact that they preclude the use of usual methods of plate-screen neutralization. The reasoning indicated is that the screen is effectively grounded by the transformer secondary. This does not agree with observed experimental findings.

Consider the standard circuit of Fig. 1A. A balanced bridge circuit is obtained, and no feedback voltage appears between grid and ground due to driving voltage across L, when the following relationship is true: $C_{GP}/C_{GS} = C_P/C_N$.

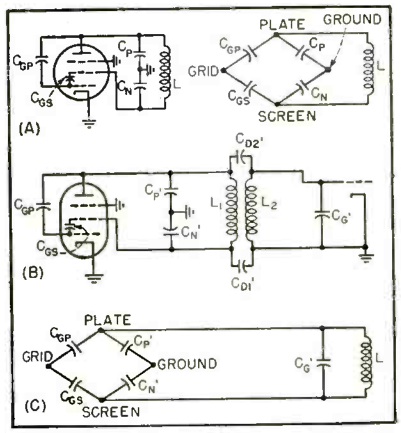

FIG. 1—Neutralization of bifilar coil stages

This method applied to a bifilar stage is shown in Fig. 1B. The screen of the i-f amplifier tube will be *close to*, but not *at*, ground potential. Usually, $C_{D1}' \ll C_N$. The effect of C_{D2}' will be to modify the effective driving voltage source of the equivalent bridge circuit. In first order terms, if transformer distributed capacitances are neglected, and $L_1 = L_2 = L$, and $k = 1$, the bridge circuit becomes that shown in Fig. 1C.

Neutralization is obtained when $C_{GP}/C_{GS} = C_P'/C_N'$. For identical conditions, C_N' is smaller than C_N. The bridge in the bifilar case will be more subject to unbalance due to tube wiring changes, and so on. Also, if C_N' is too small, Miller effect might prevent proper bridge balance conditions. Neutralization of bifilar i-f stages has been obtained, though, in development work conducted by associates of the writer.

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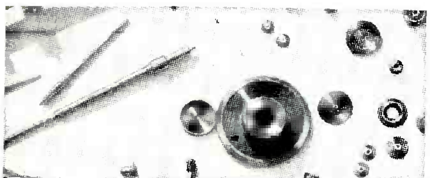

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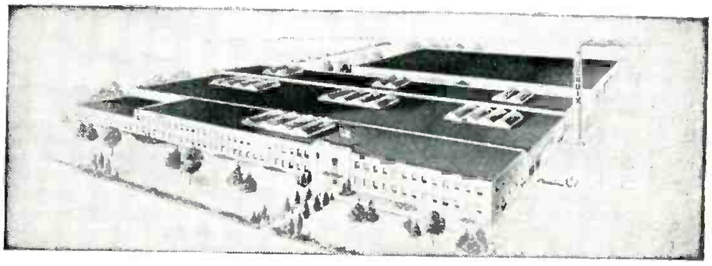

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MR. W. L. WEBB, *Director* Engineering and Research
BENDIX RADIO DIVISION
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Physicists Mathematicians Electronics Engineers Mechanical Engineers

Cornell Aeronautical Laboratory, an affiliate of Cornell University, has permanent positions open for men of project engineer caliber with advanced degrees and experience in physics, applied mathematics, electronics, and instrument design. Assignments are varied and professionally challenging in fields of pure and applied physics.

The position of our laboratory is between those of universities and commercial research institutes. We believe it combines many of the traditional advantages of both.

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Bachelors, Masters, Ph.D's in PHYSICS or E.E.
Experienced electronic engineers;
supervisory personnel for vital war work

OPPORTUNITY ON LONG ISLAND

for research minded engineers

Offers attractive working conditions, salary commensurate with experience, access to graduate schools, first-rate research and development facilities; other advantages.

Projects underway in fields of microwave receivers, transmitters, antennas; radar, air traffic control; servos, motor control systems; general electronics.

Write PERSONNEL MANAGER

Airborne Instruments Laboratory
INCORPORATED
160 OLD COUNTRY ROAD · MINEOLA, N.Y.

WANTED

MANUFACTURER'S REPRESENTATIVE

Must be sales ENGINEER. To handle growing line of electronic test instruments which now includes oscillators, DC amplifiers, transducers, electronic potentiometers, electronic DC and AC voltmeters, megohmmeters, bridges, and others. Some good territories are still open. Send qualifications to

Southwestern Industrial Electronic Co.
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With good background in Vacuum Tubes and Govt. contracts. Must have good following in the industry and a record of ability. Must be free to travel. Established well-known firm. Send detailed Resume of experience. Interview will be held in New York area.

SW 7630 Electronics
330 W. 42 St. New York 18, N. Y.

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Career Positions for Top Engineers and Analysts

SENIOR ELECTRONICS AND ELECTRONICS ENGINEERS—B.S. or M.S. degree; 2 to 7 years experience in radar, television, pulse, video or display circuit design.

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AUTOMATIC TELEPHONE SWITCHBOARD DESIGN ENGINEER

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***For Interview in Chicago* Contact**

The Glenn L. Martin Company Representative
Attending National Electronics Conference at Edgewater Beach Hotel
September 25 - 27, 1950

SENIOR ELECTRONIC ENGINEERS

Prominent New England Company needs a number of top-flight engineers, skilled on pulse circuits, microwave circuits and R. F. techniques. Minimum of at least 6 to 8 years experience. Attractive salary—Group insurance—Pension Plan—Paid vacation. Please write giving complete resume of education, experience and salary expected.

P-7551, Electronics
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Openings for experienced design and production engineers. Must have had design experience in mechanical, electrical, or electronic aspects of small intricate mechanisms. Design of servo-mechanisms, communications equipment, small power tools, sewing machines, vacuum cleaners, business machines, etc., is the type of experience desired. A degree in mechanical or electrical engineering is preferred but is not required. Give full details of education, experience, and personal history. Permanent positions with well-established firm located in central New York State.

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460 W. 34th St., N. Y. 1, N. Y.

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For smaller electronic plant in midwest. An unusual opportunity with a long established firm for executive participation as production member of executive team. Essential qualifications: Age 30 to 50. Experience in production management with an electrical or electronics manufacturer involving methods, supervision, production control, labor management and efficiency. Educational background of M.E. or E.E. helpful but not essential if candidate has adequate background and experience. Present staff knows of this ad. Written applications treated in confidence.

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ELECTRONIC ENGINEERS WRITE FOR JOB IN SAN DIEGO NOW

We need engineers for electronics research development and production. Real opportunity for graduate engineers with 5 or more years experience in basic circuit design, pulse, micro-wave, system analysis, electronic project coordination and administration. Openings for project leaders, senior designers, assistant project leaders and staff specialists.

Congenial associates, and superior living conditions in wonderful San Diego. Write today to H. T. Brooks, Engineering Personnel Office, Consolidated Vultee Aircraft Corporaiton, San Diego, California.

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To assume the responsibilities for the development, design and evaluation of airborne antenna for military aircraft. Full knowledge of measurement techniques and 8 to 10 years of related experience required.

Also several openings for junior engineers in this field.

Write qualifications to

Employment Office
CHANCE VOUGHT AIRCRAFT
Box 5907, Dallas, Texas

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1. **Senior Electronics Engineer**
   Requirements:
   5 years experience in design and development of pulse circuits, computers, nuclear instrumentation or video circuits required. Manufacturing or production experience desirable.
2. **Production Engineer**
   Requirements:
   5-10 years experience as electronic and mechanical instrument production engineer in small lot production. Thorough electronic theory grounding.

Send complete resumes and salary requirements.

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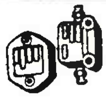

MICA
SOLAR XMB
TAPPED HOLES

Mfd.	Price
2500 V Test	
00001	$0.29
.000025	.29
.00003	.29
.00005	.29
.000075	.29
.0001	.29
.00015	.29
.00025	.29
.0003	.29
.0004	.29
.0005	.35
.00075	.35
.00085	.35
.001	.35
.0015	.35
.0016	.35
.0017	.35
.002	.50
.0023	.50
.003	.50
.004	1.79
.005	1.79
.006	1.79
.0063	1.79
.0069	1.79
.007	1.79
.0075	1.79
.0076	1.79
.008	1.79
.01	1.10
.015	1.10
.02	1.10
.025	1.10
.027	1.10
.03	1.10
5000 V Test	
.0015	1.75
.002	2.00

SOLAR XO
Solder Lugs
2500 V Test

.01	.85
.015	.85
.02	.85
.04	.85
.001	.60
.0015	.60
.002	.60
.0022	.60
.0023	.60
.0024	.60
.0025	.60
.0027	.60
.003	.60
.004	.60
.005	.60
.0056	.60
.006	.60
.0063	.60
.0075	.80
.0076	.80
.008	.80
.0085	.80
.0005	.60
.00085	.60
.00015	.60

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Trimmer Cond. Variable

15 MMF
5 MMF
20 MMF
40 MMF
50 MMF
60 MMF
21¢ ea.

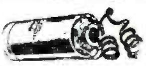
Ceramicons

Mmt	
1	25
3	27
3.4	35
4	30
5	47
6	50
7	57
8.5	58
11	60
15	62
20	67
24	70
79	220
115	240
125	250
150	350
180	1000
200	
100	

$7.50 per 100

Button		Feed Thru
40	100	50
180	200	
175	500	470
185	108	

$8.50 per 100



SCREW MTG
Wireleads D TYPE

Mfd	Volt	Price
4	600	$0.35
8	250	.25
8–8	450	.50
16	450	.40
20	450	.45
30	450	.50
29	250	.45
12	250	.30
8	600	.60
8	450	.30
16	600	.80
30	450	.50
20	150	.30
240	250	.80
30–30	450	.75

MINICAPS PIGTAIL

Mfd.	Volt	Price
30	450	$0.49
30	300	.45
30	350	.48
40	450	.50
40	525	.70
16	350	.35
16	525	.45
16	450	.40
16	100	.24
20	25	.20
20	80	.25
20	450	.40
24	350	.30
8	400	.30
8	150	.15
10	150	.20
10	50	.15
4	50	.10
4	150	.14

Birtcher Tube Clamps

926-C
926-16
926-B1
926-B2
926-B8
926-C15
926-C-13
926-C-19
926B-16
926A-14
926C1
926A11
926-B31
926C-23
929-1
926B-10
926B-18
926-K2
Each 15¢
10 $1.40
100 $12.00

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Mfd	Volt	Price
6000	12	$2.75
1000	15	.90
3000	15	1.95
2x500	15	1.75
300	25	.95
500	25	.95
100	30	.70
1000	35	1.39
1000	35	3.49
2000	50	3.00
3x290	50	2.25
500	80	1.40
125	150	1.40
250	150	1.69
2x1000	6	1.10
75	250	.75

Wholesale Qtys Available

110 volt AC CONDENSERS

Mfd	Price
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26-30	1.00
31-37	1.00
38-42	1.00
43-48	1.00
43-65	1.25
50-75	1.25
72-87	1.25
86-96	1.45
88-106	1.50
107-129	1.75
124-138	1.75
130-150	1.75
130-180	1.90
161-180	1.75
158-191	2.00

Many others in stock

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Ceramic Case

120 MMF 10KVW	$19.00
30 MMF 10KVW	19.00
.08 MFD 1500	10.00
.045 MFD 2000	12.00
.0001 20 KVW	24.00
.0051 15 KVW	21.00
.001 25 K	35.00

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Large Qtys.

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Prong Mount
D. Y. Type

18c ea.
10 for $1.75

Mfd.	Volt
40	150
80	150
10	200
8	450
16	450
20-20	25
10-10	150
20-20	150
40-40	150
20-30	250
3x20	450
40	250
30	300
80	350
10	450
15	450
30-30	25
20-10	150
40-20	150
50-30	150
20-1	350
10-1	300

29c ea.
10 for $2.75

6	400
50	400
40	450
30-20	150
50-50	150
20-20	350-25
20-20	400-25
40-20-10	150
40-30-20	150-25
50-50-20	150-25
60-40-10	150-25
60	300
30	450
32	450
30-30	150
70-30	150
30-20	350-25
10-20	450
40-20-20	150
40-30-20	150
3x50	150
40-10-100	150-10

Type	Input Volts	Input Amps.	Output Volts	Output Amps.	Radio Set
PE86	28	1.25	250	.060	RC 36
DM416	14	6.2	330	.170	RU 19
DY-2/ARR-2	28	1.1	250	.060	ARC-5
DM36	28	1.4	220	.080	SCR 508
DM25	12	2.3	250	.050	BC 367
	28	1.25	275	.070	BC 348
DM31A	28	7	540	.250	BC 456
DM42	14	46	515	.110	SCR 506
			1030	.050	
			2/8		
PE10C	13/26	12.6	400	.135	SCR 515
		6.3	800	.020	
BD AR 93	28	3.25	375	.150	
23350	27	1.75	285	.075	APN-1
35C045B	28	1.2	250	.060	
ZA .085	12/24	4/2	500	.050	
ZA .056	12/24	8/4	12/275	3/110	
B-19 p ck	12	9.4	275	.110	Mark II
			500	.050	
D-104	12		225	.100	
			440	.200	
DA-3A	28	10	300	.060	SCR 522
			150	.010	
			14.5	.5	
#5053	28	1.4	250	.060	APN-1
PE 73CM	28	19	1000	.350	BC 375
DM21	14	3.3	235	.090	BC 312
CW21AAX	13	12.6	400	.135	
	26	6.3	800	.020	
			9	1.12	
BD 77KM	14	40	1000	.350	MC 191
PE 94	28	10	300	.200	SCR
			150	.010	522
			14.5	.5	

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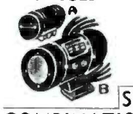

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STC-16A	220V IN, 260V/.03, 100V/1, 6.3V/4.2	2.95
STC-607	220V IN, 700VCT/75MA, 40VCT/.100, 15/10/15V/100MA	3.95
STC-612	230V IN, 400V/.30, 190/.30, 2 x 5V/2.5 w/2–866 Sock	3.95
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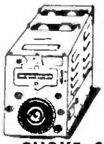
STC-047	200V IN, 700V/80MA, 110/.80MA, 24V/80MA, 2 x 6.3/.3–1A 5V/3, 5V/5A, 2.7/5A	4.95
STC-261	6–12–24 IN, Vibrator Xfrmr. 420VCT/30, 6.3V/900MA, 115/220	2.39



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CT-825	360VCT	.340	6.3VCT/3.6, 6.3VCT/3A	3.95
CT-076	600V	.100	2 x 12.6V/1	1.95
CT-626	1500V	.160	2.5/12, 30/.100	9.95
CT-15A	350VCT	.070	6.3/.6, 6.3/1.8 3 lbs.	2.95
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CT-378	2300V	4 MA	2.5/2	6.95
CT-367	580VCT	.050	5VCT/3A	2.25
CT-721	550VCT	.100	6.3/1, 2.5VCT/2	2.95
CT-99A	2x110VCT	.100	6.3/1A, 2.5VCT/7A	3.25
CT-91A	726V	.100	5V/3A, 6.3/3.5	3.25
CT-080	700VCT	.205	5V/3, 5V/2A	3.95
CT-328	115V	2.2	40V/2.2A, 115V/2.2A	4.49
CT-441	50V	.200	5V/2.4, 5V/1.2	2.29
CT-408	350VCT	.026MA	5V/3A	2.75
CT-26B	1100VCT	400MA	6.3V/1.6	6.95
CT-931	585VCT	.086	5V/3A, 6.3V/6A	4.25
CT-610	1250	.002MA	2.5V/2.1A, 2.5V/1.75A	4.95
CT-137	350VCT	.026MA	5V/3A	2.75
CT-102	1080VCT	.055	25V/3A, 6.3V/1.8A, 6.3V/1.2A	5.95
CT-866	330V	.065	6.3V/1.2, 6.3V/600MA	1.75
CT-319	330VCT	.085	5V/2, 6.3/7.5, 6.3/.3	3.25
CT-526	510VCT	.025	12.5/.900MA, 6.3/.5A	1.95

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w/10 Tubes, 6 Selector-Relays operate on Xtal Controlled Freq. 108.3-110.3 MC. Can easily be converted to 2 Mtr. ham bands

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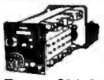
866 Filament Xfrmr 2x2.5v 6 Amp 8000 V Test Size. Approx 3½" SQ. Easy to Mount. Price ..$2.95

PE 157 VIBROPACK FOR BC 745
Runs on 2V DC. Obtained from small Willard Rechargeable battery contained in case which is charged from 6 Vac or DC. Also contains 5" PM Speaker & Jacks for Mike. Used, excellent $9.95



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Tunes 234-258 Mc. Contains 4-6AKS, 6-3001, 1 — 12A6. Ideal for 2-0-10 Meter Conv. Less Dyn. As is fair $7.95

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BC 434 CONTROL BOX
Remote Control for ADF-Rec. BC 433. Contains 0-5 Mill Tuning Meter, Dial Control, 4 Scb Min Grain of Wheat, 24V Pilot Lights. Brand New......$3.95

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Contract #NOAS-858 Bendix Aviation. MFRS Drawing 111144 w/mnt & pot. Ser. #Y519. — Type A .105-.115 amps 35°-45° C. Ser. 28YK 809-JL. Reg. Volt. 80 Volts. Leland Electric Mark I. Resis. in enclosed base. Ser. 30463 323601-1. Bendix Aviation. — A-M Ser. #11058. Ref. #5U/1304 w/rect. & resist. in base. Type E 80V AC. — Type C. Coil amps .30 at 25C. Output volts 19. Ser. 3711-702. Spec. VR 9000-2C. Output amps 5.7. Input volt 22-30 W/resis. Leland Electric. —
These regulators are in brand new condition, priced at $2.75 each.

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COMMUNICATIONS EQUIPMENT CO.

131 Liberty St., New York, N. Y. **Dept. E-10** CHAS. ROSEN **Phone: Digby 9-4124**

RADAR
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QCQ2. ECHO RANGING AND LISTENING EQUIPMENT
Use: Medium ASW ships.
Keying interval. 1,000, 2,000, 4,000, 8,000 yards and manual.
Projector. Magnetostrictive, permanent magnet polarization. resonant frequency about 25 kc.
Transmitting system. The electron tube driver oscillator and two amplifier stages are contained in the receiver chassis; the variable tuning condenser being ganged with the receiver tuning condensers in order to give uni-control of receiver and driver tuning. In another chassis are located the output tubes and the high voltage rectifier. Sweep frequency modulation is provided, giving a shift from 400 cycles below to 600 cycles above the operating frequency during the transmission.
Receiving system. The receiver is of the tuned-radio-frequency type. It includes time varied gain, to reduce the volume of reverberations immediately following the transmission, and has a "Flat-Peak" audio filter, and an adjustable BFO to give an audible note above or below 800 cycles.
Keying and indicating system. Keying is mechanical; cams in the indicator unit determine the pulse length and keying interval. Ranges are indicated by the flash of a neon lamp.
Complete sets available less hoist. Also stacks alone.

QBF AND QJA. ECHO RANGING AND LISTENING EQUIPMENT
Use. Large ASW ships.
QBF may be converted by field modification, to QJA available.
Keying interval. 1,000, 2,000, 3,000, 4,000, 5,000, 10,000 yards and manual.
The electrical train system consists of a handwheel on the stack which selects, by commutation, three voltages from the secondary of a transformer-like device called a Commutator Transmitter.
Projector. The projector is of the Rochelle salt crystal type with a single element used for both listening and ranging. The frequency is 22 to 28 kc.
Transmitting system. The receiver-driver oscillator unit contains two electron tube oscillators, one fixed at about 150 kc and one tunable over the range from 160 to 180 kc. The outputs of the two are mixed, producing a difference frequency, which is then fed to the driver-amplifier unit and thus to the projector.
Receiving system. The receiver is a superheterodyne type covering the range from 10 to 30 kc.
Keying and indicating system. Ranges are indicated by the flash of a neon lamp which revolves at a constant speed, driven by a synchronous motor.

QCU, QCU-1 ECHO RANGING AND LISTENING EQUIPMENT
Use. Small ASW Ships.
Intended to be used as a replacement for the obsolete WEA-1 equipment the old hoist.
Keying interval. 1,000, 2,000, 4,000, 8,000 yards and manual.
Training is electrical, controlled by hand crank at the remote station.
Projector. Magnetostrictive, permanent magnet polarization, resonant frequency about 25 kc, split for BDI.
Transmitting system. The electron tube driver oscillator and two amplifier stages are contained in the receiver chassis; the variable tuning condenser being ganged with the receiver tuning condensers in order to give uni-control of receiver and driver tuning. In another chassis are located two type 811 output tubes and two type 836 high voltage rectifier tubes. Sweep frequency modulation is provided, giving a shift from 400 cycles below to 600 cycles above the operating frequency during the transmission.
Receiving system. The receiver is of the tuned radio frequency type. It includes time varied gain, to reduce the volume of reverberations immediately following the transmission, and has a "Flat-Peak" audio filter, and an adjustable BFO to give an audible note, above or below 800 cycles.

QCS, QCS-1, QCT-1 ECHO RANGING AND LISTENING EQUIPMENT
Use. ASW ships.
Keying interval (original).—1,000, 2,000, 5,000, 10,000 yards and manual (field modification added 3,000 and 4,000 yards)
Transmitting system. The driver-rectifier unit contains an electron-tube oscillator tunable over the range of 17 to 25.5 kc, and electron-tube amplifier and a rectifier power supply.
Receiving system. The superheterodyne receiver covers the range from 13 to 37 kc and may be connected by a selector switch to either the "QCQ" or the "JK" face of the projector. It has separate audio amplifiers for the range indicator lamp and for the loud-speaker. The audible note may be adjusted over the range from 0 to 1600 cycles. Three degrees of I-f selectivity and two of audio are provided by selector switches connected to filters.
Keying and indicating system. Keying is mechanical; cams driven by the range indicator disc shaft determine the pulse length and keying interval.

THE MUST OF THE MONTH

Complete 3 CM Radar System equipment 40 KW peak transmitter, pulse modulator, receiver, using 723AB, power supply operating from 115V 800 Cycle, antenna system. Complete radar set neatly packaged in less than 16 cubic feet, all tubes, in used but excellent condition—$350.00. This price for laboratories, schools, and experimental purposes only.

High Voltage Power Supply

15 KV at 30 Ma DC, Bridge Rectifier, Western Electric....$125.00

FM STATION

General Electric Kilowatt Amplifier
Model 4BT2A1 Type BT2A Serial RC25
General Electric 250 Watt Exciter
Model 4BT1A1 Type 3T1A Serial CC833
General Electric Station Monitor
Model 4BM1A1 Type BM1A Serial WC268
General Electric Power Supply
Model BP241 Type BF2A Serial WC547
General Electric Transmitter Console
Model 4BC3A1 Type BC3A Serial WC5
Type BX-2A Two Bay Circular Antenna with Mast, Transmission Line, Elevators and Matchers.
100 Feet of 1⅝ coax. transmission line including 90° elbows.
Dehydrator for transmission line.
Desk and Chair for Transmitter Console.
Write or phone for data & price.

APS-2. 10 cm. airborne radar set designed for navigation and high altitude bombing. The antenna rotates through 360 degrees. Presentation is PPI and A Scope. The following units of the set are supplied: Antenna, transmitter-receiver, modulator, indicator, 24VDC input power unit. New with all tubes, incl. 714AY magnetron, 417A klystron.

APS-3. 3cm. airborne radar set designed for intercept of enemy aircraft and nominal navigation. Antenna is sector scan. Remote as well as master indicator is supplied. 725A magnetron operates the set at 45kw. Complete sets available with all tubes incl. magnetron and 723AB klystons. Both new and used condition.

APS-4. 3 cm. airborne radar set designed for sector scan surface search, mapping and navigation, weather forecasting, intercepting of enemy aircraft. Entirely enclosed in a streamlined housing for optional mounting on aircraft bomb rack, or on nose of large bombers. Complete sets with indicator equipment, and power unit ready for installation

APS-6. 3 cm Night Fighter radar with pencil beam antenna. Transmitter-receiver packages and antennas available in equal to new condition.

APS-6A. 3 cm airborne radar RF package, 45kw, using 725A magnetron, IF strip using 6AK5's, 723AB beacon and local oscillator.

ASP-10. 3 cm airborne radar using 2J42 magnetron. Modulator decks and low voltage power supply, only, available, less tubes. Beacon-local oscillator klyston mounts are available.

APQ-13. 3 cm airborne radar complete RF package in excellent condition including all tubes.

APS-15. 3 cm airborne radar designed for high altitude bombing, navigation, intercept of enemy aircraft weather forecasting. Antenna rotates 360 degrees. Presentation is PPI and A scope. The following units are supplied: Antenna, transmitter-receiver, modulator, indicator, slant-range computer, 24VDC input power unit. New with all tubes including 45kw 725A magnetron, 723AB local oscillator-beacon.

CPN-6. 3 cm Navigation Beacon ground station. Complete installation. High power coded beacon of latest JAN design. 115VAC input.

CPN-8. 10cm Navigation Beacon ground station. Complete and partial installations available. High power beacon of long range capability. Complete power, frequency, operation analyzer (5" scope) included.

CXBR. 10cm MIT navigation beacon equipment. Complete, in excellent condition.

FD & Mark IV. 800mc gunlaying radar mfg and designed by Western Electric for battleships. Complete consoles available with all tubes including 700A magnetron and modulator thyratron.

Mark 10. 10cm gunlaying radar, complete, for automatic firing of guns as antenna tracks target. 250 KW.

SA. 200mc Air Search radar especially designed for shipboard or mobile installation. Ideal for ground intercept and control of aircraft. PPI 7" indicator. Long range.

SD. 200mc radar similar to SA but designed for installation on submarines. New.

SE. 10cm shipboard Surface Search radar, using thyratron modulator. Complete installation available including spare parts. "A" scope presentation. 250 KW.

SF-1. 10cm shipboard Surface Search radar with PPI and A scope. Used for navigation and target range information on naval vessels. 250 KW.

SG. 10cm shipboard Surface Search radar with PPI and A scope. Heavy, rugged equipment designed for large naval and merchant vessels. 250 KW.

SJ-1. 10cm radar designed for installation on Submarines. Equipped with PPI and A scope. Complete installations.

SL. 10cm radar designed for Surface search on shipboard. PPI indicator console.

SN. 10cm portable radar. Lightweight, easily transportable complete radar installation using lighthouse tubes with a 25 mile maximum range. 115 VAC operation.

SO-1. 10cm shipboard radar for navigation on all types of vessels. 4, 20, and 80 mile range. PPI indicator. Large antenna. 115 VDC input.

SO-8. same as SO-1 but with a lightweight antenna.

SO-13. same as SO-1 but with lightweight antenna, 28VDC input. Designed for PT Boat installation.

SCR 518. Radar altimeter using pulse-echo-time principle, 400mc, 28 VDC input, CR tube altitude indication.

SCR 520. Airborne radar RF package, 10cm, complete with pulser, hard tube, 714AY magnetron.

SCR 533. IFF/Air Search trailer, complete, 500mc operation, A scope.

SCR 663. Sperry searchlight training, aircraft tracking ground installation. Used condition.

SQ. 10cm portable radar designed for use on landing barges and beach-heads. PPI, B, A indication on 3" scope. 115 VAC operation.

TPS-2. 1000mc Portable Early Warning System. Bedspring antenna. Complete with portable generator.

RT73/UPN-2. 10cm Portable Beacon Equipment.

TAJ. 500 Watt Low Frequency Transmitter, 150-550 KC, C.W., M.C.W.

TBK. 500 Watt High Frequency Transmitter 2 to 18 MC, A1, A2, A3, Emission. Mfg. by RCA.

RADIO SYSTEMS

White Radio Telephone Model #WRM55. Ship To Ship—Shore To Ship—Small Airports—Mines—Plantations—Inter Island—Ranches. 10 channel Fix Tuned Receiver & Transmitter XMTR Pwr Output in excess of 100W unmodulated into antenna of 18 & 100 MMF. Freq. Range 2-12 MC. Can be modified to increase range. Xtal controlled. 110V 60 Cy or 220V 60 or 25 Cy. Meas. 24" H x 19" W x 14" D. 125 lbs. Write or phone for data.

All merch. guar. Mail orders promptly filled. All prices F.O.B. N.Y.C. Send MO or Chk. Only shipping chgs sent C.O.D. Rated concerns send P.O.

COMMUNICATIONS EQUIPMENT CO.

131 Liberty St., New York, N. Y. Dept. E-10 P. J. PLISHNER Phone: Digby 9-4124

MICROWAVE TEST EQUIPMENT

THERMISTORS

- D-167332 (tube) ...$1.50
- D-170396 (bead) ...$1.50
- D-167613 (button) .$1.50
- D-164699 for MTG in "X" Band Guide $2.50
- D-167018 (tube) ...$1.50

WRITE FOR C.E.C. MICRO-WAVE CATALOG NOW AVAILABLE

VARISTORS

- D-170225 ....$1.25
- D-167176 ....$1.50
- D-168687 ....$1.50
- D-171812 ....$1.50
- D-171528 ....$1.50
- D-171528 ....$1.50
- D-168442 ....$3.00
- D-165593 ....$1.25
- D-98836 ....$2.00
- D-161871A $2.85
- D-171121 ....$1.50
- D-98836 ....$1.50
- D-162356 (308A) ....
- D-163357 ....$2.00
- D-99946 ....$2.95

23,000 to 27,000 mc. BENCH TEST PLUMBING—½" to ¼" Waveguide

Precision Slotted Line. DeMornay Budd type 337 ....$400.00
Complete with adjustable probe and crystal output. Square flanges.
Precision Slotted Line. Adjustable probe. Humble Oil type. CPK-21HU $200.00
Directional Coupler-Wavemeter Mnt. 12DB..$60.00
Precision Var Attenuator, mfg. Bernard Rice.$90.00
Tunable Xtal Mnt. DB423 less tuning plung. $30.00
Flap Attenuator. DB405 10DB attenuation..$25.00
Low Power Load $20.00
Screw Tuner $25.00
Shunt Tee $35.00
Waveguide Lengths. 2" to 6" long, gold-plated with circular flanges and coupling nuts....$2.25 per inch
APS-34 Rotating Joint $49.50
Right Angle Bend E or H Plane, specify combination of couplings desired $12.00
45° Bend E or H Plane, Choke to cover......$12.00
Directional coupler CU-103/APS32..........$49.50
Mitered Elbow, cover to cover..........$4.00
TR-ATR Section, choke to cover..........$4.00
Flexible Section 1" choke to choke..........$5.00
"S" Curve Choke to cover..........$4.50
Adaptor, round to square cover..........$5.00
Feedback to Parabola Horn with pressurized window $27.50
Low Power Load, less cards..........$18.50
K Band Mixer Block $45.00
Waveguide ½ x ¼" ....$1.00 per ft.
Circular Flanges ....50¢
Flange Coupling Nuts ....50¢
Slotted line, DeMornay-Budd #397, new....$450.00
90° Twist $10.00
"K" Band Directional Coupler CU104/APS-34 20 DB ....$49.50 ea.
K BAND 2K33 w/cav. $115.00
3J31 Magnetrons $55.00

8500 Mc to 9600 Mc Bench Test Plumbing—1" x ½" Waveguide

Slotted Line. Complete with adjustable probe, crystal output, precision vernier adjust. Humble oil type $220.00
Klystron Mount. DeMornay Budd type DB380 for 2K25, etc., includes tunable termination......$70.00
Variable Attenuator. DeMornay Budd type DB383. Maximum attenuation 35DB..........$120.00
Variable Stub Tuner. DB536. 180 degree phase shifting capability $70.00
Flap Attenuator. DB385. **Maximum Attenuation** 10DB $25.00
Magic Tee. DB539 ....$42.00
Wave Guide to Type "N" Adapter. DB377..$15.00
Low Power Termination. DB381..........$18.50
Uni-Directional Coupler. DB390. 23DB type "N" output $18.50
Pick Up Horn. Type "N" output..........$4.50
Wavemeter. 8500 to 9400 mcs. with calibration. Micrometer adjust head. Reaction type.....$85.00
Waveguide Lengths. Plated and fitted with couplings available in 6", 12", 24", 30", 60" sections ....$2.00 per ft.
90 Degree Elbows. E or H plane, 2¼" radius.$12.50
Mitered Elbows. E or H plane..........$10.00
45 Degree Offset Elbows. E or H plane....$10.00
90 Degree Twist. 6" long..........$8.00
Bulkhead Feed-Thru Assembly..........$15.00
Pressure Gauge Section. 15 lb. gauge and press. nipple $10.00
Pressure Gauge. 15 lbs..........$2.50
Crystal Mount. 1N23 type crystal holder....$17.50
Dual Oscillator-Beacon Mount. P/O APS10 Radar for mounting two 723A/B klystrons with crystal mts. matching slugs, shields..........$42.50
Dual Oscillator Mounts. (Back to back) with crystal mount, tunable termination, attenuating slugs $18.50
Directional Coupler, UG-40/U Take off 20 DB $17.50
Directional coupler, APS-6 type "N" take off 20 DB calibrated $17.50
Flexible Section 18" long..........$12.00
Rotary Joint Choke to Choke..........$10.00
2K25/723 AB Receiver local oscillator Klystron Mount, complete with crystal mount, Iris coupling and choke coupling to TR..........$22.50
TR-ATR Duplexer section for above..........$8.50

1¼" x ⅝" WAVEGUIDE

Slotted Line. Complete with adjustable probe, crystal output, precision vernier adjust. Humble Oil type $225.00
Tunable Termination. Precision adjust......$65.00
Low Power Termination..........$25.00
Magic Tee $45.00
Transition. 1¼" x ⅝" to 1" x ½"..........$19.50
Oscillator Mount. for four 723AB klystron..$38.50
90 Degree Elbows. E or H plane..........$12.50
Waveguide Lengths. Cut to size and supplied with 1 choke, 1 cover, per length..........$2.00 per ft.
Wavemeter. Absorption type. Precision micrometer adjust. Very high "Q"..........$150.00

MAGNETRON MAGNETS

Gauss	Pole Diam.	Spacing	Price
4850	¾ in.	⅝ in.	$12.50
5200	11/32 in.	¾ in.	$17.50
1300	1⅝ in.	1 5/16 in.	$12.50
1860	1⅝ in.	1½ in.	$14.50

Electromagnets for magnetrons..........$24.50 ea.

GE Magnets type M7765115. GI Distance Between pole faces variable. 2 1/16" (1900 Gauss) to 1½" (2200 Gauss) Pole Dia. ⅝" New Part of SCR 584 ....$34.50

MAGNETRONS

QK 61 2J32	2J61	720CY	
QK 60 2J37	2J62	725-A	
2J21	2J38	3J31	730-A
2J22	2J39	5J30	728
QK 915 2J26	2J40	714AY	700
CK 62 2J27	2J49	718DY	706
QK 59 2J31	2J34	720BY	

Klystrons 723A, 707B, 417A, 2K41

COUPLINGS—UG CONNECTORS

UG/15U	$ .75	UG 117 Choke	$2.50
UG206U	.90	UG 51 Cover	1.00
UG87U	1.25	UG 52 Choke	1.35
UG27U	1.69	UG 210 Cover	1.85
UG21U	.89	UG 212 Choke	2.40
UG167U	2.25	⅞ Coax Female Ring	.50
UG29U	.90	⅞ Coax Male Fitting	.95
UG254U	1.69	X Band Circ. Choke Flange	.50
UG86U	1.40		
UG342U	3.25	X Band Flat Contact Flange ⅛ Thk.	.25
UG85U	1.45		
UG58U	.60	Contact Ring ¼" Thk 1⅜ dia. hole	.25
UG9U	.89		
UG102U	.45	UG 53/U, Cover	4.00
UG103U	.45	UG 54/U, Choke	4.75
UG255U	1.65	UG 55/U, Cover	4.00
UG 40/U Specl. for Mixer Assy.	.75	UG 56/U, Choke	4.75
		UG 65/U, Contact	6.50
UG 40A	1.10	UG 149/U, Cover	3.00
UG 343 Cover	2.35	UG 148/U, Choke	4.00
UG 344 Choke	3.00	UG 150/U, contact	3.00
UG 425 Contact	2.00	UG 39/U, Cover	.60
UG 116 Cover & Coup Ring	1.95	UG 40/U, Choke	.80

Write us your needs.

6000 Mc. to 8500 Mc. Bench Test Plumbing
1½" x ¾" Waveguide

Klystron Mount. DB356 complete with shield and tunable termination $125.00
Flap Attenuator. DB361..........$45.00
Precision Wavemeter. DB358. Micrometer adjust head $190.00
Variable Stub Tuner $90.00
Waveguide to Type "N" Adapter..........$18.50
Wavemeter Tee. DB352..........$32.50
Slotted Line. DB354 Precision vernier adjust, less probe $320.00
Magic Tee $80.00
Directional Coupler., two hole 25DB coupling, type "N" output $25.00
Precision Crystal Mount. Equipped with tuning slugs and tunable termination..........$125.00
Tunable Termination. Precision adjust......$70.00
Low Power Load..........$35.00

4000 to 6000 mcs. Bench Test Plumbing
2" x 1" Waveguide

Slotted Line. DEMornay type 332 complete with probe, etc. $600.00
Flap Attenuator $48.00
Variable Stub Tuner and Low Power Termination $48.00
Wavemeter Tee $48.00
Adapters: Choke to choke..........$18.00
Cover to cover..........$14.00
Choke to cover..........$16.00
Waveguide to Type "N" Adapter..........$45.00
Directional Coupler. Two hole type, type "N" output $48.00
Klystron Mount. Equipped with tunable termination and micrometer adjust. klystron antenna tuning $110.00
Crystal Mount. Equipped with tunable termination and micrometer adjust crystal tuning......$125.00
Tunable Termination. Precision adjust......$90.00

3000 MC. BENCH TEST PLUMBING
TEST EQUIPMENT

10 CM Wavemeter WE type B435490 Transmission type, type N Fittings, Veeder Root Micrometer dial., Gold Plated W/Calib. Chart P/o Freq. Meter X66404A. New $99.50
AS14A/AP-10 CM Pick up Dipole with "N" Cables $4.50
LHTR. LIGHTHOUSE ASSEMBLY. Part of RT39 APG 5 & APG 15. Receiver and Trans Cavities w/ assoc. Tr. Cavity and Type N CPLG. To Revr. Uses 2C40, 2C43, 1B27. Tunable APX 2400-2700 MCS. Silver Plated $49.50
Beacon Lighthouse cavity 10 cm with miniature 28 volt DC FM motor. Mfg. Bernard Rice..$47.50 ea.

S. BAND

90° Twist, circular cover to circular cover...$25.00
Magnetron to Waveguide Coupler with 721A Duplexer Cavity, gold-plated $45.00
721A TR Box complete with tube and tuning plungers $12.50
McNally Klystron Cavities for 707B or 2K28. Three types available $4.00
F-29/SPR-2 Filters, Type "N", input and output $12.50
726 Klystron Mount. Tunable output, to type "N" complete, with socket and mounting bracket $12.50
WAVEGUIDE TO ⅞" RIGID COAX "DOOR-KNOB" ADAPTER, CHOKE FLANGE, SILVER PLATED BROAD BAND $32.50
WAVEGUIDE DIRECTIONAL COUPLER, 27 db. Navy type CABV-47AAN, with 4 in. slotted section $32.50
SQ. FLANGE to rd choke adapter, 18 in. long OA 1½ in. x 3 in. guide, type "N" output and sampling probe $27.50
AN/APR5A 10 cm antenna equipment consisting of two 10 cm waveguide sections, each polarized. 45 degrees ....$75.00 per set.
POWER SPLITTER: 726 Klystron input dual "N" output $5.00

⅞" RIGID COAX

10 CM FEEDBACK DIPOLE ANTENNA, in lucite ball, for use with parabola ⅞" Rigid Coax Input $8.00
721A TR cavities, heavy silver plated......$2.00 ea.
Magnetron Coupling with TR Loop..........$7.50
Sperry Rotating Joint, pressurized..........$22.50
5 Ft. Lengths Stub Supported, gold-plated, per length $7.50
Short Right Angle Bends (for above)........$2.50

GENERAL TEST EQUIPMENT

Multi Frequency Generator. American Time Product type SC-16. Frequency 10 to 190. Precision Standard "Watch-Master".
UHF Signal Generator. R.C.A. type 710A. 370 to 560 mcs.
Wheatstone Bridge. Industrial Inst. type RN-1.
FM Signal Generator. Boonton Radio type 155A. Freq. range 1 to 10 mcs., 38 to 50 mcs.
Condenser Weld Power. Cap. 56 mfd. max., max. chg. 1500 Volts.
Frequency Meter. Lavoie Model 105-300 to 600 mcs.
Megohm Bridge. Industrial Instruments type MB.
Visual Alignment Signal Generator. General Electric—0 to 60 mcs.

NEW TEST EQUIP. IN STOCK

- I-185A Oscillator
- I-158 Range Calibrator
- I-233—Range Calibrator
- BC 438 Freq. Meter
- RF Preamp
- G.R. Capacity Brdg #216
- G.R. Uni Galvo Shunt #229
- G.R. 1000 Aud. Osc. #213
- TS 226A/AP Pwr. Mtr. 0-1000W.
- Sig Gen #804 8-330 MC

Write or Phone for Data and Price

PULSE EQUIPMENT

G.E.K.—2745 ....$39.50
G.E.K.—2744-A. 11.5 KV High Voltage, 3.2 KV Low Voltage @ 200 KW oper. (270 KW max.) 1 microsec. or ¼ microsec. @ 600 PPS..........$39.50
G. E. K2450A. Will receive 13 KV .4 micro-second pulse on pri., secondary delivers 14KV. Peak power out 100KW G. E. $34.50
TPS10 Modulator X Band..........$350.00
SO-4 Thyraton Modulator $600.00
SCR-268 Keyer units..........$95.00
715B Tubes ....$[illegible]
705A Tubes $2.85
705 Sockets ....70¢
Complete line of high voltage pulse transformers, networks and dual lines.

ARMY-NAVY TEST SETS

TS-45/APM—3 cm Signal Generator.
TS-226A/AP Power Meter.
TS62/AP 3 centimeter precision echo box.
TS36/AP 3 centimeter Thermistor Bridge—Power Meter.
TS89/AP Voltage divider.
TS268/U Crystal checker for 1N23 type crystals etc.
CW-60ABM 10 Centimeter Wavemeter. Coaxial type micrometer adjust cavity. Resonance indicating meter, carrying case (similar to TS117/GP).
TS235/UP High Power Load. "L" band (1000 mcs.)
LU-1 FREQ. Meter and Test Oscillator. Type CRV-60ACL.
TVN-9HU POWER SUPPLY. MIT Rad. Lab.
TVN-8SE KLYSTRON POWER SUPPLY. MIT. Rad. Lab.
CS60ABW WATT METER—Wavemeter. 3 CM.
APR5 RECEIVER—1000 to 6000 mcs.
AN/CPN-8—10 centimeter 40 kw. output RF package. Includes magnetron oscillator, complete modulator, complete receiver, complete signal and power analyzer with 5" scope. 115V AC input.
Dehydrator Unit CPD 10137 Automatic cycling. Compressor to 50 lbs. Compl. for Radar XSMN. Line. New $425.00
SO-3 Receiver. 30 mc. IF. 6 stages 6AC7, 10 MC. Band width inpt. 5.1 mc B.W. per stg. 9.6 volt gain per stage as desc. in ch. 13 vol. 23 M I T Rad. Lab. Series..........$99.50

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COMMUNICATIONS EQUIPMENT CO.

131 Liberty St., New York, N. Y. Dept. E-10 P. J. PLISHNER **Phone: Digby 9-4124**

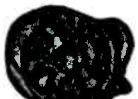
FULLY GUARANTEED

BRAND NEW SURPLUS OFFERED BY A LEADING

A.C. MOTORS

5071930, Delco, 115 V., 60 Cycle, 7000 r.p.m. **Price $4.50 each net.**

36938-2, Haydon Timing Motor, 110 V., 60 cycle, 2.2 w., 4/5 r.p.m.



Price $3.00 ea. net.

Type 1600 Haydon Timing Motor—110 V., 60 cycle, 3.2 w., 4 r.p.m., with brake **Price $4.00 each net.**

Type 1600 Haydon Timing Motor—110 V., 60 cycle, 2.2 w., 1/240 r.p.m. **Price $3.00 each net.**

Type 1600 Haydon Timing Motor 110 V., 60 cycle, 2.3 w., 1 r.p.m. **Price $2.70 each net.**

Type 1600 Haydon Timing Motor, 110 V., 60 cycle, 2.2 w., 1 1/5 r.p.m. **Price $2.70 each net.**

Type 1600 Haydon Timing Motor 110 V., 60 cycle, 3.5 w., 1 r.p.m. With shift unit for automatic engaging and disengaging of gears. **Price $3.30 each net.**

Type 1600 Haydon Timing Motor, 110 V., 60 cycle, 2.2 w., 1/60 r.p.m. **Price $3.00 each net.**

Eastern Air Devices Type J33 Synchronous Motor 115 V., 400 cycle, 3 phase, 8,000 r.p.m. **Price $8.50 each net**

Telechron Synchronous Motor, Type B3, 115 V., 60 cycle, 2 r.p.m., 4 w. **Price $5.00 each net.**

Barber-Colman Control Motor, Type AYLC 5091, reversible 24 volts D.C. .7 amps 1 R.P.M., Torque 500 in. lbs. Contains 2 adjustable limit switches with contacts for position indication. Ideal for use as a remote positioner or a beam or television antenna rotator, will operate on A.C. 60 cycle. **Price $6.50 each net**

SERVO MOTORS

CK 1, Pioneer, 2 phase, 400 cycle. **Price $10.00 each net.**

CK 2 Pioneer, 2 phase, 400 cycle. **Price $4.25 each net**

10047-2-A Pioneer 2 phase, 400 cycle, with 40:1 reduction gear. **Price $7.25 each net.**

FPE-25-16 Diehl Low-Inertia 20 V., 60 cycle, 2 phase, 1600 r.p.m., 85 amps. **Price $10.00 each net.**

CK2, Pioneer, 2 phase, 400 cycle, with 40:1 reduction gear. **Price $6.50 each net.**

CK5 Pioneer, 2 phase, 400 cycle. **Price $20.00 ea. net.**

MINNEAPOLIS-HONEYWELL TYPE B Part No. G303AY, 115 V., 400 cycle, 2 phase, built-in geor reduction, 50 lbs. in torque. **Price $10.00 each net.**

Kollsman Type 776-01 400 cycle 2 phase drag-up type, fix phase voltage 29, variable phase 35V. maximum, frequency 400 cycle. **Price $10.50 each net.**

REMOTE INDICATING MAGNESYN COMPASS SET

Pioneer Type AN5730-2 Indicator and AN5730-3 Transmitter 26 V., 400 cycle.

Price $40.00 per set new sealed boxes.

Kollsman Remote Indicating Compass Set Transmitter part No. 679-01, indicator part No. 680k-03, 26 V., 400 cycle. **Price $12.50 each net.**

GYROS

Schwein Free & Rate Gyro type 45600. Consists of two 28 V. D.C. constant speed gyros. Size 8" x 4.25" x 4.25". **Price $15.00 ea. net.**

Sperry A5 Directional Gyro, Part No. 656029, 115 volts, 400 cycle, 3 phase. **Price $17.50 each net.**

Sperry A5 Vertical Gyro, Part No. 644841, 115 V., 400 cycle, 3 phase. **Price $20.00 each net.**

Sperry A5 Amplifier Rack Part No. 644890. Contains Weston Frequency Meter. 350 to 450 cycle and 400 cycle, 0 to 130 voltmeter. **Price $10.00 each net.**

Sperry A5 Control Unit Part No. 644836. **Price $7.50 each net.**

Sperry A5 Azimuth Follow-Up Amplifier Part No. 656030. With tube. **Price $5.50 each net.**

Sperry A5 Autopilot Indicator: contains Pioneer AY20 Autosyn 26 V., 400 cycle. **Price $9.50 ea. net.**

Pioneer Type 12800-1-D Gyro Servo Unit. 115 V., 400 cycle, 3 phase. **Price $10.00 each net.**

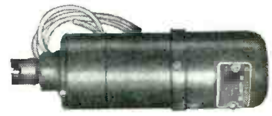
Norden Type M7 Vertical Gyro. 26 V., D.C. **Price $19.00 each net.**

Allen Calculator, Type C1 Bank and Turn Indicator, Part No. 21500, 28 V. D.C. Contains 28 V. D.C. constant speed gyro. **Price $10.00 each net.**

Type C1 auto-pilot formation stick, part No. G1080A3. **Price $15.00 each net.**

GOVERNMENT approved instrument repair station No. 3564.

D.C. MOTORS



5069625, Delco Constant Speed, 27 V., 120 r.p.m. Built-in reduction gears and governor. **Price $4.50 each net.**

A-1755, Delco Constant Speed Shunt Motor, 27 V., 2.4 amps., 3600 r.p.m., 1/30 h.p. Built-in governor. **Price $6.25 each net.**

C-28P-1A, John Oster Series Motor, 27 V., 0.7 amps., 7000 r.p.m., 1/100 h.p. **Price $4.50 each net.**

Jaeger Watch Co. Type 44-K-2 Contactor Motor, Operates on 3 to 4.5 volts D.C. Makes one contact per second. **Price $2.00 each net.**

General Electric Type 5BA10AJ52C, 27 V. D.C., 0.65 amps., 14 oz. n. torque, 145 r.p.m. Shunt Wound, 4 lead reversible. **Price $5.00 each net.**

General Electric Type 5BA10AJ37C, 27 V.D.C., 0.5 amps., 8 oz., in. torque, 250 r.p.m. Shunt Wound, 4 leads reversible. **Price $6.50 each net.**

General Electric Type 5BA10J18D, 27 V. 0.7 amps. 110 R.P.M. 1 oz. ft. torque. **Price $4.75 ea. net.**

D.C. ALNICO FIELD MOTORS

S. S. FD6-16, Diehl, 27 V., 10,000 r.p.m. **Price $4.50 each net.**

S. S. FD6-18, Diehl, 27 V., 10,000 r.p.m. **Price $4.50 each net.**

S. S. FD6-21, Diehl, 27 V., 10,000 r.p.m. **Price $4.50 each net.**

5069600 Delco 27.5 V. 250 R.P.M. **Price $10.00 each net.**

706343 Delco 27.5 V. 10,000 R.P.M. Shaft 0.5 in. long. **Price $7.50 ea. net.**

5068571 Delco 27.5 V. 10,000 R.P.M. with blower ossembly. **Price $10.00 ea. net.**

5071895 Delco 27.5 V. 250 R.P.M. **Price $10.00 ea. net.**

5072400 Delco 27.5 V. 10,000 R.P.M. Shaft 0.5 in. long with worm gear. **Price $6.75 ea. net.**

GENERAL ELECTRIC D. C. SELSYNS

8TJ9-PDN Transmitter, 24 V. **Price $3.75 each net.**

8TJ9-PAB Transmitter 24V. **Price $3.75 each net.**

8DJ11-PCY Indicator, 24 V. Dial marked —10° to +65°. **Price $4.50 each net.**

8DJ11-PCY Indicator, 24 V. Dial Marked 0 to 360°. **Price $7.50 each net.**

AMPLIFIER

Pioneer Gyro Flux Gate Amplifier, Type 12076-1-A. **Price $17.50 ea. net, with tubes.**

G. E. Servo Amplifier Type 2CV1C1, 115 V. 400 cycle. **Price $9.00 ea. net.**

Minneapolis Honeywell Amplifier Type G403, 115 V. 400 cycle. **Price $8.00**

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Telephone GReat Neck 4-1147

Write for Catalog NE100

U. S. Export License-2140

SUPPLIER OF ELECTRONIC & AIRCRAFT EQUIPMENT

IMMEDIATE DELIVERY

INVERTERS

Winchorger Corp. Inverter PU/16 type MG 750, Input 24 V.D.C., 60 amps. Output 115 V, 400 cycle, 1 phase, 6.5 amps. **Price $60.00 each net.**

153F, Holtzer Cabot, Input, 24 V.D.C. Output 115 V., 400 cycle, 3 phase, 750 V.A. and 26 V., 400 cycle, 1 phase, 250 V.A. Voltage and frequency regulated also built in radio filter. **Price $115.00 each net.**

149H, Holtzer Cabot. Input 28 V. at 44 amps. Output 26 V. at 250 V.A., 400 cycle and 115 V. at 500 V.A., 400 cycle. **Price $40.00 each net.**

149F, Holtzer Cabot. Input 28 V. at 36 amps. Output 26 V. at 250 V.A., 400 cycle and 115 V. at 500 V.A., 400 cycle. **Price $40.00 each net.**

12117, Pioneer. Input 12 V.D.C. Output 26 V., 400 cycle, 6 V.A. **Price $22.50 each net.**

12117-2 Pioneer. Input 24 V.D.C. Output 26 V. 400 cycle, 6 V.A. **Price $20.00 each net.**

12116-2-A Pioneer. Input 24 volts D.C., 5 amps. Output 115 volts 400 cycle single phase 45 watts. **Price $100.00 each net.**

5D21NJ3A General Electric. Input 24 V.D.C. Output 115 V., 400 cycle at 485 V.A. **Price $15.00 each net.**

PE 218, Ballentine. Input 28 V.D.C. at 90 amps. Output 115 V., 400 cycle at 1.5 K.V.A. **Price $50.00 each net.**

METERS

Weston Frequency Meter, Model 637, 350 to 450 cycles, 115 volts. **Price $10.00 each net.**

Weston Voltmeter. Model 833, 0 to 130 volts, 400 cycle. **Price $4.00 each net.**

Weston Voltmeter. Model 606, Type 204 P, 0 to 30 volts D. C. **Price $4.25 each net.**

Weston Ammeter. Model 506, Type S-61209, 20-0 100 amps. D. C. **Price $7.50 each net with ext. shunt.**

Weston Ammeter. Type F1, Dwg. No. 116465, 0 to 150 amps. D. C. **Price $6.00 each net. With ext. shunt $9.00 each net.**

Westinghouse Ammeter. Type 1090-D-120, 120-0-120 amp. D. C. **Price $4.50 each net.**

Weston Model 545. Type 82PE Indicator. Calibrated 0 to 3000 RPM. 2¾" size. Has built-in rectifier, 270° meter movement. **Price $15.00 each net.**

RECTIFIER POWER SUPPLY

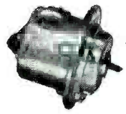
General Electric, Input 230 V. 60 cycle 3 phase. Output 130 amps. at 28 V. D.C. Continuous duty, fan cooled, has adjustable input taps. G.E. model No. 6RC146F. Size: Height 46", width 28", depth 17½". **Price $200.00 each net.** New

PIONEER AUTOSYNS

AY1, 26 V., 400 cycle. Price $5.50 each net.

AY14D, 26 V., 400 cycle, new with calibration curve. **Price $15.00 each net.**

AY20, 26 V., 400 cycle. **Price $7.50 each net.**



AY5, 26V., 400 cycle. Has hollow shaft. **Price $7.50 ea. net.**

PRECISION AUTOSYNS

AY101D, new with calibration curve.

PRICE—WRITE OR CALL FOR SPECIAL QUANTITY PRICES

AY131D, new with calibration curve. **Price $35.00 each net.**

AY201-2-A. Price $35.00 each net.

PIONEER AUTOSYN POSITION INDICATORS

Type 5907-17. Dial graduated 0 to 360°, 26 V., 400 cycle. **Price $15.50 each net.**

Type 6007-39, Dual, Dial graduated 0 to 360°, 26 V., 400 cycle. **Price $30.00 each net.**

PIONEER TORQUE UNIT

Type 12602-1-A. Price $40.00 each net.

Type 12606-1-A. Price $40.00 each net.
Type 12627-1-A. Price $80.00 each net.

MAGNETIC AMPLIFIER ASSEMBLY

Pioneer Magnetic Amplifier Assembly Saturable Reactor type output transformer. Designed to supply one phase of 400 cycle servo motor. **Price $8.50 each net.**

PIONEER TORQUE UNIT AMPLIFIER

Type 12073-1-A, 5 tube amplifier, Magnesyn input, 115 V., 400 cycle. **Price $17.50 each net with tubes.**

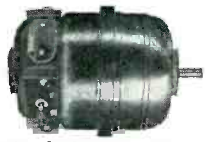
ALL PRICES, F. O. B. GREAT NECK, N. Y.

BLOWER ASSEMBLY MX-215/APG

John Oster, 28 V.D.C., 7000 r.p.m. 1/100 h.p. **Price $4.50 each net.**

Westinghouse Type FL Blower, 115 V., 400 cycle, 6700 r.p.m., Airflow 17 C.F.M. **Price $3.70 each net.**

RATE GENERATORS



F16, Electric Indicator Co., two-phase, 22 V. per phase at 1800 r.p.m. **Price $12.00 each net.**

J36A, Eastern Air Devices, .02 V. per r.p.m. **Price $9.00 each net.**

B-68, Electric Indicator Co., Rotation Indicator, 110 V., 60 cycle, 1 phase. **Price $14.00 each net.**

PM-1-M Electric Indicator Co. Same as type B35. 2 V. per 100 R.P.M. Max. speed 5,000 R.P.M. Can be used as D.C. motor, 1/77 H.P. 115 V. D.C. **Price $9.75 ea. net.**

SINE-COSINE GENERATORS
(Resolvers)

FPE 43-1, Diehl, 115 V., 400 cycle. **Price $20.00 each net.**

SYNCHROS

1F Special Repeater, 115 V., 400 cycle. Will operate on 60 cycle at reduced voltage. **Price $15.00 each net.**

7G Generator, 115 V., 60 cycle. **Price $30.00 each net.**

2J1F3 Selsyn Generator 115 volts, 400 cycle. **Price $5.50 each net.**

2J1M1 Control Transformer 105/63 V., 60 cycle. **Price $20.00 each net.**

2J1G1 Control Transformer, 57.5/57.5 V., 400 cycle. **Price $1.90 each net.**

2J1H1 Selsyn Differential Generator, 57.5/57.5 V., 400 cycle. **Price $3.25 each net.**

W. E. KS-5950-L2, Size 5 Generator, 115 V., 400 cycle. **Price $10.00 each net.**

5G Generator 115 volts, 60 cycle. **Price $50.00 each net.**

5SF Repeater, 115/90 V., 400 cycle. **Price $19.00 each net.**

2J1F1 Selsyn Generator, 115 V., 400 cycle. **Price $3.50 each net.**

5SDG Differential Generator 90/90 V., 400 cycle. **Price $12.00 each net.**

1CT Control Transformer, 90/55 volts, 60 cycle. **Price $40.00 each net.**

POSITION TRANSMITTER

Pioneer Type 4550-2-A Position Transmitter, 26 volts 400 cycle, gear ratio 2:1. **Price $15.00 each net.**

INSTRUMENT ASSOCIATES

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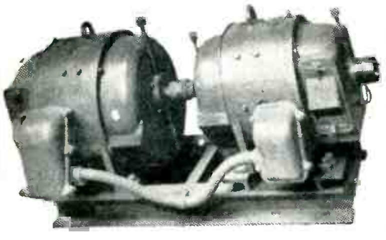
MOTOR GENERATORS DYNAMOTORS, INVERTERS, ETC.



2.5 KVA MG SET. Diehl Elec. Co. 120V DC to 120V AC, 60 cy, 1 Ph. Complete with Magnetic Controller, 2 Field Rheos and Full Set of Spare Parts including Spare Armatures for Generator and Motor. Full specs. on request. New............. **$285.00**

2 KVA MG SET. O'Keefe and Merritt. 115V DC to 120V AC, 50 cy. Idles as 3 Ph. syncs motor on 208V, 50 cy. New. Export crated $165.00

1.25 KVA MG SET. Allis-Chalmers. 115V DC to 120V, AC, 60 cy, 1 Ph. Fully enclosed. Splashproof. Ball Bearings. New.$97.50

Same machine but for 230V DC operation.$110.00

Spare Parts for either machine...........$15.00

MG SET FOR NAVY TBS TRANSMITTER. Type CG-21302. 440V AC, 60 cy, 3 Ph, 1500 VA to 875V DC and 300V DC. New $69.50

DYNAMOTOR. Navy Type CAJO-211444. 105/130V-DC to 13V DC at 40A or 26V DC at 20A. Radio filtered. Complete with Line Switch. New $69.50

DYNAMOTOR. Elcor. 32V DC to 110V AC. 60 cy, 1 Ph. 2.04 Amps. New............$24.50

DYNAMOTOR. Elcor. 32V DC to 110V AC. 60 cy. 1 Ph, 0.43 Amps. New............$17.50

AMPLIDYNE—G. E. Model 5AM31NJ9A. 530 Watts. 7500 R.P.M. Input: 27V DC, Output: 60V. DC. Weight 34½ lbs. New........$10.50

AMPLIDYNE—G. E. Model 5AM21JJ7. 4600 R.P.M. Motor Compound wound. 150 Watts. Input: 27V. DC. Output: 60V. DC Sig. Corps. U. S. Army MG-27-B. New............$26.50

INVERTER—Leland Elec. Co. Model PE206A. Input: 28V. DC, 38 Amps. Output: 80V., 800 cy, 485 VA. New...........................$12.50

INVERTER—G. E. Model 5D-21NJ3A. Input: 24V. DC, Output: 115V. 400 cy. 485 Va. New $12.50

PE 218 INVERTER—G. E. J8169172. Input: 28V. DC, Output: 115V. 400 cycles at 1.5 KVA. $50.00

D. C. MOTOR—G. E. Model 5BA 50LJ2A 0.5 HP. Armature: 27V. at 8.3 Amps. Field: 60V. at 2.3 Amps. R.P.M. 400. New.........$12.50

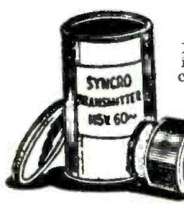
DYNAMOTOR—Type PE94C. For use with SCR522 Transmitter-Receiver. Brand new in export cases $9.50

U. S. NAVY SOUND POWERED BATTLE PHONES

Western Electric No. D173312, Type O. Combination headset and chest microphone as illustrated. Brand new including 20 ft. of rubber covered cable........... **$17.50**

Automatic Elec. Co. No. GL843AO. Similar to above but including Throat microphone in addition to chest microphone. Brand new with 20 ft. rubber covered cable.. **$13.50**

SYNCHRO GENERATORS



Brand new—Gov't. sealed and inspected—Packed in overseas cans, Synchro Transmitters 115 V., 60 cy. operation. Precision accuracy made for gun fire control. Cost Gov't $90.00 each. Wgt. 5 lbs. Dimensions: 4½" L x 3¼". **Brand New** **$17.50** Per Pair

S. G. RADAR EQUIPMENT

Navy Yard Spares for Model SG Radar

Consisting of the following:

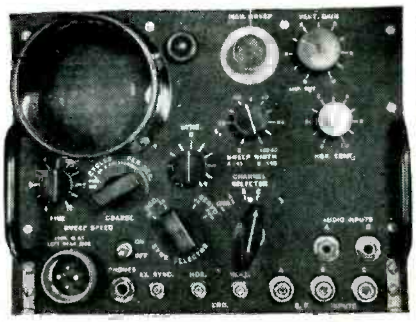
2—CRP-20ABM Rectifier Power Units for modulation generators.
2—CRP-20ABM Rectifier Power Units for Radar Receivers.
2—CRP-35AAH Modulation Generators.
2—CRP-46ABD-1 Radar Receivers (including R-906 Gain Controls for Range and Train Indicators).
2—CRP-60AAN Signal Monitors.
2—Complete Transmitter R.F. System coupling assembl.es including—10087 magnets and Duplexing tube cavity assemblies.
1—Complete Power Control Chassis.
2—Complete Driver and modulator assembly including driver chassis with delay line, Modulator and Driver Rectifier Tube Assembly and Driver Rectifier Power Unit.
2—Complete sets of equipment spare part sconsisting of R.F. Assemblies, motors and accessories, switches, interlocks, fuses, fuse holders, fuse links, relays, contacts, crystals, thermostats, R.F. inductors, capacitors, sockets, test equipment, cables, resistors, etc., as listed in Navy Spare Parts List WX3885.

All above in new and unused condition packed in original metal spare parts boxes.

RADAR COMPONENTS

CRP-23AGC Load Dividers for use with S.G. Modernization Kits. New.
CBM-50AFO Navy type Radar Repeater Adapters, New and complete with 14 tubes, coax fittings, installation plans and wiring diagram.
Synchro Amplifiers. New.
Type CARD 23AEK Bearing Control Units. New.
Type T.D.Y., SO-1, SO-13, SO-3 Radar Antenna Assemblies. New.
Radar Crystals Raytheon 98.35 KC.
Type SO-11 Radar Modulator.
Type SO-1 Transmitter Receivers.

MODEL AN/APA-10 PANORAMIC ADAPTER



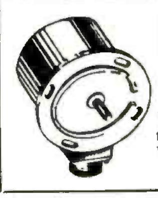
Provides 4 Types of Presentation: (1) Panoramic (2) Aural (3) Oscillographic (4) Oscilloscopic

Designed for use with receiving equipment AN/ARR-7, AN/ARR-5, AN/APR-4, SCR-587 or any receiver with I.F. of 455kc, 5.2mc, or 30mc. With 21 tubes including 3" scope tube. Converted for operation on 115 V. 60 cycle source.
PRICE **$245.00**
AN/APA-10 80 Page Tech Manual.......... **$2.75**

MICROWAVE TUNING UNITS

Tuning Units for APR-1 or APR-4, TN-16 (38-95 mc.) TN-17 (74-320 mc) TN-18 (300-1000 mc.) These front ends may be used with any 30 mc. IF amplifier or as converters into receivers tuned to 30 mc.

LINEAR SAWTOOTH POTENTIOMETER



W.E. KS-15138

'as continuous resistance winding to which 24 volts D.C. is ed to two fixed taps 180° apart. Two rotating brushes 180° apart take off linear sawtooth wave voltage at output.

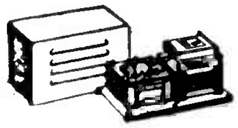
Brand New $5.50

LAVOIE FREQ. METER MICRO-WAVE

375 to 725 MCS

Model TS-127/U is a compact, self-contained, precision (± 1 MC) frequency meter which provides quick, accurate readings. Requires a standard 1.5V "A" and 45V "B" battery. Has 0-15 minute time switch. Contains sturdily constructed HI-"Q" resonator with average "Q" of 3000 working directly into detector tube. Uses 957, LS6 and 3S4 Tubes. Complete, new with inst. book, probe and spare kit of tubes. Less batteries. Write for descriptive circular **$69.50**

RAYTHEON VOLTAGE REGULATOR Adj. input taps 95-130V., 60 cy. 1 Ph Output: 115V., 60 Watts. ½ of 1% Reg. Wt. 20 lbs. 6⅛" H x 8¼" L x 4⅝" W. Overload protected. Sturdily constructed. Tropicalized.



Special.... **$14.75**

400 CYCLE TRANSFORMERS

AUTO. 400 cy. G.E. Cat. No. 80G184 KVA .945S—.520P. Volts 460/345/230/115. New $3.45
FILAMENT. 400/2600 cy. Input: 0/75/80/85/105/115/125V. Output: 5V3A/5V3A/5V3A/5V3A/5V6A/5V6A/6.3V6A/6.35A. New $1.95
THYRATRON POWER. 400/1600 cy. Raytheon UX-8876. 400/1600 cy. Pri: 115V. Sec: 50-0-50V at 0.5A, 6.3V at 1.2A. Test r.m.s. 1780. New $2.75
PLATE WECO KS9560. 400/800 cy. Pri: 115V. Sec: 1350-0-1350 at .057A (2700 V Total). Elecstat shlded. Wt. 2.3 lbs. New...............$2.95
SCOPE PL. & FIL. WECO 9556. 400/2400 cy. Pri: 115. HV. Wdg. 1125V at .008A. Fil. Wdgs. 6.4V4A/2.5V1.75A/6.4V.6A. Elecstat shlded. Wt. 1.4 lbs. New $2.75
FILAMENT. 400/2400 cps. WECO KS9553. Pri: 115V. Sec: 8.2V1.25A/6.35V1.5A. Elecstat shlded. Wt. 0.5 lbs. New..................$1.65
PLATE & FIL. 400/2600 cy. Pri: 0/80/115V. Sec #1=1200VDC at 1.5MA, Sec#2=400VDC at 130MA. Fil. Secs: 6.4V4.3A/6.35VO.8A. (Ins 1500V)/5V2A/5V2A $3.95
RETARD. 400 cy. WECO KS9598. 4 Henry 100MA $1.00

400 CY. SERVO TRANSFORMERS

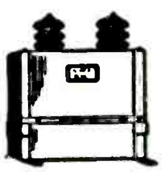
G.E. #68G665X Pri: 57.5V. Sec:#1=28.75V. Sec: #2=28.75V $1.50
G.E. #68G666X Pri: 57.5V. Sec: 115V C.T. $1.50
G.E. #68G667 Pri: 220V C.T. Sec: 220V C.T. $1.50
G.E. #68G668X Pri: 115V. Sec: 275V/275V/275V/275V/230V/230V/6.3V CT/6.3V CT..$3.50

60 CYCLE TRANSFORMERS

1.5 KVA STEPDOWN. G.E. Cat. No. 76G173. Pri: 115/230V Sec: 23/11.5V. Either high voltage connection may be used with either low voltage connection $23.95
50KVA STEPDOWN. Standard Trans Corp. trans type MD. Pri: 450V111A. Sec: 117V427A. Navy type. Ambient temp. 50 Deg. C.........$125.00
FILAMENT. Raytheon Hypersil Core. Pri: 115V. Sec: 6.3V22A/6.3V2.4A/6.3V2.25A/6.3VO.6A Ins. for 1700V $3.95

PULSE TRANSFORMER

PULSE. WECO KS-9563. Supplies voltage peaks of 3500V from 807 tube. Tested at 2000 Pulses/sec and 5000V peak. Wdg. 1-2=18 ohms. Wdg. 1-3=72 ohms. L of Wdg. 1-3=.073-.082H at 100 cps $5.50



High Voltage Capacitors Oil Filled

.25 MFD.. 20KV.......$17.75
.25 MFD.. 15KV.......$15.75
.5 MFD.. 25KV........$26.50
1 MFD.. 15KV.........$18.50
1 MFD.. 7.5KV........$ 7.95

All brand new. Made by prominent manufacturers.

SWEEP GENERATOR CAPACITOR

High speed ball bearings. Split stator silver plated coaxial type 5/10 mmfd. Brand new.

$2.50

PARABOLOIDS

Spun Magnesium dishes 17½" dia., 4" deep. Mounting brackets for elevation and azimuth control on rear. 1½" x 1⅝" opening in center for dipole. Brand new per pair.................. **$8.75**

All prices indicated are F O B Tuckahoe, New York. Shipments will be made via Railway Express unless other instructions issued.

ELECTRONICRAFT INC.

5 WAVERLY PLACE TUCKAHOE 7, N. Y.
PHONE: TUCKAHOE 3-0044

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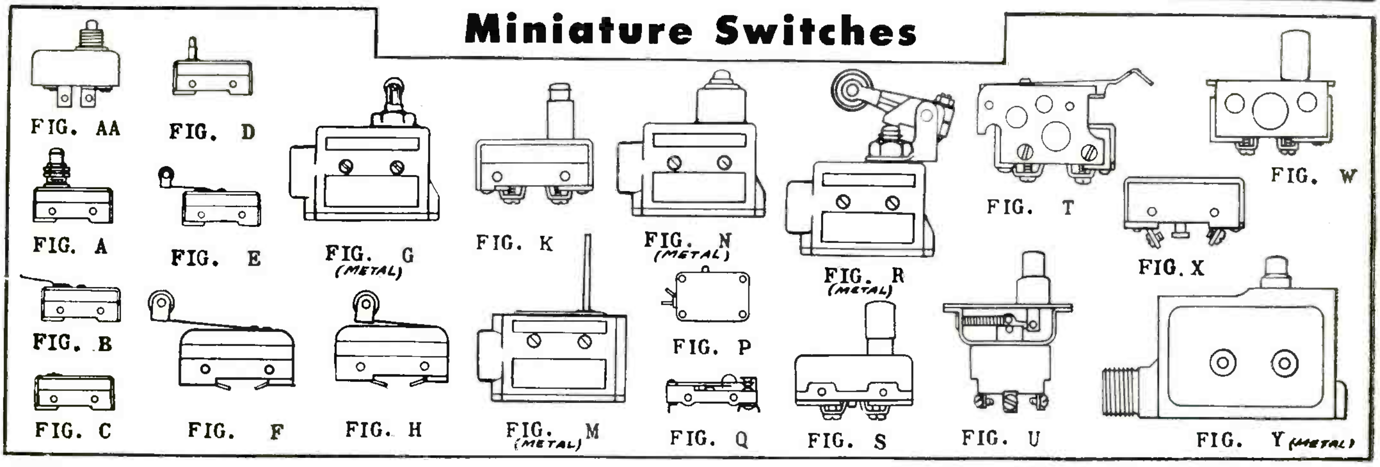
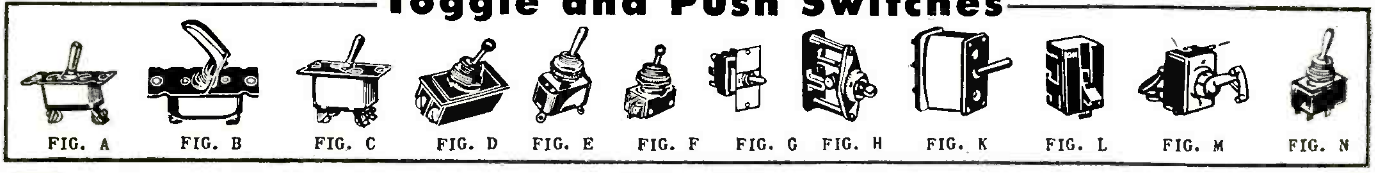
SAVE on Miniature and Toggle Switches at WELLS

Miniature Switches



STOCK NUMBER	MANUFACTURER	MFR. TYPE NO.	CONTACTS	ILLUSTRATION	PRICE EACH
305-10	Microswitch	WP3M5	N.C.	FIG. AA	$0.40
305-160	Microswitch	WP-5M3	N.C.	FIG. AA	.40
307-210	Microswitch	YP3A	N.O.	FIG. AA	.50
303-67	Microswitch	YZ7RA6	N.O.	FIG. A	.71
PH-100	Acro	R0182T	N.O.	FIG. A	.71
301-46	MU-Switch	MLB-321	SPDT	FIB. B	.85
301-93	Microswitch	YZ-2YLTC1	SPDT	FIG. B	1.01
301-30	MU-Switch	R02M	SPDT	FIG. B	.95
301-78	MU-Switch	Green Dot	SPDT	FIG. B	.75
303-79	Microswitch	BZ-RL32	SPDT	FIG. B	.75
303-85	MU-Switch	MLB329	SPDT	FIG. B	.67
305-154	Acro	XD4-5L	SPDT	FIG. B	.78
311-130	Acro	— —	SPDT	FIG. B	.70
PH-101	Microswitch	BRL18	SPDT	FIG. B	.78
PH-102	Microswitch	YZRL812	N.O.	FIG. B	.65
PH-104	Microswitch	YZ3RLTC2	N.O.	FIG. B	.64
PH-105	Microswitch	YZR31	N.O.	FIG. C	.53
PH-106	Microswitch	R-R36	N.C.	FIG. C	.50
PH-107	Microswitch	BR-26	N.C.	FIG. C	.53
PH-108	Microswitch	WZ-2RT	N.C.	FIG. C	.50
305-161	Microswitch	YZ3R3	N.O.	FIG. C	.71
311-115	Microswitch	WZR31	N.C.	FIG. C	.71
311-123	Microswitch	WZ-7R	N.C.	FIG. C	.60
311-126	Acro	HRRC7.1A	N.C.	FIG. C	.50
311-125	Acro	HRR07.1A	N.O.	FIG. C	.53
311-121	Microswitch	WZ7RTC	N.C.	FIG. C	.50
311-128B	Microswitch	YZ	N.O.	FIG. C	.53
370-6	Microswitch	X757	N.C.	FIG. C	.45
PH-119	Microswitch	WZR-8X	N.C.	FIG. C	.45
PH-109	Microswitch	RRS13	N.C.	FIG. D	.45
PH-110	Microswitch	BRS36	SPDT	FIG. D	.53
PH-111	Microswitch	GRS	N.O.	FIG. D	$0.49
311-116	Microswitch	SW-186	N.C.	FIG. D	.63
303-49	Microswitch	YZ2YST	SPDT	FIG. D	.68
309-93	Microswitch	BRS36	SPDT	FIG. D	.68
370-17	MU-Switch	QRS	SPDT	FIG. D	.75
PH-112	MU-Switch	MBW	SPDT	FIG. E	.72
311-25	MU-Switch	CUN24155	N.C.	FIG. E	.85
370-10	Acro	R02M12T	N.O.	FIG. E	.70
303-32	Microswitch	YZ-3RW2T	N O.	FIG. F	.65
306-10	Microswitch	BZE-2RQ9TM1	SPDT	FIG. G	2.48
PH-120	Microswitch	YZ7RQ9T6	N.O.	FIG. G	.75
309-101	Microswitch	BZ-2FW221	SPDT	FIG. H	.95
PH-113	Microswitch	RZBQT	SPDT	FIG. K	.58
L306-1010	Acro	R07-8586	N.O.	FIG. K	.55
370-18	Acro	HR071P2TSF1	N.O.	FIG. K	.60
370-19	Microswitch	YZRQ41	N.O.	FIG. K	.65
370-8	Microswitch	RN-11-H03	SPDT	FIG. M	1.50
309-157	MU-Switch	— —	N.C.	FIG. N	1.15
370-15	MU-Switch	AHB203	SPDT	FIG. N	1.25
370-7	Microswitch	WZE-7RQTN	N.C.	FIG. N	1.35
305-11	Acro	2M031A	N.O.	FIG. P	.37
305-50	Microswitch	Open Type	SPDT	FIG. Q	.35
303-84	Acro	HR07-4PST	N.O.	FIG. S	.50
303-83	Microswitch	YZ-RQ4	N.O.	FIG. S	.50
PH-114	Microswitch	WZR-31	N.C.	FIG. T	.65
PH-115	Cutler Hammer	8905K564	DPDT	FIG. U	.65
PH-116	Microswitch	WZRQ41	N.O.	FIG. W	.60
PH-118	Microswitch	BZRQ41	SPDT	FIG. W	.60
311-128A	Microswitch	YZ-RTX1	N.O.	FIG. X	.90
PH-117	MU-Switch	Z	N.C.	FIG. Y	1.35

Toggle and Push Switches



STOCK NUMBER	FIG.	CONTACT ARRANGEMENT	MANUFACTURER & NUMBER	PRICE EACH
PH-500	A	SPDT	B1B	$0.35
PH-501	A	SPDT	AN3022-3B	$.35
PH-503	A	SPDT CENTER OFF MOM EACH SIDE	B11	.32
PH-505A	A	SPDT MOMENTARY	B21	.30
PH-505	A	SPST	AN-3022-2B	.30
PH-506	A	SPDT CENTER OFF	AN-3022-1	.35
PH-507	A	SPDT CENTER OFF MOM EACH SIDE	AN-3022-7B	.32
PH-508	A	SPST MOMENTARY	AN-3022-8	.28
PH-513	A	SPDT CENTER OFF	CH AN-3022-1B	.38
PH-514	A	SPST	CH B-5 A	.35
PH-516	A	SPST	B5	.35
LT-104	A	SPDT 1 SIDE MOMENTARY	CH 8905K568	.35
309-168	A	SPST	168553	.30
370-1	A	SPST MOMENTARY	CH AN-3022-8B	.25
370-4	A	SPDT CENTER OFF	CH B-9A	.35
370-14	A	SPDT CENTER OFF 1 SIDE MOM.	CH B-7A	.30
370-25	A	SPST MOMENTARY	CH B-6B	.25
305-171	A	SPDT CENTER OFF MOM 1 SIDE	8209K5	.32
309-169	B	SPST MOMENTARY	CH B-19	.35
PH-509	C	DPST	AN-3023-2B	.45
PH-510	C	DPDT MOMENTARY	CH 8715K2	.50
PH-511	C	DPDT MOMENTARY	CH 8715K3	.50
PH-512	C	DPST CENTER OFF	CH 8720K1	.55
PH-515	C	DPDT CENTER OFF	C-9A-8700K2	.55
PH-517	C	DPDT	C-5A-8701K2	.55
303-65	C	DPST	CH AN-3023-2	.45
305-174	C	DPDT CENTER OFF MOM 1 SIDE	AN-3023-5	$0.50
305-177	C	DPDT CENTER OFF MOM EACH SIDE	C-3	.50
305-176	C	DPDT CENTER OFF MOM EACH SIDE	AN-3023-7	.50
305-173	C	DPDT	8710K3	.55
305-175	C	DPDT CENTER OFF MOM EACH SIDE	3712K3	.50
305-179	C	DPDT CENTER OFF MOM EACH SIDE	8732-K2	.50
309-163	C	DPDT CENTER OFF MOMENTARY	CH C-11	.55
309-162	C	DPST	CH C-1	.45
309-164	C	DPST MOMENTARY	CH 8711K3	.40
370-31	C	DPDT	CH C-1B	.55
305-87	D	1 SIDE DPST MOM 1 SIDE SPST	AH & H	.95
LT-100	F	SPST	CH	.22
LT-101	F	SPST MOMENTARY	AH & H w/LEADS	.20
301-51	G	4PDT MOMENTARY	CH 8905K12	.75
305-140	H	DT NO MAKE EACH SIDE	OPEN FRAME	.25
309-161	K	SPST	CH 8781K3	1.95
305-76	L	DPST	AH & H OPEN FRAME	.75
301-12	M	DPST	AH & H SPECIAL FOR HANDY	.40
LT-107	N	DPST	AH & H TALKIE	.25

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2 speed dial drive for ¼" shaft ratios 5:1 1 to 1	.39
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2 mfd 3000v oil condenser Aerovox	3.25
3 mfd 4000v oil condenser Micamold	3.95
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1B27	24.50
1B29	2.75
1B32	1.79
1B36	24.96
1B38	32.50
1N21 Xtal	.59
1N21A Xtal	.89
1N21B Xtal	1.39
1N22 Xtal	.89
1N23 Xtal	.79
1N23A Xtal	.79
1N23B Xtal	2.95
1N27 Xtal	1.69
1N34 Xtal	.79
1N34A Xtal	.85
1P23	2.95
1P24	.79
1P36	2.69
1S21	3.79
2AP1	4.95
2AP5	4.95
2C21/RK33	.35
2C22/7193	.19
2C26A	.19
2C34/RK34	.27
2C39	24.50
2C40	3.45
2C43	8.95
2C44	.98
2C46	6.95
2C51	5.75
2D21	1.25
2E22	1.19
2E24	4.69
2E26	3.39
2E30	2.29
2J21A	7.95
2J22	8.45
2J26	6.50
2J27	10.95
2J30	39.50
2J31	8.49
2J32	12.95
2J33	18.95
2J34	18.95
2J36	97.50
2J37	12.75
2J38	9.95
2J39	19.95
2J40	24.50
2J46	49.50
2J48	15.75
2J49	39.50
2J50	22.50
2J54B	22.95
2J55	69.50
2J61	24.50
2J62	34.50
2K25	19.75
2K28	24.95
2K29	24.50
3AP1	4.59
3B22/ELIC	1.35
3B23/RK22	4.85
3B24	1.59
3B24W	2.89
3B25	4.39
3B26	1.49
3B27	1.95
3B28	7.95
3BP1	2.59
3C22	39.50
3C23	5.95

3C24/24G	$ .39
3C31/C1B	3.49
3C45	12.75
3CP1	1.39
3CP1-S1	2.25
3DP1	3.10
3DP1A	3.95
3DP1-S2A	4.75
3D21A	.98
3E29	9.95
3FP7	1.15
3GP1	4.45
3HP7	2.89
4-65A	14.21
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4B24/EL3C	4.75
4B25/6CF	7.50
4B26/2000	4.95
4B28	2.95
4B32	9.95
4C27/CV92	49.50
4C35	22.50
4D22	9.95
4D32	12.95
4E27/257B	14.95
5AP1	1.79
5AP4	1.79
5BP1	2.29
5BP4	2.39
5CP1	1.39
5CP7	3.49
5C22	49.50
5D21	18.95
5FP7	1.19
5GP1	2.69
5JP1	24.45
5JP2	8.95
5JP4	24.45
5J23	12.95
5J29	12.95
5J30	49.50
5LP1	11.95
5NP1	2.49
6C21	18.95
6F4	5.79
6J4	4.59
7BP7	4.49
9GP7	8.95
9JP1	5.95
9LP1	19.95
9LP7	3.49
10BP4	18.95
7DP4	17.95
10	.25
12DP7	11.95
12GP7	12.75
12HP7	12.75
12LP4	22.50
15E	1.19
15R	.59
16AP4	42.50
16CP4	42.50
19T8	.87
23D4	.19
28D7	.39
30 SPEC	.25
35TG	5.95
45 SPEC	.19
53A	5.95
75TL	5.95
100R	.89
100TH	9.95
121A	2.65
203A	5.95
211	.39
212E	49.50
215A	.19
217C	6.75

227A/5C27	$2.49
249C	1.75
250R	5.95
250TH	18.95
250TL	18.95
274A	5.50
274B	1.95
276A	6.95
293A	2.98
294A	3.95
300B	9.95
304TH	3.65
304TL	1.29
305A	24.95
307A/RK75	6.95
310A	6.95
316A	.45
323A/B	24.50
327A/5C37	2.49
328A	12.95
331A	12.95
350A	1.98
350B	1.69
368AS	2.39
371A	.59
371B	.39
388A	.79
393A	3.49
394A	3.49
417A	8.95
434A	2.95
446A	1.25
446B	1.79
450TH	19.95
450TL	44.50
527	9.75
559	.98
562	97.50
575A	11.95
701A	2.95
702A	2.69
703A	2.39
704A	1.05
705A	.89
706B	24.95
706CY	16.95
706FY	42.50
706GY	42.50
707B	14.95
708A	3.59
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715B	6.85
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721A	2.25
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723A	6.75
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725A	6.45
726A	4.95
726B	29.50
726C	49.50
730A	8.95
750TL	79.50
800	1.69
801A	.25
802	3.89
803	3.10
804	6.45
805	3.65
806	29.95
807	1.49
808	1.29
809	2.25
810	9.55
811	2.10

812	$2.45
812H	6.90
813	6.85
814	2.25
815	2.25
816	1.05
826	.39
828	9.95
829	7.45
829B	9.95
830B	3.19
832	4.95
832A	7.95
833A	33.95
836A	1.25
837	1.35
838	2.35
841	.33
843	.27
845	3.75
849	29.50
851	13.95
852	6.25
860	6.95
861	10.95
864	.29
865	1.45
866A	1.05
866JR	1.05
869B	26.50
872A	1.25
874	.89
876	.35
878	1.69
884	1.39
885	1.39
902	3.39
905	2.59
908	7.95
918	1.49
919	1.95
923	.72
927	1.09
930	.79
931A	3.59
954	.19
955	.24
956	.24
957	.22
958	.22
959	.49
991/NE16	.22
1603	1.98
1613	.49
1614	1.29
1616	.59
1619	.24
1622	1.49
1624	.98
1625	.18
1626	.24
1629	.25
1630	.98
1631	.85
1632	.79
1633	.69
1634	.75
1636	2.95
1638	.65
1644	.98
1654	2.39
1665	1.19
1851	.89
1960	.79
1961	4.99
2050	1.19
2051	.39
8005	4.59
8011	.49
8012	1.29
8013	1.39

8014	$19.95
8020	.89
8025	3.69
9001	.39
9002	.32
9003	.49
9004	.34
9005	1.49
9006	.18
C1JA	9.95
C5B	6.75
C6A	7.95
C6J	4.45
C100D	1.49
CK502AX	2.95
CK503AX	2.95
CK505AX	2.25
CK506AX	2.25
CK507AX	2.25
CK512AX	2.25
CK571AX	8.45
CK1005	.15
CK1006	.63
E1148	.29
EF50	.69
F123A	7.95
F127A	22.50
F128A	89.50
F606	37.50
F660	49.50
F862	397.50
FG17	3.95
FG27A	8.75
FG32	7.95
FG57	12.95
FG81A	3.29
FG105	8.95
FG172	29.50
GL146	8.95
GL434A	2.69
GL451	.89
GL502A	1.85
GL562	49.50
GL592	14.95
HF125	14.95
HF300	19.95
HY114B	.79
HY115	.79
HY615	.19
KC4	37.50
KU610	6.95
ML101	49.50
REL21	.98
RK20	7.95
RK25	4.19
RK33	.24
RK34	.27
RK48A	14.95
RK59	1.49
RK65	24.50
RK72	.59
RK73	.59
RX21A	2.39
RX120	8.95
V70D	7.35
VR78	.29
VR91	1.10
VR92	.69
VT127A	1.98
VT158	14.95
VU29	2.95
VU111	.49
WL468	5.95
WL530	12.75
WL531	1.75
WL532	1.89
WL578	.89
WL616	37.50
WL619	18.95
WL677	34.50
WL681	22.50

0A2, 0A4G, 0B2, 0Z4, 01A, 1A3, 1A4P, 1A5GT, 1A6, 1A7GT, 1AB5, 1B3/8016, 1B4, 1B5/25S, 1B7GT, 1C5GT, 1C6, 1C7G, 1D5GP, 1D7G, 1D8GT, 1E5GT, 1E7G, 1F4, 1F5G, 1G4GT, 1G6GT, 1H4G, 1H5GT, 1H6GT, 1J6GT, 1L4, 1LA4, 1LA6, 1LB4, 1LC5, 1LC6, 1LD5, 1LE3, 1LG5, 1LH4, 1LN5, 1N5GT, 1P5GT, 1Q5GT, 1R4, 1R5, 1S4, 1S5, 1T4, 1T5GT, 1U4, 1V, 2A3, 2A4G, 2A5, 2A6, 2A7, 2B7, 2V3G, 2X2, 2X2A, 3A4, 3A5, 3A8, 3B7/1291, 3D6/1299, 3LF4, 3Q4, 3Q5GT, 3S4, 3V4, 5R4GY, 5T4, 5U4G, 5V4G, 5W4, 5X4G, 5Y3GT, 5Y4G, 5Z3

DUE TO THE CURRENT NATIONAL EMERGENCY AND THE CRITICAL RECEIVING TUBE SHORTAGE, TUBES WILL BE SHIPPED AT PREVAILING PRICES.

5Z4, 6A3, 6A4LA, 6A6, 6A7, 6A8, 6AB7, 6AC5GT, 6AC7, 6AD7G, 6AE6G, 6AF6G, 6AG5, 6AG7, 6AH6, 6AJ5, 6AK5, 6AK6, 6AL5, 6AQ5, 6AQ6, 6AR5, 6AT6, 6AU6, 6AV6, 6B4G, 6B6G, 6B7, 6B8G, 6BA6, 6BE6, 6BF6, 6BG6G, 6BH6, 6BJ6, 6C4, 6C5, 6C6, 6C8G, 6D6, 6D8G, 6E5, 6F5, 6F6, 6F6GT, 6F7, 6F8G, 6G6G, 6H6, 6H6GT, 6J5, 6J5GT, 6J6, 6J7, 6J7GT, 6K5GT, 6K6GT, 6K7, 6K8, 6L5G, 6L6, 6L6G, 6L6GA, 6L7, 6L7G, 6N7, 6Q7, 6R7, 6S7G, 6S8GT, 6SA7, 6SC7, 6SD7GT, 6SF5, 6SF5GT, 6SF7, 6SG7, 6SH7, 6SJ7, 6SK7, 6SL7GT

DUE TO THE CURRENT NATIONAL EMERGENCY AND THE CRITICAL RECEIVING TUBE SHORTAGE, TUBES WILL BE SHIPPED AT PREVAILING PRICES.

6SN7GT, 6SQ7, 6SR7GT, 6SS7, 6ST7, 6SU7GTY, 6SV7, 6T7G, 6T8, 6U5G, 6U6GT, 6U7G, 6V6, 6V6GT, 6W4, 6W7G, 6X4, 6X5GT, 6Y6G, 6Y7G, 6Z7G, 6ZY5G, 7A4/XXL, 7A5, 7A6, 7A7, 7A8, 7AG7, 7B4, 7B5, 7B6, 7B7, 7C4, 7C5, 7C6, 7C7, 7E5, 7E6, 7E7, 7F7, 7H7, 7K7, 7L7, 7N7, 7Q7, 7R7, 7S7, 7V7, 7W7, 7X7, 7Y4, 7Z4, 12A, 12A6, 12A7, 12A8GT, 12AH7GT, 12AL5, 12AT6, 12AT7, 12AU6, 12AU7, 12AV6, 12BA6, 12BE6, 12C8, 12F5GT, 12H6, 12J5GT, 12J7GT, 12K7GT, 12K8, 12Q7, 12SA7GT, 12SC7, 12SF5, 12SF7, 12SG7, 12SH7

DUE TO THE CURRENT NATIONAL EMERGENCY AND THE CRITICAL RECEIVING TUBE SHORTAGE, TUBES WILL BE SHIPPED AT PREVAILING PRICES.

12SJ7, 12SK7, 12SL7, 12SN7, 12SQ7, 12SR7, 12Z3, 14A4, 14A7, 14B6, 14F7, 14F8, 14H7, 14J7, 14N7, 14Q7, 14R7, 19, 24A, 25L6GT, 25Z5, 25Z6GT, 26, 27, 28D7, 30, 31, 32, 32L7GT, 33, 34, 35/51, 35A5, 35B5, 35C5, 35L6GT, 35W4, 35Y4, 35Z3, 35Z4, 35Z5, 36, 37, 38, 39/44, 41, 42, 43, 45, 45Z3, 45Z5, 46, 47, 48, 49, 50A5, 50B5, 50C5, 50L6GT, 50Y6, 53, 56, 57, 58, 59, 70L7, 71A, 75, 76, 77, 78, 80, 82, 83, 83V, 84/6Z4, 85, 89Y, 117L7/M7, 117N7, 117P7, 117Z3, 117Z6

DUE TO THE CURRENT NATIONAL EMERGENCY AND THE CRITICAL RECEIVING TUBE SHORTAGE, TUBES WILL BE SHIPPED AT PREVAILING PRICES.

SELENIUM RECTIFIERS
FULL WAVE BRIDGE TYPE

Input 0-20V AC Type No.	Current	Output 0-14.5V DC Price
20D1	1.2 Amps	$ 2.49
20E1	2.4 Amps	3.49
20F1	6.4 Amps	4.95
20K1	13.0 Amps	8.95
20J1	17.5 Amps	11.95
20K2	26.0 Amps	17.95
20K3	39.0 Amps	24.95
20K4	52.0 Amps	29.95
20K5	65.0 Amps	35.95
0-40v AC	**Current**	**0-34v DC**
40D1	.6 Amps	$ 2.95
40E1	1.2 Amps	3.89
40F1	3.2 Amps	5.25
40K1	6.0 Amps	9.95
40J1	9.0 Amps	12.95
40K2	12.0 Amps	18.95
40J2	18.0 Amps	22.45
40K4	24.0 Amps	32.50
40K5	30.0 Amps	34.95
40J4	36.0 Amps	39.50
0-120v AC	**Current**	**0-100v DC**
40D1A	.6 Amps	$ 7.85
40E1A	1.2 Amps	10.76
40F1A	3.2 Amps	16.65
40K1A	6.0 Amps	24.75
40J1A	9.0 Amps	32.95

CENTER TAPPED RECTIFIERS
Single Phase Full Wave Bridge

10-0-10v AC	Current	0-8v DC
10D1	1.2 Amps	$ 1.89
10E1	2.4 Amps	2.25
10F1	6.4 Amps	3.87
10K1	12.0 Amps	4.95
10J1	16.0 Amps	7.95
10K2	24.0 Amps	10.75
10K3	36.0 Amps	14.75
10K4	48.0 Amps	17.75
10K5	60.0 Amps	19.95
10K6	72.0 Amps	25.57
10K7	84.0 Amps	27.95
10J6	96.0 Amps	32.50
10K10	120.0 Amps	42.50

Let us bid on your special selenium rectifier wants in any quantity

TRANSFORMERS—115V 60 CY HI-VOLTAGE INSULATION

6250v or 3850v or 2600v @ .036 arms	$13.95
2700v @ 2 MA; 6.3v @ .6A; 2.5v @ 1.75A	4.95
2500v @ 15 MA	3.49
1600v @ 4 MA; 350-0-350v @ 150 MA; 6.3v @ 9A	4.45
1540v @ 5 MA; 340-0340v @ 300 MA	4.35
1120-0-1120v @ 500 MA; 12v CT @ 14A; 2.5v @ 10A; 17v @ 2.5A; 32v @ 25 MA; 115/230 Pri	16.95
925v @ 10 MA; 525-0-525v @ 60 MA; 2X5v @ 3A; 6.3v CT @ 3.6A; 6.3v @ 2A; 6.3v @ 1A	5.55
700-0-700v @ 300 MA	7.55
500-0-500v @ 175 MA	4.55
430-0-430v @ 340 MA; 6.3v CT @ 6.3A; 5v @ 6A	4.85
425-0-425v @ 75 MA; 6.3v @ 1.5A; 5v @ 3A	3.65
415-0-415v @ 60 MA; 5v CT @ 2A; 115/230 Duel Pri	4.97
405-0-405v @ 150 MA; 6.3v CT @ 2½A; 5v @ 3A; 2.5v CT @ 5A	4.35
400-315-0-100-315v @ 200 MA; 2x6.3v @ 9A; 5v @ 3A; 2.5v @ 2A	5.35
500-385-0-385v @ 200 MA; 3x6.3v @ .6A; 5v @ 3A; 2.5v @ 2A	4.75
325-0-325v @ 12 MA; 255-0-255v @ 240 MA	4.25
300-0-300v @ 65 MA; 6.3v @ 2.5A; 6.3v @ 1A; 2x5v @ 2A	3.25
80-0-80v @ 225 MA; 5v @ 2A; 5v @ 4A	2.97
0-17.4/21.6/25.8v @ 400 MA; 6.4v @ .5A; 2.6v CT @ 2.5A Pri 115/230	3.85
18 or 36v @ 15A..$8.75 13.5v CT @ 3.25A	2.17
12.6v CT @ 10A; 11v CT @ 6.5A	6.35
3x10.3v CT @ 7A..$6.95 6.3v @ 1A	.77
6.5v @ 12A; 6.3v @ 2A; 115v @ .1A	3.50
6.4v @ 10A; 6.3v @ .6A	2.77
6.5v @ 8A; 6.5v @ 6A; 2.5v @ 1.75A	.17
6.3v @ 1A; 2.5v @ 2A..$2.29 4-0-4v @ 1A	.87
6.3v CT @ 3.5A; 2x2.5v CT @ 3A	2.97
5v CT @ 20A; 10 KV INS	8.95
.6v @ 15A RMS	1.47

TRANSFORMERS—220v 60 Cyc

512.5-0-512.5 @ 427 MA	$ 5.35
3x5v @ 6A; 4v @ .25A	2.95
3x6.3v CT @ 3A; 6.3v CT @ 1.6A	2.95
10v CT @ 6.5A; 6.3v CT @ 2.5A; 6.3v CT @ 1.8A 220/440 Pri	3.95
Step Up/Down 110/220, 500 watt	10.95
Step Up/Down 110/220, 220/440 600 watt	14.95

EQUIPMENT SPECIALS

APN-1 Altimeter Xceiver	Like New	$ 7.95
ATR Inverter 12v DC in 110v AC Out 125 w Int. 100 w Cont.	New	14.95
AN/CRW-2 UHF Receiver	New	5.95
BC357 Beacon Receiver	Good	3.45
BC433 Receiver	Good	24.94
BC456 Modulator	Good	1.98
BC434A Control Box/BC433	Used	1.95
BC458 Transmitter	New	8.95
BC602A Control Box/SCR522	Used	.39
BC778 Gibson Girl	Good	3.95
BC958-121 Xmitter 100-156 MC	New	39.50
BC1016 Tape Recorder	New	459.50
BC1206A Beacon Receiver	Good	4.95
CF1 Navy Unit w/200KC Crystal	New	14.95
DM 19 Dynamotor 12v DC in 500v 200 MA Cont. Out	Good	4.95
EE8 Foundation Unit	Good	4.95
MN26C Compass Receiver	Good	24.95
M110 Dynamic Chest Mike	New	3.95
PE94 Dynamotor/SCR522	Good	1.98
PE97A Vibrator Power Supply	New	6.95
PE104 Vibrator Supply	Excellent	24.95
R89/ARN5 Receiver	New	9.95
R89/ARN5 Receiver Less Tubes, Covers	Good	4.95
SCR518 Altimeter Complete	New	39.95
T17 Carbon Mike	New 1.98 Used	1.29
TU25 Tuning Unit/BC223	New	1.79

FILTER CHOKES HI V INS

.025 HY @ 1.36A	$1.98
.05 HY @ 15A	7.95
.065 HY @ 2.5A	2.49
.1 HY @ 5A	6.95
2 HY @ 175 MA	1.49
3 HY @ 50 MA	.39
3/30 HY @ 250 MA	3.65
5 HY @ 70 MA/.2 HY 350 MA Duel	2.39
5.3 HY @ 775 MA	9.95
10 HY @ 55 MA	.89
10 HY @ 100 MA	1.49
10 HY @ 200 MA	$2.15
10/20 HY @ 85 MA	1.49
13 HY @ 130 MA	1.55
13 HY @ 250 MA	2.95
14/3.5 HY @ 40/400 MA	6.95
15 HY @ 25 MA	.59
15 HY @ 70 MA	1.15
26.5 HY 125 MA	1.98
200 HY @ 10 MA	2.95
325 HY @ 2 MA	2.95
600 HY @ 1 MA	2.95

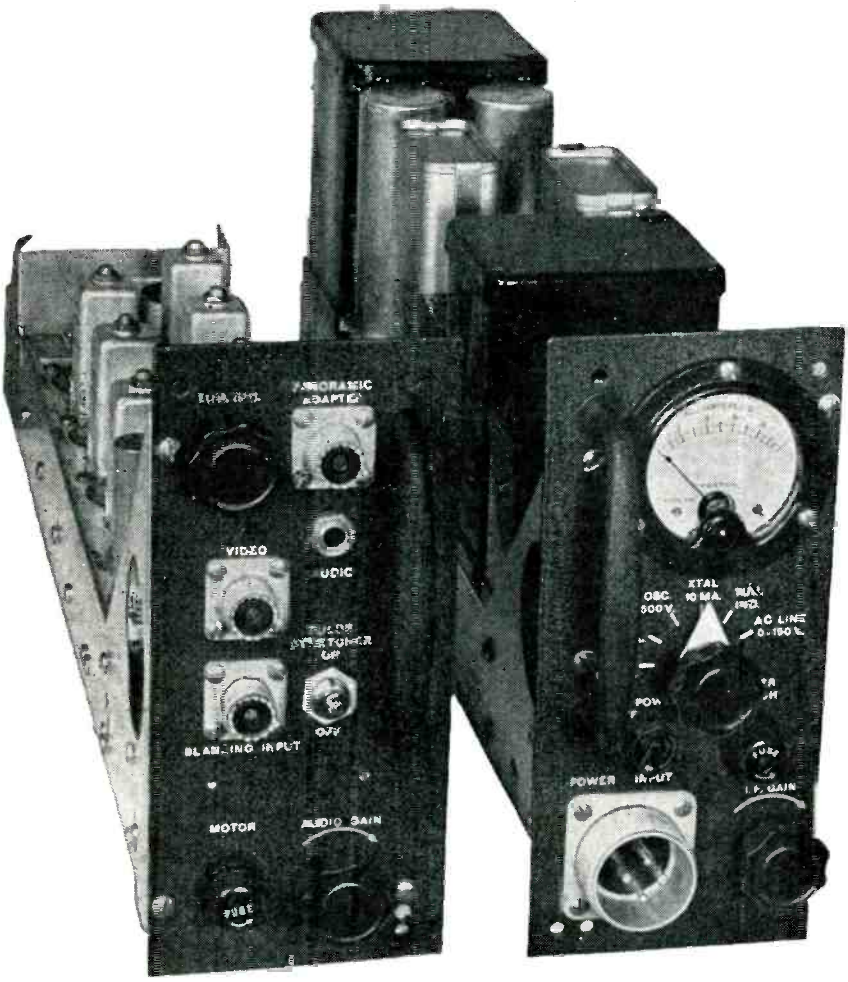
RADIO HAM SHACK Inc.
189 GREENWICH STREET . NEW YORK, N. Y.

PHONE DIGBY 9-0347

WRITE FOR QUANTITY PRICES

Prices subject to change without notice. F.O.B. NYC, minimum order $10.00. 20% deposit required. All merchandise guaranteed.

TEST EQUIPMENT



30 MC I.F. STRIP, VIDEO, and AUDIO AMPLIFIER AND 110 Volt 60-2600 cps POWER SUPPLY, Bandwidth 10 mc, new, part of APR-5 Receiver . . . . $65.00 less tubes

AMPLIFIER STRIP AM-SSA/SPR-2 contains I. F. amplifier, detector, video amplifier, pulse stretcher and audio amplifier and Rectifier Power Unit PP-155A/SPR-2 bandwidth 10 mc, center frequency 30 mc, sensitivity 50 microvolts for 10 milliwatts output. Power supply 80/115 V ac, 60-2600 cps 1.3 amps.

K Band Test Load low power. . . .**$20.00**

X Band Below Cut-Off Wave Guide Attenuator, with calibrated dial, type N input connector, output connects to ½" x 1" wave guide **$55.00**

X Band Test Load, low power. . . .**$15.00**

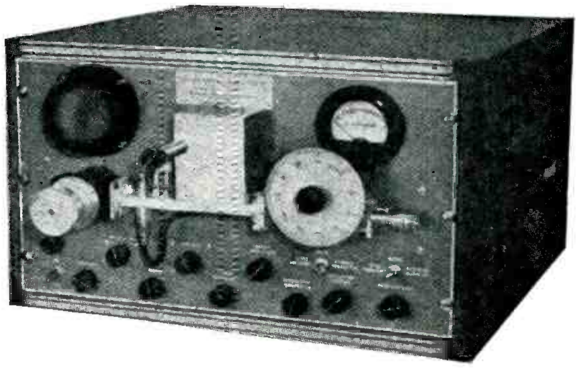
TS-62 X Band Echo Box with r.f. cable and pick-up antenna.

TS-33 X Band Frequency Meter, 8500-9600 Mcs. Crystal detector and 50 micro-amp. meter. Indicates Resonance. Connection for scope available.

TS-125 CALIBRATED S BAND POWER METER with attenuator.

TS-155 S BAND SIGNAL GENERATOR and Power Meter.

APR-1 or APR-4 Radar Search Receiver, 30 mc I.F., 2 mc wide.



Tuning Units For APR-1 or APR-4 Receivers (can be used with any 30 mc amplifier):
TN-19, range 1000-2000 mc, tuned mixer cavity **$150.00**
TN-54, range 2000-4000 mc, tuned mixer cavity **$150.00**

TS-110 S Band Echo Box 2400-2700 mc, portable **$110.00**

TS-184 Echo Box and Attenuator for APS-13

TS-170 Test Oscillator for ARN-5

TS-226 Peak Power Meter for APS-13

TS-89 Voltage Divider for measuring high video pulses, ratios, 1:10 and 1:100, transmission flat within 2db 150 c.p.s. to 5 mc., with cable for attaching to syndroscope.

Waveguide Below Cut-off Attenuator L-101-A U.H.F. Connectors at each end, calibration 30-100 db. **$10.00**

X Band Test Load, 50 watts, average power, ½" x 1" waveguide, Sand load **$35.00**

HI POWER X BAND TEST LOAD, dissipates 280 watts of average power for ⅛" x 1¼" waveguide, VSWR less than 1.15 between 7 and 10 KMC. . .**$150.00**

HI POWER S BAND TEST LOAD, dissipates 1000 watts of average power, for 1½" x 3" wave guide. Range 2500 to 3700 MC.

TS-45A/APM-3 Signal Generator, 9200-9600 mc, 110 V, 60-800 cps.

TS-35/AP X Band Signal Generator, pulsed, calibrated power meter, frequency meter, 8700-9500 mc.

X Band VSWR Test Set TS-12/AP, complete with linear amplifier, direct reading VSWR meter, slotted waveguide with gear driven traveling probe, matched termination and various adapters, with carrying case.

Standard Signal Generator Measurements 65B, 100 kc to 30 mc, 1-2,000,000 micro-volts, good working order. **$400.00**

S Band Mixer, tunable by means of slider type N connector for the R.F. and local oscillator input, U.H.F., connector for the I.F. output, variable oscillator injection **$30.00**

X Band Spectrum Analyzer 8500-9600 Mc., calibrated linear below cut-off attenuator, calibrated frequency meter, tuned mixer, 4 i.f. stages, 3 video stages overall gain 125 db., regulated power supply.

S Band Spectrum Analyzer 2700-3400 Mc., similar to above.

ELECTRO IMPULSE
LABORATORY

P. O. Box 250 Eatontown 3-0007 Red Bank, N. J.

Reliance Specials

WIRE WOUND PRECISION RESISTORS, 1% OR BETTER

1/4 WATT—25c

6.68Ω	12.32Ω	16.37Ω	125Ω	414.3Ω
10.48	13.02	62.54	147.5	705
10.84	13.52	79.81	220.4	2193
11.25	13.89	105.8	301.8	59,148
11.74	14.98	123.8	366.6	100,000

1/2 WATT—25c

.250Ω	1.53Ω	75Ω	260Ω	4,000Ω	8,500Ω
.334	2.04	90	270	4,451	14,825
.444	11.1	97.8	298.3	5,000	15,000
.502	13.15	100	400	5,900	15,750
.557	18.75	125	723.1	6,500	17,000
.627	46	180	2,500	7,000	30,000
.76	52	210	2,850	7,500	37,000
1.01	55.1	235	3,427	8,000	79,012
					100,000

1 WATT—30c

1.01Ω	5.21Ω	270Ω	9,000Ω	55,000Ω
2.58	10.1	3,300	18,000	65,000
3.39	10.9	7,000	20,000	60,000

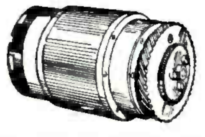
1 WATT—40c

100,000Ω	128,000Ω	320,000Ω	600,000Ω
120,000	130,000	522,000	700,000

1 Megohm—1 Watt 1%—65c; 5%—40c

Orders for 100 precision resistors—10% Discount

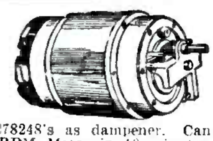
SELSYNS



115 V., 60 Cyc.
#C78248
3⅝" dia. x 5⅜" long
$8.50 pair

Mounting Brackets — (Bakelite) for selsyns, and differentials shown above................35¢ pair

DIFFERENTIAL



115 V., 60 Cyc.
#C78249
3⅝" dia. x 5⅜" long
$2.95 ea.

Used between two #C78248's as dampener. Can be converted to 3600 RPM Motor in 10 minutes. Conversion sheet supplied. (Converted).....$3.50

JONES BARRIER STRIPS

Type	Price	Type	Price	Type	Price
2–140Y	$0.10	4–141¾W	.25	3–142	.17
2–140¾W	.11	5–141	.22	3–142Y	.23
3–140¾W	.15	5–141¾W	.30	4–142¾	.30
8–140W	.36	5–141Y	.30	5–142	.26
9–140¾W	.40	7–141	.29	5–142¾W	.37
10–140¾W	.44	7–141¾W	.41	8–142¾W	.57
11–140¾W	.48	7–141Y	.41	10–142¾W	.71
12–140¾W	.53	8–141	.33	11–142Y	.78
13–140	.40	8–141¾W	.47	14–142	.68
14–140Y	.61	9–141¾W	.52	2–150	.31
2–141	.10	9–141Y	.52	2–150¾W	.38
3–141¾W	.19	10–141Y	.58	3–150	.44
3–141W	.19	15–141Y	.85	4–150	.57
4–141W	.25	17–141Y	.96		

METERS

Brand New—Guaranteed

0–1 Amp. RF, 2½"................$3.29
0–300 V. D. C., 2½"................3.50
0–500 Microamp, 2½"................3.85
0–7.5 V. A. C., 3½"................3.46

VERNIER DIAL (From BC-221)

2⅝" Dia. 0-100 in 360°. Black with silver marks. Has thumblock................85c

UNIVERSAL JOINT
3/16" hole x 3/8" O.D.
1 1/8" long
Steel or Aluminum
50¢

PRECISION CAPACITOR

D-161270. 1 mfd @ 200 VDC: —40° to +65°C....$8.50

CAPACITORS

POSTAGE STAMP MICAS

MMF	MMF	MMF	MMF	MMF	MFD	MFD
5	43	100	250	580	.0013	.0051
8.2	47	110	300	600	.00136	.006
10	50	120	330	620	.0015	.0062
15	51	125	350	680	.001625	.0065
20	56	130	370	750	.002	.0068
22	60	150	390	800	.0025	.007
24	62	160	400	820	.0026	.0075
25	68	175	430	910	.0027	.008
30	75	180	470	MFD	.003	.0082
35	82	200	500	.001	.0033	.009
39	85	220	510	.0011	.0047	.01
40	90	240	560	.0012	.005	

Price Schedule

5 MMF to .0011 MFD................5¢
.0012 MFD to .002 MFD................7¢
.0023 MFD to .009 MFD................12¢
.01 MFD................18¢

SILVER MICAS

MMF	MMF	MMF	MMF	MMF	MMF	MFD
8	45	115	260	450	750	.0027
10	50	120	270	466	800	.00282
18	51	125	300	470	815	.002826
20	60	130	325	488	820	.003
22	62	150	330	500	875	.0032
23	66	180	360	510	MFD	.0039
24	68	200	370	525	.001	.005
30	75	208	390	560	.0012	.0051
33	82	225	400	660	.001625	.0056
39	100	240	410	680	.0022	.006
40	110	250	430	700	.0023	.0068
					.0024	.0082

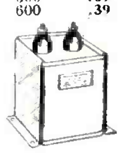
Price Schedule

8 MMF to .001 MFD................10¢
.0012 MFD to .0027 MFD................20¢
.00282 MFD to .0082 MFD................50¢

OIL FILLED

MFD	V. D. C.	Price	MFD	V. D. C.	Price
.25	20,000	$15.75	1	2,000	$.95
.03	16,000	1.95	3	1,000	.80
.375 @	16,000 and		2	1,000	.65
.75 @	8,000	5.95	1	800	.39
.1	7,500	1.55	4	600	.69
.1–.1	7,000	1.55	2	600	.39
.01	6,000	.95			
.03–03	6,000	1.25			
.02–.02	7,000	1.25			
1	6,000	5.25			
2	4,000	2.25			
.25	3,000	1.10			
.2	750 AC	.49			
8	2,000	4.85			
4	2,000	3.95			

2 mfd
4,000
V.D.C.
G.E.
SPECIAL
$2.25



PRECISION CONTROLS

6 WATT

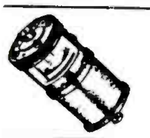
20,000Ω	Muter	314A	$1.70
6,000	De jur	260	1.70
6,000	Muter	314A	1.70
5,000	Muter	314A	2.50
2,000	De jur	260	1.70

12 WATT

10,000	Muter	471A	$2.00
10,000Ω	De jur	271T	2.00
5,000	De jur	271T	2.00
100K	GR	471A	2.75

4 WATT

200Ω	GR	301	$1.25
500Ω	Centralab	48–501	1.00
50	De jur	292	1.00
20	De jur	292	1.00
12	GR	301	1.10
12	De jur	292	1.00
2	GR	301	1.25



2J1G1 SELSYNS

BRAND NEW
400 Cycle
Can be used on 24 V.D.C. or 110 V.A.C.
$1.65

3AG FUSES

AMP	Per 100	AMP	Per 100	AMP	Per 100
⅛	$4.00	1	$2.50	5	$2.50
¼	4.00	1½	2.50	10	3.00
½	4.00	2	2.50	15	3.00
¾	4.00	3	2.50	20	3.00

Fuse Holder—for 3AG Fuse. (Littlefuse or Buss).....25c

4AG FUSES

AMP	PER 100	AMP	Per 100	AMP	Per 10
1/10	$4.00	2	$2.00	10	$2.5
1/4	3.50	3	2.00	15	2.5
1/2	3.50	3.2	2.00	20	2.5
1	2.00	5	2.00	25	2.5
				30	2.5

Fuse Holder—for 4AG Fuse. (Littlefuse of Buss)....18¢

Wrapped—BALL BEARINGS—New

Mfg	ID	OD	Width	Price
Fafnir 33K5	3/16"	1/2"	5/32"	$0.25
Fafnir K8A	1/2"	1 1/8"	5/16"	.60
N.D. 5202C13M	1/2"	1 3/8"	1/8"	1.00
Fafnir 7308W	1 37/64"	3 9/16"	5/16"	2.00
SKF466430	6"	8"	1"	5.00
Fafnir 545	2 1/16"	2 5/8"	15/32"	1.00

NEEDLE BEARINGS

B108 1/2" wide	5/8"	13/16"	30¢
GB34X 1/4" wide	3/16"	11/32"	25¢

ALLEN SET SCREWS

4–40 x 1/8 8–32 x 1/8 8–32 x 5/16
4–40 x 3/16 8–32 x 3/8
ALL SIZES................$1.50 per 100

POWER TRANSFORMER

Pri., 110/220/440 V.; Sec., 2 windings each 300 V., 4 Amp................$10.95

SELENIUM RECTIFIERS

Full wave—200 ma., 115 V................$1.57
Half wave—100 ma., 115 V................72

TIME DELAY RELAY

Raytheon CPX 24166 KS 10193-60 Sec. • 115 V., 60 Cycle • Adj. 50-70 Seconds • 2½ second recycling time—spring return • Micro-switch contact. 10A. • Holds ON as long as power is applied • Fully cased • ONLY................$6.50

DELAY NETWORK—ALL 1400Ω

T 113—Approx. 1.2 micro sec. delay................85c
T 114—Approx. 2.2 micro sec. delay................85c
T 115 Similar to T 114 with tap brought out................85c

Get On Our Mailing List!

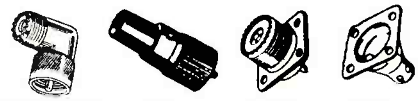
COAXIAL CABLES

GUARANTEED!! NEW!!

	Ohms	Price per 1,000 ft		Ohms	Price per 1,000 ft
RG-5/U	53.5	$70	RG-29/U*	53.5	$50
RG-6/U	76	150	RG-34/U	71	175
RG-7/U*	97.5	65	RG-35/U	71	450
RG-8/U*	52	60	RG-37/U	55	40
RG-9/U*	51	135	RG-39/U	72.5	180
RG-10/U	52	125	RG-41/U	67.5	550
RG-11/U*	75	120	RG-54/U	58	65
RG-13/U*	74	125	RG-54/AU	54	75
RG-15/U	76	160	RG-55/U	53.5	65
RG-18/U	52	450	RG-57/U*	95	100
RG-21/U	53	100	RG-58/U*	53.5	50
RG-22/U*	95	110	RG-59/U*	73	40
RG-24/U	125	240	RG-62/U*	93	50
RG-25/U	48	575	RG-74/U	52	250
RG-26/U	48	75	RG-77/U*	48	100
RG-27/U	48	290	RG-78/U	48	80
RG-28/U		160			

*No minimum order—others 250′ minimum
Add 25% for orders less than 1,000 feet

COAXIAL CABLE CONNECTORS



Angle Adapter	Plug	Socket	Hood
15¢	35¢	35¢	9¢
M-359	PL-259A	SO-239	83-1H
83-1AP	83-1SPN	83-1R	

Adapter for PL-259 A for use on small coax.
12¢ each................$10.00 per 100

83-1AC	$0.42	UG-22/U	.86	UG-87/U	.68
83-1J	.80	UG-23/U	.63	UG-102/U	.60
83-1RTY	.45	UG-24/U	.60	UG-103/U	.48
83-1SP	.35	UG-25/U	.60	UG-104/U	.85
83-1T	1.12	UG-27/U	.60	UG-167/U	2.00
83-22AP	.72	UG-28/U	2.10	UG-171/U	1.33
83-22F	.88	UG-29/U	.83	UG-175/U	.15
83-22F	.48	UG-30/U	.94	UG-176/U	.15
83-168	.15	UG-33/U	14.80	UG-180A/U	3.82
83-185	.15	UG-34/U	12.80	UG-191/AP	.57
UG-7/AP	2.14	UG-36/U	12.80	UG-197/U	1.33
UG-12/U	.63	UG-37/U	12.80	UG-206/U	.58
UG-13/U	.60	UG-58/U	.57	UG-255/U	.82
UG-18/U	.63	UG-59/U	.60	UG-264/U	1.74
UG-19/U	.73	UG-61/U	.60	UG-281/U	.60
UG-21/U	.67	UG-85/U	.62		

PULSE TRANSFORMERS

X 124 T2, UTAH, marked 9262, 9340, small gray case. Ratio 1:1:1; hypersil core................$2.75
D161310, 50 Kc to 4 Mc. 1¾" dia. x 1⅞" high. 120 to 2350 ohms................$1.50
352-7178—Spec. 10, 111 Chicago Trans. equivalent to 9262 (above)................$1.50
D-166638 W. E. Permalloy core, Semi-toridal windings................$1.25
KS9800, Ratio, 1:1:1, 2:1, Freq. range 380 to 520 C.P.S................$3.50
D106173, W.E. Freq. resp. 10KC to 2 MC................$9.80
800 KVA G.E. #2731, 28,000 Volt peak output: Bilifar; one microsecond pulse width................$28.50

HAYDON TIMING MOTOR

4 R.P.M., 115 V., 60 Cycle................$1.79

SOUND POWERED HANDSET

Brand New!
Includes 6 ft. cord. No batteries or external power source used.
$8.92 ea. — $17.60 pr.

CERAMICONS

2 MMF	30 MMF
5.6	35
10	39
12	45
15	62
20	82
22	150
	200

$4.50 per hundred

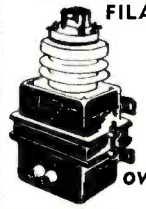
CHOKE

400 MA
12 Hy.
90 OHM
HIGH
VOLT
TEST
$3.85
10 for $34.00

FILAMENT TRANSFORMER

Pri., 115 V., 60 Cyc.—Sec., 5V., 115 A. 6000 volt insulation................$9.95 each

FILAMENT TRANSFORMER



Amertran Type WS

For High Voltage Rectifiers. PRI. 115V., 60/60 Cycle.

SEC. 5V., C/T @ 10 Amp.

35 KV R.M.S. Test 12 KV D.C. Operating. Uses 872 Tube or other tubes.

NEW OVERSEAS PACKED **$10.95**

872-A Tube...... **$1.88**

Minimum Orders $3........All orders f.o.b. PHILA, PA.

RELIANCE MERCHANDIZING CO.

Arch St. Cor. Croskey Phila. 3, Pa. *Telephone RIttenhouse 6-4927*

GENERAL ELECTRIC TUBE SPECIALS

Brand New Mfd. by G.E.

12GP7	12.85	FG-95	20.60	GL-415/ 5550	22.00
1P24	.79	FG-105	10.95	8020	1.39
FG-32	4.25	FG-172	19.50	189048	3.79
FG-33	11.95	FG-190	12.15	189049	3.79
FG-81A	4.95	2C39	13.50		

GENERATORS

- Eclipse-Pioneer type 716-3A (Navy Model NEA-3A) Output—AC 115V 10.4A 800 to 1400 cy 1 ϕ DC 30 Volts 60 Amps. Brand New — Original Packing $38.50
- Eclipse-Pioneer type 1235-1A. Output—30 Volts 15 Amps. Brand New—Original Packing......$9.50

PIONEER SERVO SYSTEM UNITS

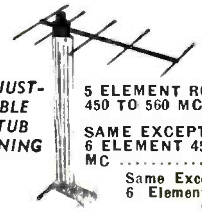
- Type 12073-1A Torque Amplifier, Input 115 V 400 cy. Complete with Tubes.................$14.95
- Magnetic Amplifier Assy. Saturable Reactor Type to supply one phase of 400 cycle Servo Motor $5.95

COAXIAL CABLE

RG-8/U—$60.00 per 1000 ft.—Other types in stock

SPRAGUE PULSE NETWORKS

7.5 E3-1-200-67P, 7.5 KV, "E" Circuit 1 microsec. 200 PPS, 67 ohms imped. 3 sections........$4.30
7.5 E3-3-200-67P, 7.5 KV, "E" Circuit 3 microsec. 200 PPS, 67 ohms imped. 3 sections........$6.75
7.5 E4-16-67P, 7.5 KV, "E" Circuit 4 sections. 16 microsec. 60 PPS, 67 ohms imped........$8.25
15—E4-1.5-600-50P, 15 KV "E" Circuit 1.5 microsec. 600 PPS, 50 ohms imped. 4 sections..$12.00
15—E6-5-180-50P, 15 KV, "E" Circuit 5 microsec. 180 PPS, 50 ohms imped. 6 sections......$25.00



ASB YAGI ANTENNA

ADJUSTABLE STUB TUNING

5 ELEMENT ROTATABLE ARRAY—450 TO 560 MC **$7.00**

SAME EXCEPT DOUBLE STACKED 6 ELEMENT 450 TO 560 MC **$12.70**

Same Except Double Stacked 6 Element 370 to 430 MC **$29.40**

Double stacked antennas can be supplied with hydraulic remote controls at $29.50 per set additional.

SELENIUM RECTIFIER STACKS

FULL WAVE BRIDGE

MAXIMUM RATINGS AC VOLTS INPUT 18, DC VOLTS OUTPUT 14.5		MAXIMUM RATINGS AC VOLTS INPUT 40, DC VOLTS OUTPUT 34	
1.2 Amps	$2.64	0.6 Amps	$3.00
2.4	3.07	1.2	3.44
6.4	4.09	3.2	5.15
13.0	7.67	6.0	9.32
17.5	8.69	9.0	10.05
26	15.33	12	18.64
39	23.00	18	20.12
52	30.67	24	35.96
65	38.33	36	41.24

All voltage and current ratings based on continuous operation in 35°C. (95°F.) ambient, self-cooled. Current ratings can be increased up to 2½ times normal ratings by intermittent operation or forced cooling.

PULSE TRANSFORMERS

UTAH 9262....................$2.75
UTAH 9278....................$2.75
G. E. 68G-627....................$4.75
AN/APN-9 (901756-501)....................$1.50
AN/APN-9 (901756-502)....................$1.50
AN/APN-4 Block, Osc....................$1.25

W. E. MERCURY CONTACT RELAYS

Glass sealed mercury wetted SPDT contact assemblies. Magnetically operated. Used in Western Electric D-168479 high speed plug in relays. Supply your own coil ....$2.00 each

CONSTANT VOLTAGE TRANSFORMERS

Federal Constant Voltage Transformer Input 95-135V 50/60cy Output 115V 210W....................$34.00
Raytheon VR-5 Constant Voltage Transformer Input 95-130V 60cy-Output 115V 500W..............$38.50
Sola Constant Voltage Transformer Input 95-125V 60cy-Output 15.8V 285VA....................$24.70
Sola Constant Voltage Transformer Input 105-125V 60cy-Output 115V 80VA....................$15.95

TYPE "J" POTENTIOMETERS

75¢ each

Resis.	Shaft	Resis.	Shaft	Resis.	Shaft
100	SS	10K	SS	100K	5/16"
200	SS	15K	½"	100K	⅜"
500	½"	15K	SS	100K	7/16"
650	½"	20K	SS	100K	SS"
5000	⅜"	25K	1½"	150K	½"
6500	SS	25K	SS	200K	SS
10K	⅜"	30K	1⅛"	250K	SS
10K	½"	50K	SS	1 MEG	SS

Triple 100K - ⅜" Shaft - 1.47
All shaft lengths beyond bushing - SS (screw slot)

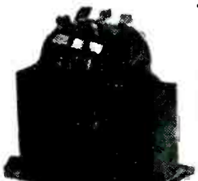
STANDARD BRANDS ONLY

TUBE SPECIALS

BRAND NEW FIRST QUALITY

COMPLETE STOCK OF RECEIVING, TRANSMITTING, CATHODE RAY, THYRATRON, IGNITRON, MAGNETRON, KLYSTRON, PHOTOCELL, T-R & ATR TUBES.
QUOTATIONS UPON REQUEST

WESTINGHOUSE HYPERSIL TRANSFORMER



PRI-115V. 60CY ¾ KVA
SEC #1 - 240V - 1.56A
SEC #2 - 240V - 1.56A
WT. 30 LBS.

$11.50 EACH

KOLLSMAN INSTRUMENT

LOW INERTIA SERVO MOTORS

Type 937-0240—85/68 Volts—100 Cycles
2 Phase—5 Watts—2650 RPM
Will Operate Satisfactorily at 60 Cycles
Original Price $34.50—Our Price—$8.22 ea.

$7.50 EACH—Lots of 10

SOUND POWERED TELEPHONES

- U. S. INSTRUMENT Type A-260
- WESTERN ELECTRIC Type D-173013
- AUTOMATIC ELECTRIC Type GL-832BA0

U. S. NAVY TYPE M HEAD AND CHEST SETS

These are high quality heavy-duty units not to be confused with cheaper units now available. Designed to withstand exacting shock, vibration, salt water corrosion, temperature and pressure tests. ANY TYPE $14.88 ea., $28.00 per pair.
TS-10 Handsets ....$8.92 each

MISCELLANEOUS EQUIPMENT

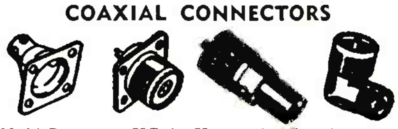
ID-6APN-4 Indicator $29.50
R-7/APS-2 Receiver 49.50
R-78/APS-15 Receiver 49.50
SCR-522 Transceiver 32.50
RT-7/APN-1 Transceiver 8.95
FL-8 120 cycle filter.......................... 1.37
RM-29 remote control unit.......................... 8.95
RM-14 remote control unit.......................... 8.95
RTA-1B 12/24 V dynamotor.......................... 30.00
BC-1206 Receiver 6.95
A1A Antenna—3cm conical scan..........................120.00
AT-38A/APT antenna (70-400 MC).......... 13.70
AT-49/APR-4 antenna (300-3300 MC).......... 13.70
CY-230/MPG-1 Radar Console..........................575.00
G.E. Type JP-1 portable current transformer.. 32.50
AT-8/AP Antenna 3.95
ASB-4 Radar equip. Complete.......................... 69.75
DZ-2 loop antenna with pedestal.......................... 14.50

MONTHLY BULLETINS

SEND IN YOUR NAME AND ADDRESS TO GET ON OUR MAILING LIST

All material brand new and fully guaranteed. Terms 20% cash with order, balance C. O. D. unless rated. All prices F.O.B. our warehouse, Phila., Penna., subject to change without notice.

COAXIAL CONNECTORS



83-1AC	.42	UG-12/U	.63	UG-86/U	1.22
83-1AP	.15	UG-21/U	.67	UG-87/U	.68
83-1F	1.12	UG-22/U	.86	UG-171/U	1.33
83-1H	.10	UG-23/U	.63	UG-175/U	.15
83-1J	.80	UG-24/U	.67	UG-176/U	.15
83-1R	.35	UG-27/U	.68	UG-180A/U	3.82
83-1SP	.35	UG-29/U	.83	UG-191/AP	.57
83-1SPN	.35	UG-30/U	.94	MX-195/U	.41
83-1T	1.12	UG-34/U	12.80	UG-197/U	1.33
83-22AP	1.10	UG-36/U	12.80	UG-206/U	.58
83-22F	1.48	UG-37/U	12.80	UG-255/U	.82
83-22R	.48	UG-58/U	.57	UG-264/U	1.74
83-22SP	.85	UG-85/U	.62	MX-367/U	.15

FULL LINE OF JAN APPROVED COAXIAL CONNECTORS IN STOCK

COMPONENT SPECIALS

Fuses	4AG	10 Amp.	$3.00/c
	4AG	20 Amp.	$3.00/c

MOLDED PAPER CONDENSERS—

.02 MFD	200 VDC	.04½ Ea.	$3.00 per 100
.05	200	.04½	3.00
.1	200	.04½	3.00
.25	200	.06	4.00
.1	400	.09	6.00
.005	600	.04½	3.00
.01	600	.07	4.75
.05	600	.08	5.50

CRYSTAL DIODES—

1N21	.79	1N22	.89	1N34	.69
1N21A	1.19	1N23	1.19	1N45	.94
1N21B	2.25	1N27	1.09	1N63	1.39

Phase shift capacitor—Type D—150734—4 stator single rotor $2.69

HIGH VOLTAGE MICA CAPACITORS—

Type G-1	.004 mfd	6 KV	$6.35
Type G-3	.00015 mfd	20 KV	12.70
Type UC-3260	.0005 mfd	20 KV	6.9
Type UC-2317K	.0035 mfd	4 KV	3.10
Type UC-2938K	.002 mfd	5 KV	3.15
Type UC-3135A	.00005 mfd	35 KV	11.95

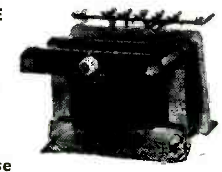
0

OIL-FILLED CAPACITORS

50 MFD	220 VAC	$3.95
60 MFD	330 VAC	$5.75
32 MFD	2500 VDC	$10.80
7 MFD	660 VAC	$2.95
3.5-.5 MFD	1000 VDC	.95
.1 MFD	7000 VDC	$1.79
.045 MFD	16 KVDC	$4.70

SPECIAL
2 MFD 12,500 VDC
INERTEEN TYPE FP
$23.95

RCA HI-VOLTAGE TRANSFORMER



Pri—115/230V. 60Cy
Sec—6000V—80 MA

$11.80

Insulated for Voltage Doubler Use

TEST EQUIPMENT

- Alfred W. Barber Labs. Mod. VM-25 VTVM * $86.00
- General Radio Model P-500A Standard Signal Generator (Same as G. R. 805A except covers 9KC to 32 MC) ....* $450.00
- TS-10A/APN Delay Line Test Set.........$25.00
- TS-19/APQ-5 Calibrator $75.0
- AT-48/UP "X" Band Horn....................$3.95
- REL W-1158 Frequency Meter 160-220 MC..$32.95
- CWI-60AAG Range Calibrator for ASB, ASE, ASV and ASVC Radars $39.95
- CRV-14AAS Phantom Antenna for Transmitters up to 400 MC....................$11.75
- TS-146/AP X-Band Test Set. Price on request.
- TS-184/AP. ....Price on request.
- CPR-60AAJ and CPR-60AAK—IFF Test Sets. (pair) $16.95
- Hewlett Packard Model 200-C Audio Oscillators (10 available) *$87.50
- C-D Quietone Filter Type IF-16 110/220 V AC/DC 20 Amps ....* $9.00

All items New Except Where Noted * (Exc. Used Condition)

FILAMENT TRANSFORMERS

(All 115V 60cy primary except where noted)

UTC herm. sealed 5V @ 1A..................1.22
UTC herm. sealed 6.3V @ 0.6A 1.33
UTC herm. sealed 6.3V @ 3.2A..................2.21
Raythoen herm. sealed 6.3VAC @ 0.6A 1.35
Raytheon herm. sealed 6.3VCT @ 3A, 6.3V @ 0.5A 2.31
G.E.—6.3V @ 13A, 6.3V @ 1.2A 3.82
Pri. 115/230V—Sec. 11V @ 15A-25KV insul. 48.00
Pri. 115$230V—Sec. 9VCT @ 35A..................7.65
Amertran—5V @ 190A—35KV insul. 19.50
6.3VCT @ 5A, 6.3VCT @ 2A, 6.3VCT @ 2A, 2½VCT @ 5A, 2½VCT @ 5A..................4.77

GENERAL ELECTRIC AMPLIDYNE Motor-Generator

Consists of G.E. 1HP 115V 1 ph 60 cy 11.5A 3450 RPM continuous duty motor coupled to G.E. model 5AM65FB31 250V DC 2A 0.5KW 3450 RPM Amplidyne generator.

Brand New $107.50

LECTRONIC RESEARCH LABORATORIES

1021-A CALLOWHILL ST. PHILA. 23, PA.

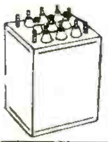
Telephones - MARKET 7-6590 and 6591

OCT. SPECIAL
WESTINGHOUSE 2" 0-500 MICROAMP PANEL METER BAKELITE CASE (VOLT SCALE) $2.95 ea.

PEAK ELECTRONICS CO.
COMPONENTS
Phone COrtlandt 7-6443 7-6486

SELECTED AND GUARANTEED SURPLUS AT A FRACTION OF ORIGINAL COST.
188 WASHINGTON ST., NEW YORK 7, N.Y.

OCT. SPECIAL
POWER TRANS. 740 Volts CT. 185 Mills 6.3V@5A,5V@4A HALF SHELL $3.49 ea.



POWER TRANSFORMER
550 volts CT, 125 ma. 5 V. @ 2 A, 6.3 V @ 4A, Pri. 117 V 60 cy. Fully cased ....$1.95 ea.

POWER SUPPLY KIT
Uses transformer described & illustrated plus (1) 150 ma. choke (1) dual oil capacitor, (1) socket. All for only $2.99

POWER TRANSFORMER
Pri. 110 V 60 cy. Sec. 880 V CT @ 100 ma. 6.3 V. @ 4 A, 5V @ 3 A. Hermetic. Seal..............$2.49 ea.

POWER TRANSFORMERS
Hermetically sealed. Pri 110 volts 60 cy.
940 volts CT, 125MA, 6.3V 8A, 6.3V, 2.5A, 6.3, 1.2A, 6.3V, .5A, 5V, 3A.................. 3.95 ea.
1110 volts CT 60 MA, 920 volts CT 160 MA, 6.3V, 18A, 6.3V, 1.25A, 5V2A, 5V2A........ 4.95 ea.
300 volts CT 300 MA, 2.5V7A, 2.5V7A, 0.3V, 1.5A 2.75
1050 volts @ 20 ma, 20V, 4A, 2.5V, 5A........ 2.75

CHOKE BARGAINS
6 Henry 50 Ma 250 Ohms, open frame......3 for .99
6 Henry 80 Ma 220 Ohms, open frame.......... .69
8 Henry 150 Ma 140 Ohms, open frame.......... .99
8 Henry 175 Ma 120 Ohms, fully saced......... 1.49
6 Henry 400 Ma 97 Ohms, fully cased.......... 3.69
4.3 Henry 445 Ma 39 Ohms, fully cased........ 4.25
10 Henry 350 Ma 125 Ohms, tapped, full case 2.95
20 Henry 36 Ma 350 Ohms, fully cased......... .69
12 Henry 250 Ma 190 Ohms, fully cased......... 2.00
5 Henry 170 Ma 110 Ohms, fully cased......... 1.35

HIGH CURRENT MICAS
Type G4 Ceramic Case 5¾" High, 5" Diameter Tolerance 5% or Better.

CAP MFD	Amps 1 Mc	KV DC	Price Each	CAP MFD	Amps 1 Mc	KV DC	Price Each
08	60	4	$27.50	.009	40	15	$29.50
.1	70	4	29.50	.01	43	15	29.50
.65	60	5	24.50	.0047	32	15	24.50
.037	45	6	26.50	.0031	26	20	29.50
.02	40	9	29.50	.004	30	22	33.50
.02	55	10	29.50	.0033	25	25	35.50
.0117	40	14	24.50	.001	12	30	26.50
.0075	39	15	24.50	.0005	9	30	26.50
TYPE G1				TYPE G2			
.00024	4	6	3.95				
.0003	4	6	3.95	.001	10	10	5.95
.0005	5	6	3.95	.002	13	10	5.95
.001	7	6	4.95	.01	25	7	6.95
.002	11	6	4.95				

PANEL METER KIT
Consists of:
- 2" 0-50 Ma, Gov't Surplus Meter, Square Case.
- 4 Scales for the following Ranges: 0-50 Ma, 0-100 Ma, 0-200 Ma, 0-500 Ma.
- Precalculated Shunt Sizes.
- Complete Data and Instructions.

All for $2.50

BAKELITE CASED MICAS

MMF	VDC	Price	MMF	VDC	Price
D .001	600	$ .18	C .002	3 KV	.95
E .01	600	.26	D .005	3 KV	.70
D .02	600	.26	C .005	3 KV	1.24
E .027	600	.26	C .006	3 KV	1.50
C .01	1 KV	.45	D .002	3 KV	.70
D .02	1200	.35	C .0001	5 KV	.70
C .024	1500	.65	C .0005	5 KV	.85
C .033	1500	.75	C .0015	5 KV	1.60
C .015	2 KV	.80	C .003	5 KV	1.90
C .02	2 KV	.90	C .005	5 KV	2.50
D .002	2500	.45	C .002	6 KV	2.90
E .005	2500	.55	B .002	8 KV	5.95
C .025	2500	1.25	B .0005	8 KV	2.90
C .001	3 KV	.90	B .0012	8 KV	4.50

SCR 522 TRANSMITTER RECEIVER
Complete with tubes and separate Dynamotor Power Supply. Excellent condition $36.50

MOTOR & GEAR BOX
Type RL42B, Motor 24 Volts DC, ⅛ HP—1 min. with Gear Reduction Box..................$2.25 each

NON INDUCTIVE RESISTORS
250 Ohm 100 Watt.. .75
500 Ohm 100 Watt.. .75
12500 Ohm 150 Watt...................................... .95

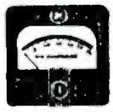
METER MULTIPLIERS
2 Meg 1/5 of 1% Cage Enclosed 2 KV.........$3.95
2 Meg 1/2 of 1% Tubular 2 KV.............. 1.95
4 Meg 1/2 of 1% Tubular 4 KV.............. 3.75

HEAVY DUTY CERAMIC RF SWITCH
Single Pole 11 pos.............................. .99 ea.

UTC type PA 5000 ohm plate to 500 ohm line and 6 ohm voice coil. 10 watt. 60 to 10,000 cps +1 DB. ....CLOSE OUT AT $1.99

PRECISION 1% W.W. RESISTORS
Ohms: 2K, 5K, 8500, 50K, 95K.............. .25 ea.

PANEL METERS
BRAND NEW GOVERNMENT SURPLUS



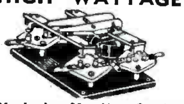
2" Simpson 0-200 microamp, Mile scale........$4.50
2" Simpson 0-5 Ma, Basic, square............ 2.25
2" GE 0-5 Ma, amp. scale.................... 1.95
2" Simpson 0-20 Ma, amp scale............... 1.75
2" Sun 0-25 Ma, 0-100 scale................. 1.75
2" GE 0-50 Ma............................... 2.45
2" Sun 0-50 Ma, 0-100 scale, square......... 1.95
2" GE 0-250 Ma, AC.......................... 2.95
2" GE 0-1 amp RF, internal thermo........... 1.95
2" Simpson 0-2 Amp RF, internal thermo...... 1.95
2" GE 0-4 amprf., internal thermo........... 1.95
2" Westinghouse 0-9 AMPRF, int. thermo...... 1.95
2" Sun 0-20 volts DC........................ 1.75
2" Weston 0-20 volts DC..................... 2.45
2" GE 0-30 volts DC 1000 ohms per volt...... 2.75
2" GE 0-25 volts AC, 0-100 scale, Linear.... 2.95
2" Triplett 0-300 volts AC.................. 2.95
2" GE 0-38 Amps DC.......................... 1.95
3" WESTON 0-20 UA Mod. 301, spcl scale.....12.50
3" WESTON 40-0-40 UA Mod. 301, spcl scale... 8.75
3" GE 50-0-50 microamps square.............. 8.75
3" GE 6-75 Microamps Sq..................... 9.95
3" McClintock 0-1 Ma 10-10 scales........... 4.50
3" Westinghouse 0-1 MA (KV scale)........... 4.50
3" Westinghouse 0-2 MA...................... 3.95
3" Simpson 0-2 Ma........................... 3.95
3" GE 0-5 Ma square......................... 3.95
3" Westinghouse 0-10 Ma (Amp scale)......... 2.75
3" GE 0-10 Ma, square....................... 3.95
3" Westinghouse 0-15 Ma..................... 3.95
3" Westinghouse 0-20 Ma..................... 3.95
3" Simpson 0-20 Ma.......................... 3.95
3" GE 0-20 Ma, square....................... 3.95
3" GE 0-30 Ma, square....................... 3.95
3" GE 0-50 Ma, square....................... 3.95
3" Western Electric 0-80-Ma................. 2.95
3" GE 0-100 Ma square....................... 3.95
3" GE 150 Ma square......................... 3.95
3" GE 0-200 Ma, square...................... 3.95
3" GE 0-300 Ma, square...................... 3.95
3" GE 0-1 Amp DC............................ 3.95
3" Westinghouse 0-2 Amp. DC................. 3.95
3" GE 0-2 Amps. DC square................... 3.95
3" Weston 0-1 Volt DC....................... 3.95
3" Dayton-Acme 0-30 volts DC................ 2.50
3" GE 0-300 volts DC (1000 ohms/v).......... 4.50
3" Westinghouse 0-750 V DC (1000 ohms/v).... 4.50
3" GE 0-800 volts DC (1000 ohms/v) sq....... 4.50
3" GE 0-15 volts AC square.................. 3.95
3" GE 0-300 volts AC square................. 4.95
3" GE 0-3 KV, DC, with Multiplier........... 7.95
3" GE 0-5 KV, DC, with Multiplier........... 8.95
4" McClintock 0-200 micro amp, Meg scale.... 9.95
4" GE 0-200 Micro amp illuminated scale..... 9.95
4" GE VU Meter, —20 to +3..................16.95
4" GE 0-300 volts AC........................ 5.95
4" GE 0-8 KV DC with Multiplier.............10.75
6" GE 0-1.5 Amps DC Model 8DB............... 6.50
6" GE 0-10 Amp. DC Model 8DB................ 6.50
6" GE 0-15 Amps. DC. Model 8DB.............. 6.50
6" GE 0-25 amps DC., Model 8DB.............. 6.50
6" GE 0-20 volts AC, model 8AB.............. 6.50
6" GE 0-12 KV DC, with Multip., Mod. 8DB..11.95

LINK TEST SET
Type #1410. Contains two 3½" meters—a 75-0-75 microamp Galvanometer and a 0-1 MA multi-scale meter. Has tap switch for changing range, Ranges are as follows: 75-0-75 microamps, 1 MA 2.5 MA, 50 MA, 25 volts, 500 volts. Ideal for balancing discriminators and general lab use. Housed in hard wood case with hinged cover. 10" x 8" x 4½". Only ....$14.95 ea.

MOSSMAN SWITCHES
4 Pole Single Thow.. .95

GUARDIAN LATCHING RELAY
Type RC 100. 110 volt 60 cycle coil. S.P.D.T. each impulse reverses the position of the contacts. Locks automatically. Contacts rated 1500 watts at 110V 60 cycles. Size 3" long, 2⅛" wide. 1½" high. Only ....$1.95 ea.

HIGH WATTAGE ANTENNA RELAY



110/220 volt 60 cycle Solenoid. D.P.D.T. rated at 5000V. 15A. Heavy duty parelleled contacts. Sturdy construction. Isolantite Insulation. Base 8" x 10½".
Made by Monitor Controller.....................$18.50
Same specs. as above but DPST.................. 12.50
Same specs. as above but SPDT.................. 12.50

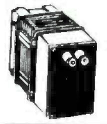
SENSITIVE RELAY

Breaks at 3 MA. Beautifully Constructed and delicately pivoted. Approx. 2000 ohms resistance. Housed in dustproof aluminum can. Plugs into 5 prong socket. Only ....99¢ ea.

500 MICROAMP RELAY
Delicately balanced, S.P.D.T., 10,000 ohm coil Trips at .4 to .5 MA. 2⅝" x 2⅝" x 1⅝" high..$2.95

General Electric Overload Relay. Electrical Reset 110 Volts 60 Cycle
Breaks at 640 Milliamps but easily adjustable for other currents. Terrific values at only..........$1.95

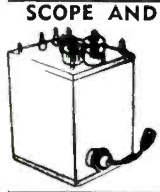
SOLA CONSTANT VOLTAGE TRANSFORMER
2 KVA. 17.4 Amps. Input 95-125 Volts, 60 Cycles, 1 Phase. Output 115 Volts. Type 4, 31⅛" long, 9½" H, 7⅞" W. Weight 225 Lbs......$137.50 each



RAYTHEON SWINGING CHOKE
2 to 12 Henrys. 1 Amp to 100 Ma, 15 Ohms DC fully cased. High voltage insulation, ceramic insulators. Very conservatively rated. Weight 60 Lbs. $14.95 ea.

THORDARSON PLATE TRANSFORMER
CHT Series, Model T15P 22. 110/220 volt 60 cy. Primary: 3500V, 3000V, 2500V, 2000V C.T. Secondary: 625 watts. Weight 70 Lbs........$22.50 ea.

SCOPE AND FIL. TRANSFORMER



Pri. 115 volts, 60 cycles, Sec. 4400 volts RMS 4.5 MA., 5 volts. CT 3 amps. Fil. Ins. 15 KV. RMS test. Hermetically sealed. Has insulated plate cap for rectifier. Made by Raytheon. 4½ x 5 x 5½.............Only $4.95

Mallory Vibropack Transformer 6 Volt Input. Output 300 Volts at 100 MA.........................$3.95

WESTINGHOUSE SELENIUM RECTIFIER
Hermetically sealed. Oil Immersed Full Wave Bridge. 30 Volts AC Input. 24 Volts at 2 Amps Output. Size 2⅝x2⅝x3⅞ hl.....$3.75 ea.

50 megohm 35 watt Resistor with mount. $1.49 each; 10 for $9.90. 10 Meg 10 Watts 49¢; 2 Meg 5 Watt 35¢

30 WATT WIRE WOUND RESISTORS
Ohms: 100-2500-3k-4500-5300-18k..........8 for .99

Precision 15 Meg. 1% Accuracy Resistor, Non-inductive, 1 watt, hermetically sealed in glass .25 ea. 10 for.................................$1.90

WIRE WOUND RESISTORS
5 watt ohms: 25-50-200-470-2500............ .09 ea.
10 watt ohms: 25-40-84-400-470-1325-2K-4K .15 ea.
20 watt ohms: 50-70-100-300-750-1K-1.5K 2.5K-2.7K-5K-10K-16K-20K .... .20 ea.

SLIDER ADJUSTABLE RESISTORS
20 Watt: 1, 5, 50 Ohms........................ .25
50 Watt: 100, 500 Ohms........................ .35
75 Watt: 100, 150, 200 Ohms................... .39
100 Watt: 20, 50, 75, 120, 500 Ohms........... .49

MIDGET VARIABLE CONDENSERS
15 MMF (HF 15)................................ .39
Dual 15 MMF (HF 15 D)......................... .69
250 MMF (MC 250 S)............................ .69

CERAMICONS
MMF: 1.5, 2, 3, 8, 10, 20, 22, 120, 500...... .05 ea.

SILVER MICA CAPACITORS
MMF: 10, 47, 50, 60, 340, 750, 780, 1000.... .09 ea.

OIL CONDENSERS

56 mfd	220 vdc—3.95	10 mfd	2000 vdc—4.95
4 mfd	600 vdc— .59	2 mfd	4000 vdc—4.90
6 mfd	600 vdc— .79	4 mfd	4000 vdc—6.75
3/3 mfd	600 vdc— .79	1 mfd	5000 vdc—4.50
8/8 mfd	600 vdc—1.39	.1 mfd	7500 vdc— .95
10 mfd	600 vdc— .99	.1/.1 mfd	7000 vdc—2.25
10 mfd	1000 vdc—2.50	2 mfd	6000 vdc—9.95
2 mfd	1500 vdc—1.25	1 mfd	7500 vdc—6.50
6 mfd	1500 vdc—2.95	.01/.01 mfd	12 kv 5.75
10 mfd	1500 vdc—3.75	2 mfd	7500 vdc—12.75
2 mfd	2000 vdc—2.25	.65 mfd	12,500 vdc—12.95
8 mfd	2000 vdc—3.75	1 mfd	15 kv dc—15.95

FILAMENT TRANSFORMERS
110 V 60 CY Primaries—Full Casings.
6.3 Volts, 12 Amps..............................$1.69
2.6 Volt 10 Amp. H.V. Insulation............... 3.49
2.5 Volt CT 21 Amps............................ 4.75
5 Volt 4A, 6.3V, 3A............................ 2.45
2.5V CT 20A, 2.5V CT 20A....................... 6.95

MISCELLANEOUS BARGAINS
2 mfd 250 volts ac oil cond .... 6 for .99
Ceramicon .0005 mfd.......................20 for .99
.01 600 volt dc pigtail micas.............10 for .99
.001 600 volt dc pigtail micas............15 for .99
.006 600 volt pigtail micas...............12 for .99
Butterfly cond. 2 to 11 mmf ball brngs.... 3 for .99
CD type 4 micas .001 600vdc...............10 for .99
10,000 ohm potentiometers................. 6 for .99
Var. cond. 150 mmf .07 spacing............ 2 for .99
Variable ceramicon 20 to 125 mmf type 823 5 for .99
Western Electric silver varble .5 to 2.5 mmf 8 for .99
.35 at 16 KV plus .75 at 8 KV Oil Cond........ 3.95
.05 MFD 7500 DC Oil Cond....................... .75
7 MFD 330 VAC Oil Cond......................... .69
25 ohm 675 Watt Rheostat...................... 2.95
1 Meg. W.W. 1/5 of 1%....................... 1.50 ea.

SOLAR RT-3 RAPID TEST FIXTURE $1.49 ea.

BRAND NEW U. S. GOV'T. SURPLUS GUARANTEED

1.MFD 6000 VDCW CP70D1FP105K *List $75.95* Special $7.95

POWER RHEOSTATS

Ohms	watt	ea.	Ohms	watt	ea.
2	225	$4.95	150	150	$3.50
3	100	2.90	200	25	.98
3	225	4.95	200	150	3.50
4	225	4.95	225	50	1.24
5	50	1.24	250	25	.98
5	100	2.90	350	25	.98
5	150	3.50	350	100	2.70
6	25	.98	378	150	3.50
6	50	1.24	400	25	.98
7	25	.98	500	25	.98
8	50	1.24	500	75	2.49
10	25	.98	585	150	3.50
10	100	2.70	750	25	.98
12	25	.98	750	150	3.50
15	25	.98	1000	25	.98
16	50	1.24	1200	225	4.95
22	50	1.24	1250	50	1.24
25	25	.98	1250	150	3.50
32	300	5.25	1500	50	1.24
50	25	.98	2000	25	.98
50	50	1.24	2000	50	1.24
50	750	14.95	2500	100	2.90
60	25	.98	3000	25	.98
75	150	3.50	3000	100	2.90
80	50	1.24	3500	50	1.24
80	500	7.60	5000	25	.98
100	25	.98	5000	50	1.49
100	50	1.24	7500	50	1.63
100	225	4.95	7500	100	3.30
125	25	.98	10000	50	1.63
125	500	7.60	10000	100	3.50
150	50	1.24	20000	150	5.26

Specify whether shaft required is for knob or screwdriver adjust. (Discount to Quantity Users.)

SELECTOR SWITCHES

Pole	Pos.	Deck	Type	Each
1	6	1	Bak-shtg	.31
1	11	1	Bak-n/shtg	.50
1	12	1	Cer-n/shtg	.55
1	21	3	bak-n/shtg	.69
1	24	2	bak-n/shtg	.79
2	2	1	cer-shtg	.39
2	6	2	bak-n shtg	.49
2	8	2	bak-shtg	.54
2	11	2	bak-shtg	.60
4	4	2	cer-n/shtg	.54
4	11	4	bak-shtg	1.20
5	3	2	cer-n/shtg	.56
6	11	6	bak-n/shtg	1.98
10	5	5	cer-shtg	1.49
12	2	3	bak-shtg	.75
16	2	4	bak-n/shtg	.98

(many other types in stock)

"AN" CONNECTORS

LARGE VARIETY AVAILABLE AT GREAT SAVINGS

Send your specs and let us quote

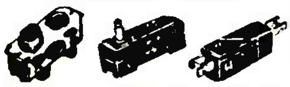
BIRTCHER TUBE CLAMPS

#926-A
#926-A1
#926-B
#926-B1
#926-B2
#926-B7

18¢

#926-B22
#926-C
#926-C1
#926-C5
#926-C10
#926-C24

MICROSWITCHES



A-#YZ-RS13 SPST 10a/125vac type "S" plunger, metal housing, normally open .49
B-#B-RS10 SPDT 10a/125vac type "S" plunger, 2-circuits: one open and one closed .49
#WZ-RL8 (not illus.) SPST 10a 125 vac leaf actuator, normally closed .49
#R-RL2T (not illus.) SPST 10a 125 vac roller plunger, normally closed .49
C-G.E. SWITCHETTE 10a/115voltsAC
#CR1070-C103A3 SPST closed .. .49
#CR1070-C103E3 SPST open .... .49
#CR1070-C103R3 SPST closed .. .49
#CR1070-C123C3 DPST op/cl .... .49
(Many other types in stock)

OIL CONDENSERS

Mfd	VDCW	Each
.1	3000	$.75
.1	6000	1.89
.1	20,000	18.95
.25	3000	1.10
.5	1500	.89
1	600	.49
1	2000	1.95
2	400	.49
2	600	.59
2	1000	.79
4	600	.75
6	400	.79
6	600	.89
10	600	1.25
14	600	2.29
15	600	2.49
15	1000	3.25
2 x .1	7000	3.95
2 x .5	9000	14.95

BATHTUBS

mfd	vdcw	each
.033	400	$.17
.05	200	.17
.05	400	.19
.05	600	.21
.1	400	.20
.1	600	.22
.1	1000	.32
.15	600	.22
.25	200	.19
.25	600	.23
.35	400	.22
.5	400	.23
.5	600	.25
.5	1000	.35
1	200	.29
1	600	.35
2	400	.44
2	600	.59
4	50	.25
8	500	.59
25	50	.28
25	75	.30
40	25	.27
50	25	.28
200	12	.35
300	6	.39
.05-.05	600	.29
.05-.05	1500	.45
.1-.05	200	.25
.1-.1	400	.26
.1-.1	600	.28
.16-.16	600	.28
.2-.2	600	.29
.25-.25	600	.30
.5-.5	600	.35
1.0-.1	300	.29
200-200	9	.49
3 x .05	600	.40
3 x .1	400	.42
3 x .1	600	.45
3 x .25	600	.50
3 x 1.0	100	.40

Specify Top, Side, or Bottom Lugs.

"UG" Connectors

UG-12/U ...... $.89
UG-13/U 1.49
UG-18/U ...... .89
UG-19/U 1.15
UG-21/U ...... .89
UG-22/U ...... .98
UG-24/U ...... .95
UG-25/U 1.15
UG-27/U 1.75
UG-57/U ...... .89
UG-58/U ...... .65
UG-123/U ..... .40

SHOCKMOUNTS

100P-1	1 lb.	.10
100P2	2 lb.	.10
100PR-2	2 lb.	.10
100P-3	3 lb.	.10
100P-4	4 lb.	.12
100P-6	6 lb.	.15
150P-4	4 lb.	.15
150PH-8	8 lb.	.22
150PH-15	15 lb.	.25
156P-6	6 lb.	.20
200PD-15	15 lb.	.27
200PHN-35	35 lb.	.49
204P-112	112 lb.	.50
Barry C-2040	40 lb.	.50

TYPE "J" POTENTIOMETERS

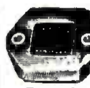
TYPE "J" 75¢ ohms	TYPE "J" 75¢ ohms	TYPE "J" 75¢ ohms	TYPE "JJ" $1.75 ohms	TYPE "JJ" $1.95 ohms
60*	1500†	25K†	100-100*	100K-100K*
100†	2000*	30K†	200-200†	100K-100K†
200†	2000†	50K *†	500-500*†	150K-150K†
300†	4000†	75K†	600-600†	250K-250K†
400*	5000*	100K *	1500-1500 †	350K-5000†
500*	5000†	100K †	2000-2000 *	350K-25K†
500†	10K*	200K *	2000-2000 †	500K-8000†
600†	10K†	200K †	2200-24K†	500K-500K†
750†	15K*	250K *	20K-2000†	800K-75K†
1000*	20K*	250K †	25K-10K†	1meg-1meg†
1000†	20K†	1meg*	35K-5000†	2meg-2meg†
1500*	25K*	2meg*	50K-50K†	5meg-5meg†

TYPE "JJJ" $2.95

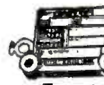
ohms	ohms
20K-200K-20K†	750K-750K-750K†
45K-27K-2500†	800K-800K-800K†
700K-700K-700K†	1meg-1meg-1meg†

* 1/8" screwdriver slotted shaft.
† Knob type shaft.

TRANSMITTING MICAS



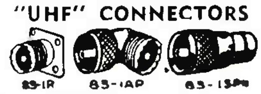
Type 9



Type 4

mfd	vdcw	type	ea.	mfd	vdcw	type	ea.
.00001	600	4	.18	.00162	600	4	.18
.00003	600	4	.18	.002	600	4	.20
.00005	600	4	.18	.002	1200	4	.48
.00005	2500	8	.31	.0022	2500	9	.78
.0001	600	4	.18	.0025	600	4	.25
.0001	2500	9	.31	.003	600	4	.25
.000152	600	4	.18	.0039	600	4	.25
.0002	600	4	.18	.005	600	4	.25
.00025	600	4	.18	.005	1200	9	.60
.0005	600	4	.18	.005	2500	9	1.18
.00051	2500	4	.43	.0062	600	4	.30
.0007	600	4	.18	.01	600	4	.40
.0008	600	4	.18	.01	600	9	.49
.0009	600	4	.18	.01	1200	9	.98
.001	600	4	.18	.0142	600	4	.45
.001	1200	4	.31	.02	600	4	.55
.001	1200	9	.31	.02	1250	9	1.36
.0013	600	4	.18	.027	600	4	.69
.0015	600	4	.18	.043	600	4	.99

"UHF" CONNECTORS

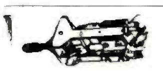


Cat. No.	Army No.	Each	Per C
83-1AC		.42	.39
83-1AP	M-359	.40	.28
83-1D	PL-271	1.25	1.00
83-1F	PL-274	1.10	.90
83-1R	SO-239	.40	.35
83-1SPN	PL-259A	.40	.35
83-22R	SO-264	.50	.40

MALLORY PUSH SWITCH

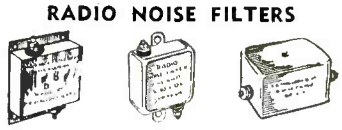
#2001 S.P. make cont., non-L .... 33¢
#2003 S.P.D.T., non-lock .... 35¢
#2003L S.P.D.T., lock .... 35¢
#2004 D.P., make 2 non-L .... 40¢
#2004L D.P., make 2 lock .... 40¢
#2006 D.P.D.T., non-lock .... 49¢

LEVER SWITCH



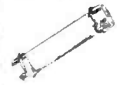
DPDT 10-amp. standard heavy duty contacts—Mossman #4101 momentary lever action, norm open and norm closed circuits $1.98
(Many Other Types Available)

RADIO NOISE FILTERS



A-MALLORY #NF12-7, 115 volts AC. Case: 3¼" x 3" x 1" $1.10
B-SPRAGUE #JX-51, 10 amps 6-30 vDC. Case: 2" x 2" x 1⅛" .... .75
SPRAGUE #JX-55D, 4 amps 6-30 vDC. Case 1¾" x 1" x ¾" .... .59
MALLORY #NF12-6EG, 7 amps 50 vDC. Case 2" x 1¾" x 1" .... .69
SOLAR #EA-121, 4 amps. Case: 1-13/16" x 1" x ¾" .... .49
C-MALLORY #NF1-1 Battery-Motor type. Case: 3⅛" x 3⅞" x 2⅜" 1.69

MILKY GLASS FERRULE RESISTORS



Standard Brand, ± 5%

Ohms	watt	each	ohms	watt	each
1	15	.98	3150	15	1.05
4	90	1.95	3150	90	1.95
5	15	.98	3300	20	1.35
10	15	.98	4000	20	1.35
20	15	.98	4000	50	1.65
20	90	1.95	5000	40	1.55
32	90	1.95	6000	120	2.85
80	20	1.35	6300	40	1.55
100	15	.98	6500	120	2.85
125	90	1.95	7500	15	1.10
160	20	1.35	8000	90	2.00
250	15	.98	8200	40	1.55
270	20	1.35	10000	15	1.15
400	20	1.35	10000	40	1.75
600	40	1.49	10000	90	2.15
630	90	1.95	12000	15	1.15
1000	15	1.03	12500	15	1.15
1000	20	1.35	12500	90	2.15
1000	40	1.49	13000	20	1.49
1000	90	1.95	16000	12	1.20
1250	20	1.35	16000	50	1.85
1500	20	1.35	16000	90	2.25
1500	40	1.49	20000	120	3.25
1800	15	1.03	25000	90	2.50
1800	20	1.35	40000	90	2.65
2000	15	1.05	50000	6Kv	2.15
2000	20	1.35	100000	120	3.75
2000	120	2.75	300000	.3Kv	2.75
2500	20	1.35	500000	6	2.39
3000	20	1.35	4.0 meg	4Kv	3.36
3100	40	1.49	40 meg	10Kv	4.40

Connectors

S-304-CCT	.25
P-306-AB	.16
P-306-CCT-L	.3?
S-306-FHT	.24
S-308-AB	.21
P-312-AB	.24
P-312-CCT-L	.42
P-315-FHT	.40
P-315-EB	.30
P-315-CCE	.40
S-315-AB	.36
S-318-AB	.43
P-324-FHT	.74
P-324-EB	.58
P-330-FHT	.96
S-330-AB	.84
S-404-AB	.33
P-406-AB	.33
S-406-CCT	.58
S-408-CCT	.69
S-2408-SB	.53
P-2412-SB	.61
P-502-DB	.97
S-502-DB	.97
P-508-CE	2.55
P-510-CE	3.04
S-510-SB	2.64
P-512-CE	3.52

BARRIER STRIPS

2-140-Y	.13
4-140	.17
4-140-Y	.23
5-140-Y	.28
8-140	.31
9-140	.34
10-140-Y	.53
10-140-3/4W	.53
10-240	.38
13-140	.48
4-141-W	.30
4-141-3/4W	.30
5-141-Y	.36
7-141-Y	.49
11-141-Y	.76
12-141-Y	.82
13-141-Y	.89
14-141-Y	.96
15-141-Y	1.02
4-142	.26
4-142-Y	.36
8-142	.48
10-142-3/4W	.85
12-142	.70
3-150	.53
4-151	1.30
5-151	1.60
4-152	1.89

1% PRECISION RESISTORS

24	125	680	2000	5294	17000	40500
38.6	200	743	2142	5470	18380	44710
40	215	900	2170	5500	20000	60000
47.7	225	1000	3460	6000	20500	61430
78.8	248	1155	3500	6550	21000	70000
80	280	1250	3760	6800	30000	72000
88	286	1280	3900	7000	32000	75000
107.85	300	1477	4280	7500	37500	83700
110	370	1485	4500	15000	39000	90000

Any above 30¢ each; 10 for $2.50

100000	130000	347000	1.0 meg
110000	135000	390000	4.0 meg
115000	140000	500000	10.0 meg
120000	145000	750000	
125000	235000	800000	75¢ each
40¢ each; 10 for $3.50			10 for $6.50

(many other types in stock)

DYNAMOTORS

brand new in sealed cartons

No. 19 Mark II

Delco, Pioneer, Winco

Input: 12 volts @ 9.4 amps
Output: 275 volts @ .110 amps
500 volts @ .050 amps

$9.95

TERMINAL BOARDS

5 terminal ..... .59
8 terminal ..... .98
12 terminal 1.49

30 AMPERE RELAY

DPST Leach type 6104. Coil 250vdc 5000-ohm res. Normally open contacts. Each pole rated 30a-110vac or 20a-220vac; 6-440 vac input; consumes 13.5 v/a. 3¼" wide x 4" long, 3" overall height $3.95

ANTENNA REEL

50-ft. Antenna, flexible sturdy braided wire. Winds up into compact bakelite case only 2¾" x 2¼" x ⅞". Perfect for portable or fixed use $1.69

W. B. Driver "Cupron" #28 D. Nylon RES. WIRE Special $1.49 lb.

ALEXANDER MOGULL CO., INC.

161 Washington St., N. Y. 6, N. Y. WOrth 4-0865

Open A/C to Rated Firms
Prices net FOB NYC whse
SEND FOR OUR FLYER #503

Portable VHF Communication Unit

Two-way radio telephone equipment designed for operation between 152 and 162 megacycles. Adaptable for many uses, a complete unit including the rechargeable storage battery weighs but fifteen pounds, and is housed in a sturdy case 11½" x 9" x 4¼", provided with shoulder straps.
This brand new set of big name manufacture comes complete with battery, battery tray, and handset but less crystal $89.50.
Battery charger is extra at $19.95.

Mobile VHF Communication Unit

Adaptable for many mobile uses, this is a compact unit 3½" x 8" x 15½" operating on 152 to 162 megacycles. It is six volt powered direct from storage battery, and is complete with the tone filter and crystal; handset, control box, antenna and installation kit. Brand new, ready to go.......................... **$129.50**
Extra 18" stub type antennae are available............... **$2.95**

Condensers

	Each
2 mfd. 4000 VDC. OIL FILLED	$2.95
1 mfd. 6000 VDC. OIL FILLED	1.98
.25 mfd. 15000 VDC. OIL FILLED	4.95
.00025 mfd. 25000 VDC. OIL FILLED	2.95
.4 mfd. 1500 VDC. OIL FILLED	.29
10 for	2.49
2 mfd. 600 VDC. OIL FILLED	.39
3 for	1.00
1 mfd. 600 VDC. OIL FILLED	.24
5 for	1.00
.1x.1x.1—1200 VDC. OIL FILLED	.59
2 for	1.00
50 mmfd—5KV—5 Amp. Vacuum Cond.	1.19

TEST EQUIPMENT

I 135 Test Set
BC 771 Frequency Meter
BC1287 Scope
TS 62/AP
TS 13/AP
TS 102A/AP
TS 251
BC 221 Freq. Meter
I 222 Signal Generator
LM Frequency Meters

RC 150 EQUIPMENT

Receiver BC 1161 A
Transmitter BC 1160 A
Control Unit BC 1162A
Signal Generator I-198A

T-85/APT5 UHF TRANSMITTER

Operating over a frequency range of 300 to 1400 MCPC with a nominal output of from 10 to 30 watts. Unit is equipped with 110 V 60 CPS filament transformer; blower; lecher wire test frequency set, and 8 tubes —1-931A; 2-6AC7; 2-6AG7; 1-6L6G; 2-829B; 1-3C22 (GL522) (oscillator).
New in original box with Operating Instruction Manual.......... **$69.50**

BC-603 Receiver—Good, Used.... **$24.95**

BC-604 Transmitter FM 20-26 MC
11 and 15 meters. Can be operated on 10 meters-10 channel push button crystal. With all tubes and meter but less dynamotor.
Excellent condition **$14.95**
Crystals—Set of 80..................... **14.95**

IS-185 Weston Voltmeter Model 433 0 to 150 VAC, 25 to 2400 cycles. New............$24.95

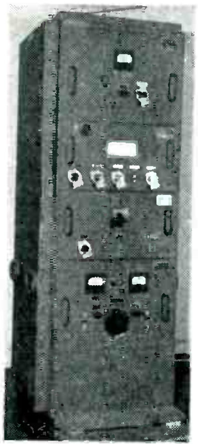
Miscellaneous Specials

ID6/APN4 - Scope
R78/A PS 15 - Scope
R7/APS 2 Receiver and Scope
ASB7 Scope
SCR 522 Receiver-Transmitter
MN26 C- or Y Receiver
RA 10 Receiver
BC 639 Receiver }
RA 42 Rectifier }
TA2J24 Transmitter
SCR 269 G Compass Installation
ARN7 Compass Installation
MN 26 Compass Installation
ILS Installation (BC733 & R89)
R 132/TPS10 Radar Receiver
MD22 - URA/T1 Modulator
AN/APRI Receiver and Tuning units
ASB 7 Complete Radar Installation
BD 71—6 position Field Switchboard
EE8 Field Phones
RM 29 Remote Phone Control
SCR 183 complete
ARC/1 Transceiver
ART 13 Transmitter
BC348 Receiver
RTA1B Transceiver
Model 15 Radar Trainer
BC-906-Frequency Meter

PRICES OF ABOVE UPON REQUEST

ARROW has the VALUES!

RADIO EQUIPMENT R. C.-100-B



This equipment made by General Electric, was designed for ground use as an identification of friendly aircraft.

Radio equipment RC-100-B consists of Cabinet CH-118 in which are mounted Transmitter BC-769, Keying unit BC-770, Radio Receiver BC-768, Rectifier RA-52, Wave Trap FL-25, wiring and Blower. Additional equipment consists of Antenna unit AN-82B; Transmission line MC-377, air compressor M-349, Oven M-348, control box BC-773, Amplifier BC-783B and associated cords and hardware.

Primary requirements are 110 to 120 volts, 50 to 60 cycle for the entire unit and accessories.

Cabinet CH-118 is of the Standard 19 inch rack type structural steel frame with runner angles for each of the units. A full length access door with safety interlocks forms the rear of the cabinet.

Transmitter BC-769 is designed to transmit RF pulsed signals at 470 megacycles with the use of two type 15E Tubes operating in push-pull with resonant grid, plate and filament lines.

Keying unit BC-770 furnishes the pulse of the Transmitter.

Receiver BC-768 was used to detect the 493.5 megacycle reply pulses from the interrogated station and to sufficiently amplify these signals for oscilloscope observation.

Rectifier RA-52 produces the high voltage. An 0-15 kilovolt DC Meter is connected across the output of the filter to measure the voltage fed to transmitter BC-769, while an 0-20 milliammeter is connected to the ground return to measure the average current drawn.

Antenna AN-82B consists of 24 vertically polarized, half wave radiating elements, a reflecting screen, open-wire transmission line sections and a concentric-line terminating section or elevator.

Wave trap FL-25 is used to separate received and transmitted signals.

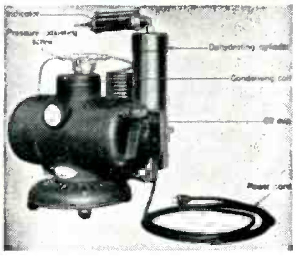
Transmission line MC-377 is of ⅞ inch air-dielectric, 70 ohm concentric line type and is assembled by means of solderless air tight connectors.

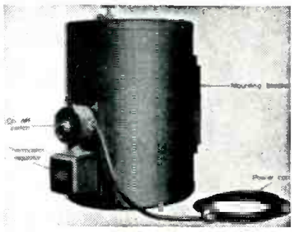
Control Box BC-773 contains necessary controls for operation.

Amplifier BC-783-B is used to amplify the output of Receiver BC-768 for suitable oscilloscope presentation.

Air Compressor M-349

together with 12 feet of ¼ inch soft copper tubing and necessary hardware is used to fill and maintain transmission lines with dry air under pressure. Operation is direct from 110 V AC 60 Cycles.





Oven M-348

is furnished for removal of moisture from the dehydrating cylinders of the compressor. It too operates from 110V AC 60 cycles.

Frequency Meter BC-771

Frequency Meter BC-771 is used for frequency checking and for tuning operations on Radio Transmitter BC-769 and Radio Receiver BC-768. It is a separate unit mechanically and has its own power supply, which requires a 110 to 120 Volt, 50 to 60 cycle source.

The circuits consist of an r-f oscillator, a crystal oscillator, a 30,000 cycle oscillator and associated mixer, multiplier, and amplifier tubes. The crystal oscillator is used to set the r-f oscillator to exactly 94 or 98.7 megacycles.

For tuning Radio Transmitter BC-769 to 470 megacycles, the signal from the radio transmitter is mixed with the fifth harmonic of the r-f oscillator, operating at 94 megacycles, to produce an audio-beat frequency. For tuning Radio Receiver BC-768 to 493.5 megacycles, the fifth harmonic r-f oscillator, operating at 98.7 megacycles and modulated by the output of the 30,000 cycle oscillator, is fed into the radio receiver.

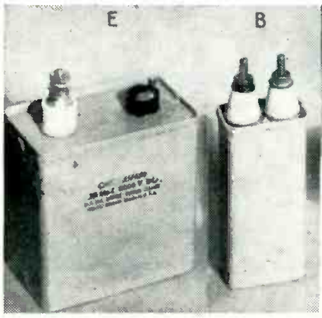
The entire RC 100 as described above—
all brand new—complete—
Technical Manual TM11-1113B is furnished with the complete set.

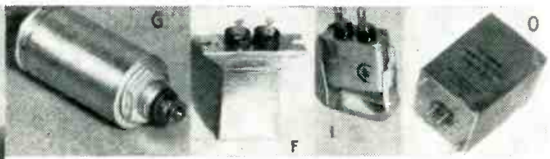
$595.00
F.O.B. Warehouse

Prices on individual components will be furnished on request.

ARROW SALES, Inc.
Dept. E
1712-14 S. Michigan Ave., Chicago 16, Ill.
PHONE: HArrison 7-9374

All items FOB warehouse. 20% Deposit required on all orders. Minimum order accepted—$5.00. Illinois residents, please add regular sales tax to your remittance.





CONDENSER SPECIAL

5—5mfd—400 vdc Oil Cond.

3 terms. bot. mntgs flanged type. Dims. 3¾ x 3½ x 2. Tested at 1800v. Meets commercial specs. for 600v. operation up to 40 degrees C. Currently being used for power factor correction. Numerous applications for this high quality condenser. See symbol "F".

Price $.55—CARTON of 24 $.45

OIL CONDENSERS—New

Symbol	Capacity	Voltage	Type	Price
B	.001	50KV	#14F112	$30.00
B	.005-.005-.01	10KV	#26F344	3.50
B	.01	3000V		.50
Special	.02	20KV		10.50
E	.03	16KV	#26F380	7.75
B	.05-.05	2000VAC		.95
B	.1	1500V		.28
	.1	2000V	1 Term	.32
F	.1	2500V		.40
G	.1	3500V		.55
G	.1	7000V	1 Term	.95
E	.1	7500V	#25F475	.85
B	.1	7500V	26F469	1.35
B	.1	10KV	#23F644	6.95
B	.1	15KV	#25F572	10.95
B	.1	25KV	#14F52	20.95
B	.2	10KV	#25F433	7.95
B	.25	3500V		1.30
E	.25	6000V	#23F659	1.25
B	.25	20KV		19.95
B	.4	10KV		8.95
D	.5	400V		.14
D	.5	500V		.16
F	.5	600V		.24
G	.5	1500V		.29
B	.5	2000V		1.25
B	.5	3000V		1.65
B	.5	25KV		29.95
B	.5–.1	2000V		.89
B	.5–.5	600V		.24
B	.65	12.5KV		10.75
D	.75	1000V		.22
F	1	400V		.18
D	1	500V	#23F266	.24
F	1	500V	#23F225	.24
F	1	600V	CP6881EF105	.28
B	1	600V		.24
B	1	1000V		.30
B	1	2500V	#23F121	1.25

Symbol	Capacity	Voltage	Type	Price
B	1	10KV	#14F267	14.95
B	1	15KV		17.75
B	1	20KV	#14F35	28.75
B	1.75	450V		.25
D	2	600V		.33
B	2	600V	#26F407	.38
G	2	600V	TLA	.16
B	2	1000V		.55
G	2	1000V	TLA	.55
B	2	2500V		2.50
B	2	4000V	#23F47	3.95
B	2–2	600V		.65
B	3	600V	Can	.39
B	3	4000V		5.25
B	3–3	150V		.25
B	3-3	600V		.70
B	4	440VAC		.78
B	4	500V	#26F796	.55
B	4	600V	#23F317	.69
G	4	600V	TLA (2) Terms	.69
G	4	600V	TLA	.69
B	4	1000V		1.15
B	4	3000V		5.25
B	5	600V		.59
B	5	1500V		2.75
B	6	600V		.74
B	7	600V		.79
B	7	800V		.89
B	8	600V		.95
O	8–8	600V		1.20
F	8–8	600V		.90
B	10	600V		1.10
B	10	1000V		2.50
B	10	1500V		2.95
B	13.5	220VAC		.90
B	15	600V	#25F472	1.25
B	15	1000V	TJ30040	2.65
B	42	600V	#25F673	4.95

CERAMICON CONDS.

10, 56, 100, 500, 1000 and 5.000 mmfds @ $5.00 per "C"...

NEW SILVER MICA CONDS.

10 mmfd to 950 mmfd .... .08
1000 mmfd to 6000 mmfd .... .09
10,000 mmfd .... .12

mmfd	mmfd	mmfd	mmfd	mmfd	mmfd	mmfd	mmfd
10	300	50	500	120	1000	200	5000
20	345	51	670	140	1500	240	6000
25	350	60	900	150	2000	250	10,000
30 z	400	100	950	180	2500	260	

Special Silver Mica Kit—100 @ $5.95

MOLDED PAPER CONDS.

.004, .01, .03—600V @ $4.50 per "C"
.01, .03, .05—400V @ $3.50 per "C"
.01—1000V @ $10.00 per "C"

NEW MICA CONDS.

6 mmfd to 750 mmfd .... .04
1000 mmfd to 6000 mmfd .... .045
10,000 mmfd .... .06

mmfd	mmfd	mmfd	mmfd	mmfd	mmfd	mmfd	mmfd
6	350	39	600	140	1500	240	5100
10	390	50	750	150	2200	250	6000
15	400	75	1000	185	3800	300	10,000
25	500	100	1250	200	5000		

Special Mica Kit—100 @ $2.95

Price F.O.B., 25% with order. Balance C.O.D. Minimum order $2.00.

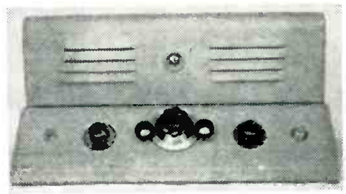
PRICES SUBJECT TO CHANGE WITHOUT NOTICE.

MONMOUTH RADIO LABORATORIES

BOX 159 OAKHURST, N. J.

$59.50
ELECTRONIC RADIO ALARM

Make it Secure



Guaranteed new, functionally perfect and designed by a leading manufacturer. Uses balanced bridge principle. Intrusion operates any external alarm system. (Bell, horn, light, etc.) Automatic reset. Protects any ungrounded object, room or bldg. (Safe, cabinet, window screen, screening under window or door. Protection against injury by high voltage, hazardous equip and locations. Added feature includes built in fire detector. Operates alarm at 160 deg. F. Complete with instructions.

TYPE "J" POTS $.50

SYMBOLS: LS—Locking Type Shaft
S—Screwdriver, R—Round

Ohms	Shaftz	Ohms	Shaft
50	1/4 S	20,000	1 1/4 R
200	1/8 LS	25,000	3/8 R
1000	1/8 LS	25,000	1/8 LS
1000	1/4 S	25,000	1/8 S
2000	3/8 LS	50,000	1 5/16 R
2500	1/2 R	50,000	1/8 S
2000	1/8 LS	50,000	1/4 S
3000	1/8 LS	50,000	1/8 LS
3000	1/2 R	100,000	1/8 LS
5000	1/8 S	100,000	1/2 R
5000	1/8 LS	100,000	1.0 R
10,000	1/4 S	100,000	1/8 S
10,000	3/8 R	150,000	2 1/8 R
10,000	1/8 LS	200,000	9/16 R
10,000	5/16	250,000	1/8 S
15,000	1/8 S	300,000 (2 Terms)	1/8 S
15,000	1 1/8 R	1 Meg	1/8 S
20,000	3/8 S	1 Meg	1/8 LS
20,000	1/8 LS		

TYPE "JJ" $1.00

2K	3/8 R	10K-50K (10K 2 terms.)	1/2 R
1K–5K	3/8 R		
100K	1/2 R		

25 WATT RHEOSTATS

Ohmage	Shaft	Price	Ohmage	Shaft	Price
Dual 1.3	1/8 S	$.98	225	1/8 LS	.65
15	1/2 R	.45	250	1/2 with knob	.59
20	1/2 R	.45			
25	1/2 R	.45	300	1/2 with knob	.59
50	1/8 S	.45			
Dual 50	1/2	.98	500	1/4 S	.55
75	1.0	.45	500	1/8 S	.55
100	1/2	.55	1500	1/2 S	.65
125	1/2 S	.55	2000	3/8	.65
175	1/2 with knob	.59	2500	1/2	.65
			5000	1 1/4	.65
225	1/4 S	.59	5000	1/8 S	.65

BAKELITE TOGGLE SWITCHES

SPST 3A. 250V, 7/16" Bushing, Ball Handle (On-Off) .18
SPST 3A. 250V. ⅜" Bushing. ⅛" SD shaft.... .18
SPDT Type C-H 8800 K4, 7/16" Bushing, Bat Handle (On-Off-On) .... .34
DPST 3A. 250V, 7/16" Bushing, Bat Handle... .30
DPST Type C-H 8823K4, 7/16" Bushing, Bat Handle .35
DPDT 3A. 250V, 7/16" Bushing, ¾" Shank, ½" Ball Handle .... .44
DPDT Type C-H 8824K4, 7/16" Bushing, Bat Handle .48

COAX CONNECTORS

83–1SP	$.28	83–1J	$.64
83–1SPN	.28	83–1R	.28

FREQ. METER
Type BC—906 C

150—225 megacycles. Brand new. Boxed. Price $11.95

MILLIONS OF
RESISTORS

½-1-2 Watts

FOR THOSE IMMEDIATE REQUIREMENTS

LIFE ELECTRONIC SALES

91 Gold St. DI 9-4154 N. Y. 7, N. Y.

CLOSE OUT
SURPLUS LABORATORY EQUIPMENT

Boonton

2—140-A Beat Frequency generator..Each $445.00
9—120-A V.H.F. Circuit Checkers (3 Ranges —27-210 MC) for TV & FM......Each 95.00
Entire lot of 9 units.......... 450.00
1—Clough-Brengle 230A AC Bridge (A.C. volts, capacity, turns ratio).......... 35.00
1—Industrial Instruments MB-8 0-1000 MEG Bridge 40.00
1—Weston 796 Megohmmetor 0-20, 200 Megohms 50.00
1—Weston 45 D.C. Volt Meter 0.1% ACC... 40.00

MISCELLANEOUS

3—W.E. TS5/AP Range Calibrators...Each 35.00
7—Boston Gear 150 LBT Gear Reduction Turntables 150:1 New ....Each 10.00
1—Shallcross 621H Per Cent Limit Bridge As is 25.00
1—W.E. Synchroscope 95.00
1—W.E. TS/19APQ5 Range Cal. Modulator 25.00
1—Sylvania Pirani Tube #R1110.......... 10.00

Entire lot above; write for price.

LINEAR EQUIPMENT LABS—5MC OSCILLOSCOPE—BRAND NEW 169.50

Write for complete details

THE NATIONAL INSTRUMENT CO.
21 Cathay Road East Rockaway, N. Y.
Telephone Lyn. 9-10116

OUTSTANDING VALUES

CATHODE RAY—X-RAY—TRANSMITTING TUBE MANUFACTURING EQUIPMENT

- **HIGH VACUUM MERCURY PUMP** with "Mc Leod" gauge. Mercury diffusion pump is electrically heated. Pressure switch controls operation of pump. Diffusion pump exhausts into a mechanical rotary vacuum pump. "McLeod" gauge measures vacuum to .5 microns.
- **BOMBARDMENT EQUIPMENT** A grid controlled rectifier using two metal thyratrons which allow continuous and smooth control of anode current.
- **OVEN CUBICLE** with "Brown" pyrometer controller.
- **HI POT TRANSFORMERS**
  GE 78G342
  25KVA 60CY 440-1100/440-2200v.
  GE Typer
  2KVA 60 Cy 110v-60,000v

LABORATORY EQUIPMENT

- **ESTERLINE ANGUS** model AWT-N, twin chart recorder scale 2.5-0-2.5 MA DC. Feeds hourly ¾"-1½"-3"-6"-12". Minute ¾"-1½"-3"-6". Writing door—synchronous clock—chronograph pens on each meter. Complete with pens, filler, ink, charts. Brand new, $550.00.
- **HARTRON SOUND-ON-FILM RECORDER REPRODUCER.** Model A-30. Immediate play back. No processing of film required with operating accessories. Brand new, $170.00.
- **LECTURE TYPE GALVANOMETER.** DC galvano-volt-ammeter—scale 5-0-5. Complete with shunts, 15" x 14½" x 7½". Cenco #82145. Brand new, $90.00.

AVAILABLE

POTENTIOMETERS CONDENSERS
TRANSMITTING MICA ROTARY SWITCHES
Inquiries Will Receive Prompt Attention

BRAND NEW EQUIPMENT

MN26Y Radio Compass Receiver
DAB-3 Direction Finder
TBL-13 Transmitter with Spares
Walkie Talkies
BC-325 Transmitter
RF Tuning Unit for BC-446 Radio Range Transmitter
SCR-625 PPI Receiver-Indicator Console

ROUND PANEL METERS

R F

.5 volts output 50 micro	Amp	Weston	2½"	4.75
0-4 RF	Amps	GE	2"	3.95
o-5RF	Amps	Weston	3½"	4.50
0-300MA	DC	Weston	2½"	3.75
5-0-5MA	DC	Weston with 50MA shunt	3½"	4.25
0-50Amp	DC	Weston	3½"	4.95
0-100Amp	DC	Hoyt	3"	5.00
0-3Volts	DC	Sun	2½"	1.95
0-2500Volts	DC	Simpson with 2500 volt Multiplier	3½"	5.95
0-5KV	DC	0-10 MADC	3½"	5.75
0-150Volts	DC	Hoyt	3½"	3.95
10-0+6	DB	Weston	2½"	4.50

PORTABLE METERS

0-10Amps	DC	Weston 489	7.50
0-3-6-30v	DC	Weston 280	17.50
0-25Amps	DC	Weston 433	29.95
0-100Amps	DC	Weston 269 with 100 Amp Shunt	24.95
0-1.5-6v	AC	Output Meter Weston 571	12.00

TIME DELAY SWITCHES

1 Minute 115v AC 60 cy enc. in waterproof case. ....New 5.25
3 Micro Switches make contact at 40-41-42. Second time delay 110v AC motor. ....New 4.00
30-40 Second Mercury Time Delay Relay. Adlake. ....New 6.50
Thermo Switch 50°F to 300°F 115v AC @ 6A, 230v AC @ 5A breaks contact with increase in temperature. New 1.35

TIME DELAY LINE

1 Micro Second 15 KVA 400 cy 50 ohm. Brand new........$14.95

GENERATOR VOLTAGE REGULATOR

115 Volt 400 cycle GE GBA 20C. New $19.95

TOGGLE SWITCHES

DPST 3A-250v w/hardware.. .25
DPDT One throw momentary 20 amp 125v AC.............. .70
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DPDT 5A-250v .... .70

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DPST 115 v 60 cy 15 amp 1 h.p. Whse. with interlock...New $4.95

AMERICAN BLOWER AND MOTOR

⅛ HP GE motor 115v 1 phase 60 cy. 1725 rpm cw rotation—10¼" wide. 12" high intake 6" dia. output 4⅜" x 4⅜". Brand new $24.95

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PLASTIC—NYLON
Special #22 Spiral Wound Around Nylon Core Colors—Red, Black-White Plastic Insulation

COAXIAL
RG-221v RG-74/v

MAST

76 Feet Telescopic Aluminum Mast Fully Collapsed Only 11 feet. 7" dia. At Base Tapers to 3" at Top 175.00

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2X2A	.65	7193	.30
2X2/879	.50	8011	2.40
3C24/24G	.50	9001	.50
7C4/1203A	.40	9002	.35
10Y	.35	9006	.30
15R	.75	C5B	9.75
39/44	.25	CEQ72	1.40
45 Spec	.35	CK-70	3.50
211	.45	CRP-72	1.40
713A	.80	E-1148	.30
801A	.40	HY-615	.40
803	3.25	RKR-72	.75
826	.45	RK-73	.75
869B	23.95	VT-127A	2.00
872A	1.45	CBP1	3.45
1626	.30	5CP1	2.75
1629	.25	5BP4	4.24

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CLARE #BA10059-3 275 ohms SPDT 24VDC Micalex Insul 1 amp cont. #R73....69¢ ea.
ALLIED 55837 250 ohms SPST N. O. Double break 15 amp cont. #R108......98¢ ea.

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4-40 Thread
LOW-LOSS BAKELITE INSULATION
$7.50/C $60.00/M

Relays Telephone Type

CLARE 2000 ohms 3PST N. O. 1 amp cont. #R94.....98¢ ea.
AUTOMATIC 1300 ohm SPST N. O. 1 amp cont. #R103 98¢ ea.

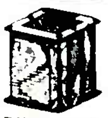
TIME DELAY RELAY — Amperite 24N02 24V AC or DC, SPST N. O. 5 amp. cont. 2 sec. delay #R316 ....89¢ ea.

Allied Type BO Relays

55 VAC DPDT. Operates on 12 VDC or 110VAC intermit. duty (5 min.) Two units in series for 110VAC for 4PDT oper. #R211 $1.25 ea.
BO-13D35 24VDC SPST NO. Dble Br 230 ohms #R06 98¢ ea.

Antenna Switching Relays

115 VAC DPDT 10 amp cont., manual release latch 200 ohms, Allied ..$1.49 ea.
G. E. #37843 50 ohm 12VDC ceramic insulation 10 amp, cont. #R57. ....$1.25 ea.
LEACH 1054B, 265 ohms 24 VDC DPST N. O. 10 amp cont. #R110 ....89¢ ea.



Servo Output XFMRS

PP6L6 to Servo mechanism with 10% feed-back winding. MU metal core $2.95 ea.
DUAL unit PP6V6 to Servo mechanism with 10% feedback winding and 6SN7 to Servo mechanism.
Both in 1 can........$3.25 ea.

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BC-610 Transmitters with BC-614 Speech Amplifier. 4 Plug-In Coils and Exciter Units for 10, 20, 40, and 80 meter operation. Output 400 watts A1, 300 watts A3. Operates from 110/1/50-60 cycles AC. Used in SCR-299,399,499 eqpt. Spares available at extra cost. Condition Excellent to like new. Export Packed. **PRICE, EACH** $900.00

SF-1 Radar Eqpts. 10 Centimeter, Brand NEW with complete spares to insure over 10 years of continuous operation. Includes motor-generator set in each, all wave-guide plumbing, instruction books, etc. 19 cases per set, export packing. **PRICE, EACH** $2,500.00

TCS, Collins Ship Transmitter-Receivers, for 12 V. DC operation, radio telephone and radiotelegraph at 20 & 40 watts, 1:5 to 12.0 mc. Complete with all accessories. Excellent, like new condition. **EACH** $300.00

Beachmaster, 250 watt Portable Sound Amplifier Systems, with nine speaker rack, tubes, mike, cables, and spares. Operation from 110 volts, one phase, 60 cycles AC. Excellent and New condition units. **PRICE, EACH**..................$495.00
PRICE, less case of spares..................$395.00

Western Electric Model HLAS, 500 watt Sound Amplifier Systems, consisting of 40 watt Pre-Amplifier; 500 watt Power Amplifier with built-in power supply, expander-compressor circuit, internal blower-ventilation, 30 kc erasing oscillator circuit for magnetic tape recording, volume and meter controls; two speaker racks, each with 6-60 watt dynamic horn units. Operation from 115/3/60 AC. New, Unused. Complete with tubes, cables, connectors and instruction manual. **EACH**......$695.00

RMCA, Model 8010 I.F. Ship Main Radio Transmitter, 325 to 500 KC. types CA & E. Excellent condition. Less motor generators. **PRICE, EACH** $475.00

RMCA, Model 8019A/H.F. Ship Transmitter, complement to 8010 above, for H.F. transmission A1 and A2. 200 watts output. Excellent Condition, less tubes and MG (mg with 8010 powers this unit.) **PRICE, EACH** $400.00

RMCA, 8003 Emergency Transmitter. 500 KC. 50 watts output with 12/115 V. DC. motor generator set, and battery charging unit. Excellent Condition. Complete with tubes. **PRICE, EACH**.....$275.00

RMCA, 8007 Lifeboat Transmitter-Receiver, 500 KC. for permanent installation. Complete with installed 12 V. Dynamotor. Excellent Condition. **PRICE, EACH** $100.00

RMCA, 8600X Auto Alarm Receivers, 500 KC Automatic SOS (4-second dash actuated) Alarm Unit. Complete with Relay Control Box and warning light. For 110 V. DC operation. Excellent Condition, with tubes. **PRICE, EACH**...........$250.00

RMCA, 8506B H.F. Receiver, 2 to 23 mc., low-radiation superheterodyne. With tubes. Excellent Condition. **PRICE, EACH**......................$200.00

RMCA, 8707 Direction Finder. (Int. Freq.) consists of receiver, loop, shaft, rotating wheel. Excellent Condition except shaft housing not available (can be easily improvised). With tubes. **PRICE**..$750.00

Mackay, Model 150-AY, I.F. Ship Transmitter. 325 to 500 KC, A1 and A2 emission. Excellent Condition. **PRICE** with MG, 115 V. DC. **EACH**..$350.00
PRICE without MG. **EACH**...............$275.00

RC-163 Radio Beacon Eqpt. 20-40 MC. Converts SCR-508/528/608/628 to directional transmitters and receivers. Ideal for airports for homing application. NEW and complete eqpt. Export packed. **EACH** $90.00

SCR-511 "Pogo Stick" Walky-Talky. Portable low-power AM radiotelephone for 2 to 6 mc operation, with 12 plug-in tuning coils containing crystals for crystal control of both receiver and transmitter. Transmitter-Receiver BC-745 of this SCR-511 includes telescopic antenna and "Press-Talk" Switch as well as all cables. Range 5 miles, plus. With PE-157 Vibrator Power Supply 2-volt battery (less electrolyte). P-17 mike, ready for immediate operation. **PRICE, EACH**..........................$75.00

32 Volt DC to AC Rotary Converter, mfd. by Kato. For yachts, workboats, or farm installation. Output 110 V., 60 cycles AC, rated 225 watt but good to 300 watts. All NEW Units. **PRICE, EACH** $39.95

Deck Entrance Insulators, bowl and flange type. 8⅞" dia. with heavy galvanized metal flange and bell. Top bell 6¼" dia. x 11"; brass feed thru rod. Very high voltage insulation. Individually packed in cartons, all NEW. **12 FOR**............$18.00

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British Infra-Red Image Converter Tubes. For "Snooperscopes", Etc. For infra-red detectors, devices that see in the dark, camera work, laboratories, etc. Six for $25.00. Discount on larger quantities.

Hundreds of other Items, including: AN/CRT-1A Sonobuoy Transmitters 67.7 mc, excellent condition to new, 40 available; APQ-2 Transmitters, new condition; TCR Control Boxes; 12 V. DC to 110 V. AC Rotary Converters; Transformers of all types; Capacitors; Relays; Insulators; Bowl, Egg, Strain, and Stand-Off in large quantities, Etc., Etc.

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15 Volts, Westinghouse NA-35, 3½" Round flush bakelite case (JAN MR35WO15 ACVV) @ $3.95

40 Volts, Westinghouse NA-33, 2½" Round flush metal case, black scale luminous markings. (These were originally calibrated for 400 cycle use but have been adjusted for 60 cycle) @ $3.95

40 Volts, Westinghouse NA-33, 2½" Round flush metal case, black scale, luminous markings, calibrated for 400 cycles @ $3.50

40 Volts, Weston 517, 2½" Round flush metal case, black scale luminous markings, calibrated for 400 cycles @ $3.50

75 Volts, Weston 517, 2" Round flush metal case ring-clamp type mounting, non-flanged @ $2.95

150 Volts, Weston 517, 2½" Round flush bakelite case (JAN type MR24W150ACVV) @ $4.50

150 Volts, Triplett 332-JP, 3½" Round flush metal case @ $4.00

150 Volts, Triplett 331-JP, 3½" Round flush bakelite case @ $4.50

150/300 Volts, Dual Range, Triplett 331-JP, 3½" Round flush bakelite case with external series res. for 300 volts, scale calibrated 150, double scale indications for 300 volt use @ $5.50

300 Volts, Triplett 232-C, 2½" Round flush metal case @ $6.00

A. C. AMMETERS

10 Amperes, G.E. AO-25, 3" Square flush bakelite, expanded between 4 and 7 amps. Scale calibrated 100 Amps for reading div. scale indicated by 10 @ $4.95

30 Amperes, Triplett 332-JP, 3½" Round flush metal @ $3.50

30 Amperes, Triplett 331-JP, 3½" Round flush bakelite @ $4.00

50 Amperes, Westinghouse NA-35, 3½" Round flush bakelite case 25 to 500 cycles @ $4.95

60/120 Amperes, Dual Range, Burlington 32xC, 3½" Round flush bakelite case, 5 Amp movement external current transformer @ $7.50

75 Amperes, Burlington 32 C, 3½" Round flush bakelite @ $4.95

150 Amperes, Multirange, General Electric AO-22, 3½" Round flush bakelite, 5 Amp movement with external current transformer. This unit can easily be made into a Multirange Ammeter containing any or all of following: 5, 15, 30, 50, 75, 150. Simple wiring diagram furnished with meters or free on request

COST ONLY $7.50

RADIO FREQUENCY AMMETERS

120 Milliamps, Simpson 125, 3½" Round flush bakelite, arbitrary linear scale calib. 0-10, with caption Output Units, complete with external thermocouple @ $7.50

120 Milliamps, Triplett, 2½" Round flush metal case, arbitrary linear sc. calib. 0-100, black face, lum. markings, no caption, complete with external thermocouple @ $7.00

1 Amp, General Electric DW-52, 2½" Round flush metal @ $3.50

1 Amp, General Electric DW-44, 2½" Round flush bakelite case, black scale @ $2.95

1 Amp, Weston 425, 3½" Round flush bakelite case @ $11.00

1.5 Amp, Weston 507, 2½" Round flush metal black scale @ $3.50

1.5 Amp, Westinghouse RT-35, 3" Square flush bakelite @ $5.50

1.5 Amp, General Electric DW-52, 2½" Round flush metal case, black scale @ $2.95

2 Amps, Westinghouse NT-35, 3½" Round flush bakelite case, with external thermocouple @ $6.50

2 Amps, Westinghouse RT-35, 3" Square flush bakelite case @ $5.50

2 Amps, Weston 425, 3½" Round flush bakelite case @ $8.50

2.5 Amps, Simpson 35, 3½" Round flush bakelite @ $4.95

3 Amps, Weston 507, 2½" Round flush bakelite, black scale @ $3.95

3 Amps, Westinghouse NT-35, 3½" Round flush bakelite (JAN type MR35W003FAA) @ $5.50

5 Amps, Westinghouse RT-35, 3" Square flush bakelite @ $7.50

5 Amps, General Electric DO-44, 3½" Round flush bakelite @ $7.50

6 Amps, General Electric DW-44, 2½" Round flush bakelite case, black scale @ $2.50

8 Amps, General Electric DW-44, 2½" Round flush bakelite case, black scale @ $2.95

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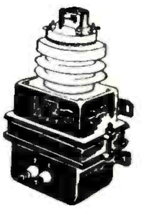
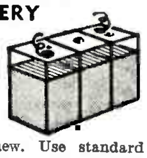


For hi voltage rectifiers. PRI. 115 V., 50/60 cycle. SEC. 5V., C/T @ 10 Amps. 35 KV R.M.S. Test 12 KV D.C. Operating. Uses 872A Tube or other tubes.

Brand New **$9.95**

872-A Tube $1.49

WILLARD MIDGET 6V STORAGE BATTERY



$2.49

3 amp. hour rating. Transparent plastic case. 3-5/8"x1-13/16" x2-⅝" high. Brand new. Use standard electrolyte.

A Real Money-Saving Value!

TS 164/AR FREQUENCY METER $75.00

This is the Airborne version of BC-221. Comes complete with original calibration book.

Compare this value anywhere!

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Just a few left to go at this one low price while they last.

A Real Bargain Buy!

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Priced complete with tubes. Used, but in excellent condition.

Manufactured by Galvin!

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This is an outstanding precision instrument—ideal for any electronic laboratory.

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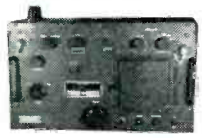
TS-47/APR

$125.00

Complete with self-contained power supply and power cord. Tunes 40-500 Mc. with usable harmonics up to 3000 Mc. In good used condition. A real precision instrument priced well below its original cost.

SIGNAL GENERATORS

Choice of Three at $77 ea.



I-222-A RF. Covers 2 bands—8-15 mc., 150-230 mc. Can use up to third harmonic. Built-in 110 V., 60 cycle power supply. In good condition $77

I-126. 15-26 mc., 95-130 mc. with built-in power supply. Good condition $77

I-126. 15-26 mc. 180-235 mc. with built-in power supply. Good condition $77

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OTHER MODELS from ½ watt to 1500 watts output, NEW and complete for ground, aircraft, and shipboard installations.

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US Army 50 watt equipment from recordings & console to antenna, 1100-1500 Kcs. In FIVE portable trunks. **NEW & COMPLETE.**

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5 WATT, Model JT-52 by Jefferson-Travis, 2 channel, crystal controlled recvr-transmitter, built-in speaker, hand microphone, 6 Volt DC power supply. Freq: 2000-3000 KCS, in compact steel cabinet, complete less xtals. New in original cartons. In dealer quantities.

Also 50 and 75 watt models in stock, 6 channel, NEW.

RADAR SEARCH RECEIVER

ARD-2

EQUIPMENT: Consists of the following: **1 ANTENNA-DETECTOR** (CMD-66AFH) has variable length antennas (2), diode detector, and silver plated tuning stub with calibrated scale; **1 AMPLIFIER** (CMD-50ADC) has three stage pulse amplifier, a trigger circuit, a pulse rate counter circuit and audio amplifier, a visual signal indicator, and a rectifier power supply which is operative on 115 Volts AC, single phase, at 60 to 2400 cycle current, regulated; **1 TEST OSCILLATOR** (CMD-60-ABG) has carrier frequency of 400 cycles with selection of four pulse repetition rates. With the above are included all cables with fittings, accessories, and shock mounted rack, a steel chest with complete spare parts and 200% additional tubes and 2 technical manuals. Gross weight 113 pounds. **NEW. Each** $175.00

ALSO: HANDY-TALKIES & WALKIE-TALKIES; Receiver & Transmitter combinations TCS, SCR-508/528, SCR 608/628, AVT/R/A, and others for field use, mobile, aircraft, maritime & ground control installations.

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A limited number of this finest available laboratory instrument is offered subject to prior sale. Specifications are:

Range: 1.9-4.5 mc. & 19-45 mc.

Deviation: 0-5 kc. each side of center frequency in first range and 0.50kc. each side in second band.

Modulation: internal 150, 400, 1000, 2500, or 5000 c.p.s. Provision for external source.

Accuracy: 0.3% with aid of internal 500kc. crystal calibrator.

Output: up to 100,000 microvolts calibrated with internal V.T.V.M., .84 volts uncalibrated.

Termination: 30 ohm line.

Power source: 12 volts dc or 115 volts 60 cycles.

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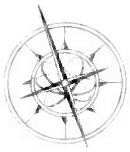

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WESTERN ELECTRIC radiotelephone 800 watts, new with spares for ship or shore. Same transmitter as used on famous S. S. "Queen Mary." 110-220 volts ac.

100 Watt W. E. radiotelephone w/selective ringer ship or shore. 10-channel, 110 ac oper'n.

25 Watt RCA RT, 32 vdc, 4-channel.

MANY NAVY MODELS, including TDE, TCS, TBK, TBM, TAJ, etc. to choose from. Write for info.

SONAR

30 complete, new model **NAA**, "Herald" underwater anti-submarine units. See "Electr. Eng.," for Feb. 1949 for description

QBG—12 volt, portable, new .... $300.

Also, **WEA, QBE, QCO**, et. al.

RADAR

SN—10 cm, portable, easily set up. Has 2, 5 & 25 mile ranges; 5-in. A-scope. Complete w/full spares $685.

SQ—10 cm, PPI .... Write

Submarine—SJ and **SD** .... Write

Navigation Beacons—Navy Models **CXEH** and **CPN-8**, for 115-230 VAC.

Airborne APS3 and **APS-4**; also new **ASB** 515 mcs, complete w/ant. & hydraulic controls. Only .. $285.

— Many other types in stock —

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TUBES (New, Boxed, Guaranteed)

1H4G	$ .75	464	$8.50
1H6G	.75	829	4.90
1J6G	.75	829A	7.50
6AC7	1.05	860	12.50
6SN7GT	1.05	861	32.50
6V6	.95	872A	1.95
6SL7GT	1.15	715B	6.75
446B	1.75		

MAGNETRONS, KLYSTRONS

2J26	$ 6.50	700 A-C	$18.50
2J27	11.00	706 D-GY	49.00
2J61	24.00	707A	12.00
2K25	24.00	728 AY	20.00
4J31	95.00	728 GY	24.00
4J33	110.00	D161145 (W.E.)	150.00

CAPACITORS (oil-filled)

.01 mfd 500 vdc	$1.00	10 mfd 600vdc	$1.00
.1 mfd 6000 vdc	2.50	2 mfd 1000vdc	1.25
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2 mfd 600 vdc	.60	1 mfd 10 kv dc	14.00
4 mfd 600	.85	.25 mfd 20 kv dc	25.00

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A. 28 @ 1.25 a to 250 @ 60 ma	$ 3.00
B. 28 @ 7 a to 540 @ 250 ma	5.00
C. 13/26 @ 12/6 a to 400/800	6.50
D. 14 @ 46 a to 515/1030 and 2/8, 50 ma up	9.50
E. 28 @ 10 a to 300/150/14.5, 10 ma up	10.00
F. 32 @ 13 a to 430/6.3 @ 350/8.0	35.00
G. 13 @ 13 a to 250/300 @ 60/225 ma	15.00

AND MANY OTHERS

COAX CONNECTORS

83 1SP	$ .35	UG 87 U (Gold pl w/hood)	1.25
83-1AP	.17	UG 65 U	6.50
83-R	.35	UG 56 U	4.75
83-1H	.08		
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METER MULTIPLIER

High precision resistor, 20 megohms at 20,000 volts with accuracy of ½ of 1%. Mfrs. Weston, Sprague. Only $24.25

TRANSFORMERS

650 VA—115 V, 60c to 50-55-60-65 V or 350 VA—220 V, 60c to 110 .... $9.00

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3 cm., multipurpose, portable, field and bench test set, model TS-263A/TPS-10. Brand new $575.

*New only. Some quantities limited.

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3—4—6—8—10—12

Priced From 10¢

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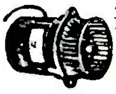
WO 2-3064

MIRROR — front surface aluminized on optical glass 1 3/16" diameter 3/32" thick .... $.50

PRECISION LEVEL — interior ground tube level with 4 adjusting screws. Overall length 1⅝", diam. 15/32". One end with shoulder ½" diam. $.85



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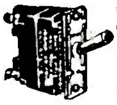

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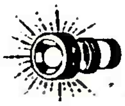

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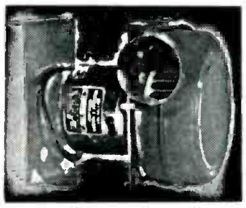

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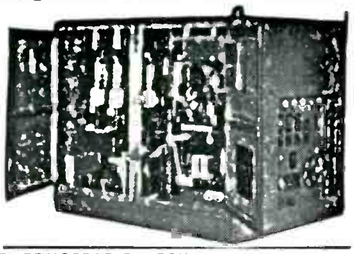

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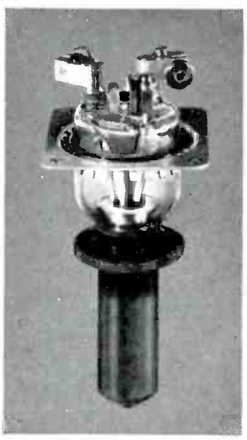

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Synchronizing Level	2.5
Black Level	1.76
D.C. Grid Current (MA)	
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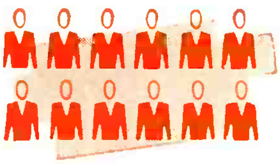
it pays equipment manufacturers to deal with RCA



1. RCA Application Engineering Service—Twelve field engineering specialists devote their time *exclusively* to the design problems of equipment manufacturers. They're ready to pitch in and help you at any time.

2. RCA Application Engineering Laboratories—RCA maintains application laboratories at Harrison, Lancaster, and Chicago. The services of these laboratories are at the disposal of all RCA tube and component customers.

3. RCA Circuit Investigations – RCA carries on independent research in circuit design for the exclusive benefit of its tube and component customers. Engineering reports are provided as a free service.

4. RCA Tube and Component Development—RCA works years ahead in tube and component design—anticipates future requirements. That's why you get the types of tubes and components you want *when* you want them.

5. RCA Engineering Literature—RCA technical bulletins and data, covering the specifications and operating conditions of RCA tubes and components, are the most authoritative and comprehensive in the field.

6. RCA Manufacturing Facilities – RCA tubes and components are manufactured in modern plants equipped largely with RCA-designed, precision machinery—your assurance of uniform, dependable quality tubes and components.

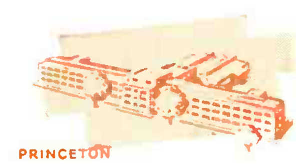
7. RCA Quality Control—Quality controls begin with the raw material and are followed through in every successive step of manufacture and assembly. That's why RCA tubes and components are consistently reliable.

8. RCA Sales and Customers' Service – A staff of seasoned sales representatives are within convenient reach. They're available *when* you want them. In addition, a staff at the Home Office devotes its time *exclusively* to expediting your orders.

9. RCA District Offices—RCA maintains three conveniently located district offices in Harrison, Chicago, and Los Angeles to serve equipment manufacturers. You can get prompt service from the office nearest you.

10. RCA Distribution–RCA maintains bulk tube and component stocks in three warehouses strategically located in Jersey City, Chicago, and Los Angeles for quick service.

11. RCA Pricing– Mass-production techniques and the RCA "Preferred Type Plan" have consistently operated to reduce manufacturing costs—which mean lower prices to you.



12. RCA Engineering Leadership—The vast resources of experience and ability that account for RCA's engineering leadership in tubes and components, are of direct benefit to RCA customers . . . a final reason why it pays to deal with RCA.

Sales and Product Directory

1. General sales information or requests for application engineering assistance on receiving and television picture tubes, communications and industrial tubes, power tube fittings, electronic components, and test and measuring equipment:

Equipment Sales Field Representatives at the RCA Sales Office nearest you:

City and State	Street Address	Telephone No.
Harrison, N. J.	415 S. 5th St.	Harrison 6-8000
Chicago 11, Ill.	589 E. Illinois St.	Whitehall 4-2900
Los Angeles 13, Calif.	420 S. San Pedro St.	Madison 9-3671

2. Inquiries relative to technical bulletins: Commercial Engineering, RCA, 415 South 5th Street, Harrison, N. J.

3. Orders and inquiries on orders: Tubes: RCA warehouse serving you:

Jersey City Warehouse, RCA
34 Exchange Place
Jersey City 2, N. J.
Phone: Bergen 4-2100

Chicago Warehouse, RCA
589 E. Illinois St.
Chicago 11, Ill.
Phone: Whitehall 4-2900

Los Angeles Warehouse, RCA, 420 S. San Pedro St.
Los Angeles 13, Calif. Phone: Madison 9-3671

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