electronics

OCTOBER · 1951

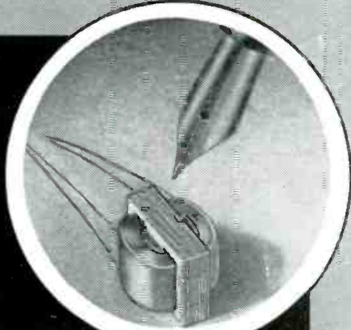
PRICE 75 CENTS

A McGRAW-HILL PUBLICATION

WAVEGUIDE TEST EQUIPMENT

FOR MINIATURIZATION

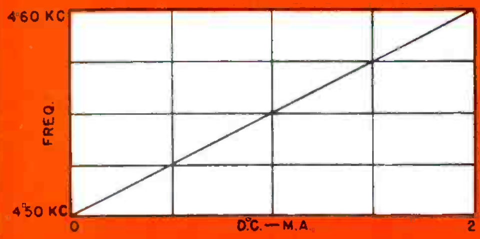
The miniaturization of transformers has been a UTC specialty ever since the development of the Ouncer series in 1937. The importance of this engineering "know how" is reflected by the large number of UTC Miniature components in present military equipment. Some examples of this engineering leadership are illustrated below.

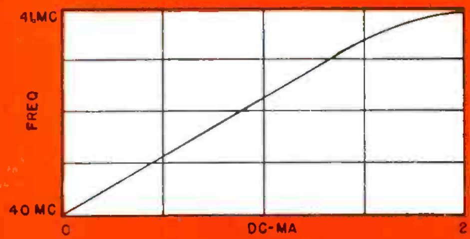


SM Unit ACTUAL SIZE — As photographed with normal pen for comparison.

DC CONTROLLED OSCILLATOR INDUCTORS

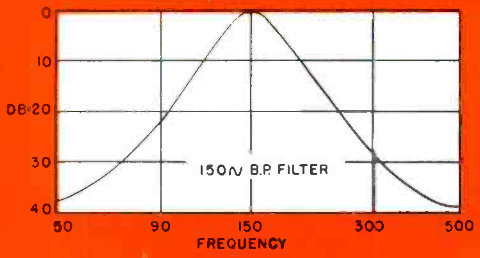
The curves below illustrate oscillator frequency variation using two types of RF inductors varied by the amount of DC through the controlled windings. These units are available in ouncer size and smaller.

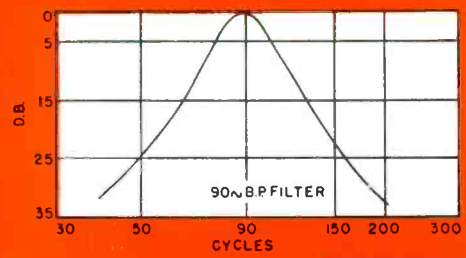




MINIATURIZED AIRCRAFT FILTERS

The standard 90-150 cycle aircraft filters have been reduced in size and weight in UTC's miniaturization program. The curves below illustrate the frequency characteristics of these units.

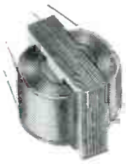




Ouncer case, non hermetic, is 7/8" diameter x 1 1/8" height. Weight — .06 lbs.

Ouncer case, hermetic, is 15/16" diameter x 1 3/8" height. Weight — .11 lbs.

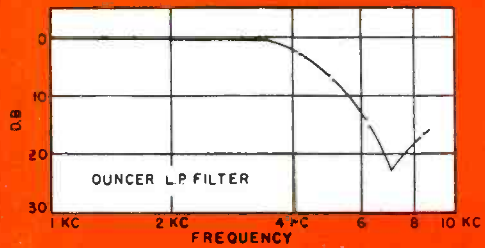
Miniaturized filter case is 1 11/16" x 13/16" x 1 5/8" height. Weight — .3 lbs.

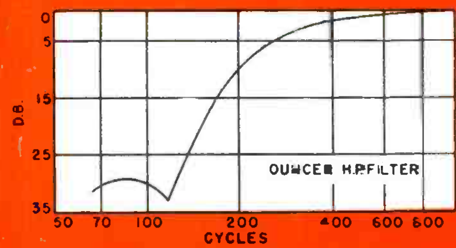


SM sub-miniature audio components, 7/16" x 1/2" x 7/16" height. Weight — .009 lbs.

OUNCER FILTERS

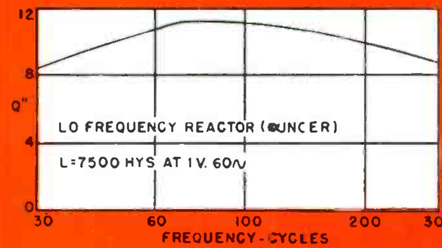
Filter miniaturization is a specialized art. The curves below show a low pass filter and a high pass filter being supplied in the UTC ouncer case.

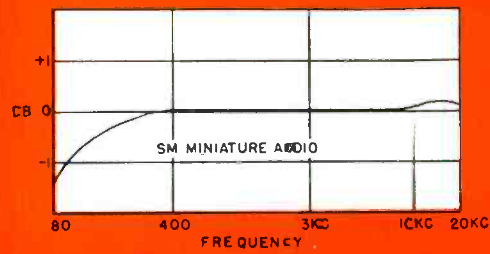




EXTREME MINIATURIZATION

Through the use of specialized materials, extremely compact designs are possible. The curve below illustrates the Q characteristics of a 7500 hy. low frequency reactor housed in the UTC ouncer case.





The sub-miniature audio transformer whose frequency curve is shown above, weighs less than one-seventh of an ounce yet provides wide range frequency characteristics. Its impedance ratio is 500 to 50,000 ohms for operation into a 1/2 meg. loaded grid.

United Transformer Co.

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WAVEGUIDE TEST EQUIPMENT .... COVER
Test equipment items developed by the Polytechnic Research and Development Co., Inc. permit microwave measurements over a thirty-to-one frequency range. Photograph by Gerald P. Oddo and Henrietta P. Kravis. (See page 138)

SELECTING AN INDUSTRIAL TRADEMARK, by A. S. Greenberg 82
How to save time and money when choosing one

HORN ANTENNAS FOR TELEVISION, by Dean O. Morgan 84
Eight-foot receiving horn provides over 14-db power gain on channel 13

NEW UHF RESNATRON DESIGNS AND APPLICATIONS, by D. B. Harris 86
Use as high-power uhf amplifiers for tv and military applications is described

SOUND WAVES TEST CYLINDER HEADS 90
Differences in sonic frequencies are used for precision comparison to a standard

MODIFIED BUTTERFLY UHF-TV CONVERTER, by Matthew Slate 92
Compact unit provides continuous tuning over proposed uhf television band

MULTIPLEXED BROADCAST FACSIMILE by John V. L. Hogan and John W. Smith 97
New York State network employs ultrasonic subcarrier without degrading 15-kc audio programs

VARIABLE PULSE DELAY FOR RADAR RANGING, by James Gordon 100
Delay is obtained with range from microseconds to milliseconds and maximum error of 0.3 microsecond

PRECISION MEASUREMENT OF SHAFT SPEEDS, by Oliver V. Riley 104
High degree of accuracy is obtained by using standard WWV tone for comparison

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Gives gain of 12.5 db over entire range of 470 to 890 mc and improves noise figure 4 db

MINIATURE TRAVELING-WAVE TUBE, by Robert Adler 110
Broad-band amplifier tube is true traveling-wave type operating between 100 and 1,000 mc

WIDE-RANGE SWEEPING OSCILLATOR, by Louis A. Rosenthal 114
All-purpose single-tone or wobbled audio generator uses thermistor and Thyrite or Varistor elements

HIGH-POWER UHF-TV KLYSTRON, by Engineering Staff of Varian Associates 117
Development of 5-kw cascade tube used in commercial uhf-tv transmitter

SELF-GENERATING ACCELEROMETERS, by G. K. Guttwein and A. I. Dranetz 120
Advantages of piezoelectric barium titanate units include useful range from 0.022 to 600 g

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Gives directly values required when combining two capacitors to get particular overall temperature coefficient

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October, 1951 — ELECTRONICS — Vol. 24, No. 10

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Marion portable, bench-type induction soldering unit . . . .

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A PRODUCTION TOOL This unit was designed to simplify and improve both the quality and quantity of production of many different assemblies in the electronic and electrical fields. It has been used successfully for many years in the manufacture of Marion hermetically sealed instruments. Assembly applications include magnet assemblies, relay armatures, connectors, capacitors and transformer cans and germanium diode assemblies; also jewelry, watches, toys, automotive parts, household fixtures, etc.

HERMETICALLY SEALED COMPONENTS Because of the present intense interest in hermetically sealed components, Marion offers the benefit of its experience in true glass-to-metal hermetic sealing with the Marion Induction Soldering Unit and Marion metalized (platinum film) glass. Marion platinum film base glass has been developed to permit higher sealing temperatures, greater thermal shock range and resoldering if necessary.

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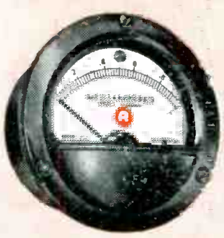

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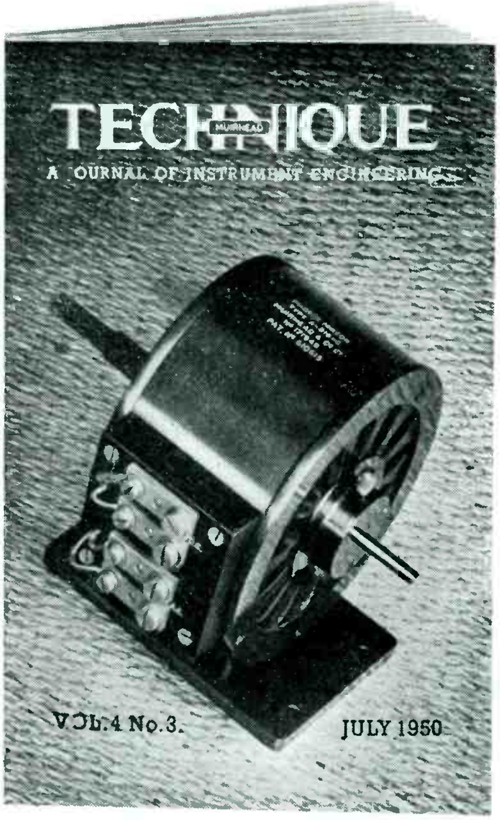

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ELECTRONICS 55

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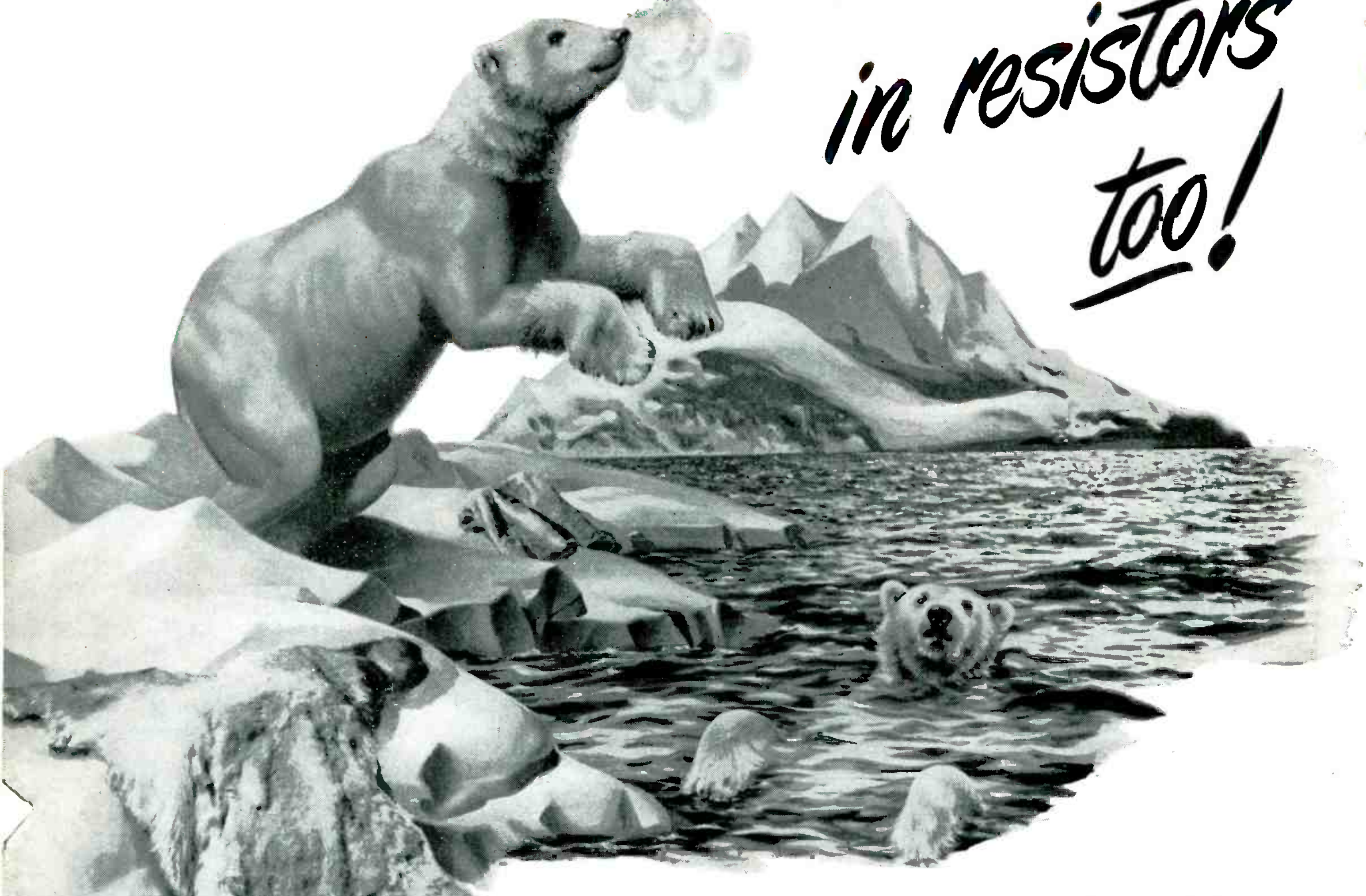
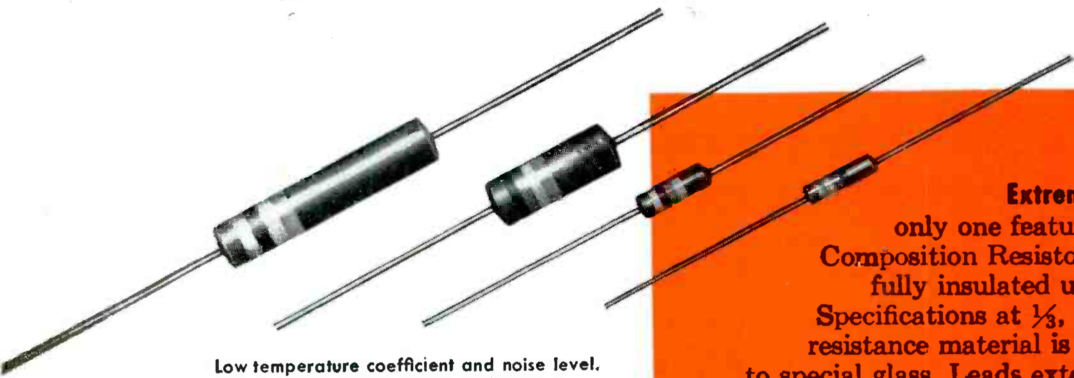
Low temperature is

in resistors too!



Any resistor can reduce voltage and dissipate heat. Amazingly few can do it without overheating themselves! Chief among those who *can* are IRC Resistors. Advanced, yet practical design—unusual use of heat-dissipating materials—and a rigid quality-control system—all combine to give these resistance units low operating temperatures, greater efficiency and longer life.



Low temperature coefficient and noise level. Meet and beat JAN-R-11 Specifications.

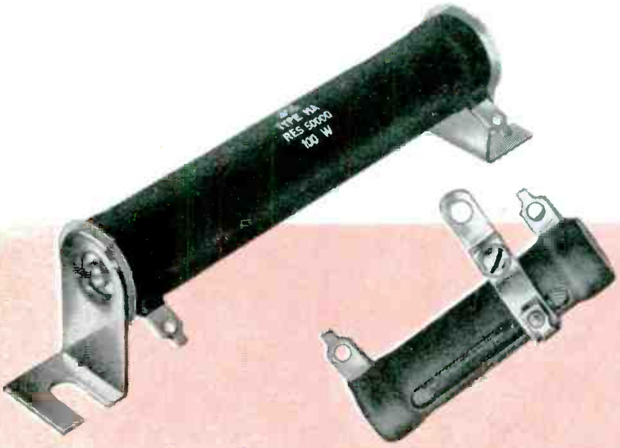
⅓, ½, 1 and 2 watts—available in ±5%, ±10%, and ±20% tolerance.

Easily meet critical requirements of television.

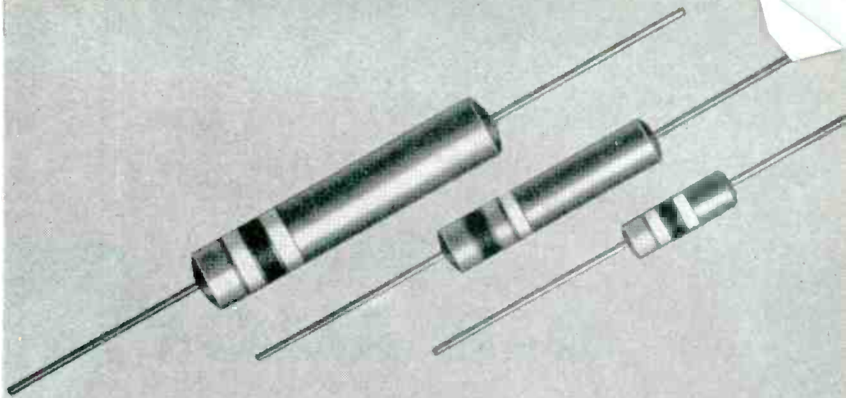
Fully tested by independent agencies under actual field conditions.

Extremely low operating temperature is only one feature of Advanced Type BT Fixed Composition Resistors. These compact, lightweight, fully insulated units actually surpass JAN-R-11 Specifications at ⅓, ½, 1 and 2 watts! In BT's, the resistance material is permanently cured and bonded to special glass. Leads extend into filament for faster heat conductivity. Molded bakelite seals element against moisture and prevents grounding. BT's are available in standard RTMA resistance ranges. Send for full details in 12-page technical data Bulletin B-1.

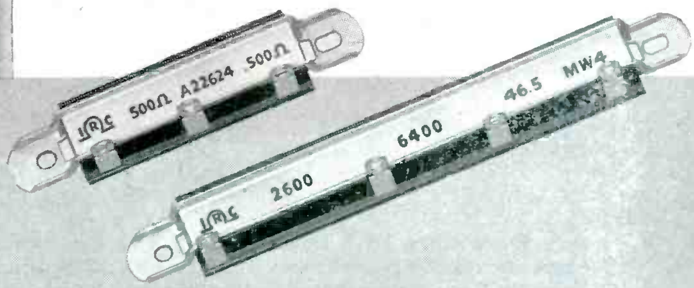
essential



Besides unusually rapid dissipation of heat, IRC Fixed and Adjustable Power Wire Wound Resistors give balanced performance in every characteristic. Special cement coatings are designed for low range high temperature requirements—or for maximum protection against extreme atmospheric conditions. For exacting, heavy-duty applications—high voltage bleeders, bias supply, grid and filament dropping resistors—PWW's are available in a full range of sizes, types and terminals. Leading industrial, aircraft and broadcasting users have specified them for more than 14 years. Technical data Bulletin C-2 gives complete information.

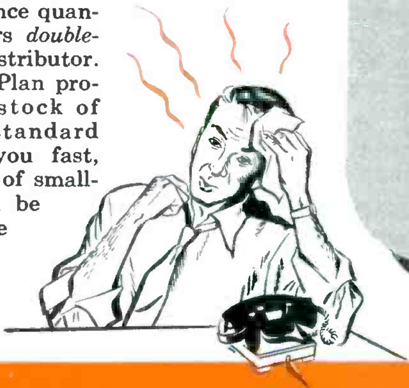


Temperature coefficients cover many resistance values in IRC Type BW Insulated Wire Wound Resistors. At ½, 1 and 2 watts, they are exceptionally stable, economical units for low range applications such as meters, analyzers, spark suppression units, TV circuits, low power ignition circuits. Resistance elements are wound uniformly on insulated core. Molded phenolic housing protects against humidity and grounding. Noise and aging are negligible. Technical data Bulletin B-5 contains full details.



For extremely fast heat dissipation, the unique mounting brackets of Type MW Wire Wound Resistors actually transfer heat from chassis to outside. Other radical departures from conventional design give MW's widest adaptability to individual requirements. MW's are flat wire wound resistor strips, permanently enclosed by high pressure molding in a special mica-filled phenolic compound. Special feet permit mounting on any flat metal surface. Low initial cost, lower mounting cost, flexibility in providing taps at low cost, and savings in space, all offer amazing economies. Ask for technical data Bulletin B-2.

When you're in a hot spot and need experimental or maintenance quantities of standard resistors *double-quick*, phone your IRC Distributor. IRC's Industrial Service Plan provides him with a full stock of uniformly dependable standard resistors; he can give you fast, round-the-corner delivery of small-order requirements. We'll be glad to send you his name and address.



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- ☐ BW Resistors (B-5)
- ☐ Power Wire Wounds (C-2)
- ☐ MW Resistors (B-2)
- ☐ Name and Address of nearest IRC Distributor

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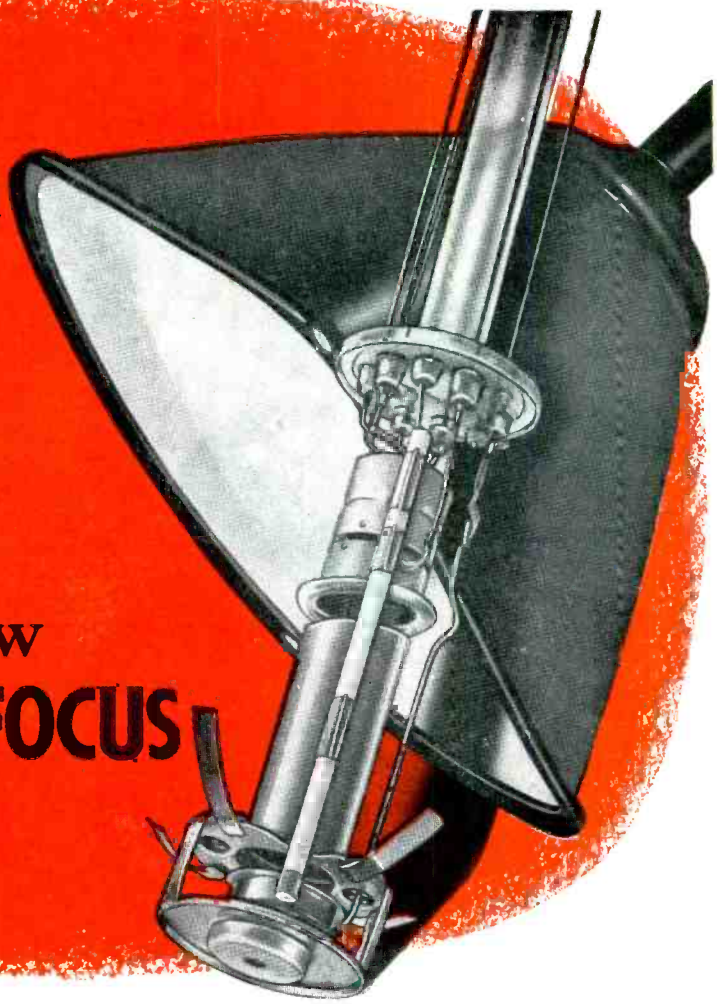
Again a **D-H ALLOY** contributes as **RCA** introduces new **ELECTROSTATIC-FOCUS** TV TUBES



Once more, RCA leads the field! This time, with new rectangular picture tubes which require no focusing coil or focusing magnet . . . thus effecting important savings in critical materials.

The currently used magnetic focus in TV sets requires coils and magnets containing the metals cobalt and copper . . . both on the Government's restricted list.

To meet the shortages, RCA engineers have developed improved electrostatic focusing for wide-deflection-angle TV tubes—eliminating need for a focusing magnet or coil. Result: The new RCA kinescopes—which not only make possible savings in critical materials, but introduce advantages that destine them to become industry's most widely used picture tubes.

Such advantages, for example, as: (a) An improved electron gun which provides excellent uniformity of focus over the entire picture area, and is so designed that the focusing electrode takes negligible current—permitting voltage for the electrode to be supplied easily and economically; (b) Focus automatically maintained with variation in line voltage and adjustment of picture brightness; (c) Simplification of tube installation and adjustment for optimum performance.

When RCA produced its outstanding Image Orthicon, "eye" of the television camera, it called upon the superlative Driver-Harris radio alloy Nichrome* V to provide 95% of the metal components of the tube. Now, in the case of the kinescopes, a Driver-Harris produced alloy fills a need.

Here are typical examples of how Driver-Harris stands ready to serve all industry with alloys necessary for new or standard applications.

During the present emergency, of course, strategic materials and the alloys made from them are on strict allocation. However, we shall be glad to make recommendations based upon your specific needs, and serve you to the best of our ability.

Makers of world-famous Nichrome and over 80 other alloys for the electronic, electrical and heat-treating fields*

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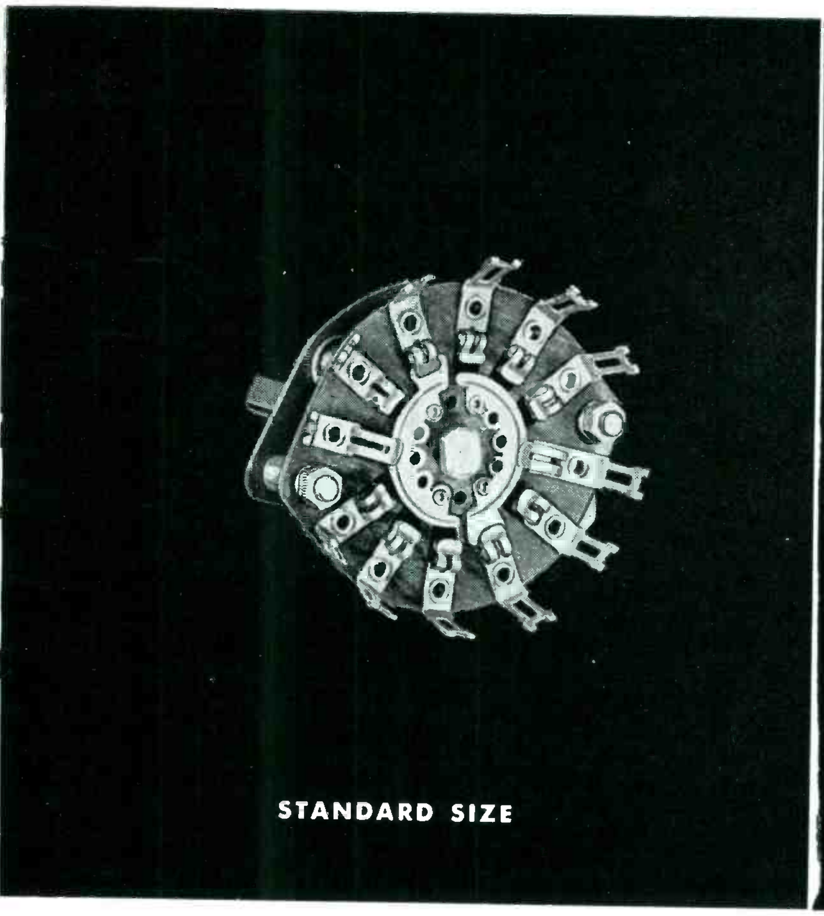
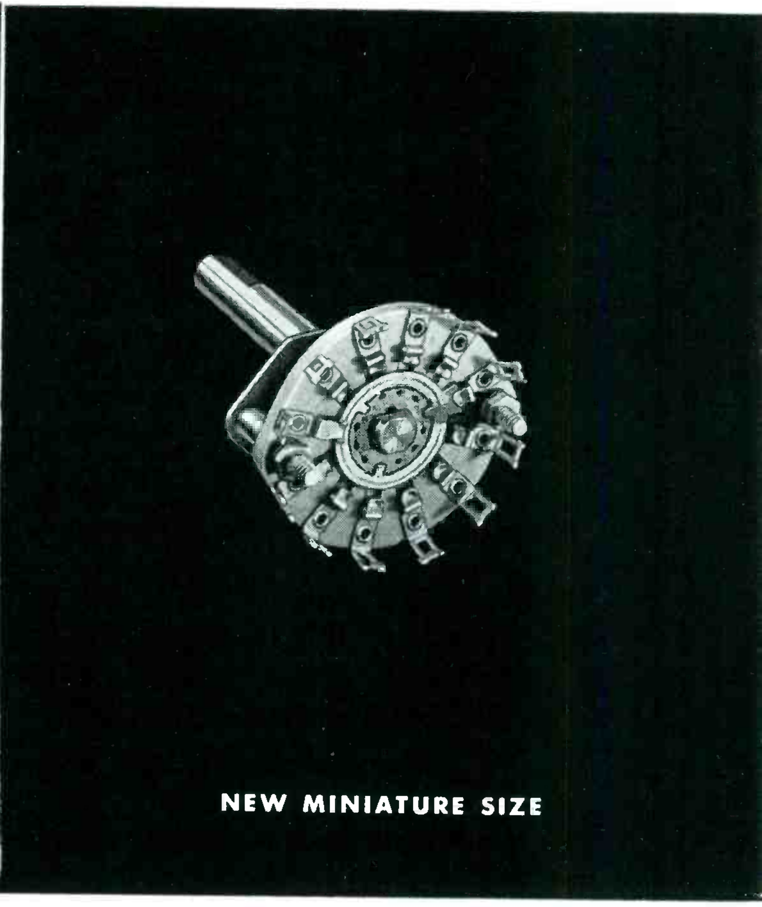
NEW
MINIATURE SWITCHES
BY CENTRALAB





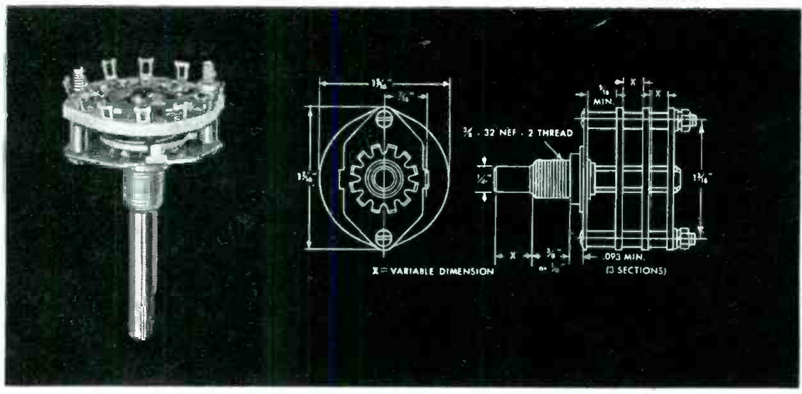
Now, Centralab, the first name in Electronic Components, offers new design possibilities in an entirely new line of truly miniature, top-quality, rotary switches for radio, TV and similar high-frequency, low-power applications.

WANT MORE INFORMATION? **SEE NEXT 2 PAGES ➡**

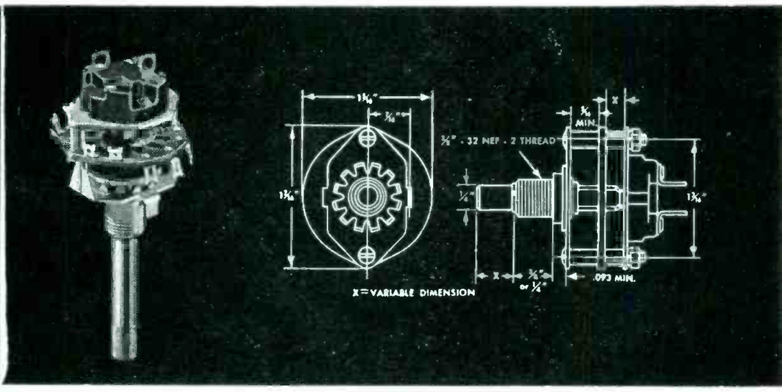
NEW LINE OF MINIATURE SWITCHES

MILITARY APPLICATIONS

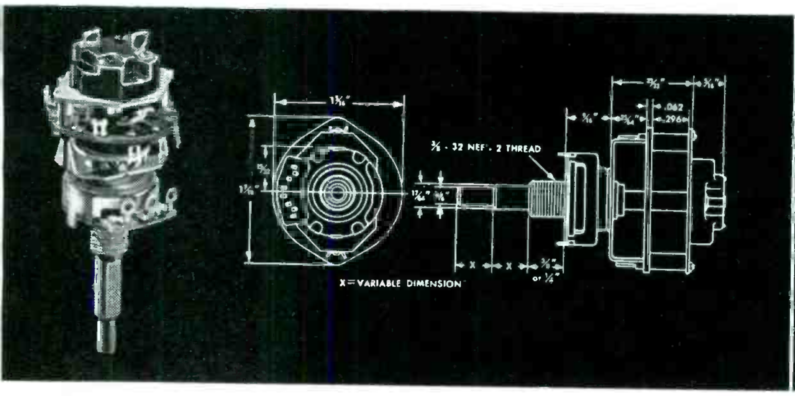
Now Centralab offers a completely new, unusually small rotary switch line — available in a variety of multi-pole, multi-position, multi-section models and in combination with line switches and variable resistors.



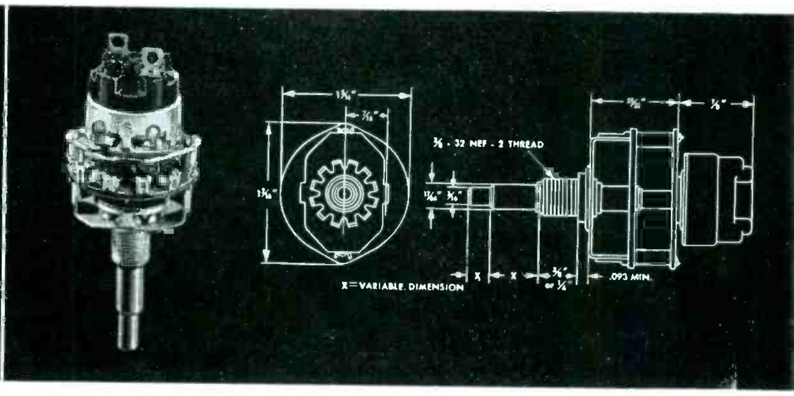
New Centralab Series 20, miniature, single steatite section switch. Available in 2 to 11 positions with stops, or 12 position continuous rotation — and with multiple sections.



Here's standard Series 20 miniature switch with standard shaft and phenolic section with conventional off-on switch added. Also available with multiple sections.



Combination Series 30 miniature switch unit with dual concentric shaft — permits independent operation of miniature switch including off-on switch, and Model 2 variable resistor.



Same combination Series 30 unit as shown at left, *except* that Model 2 variable resistor is mounted at rear of miniature switch. Position of resistor provides convenience of wiring.

If you need a truly small size, long-life switch, Centralab's new miniature Series 20 and Series 30 switches are the answer. They have been specifically designed to meet the modern trend toward greatly reduced size in electronic equipment for high-frequency, low-current applications. Extremely compact design and small size, plus availability of separate sections and index assemblies provide an adaptability that is invaluable to design engineers and manufacturers. For complete specification information on the new Centralab Miniature Series 20 and Series 30 Switch line, mail the coupon today. *Manufacturer's samples promptly.*

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Please send me complete specification information on Centralab's new Series 20 and Series 30 Miniature Switch line.

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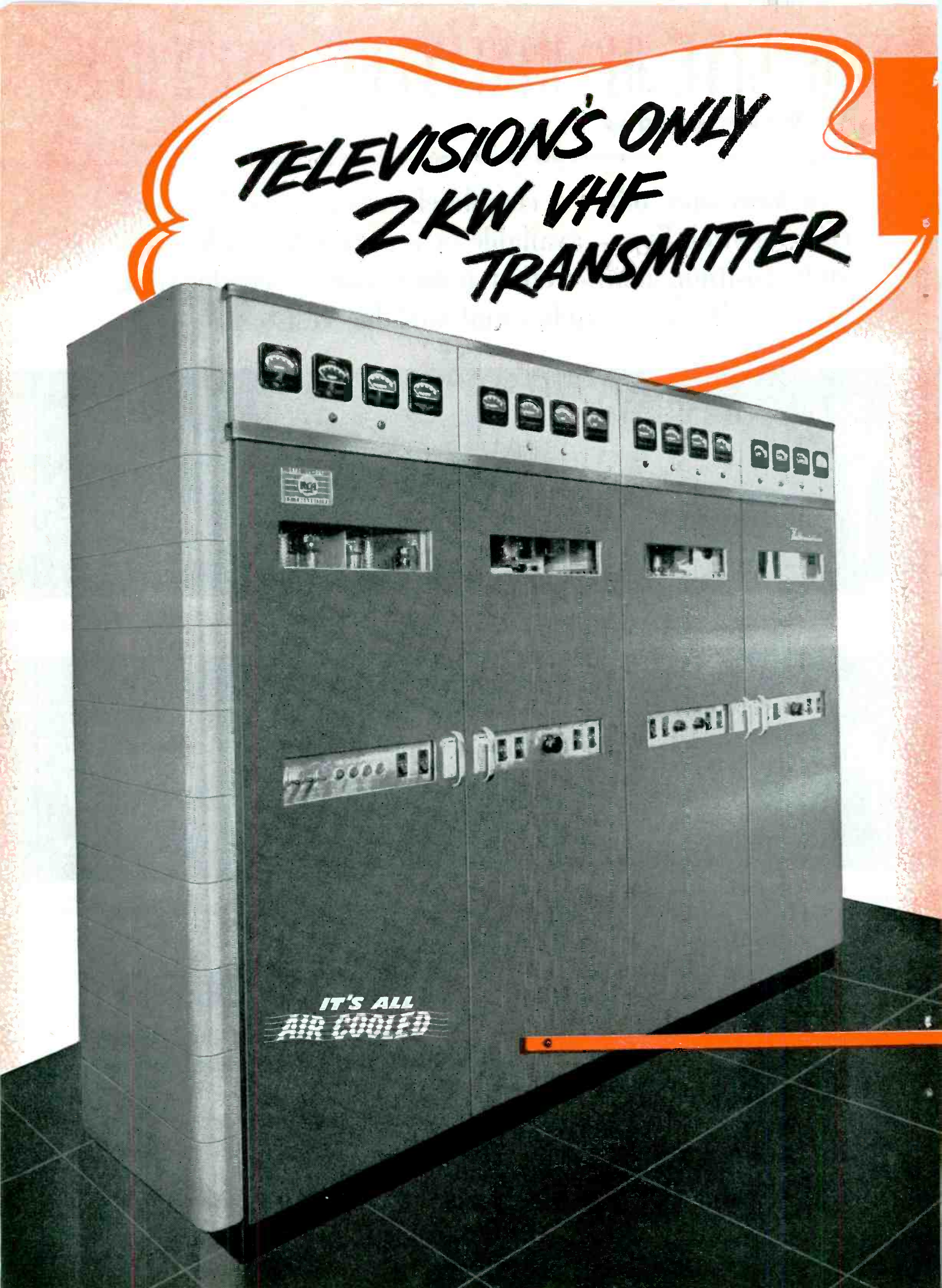
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2 KW VHF
TRANSMITTER
IT'S ALL
AIR COOLED

for 2 to 20 kilowatts ERP*

If you plan to start TV station operations with a modest equipment investment . . . and still be sure you get adequate signal coverage . . . this new "2 kw" is a logical, economical solution to your problem. Initial equipment expense is lower than that of most TV stations on the air today. And tube costs are low—*because all the tubes are standard types.*

Used with RCA's popular and inexpensive high-gain 3-section Super Turnstile Antenna, this transmitter produces 5 kilowatts ERP—at the lowest cost per radiated kilowatt in TV history. Used with RCA TV antennas of higher gain, this transmitter provides up to 20 kw ERP!

Why not ask your RCA Broadcast Sales Specialist to help you with your planning. He can tell you precisely what you'll need to go on the air—and how to do it at lowest cost. Make use of his "know-how." Call him today.

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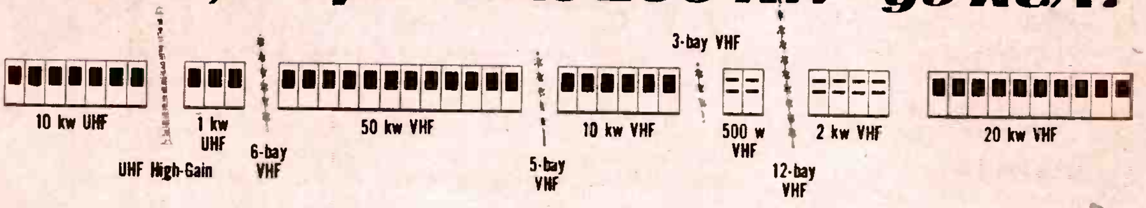
For any TV power to 200 KW—go RCA!



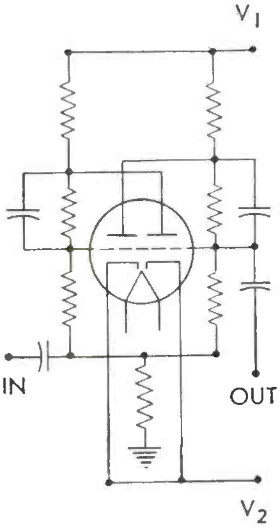
The heart of the "2 kw"—
the forced-air-cooled triode, RCA-5762

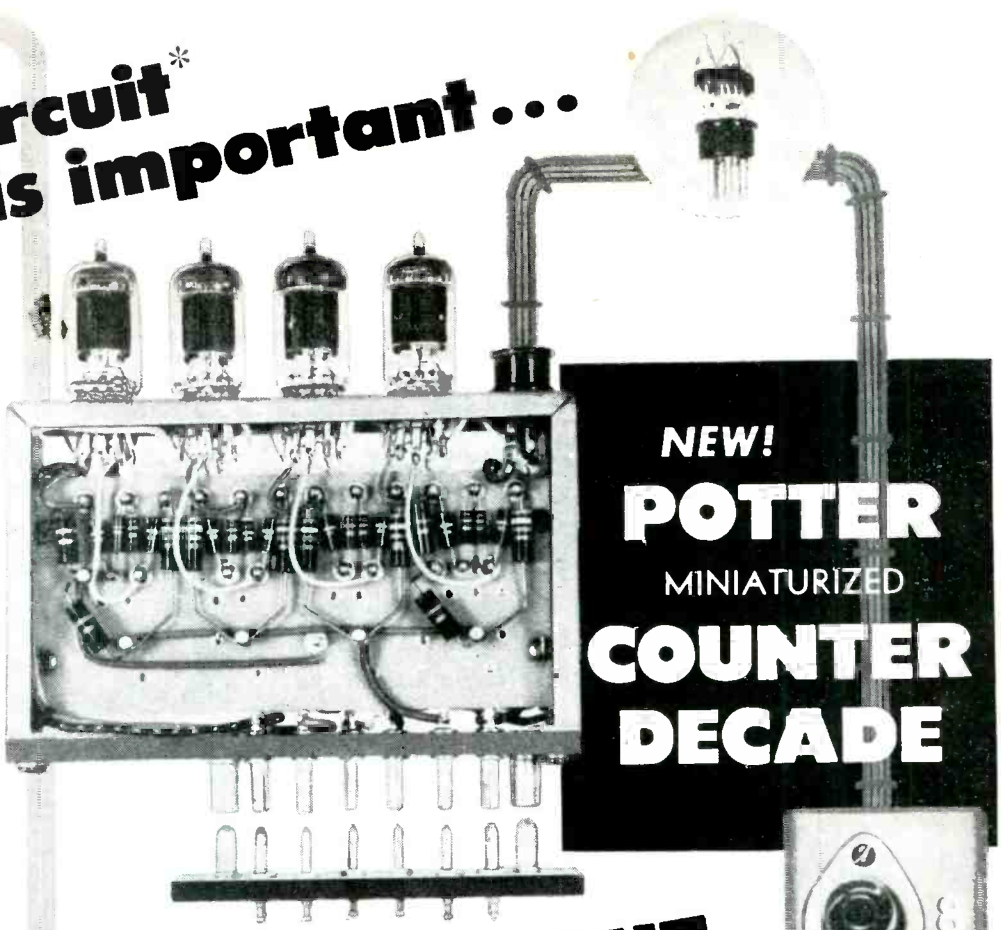
This service-proved triode features sturdy internal construction—and a very efficient plate radiator. The tube takes less than half the air flow previously needed for a tube having the same power-handling capability. And it's available through any RCA Tube Distributor!

RADIO CORPORATION of AMERICA
ENGINEERING PRODUCTS DEPARTMENT **CAMDEN, N.J.**

The Circuit* is important...

*Manufactured under U.S. Patent 2538122 and other patents pending.





DEPENDABLE
Widest possible bias range results from grid input, common tie-point feed, simple feedback circuit and elimination of a complex readout matrix—all exclusive Potter features.

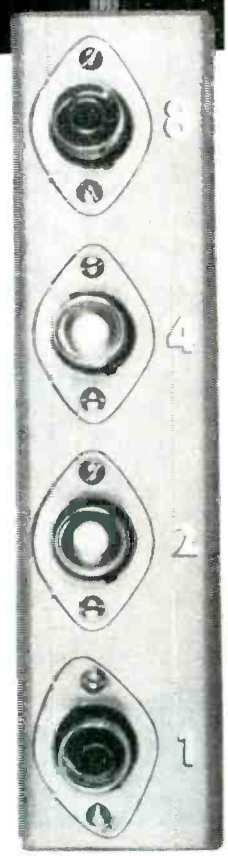
FAST AND ACCURATE
Absolute accuracy up to 130,000 counts per second assured by self-biasing under wide excursions of line voltage.

SIMPLE AND STRAIGHTFORWARD
Minimum number of components, all turret-lug mounted, in a true binary-coded decimal reset circuit.

COMPATIBLE
Binary-decimal coding (1-2-4-8) directly usable in computers, recorders and data-handling systems.

EASY TO MAINTAIN
Tube failure "locks-up" the decade and furnishes instantaneous identification through the on-off synchronization of neons and tubes, thus simplifying replacement.

...this READ-OUT really counts!



Four ultra-visible neons, coded 1-2-4-8, are read as decimals with unerring ease—provide a swift check on tube operation.

This unique decimal read-out offers unparalleled observability. The lamps are brilliant and significant under high ambient lighting at oblique angles and from remote distances. No other visual indicator can be read faster or with less chance of error.

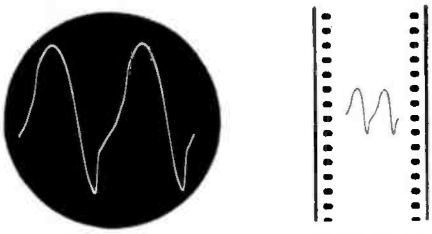
The indicating lamps couple with the decade stages and follow the true binary progression of count. Trouble in any stage is instantaneously reflected in its associated lamp. The lamps themselves are free from marginal voltage limitations.

In addition to a space-saving of one-third, the newly miniaturized decade provides a read-out adaptable to remote mounting. A small plug-in cluster of four neons is optional as a tube-servicing feature where frequency dividing, for example, makes a read-out unnecessary.

These electronic counting decades may be obtained as individual components. They are also available in complete counting, timing, computing or frequency-measuring systems. Detailed information or technical assistance will be provided upon request to Dept. 6E.

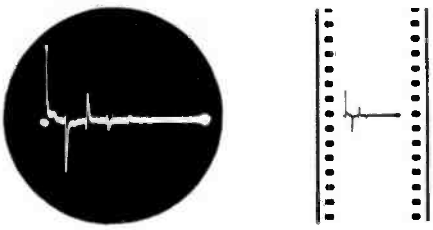
POTTER INSTRUMENT COMPANY
INCORPORATED
115 CUTTER MILL ROAD, GREAT NECK, NEW YORK

How much can you expect an oscilloscope camera to do?



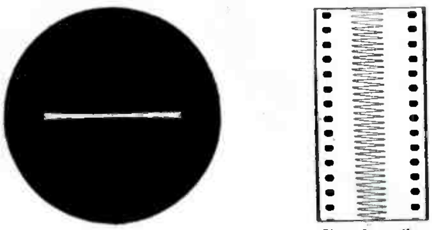
Scope Image — Film Recording

1. Single-frame photography of stationary patterns using a continuously running sweep.



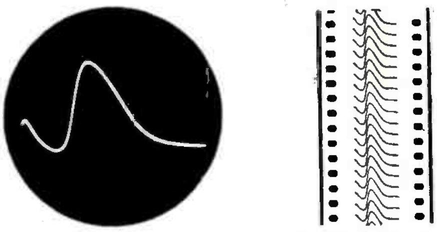
Scope Image — Film Recording

2. Single-frame photography of single transients using a single sweep.



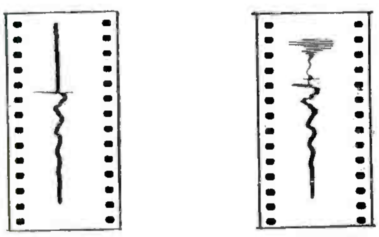
Scope Image — Film Recording

3. Continuous-motion photography employing film motion as a time base.



Scope Image — Film Recording

4. Continuous-motion photography employing oscilloscope sweep as a time base.



FILM MOTION TIME BASE — FILM MOTION & SCOPE SWEEP

5. Continuous-motion photography employing combination of film motion and oscilloscope sweep as a time base.

It's only reasonable that you should expect the oscilloscope camera you buy to record what you see on an oscilloscope screen during any period. But can it be expected to do any more? We think so.

For example, did you know that the *Fairchild Oscillo-Record Camera*—our idea of the most versatile 35-millimeter oscilloscope camera now available—can GREATLY EXTEND THE USEFULNESS OF YOUR OSCILLOSCOPE?

As you know, many non-recurring phenomena occur too rapidly to permit adequate visual study. Others occur so slowly that continuity is lost. Sometimes you have combinations of very slow-speed phenomena and occasional high-speed transients. In any one of these cases, the Fairchild Oscillo-Record Camera will take over where your eye and the oscilloscope leave off.

This extremely versatile instrument is now being used daily by many hundreds of engineers in widely divergent fields. For an idea of what it can do for you, study the five scope images and recordings illustrated at left. Each solves a particular problem.

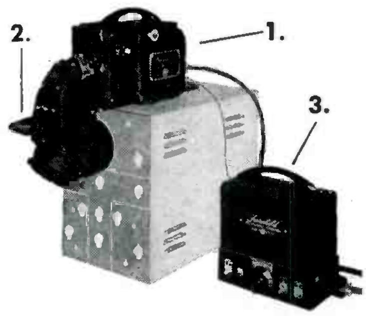
Oscillo-Record users especially like its:

CONTINUOUSLY VARIABLE SPEED CONTROL—1 in./min. to 3600 in./min.

TOP OF SCOPE MOUNTING that leaves controls easily accessible.

PROVISION FOR 3 LENGTHS OF FILM—100, 400, or 1000 feet.

For more data write *Fairchild Camera Instrument Corp., 88-06 Van Wyck Blvd., Jamaica 1, N. Y. Dept. 120-16A.*

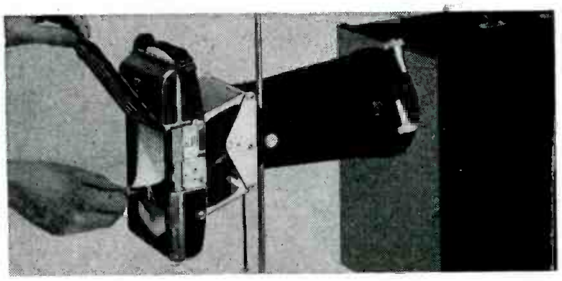


FAIRCHILD OSCILLO-RECORD CAMERA—1. camera, 2. periscope, 3. electronic control unit. *Available accessories* include external 400 and 1000 foot magazines, magazine adaptor and motor, universal mount for camera and periscope, binocular split-beam viewer.

VALUABLE RECORDS FOR IMMEDIATE EVALUATION

The Fairchild-Polaroid® Oscilloscope Camera produces a photographic print in a minute

Valuable but inexpensive oscillograms for immediate evaluation; automatic one-minute processing without a darkroom; a set up time of two minutes or less—they're just three of the many advantages that are yours when you use the Fairchild-Polaroid Oscilloscope Camera. Wherever individual exposures meet your recording requirements—where you'd like to have permanent records of the traces you're now sketching or carrying in your memory, this is the camera that can bring new speed, ease and economy to your job. Prints are 3¼x4¼ and each records two traces exactly one-half life size. Write today for details.



A minute after you've pulled the tab a finished print is ready for evaluation

FAIRCHILD

OSCILLOSCOPE RECORDING CAMERAS

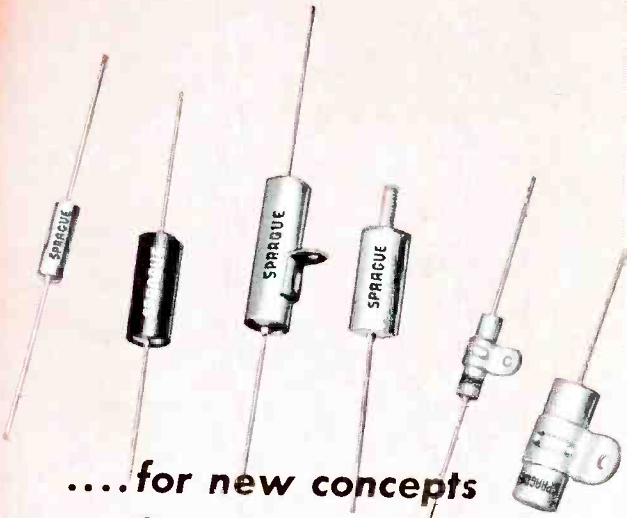
Ahead of and beyond JAN...

Sprague has developed many new ways to reduce size and weight and to improve the high-temperature performance of components

Joint Army and Navy component specifications were never meant to limit engineering progress—and, with Sprague, they most certainly haven't!

The extent of what has been achieved is no better indicated than by the fact that much of Sprague's vast military-use production is based on capacitors, wire-wound resistors and high-temperature wire insulation for which no standard JAN specifications yet exist! These are, in effect, super-JAN—fully approved via waivers to the equipment manufacturers. Such components are being produced and used in ever increasing quantities.

If your problem is one that can be solved by smaller, lighter components or by better elevated temperature performance, chances are excellent that a Sprague application engineer can help you.



....*for new concepts of equipment design*

Typical of Sprague engineering progress ahead of and beyond JAN limits are these famous subminiature, hermetically-sealed, metal-encased paper capacitors. Far smaller than equivalent JAN styles and available in types for 85°C. and 125°C. operation, these capacitors have helped make possible a long list of military electronic equipment, which never could have met size and weight limitations prior to the development of these capacitors. Sprague Bulletin 213-B gives full technical data.

SPRAGUE

PIONEERS IN ELECTRIC AND ELECTRONIC DEVELOPMENT

SPRAGUE ELECTRIC COMPANY • NORTH ADAMS, MASSACHUSETTS

FXC

OUTLINE OF ESTABLISHED AND POTENTIAL APPLICATIONS

WRITE FOR BULLETIN

OUTLINE OF APPLICATIONS	RECOMMENDED FERROXCUBE MATERIAL	SHAPE
1 TELEVISION FLYBACK CIRCUITRY		
a) Flyback transformers	3C	U-Core
b) Deflection yokes	3C	Ring segment
c) Correction coils—to improve sawtooth linearity	3C	Slug
2 RADIO RECEIVERS		
a) I F Transformers	Depends upon Frequency	Slug
b) R F Tuning Coils		Slug
i) fixed L		
ii) permeability tuning		
c) Antenna cores	4B	Rod
3 TELEPHONY (Voice Frequency and Carrier)		
a) Interstage transformers	3C	E-Core
b) Transformer for matching to co-axial cable	3C	E-Core
c) Loading coils	Special grade	Pot-Core
d) Filter circuits (not limited to telephony)	Special grade	Pot-Core
e) Delay lines (not limited to telephony)	Special grade	Pot-Core
4 PULSE NETWORKS AND TRANSFORMERS		
a) Signal-shaping	Depends upon Pulse width	Simple closed magnetic circuit
b) Power—to feed magnetron directly—built up from Ferroxcube rods		
c) Low-power—e.g., in computer applications	Special grade	
5 MODULATION APPLICATIONS		
a) Use of loss effects to achieve AM without FM in modulating Klystron output	4B	Rod
6 APPLICATION OF NON-LINEAR EFFECTS—e.g., in saturable core reactors	4B	Toroid or rod with saturating circuit
a) Permeability tuning of diathermy apparatus		
b) Pulse generation from sine waves		
c) Magnetic amplifiers and saturable core reactors		
7 RECORDING HEADS		
8 IGNITION COILS		
a) Automotive		
b) Aircraft		
9 MAGNETOSTRICTION APPLICATIONS		
a) Band-pass filters		
b) Transducers		

FERROXCUBE

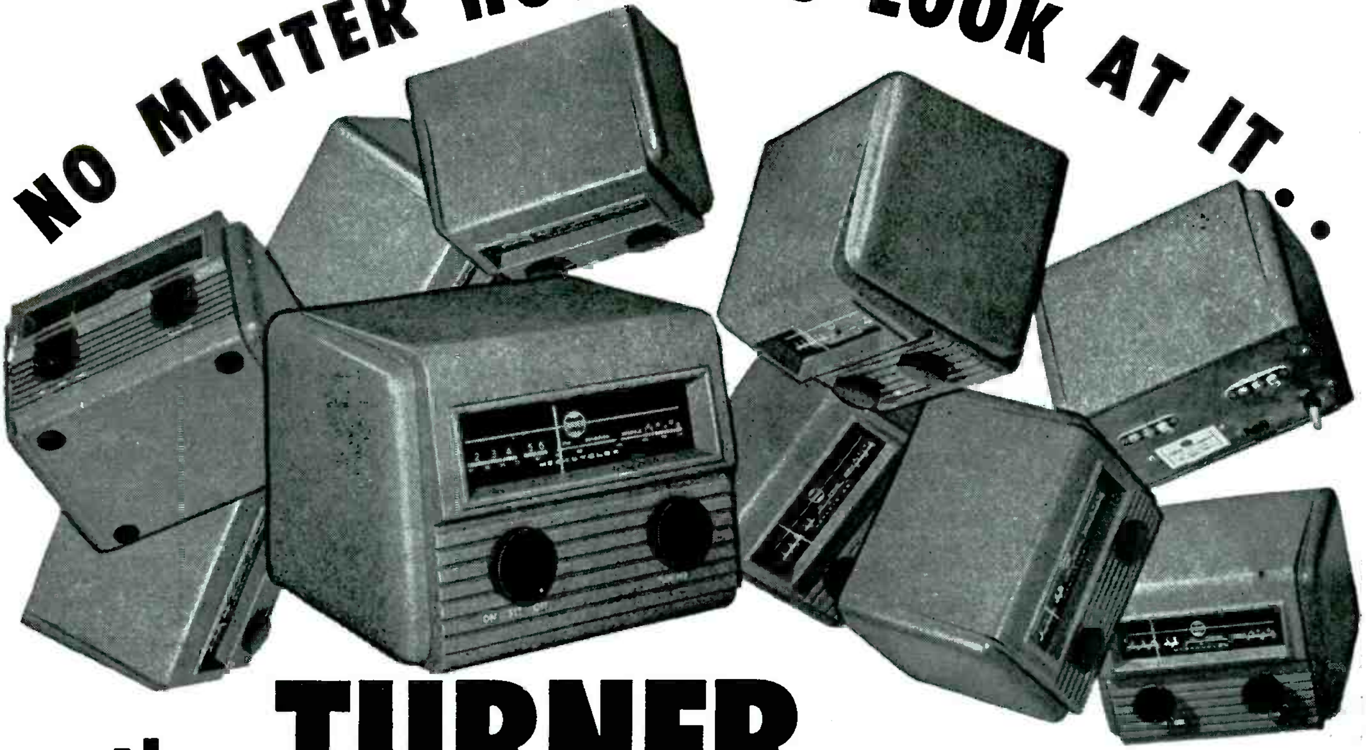
THE MODERN CORE MATERIAL

FERROXCUBE CORPORATION OF AMERICA

A Joint Affiliate of Philips Industries and Sprague Electric Co., Managed by Sprague

50 East 41st Street • New York 17, New York • Factory: Saugerties, New York

NO MATTER HOW YOU LOOK AT IT..



the TURNER is a better BOOSTER!

From every angle the new Turner Model TV-1 Booster is the finest on the market today. Under the worst possible fringe area receiving conditions, the TV-1 consistently produces sharper, clearer pictures and crisper, more natural sound.

There are many reasons for the superiority of the Turner Booster, but the two most important are advanced electronic engineering and finest construction using only high quality component parts.

Turner's low-noise-level **cascode** circuit stabilizes the picture, reduces noise and snow to a minimum.... makes viewing a real pleasure.

The Turner TV-1 is simple in operation. A single tuning knob permits fine adjustment for the best reception of picture and sound over all 12 TV channels. And because it tunes continuously from 54 to 216 megacycles, you can use the TV-1 to amplify FM, aviation and mobile radio signals. Three position control switch turns on the TV set only, the TV set and Booster, or shuts off both set and Booster.

The unit is quickly and easily installed. Attaches to any television set. Attractive styling and neutral finish harmonize with any furniture design.

CHECK THESE SUPERIOR FEATURES

Continuous Tuning - single knob control for finest adjustment to permit best possible reception of both picture and sound.

Cascode Circuit - inherent low noise level circuit with great stability and high signal-to-noise ratio.

Construction - finest quality materials carefully assembled to rigid Turner standards assure years of continuous, repair-free use.

Appearance - handsome cabinet designed to harmonize with any furniture design and finish.

Uses - amplifies FM, mobile and aviation radio signals as well as TV.

Results - most important, the Turner TV-1 produces an excellent picture under conditions which nullify the best efforts of many other boosters.

List Price $57.50

FOR THE BEST POSSIBLE TV RECEPTION, TURN TO

THE TURNER BOOSTER

THE TURNER COMPANY, 905 17th Street, N. E. Cedar Rapids, Iowa

In Canada: Canadian Marconi Co.,
Toronto, Ont., and Branches

Export: Ad. Auriema, Inc.
89 Broad Street, New York 4

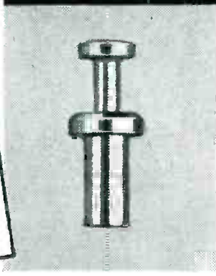
NOW! Fill Your Needs

FOR ALL TYPES OF ELECTRIC AND ELECTRONIC COMPONENTS

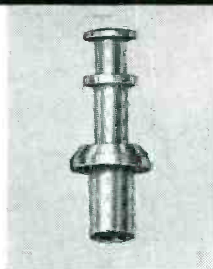
custom or standard the guaranteed components

CTC

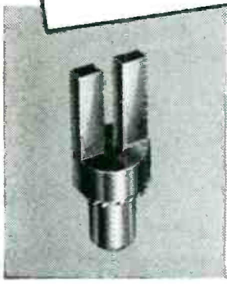
SILVER-PLATED BRASS TERMINAL LUGS



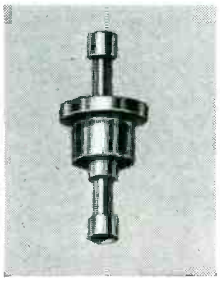
Short Lugs. For low "headroom" applications. Mounted heights from 3/32". In shank lengths for 6 board thicknesses, starting with 1/64".



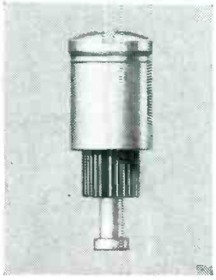
Turret Lugs. With 2 soldering spaces for 2 or more connections. Sizes range from 1/32" to 1/4" terminal board thicknesses. Mounted heights from 7/32".



Split Lugs. For potted units where later soldering is advisable. Also standard applications. Hole through shaft allows top or bottom wiring. Fit standard board thicknesses from 1/64" through 1/4". Mounted heights from 5/32".

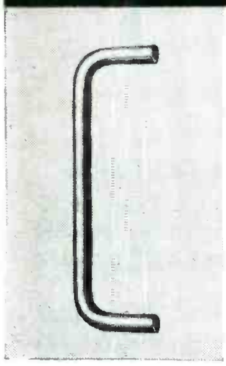


Double End Lugs. Provide terminal posts on both sides of board. Through connection for easy wiring. For board thicknesses from 1/32" to 1/4". Mounted heights from 5/32".



Combination Lug. Removable screw permits mounting components directly to screw end. Also provides removable link connections at screw end. 3 sizes, 5/16", 11/32", 3/8" diameter. Bright alloy plated for easy soldering.

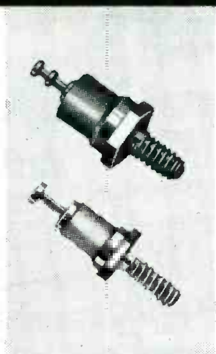
HARDWARE



Handles in nickel-plated brass are available in 3 sizes ranging from 3 5/16" length to 6 3/4" length. Black alumilite aluminum handle available in 4 3/8" length. Ferrules available on brass and aluminum handles.

Other Hardware includes tube clamps, panel and thumb screws, combination screw and solder terminals, shaft locks, terminal board brackets, standoff mounts, etc.

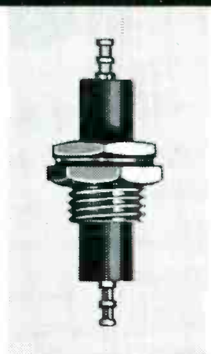
INSULATED TERMINALS



Phenolic. 1/4" diameter, in rivet or screw stud type. Voltage breakdown from 4800 — 11,000 V at 60 cycles RMS.

Ceramic. Silicone impregnated. 5 lengths of dielectric. Voltage breakdown ratings up to 5800 V. Over-all heights range from 3/8", including lug. For high electrical stresses over a broad humidity range. Cadmium plated studs. Brass terminals plated for soldering.

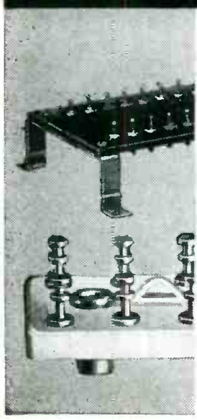
INSULATED FEED THROUGHS



Phenolic. Approved XXX material. Brass bushings, nickel plated. Brass through-terminals, silver plated for easy soldering. Rugged, withstand shock and vibration. Two sizes: for 1/4" and 3/8" mounting holes.

Ceramic. Silicone impregnated. Threaded for 1/4" hole mounting. O.A. length 7/8". Voltage breakdown 4800 RMS at 60 cycles.

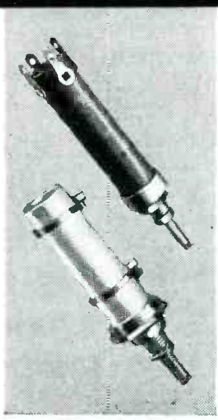
TERMINAL BOARDS



Phenolic. Available in various widths and terminal arrangements from 1/2" wide to 3" wide. Thicknesses: 3/32"; 1/8"; 3/16". All boards in 5 sections scribed for easy separation. Special boards made to your specifications.

Ceramic. Silicone impregnated. Type X1986 with 8 lugs staked in two rows. Standoffs riveted and soldered to ground strap for good grounding at R.F. frequencies. 1 1/4" long, 7/8" wide. All metal parts plated. O.A. mounted height: 35/64".

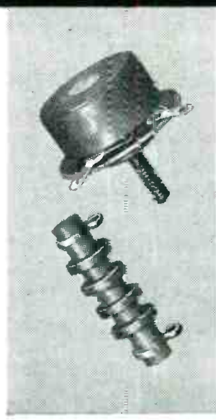
SLUG TUNED COILS



Phenolic. 3 sizes: 27/32"; 1 1/8", and 2" high. 5 standard windings — also special windings or as high-quality phenolic coil forms.

Ceramic. Silicone impregnated. 5 sizes, mounted heights from 19/32" to 1 11/16", diameters from 3/16" to 1/2". Spring lock for slug. Cadmium plated mounting studs. Complete with mounting hardware and high, medium or low frequency slug.

R. F. CHOKES



LHC. High Q iron core with 6-32 mounting stud. 8 values from 2.5 mh to 125.0 mh. Wax impregnated.

LAB. Pie wound on phenolic core with cotter pin terminals. 8 windings .75 mh to 15.0 mh. Current rating 125 ma.

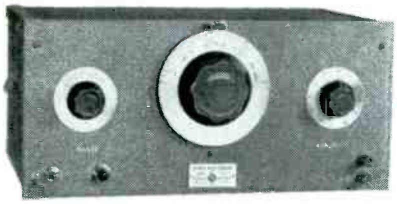
CUSTOM ENGINEERING	to your specifications or standard government specifications. C.T.C. Engineers will design all types of Boards, Coils, and Terminal Lugs for production in quantity to fill your needs. No extra charge for this service
WRITE FOR NEW CATALOG	For complete data and engineering drawings on these and other C.T.C. Electrical and Electronic Components and Hardware. No obligation.

CAMBRIDGE THERMIONIC CORPORATION, 437 CONCORD AVE., CAMBRIDGE 38, MASS.

West Coast Stock Maintained by: E. V. Roberts, 5068 West Washington Blvd., Los Angeles, California

Accurate ac test voltages ½ to 10,000,000 cps

Complete Coverage

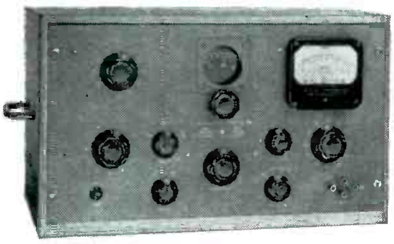


-hp- 200 Series Audio Oscillators

Six standard models, -hp- 200A and 200B have transformer-coupled output delivering 1 watt into matched load. -hp- 200C and 200D have resistance-coupled output and supply constant voltage over wide frequency range. -hp- 202D is similar to 200D, with lower frequency range. -hp- 200I is a spread-scale oscillator for interpolation or where frequency must be known accurately.

-hp- 650A Resistance-Tuned Oscillator

Highly stable, wide band (10 cps to 10 mc), operates independently of line or tube changes, requires no zero setting. Output flat within 1 db. Voltage range 0.00003 to 3 volts. Output impedance 600 ohms or 6 ohms with voltage divider.



-hp- 206A Audio Signal Generator

Provides a source of continuously variable audio frequency voltage with less than 0.1% distortion. Very high stability, accuracy 0.2 db at any level. Specially designed for testing high quality audio circuits, checking FM transmitter response and distortion, broadcast studio performance or as a low distortion source for bridge measurements, etc.

INSTRUMENT	PRIMARY USES	FREQUENCY RANGE	OUTPUT	PRICE
-hp- 200A	Audio tests	35 cps to 35 kc	1 watt/22.5v	$120.00
-hp- 200B	Audio tests	20 cps to 20 kc	1 watt/22.5v	$120.00
-hp- 200C	Audio and supersonic tests	20 cps to 200 kc	100 mw/10v	$150.00
-hp- 200D	Audio and supersonic tests	7 cps to 70 kc	100 mw/10v	$17[illegible].00
-hp- 200H	Carrier current, telephone tests	60 cps to 600 kc	10 mw/1v	$350.00
-hp- 200I	Interpolation and frequency measurement	6 cps to 6 kc	100 mw/10v	$225.00
-hp- 201B	High quality audio tests	20 cps to 20 kc	3 w/42.5v	$250.00
-hp- 202B	Low frequency measurements	½ cps to 50 kc	100 mw/10v	$350.00
-hp- 202D	Low frequency measurements	2 cps to 70 kc	100 mw/10v	$275.00
-hp- 204A	Portable, battery operated	2 cps to 20 kc	2.5 mw/5v	$175.00
-hp- 205A	High power audio tests	20 cps to 20 kc	5 watts	$390.00
-hp- 205AG	High power tests, gain measurements	20 cps to 20 kc	5 watts	$425.00
-hp- 205AH	High power supersonic tests	1 kc to 100 kc	5 watts	$550.00
-hp- 206A	High quality high accuracy audio tests	20 cps to 20 kc	+ 15 dbm	$550.00
-hp- 650A	Wide range video tests	10 cps to 10 mc	15 mw/3v	$475.00

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

Whatever ac test voltage you need—whatever frequency or magnitude you require—there is an *-hp-* oscillator or generator to provide the exact signal desired.

-hp- oscillators offer complete coverage, ½ cps to 10,000,000 cps. They are dependable, fast in operation, easy to use. They bring you the traditional *-hp-* characteristics of high stability, constant output, wide frequency range, low distortion, no zero set during operation.

-hp- oscillators and audio signal generators are used by manufacturers, broadcasters, sound recorders, research laboratories and scientific facilities throughout the world. For complete details on any *-hp-* instrument, see your *-hp-* sales representative or write direct.

HEWLETT-PACKARD COMPANY

2250A Page Mill Road **Palo Alto, California, U.S.A.**

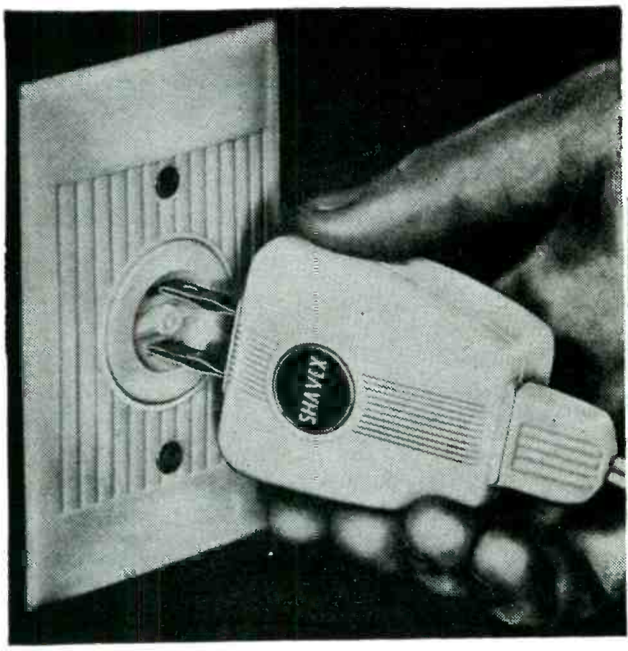
Sales representatives in principal areas.

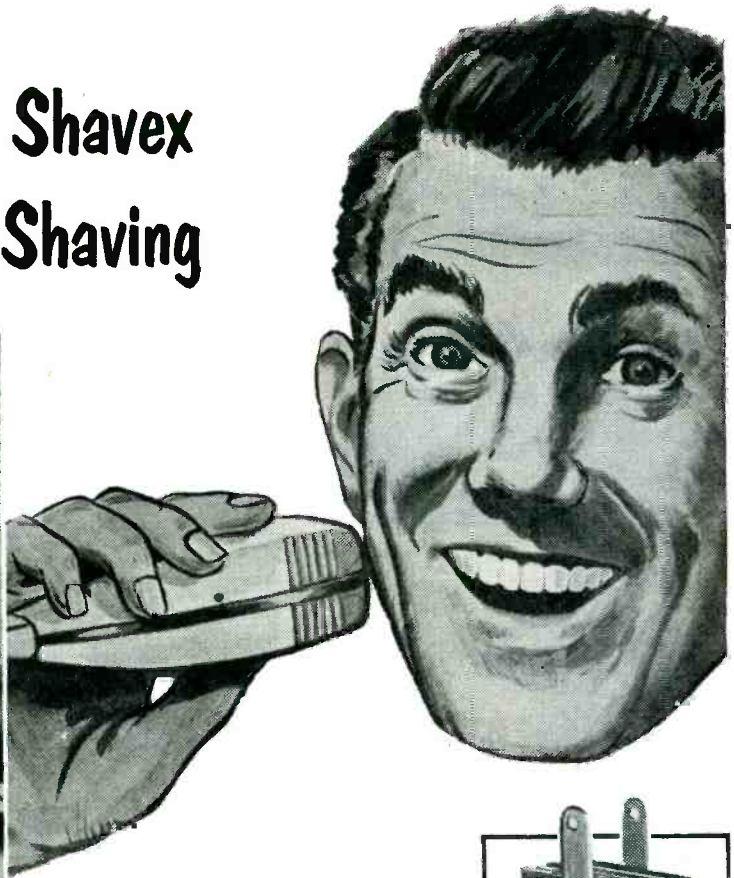
Export: Frazar & Hansen, Ltd., San Francisco, New York, Los Angeles

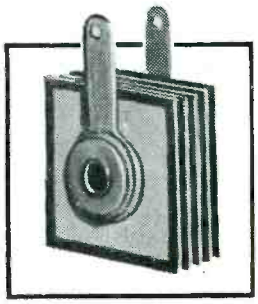
2250

HEWLETT-PACKARD *hp* INSTRUMENTS

How Bing Crosby's Shavex Speeds up Electric Shaving







Model 5M4 Rectifier illustrated. Current rating 75MA. Max. input 130V RMS. Max. inv. voltage 380V. Size 1" square.

...THANKS TO VERSATILE SELETRON SELENIUM RECTIFIERS

A wonderful boon to faster whisker removal as smooth as Bing's voice is the Crosby Shavex* which changes household alternating current to D.C., thus boosting the power and speed of any electric razor as much as 40% . . . And built into each unit is a miniature SELETRON Selenium Rectifier No. 5M4 for trouble-free operation.

The Shavex is very small, and excessive heating within such a compact enclosure could be a problem. Yet President William H. Burgess of Shavex Division, Electronic Specialty Co., Los Angeles 39, says that extensive temperature tests under full load show SELETRON rectifiers operate much cooler than other rectifiers tested . . . and SELETRON's reliability has been *confirmed* by successful use of the Shavex under varied conditions of temperature and humidity over a period of several years.

SELETRON builds 'em midget size for radio, TV and other electronic circuits, all the way up to the giant stack assemblies for industrial use. Perhaps the unusual Shavex application may give *you* an idea for putting these versatile selenium rectifiers to work in some other unique spot . . . If so, SELETRON engineers can be of real assistance. Write us today, and request your copy of bulletin 104—D-10.

*Reg. T.M. of Electronic Specialty Co.

SELETRON DIVISION

RADIO RECEPTOR COMPANY, INC.

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For *lasting* insulation strength, Sperry counts on HARVEL 912-C

For more than 10 years, Sperry Gyroscope Company has been insulating coils and other components with Harvel Internal Curing Varnishes, because of their excellent mechanical and electrical properties. Sperry . . . world famous for the quality and performance of its instruments . . . reports these specific advantages from the use of Harvel 912-C, electrical insulating varnish:

1. *High mechanical strength.* Conductors rigidly bonded into a compact mass. No soft, tacky varnish interiors to allow movement of conductors.
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Sperry also turns to Irvington for Class "H" flexible insulations when space and weight are at a premium. Running safely at temperatures as high as 500°F, these insulations permit using smaller conductors, and thus open the way to lighter, more compact designs. It will pay *you* to investigate these Irvington products—mail coupon today for the full story.

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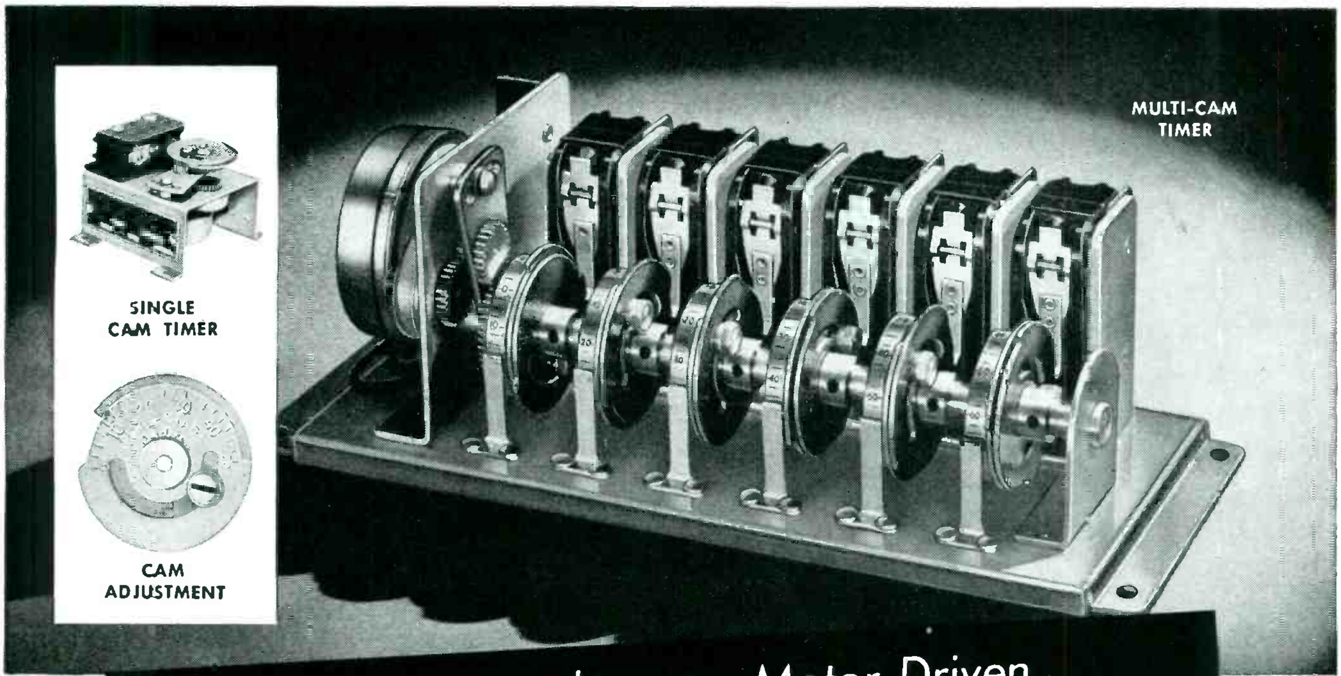

NEW! Synchronous Motor Driven SINGLE CAM and MULTI-CAM RECYCLING TIMERS

The new Industrial Cam Recycling Timer continuously repeats a constant cycle consisting of definite ON and OFF periods which can be adjusted from 2% to 98% of the cycle. By means of percentage calibrations on the cam face any desired setting is quickly and accurately obtained. The time cycle itself can also be changed easily by substituting simple gear-rack assemblies. Thus, from one timer, by using different gear racks you can obtain 50 different cycles ranging from the lowest cycle of the timer up to nine times that cycle. The snap action switch operated by the timer is a single pole double throw, totally enclosed 10 ampere type. We can supply 500 different time cycles in this model ranging from one revolution in 15 seconds to one revolution in 72 hours.

The Multi-Cam Recycling Timer is identical to the Single Cam Timer but operates from 2 to 6 circuits and incorporates several additional features. On this timer all cams are mounted on a single driving shaft which assures a common time cycle for all circuits. Each cam, however, is independently adjustable for a specific timing sequence. This is accomplished by actually rotating the cam with finger pressure using the drum calibrations for guidance. Thus a range of timing sequences from 0% to 100% is obtainable on each circuit with ease. The elimination of cam followers and other types of moving parts makes possible this compact unit. 11 models are available with time cycles ranging from one revolution in 1 minute to one revolution in 72 hours.

REMOTE CONTROL FOR SINGLE CYCLE OPERATION AVAILABLE.

Send today for complete details—or, if you would like to send us specifications, we shall be glad to make recommendations based on your particular needs.

Manufacturers of These and Other Timers and Controls for Industry

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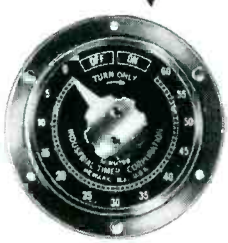
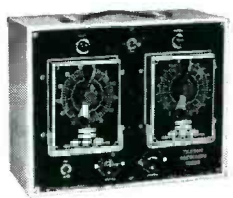
INSTANTANEOUS RESET TIMERS



MANUAL SET TIMERS



TANDEM AUTOMATIC RECYCLING TIMERS

RUNNING TIME METERS

Timers that Control the Pulse Beat of Industry

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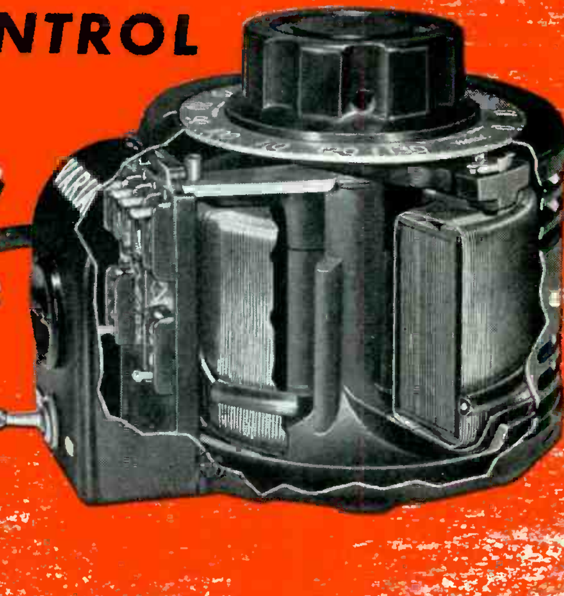
for SMOOTH VOLTAGE CONTROL

Variac



Variac® — the original continuously-adjustable auto-transformer — is the ideal device for controlling any a-c operated equipment. VARIACS not only supply perfectly smooth control of voltage from zero, but also furnish output voltages 17% above line voltage. VARIACS are correctly designed for many years of trouble-free operation. Data below are for single-phase operation. Polyphase and other ganged assemblies are available.

Single Phase Data

	Input Voltage	KVA	OUTPUT Output Voltage	OUTPUT Amperes Rated	OUTPUT Amperes Maximum	Type of* Mounting	Type	Price
Type 200-B	115	0.17	0-115 0-135	1	1.5 1.0	1	200-B	$12.50
Type V-5	115	0.86	0-115 0-135	5	7.5 5.0	1 2 3	V-5 V-5M V-5MT	18.50 20.50 25.00
	230	0.60	0-230 0-270	2	2.6 2.0	1 2 3	V-5H V-5HM V-5HMT	21.00 23.00 27.50
Type V-10	115	1.5	0-115 0-135	10	13.0 10.0	1 2 3	V-10 V-10M V-10MT	33.00 35.50 40.00
	230	1.2	0-230 0-270	4	5.2 4.0	1 2 3	V-10H V-10HM V-10HMT	34.00 36.50 41.00
Type V-20	115	3.	0-115 0-135	20	26.0 20.0	4	V-20M	55.00
	230	2.4	0-230 0-270	8	10.4 8.0	4	V-20HM	55.00
Type 50	115	5. 10.	0-115 0-115	40 80	45.0 90.0	4 5	50-A 50-AG2	140.00 310.00
	230	7 14.	0-230 0-230	20 40	31.0 62.0	4 5	50-B 50-BG2	140.00 310.00

The trade name Variac is registered at the U. S. Patent Office. Variacs are patented under U. S. Patent No. 2,009,013 and are manufactured and sold only by General Radio Company or its authorized agents.

* 1 Unmounted model.
2 Protective Case around windings.
3 Protective Case, terminal cover line switch, convenience outlet and line cord.
4 Protective Case, terminal cover and BX outlet.
5 Two gang assembly — requires type 50-P1 choke — $12.00.

Write for the NEW Variac Bulletin

GENERAL RADIO Company

275 Massachusetts Avenue, Cambridge 39, Mass.

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How to Select the Variac (or the Variac Assembly) for Your Needs

Single Phase

Input Volts	KVA(a)	OUTPUT VOLTS(b)	AMPERES Rated(c)	AMPERES Max.(d)	Type	Price	Description
115	.17	0–115 0–135	1.0 1.0	1.5 1.0	200-B	$ 12.50	*Uncased, with terminal strip.*
115	.86	0–115 0–135	5.0 5.0	7.5 5.0	V-5 V-5M V-5MT	18.50 20.50 25.00	*Uncased, with terminal strip.* *With case and terminal strip.* *With case, terminal box, line cord, plug and switch.*
115	1.5	0–115 0–135	10.0 10.0	13.0 10.0	V-10 V-10M V-10MT	33.00 35.50 40.00	*Uncased, with terminal strip* *With case and terminal strip.* *With case, terminal box, line cord, plug and switch.*
115	3.	0–115 0–135	20.0 20.0	26.0 20.0	V-20M	55.00	*With case and terminal box.*
115	5.	0–115 0–135	40.0 40.0	45.0 40.0	50-A	140.00	*With case and terminal box.*
115	6.	0–115 0–135	40.0 40.0	52.0 40.0	V-20G2	126.00	*2-Gang for Windings in parallel. Requires one 50-P1 Choke ($12).*
115	9.	0–115 0–135	60.0 60.0	78.0 60.0	V-20G3	182.00	*3-Gang for Windings in parallel. Requires one 50-P1 Choke ($12.) and one 50-P2 Choke ($12)*
115	10.	0–115 0–135	80.0 80.0	90.0 80.0	50-AG2	310.00	*2-Gang for Windings in parallel. Requires one 50-P1 Choke ($12).*
115	15.	0–115 0–135	120. 120.	135. 120.	50-AG3	460.00	*3-Gang for Windings in parallel. Requires one 50-P1 Choke ($12) and one 50-P2 Choke ($12).*
230 *115*	.60	0–230 0–270 *0–270*	2.0 2.0 *1.0*	2.6 2.0 *1.0*	V-5H V-5HM V-5HMT	21.00 23.00 27.50	*Uncased, with terminal strip.* *With case and terminal strip.* *With case, terminal box, line cord, plug and switch.*
230 *115*	1.2	0–230 0–270 *0–270*	4.0 4.0 *2.0*	5.2 4.0 *2.0*	V-10H V-10HM V-10HMT	34.00 36.50 41.00	*Uncased, with terminal strip.* *With case and terminal strip.* *With case, terminal box, line cord, plug and switch.*
230 *115*	1.7	0–230 0–270 *0–270*	5.0 5.0 *2.5*	7.5 5.0 *2.5*	V-5G2	49.00	*2-Gang for Windings in series. Cannot be used with grounded load.*
230 *115*	2.4	0–230 0–270 *0–270*	8.0 8.0 *4.0*	10.4 8.0 *4.0*	V-20HM	55.00	*With case and terminal box.*
230 *115*	3.	0–230 0–270 *0–270*	10.0 10.0 *5.0*	13.0 10.0 *5.0*	V-10G2	79.00	*2-Gang for Windings in series. Cannot be used with grounded load.*
230 *115*	4.8	0–230 0–270 *0–270*	16.0 16.0 *8.0*	20.8 16.0 *8.0*	V-20HG2	126.00	*2-Gang for Windings in parallel. Requires one type 50-P1 Choke ($12).*
230 *115*	6.	0–230 0–270 *0–270*	20.0 20.0 *10.0*	26.0 20.0 *10.0*	V-20G2	126.00	*2-Gang for Windings in series. Cannot be used with grounded load.*
230 *115*	7.	0–230 0–270 *0–230*	20.0 20.0 *10.0*	31.0 20.0 *10.0*	50-B	140.00	*With case and terminal box.*
230 *115*	14.	0–230 0–270 *0–230*	40.0 40.0 *20.0*	62.0 40.0 *20.0*	50-BG2	310.00	*2-Gang for Windings in parallel. Requires one type 50-P1 Choke ($12).*
230 *115*	21.	0–230 0–270 *0–230*	60.0 60.0 *30.0*	93.0 60.0 *30.0*	50-BG3	460.00	*3-Gang for Windings in parallel. Requires one type 50-P1 Choke ($12) and one 50-P2 Choke ($12).*
460	1.2	0–460 0–540	2.0 2.0	2.6 2.0	V-5HG2	54.00	*2-Gang for Windings in series. Cannot be used with grounded load.*
460	2.4	0–460 0–540	4.0 4.0	5.2 4.0	V-10HG2	81.00	*2-Gang for Windings in series. Cannot be used with grounded load.*
460	4.8	0–460 0–540	8.0 8.0	10.4 8.0	V-20HG2	126.00	*2-Gang for Windings in series. Cannot be used with grounded load.*
460	14.	0–460 0–540	20.0 20.0	31.0 20.0	50-BG2	310.00	*2-Gang for Windings in series. Cannot be used with grounded load.*

Three Phase

Input Volts	KVA(a)	OUTPUT VOLTS(b)	AMPERES Rated(c)	AMPERES Max.(d)	Type	Price	Description
230(e)	1.	0–230 0–270	2.0 2.0	2.6 2.0	V-5HG2	54.00	*Open Delta Circuit.*
230	2.	0–230 0–270	4.0 4.0	5.2 4.0	V-10HG2	81.00	*Open Delta Circuit.*
230	3.	0–230	5.0	7.5	V-5G3	68.50	*Wye Circuit. Overvoltage connection not recommended.*
230	4.	0–230 0–270	8.0 8.0	10.4 8.0	V-20HG2	126.00	*Open Delta Circuit.*
230	5.	0–230	10.0	13.0	V-10G3	113.00	*Wye Circuit. Overvoltage connection not recommended.*
230	10.	0–230	20.0	26.0	V-20G3	182.00	*Wye Circuit. Overvoltage connection not recommended.*
230	12.	0–230 0–270	20.0 20.0	31.0 20.0	50-BG2	310.00	*Open Delta Circuit.*
230	18.	0–230	40.0	45.0	50-AG3	460.00	*Wye Circuit.*
460	2.	0–460	2.0	2.6	V-5HG3	76.00	*Wye Circuit. Overvoltage connection not recommended.*
460	4.	0–460	4.0	5.2	V-10HG3	116.00	*Wye Circuit. Overvoltage connection not recommended.*
460	8.	0–460	8.0	10.4	V-20HG3	182.00	*Wye Circuit. Overvoltage connection not recommended.*
460	25.	0–460	20.0	31.0	50-BG3	460.00	*Wye Circuit. Overvoltage connection not recommended.*

(a) KVA as listed = normal input line voltage x maximum output current.
(b) Maximum output voltage = line input voltage, for "Line Voltage" output connection.
(c) Rated current (amps) should not be exceeded for the overvoltage connection. Output KVA for overvoltage connection = output voltage x *rated current*.

(d) Maximum current (amps) can be drawn at maximum voltage for the line-voltage connection only.
(e) On 208-volt circuits, current ratings remain unchanged, but voltage range and KVA ratings are reduced in proportion to voltage. Overvoltage connections may be used, but are *not* recommended on 230-volt Wye connections.

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is an INDIANA HYFLUX ALNICO V

. . . weighing 350 pounds and developing a magnetic field of 8,000 gausses in a gap 1¼" long, this giant horn type permanent magnet was developed for one of the nation's leading university research laboratories. It is used in development work in the fields of nuclear physics, micro-wave research and polymerization.

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. . . no extra cost—INDIANA HYFLUX Alnico V develops the highest energy product of any magnet material—an average of 5½ million BH max or more, with 5¼ million guaranteed! This means greater strength—yet HYFLUX costs no more than ordinary Alnico V! You, too, will want to join the swing to HYFLUX!

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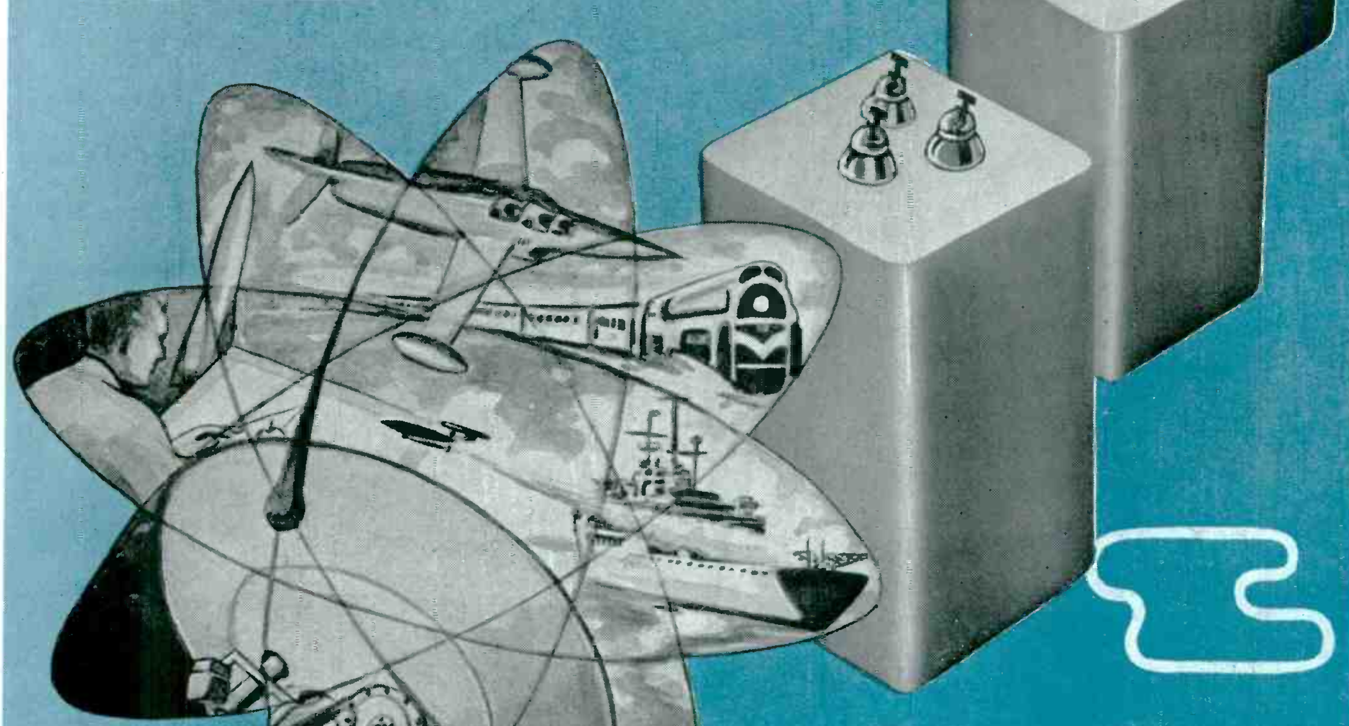
FOR MILITARY APPLICATIONS

With the increasing number of audio filter applications in electronic military equipment, the importance of stability and durability under extreme service conditions creates many more problems in the design and manufacture of these networks.

A filter, which is not really a component, but an assembly of many components (often quite intricate) is affected by the slightest weakness in any of these parts. As a consequence, it has been our greatest task to either develop or find sources of the highest quality for materials employed in the production of filters. This project has so far been very fruitful although it necessarily resulted in increased material cost, much of which has been offset by the introduction of new and more efficient production and design methods.

All of this adds up to another step forward for Burnell & Company in the production of high quality filter networks for the Nation's military electronic program.



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YONKERS 2, NEW YORK
CABLE ADDRESS "BURNELL"

FIRST *in Timing*

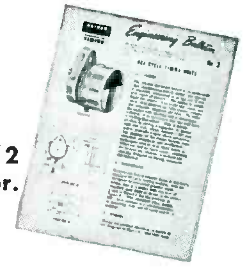
SYNCHRONOUS
TIMING MOTORS and TIMERS

SPECIFICATIONS:

Hysteresis type synchronous timing motor, essentially two phase . . . furnished with capacitor for self-starting operation on single phase . . . standard gear trains available, special designs available for quantity production . . . speeds available with standard gear trains range from 1/60 to 30 rpm . . . weighs approximately 6-1/2 oz. . . . dimensions, except for slightly greater depth, closely follow those of HAYDON 60 cycle timing motors.

FEATURES:

Inherently accurate approach to timing problems. Not affected by variations in temperature, supply voltage, load and altitude. R-F filtering or shielding not required. Brush life or wear not a problem. Where primary current supply is 400 cycle, rectifying equipment and duplication of wiring may be reduced or eliminated.



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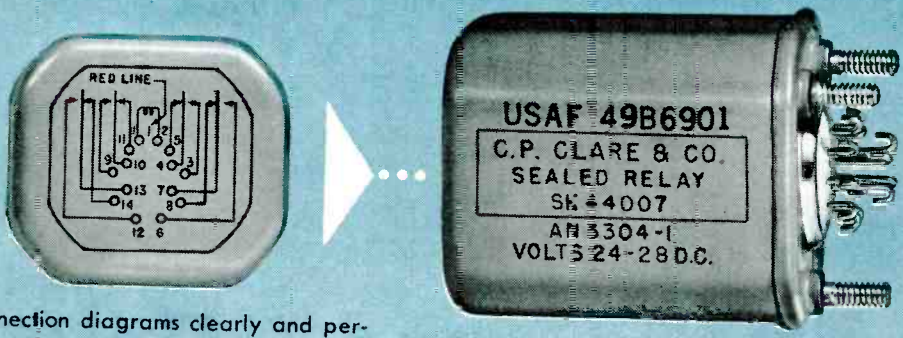
Plus Values of CLARE when unfailing



CLARE hermetically sealed relay with solder terminals.

Connection diagrams clearly and permanently imprinted by silk screen process. Not just stamped upon top of enclosure.

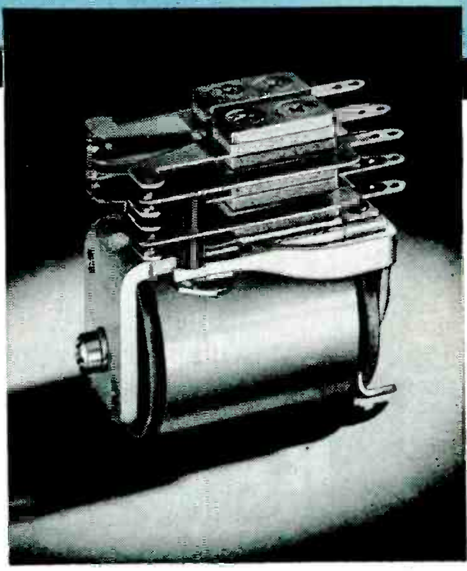
Same relay with AN Plug Connector

This small CLARE Type "R" Relay supplies many special features responsible for the outstanding performance of these new "AN" approved relays.

The operating "heart" of these two new hermetically sealed relays is the CLARE Type "R" Relay which is characterized by unusual sensitivity and extremely long life.

It combines the advantages of a telephone-type relay with the small size, light weight and resistance to vibration required to meet the rigid demands of aircraft service. The Type "R" retains in an improved form the reed armature suspension which discerning engineers have come to recognize as one of the subtler reasons for the superior performance of CLARE Type "K" relays.

The Type "R" is 1 7/16" long, 1 3/64" high and 1" in width. It weighs approximately 2 ounces. Coil may be single or double-wound; armature, single or double-arm; operating voltage up to 230 volts d-c.

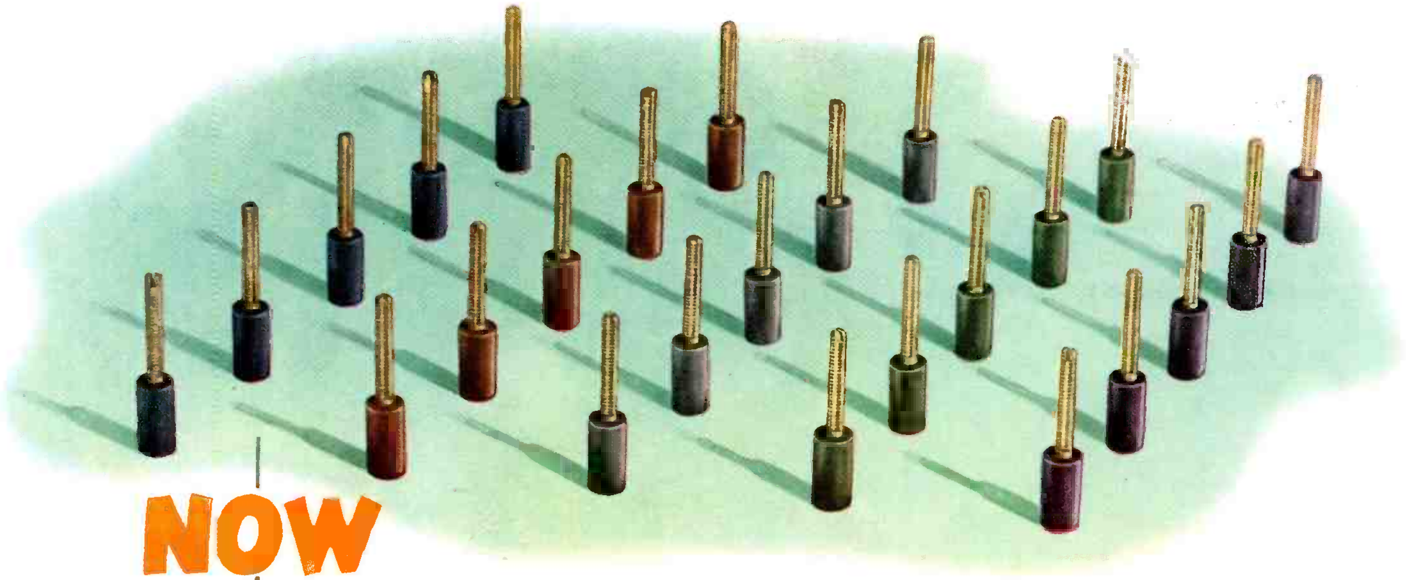


CLARE Type "R" RELAY

CLARE RELAYS . .

COLORED CORES....

prevent costly errors, save time, reduce core selection to a routine



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to MANY GRADES . . . G A & F Carbonyl Iron Powders do a precision job—because they are manufactured to exacting standards of uniformity . . . in particle size, particle shape, purity, permeability, "Q" value, etc. With six different grades, there is a powder for every use.

and MANY USES . . . The cores made from G A & F Carbonyl Iron Powders are designed and made for specific jobs in electronics, and on exacting standards. These cores become the hearts of accurate instruments and dependable receiving sets . . . Each must be used for the application for which it was designed. This means that these cores must be accurately identified or otherwise protected against costly errors of selection.

ADD MANY COLORS . . . Instead of embossing, engraving or paint-daubing the finished cores—all slow and expensive processes—Antara Products now offers the simplest and easiest of all possible answers: distinctive, *permanent* dyes, incorporated with the powder, to be built into the cores. With an adequate color choice, these dyes provide the fool-proof identification that cuts down costly errors, reduces production costs, makes core selection routine instead of a mental hazard.

The dyes are strong and easily seen; they withstand the heat of the curing; they are not affected by humidity or temperature; they are satisfactory at a wide range of molding pressures and shapes. They do not improve electrical or magnetic properties, to be sure, but any decrease is very minor and more than compensated by the production advantages. *For further details, kindly contact your core manufacturer and write us for Technical Bulletin.*

gdc ANTARA gaf

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G A & F® Carbonyl Iron Powders

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For Home Entertainment Units

High in quality . . . yet low in price . . . General Industries' Model 250 Tape-Disc Recorder Assembly meets every need for an all-purpose sound recorder. It is simple to operate, foolproof and dependable—built to the same high quality standards which identify all GI *Smooth Power* phonomotors and turntable assemblies.

Now is the time to investigate the tremendous profit possibilities offered by this versatile recording assembly. Write today for catalog sheet describing both recording and playback features of the GI Model 250.

Model 250 Tape-Disc Recorder Assembly

Suggested amplifier circuit and complete amplifier parts list is contained in a comprehensive service manual which accompanies each unit.

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* That's the "why" of Aerovox capacitors. For along with these capacitors you can get Aerovox Application Engineering — experience background second to none — in fitting the RIGHT capacitor to the RIGHT circuitry for the RIGHT operating conditions. And that's most important.
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Transient-free test voltages down to 0.01 cps!

Versatile, general purpose generator for subsonic and audio work! Continuously variable, 0.01 to 1,000 cps, 5 bands. High stability, distortion less than 1%. Radical new circuitry offers sine, square and triangular waves.

-hp- 202A Low Frequency Function Generator

SPECIFICATIONS

-hp- 202A Low Frequency Function Generator

FREQUENCY RANGE: 0.01 to 1,000 cps in five decade ranges.

DIAL ACCURACY: Within 2%.

FREQUENCY STABILITY: Within 1% including warm-up drift.

OUTPUT WAVEFORMS: Sinusoidal, square, and triangular.

MAXIMUM OUTPUT VOLTAGE: At least 30 volts peak-to-peak across rated load for all three waveforms.

DISTORTION: Less than 1% RMS distortion in sine wave output.

OUTPUT SYSTEM: Can be operated either balanced or single-ended. Output system is direct-coupled; dc level of output voltage remains stable over long periods of time. Adjustment available from front panel balances out of any dc.

FREQUENCY RESPONSE: Constant within 1 db.

HUM LEVEL: Less than 0.1% of maximum output.

SYNC PULSE: 5 volts peak, less than 10 µsec duration. Sync pulse occurs at crest of sine and triangular wave output.

POWER: 115-volt, 50/60 cycles, 175 watts.

DIMENSIONS: 10½" high, 19" wide, 13" deep.

PRICE: $450.00 f.o.b. Palo Alto, California. End frames, for table use, $5.00 per pair f.o.b. factory. (Specify No. 17.)

Data subject to change without notice.

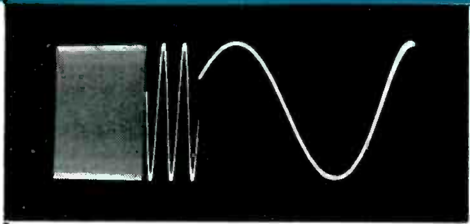

Figure 1. Oscillogram shows freedom from transients as output frequency is changed.

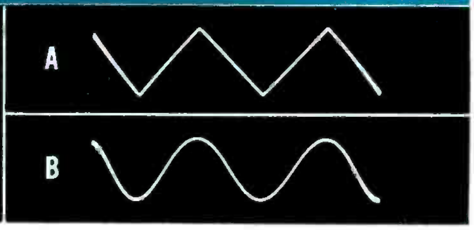

Figure 2. Oscillogram of (a) triangular wave applied to shaping circuit and (b) resulting sine wave.

–hp– 202A Low Frequency Function Generator offers you a compact, convenient and versatile source of transient-free test voltages between 1,000 and 0.01 cps. It provides virtually distortion-free signals for vibration studies, servo applications, medical and geophysical work, and other subsonic and audio problems. For such applications, the equipment generates 3 wave forms: sine, square and triangular. (Desired wave form is selected on front panel switch.) Output is 30 volts peak-to-peak for all 3 wave forms.

NEW CIRCUIT CONCEPT

–hp– 202A differs from conventional low-frequency oscillators in that the sine wave is electronically synthesized. A controlled bi-stable circuit generates a rectangular wave. This wave is passed through a special integrator providing a true triangular wave (Figure 2a). The triangular wave then enters a shaping circuit developed by *–hp–*. Here 6 duo-diodes modify or "shape" the peaks and provide a true sine wave with distortion of less than 1% (Figure 2b). This synthesizing circuit provides virtually transient-free output even when range switch is operated or frequency is rapidly varied. This circuit also maintains the amplitude constant under all conditions. It is not necessary to wait long periods for the circuit to stabilize at a new level as with conventional oscillators.

OTHER FEATURES

The output system of *–hp–* 202A is fully floating with respect to ground. May be used to supply a balanced voltage or either terminal may be grounded. It will deliver 10 v RMS to a load of 5,000 ohms or greater; internal impedance, however, is only 100 ohms. There are no coupling capacitors in the output system, and a high degree of dc balance is achieved by means of a special circuit.

-hp- field engineers, in most major cities, have complete details. Or, write direct.

HEWLETT-PACKARD CO.
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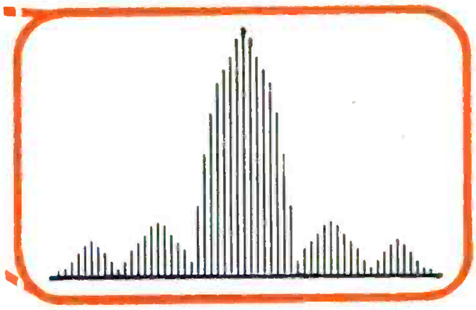
HEWLETT-PACKARD hp INSTRUMENTS

The FIRST all-band direct reading SPECTRUM ANALYZER

10 MCS to 16,520 MCS

Polarad's Model LSA Spectrum Analyzer is the result of years of research and development. It provides a simple and direct means of rapid and accurate measurement and spectral display of an r.f. signal.



Outstanding Features:

- Continuous tuning.
- One tuning control.
- 5 KC resolution at all frequencies.
- 250 KC to 25 MCS display at all frequencies.
- Tuning dial frequency accuracy 1 percent.
- No Klystron modes to set.
- Broadband attenuators supplied with equipment above 1000 MCS.
- Frequency marker for measuring frequency differences 0-25 MCS.
- Only three tuning units required to cover entire range.
- Microwave components used latest design non-contacting shorts for long mechanical life.
- Maximum frequency coverage per dollar invested.
- 5 inch CRT display.

Where Used:

Polarad's Model LSA Spectrum Analyzer is a laboratory instrument used to provide a visual indication of the frequency of distribution of energy in an r.f. signal in the range 10 to 16,520 MCS.

Other uses are:

1. Observe and measure sidebands associated with amplitude and frequency modulated signals.
2. Determine the presence and accurately measure the frequency of radio and/or radar signals.
3. Check the spectrum of magnetron oscillators.
4. Measures noise spectra.
5. Check and observe tracking of r.f. components of a radar system.
5. Check two r.f. signals differing by a small frequency separation.

Write for Complete Details

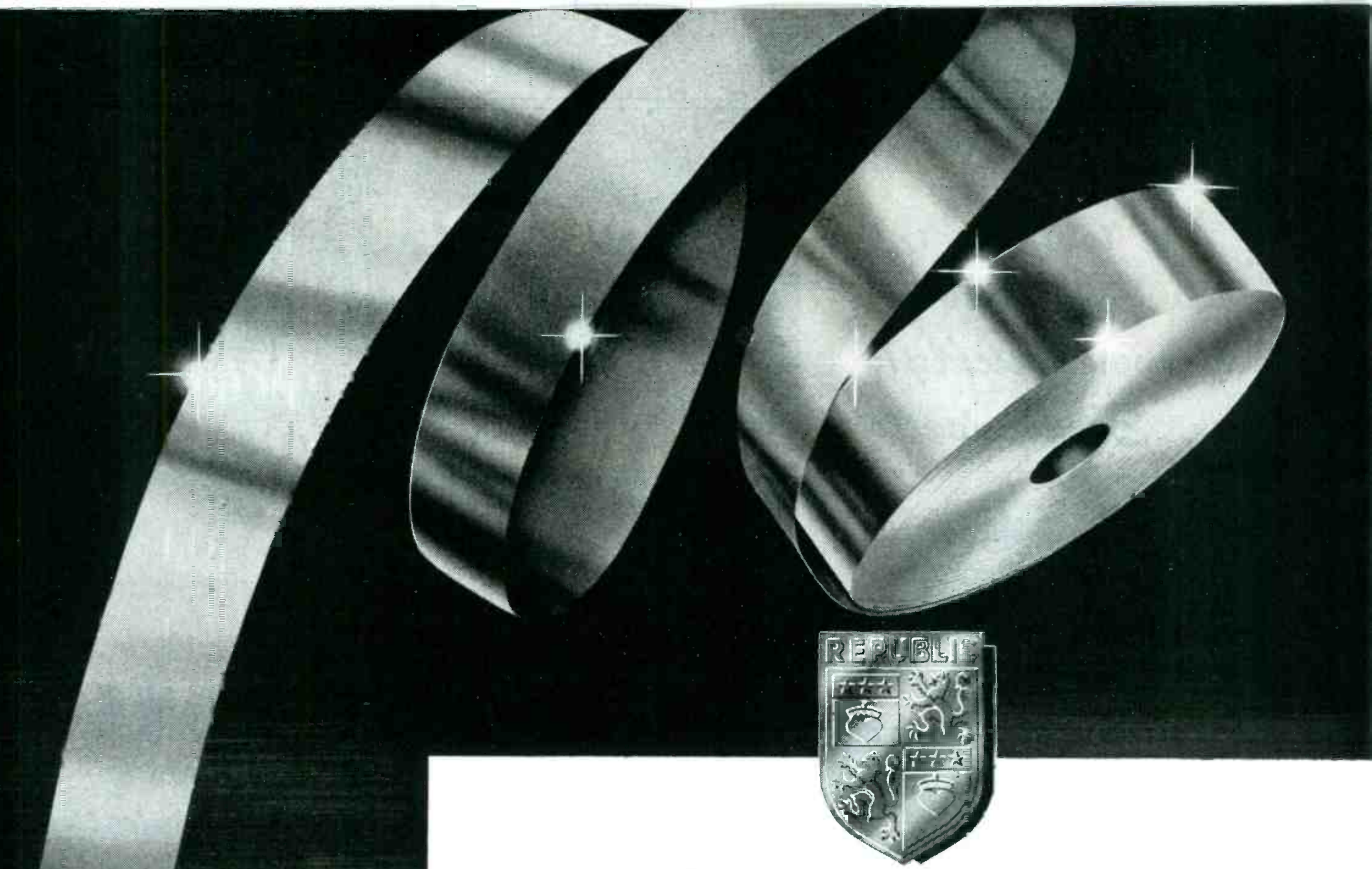
the instrument consists of the following units:

Model LTU-1 R.F. Tuning Unit—10 to 1000 MCS.
Model LTU-2 R.F. Tuning Unit—940 to 4500 MCS.
Model LTU-3 R.F. Tuning Unit—4460 to 16,520 MCS.
Model LDU-1 Spectrum Display Unit.
Model LPU-1 Power Unit.
Model LKU-1 Klystron Power Unit.

Polarad Electronics Corporation

100 Metropolitan Ave. Brooklyn 11, N. Y.

Manufacturers of broadband microwave laboratory instruments.



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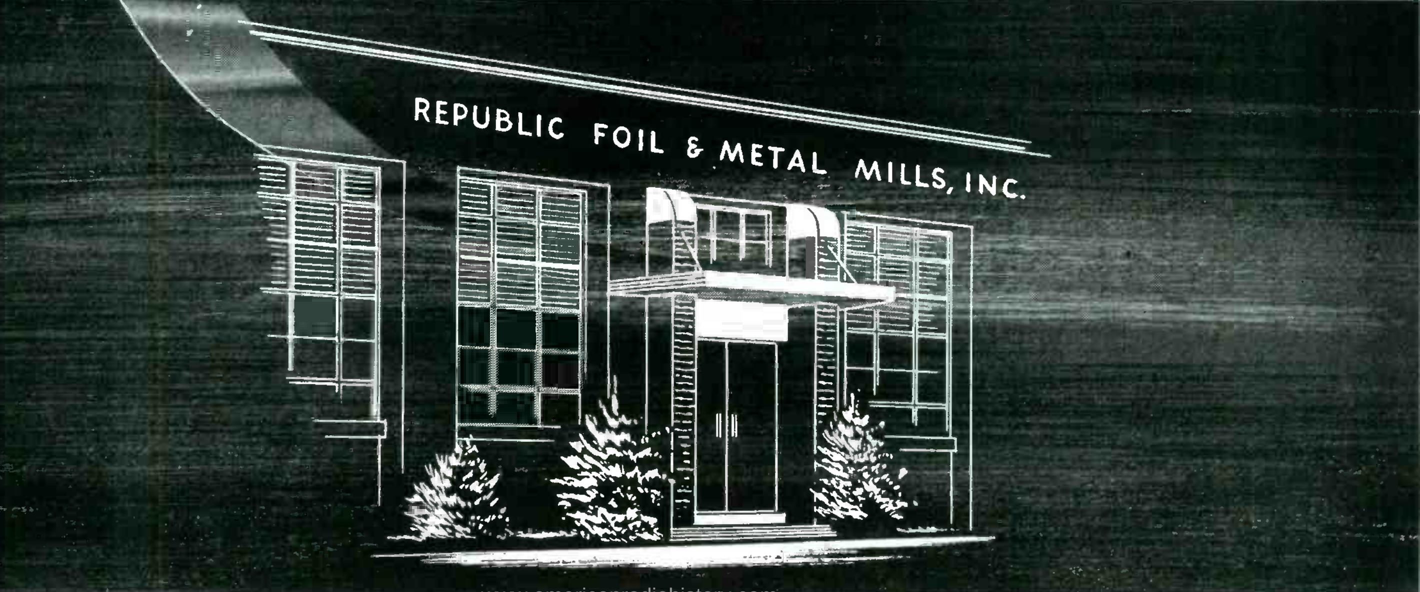

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EICOR engineering starts with load tests and analysis of your power requirements and ends only after proof of satisfactory installation performance. With complete laboratory testing facilities, every phase of design and production is under strict quality control.

That is why Eicor Dynamotors are standard equipment with many manufacturers of radio and electronic devices for railroad, aircraft, marine, police, and other mobile users.

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Complete range *from the smallest in size to the largest in output* makes it easier to provide the exact units needed for your application. Available in both open and enclosed types . . . with or without filters. Supplied with or without metal base, operate satisfactorily in any position.

Hundreds of optional output ratings are completely designed and can be produced on short notice. Our facilities are equally adaptable to the engineering of a single experimental unit or to the production of large quantities. EICOR experience can prove profitable and time-saving for you. *Check your needs with us now!*

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MANUFACTURERS OF *Rotary Electrical Equipment*

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STRAIGHT-SIDE DESIGN

gives you G-E rectifier tubes for broadcasting that are better in three ways—

1. Safety margin is high, with less chance of arc-backs.
2. Designers can group these "slim" tubes compactly.
3. Straight-side rectifier tubes are easy to handle and install.

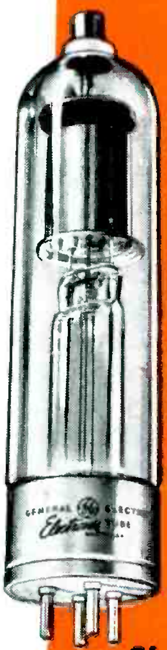
GL-8008
(also supplied with 50-watt base as GL-872-A)

CLOSE TUBE-ELEMENT SPACINGS WARD OFF ARC-BACKS in popular G-E rectifier types GL-8008 and GL-673, giving improved protection from high voltages. The narrow straight-side bulb lies close to the anode. Spacings between anode, cathode, and cathode-shield are reduced. Volume of ionization thus is less—deionizing time shortened.

"SLIM" TUBE CONTOUR HELPS THE DESIGNER. Space is at a premium in compact modern equipment, and GL-8008's and GL-673's will mount side-by-side to take up minimum panel area. Maintenance men find these straight, slender tubes ideal to handle; quick to install.

YOU CAN COUNT ON UNIFORM QUALITY, UNIFORM PERFORMANCE. G-E know-how in precision-building rectifier tubes goes back more than 20 years to basic development work done by General Electric. *Four out of the five tubes* rated below were pioneered by G.E.—these types covering most broadcast requirements for high-vacuum rectifier tubes!

G.E. OFFERS YOU A TOP-TO-BOTTOM RANGE OF SIZES. Types shown and listed here are examples. Whatever your rectifier-socket need may be, there's a G-E tube to meet that need! If your problem is one of circuit application, your nearby G-E electronics office is ready to offer expert counsel. If you are a broadcaster wishing replacements, phone your nearby G-E tube distributor for fast, competent service! *Electronics Department, General Electric Company, Schenectady 5, New York.*



GL-673
(also supplied with 50-watt base as GL-575-A)

Type	Cathode voltage	Cathode current	Anode peak voltage	Anode peak current	Anode avg current
GL-866-A	2.5 v	5 amp	10,000 v	1 amp	0.25 amp
GL-8008	5 v	7.5 amp	10,000 v	5 amp	1.25 amp
GL-673	5 v	10 amp	15,000 v	6 amp	1.5 amp
GL-869-B	5 v	19 amp	20,000 v	10 amp	2.5 amp
GL-857-B	5 v	30 amp	22,000 v	40 amp	10 amp

GENERAL ELECTRIC

J-K8

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Remember, too, that Hermetic Seal Products' staff of specialist-engineers is eager to help you with your problems in the ever-expanding field of hermetic sealing.

HERMETIC SEAL PRODUCTS' headers are available in unlimited shapes and with any number of terminals as required. They are the only seals you can hot tin dip at 525°F. for easy assembly soldering, for a strain and fissure-free sealed part with resistance of over 10,000 megohms. They will also withstand subzero conditions, swamp test, temperature cycling, high vacuum, high pressure, salt water immersion and spray, etc.

Important! Terminals and Headers are available in RMA Color Code.

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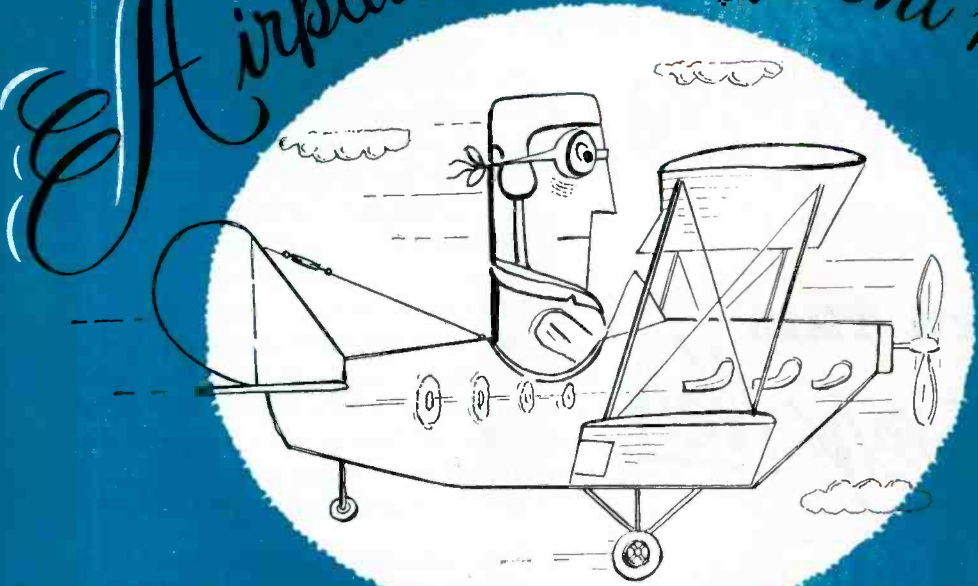

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In the air, where space and weight are at a premium, the value of the minute compactness of **HI-Q** Components is vividly dramatized. Of equal importance is their never failing dependability under any and all conditions. For let a single small unit fail, and life itself may hang in the balance.

The same high engineering standards and unvarying quality which have made **HI-Q** a leader with producers of aircraft equipment, have found equal favor with other electronic manufacturers. Individual tests of every single component at each stage of production, and as a part of final inspection, insure the precise adherence to specifications, ratings and tolerances. That is one reason why **HI-Q** is now serving virtually every leading producer of television, communications and other electronic equipment. Another is the ready availability of **HI-Q** engineers to cooperate in the development of new components to meet specialized needs.

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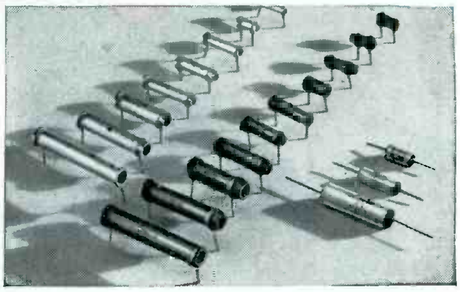

HI-Q TEMPERATURE COMPENSATING CAPACITORS

These high voltage tubular capacitors are available in capacities from 25 mmf. to 250 mmf. Units with working voltage of 3000 V. D. C., are 1.840″ long with .375″ diameter. Those between 500 V. D. C. and 3000 V. D. C. are slightly smaller. All are Durez coated and made of temperature compensating materials.

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- ✓ DEPENDABILITY
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OLEAN, N. Y.

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

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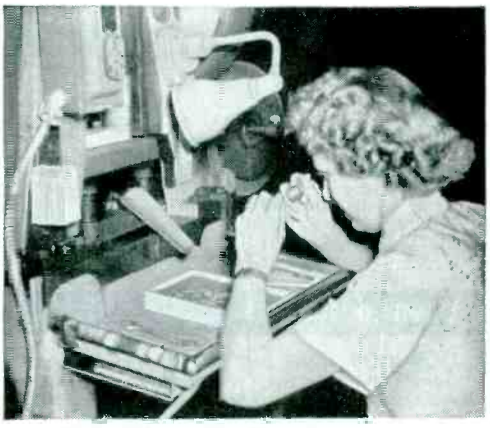
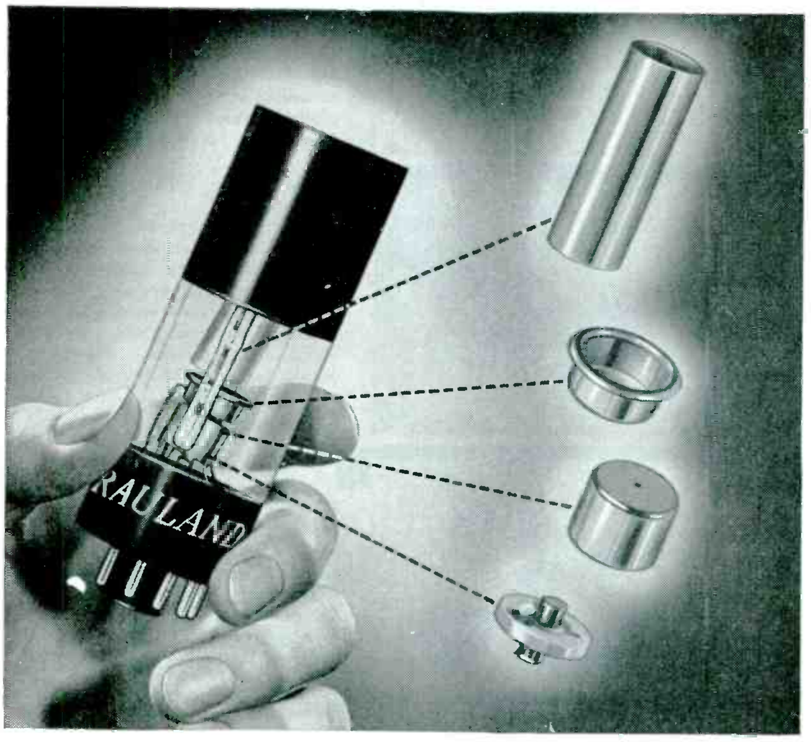
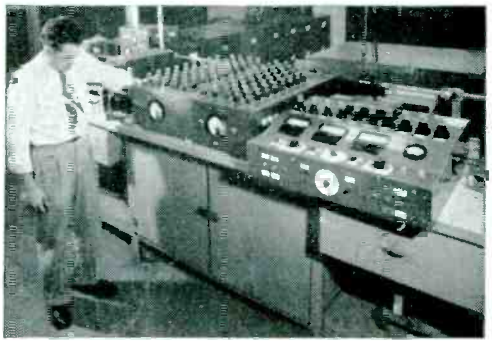
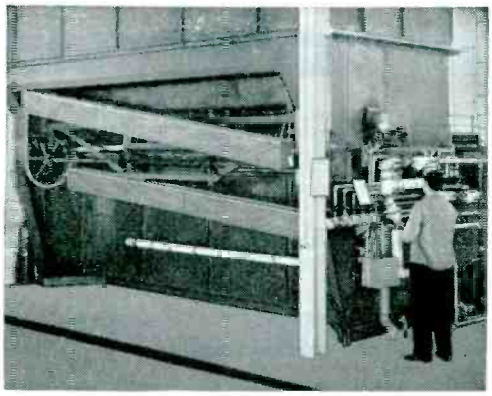


Part of Inspection Procedure on Lockseam Nickel Cathodes as they come off the production machine. Each cathode must undergo many rigid tests before being approved.





Engineering . . . laboratory equipment for all kinds of testing, including emission characteristics of nickel cathode materials.



To Guard Against contamination by processing lubricants, Superior tubing is thoroughly degreased before each annealing operation.

Superior supplies disc cathodes, cups and anodes for the famous *Rauland* "Tilted Offset" Electron Gun used in peak-performance picture tubes. This new development of Rauland permits the use of a single Ion Trap magnet, bends the electron beam only once and gives the sharpest possible beam focus. The new Indicator Ion Trap reduces adjustment time to a matter of seconds, eliminates the need for mirrors or guesswork in Ion Trap adjustment. This "Double Feature" gun is a triumph of Rauland research.

But no electronic device can be better than the components of its assembly. That's why Rauland and so many other electronics manufacturers specify Superior tubular parts.

Here at Superior we combine production know-how, research facilities and engineering experience to produce tubular parts, in many forms and metals, each designed to do tough electronics jobs better. We have specialty equipment for the high speed production of anodes, cups, cathodes, grid cylinders and many other parts for television and cathode ray gun structures. If you are not now a customer of Superior it will pay you to check on the many ways in which we can serve you. Write for information—no obligation of course. Superior Tube Company, 2500 Germantown Ave., Norristown, Pennsylvania.

Which Is The Better For Your Product . . .

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.
Certain analyses (.035″ max. wall) Up to 1⅝″ O.D.

*MFD. UNDER U. S. PATS. *SUPERIOR TUBE COMPANY • Electronic Products for export through Driver-Harris Company, Harrison, New Jersey • Harrison 6-4800*

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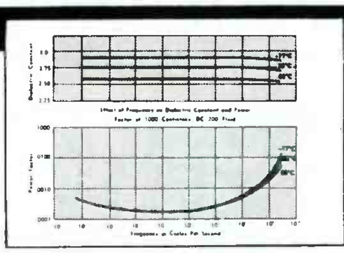
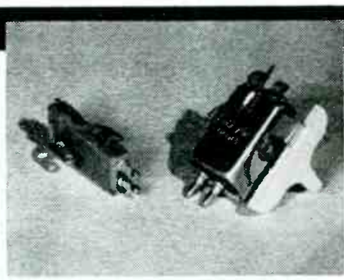
DOW CORNING 200 FLUIDS are a series of clear, inert liquids, notable for their thermal stability and for their remarkably flat viscosity-temperature slopes. Available in viscosities from 0.65 to 1,000,000 centistokes. Pour points range from −123° to −47°F. and flash points range from 30° to 600°F. Low dissipation factors at elevated temperatures or at high frequencies, inertness to moisture, oxidation resistance and heat stability make Dow Corning 200 Fluids unique among liquid dielectrics.



As indicated by these curves, neither frequency nor temperature changes have any pronounced effect on the power factors or dielectric constants of Dow Corning 200 Fluids. Power factor and dielectric constant of 1000 cs. fluid at −17°, 23°, and 83° C. are plotted against frequencies ranging from 10 to 10^{10} cycles per second.

DIELECTRIC COMPOUND

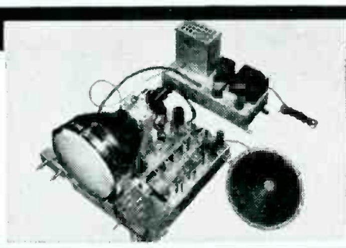
DOW CORNING 4 COMPOUND is a nonmelting water-repellent dielectric paste which retains its grease-like consistency at temperatures from −70° to 400°F. It is highly resistant to oxidation and to deterioration caused by corona discharge. Power factor is less than 0.003 at frequencies up to 10,000 megacycles; volume resistivity is more than 10^{12} ohm centimeters at temperatures up to 400°F.; dielectric strength is more than 500 volts per mil at a 10 mil gap. Dow Corning 4 meets all requirements of Specification AN-C-128a.



Dow Corning 4 packed in phonograph pick-up head cartridges increased crystal service life 20 times. The silicone compound prevents Rochelle Crystals from deteriorating due to absorbed moisture. It also acts as a viscous damping medium, thereby reducing excess vibration and enabling the head to handle a much higher frequency.

ELECTRICAL INSULATING VARNISHES

DOW CORNING 996 VARNISH dries tack-free in not more than 3 hours at 150°C. Dielectric strength measured with 2 inch electrodes on 2 mil films baked for 16 hours at 150°C. is 1000-2000 volts/mil, dry, and 500-1500 volts/mil, wet. Heat flexibility is more than 100 hours at 250°C. Cured films have good resistance to dilute acids, concentrated hydrochloric acid, and dilute or concentrated alkalies.

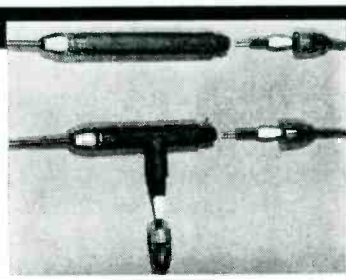


Flashover in high voltage television power supply coils can set ordinary organic varnish aflame. To eliminate this fire hazard, coils are impregnated with Dow Corning 996. Highly resistant to arcing, 996 provides positive protection against carbon tracking for the life of the entire set.

SILASTIC *, THE DOW CORNING SILICONE RUBBER

Silastic combines the remarkable heat stability and moisture resistance of resinous silicones with the physical properties of rubber, including resilience, shock and abrasion resistance, and resistance to both mechanical and electrical fatigue. Its dielectric properties show little change over a wide range of frequencies, even after aging at high temperatures. The surface resistivity of Silastic is high, and its thermal conductivity is about twice as great as that of either organic rubber or resinous insulating materials.

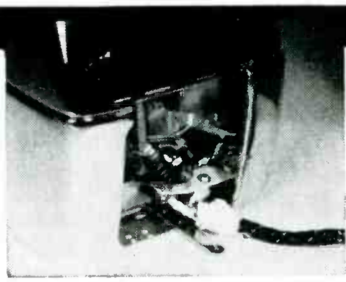
*T.M. REG. U.S. PAT. OFF.



Completely eliminating taped connections on aircraft antennae, white Silastic seals reduce static and corona discharge by as much as 90%. They retain their resilience as well as their dielectric properties, excluding moisture and foreign matter after long exposure to the full range of ground and stratospheric temperatures.

SILICONE-GLASS LAMINATES

DOW CORNING THERMOSETTING RESINS are used to bond inorganic fabrics and finely divided particles such as powdered metals or mica. Typical 1/8" silicone-glass laminates have a flexural strength of 22,000 to 45,000 psi; water absorption after 24 hours of 0.25%; dielectric strength with continuous filament cloth of 250 volts/mil or more; power factor of 0.002 at 1 mc; loss factor of 0.007 at 1 mc; wet insulation resistance of more than 10^{12} ohms; arc resistance of 300 seconds and a heat distortion value above 250°C.



For maximum dependability and long service life, silicone-glass terminal blocks and contactor bases are being used in late model automatic toasters. Tests prove that Dow Corning silicone resin bonded glass laminates are more rigid, more heat-stable, more resistant to moisture and easier to fabricate and assemble than conventional materials.

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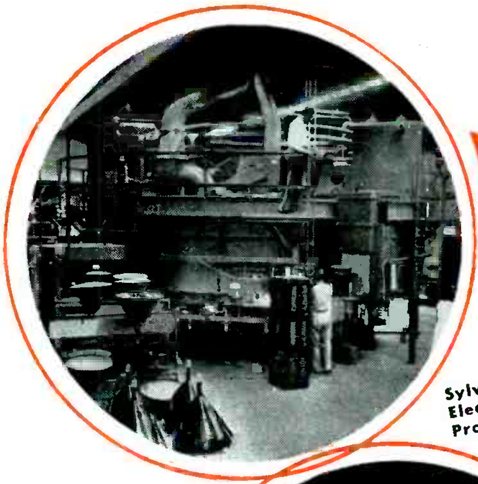
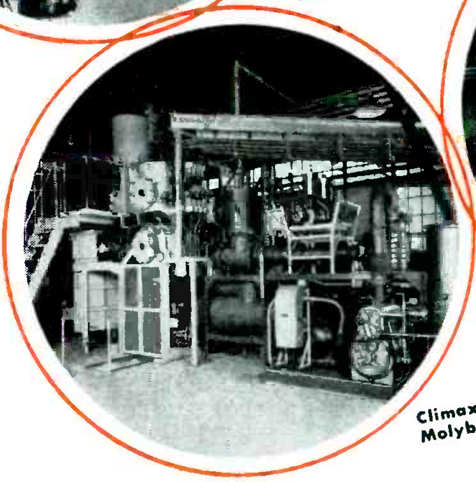
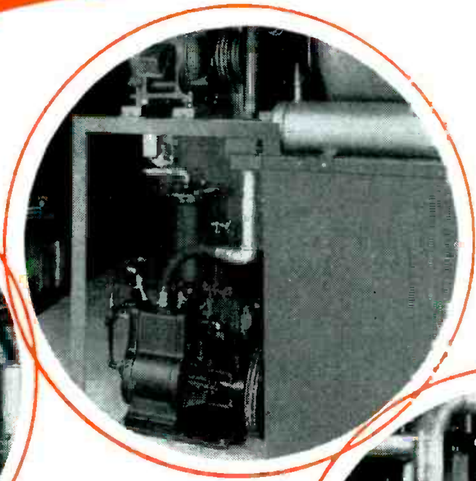


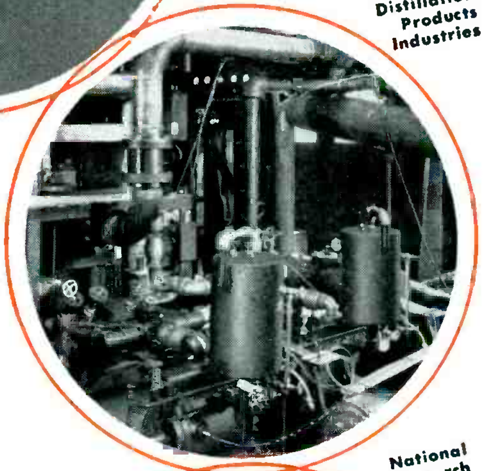
Sylvania Electric Products



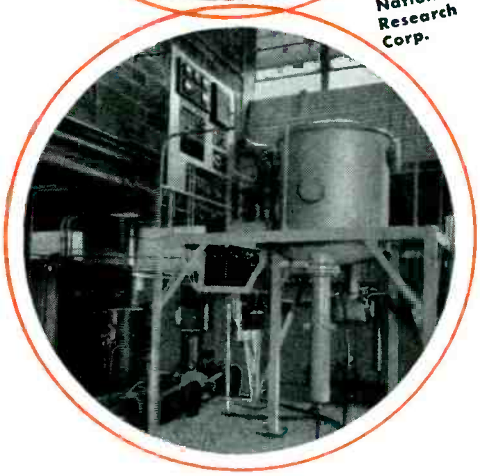
Climax Molybdenum



Proctor & Schwartz



Distillation Products Industries

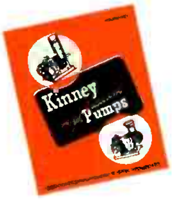


National Research Corp.

- **Sylvania Electric Products is producing super-size TV picture tubes in this giant merry-go-round.**
- **Climax Molybdenum uses this high vacuum furnace for metallurgical research.**
- **Proctor & Schwartz and Dry-Freeze Corporation have developed a process for freeze-drying materials which would otherwise be damaged by high temperatures.**
- **Putting a thin layer of metal on cellophane is the job of this vacuum coating machine made by Distillation Products Industries.**
- **Metals are melted and cast to a new high standard of quality in this National Research Corporation vacuum furnace.**

Each of these installations is different: each is designed to perform a highly specialized task. But all have this in common — all use KINNEY HIGH VACUUM PUMPS to get down to low absolute pressures fast and dependably.

For your vacuum needs, be sure to get a KINNEY, the pump that's seen in the best of circles. Send for new Bulletin V-51B. KINNEY MANUFACTURING CO., 3565 Washington St., Boston 30, Mass. Representatives in New York, Chicago, Cleveland, Houston, New Orleans, Philadelphia, Los Angeles, San Francisco, Seattle.



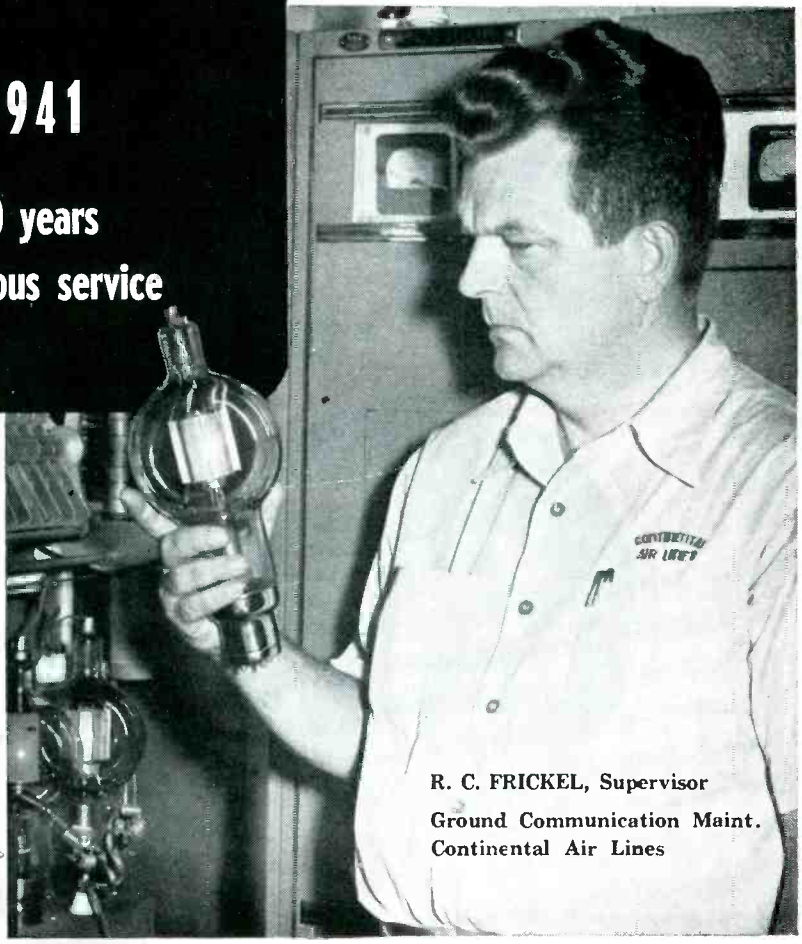
SEND FOR THIS NEW BULLETIN V-51B

Kinney VACUUM PUMPS

FOREIGN REPRESENTATIVES: Gen'l Engineering Co., Ltd., Radcliffe, Lancs., England • Horrocks, Roxburgh Pty., Ltd., Melbourne, C. I. Australia • W. S. Thomas & Taylor Pty., Ltd., Johannesburg, South Africa • Novelectric, Ltd., Zurich, Switzerland • C.I.R.E. Piazza Cavour 25, Rome, Italy.

INSTALLED . . . 1941

Old P-167 gave 10 years of almost continuous service



R. C. FRICKEL, Supervisor
Ground Communication Maint.
Continental Air Lines

CONTINENTAL AIR LINES, Inc.

STAPLETON AIRFIELD
DENVER 7, COLORADO

August 9, 1951

Eitel-McCullough, Inc.
San Bruno, California

Gentlemen:

We finally had to replace old "P-167." This tube had been in continuous use at Continental Air Lines so long that it almost seemed like the passing of an old friend.

We here at Continental are very proud of our 17 year safety record and we know that dependable plane-to-ground radio communications have played an important part in the maintaining of this perfect record of safety.

Old P-167 was installed on June 17, 1941, and was removed July 28, 1951. During these 10 years the tube has seen almost continuous use at Continental's Denver transmitter, which is the communications control center of the airline's plane-to-ground radio contact.

The dependable performance of your tubes, as demonstrated by old P-167, is all the evidence we need as to where to buy our tubes. We will continue to use Eimac Tubes, as in the past.

Cordially,

R. C. Frickel, Supervisor
Ground Communications Maintenance

RCF:wrs
Attch.

P.S. Tubes P-117 and P-118, which were installed at the same time as P-167 in the same transmitter are still going strong.

The feelings expressed in Continental's letter are not unlike the feelings of thousands of other users of Eimac tubes. Top performance and a low cost to life ratio always make for customer satisfaction.

The new Eimac 450T that replaced "Old P-167" in Continental's transmitter should, because of improved vacuum tube materials and techniques, give even more satisfactory service.

Eimac tubes invariably do a job better . . . and at lower cost. Take advantage of their almost two decades of proved performance.

A new "Quick Reference" catalog on Eimac's Wide Variety of Tube Types is yours for the asking.

Follow the Leaders to Eimac TUBES
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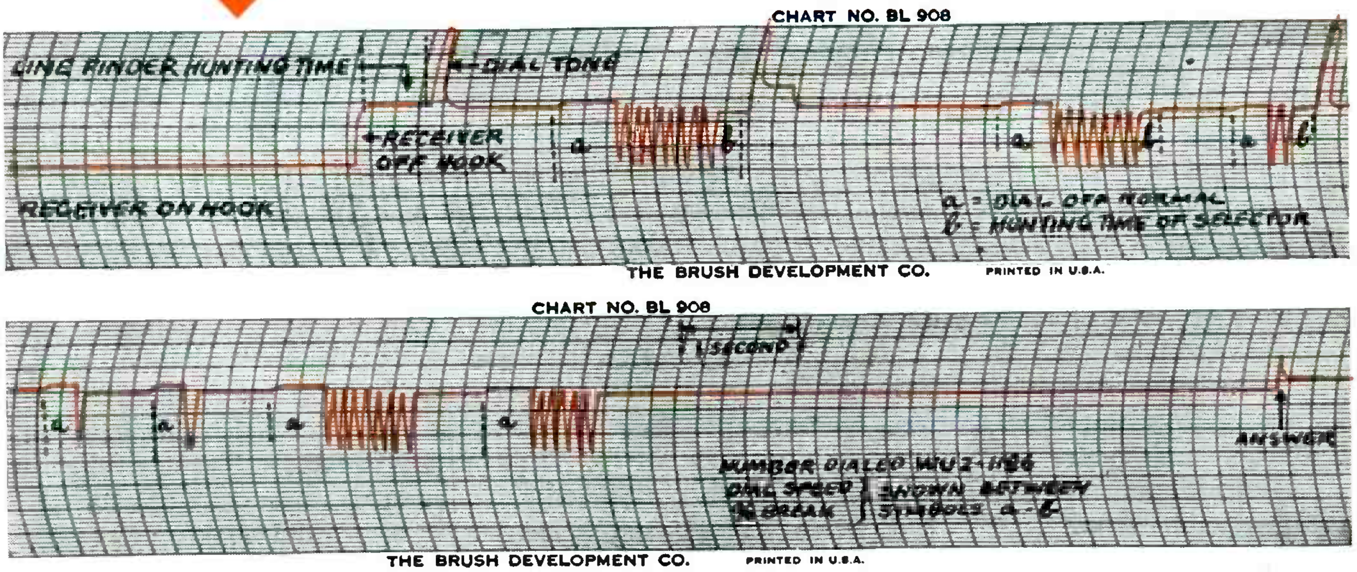
Specialists in Fabricating Sheet Metal for Industry

What's wrong with telephone WU 2-1186?



Fast relays checked by BRUSH Analyzer

A Brush Analyzer drew the graph above when one of the subscribers of an eastern telephone company picked up his phone and dialed WU 2-1186.

This record—drawn automatically in the time it took to dial the number—shows the timing and magnitude of every electrical impulse involved in the complex operation. Such records of impulses from the dials of both subscribers and operators provide the tip-off on equipments which require adjustment or repair.

This check on fast relay operation is but one of hundreds of investigations of electrical and mechanical phenomena which are being made speedily with Brush Analyzers. They record instantaneously. They simplify the study of strains, displacements, pressures, light intensities, temperatures, d-c or a-c voltages or currents.

Write for time-saving help stating your problems. The Brush Development Company, Dept. K-6, 3405 Perkins Avenue, Cleveland 14, Ohio, U. S. A. *Canadian Representatives:* A. C. Wickman (Canada) Limited, P. O. Box 9, Station N, Toronto 14, Ontario.

Put it in writing with a
BRUSH RECORDING ANALYZER

THE **Brush** DEVELOPMENT COMPANY

PIEZOELECTRIC CRYSTALS AND CERAMICS • MAGNETIC RECORDING
ELECTROACOUSTICS • ULTRASONICS • INDUSTRIAL & RESEARCH INSTRUMENTS

Not, PLEASE, In the Name of Fairness

Our national Office of Economic Stabilization has adopted a policy of gearing wages to the cost of living. We are told that "escalator clauses," which provide that rates of pay shall be adjusted to take account of changes in the cost of living, will be generally approved.

If the adoption of this policy had been announced as a frank concession to political expediency, it would have been quite understandable. There may very well be votes, lots of them, in a policy which purports to protect the income of a large group against loss through the price inflation caused by the defense program.

A case might even have been made for a policy of approving escalator clauses on grounds of production expediency. The leaders of some three million organized workers now covered by such clauses have indicated that they would fight to the limit to keep them and thus maintain "real wages," that is, wages measured by their purchasing power. The leaders of other organized groups have indicated they would fight to get the benefit of such clauses. Denial of them might mean serious strikes.

Justified "in Fairness"

However, the policy of approving escalator clauses was not based on these relatively low grounds of expediency. It was justified on high moral grounds, on grounds of "fairness." In the words of the President's Council of Economic Advisers, "maintenance of real wages during inflation cannot in fairness be disallowed."

That proposition is false.

It would be truthful to say, "maintenance of real wages during inflation cannot in fairness be allowed."

The truth of the corrected proposition becomes evident immediately when you take a look at the basic nature of the inflationary problem created by defense mobilization.

We are devoting a large share of our national production to defense. The share is now scheduled to hit about 20% in 1952.

Since we are not able to increase our total production fast enough to meet defense needs in addition to civilian needs, that means a cut in the supply of goods and services that is available for civilian consumption. But the money paid out for the production of defense materials is added to that which is available to buy civilian goods.

Thus, more money is put into the hands of the people to buy less goods. So prices go up. That is inflation.

If one group of people then is granted enough additional money to offset the price increases — and that is the purpose of an escalator clause — and thus can continue to buy as much as they have been buying right along, less goods will be left for other consumers who are not getting this advantage. That is palpably an unfair distribution of the sacrifices necessitated by defense mobilization. In fairness, therefore, maintenance of real wages in inflation cannot be allowed.

Organized workers were not the first, of course, to get the benefit of an automatic adjustment to take account of the increased cost of living. The farmers got theirs first. The price parity formula is, in essence, an escalator clause. The federal government underwrites increases in the prices of the things farmers sell in order to match increases in the prices of the things they buy.

Crucifying the Helpless

As matters stand, two groups are without benefit of escalator clauses. One group is composed of manufacturing firms. While they have not been nearly as successful as the misleading reports of "record-breaking profits" suggest, they have been able to look after themselves fairly well — thus far.

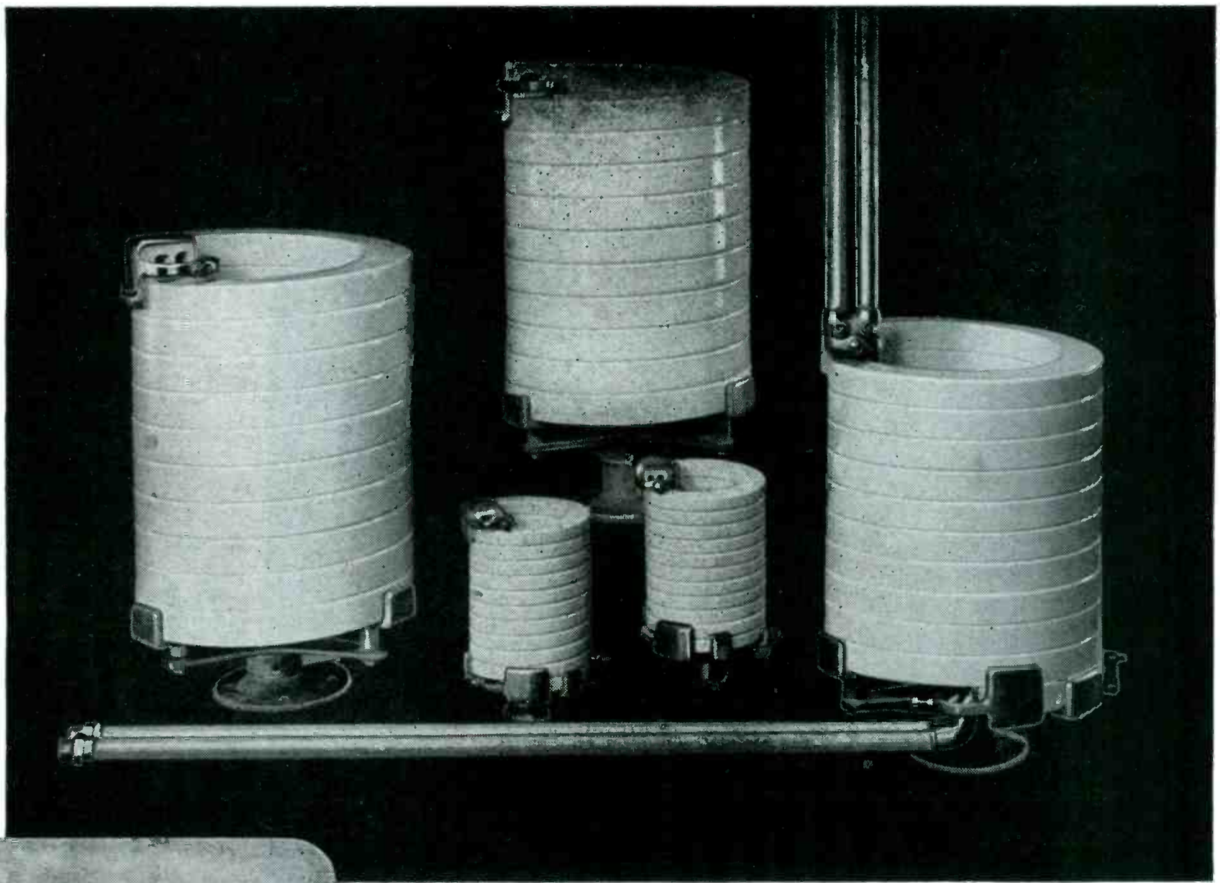
But one group is completely without protection. It is that numerically large but politically unorganized mass of people — many of them old and relatively helpless — who are trying to live on pensions, annuities and other fixed incomes derived from their savings. They are at the end of the line when the increased costs of inflation are passed along. They have no one to whom they can pass the buck. They are being progressively pauperized by the continuing inflation caused by progressive boosting of costs and hence prices.

With the present line-up of pressure groups in Washington, protection for the principal victims of inflation — those who have saved for a rainy day only to find inflation has blown away the roof — is obviously an extremely difficult business. But to have even temporary insulation against inflation granted to powerful groups in the name of fairness should be offensive to the nostrils of a nation that presumes to assert the moral leadership of the Western World.

The only really fair way to handle inflation is to prevent it. But once it is under way, fairness demands that the burdens be as evenly distributed as practicable.

An escalator clause — or a farm parity provision — is explicitly a device to enable the group favored by it to escape the burden of inflation. Whatever concessions we feel we must make to political pressures or production expediency, let us at least be honest enough not to invoke "fairness" as justification for so arbitrary a discrimination in the distribution of the defense burden.

McGraw-Hill Publishing Co., Inc.



Lapp PORCELAIN WATER COILS

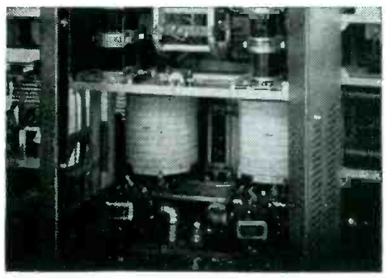
for tube-cooling water . . .

2 gals. per min. . . .

or 90 gals. per min.

Lapp porcelain water coils are now available in twin-hole types (for water supply and return) and single-hole models in a variety of standardized sizes. Of pure white, completely vitrified, non-porous, low-loss chemical porcelain, they provide for positive cooling and long tube life, because they are permanently non-deteriorating and non-sludging. They permit no water contamination, so avoid need for frequent inspection and water changing, eliminate possibility of electrolytic attack on fittings with consequent leakage. Compact, too—a 29-foot coil of porcelain pipe with two holes of size equivalent to ¾″ pipe, and capable of carrying 35 gallons per minute both ways, at 25 pounds water pressure, measures only 12″ outside diameter by 18″ overall height including base mount.

WRITE for complete description and specifications. Radio Specialties Division, Lapp Insulator Co., Inc., Le Roy, N. Y.



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RANGE — is continuously adjustable from a minimum of —0.1 to +1 mv . . . up to a maximum of —2 to +20 mv.

ZERO SUPPRESSION — uncalibrated coarse and fine . . . is continuously adjustable from —50 to +50 mv.

NEW — SPEEDOMAX RECORDER for 1001 tests..

range and zero suppression are continuously adjustable

Just turn a knob . . . twist a dial . . . and you have adjusted this new Speedomax Recorder to the exact specs required for the automatic data-charting job at hand.

Turning the ZERO knob varies zero suppression . . . pushes off-scale that portion of the range in which you are not interested . . . spreads the few millivolts you want to watch across full width of the 9⅞" Speedomax chart. Twisting the RANGE dial calibrates the recorder so that its scale represents the range span in which changes occur.

With full scale pen speed of 3, 2, even 1 second . . . limit of error only 0.3% of range, Speedomax proves especially useful for measuring:

Force, weight, etc.—with load cells. Adjustable zero compensates for tare. Range is adjusted to provide desired calibration.

Temperature or temperature-difference—with thermocouples. Minute changes can be measured with extreme sensitivity.

Speed—with electric tachometers. Change of speed can be measured over a narrow band in detailed studies of motors, engine governors, etc.

Voltage—from other transducers and amplifiers.

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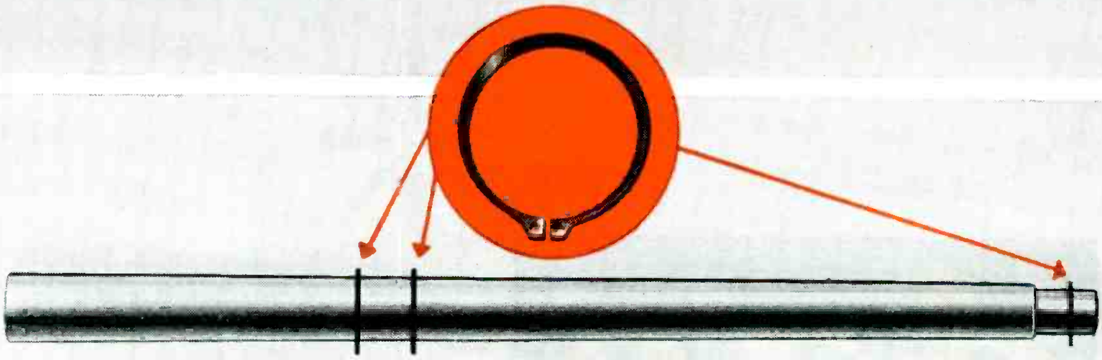
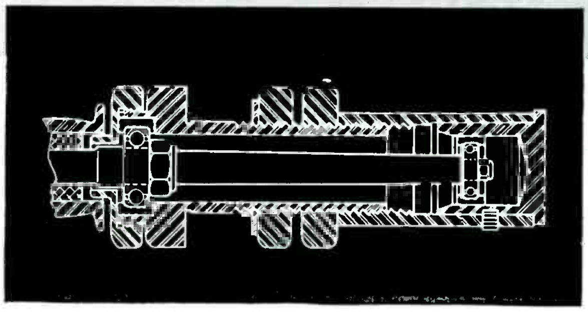
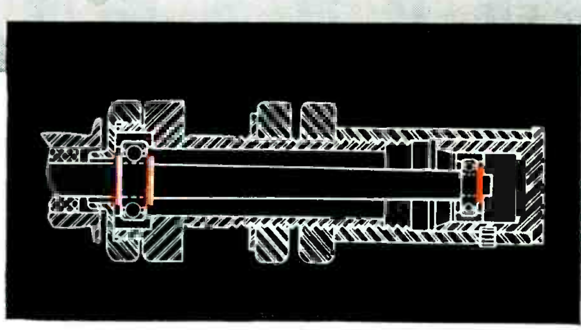
Jrl Ad EM9(3)

3 TRUARC RETAINING RINGS LOWER COST... IMPROVE PERFORMANCE OF REVOLUTIONARY NEW TEXTILE SPINDLE!





OLD CONSTRUCTION. To position 2 ball bearings, an oversize diameter rod had to be turned on a lathe to provide 3 shoulders. In addition, blade required 2 threading operations . . . 2 lock nuts . . . separate tapering operation. Proper pressure of nuts against ball bearings required skilled labor adjustment.



NEW CONSTRUCTION. Standard rod, equal in diameter to finished blade is used. Three grooves for Truarc Rings and shoulder are made quickly and easily on screw machine. Blade is economically tapered by centerless grinding. Truarc Rings maintain correct pressure on ball bearings for life of unit!

The H & B American Machine Company's new anti-friction CENTURY spindle is probably the most mechanically advanced spindle on the market today. Waldes Truarc Retaining Rings have eliminated many of the material, tooling and assembly costs...have kept its price competitive. Truarc Rings not only simplify spindle assembly, they position ball bearings accurately...simplify maintenance...eliminate skilled labor...improve performance! And there are Truarc Rings to solve any design or re-design problem!

Redesign with Truarc Rings and you too will cut costs.

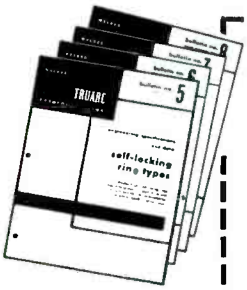
Wherever you use machined shoulders, bolts, snap rings, cotter pins, there's a Waldes Truarc Retaining Ring designed to do a better job of holding parts together.

Truarc Rings are precision-engineered...quick and easy to assemble and disassemble. Always circular to give a never-failing grip. They can be used over and over again.

Find out what Truarc Rings can do for you. Send your blueprints to Waldes Truarc engineers for individual attention, without obligation.

Waldes Truarc Retaining Rings are available for immediate delivery from stock, from leading ball bearing distributors throughout the country.

SEND FOR NEW BULLETINS ➡



WALDES TRUARC REG. U. S. PAT. OFF.

RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

WALDES TRUARC RETAINING RINGS AND PLIERS ARE PROTECTED BY ONE OR MORE OF THE FOLLOWING U. S. PATENTS: 2,382,947; 2,382,948; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,509,081 AND OTHER PATENTS PENDING.

Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N. Y.
Please send engineering specifications and data on Waldes Truarc Retaining Ring types checked below. E-103

- ☐ Bulletin #5 Self-locking ring types
- ☐ Bulletin #6 Ring types for taking up end-play
- ☐ Bulletin #7 Ring types for radial assembly
- ☐ Bulletin #8 Basic type rings

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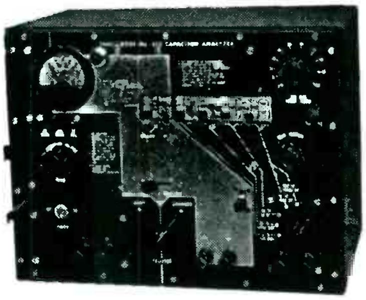
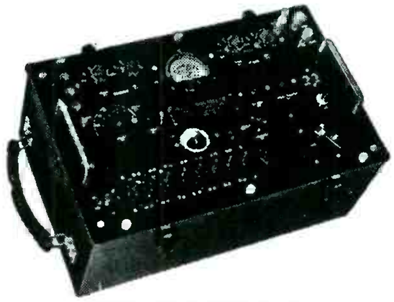
Products bearing the registered trademark **"dag"** originate only with the Acheson Colloids Corporation, Port Huron, Michigan, or with Acheson Colloids Ltd., London, England. Acheson Colloids is the world's largest producer of colloidal graphite dispersions for the metalworking and electronic industries, and also supplies dispersed pigments to a large segment of the color-consuming trade. The trademarks "Oildag", "Aquadag", "Prodag", "Glydag", "Castordag", "Varnodag" and "Gredag" identify particular products of Acheson Colloids Corporation or its affiliates, and are duly registered in the United States and in other principal countries of the world.

Something New



WIDE-RANGE, DIRECT-READING CAPACITOR ANALYZER

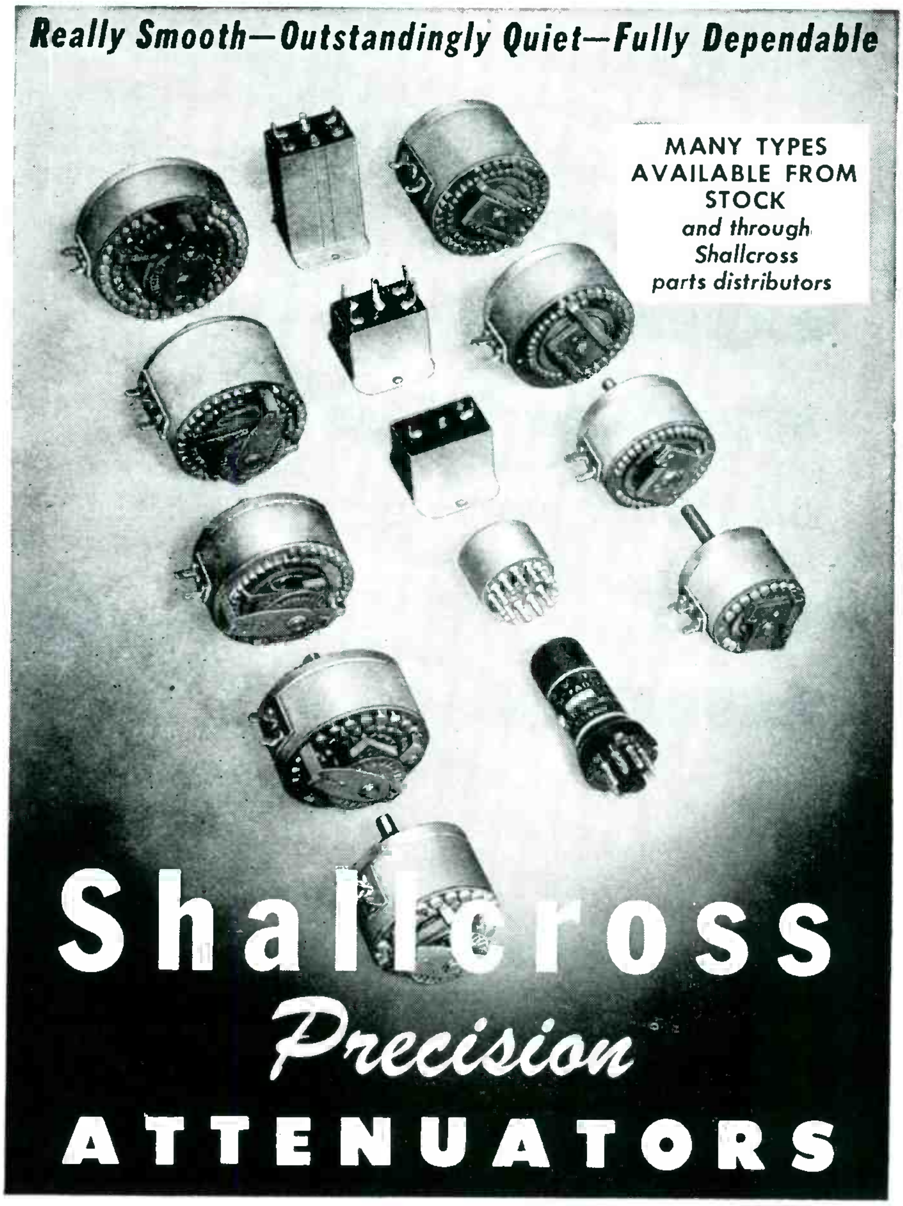
A laboratory-type Capacitor Analyzer meeting the need for a highly accurate, wide-range, direct-reading measuring instrument capable of determining the essential characteristics of capacitors has been announced by the Shallcross Manufacturing Co. This versatile instrument will determine capacitance values between 5mmf. and 12,000 mfd.; insulation resistance from 1.1 to 12,000 megohms; also leakage current, dielectric strength, and percentage power factor. A divided panel carrying an outline of the operating instructions makes it readily possible to use the instrument without reference to an instruction book. The Shallcross analyzer operates on 110 volt, 60-cycle alternating current. Literature giving full details will gladly be sent on request to the Shallcross Manufacturing Company, Collingdale, Pa.



MULTI-PURPOSE TRANSMISSION TEST SET

In addition to measuring the electrical characteristics of telephone lines and equipment the new Shallcross multi-purpose transmission test set may be used for efficiency tests on local and common battery telephone lines and sets, carbon microphones, receivers, and magnetic microphones. It also provides a fast, efficient means of testing capacitors, generators, ringers, insulation resistance, dials, and continuity. Key switches and dials are used to select and control the test circuits. The 693 Transmission Test Set is powered by external batteries. It features compact, substantial construction and is fully portable, thus making it ideal for either field or laboratory use. Details may be obtained from the Shallcross Manufacturing Company, Collingdale, Pennsylvania.

ADV.



ALL STANDARD FIXED AND VARIABLE TYPES

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SPECIAL NETWORKS

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There's a reason! Improved design, materials and production techniques have resulted in a line that sets new, higher standards of attenuation performance for practically every audio and communications use.

Shallcross Attenuation Engineering Bulletin 4 gladly sent on request.

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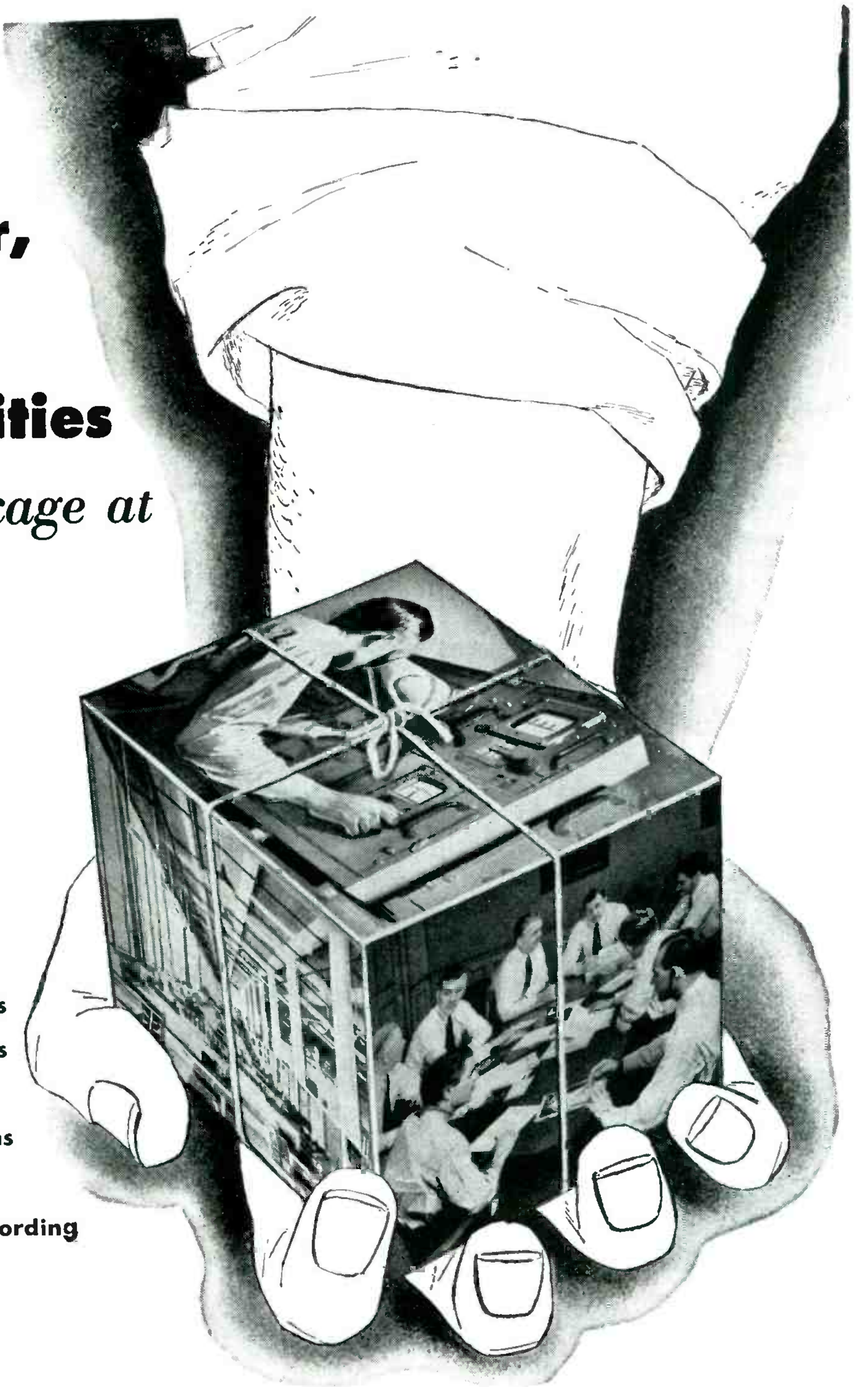

- Television
- Video and display systems
- Audio and communications
- Teleprinter techniques
- Precise electro-mechanisms
- Aeronautic control devices
- Data transmission and recording
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In each of the defense-important fields listed here, the Gray organization has recently solved important problems. These facilities are available to prime contractors and to the military services as our contribution to the national effort in furtherance of communications, engineering or electro-mechanical designing. A booklet telling more of the Gray story will be sent for the asking.

● Please write for Bulletin RB-10 describing the above equipment

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Division of The GRAY MANUFACTURING COMPANY—
Originators of the Gray Telephone Pay Station and the Gray Audograph

President

tooling costs reduced 66⅔%

Let Mr. Ray Blakeman, president of Blakeman Bros. Electric Mfg. Co., Los Angeles, tell you this story of savings with Plaskon Alkyd Molding Compound in the manufacture of his company's commercial and residential watt-hour meter-mounting devices. Mr. Blakeman writes: "Tooling cost is about one-third using this material as compared to the tooling cost of other plastic materials"..."We have found that Plaskon Alkyd lends itself very well to automatic molding, giving us a high production rate on automatic presses"..."Percentage of reworks and breakages is extremely low"..."Our particular device requires a high dielectric strength for which Plaskon Alkyd is noted"..."Since using Alkyd we have not had one operating failure...of our product."

Here is more evidence that parts can be molded better and faster at lower cost—with the amazing quick-curing plastic which has created new concepts of speed and economy in compression molding.

It may pay you well to check the possibilities of Plaskon Alkyd in relation to your product. We will be glad to send you a complete set of the latest bulletins describing the many unusual properties of this unusual thermosetting plastic molding compound.

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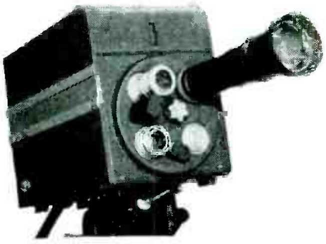
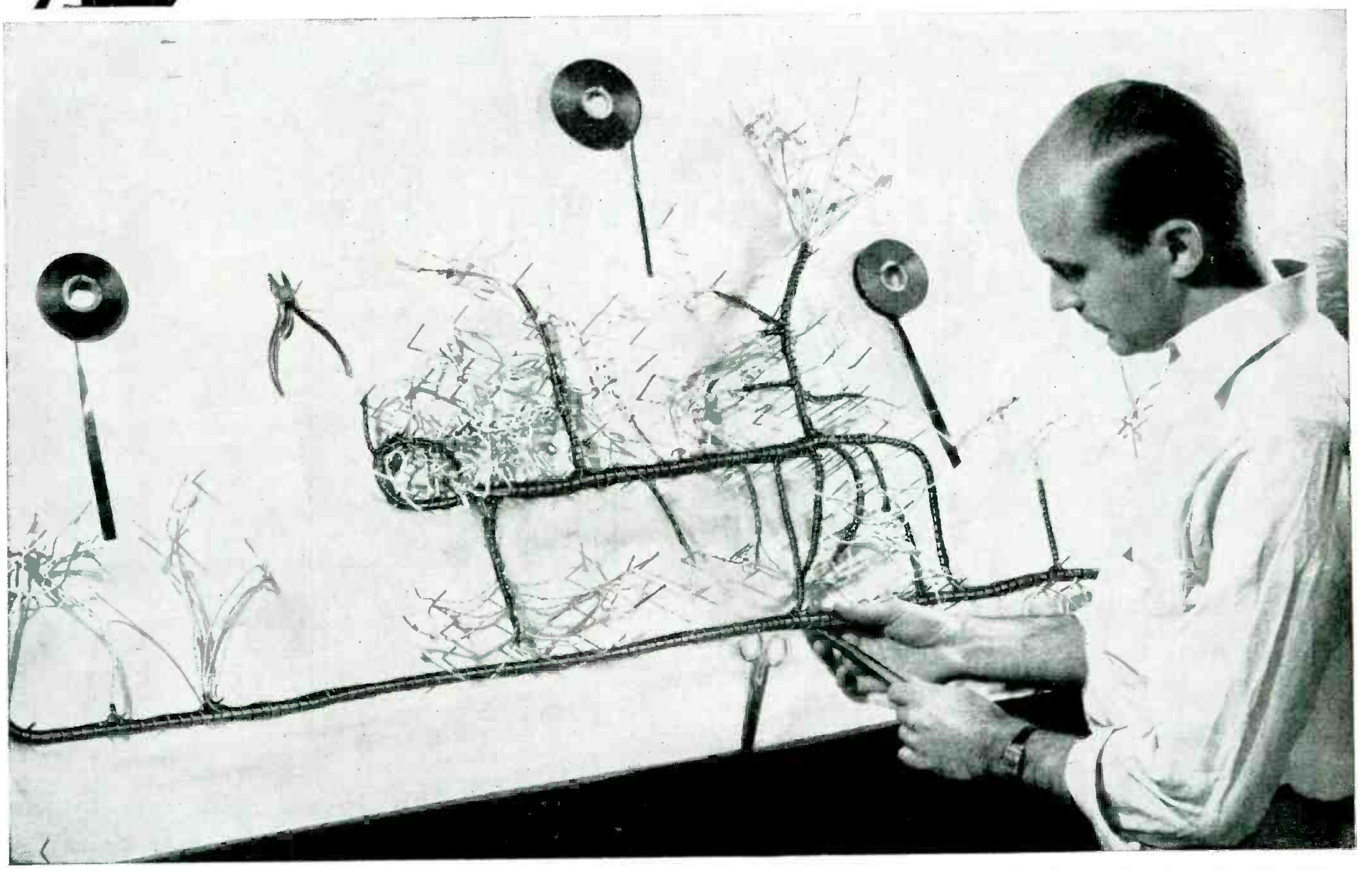


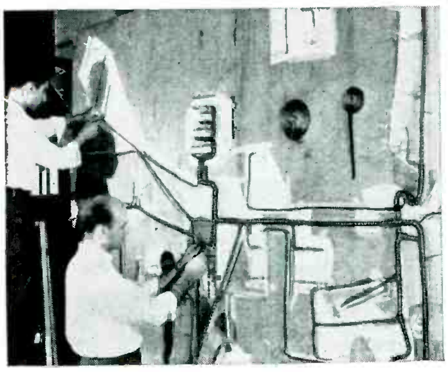
Plastic tape's the choice in compact Du Mont cameras!



See that neat Du Mont camera harness being wrapped with "SCOTCH" No. 33 Electrical Tape? That's typical of over 100 feet of harnessing protected with this super-thin plastic tape in every Du Mont Image Orthicon Camera Chain assembled at the Allen B. Du Mont Laboratories, Inc., Clifton, New Jersey.

Du Mont finds, like many other manufacturers, that "SCOTCH" No. 33 Electrical Tape takes less room to do a better job than conventional insulating tapes. It's easier, *faster* to work with. Smooth, stretchy backing speeds harness installation, leaves plenty of working space and stays neat and tight.

Harnessing cables is just one of hundreds of uses for this remarkable tape. High dielectric strength makes it ideal for insulating splices on all kinds of wiring. Acids can't harm it—resists abrasion, too! Try "SCOTCH" No. 33 on *your* next job. There's nothing else like it.



DU MONT TRANSMITTER HARNESSES get the same care and attention as the *camera* harnesses. Here's another big job done better with "SCOTCH" No. 33 Electrical Tape! Replaces bulky, old-fashioned insulating tapes, cuts costs, saves time.

Quick Facts about "SCOTCH" No. 33 Electrical Tape

- **TOUGH**—plastic backing is abrasion-resistant, unaffected by water, oil, acid, alkalies.
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The term "Scotch" and the plaid design are registered trade marks for the more than 100 pressure-sensitive adhesive tapes made in U.S.A. by Minnesota Mining & Mfg. Co., St. Paul 6, Minn.—also makers of "Scotch" Sound Recording Tape, "Underseal" Rubberized Coating, "Scotchlite" Reflective Sheeting, "Safety-Walk" Non-slip Surfacing, "3M" Abrasives, "3M" Adhesives. General Export: Minn. Mining & Mfg. Co., International Division, 270 Park Avenue, New York 17, N. Y. In Canada: Minnesota Mining & Mfg. of Canada, Ltd., London, Canada.

triple-threat to trouble!

A PROBE TYPE VACUUM TUBE VOLTMETER

As an a-c probe type vacuum tube voltmeter, ranges of 3 to 300 volts, frequency coverage extends from 50 cycles to 300 megacycles. Specially designed RF and D-C probes supplied.

AN ELECTRONIC VOLT-OHMMETER

Using 115 volts, 60 cycle external power, Model 769 is a stable electronic instrument providing 6 ranges from 3 to 1200 volts d-c full scale and 6 ohmmeter ranges to 2000 megohms full scale.

A VOLT-OHM-MILLIAMMETER

With self-contained power source, provides 6 d-c voltage ranges (10,000 ohms per volt)—6 a-c rectifier type voltage ranges (1,000 ohms per volt)—6 d-c current ranges and 3 ohmmeter ranges.

WESTON model 769

ULTRA HIGH FREQUENCY ELECTRONIC ANALYZER

Here is a truly versatile, three-in-one instrument that's a natural for those engaged in electronics production or maintenance. The entire instrument is protected from external RF influences. Its broad range and its complete stability make it ideally suited for AM, FM, and television testing, as well as for many applications in the HF and VHF fields. Uses standard commercial tubes, replaceable without recalibration. Extremely compact, Model 769 provides greater economy, greater convenience, because this one instrument provides for practically all electronic measurements. Literature available . . . WESTON Electrical Instrument Corporation, 595 Frelinghuysen Avenue, Newark 5, New Jersey . . . manufacturers of Weston and TAGliabue instruments.

WESTON *Instruments*

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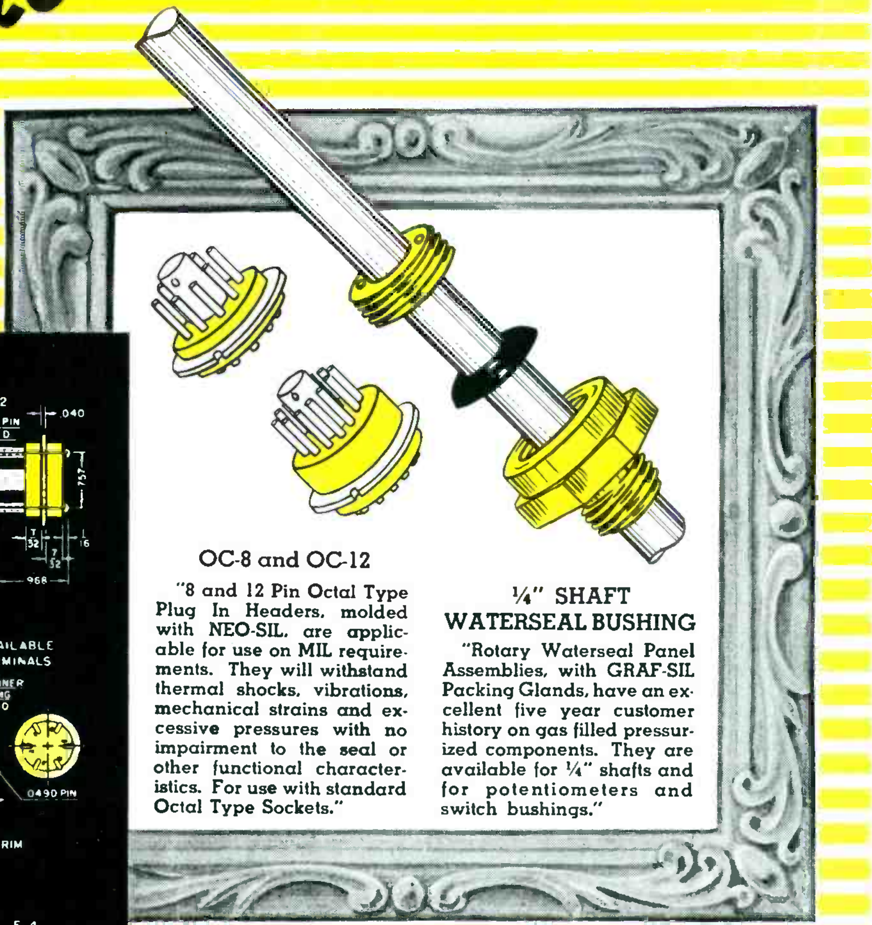
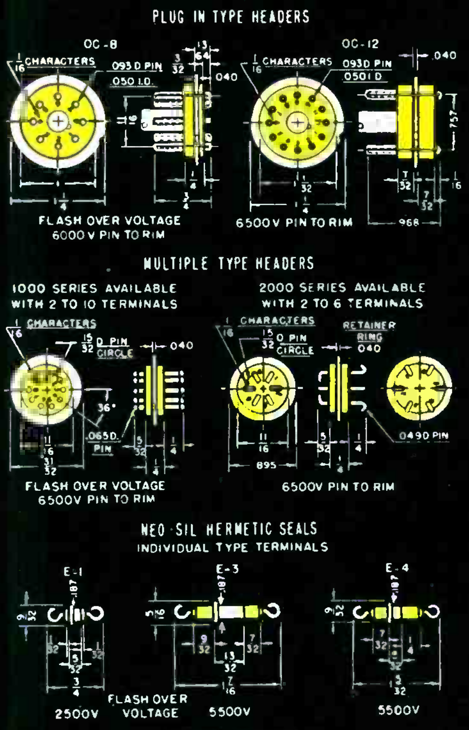
Master Pieces of Hermetic Sealing





TEST DATA

The result of the Electrical Testing Laboratories Inc., Report #330655, dated March 18, 1949, on this material shows the following:

Volume Resistivity at 800 Volts d-c

Room Temperature 25°C	R.H. 30 percent
Megohm-inches	*ohm-centimeters*
1.4×10^{6}	3.5×10^{12}

Dielectric Constant and Dissipation Factor

Dielectric Constant	*Dissipation Factor*	*Loss Factor*
	@ 60 cycles per second	
9.22	.058	5.32
	@ 1 megacycle per second	
6.17	.0455	.28
	@ 50 megacycles per second	
5.35	0.20	1.1

Dielectric Strength at 60 cycles
Volts per mil — 370

Durometer Average — 80 ± 5

Temperature — Rated as a Class A material conservatively + 160° to —70° centigrade.

The Flashover Voltages indicated were taken at a temperature of 68° Fahrenheit, and 47% Relative Humidity.

OC-8 and OC-12

"8 and 12 Pin Octal Type Plug In Headers, molded with NEO-SIL, are applicable for use on MIL requirements. They will withstand thermal shocks, vibrations, mechanical strains and excessive pressures with no impairment to the seal or other functional characteristics. For use with standard Octal Type Sockets."

¼" SHAFT WATERSEAL BUSHING

"Rotary Waterseal Panel Assemblies, with GRAF-SIL Packing Glands, have an excellent five year customer history on gas filled pressurized components. They are available for ¼" shafts and for potentiometers and switch bushings."

"NEO-SIL's proven Hermetic sealing components will eliminate rejects resulting from breakage, strains, cracks, etc. Each NEO-SIL component is pressure checked at 25 psi — to meet military requirements and as applied to our units, NEO-SIL rubber will resist abusive temperature cycling, salt water, most acids and alkalies, and withstand high pressures and vacuums."

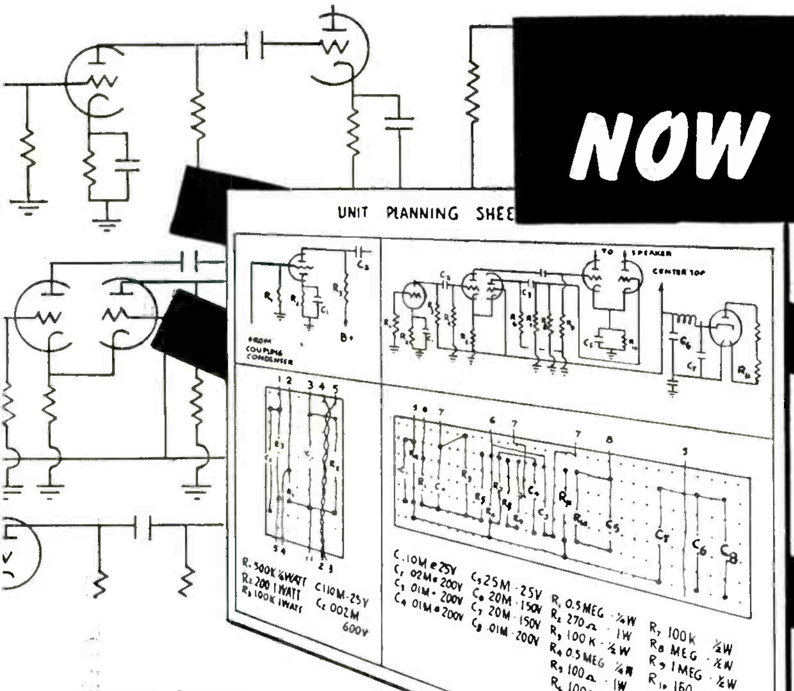
"In addition to the items illustrated above, NEO-SIL offers many other components, such as Hermetically Sealed Fuse Holders, Hermetic Sealing Terminals, Multiple Pin Headers, Hermetically Sealed Cables, Hermetically Sealed Line Cords With Plugs for European use, Meter Gaskets, Panel Gaskets, Adapters (U. S. to Continental), Coil Forms, Crystal Contacts and other molded bakelite and NEO-SIL rubber units."

"Hermetically Sealed Fuse Holders are available for 3-AG and 4-AG fuses. These units are completely sealed from moisture with or without the cap or fuse inserted and are applicable for use on vacuum or gas filled units."

Your special problems are solicited.

NEO-SIL CORPORATION

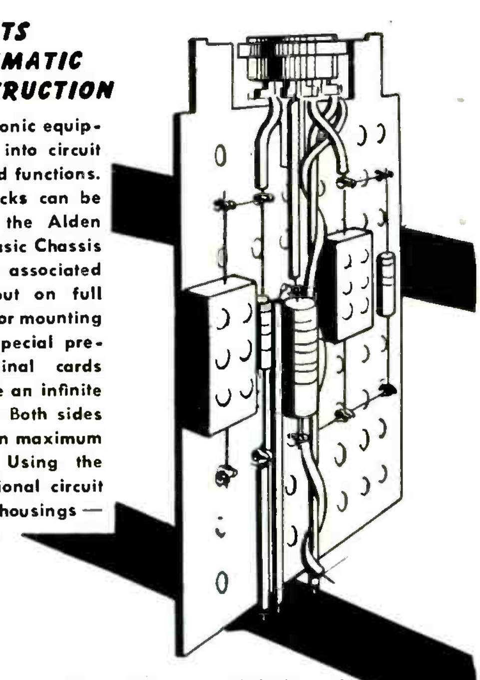
26 CORNELISON AVE., JERSEY CITY 4, N. J.



NOW YOU CAN MOVE

① ORGANIZE CIRCUITS QUICKLY FOR SYSTEMATIC LAYOUT AND CONSTRUCTION

Schematics of most all electronic equipment can be broken down into circuit blocks of logically associated functions. These functional circuit blocks can be mounted readily either in the Alden "20" plug-in packages or Basic Chassis unit. The tube sockets and associated components quickly lay out on full scale Unit Planning Sheets for mounting on terminal cards. These special pre-punched, multi-hole terminal cards have wide flexibility to take an infinite variety of circuit variations. Both sides of card can be used to obtain maximum component density area. Using the Unit Planning Sheets, functional circuit units — components and housings — are all planned in one step.



FROM IDEA TO EQUIPMENT FAST!

If you are designing urgently needed electronic equipment that must be produced quickly, and in quantity — start with the Alden Basic Chassis — follow through with Alden Plug-in Units and other components.

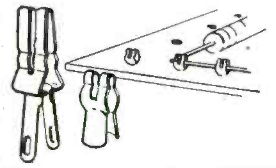
Make your original model with the Alden Basic Chassis rather than breadboard — automatically force isolation of circuits — ready accessibility, easy replacement — and natural functional sub-assemblies. Save vital engineering and planning time — machine and tool hours — critical material and manhours.

IT'S AS SIMPLE AS THIS!

Basic Chassis Construction

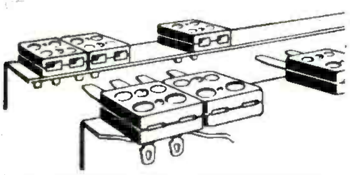
The **Basic Chassis** frame is of strong "U" shape construction — designed for utmost accessibility in assembly and servicing — and for rapid manufacture and delivery to you from small to large volume.

Manufacturing technique allows most of chassis work to proceed as flat piece — Without stacking — it flows from one operator to next, similar to progressive die. Bending is last. Finish and plating is done by automatic conveyorized equipment. Means fast delivery — minimum delay.



Miniature Terminals — 650 Series

Terminal cards have been designed to accommodate tremendous number of circuit variations — to make neat tube and component sub-assemblies with a minimum of wiring and simplified assembly techniques. Special **Alden Miniature Terminals** are new and radical punch press configuration — ratchet slot holds various size component leads for soldering — no twisting of leads with pliers. Figure "eight" shape accommodates cross wiring and buss leads. Punch press parts — so take a minimum of solder, reduce solder time, eliminate danger of cold solder joints.



Back Connectors — 462 Min Series

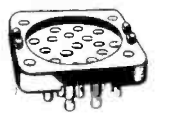
Alden Terminal Card System means minimum of inter-cabling — but even this cabling can be laid out easily and proceed as simple sub-assembly. Open sided chassis construction makes cable easy to wire to front panel, terminal cards and back connectors. **The Alden Back Connectors** are units that can be discretely positioned on the back of the chassis — isolating lines with incompatible voltages, currents, or frequencies. This design insures accessible solder terminals for soldering — avoids rat nests of congested conventional back connector wiring — Color coded, the Alden back connectors provide beautiful operational or service check points for all leads to and from chassis.

Target Screws

Hinged front panel design of chassis — allows rheostats, indicator lights, jacks, etc. to be mounted on panel as another easy-to-work sub-assembly. This panel attaches easily to chassis — is wired — swung up and fastened with **Alden Target Screws.** These screws have concave head with arced notch so power screw driver locates head quickly, no danger of it slipping out and marring panel surface — yet same screw can be unfastened with coin in order to hinge forward the front panel for servicing and check in the field.

Assembled — Basic Chassis simplifies the operation of your equipment — Slashes service and maintenance time. Smooth, positive insertion and removal of the chassis is provided by the Alden **"Serve-A-Unit Lock."** A simple twist of the handle and the chassis backs off with finger tip ease. It also pilots the chassis back into place — securely locking it for operation with the same facility.

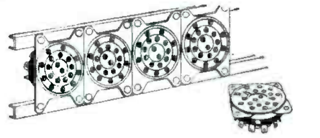
FOR YOUR SMALLER UNITS!



"20" Non-Interchangeable Base

Get the same ease of layout — speed of assembly — ready check or replacement — with the Alden "20" Plug-in Packages. The Alden Terminal Cards with completely interwired tube sockets and components are mounted on special **Alden "20" Non-Interchangeable Bases.** These bases have stubby, strong pins — no molded locating boss to break. Units can be made non-interchangeable to prevent mismating by selected variable pin layouts of less than 20 pins. Using the same Alden "20" base — coupled with simple brackets and housing — relays, stepping switches, and condensers can be made neat, accessible, replaceable units.

Only recently developed, Alden "20" Packages have already saved thousands of vital engineering and construction hours in large computer projects. They are natural for extensive, complicated electronic equipment.



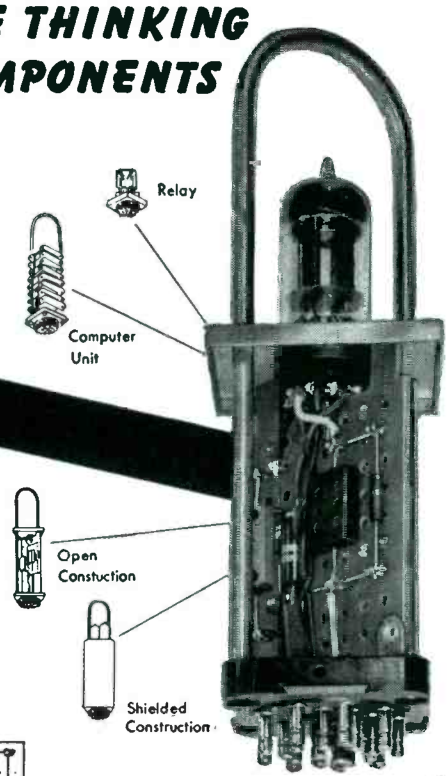
"20" Rack and Chassis Mounting Sockets

Whole Alden "20" Packaged circuit panels can be constructed by simply mounting "U" channels across racks! The **Alden "20" Rack Mounting Socket,** having 4 extended ears, quickly rivets side by side between the channels. Wiring to sockets feeds up from cables laid along "U" frame — leaving contacts accessible for soldering and checking. Where Alden "20" Packages are mounted on chassis, the space saving **Alden "20" Chassis Mounting Socket** has 4 mounting ears which rivet within the square area covered by the Alden "20" Base.

ALDEN PRODUCTS COMPANY

FROM IDEA TO EQUIPMENT FAST

FORCE STRAIGHT LINE THINKING WITH NEW ALDEN COMPONENTS FOR PLUG-IN UNIT CONSTRUCTION



② GET THE MOST NATURAL, EASY SUB-DIVISION OF LABOR IN MANUFACTURE

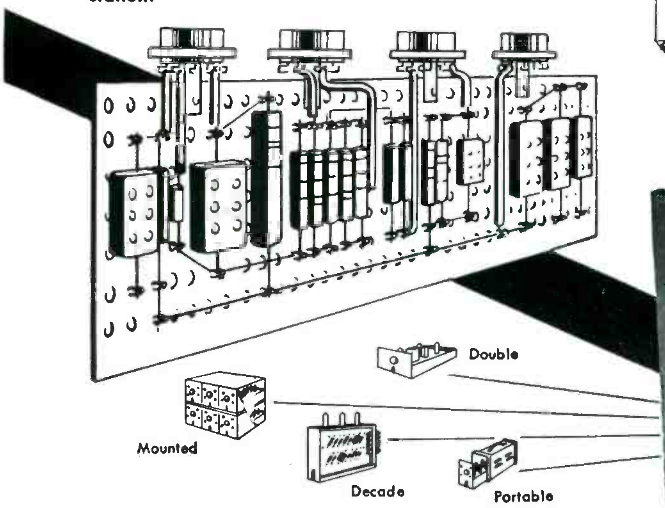
Solder terminals and sockets quickly rivet to Alden terminol card according to layout on Unit Planning Sheet. Components snap into the special Alden Miniature Terminals which hold them for soldering. — (No twisting or wrapping of leads necessary) — With all tube sockets and their associated components mounted on one card — the wiring and soldering of circuits is an open, easy-to-work sub-assembly operation.

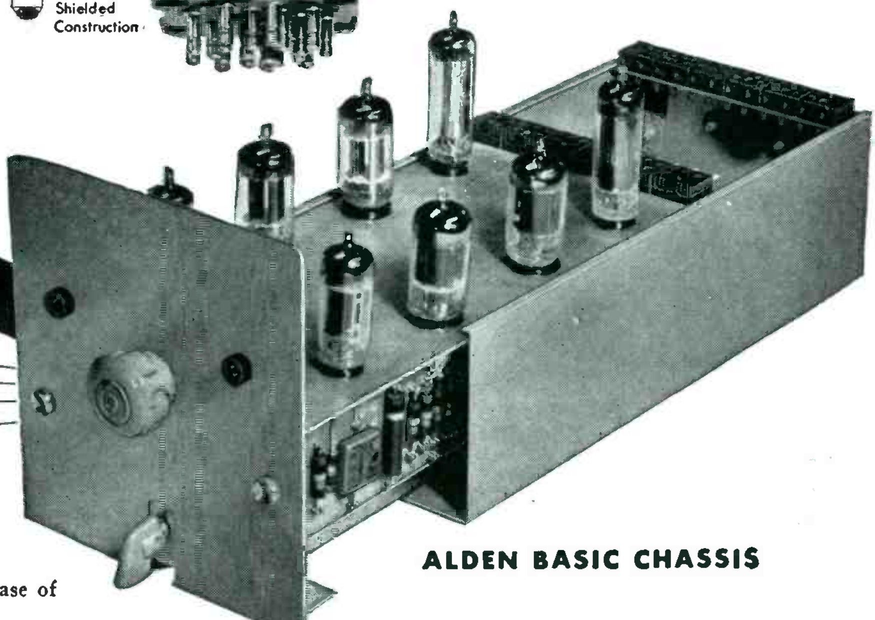
③ INSURE THE LOWEST OPERATING AND SERVICE COSTS IN FINAL EQUIPMENT

The ALDEN "20" PLUG-IN PACKAGE is completed simply by mounting the terminal card on the Alden "20" Non-Interchangeable base, dip soldering the leads and adding cover or housing and handle. . . . In operation, visual or instrument checks are easily made — if trouble occurs doubtful units are quickly isolated — these units easily unplug and a comprehensive inspection made. Spare units can be plugged in so equipment doesn't have to be inoperable while repairs are in process.

The ALDEN BASIC CHASSIS UNIT is rapidly completed by mounting terminal cards into the chassis — soldering unit cables and making connections to Alden Color Coded Back Connectors and detachable front panel. Completed unit is easily piloted in and out of rack with the Serve-A-Unit Lock. Open sided construction, aided by the neat direct front and back connections, gives instant accessibility for rapid circuit checks and service.

ALDEN "20" PLUG-IN PACKAGE

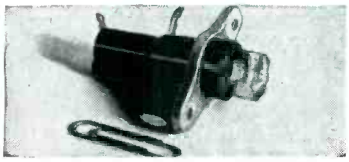




ALDEN BASIC CHASSIS

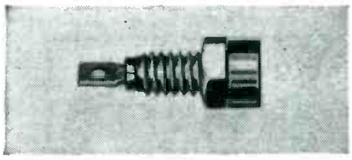
GET LOGICAL FOLLOW THROUGH WITH THESE COMPONENTS !

Use entire Alden Component line for maximum ease of service and replacement —



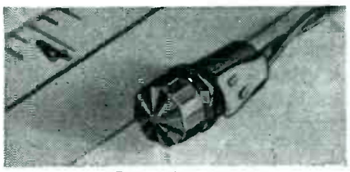
Indicating Fuseholder – 440-3FH

Immediately spot blown fuse — quickly replace it. Neon bulb glows when fuse blows — is molded as integral part of crystal clear lens. **Compact Indicator Fuseholder** rivets or eyelets easily to mounting panel — accessible solder tabs for fast soldering.



Miniature Test Point Jack — 110BCS

Beautiful **Miniature Test Point Jack** available for making instantaneous circuit checks while equipment is in operation. Has 100% insulation around the beryllium copper spring contact. Contact retains its life over thousands of insertions and doesn't score the test prod. Yet it takes minimum of panel space — solders easily to leads.



Pan-i-Lite — 86L

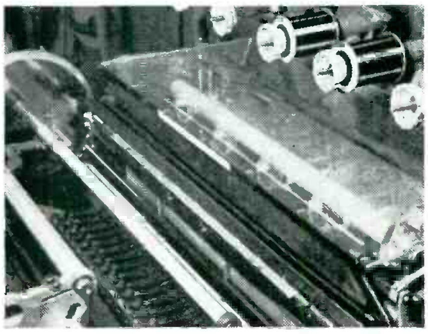
Here's the indicator light you've probably been waiting for. The **Alden Pan-i-Lite** — really small — easy-to-service. Bulb is made integral part of lens. Replaces from the front of panel — no digging into equipment necessary. Takes the absolute minimum of space. Less than 1" overall, it can mount almost anywhere — simply punch 3/8" hole. Tiny but powerful 6 V. bulb gives brilliant indication through the high-temperature — translucent lens. Use minimum of critical material.

TO GET STARTED QUICKLY !

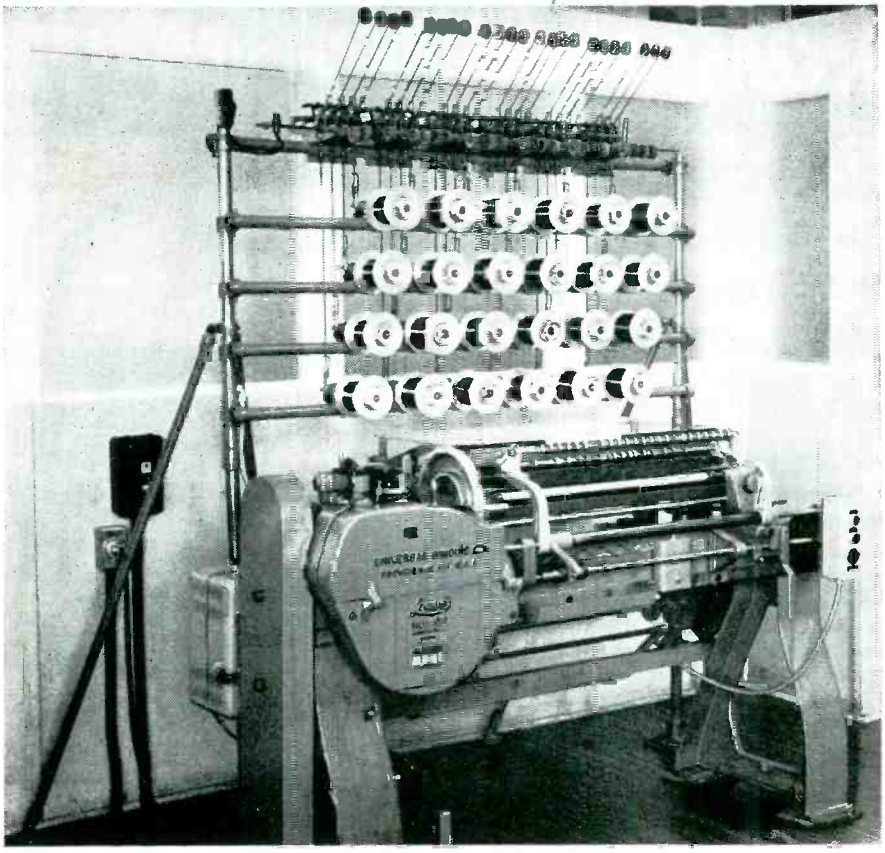
'phone our New Products Director for an appointment to visit our plant— wire for a sample Basic Chassis at $40.00 or an Open and Closed Alden "20" Plug-in Package at $10.00 or write Dept. E for booklet: "Basic Chassis and Components for Plug-in Unit Construction".

117 North Main Street • Brockton • Massachusetts NA-ALD

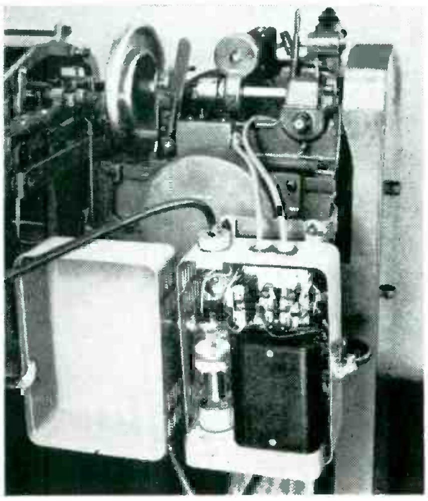
AUTOMATIC FEED BOOSTS PAPER-SECTION COIL OUTPUT



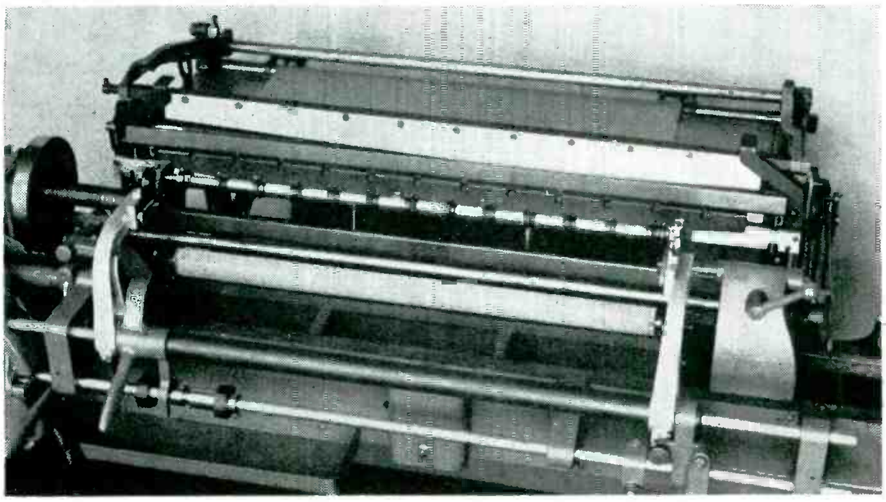
MAXIMUM COIL DENSITY An entirely new type of delivery shelf is used to insure coils of extreme accuracy and high density. It imparts a uniform backward pull to the paper as it is fed into the coil.



25 INSERTS A MINUTE Single or laminated insulating sheets, either paper or acetate, are fed into the Leesona No. 107 Coil Winder at rates as high as 25 per minute. Thus, on a coil containing 100 wire turns per layer, the machine can be run at speeds as high as 2500 rpm.



SLOW, CUSHIONED AUTOMATIC START Electronic speed-control automatically and smoothly accelerates the winding arbor to required speed and maintains it. No "jockeying" needed by operator. Wire breakage is minimized, tension is uniform.

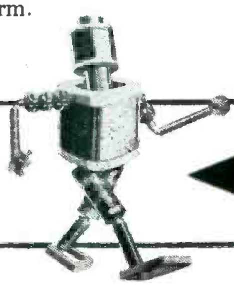


EASY MANUAL OPERATIONS Photo shows coil arbor in position for quick transfer. Wire turn counter can be reset quickly. No cam transfers are required when changing wire layer length, wire spools are easily changed.

Write for GMCW-15

UNIVERSAL WINDING COMPANY

P. O. Box 1605, Providence 1, R. I.



LEESONA ®

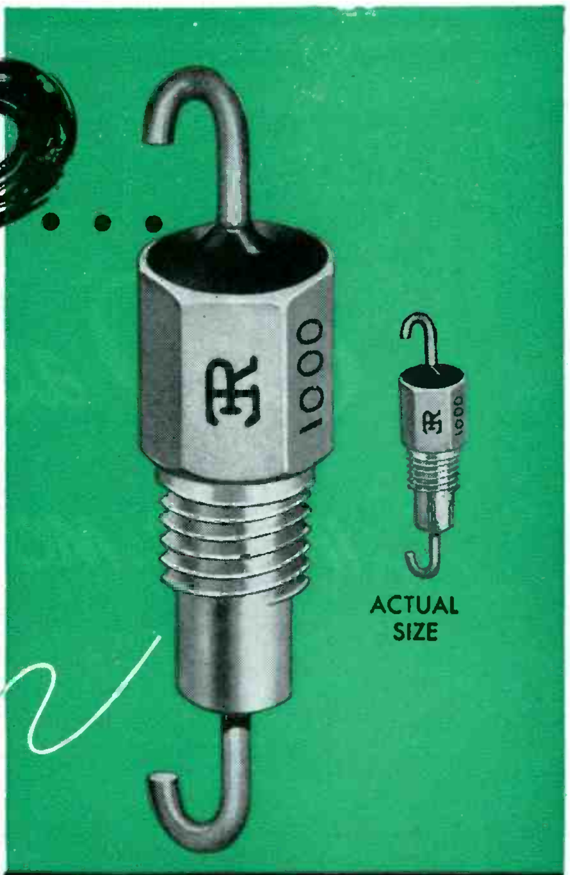
For winding coils in quantity accurately . . . automatically use Universal Winding Machines

23B.1.3

RUGGED...

is the word for the new Erie Style 327

FEED-THRU CERAMICON®



ERIE adds another outstanding capacitor to the most complete line of ceramic by-pass units available. Style 327 Feed-Thru design is a further result of continued Erie development in accomplishing ruggedness in components to meet severe military requirements and to give trouble-free service in other electronic applications. It embodies the following outstanding features:

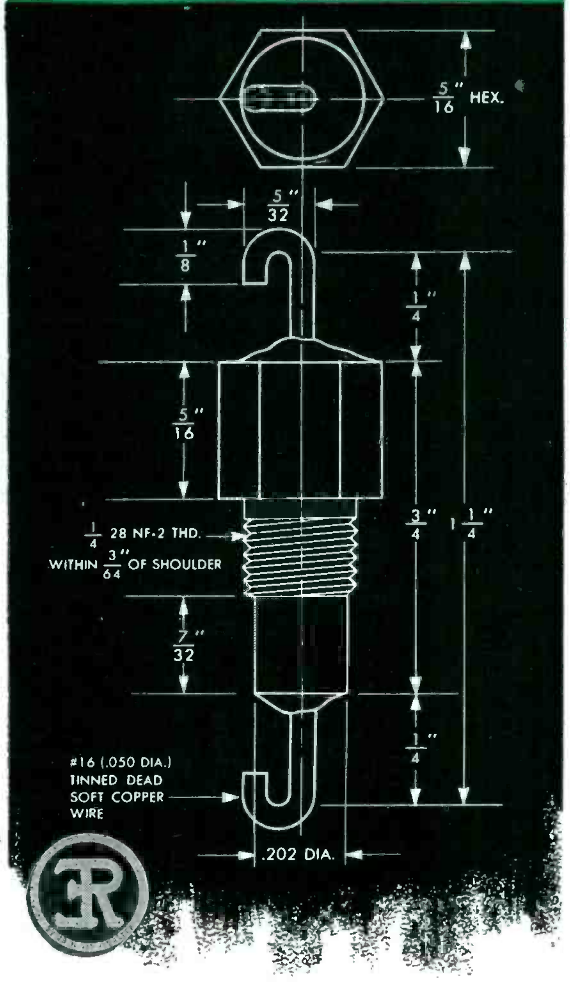
1. Mechanically rugged. Tubular ceramic capacitor is sealed at both ends in thermosetting low loss insulation.
2. Very low and uniform inductance path to ground.
3. Electrical shielding is provided by means of the grounded metal case.
4. All internal connections are soldered; no pressure contacts.
5. Hook type terminals provide sturdy connection tie points; also facilitate precision spacing of leads from other components where required in VHF and UHF circuits.

Specifications:

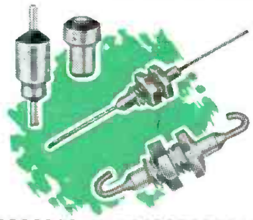
Standard capacitance values, mmf: 10, 33, 47, 68, 82, 100, 470, 680, 1000

Capacitance tolerance: ± 20% or + 80%, —20%

Rated voltage: 500 WVDC (values through 100 mmf also available in 1000 WVDC rating)



OTHER ERIE FEED-THRU CERAMICONS:

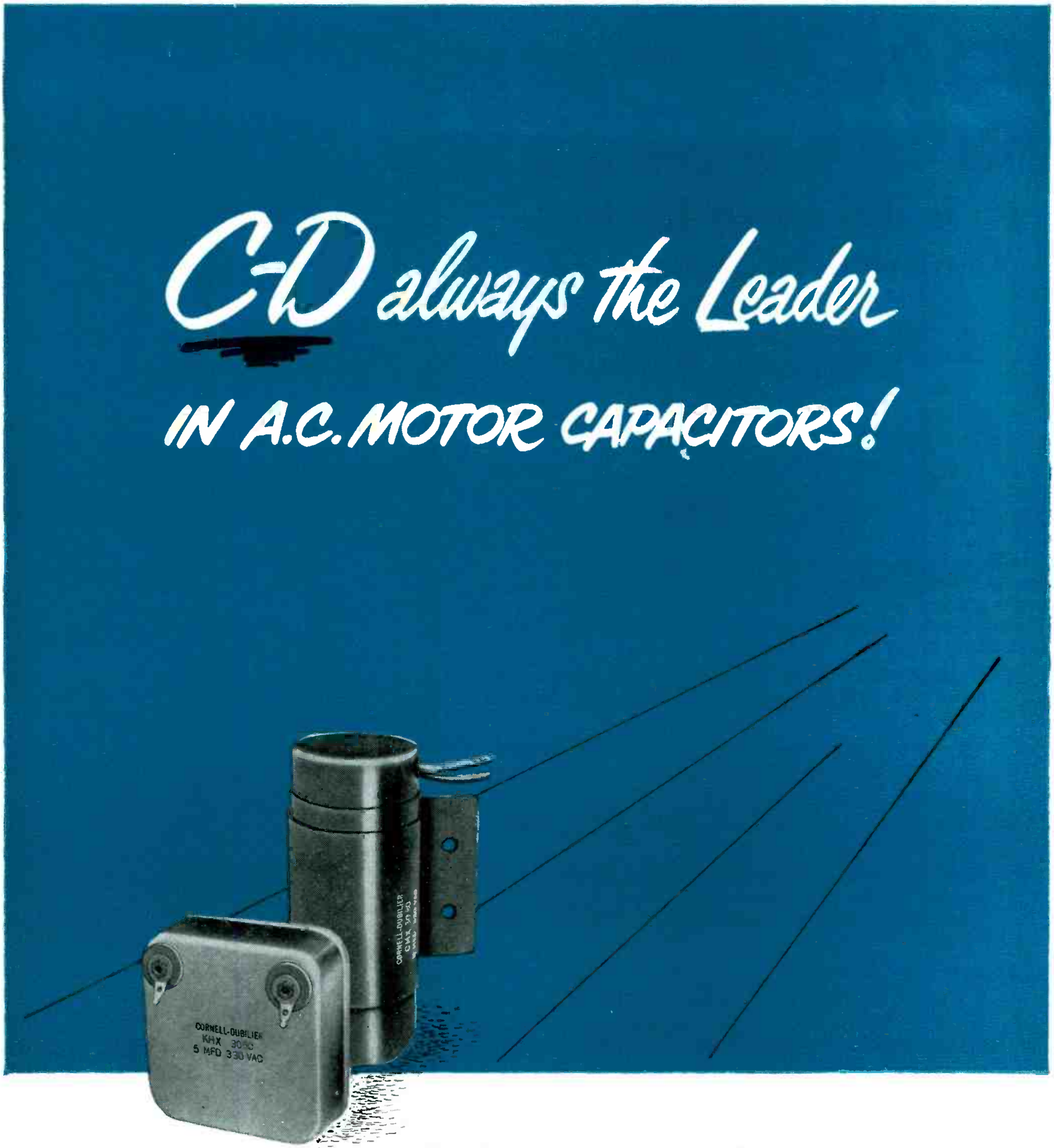


Style 357, rigid hooked wire lead, maximum capacitance 1000 mmf.
Style 362, #20 straight pig-tail wire lead, maximum capacitance 1500 mmf.
Style 2416, rigid wire lead, cadmium plated shell for solder mounting, maximum capacitance 1500 mmf.
Style 2418, no center lead, cadmium plated shell for solder mounting, maximum capacitance 1500 mmf.

Electronics Division

ERIE RESISTOR CORP., ERIE, PA.

LONDON, ENGLAND . . . TORONTO, CANADA



Year after year, more motor manufacturers use more Cornell-Dubilier A.C. motor capacitors than any other. The reason: a great record of trouble-free service in the field! Filled with C-D's world-famous Dykanol, and conservatively rated for extra dependability. Dept. K-101, Cornell-Dubilier Electric Corp., South Plainfield, N. J.

CONSISTENTLY DEPENDABLE

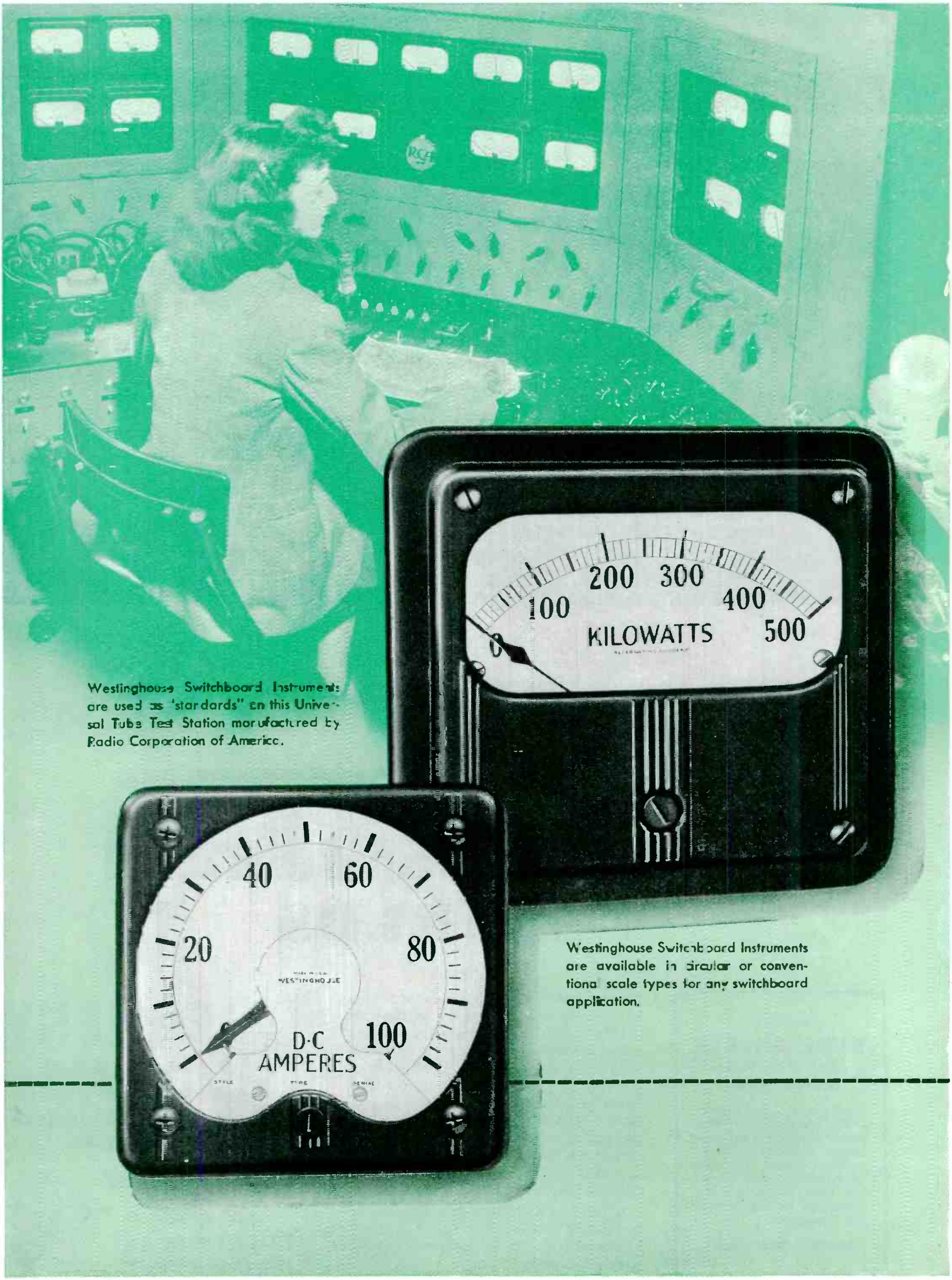
CORNELL-DUBILIER

CAPACITORS

1910-1951

SUBSIDIARY

PLANTS IN SOUTH PLAINFIELD, N. J.; NEW BEDFORD, WORCESTER, AND CAMBRIDGE, MASS.; PROVIDENCE, R. I.; INDIANAPOLIS, IND.; FUQUAY SPRINGS, N. C.; AND SUBSIDIARY, THE RADIART CORP., CLEVELAND, OHIO



Westinghouse Switchboard Instruments are used as "standards" on this Universal Tube Test Station manufactured by Radio Corporation of America.

Westinghouse Switchboard Instruments are available in circular or conventional scale types for any switchboard application.

Where instrument accuracy is a "Must"... specify Westinghouse

The use of Westinghouse instruments as "standards" on RCA's Master Tube Test Stations demonstrates how they measure up to *your* need for accurate measurement of any electrical quantity.

In order to reliably measure the quality of all types of electronic tubes the instruments have to consistently maintain precise accuracy. Westinghouse Switchboard Instruments not only fulfill this requirement but provide important plus benefits as well: Easier readability—to simplify the operator's job . . . and co-ordinated space-saving design—to contribute to the functional compactness of the unit.

Here's further assurance of quality: all Westinghouse switchboard panel, portable and recording instruments are built to meet the rigid performance requirements of the American Standards Association. Moreover, you can select from . . .

The most complete line in the industry!

You get a wider selection for every need whether it be a-c or d-c current and voltage, single or polyphase circuits, watts or vars, frequency, power factor, synchroscopes, temperature indicators, ground detectors or synchrotie (position indicators). And you get . . .

Competent application assistance!

Westinghouse Instrument Application Engineers are available to consult with and serve you in selecting and applying the proper instruments for your application. Simply call your nearest Westinghouse office.

For complete information about Westinghouse Instruments write for Booklet B-4696. Address: Westinghouse Electric Corporation, P.O. Box No. 868, Pittsburgh 30, Pennsylvania. J-40400

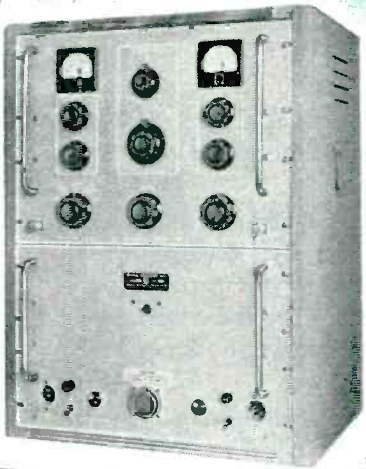
YOU CAN BE SURE.. IF IT'S
Westinghouse

INSTRUMENTS

When you TEST use the BEST...

THE STANDARD OF COMPARISON IN

Type 578-A
PRECISION COAXIAL FREQUENCY METER
0.925—1.70 kmc/s



Type 801-A
UNIVERSAL KLYSTRON POWER SUPPLY
300–1500 V at 65 ma; 1.5–3.6 KV at 25 ma

Augmented by many new components, the PRD line of RF Test Equipment is presently the most complete line available covering the entire frequency range from .01 to 40 kilomegacycles per second. The units listed indicate the wide diversity and applicability of PRD equipment. In addition to the standard line, PRD specializes in the design and manufacture of special equipment to meet special requirements. A skilled staff of engineers is available to analyze your requirements and to assist in the application of standard or special components to your test problem. PRD equipment is engineered and manufactured to the highest attainable standards. No effort has been spared to make this equipment the finest available anywhere with the result that PRD equipment is now used in leading laboratories all over the world.

FREQUENCY MEASURING DEVICES

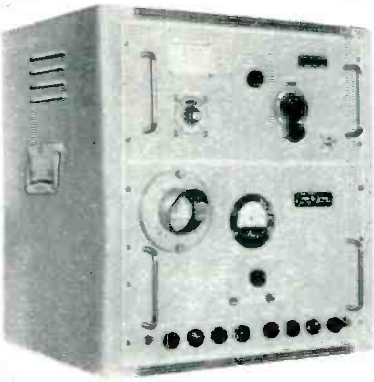
Frequency Meters	Frequency Range (kmc/sec)	Type No.	Transmission Line Size (Nominal O.D.—inches)	R—Reaction T—Transmission
General Purpose	0.47—0.95	584	3/8	T
	3.95—5.85	574	2 x 1	R
	4.00—10.0	562-A	3/8	Detector included
	5.85—8.20	575	1 1/2 x 3/4	R
	7.05—10.0	576	1 1/4 x 5/8	R
	8.45—9.91	551-E	1 x 1/2	R
	8.45—9.91	551-F	1 x 1/2	T
	8.45—9.91	551-G	1 1/4 x 5/8	R
	8.45—9.91	551-H	1 1/4 x 5/8	T

In addition to the General Purpose Frequency Meters listed above, PRD manufactures a complete line of Precision Frequency Meters covering the entire frequency range from 0.55 to 39.0 kmc/s. Transmission line sizes include 3/8" coaxial line and all standard wave guide sizes from 0.280" x 0.140" I.D. to 2" x 1" O.D. All types are available in Reaction and Transmission styles.

The Type 500 Frequency Standard Multiplier is available to generate standard frequency signals in the UHF and microwave regions when used with the Type 612-A Tunable Crystal Mount.

SIGNAL SOURCES AND RECEIVERS

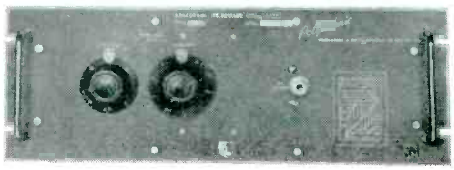
ITEM	DESCRIPTION
TUBE MOUNTS	
Type 701	For type 2K28 klystrons, 2.400—3.445 kmc/sec
Type 702	For type 2K25 klystrons, 8.50—9.60 kmc/sec, 1 1/4 x 5/8 waveguide
Type 703	For type 2K25 klystrons, 8.50—9.60 kmc/sec, 1 x 1/2 waveguide
OSCILLATORS	
Type 705	Covering the frequency range from 7.0 to 11.0 kmc/sec
Type 706	Covering the frequency range from 3.6 to 7.3 km/sec
POWER SUPPLIES Type 801-A	Providing all required electrode voltages to operate a wide variety of klystrons, plus internal modulators
SPECTRUM ANALYZERS	
Type 853	Covering the frequency range from 2.40 to 3.40 kmc/sec
Type 854	Covering the frequency range from 8.50 to 9.60 kmc/sec
Type 855	Combining both of the above ranges in one instrument
SIGNAL GENERATORS	
Type 902	Covering the frequency range from 3.65 to 7.30 kmc/sec
Type 903	Covering the frequency range from 7.00 to 10.5 kmc/sec
NOISE GENERATORS Type 904	For the direct measurement of noise factors in the range of 10 to 1000 mc/sec



Type 854
UNIVERSAL SPECTRUM ANALYZER
8.5–9.6 kmc/s

Type 902
BROADBAND MICROWAVE SIGNAL GENERATOR
3.65–7.3 kmc/s

Type 904
VHF-UHF NOISE GENERATOR
.01–1.0 kmc/s



Type 706
BROADBAND MICROWAVE OSCILLATOR
3.6–7.3 kmc/s

Polytechnic RESEARCH & DEVELOPMENT COMPANY • INC

VISIT US AT THE NATIONAL ELECTRONICS CONFERENCE

... from VHF to EHF it's PRD

QUALITY, ACCURACY, DEPENDABILITY

Precision RF Test Equipment

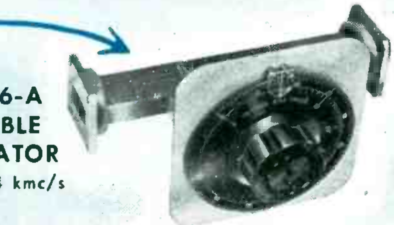
ITEM	TRANSMISSION LINE SIZE: COAXIAL (Nominal O.D.—inches) 7/8	COAXIAL 3/8	WAVEGUIDE (Nominal O.D.—inches) 3x1½	2x1	1½x¾	1¼x5/8	1x½	0.622x 0.311 I.D.	0.420x 0.170 I.D.	0.280x 0.140 I.D.
ATTENUATORS AND TERMINATIONS										
Variable Attenuators Uncalibrated			171	162	161	160	154 159	189	190	191
Dial			174-A	169-A	177-A	184-A	196-A 196-B	187-A		
Precision			175-A	170-A	178-A	185-A	195-A	188-A	153-A	192
Cut-Off		181, 198					180			
Fixed Attenuators Low Power	136 series 142 series	130 series 135 series	s	s	s	s	140 series	s		
High Power	141, 143	144								
Terminations	145	139	129	115	121	114	116	131	132	133
TRANSMISSION LINE COMPONENTS										
Waveguide to Coaxial Adapters			365	357	356	355	354			
Coaxial Transitions	389, 390 391, 392	389, 390 391, 392								
Directional Couplers				400	404	401	402	405		
Waveguide Stands			375-A	376-A	377-A	378-A	379-A	386A	387-A	388-A
Flange Bolt and Nut Assemblies			369-A	369-B	369-B	369-C	369-D	369-E	f	f
Bends and Tees				s	s	s	462 465 481	s	s	s
IMPEDANCE MEASUREMENT AND TRANSFORMATION										
Slotted Sections	200-C 200-D	205-A 215-A	209-A	201-A	204-A	202-A	203-A	210	211	212
Tuners		306	309	300	305	302	303	311 314	313	312
The Type 250-A Broadband Probe is designed for use with the Types 200-C through 209-A and 215-A Slotted Sections; Types 210-212 are supplied with built-in tunable probes. The Type 361 R-F Adapter is available for use with the Type 250-A Probe.										
DETECTION AND POWER MEASUREMENT										
Detector Mounts Crystal		612-A 613					601	616	621	615
Bolometer	623, 624 625, 626	612-A, 613 627, 628						616	620 621	618
Thermistor							635			
The Type 650 Universal Power Bridge is designed to be used with any of the bolometers or thermistors listed for the measurement of absolute power level.										

BOLOMETERS

TYPE No.	FOR USE WITH	TYPE No.	FOR USE WITH	TYPE No.	FOR USE WITH
610-A	250-A, 612-A, 613	629-A	623	630-B	626
614	210, 211, 616, 621	629-B	624	631-A	627
617	212, 618, 620	630-A	625	631-B	628

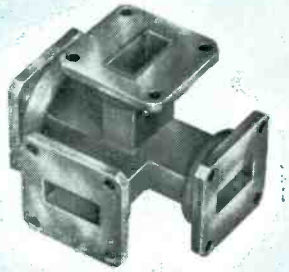
f—Equipment supplied with captive flange screws

s—Available on special order only



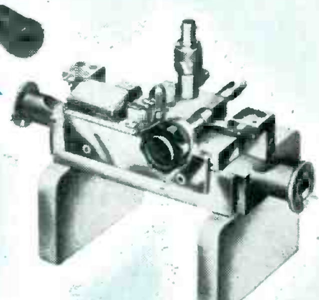
Type 196-A VARIABLE ATTENUATOR
8.20—12.4 kmc/s

Type 389 COAXIAL TRANSMISSION LINE ADAPTER
0—4.0 kmc/s



Type 481 E/H TEE
8.20—12.4 kmc/s

Type 312 E/H TUNER
26.5—40.0 kmc/s

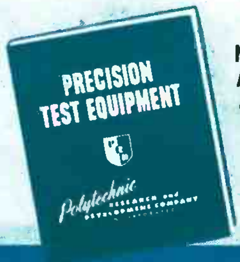


Type 211 PRECISION WAVEGUIDE SLOTTED SECTION
18.0—26.5 kmc/s

Type 250-A BROADBAND PROBE
1.00—12.4 kmc/s

Type 650 UNIVERSAL POWER BRIDGE
0.1, 1.0, 10, 100 mw full scale

Type 627 BROADBAND COAXIAL BOLOMETER MOUNTS
4.0—10.0 kmc/s



NEW ILLUSTRATED CATALOG AVAILABLE ON REQUEST

Contains complete information on the entire PRD line of precision rf test equipment. Write for your copy today on your company letterhead — no obligation; address Dept. E-15.

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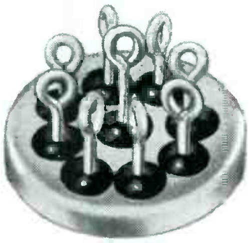
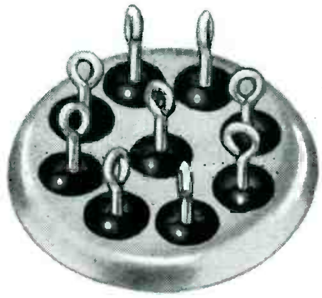
in Chicago, October 22, 23 and 24—Booth No. 14



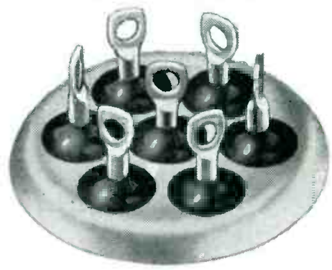
4-900 Series
1000 V (RMS)

Disc size $\frac{11}{16}$ D
Available 2 to 9 electrodes.
Electrode treatment L only.



5-900 Series
1500 V (RMS)
Disc size $\frac{61}{64}$ D
Available 2 to 9 electrodes.
Electrode treatment L only.

7-700 Series
2000 V (RMS)



Disc size $\frac{61}{64}$ D
Available 2 to 7 electrodes.
Electrode treatments
TH, FP, HT and L.

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FUSITE FAMILY *of* MULTIPLE TERMINALS

Glass to Steel for a True Fused Hermetic Seal

Protect Sensitive Electrical Components from

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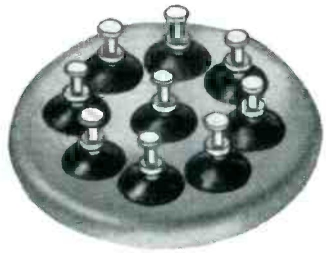
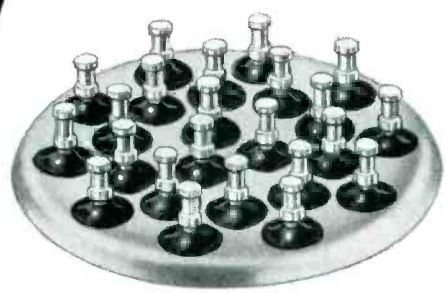
- MOISTURE
- FUMES
- CHANGING PRESSURES



7-900 Series
2000 V (RMS)
Disc size $1\frac{15}{64}$ D
Available 2 to 9 electrodes.
Electrode treatments
TH, FP, HT, and L.



7-1300 Series **2000 V (RMS)**
Disc size $1\frac{15}{64}$ D
Available 10 to 13 electrodes.
Electrode treatments TH and HT.

7-2300 Series **2000 V (RMS)**
Disc size $1\frac{5}{8}$ D
Available 11 to 23 electrodes.
Electrode treatments TH and HT.

GENERAL SPECIFICATIONS

materials -- C.R. steel disc and steel electrodes. Interfused with glass.

finish -- fused electro tin plate.

voltage test -- see individual terminal.

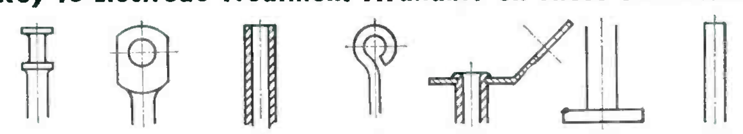
pressure test -- 12 pounds gauge.

insulation test -- 10,000 megohms after salt water immersion.

sudden thermal shock test -- dry ice to boiling water.

INSULATE ELECTRICALLY
GLASS TO METAL
FUSITE
TERMINALS
PROTECT PRODUCT PERFORMANCE
SEAL HERMETICALLY

Key to Electrode Treatment Available on These Terminals



TH	FP	HT	L	HTL	NH	SW
TURRET HEAD	FLATTENED AND PIERCED	HOLLOW TUBE	LOOPED	HOLLOW TUBE LUG	NAIL HEAD	STRAIGHT WIRE

Write
FOR CATALOG of Complete Line and Engineering Details -- Dept. B

THE FUSITE CORPORATION
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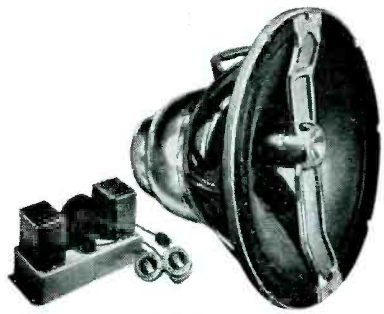
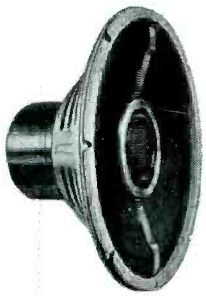


G-610 Triaxial 3-way
World's Finest Loudspeaker (15")

H-510 Coaxial with Acoustic Lens
World's Finest Coaxial (15")

K-310 Coaxial (15")



K-210 Coaxial (12")

Single-Unit Direct Radiator Types
(5-15")

how to choose a high fidelity loudspeaker

GENUINE Jensen WIDE RANGE

This trademark* denotes the most comprehensive series of high fidelity loudspeakers available today. Every unit has been designed with the same objective . . . the achievement of the finest possible reproduction of music attainable for the size and type. Every model in the series sets a new high standard of performance . . . a new value . . . makes listening a thrilling new experience.

what GENUINE JENSEN WIDE-RANGE means

Mere extension of response to high frequencies is not enough to insure truly satisfying reproduction . . . good listening which improves with closer acquaintance. Much more is required to make music come to life, free from annoying factors which might mar the illusion of reality. So, by application of the most modern principles of acoustics, confirmed by precise measurements and checked by exhaustive quality judgments and comparative listening tests, Genuine JENSEN Wide-Range loudspeakers give you all 7 Performance Points for enhanced listening pleasure: (1) Wide Frequency Range, (2) Balanced Frequency Response, (3) Smooth Reproduction, (4) Wide-Angle Distribution, (5) Low Distortion, (6) Good Efficiency, and (7) Adequate Power-Handling Capacity.

Thus Genuine JENSEN Wide Range means much more than wide frequency range — it means superior performance all the way — in every attribute that makes for enhanced listening pleasure.

Whatever the limitations on cost or size, the choice of a loudspeaker from the Genuine JENSEN Wide-Range series automatically insures a maximum of performance to today's new high standards . . . a judicious choice to meet exact needs. Only in the Genuine JENSEN Wide-Range series can you make such an exact choice.

Write today for free booklet, "Let Music Come to Life." It includes a complete listing of Genuine JENSEN Wide-Range loudspeakers.

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Division of The Muter Company
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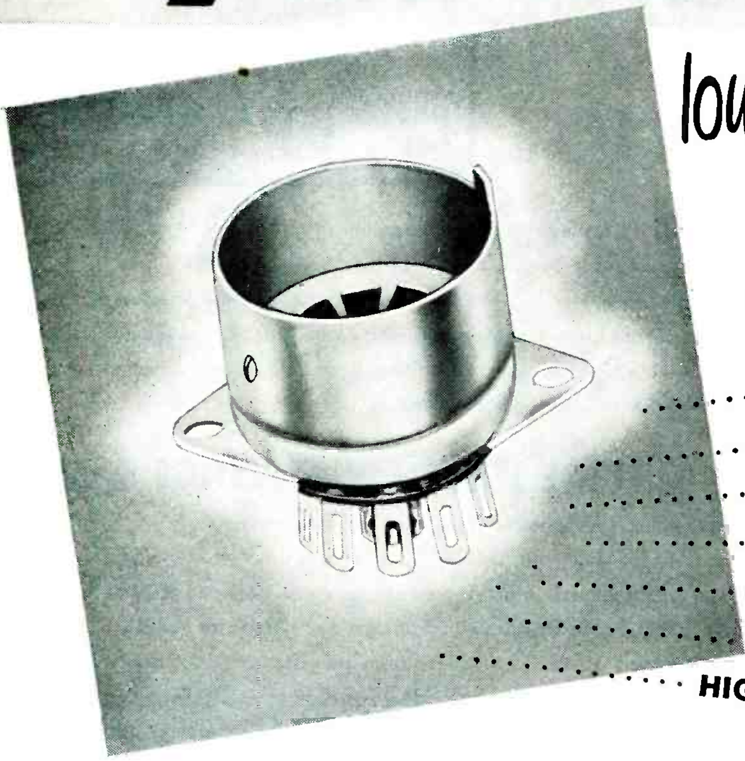
BURTON BROWNE ADVERTISING

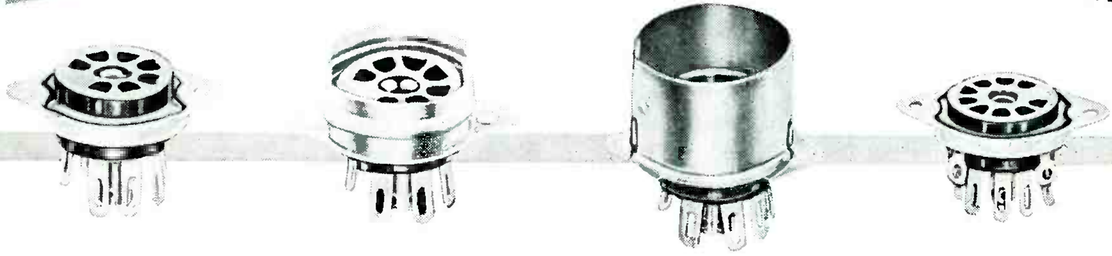
MYCALEX



low-loss miniature
TUBE SOCKETS

OFFER ALL THESE ADVANTAGES:

- CLOSER TOLERANCES
- LOWER DIELECTRIC LOSS
- HIGH ARC RESISTANCE
- HIGH DIELECTRIC STRENGTH
- GREAT DIMENSIONAL STABILITY
- IMMUNITY TO HUMIDITY
- HIGH SAFE OPERATING TEMPERATURE



-cost no more than
PHENOLIC TYPES

These glass-bonded mica sockets are produced by an exclusive MYCALEX process that reduces their cost to the level of phenolic sockets. Electrical characteristics are far superior to phenolics while dimensional accuracy and uniformity exceed that of ceramic types.

MYCALEX miniature tube sockets, available in 7-pin and 9-pin types, are injection molded with great precision and fully meet RTMA standards. They are produced in two grades, described as follows, to meet diversified requirements.

MYCALEX 410 is priced comparable to mica-filled phenolics. Loss factor is only .015 at 1 mc., insulation resistance 10,000 megohms. Conforms fully to Grade L-4B under N.M.E.S. JAN-1-10 "Insulating Materials Ceramic, Radio, Class L."

MYCALEX 410X is low in cost but insulating properties greatly exceed those of ordinary materials. Loss factor is only one-fourth that of phenolics (.083 at 1 mc.) but cost is the same. Insulation resistance 10,000 megohms.

MYCALEX TUBE SOCKET CORPORATION
Under Exclusive License of
MYCALEX CORPORATION OF AMERICA
30 ROCKEFELLER PLAZA, NEW YORK 20, N.Y.

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THE INSULATOR
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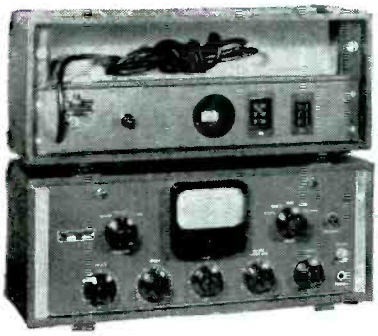
tape it...

with a PRESTO

PRESTO has been a byword of discriminating broadcast and recording engineers for almost two decades. Recognized as the designer and builder of the finest tape recorders available today, PRESTO stands behind this reputation with a complete guarantee of satisfaction on every instrument sold. For smooth operation, for minimum maintenance, for best results . . . tape it with PRESTO, the best buy in tape recorders today.

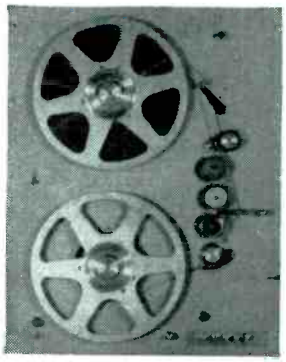


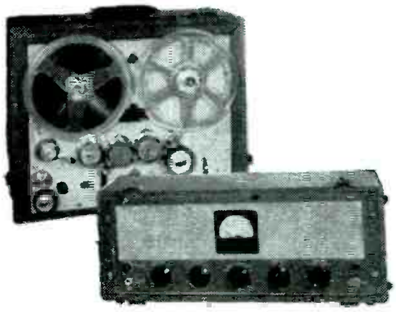
PRESTO AMPLIFIER 900-A2

The recommended amplifier for the RC-10/24 tape recorder, has a frequency response of 50 to 15.000 cps., a low level three mike mixer and a bridging input. Five-way switch for recording, playback, remote, erase current and bias current.

PRESTO MODEL RC-10/24

World favorite for relay rack mounting. Accommodates 10½" reels, three magnetic heads, push-button controls, response up to 15,000 cps. Panel size 19" x 24½". Also available in console unit.



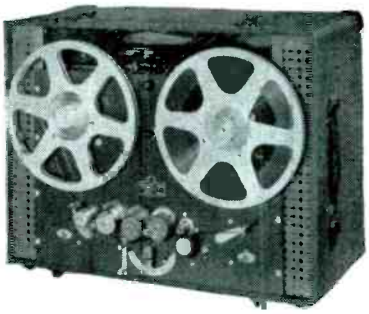


PRESTO PORTABLE PT-920

Brand new and improved successor to the famous PT-900. Three motors, no friction clutch or tension adjustments. Fast forward and rewind speeds, instantaneous monitoring from tape. Compact case contains 10 watt amplifier, two speakers, power supply.

PRESTO PORTABLE RC-10/14

Portable version of the RC-10/24 with smaller panel size (19" x 14") and rotary switch selector. Weighs only 68 lbs. Superb audio quality, speed control and reliability.



PRESTO RECORDING CORPORATION

PARAMUS, NEW JERSEY

Export Division: 25 Warren Street, New York 7, N. Y. Canadian Division: Walter P. Downs, Ltd., Dominion Square Bldg., Montreal

WORLD'S LARGEST MANUFACTURER OF PRECISION RECORDING EQUIPMENT AND DISCS

BUSINESS BRIEFS

By W. W. MacDONALD

Production Potential of electronic equipment manufacturers in the Los Angeles-San Diego area is very substantial, according to a report prepared by the local Inspector of Naval Material and forwarded to the Electronic Production Resources Agency in Washington.

The report lists 236 active manufacturers of end equipment, subassemblies and component parts, having a total of 6,710,168 sq ft of floor space and 45,020 employees. The letter of transmittal points out that many of the companies listed are not using their full manufacturing facilities and that they have ample trained personnel to handle many military equipment contracts. Very few are, however, represented at any procurement location, so they are frequently overlooked.

It so happens we will be in California on an editorial trip within a week after this is written and will have an opportunity to see some of this productive capacity at first hand, not only in the section mentioned but also in the San Francisco area. We're looking forward to it with interest.

Presidential Directive to government departments and agencies says that to the greatest extent practicable certificates of necessity, allocation of critical materials for construction purposes, emergency loans growing out of defense production and defense contracts should go to manufacturers meeting satisfactory standards of plant dispersal.

Comforting to many in the field of electronics who wonder how rigorous the standards will be in view of the threat of atomic bombing are the following excerpts from an approved National Security Resources Board planbook: *"This . . . program . . . is designed to disperse new industry and expanding industry, not to move established industry."* Dispersion of facilities is suggested *"within your local marketing area"*, with space, *"perhaps only several miles"*, between manufacturing facilities.

The plan does not contemplate mass shifts of manufacturing facilities from any one section of the country to any other.

Wright Field advises that increased use of electronic equipment in military aircraft has required revamping of the training program to provide men adept in the handling of instruments required by modern speeds and all-weather flying. Ellington Air Force Base, in Texas, is the first to institute the new observer training plan.

Department Of Army invites us, through the mails on their Form 49-R275 in duplicate, to bid on resistors destined for delivery at the Lexington Signal Depot. We are indeed flattered to be identified so closely on Army's mailing list with manufacturers of electronic equipment whom we serve, but must decline.

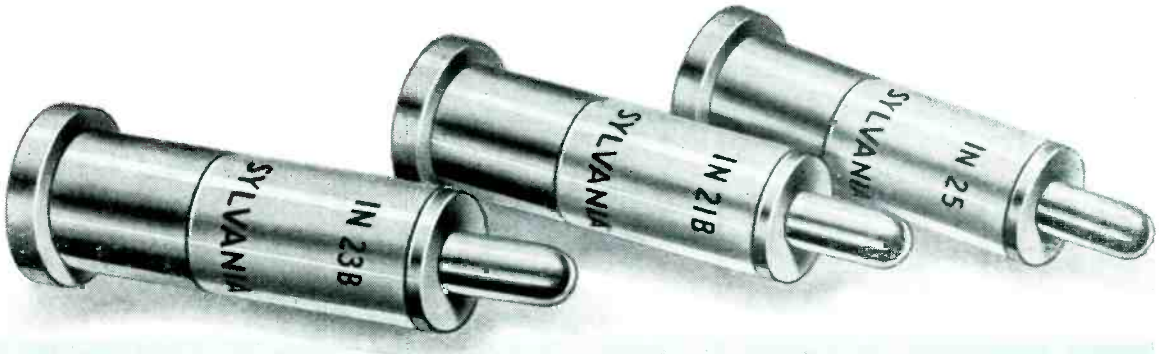
Our business is publishing ELECTRONICS magazine, and it keeps us plenty busy.

TV License Applications on hand at the FCC total 400, according to chairman Wayne Coy, who thinks at least this many more may be expected when the freeze is lifted.

Coy believes it would take a year to get the average new station on the air, and says consideration will first be given to areas with no facilities and second to heavily populated areas with only one station. He estimates that there will be 1,500 tv stations in operation within five years and perhaps 2,500 within 10, with a probable limit of about 3,000.

Definition going the rounds: CBS—*Color Belongs to Stanton.*

TV Picture Tube Sales to manufacturers dropped 20 percent in the first six months of 1951 as against the corresponding period of 1950, according to RTMA. Sales



SYLVANIA PLUGS THE 16,000 MC GAP

with the new 1N78 Silicon Crystal Mixer

Sylvania adds another to the world's widest Silicon Crystal Mixer line – the 1N78 for 16,000 mc, one of the newest SHF bands. This new diode is the latest product of Sylvania's continuing exploration into frequency conversion in microwave regions.

Better and better performance at existing frequency bands and new designs for tomorrow's frequencies are both to be expected of Sylvania's advanced research and long experience in Silicon Diode technology.

Sylvania also makes Silicon Crystal Video Detectors for use as microwave detectors in receivers of non-heterodyne type. Other Sylvania products engineered for radar and SHF receivers include magnetrons, TR tubes, ATR tubes and hydrogen thyratrons.

Sylvania Silicon Mixer Diodes

Type	Construction	Design Frequency (Approx.)
1N25	Cartridge	1000 mc.
1N21B	Cartridge	3000 mc.
1N23B	Cartridge	10,000 mc.
1N78	Coaxial	16,000 mc.
1N26	Coaxial	24,000 mc.
1N53	Coaxial Miniature	Above 30,000 mc.

Write for this 16-page book, "Microwave Crystal Rectifiers," including the new 1N78 characteristics and ratings.

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

Please send me the "Microwave Crystal Rectifiers" booklet, including data on the 1N78.

Name____________________

Company____________________

Street____________________

City__________ Zone____ State______

SYLVANIA

SYLVANIA ELECTRIC PRODUCTS INC. 1901-1951 — 50th ANNIVERSARY — FIVE DECADES OF PROGRESS

ELECTRONIC DEVICES; RADIO TUBES; TELEVISION PICTURE TUBES; ELECTRONIC TEST EQUIPMENT; FLUORESCENT TUBES, FIXTURES, SIGN TUBING, WIRING DEVICES; LIGHT BULBS; PHOTOLAMPS; TELEVISION SETS totaled 2,552,757 as against 3,171,-660 units.

Tubes sold in the first six months of 1951 were valued at $66,546,932. Some 86 percent of them were rectangular in form, and 92 percent were 16 inches or larger in size.

American Gas & Electric is going in heavily for industrial television. The Tidd generating station has four units, Sporn has six and is adding two more, Tanners Creek has two and is adding two, Twin Branch has two and two new generating stations now under construction will each have four units.

Bogota, Colombia, has just ordered a Marconi television transmitter, with the Municipal Bank of Bogota doing the financing. British manufacturer **E. K. Cole** has simultaneously been given an order for receivers using the American 525-line standard. The sets will be rented.

West German Officials are seeking Washington's advice on whether to start commercial television service in black and white or in color. We hope we eventually get to see what should be a very interesting reply.

Quotable Quotes from a speech by Edwin T. Gibson of DPA before the RTMA:

"Of the total money available during fiscal '51 for electronic gear, $2,482,000,000 had been obligated as of May 1, and the backlog of orders as of that date, including some long-lead-time material going back to fiscal 1950, amounted to $2,784,000,000. . . . .

"The expected rate of deliveries will be $881,000,000 worth during the fourth quarter of this year, with much much more to come in 1952. . . . ."

Electronic equipment manufacturers are being called upon to produce at "a rate approximately equal to 85 percent of the peak production in World War II. . . . .

"About 86 percent of the price of a typical 17-inch television set is represented by purchased materials and components, labor and engineering representing the balance. For a modern airborne fire-control equipment, only 49 percent represents materials. . . . ."

Germanium Diode Production is currently in the neighborhood of 4,000,000 units a year, and the units are now standing up well. The National Bureau of Standards eastern automatic computer (SEAC) uses 16,000 of them and after 2,500 hours of service only 5.4 percent of those originally installed had to be replaced, most of the replacements being for back-current drift or creep. The rejection rate for several thousand diodes purchased in the last six months of 1950 was less than 2 percent.

Many Products that one would not ordinarily think of as being saleable to electronic equipment makers find a market in our field. Fibre-glass erasers, for example, are being used to reduce the value of resistors in certain printed circuits.

Life lists total investment by advertisers in ten top media for the six months period between January and June 1951 as follows:

Life	$43,089,969
CBS Radio	39,285,216
Saturday Evening Post	34,121,636
NBC Radio	30,000,036
NBC TV	*26,739,532*
ABC Radio	17,344,512
CBS TV	*17,069,328*
Time	14,229,834
Ladies Home Journal	11,484,173
Better Homes & Gardens	11,413,731

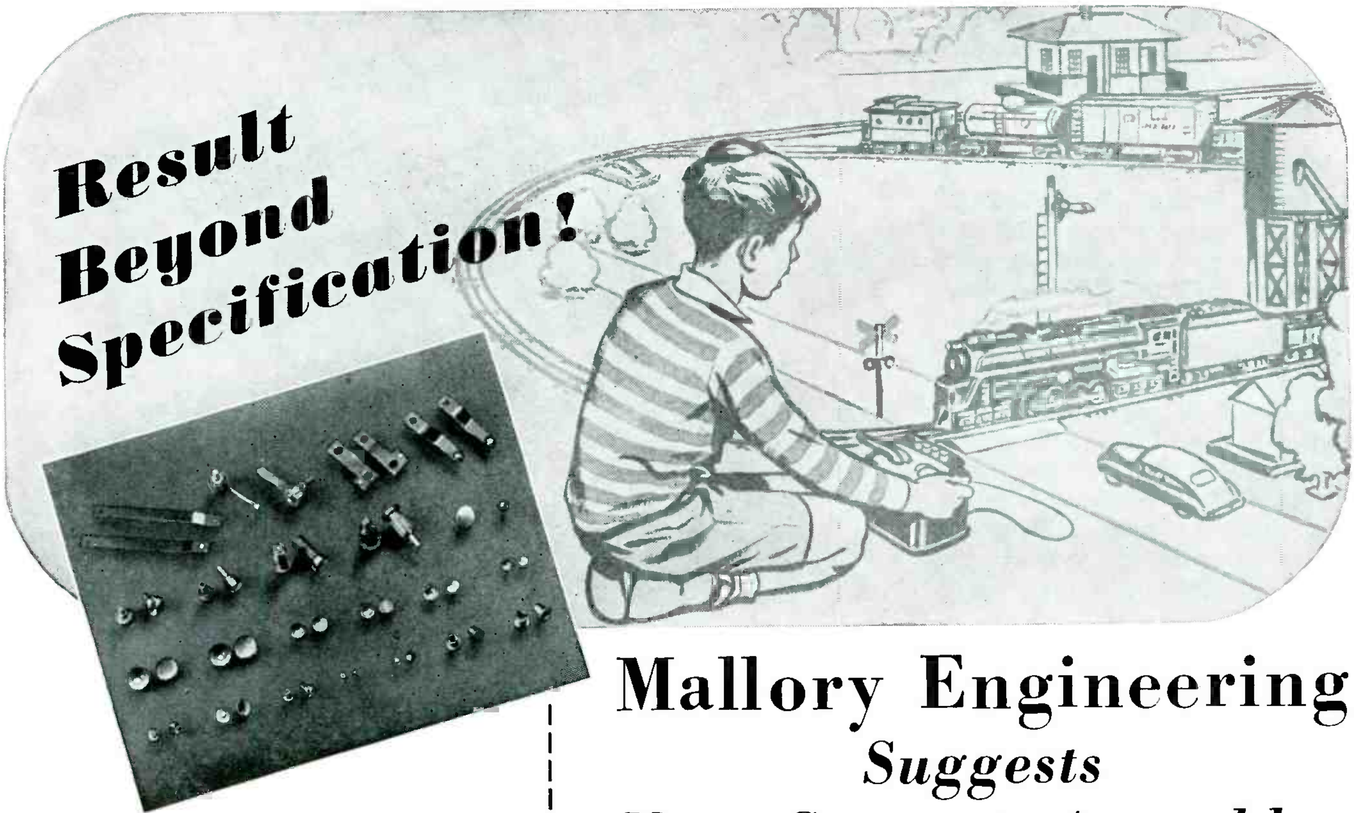
Radio and tv figures are for network time only. The italics are ours.

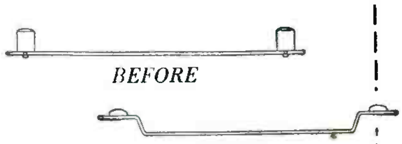
Positions of a two-point switch in a circuit diagram currently being edited are intriguingly labelled. In television as in many other fields of endeavor, apparently, one must still *Synch* or *Skim.*

Editor O'Brien, planning some scientific experiment the nature of which remains a mystery, returned from lunch the other day with a white mouse in a cardboard box. The box rested on top of a copy of our September issue overnight and by morning the rodent had gnawed his way down to page 132.

No one, it seems, can digest a copy of fact-packed ELECTRONICS in one session.

Result Beyond Specification!





MALLORY SILVER CONTACTS

Fine and coin silver, while having desirable properties for many applications, do not provide the physical properties required for some applications. To cover these applications, Mallory has developed a series of silver base alloys. These alloys have such improved characteristics as greater resistance to wear, less sticking or metal transfer, and greater hardness. Mallory is fully qualified to recommend the best contact material for your design. Write today.

Mallory Engineering
Suggests
New Contact Assembly ...Saves Customer Money

Hundreds of customers are profiting from Mallory contact know-how which simplifies design and production, saves valuable time and money.

A manufacturer of electric toy trains submitted a contact assembly job to Mallory which called for large silver contacts on a flat section of spring steel. Mallory suggested a re-design of the part enabling a great reduction in the size of the silver contact and utilizing a Mallory-developed welding technique to insure maximum mechanical strength. The customer was given improved performance . . . at a substantial saving!

That's result beyond specification!

Mallory contact know-how is at your disposal. What Mallory has done for others can be done for you!

In Canada, made and sold by Johnson Matthey and Mallory, Ltd., 110 Industry St., Toronto 15, Ontario

Electrical Contacts and Contact Assemblies

P. R. MALLORY & CO., Inc.
MALLORY
P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

SERVING INDUSTRY WITH

Electromechanical Products
Resistors *Switches*
TV Tuners *Vibrators*

Electrochemical Products
Capacitors *Rectifiers*
Mercury Dry Batteries

Metallurgical Products
Contacts *Special Metals*
Welding Materials

CROSS TALK

▶ **TV POWER** . . . As we write, the FCC has granted power increases to 42 television stations, ranging from 1.02 times for KPIX, San Francisco, to 11.4 times for WTVJ in Miami, amid shouts of joy from just about everyone concerned. Before the boost these stations had a combined effective radiated power of 546 kw; now the combined power is 896 kw, an average increase of about 64 percent. This 64 percent is a nice juicy bit, as measured by the timesalemen's pitch and even as measured in the electric light bill. But in good old decibels it ain't much, only 2.2 db, which is an amount the eye can just barely detect by looking at the image. All of which goes to prove that a mere scratch has been made on the surface of this power increase business. Some stations, those having high towers and high-gain antennas, have done very well. Others only think they have.

The moral of the story is that the broadcaster who soaked a lot of money into a high tower, plus a lot of antenna gain, when he built his station, is now reaping the harvest. The ground rules of the recent power-boost authorizations allow him to turn his final amplifier up to its maximum rating, whereas the old rules required him to turn down the power, the higher his tower and the more gain stacked into his array. The new rules also allow him to put in more antenna gain, but this takes time, and, if the Empire State story is any criterion, plenty of bucks. So a free hand with the stockholders' money is rewarded again, as is only right.

This is, of course, only a preliminary step, a partial derogation of the freeze allowed by an enlightened (repentant?) government body which shall be nameless. Much more is in the offing. Post-freeze power increases of the order of 5 to 10 times above the present average level are promised. Then we'll have decibels of improvement in substantial, rather than liminal, numbers. For which praise be to Allah!

▶ **EDUCATIONAL** . . . The educational-tv argument is in the doldrums at the moment, so we'll give it a kick to keep it alive. Our stand: Television needs educational institutions, their facilities and personnel, as fulltime program sources if it is to serve the people fully. We need now, and even more we'll need later, a leaven for a program fare geared principally to the channels of trade. But television will never get such educational support while we, and that's us, take a parsimonious stand on educational expenses in general. Every time a taxpayers group in your town or mine gets up to oppose increases in teachers' salaries or better school facilities, the forces against educational tv can be seen at work. Broadcasters who want channels may relax so long as this goes on. But it's bad nonetheless. More money, much more, is needed for primary and secondary schools. If we wake up in time, we may have some takers for educational channels, and we'll all be the richer for it.

▶ **STATESMAN** . . . President Truman could not have picked a better man as his Telecommunications Adviser than Haraden Pratt. The job, suggested in the report of the President's Communications Policy Board, has been filled with a man who combines knowledge and experience with an ability to inspire confidence to a degree unmatched in the profession of radio engineering. A chairman of the FCC, under whom Pratt had served at an international conference, called him "an honest man, absolutely straight"; and from this particular chairman that statement was the accolade.

In noting the departure of industry figures for government service we try to avoid the style of an obituary notice. Nevertheless we cannot avoid the statement that Haraden will be missed, badly missed, by his associates. The nature of his new job requires his resignation as secretary of the IRE, a position he has held since 1943 and from membership on JTAC, in whose work he has served as principal moderator since its inception. Good luck has not figured as a prominent explanation of his past achievements. But, such being the responsibility of bringing order out of the present chaos in the administration of civil and military radio, he's going to need it from now on. Good luck!

Selecting an INDUSTRIAL

By
ABRAHAM S. GREENBERG
Trademark Attorney
Radio Corporation of America
New York, N. Y.

SELECTION of a trade symbol is most important in the field of electronics. If advertising funds are to be expended, they should be used for a symbol which is capable of legal protection. If a trademark is selected in a haphazard fashion, the business or promotion campaign based on it will be founded on a symbol having little value and the symbol will not be easily retained as exclusive property of the company.

Trademark Categories

Trademarks and service marks as used in modern trade generally fall into the following categories:

Coined Designations: Coined designations are very desirable from a legal viewpoint. Trademarks such as "Kodak" and "Philco" are readily protected. The inventing or coining of trademarks has been studied by A. H. Cousins and H. E. Wadsworth in "Trade Names . . . a Guide to Their Invention, Protection and Use", published by Harlequin Press Co., Ltd., London, England.

Picture or Motif: The dog and phonograph of RCA, the musical clef of Emerson radio and the cat of the National Carbon Company are familiar examples of valuable picture trademarks. By choosing such a mark, the following advantages are gained: perfect export use identification, personalization of the product, a source of interesting themes for advertising, and symbolic representation which lends itself to television promotion.

Sounds: Sound trademarks have been popularized by radio. One good example is the NBC chime-like notes (trademark registered April 4, 1950, No. 523,616).

Letters and Numerals: The mark "GE" is an excellent example of letter type marks. Brevity is their virtue.

Descriptive: Descriptive trademarks should be avoided. The U. S. Patent Office will not register them nor will courts normally protect them. The word "Telecolor" has been refused registration as descriptive of television apparatus. The mark "Kwickstart" has been refused registration for storage batteries. The word "Sightmirror" was held as descriptive of mirror screens for television receivers. Sufficient use is required to create distinctiveness. After this, the trademark may acquire a secondary meaning which can be protected.

Color: Color, as a trademark, should be avoided since color-type trademarks are not normally capable of protection. For example, the light and dark vertical stripes for Burgess batteries was refused registration as a trademark. Also, a circular red area for phonograph record labels was ruled not a valid trademark.

Others: Other trademark categories frequently used are geographic names, historical names, literary references, family names and laudatory titles. The latter are not too wise to select as they can be protected only with great difficulty.

Searching Sources

Once a desirable expression has been selected for a trademark, it is a good plan to do preliminary search screening to be certain that the expression is clear or available. Search facilities which are available to the business man are as follows:

RTMA Trade Directory: This directory is the most obvious search source in the radio and television fields and provides a rough screening. The members of the RTMA list their trade names in the directory.

U. S. Patent Office—Trademark Register: The Patent Office Register in Washington contains files arranged alphabetically and by product and service classes. There are also available published notices of pending applications and special classified files of registered trademark pictures and symbols.

Forty-Second Street Library—Engineering Section (New York City); Files of alphabetically arranged trademarks are provided up to the year 1947. Files are not of registered trademarks but only those which were published for opposition.

Private Search Services: There are a number of private search facilities. Three typical ones are Thomson and Thomson, 80 Federal St., Boston, Mass.; Trade-Mark Service Corp., 253 Broadway, New York, N. Y. and U. S. Printing and Lithograph Co., Cincinnati, Ohio. Such organizations maintain files of registered trademarks as well as files of unregistered trade names

FUNCTIONS OF A TRADEMARK

In choosing a trademark, the three functions performed by such a symbol should be kept in mind. These functions are as follows:

(1) As an advertisement, the trademark helps sell the product

(2) As a guarantee of the quality of a product, the trademark vouches for the company's integrity

(3) As an identification of the manufacturer, the trademark indicates the source of a product

TRADEMARK

Cautious approach to the choice of a trademark for use in the field of electronics will result in fewer headaches and less wasted money. Proper procedure is discussed together with some of the more common pitfalls to avoid

collected from trade periodicals.

Slogan Searches: Among important search sources for slogans are U. S. Trade-Mark Association, 522 Fifth Ave., New York, N. Y. and Printer's Ink Clearing House of Advertised Phrases, 205 E. 42nd St., New York, N. Y. The book "American Slogans" by William Sunners, published in 1949 by The Paebar Co., New York, N. Y., has an excellent classified slogan collection.

Miscellaneous Sources: If the selected word has a "tron" suffix, it would be worthwhile to check lists appearing in: *Electronic Industries*, January, 1946, page 80; *Electronic Industries*, November, 1946, page 58; ELECTRONICS, May, 1950, page 112 and ELECTRONICS, June, 1951, page 218.

Controlling Trademarks

Every trademark involves an initial and continuing investment in creating and defending the mark. The expense of these items multiplies with the number of marks.

The initial investment comprises many items including selection, advertising and marking of products. In addition, one or more trademark registrations are usually required in each country, according to the variety of merchandise upon which the mark is used or is likely to be used. The cost of obtaining trademark registrations is substantial.

The continuing investment includes renewals from time to time at a cost generally equal to that of the original registration. Further, most successful trademarks are encroached upon either inadvertently or intentionally. Much time, effort and expense are required to trace and stop imitations.

Every additional mark used duplicates the initial and continuing investment and expense and the expenditures are further multiplied by the number of countries in which trade is conducted.

A word of warning is perhaps in order. Do not go in for mass trademark, slogan and name usage. District Judge Tuttle once had this to say about an advertising man's "vice". ". . . It is like the monkey of the fable who reached into the jar to get nuts. The monkey was so greedy and grabbed so many that he couldn't get his hand out of the jar and he lost them all. The plaintiff has attempted to adopt so many alleged trademarks, trade names, trade slogans and trade configurations that, if one were to understand this fully and speak intelligently about all of the baits, slogans, boasts and names that have been used, it would be necessary to prepare a dictionary of substantial size. . . . A manufacturer cannot build a business up around a thousand slogans. . . . He cannot take a thousand words out of the dictionary and build a business around all of them . . . because the plaintiff has used so many different things that the public has never come to associate its goods with any of those things."

Before selecting a trade symbol, the owner of a new business or the merchandise director of a new promotion campaign should first acquire an understanding of the nature and function of a trademark. A simple rule to follow is a commercial adaptation of the Golden Rule. Don't select a trade symbol that you would not want a competitor to select. If this rule is followed, the average business man will see why the trade symbol to be selected should be unique, not a part of the public reservoir of words or pictures, not deceptive and above all nonconflicting.

When in doubt about the availability of a trade symbol it is the best policy to contact the owner of the adverse symbol. A simple and frank statement of the facts will more often than not clear up any doubts as to the right to use a selected trademark. A wise rule for the business man and his counsel to follow is that when in doubt about a selected symbol leave it alone. It is not worth the expenditure of promotion funds.

REQUIREMENTS FOR A GOOD TRADEMARK

Experience has shown that certain requirements for a trademark will insure its value to a company. Of primary importance is the consulting of available search material (see text) to reveal legal clearance over trademarks in the same competitive field. In addition, the trademark should be:

Easy to remember
Easy to read and speak
Brief and striking
Creative of proper association
A selling idea for the product
Unrestricted to one line of goods
Suitable for export use
Pictorial in nature

HORN ANTENNAS For Television

Eight-foot equilateral bisectional horn antenna provides over 14-db gain on channel 13 compared with isotropic source antenna. Same performance can be obtained for transmission. Antenna matches commercially available 300-ohm line

By **DEAN O. MORGAN**
Engineering Section
Broadcast Engineering
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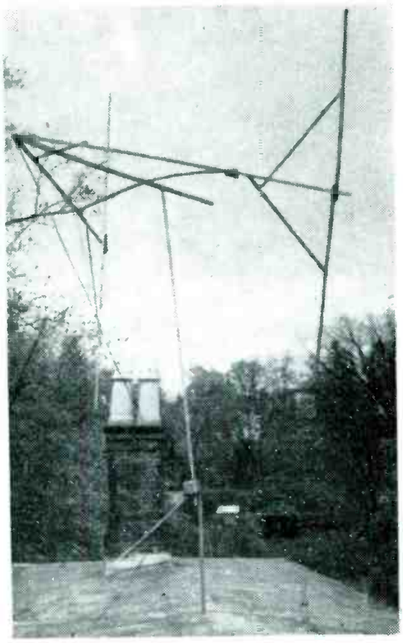
Syracuse, N. Y.



Experimental modified horn antenna made from wood scraps and chicken wire. High directivity makes rotator a very desirable adjunct to system

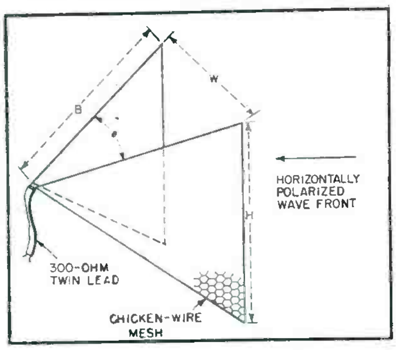


FIG. 1—For reception of channels 2 through 13, where channel 2 is not especially weak, the most practical dimensions are $W = H = B = 8$ feet, and $\theta = 60$ degrees

Most of the transmitting and receiving antennas in use today for television and communication are of the linear or standing-wave variety. Examples include the dipole, dipole-reflector-director combinations and multiple stacked arrays of all sorts. In general, these types are characterized by comparatively narrow frequency bandwidth and concomitant matching problems. Power gains of 10 db are possible only with large structures which by their nature become more critical toward bandwidth as the gain increases.

Another type of antenna finding moderate use where space will permit, is the traveling-wave antenna. This category includes the terminated long wire, the *V* and the rhombic. These types, however, in addition to requiring a large space, require more than one supporting pole; changes in directivity are difficult; many minor lobes exist; and feed impedances are generally undesirably high (400 to 800 ohms). Bandwidth in the traveling-wave types is often in excess of 3 to 1, which is entirely adequate for most receiving and transmitting conditions.

The antenna shown in experimental form in the photograph offers several advantages over both of the types mentioned above. It has not, however, found very wide application for tv and communication on the lower frequencies, except by a few. This antenna will be recognized as a modified horn type. Since horizontally polarized waves are of primary importance (for the reception of television and f-m signals) two of the usual four sides of a horn may be omitted, and the resulting two-sided horn may be fed by direct excitation.

A drawing of this antenna is shown in Fig. 1. This design consists of only two vertical side sectors of the horn. The feed line is connected at the apex of the horn, one conductor being connected to each sector. There are no metallic ties between sectors.

Attenuation to transmission transition being gradual, the approximate cutoff is determined when

$$W_c = 0.5\lambda_c$$

If true unidirectional characteristics are wanted, the flare angle θ should be small. However, a small θ would necessitate a long horn. A good compromise angle of 60 degrees may be used. In this case the dimension *B* is given by

$$B_c = \frac{W_c}{2 \sin \theta} = 0.5\ \lambda_c$$

The height of each sector *H* is made equal to the mouth width *W*, so

$$H_c = W_c = 0.5\lambda_c$$

Resistive and reactive components of an equilateral bisectoral horn antenna of the type described are shown in Fig. 2. It will be noted that the resistance approaches 377 ohms at infinite frequency. The reactive component similarly approaches zero.

Line Match

Since both 300-ohm and 400-ohm line are commercially procurable,

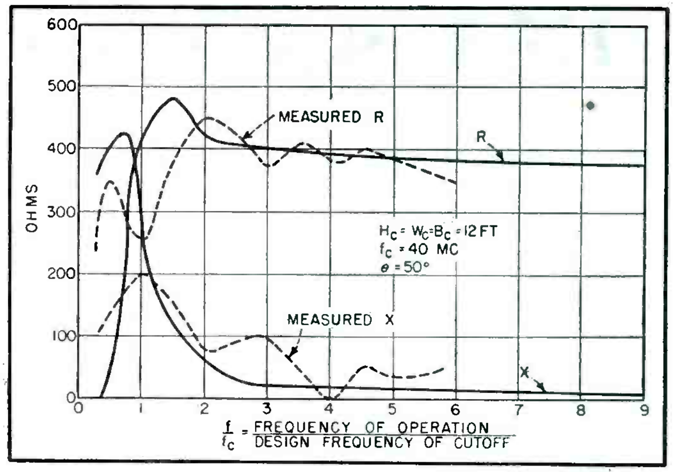


FIG. 2—Universal impedance curves show resistance approaching 377 ohms and reactance approaching zero ohms as frequency increases

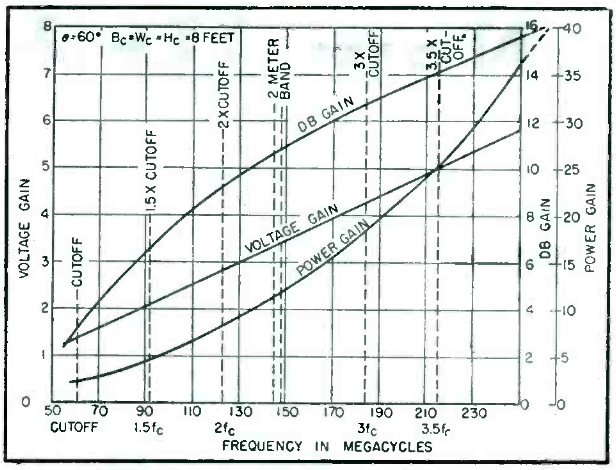


FIG. 3—Curves show calculated gain characteristics (over isotropic point source) for 8-foot 60-degree modified horn antenna

it follows that an ideal match may be secured over a wide band of frequencies with this antenna. In the case of 300-ohm line, the mismatch is only 2 percent in power or 0.8 db in addition to the published attenuation loss of the line, when perfectly matched. At cutoff frequency the loss increases to 0.25 percent in power or 1.22 db. Below cutoff the loss increases rapidly due to the decrease in resistance. The use of 400-ohm line would decrease these losses quite a bit from the infinite frequency down to cutoff (being an ideal match at three times cutoff, or channel 7 and 8).

Dimensions

The actual dimensions used will depend upon the individual problem. For most practical vhf-tv reception, cutoff can be taken as 57 megacycles. For this value of cutoff, $W_c = B_c = H_c = 8.6$ ft. With these dimensions the power gain at 213 mc over an isotropic source is 14.7 db.

Using a slightly reduced size (8 ft) this gain is reduced to 14 db. This is comparable to the gain from 10 dipoles and reflectors in a stacked array, or 20 elements with their added complexity.

Figure 3 is a calculated plot of power gain, db gain and voltage gain. These curves are based on the 8-ft dimension, or a cutoff frequency of 61.2 mc. Figure 4 shows the horizontal and vertical pattern of a scaled model at 28.7 cm, which had an aperture of slightly less than 3 times cutoff. Rear radiation is of the order of 1 percent.

Performance

During the course of the experiments, a 12-ft model was erected at Skaneateles, New York. Good pictures and sound were obtained on channels 4 (Buffalo and Schenectady), 5 (Syracuse), 6 (Rochester), 8 (Syracuse), 12 (Binghamton), and 13 (Utica). Other high-gain types failed to produce a usable picture on any channel except 5. This particular location is down in a valley with hills of 100 ft or more an all sides.

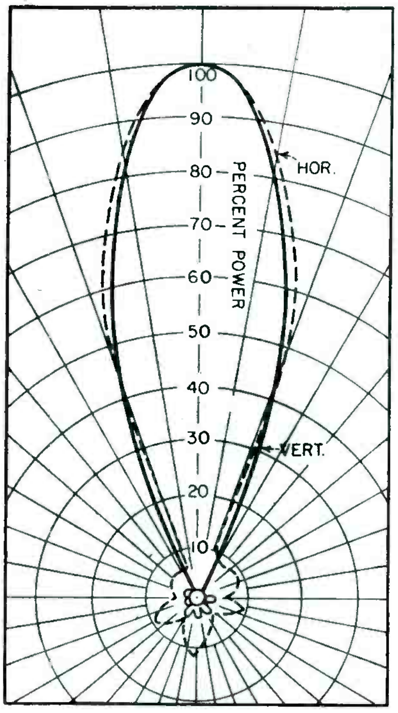


FIG. 4—Directivity patterns for 28.5-cm model (antenna rotated for vertically-polarized signal)

The 8-ft model is almost as good as the 12-ft version, but the lower channels were inferior. Also, channel 6 could not be enjoyed when channel 5 was on the air because of adjacent-channel interference caused by broadening of the beam.

It should be pointed out that the modified horn type of antenna makes an excellent harmonic radiator when used in transmission work. Experiments show that the presence of a metal supporting pole does not affect operation, and the planes may be constructed from wire mesh (chicken wire variety shown in photograph), spline-type construction, woven wire or flat sheets.

Acknowledgements

The author wishes to thank R. B. Dome for his assistance in regard to the fundamental concepts of this antenna. Much advice and helpful hints were also appreciated from R. E. Fisk and L. O. Krause, associates in antenna development at General Electric, Electronics Park, Syracuse, N. Y.

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New UHF RESNATRON

Recent resnatron developments include uhf amplifier operation with high power output, and greater bandwidth and gain. Experiments indicate suitability of resnatrons for uhf television transmission and certain military applications

THE RESNATRON PRINCIPLE was originally developed[1] in 1938, by W. W. Salisbury, D. H. Sloan, and L. C. Marshall at the University of California, in an attempt to find a solution to the problem of obtaining high power outputs at frequencies in excess of 100 mc. Previous designs had always suffered from transit time effects, and from difficulties inherent in the necessarily finite inductance of the leads to the external terminals of the tube.

In the resnatron, (the theory of which has been discussed by Dow[2, 3]) interelectrode spacings are so chosen with relation to the operating voltages on the various elements of the tube that the transit time ceases to be a disadvantage. In general, this demands rather high plate and screen grid voltage. These are not objectionable, however, since one of the objectives of design is a tube capable of extremely high c-w power outputs. Complete electron bunching is employed and the phase delay caused by the transit time is augmented by a controllable phase shift in the cathode circuit to bring the cathode and anode resonating elements into the proper phase relations for oscillator operation.

Early models of the resnatron solved the lead inductance problem by adopting the simple, yet revolutionary, approach of placing all resonating circuits inside the evacuated envelope of the tube. Supply leads, therefore, are not a part of the resonating circuits, and their inductance has a negligible effect on the operation of the system.

These principles of operation may be more clearly understood by reference to Fig. 1, which is a diagram of a resnatron amplifier tube. Without describing the operation of this tube in detail, it may be pointed out that the resonant circuits consist of two concentric three-quarter-wave coaxial lines, with the active elements of the tube, including the cathode, control grid, screen grid and anode, located one-quarter wavelength from the shorted end. Standing waves are set up along these lines, with voltage peaks at the location of the active elements. There are no leads between the active elements and the resonant circuits, as the former are built into, and continuous with, the latter.

It may be observed from Fig. 1 that the interelectrode spacings in the tube are quite large, particularly in the output cavity, and in the screen-grid-control-grid section, where high d-c supply voltages might cause breakdowns if critical dimensions were involved. Later developments have made it possible to operate resnatron tubes with external tuning elements.

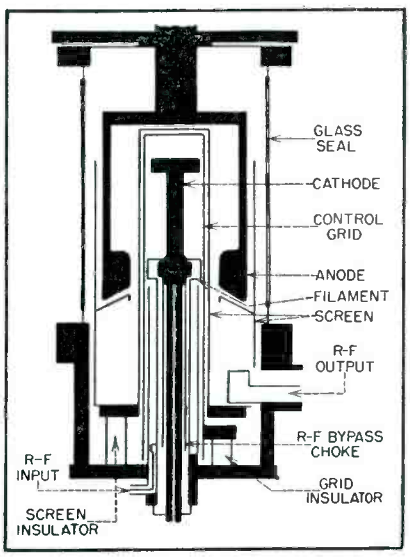

FIG. 1—Cross section of uhf resnatron of the grounded-cathode type

Wartime Development

Several years after the original conception of the resnatron principle, an urgent need arose, in connection with the radar countermeasures program being directed by Terman at Harvard's Radio Research Laboratory, for vacuum tubes capable of generating high c-w power output levels (20 kilowatts to 100 kilowatts) at frequencies in the range from 350 to 650 mc. There was no particular requirement for frequency stability or low noise level. Self-excited oscillators were, therefore, known to be satisfactory for the purpose. It was immediately evident that the resnatron would be entirely suited for this application, and a program was, therefore, established, under the sponsorship of Division 15 of NDRC, C. G. Suits, Chairman, for the development of resnatron oscillators designed for c-w power outputs in excess of 50 kilowatts in the frequency range centering at 500 mc.

This program finally culminated in the development of the Model 4 resnatron oscillator. This oscillator has been operated with c-w power outputs as high as 85 kilowatts, a figure which could probably have been increased to 100 kilowatts if an adequate power supply had been available. The tuning range is from 350 to 650 mc, requiring a minor change in the cavity geometry near the middle of the range. Its efficiency is high, measuring from 40 to 70 percent, depending

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Designs and Applications

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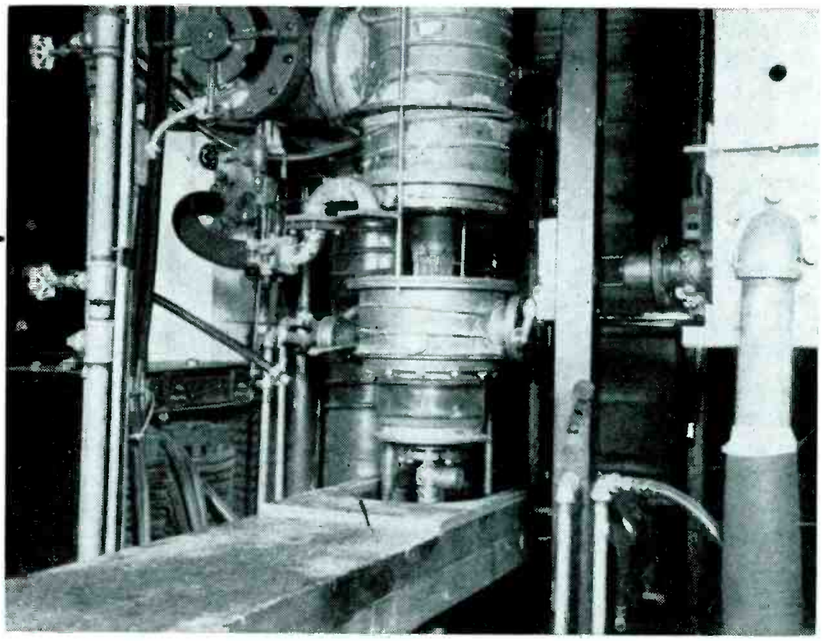

Partially assembled resnatron shows tube parts, including output waveguide (right). The screen grid is visible in gap between upper and lower housings. Vacuum pumps are not shown

upon the modulation bandwidth required. Plate voltages of the order of 15 kv are employed for maximum power output.

The problem of modulation of the resnatron was studied in great detail with the result that, at the end of the war, noise-modulated outputs, having bandwidths in excess of 4 mc, had been achieved. This type of equipment (called "Tuba") was used in connection with the jamming of airborne interceptor radar equipment carried by German night fighters over the English Channel. In all, three models of the Tuba transmitter were delivered to the operational theater.

Resnatron Amplifiers

Following the war, resnatron equipment was used for propagation study. When it became evident, in 1947, that it would be necessary to assign uhf channels for television broadcast purposes, due to a shortage of vhf channels, consideration was given to the possibility of adapting the resnatron for television transmitter purposes. It was known that, due to the high frequencies involved, television transmitters for the uhf band would require much higher power output ratings than those previously employed in the vhf band. It was, in fact, estimated that radiated powers of the order of 200 kilowatts would be necessary to produce adequate coverage in an average service area. Power levels of this order could be obtained with the resnatron assuming reasonable antenna gains. No other known tubes were, or are, capable of such c-w power outputs with reasonable efficiency.

Another requirement for uhf television transmitters was a high degree of frequency stability. It was also evident that, for commercial operation, efficiency was a matter of paramount importance.

These considerations, studied accumulatively, led to the conclusion that the prime requirement for satisfactory uhf television transmitter operation was the development of a high-power uhf amplifier tube capable of being driven by a highly frequency-stable oscillator system.

First Design

In view of these circumstances, a program was instituted by W. W. Salisbury, then Director of Research of the Collins Radio Company, for converting a resnatron oscillator tube to operate as an amplifier.

In the first tube converted for amplifier operation, shown in Fig. 1, the cathode was operated at ground potential, a high positive voltage being placed on the anode.

It was found that the principal problem involved in converting to amplifier operation was the design of an input circuit capable of feeding energy into the input cavity with good effectiveness. Due to the small dimensions of the cathode cavity, it was not possible to introduce a conventional coupling loop of any sizable area. A considerable amount of experimentation, carried on under the supervision of S. G. McNees, developed the fact that one method of obtaining optimum coupling involved the use of a metallic connection from the center conductor of the input coaxial line to the inner wall of the cathode cavity. By varying the point at which this connection was made, an adequate match, resulting in an acceptable standing-wave ratio, could be obtained without undue complication.

Using a resnatron oscillator as a driver, a tube converted to amplifier operation in this fashion was operated at 570 mc, with c-w power outputs of 20 kw, a power gain of 10 to 1, and an efficiency in excess of 75 percent.

Further experimentation succeeded in broadening the bandwidth of the tube to 6 mc. This was achieved principally by eliminating standing waves in the input coaxial line. The structure of the input seal was, of course, sufficiently rugged to withstand standing waves of considerable amplitude, and when the first amplifier tests were made, no particular effort was exerted to avoid standing waves in this section of the system, the standing-wave ratio in the input waveguide, beyond the input seal, being reduced to a satisfactory level by adjusting the tuning plungers at the input seal. It was found, however, that the coaxial line in the input seal had a sufficiently high Q so that, if standing waves were permitted to exist in this section of line, the bandwidth was narrowed to an unsatisfactory extent.

By further adjustment of the point at which a connection was made at the inner wall of the cathode cavity, it was found possible to eliminate standing waves in the input section and produce bandwidths in excess of 4 mc. Having reached this point, it was found that the Q of the output circuit became controlling; additional manipulation of the output seal circuit resulted in broadening the over-all bandwidth beyond 5 mc.

Difficulty was experienced on account of radio-frequency leakage. It was found, under operating conditions, that as much as 5 to 10 kilowatts of output power leaked out of the output cavity without entering the output seal, causing undesirably high leakage field strengths in the vicinity of the tube, and wasting power output. Since the anode cavity was isolated from ground, shielding was inadequate in the section of the tube carrying the highest power. It was concluded that it would be necessary to ground the anode to remedy this fault completely.

Improved Version

A revised design of the tube, incorporating the necessary changes, is shown in Fig. 2. In this design, which is the result of the joint efforts of S. G. McNees, W. J. Armstrong, and Roger Borne of the Research Division Staff, the anode is operated at ground potential, a high negative potential being applied to the cathode. Under these conditions, the elimination of leakage fields due to the anode cavity is greatly facilitated, as the output coax can be tied down solidly to the anode cavity without employing external chokes. Special arrangements must be employed in the input feed to isolate the external parts of the feed from the high voltage applied to the cathode, but any chokes used in this section of the system are operated at relatively low power levels, and any leakage fields which may exist may, therefore, be expected to be relatively low in power.

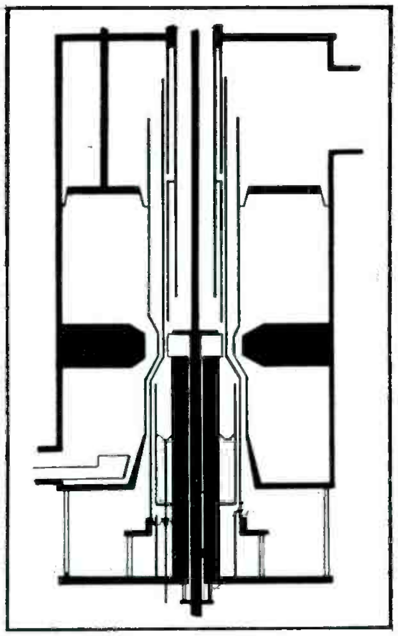

FIG. 2—Grounded-anode resnatron makes better shielding of high-power cavity possible

Employing tubes of this general design, a crystal-controlled uhf propagation transmitter for service at 500 mc is now being constructed under the general direction of R. L. McCreary, head of the Vacuum Tube Design Section of the laboratory. A prototype of the power amplifier stage of this transmitter, consisting of two resnatron amplifiers in cascade, operates at a c-w power output of 75 kw, when driven with an input driving power of 100 watts derived from a crystal-controlled driver. No appreciable leakage is observed and the bandwidth has been found to be about 3 mc, without any attempt having been made to widen it.

As may be inferred from these results, it has been found that when resnatron amplifiers are operated with low driving powers, gains as high as 70 to 1 are obtained. As the power input is increased, a condition is reached where the input feed is no longer matched. At a certain point, which may coincide with the point at which the grid begins to be driven positive, the power output flattens off, and very little increase in output power is obtained with further increase in driving power. This effect, again, is evidently due to an imperfect match which starts to take effect as soon as the load impedance of the cathode circuit becomes low.

Further work in this program will, therefore, concern itself principally with the problem of designing an input feed which will satisfactorily match the impedance of the cathode cavity when the grid is driven positive. It is anticipated that even higher gains and power outputs can easily be obtained through judicious design of the input system.

Characteristics

Figure 3 shows the static characteristics of a resnatron amplifier. It should be noted from this figure that the calculated transconductance of this tube is approximately 15,000-micromhos at a plate voltage of 10 kv and a plate current of 3 amperes.

In connection with all aspects of the amplifier development program, emphasis is being laid on tunability. The original oscillator tubes function satisfactorily over a tuning range from 350 to 650 mc. Amplifier tests so far made have concentrated principally on certain spot frequencies, as the particular applications for which these amplifiers are intended have not required tunability.

Tests made for informational purposes outside the bands specifically required for these applications have, however, indicated that the broad tunability of the original oscillator tubes will also be obtained without difficulty. This aspect of the matter will be borne in mind during the progress of the work, and it is intended that any amplifier tubes produced will have broad tuning ranges.

200-Mc Resnatron Amplifier

The Research Division of the Collins Radio Company is also engaged at present in the design of an extremely high power resnatron amplifier for linear accelerator applications, at a frequency of 202.5 mc. This work will be done under a sub-contract with the University of Minnesota, which is operating under a prime contract with the Atomic Energy Commission for the development of a large proton linear accelerator of the Alverez type. This accelerator will include four accelerating tanks, driven by four resnatron power amplifiers, which will deliver, respectively, 1.2, 8.5, 8.5, and 8.5 megawatts, to the tanks with which they are associated. The power will be delivered in pulses about 160 microseconds in length.

Higher Frequency Tubes

The usefulness of the resnatron is not confined to the uhf range. Tubes of the axial flow type, in which the electron stream travels in a direction parallel to the axis of revolution of the tube structure, may be expected to reach much higher frequencies. Some work along these lines has been done at Collins, and L. C. Marshall and D. H. Sloan, at the University of California, have also undertaken a program for the development of high-power resnatron oscillators and amplifiers designed for operation at a frequency of approximately 3,000 mc. Theoretical considerations indicate that the resnatron principle should still be effective at frequencies as high as this, and the work of Sloan and Marshall has resulted in the construction of models which promise to produce the desired results.

Other Tube Types

Only three types of tubes are known which are capable of generating or amplifying c-w power at the levels (20 to 100 kw) required for satisfactory operation in the uhf band. These are the resnatron, the magnetron, and the klystron. Of these tubes, the magnetron would not seem to be a permanently satisfactory solution to the problem, since it is not an amplifier, although proposals for magnetron amplifiers have been made, and, if such amplifiers can be developed, the magnetron might be found to have all of the necessary characteristics for satisfactory system operation.

Both klystrons and resnatrons may be operated as amplifiers. Klystrons capable of high power outputs and utilizing extremely high electron stream currents (100 amperes) have been built. The power gains obtainable with tubes of this type have also been determined to be adequately high, and they possess important manufacturing advantages over the resnatron. Their development is also further advanced in that sealed-off klystrons have been constructed. Nevertheless, the klystron, at least in its present state of development, possesses an important drawback: its efficiency is low. The electron stream efficiency under present operating conditions is limited to 57 percent, and this figure must, of course, be multiplied by the circuit efficiency in determining the over-all efficiency of the tube. In practice, klystrons are seldom operated with over-all efficiencies higher than 25 percent. It is possible that the development of multi-cavity power klystrons, or changes in the operating parameters might result in some improvement in electron stream efficiency, but it seems doubtful whether efficiencies as high as those obtainable from triodes and tetrodes of the type now generally used in low-frequency transmitter operation will ever be obtainable. From a commercial standpoint, this characteristic of the klystron is an extremely important consideration since, in the applications, discussed herein, the power outputs are large, and power dissipated due to low efficiency is excessive and costly.

The resnatron, in its present state of development, already possesses excellent efficiency characteristics. Efficiencies as high as 80 percent have been obtained in normal operation at ultra-high frequencies. This high efficiency is due to the fact that in the resnatron the density of the electron stream may be completely modulated, while in the klystron it can be modulated only downward and upward from an average current value which, in itself, contributes nothing to the useful output power and results merely in power dissipation. A resnatron operated on a class-C basis is entirely similar to other class-C amplifiers, the plate current being entirely cut off during the passive part of the driving cycle.

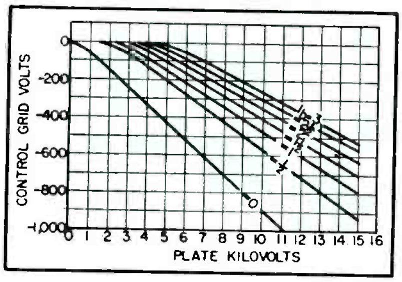

FIG. 3—Static characteristics of a resnatron amplifier. Calculated transconductance is about 15,000 micromhos at 10 kv and anode current of 3 amperes

Resnatrons, like high-power klystrons, have also been demonstrated in actual practice to be comparatively noise-free. Noise measurements were made in connection with the tests of a resnatron amplifier when it was being driven by a frequency-stable oscillator system. It was found that the noise level observed at the output of the detector of a receiver monitoring the signal was more than 60 db below the d-c level of the carrier, as determined by measuring the direct current in the detector circuit. Resnatron class-C amplifiers may, therefore, be expected to have noise characteristics fully as satisfactory as those of conventional tubes now in use.

Summarizing the situation, it thus appears that the resnatron is best able to fulfill the requirement for a high-power, high-gain, high-efficiency, ultra-high-frequency amplifier having a low noise figure. This conclusion is subject to modification in the light of any new developments which may be made. The traveling-wave tube, for example, shows promise of being able to operate at fairly high power levels. As yet, however, such tubes have not been developed as high-power amplifiers.

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Sound Waves Test Cylinder Heads

Fast, precision testing of tolerances in production is accomplished by translating differences in natural sonic frequencies of standard cylinder-head cavity and unknown to differences in volume. Rate of inspection is 180 six-cylinder heads per hour

INDUSTRIAL TESTING of cylinder-head tolerances in automobile manufacturing has been speeded up considerably through the application of an electronic volume comparator known as the Cavitometer.

The underlying principle of volume measurement by the instrument is that all cavities within a certain type of throat opening have a natural resonant frequency. If a master cavity of known volume is used for comparison with an unknown cavity and the two cavities are made to resonate at their natural sonic frequency with the frequencies opposing each other, then the difference in frequency may be interpreted in terms of difference in volume as compared with the master cavity. The volume varies as the reciprocal of the square of the frequency.

The difference in sonic frequency may be translated into a difference in electrical frequency and used to deflect a pointer on a dial which is calibrated in terms of volume. Any change in ambient temperature or humidity affects equally the natural resonance period of both the cylinder head being tested and the master cylinder-head cavity.

Principle of Operation

If a cavity is connected to an open tube of small cross-section as compared to its length and the volume of the tube is very small compared to the cavity, then the air contained in the volume of the tube can be considered as a piston. Because of the minute displacements of the air piston, it moves as a whole. The cavity volume, whose diameter is large compared with its depth, will suffer compression and expansion which will set up a sonic wave. The principle is similar to a weight hanging on a coil spring.

A source of sound, such as a transducer energized by an oscillator, placed just outside the tube or air piston and driven at resonant frequency will cause the cavity to resonate. If a microphone is imbedded in the cavity wall, then its output will experience a sharp rise when the cavity resonates. If two cavities, one of known volume, are opposed, as described previously, the volume of the unknown cavity can be measured.

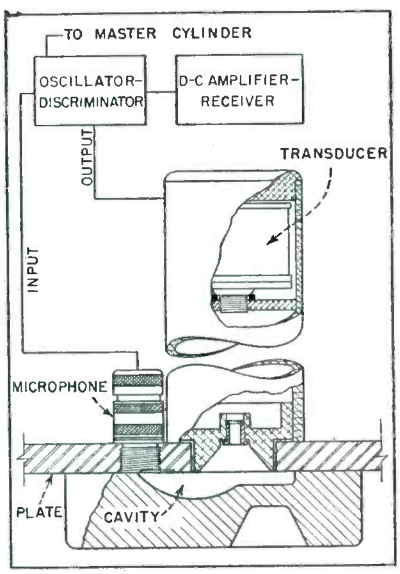


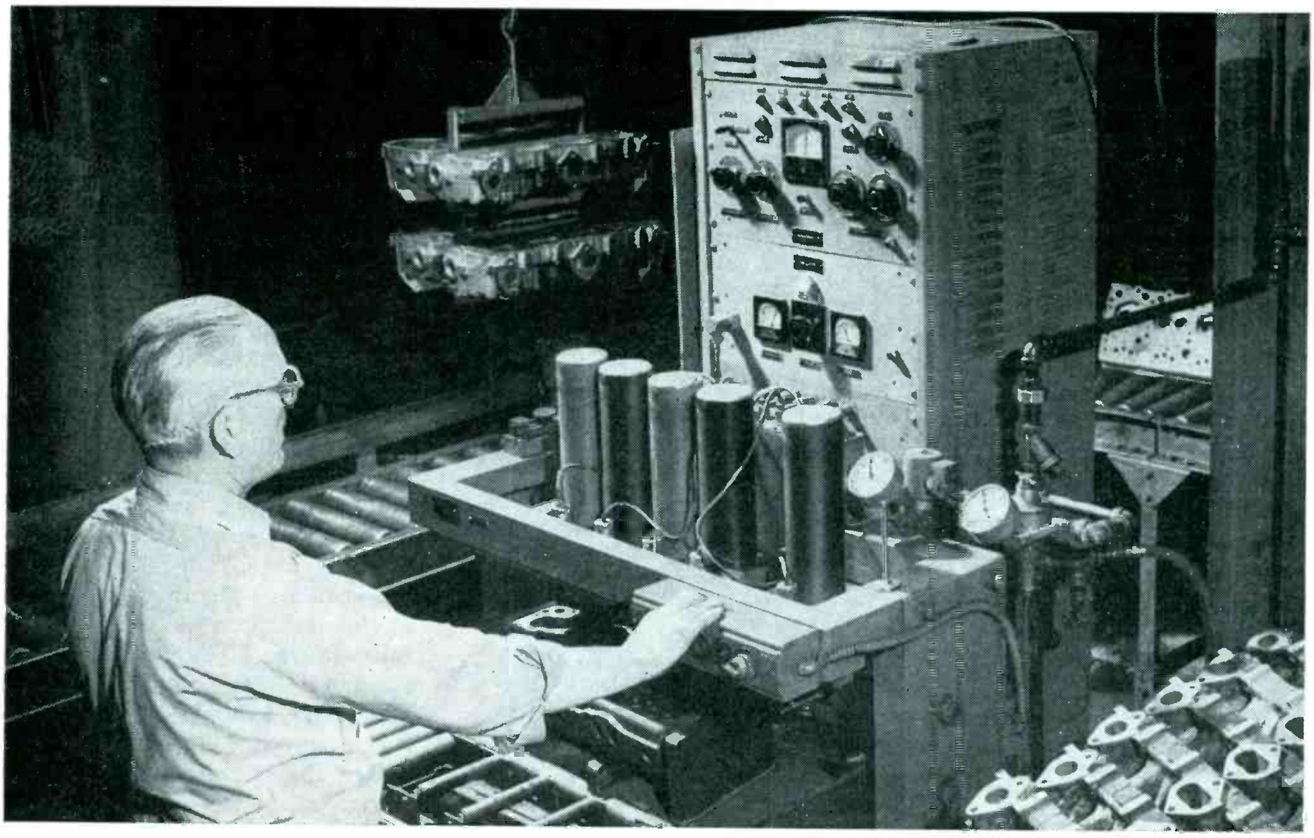
FIG. 1—The closed oscillatory system operates at the resonant sonic frequency of the cavity. The discriminator translates the resonant frequency into direct current proportional to volume differential as compared with a master volume

Automotive Application

In the use of the volume comparator for automotive application, each engine block head slides upside down on hardened slides on to a fixture table. The engine head slides into a predetermined location adjacent to a master cylinder head. Pushing a button on the control panel energizes an electric air valve and loads a hydraulic piston which clamps the head against transducer plates, thus cutting off the cavities.

The setup for testing an individual cavity is shown in Fig. 1. The transducer plates are made of steel. Imbedded in the plates opposite the center of each cylinder-head depression are adjustable-length sonic piston throats, 4, 6 or 8 as required. Back of each piston throat is a transducer encased in a sound-absorbing housing. Adjacent to the sonic piston throats are microphones also imbedded in the transducer plates. Either 4, 6 or 8 microphones are used depending on the number of cylinders in the head.

A stepper selector switch com-



Volume comparator in use on the assembly line of the Rocket engine plant of the Oldsmobile Division of General Motors. Cylinder-head cavities are held to a tolerance of plus or minus one cubic centimeter

pares the sonic resonant frequency of each cylinder-head cavity in turn against the sonic resonant frequency of the master cylinder-head cavity. The difference in frequencies, if beyond tolerance, is indicated by HIGH or LOW lights supplemented by a dial indication in terms of some deviation from master cylinder-head cavity volume.

Operating Procedure

To start the operation of the comparator, a start button is depressed which causes the selector switch to connect the master cavity to the oscillator assembly. This operation permits a zero adjust of the instrument.

After a period of about two seconds, automatic operation starts for comparing each cylinder cavity in turn with the master cavity. Within one-half to one second, the discriminator circuit compares the frequency of the voltage from the cylinder being tested to that of the master cylinder. If the difference is within tolerance, the selector switch automatically moves on to the next cylinder head to be tested. The operation is repeated until all the cylinder heads have been tested or until one is found beyond volume tolerance. A signal light shows which cylinder head is being tested at the moment.

If a particular cylinder head is beyond tolerance, a sequence of operations takes place. The selector switch automatically stops. The signal light, indicating excessive negative or positive tolerance as the case may be, lights. An indicating meter automatically indicates the amount of excess volume tolerance. The entire system remains in standby position until the inspector makes the decision about the particular cylinder head and restarts the system by pressing down on the ADVANCE button.

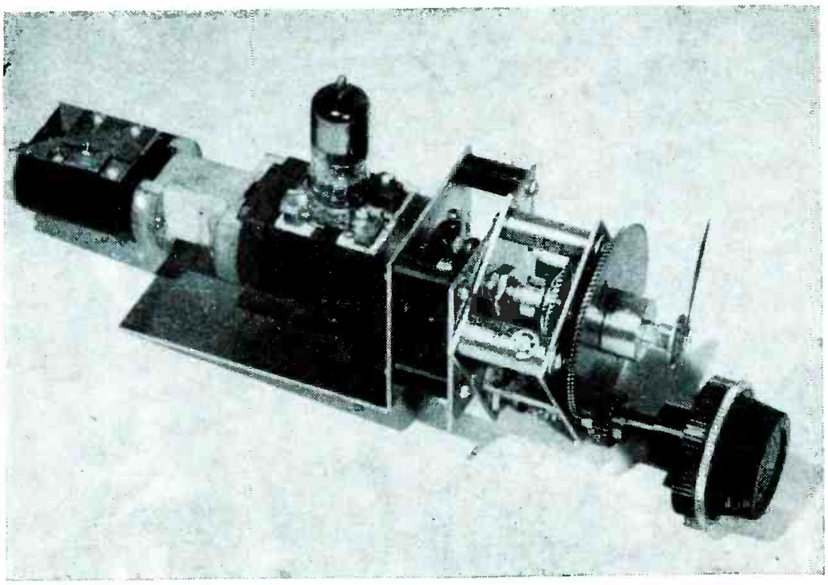
After a cycle of operation is completed, approximately eight seconds total time for six cylinders if they are within tolerance, the selector switch stops at its original position and is ready for zero checking before inspecting another engine head.

In the event there is a production requirement involving double tolerances, one tolerance between any two cavities in a given head and a second tolerance between the cavities of any two different heads, an electronic memory circuit may be added. In this case, when either tolerance requirement is violated, the system remains in standby until the inspector restarts the system by pressing the ADVANCE button.

The instrument can be stopped or moved on to any cylinder position to let the indicating meter indicate the actual difference in volume as compared with the master cylinder-head cavity by holding a MANUAL button until the desired cylinder cavity is connected.

The Cavitometer, manufactured by Poole Manufacturing Engineers of Dallas, Texas, will inspect cylinder heads at about two seconds per cylinder if they are within tolerance. Six seconds are required for the operator to take a cylinder head off the rack and place another one on. Six-cylinder heads can be inspected at the rate of about 180 per hour—R.K.J.

Modified Butterfly



Photograph of uhf-tv converter tandem oscillator-mixer and dial drive. Complete converter contains components shown plus appropriate shielding and power supply, and cascode amplifier for converted i-f signals

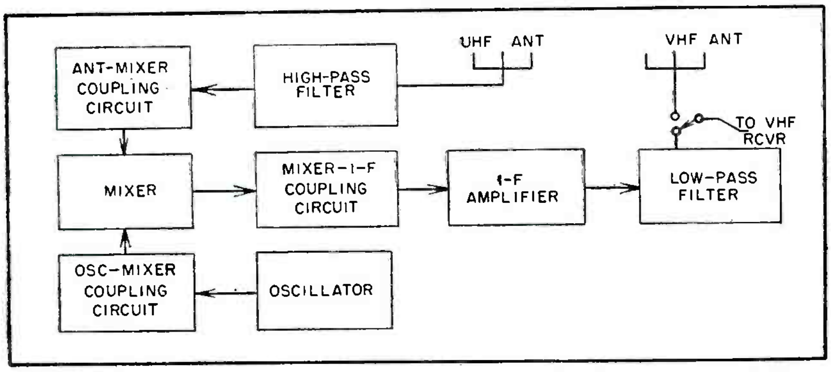


FIG. 1—Block diagram of uhf converter. Present FCC allocation plans indicate desirability of using vhf channel 5 or channel 6 for first i-f

THE POSSIBILITY of an eventual opening of uhf television channels in this country has stimulated a number of research programs seeking new and better techniques for adapting present-day vhf receivers for uhf reception. One such program resulted in the development of the continuous tuning converter to be described.

Figure 1 shows a block diagram of a complete uhf tuner. The three essential portions of the tuner are the oscillator circuit, the mixer circuit and the i-f amplifier. A developmental 7-pin miniature-based version of the 6F4 (since designated as type 6AF4) was chosen as the most likely usable oscillator tube to be available and commercially practical for use in this tuner. The only practical mixer for the uhf range was considered to be a germanium crystal diode. Triode mixers are generally inferior to crystals at frequencies above about 500 mc.

No r-f amplifier is included because of the lack of a satisfactory tube for commercial use. If such a tube should become available, it might then profitably be incorporated into the tuner design.

Tuned Circuit Design

The primary requirements of a tuned circuit design are range and

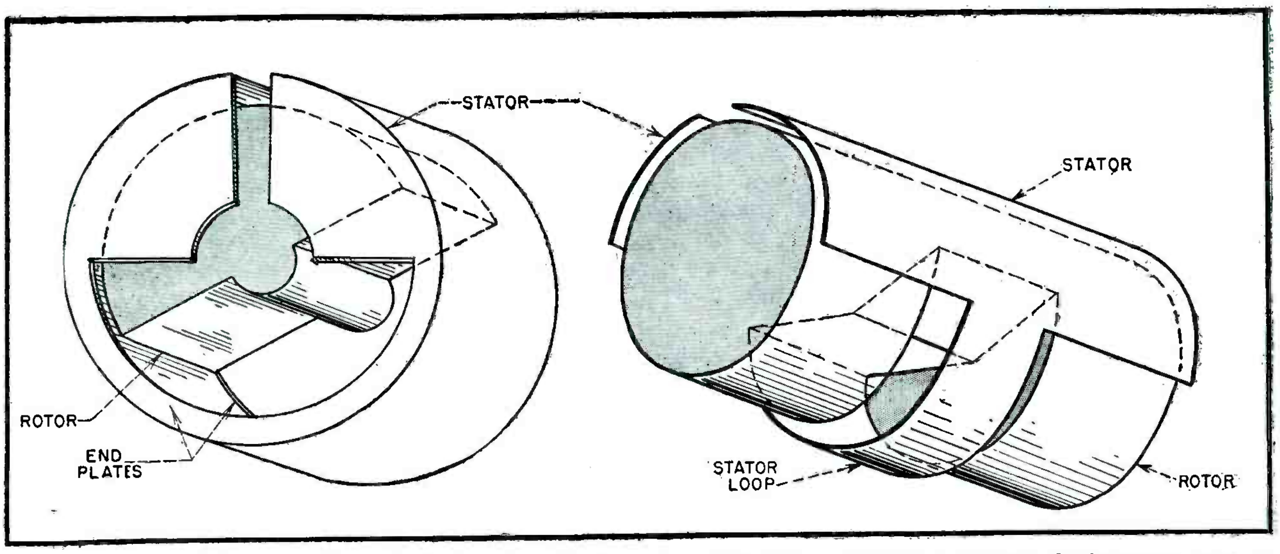


FIG. 2 —Typical solid-rotor semi-butterfly (left) and modified version (right) used in converter to increase the frequency range to cover the 470 to 890-mc uhf-tv band

UHF-TV Converter

Converts uhf signals to vhf for reception on existing television receivers. Modified butterfly tuned circuits provide good tuning linearity with low noise figure and excellent high-frequency oscillator stability over 470 to 890-mc uhf-tv frequency range

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stability. Both of these factors are more critical for the oscillator circuit than for the mixer.

The oscillator tuned circuit range is important because the oscillator tube has a lower resonant frequency than the crystal diode, and because the high-impedance tube must be connected to the high-impedance points of the oscillator circuit while the crystal, representing an impedance of two to three hundred ohms, is tapped down on the mixer circuit. The wide range required makes both inductance and capacitance variation desirable.

Since the i-f bandwidth is much less than the r-f bandwidth, the stability of the oscillator circuit is more important than that of the mixer. Stability, both thermal and mechanical, in a unit of this type is a function both of the basic design of the circuit and of the materials of which it is made. Electrical and mechanical design cannot be considered separately.

It was early decided to use wide-range continuously-tuned noncontacting resonators. The maximum obtainable inductance variation is desirable to minimize mixer bandwidth variations. The familiar semi-butterfly approach was used.

A typical solid rotor semi-butterfly is shown at left in Fig. 2. The rotor is a solid metallic semi-cylinder. The stator consists of a cylindrical metallic ring with a slot near the top plus two end plates at each end as shown. The rotor revolves inside the stator with a small clearance between the ends of the rotor and the end plates attached to the stator. The points of connection to the circuit are at the top of the stator across the slot.

In the low-frequency position the rotor is turned upward. A capacitance exists from each side of the stator to the rotor through the small air gap between the rotor and the stator loop and between the rotor and the end plates. These two capacitances in series form the tank capacitance. The inductance of the circuit is essentially that of the lower portion of the stator loop since the upper portion is magnetically shielded by the rotor and the end plates. In this position the inductance and capacitance are both at their maximum values. As the rotor is turned somewhat, as shown in Fig. 2, the effective capacitance area is decreased, decreasing the total tank capacitance. The total circuit inductance is decreased because the rotor now

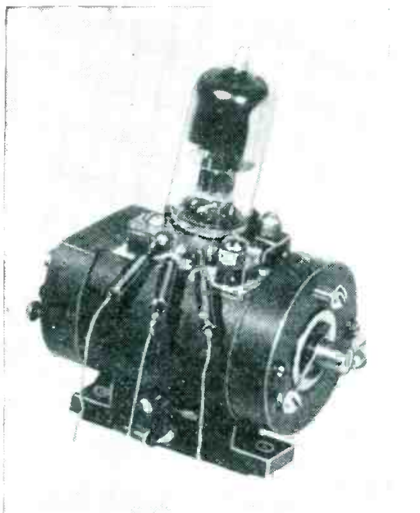

FIG. 3—Complete assembled oscillator unit

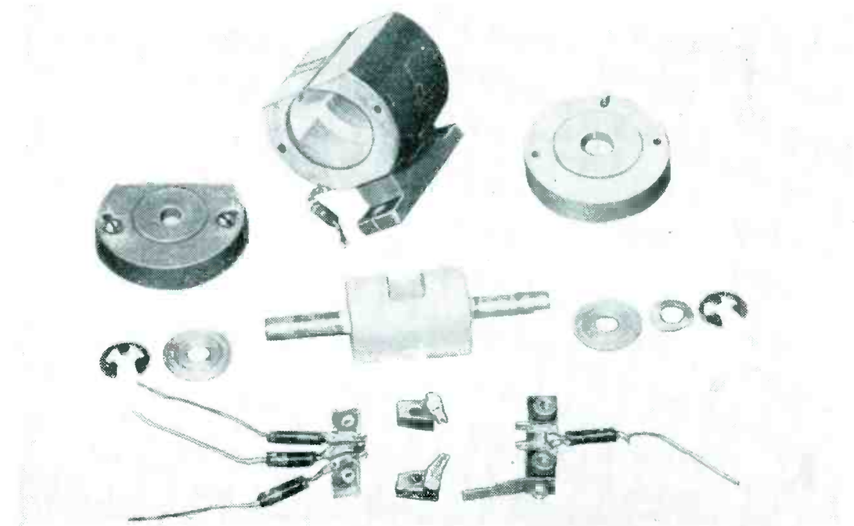

FIG. 4—Disassembled view of oscillator. Stator consists of silvered area on inside of glass-bonded mica housing

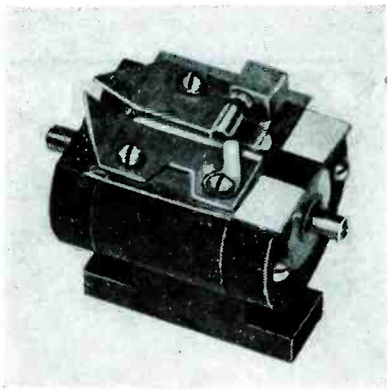

FIG. 5—Assembled view of mixer used in uhf-tv converter

obstructs the magnetic field of the inductance loop portion of the stator. The upper portion of the stator is still magnetically shielded by the end plates to some degree. At the highest frequency, with the rotor in its lowest position, the inductance loop of the stator is completely shielded by the rotor for minimum inductance, capacitance also being at a minimum.

A slight modification of the semi-butterfly will serve further to increase the inductance variation, as shown at right in Fig. 2.

By removing the portions of the inductance loop shown, the low-frequency inductance is substantially increased, while the capacitance is not affected. In the high-frequency position, due to the shielding effect of the rotor, variations in the width of the stator inductance loop have only a second-order effect if the gap between rotor and stator is small.

The stator in the modified version is a thin shell. The rotor, however, instead of being essentially semicylindrical is a solid cylinder with a single transverse slot. No end plates are used. Inductance variation is obtained in much the same manner as previously. In the low-frequency position the slot on the rotor, which is somewhat wider than the narrow inductance loop, is adjacent to that loop. Because there is sufficient space between the slot and the loop, the rotor causes little reduction in inductance of the loop. The capacitance is essentially that from the upper portion of the stator through the air gap to the rotor. In the high-frequency position the inductance of the loop is reduced as before, but because the upper portion of the stator is largely obstructed by the solid rotor, its inductance is low. The high-frequency capacitance is less than that at the low-frequency end because with the slot in the upper portion the effective capacitance area is less. Capacitance variation, though, is less than that of the units previously described, and the inductance variation is greater. This is basically the type of resonator that has been used in the units to be described.

Resonator Materials

As was previously mentioned, one of the most important factors affecting the operation of the resonator is the nature of the materials of which it is made. For reasons both of stability and producibility, it was decided to make rotor and stator of a glass-bonded mica material with silvered conducting surfaces. Figure 3 shows an oscillator unit made in this manner. Figure 4 is a disassembled view of the same oscillator unit. As can be seen, the stator electrically consists of the silvered areas on the inside and the top of the glass-bonded mica stator. The rotor consists of a slotted glass-bonded mica cylinder entirely silvered, and with a shaft inserted in place.

Figure 5 shows a mixer unit made in the same manner. The glass-bonded mica has several advantages over other materials which might be used. One is stability. It has a low moisture absorption and low thermal coefficient of expansion—approximately that of steel. This means, for example, that in addition to the degree of stability expected from such a low coefficient, shafts and inserts may readily be molded in place. These materials can be molded to close tolerances—$\pm$ 1 mil is obtainable. If closer tolerances or shapes which cannot be molded are required, the material can readily be machined.

The conducting surfaces were applied by means of an air-drying conductive silver paint which may be applied by conventional printed circuit techniques. Firing-on paints were unsatisfactory because the glass-bonded mica would not withstand the required temperatures. The best air-drying paints encountered to date have been found to have conductivities of the order of 0.1 to 0.05 of that of pure silver. Consequently, a further coating of silver was electroplated for improved conductivity. Conventional plating techniques could not be used because the usual acid-copper bath attacked the glass-bonded mica base, and because the high current densities ordinarily used in silver plating produced a blistering of the silver paint. Consequently, silver was directly plated onto the conductive paint from a cyanide bath at low current densities, with excellent results.

One important problem encountered in the design of these units was that of getting a suitable wear-resistant, rigid and accurate bearing. One approach that was tried was the use of a steel or bronze sleeve inserted into the glass-bonded mica end cap, but a much more accurate and durable means was found. Although the glass-bonded mica is abrasive, it machines smoothly. Reamed holes in the glass-bonded mica end caps, with the steel rotor shafts running through them, were found to produce excellent bearings. For example, when an attempt was made to life-test an oscillator unit with a motor-driven rotor and an arm

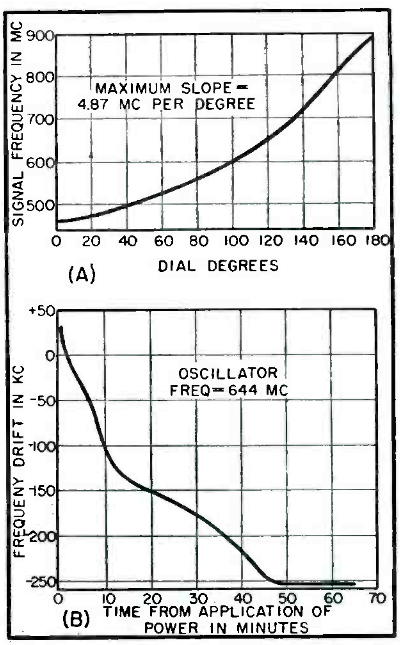

FIG. 6—Calibration and warm-up curves for converter

attached to the shaft actuating a counter, after 130,000 revolutions the metal counter-actuating arm wore through, stopping the test. When the oscillator unit was disassembled and carefully inspected no wear whatsoever was noticeable on either the shaft or the reamed bearing hole.

Oscillator Circuit

The oscillator unit is basically a conventional balanced Colpitts circuit. The plate blocking capacitor is formed by a sheet of mica under the plate contact mount. The grid return is taken from a low-impedance point to minimize loading effects. The required range of the oscillator is 361.75 to 775.75 mc plus whatever overlap and trimming range is desired. At the high-frequency end of the range the major portion of the oscillator circuit is within the tube, which means that the resonator structure itself must have a very much greater unloaded range. A typical tuning characteristic is shown in Fig. 6A. More linear curves are readily obtained at the expense of range. For example, for 50 mc less range an almost linear curve may be obtained.

The thermal coefficient of frequency of these units has been found to be essentially constant over the tuning range. This means that thermal drift is a problem proportional to frequency. Thermal coefficients of frequency of 25 parts per million per deg C have typically been obtained. A typical oscillator warm-up drift characteristic measured in the upper part of the range is shown in Fig. 6B. This curve was measured with the oscillator unit in a large enclosure maintained at a constant temperature. The drift therefore is that of the oscillator unit alone. The effect of enclosure may be determined from this drift and from the temperature coefficient and the rise in temperature of the oscillator enclosure.

The mechanical stability of these units has been found to be excellent. This has been most vividly shown by the remarkable freedom from microphonics. For example, when a complete tuner was placed in a vhf receiver with a separate sound i-f, slight microphonic effect was observed. This, however, was no greater than that of the vhf tuner of the receiver itself. In one instance the speaker was placed directly on top of and actually touching the uhf tuner with no microphonic effect. Of course a test made in a nonintercarrier receiver is far more stringent than one made in an intercarrier receiver since any frequency modulation of the uhf local oscillator in the latter will affect sound and picture carrier equally and hence have no significant effect on the sound output.

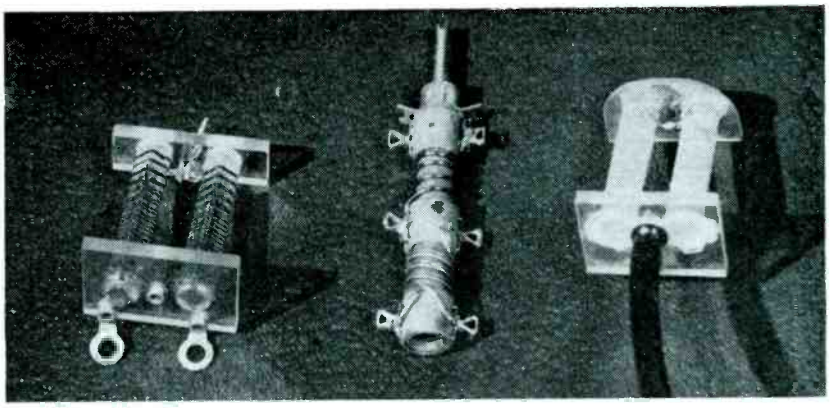

FIG. 7—Closeup photograph of oscillator injection transformer (left), i-f take-off coil (center), and antenna balanced-to-unbalanced transformer (right)

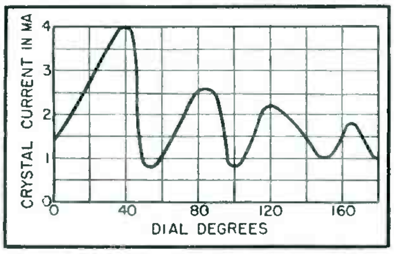

FIG. 8—Uncompensated injection characteristic

When a complete tuner was connected to a frequency calibrator and the frequency calibrator adjusted for zero beat with the local oscillator, it was found that pounding on top of the unit produced some frequency modulation but it still remained within a low audio beat.

Mixer Circuit

The tuning range required for the mixer circuit, if this circuit is tuned to a frequency between picture carrier and sound carrier, is approximately 472 to 886 mc. This range, being different from that of the oscillator, calls for different dimensions than those of the oscillator resonator, but similar shapes.

Since the crystal mixer is a low-impedance device of the order of 200 to 300 ohms, a tap down on the high-impedance tuned circuit is required. The structure (Fig. 5) is generally similar to that of the oscillator. The capacitive tap-down circuit consists of three capacitors printed on a sheet of mica. This sheet of mica can be seen underneath the two metal plates to which the antenna coupling transformer is connected. One end of the crystal is connected to the lug shown, which, with a small piece of mica underneath it, forms the diode load capacitor. The other end of the crystal connects to a lucite block, the purpose of which is described later.

The antenna is coupled to the mixer by a balanced-to-unbalanced transformer shown at the right of Fig. 7, consisting of two bifilar-wound coils. Each bifilar winding may be considered as a coiled-up transmission line with a characteristic impedance of 100 ohms.

These windings are connected in parallel at the unbalanced 50-ohm input end, and in series at the balanced 200-ohm end of each coil; due to the high unbalanced inductance the impedance at the 200-ohm end is essentially balanced.

The oscillator injection was obtained by using a tapered balanced-to-unbalanced transformer to couple from the high-impedance oscillator circuit to low resistance in series with the crystal. This resistance, which is approximately 30 ohms, is printed on the previ-

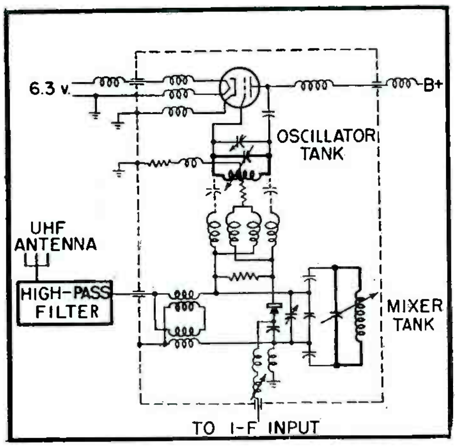

FIG. 9—Schematic diagram of oscillator-mixer circuit

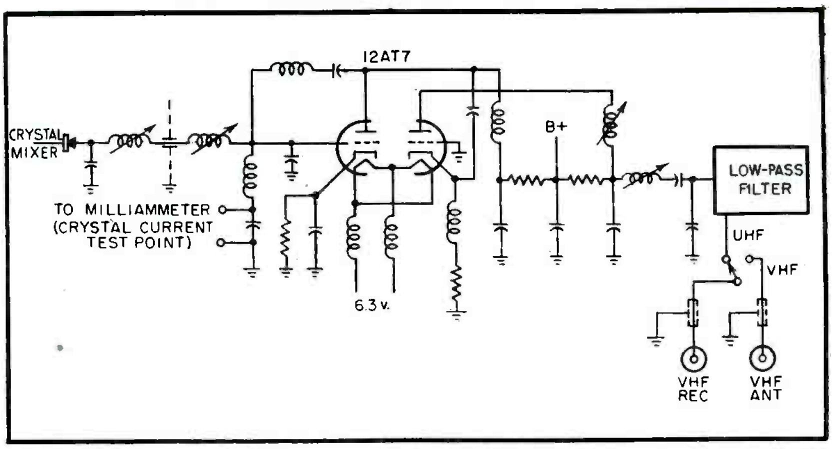

FIG. 10—Intermediate-frequency amplifier. Substituting newly-developed 6BQ7 for 12AT7 provides circuit with noise figure of approximately 6 db

ously mentioned insulating block, which also serves as one of the crystal mounts.

The injection transformer, shown at the left of Fig. 7, is similar to the previous one, except that instead of each bifilar winding having a constant characteristic impedance, the two wires are wound with slightly different pitches, causing the characteristic impedance to vary along the length. The windings are so arranged that the transformer impedance is approximately 600 ohms at the high-impedance series end and about 30 ohms at the low-impedance parallel end. Because of the high unbalanced inductance, balance is not a problem at either end.

The transformer is coupled to the oscillator by the small capacitance between its mounting and the oscillator structure and is connected at the other end to the resistance in series with the crystal.

An uncompensated injection characteristic is shown in Fig. 8. This curve, which has a range of 5 to 1, shows a cyclical variation which should be amenable to correction. The absolute value of the injection can readily be varied by changing the capacitance from the injection transformer to the oscillator.

The i-f take-off from the mixer presented a problem, since with the mixer arrangement shown neither side of the crystal was grounded for either r-f or i-f. The solution was to use a bifilar-wound coil which acts as an unbalanced choke at r-f and a short length of transmission line at i-f. This length of line and an adjustable series inductance at the bottom of the coil form are the inductance elements in the double-tuned bottom capacitance-coupled i-f input circuit. This coil is shown in the center of Fig. 7.

Integrated Tuner

The r-f circuit schematic is shown in Fig. 9. The oscillator circuit is shown at the top and the mixer circuit at the bottom. Between the two is the representation of the tapered injection transformer, showing the method of connection of the windings. The antenna-to-mixer unbalanced-to-balanced transformer is shown at the left of the mixer tank and the i-f output circuit directly below the crystal.

Figure 10 is the schematic of the driven grounded-grid or cascode i-f amplifier. A 12AT7 has been used in this work, but the newly developed 6BQ7 which is designed specifically for use in a circuit of this type is apt to have a noise figure of two or three db less. The output circuit is a double-tuned bottom capacitance-coupled circuit. The primary purpose of the low-pass filter in the output of the i-f amplifier is to eliminate the vhf receiver local oscillator frequency and its harmonics from the mixer circuit, where small amounts of such extraneous signals would produce spurious responses.

The purpose of the high-pass filter, shown between the antenna and the r-f transformer in Fig. 1, is to get added rejection to undesired low-frequency signals, such as those of vhf stations, beyond that rejection due to the selectivity of the mixer circuit and the essentially broad-band r-f coupling transformer.

Performance

With the unit as described, noise figures of approximately 22 db have been obtained. With a somewhat modified design having a broad-band r-f circuit, noise figures of approximately 17 db were obtained.

The 12AT7 i-f circuit has been found to have a noise figure of approximately 8 db. The use of a 6BQ7 in place of the 12AT7 may be expected to reduce the i-f noise figure by about 3 db and the overall noise figure by about 2 db.

Due to the fact that only one tuned circuit was used ahead of the oscillator in this tuner, local oscillator radiation has been a problem. The obvious solution and one which eventually will be required is the use of a double-tuned resonator in the mixer circuit.

In a unit of this type a double-tuned input circuit can readily be built in one mechanical assembly to replace the present single-tuned input circuit. It is expected that the use of this arrangement will give satisfactory oscillator radiation performance.

In this paper it has been attempted to describe several new techniques useful in solving the problems of uhf operation. We have attempted to indicate the advantages of these methods, and have described a completed tuner which has been built incorporating them.

Multiplexed Broadcast Facsimile

Ultrasonic system now used by Rural Radio Network permits relaying facsimile newspaper from New York to Ithaca audience on same f-m channels that provide audio programs up to 15 kc. Subcarrier channel has also been successfully tested with ordinary voice modulation for Civil Defense commands

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COMMUNICATION by facsimile and document duplication by the use of facsimile scanning have progressed to an advanced state of utility and reliability, but the growth of facsimile broadcasting has been stunted by a number of factors.

Although the Federal Communications Commission, and their predecessors, have for many years provided frequencies for experimental facsimile broadcasting, it was not until July 15, 1948 that commercial facsimile broadcasts were authorized, for extremely limited periods, in place of audio programs on f-m stations. Providing there was no degradation of the audio below 10 kc, multiplexed commercial facsimile programs were permitted for three hours during normal listening periods[1].

Effective June 13, 1951, multiplexed facsimile became available to f-m broadcasters for commercial programs on an unlimited time basis. The modern development demonstrated before the FCC in December 1949, and which influenced the recent ruling, is described below.

The idea of putting both audio and facsimile on the same radio-frequency channel is not new and was originally demonstrated at 5 square inches a minute by Armstrong[2], but it is not likely that the techniques of the earlier days would satisfy present requirements. Although the 1948 rule of the FCC specified no degradation of the audio below 10 kc, it was felt that a truly satisfactory service could be rendered only by a system that allowed the full 15 kc of audio without impairment by facsimile on the same carrier.

Various schemes, including low percentage amplitude modulation of the radio carrier, had been suggested. Some had been tried successfully in the laboratory but the complication and potential high cost discouraged further development. It was then decided to investigate the possibilities of a very simple system using an ultrasonic facsimile-modulated subcarrier to frequency-modulate the radio trans-

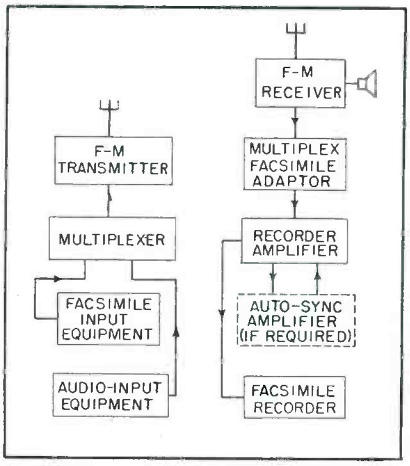
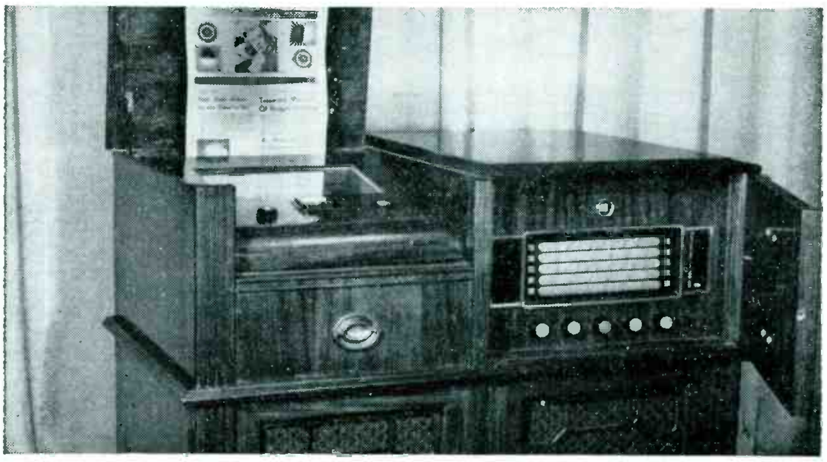


FIG. 1—Equipment used to multiplex facsimile with f-m broadcasting



General Electric type 417A radio receiver used in the type FR-1 combination for sound and facsimile mitter in the normal manner. It was felt that the low inherent distortion and wide frequency range of f-m modulators and detectors of conventional types might make such operation possible with a low percentage of radio carrier modulation. If a relatively low facsimile level could be used, the loss in the audio could be kept to negligible proportions in this double modulation scheme.

Standard broadcast facsimile receiving equipment designed for operation with a 10-kc double-sideband amplitude-modulated subcarrier was tested with subcarriers in the range between 20 and 30 kc and satisfactory results were obtained. Since it appeared that little except complication could be gained by altering the type of modulation, a subcarrier of 25 kc with double-sideband amplitude modulation was selected for the system. Laboratory tests were conducted using a Measurements Corp. Model 78 f-m standard signal generator as a simulated broadcast station. Audio program signals received on a Pilotuner at the laboratory from WQXR-FM were amplified, high-frequency pre-emphasized and low-pass filtered to a top of approximately 16 kc. These audio signals were combined with the facsimile-modulated 25-kc subcarrier in a simple resistance mixing pad after the facsimile signals had passed through a bandpass 20-to-30-kc filter. The combination output of the mixing pad was used to modulate the f-m signal generator.

At the receiver, the output of the discriminator (before the de-emphasis network) was fed to a high-pass filter and amplifier and thence to the regular facsimile recording equipment. Various relative audio and facsimile levels were tested. Satisfactory facsimile recordings were made with full-black radio-carrier facsimile deviation as low as 400 cycles and with simultaneous audio deviation of 75 kc. Facsimile black deviations as high as 10 kc could not be audibly detected in the output of standard f-m radio receivers.

Field Tests

Bench demonstration having worked out successfully, the first field tests of the system were conducted over Station WQXR-FM in New York in September 1948. A full-black facsimile deviation of 5 kc was used, simultaneously with a peak audio deviation of 70 kc. Observations on approximately 120 f-m receivers of more than 20 makes scattered throughout the city revealed no trace of the facsimile signals in the audio output of the receivers. Furthermore, no report of any interference was received from the critical WQXR-FM audience. Other field tests were conducted, with similar results, over stations WFIL-FM in Philadelphia, WEAW, Evanston, Ill., and WMAQ-FM in Chicago.

The complete system for single station operation is shown in the block diagram of Fig. 1. The transmitting multiplexer is shown in greater detail in Fig. 2. The facsimile preamplifier provides for facsimile full-black (peak-level) input as low as −50 dbm. This input signal is received as a standard amplitude-modulated 10-kc subcarrier, which is fed over a wire line or STL from the facsimile program originating location or studio. In all cases, the multiplexer is located at the radio transmitter. It will be noted that audio as well as the facsimile signal are fed through the multiplexer unit. Sufficient noise, distortion and direct audio components in the 20-to-30-kc region exist in the output of the best of audio equipments to necessitate the use of the low-pass audio filter. High-frequency pre-emphasis of the audio can be accomplished before feed to the multiplexer, or in the unit itself, since both standard pre-emphasis and flat plug-in networks are provided for the audio amplifier. Pre-emphasis after combination with the facsimile signal is not advisable since pre-emphasis characteristics beyond 15 kc are not normally specified.

Upon installation, the audio section of the multiplexer is adjusted to a gain of approximately unity so that it can be cut in or out of the transmitter-input circuit by means of patch cords or keys without disturbing the audio level. After initial installation adjustment, no further attention by the transmitter operator is required.

The principal requirement for multiplexing with the equipment described is that the transmitter be capable of being modulated properly in the 20-to-30-kc region. It is desirable for the output of the multiplexer to feed the grid of the modulator tube directly. Any intervening amplifiers introduce the possibility of intermodulation distortion, causing interference.

The only equipment required to

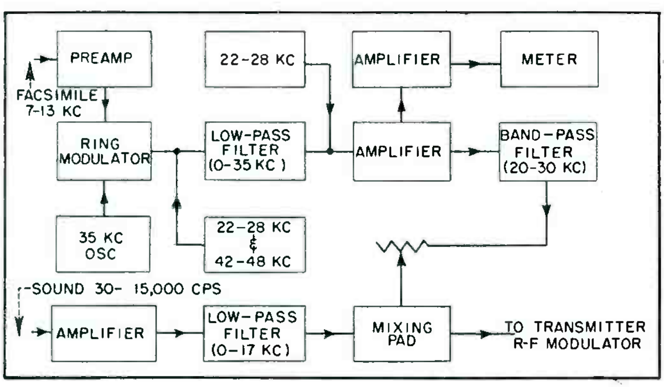


FIG. 2—Essentials of multiplex transmitting amplifier used to combine facsimile and sound

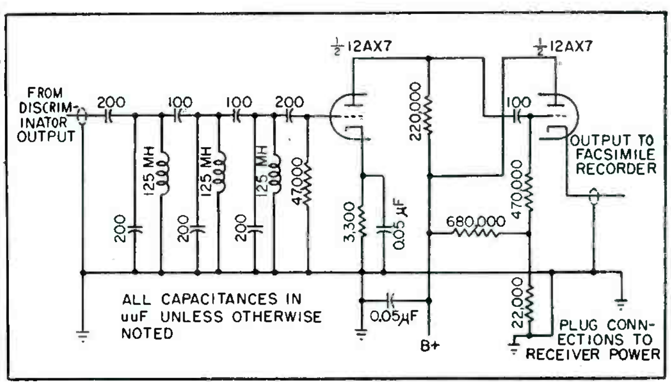


FIG. 3—Circuit diagram of adapter amplifier used between f-m receiver and standard facsimile recorder

adapt a standard combination sound-and-facsimile receiver to multiplex operation is the adapter amplifier shown in Fig. 3. The unit is designed to plug into a connector on the back of a GE 417A radio receiver used in the type FR-1 combination sound and facsimile receiver illustrated. The adapter amplifier operates successfully with other receivers, its output circuit being completed through a 3,000-ohm resistor in the RA-3 facsimile recorder amplifier used to supply the marking current. Total power required from the 417A receiver for the single miniature tube is 0.3 ampere at 6.3 volts and 2 to 5 milliamperes at 100 to 300 volts.

Filter Construction

The band-pass input filter (18 to 32 kc) is assembled from available radio-frequency chokes and 20-percent tolerance mica capacitors. Acceptable units are flat within ±1.5 db from 22 to 28 kc and down at least 40 db at 15 kc. It was discovered early in the development that it is of the utmost importance to provide a high-pass or band-pass filter directly at the output of the discriminator in the radio receiver. Any amplifier, even a cathode follower, ahead of the filter results in sufficient intermodulation with the relatively high-level audio signals to make subsequent clean separation impossible with any type of filter. The result is noisy sound-degraded facsimile copy. The filter shown opens-up at lower frequencies so that loading of the discriminator tends to become negligible in the audio region.

Practical Applications

Satisfactory equipment having become available, regular operation of multiplexed facsimile is increasing. A multiplexer installed at station WELD, Columbus, Ohio, in 1949 is in use on a predetermined schedule. A similar installation was made in the summer of 1950 at WMC-FM in Memphis, Tenn. The latter is used to disseminate information from a private weather service to planters in the rich Mississippi Valley cotton-growing region at distances up to more than 100 miles from the f-m radio transmitter. In all cases, it has been found that satisfactory facsimile can be recorded at any point at which good quality audio can be received, when a facsimile-black deviation of 3 to 5 kc is employed. Major E. H. Armstrong and his staff have confirmed this observation by means of tests from his experimental station KE2XCC at Alpine, N. J., to receivers located at such points as Poughkeepsie and West Hampton, Long Island, N. Y.

Relayed Multiplex

The possibility of satisfactory radio relay multiplex operation inspired further laboratory experimentation and field tests in the latter part of 1950 and early 1951. Two multiplexer units similar to the type described were constructed, but with the heterodyning modulator and oscillator eliminated and a good 20- to 30-kc band-pass filter designed to work out of a radio receiver discriminator substituted therefor. Using three type 78 f-m signal generators and two REL model 646 radio receivers for relaying, two-hop-and-broadcast relay operation was achieved in the laboratory. An audio program was relayed simultaneously with the facsimile transmission. Thus encouraged, an experimental field test was arranged with Major Armstrong and the Rural Radio Network. This network uses radio relay with frequency-modulation broadcast stations for audio program distribution throughout New York State and northern Pennsylvania. During the experiments programs from the Columbia University campus were sent by 900-mc STL to KE2-XCC, Alpine, N. J. Multiplex facsimile signals on 93.1 mc from Alpine were picked up by WQAN-FM in Scranton, Pa., and rebroadcast multiplex on 92.3 with the regular WQAN-FM audio program. These signals were received by WHCU-FM in Ithaca, N. Y. and there rebroadcast multiplex on 97.3 mc with the regular WHCU-FM audio program. Despite the marginal reception caused by the long hops (Alpine to Scranton is 90 miles and Scranton to Ithaca is 95 miles), satisfactory facsimile copy was recorded in the Ithaca region a good part of the time.

After these initial tests, commercial broadcast station WOR-FM operating at 98.7 mc in North Bergen, N. J. replaced KE2XCC. This change necessitated another link, since WOR-FM could not be received satisfactorily in Scranton because of adjacent-channel interference. The fourth station was WHVA-FM on 104.7 mc in Poughkeepsie (transmitter at Beacon), New York. The final network includes a wire line that handles the 10-kc amplitude-modulated subcarrier to WOR-FM.

An MTA-2 multiplexer at the WOR-FM transmitter converts the subcarrier to 25 kc. The facsimile signals are passed on by MTA-3 (relay-type) multiplexers from Beacon through the rest of the net. All links except the New York-to-Beacon hop are still in the marginal class. Reception is satisfactory a large percentage of the time, despite this serious handicap.

The program material prepared by supervised students at the Columbia School of Journalism is actually a miniature four-page to eight-page newspaper consisting of the news-in-brief, together with weather and market information of importance to the Rural Radio Network audience in New York and northern Pennsylvania. Each page is $9\frac{1}{2} \times 12$ in. in size and the four pages are transmitted in a period of 15 minutes. Photographs and typewritten and typeset printing are pasted on make-up sheets together with late weather maps supplied by the U. S. Weather Bureau. These made-up pages are wrapped around the drums of the dual-scanner FT-3 facsimile transmitting console and the scanners are operated alternately, in the same manner as dual-record turntables, so that there is no reloading pause between pages.

The possibility of using the multiplex relay net with audio rather than facsimile has been suggested for Civil Defense and similar applications. The laboratory relay setup was tested with a voice channel and results indicated that such operation is perfectly feasible.

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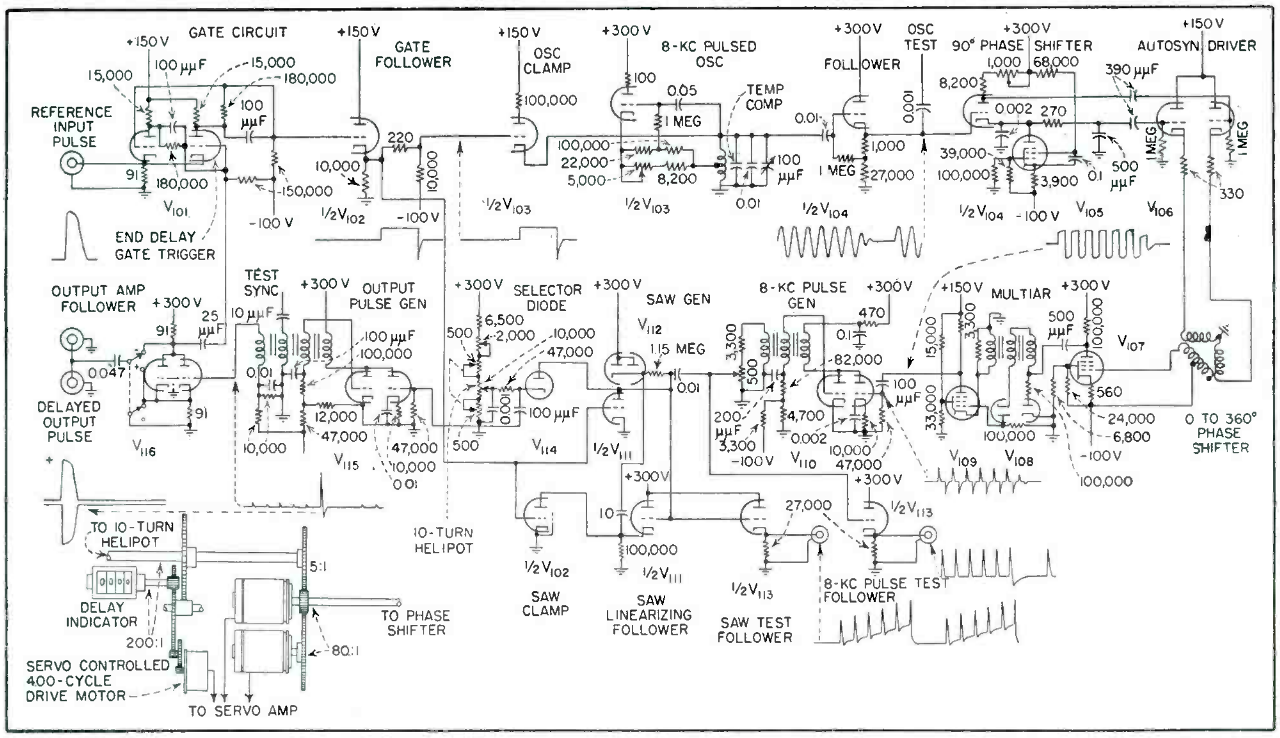

Schematic diagram of pulse delay unit. Output pulse has a width of one μsec and a peak value of 70 volts. Delay is variable from a few μsec to several milliseconds

Variable Pulse Delay

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Although there are several methods for obtaining variable pulse delays, many of them become impractical where a number of general requirements must be met. It is possible to design a multivibrator-type delay[1] for periods extending from a few microseconds up to several milliseconds. These delays are entirely satisfactory for applications not requiring high stability or calibration accuracy.

For short periods of fixed delay, both real and artificial delay lines are generally satisfactory. Other methods of creating pulse-type delays may be considered such as the phantastron,[1,2] mercury delay lines,[3] and other types wherein an ultrasonic delay[4] may be accomplished.

One of the requirements of such a delay unit may be to establish pulse delays of the order mentioned above while maintaining a calibration accuracy which is independent of the repetition rate of the reference input pulse. A system which may be made reasonably insensitive to repetition rate is that used considerably in the past several years as a means of creating a pulse delay.[5]

A brief review of the general function of such a system is as follows: A delay reference input pulse is made to trigger, simultaneously, a sine-wave oscillator circuit and a sawtooth generator. The oscillator feeds a 0 to 360-deg variable phase-shifting circuit, the output of which feeds a pulse generator. The pulse generator output consists of pulses, one for each cycle of the sine-wave oscillator. These pulses are superimposed upon the sawtooth circuit and appear as shown in Fig. 1.

By making the sawtooth generator trigger itself after it reaches a predetermined peak value, sawtooth plus superimposed pulse, and by using this peak trigger voltage to develop an output pulse, a time delay is realized. The time delay is essentially equal to the period of the total sine-wave oscillations represented by the pulse spacings on the sawtooth.

By changing the point at which the sawtooth generator triggers itself, it is possible to create a delay

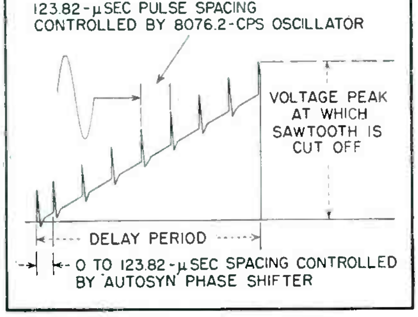
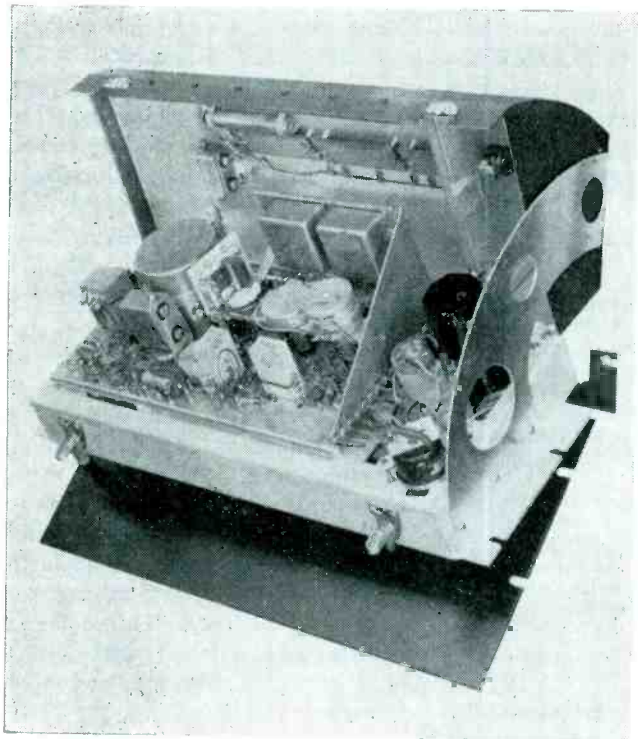
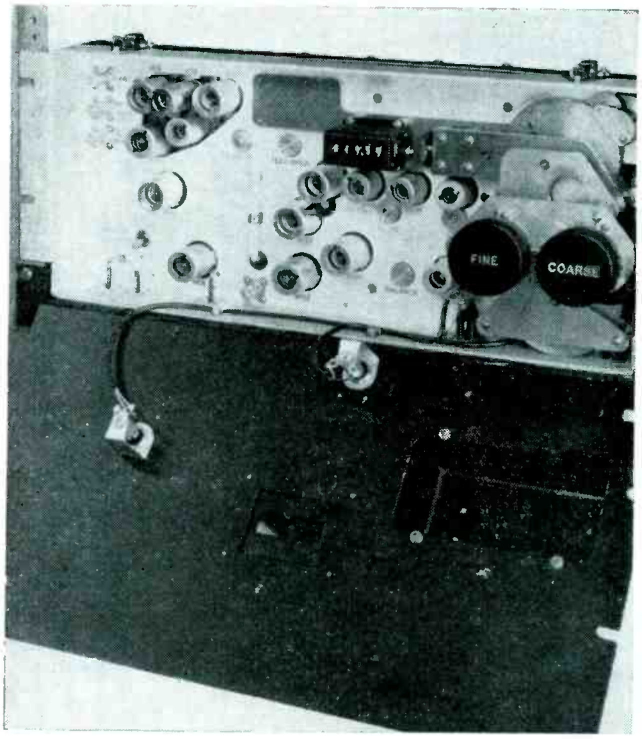


FIG. 1—Basic sawtooth time delay

This article is based on a paper presented at the 1950 National Electronics Conference. The Conference paper will appear in the *NEC Proceedings*.



Delay unit chassis in one position of the double-hinged relay rack. Servo system and helipot are in black case at right



Delay unit chassis in alternate position showing counter in center, fine and coarse servo autosyns and gear assembly

for Radar Ranging

Accurate, continuously-variable or fixed pulse delay unit may be used in radar ranging, navigation, propagation studies and other similar techniques. Delay is obtained locally or remotely with range from a few microseconds to several milliseconds with a maximum error of 0.3 microsecond

which is adjustable in steps, each step equal to one cycle of the sine-wave oscillator. By virtue of the phase shifter following the pulse sine-wave oscillator circuit it is possible to superimpose upon this sawtooth, pulses equally spaced by one cycle of the sine-wave following the first pulse.

The first pulse at the base of the sawtooth will be spaced a period from the start of the sawtooth by a 0 to 360-deg value depending upon the setting of the phase shifter. By suitably adjusting the sawtooth stopping point and by setting the phase shifter it is possible to superimpose any number of pulse spacings plus any part of a pulse space on the sawtooth. If the sawtooth cut-off point is made to increase in synchronism with the corresponding sine-wave phase shifter, the delay period as indicated will be continuously adjustable. Since this is accomplished in practice by a mechanical linkage, the unit is referred to as an electromechanical pulse delay unit.

In a unit designed on the foregoing basis the total pulse delay accomplished is the same as a number of individual delays, all of which are not immediately apparent. One of the general sources of such individual delays results from the existing condition in all pulsed timing equipments that any pulse must necessarily have a finite rise period. The designer should make all pulses in the delay chain have as short a rise period as possible and the amplitude should be generous in all cases to reduce the total delay in any system and the triggering action sensitivity to amplitude variations. Sensitivity of this sort is often responsible for a type of annoying pulse phase modulation generally referred to as jitter. Long term variations of the same type result in reset inaccuracies.

The total delay effected by a unit of this type must take into consideration the delay introduced by the character of the delay reference input pulse and by the effect of the

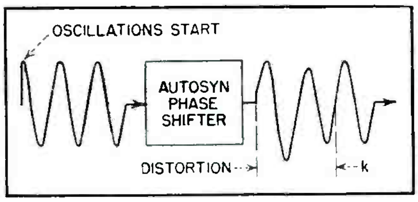


FIG. 2—Input and output waveforms for autosyn phase shifter. Resulting distortion is not dissipated until the end of the first two cycles

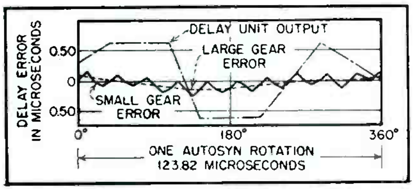


FIG. 3—Relationship between electrical error and mechanical error due to the gear train of the counter

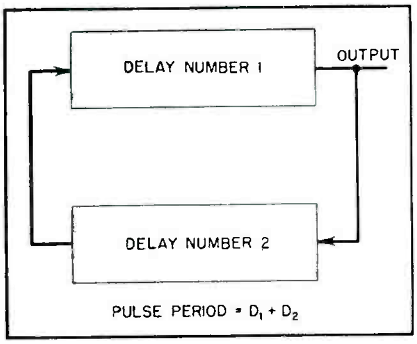


FIG. 4—Stable and adjustable pulse generator consisting of two delay units connected back to back

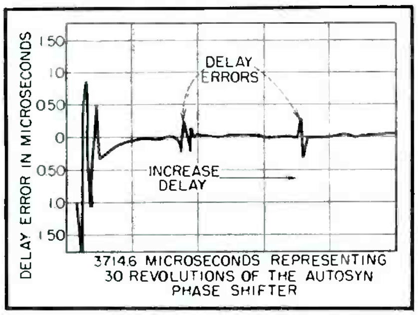


FIG. 5—Total calibration error of a typical delay unit over a range of 3714.6 microseconds plotted at each autosyn revolution except for the two points indicated. The two delay-error points shown were plotted from more frequent readings

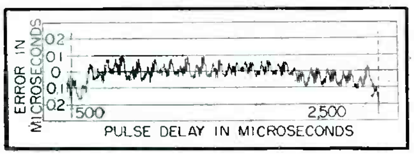


FIG. 6—An automatically traced error curve for a carefully balanced and adjusted unit over a 500 to 2,500-microsecond delay

delayed output pulse characteristic upon the circuit to which the unit is connected. The total unit delay in microseconds for a given control setting may be expressed as $D = d + k + m + 10^6/360f\ (\theta + \rho)$ where

- d is the delay in microseconds due to the character of the input pulse, the effect of the output pulse on the driven circuit and the delay caused by triggering characteristics within the circuit
- θ is the phase angle due to sine-wave oscillator phase shifter
- ρ is the total degrees of sine-wave oscillator duration between second and last pulses on sawtooth, (see Fig. 1 and 5.)
- f is the sine-wave oscillator frequency in cycles
- k is the additional delay, positive or negative, created by waveform distortion of the initial cycles following triggering of the sine-wave oscillator, (see Fig. 2 and 6.)
- m is the delay due to errors in the mechanical system

As shown in Fig. 2, the oscillator output is clean and harmonic free following the initial time t, and should have a total harmonic distortion of less than 1%. The sharp wave front caused by starting the sine wave creates a waveform distortion following the autosyn phase shifter that is not dissipated until after the first two cycles at least, also shown in Fig. 2. Depending upon the adjustment of the phase shifter, the total delay adjustment for delays less than the first two cycles will not have correct angular agreement and k will either be a plus or a minus value. A linear calibration cannot be made for delays appreciably less than 360 μsec, although the unit is capable of about a 30-μsec minimum delay. A variation in the phase balance of the 90-deg phase shifter by a value of 1 deg will create an error of ±0.4 μsec. For delays extending beyond the region of distortion shown in Fig. 2, k may be neglected.

Design Limitations

There are some obvious limitations to the arrangement as described. The method requires a very stable sine-wave oscillator and a faithful sine-wave phase shifter.[6] The method also requires a rigid means of developing pulses from the sine-wave oscillator which are phase locked to the sine-wave oscillator. Increasing the delay period accentuates these requirements.

A limitation is presented by the maximum amplitude of linear sawtooth that may be generated. This maximum amplitude determines the minimum sawtooth pulse spacing which may be accommodated on the sawtooth without danger of ambiguous pulse selection. This in turn determines the frequency of the sine-wave oscillator.

For the unit described here, the sine-wave oscillator operates at 8,076.2 cycles resulting in a voltage separation on the sawtooth of approximately 3.5 volts. This represents a peak sawtooth voltage of 3.5 × 40 or 140 for the maximum delay of 40 pulse spaces and is the condition for a delay of approximately 5,000 μsec. The delay is readily accomplished with miniature vacuum tubes and low supply voltages.

Sine-Wave Oscillator

The sine-wave oscillator shown in the circuit diagram is a pulsed Hartley type. It is rendered operative by removing the impedance of a cathode-follower-type clamp from across its tank circuit as soon as a reference input pulse is applied to the unit. The oscillator feedback network is adjusted to maintain a sine-wave oscillation at the peak direct voltage determined by the energy stored in the inductance at the time of release. The oscillator is made inoperative by replacing the oscillator clamp across it at the end of the delay period.

To obtain both short and long-term stability the oscillator is arranged to include a high-Q inductor, well shielded and rigidly mounted within a magnetic shield. Temperature compensation is provided. The 90-deg phase-shifter circuit is utilized primarily because it requires only one R and one C and is less critical to adjust.

The variable 0 to 360-deg phase shifter is the familiar autosyn.[6] Many phase shifters of this sort utilize a rotating capacitor.[5] By the use of the autosyn, a low impedance results at the sine-wave oscillator frequency plus relatively high-level operation. These characteristics are desirable in order to reduce the total tube requirements. The phase accuracy of the arrangement can be made to be of the order of 10 minutes.

Use of the Multiar

In order to phase-lock the pulses to the sine-wave output of the autosyn phase shifter, a form of multiar[7] is used. The multiar has the advantage of being regenerative for voltage increments of one sign and insensitive to those of opposite sign. This creates a situation where, as the sign of the voltage changes through zero, the circuit becomes immediately operative.

In the multiar circuit shown, the conduction which triggers V_{109} is obtained when the sine-wave input is going from positive to negative with respect to ground.

The method described performs well enough to be satisfactory. The multiar output pulse drives a conventional pulse generator which functions to maintain both a constant level output and a low-impedance pulse source to feed the pulses to the sawtooth generator.

The sawtooth generator utilizes a single feedback follower to provide a linear charging current for the sawtooth capacitor. The linearity resulting is of the order of one-tenth of one percent. Precision resistors and capacitors are used in the circuit.

A triode may be used instead of a selector diode. There is a greater stability in the cut-off characteristics of a biased diode which reduces the hazards of pulse skipping.

A second conventional parallel-triggered blocking oscillator type of pulse generator provides an output pulse. The pulse is shaped and made available as either a positive or negative pulse to feed a 90-ohm line.

To provide rigid synchronization of the triggered functions in the circuit, an Eccles-Jordan bistable type of biased multivibrator[8] is rendered conducting in one direction by the delay reference input pulse. This is referred to as a gate circuit and it remains conducting until one delay period has been completed. The output pulse resulting from the delay function triggers the Eccles-Jordan circuit back to its original position to await the next delay reference input pulse. The gate circuit control to the sine-wave oscillator and sawtooth is accomplished by means of a cathode follower to minimize loading effects on the gate circuit.

The smallest disturbance to any part of the circuit is likely to affect the stability and hence the accuracy. Since in order to operate and calibrate it is necessary to observe circuit functions, two follower tubes are built into the unit as nonloading test connections. The follower tubes allow examination of the sawtooth and the 8,076.2-kc derived blocking-oscillator output pulse.

Unit Construction

The chassis is mounted in a temperature-controlled oven so that all thermosensitive components associated with the accuracy of the delay are kept at a constant temperature. To improve the uniformity of component temperature, a small air circulator is incorporated within the oven.

The unit uses 16 miniature-type vacuum tubes and is arranged to provide complete accessibility as a relay rack-mounted unit.

The front panel hinges outward exposing first the vacuum tubes and adjustments. The component side of the chassis and the oven is available by hinging back the oven cover. Complete hinge-out of the chassis and dust cover makes the cable connectors accessible.

By utilizing a counter and suitable gearing, it is possible to arrange a means of directly reading the delay period to which the unit is adjusted. Accuracy of the reading depends upon the accuracy of the gearing between the counter indicator and the delay control shaft. The accuracy is excellent with precision gearing. The error curve for a 120-μsec section of the total delay range is shown superimposed upon the gear error in Fig. 3. The long-period cyclic gear error as indicated by the dotted line may be attributed to a large gear in the mechanical part of the system. The short-period cyclic error may be attributed to a smaller gear and other mechanical errors.

The linearity of the unit as a function of the position of the control shaft is degraded by the "run out" in the gearing driving the indicator but is a minor factor. By careful balancing of the 90-deg. phase shifter, the measured results shown in Fig. 6 may be obtained. Here, the gear-train error becomes predominant.

Remote Control

The unit may be operated remotely by a servo system comprising a coarse and fine autosyn system which is designed as an integral part of the unit. The error curve of Fig. 3 does not take into account the errors in the servo system. These errors must be added algebraically to the results obtained with direct control of the unit.

Units of the type described are applicable in radar ranging, navigation, propagation studies, coding, and other similar techniques. A novel application is the use of two such units to trigger each other to form a very stable pulse generator as shown in Fig. 4. In this arrangement the pulse output period is equal to $D_1 + D_2$ and may be varied by changing the period of either or both of the delays. It is necessary to start the action by causing either of the units to generate a pulse. If either of the units fail to deliver a pulse, the oscillation ceases. The probability of failure during normal operation is so remote as to be insignificant.

The successful development of the unit described is due to the contributing efforts of H. A. Straus, J. M. Miller, Jr., C. G. McMullen, E. C. Nunn, E. L. Gray, W. G. Chenoweth and G. M. Trinite.

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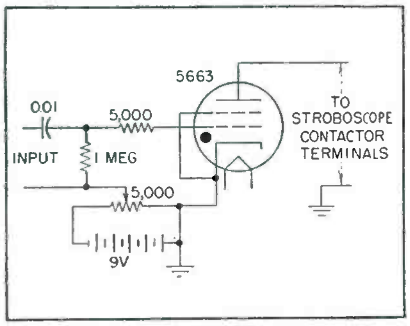

FIG. 1—Schematic of thyratron circuit

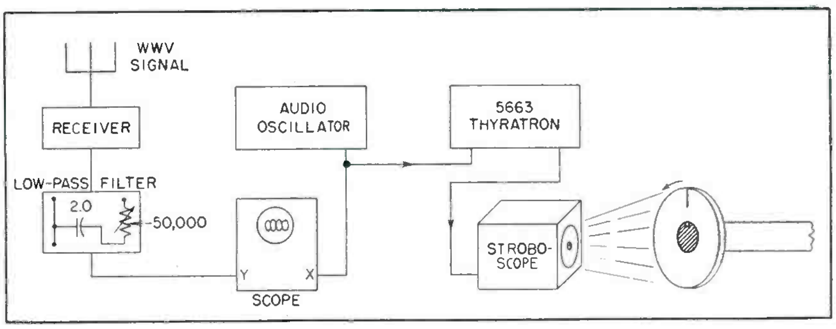

FIG. 2—Block diagram of synchronized stroboscope

Precision Measurement of Shaft Speeds

Accuracy within a fraction of one percent is obtained when measuring shaft speeds by use of 440-cycle tone from station WWV as standard. Audio oscillator is synchronized to submultiple of 440 cycles and used with thyratron to trigger stroboscope

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A RESEARCH PROJECT concerned with the design of exit nozzles in a hot-air heating system required the precision measurement of the speed of a cage-type fan providing the air pressure for the system. Measurements of the nozzle velocities were being conducted to a high degree of accuracy and long-time variations in the velocity were suspected as being due to the d-c motor-driven fan.

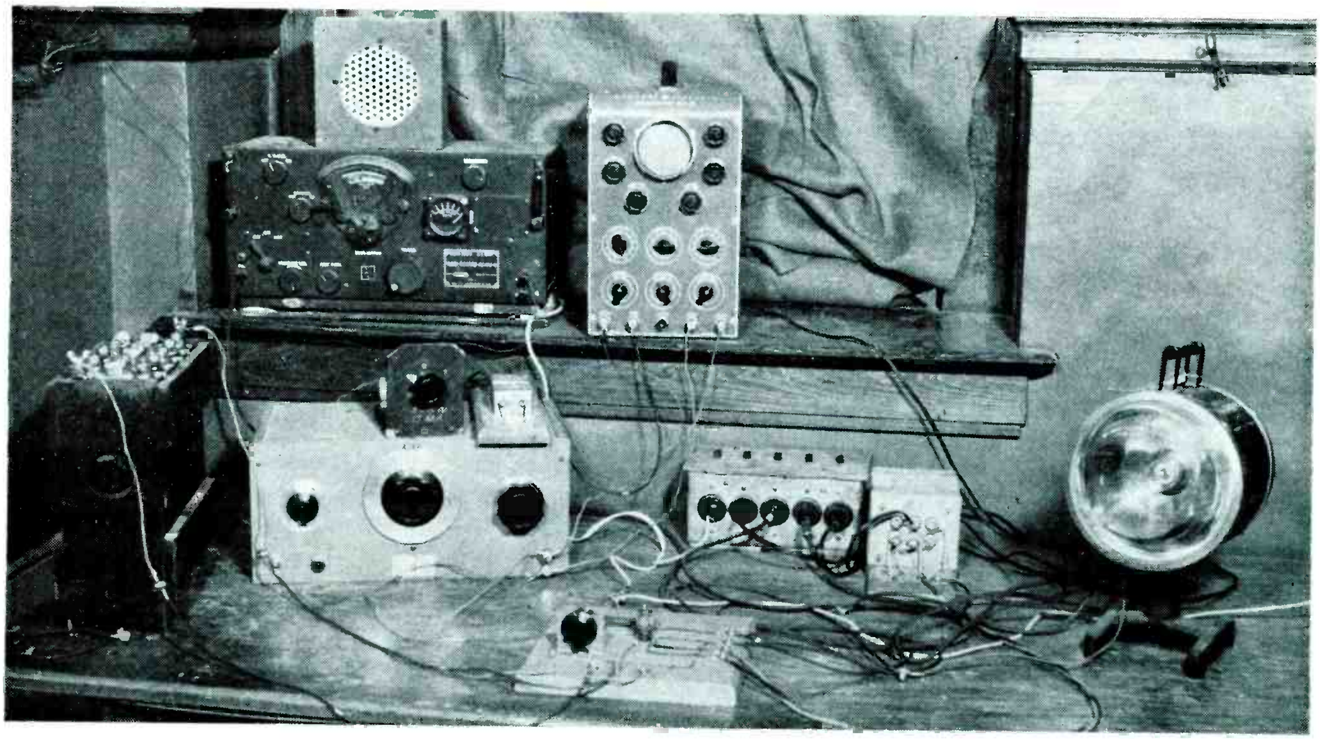
Ordinary integrating tachometers are averaging instruments by nature and were considered not suitable for high-accuracy shaft speed measurements or for disclosing the nature of any variation. The d-c generator type of tachometer cannot be more reliable than the meter readability or accuracy, therefore not much better than one percent. The ordinary stroboscope is not accurate to better than this; thus it appears that most conventional speed-measuring techniques are not suitable for high precision work.

Time Standard

A search for an accurate time standard with which to compare the unknown shaft speed indicated that the Bureau of Standards station WWV was the most convenient and accurate standard available. The 440 and 600-cycle audio tones transmitted on alternate 5-minute intervals are accurate to one part in 50 million.

The first attempt using WWV was to take the audio signal through a low-pass filter to a type 5663 thyratron, as shown in Fig. 1, and use the thyratron as a switch across the contactor terminals of a standard stroboscope. The flashing light of the stroboscope would then monitor a chalk mark on the fan pulley. An arbitrary adjustment of the d-c motor speed to obtain stationary chalk mark positions allows any drift in speed to be determined quickly.

The system as described has two faults: fading of the signal results in faulty firing of the stroboscope and the flashing rate is much greater than the shaft speed giving closely-spaced multiple images of the chalk mark on the fan pulley. For example, a 1,200-rpm pulley speed and a 600-cps flashing speed



Arrangement of equipment used for measuring shaft speed of a cage-type fan

would result in 30 chalk mark images on the wheel. This ambiguity makes reading difficult.

An audio oscillator and an oscilloscope were added to the system to overcome these two faults. The audio oscillator provides the flywheel effect during signal fading and the oscilloscope, through the medium of Lissajous figures, provides a convenient count-down system. The resulting circuit arrangement used is shown in Fig. 2. Here the receiver audio output signal is fed through the low-pass filter to the Y input of the scope, while the audio oscillator is used to drive the thyratron contactor control and the X input of the scope.

Operating Procedure

As an example of operation, the 440-cycle WWV tone is fed from the receiver to the oscilloscope and a 44-cycle signal comes from the audio oscillator. A 10 to 1 Lissajous pattern is obtained on the oscilloscope and is adjusted to stability by synchronizing the audio oscillator manually for the proper Lissajous ratio. The thyratron bias control is adjusted for best operation of the stroboscope. The stroboscope flashing rate is then 44 × 60 = 2,640 flashes per minute.

A pulley wheel rotating at 880 rpm will have three images of the peripheral chalk mark appearing at equal angular intervals. Assuming a speed change of 0.1 percent, the marks would creep 0.88 part of a revolution in one minute. The ability to keep the audio oscillator manually synchronized with the WWV tone should be much better than this. A frequency drift of one part in 4,400 is represented by the coincidence of wave crests of the Lissajous patterns at 10-second intervals. Manual adjustment within these limits is feasible with a stable audio oscillator; thus speed stability measurements and precise speed measurements are possible.

This system could be considerably simplified by the attachment of a small permanent bar magnet to the rotating pulley and the use of a coil of wire placed near the magnet path. This coil would have a pulse of voltage developed in it which could be applied directly to the scope Y input. The WWV audio tone could then be applied directly to the X input. The shaft speed would need to be 26,400 rpm for a pulse to appear on each complete excursion of the trace along the X axis. Should the shaft speed be 440 rpm, the pulse would appear only once in 60 traversals of the sweep. This limitation may be overcome by constructing a 60-tooth wheel and placing the pickup coil on a U-shaped magnet, the span of which is equal to the slot span of the toothed wheel.

Another system is to feed the coil pulse voltage to the Y plates in series with the 440-cps tone and establish a stable Lissajous pattern with 44 cps applied from the audio oscillator to the X plates. A drift of one rpm in pulley speed would cause the voltage pip to move three times around the X traversal per minute. Since the X sweep is actually moving at the rate of 2,640 traversals per minute and the pickup feeds in pulses at 880 ppm, there would be 3 traversals per pulse.

Interpolation

Interpolation of the speeds using these techniques may be done by allowing the chalk mark image to drift and timing the rate of drift with a stop watch over long enough intervals to minimize the operator error on the stop watch. This method is applicable to narrow speed ranges about those stable image values obtained as an integral submultiple of the 440 and 600-cycle tones.

R-F Amplifier for

By B. F. TYSON and J. G. WEISSMAN

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IN THE DESIGN of head-end tuners for television receivers, there are two important reasons why an r-f amplifier stage is usually included. The first reason is to improve the receiver's noise figure, or ability to pick up weak signals. The second is to isolate or shield the local oscillator from the antenna.

Tuners for the uhf band of 470 to 890 mc will probably employ crystal mixers which intrinsically have quite good noise performance. However, where the service range may be limited by low transmitter powers, small receiving antennas and inefficient transmission lines, an improvement in noise figure by the use of an r-f amplifier would be most welcome. Also, local oscillator excitation power required for optimum conversion in crystal mixers is relatively low, but the radiation might still be high enough to interfere seriously with other television receivers or other services.

Design of R-F Amplifier

In order to investigate these points and solve the circuit problems of covering the wide tuning range of the uhf band, an r-f amplifier using a Sylvania type 5768 disk-seal planar triode in a grounded-grid circuit was designed and built. The physical construction of this tube, shown in Fig. 1A, results in extremely low lead inductances and interelectrode capacitances. The grid connection at the center is in the form of a disk or flange completely encircling the tube, so that a low-impedance connection to ground may be made and the shielding between input and output maintained. The cathode and plate leads on either end are 0.2-inch-diameter rods which continue right in through the glass, coming up close to the flat mesh grid. The ends of the rods act as the effective cathode and plate surfaces. The grid-cathode input capacitance and the grid-plate output capacitance are only slightly over 1 $\mu\mu$f each and the plate-cathode capacitance has a maximum value of 0.015 $\mu\mu$f. The tube also features high g_m and low power consumption. A g_m of 6,500 micromhos is obtained with 8 ma of plate current. The low plate-cathode capacitance and high g_m, together with the high mu of 100, are all desirable characteristics for grounded-grid amplifier operation.

The small physical size of the 5768 and its double-ended construction make it readily adaptable to concentric line circuitry. Operation at frequencies as high as 2,500 or 3,000 mc is possible, so a relatively simple circuit arrangement is capable of producing good results in the 470 to 890 mc range.

First, let us look at the input impedance of the tube under the conditions shown in the simplified circuit of Fig. 1B. Assuming the output load impedance Z_L equal to the plate resistance, and neglecting loading due to transit time, the input admittance is given by:

$$Y_{in} = \frac{g_m}{2} + j\omega\left(C_{gk} - \frac{\mu}{2}\,C_{pk}\right)$$

Substituting the values of g_m = 6,500 micromhos, μ = 100, C_{gk} = 1.6 $\mu\mu$f, and C_{pk} = 0.015 $\mu\mu$f, and taking a frequency of 700 mc near the middle of the uhf band gives an input admittance of 5 /50° millimhos. Here C_{gk} is assumed slightly higher than the rated value to allow for the unavoidable increase due to stray capacitance. The input impedance is therefore 200 ohms at a phase angle of −50°. This impedance is so low that it was decided to feed the cathode input directly from the 50-ohm antenna transmission line. The resulting mismatch loss is quite low, between 1 and 2 db. With a direct input connection, the mechanical complexities of providing a tuned input matching transformer are avoided without appreciable loss.

The input circuit is untuned, as shown in the complete amplifier circuit diagram of Fig. 1C. The input blocking capacitor and the heater and cathode bypass capacitors are all 100-$\mu\mu$f mica buttons. The cathode and heater feed chokes

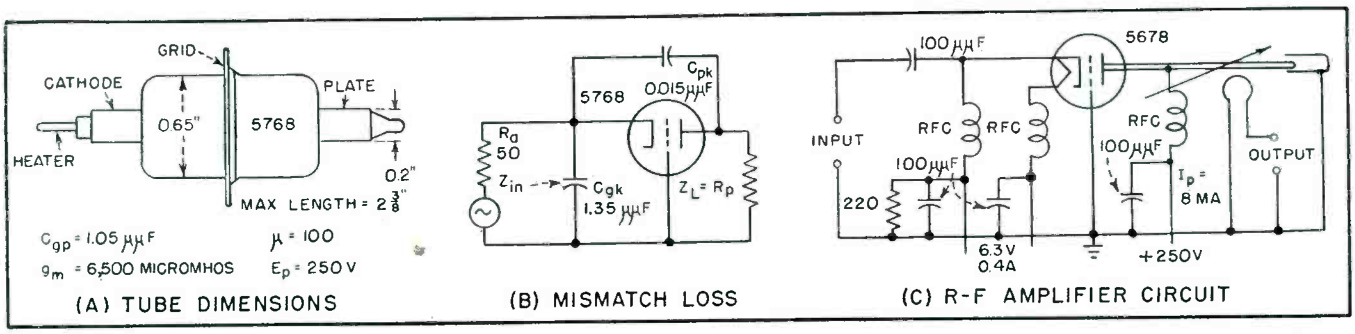
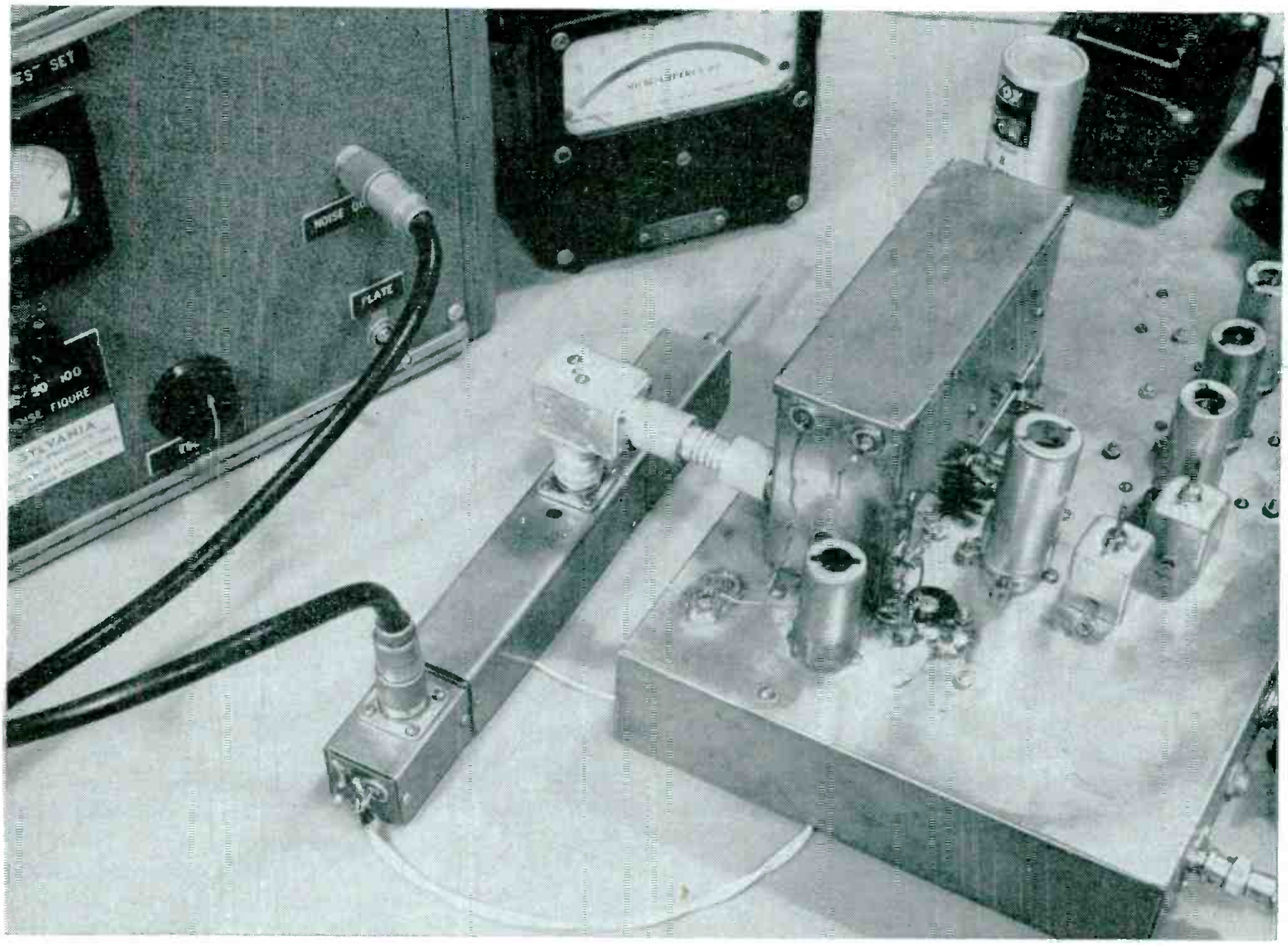


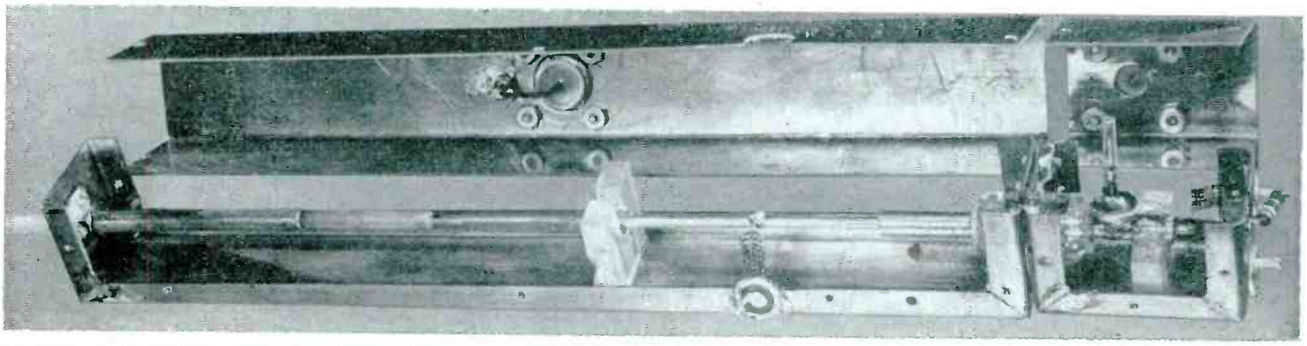
FIG. 1—Dimensions of Sylvania type 5768 triode, simplified circuit used in measuring its input mismatch loss, and circuit of r-f amplifier using tube for uhf television

UHF Television Tuners

Design and performance of concentric-line r-f amplifier circuit using disk-seal planar triode with grounded grid. Ahead of typical crystal mixer, amplifier gives gain of 12.5 db over entire uhf range of 470 to 890 mc, improves overall noise figure by 3 to 4 db and reduces radiated local oscillator power 500 times. Chief drawback is high cost of tube



Setup used to measure noise figure of amplifier. Noise generator, feeding into amplifier, is at upper left; output of amplifier feeds into crystal mixer and i-f amplifier at right, which also provides operating voltages



Complete concentric-line uhf r-f amplifier, with covers lifted off to show inner construction. Tuning push-rod is at left; input jack is on small cover at right; output jack with coupling loop is on longer cover are 7 turns of No. 22F wire wound ⅛ inch in diameter and ½ inch long.

In the plate circuit of the amplifier, a half-wave type of concentric line is used as the tuning element. Since the gain-bandwidth product of an amplifier is limited by total circuit capacitance and the capacitance of a concentric line varies inversely with its characteristic impedance, the impedance of the line is made as high as physically possible. The highest practical ratio of outer-conductor effective diameter to inner-conductor diameter is about 9 to 1, giving a line impedance of approximately 130 ohms.

Tuning of the line over the band is achieved by sliding a movable telescoping section of the inner conductor into a fixed hollow section connected to the plate rod. The amount of fixed line external to the tube is determined by the highest desired frequency of 890 mc. This external length is not a full half-wavelength at 890 mc because of the equivalent length of line within the tube itself. The length of the plate rod of the tube itself is approximately 2.8 cm. For a line impedance of 130 ohms the grid-plate output capacitance of 1.05 $\mu\mu$f corresponds to a line length of 3.5 cm. At 890 mc a half-wavelength equals 16.8 cm. Subtracting the 6.3 cm due to the tube leaves an external length of 10.5 cm available for the telescopic tuning action.

The lowest tunable frequency is determined by the line length at full extension of the telescoping section. Allowing ½ cm of overlap, there are 20.5 cm of line external to the tube, plus 6.3 cm in the tube, or a total of 26.8 cm. A half-wave line this long resonates at 560 mc and the lower frequency limit of 470 mc has not been reached. To overcome this difficulty, a small length of grounded tubing was arranged so that the sliding inner conductor forms a cylindrical capacitor with it at the low-frequency end of the range. This capacitive loading extends the coverage down to 470 mc.

Construction Details

The physical construction of the amplifier is shown in Fig. 2. The tube is mounted with its grid disk firmly grounded between the ends of the input and output shield boxes. The cathode input connections are made as short as possible. One side of the input blocking capacitor is soldered directly to the cathode connector, while the other side carries the center pin of the type N input jack. The long shield box acts as the outer conductor of the plate circuit tuning line. The fixed portion of the line is supported by a small insulating block near the output jack. The movable portion is driven by an insulated push rod. The ground side of the low-frequency loading capacitor is soldered to the end shield plate. The plate circuit r-f choke is connected to the tuning line at the point of minimum voltage for the center of the range. This results in least disturbance to the plate circuit. The choke is the same as those used in the cathode circuit, and the bypass capacitor is another 100-$\mu\mu$f mica button.

Gain and Bandwidth

Output power is taken from this amplifier at an impedance level of 50 ohms by means of a small loop coupled to the tuned line. The magnetic field intensity along the length of a half-wave resonator varies sinusoidally, rising to a maximum at a quarter-wavelength from the open ends. Loop coupling is essentially electromagnetic so that the amount of coupling is a function of the position of the loop along the line. Maximum coupling occurs at the region of maximum field intensity, resulting in greatest amplifier bandwidth at this point. This is not necessarily the point of maximum gain, which only occurs when the output impedance of the tube is matched. These effects were explored at several frequencies in the band by cutting a longitudinal slot in the outer conductor of the line so that the position of the loop could be varied.

The curves of Fig. 3 show how the amplifier's gain and bandwidth depend on the loop position. Examination of the 700-mc bandwidth curve, for example, shows that the

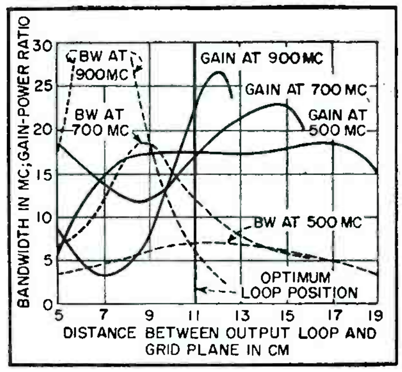


FIG. 3—Effect of output loop position on gain and bandwidth

bandwidth increases to a maximum of 17.5 mc with the loop about 8.5 cm from the grid plane and then falls off again. The point of maximum bandwidth at 8.5 cm is the maximum coupling point for 700 mc, but the gain curve shows that the 8.5-cm point gives the lowest gain. The gain rises on either side, reaching a maximum when the loop position is about 14.5 cm from the grid plane. This is the point where the tube impedance is matched, while the 8.5-cm point is actually the point of greatest mismatch. The curves at other frequencies show similar effects except that the gain and bandwidth maxima and minima come at different loop positions because of the change of wavelength.

Observation of the variation in gain and bandwidth with loop position at different frequencies throughout the uhf band enables one to choose the best fixed position of the loop. If the loop is placed 11 cm from the grid plane, the bandwidth is 7 mc at 500 mc, rises to

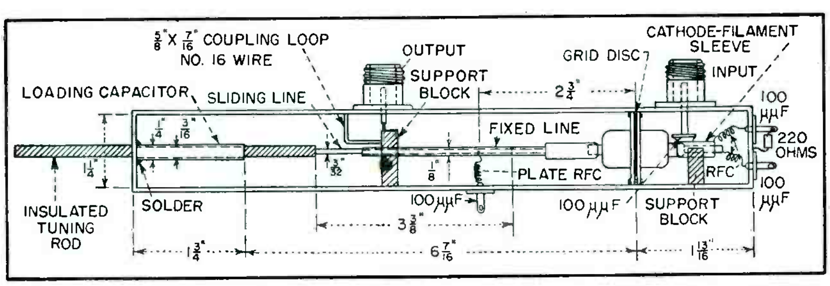


FIG. 2—Construction details of grounded grid r-f amplifier for 470 to 890-mc tv band

12 mc at 700 mc, and then decreases again to 6 mc at 900 mc. The corresponding power gains are fairly constant, ranging between 17 and 23 times. Any other choice of a fixed coupling position would result in greater departures from uniformity of either gain or bandwidth over the tuning range.

The table in Fig. 4 lists the final measurements of gain and bandwidth with the coupling loop fixed at 11 cm from the grid plane. The gain is quite constant in the neighborhood of 12.5 db, with the 3-db bandwidth ranging between 6 and 12 mc.

FREQUENCY IN MC	GAIN		BANDWIDTH IN MC	NF_{12} DB	NF_1 DB
	POWER RATIO	DB			
500	17.5	12.4	7.0	11.0	10.3
600	16.5	12.2	10.3	11.1	10.4
700	17.0	12.3	12.0	11.4	10.8
800	19.0	12.8	10.6	11.5	11.0
900	23.0	13.6	6.0	11.6	11.2

$$NF_{12} = NF_1 + \frac{NF_2 - 1}{G_1} \; ; \; NF_2 = 15 \text{ DB}$$

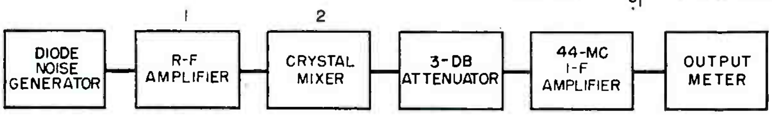


FIG. 4—Performance data for amplifier, and circuit arrangement used for obtaining noise figure data

Noise Figure

The noise figure of this amplifier was measured at several frequencies in the uhf band by the setup shown in Fig. 4. The amplifier feeds a crystal mixer which is followed by a 3-db attenuator, a 44-mc i-f amplifier and an output meter. The crystal mixer section also includes a local oscillator and a cascode-connected i-f preamplifier. To measure the overall noise figure, NF_{12}, the diode noise generator at the input is turned off, the 3-db pad is switched out of circuit and the noise output observed on the output meter. The 3-db pad is now switched in and the noise input from the generator increased until the same output reading is obtained. This means that the generator is producing noise equal to that of the apparatus under test. The ratio of this noise to that produced in the 50-ohm antenna resistance gives the noise figure. The measured overall noise figures range between 11.0 and 11.6 db across the uhf band.

The noise figure of the mixer used in these tests was measured by the method outlined above and found to be 15 db. Therefore, use of the r-f amplifier gave an improvement of 3.4 to 4 db over the noise figure of the mixer alone.

The equation under the block diagram gives the overall noise figure of two networks in cascade in terms of their individual noise figures and the gain of the first. In the case discussed here, the amplifier is the first network and the mixer is the second network. Having measured the overall noise figure NF_{12}, the noise figure of the mixer NF_2 and the amplifier gain G_1, it is possible to compute the noise figure NF_1 of the amplifier alone. The computed values of NF_1 range between 10.3 and 11.2 db over the band.

Oscillator Radiation

An attempt was made to measure the local oscillator power coming out of the antenna terminal of the amplifier in the same setup which was used for noise measurements. However, the level was so low that reliable measurements could not be obtained. Another method was tried, with the r-f amplifier turned around and inserted between a c-w signal generator and a uhf receiver. The signal generator output simulates the local oscillator power entering the plate circuit side of the amplifier. The uhf receiver picks up the simulated local oscillator power which gets through the amplifier, and an output meter indicates the strength of the signal. A 6-db pad was used ahead of the uhf receiver to smooth out any impedance irregularities in its input. In the tests, the amplifier plate circuit was tuned to the generator frequency so the attenuation measured is that due to the shielding effect of the tube alone. Under those conditions, the measured reduction in local oscillator feed-through is 500 times in power or 27 db. The measured values were about the same throughout the entire band.

It is interesting to estimate the local oscillator radiation field strength from a receiver using this r-f amplifier. Assume that 1 milliwatt of local oscillator power is available to the plate circuit of the amplifier and that the oscillator runs at 44 mc above the signal frequency. At a frequency of 700 mc near the center of the uhf band, the amplifier 3-db bandwidth is 12 mc. Therefore, at 44 mc off resonance, the circuit selectivity will introduce about 17 db attenuation to the local oscillator. This, added to the 27 db due to the shielding effect of the tube, makes a total of 44 db. The power available for radiation is therefore 44 db below 1 milliwatt or 0.04 microwatt. Assuming that there are no other radiation paths from the local oscillator and that there is no attenuation in the antenna line, a half-wave dipole radiating 0.04 microwatt in free space would create a field strength of 45 microvolts per meter at a distance of 100 ft.

Conclusions

The r-f amplifier described uses a tube type which may be too costly for application in competitive receiver designs. However, the results obtained show the possibilities of improving tuner performance in the uhf television band. Use of this amplifier ahead of a typical crystal mixer improves the overall noise figure by 3 to 4 db and reduces the radiated local oscillator power by 500 times. Circuit design techniques have been presented which are simple and straightforward and should prove useful in future work.

Miniature Traveling-Wave Tube

Gain per unit length and noise figures are good for miniature broad-band amplifier tubes operating at frequencies between 100 and 1,000 mc. Operating voltages and currents are no larger than those required for other small tubes

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THE TRAVELING-WAVE tube to be described is a wide-band low-noise low-level exponential amplifier for frequencies between 100 and 1,000 megacycles. The tube stands midway between conventional miniature tubes used at the lower end of this frequency range and traveling-wave tubes built for much higher frequencies.

Perhaps the most powerful tool for controlling electrons is the old-fashioned grid; it seems promising to use this well-known mechanism in traveling-wave tubes. This paper describes one possible approach.

Tube Constructions

The arrangement shown in Fig. 1 is a model in which the various functions are neatly separated; it is not a practical tube. Two helices are shown. One helix is wound around a cathode so that one of its surfaces acts like a control grid; the other one forms an anode. The two helices are so thoroughly coupled with each other that they constitute two parallel branches of a single transmission line. This is indicated in Fig. 1 by the four coupling capacitances between corresponding points on the two helices. Actually, these capacitances should be uniformly distributed and very large so that no potential difference can exist across them.

A generator on the left sends a wave traveling along both helices simultaneously toward a load on the right. Corresponding points on the two helices are in phase with each other; the cathode serves as ground return.

Electrons leave the cathode in accordance with the instantaneous potential distribution along the grid helix. If the frequency is so low that electron transit time can be neglected, each short section of the tube acts like a triode with feedback directly from plate to grid. A resistance load appears between the helices and ground and the signal is attenuated. This remains true if generator and load are interchanged. For low frequencies, the tube merely acts like a lossy transmission line.

If the frequency is increased until the electron transit angle becomes one-half cycle and the electron trajectories are kept straight, then in each short section of the tube, the half-cycle transit time reverses the phase of the feedback. A negative resistance load appears everywhere. Again, interchanging generator and load has no effect. The tube has a negative attenuation constant in both directions and becomes unstable.

But now let the electron trajectories be deflected toward the left in the manner shown in Fig. 1. This is done by a magnetic field perpendicular to the plane of the paper. The amount of deflection is chosen so that for a wave traveling from right to left, an electron leaving the cathode while a positive voltage peak passes through the

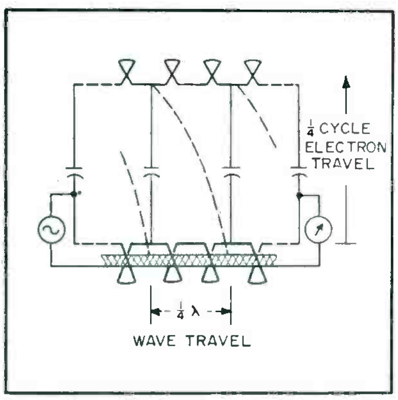


FIG. 1—Schematic diagram of a theoretical tube

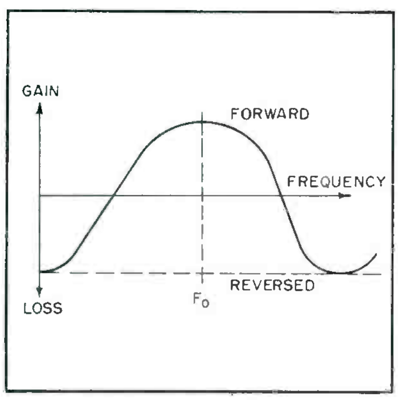


FIG. 2—Gain-loss characteristics for tube of Fig. 1

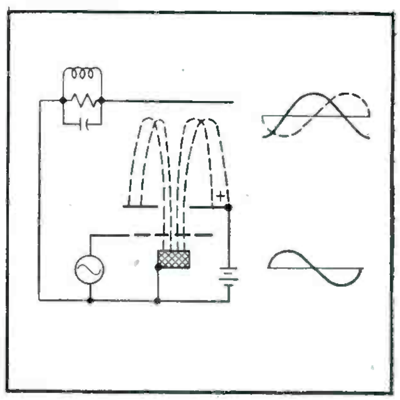
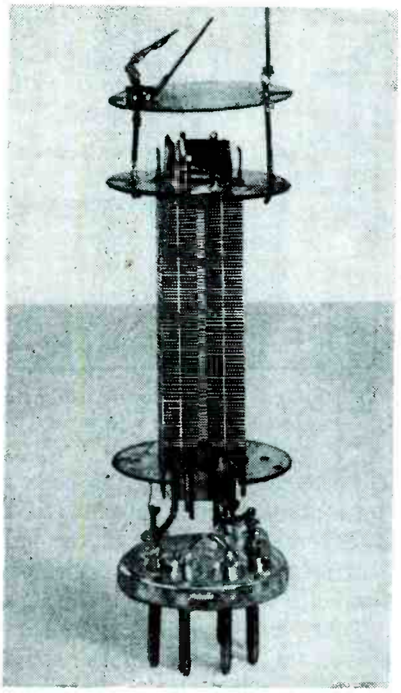
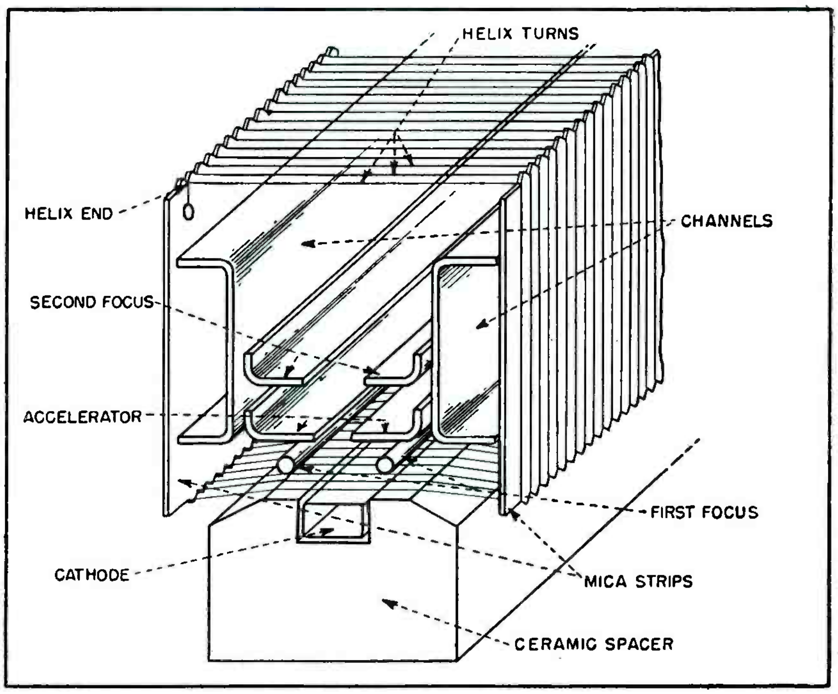


FIG. 3—Setup for measuring space-charge coupling



In the miniature traveling-wave tube, uhf signals enter through button base, travel through helix to the top



Cross-sectional view of the construction of the miniature traveling-wave tube. Tube is true traveling-wave type in which energy is carried from input to output along a transmission line with the signal increasing exponentially along the way

grid helix next to it, will rejoin the same positive peak upon reaching the anode helix.

For waves traveling from right to left, the bend in the electron trajectories wipes out the effect of transit time. No matter what the frequency, the point on the anode helix where an electron lands has the same phase which its take-off point under the grid helix had. The phase shift caused by the finite speed of wave travel cancels the phase shift caused by electron transit time. Each section acts like a triode with feedback from plate to grid. The resulting attenuation remains the same irrespective of frequency.

The case is different for wave travel from left to right. With the electrons swerving against the direction of wave travel, the two phase shifts no longer cancel; instead, they add up. At a frequency where it takes the electrons one-quarter cycle to reach the anode helix, the point where they land is one-quarter wavelength closer to the generator. The phase at that point is one-half cycle different from what it was on the grid helix at take-off. A negative resistance load now appears across each section of the tube, producing gain for signals traveling from left to right.

Gain Considerations

Full gain is only obtained for the frequency at which the two phase shifts—electron transit and wave travel—add up to one-half cycle. At other frequencies, the phase angle of the apparent feedback in each short section varies in proportion. Fig. 2 illustrates the resulting performance. The maximum forward gain is numerically equal to the constant loss in the reverse direction. There is no need for additional damping to insure stability.

The gain per unit length at the optimum frequency may be found as follows: The apparent resistance between line and ground is one-half the characteristic impedance Z_o. The voltage increase in a short section of transconductance Δg_m is thus $\frac{1}{2}Z_o\Delta g_m$. Over many such sections the voltage increases exponentially; the voltage gain is $e = 2.718$ or 8.6 db over a length for which $\frac{1}{2}Z_o g_m$ is unity. The gain of the entire tube is $4.3Z_o g_m(db)$, where g_m indicates the total transconductance.

A g_m of 1,000 micromho per cm length is not unusual and a helix with turns closely spaced to make a good control grid may have $Z_o = 1,000$ ohms. Therefore, gains of the order of 4 db per cm or 10 db per inch may be expected. Much higher gain is possible if a higher g_m per unit length is assumed.

It was mentioned before that the double-helix model of Fig. 1 does not represent a practical tube. This is true because when waves travel along a pair of mutually inter-coupled helices, two separate modes of wave propagation appear.[1] They may be described as the push-pull and in-phase modes. Here, the interest is in the in-phase mode. Unfortunately, the push-pull mode also exists on the same helices and analysis shows that it would tend to render the tube unstable.

Two separate helices were needed because a grid and an anode must carry different d-c potentials. If a mechanism were available which would permit the same potential on control grid and receptor electrode, a single helix could be used for both functions. Fortunately, such a mechanism does exist; it reaches its greatest efficiency in the range of a few hundred megacycles. It is the effect known as space-charge coupling.

Figure 3 shows how this effect can be observed with a simple

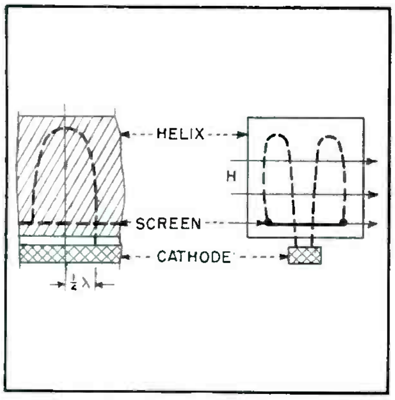


FIG. 4—Two sections through an early model of a traveling-wave tube

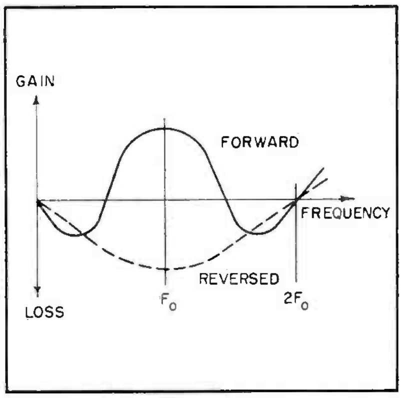


FIG. 5—Gain-loss characteristics for tube of Fig. 4

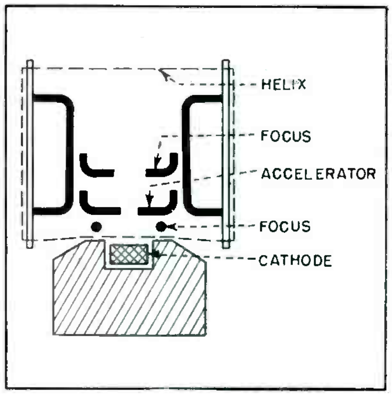


FIG. 6—Tube construction virtually free from parasitic effects

tetrode. An electron stream leaves the cathode, is subjected to intensity control by the first grid, accelerated by a positive electrode which may be a screen or, better, a solid plate with an opening for the beam, and then again retarded by a receptor electrode at cathode potential. After approaching the receptor electrode, the electrons turn around and are eventually absorbed by the positive electrode.

In the vicinity of the receptor electrode a concentrated negative space charge is set up which varies in accordance with the signal voltage on the control grid. Electrostatic induction generates a corresponding charge in the receptor electrode and a charging current flows through the tuned load circuit back to the cathode.

The charging current increases with frequency and reaches a maximum when the electron transit angle from the positive electrode to the receptor electrode is 180 deg. The transconductance for space charge coupling is then slightly higher than the conventional transconductance, measured with the receptor electrode strongly positive.

A 90-degree phase advance is the trade mark of space charge coupling; it is maintained at all frequencies. To match the output phase of a triode amplifier with a 90-deg transit angle, a space-charge coupled amplifier must have a 180-deg transit angle. A substantial part of the total transit time may be taken up by the trip from the positive electrode to the receptor electrode, so that the condition for optimum transconductance is almost realized.

Figure 4 shows two sections through an early model of a traveling-wave tube designed to utilize space-charge coupling in a single helix. The helix is wound on a frame of square cross section in such a manner that its top and bottom surfaces remain exposed. The bottom surface forms the control grid; the cathode runs alongside below this surface. A simple flat screen grid is positioned inside the helix. Electrons pass through grid and screen, approach the top surface of the helix which acts as the receptor electrode of a space-charge coupled amplifier, and finally return to the screen.

A weak magnetic field is directed across the tube to deflect the electron trajectories. The effect of the field is best visible on the left in Fig. 4.

The electron paths are so bent that at the frequency for which the transit angle is an optimum—180 deg from cathode to receptor electrode—the displacement of the turning point from the starting point corresponds to one-quarter wavelength. With these relations, maximum gain is obtained for wave travel from left to right; simultaneously, a corresponding loss appears for waves traveling in the opposite direction.

Gain-Loss Curves

Figure 5 shows gain-loss curves for such a tube. Compared to Fig. 2, the useful band is narrowed. At low frequencies, both forward gain and reverse loss vanish. At frequencies above twice the design frequency, gain seems to exist in both directions so that one might expect instability. In practice, factors arise which prevent oscillation. The wavelength along the helix becomes too short compared to the transverse dimensions of the helix. Scattering of electron trajectories also helps to destroy undesired gain.

Tubes built according to Fig. 4 proved the existence of the sought-for effect. They also showed a wide variety of parasitic phenomena, traceable to the poor accuracy with which electron paths were defined. The two trajectories shown on the right in Fig. 4 may be highly desirable but many others are possible. A large number of electrons pass the screen again on their return trip, induce signals on the grid and some may even go back and forth several times.

Experience gained in the development of the gated-beam tube had shown that multiple return trips can be almost entirely eliminated if the screen is replaced by a solid electrode with a narrow slot through which an electron sheet is focused. This approach led to a tube virtually free from parasitic effects, shown in section in Fig. 6.

This is an experimental construction. Two auxiliary focusing electrodes are used to provide maximum freedom of adjustment. The first focusing electrode, formed by two parallel wires located closely adjacent to the grid surface, is held negative in order to direct the entire beam through the narrow slot in the accelerator. The second focusing electrode, a wider slot, is strongly positive. It accepts the bulk of the return current. The outgoing beam misses it completely. The two channels, supporting mica strips on which the helix is wound, are operated slightly positive.

In the range from 300 to 400 mc,

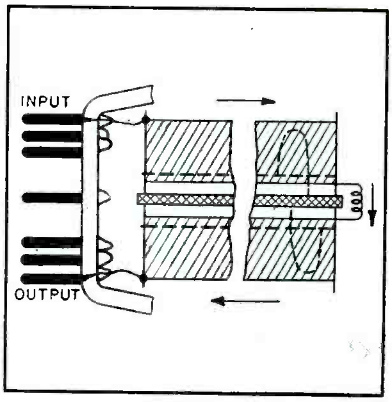


FIG. 7—Single-ended version of miniature traveling-wave tube

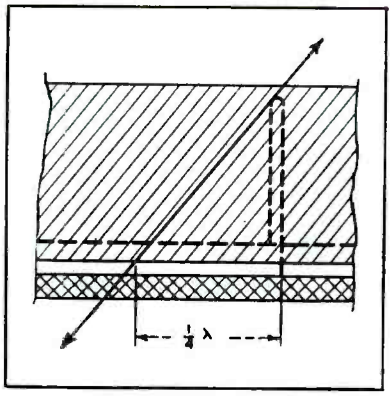


FIG. 8—Drawing of a tilted helix form of traveling-wave tube

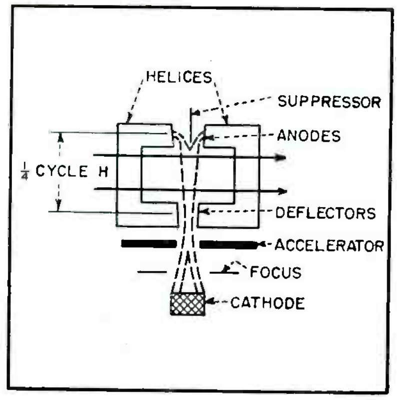


FIG. 9—Cross section of a beam-deflection system for tube

such tubes give gain of the order of 6 to 8 db over a band 40-mc wide and some gain over about 100 mc. With such short tubes, the gain is hardly high enough to be useful. The tubes are strictly of experimental value.

To operate in this frequency range, 100 to 150 volts are applied to accelerator and second focus. The combined drain of the electrodes is about 4 ma for a tube with 2-cm active length. For longer tubes, proportionately more current is needed, at the rate of ½ ma per db maximum gain. The transverse magnetic field is only about 10 to 15 gauss.

The magnetic field intensity required depends on the dimensions of the tube but not on the frequency for which operating voltages are selected. This comes about because the electron transit time across the helix and the amount of deflection produced by a fixed magnetic field both vary the same way—with the inverse square root of the potential.

With tubes providing about 8 db of gain, followed by a triode mixer, noise figures of 10 and 12 db have been measured at 320 and 370 mc. It is interesting to note that the helices in these tubes had 100 turns per inch. It would be rather difficult to obtain noise figures of the same order in conventional triodes with such coarse grids.

Other Tube Forms

It may be of interest to review some alternative forms of the tube. Figure 7 shows a single-ended version in which both sides of the cathode are used, so that the active length of the tube is doubled. Because the electrons in the two helices travel in opposite directions, a transverse magnet field of proper polarity produces gain from left to right in one helix and from right to left in the other. With this construction, at least 20 db of gain can probably be obtained in a single-ended miniature tube. The frequency response might be flattened by making the two halves slightly different (stagger-tuning).

Figure 8 shows a form of the tube in which the tilt of the electron trajectories is replaced by an opposite tilt in the turns of the helix. The double arrow indicates the position of one turn. The principle of operation remains unchanged. The design is of interest because it requires no magnet field to develop directional properties. It bears a superficial resemblance to tubes described by L. M. Field early in 1950[2]. The mode of operation, however, is quite different and the two types should not be confused.

The combination of grid control and space-charge coupling is not the only known means for operating a control element and a receptor element at a common d-c potential. Another combination consists of a pair of beam-deflector electrodes followed by a pair of push-pull anodes, both pairs operating at a common positive potential. The transconductance of a beam-deflection system is inferior to that of a grid but a factor of two, gained from push-pull operation, makes up for part of the loss. Application of this principle leads to surprisingly simple designs as shown in Fig. 9 and 10. Such tubes have been built successfully. Because of their inherently low gain, their value remains in doubt.

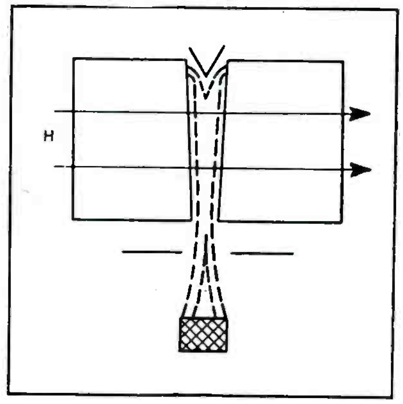
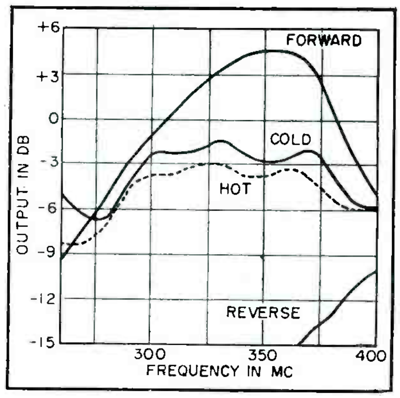


FIG. 10—Simplified version of the tube shown in Fig. 9



Measured transmission characteristics for typical adjustment of tube. Curve marked cold shows imperfections of termination, curve marked hot is with tube biased off, forward curve is normal operation and reverse curve is for normal operation with magnetic field reversed

Thanks are due to E. C. Ewing for intricate experimental models and to J. G. Spracklen for measuring equipment and measurements.

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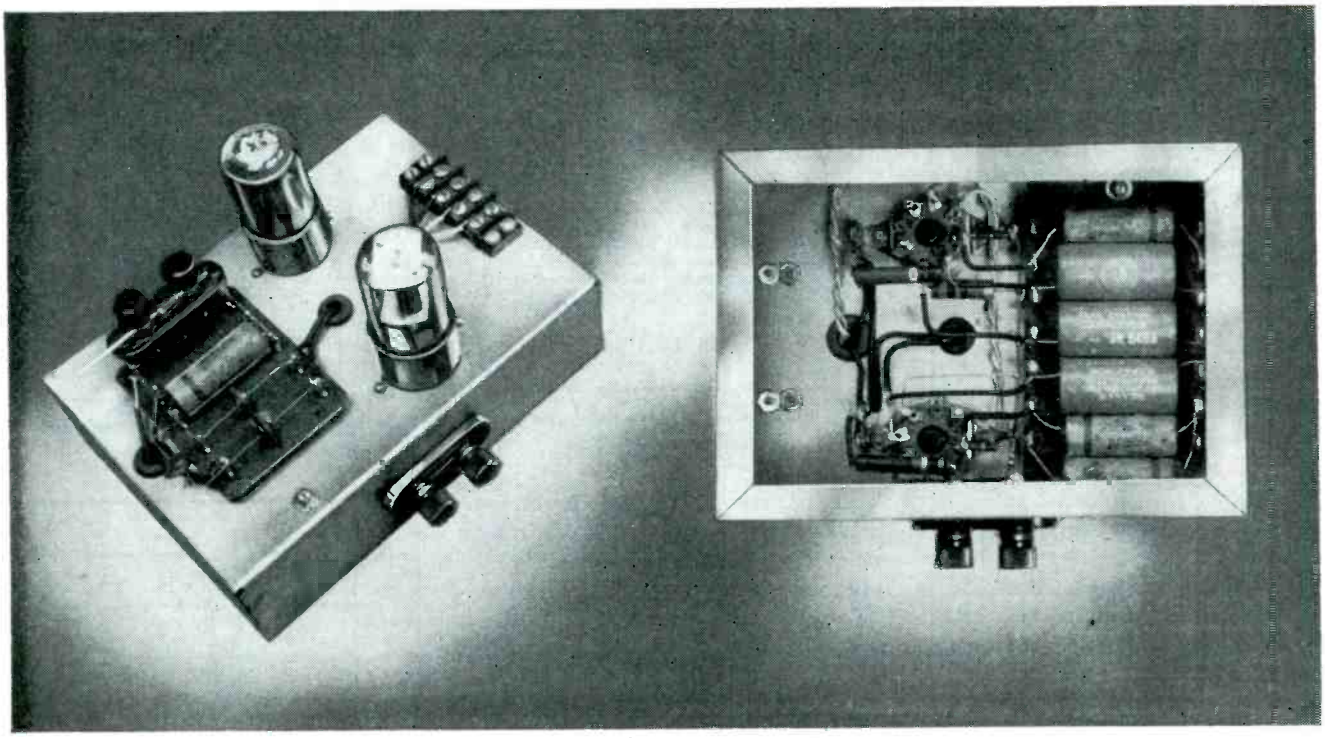

Experimental oscillator chassis. Top view shows Thyrite resistor network mounted on strip with thermistor between binding posts

Wide-Range Sweeping Oscillator

Wobbled audio output or variable single tone is obtained over a 20-to-1 frequency range by means of Thyrite or Varistor elements in a modified Wien-bridge circuit. A thermistor stabilizes bridge amplitude

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The variable-frequency audio oscillator described uses a modified Wien network with silicon carbide nonohmic resistors as part of the frequency-determining element. By controlling direct current through the nonlinear resistors the frequency of oscillation can be varied through a range of better than 20 to 1. A nonlinear thermistor element in the bridge stabilizes the amplitude of oscillation and insures good sinusoidal waveform. Although the equipment was designed for telemetering, it can be applied wherever large frequency deviations are required.

A number of articles [1, 2, 3] have described various methods, most of which are incapable of large deviations or lack amplitude stabilization. Without amplitude control poor waveform may result, because distortion will adjust the loop gain to unity. Vacuum tubes have been used as variable-impedance elements but do not allow simple circuit configurations and are limited in the range of nonlinearity.

Basically all schemes consist of an amplifier, feeding back regeneratively through a variable phase-shift network. The circuit oscillates at a frequency at which the loop phase shift is zero and the loop amplification is unity. The phase shift network must be modulated so as to vary the phase shift and so the frequency. Since the phase-shift network may also change its attenuation with frequency, the loop gain will have to readjust itself automatically. The phase-shift network described is found to have

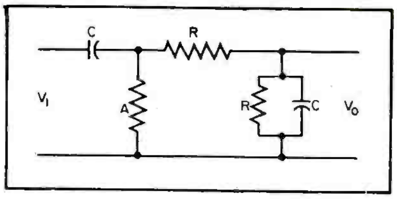

FIG. 1—Modified Wien phase-shift network used for frequency control

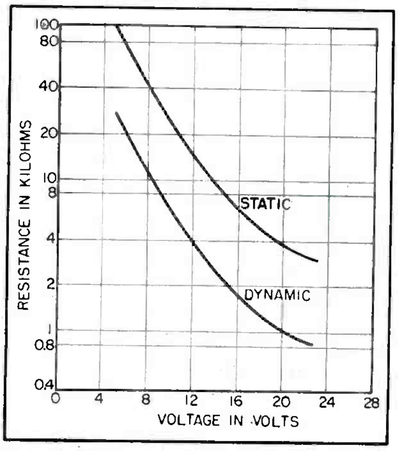

FIG. 2—Static and dynamic resistance as a function of voltage for GE 8399401G1 Thyrite

a constant attenuation and is readily phase modulated.

Phase-Shift Network

Figure 1 is the a-c equivalent of the phase-shift network used. Resistor A is necessary for modulation purposes and resistors R are actually silicon-carbide nonohmic resistors called Thyrite by General Electric and Varistor by Western Electric[4]. The frequency at which the network produces zero phase shift is

$$\omega_0 = \frac{1}{RC}\left(1 + \frac{2R}{A}\right)^{\frac{1}{2}} \qquad (1)$$

and the voltage attenuation at this point is

$$\frac{V_0}{V_1} = \frac{1}{3 + R/A} \qquad (2)$$

The modulating resistor A will change the attenuation as R changes; the minimum attenuation is $\frac{1}{3}$. Since R has a usable upper limit the presence of A increases the lowest frequency obtainable. These limitations can be eliminated by making A another Thyrite element identical to the other two. The equations are then

$$\omega_0 = \sqrt{3}/RC \qquad (3)$$

and

$$V_0/V_1 = 1/4 \qquad (4)$$

The frequency varies inversely with R and the attenuation is a constant of 0.25 providing the individual Thyrite elements track one another.

The resistance R is actually the dynamic resistance at the static operating point for the Thyrite. Although the dynamic resistance changes with voltages, keeping the phase-shift network at a low voltage amplitude point in the feedback loop minimizes the harmonic generation. Thyrite is a voltage sensitive nonlinear element. Its volt-ampere characteristic is very closely of the form

$$V = kI^n \qquad (5)$$

where n is generally between 0.2 and 0.4. The static resistance is

$$R_s = V/I = kI^{n-1} \qquad (6)$$

and the dynamic resistance or slope of the volt-ampere characteristic is

$$R_d = dV/dI = knI^{n-1} = nR_s \qquad (7)$$

It can be seen that the dynamic resistance is n times the static resistance. The dynamic resistance is the resistance to be used in the frequency equations since it represents the a-c impedance at the operating point. Figure 2 is a plot of the experimentally-determined static and calculated dynamic resistance as a function of d-c voltage. For the Thyrite used (GE 8399401-G1) the static characteristic was very closely $V = 80\ I^{0.27}$. An applied voltage of 20 volts will dissipate the rated power of 0.1 watt and it would appear that the usable dynamic resistances can vary from 1,000 ohms up to infinity. Actually because of the modulation scheme the maximum voltage was about 16 volts and the minimum 2 volts. Two volts corresponds to a current of about 4 microamperes flowing through the Thyrite (R_d = 130,000) and is the best cutoff condition for the modulator tube ($e_g = -10$ volts). This very large variation of resistance will allow corresponding frequency changes.

The three Thyrite elements are connected in series with the supply voltage and a triode modulator tube as shown in Fig. 3. The same direct current passes through all three elements and it was observed that the d-c voltage drops followed one another within 5 percent. Negative voltages applied to the grid of the modulator will reduce the current flowing through the Thyrite, increase the dynamic resistance, and so decrease the frequency.

Amplitude Stabilization

Since the nonlinear elements do not track perfectly, the attenuation can change from the theoretical value of 0.25. Amplitude stabilization will keep the oscillation level constant and insure good waveform. For a simple approach, a nonlinear bridge is used. Referring to the circuit diagram, the bridge consists of two 1,000-ohm arms, a thermistor and a comparison resistor of 470 ohms. The bridge is fed through a phase inverter. Initially the cold thermistor resistance is high and the bridge

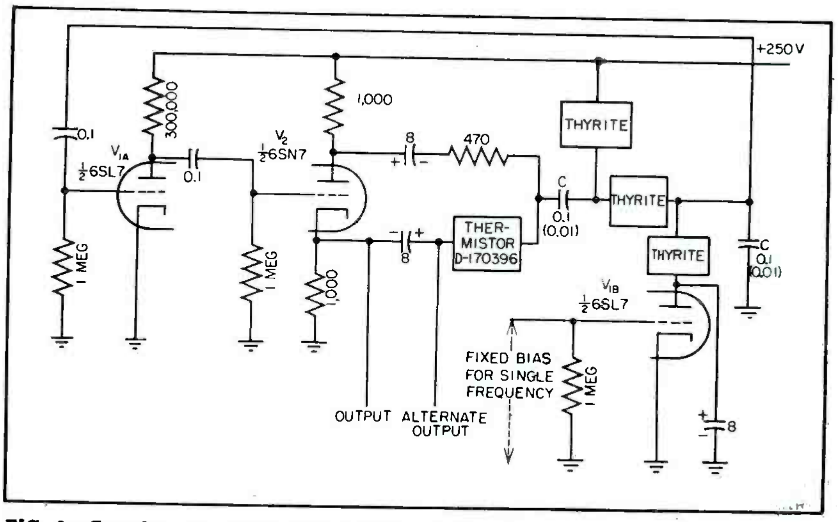

FIG. 3—Complete circuit diagram of the oscillator. Range is changed by choice of capacitors (C). See Fig. 5 for frequency characteristics

is unbalanced, resulting in a high loop amplification. Oscillations build up, increasing the power dissipated in the thermistor, decreasing its resistance, and bringing the bridge closer to balance. At the stable operating point the loop amplification is unity. Any tendency for the amplitude to increase or decrease will be offset by the bridge output decreasing or increasing, respectively.

The mechanism can be further explained by referring to Fig. 4, which shows the bridge characteristic as experimentally determined. It is plotted in terms of output voltage as a function of applied voltage. It requires about 3.35 volts to balance this particular bridge. The thermistor operates in its negative-temperature-coefficient and negative-differential-resistance region and reduces its resistance as the power dissipated in it increases. The remaining loop amplification, which is the product of the amplifier gain and loss in the phase-shift network, is superimposed as a straight line of slope equal to the reciprocal of loop amplification. The common intersection is the operating point resulting in the bridge being sufficiently unbalanced to produce an output of 0.22 volt. As the loop amplification varies, the bridge output, as well as operating amplitude, will change to a much lesser degree depending on the slope of the bridge characteristic at the operating point. A greater slope and higher loop amplification result in greater stability. The rapidity with which the amplitude stabilizes depends on the thermal time constant of the thermistor. Elements such as lamps with positive temperature coefficients can be used if the positions of the comparison resistor and nonlinear element are reversed.

However, elements with negative-differential-resistance regions result in bridges with better stabilization properties. If the loop gain were not to change with frequency there would be no readjustment in amplitude necessary and correspondingly no limit to the rate of frequency modulation. It should be noted that the bridge nonlinear element is really linear at the frequency of oscillation and is nonlinear only to average amplitude or power instead of instantaneous amplitude as in the case of Thyrite.

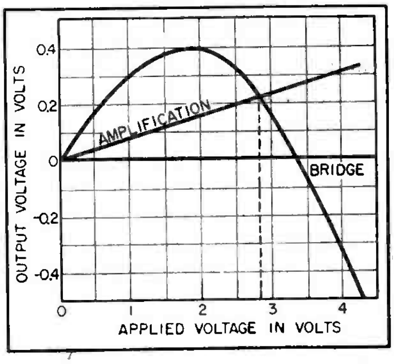

FIG. 4—Amplitude stabilizing bridge characteristic with superimposed loop amplification. The bridge operates at the common intersection with an output of 0.22 v and applied voltage of 2.8 v

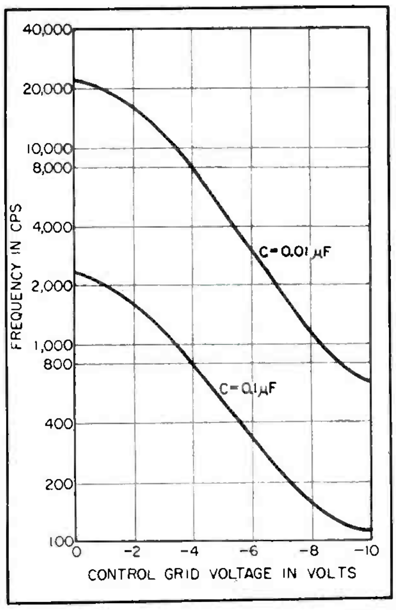

FIG. 5—Frequency versus control-grid potential for two different phase-shift network capacitances

Practical Circuit

In the circuit of Fig. 3, a triode voltage amplifier with a gain of 52 drives the amplitude-stabilizing bridge through a phase inverter. The bridge contains two electrolytic capacitors in order to eliminate d-c and keep the bridge balanced. The bridge and phase inverter offer a low impedance to the phase-shift network whose impedance level can vary considerably. The modulator tube is bypassed so as to put the shunt Thyrite element at a-c ground potential. After the phase-shift network, the loop is closed. It is important that the amplifier proper have negligible phase shift for the variable frequency range so that all phase shift takes place in the frequency-determining network. Voltages measured at various points in the circuit for a frequency of 1 kc were as follows: input to V_1, 0.051 v; output V_1, 2.66 v; bridge output, 0.208 v; phase-inverter cathode, 1.48 v. The gain of the amplifier is therefore 52.2, the phase-shift network attenuation is 0.245 and the bridge is operating close to the point described in Fig. 4. Frequency curves are shown in Fig. 5 for the control voltage variations between 0 and −10 volts. At low grid voltages, the Thyrite resistance is changing at a lesser rate and below −8 volts cutoff is approached gradually. In the center region the frequency variation is logarithmic. By self-biasing the control tube, the curve can be made to start at any convenient frequency. Like the capacitors the curves represent a 10-to-1 ratio down to low frequencies where the amplifier phase shift becomes a limiting factor.

The waveform is excellent at all times and the amplitude never changes by more than 2 percent in these typical frequency ranges. Frequency stability depends on the power-supply regulation and the temperature coefficient of the Thyrite which is about −0.5 percent per degree centigrade[5]. The particular circuit described was used up to 100 kc and with better high-frequency amplifier characteristics the range can undoubtedly be extended. Other nonlinear elements can provide a variety of frequency characteristics.

Thanks are extended to the United States Air Force, Watson Laboratories, who sponsored this work under Contract No. AF28-(099)-33. The assistance of H. Zablocki, Research Assistant at Rutgers University, is appreciated.

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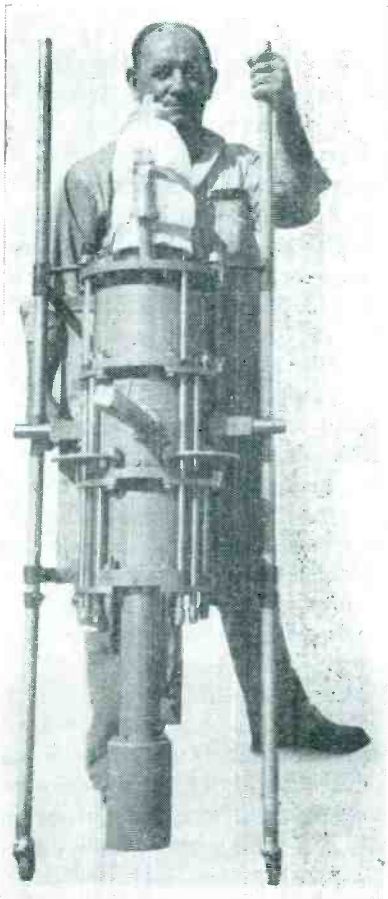
High-Power UHF-TV KLYSTRON

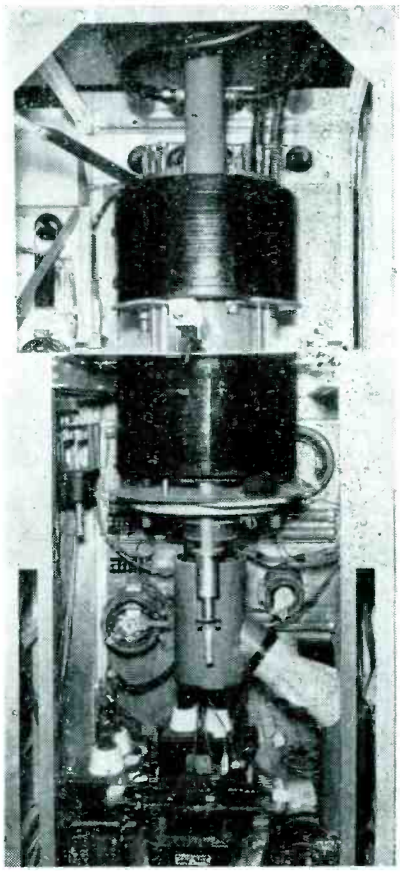
Two-stage klystron provides power gain of 250 with bandwidth of 5.6 mc between 1-db points in uhf television band. Special bombardment cathode design permits replacement of worn out cathodes to extend life of tube almost indefinitely

By The Engineering Staff of Varian Associates

San Carlos, California



Amplifier, complete with cavities, is shown ready for shipping



Five-kilowatt uhf-tv klystron is shown installed in transmitter

EXPANSION of present television broadcasting facilities to include the uhf band is imminent. One of the main stumbling blocks lying in the path of uhf-tv has been the lack of power tubes capable of operating at these frequencies and having other properties necessary for the final amplifier of a television transmitter.

Conventional tubes designed for uhf operation require small sizes and spacings, requirements inconsistent with high power. Transit time becomes a major problem, and low gain per stage adds complexity in both construction and operation. A successful final amplifier tube should combine high power capability with high power gain and bandwidth. The klystron has proved to be capable of such performance.

High-power uhf klystrons have been built. In 1939, John Woodyard of Stanford University built a two-cavity oscillator that had a power output of 250 watts continuous at 750 mc. A three-cavity amplifier tube with two kilowatts output at 750 megacycles was used in a c-w radar, type TPS-7, in 1943. A 5-kw tube for 500 mc was designed and built independently by R. Warnecke in the Research Laboratories of the Compagnie Generale de Telegraphie Sans Fil in Paris at about the same time that the work described below was initiated but no data are available concerning the performance under field conditions.

General Design

The tube to be described was developed by Varian Associates to specifications provided by General Electric. It is now part of the GE uhf-tv transmitter described in the June 1951 issue of ELECTRONICS.

As a starting point in the adaptation of the klystron for television transmitter service, the following specifications were set up: (1) 5 kw c-w output, (2) power gain of 100, and (3) bandwidth of 6 mc between 1-db points. The proposed power output and gain were chosen to take advantage of conventional 50-watt driver tubes of the lighthouse and planar electrode types.

Other important requirements were linearity and freedom from noise and spurious modulation. In both these respects the klystron has inherent advantages. The output of a klystron varies with the input as a Bessel function of the first order. For low levels this is exactly linear, and it does not depart much from linearity until the output is approximately 80 percent of the maximum power. Even this last 20 percent of power need not be wasted, however, since only the synchronizing peaks occur at this level, and these can be predistorted to give the desired output shape. Thus, in the range where linearity is needed for picture clarity, the klystron is inherently linear and the full peak power can be utilized in a transmitter.

Random noise and spurious modulation present no problems in a klystron operating at transmitting power levels. Since the grids have been eliminated, there is no partition noise. All the tube structures are big and rugged, making the tube insensitive to vibration. The heater for the cathode is at one end of the tube, far removed from the interaction space, so the alternating current in the heater can produce no hum. The greatest source of spurious modulation appears to be the power supply ripple, but even the simplest filtering reduces this to a point more than 60 db below the carrier.

In connection with the power supply, there is another advantage of a klystron amplifier to be noted. Since the current drain from the power supply is independent of the r-f level, a regulated or low-impedance power supply is not required to handle modulation peaks.

Development of a klystron at the low end of the uhf band (instead of at a higher frequency such as 800 or 900 megacycles) was a case of attacking the harder problem first. To klystron designers, 500 mc is a very-low frequency rather than an ultra-high frequency and presents special problems. Cavity sizes at this frequency tend to become excessive. Tubes similar to the one described here have produced more than 5 kilowatts of c-w power at over 1,000 mc. Thus it is clearly practical to produce an amplifier with more than 5 kilowatts output at any frequency between 500 and 1,200 mc.

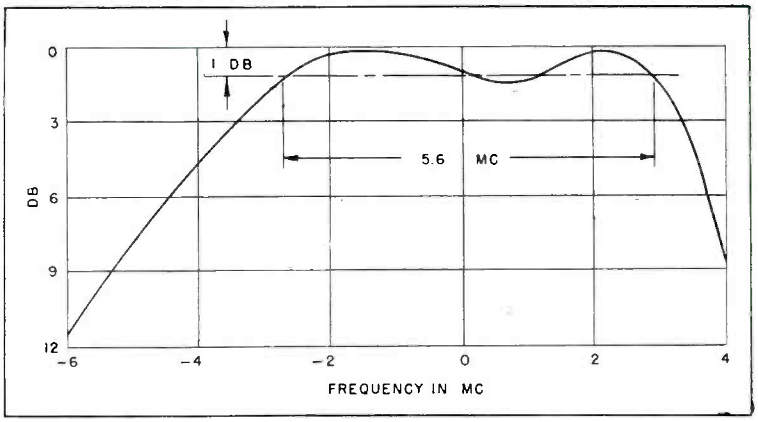


FIG. 3—Response curve shows bandwidth of amplifier

Figure 1 is a schematic diagram of the new tube, showing how the design problem reduces to three separate and distinct parts. First, there is the problem of producing a direct-current beam of electrons of suitable size and density. This is accomplished by the cathode assembly. Second, there must be structures for the radio-frequency interaction with the beam. These are the cavities. Finally, the disposal of the residual energy of the electrons is accomplished in the collector.

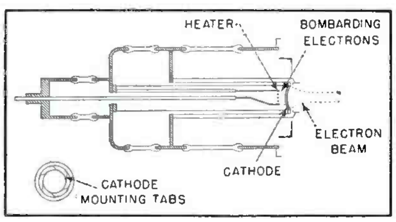


FIG. 2—Bombardment cathode is free from poisoning and may be replaced periodically to make new tube out of old

In the triple-cavity or cascade klystron, the first stage, as shown in Fig. 1, can be likened to a voltage amplifier and the stage between the second and third cavities acts as a power amplifier. The efficiency of the cascade klystron is about the same as the conventional two-cavity (single-stage) klystron, but the gain is much higher, being approximately the product of the gains of two single-stage klystrons. The electrons are actually used twice to obtain a very high gain from a given expenditure of power.

Cathode Structure

Expected efficiency, r-f considerations and physical convenience determine the diameter and length of the drift tube as well as the voltage and current of the beam. For this tube, the figures came out to be 2 amperes and 10,000 volts to pass through a tube 1 inch in diameter and 24 inches long. A cathode design to produce such a beam is straightforward, using the so-called Pierce gun techniques. A magnetic field of approximately 200 gauss, produced by coils outside the resonators, is used to keep the beam from spreading to the walls of the drift tube.

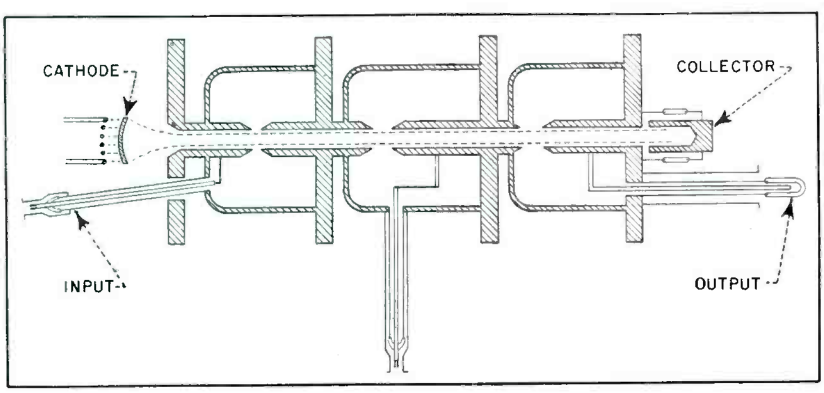
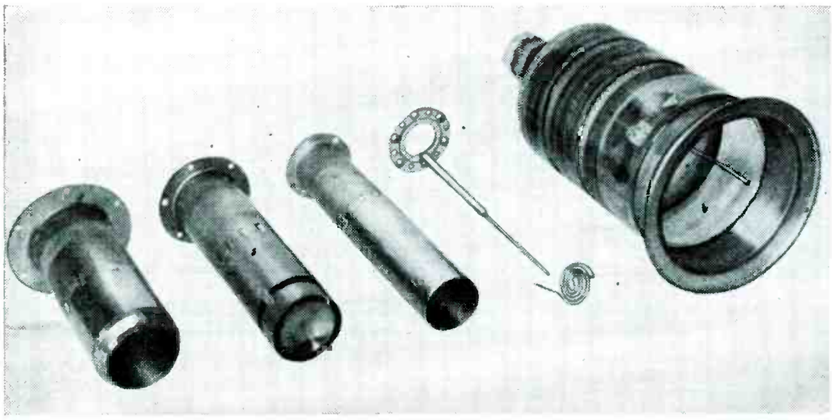


FIG. 1—Schematic of triple-cavity (two-stage) klystron amplifier shows inherent simplicity and straightforward arrangement of elements

The physical design of the cathode is interesting, in that it departs from the usual oxide emitting surface. One of the prime requirements of the amplifier is long life, and since practically everything else except the cathode consists of



Disassembled view shows components of cathode structure

Complete cathode assembly

heavy copper machined parts with essentially infinite life, the limiting factor on tube life is the cathode itself. To eliminate the troubles associated with oxide cathodes, our engineers developed a form of what is called a bombarded cathode. The schematic diagram of Fig. 2 illustrates such a cathode.

The emitting surface of the cathode is a piece of tantalum sheet 0.1 inch thick, supported by tabs from the end of a molybdenum tube. The moly tube, is supported in a kovar-to-glass ring seal. A focussing electrode is similarly supported at this point on another cylinder. Behind the tantalum cathode button is mounted a heater of tungsten wire. Radiation from the heater is insufficient to heat the tantalum to an emitting temperature, so a direct voltage is applied between the heater and the cathode. This causes a current to flow, as in a diode, and the electron bombardment of the back of the cathode button heats it to an emitting temperature.

Bombarded cathodes have been used in several klystrons, and they give long, trouble-free life. The limiting factor on life seems to be the evaporation of the tungsten heater, but if the heater is operated somewhat temperature limited (in the bombarding diode) life approaching 10,000 hours can be achieved. An advantage of this type of cathode is that it does not poison. The tube can be let down to air for repairs and repumped without damage to the cathode.

The usefulness of this tube is not limited to the 10,000-hour life of the cathode. Even though all possible care has been taken in designing both cathode and filament, failure in one or the other must occur eventually. When this happens, it is not necessary to scrap the entire tube structure since the cathode mount has been so arranged that it can be easily removed and replaced with a new assembly. This operation costs approximately one-sixth the original value of the tube. A tube which has been fitted with a new cathode is literally as good as new. The operation can be repeated, and there is no apparent limit to the number of times the cathode can be replaced.

In connection with cost considerations, it is important to realize that the klystron reaches the user completely fitted with its tank circuits. The klystron is actually a complete final amplifier requiring only the connection of power supply voltages and cooling water to put it into operation.

Collector

The collector is cooled by a stream of water flowing at approximately 5 gallons per minute. It is insulated from the body of the tube by a glass seal for the purpose of metering the relative currents lost to the drift tube and reaching the collector. Both the body of the tube and the collector are at ground potential (both d-c and r-f) since the cathode is operated below ground. This provides the maximum safety to operating personnel and avoids the usual troubles of electrolysis and of insulation for d-c and r-f potentials in the water hoses.

The bandwidth of a cascade klystron is approximately the same as that of a single-stage klystron. It can be increased beyond that corresponding to the Q's of the cavities either by loading the cavities to reduce their Q's or by stagger tuning. Stagger tuning is generally a preferable way of trading gain for bandwidth. The three cavities are tuned to different frequencies in such a manner that the band over which gain is obtained is increased, but gain is reduced.

Test results for the tube have shown that satisfactory performance can be obtained by an appropriate stagger tuning scheme in which there is no external loading on the center cavity. This permits an appreciable simplification of construction of the tube since the need for a coaxial line coupled to the center cavity is eliminated. In addition, the radio-frequency power which inevitably would have been lost in the band-widening load on the center cavity is conserved.

An actual measurement of the response curve shows a bandwidth of 5.6 mc between 1-db points. This curve is plotted in Fig. 3. The power gain corresponding to this curve was about 24 db or 250 times. This can be considered a typical performance for a cascade amplifier klystron in the uhf television band. The adequacy of this performance for television purposes was demonstrated by the General Electric Company when they actually used the klystron to amplify a television picture. The quality of the picture was essentially unchanged by its passage through the klystron amplifier.

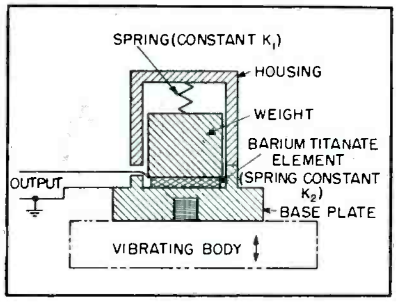


FIG. 1—Cross-section of compression-type accelerometer having self-generating piezoelectric element

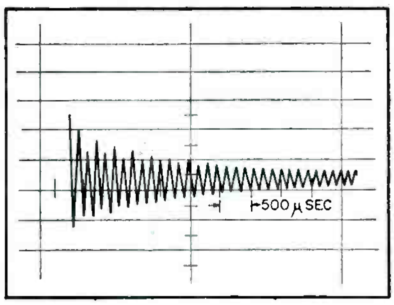


FIG. 2—Free vibrations of compression-type unit when excited by a transient applied force

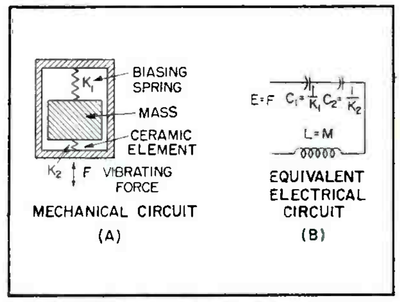


FIG. 3—Vibration system of accelerometer and equivalent electrical circuit having output voltage *E*

SELF-GENERATING

Characteristics and advantages of compression and bender-type accelerometers using piezoelectric barium titanate elements. Useful range of typical unit is from 0.022 g to 600 g; corresponding voltage output range of 1 mv to 27 v is readily measured conventionally

THE PIEZOELECTRIC principle is particularly suited for accelerometers used in industrial vibration studies ranging from machinery balancing to performance testing of guided missiles because the reaction force of a vibrating body is proportional to its acceleration. A relatively new ceramic piezoelectric is essentially composed of polycrystalline barium titanate, which combines sufficient piezoelectric sensitivity, high capacitance and good electrical stability.

The voltage sensitivity of the ceramic is not as high as that of Rochelle salt, which exhibits the highest sensitivity of all known materials. This disadvantage, however, is outweighed by a number of desirable features. The conversion characteristic is hardly affected by temperature and humidity. The mechanical strength is greater than that of Rochelle salt crystals. The dielectric constant is higher, which gives the transducer a larger electrical capacitance. This makes it easier to match its electrical output to the input of electrical measuring equipment and permits the use of a long cable between transducer and equipment. Finally, the material can be manufactured easily in any desired size and shape. No precisely made cuts, as in the case of a single crystal, are necessary.

Ceramic barium titanate already had been used for microphones and phonograph pickups. It was believed that the characteristics of the material could be utilized to an even larger extent in applications where adverse atmospheric and temperature conditions were encountered. The use of the material for electromechanical transducers was studied by the Signal Corps. The investigation resulted in the development of several types of barium titanate accelerometers.

Accelerometer Design

These instruments may be designed in different ways, depending upon the kind of stress to which the piezoelectric element will be subjected. Figure 1 shows a compression-type accelerometer. The base plate of the instrument is rigidly attached to the vibrating body under test. The ceramic element has silvered plane parallel surfaces, the bottom surface resting on the base plate. A weight is pressed against the top surface by means of a spring. The output terminals are connected to the two surfaces of the element.

If the vibrating body moves with a given acceleration, the weight will also be subjected to this acceleration, and the accelerating force is thereby transmitted through the ceramic element. Thus a compressional force, proportional to the acceleration, is exerted upon the element. Because of the piezoelectric properties of the material, the compressional force generates a charge at the terminals of the accelerometer which can be measured.

From a general viewpoint, the accelerometer represents a spring-mass system having a spring constant which is mainly determined by the stiffness of the ceramic element. The theory of such systems shows that the force which is exerted upon the spring element is proportional to the acceleration of the base plate, provided the natural frequency of the spring-mass system is high compared with any of the frequencies at which accelerations are to be measured. The electrical output of the device is proportional to the force applied to the element and, therefore, is a true indication of the acceleration of the base plate, if the above conditions can be maintained.

Since the natural resonant frequency of a compression-type accelerometer is very high, such a de-

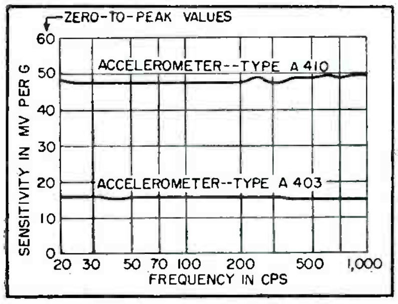


FIG. 4—Variation of sensitivity with frequency for two Gulton compression-type accelerometers

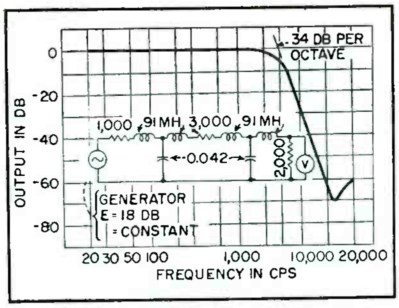


FIG. 5—Attenuation characteristic of two-stage low-pass filter used to avoid resonant-peak errors

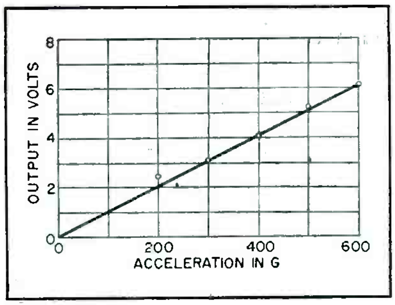


FIG. 6—Amplitude characteristic of Gulton type A-403 accelerometer, showing linearity up to 600 g

ACCELEROMETERS

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vice can measure accelerations correctly up to high exciting frequencies. The magnitude of the resonant frequency can be evaluated from Fig. 2, which gives the electrical output of a compression-type accelerometer when subjected to a transient blow with a lead hammer. The output voltage of the accelerometer was recorded on an oscilloscope having a pulse-triggered sweep. Since a vibrating system which is excited by a single pulse continues to oscillate at its resonant frequency, the above method is a convenient way of finding such resonant frequencies. It can be seen from Fig. 2 that the natural frequency of this particular unit is higher than 6,000 cps.

The existence of such a high resonant frequency is explained in Fig. 3A. Here the vibrating system is reduced to its essential parts—the mass M, the biasing spring K_1 and the ceramic element of stiffness K_2, where K_2 is determined by the dimension of the element and its elastic modulus. Figure 3B gives the analogous electrical circuit for the mechanical system. Masses are represented by inductances and springs by capacitors, the capacitance C being related to the spring constant K as $C = 1/K$. Since C_2 is small compared with C_1, the resonant frequency is determined by M and C_2 and is barely affected by C_1.

Initial Pressure

The spring is only an auxiliary element in the basic function of the accelerometer. If the acceleration to be measured never exceeds that of gravity (1 g), the weight exerts sufficient pressure upon the mass to insure close contact at all times (provided the unit is always used in a vertical position) and no spring is needed. For the measurement of an acceleration greater than 1 g, an initial pressure is necessary which must be equivalent at least to the maximum acceleration force encountered in the signal. The spring is a convenient means for obtaining this pressure.

It has been possible to obtain natural frequencies ranging between 5,000 cps and 25,000 cps with the compression-type accelerometer. This is due to the high spring constant of the ceramic element, which is of the same order as that of a solid piece of metal. For this reason, it is possible for the mass and elasticity of the housing to introduce parameters which will affect the output of the accelerometer, and particular attention must be paid to the construction of the accelerometer.

A compression-type accelerometer constructed by the Gulton Manufacturing Corp. for Signal Corps Engineering Laboratories has a sensitivity of 45 millivolts per g and a capacitance of 1,500 μμf. The natural frequency surpasses 6,000 cps, as shown by Fig. 2, which was obtained with this instrument.

The frequency characteristic (open-circuit voltage versus frequency) of these accelerometers can be expected to be flat from the lowest frequency up to one-half the resonant frequency. In Fig. 4, the results of measurements made on two compression-type accelerometers are presented and show a very flat characteristic. The measurements were carried out with an electrodynamic vibrator. No attempts were made to damp the resonant peak. In normal applications, the frequency range of interest for the investigator seldom exceeds 1,000 cps, which is far below the resonance frequency.

If desired, an electrical low-pass filter can be inserted in the measuring circuit to eliminate errors caused by the resonant peak. A circuit diagram and frequency characteristic of such a filter are given in Fig. 5. It can be seen that the filter attenuates the frequencies above 2,500 cps. By the use of low-Q coils and resistors inserted in the circuit, resonant frequencies of the filter itself are damped and no ringing of the filter will occur.

The amplitude characteristic of the accelerometer is linear as long as the elastic limit of the elements and other components is not exceeded. Another condition for linearity requires that the voltage generated in the element should always be small compared with the polarizing potential as otherwise the remanent polarization could be affected. Both linearity requirements can easily be met by proper design. Figure 6 shows the amplitude characteristic as obtained with an impact-type shock tester.

The temperature characteristic of the compression type units compares very favorably with any other type of accelerometer. Figure 7A gives the results of measurements where the accelerometer was excited mechanically with a constant amplitude of 60 cps and its output voltage observed at different temperatures. The deviations between 20C and 80C were very small. The units should not be used above 100C because the barium titanate employed in the elements has a Curie point at 125C. At this temperature, the crystalline structure changes and the material loses its piezoelectric property. At low temperatures, a decrease of sensitivity can be expected but the instruments are usable to approximately −50C.

Compression-type accelerometer having resonant frequency of 12,000 cps, capacitance of 1,500 $\mu\mu$f and sensitivity of 10 mv per g, and individual parts used in its construction

Amplifier Requirements

In considering the overall characteristics of any transducing device, one must consider the equivalent electrical circuit as seen by a recording device. The equivalent circuit of a piezoelectric transducer is given in Fig. 7B. The transducer is represented by a constant-voltage generator in series with its internal capacitance C_A. The transducer is connected by means of a shielded cable, which itself has the capacitance C_C, to an indicating instrument such as a vacuum-tube voltmeter, cathode-ray oscilloscope or recorder preceded by a vacuum-tube amplifier. If the resistive load into which the accelerometer feeds is too low to obtain proper matching at the low-frequency end, the amplifier input may be shunted with the matching capacitor C_M. The lower half-power frequency f_o will occur where the impedance of $C_M + C_A + C_C$ equals the input resistance of the amplifier. For $R = 1$ megohm and $f_o = 10$ cps, the matching capacitor becomes $C_M = 0.02$ μf. This value is much larger than the source capacitance of the generator and a decrease of sensitivity will result. The voltage E_A applied to the input of the amplifier is related to the generated voltage E_G by $E_A = E_G C_A/(C_A + C_C + C_M)$.

To obtain a high sensitivity and a good response at low frequencies, it is desirable to employ an amplifier having a high input resistance. Figure 7C shows the circuit diagram of a cathode follower amplifier which uses a grid leak resistance of 15 megohms and provides, due to the cathode follower action, an input resistance of about 100 megohms. When a transducer with 1,500-$\mu\mu$f capacitance is connected to its input, a flat frequency characteristic (3-db loss point) down to 1.2 cps is obtainable. In cases where extremely good amplitude and phase characteristics at low frequencies are desired, a matching capacitor can be employed. When $C_M = 0.02$ μf is used, the 3-db point is decreased to 0.08 cps and a 5-degree phase deviation will occur at 0.9 cps.

The low-frequency response can be extended considerably in this manner, so that all requirements for normal shock and vibration work can be met easily with this type of accelerometer. No static measurements can be made, however, since a piezoelectric transducer has no d-c response.

Bender-Type Accelerometers

In a bender-type accelerometer, a strip of phosphor-bronze is clamped at one end of a solid structure which is connected to the vibrating body, as shown in Fig. 8A. Due to its inertia, the beam vibrates and generates stresses in the barium titanate element attached to the beam. The two surfaces of the element are connected to the output terminals. The element can be made very thin, in the order of 1/100 of an inch, and hardly affects the flexibility of the beam.

The natural frequency of such an arrangement is normally several hundred cycles. Figure 8B shows the fundamental resonance frequency of a 0.1-inch phosphor-bronze cantilever beam plotted against its length. The graph indicates that the natural frequency of such bender systems is much lower than for compression-type devices. A means of damping the system, such as with silicone oil, should therefore be provided.

Many variations may be employed in the construction of a bender-type accelerometer. The dimensions of the beam and the sensitive element can be changed. Small weights may be attached to the end of the beam. Clamping may be provided in the center or at both ends. The ceramic element itself may be used as a beam.

It is not possible, however, to employ a homogeneous piece of barium titanate. In the latter case, the upper portion of the beam would be in compression and the lower portion in tension, or vice versa. The charges generated in these two parts would have opposite polarity and would cancel each other. This difficulty is overcome by using a laminated element. For example, the beam may consist of two sheets of barium titanate, each 0.01 inch thick, which are soldered to a 0.003-inch copper armature. The natural frequency of such a laminated beam is also plotted in Fig. 8B.

The temperature characteristic of bender-type accelerometers is not as good as for compression-type units. A decrease in sensitivity of about 0.5 percent per degree C was observed with rising temperature. This effect is probably caused by the bond between element and armature. Another temperature effect is introduced by the damping fluid.

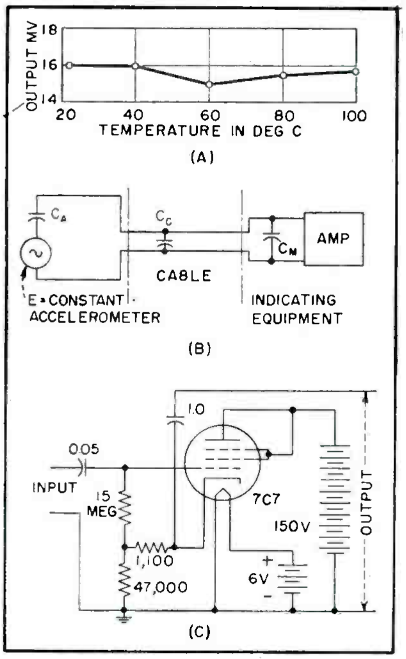

FIG. 7—Temperature characteristic of compression-type accelerometer, block diagram of complete transducer system, and cathode-follower amplifier circuit suitable for matching a piezoelectric accelerometer to electrical measuring equipment

Bender Applications

Despite these facts and the very satisfactory performance of the compression-type units, it can be expected that bender-type accelerometers will be helpful in applications where special requirements must be met. Such requirements are:

(a) High capacitance to obtain very low frequency response with an indicating device having only medium input impedance. It has been possible to build benders with a capacitance as high as 0.1 μf.

(b) High sensitivity but a limited frequency range. A cantilever beam, with small weights attached to its end, was built for this purpose. A sensitivity of about 200 millivolts per g was obtained. The frequency characteristic of an experimental model of such a unit is given in Fig. 8C.

(c) Very small dimensions. One accelerometer designed to this specification measures only $1\frac{1}{8} \times \frac{5}{8} \times \frac{3}{16}$ inches. Its laminated barium titanate element operates as a bender. The sensitivity is 8 mv per g and the natural frequency approaches 3,000 cps. Silicone fluid is used as a damping medium. The miniature-unit curve in Fig. 8C shows the frequency characteristic of this unit.

(d) Capability of measuring extreme high accelerations, of the order of 10,000 g. By using a bender type for such an application, it is possible to obtain a design where a sturdy armature takes the full impact of the shock. The ceramic element, which can be made very thin and light, is attached to the armature and measures its deformation.

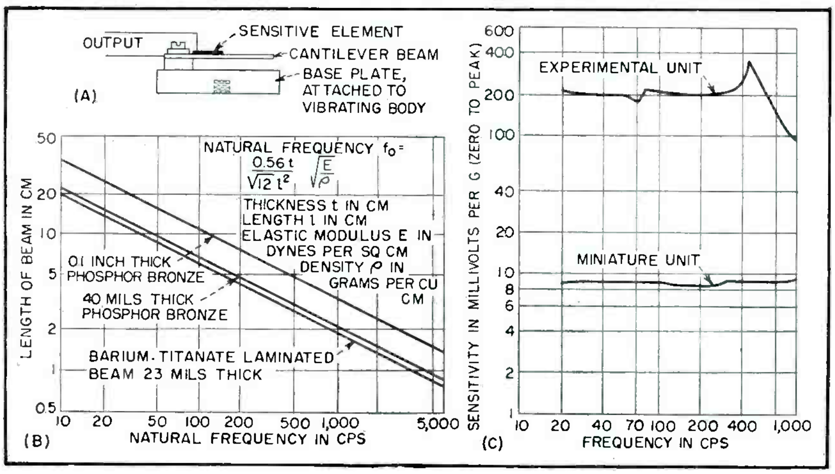

FIG. 8—Bender-type accelerometer construction, relationship of its natural frequency to cantilever beam length, and frequency characteristics of two different bender units

Conclusions

A very desirable feature of all barium titanate accelerometers is the extremely wide range of acceleration which they can indicate. One model can withstand 600-g shocks which will generate an output voltage of 27 volts. On the other hand, for measurement of small accelerations, it is possible to read an output of about 1 millivolt, because this voltage is still above the noise level of normal measuring equipment. Consequently, an acceleration range from 600 g to 0.022 g (27,000 to 1) can be covered; this is an excellent figure for a measuring instrument. Another desirable feature is the fact that the accelerometers are self-generating, which makes their output independent of external supply voltages. Barium titanate accelerometers have already been used in many tests in the laboratory and in the field. The instruments have operated satisfactorily under all conditions and have shown reliability and ease of handling.

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Automatic BROADCAST

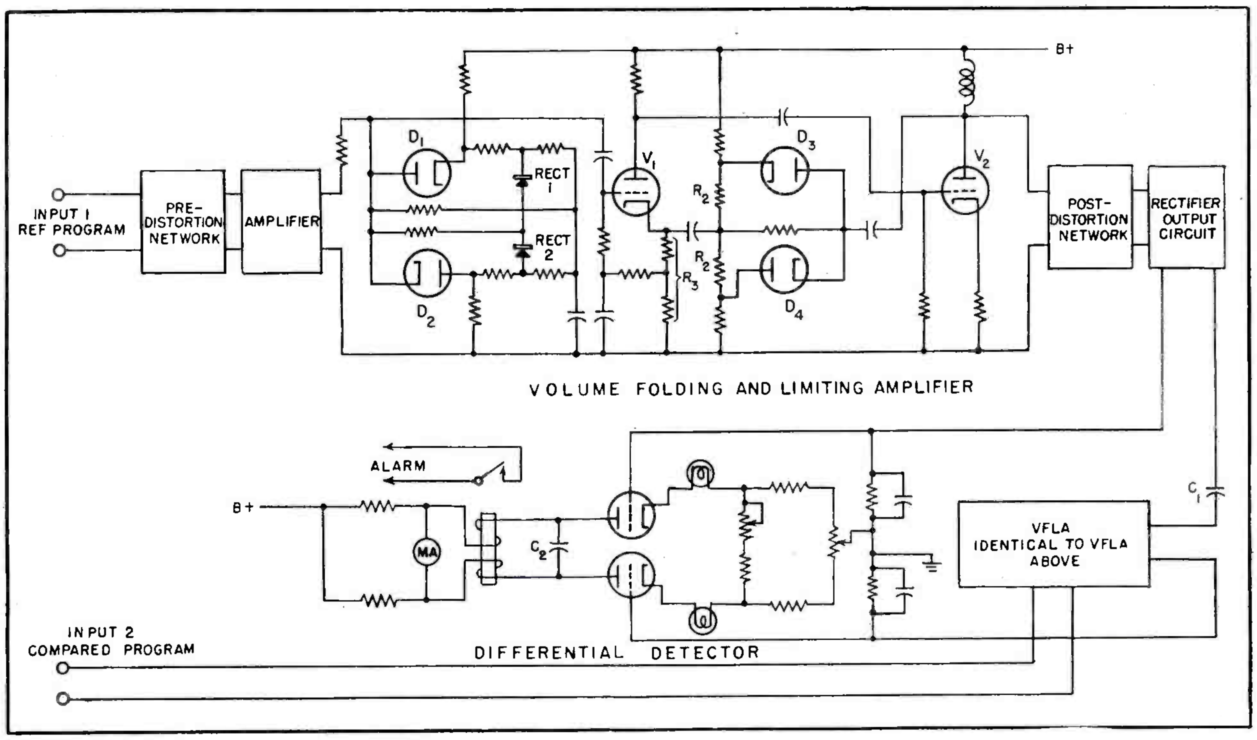


FIG. 1—Basic circuit of the automatic monitor used for comparing signals at two points geographically close

Program monitor compares recovered audio from transmitter signal with that from studio monitor and sounds alarm if it detects undue noise or distortion. For remote comparison, a processed information signal is sent out on same lines with audio but at higher frequency

In England, the British Broadcasting Corporation produces some ten different sound programs that are fed over wire lines to nearly 100 transmitters. Monitoring is required at the several pick-up points, as well as at intermediate points to insure maintenance of level and quality of program. The equipment to be described provides automatic monitoring at the intermediate points so that the technical staff can be freed for other duties.

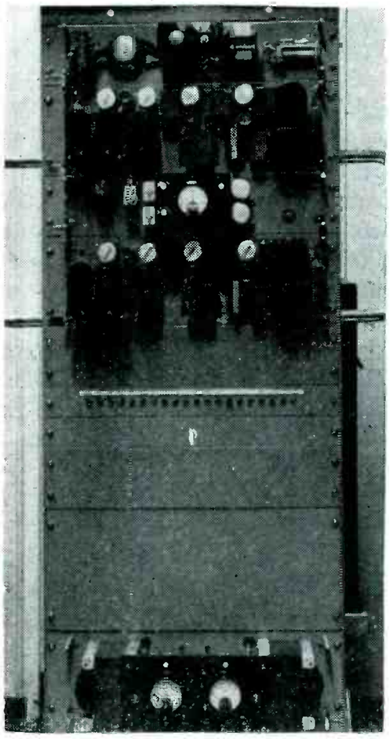
The automatic monitor compares program characteristics at two separate points in the transmission chain. When the two programs differ by a predetermined amount, the monitor sounds an alarm. Often, the programs to be compared are available in the same building. In other cases, it is necessary to convert the information to a signal that can be sent back and compared with the characteristics of a similarly processed signal. The simple comparison equipment is known in the BBC as "automatic monitor minor" and the remote comparison system as "automatic monitor major."

Since the major monitor, not yet in general use, is based upon the equipment that is used in the minor monitor, the latter will be described first. Both types are designed to operate an alarm on an arbitrary magnitude of defect with respect to: transmission equivalent (including complete break); background noise (including crosstalk); frequency-amplitude response; and overload or nonlinearity.

By a comparison measurement, all these defects may be recognized in terms of amplitude. For instance, a falling-off in response at the upper frequencies will be discerned as a reduction in amplitude of the top notes of music or the sibilants in speech. In the low-volume passages or gaps in program, noise will also appear as an amplitude difference. Such amplitude comparison is the basic principle on which these monitors are designed.

The transmission circuit may include a long line or several amplifiers. In either case the envelope

PROGRAM MONITOR



Automatic monitor equipment in rack

of the signal is likely to be distorted by phase change, and such systems differ in this respect only by the degree of phase change. As long as the phase or delay distortion is within the rather wide limits that the ear cannot detect, no correction for this is normally made.

The automatic monitor must compare two envelopes, one of which is distorted, and show a balance so long as no defect is aurally noticeable. In this respect it must contend with a time delay in the arrival of a pulse of signal and a distortion of the envelope of the pulse. An instantaneous comparison of the amplitude of the signals is not possible. There must be integration over a period long enough to negate the error due to phase-delay distortion.

If the integration period is too long, however, the automatic monitor will be insensitive to the distortion it is intended to disclose. Although many periods of amplitude distortion apparent to the listener will be of short duration, there will be a number lasting several milliseconds at least. If the integration period does not exceed about ten milliseconds, such periods occur often enough to give reasonable operation of the monitor on fault conditions.

Although the rms value of the wave might give an ideal comparison, it is more practical to use rectifiers with suitable time constants. The discharge time has been made longer than the charge time, so that comparison of amplitude difference may be delayed until both program-pulses approximate their maximum values. This method of measurement normally produces good monitor balance on fairly short transmission circuits if there is no audible distortion between the points at which the program is being compared.

Bridge-Balance Detector

Voltages from the reference signal supply one arm of the bridge shown in Fig. 1 and those of the compared signal feed another arm. The output of these arms is applied to the tubes of a differential detector. Detector output (zero if both voltages are so nearly alike as to produce no appreciable unbalance) operates a relay that actuates a buzzer or bell. Thus, a warning is given when the compared signal suffers a predetermined amount of deterioration, owing to any of the factors mentioned.

The whole volume range of reference or compared signal is not needed to detect defects. Signals in the larger volume levels give indications of overload and defects in frequency response and transmission equivalent. The low-volume levels disclose the faults mentioned but show noise rather than overload distortion. Intermediate volume levels are not required, for they convey no information not given by the others.

The requirement for an amplifier with two different gains inspired the development of the volume-folding-and-limiting amplifier (VFLA). This apparatus receives voltages resulting from the whole range of volume levels. For a fault just serious enough to mar reception by the average listener it must have the same output whether the indications are conveyed by the high-volume of low-volume portions of the signal. Overall response of the VFLA must approximate that of the ear of the average listener. It must be able to gloss over faults (such as brief overloads) that would not distress the listener, but it must be infallible in calling attention to defects that annoy him.

The term "volume" applies here

Broadcasting in the United Kingdom is different in several respects from that to which engineers in the United States and Canada are accustomed. Among others, the American engineer is accustomed to feeding an audio program at a certain maximum level into a telephone line and having it come out at the other end, often many hundreds of miles away, with predetermined level and characteristics. The problems of maintaining the standard of transmission have been paid for according to Telephone Company rates previously approved by the Federal Communications Commission.

In Great Britain, where the British Broadcasting Corporation operates all broadcasting on funds collected by the government from receiver owners, the Corporation must in many cases maintain long-line audio levels and quality. In addition, the BBC is allowed to operate remote, unattended transmitters in a manner not permitted in the States by the FCC.

Automatic monitoring equipment of the type used by the British and described here may find interesting applications in the fields of telemetering, microwave relay, and remote control of satellite f-m broadcast transmitters, in addition to the application for which the system was devised to signal indicated by the peak program meter used at the BBC. This measures the rectified peak value of signal with a charge time-constant of 2.5 milliseconds and a discharge time-constant of 1 second.

The two different gains at which the VFLA operates are selected by the amplitude of the applied input signal. This is accomplished by diodes D_3 and D_4 (Fig. 1) in the negative-feedback path of the amplifier section of V_1 and V_2. The diodes are back-biased from the high-voltage supply so that, below a predetermined signal amplitude, they do not conduct.

When they are not conducting, the gain of the amplifier is approximately $1 + R_1/R_3$ where R_3 is the resultant cathode-to-ground resistance. When the applied input signal is large enough to cause the diodes to conduct, the gain of the amplifier is reduced to approximately $1 + (R_1R_2)/R_3(R_1 + R_2)$. The amplifier formed by V_1 and V_2 has approximately a linear input-output law at low-volume input and represents an amplifier of less gain above the volume at which the diodes operate.

The differential detector operates when a certain output-voltage difference between the two VFLA's is reached or exceeded. This value of voltage is to be attained for the same input volume difference, whether this occurs at low or high volumes. The critical value of voltage difference for operation is fixed by the volume at which noise should cause operation and that at which the diodes in the feedback path of the amplifier containing V_1 and V_2 switch to reduce gain.

This is seen more clearly by the following example:

Let the volume at -40 db give the 6-volt output necessary for the detector to operate. Let a 3-db difference (or an excess of this difference) between the reference program v_1 and the compared program v_2 be required to cause the detector to operate. The gain of the amplifier must be reduced at that critical volume above which a change of 3 db in input gives more than a 6-volt change in output.

$$20 \log v_2/v_1 = -3 \text{ db}$$

$$v_1 - v_2 = 6 \text{ v}$$

$$v_1 = 21 \text{ v (approximately)}$$

This output voltage corresponds to an input volume of about -29 db and this is the point at which diodes D_3 and D_4 operate.

The effective ratio between the gain of the amplifier with the diodes operated and that without the diodes operated will determine the higher volume at which a 3-db difference between v_1 and v_2 will again provide 6 volts in output. Above such a volume there must again be a reduction in gain, or this 3-db sensitivity will be exceeded. In the automatic monitor, this reduction is provided by rectifiers 1 and 2. These are back-biased so that they conduct at, and above, this second critical volume and place a shunt across the amplifier input containing V_1 and V_2.

Maximum Gain Reduction

A further and final reduction in gain occurs at the maximum input level to be experienced, or zero volume. At this level, diodes D_1 and D_2 conduct and almost short-circuit the input of the amplifier. This final limiting of the sensitivity of the monitor to the maximum value of signal that can be handled by the transmitter reduces its monitoring sensitivity to overload distortion at such volumes. This reduced sensitivity is compensated by an auxiliary device.

The amplitude input-output law of the VFLA unit has been described without regard to the frequency of the input signal. If the monitor is to correspond in its operation to the audibility of defects, it must be suitably graded in sensitivity with respect to frequency. The predistortion network determines the lowest volume with respect to frequency at which the VFLA gives sufficient rectified output to operate the differential detector. Its response is designed so that operation of the alarm corresponds approximately to aural sensitivity at noise volume.

The circuit to be monitored may contain about a hundred miles of cable. In such circumstances, the rectified outputs of VFLA units will not synchronize, and will provide momentary amplitude differences. The action of the differential detector is therefore delayed by C_2 of Fig. 1. Although programs are monitored at their source, so that compression of peaks at the transmitter is kept at a reasonable minimum, the frequency of compression on some types of program is relatively high. It is not desirable that the automatic monitor should give alarms on such defects unless they become abnormal. Silencing of the alarm by action of D_1 and D_2 brings an integrator into operation so that, if this kind of defect is too frequent or persistent, the alarm is sounded. The circuit used if a transmitter is included in the chain is shown in Fig. 2.

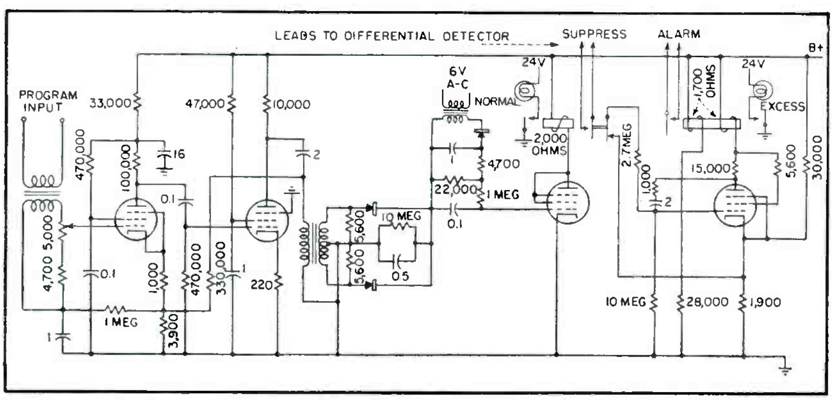


FIG. 2—Overmodulation-alarm suppressor prevents warning on occasional peaks but allows alarm to operate if they are frequent

Overmodulation-Alarm Suppressor

The program is amplified and rectified to provide opposing bias to a back-biased detector. At a critical volume of program, the current in the anode of the detector operates a relay, the contacts of which are interconnected with the alarm circuit in the differential detector unit. When this relay operates, the differential detector alarm is sup-

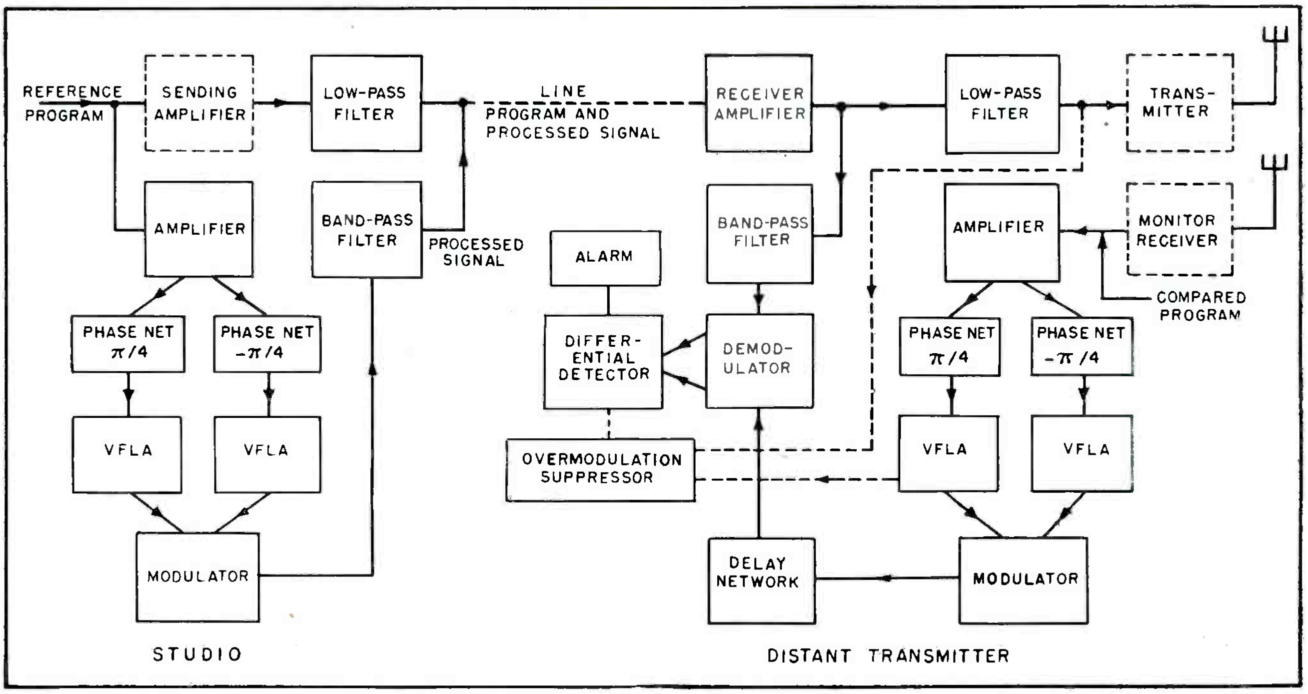


FIG. 3—Automatic monitor used to compare signals separated by long telephone lines. Essential information is encoded by modulator

pressed. A time delay in the relay operation in the differential detector circuit is provided for this purpose. If, however, this plate relay operates with undue frequency of persistency, the capacitor in the grid-plate circuit of the integrator (final stage of Fig. 2) has its standing charge sufficiently disturbed to operate its plate-circuit relay, giving an alarm. A supervisory lamp indicates the nature of the fault.

When a radio link returns the program to be compared, it is desirable to prevent static from operating the monitor alarm. A second receiver fed from the monitoring receiver antenna is tuned to a nearby wavelength on which there is normally no appreciable background signal. The audio output of the static receiver is connected to a circuit similar to that of the overmodulation-alarm suppressor. Incoming static will thus operate a relay and suppress the monitor alarm, but an integrator circuit is again included, so that persistent or unduly frequent suppression from any cause sounds the alarm.

Automatic Monitor Major

The major monitor has been designed to perform a function similar to that of the minor, but uses specially derived signals rather than regular program for its monitoring function. In practice, both program and a low-level reference signal are sent over the program line. The block diagram of a representative major monitor system is shown in Fig. 3. The program is sent out on the line through a low-pass filter and at the same time through a pair of phase networks into two VFLA units similar to those used in the minor monitor system.

The combined rectified outputs are fed into a modulator that converts the signal into an a-m carrier between 7 and 8 kc. Bandwidth of the resultant signal is about ± 150 cycles. The processed signal is fed onto the program line through a band-pass filter at a level some 20 db below that of the program. At the transmitter end, the program as picked up on a monitor receiver is similarly processed, put through a delay network and compared with the incoming processed signal. Any marked discrepancies of quality cause the differential detector to operate the alarm.

To keep the reference signal stable and avoid the effects of transmission-equivalent drift a special form of automatic gain control with a long time constant is employed. This agc provided by the reference signal keeps the balance constantly adjusted. It is made to operate only at low volume and so does not mask defects that need correction.

Another problem of some magnitude is that if the program signal contains two frequencies such that $f_2 \pm nf_1$, a low-frequency amplitude modulation may be produced in the reference signal. This is counteracted by making the processed signal the sum of two signals with a phase shift between them of $\pi/2$. It is for this reason that pairs of VFLA's are used in major monitor systems for dealing with both reference and compared signals.

Acknowledgements

In preparing this article the writer has made use of some of the information and diagrams in a paper entitled "The Automatic Monitoring of Broadcast Programmes" by H. B. Rantzen, F. A. Peachey and C. Gunn-Russell, which is to be published as Paper No. 1045R in the Proceedings of the Institution of Electrical Engineers, Part III, proofs having been made available to the public in August, 1950.

Thanks are extended to Ralph W. Hallows of Berkhamsted, Herts, England, for pointing out the salient features of this new technique and its associated equipment and circuits.—A. A. McK.

Universal Direct-Coupled

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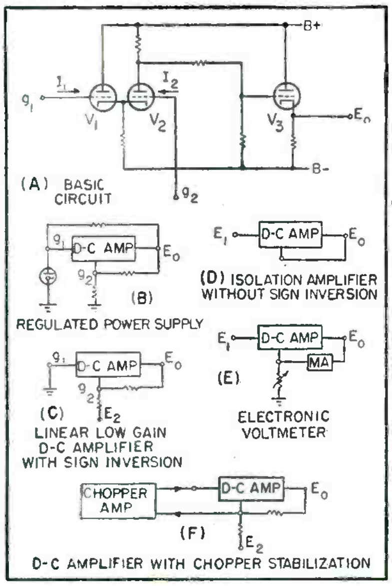


FIG. 1—Basic amplifier and examples of present uses

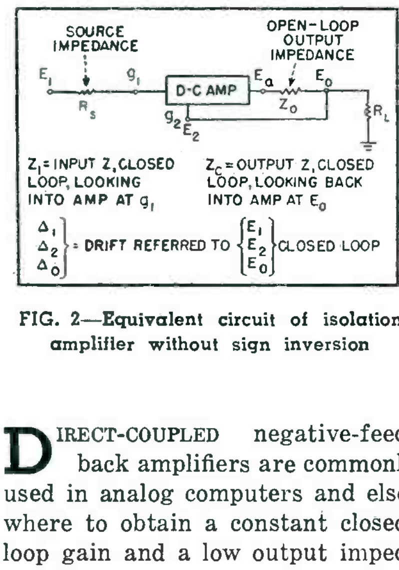


FIG. 2—Equivalent circuit of isolation amplifier without sign inversion

DIRECT-COUPLED negative-feedback amplifiers are commonly used in analog computers and elsewhere to obtain a constant closed-loop gain and a low output impedance. One of the more basic characteristics of this type of circuit is the fact that the gain is negative. Whereas the necessity to accept this sign inversion is frequently undesirable, it heretofore has been considered an inevitable feature of feedback circuitry.

This paper presents a universal amplifier that may, with or without sign inversion, attain a constant closed-loop gain and low output impedance. Some of the mathematical operations made possible through the use of this circuit are listed and described. Circuit properties are derived, and test data is given for an actual circuit.

Basic Amplifier

The circuit herein described consists of a basic direct-coupled amplifier with two input terminals and one output terminal, as illustrated in Fig. 1. The manner in which the input and overall loop feedback are connected determines the function the amplifier is to perform. This type of circuit is currently employed to perform a limited number of its potential functions, as illustrated by the block diagrams in Fig. 1. This paper extends the use of this valuable basic circuit to include several new applications.

As used in this paper, the definition and requisites of a basic amplifier are that it be direct coupled and use a differential first stage with both grids thereof accessible. The gain to the output is positive from input grid g_1 and negative from input grid g_2. The output voltage is sensitive only to the difference between the two inputs and not to their absolute level relative to ground. The circuit will be analyzed for three different operating conditions, wherein the closed-loop gain is +1, greater than +1 and less than +1.

Closed-Loop Gain = +1

To attain a gain of one so that $E_o = E_1$, simply connect the grid of V_2 directly to the output, as in Fig. 2. No additional resistors are required. To calculate the closed-loop gain G without external load, assume that load resistance R_L is ∞ and that grid current I_1 is 0, so that $E_{g1} = E_1$ and $E_{g2} = E_o$. The basic circuit equation is $(E_{g1} - E_{g2}) A = E_o$, where A is the open-loop gain of the basic amplifier. For unity gain, this becomes $(E_1 - E_o) A = E_o$. The closed-loop gain is then $G = E_o/E_1 = A/(A + 1)$. If A is made sufficiently large, this figure closely approximates 1.

To calculate output impedance Z_o, assume only that $I_1 = 0$, so that $E_1 = E_{g1}$. Then $(E_1 - E_o) A = E_a$, and $E_o = E_a R_L/(R_L + Z_o)$. This gives the exact expression

$$\frac{E_o}{E_1} = \frac{R_L}{(Z_o/A) + \frac{R_L\,(A+1)}{A}} \qquad (1)$$

If A is made sufficiently large, the term $[(A + 1)/A]$ approximates 1 and the equation becomes

$$\frac{E_o}{E_1} = \frac{R_L}{\frac{Z_o}{A} + R_L} = \frac{R_L}{Z_c + R_L} \qquad (2)$$

This shows that the closed-loop output impedance is equal to the open-loop output impedance divided by the open-loop gain of the amplifier, or $Z_c = Z_o/A$. This value is very low, which is characteristic of negative-feedback amplifiers.

In the amplifier under consideration, Δ is the drift referred to the grid; in other words, with one input grid grounded, it is the voltage necessary at the other input grid to maintain $E_o = 0$, to accommodate for drift due to such factors as power supply variations, temperature and aging. Δ_1 is the drift referred to the input, or the voltage necessary at the input to a closed-loop circuit to maintain $E_o = 0$. Δ_o is the drift referred to the output, or the voltage variation at the output of a circuit, where the input is grounded.

Differential Amplifier

Analysis of basic circuit capable of providing constant closed-loop gain and low output impedance, with or without sign inversion, for applications requiring a high-gain differential amplifier. Mathematical uses in analog computers are summarized

Then $\Delta_o = G\,\Delta_1$. The designation d refers to a change; thus, I_{2d} means the change in I_2.

The total drift (zero shift) of the circuit of Fig. 2 (Δ_o and Δ_1) is equal to the sum of the drifts contributed by grid current in the first stage, and by Δ (where Δ is an independent variable not affected by external circuitry).

To calculate the drift due to Δ, observe that since the input signal is fed directly in g_1, to which point Δ is referred, Δ_1 of necessity is equal to Δ and $\Delta_o = \Delta_1 = \Delta$.

To calculate the drift due to grid current, observe that: (a) I_2 will cause no zero shift, as g_2 is connected to E_o which is a source of low impedance; (b) I_1 will cause a constant zero shift of amplitude I_1R_s, which effect may be completely nullified by the setting of a manual zero adjustment within the amplifier; (c) I_{2d} will cause no zero shift for the same reason as in (a); (d) I_{1d} will cause a zero shift referred to the input equal to $I_{1d}R_s$, hence it is desirable that the source impedance be kept to a minimum; (e) should the source impedance vary by an amount R_{sd}, it will cause a zero shift equal to I_1R_{sd}. It is therefore desirable that the grid current in the first stage be kept to a minimum.

The total drift of the amplifier from all causes is $\Delta_o = \Delta_1 = \Delta + I_1R_{sd} + I_{1d}R_s$, which for most actual circuits is approximately Δ.

Since the input is fed onto a grid whose only ground return is through the source itself, the input impedance Z_1 is infinite, excepting the effects of grid current which may in most cases be considered negligible.

An infinite input impedance is of particular advantage where the source impedance is variable, for the gain is completely independent of the value of the source impedance and therefore of any change in source impedance.

Summarizing these results, the characteristics of the circuit of Fig. 2 are: (a) Function is that of an isolation amplifier, where accuracy and output impedance requirements will not allow for the use of a cathode follower; (b) gain $G = A/(A + 1)$; (c) output impedance $Z_c = Z_o/A$; (d) drift $\Delta_o = \Delta_1 = \Delta + I_1\,R_{sd} + I_{1d}\,R_s$; input impedance $Z_1 = \infty$.

Closed-Loop Gain > +1

To attain a gain greater than one, two precision resistors are required, connected as in Fig. 3A. The exact expression for gain in this case is

$$\frac{E_o}{E_1} = \frac{R_3 + R_4}{R_4 + \dfrac{R_3 + R_4}{A}} \qquad (3)$$

If A is made sufficiently large,

$$\frac{E_o}{E_1} \cong \frac{R_3 + R_4}{R_4} \qquad (4)$$

Observe that the amplifier will always adjust itself such that $E_{g1} \cong E_{g2}$. Utilizing this information as a tool for calculation, Eq. 4 and many other circuit properties may be less rigorously calculated with greater ease.

To calculate Z_c, which is dependent upon open-loop gain, a more rigorous approach is needed. Figure 3B represents the equivalent circuit when closed-loop gain G without external load is greater than 1, where R_L is the total load from E_o to ground. Here the exact expression for gain is

$$\frac{E_o}{E_1} = \frac{G\,R_L}{(Z_o\,G/A) + R_L\,(A + G)/A} \qquad (5)$$

If A is made sufficiently large, the

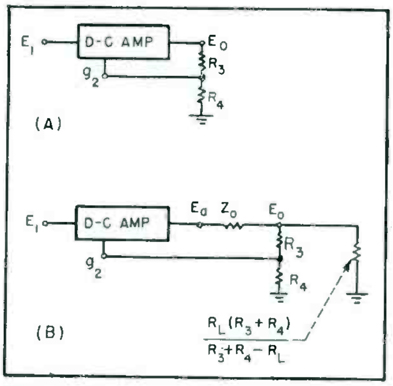
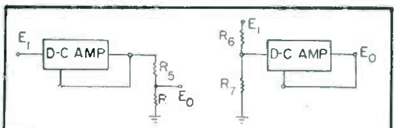


FIG. 3—Circuit connections and equivalent circuit giving gain greater than one



CIRCUIT CHARACTERISTIC	(A)	COMPARISON	(B)
G	$\frac{R_L}{R_5 + R_L}$	=	$\frac{R_7}{R_6 + R_7}$
Δ_1	$\Delta + I_{1\Delta} R_5 + I_1 R_{5\Delta}$	<	$\frac{\Delta}{G} + I_{1\Delta}\left(\frac{R_6 R_7}{R_6 + R_7}\right) + I_1\left(\frac{R_6 R_7}{R_6 + R_7}\right)_\Delta$
Z_1	∞	>	$R_6 + R_7$
Z_o	R_5	>	$\frac{Z_0}{A}$

FIG. 4—Amplifier connections giving gain less than one, with attenuation at output and with attenuation at input

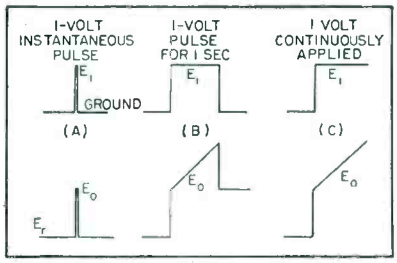


FIG. 5—Circuit action for integration of instantaneous, pulse and step functions

equation becomes

$$\frac{E_o}{E_1} \cong \frac{G\,R_L}{(Z_o\,G/A) + R_L} = \frac{G\,R_L}{Z_c + R_L} \quad (6)$$

from which it is determined that the closed-loop output impedance is equal to the open-loop output impedance divided by the ratio of open to closed loop gain, or $Z_c = Z_oG/A$. For $G = 1$, this value is identical to that previously derived.

To calculate Δ_1 (drift referred to the input), the same reasoning may be applied as for the case where $G = 1$, with almost identical results, the only difference being in the case of grid current in V_2. As before, any steady grid current I_2 may be counteracted by the manual zero adjustment, whereas the zero shift due to I_{2d} is simply I_{2d} times the parallel impedance offered by R_3 and R_4. Because R_3 and R_4 must be precision resistors to maintain constant gain, it may be safely assumed that no zero shift is to be expected from their change. However, in the event of any change, the zero shift is $I_2\ [R_3R_4/(R_3 + R_4)]_d$.

The total drift of the amplifier from all causes is

$$\Delta_1 = \Delta + I_{1d}\,R_s + I_1\,R_{sd} + I_{2d}\left(\frac{R_3\,R_4}{R_3 + R_4}\right) + I_2\left(\frac{R_3\,R_4}{R_3 + R_4}\right)_d \quad (7)$$

Then $\Delta_o = G\Delta_1$, which for most actual circuits is approximately $\Delta_1 = \Delta$.

Closed-Loop Gain < +1

Two methods of attaining a gain of less than one are illustrated in Fig. 4. Because of its low drift factor, the circuit of Fig. 4A is recommended for all cases where R_L is constant, since any change in R_L alters the output voltage accordingly; here $E_o = E_1R_L/(R_L + R_o)$. The circuit of Fig. 4B is recommended for use with a variable load.

For the same overall gain G, the circuit of Fig. 4A yields better performance in terms of drift and input impedance, whereas the circuit of Fig. 4B is better in terms of output impedance. The applicable circuit must therefore be chosen to fit individual requirements.

Some of the operations made possible through the use of this type of amplifier are listed in Table I, along with pertinent equations. A wider variety of functions may be had by using more complex external circuitry. The book "Electronic Time Measurements", Radiation Laboratory Series, p 292–293, contains an unusually long list of functions made available through use of the conventional inverse gain amplifier. The universal amplifier may be used to yield all of these functions by grounding input grid g_1, plus at least an equal number of functions by ungrounding g_1 and feeding an input signal thereto.

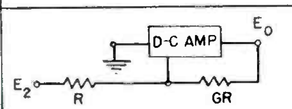
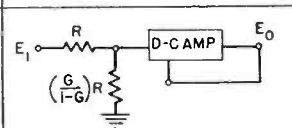
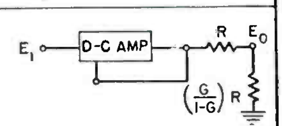
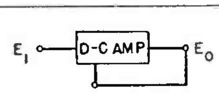
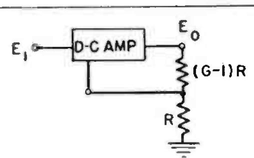
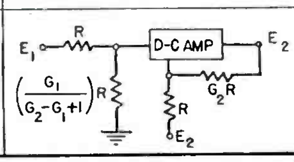
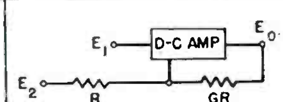
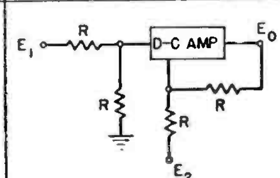
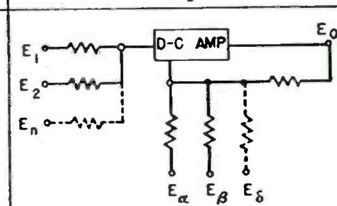
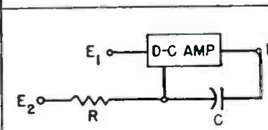
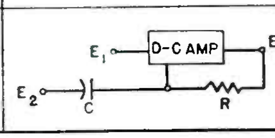
Mathematical Operations

Table I, example 1 is the conventional feedback circuit as illustrated in Fig. 1C. It yields any desired inverse gain.

Examples 2, 3, 4 and 5, all previously described, yield any desired gain without sign inversion.

Example 6 is the general case of subtraction of two variables, each with its own constant of multiplica-

Table I—Partial List of Mathematical Operations Made Available Through Use of Universal Amplifier

MATHEMATICAL FUNCTION AND CIRCUIT EQUATION	CIRCUIT
(1) MULTIPLICATION BY A NEGATIVE CONSTANT $E_0 = -GE_2$	
(2) MULTIPLICATION BY A POSITIVE CONSTANT LESS THAN ONE $E_0 = GE_1$	
(3) MULTIPLICATION BY A POSITIVE CONSTANT LESS THAN ONE $E_0 = GE_1$	
(4) MULTIPLICATION BY ONE $E_0 = E_1$	
(5) MULTIPLICATION BY A POSITIVE CONSTANT GREATER THAN ONE $E_0 = GE_1$	
(6) MULTIPLICATION OF TWO VARIABLES, ONE BY A POSITIVE CONSTANT AND ONE BY A NEGATIVE CONSTANT $E_0 = G_1E_1 - G_2E_2$	
(7) SPECIAL CASE OF EXAMPLE 6 $E_0 = (G+1)E_1 - GE_2$	
(8) SIMPLE SUBTRACTION $E_0 = E_1 - E_2$	
(9) MULTIPLICATION OF n VARIABLES, EACH BY A POSITIVE OR NEGATIVE CONSTANT $E_0 = (G_1E_1 + G_2E_2 + \ldots G_nE_n) - (G_\alpha E_\alpha + G_\beta E_\beta + \ldots G_\delta E_\delta)$	
(10) INTEGRATION $E_0 = E_1 + \frac{1}{RC}\int_{t=0}^{t}[E_1(t) - E_2(t)]\,dt$	
(11) DIFFERENTIATION $E_0 = E_1 + RC\frac{d}{dt}[E_1(t) - E_2(t)]$	

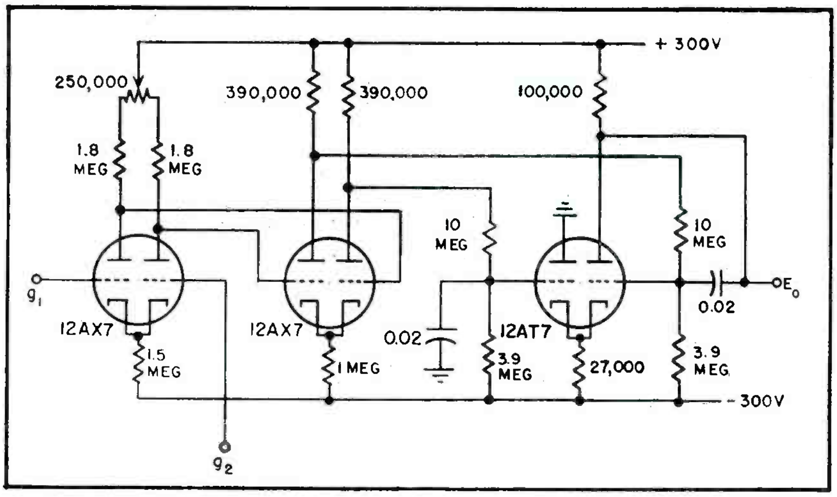


FIG. 6—Universal direct-coupled negative-feedback differential amplifier circuit used to verify the mathematical analysis

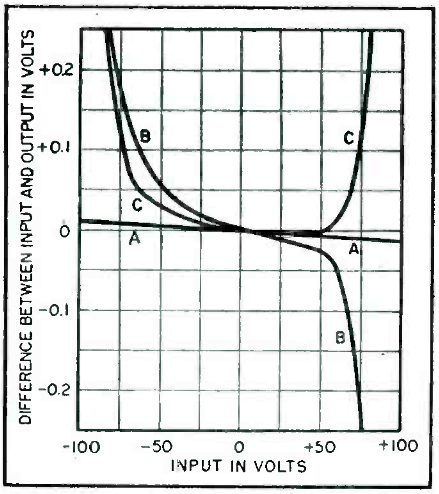


FIG. 7—Curves showing zero shift at various input levels for three combinations of tubes

tion. The equation is valid only when G_1 is less than $(G_2 + 1)$. When it is desired that $G_1 = (G_2 + 1)$, the input-shunting resistor becomes infinite, and the circuit is transformed into the special case illustrated as example 7.

In order to make G_1 greater than $(G_2 + 1)$, the inputs must be reversed and resistors adjusted accordingly. The sign of the output will then be inverted.

Example 8, for simple subtraction, is merely a special case of example 6 where $G_1 = G_2 = 1$.

Example 9 is the most general example of subtraction, wherein any number of inputs may be multiplied, each by its own constant, and mutually added and subtracted. The same limitation for gain is valid for this circuit as for example 6.

Example 10 yields either positive or negative integration, or, using two inputs as shown, integration as a function of the difference between two variables. Grounding input E_1, a conventional negative-going integrator is obtained, with both E_1 terms dropping out of the equation.

Grounding input E_2, the E_2 term drops out and the circuit equation is no longer a case of simple integration. Circuit action under this condition is shown in Fig. 5. Note that as an integrator, the output remains constant at whatever voltage it happens to be whenever the input is zero.

Example 11 yields either positive or negative differentiation, or using two inputs as shown, differentiation as a function of the difference between two variables. If input E_1 is grounded, both E_1 terms drop out of the equation. Similarly, with E_2 grounded the E_2 term drops out.

Test Results

Figure 6 shows the circuit of an amplifier which was constructed and thoroughly tested, and which gave results according to theory. Open-loop gain $A = 10{,}000$; $I_1 = I_2 = 10^{-10}$ amp; $I_{1d} = I_{2d} = 10^{-11}$ amp; $Z_o = 12{,}000$ ohms; Δ as a function of variation of the +300-v supply $= \pm 0.4$ mv per v; Δ as a function of variation of the −300-v supply $= \pm 0.35$ mv per v; Δ as a function of variation of the filament supply $= \pm 5$ mv per v; Δ as a function of variation in ambient temperature $= \pm 0.1$ mv per deg C.

The zero shift as a function of the level of the input signal (common mode effect), when connected for $G = 1$, is shown in Fig. 7. Observe that the amplifier operates over an input range of from −50 to +50 volts. Curve *A* shows the theoretical input-output curve when $A = 10{,}000$ and tubes V_1 and V_2 have identical characteristics. Curve *B* shows the actual results of the amplifier using a random 12AX7 in the first stage, while curve *C* shows the corresponding results using the same tube in reverse position. The deviation of curves *B* and *C* from curve *A* is caused by tubes V_1 and V_2 not having identical characteristics throughout the operating range of the first stage.

Note, however, that the amplitude of the zero shift for input signals of ±30 volts is only 2, 10, 17, or 25 millivolts in Fig. 7; this is at worst an error of less than 0.1 percent.

The primary purpose of presenting a particular circuit with test results is to make clear the fact that no trick circuitry is required, and that it is a simple matter to construct a reliable, low-drift amplifier.

Conclusion

In essence, the new circuit design lies in the use of a differential first stage wherein both grids are employed to receive input signals, rather than grounding one grid as is conventional in inverse gain circuitry. Since it is a basic open-loop amplifier, the circuit is capable of great versatility, and may be operated to perform any one of a multitude of functions by the proper choice of external circuitry. Some of the functions available are addition, subtraction, multiplication by a positive or negative constant, positive or negative integration or differentiation, and when connected open-loop, a high-gain differential amplifier.

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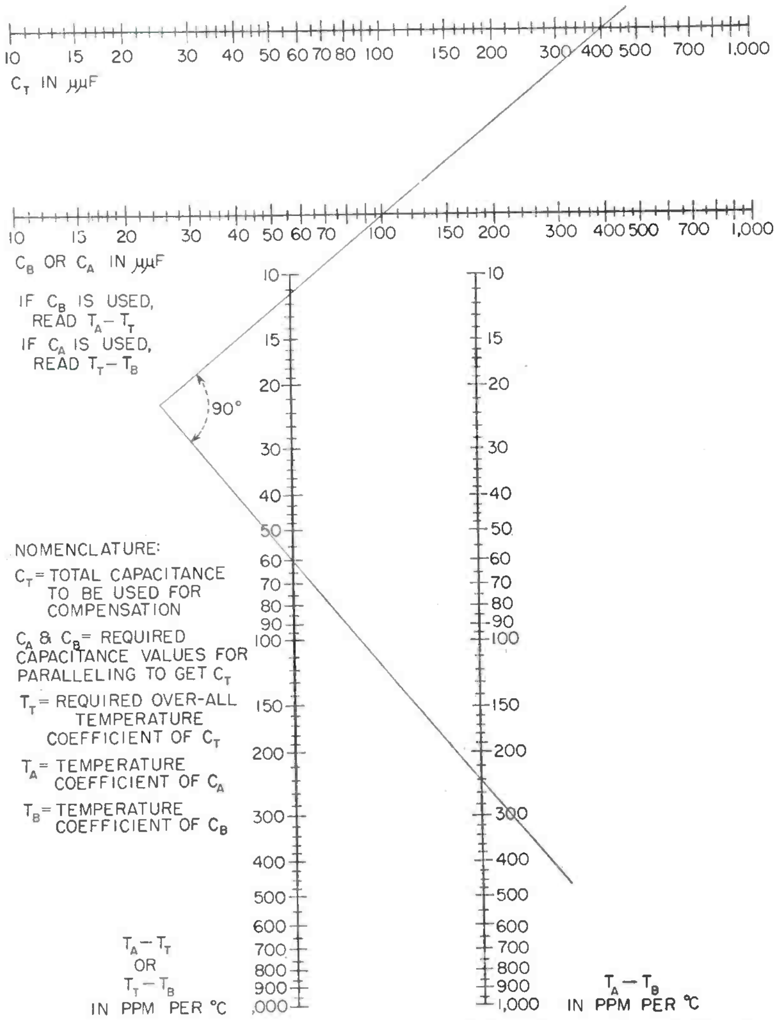
Edwin A. Goldberg, Stabilization of Wide-Band D-C Amplifiers for Zero and Gain, *The RCA Review*, June 1950.

Temperature-Compensating Capacitor Nomograph

By THOMAS T. BROWN

Aircraft Transmitter Department
Marconi's Wireless Telegraph Co.
Writtle, Essex, England

Gives directly with one setting of a celluloid triangle the capacitance values required when two temperature-compensating capacitors are paralleled. Solves problem of compensating a tuned circuit when a single capacitor having the required temperature coefficient is not available



Set-square nomograph, used with right-angle sides of any celluloid triangle

One of the most common ways of compensating for the effect of temperature coefficients of coils or capacitors on the frequency of a tuned circuit is by the use of ceramic capacitors of large negative coefficient in parallel with the normal mica or air-spaced capacitor. The values of these components are usually estimated by proportion and trial and error to get an overall temperature coefficient of zero. The accompanying chart gives these values directly.

To use the chart, set a triangle or set square to join two known values on two parallel scales. Then move the triangle back or forward along the line of intersection until its right-angle edge cuts the third value on the other scale. The unknown value is then read off where this edge cuts the remaining scale; i.e., each side intersects two values. A setting of three values on one edge is not valid.

The algebraic sign of an unknown value obtained from a vertical scale will be the same as that of the known value on the other vertical scale.

The range of the chart can be readily extended by multiplying the scales by factors of ten in any of the following four ways: all four scales, two parallel scales, top horizontal and right vertical or lower horizontal and left vertical pairs of scales.

Example 1

A fixed-frequency oscillator is tuned by a 400-$\mu\mu$f capacitor to 2 mc. The coil has a temperature coefficient of +40 parts per million per degree C, and it is required to compensate this to zero drift. Capacitors rated at

(Continued on page 134)

Temperature-Compensating Capacitor Nomograph (continued from page 132)

+20 ppm and −220 ppm are available. What are the values required?

Solution. $C_T = C_A + C_B$. $T_T = -40$ ppm, $T_A = +20$, $T_B = -220$ and $C_T = 400$, so that $T_A - T_T = +60$ and $T_A - T_B = +240$.

With one of the right-angled sides of a set-square or triangle on the nomograph, join the point 60 on the $T_A - T_T$ scale with 240 on the $T_A - T_B$. Now advance the perpendicular edge of the set-square until it cuts the C_T scale at 400 $\mu\mu$f, still keeping the other two points intersected, and read the required value of C_B as 100 $\mu\mu$f at the intersection on the C_B scale. The required values are thus a 100-$\mu\mu$f capacitor with −220 ppm temperature coefficient and a 400 − 100 = 300 $\mu\mu$f capacitor with +20 ppm coefficient, connected in parallel.

Example 2

In a particular wave analyzer, the low-frequency waveform is heterodyned by an oscillator working between 500 and 550 kc, and the harmonic components of the modulated wave are separated by a crystal filter. It is desirable to have this oscillator free from frequency variation due to changes in ambient temperature. The tuning capacitor to be used has a range of 50 to 300 $\mu\mu$f with the low-temperature coefficient of +20 ppm. The coil is wound on a ceramic form and has a coefficient of +80 ppm.

Since only a 10-percent frequency sweep is required, it will be necessary to pad out the capacitor to reduce the capacitance sweep to 20 percent; at the same time this capacitor can be used to provide temperature compensation. A 950-$\mu\mu$f unit in parallel with the variable capacitor gives a sweep of 1,000 to 1,250 $\mu\mu$f providing slight overlap at the ends of the scale. Exact temperature compensation is to be provided at the center of the band, which is 1,125 $\mu\mu$f.

Solution. Let C_T = 1,125 $\mu\mu$f, C_A = **950 $\mu\mu$f**, C_B = 175 $\mu\mu$f, and $T_B = +20$.

The overall coefficient of the capacitor combination to compensate for the +80 ppm of the coil will be given by $T_T = -80$, and therefore $T_T - T_B = -100$.

Multiplying scales C_T and C_A by a factor of 10, with 112.5 $\mu\mu$f on the C_T scale joined to 95 $\mu\mu$f on the C_A scale by one edge of a right-angle triangle, the other edge is advanced to intersect 100 on the $T_T - T_B$ scale, whence $T_A - T_B$ is read as 118. (Note that since the scales are logarithmic, the signs of the products of the right and left hand scales will be the same; thus $T_A - T_B = -118$ since $T_T - T_B = -100$. Should the corner of the triangle fall between the scales, as happens in this case, the perpendicular edge can be extended by bringing a rule or another triangle up to it. Scales C_A and $T_T - T_B$, and scales C_B and $T_A - T_T$ may only be used together, otherwise incorrect results will be obtained.)

Now $T_A - T_B = -118$, so that $T_A = -98$ ppm, which is the required coefficient for the 950-$\mu\mu$f capacitor.

It is interesting to check the total drift at the two ends of the band. When C_T = 1,250 $\mu\mu$f, C_A = 950 $\mu\mu$f and $T_A - T_B = -118$ and from the nomograph $T_T - T_B = -90$ and $T_T = -70$ ppm.

When C_T = 1,000, C_A = 950 $\mu\mu$f, $T_A - T_B = -118$ and from the chart $T_T - T_B = -114$ and $T_T = -94$ ppm.

Therefore, adding these values to the +80 ppm of the coil, it is seen that the drift varies over the band from −14 to +10 ppm, being zero at the center frequency. Frequency drift would be half these figures.

A 950-$\mu\mu$f capacitor with a negative coefficient of 98 ppm is not readily available, so this again will have to be another parallel combination of two capacitors. Since a silvered mica capacitor is generally a more stable component than a ceramic capacitor, it will be better to use a large mica capacitor with a low positive coefficient and a small ceramic with as large a negative coefficient as is available. Assume this to be −680 ppm, and that of the silvered mica to be +20 ppm. Then $T_A - T_B = 700$ and $T_A - T_T = 118$, and from the nomograph C_B = 100 $\mu\mu$f (ceramic) and C_A = 950 − 160 = 790 $\mu\mu$f (mica).

Appendix

Considering the incremental change in capacitance of two capacitors in parallel having different temperature coefficients, the following relationship holds: $C_A = nC_B = [n/(n+1)]\,C_T$, where $n = (T_B - T_T)/(T_T - T_A)$. By taking logs and putting $x = \log C_T$, $y = \log (T_A - T_B)$ and $z = \log C_B$, four simultaneous equations of the form $Ax + By + Cz + D = 0$ are obtained, which in determinant form are

$$\begin{vmatrix} 1 & 0 & 0 & -\log C_T \\ 0 & 1 & 0 & -\log (T_A - T_T) \\ 0 & 0 & 1 & -\log C_B \\ 1 & 1 & -1 & -\log (T_A - T_B) \end{vmatrix}$$

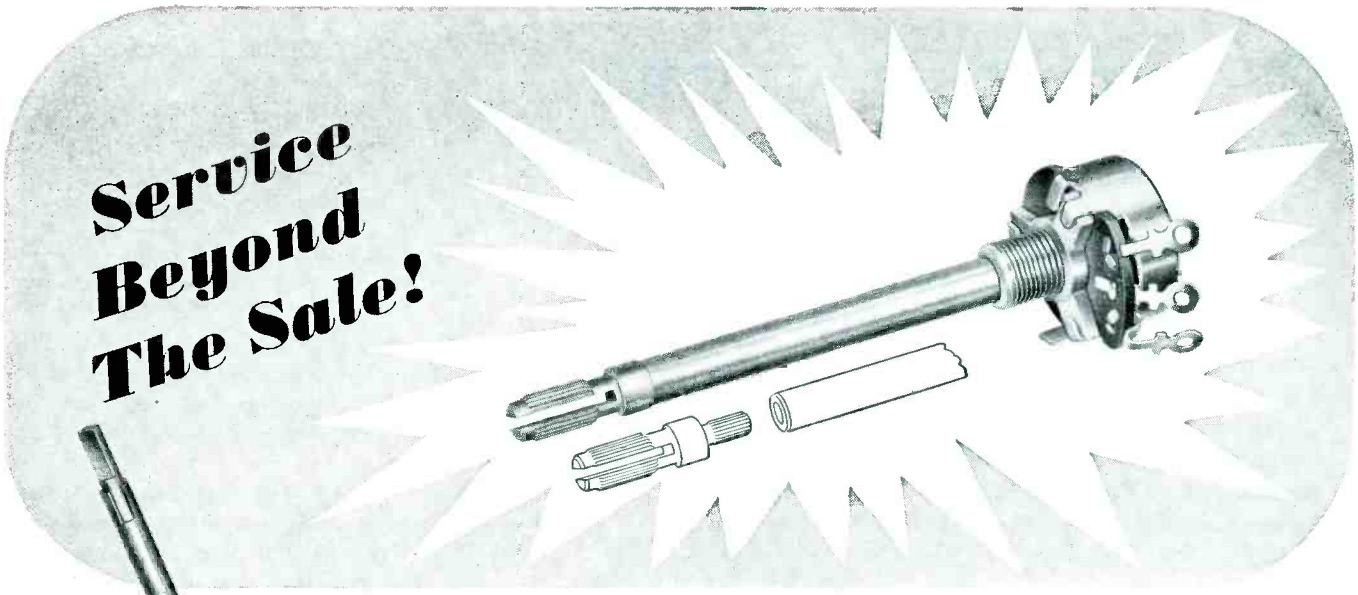
These can be converted into

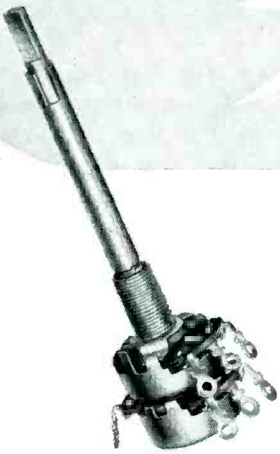
$$\begin{vmatrix} \log (T_A - T_B) & 1 & 1 & 1 \\ \log (T_A - T_T) & 0 & 1 & 1 \\ \log C_T & & 1 & 0 & 1 \\ \log C_B & & 0 & 0 & 1 \end{vmatrix}$$

and are now in standard determinant form

$$\begin{vmatrix} f(a) & g(a) & 1 & 1 \\ f(b) & g(b) & 1 & 1 \\ f(c) & g(c) & 0 & 1 \\ f(d) & g(d) & 0 & 1 \end{vmatrix}$$

satisfying the conditions of colinearity of the coordinates of any four variables *a*, *b*, *c* and *d* to permit the construction of a set-square nomograph. The second determinant can thus be interpreted as two vertical pairs of logarithmic scales spaced unit distance apart, in the *x*, *y* and *jx*, *jy* planes respectively.





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TUBES AT WORK

Including INDUSTRIAL CONTROL

Edited by RONALD K. JURGEN

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A-C Null Indicator

By Joseph C. Frommer

Electronic Consultant
Cincinnati, Ohio

Earphone null indicators provide an audible signal from low power but tie the operator to the apparatus. Speakers are more convenient in use but neither speakers nor earphones indicate phase or direction of the unbalance and the presence of uncancellable harmonics often makes it difficult to locate the exact null with the minimum of sound.

The advantages of observing the output of a-c-bridges on a cathode-ray tube were recognized early. To obtain information on the phase and the direction of the unbalance, the deflecting signal has to be synchronized with the bridge input. Figure 1 shows a block diagram of synchronized deflection. If the bridge input voltage is applied un-

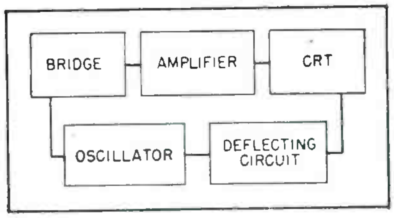


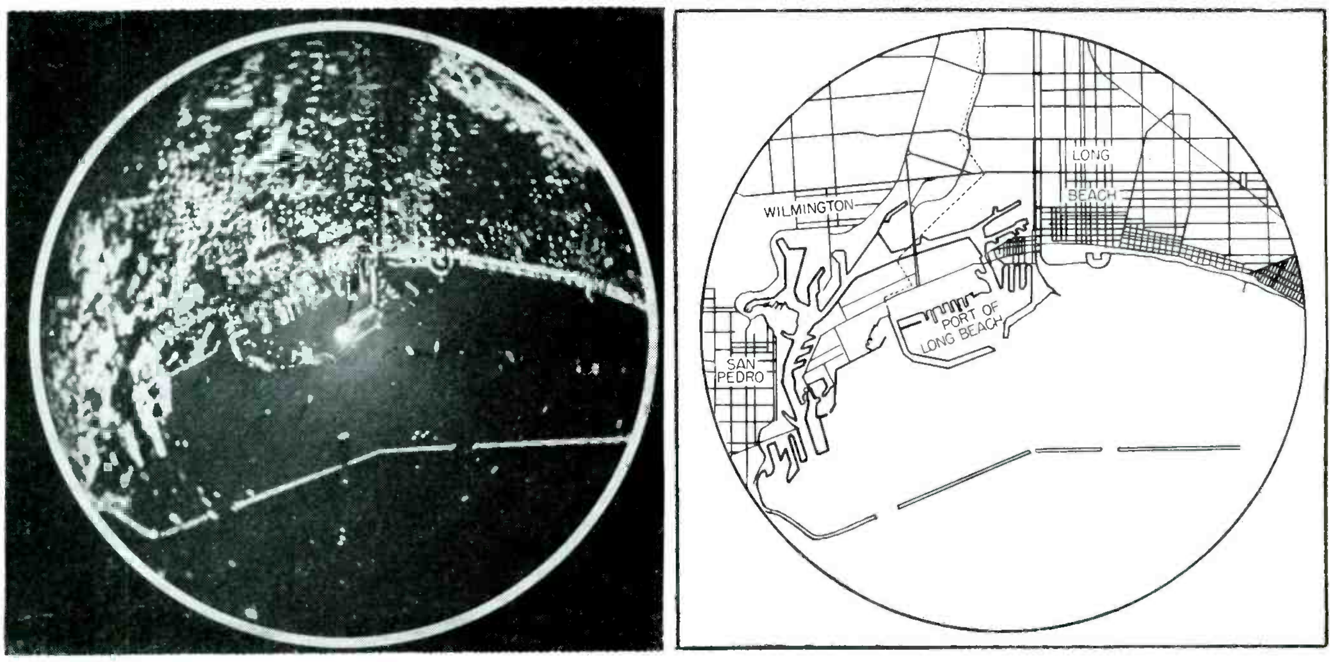
FIG. 1—Block diagram of setup used to obtain synchronized deflection of crt

changed as a deflecting signal, without being altered by the deflection circuit, the pattern on the crt screen assumes the shape of an ellipse.

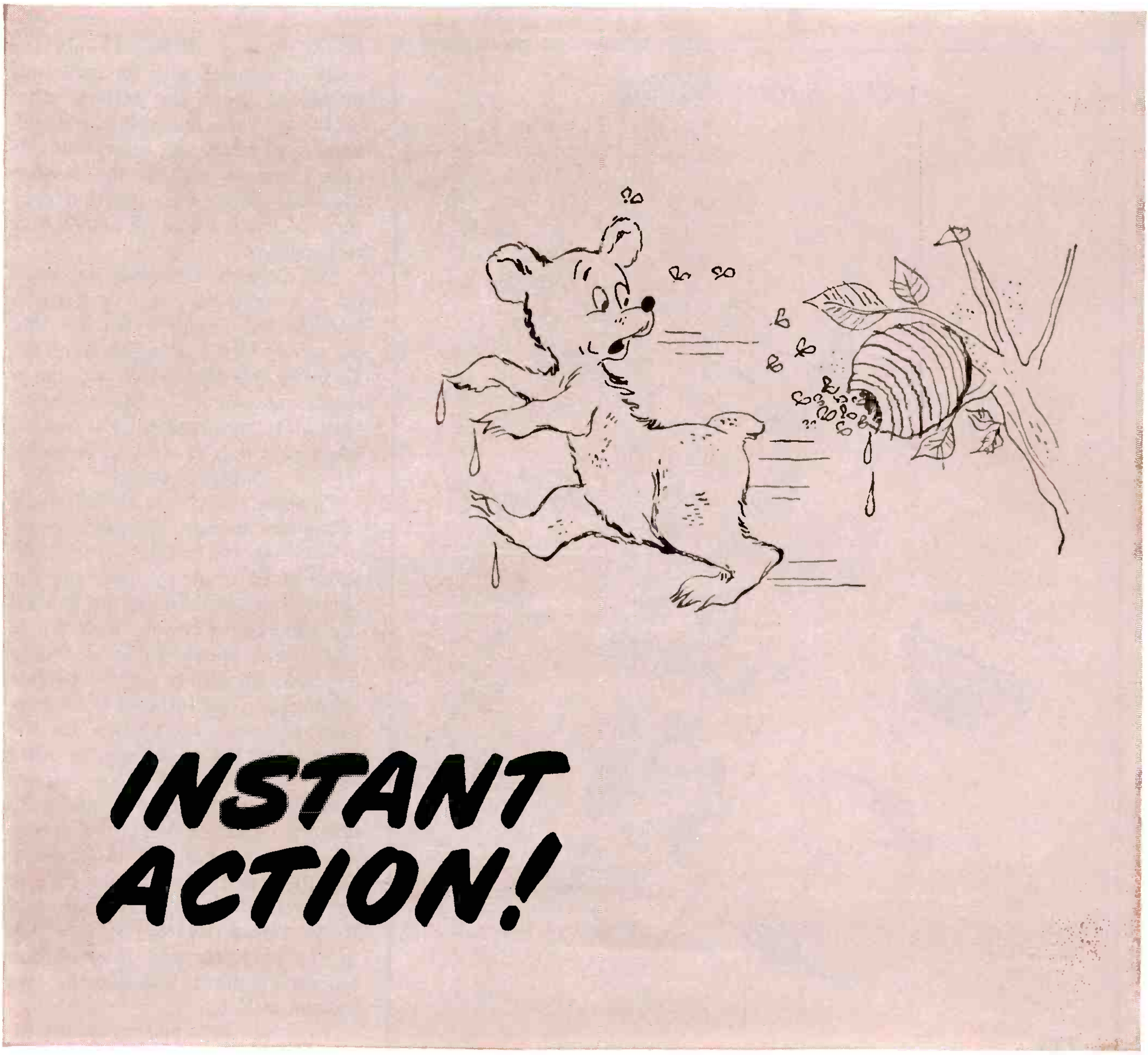
To get full advantage of synchronous deflection, the phase shift of the amplification of the signal to the horizontal plates has to be made equal to the phase shift of the signal to the vertical plates of the crt. With such an arrangement, the ellipse degenerates into a straight slanting line when the bridge output is in phase with the bridge input or when the bridge is properly balanced for phase and needs adjustment for ratio only. The principle axes of the ellipse are horizontal and vertical when the bridge output is 90-deg off phase, then the bridge is properly adjusted for ratio and needs readjustment only for phase.

Sketches *a*1 to *a*5 of Fig. 2 show

RADAR PICTURES CALIFORNIA HARBOR



Radar presentation of Long Beach Harbor (left) as compared with map of harbor (right). Outlines of breakwater, shore line and the many ships in the water are visible. Sperry Mark II, Model O radar used operates in the 3-cm band with frequency range of 9,320 to 9,430 mc, pulse rate 1,000 per sec. 0.25 μsec in width. Antenna on 120-foot tower has 4-ft reflector with beam width of 2 deg



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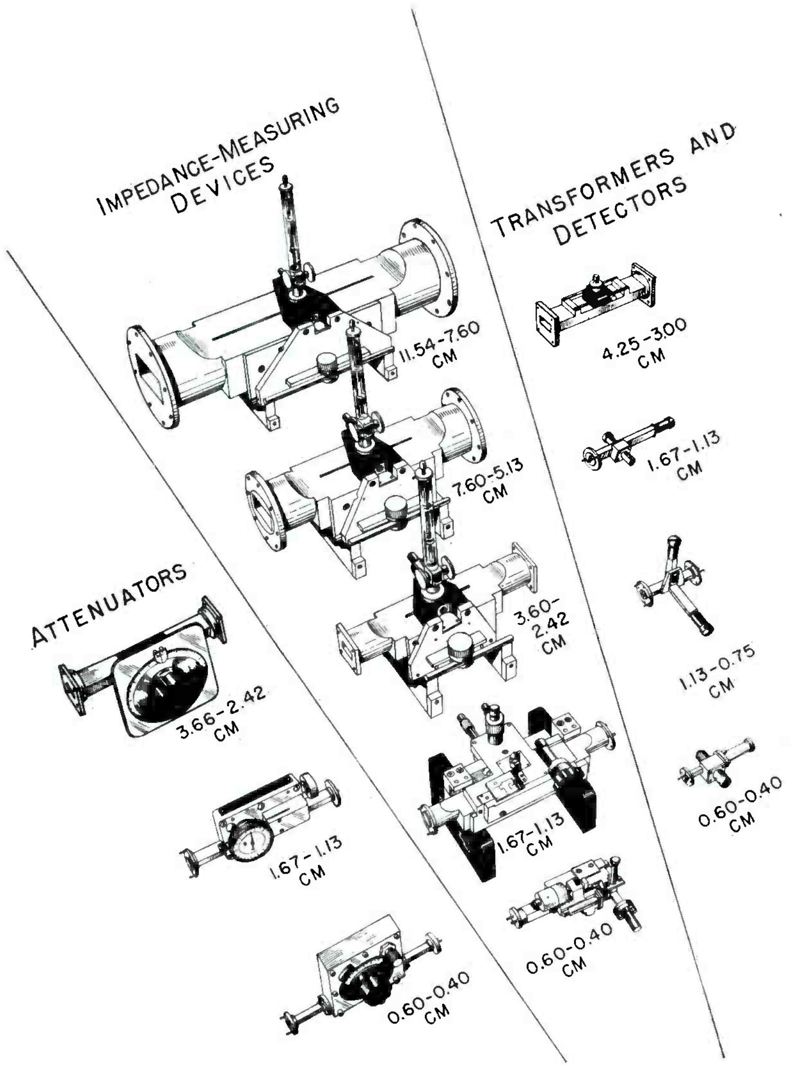

THE PRECISELY FABRICATED test-equipment items shown were developed and produced by the Polytechnic Research and Development Company, Brooklyn, N. Y., for use in the design and testing of the waveguide components of microwave radar and communications systems. The smallest units, operating in the so-called millimeter region of the electromagnetic spectrum, find additional use as components of microwave spectroscopes for the detection of molecular resonances.

The equipment pictured includes items in most of the commonly used waveguide sizes having major inner dimensions from approximately 3 inches for the largest to slightly over ⅛ inch for the smallest. Item identification and the operating ranges in wavelength are shown on the accompanying drawing.

the patterns obtained when the sine wave shown in sketch *a* is applied both to the bridge input and to the horizontal deflection. Sketch *a*, as well as sketches *b* and *c*, is drawn with a vertical time axis; the various bridge outputs are shown on sketches 1 to 5 with horizontal time axes. The patterns in the body of the figure are obtained by horizontal projection of points of the bridge output curve and vertical projection of the points of the deflecting signal curve pertaining to the same instant.

Sketch *a*1 shows the pattern obtained when the bridge is substantially off balance both for ratio and phase; *a*2 shows the pattern after balance of ratio is obtained without balance of phase; *a*3 shows the balance of phase without the balance of ratio; *a*4 shows a position very close to balance and *a*5 shows perfect balance.

The ultimate zero does not show up as sharply as could be desired, because the slightly slanting line *a*4 is very little different from the perfectly horizontal line *a*5, and a slight movement of the crt with respect to the graduated screen in front of it may cause a corresponding error in zero reading.

To obtain an unmistakable sharp indication of zero, the patterns *a*1 to *a*5 may be "folded over" into those of *b*1 to *b*5 by inverting the polarity of one half of the deflecting signal *a* as shown in sketch *b*. Any slight unbalance as shown in *b*4 shows up clearly against perfect balance, *b*5. Patterns *b*1 to *b*4 however give no information on the polarity of the unbalance, in other words in which direction adjustment has to be made to approach balance. Such information speeds up the operation of the bridge, especially if it is desired to apply agc to the vertical amplifier or if it is impossible to balance the bridge perfectly and interpolation has to be made between the two nearest values.

To obtain information on the direction of the unbalance it is necessary to tell one leg of the pattern from the other. This can be

(Continued on p 156)

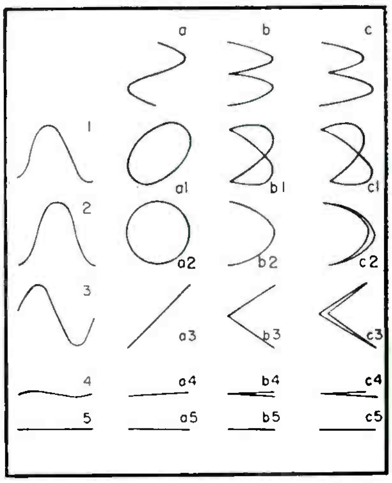

FIG. 2—Patterns obtained on cathode-ray tube. Explanation is given in text

THE ELECTRON ART

Edited by JAMES D. FAHNESTOCK

Checking Calibration of Loop Antennas 140
R-F Standard Capacitors for Minute Increments 250
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Checking Calibration of Loop Antennas

By P. C. Gardiner
General Engineering Laboratory
General Electric Company
Schenectady, N. Y.

FIELD-INTENSITY instruments, with loop antennas, are generally calibrated out in the open where field distortion is certain not to introduce error. A laboratory method of checking calibration, where loops are involved, developed in the General Engineering Laboratory of the General Electric Company has proved very satisfactory.

The usual laboratory calibration of field-intensity instruments using dipoles is satisfactory if the dipole signal output is simply replaced by a low-impedance signal generator output through a dummy impedance to obtain the gain of the instrument. The known dipole factor is then multiplied into this signal generator figure. The dipole is checked visually for change or damage. In the case of loops the loop-coupling transformer and associated circuits generally require an overall check of the calibration. Since an overall check including the loop normally involves a loop setup out in the open rather than in the confined copper-lined space of the laboratory, such a check is often omitted unless thought to be absolutely necessary.

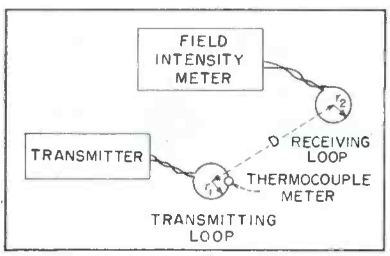


FIG. 1—Spaced loop arrangement

The National Bureau of Standards uses the spaced-loop method to establish a standard free-space quasi-static magnetic field, Fig. 1, with a single turn transmitting loop of a 10-cm radius wherein the current is measured by means of a thermocouple. Loops are in parallel planes at right angles to axis through loop centers. This calibrating setup is made in a cleared space where a distance of at least three times the spacing between the loops exists to the nearest metal wall or large metal object.

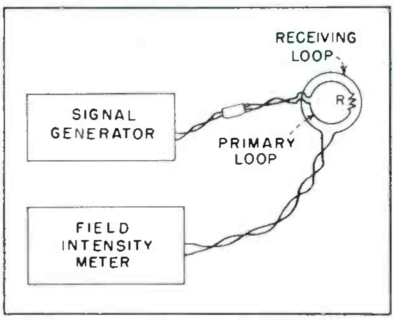


FIG. 2—Close-coupled loop arrangement

The following expression is used to give field intensity at the receiving loop:

$$E = \frac{60\,\pi\, N_1\, r_1^2\, I_1}{(D^2 + r_1^2 + r_2^2)^{\frac{3}{2}}} \sqrt{1 + \left(\frac{2\,\pi\, D}{\lambda}\right)^2} \quad (1)$$

where

E = equivalent free-space electric field, in microvolts per meter, (effectively at the receiving loop),

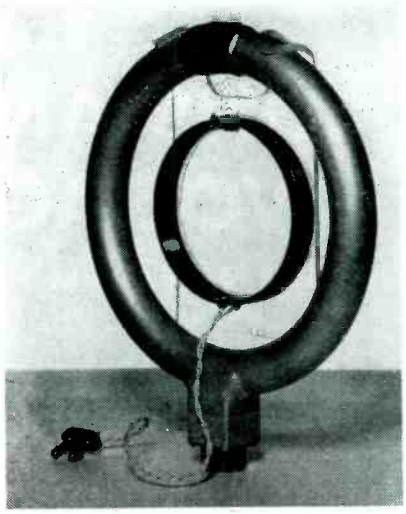


FIG. 3—View of typical 12-inch diameter receiving loop showing temporary jig-mounted primary coil at approximate center

r_1 = radius of transmitting loop, in meters. To keep a uniform current in the transmitting loop make $r_1 < 0.02\lambda_2$

r_2 = radius of receiving loop, in meters. If receiving loop is rectangular use equivalent radius of circle having same area,

D = spacing between loops, in meters,

I_1 = transmitting loop current, in microamperes.

N_1 = number of turns in transmitting loop, and

λ = wavelength, in meters.

The expression under the radical is usually neglected below 10 megacycles and is less than 1.05 below approximately 15 megacycles. This formula gives approximately one-percent accuracy up to 30 megacycles.

The first term of the expression generally is not accurate for much closer spacing than 1 meter. On the other hand the distance D appears under the radical in such a way as to make it desirable to use D as small as possible for higher frequencies.

The mutual inductance between two such spaced loops may be calculated by formula 187 of Bureau of Standards Circular 74 and then used as described later in this article to calculate the effective field intensity at the receiving loop, as an alternative in place of the procedure with Eq. 1.

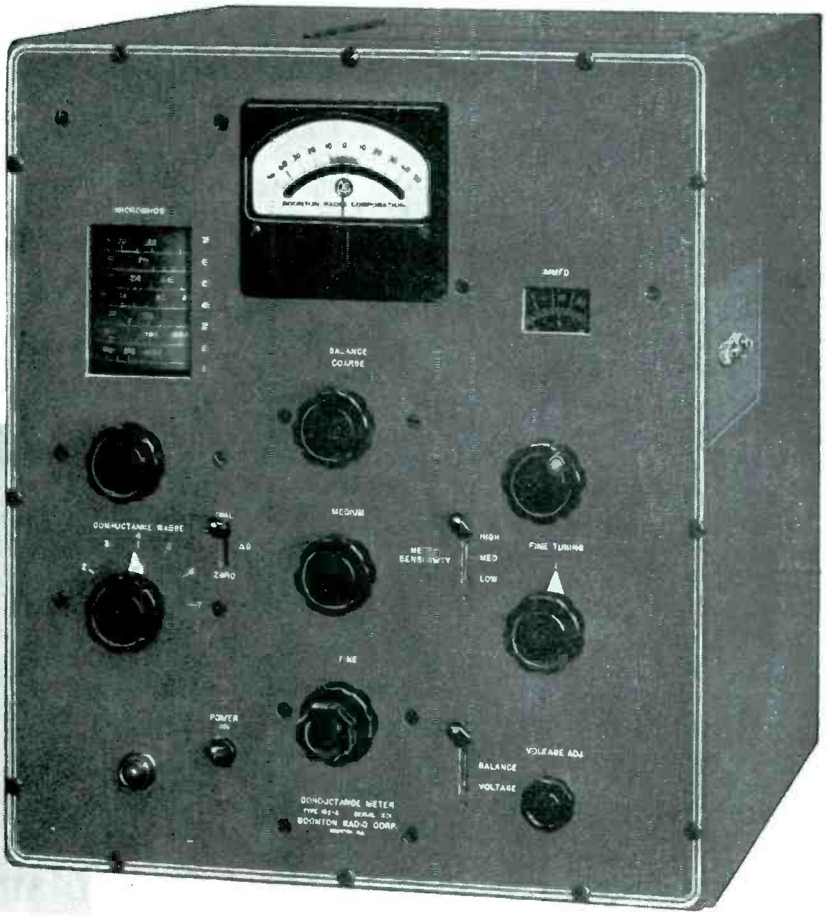
Close-Coupled Loop Method

Centering the primary loop within the receiving loop, with a jig mounting, provides a convenient

A Conductance Measuring Instrument

G meter

Type 192-A



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- **Dynamic impedance of resonant circuits.**

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The G Meter, 192-A, employs a crystal controlled oscillator to supply a constant amplitude voltage to a high quality reference tuned circuit. A calibrated precision loss circuit and a differential VTVM are internally connected across the resonant circuit. External means are provided for connecting test samples across the same resonant circuit. By substituting internally connected values of calibrated loss and capacitance for the test sample, to secure a reference voltage, the conductance and capacitance of the sample may be determined. The differential VTVM provides very great sensitivity to changes from the reference voltage allowing very accurate settings of the conductance and capacitance dials.

SPECIFICATIONS

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CAPACITANCE RANGE: 0 to 100 micro-micro-farads—Direct reading. (Simple indirect method allows measurements to 1000 mmf.)

FREQUENCIES: 1 mc. and 30 mc. crystal controlled.

SENSITIVITY: 10% Deflection of Panel Meter results from conductance change of 0.003 micromhos at 1 mc. and 0.03 micromhos at 30 mc.

VOLTAGE ON TEST SAMPLE: 20 to 35 volts RMS.

LINE VOLTAGE: Internal regulation permits operation over range of 105-125 volts.

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BOONTON RADIO *Corporation*

BOONTON, N.J. U.S.A.

arrangement with a signal generator that can be set up in the laboratory so rapidly and easily that loop-calibration-check may be used as a routine rather than as an exceptional elaborate measurement.

This procedure, of course, depends upon whether or not such close coupling of the primary constants can be kept from appreciably influencing the receiving loop circuit constants and further on whether or not close metal wall reflection can be avoided. A high primary circuit impedance is obtained with the use of considerable primary resistance and wall reflection is found to be negligible at two or more loop diameters.

Figure 2 represents the relative proximity of the two loops and emphasizes that with this arrangement it is not necessary to use a transmitter nor a thermocouple meter. In a radio laboratory one thing above all others that must be depended upon is the signal generator. A calibrated voltmeter may also be used across the signal-generator output terminals.

The primary (the signal generator loop) does not need to transfer appreciable proportion of its constants into the receiving loop. If the receiving loop is not shielded, special precautions must be taken to avoid capacitive effect, such as the balancing of both loops.

In the cases of primary concern here, namely where the receiving loop is shielded to eliminate antenna effect, both loops may be unbalanced with only the precaution that the primary loop should be of one turn and of approximately 6-inch diameter in the range 100 kc to 30 mc. Below approximately 100 kc the use of several turns in the primary loop does no harm.

It is well known in radio transformer design that a primary winding, placed concentrically and coaxially with the secondary, is not critical as to exactness of position. Such a primary loop may therefore be mounted with a jig for rapid placement into the center of the receiving loop for quick laboratory calibration. The jig mounting may be simple, consisting of two hooks for hanging and a stop-arm at the bottom for three-point support as shown in Fig. 3.

The basic relationship giving the effective field intensity delivered to the receiving loop by this primary loop is:

$$E = \frac{V}{H} = \frac{\omega M\, 10^{-6}\, I}{1.35\, A\, N\, f\, 10^{-11}}$$

$$= \frac{2\,\pi\, f\, M\left(\frac{e_g}{R}\right)}{1.35 \pi r_2^2\ N\, f\, 10^{-5}}$$

$$= 148{,}000\,\frac{M\, e_g}{r_2^2\ N\, R} \qquad (2)$$

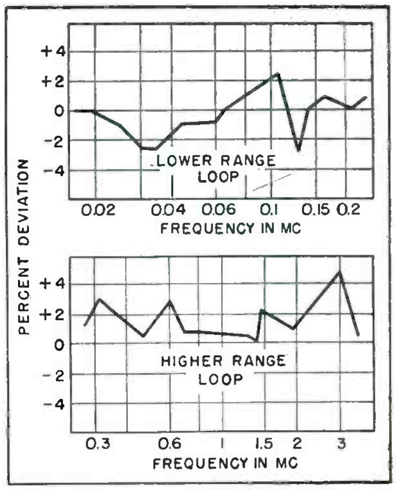


FIG. 4—Actual performance of sample jig-mounted calibration loops shown as percent deviation from standard obtained with method of Fig. 1

$$= 23{,}600\,\frac{V}{r_2^2\ N\, f\, 10^{-6}}$$

where

V = induced signal value in receiving loop in microvolts and may be measured directly thereby avoiding the use of M,
H = effective height of receiving loop in meters,
A = area of one turn of receiving loop winding in square inches,
N = number of turns in receiving loop,
f = frequency in cycles,
M = mutual inductance between transmitting loop and receiving loop in microhenrys,
R = resistance in series with primary loop, in ohms,
I = current in transmitting loop in microamperes, and
e_g = signal generator output in microvolts.

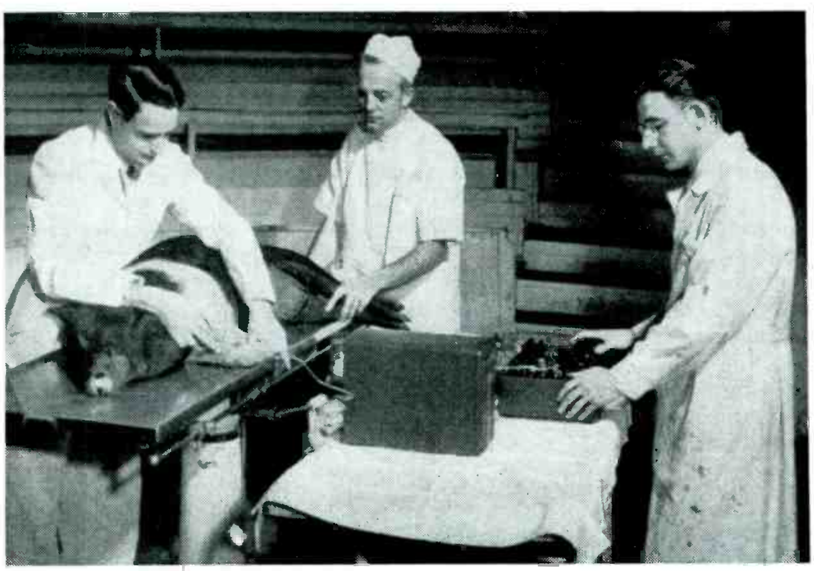
Compairing Eq. 1 and 2 it is evident that in Eq. 1 the only constant of the receiving loop that must be known is the effective radius, and that value may be very approximate where the loop spacing is substantially greater.

In Eq. 2 the number of receiving loop turns must be known and this is generally available. The mutual inductance between the two loops must be calculated or measured, but once this is obtained, the measurements thereafter are extremely simple.

The disadvantages with the spaced loop method are namely: (1) the open space set up for every calibration, (2) the accurate spacing between loops, (3) the requirement of a low radiation transmitter, (4) the careful use of a thermocouple meter, all add up to more than offset the original ascertain-

(Continued on p 244)

HEAT MEASUREMENTS ON LIMPING HOG AID MEDICAL RESEARCH



Seeking information on causes and cures for arthritis has led a group of Purdue University researchers to use electronic measuring equipment to determine the heat within the joints of an afflicted hog. Tests show similarity between symptoms displayed by humans and hogs

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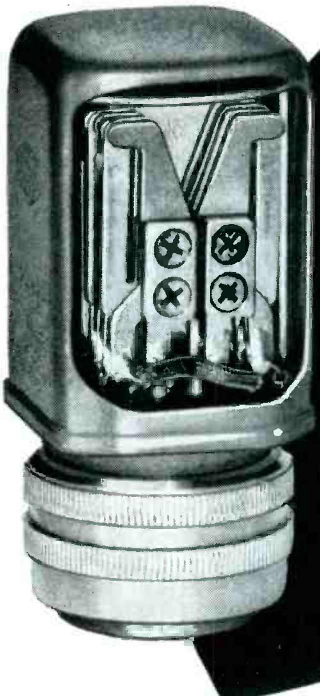

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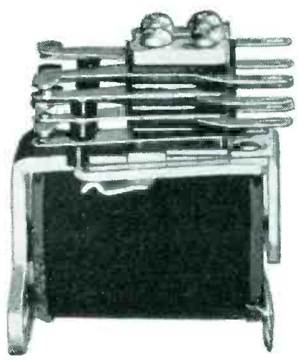

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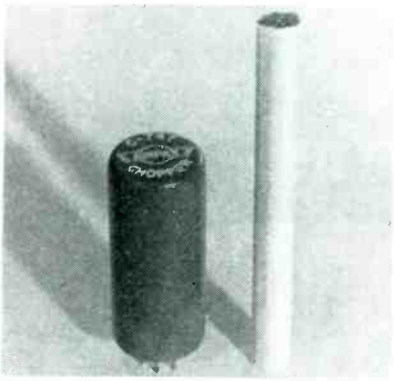
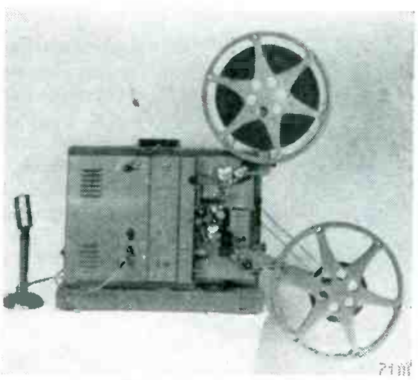


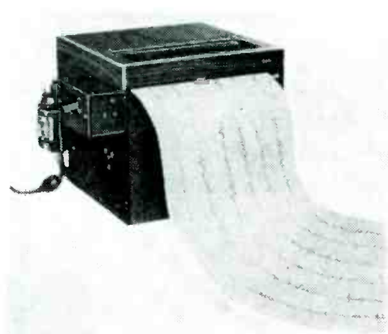
Midget Chopper

AIRPAX PRODUCTS CO., Middle River, Baltimore 20, Md., has released a new midget 400-cycle chopper, similar to its regular chopper but smaller and lighter. Weight is 37 grams. Model C747, illustrated, has a 6-volt 400-cycle drive, spdt contacts, contact phase angle of 65 deg and residual noise less than 1 mv. It is hermetically sealed and is designed to comply with AN specifications.



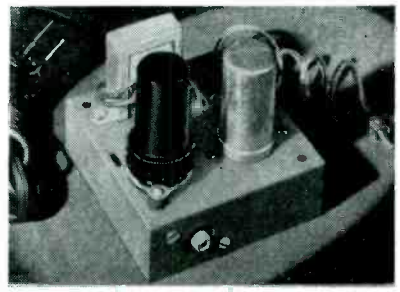
Magnetic Sound Film Projector

RADIO CORP. OF AMERICA, Camden, N. J. Model 400 recorder-projector provides a means of directly recording sound magnetically on the edge of 16-mm picture film. In addition to recording and reproducing magnetic sound it can also be used to reproduce optically recorded sound. Three main features are: (1) To record it is necessary only to turn a switch and talk or play music into a plug-in microphone. (2) After completing the recording another control may be set for immediate playback. (3) If revisions are needed or re-recording desired, an electronic erase head may be activated by another control. The equipment permits recording and reproduction of sound over a frequency range of 80 to 7,200 cycles with background noise virtually eliminated.



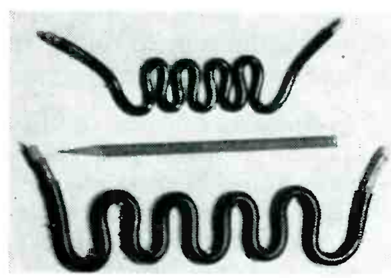
High-Speed Oscillograph

OFFNER ELECTRONICS INC., 5320 North Kedzie Ave., Chicago, Ill. The Dynograph, a direct-writing, high-speed oscillograph, designed for applications where there is a need for simultaneous recordings of rapid transients, is capable of replacing photographic recording of many variables. Features include a pen-deflection linearity of 1 percent with pen response of 1/120th of a second; sensitivity of 150 μv d-c per cm of pen deflection; stability and drift-free operation through a special chopper-type amplifier; no extra equipment needed with reluctance-type pickups and true differential input obtained through special transformer coupling.



Preamplifier

FISHER RADIO CORP., 41 E. 47th St., New York, N. Y., has designed model PR-4 high-quality preamplifier to meet the need for a self-powered, moderate-cost unit. It can be used with low-level magnetic pickups of any make, and can also be used as a microphone preamplifier. Outstanding features are: hum level better than 60 db below 1-v output in both phonograph and microphone use; frequency response, uniform within 2 db from 30 to 20,000 cycles on all applications; high-gain—on phonograph, 20 mv input to produce one-volt output, and on microphone, 5 mv input to produce one-volt output. Complete installation and service manual, as well as all necessary connecting plugs, are supplied with each unit.



Flexible Coax Cables

COLUMBIA TECHNICAL CORP., 5 E. 57th St., New York 22, N. Y., has available a line of German-made coaxial cables designed for installation in electronic apparatus and in transmission systems particularly around bends and where space is limited. These flexible cables fea-

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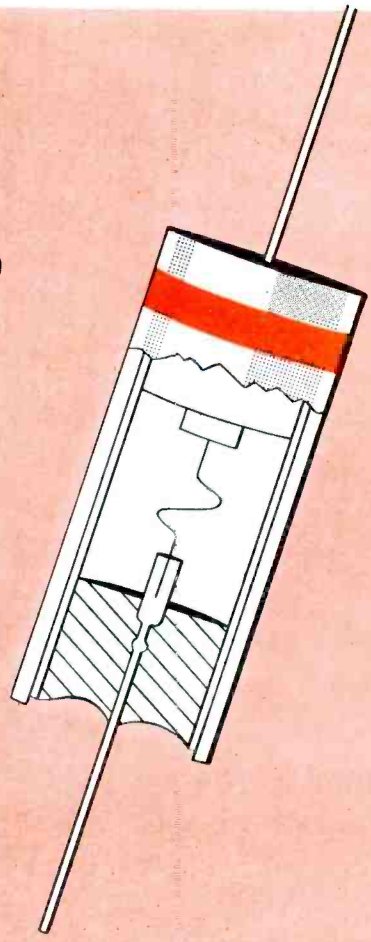

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Average Rectified Current (ma.)	50	35	35	35	25	50	35	35
Peak Rectified Current (ma.)	150	125	100	100	75	150	100	100
Surge Current (for 1 sec.) (ma.)	500	300	500	500		500	500	500
Ambient Temperature for all types	— 50 to +100°C.							
CHARACTERISTICS (at 25°C.)								
Max. Inverse Current at — 0.5 volts (ma.)					0.2			
Max. Inverse Current at — 5 volts (ma.)			0.008				0.005	
Max. Inverse Current at — 10 volts (ma.)	0.05					0.05		
Max. Inverse Current at —50 volts (ma.)	0.8		0.10			0.8	0.05	
Max. Inverse Current at —100 volts (ma.)				0.625				0.625
Min. Forward Current at +1 volt (ma.)	5.0		3.5	3.0		5.0	4.0	3.0
Min. DC Reverse Voltage for Zero Dynamic Resistance (volts)	70	50	100	120		70	100	120
Shunt Capacitance (uuf)	1.0	1.0	1.0	1.0		1.0	1.0	1.0
Rectification Efficiency at 54 mc (approx. %)		60						
Rectification Efficiency at 100 mc (%)						35 (min.)		
Oscillator injection current (ma.)					0.75*			

*Conversion loss at 500 mc. and noise factor comparable with 1N21B

†1N66, 1N67 and 1N68 must also pass humidity tests.

Other types are available for special applications.

RAYTHEON MANUFACTURING COMPANY

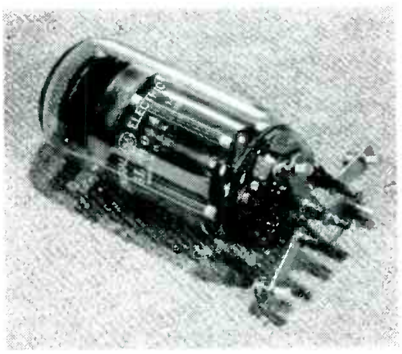
SPECIAL TUBE SECTION • Newton 58, Massachusetts

SUBMINIATURE TUBES • GERMANIUM DIODES and TRIODES • RADIATION COUNTER TUBES • RUGGED LONG LIFE TUBES

RAYTHEON

Excellence in Electronics

ture a semi-solid polyethylene base dielectric. At present several types of coax cables in the 50 and 70-ohm groups are available, their electrical characteristics and physical dimensions corresponding to those of American type RG58U, RG5U, RG8U, RG59U and RG11U cables.

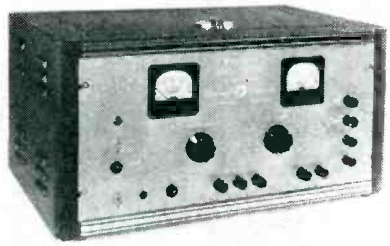


Control Thyratron

GENERAL ELECTRIC CO., Syracuse, N. Y., is now producing the GL-6044 heavy-duty thyratron designed especially for the exacting requirements of airborne electronic-control equipment. Instead of the usual prong-type base, it has contact terminals extending at right angles from heavy support rods at the bottom on the tube. This helps secure bolting to a control panel and avoids vibration trouble. The tube will operate efficiently from temperatures as low as −55 up to 120 C at normal atmospheric pressure. It is inert-gas-filled and has a current rating of 6.4 amperes. The indirectly heated cathode is rated at 2.5 volts at 17 amperes.

Grid Dip Meter

SYLVAN ELECTRONIC LABORATORIES, INC., Broadalbin, N. Y. Type GDO-1 grid dip meter covers the frequency range from 1.5 to 300 mc, with 7 plug-in coil ranges. The unit features a probe-type oscillator, built-in coil storage compartment, a large easily-read $4\frac{1}{2}$-in. microammeter, internal modulation and a calibration accuracy of 0.02 percent measured at 30 mc.

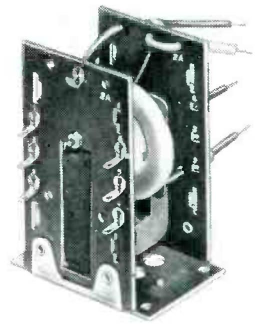


Regulated Power Supply

UNIVERSAL ELECTRONICS CO., 2012 South Sepulveda Blvd., Los Angeles 25, Calif. Model 100A compact regulated power supply furnishes from 0 to 200 ma at voltage continuously variable from 0 to 325 v d-c without switching. Bias voltage supplied can be varied from 0 to 150 v with 2 ma maximum. Also furnished from the unit are two independent outputs of low a-c voltage that may be used separately or combined to furnish either 12.6 v at 3 amperes or 6.3 v at 6 amperes. The high voltage varies less than 0.2 v from no load to full load. Internal impedance is less than 1 ohm d-c and less than 0.2 ohm from 20 cycles to 50 kc.

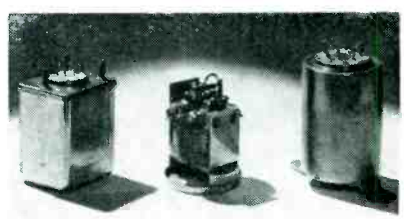
UHF Radio Noise & Field Strength Meter

MEASUREMENTS CORP., Boonton, N. J., has incorporated the "slide-back" technique in the vtvm circuit of their model 58 uhf radio noise and field strength meter. This new feature makes possible more accurate noise measurements of short pulses having a slow repetition rate, or a random variation in magnitude over a considerable period of time. The unit, covering the 15 to 150-mc range is widely used for the measurement of steady carrier voltages or fields; line loss; front-to-back ratios of directional antennas; signal-to-noise ratios of antennas; effectiveness of noise filters and for the investigation of ignition and other types of radio noise.



TV Replacement Unit

STANDARD TRANSFORMER CORP., 3578 Elston Ave., Chicago 18, Ill. The A-8130 horizontal deflection output and high-voltage transformer is for use in pulse-operated single-rectifier power supplies to deliver up to 14,000 volts of anode potential with adequate sweep for full horizontal scan of 65 to 70 deg kinescopes having up to 24-in. screens. It may be used for conversion of older tv receivers to take newer picture tube types, and requires 3-27 mh width control coil. Overall height of the unit is $4\frac{1}{16}$ in., with a base area of $2\frac{7}{8}$ in. × $2\frac{3}{16}$ in.



Balanced-Armature Relays

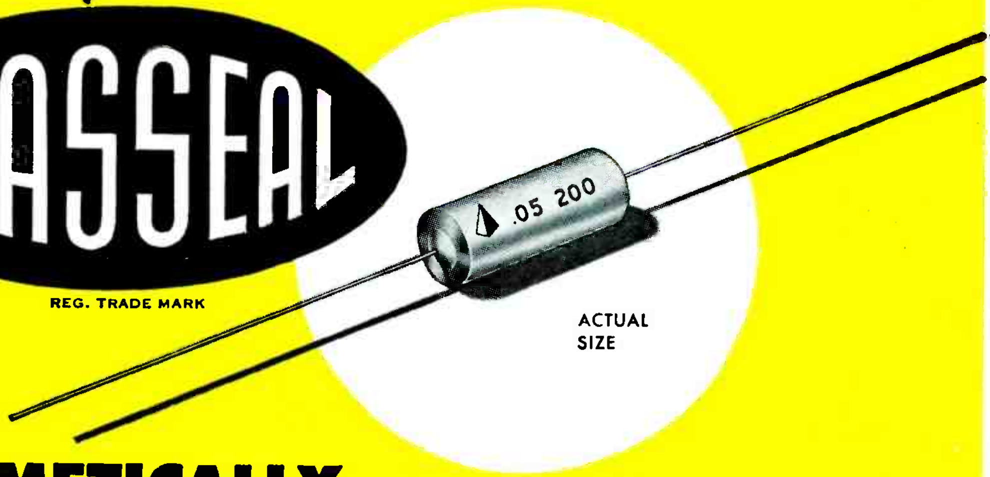
ELECTRO-MECHANICAL SPECIALTIES CO., 6819 Melrose Ave., Los Angeles 38, Calif., has announced a line of relays emphasizing balanced armature and available up to 3-pole

(Continued on page 278)

Announcing

GLASSEAL

REG. TRADE MARK



HERMETICALLY-SEALED *Miniature* TUBULAR PAPER CAPACITORS by PYRAMID

Pyramid Type PG "GLASSEAL" miniature paper capacitors are assembled in metal tubes with glass-metal terminals. They will fully meet the most exacting demands of high vacuum, high pressure, temperature cycling, immersion cycling and corrosion tests.

TEMPERATURE RANGES: −55° to +125°C.

CAPACITANCE RANGE:	.001 mfd. to 1.0 mfd.
VOLTAGE RANGE:	100 to 600 v.d.c. operating

Your inquiries are invited

PYRAMID Electric Company

GENERAL OFFICES and PLANT NO. 1
1445 HUDSON BLVD. • NORTH BERGEN, N. J.

PLANT NO. 2
155 OXFORD ST. • PATERSON, N. J.

NEWS OF THE INDUSTRY

Edited by WILLIAM P. O'BRIEN

Air Force Commissions Available

AN OPPORTUNITY to step directly from civil life into a commission in the Air Force Reserve has been held out to men with a university degree and qualifying experience in electrical, communications, radio or electronics engineering, or who have a science degree and majored in one of the foregoing engineering fields.

These men, according to Major Charles D. Morat, director of personnel procurement of the First Air Force, at Mitchel Air Force Base, N. Y., will, if they qualify, be commissioned from second lieutenants to majors, depending on age, as Electronics Officer, Air. Applicants for second lieutenants must have a master's degree in one of the specified fields, or a bachelor's degree plus a full year of qualifying experience.

Further inquiries should be addressed to: Dept. of Military Personnel Procurement, Headquarters, First Air Force, Mitchel Air Force Base, New York.

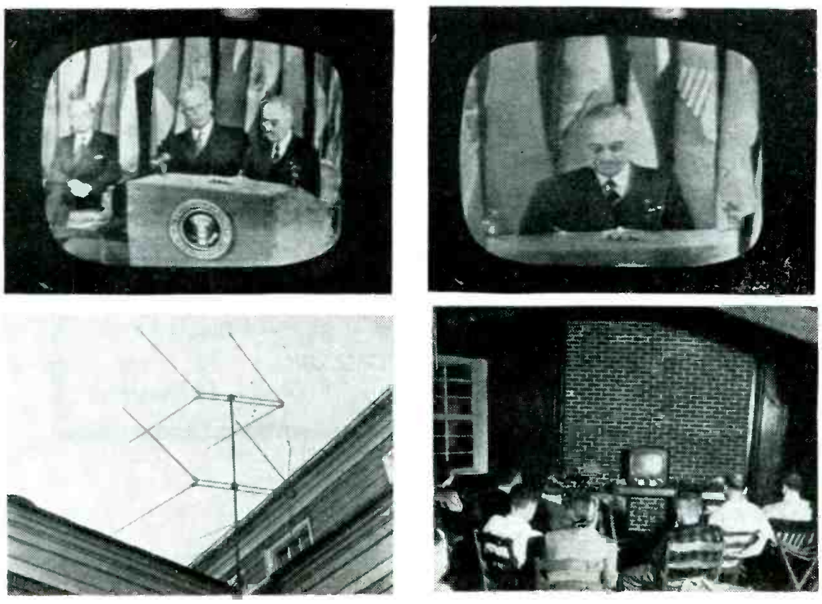
Mobile Relay Stations

THE Federal Communications Commission has adopted final rules to govern the licensing of Mobile Relay Stations in the Industrial and Railroad Radio Services. The stations themselves will be fixed but will relay signals from one mobile unit to another. With such stations, never before licensed, it will be possible to relay messages automatically between cars or locomotives up to 50 miles apart.

In general, such relay operation will be confined to messages received on frequencies above 47 mc in special situations where the applicant for such service can show a real need. In addition, the new relay stations must, in general, select for transmission only those messages specifically directed to them.

Details of the proposed operation will be resolved after hearings for which all notices must be filed by October 15, 1951.

TRANSCONTINENTAL TV-PLUS



These images of the opening of the Japanese Peace Treaty Conference, photographd by Don Fink while on vacation in the White Mountains, represent the end of the line during the inauguration of the A. T. and T. transcontinental microwave relay system on September 4th. Involved in the transmission were 107 relay stations from San Francisco to New York, plus seven similar microwave stations from New York to Boston, plus a 140-mile direct hop on channel 7 to the Summit House atop Mount Washington (altitude 6,293 feet). The last hop was terminated in a double-V antenna (lower left) which fed a standard 17-inch table model receiver (lower right) without benefit of booster

Tube Salvage Announced

IT is now possible to salvage used Eimac tubes, according to a recent announcement by Eitel-McCullough, Inc., San Bruno, Calif. Maximum salvage values have been listed for 54 tube types, ranging from 25 cents to 30 dollars, depending on the type.

Some of the better known types in the tube list are: 2-150D, 2C39, 3C24, 3X2500A3, 4-125A, 4-1000A, 6C21, 35T, 75TH, 100TH, 100TL, 250R, 304TH, 450TH, and 1000T.

In order that customers may get the maximum allowance for tubes returned, the company advises that (1) no salvage value is attached to the glass envelope, but metal parts must be received in good condition; (2) filaments are not repairable and hence a broken filament does not detract from the salvage value; (3) tungsten leads and supports are used and the plate may usually be reprocessed; therefore, these should be received in good condition.

Manpower Convocation

A CONVOCATION of engineers, educators and industrialists to discuss what must be done to maintain and increase the national supply of engineers needed both for the civilian economy and the armed services will be held September 28. The meeting has been organized by the Engineering Manpower Commission of Engineers Joint Council and will take place in Stephen Foster Memorial Hall on the campus of the University of Pittsburgh, Pittsburgh, Pa.

Purpose of the convocation is to establish a grass-roots program to convince the general public of the vital importance of the technical

BSR rotocam range
G.U.4.(3 SPEED) PHONOGRAPH UNIT
M.U.14.(3 SPEED) PHONOMOTOR
M.U.15.(78 rpm) PHONOMOTOR
The BSR range of Phonographs now leads the field in both design and appearance. The resources of a modern factory coupled with years of experience enable us to make these claims and still sell at competitive prices.
MODELS ILLUSTRATED
GU4. Three speed Phonograph unit with high fidelity pick-up and automatic stop. The pick-up is complete with two permanent sapphire stylii and the turntable is fitted with removable rubber mat. MU14. Three speed Phonomotor. Speed change is effected merely by rotation of the speed change knob. The turntable diameter is 10 inches. MU15. Phonomotor for 78 R.P.M. only, employs an 8 inch diameter turntable and is extremely robust, reliable and inexpensive.
Further details available on application.
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SAMCO PRODUCTS COMPANY
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Made by Birmingham Sound Reproducers Ltd., Old Hill, Staffs. England Grams: 'Electronic Old Hill, Cradley Heath.'

man to our way of life. Representation will include educators and engineering delegations from other areas throughout the country.

According to reliable estimates, with present schedules the total likely engineering graduates available in 1955 will be less than 20,000, whereas our expanded industrial and military personnel needs may require anywhere from 45,000 to 80,000.

MEETINGS

OCT. 2-4: Twenty-Eighth Annual Session of the Communications Section of the Association of American Railroads, Chateau Frontenac, Quebec, Canada.

OCT. 4-6: Fourth Conference on Gaseous Electronics, General Electric Research Laboratory, Schenectady, N. Y.

OCT. 8-10: Joint Meeting of the U.S.A. National Committee of URSI and the IRE Professional Group on Antennas and Propagation, Cornell University, Ithaca, N. Y.

OCT. 8-10: AIEE Conference on Aircraft Equipment, Hollywood Roosevelt Hotel, Los Angeles, Calif.

OCT. 15-19: 70th Semiannual Convention of the Society of Motion Picture and Television Engineers, Hollywood Roosevelt Hotel, Hollywood, Calif.

OCT. 22-24: 1951 National Electronics Conference, Edgewater Beach Hotel, Chicago.

OCT. 22-26: AIEE Fall General Meeting, Hotel Cleveland, Cleveland, Ohio.

OCT. 29-31: Radio Fall Meeting, sponsored by IRE and RTMA, King Edward Hotel, Toronto, Ontario, Canada.

NOV. 1-3: Third Annual Convention and Audio Fair Exhibition of the Audio Engineering Society, Hotel New Yorker, New York City.

NOV. 12-15: NEMA Convention, Haddon Hall, Atlantic City.

DEC. 10-12: Joint AIEE-IRE Computer Conference, Benjamin Franklin Hotel, Philadelphia, Pa.

Audiometer Standard Published

MANUFACTURERS and laboratories testing audiometers for general diagnostic purposes now can rely on a newly published American Standard to assure a uniform method of testing. The new American Standard Specifications for Audiometers for General Diagnostic Purposes was developed under the sponsorship of the Acoustical Society of America, and approved by the American Standards Association.

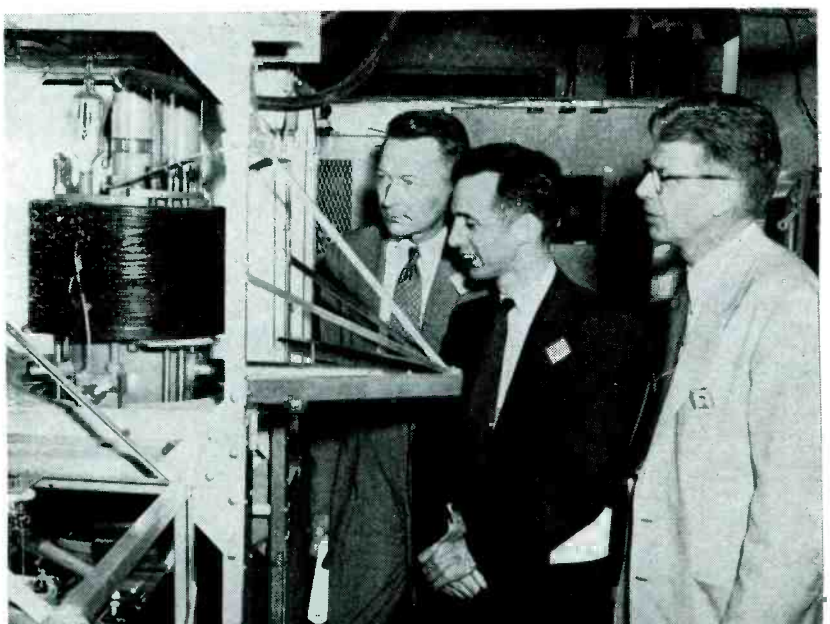
This document describes a standard audiometer and standard procedure for measuring hearing that will give doctors and others using such audiometers a dependable comparison with the normal threshold of audibility, as a basis for prescribing hearing aids or other remedial measures.

The threshold values by which normal hearing is measured are based on a study made in 1935-36 by the National Health Survey. This survey contains the only authoritative data to date available on this subject.

The audiometer described in the new Standard is an electroacoustic generator with associated air- and bone-conduction receivers, and provides pure tones of selected frequencies and intensities which cover the major portion of the auditory range. The results of measurements with this audiometer determine an individual's auditory threshold as a function of frequency.

Copies of the American Standard, designated Z24.5-1951, can be obtained from the American Standards Association, 70 E. 45 St., New York 17, N. Y., at 50 cents each.

FCC ENGINEERS VIEW UHF TV



George F. Metcalf (right), manager of the GE Commercial and Government Equipment Department, explains operation of world's most powerful uhf tv transmitter operating experimentally at Electronics Park to Edward W. Allen (left), FCC chief engineer, and Curtis B. Plummer, chief of the FCC broadcast bureau, during a recent visit to the Park

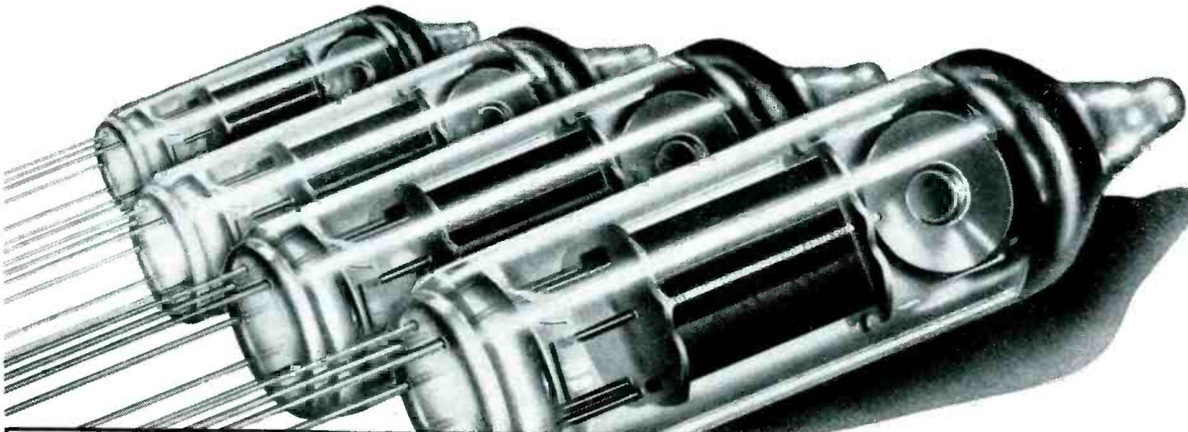
Aircraft Channel Discontinued

DESPITE the fact that use of 111.1 mc for reply to private aircraft was discontinued effective August 1, some pilots still fail to listen on the new frequency of 122.2 mc. The new channel is now in use by all interstate airways communications service stations (INSACS) that do

(Continued on p 312)

PREMIUM PERFORMANCE SUBMINIATURES . . .

SYLVANIA OFFERS A COMPLETE LINE FOR GOVERNMENT CONTRACTORS



SYLVANIA PREMIUM PERFORMANCE SUBMINIATURE TUBES
*Armed Services Preferred Types

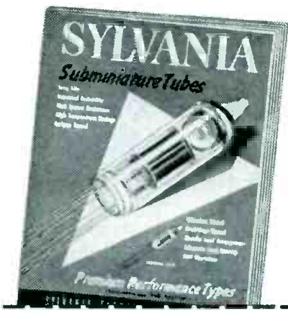
Type	Description	Ef (Volts)	If (ma)	Eb (Volts)	Ec2 (Volts)	gm (μmhos)	μ	Po (Watts)
PENTODES								
5636	Pentode Mixer	6.3	150	100	100	1250 (gc)		
*5639	Video Pentode	6.3	450	150	100	9000		1.0 (RL=9000Ω)
*5840 (5901)	Sharp Cut-off UHF Pentode	6.3	150	100	100	5000		
*5899 (5900)	Semi-remote Cut-off UHF Pentode	6.3	150	100	100	4500		
*5902	Audio Beam Power Pentode	6.3	450	110	110	4200		1.0 (RL=3000Ω)
*5905	Sharp Cut-off UHF Pentode	26.5	45	26.5	26.5	2850		
*5906	Sharp Cut-off UHF Pentode	26.5	45	100	100	5000		
*5907	Remote Cut-off UHF Pentode	26.5	45	26.5	26.5	3000		
*5908	Pentode Mixer	26.5	45	26.5	26.5	1000 (gc)		
*5916	Pentode Mixer	26.5	45	100	100	1280 (gc)		
TRIODES								
*5718 (5897)	Medium Mu UHF Triode	6.3	150	100		5800	27	0.9 (500 Mc Osc)
*5719 (5898)	High Mu Triode	6.3	150	100		1700	70	
5977	Medium Mu Triode	6.3	150	100		4500	16	
5987	Low Mu Power Triode	6.3	450	100		1850	4.1	
*5904	Medium Mu UFH Triode	26.5	45	26.5		4700	20	0.06 (400 Mc Osc)
6021	Medium Mu Double Triode	6.3	300	100		4800	35	
6111	Medium Mu Double Triode	6.3	300	100		4750	20	
6112	High Mu Double Triode	6.3	300	100		1850	70	
DIODES								
*5641	Single Diode	6.3	450	930 peak inverse plate volts 50 ma dc output				
*5647	Single Diode (T1)	6.3	150	460 peak inverse plate volts 10 ma dc output				
*5896	Double Diode	6.3	300	460 peak inverse plate volts 10 ma dc output per plate				
*5903	Double Diode	26.5	75	460 peak inverse plate volts 10 ma dc output per plate				
6110	Double Diode	6.3	150	460 peak inverse plate volts 4.4 ma dc output per plate				
GAS TUBES								
5643	Tetrode Thyratron	6.3	150	Average Anode Current = 22 ma Peak Anode Current = 100 ma				
*5644	Voltage Regulator	—	—	Operating Voltage = 95 volts Operating Current = 5-25 ma				

Long life . . . fatigue tested . . . High "g" vibration tested . . . Impact resistant . . . stabilized by burn-in period.

Twenty-five different types of Premium Performance Subminiature Tubes are now offered by Sylvania.

All are cathode types and are suitable for use in military communications equipment operating up to 400 mc. Engineered to function under severe conditions of vibration, shock, and high temperatures, they are excellent for rugged duty in guided missiles as well as in military signal equipment, fire control, etc.

Manufactured with either long or short leads in circular arrangement. At present, available only on DO or CMP rated orders. For complete data concerning characteristics and applications, mail the coupon now!



Sylvania Electric Products Inc.
Dept. R-1110, Emporium, Pa.

Please send me illustrated folder describing the complete line of Sylvania Subminiature Premium Performance Tubes.

*Name*____________________

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SYLVANIA

SYLVANIA ELECTRIC PRODUCTS INC. 1901-1951 50th ANNIVERSARY FIVE DECADES OF PROGRESS

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

NEW BOOKS

Servomechanisms and Regulating System Design

By Harold Chestnut and Robert W. Mayer. *John Wiley & Sons, Inc., New York*, 1951, 505 *pages*, $7.75.

This first volume of a two-volume series written in the interest of the Advanced Course in Engineering of the General Electric Company is an extremely worthwhile contribution to servomechanism literature. It is so definitely written as an advanced textbook, however, that it suffers severely from its interdependence with the associate volume and required instructor clarification, when considered as a possible engineering college classroom text.

This book provides an exceptionally fine presentation of the mathematics applied to servomechanisms and servo-systems, including that of La Place Transforms and the Nyquist Stability Criterion. The completeness of this presentation is greater than this reader has found in any other text or reference on the same subject.

Presentation of the subject matter is well done with many graphs and block diagrams treating several theoretical basic regulating systems and servomechanisms. However, in spite of 505 pages of comprehensive text material, this volume is inadequate in coverage or scope for use as a textbook capable of standing alone as a complete independent text for a course in servomechanisms.

The book is lacking in the definitive requirements of a text for training unpracticed engineering students in design of servomechanisms. There is no mention or explanation of the common building block components essential to such design theory, such as synchros, resolvers, rate generators and low-inertia induction motors. In short, a student taught strictly by this text would not recognize by sight or description a large majority of servomechanism components or systems in common use for the past 15 years.

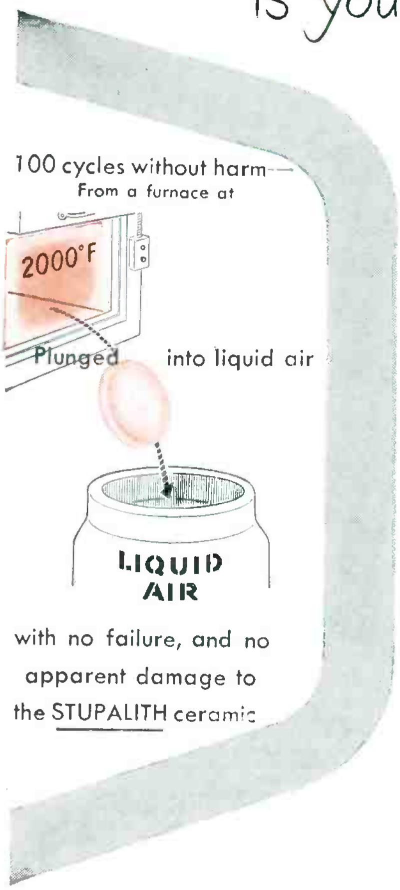
This volume would have been better entitled Servomechanisms and

(continued on page 320)

Looking for a material to withstand
EXTREME THERMAL SHOCK?

STUPALITH

is your answer!

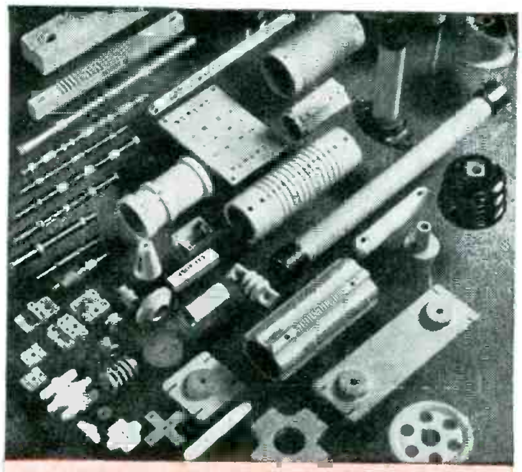


Remarkably low thermal-expansion characteristics make STUPALITH *ideal* for applications where conditions of extreme thermal shock are present.

Stupalith may be formulated and processed to possess Zero, Low-Positive and Low-Negative expansivities. Formed by conventional methods—pressing, extrusion or casting—STUPALITH may be machined or ground to precision tolerances. Can be safely used at temperatures up to 2200° F.

The demonstration described in the illustration at the left shows the amazing ability of STUPALITH to withstand thermal shock.

We will be glad to send you a copy of Bulletin 849, which gives full details of this remarkable group of ceramics.



STUPAKOFF PRODUCTS

For Electrical and Electronics Applications

ASSEMBLIES—Stupakoff assemblies include Induction COILS for radio receivers and transmitters; SHAFTS for air-tuning condensers; METALLIZED PLATES for making fixed rigid assemblies.

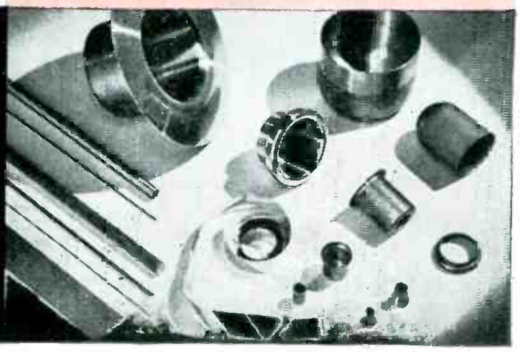
CERAMICS—Stupakoff has long been a leading supplier of ceramic products for a wide variety of electrical and electronic applications—precision made for all voltages, frequencies and temperatures.

RESISTOR CERAMICS—Stupakoff Temperature-Sensitive Resistors are used for temperature indicating or measuring equipment such as Radiosonde, for infra-red light source and for heating elements. Supplied complete with terminals, in the form of rods, tubes, discs, bars, rings, etc.

SEALS—KOVAR METAL TO GLASS—Terminals; Lead-ins; Standoffs—for hermetically sealing for mechanical construction in radio, television, electronic and electrical apparatus. Single or multiple terminal units, in a wide variety of sizes and artings.

KOVAR METAL—Kovar is the ideal alloy for sealing to hard glass. Used for making hermetic attachments for electrical and electronic products. Available in the form of rod, wire, sheet, foil—or as cups, eyelets or other fabricated shapes.

STUPAKOFF
CERAMIC AND MANUFACTURING CO.
Latrobe, Pa.



Backtalk

This department is operated as an open forum where our readers may discuss problems of the electronics industry or comment upon articles which ELECTRONICS has published.

More Information

DEAR SIRS:

A FEW months ago we undertook an instrumentation problem for which ceramic dielectric capacitors of the type designed to have zero temperature coefficient appeared ideally suited. Specifically, we were investigating the use of Wein-bridge oscillators and associated power units for operating synchronous motors to drive our telescopes at precisely controlled rates. Rate-stability of about 10 parts per million per degree C within a temperature range from −10 C to +20 C was required. Since it is necessary to vary this rate over a span of about 2 percent to accommodate differential atmospheric refraction at various telescope orientations, a temperature-stabilized Wien-bridge oscillator appeared to be the simplest solution.

Using suitable wire-wound resistors together with an array of capacitors made by a well-known manufacturer, we constructed an experimental model designed for a central frequency of 50.137 cps. However, the frequency of this oscillator was found to be unstable and to possess a scandalous temperature coefficient. With makeshift apparatus, temperature testing is slow and tedious; much time was consumed testing and retesting in an effort to find the source of the difficulty. Since we trusted the capacitors, every other possible fault was checked first. Finally as a last resort, we checked the capacitors and found them to have an average temperature coefficient of roughly 6,000 ppm per deg C positive, which

(Continued on page 328)

Solve YOUR LAMINATED PLASTICS PROBLEMS AS EASY AS . . .

1 2 3

It's as simple as that when you rely on Taylor *full-line* service. Here's how and why:

1. If your problem demands *vulcanized fibre* that is exceptionally tough, high in dielectric strength, light in weight, easily machined, attractive in appearance, insoluble to most solvents and withstands abrasion, you can solve it with Taylor Vulcanized Fibre in sheets, rods, strips, or coils.

2. If your problem calls for *phenol fibre* or *glass melamine and silicone laminates* to meet specific electrical, physical, chemical or mechanical characteristics, you'll find the material you need in our wide range of grades. These versatile materials, too, are available in sheets, tubes, rods and strips.

3. If you are looking for a dependable source of supply for parts fabricated to your specifications, Taylor Fabricating Service is equipped to turn out precision-made parts on time, ready for your production line.

Next time you require laminated plastics, remember Taylor's *full-line* service—you'll save yourself time, trouble, money, and a lot of worry!

Taylor

TAYLOR FIBRE CO.

NORRISTOWN, PENNSYLVANIA

WEST COAST FACTORY: LA VERNE, CALIF.

OFFICES IN PRINCIPAL CITIES

Here is the new Taylor 62-page catalog. It contains specifications and description of Taylor Laminated Plastics. See for yourself how you can make your product or part better with the use of these plus-value materials. Write today for Catalog E10.

TUBES AT WORK

(continued from page 138)

achieved by brightness control of the spot so synchronized with the bridge input that one half of the pattern appears substantially brighter than the other[1]. Such brightness control necessitates departure from the optimum compromise between visibility and tube life and usually detracts from the sharpness of definition for either the brighter or the dimmer portion. Optimum brightness and optimum definition can be maintained if discrimination is made by extending one leg beyond the other in the horizontal direction, as shown in sketches *c1* to *c5*.[2] This is achieved by bringing one crest of the deflecting wave slightly beyond the other crest of the deflecting wave and by bringing the furrow following the first half wave slightly beyond the furrow following the second half wave, as shown in sketch *c*. Whether the portion extending farther to the right on patterns *c1* to *c4* is above or below the portion extending less far toward the right tells whether the ratio adjustment has to be done in one direction or the other. Whether the portion extending farther to the left is above or below the portion extending less far toward the left tells whether the phase adjustment has to be done in one direction or the other.

A circuit to obtain a deflecting wave as shown in sketch *c* of Fig. 2 is shown in Fig. 3. It comprises a 6SN7 twin triode acting as a phase splitter and a 6H6 twin diode to select one phase in one half

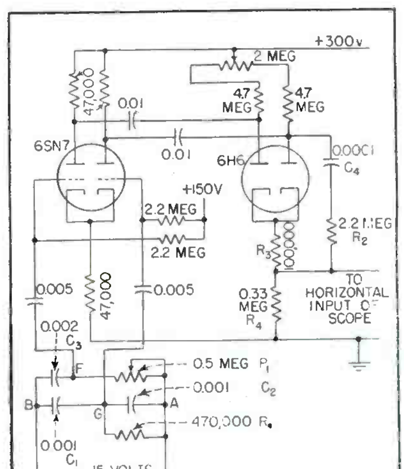
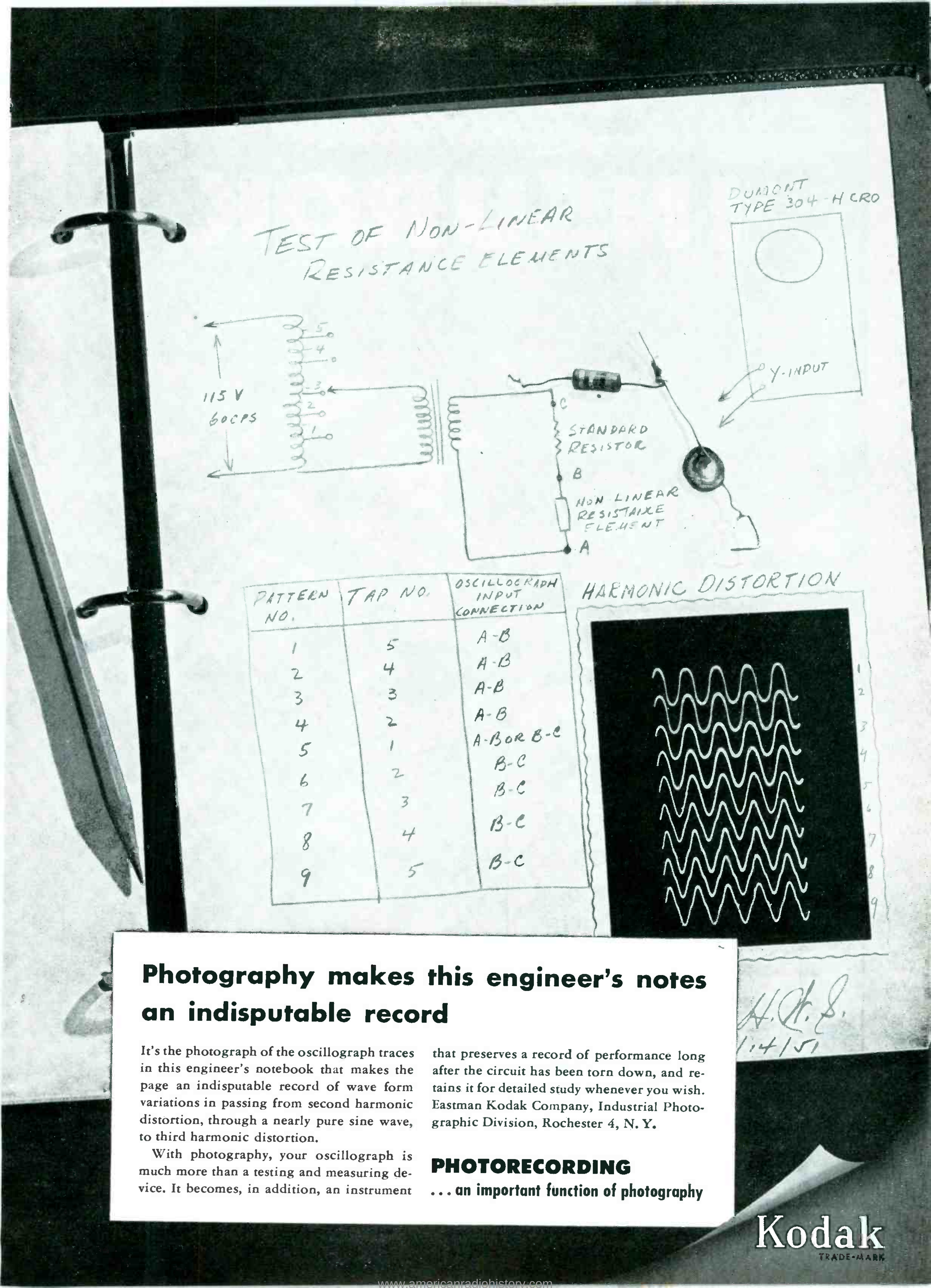


FIG. 3—Circuit used to obtain a deflecting wave as shown in c of Fig. 2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ELEMENT
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PATTERN NO.
TAP NO.
OSCILLOGRAPH INPUT CONNECTION
1 5 A-B
2 4 A-B
3 3 A-B
4 2 A-B
5 1 A-B OR B-C
6 2 B-C
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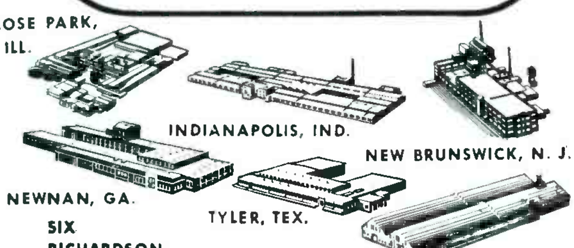

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				Short Time	Step by Step			
T-805	A paper base NEMA PC laminate, for cold-punched electrical and mechanical parts involving nominal voltage-frequency-humidity relationships.	4.0%	0.060	550	425	400	0.30	5.0
T-838	A paper base laminate, suitable for many electrical applications. Meets requirements for NEMA Grade XX. Has good machinability.	1.3%	0.040	700	500	2,000	0.20	5.0
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T-606	A fabric base laminate, meeting NEMA Grade CE requirements. For electrical applications requiring greater moisture resistance than Grade C provides.	2.2%	0.055	360	280	100	0.28	5.0
T-712	A continuous-filament Fiberglas laminate, bonded with melamine resin. Its high arc resistance is valuable in many electrical applications.	1.6%	0.013	475	375	25,000	0.08	6.4

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GRADE	DESCRIPTION	Tensil Strength (psi)		Flexural Strength (psi) Main Direction	Compressive Strength (psi) Flatwise	Impact Strength Main Direction (Ft Lb/In.)		Moisture Absorption (24 hrs.)
		Main Direction	Cross Direction			Flatwise	Edgewise	
T-689	A fine-weave fabric base laminate especially suited for intricate parts requiring great strength, such as fine-pitch gears. Good dimensional stability.	18,000	11,200	29,000	42,000	---	---	0.5%
T-733	A linen base NEMA Grade L laminate, for mechanical and electrical parts requiring fine machining, dimensional stability, and physical strength.	14,000	9,500	22,000	38,000	4.6	2.3	0.7%
T-815	A cotton-fiber, mat base laminate, featuring uniform strength in all directions in the plane of the sheet surface. For smooth, high-strength, machined parts.	15,000	15,000	22,000	45,000	3.0	1.4	0.7%
T-601	A strong, tough, fabric base laminate, suitable for gears and other mechanical parts subject to high impact loads. Meets requirements for NEMA Grade C.	11,000	11,000	21,000	40,000	4.2	2.5	0.9%
T-682	A fabric base laminate, designed for valve discs, pump valves, agitator paddles, etc., handling hot or cold water, gasoline, oil, and some mild acids.	10,700	9,700	19,800	37,400	4.2	2.5	0.8%
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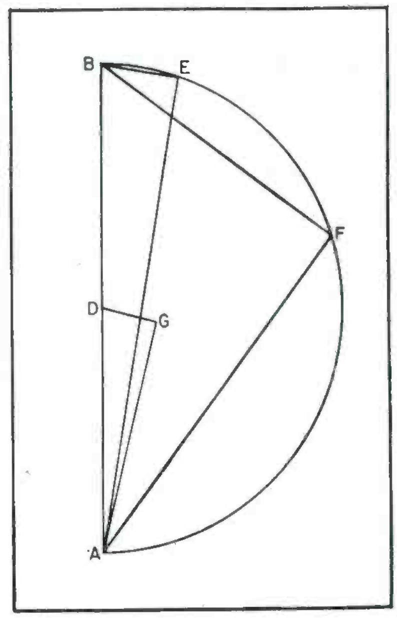


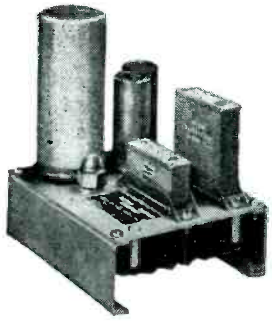
FIG. 4—Vector diagram used for phase determination

period and the other phase in the other half period. Discrimination of one half wave against the other is achieved by the capacitor-resistor combination C_4 R_2.

Terminals A and B of Fig. 3 are connected to the bridge input terminals. The network C_1, C_2, C_3, P_1 and R_1 provides a voltage of the same frequency but of adjustable phase between points F and G. Referring to the vector diagram shown in Fig. 4, the endpoint of the vector of the voltage at F may move along the arc AFE when P_1 is varied from zero to maximum resistance. The endpoint of the vector of the voltage at point G of the circuit would be at point D of Fig. 4 if conventional voltage halving would be done by C_1 C_2 alone. It is seen that the vector DF can turn by only less than 180 deg, so that in this way phase compensation can not be obtained for all possible phase shift angles in the vertical amplifier.

Resistor R_1 shifts the position of the endpoint of the vector of the voltage at point G of the circuit to point G of Fig. 4. When the vector endpoint F travels on arc AFE, the voltage vector between points F and G covers over 180° and allows phase balancing for all possible values of phase shift in the vertical amplifier.

The two grids of the 6SN7 and capacitance coupled to points F and



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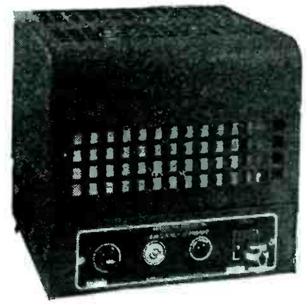

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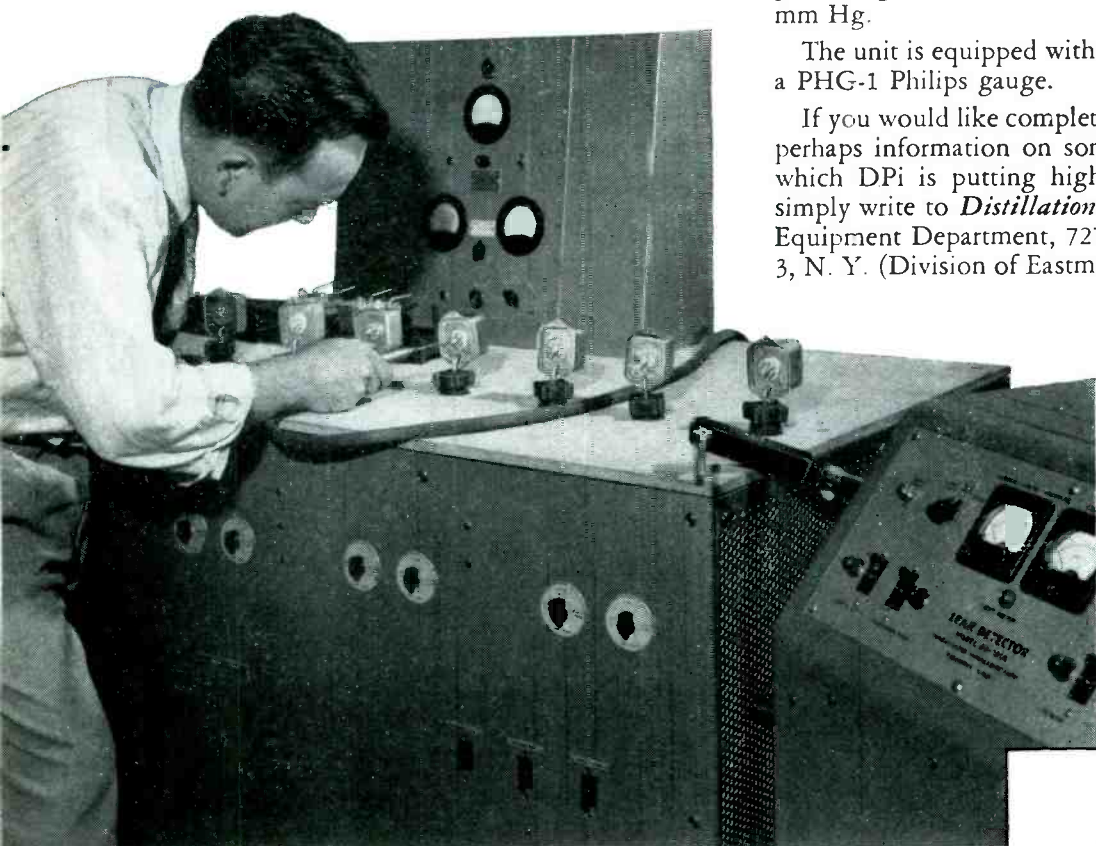

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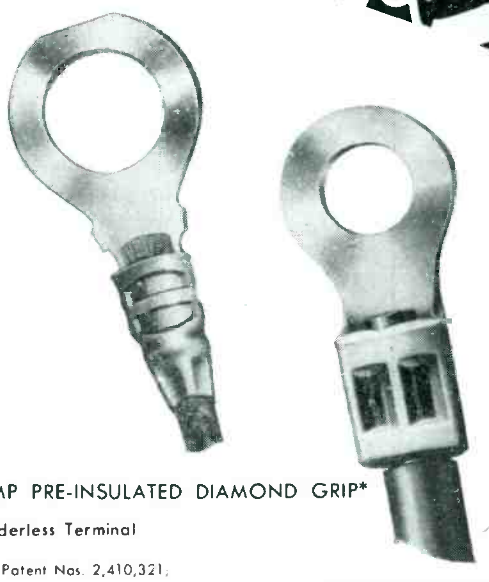

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With this simple deflection circuit it is possible to speed up the operation and to increase the accuracy of null detection.

REFERENCES

1) D. G. C. Luck, U. S. Patent No. 2,328,985.
2) J. C. Frommer, U. S. Patent No. 2,566,699.

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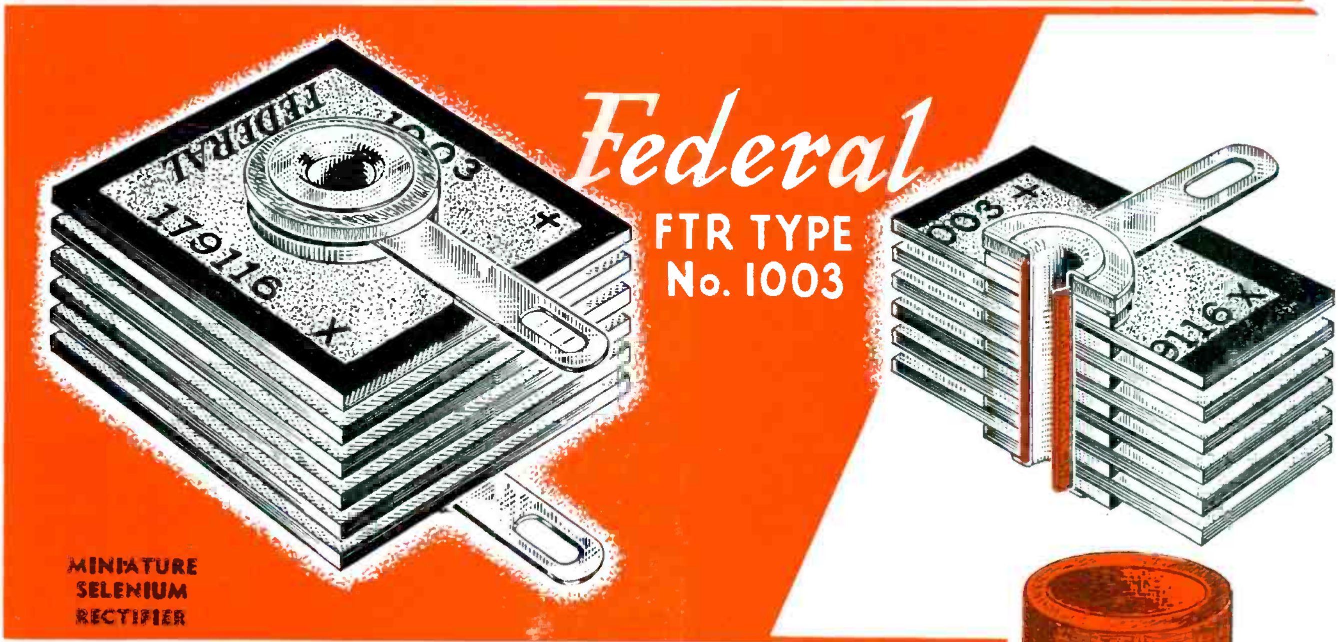

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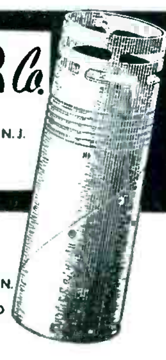

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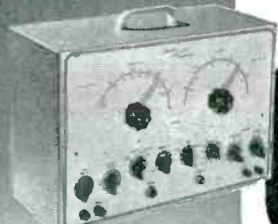

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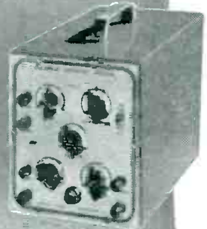

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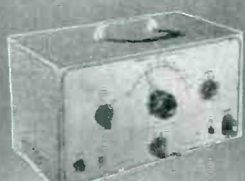

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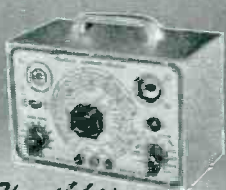

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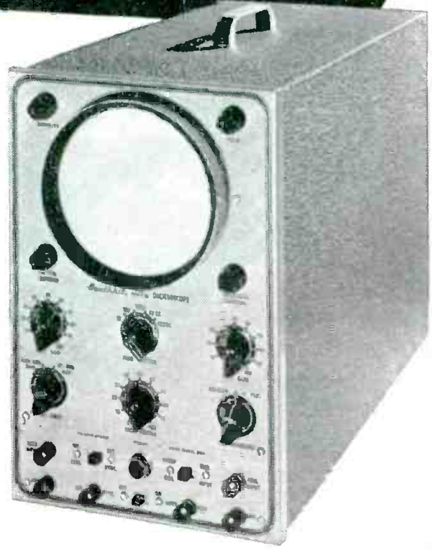

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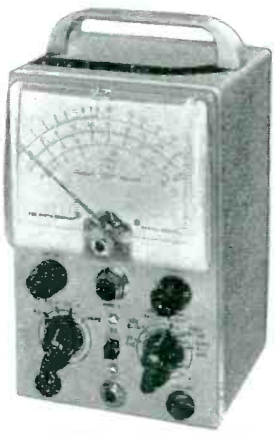

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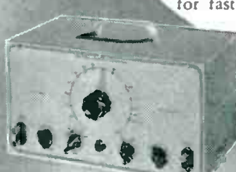

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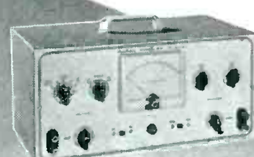

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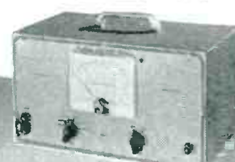

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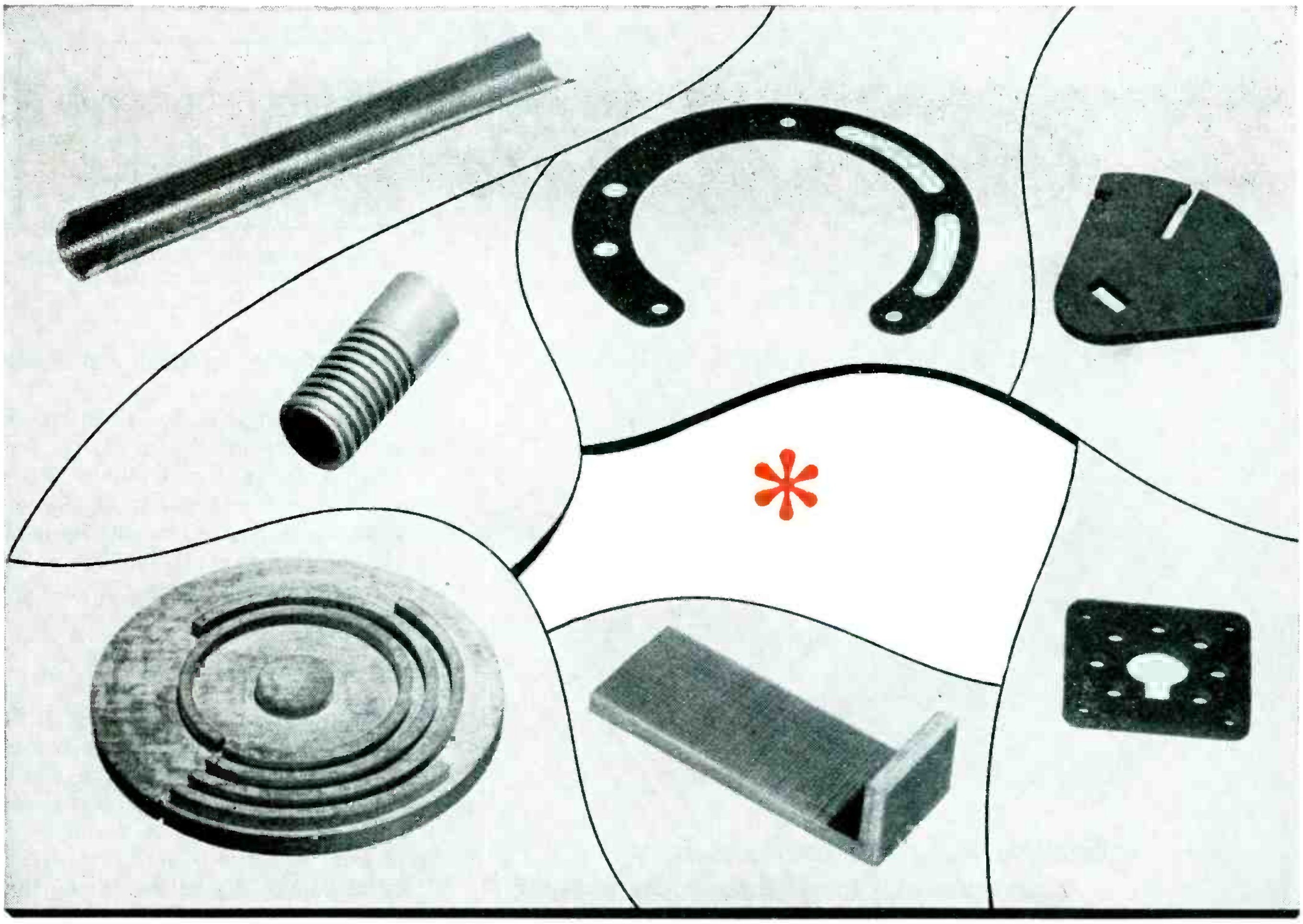

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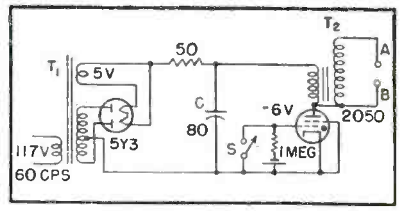

FIG. 1—Schematic diagram of the high-voltage pulse generator

is transformed, rectified and finally controlled.

The system to be described makes use of inexpensive components for rectifying and controlling pulse voltages on the low-voltage side of the transformer. The apparatus is suitable for general application as a source of synchronized high-voltage pulses.

Circuit Analysis

In the circuit shown in Fig. 1, T_1 is an ordinary power-supply transformer used to charge the 80-μf capacitor C through a full-wave rectifier to 375 volts. A resistor of at least 50 ohms is used to prevent overloading the rectifier during the charging cycle or in case C should become short-circuited.

The capacitor discharges through the primary of a six-volt automobile ignition coil whenever switch S is closed to remove bias from the thyratron. Discharge of C is rapid because of the low resistance of the primary circuit and, as a result, a high voltage appears across the terminals of the T_2 secondary as long as current flows in the primary. The open-circuit form of the high-voltage pulse is essentially rectangular and is unidirectional. The maximum voltage obtainable with the circuit elements shown is about 35 kv as evidenced by sphere-gap measurements at A-B.

A capacitor may be added across terminals A-B or from terminal A to the cathode terminal of the thyratron in order to decrease the discharge time for photographic applications involving the type of transient phenomena for which a flash tube is particularly suited. With the additional capacitor added to the circuit, the discharge time is controlled by the value of the added capacitor and the resistance of the spark discharge path. The maximum voltage obtainable is reduced

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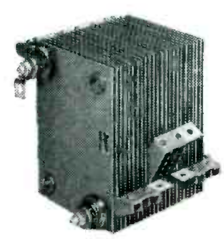

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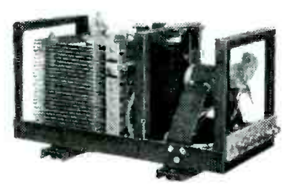
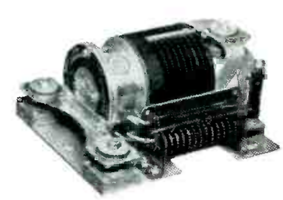


FTR 3146-BS Aircraft Power Supply



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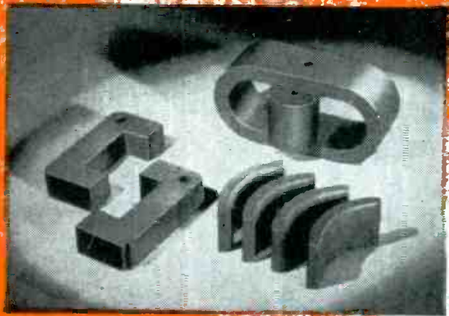

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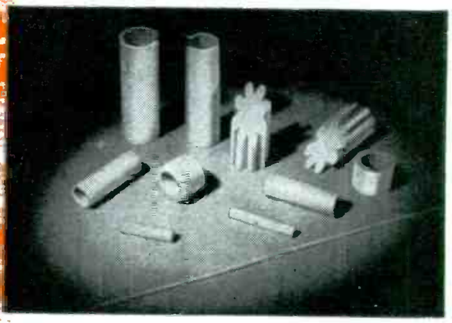

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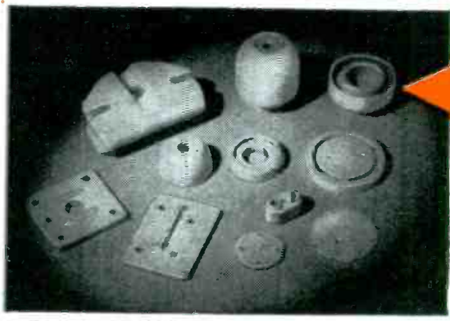

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to about 12 kv with the addition of a 0.02-μf capacitor but spark intensity is enhanced since the capacitor will discharge through a needle gap in air in less than one microsecond.

The switch S may be a microphone, photocell or other sensing instrument whose signal is suitably amplified to the lift bias of the thyratron for single-shot synchronization. For electrical synchronization, attention must be paid to the over-all delay through the apparatus. This delay is essentially controlled by the value of C and the setting of A-B. The delay is short enough to be compensated for in the usual way by adjusting the position of the sensing instrument along the time axis of the phenomenon under observation.

The material in this article was abstracted from an article entitled "A Synchronized High Voltage Pulse Generator" by C. F. Johnson which appeared in the July 1951 issue of *The Review of Scientific Instruments* on page 541.

X-Ray Liquid-Level Gage

By JOHN E. JACOBS and R. F. WILSON

Coolidge Laboratory
General Electric X-Ray Corp.
Milwaukee, Wisconsin

GAGING of the level of liquids in opaque or inaccessible vessels imposes many problems in technique used as well as associated instrumentation. This discussion will be limited to those problems which at the present time are dependent on the use of x-ray for their solution.

The objective of the gage to be described is to measure the height of fill of large vessels or to control the process by which they are filled. In most cases the problem is to fill or check height of fill of vessels in an inaccessible location under conditions which render contact-type instruments unsuitable. Instrumentation in the gage may be arranged to operate an audible or visual indicator, to actuate reject or control mechanisms or to record inspection information.

The gaging of liquid levels by use of x-ray absorption places rather strict requirements on the x-ray detectors used. In most applications, wall thickness of the container

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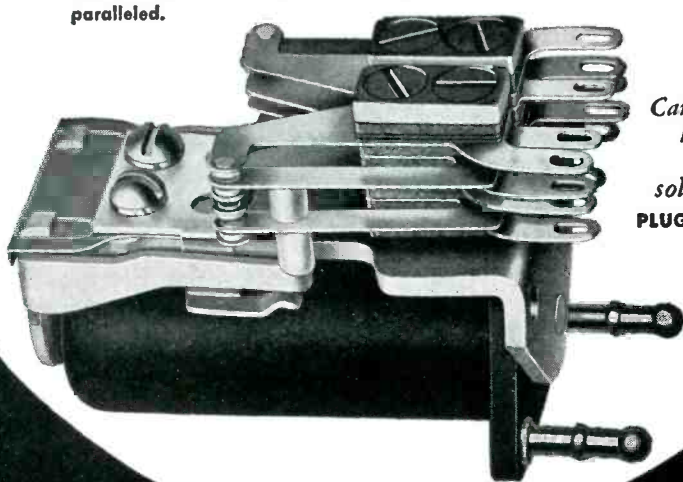

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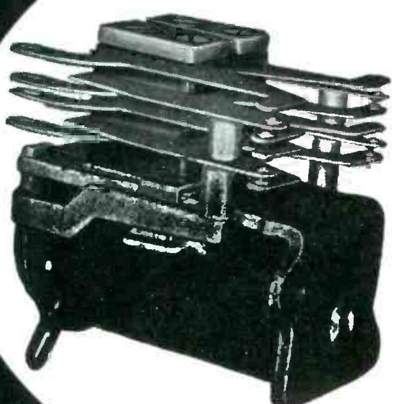

SK RELAY

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, 1$^{9}/_{16}$" LONG, 3$^{1}/_{32}$" WIDE.

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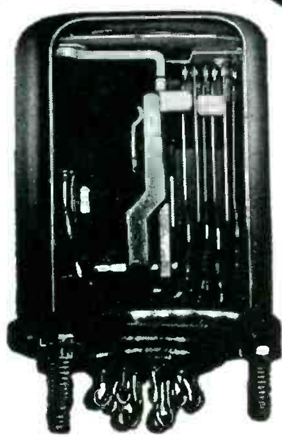

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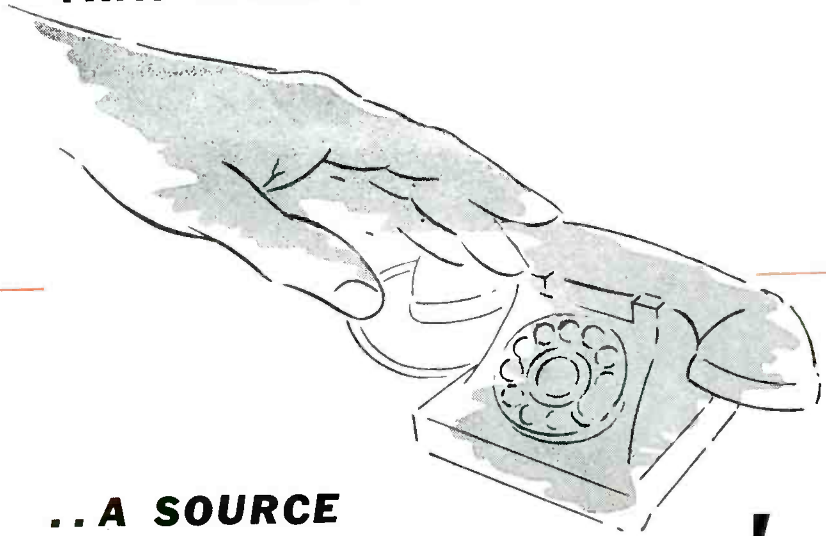


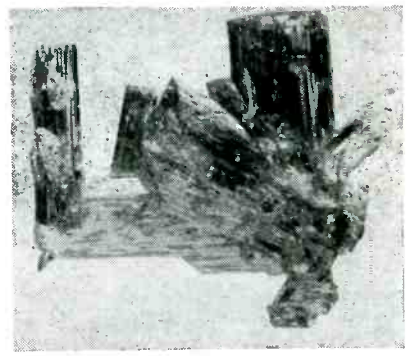


FIG. 1—Magnified view of a cadmium-sulfide crystal

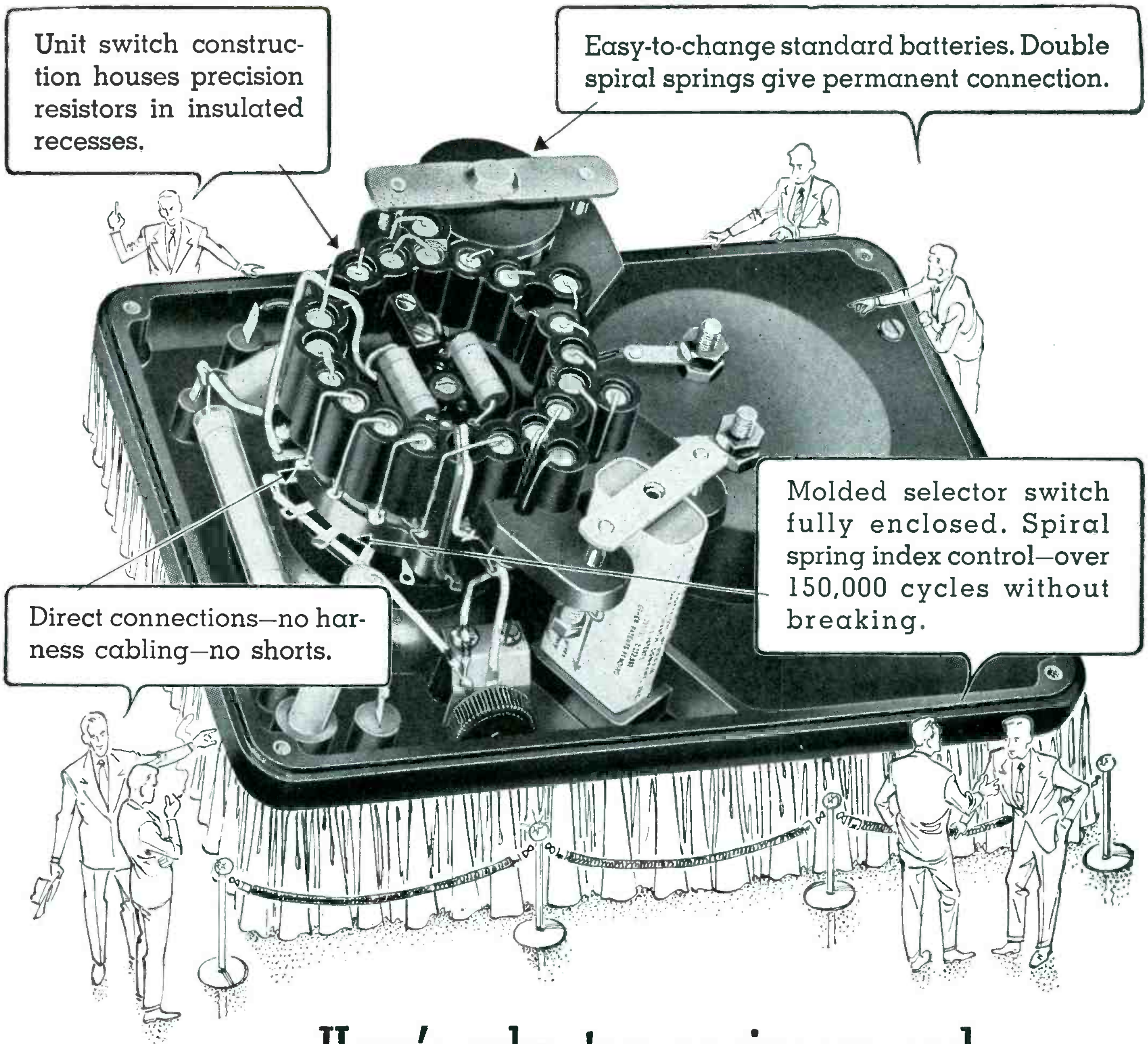
reaches a value where only x-radiation of short wave length is transmitted. All of the information as to the location of the liquid level is contained in the radiation transmitted, therefore, the detector used should be an efficient absorber of short-wave-length radiation.

The commonly used electronic detectors of x-radiation are the gas-filled ionization chamber and the fluorescent-screen photomultiplier combination. The gas-filled chamber exhibits extremely low absorption of the radiation encountered. The fluorescent-screen photomultiplier tube is better in this respect if the phosphor layer is made thick enough. However, this system suffers from the fact that the impinging radiation must first excite light in the phosphor, this light then being used to eject the photo electrons which constitute the usable signal. Practically, the two systems described are essentially large-angle detectors in that they function satisfactorily only if a relatively large beam area is scanned. In some applications where relatively low angular resolution is needed they will serve as a satisfactory detecting unit.

Semiconductors

Recently, semiconductors have received considerable attention as radiation detectors because of their unique properties as compared to the commonly used x-ray detectors.[1] Inasmuch as the gage described by this paper is made possible by the use of cadmium-sulfide crystal detectors, it is though advisable at this time to briefly describe the properties of cadmium sulfide when used as a detector of x-radiation.

The fact that CdS changes its re-



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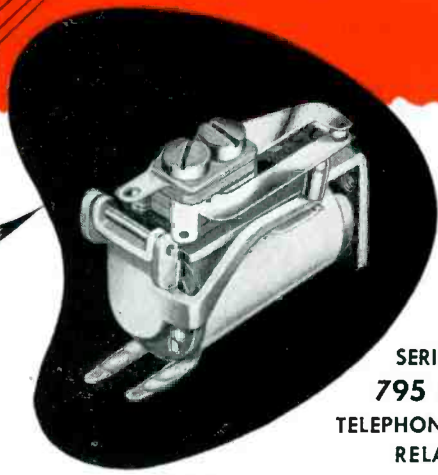

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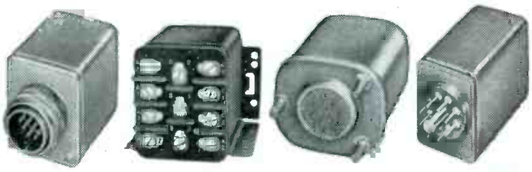

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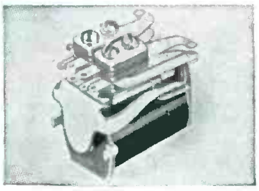

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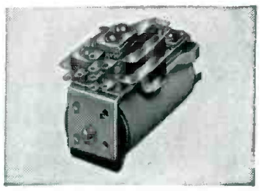

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A COMPLETE LINE OF RELAYS SERVING AMERICAN INDUSTRY sistance when irradiated with x-rays was first noted in 1946 by a German physicist, Dr. R. Frerichs.[2] He further noted that the current passed by the crystals is of greater magnitude than one would expect from primary ionization of the crystals by the incident x-radiation.

Natural occurring CdS in the form of the mineral, Greenockite, is so rare that crystals must be produced artificially.[3] This is best done by vaporizing cadmium metal in an atmosphere of hydrogen sulfide so that CdS is produced in the vapor phase. This vapor then is caused to seed out forming hexagonal crystals shown in Fig. 1. The CdS produced by reaction in aqueous solution is of the cubic form and does not exhibit photoconductivity.

There are several advantages gained by using a solid detector of the CdS type for detection of x-radiation. The most outstanding being the high efficiency of absorption of the incident energy.

On the basis of pure absorption of energy, only 7.4 mm of CdS is needed to absorb 99 percent of the energy at 0.13A, a wave length which corresponds to approximately 100 kvp, while to achieve the same efficiency with an air chamber requires a chamber 300 meters long.

A second factor in the conversion of incident x-ray energy to useful current is that the electrons in the case of CdS are released in the crystal itself, as compared to the several intermediate steps of the photocell combination.

The crystals have a further advantage of exhibiting a natural amplification which in many cases exceeds 10^6. This is best illustrated by placing a crystal in the basic circuit shown by Fig. 2. With an applied crystal potential of 100

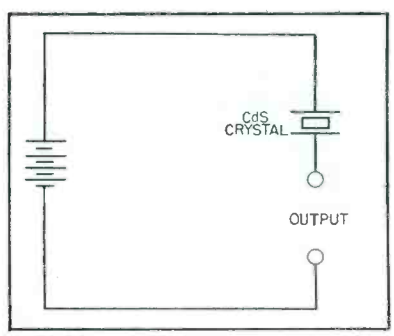

FIG. 2—Basic circuit for use of CdS crystal as a detector

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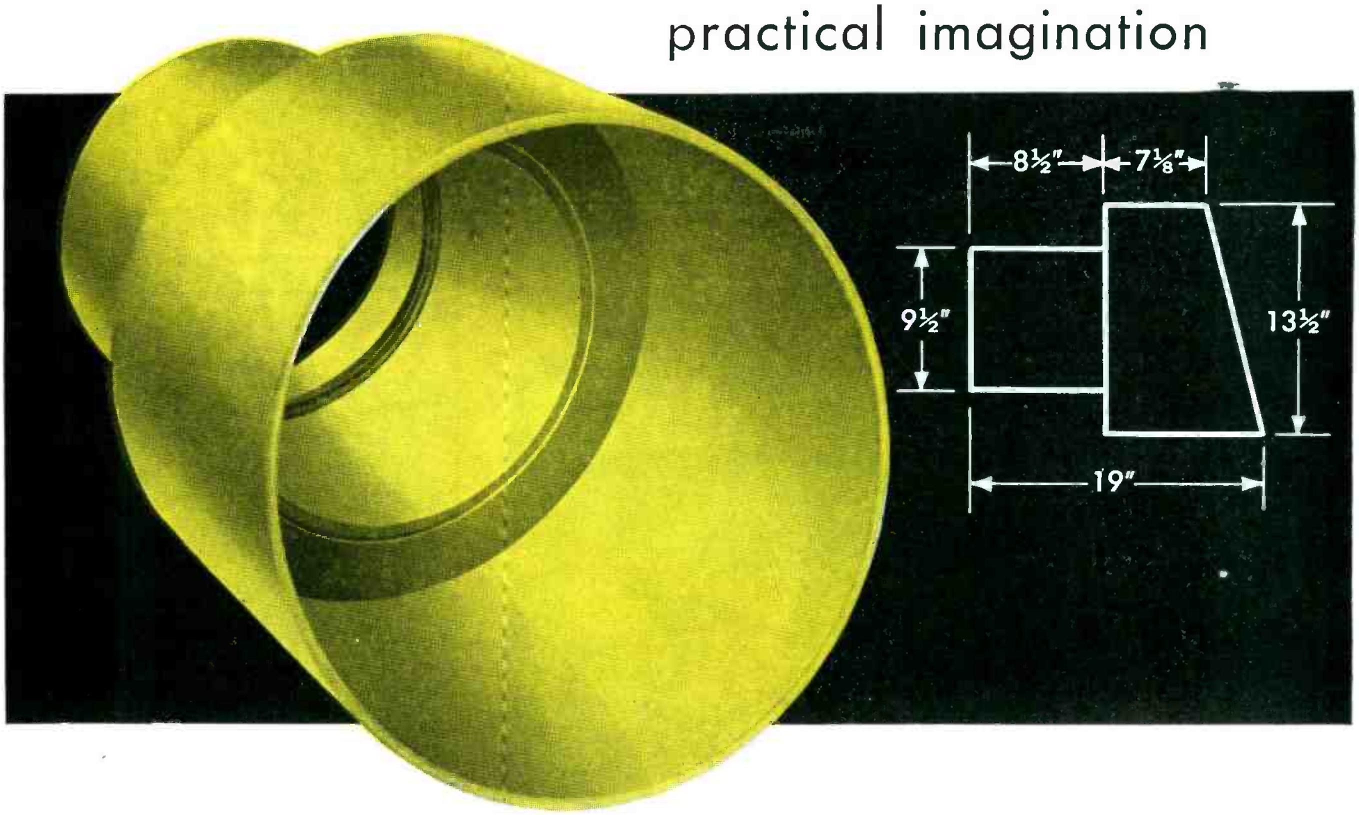

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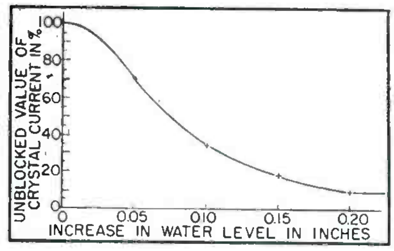


FIG. 3—Resolution of gaging station

v/cm under a low-intensity x-ray source, an output current of the order of hundreds of microamperes is obtained. No other device is know that will respond in this manner to x-radiation.

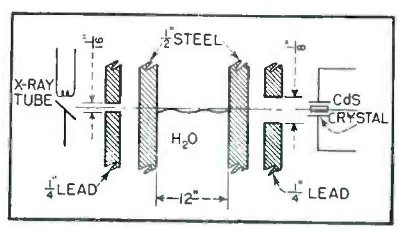
Physically the crystals may have an effective area in the order of a few square millimeters. It has been found that the natural amplification occurs over a distance of a few atomic spacings, therefore, the crystals may be reduced to what practically is the size of a pin head and yet retain this amplification.

Over the intensity range encountered in this application, the output current is linear with intensity. Crystals are usually operated with a potential gradient such that a current of less than 100 microamperes is obtained under operating conditions. This value of crystal current has been selected to assure that the crystal is not called upon to handle more power than 10 milliwatts per mm^3 of crystal volume. It has been found experimentally that this power limit is a safe one for crystal operation.

When the crystals are properly processed there appears to be no change in crystal characteristics with use. This is to be expected as no apparent physical change may be seen in the crystals following prolonged irradiation.

Liquid-Level Detecting

The crystals, because of their small physical dimensions, permit



Mechanical drawing of the setup used with level gaging

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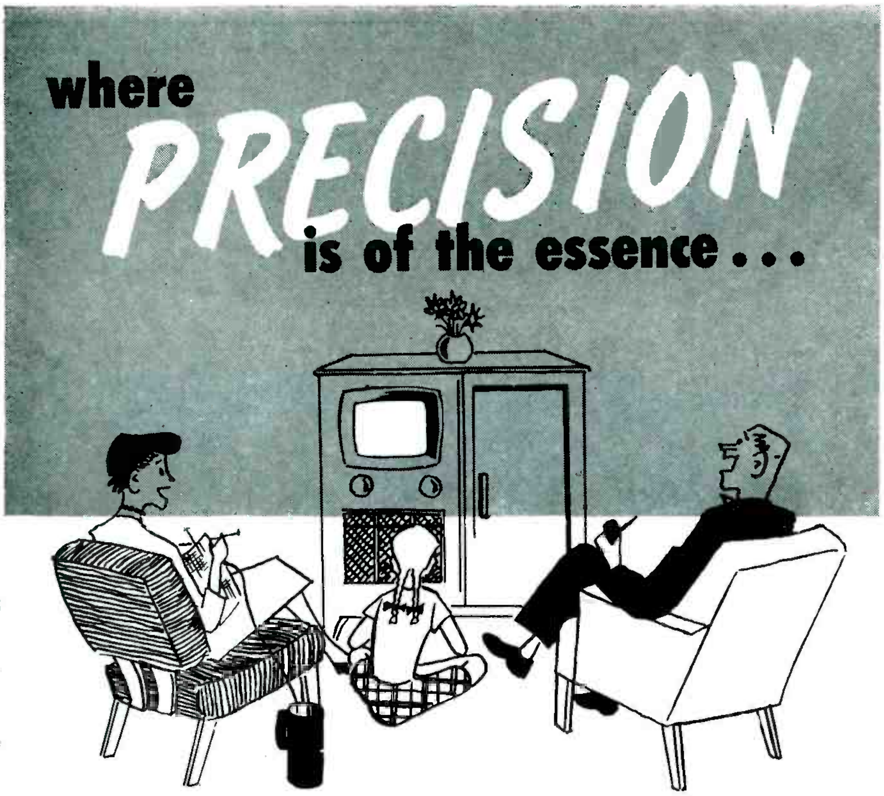

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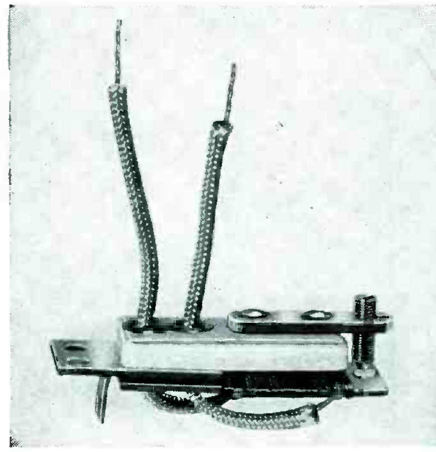

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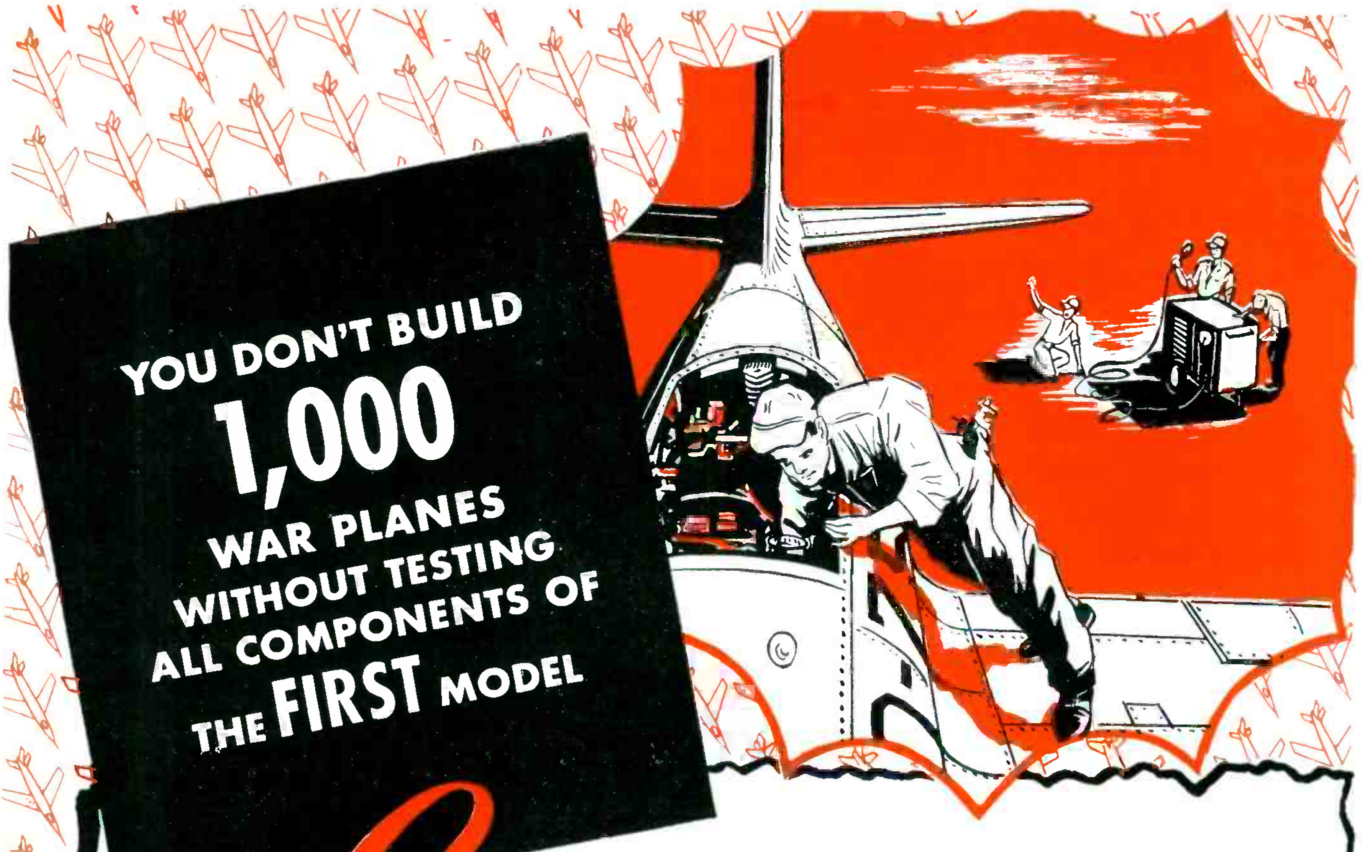

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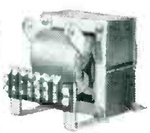

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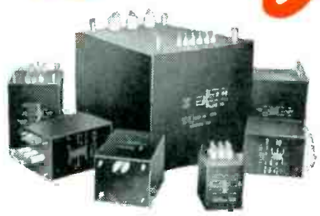

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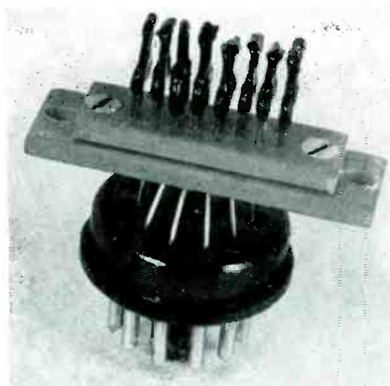

FIG. 4—Detecting assembly of eight crystals mounted on 1/8-in. centers

high degrees of precision in gaging applications. As may be seen by reference to Fig. 3, it is relatively easy to detect the level of the liquid within ± 1/16 in. of a base line. Because such a large change in crystal current is obtained as the liquid level changes, the need for regulation of the x-ray source is minimized.

The gage described in this paper was designed to indicate the level in 1/8-in. steps over a 1-in distance. Figure 4 shows the detecting assembly consisting of eight crystals mounted on 1/8-in. centers. This head is mounted with tantalum strips between the crystals to remove any scattered radiation and thus increase the resolution of the head.

The output of each crystal in the head is fed to a channel amplifier consisting of a triode and thyratron stage as shown in Fig. 5. Here again is illustrated the advantage of using the crystals having high sensitivity as the instrumentation is extremely simple.

The relay contacts for each crystal channel are used to control the filling operation to a selected height or to furnish signals to operate ejection mechanisms when previously filled containers are inspected;

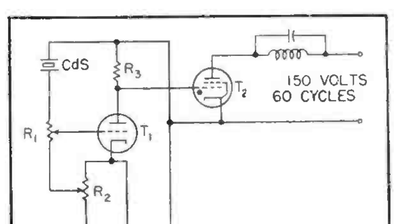

FIG. 5—Circuit of an inspecting station for gage

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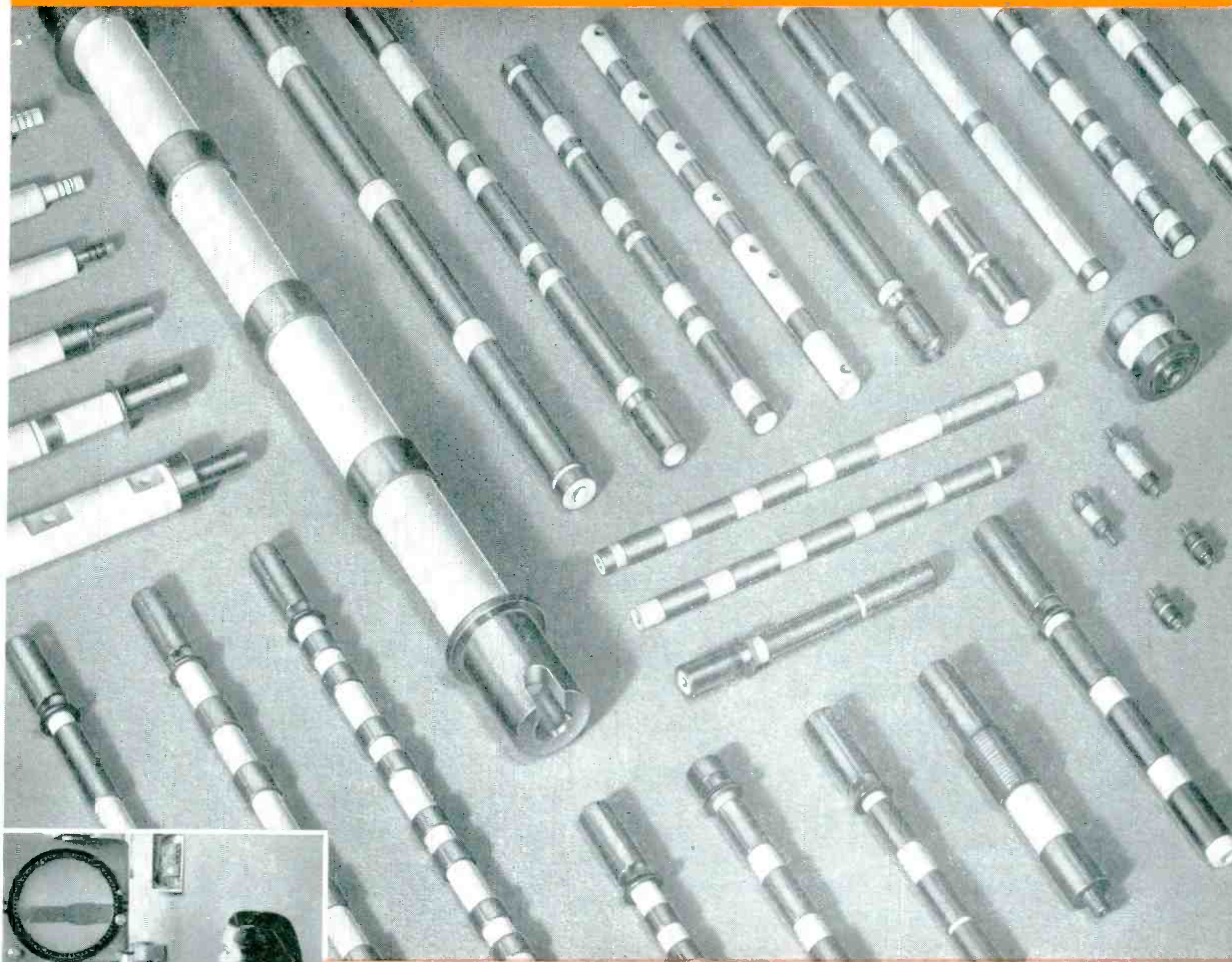

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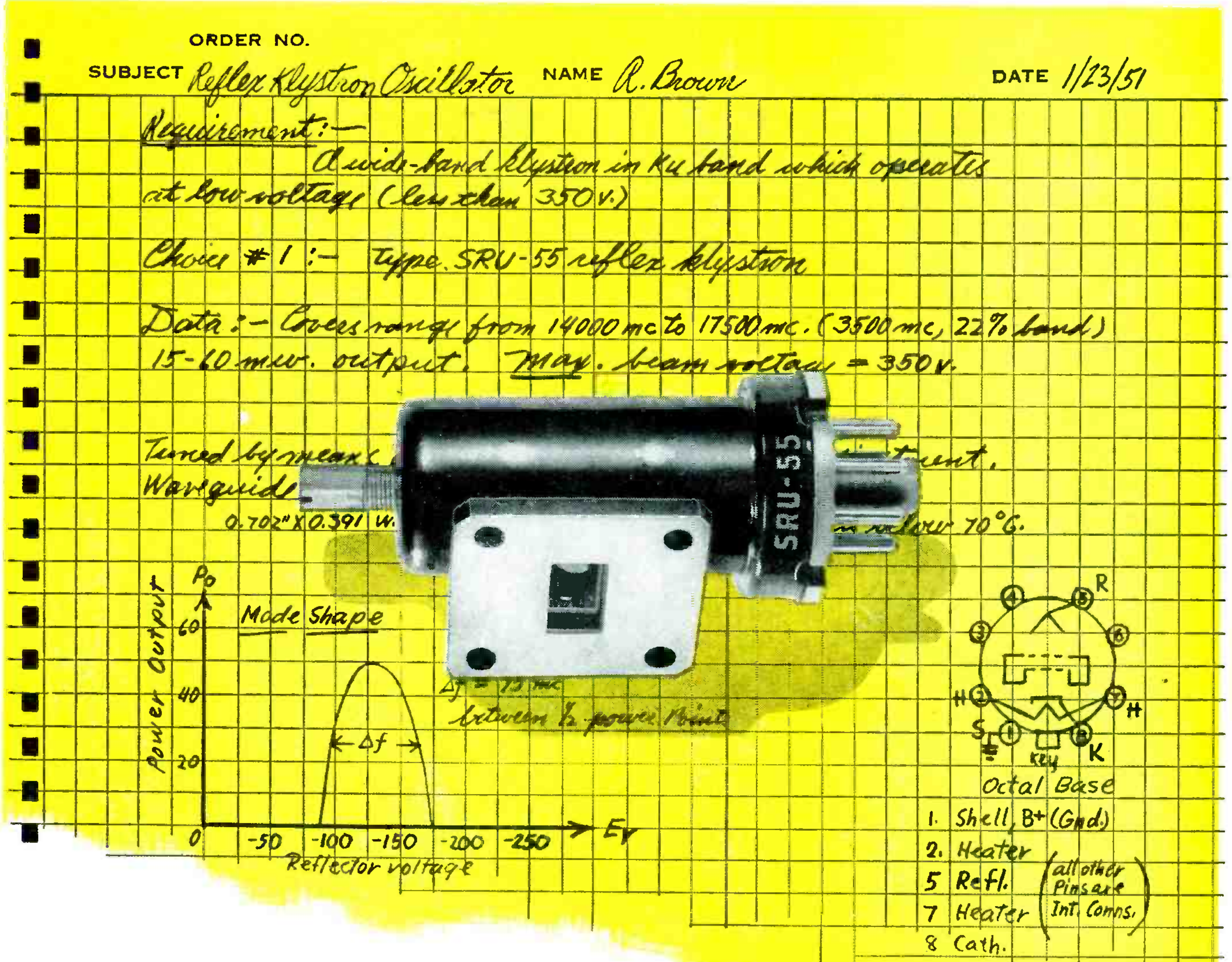

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14,000 to 17,500 MC at 300 VOLTS

Type SRU-55 is a low-voltage, reflex klystron oscillator with radio frequency output of 15 to 60 milliwatts, operating over the frequency range of 14,000 to 17,500 mc. This Sperry tube can be used as a local oscillator for microwave receivers or as a bench oscillator in the measurements laboratory.

Operating at a frequency of 16,000 mc with a beam voltage of 300 volts, this tube provides 25 milliwatts of output power. Under these conditions the modulation sensitivity is approximately 1.3 megacycles per volt. The electronic tuning range measured between 3 db points is 75 megacycles per second.

Physical characteristics of Sperry Type SRU-55 are: weight, 3¼ oz.—height, 3 1/16"—mounting, standard octal 8-pin socket (in any position). The r-f connection is a standard UG-419/U fitting for 0.702" x 0.391" waveguide. Its cathode is of the oxide coated, unipotential type. For ambient temperatures below 70°C, only free convection cooling is required. The tuning adjustment on this tube is driven by a ¼" shaft containing a screwdriver slot.

For additional information on Type SRU-55 and other Sperry Klystrons, write our Special Electronics Department.

MODEL SRU-55

GENERAL CHARACTERISTICS

Freq. Range (mech. tuning)	*14,000-17,500 mc.*
Heater Voltage (ac or dc)	*6.3 v.*
Heater Current	*0.6 amp.*
MAXIMUM RATINGS	
Beam Voltage	*350 v.*
Beam Current	*35 ma.*
Reflector Voltage	*0 to —350 v.*
Heater-Cathode Voltage (peak)	*45 v.*

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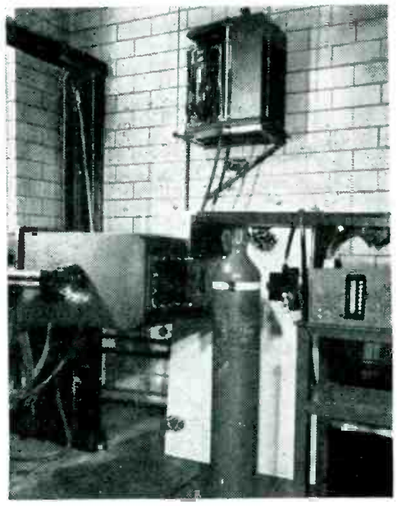


FIG. 6—Control equipment for liquid-level gaging. Control box on right has eight pushbuttons for the different levels of fill desired

this is best explained by references to Fig. 6. Here the control box is seen to have eight push-button stations adjacent to indicator lamps. The height of liquid in the vessel being gaged is continuously indicated on the front panel by the illumination of the indicator lamps. In a filling operation, the push button corresponding to the level of fill desired is depressed. When this level is reached, a signal is available which will terminate the filling process.

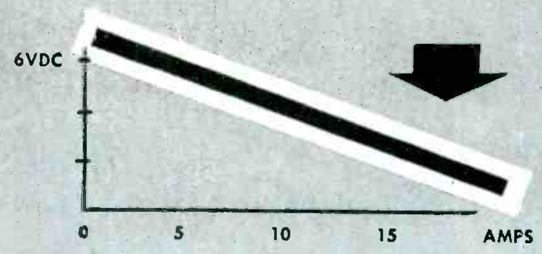
To inspect previously filled vessels, the acceptable filled range is determined and the two push-button stations at the limits of acceptability are depressed. As the vessels pass for inspection, those falling out of the acceptable limits will be marked or rejected.

The size vessel that may be inspected or filled by this gage is determined by the x-ray generator used. Generally speaking, for thicknesses of vessel wall up to ⅛ in. of steel or its radiographic equivalent, an x-ray generator which runs at 100 kvp is needed. For wall thicknesses up to ½ in. of steel or its radiographic equivalent, an x-ray generator capable of running to 250 kvp should be used. Should vessels having a thicker wall be inspected, a generator having more penetration will be needed.

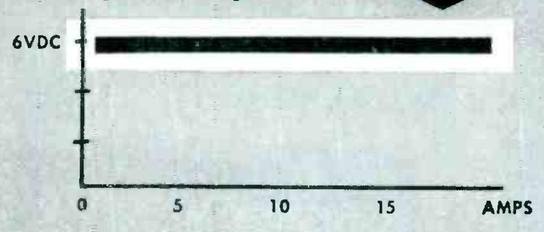
As constructed, the gage is a versatile, rugged instrument that satisfies a long standing need for a precise method of determining level in remote locations or loca-

Problem •

Your present DC source gives you



What you require is



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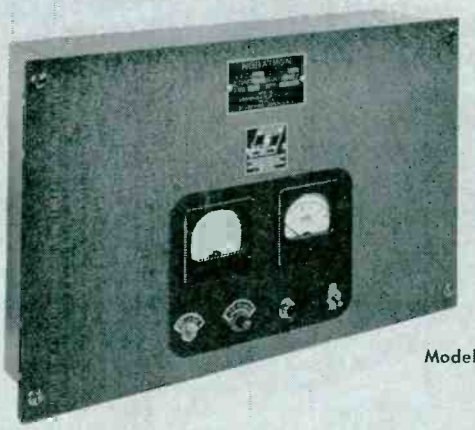

Model E-6-15

COMMON NOBATRON SPECIFICATIONS

Input Voltage range	95-130 VAC, single φ, 50-60 ~ High-current units 208/115, 3φ, 4-wire, wye.
Output voltage range	Adjustable ± 10% with rated accuracy, — 25% with lesser accuracy.
Regulation accuracy	± 0.2% from 1/10 to full load.
Ripple voltage	1% RMS. Time constant 0.2 seconds.

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SR-10

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Standard models with adjustable outputs of 3-30VDC, 3-135VDC, 200-300VDC.

Write for full information on Nobatrons, Nobatron-Rangers, and other Sorensen Isotronic† products.

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

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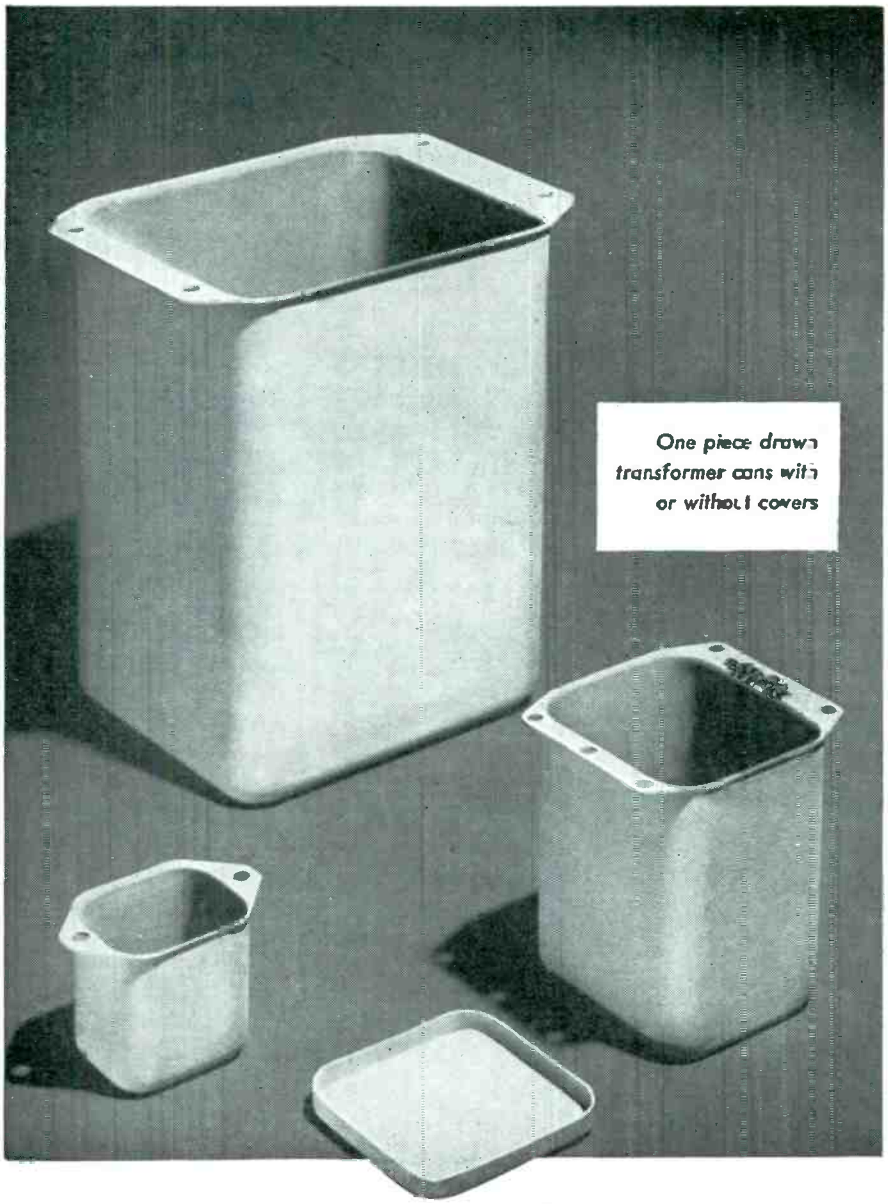

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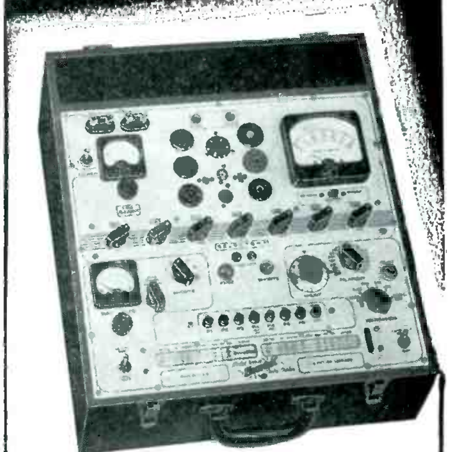

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- Optional self-bias arrangement.
- Provision for insertion of plate milliammeter for measuring plate current.
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- D.C. grid bias and D.C. plate and screen voltages.
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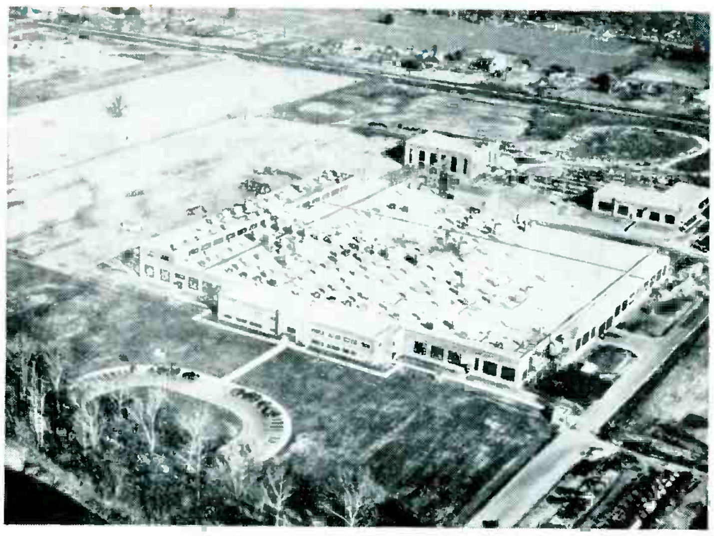

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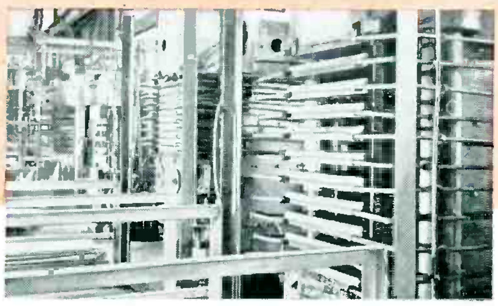

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Grateful acknowledgement is made to D. Cameli and J. Howell of the Engineering Laboratory for their valuable assistance in the construction and testing of the gage.

REFERENCES

(1) R. Hofstadtor, Crystal Counters, *Nucleonics*, **4**, p 16, April 1949; **4**, p 29, May 1949.

(2) R. Frerichs and R. Warminsky, Die Messung von beta und gamma Strahlen durch inneren Photoeffekt in Kristallphosphoren, *Naturwiss*, **33**, p 251, 1949.

(3) R. Frerichs, The Photoconductivity of Incomplete Phosphors, *Physical Review*, **72**, p 594, 1947.

Gated-Beam Mixer

BY S. RUBIN AND G. E. BOGGS
Central Radio Propagation Laboratory
National Bureau of Standards
Washington, D. C.

THE PROBLEM of isolation between the signal and oscillator circuits in a mixer is often of serious proportions for many high-frequency applications. The gated-beam tube as exemplified by the 6BN6 may be satisfactorily used as a mixer and results in improved signal circuit isolation.

With the usual mixer configurations and a high impedance in the signal grid circuit, a voltage of oscillator frequency on the signal grid may well cause grid-current flow. This will of course alter the tube characteristics. In addition, the oscillator voltage present in the signal circuit may assist in the switching or modulating of the tube and may change the shape of the switching function. If the signal circuit is returned through the avc bus, the oscillator voltage appearing on the signal grid may bias this grid thus reducing the conversion transconductance.

In practice the problems arising from poor isolation between the signal and oscillator circuits are frequently met by maintaining a low impedance in the signal grid circuit. Unfortunately, this is a poor solution, since it may drastically reduce the gain ahead of the mixer.

In tubes where the signal is injected on one grid and the oscillator on another, the coupling between

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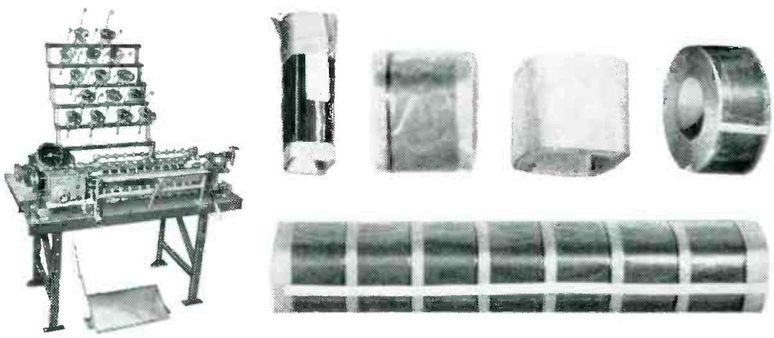

Transformer winder Model 37S multiple winds power, audio, automotive, fluorescent ballast and similar types of coils. Winds wire from No. 18 B&S to 46 B&S up to 9" O.D. Maximum economy is possible by using mandrels up to 30" long. Thirty or more coils may be wound at one time. All turns are accurately registered by Model 50 or 51 6" full vision clock face Dial Counter. Set-ups can be changed in less than 5 minutes. A gear chart is furnished to quickly determine wire spacing.

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grids is made up of two components, capacitance between the signal and oscillator grid and space-charge coupling. Tubes utilizing the inner grid for oscillator injection have relatively large space-charge coupling at high frequencies and hence are not suitable for applications where good isolation is imperative.

Outer-Grid Mixer

When the signal is applied to the first grid and the oscillator to an outer-grid the combination has come to be known as an outer-grid mixer. This arrangement exhibits a space-charge coupling effect of only $\frac{1}{5}$ to $\frac{1}{10}$ of that present with tubes employing inner-grid injection.[1] It should be noted that with an outer-grid mixer, the voltage induced on the signal grid, due to space-charge coupling between the two grids, adds to the oscillator voltage on the signal grid which is due to capacitive coupling. This is opposite to the effect when using inner-grid injection.

Since the 6BN6 has two rather high transconductance control grids it may be employed as either inner-grid or outer-grid mixer. Maximum isolation is obtained when the tube is used as an outer-grid mixer with the oscillator injected on the third grid. This grid fortunately will not develop a high bias since the grid current is limited by tube design. The grid-current limiting feature of this tube results in very low os-

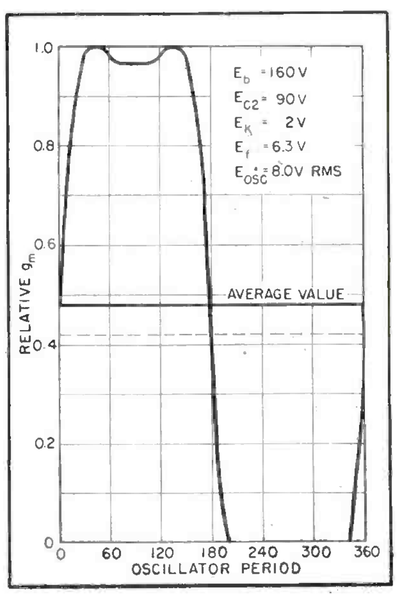

FIG. 1—Switching function characteristic for 6BN6

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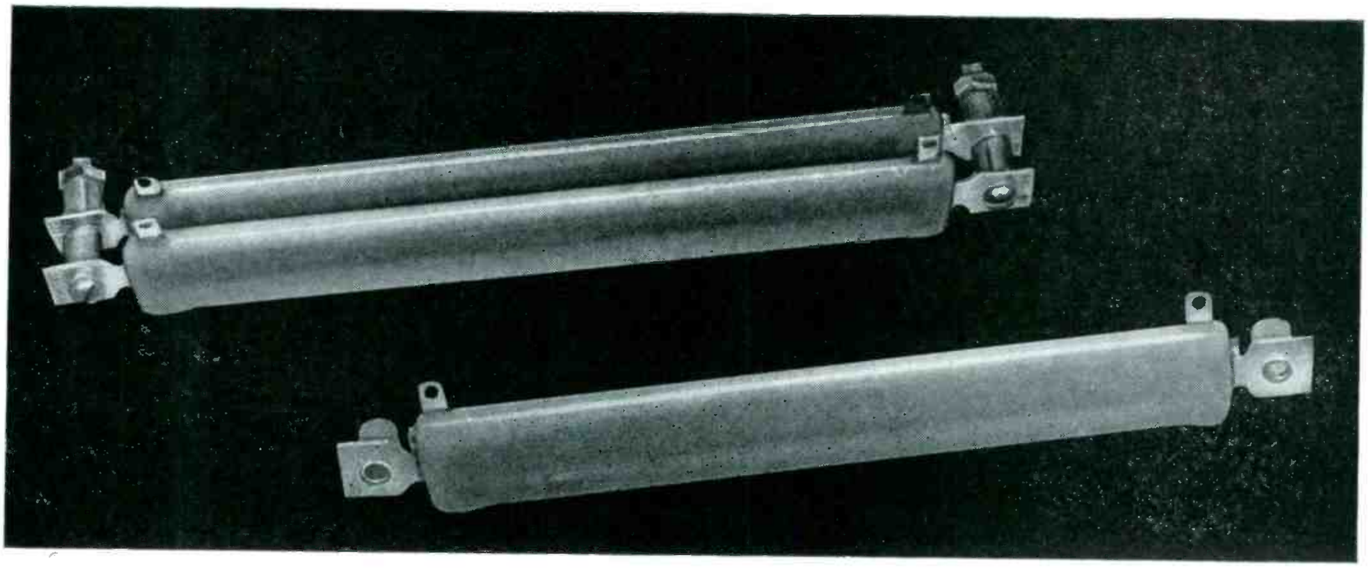

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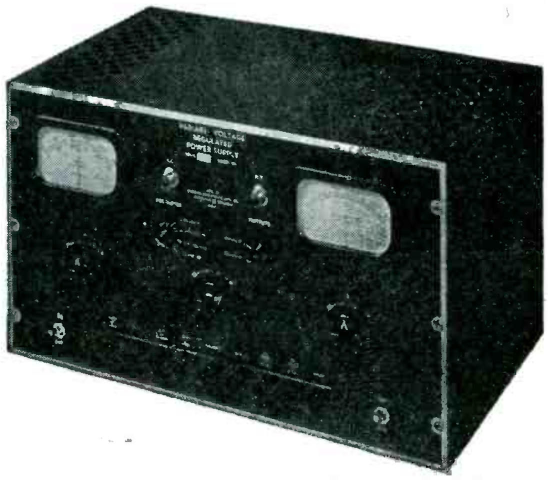

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- ✓ 6.3 volts AC at 10 amperes center-tapped.
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- ✓ Stabilized bias supply.
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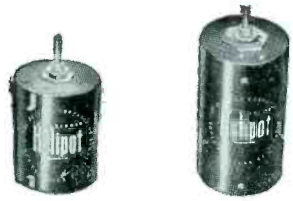
MODELS A, B, & C HELIPOTS
A—10 turns, 46" coil, 1-13/16" dia., 5 watts—resistances from 10 to 300,000 ohms.
B—15 turns, 140" coil, 3-5/16" dia., 10 watts—resistances from 50 to 500,000 ohms.
C—3 turns, 13-1/2" coil, 1-13/16" dia., 3 watts—resistances from 5 to 50,000 ohms.



MODELS D AND E HELIPOTS
Provide extreme accuracy of control and adjustment, with 9,000 and 14,400 degrees of shaft rotation.
D—25 turns, 234" coil, 3-5/16" dia., 15 watts—resistances from 100 to 750,000 ohms.
E—40 turns, 373" coil, 3-5/16" dia., 20 watts—resistances from 200 ohms to one megohm.

MODELS F, G AND J PRECISION SINGLE-TURN POTENTIOMETERS
Feature both continuous and limited mechanical rotation, with maximum effective electrical rotation. Versatility of designs permit a wide variety of special features.
F—3-5/16" dia., 5 watts, electrical rotation 359°—resistances 10 to 100,000 ohms.
G—1-5/16" dia., 2 watts, electrical rotation 356°—resistances 5 to 20,000 ohms.
J—2" dia., 5 watts, electrical rotation 357°—resistances 50 to 50,000 ohms.

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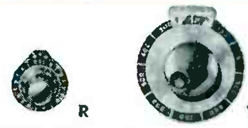
The ideal resistance unit for use in laboratory and experimental applications. Also helpful in calibrating and checking test equipment. Combines high accuracy and wide range of 10-turn HELIPOT with precision adjustability of DUODIAL. Available in eight stock resistance values from 100 to 100,000 ohms, and other values on special order.



MODELS R AND W DUODIALS
Each model available in standard turns-ratios of 10, 15, 25 and 40 to 1. Inner scale indicates angular position of HELIPOT sliding contact, and outer scale the helical turn on which it is located. Can be driven from knob or shaft end.
R—2" diameter, exclusive of index.
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In order to meet rigid government specifications on these developments—and at the same time produce them economically—HELIPOT* has perfected unique manufacturing facilities, including high speed machines capable of winding extreme lengths of resistance elements employing wire even less than .001" diameter. These winding machines are further supplemented by special testing facilities and potentiometer "know-how" unsurpassed in the industry.

So if you have a problem requiring precision potentiometers your best bet is to bring it to The HELIPOT Corporation, world's largest manufacturer of such equipment. A call or letter outlining your problem will receive immediate attention!

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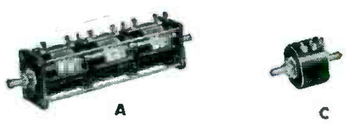
The versatility of the potentiometer designs illustrated above permit a wide variety of modifications and features, including double shaft extensions, ganged assemblies, the addition of a multiplicity of taps, variation of both electrical and mechanical rotation, special shafts and mounting bushings, high and low temperature operation, and close tolerences on both resistance and linearity. Examples of potentiometers modified for unusual applications are pictured at right.



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All HELIPOTS, and the Model F Potentiometer, can be furnished with shaft extensions and mounting bushings at each end to facilitate coupling to other equipment.
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MULTITAPPED MODEL B HELIPOT AND 6-GANGED TAPPED MODEL F
This Model B Helipot contains 40 taps, placed as required at specified points on coil. The Six-Gang Model F Potentiometer contains 19 additional taps on the middle two sections. Such taps permit use of padding resistors to create desired non-linear potentiometer functions, with advantage of flexibility, in that curves can be altered as required.

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cillator power requirement and it is found that six to ten volts rms provides adequate oscillator excitation.

A typical switching function for the 6BN6 is shown in Fig. 1. The tube has about a 10-percent improvement in conversion efficiency compared to the 6SA7.

Transconductance

Since grid current in the 6BN6 is limited by the design of the tube, the bias voltage built up on the oscillator grid is very small, resulting in a higher value of peak transconductance. With low bias voltage on the oscillator grid, the magnitude of the grid resistor is not critical within limits. Also, the g_c is practically constant with changing oscillator excitation voltage after a threshold value has been reached, which in this case is about 8 volts.

At 30 mc, with 120 v on the plate and 70 v on the accelerator, the conversion transconductance was lower than anticipated. The low g_c is attributed largely to transit time since raising the plate and accelerator voltages to 155 and 90 v respectively increased the conversion transconductance to 790 μmhos. With a high-impedance input to the signal grid, some loading of the input circuit was observed, as would be expected with outer grid injection. While no input admittance measurements have been made, it would be reasonable to assume that good performance can be obtained with this tube in the lower vhf range.

A typical circuit used during the course of this experimental work is shown in Fig. 2. No special precautions were found necessary, but a metal shield across the tube socket between pins 4 and 5 and pins 1 and 7 is recommended to maintain low capacitance between the two signal grids.

Since the 6BN6 may be employed as an outer-grid mixer, it may be assumed that the method described by Aske[2], where a tuned circuit is placed between the plate and screen, may be used to double the conversion transconductance. If desired the single tube may be used as a converter by using the number 3 grid in an outer space-current local oscillator.

It is interesting to note that

Eight ML-5682's mounted in a Doherty high efficiency linear amplifier designed for 500 kW output.

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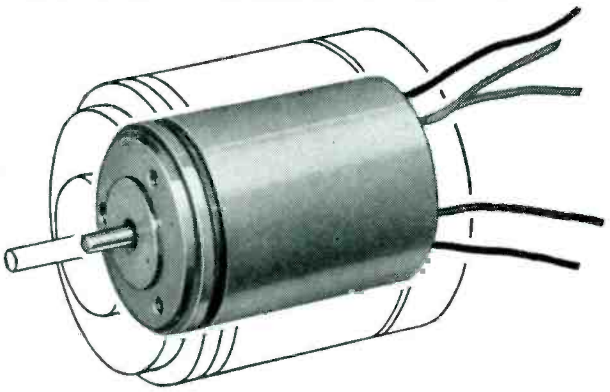

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Frequency	400 cycles	400 cycles	400 cycles
Current	88 milliamperes	110 milliamperes	55 milliamperes
Power	0.8 watts	1.2 watts	0.9 watts
Impedance	105+j280 ohms	100+j220 ohms	290+j370 ohms
OUTPUT			
Voltage Max. (rotor output)	17.9 volts	16.2 volts	14.1 volts
Voltage at null	40 millivolts	40 millivolts	40 millivolts
Sensitivity	310 millivolts/degree	280 millivolts/degree	245 millivolts/degree
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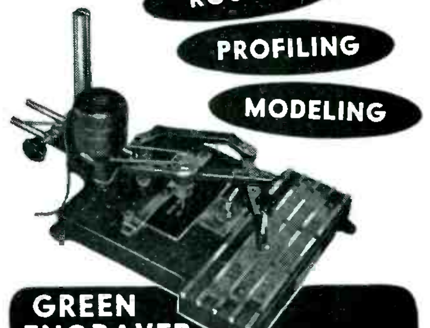

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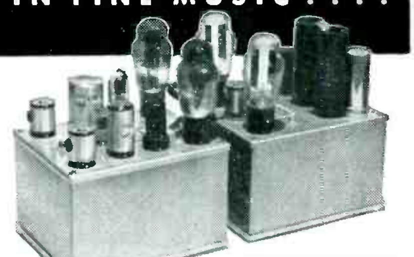

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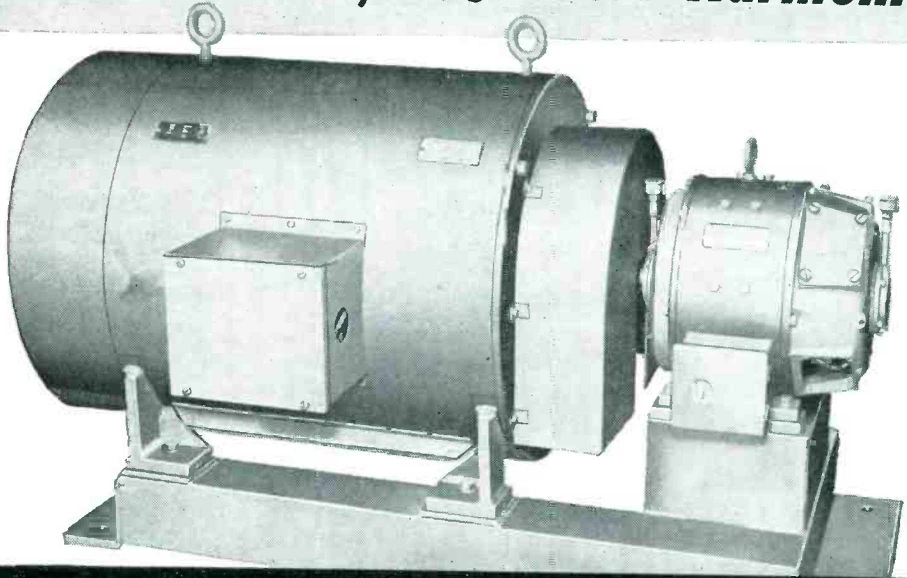

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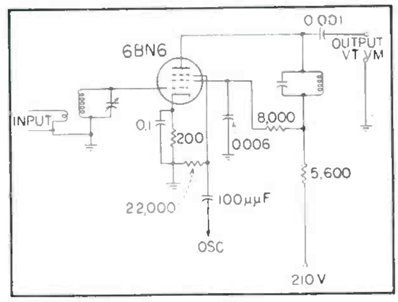


FIG. 2—Schematic diagram of the 6BN6 mixer

above a given supply voltage the conversion gain is essentially constant with increasing supply voltage. Thus in some applications it may be desirable to operate this tube at higher voltages than necessary in order to obtain good voltage stability.

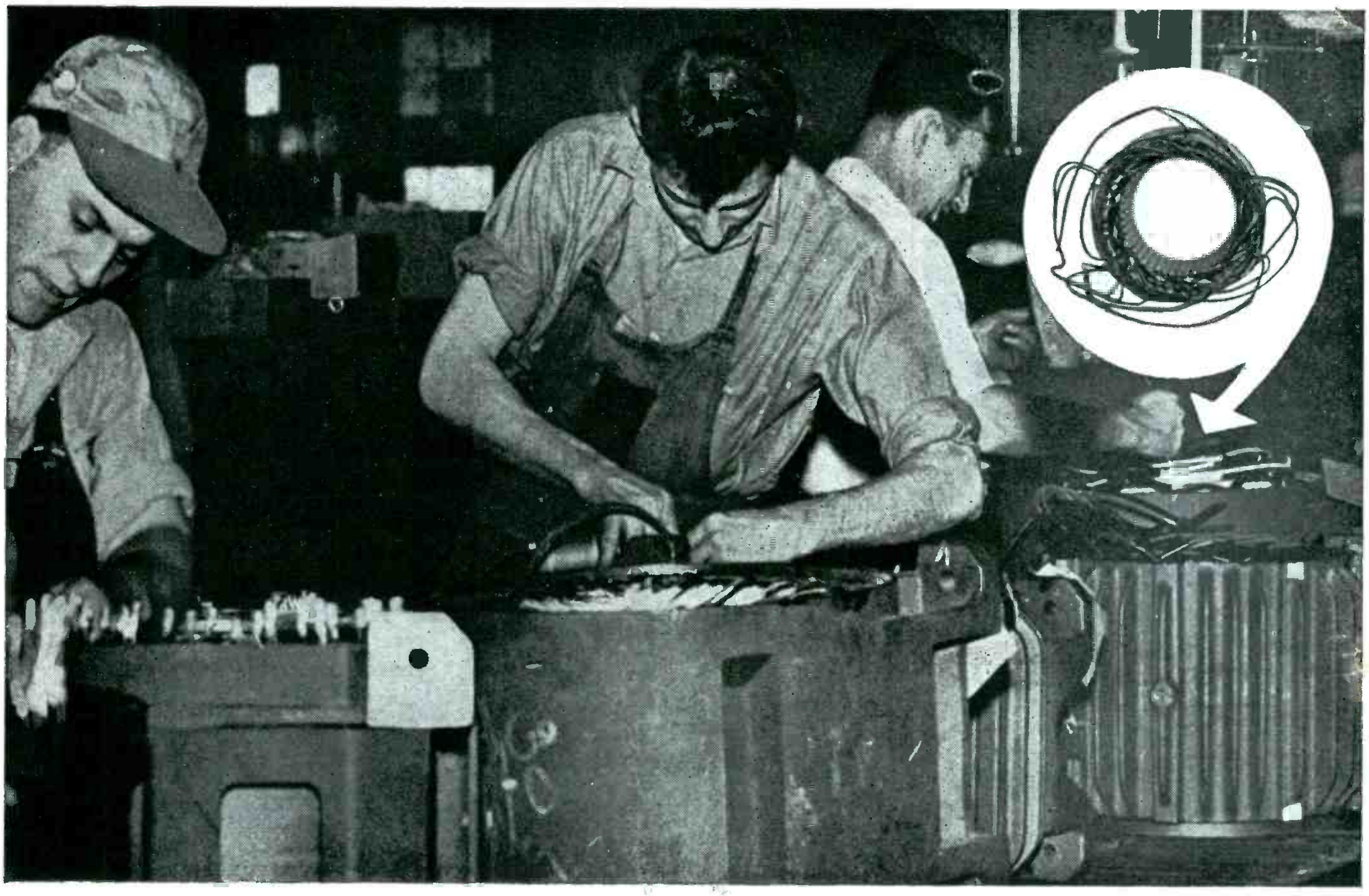
If the 6BN6 is operated at very low voltages, the linearity will suffer. When grid voltages as high as one volt are necessary, the accelerator voltage should be rather high, in the order of 90 v.

Conclusion

The 6BN6 has been shown to perform well in mixer service. It is one of the very few commercially available high-transconductance tubes for outer-grid injection. The greatest advantage obtained with this tube is the reduced space-charge coupling and low capacitance between control grids. This allows higher frequency operation with a fairly low value of i-f without resulting in excessive values of oscillator voltage appearing on the signal grid.

The tube has a conversion transconductance of approximately 800 μmhos with less cathode current than that taken by many existing pentagrid tubes. In addition the 6BN6 can probably be used in the gain-doubling circuit of Aske[2] to further increase its utility. The 6BN6 exhibits positive input loading as do all outer grid mixers. At vhf the relatively high value of input conductance may result in a serious loss in gain. While no measurements have been made of input conductance, experimental results at 30 mc indicate little input loading.

In the course of the experimental work it was found that there is a considerable variation in the char-



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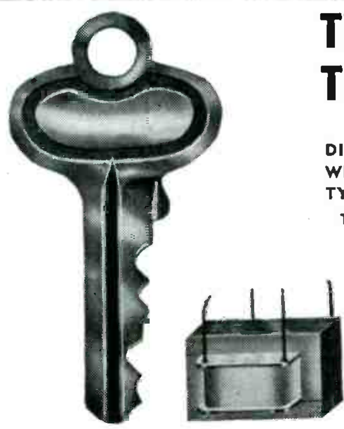

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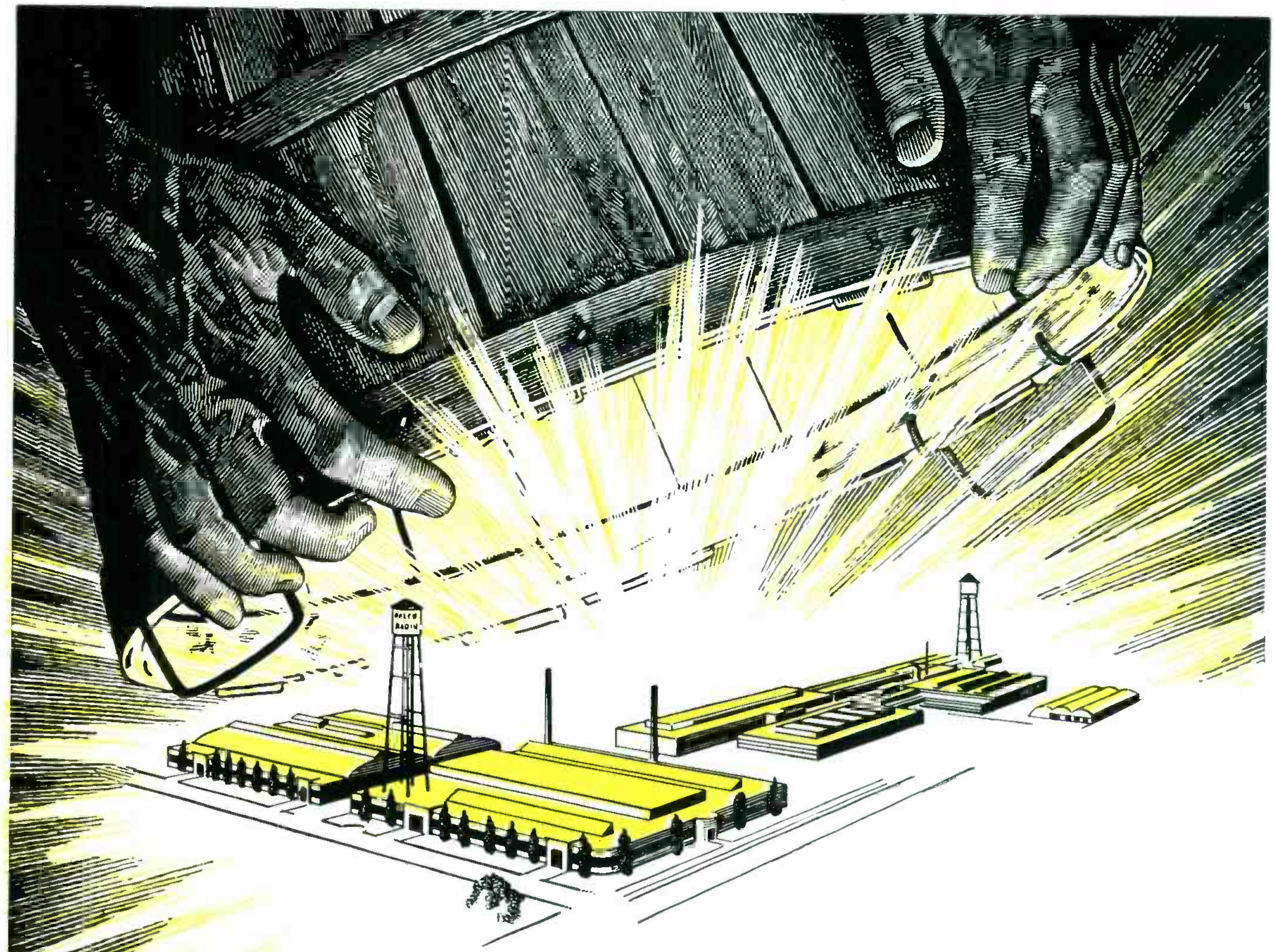

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acteristics between different tubes. In particular, the signal-grid transfer characteristic exhibited considerable variation. This is no doubt due to the fact that this tube is not tested for this type of service. It may, therefore, be suggested that the 6BN6 could be rated for mixer or converter service by the manufacturer and a portion of these tubes sold for this purpose.

While the 6BN6 makes a very satisfactory mixer for many applications, it is thought quite possible that a gated-beam tube could be developed which would have superior characteristics for mixer applications.

REFERENCES

(1) E. W. Herold, The Operation of Frequency Converters and Mixers for Superheterodyne Reception, *Proc. IRE*, 30, p 84, Feb. 1942.

(2) V. H. Aske, Gain-Doubling Frequency Converters, ELECTRONICS, 24, p 92, Jan. 1951.

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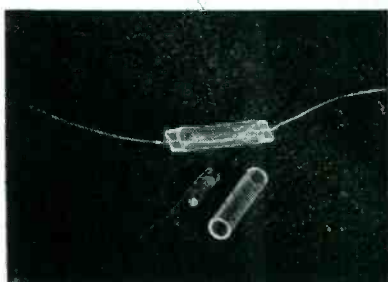
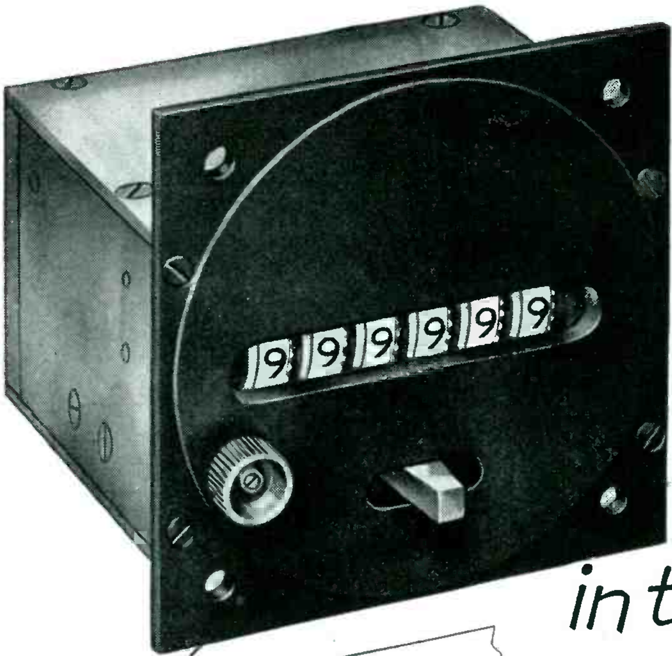


FIG. 1—Nylon tubing, thermistor and assembly of the two components



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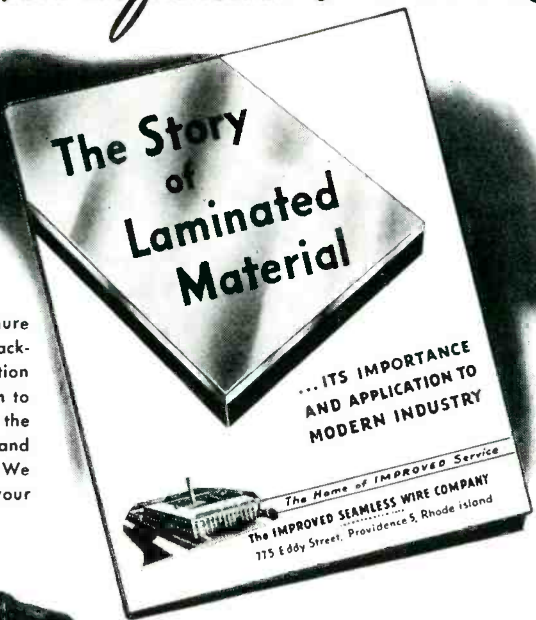

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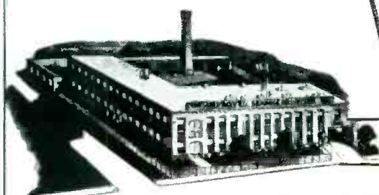

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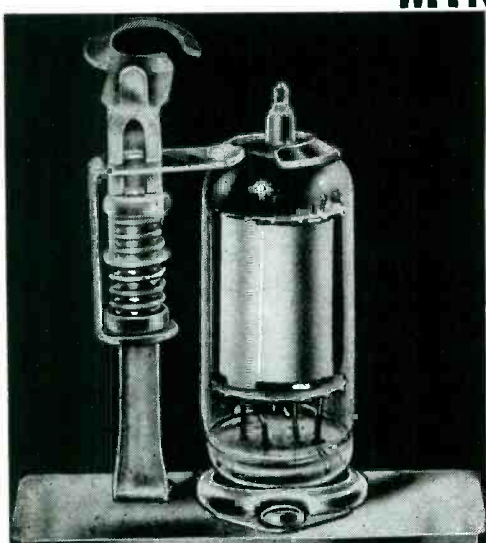

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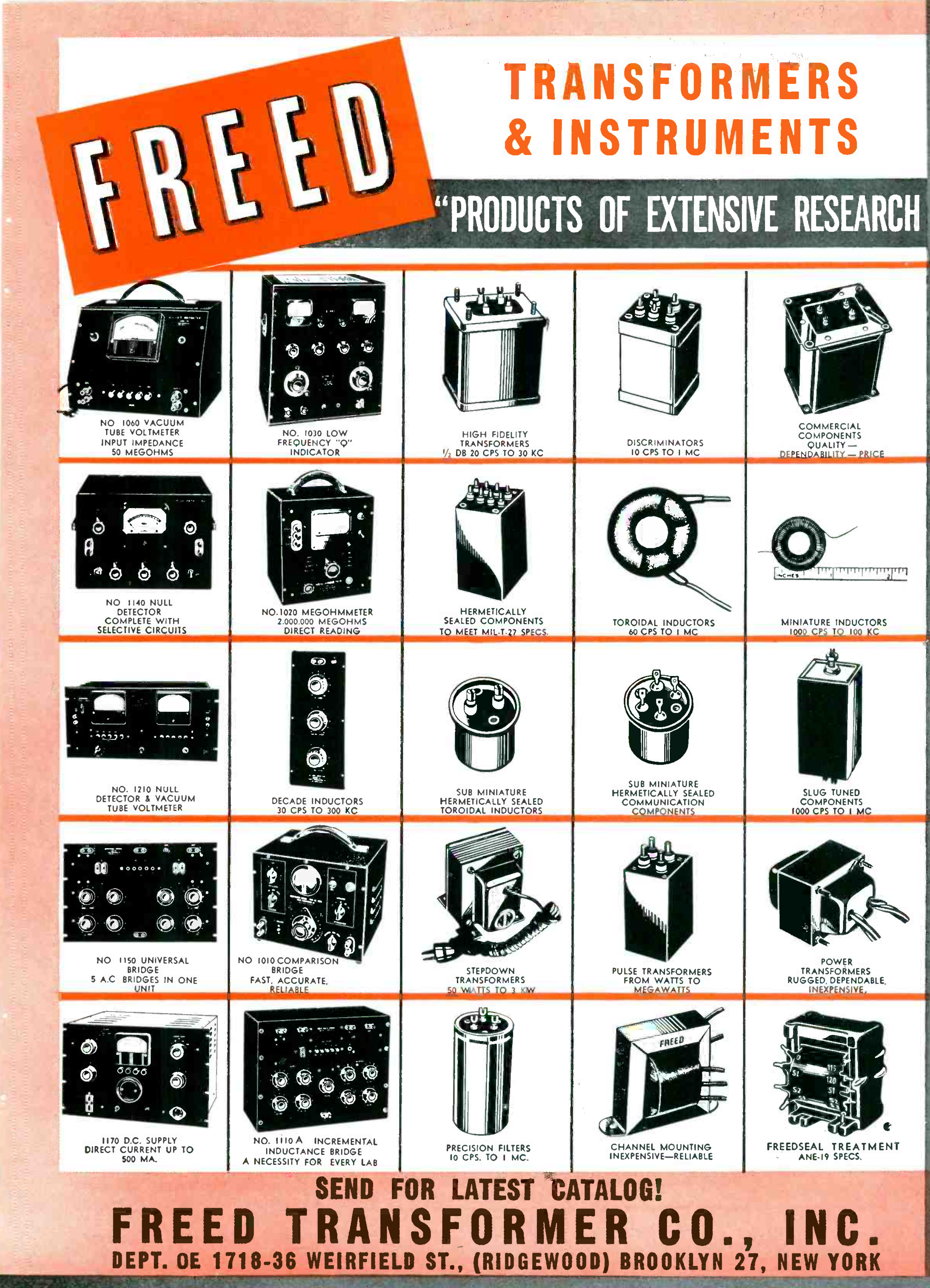
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The thermistor application is just one of many possible uses for the tubing in the electronic industry. The tubing itself is manufactured by Anchor Plastics Company, New York, N. Y.

Application of Tubes in Heating Equipment

By H. J. DAILEY and C. H. SCULLIN

Electronics Engineering Department
Westinghouse Electric Corp.
Bloomfield, New Jersey

ONE OF THE MAJOR PROBLEMS confronting the designers of induction and dielectric heating equipment is to provide for the tubes a physical and electrical environment which will favor long life and maximum reliability.

Load Variations

An important consideration in the usual r-f heating setup is the effect of expected load variations on tube-element dissipations and emission requirements. As the loading increases, the plate and grid voltage swings decrease and the plate current increases. The tube draws more power input so that the anode dissipation increases. Thus, the maximum load variation above normal should be such that neither the maximum plate dissipation nor maximum plate-current ratings are exceeded. The latter are of particular importance in the case of thoriated-tungsten filaments.

As the loading decreases the plate swing, the grid swing and the grid current both increase to give rise to higher grid dissipations and require higher peak emission currents from the cathode. In extreme cases, the

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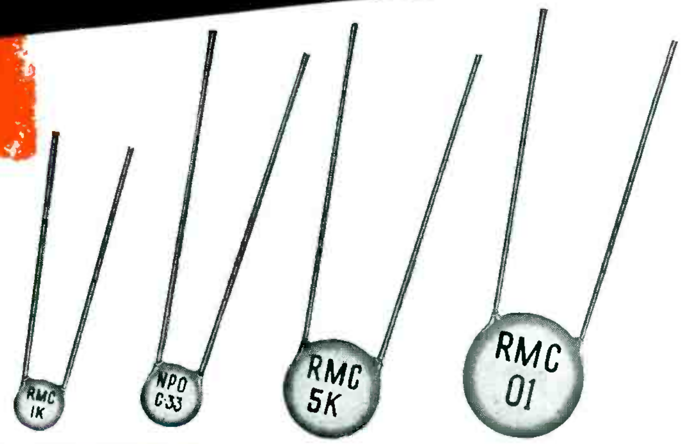

RMC DISCAPS are approved and used by leading manufacturers of TV sets and tuners, radio receivers and high frequency electronic equipment. In addition to their lower cost, they offer the advantages of small size, low self inductance, low power factor, high working voltage, greater mechanical strength and faster production line handling.

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WORKING VOLTAGE . . . . 600 V.D.C.
TEST VOLTAGE . . . . 1200 V.D.C.
INSULATION . Durez Phenolic—Vacuum Waxed
RESISTANCE . . . . Initial 7500 Megohms
After Humidity 1000 Megohms
LEADS . . . . . #22 Tinned Copper (.026 DIA.)
CAPACITY TOLERANCE . . . . GMV

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Type C DISCAPS are ideally suited to coupling and tuned circuit applications. Their capacity will not change under voltage. Available in a wide range of capacities and temperature coefficients conforming to the RMA specifications for Class I ceramic condensers.

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TEST VOLTAGE . . . . 1200 V.D.C.
INSULATION .
Durez Phenolic—Vacuum Waxed
RESISTANCE . . . . Initial 7500 Megohms
After Humidity 1000 Megohms
LEADS #22 Tinned Copper (.026 DIA.)
CAPACITY TOLERANCE . . . .
±5%, ±10%, ±20%

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TEST VOLTAGE . . . . 1200 V.D.C.
INSULATION . . . .
Durez Phenolic—Vacuum Waxed
RESISTANCE . . . . Initial 7500 Megohms
After Humidity 1000 Megohms
LEADS . . . #22 Tinned Copper (.026 DIA.)
CAPACITY TOLERANCE . . . .
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NEW! RMC DEPENDABLE HI-VOLTAGE DISCAPS

ACTUAL SIZE

SPECIFICATIONS

CAPACITY . . . . 500 MMF + 50% − 20%
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TEST VOLTAGE . . . . 30,000 V.D.C.
POWER FACTOR . . . . 1.5% Max. at 1 KC
LEAKAGE RESISTANCE . . . . . . Initial 7500 Megohms
After Humidity . . . . 1000 Megohms
INSULATION . . . . Moulded Plaskon

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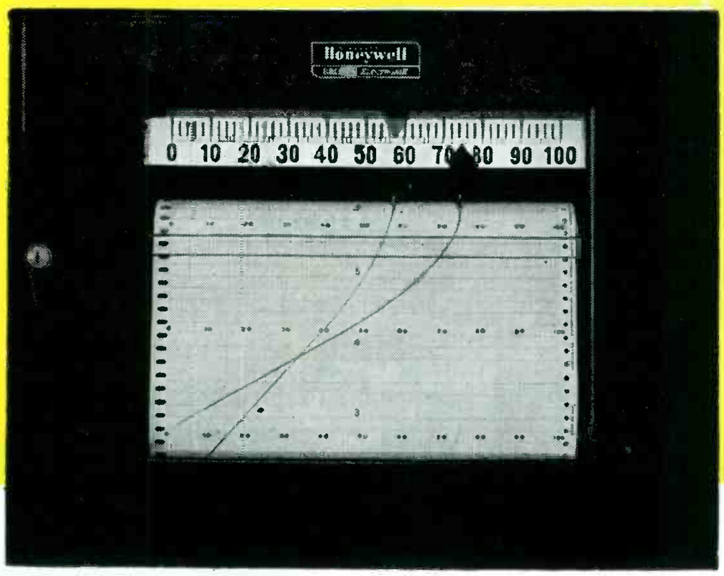

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plate-voltage swing can become larger than the d-c plate voltage and even become great enough to cause the tank circuit or the tube to arc over.

One satisfactory method of preventing excessive plate-voltage swing in high-power oscillators is a circuit which automatically adjusts the filament voltage so that the peak emission is limited enough to just maintain a normal plate-voltage swing. The plate-voltage swing is measured by a peak-reading diode-voltmeter circuit and variations in this voltage are used to control a filament regulator which adjusts the emission to give normal plate-voltage swing again. This method is limited to use only on tubes with pure tungsten filaments. It has the added advantage of increasing filament life since the filament is always operated at a temperature just high enough to supply the desired emission.

Other methods are based on circuits which automatically adjust the load coupling to maintain more or less constant load on the tube over the heating cycle. This system has not been too satisfactory because of cost and limited operating range.

Cutouts

The control of filament current is a preferred method where it can be used. The use of adequate plate and grid meters having regions of excessive currents clearly marked is of some help in avoiding excessive currents. Properly adjusted current overload relays in both circuits are a necessity in prolonging tube life. With overload relays alone for protection there is often a tendency to "set it up a little higher" when the set shuts itself off too frequently from repeated overloads.

It is quite probable that there is a more real economic justification for the added costs of some of these automatic circuits than is commonly realized by the prospective purchaser. It should be noted that overload relays provide very necessary protection in cases outside the control range of automatic systems in case of failure of such systems.

Many times premature tube failures are caused by improper operating conditions which are not as

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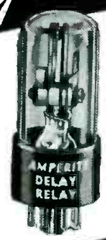

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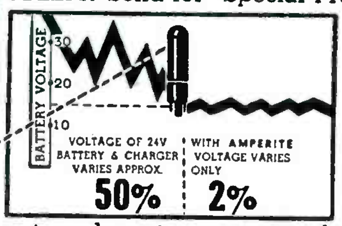

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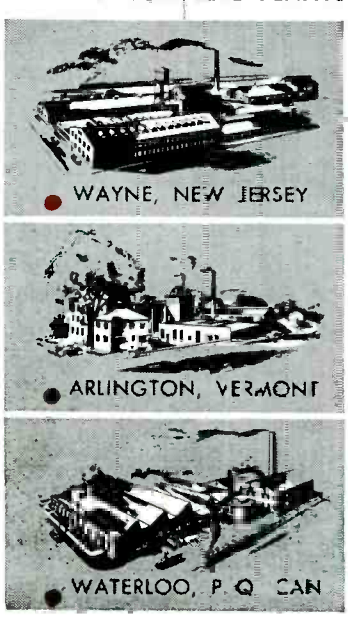


obvious to detect as excessive current on a meter. Examples of these are improper cooling conditions and improper filament connectors. Should the mineral content of cooling water for water-cooled tubes be too high, a mineral deposit will build up on the anode wall which will appreciably decrease the heat transfer from the anode to water, reduce water flow and result in anode overheating. The same result can occur due to reduced carrying capacity of the water piping when deposits build up on the pipe walls.

Solution of this problem is a clean low-mineral-content water system. For large tubes, a closed system using distilled or deionized water and a suitable heat exchanger is desirable. Flow switches and water-immersion thermal switches should be installed to protect tubes

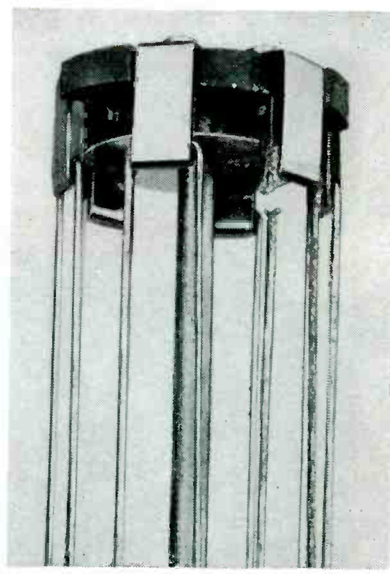
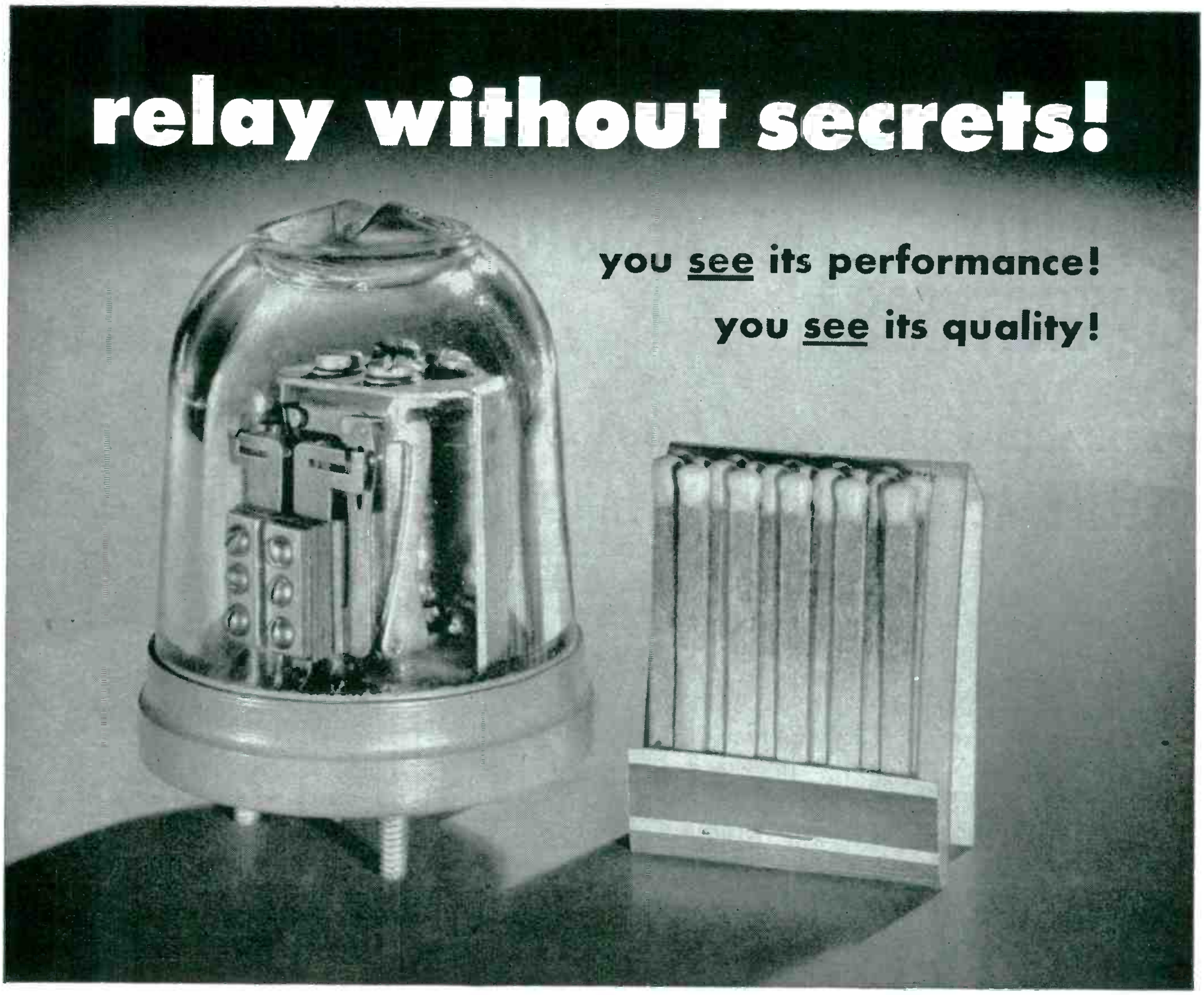


FIG. 1—An example of power arc damage to a filament structure. Tube suffered approximately 100 times normal plate current during the arc period

against insufficient water and too high a water temperature.

In the case of air-cooled tubes, the use of adequate air filters and airflow switches are of vital importance. The air filters should be located so they can be easily changed. It cannot be too highly stressed that the users of r-f heating equipment must understand the problems of such equipment and that periodic maintenance is a good investment rather than an expense.

Another factor often overlooked in using air-cooled tubes is the tem-



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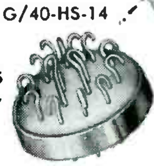
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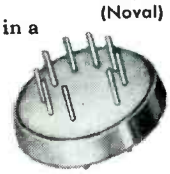
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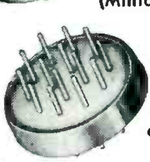
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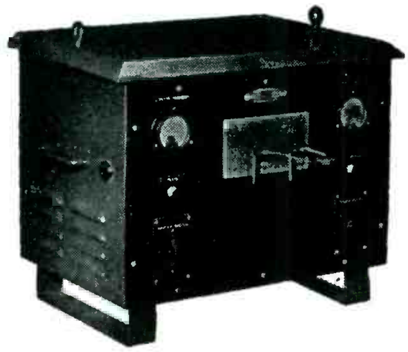

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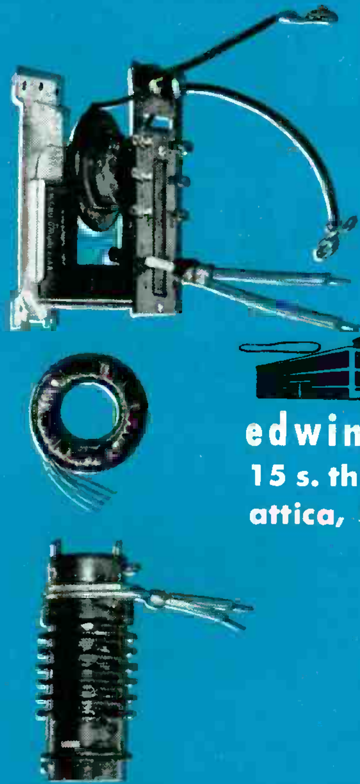

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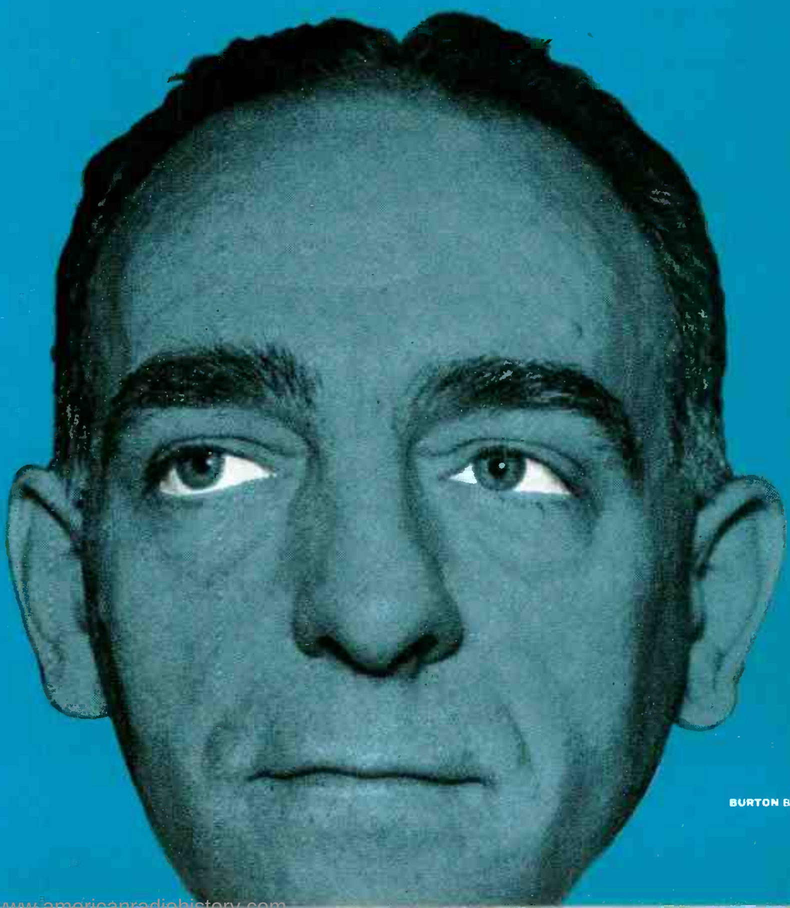

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perature of the air entering the radiator. Most tube manufacturers limit the allowable incoming air temperature to 45C. In many installations where the air temperature in a plant is high due to nearby ovens or other such equipment and particularly where the air coming into the r-f heater passes over a hot transformer or component before being forced through the radiator of the tube, this temperature may be exceeded considerably. In difficult cases it may be very worth while to install an air duct to bring air in from outside the plant or from a cooler spot in the plant. In some cases a booster blower may be necessary to compensate for airflow losses in the duct.

Another troublesome item and one which would be the least suspected, is the filament connector. It is a fact that every year many tubes fail to perform properly and suffer premature deaths because of improperly designed and used filament connectors. A good filament connector should make contact with the tube terminal at a large number of points and should keep these contact points under a definite mechanical pressure even after it has been in use for many months. The connector should be plated with a suitable coating which remains a good electrical conductor even after many hundreds of hours at operating temperatures.

Silver is usually a satisfactory plating material as silver oxide is also a good conductor. The connector should be designed with a flexible lead which does not transmit strain to the tube terminal or glass seals. The connector should be capable of being applied or removed without the use of pliers or other tools whose abuse often results in bent terminals or cracked seals. Such connectors have been made and are in use in many equipments today.

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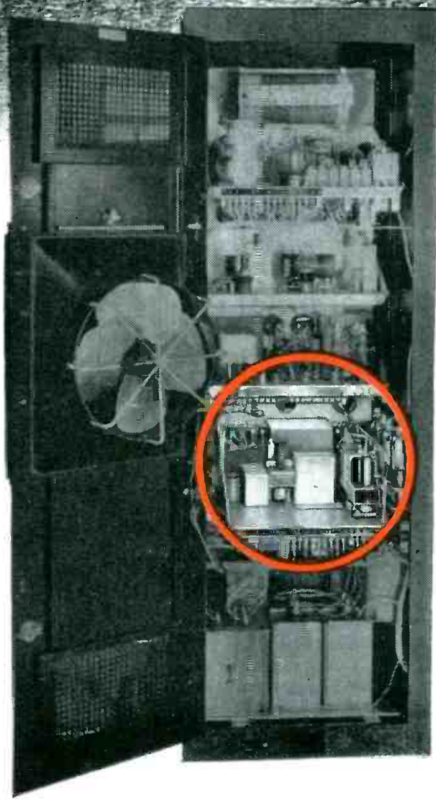

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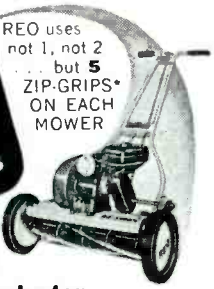

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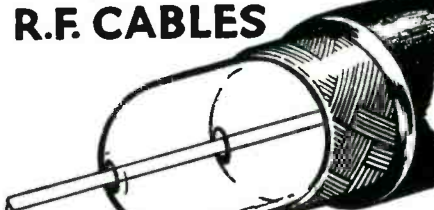

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LOW ATTEN TYPES	IMPED OHMS	ATTEN db/100ft	LOADING Kw at 100 Mc/s.	O.D."
A 1	74	1.7	0.11	0.36
A 2	74	1.3	0.24	0.44
A 34	73	0.6	1.5	0.88

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LOW CAPAC TYPES	CAPAC mmf/ft.	IMPED OHMS	ATTEN db/100ft 100Mc/s.	O.D."
C 1	7.3	150	2.5	0.36
PC 1	10.2	132	3.1	0.36
C 11	6.3	173	3.2	0.36
C 2	6.3	171	2.15	0.44
C 22	5.5	184	2.8	0.44
C 3	5.4	197	1.9	0.64
C 33	4.8	220	2.4	0.64
C 44	4.1	252	2.4	1.03

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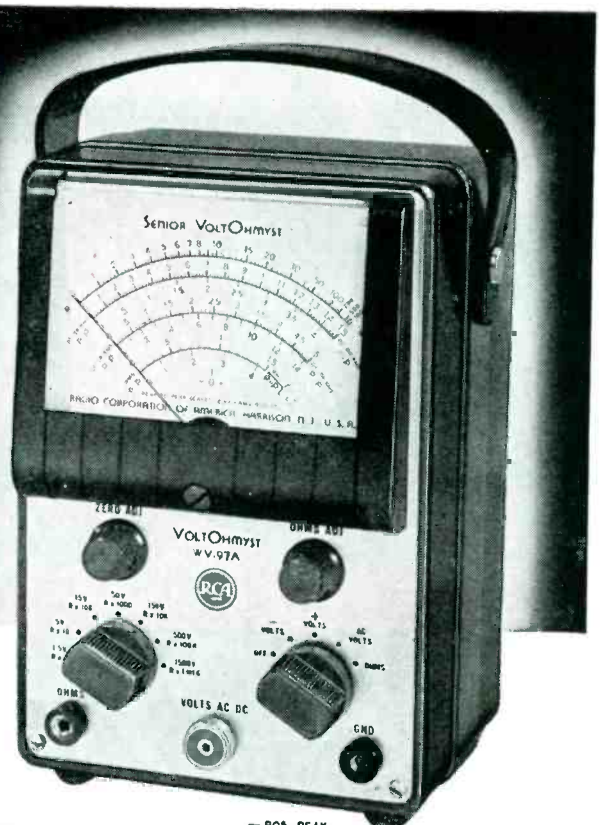
The NEW RCA WV-97A Senior VoltOhmyst*

reading peak-to-peak voltages

ONLY 67^{50} Suggested User Price

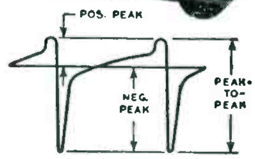
Includes direct probe and cable, dc probe, ohms lead, and ground lead



TEN WAYS BETTER!

1. Directly measures complex waves from 0.2 volt to 2000 volts, peak-to-peak.
2. Has an over-all accuracy for dc measurements of ±3% of full scale.
3. Measures dc voltages from 0.02 volt to 1500 volts.
4. Measures rms values of sine-wave voltages from 0.1 volt to 1500 volts.
5. Has 7 non-skip ranges for both resistance and voltage.
6. All full-scale voltage points increase in a uniform "3-to-1" ratio.
7. Frequency response flat from 30 cps to approximately 3 Mc.
8. Negative-feedback circuit provides better over-all stability.
9. Fully enclosed metal case shields sensitive electronic-bridge from rf fields.
10. More convenient to use because of smaller size and new slip-on probes.

The WV-97A measures peak-to-peak voltages directly. Hence, it quickly provides information essential for servicing TV receivers with their pulse-type waveforms.



The WV-97A has a range of usefulness extending beyond that of any other instrument in the field. Its quality, dependability, and accuracy make it a true laboratory instrument; it is exactly what is needed for television in the design laboratory, factory, and service shop.

The new Senior VoltOhmyst measures dc voltages in high-impedance circuits, even with ac present. It reads the rms values of sine waves and the peak-to-peak values of complex waves or recurrent pulses, even in the presence of dc. Its electronic ohmmeter has a range of ten billion to one.

Like all RCA VoltOhmysts, it features high input resistance, electronic protection from meter burn-out, zero-center scale for discriminator alignment, molded-plastic meter case, a 1-megohm isolating resistor in the dc probe, and sturdy metal case for good rf shielding.

An outstanding feature is its usefulness as a television signal tracer . . . made possible by its high input resistance, wide frequency range, and direct reading of peak-to-peak voltages.

For complete information on the new RCA WV-97A Senior VoltOhmyst, see your RCA Test Equipment Distributor, or write RCA, Commercial Engineering, Section 42JX, Harrison, New Jersey.

*Reg. U. S. Pat. Off.

SPECIFICATIONS

DC VOLTMETER:
Seven continuous ranges . . . 0 to 1.5, 5, 15, 50, 150, 500, 1500 volts
Input resistance (including 1 megohm in dc probe):
All ranges . . . 11 megohms
Sensitivity for the 1.5 volt range . . . 7.3 megohms-per-volt
Over-all Accuracy . . . ±3% of full scale

AC VOLTMETER—Fourteen continuous ranges:
Peak-to-peak ranges . . . 0 to 4, 14, 42, 140, 420, 1400, 4200 volts
Maximum peak-to-peak input voltage for complex waves, 2000 volts
RMS ranges (for sine waves) . . . 0 to 1.5, 5, 15, 50, 150, 500, 1500 volts
Input Resistance and Capacitance with WG-218 Direct Probe and Cable:
1.5, 5, 15, 50, 150-volt ranges . . . 0.83 megohm shunted by 70 μμf
500-volt range . . . 1.3 megohms shunted by 60 μμf
1500-volt range . . . 1.5 megohms shunted by 60 μμf
Frequency Response with WG-218 Direct Probe and Cable:
1.5, 5, 15, 50, 150, 500-volt ranges flat from 30 cps to 3 Mc for voltage source having 100-ohm impedance
Overall Accuracy:
1.5, 15, 50, 150, 500, 1500-volt ranges . . . ±5% of full scale

OHMMETER:
Seven continuous ranges . . . 0.2 ohm to 1000 megohms
Center scale values . . . 10, 100, 1000, 10,000 ohms; 0.1, 1, 10 megohms

DIMENSIONS: 7⅞" high; 5¾" wide, 4½" deep

AVAILABLE ACCESSORIES:
WG-264 Crystal Diode Probe. Extends range to 250 Mc ($7.75 suggested user price)
WG-289 High-Voltage Probe and WG-206 Resistor to extend range to 50,000 volts. ($9.95 suggested user price)

Available from your RCA Test Equipment Distributor

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TEST EQUIPMENT ***HARRISON, N. J.***

this type of power arc can destroy a tube very quickly.

There are at least three principle methods of limiting arc damage. First, the overload relay and circuit breaker should open the circuit in the shortest possible time. Breakers are available which will operate in $\frac{1}{10}$ sec or less. Second, the reactance of the rectifier transformer should be as high as feasible. Also, wherever possible, additional series reactance connected in the anode lead will help materially in limiting the current rise to a nondestructive value during the time required for the circuit breaker to open. Such reactances should be designed to limit the peak arc current to not over 20 times the normal plate current. Third, an ignitron can be connected across the power supply and arranged to short out the supply and absorb the extra energy when the current becomes excessive until the circuit breaker opens.

Figure 1 shows an example of power arc damage to a filament structure. This tube suffered approximately 100 times normal plate current during the arc period.

Line-Voltage Regulation

Variations in line voltage can, if excessive, have considerable effect on tube operation, particularly filament life. Figure 2 shows the theoretical variation of filament burnout life with filament voltage. It can be seen that a 5-percent increase in filament voltage above normal results in about 40-percent less life and a 5-percent decrease in voltage about doubles the life. These data apply only to pure tungsten filaments at constant filament voltage where the life is determined by the evaporation rate of tungsten.

For tubes having thoriated tung-

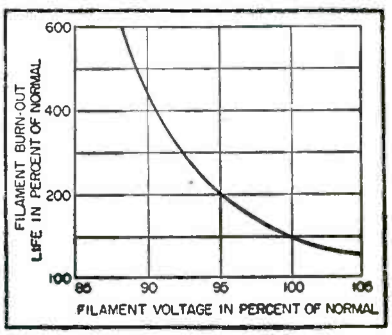
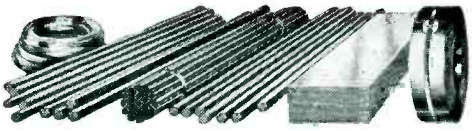


FIG. 2—Theoretical variation of filament burnout life with filament voltage



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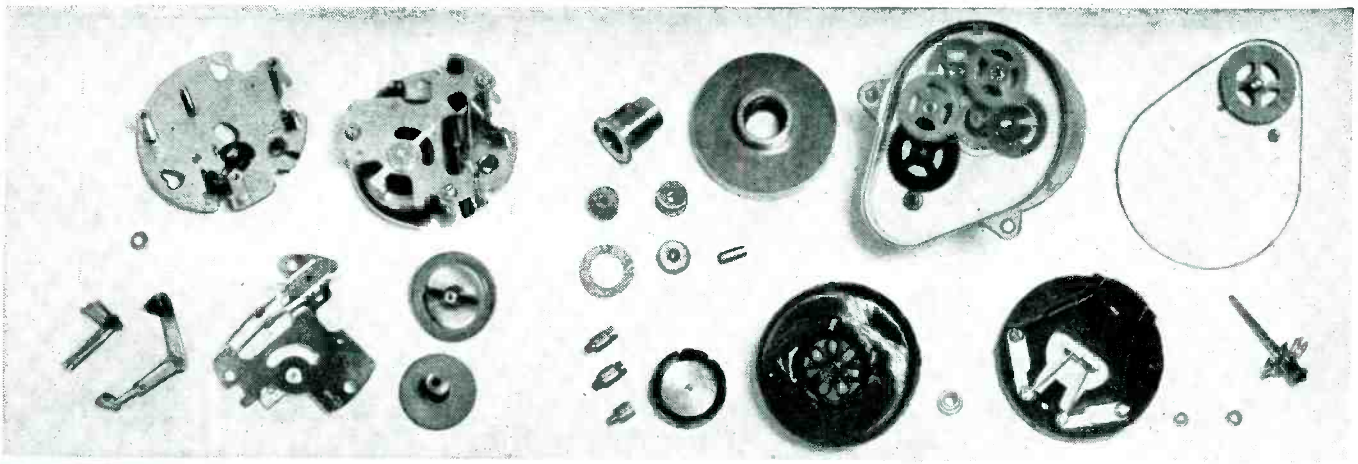
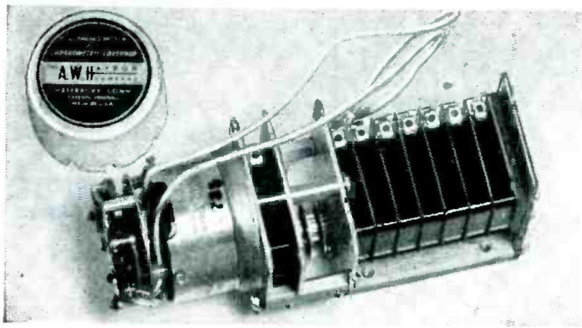




Upper left shows mechanism of governor for timing motor. Parts in center are for motor. Gear Box, cover plate, brush plate and commutator are shown at right.

Lower left is timing motor with cover removed from governor assembled in repeat cycle switch assembly—Courtesy The A. W. Haydon Co., Waterbury, Conn.

Clock Escapement Accurately Governs D.C. Timing Motor

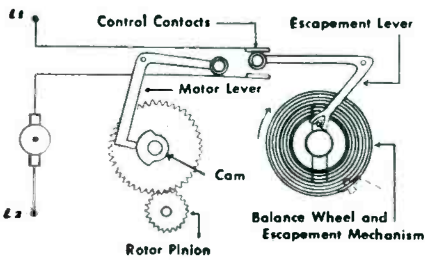
The ordinary clock escapement mechanism is proving an effective governor in controlling the speed of direct-current timing motors for military and civilian timing applications. Fluctuations in voltage, load and temperature which would affect the speed of the motor are cancelled out by the governor.

The unit is used for de-icing airplane propellers and wings, electronic devices, recorders and other precision timing units.

The accuracy of this device, manufactured by the A. W. Haydon Company, Waterbury, Connecticut, is seen in an aircraft application where the drive shaft speed is 1 revolution per minute accurate to plus/minus 0.1%.

The timing motor is geared directly to a cam which oscillates the motor lever, causing the control contacts to separate, thus opening the motor circuit. When the balance wheel returns from its free swing, it releases the escapement lever and allows the control contacts to close, applying full voltage.

Thus pulses of full line voltage are applied to the motor at regular intervals controlled by the escapement. The duration of these pulses is determined by the travel of the motor. This results in a uniform travel of the motor during each swing of the balance wheel. A constant motor speed is thereby obtained. The unit always stops with contacts closed, insuring self-starting.



Schematic Drawing of Escapement-Type Governor used in Haydon Direct-Current Timing Motor.

In the governor the two plates, motor lever, balance wheel and escapement lever are made from clock brass (62.25% copper, 2% lead and balance zinc). The lead increases the machinability and facilitates clean blanking and piercing with a minimum of burr.

Where extreme accuracy is not needed, instead of using jewels for the various bearings in the governor, the leaded brass serves as an excellent bearing surface.

The hair spring is a special alloy which has a negligible expansion and contraction factor from −50 deg. to +150 deg. F. It is therefore unnecessary to compensate for varying temperatures.

Through a gear train either the 900 RPM or 2700 RPM rotor speed of the motor can be geared down to 1 revolution in two hours. The gear box is so designed that speeds can be changed through a wide range by various standard combinations of gears.

The clock brass gears and pinions are hobbed to insure accurate meshing.

The drive shaft bearing in the gear box is commercial bronze (90% copper and 10% zinc).

The commutator sections in the rotor are made from oxygen-free copper since high conductivity is needed.

The rotor bearing is free-machining brass rod and the part is produced in a screw machine. This alloy contains 61% copper, 3.4% lead and the remainder zinc, and it has the highest machinability rating of all the copper-base alloys. (6832)

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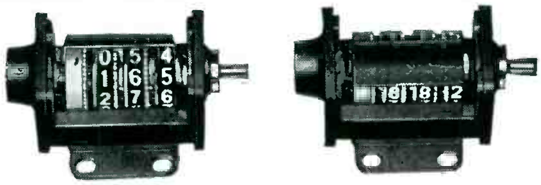
for Radar and Electronic Applications



Companion shutter counters used as dual direction indicators. One counter adds while the other subtracts. Shutter blanks out counter which is on negative side of 000.

"Y" 2-figure Rotary Counter used in navigating instruments.

High-speed, non-reset "Y" type counter for building into radar instruments.

Special Model "Y" with window at rear designed for use in radar equipment.

These are a few of the "specials" developed by Durant for Radar and Electronic applications. When one of the many standard Productimeters is not the exact answer to a problem, Durant engineers modify, combine, or develop entirely new counters to meet the particular requirements of the job.

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PRODUCTIMETERS SINCE 1879 *Speedometers* OF INDUSTRY

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Cylindrical iron-powder tuning-slug cores illustrated are available in all popular sizes between 0.195 and 3.375 in. diameter. Up to 1 inch O.D. with threaded inserts as required. Powder-iron assemblies in other forms — particularly toroids — are also produced for rapid deliveries.

Special sizes and types as well as standard items can be supplied in a wide range of magnetic materials to suit your application. Write today for further data or specific recommendations.

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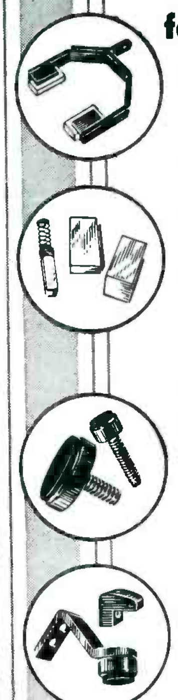

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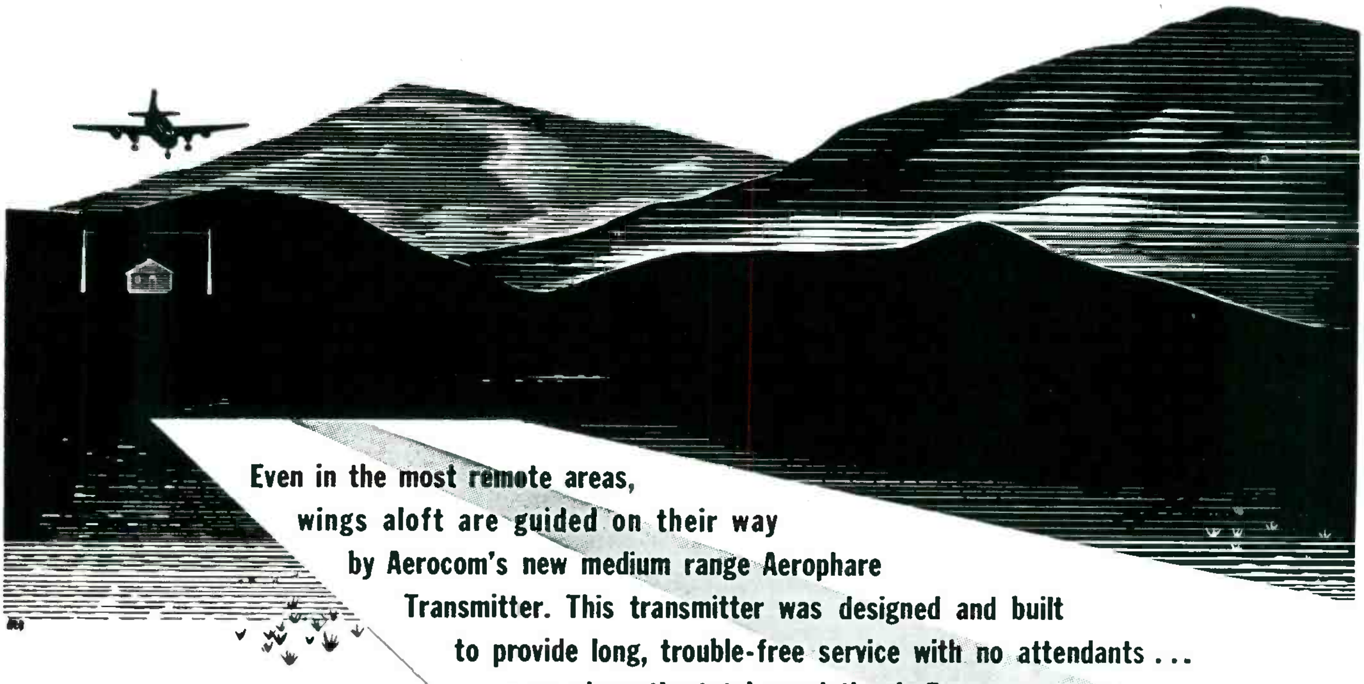
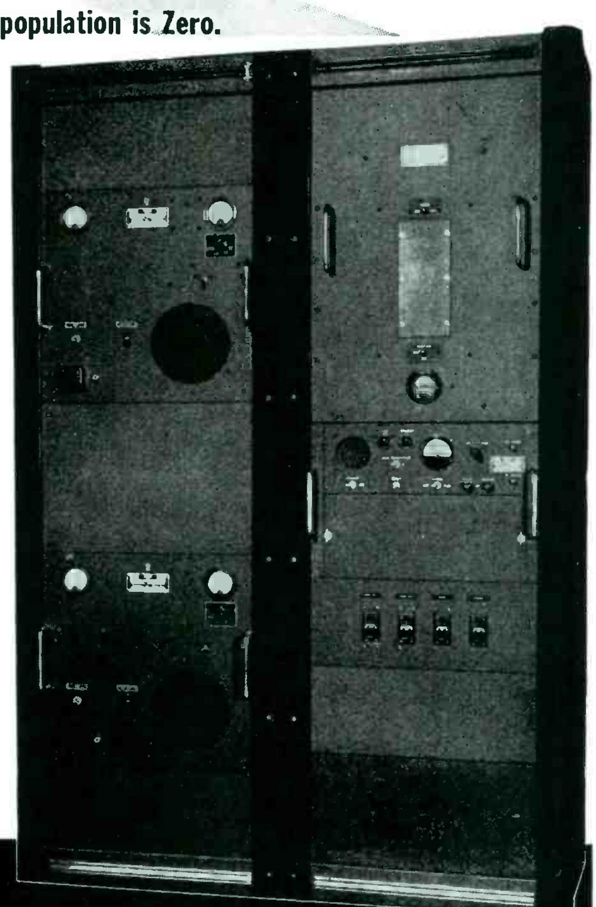


Even in the most remote areas, wings aloft are guided on their way by Aerocom's new medium range Aerophare Transmitter. This transmitter was designed and built to provide long, trouble-free service with no attendants . . . even where the total population is Zero.

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.

CONSULTANTS, DESIGNERS AND MANUFACTURERS OF STANDARD OR SPECIAL ELECTRONIC, METEOROLOGICAL AND COMMUNICATIONS EQUIPMENT

AER-O-COM
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AERONAUTICAL COMMUNICATIONS EQUIPMENT, INC.
3090 Douglas Road, Miami 33, Florida

sten filaments, the filament voltage should be operated at the rated value and line-voltage variations should not cause the filament voltage to deviate by more than ± 5 percent from this rated value. In either type of filament if the expected line-voltage variation is very great, a filament voltage regulator will give longer tube life. In all cases the filament voltage should be determined by actual measurement with a good voltmeter connected at the tube terminals.

Applications of tubes with thoriated-tungsten filaments for continuous service should not require peak plate-plus-grid currents in excess of approximately one-fourth the total peak emission available from the filament. Exceeding this ratio will often cause premature filament emission failure.

Oscillator Circuits

There are many types of oscillator circuits which have been used for r-f heating. The best circuit for a given application depends upon a great number of physical and economic factors. However, from the point of view of tube application some general guiding rules can be deduced.

The grid voltage waveform should be fairly close to sinusoidal to prevent a saddle-shaped top on the wave which results in inefficient tube operation. It is better to have the plate tank circuit isolated from the d-c supply by a blocking capacitor so that an r-f arc-over across the tank capacitor is not followed by a d-c arc.

The circuit should be stable and free of parasitics over a wide range of load variations. Each specific case has its own problems but generally designs which keep lead inductances and stray couplings to a minimum and use grid damping resistors are best. An important factor is the load Q of tank and load circuits.

As mentioned previously it is very advantageous to have some form of automatic load-matching system or plate-swing regulation to avoid too much increase in plate and grid r-f voltages with load variation. Another approach to this problem is a circuit, Fig. 3, in which the load circuit is tuned to the same *you can depend upon* **MITCHELL-RAND**

Electrical Insulation Headquarters

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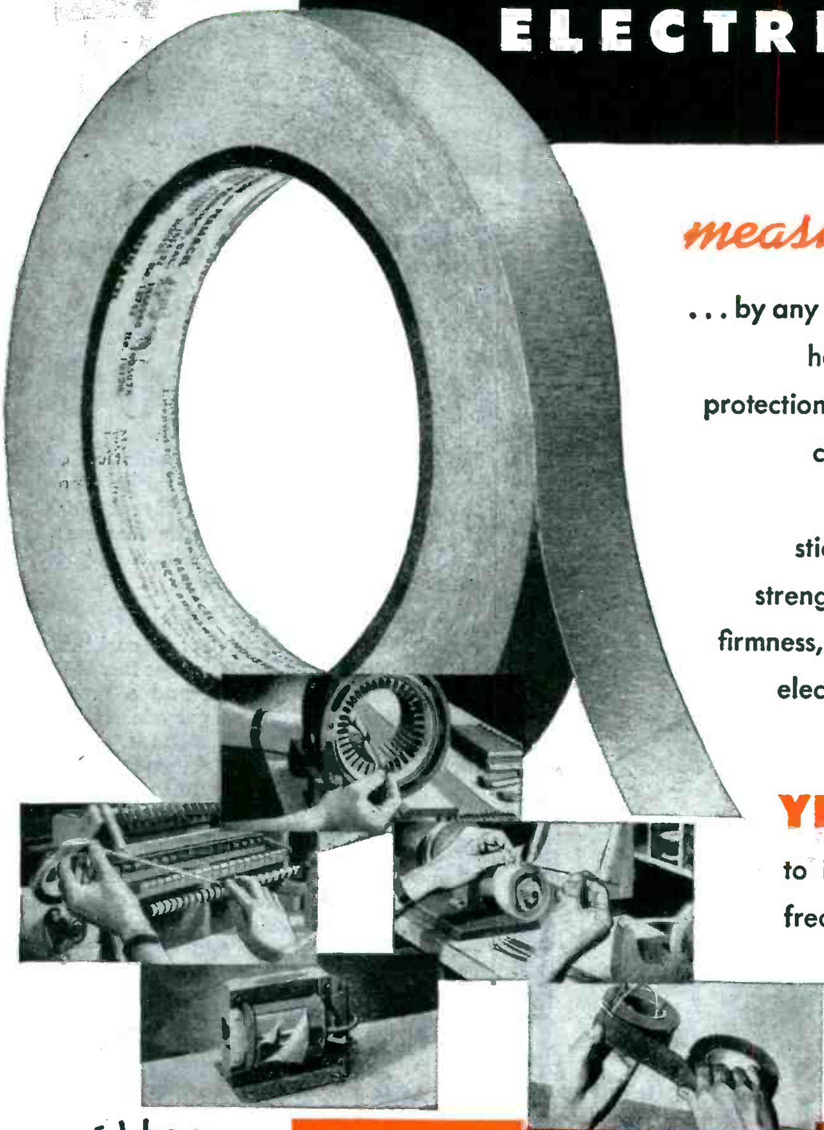
ELECTRICAL TAPES



measure for measure

. . . by any comparison and yardstick, PERMACEL TAPES have the qualities and stamina for everlasting protection and positive cohesion. Made of cotton cloth, crepe or flatback paper, acetate film or cloth, PERMACEL TAPES have instant fingertip stickiness, elasticity, great dielectric and tensile strength, great tear resistance, maximum adhesive firmness, excellent varnish penetration . . . they resist electrolytic corrosion, oils, moisture and acids, etc.

YES... PERMACEL TAPES have what it takes to insulate, protect, tie and identify . . . and frequently at lower cost!

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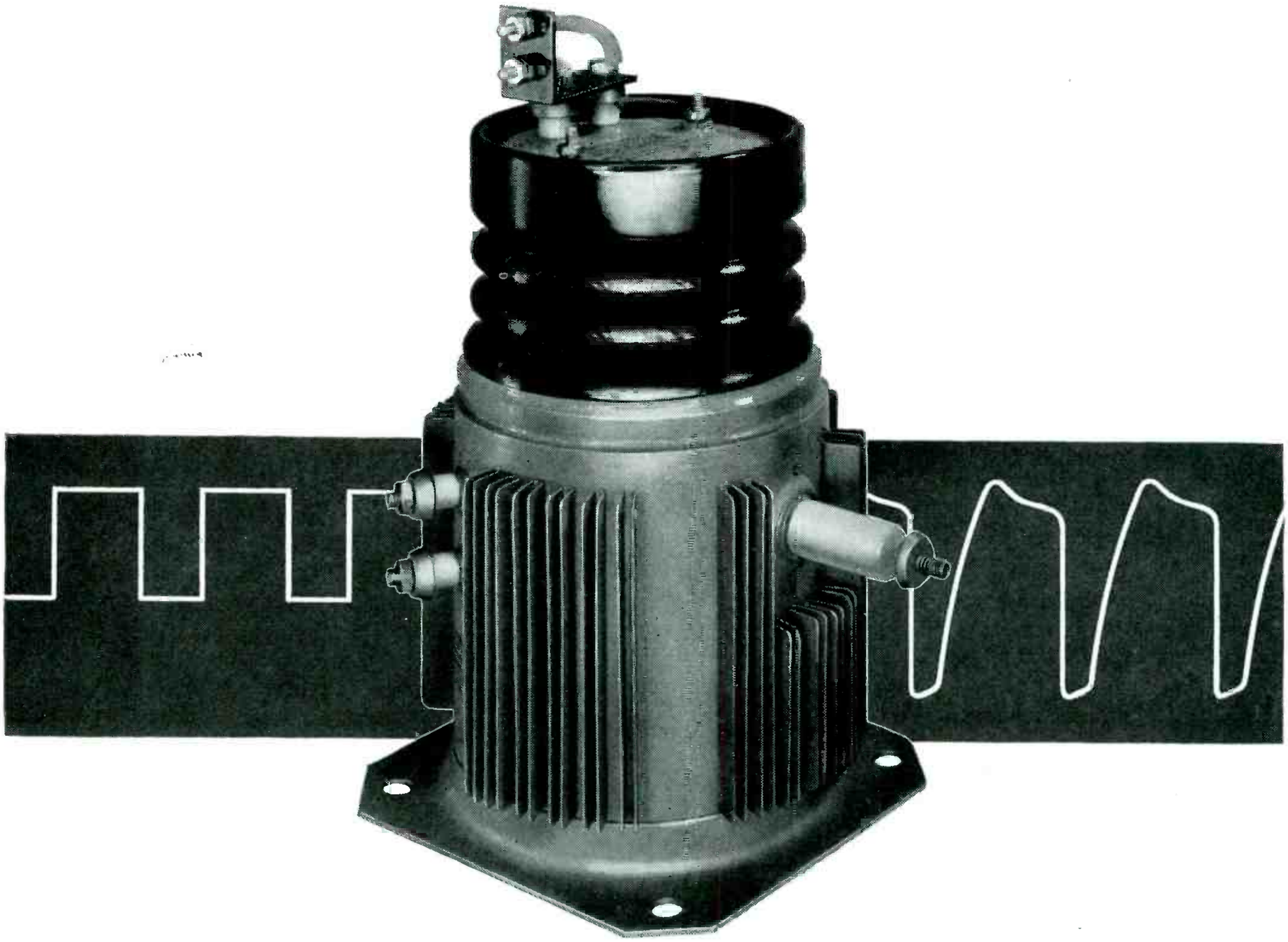

To tailor a wave more accurately...

It's a recognized principle that the smaller, more compact the pulse transformer, the more acceptable will be the shape of the output wave. That's where Westinghouse transformer engineering can offer greater advantages to the designer of electronic circuits.

In pulse transformers like the one above, for example, Westinghouse is able to produce a smaller, lighter, better performing transformer by using a two-piece HIPERSIL® type C core wound from one mil thick material. Insulation applied depends upon actual requirements . . . for instance, Fosterite® insulation on open-type transformers for adverse atmospheric conditions; silicone oil for high-temperature applications. But with an initial advantage on core size, and corresponding reduction in coils, the compactness of Westinghouse Pulse Transformers assures better wave shape, plus saving in both size and weight.

If size, weight, performance or quantity production have any bearing on your transformer problem call your Westinghouse representative. For many applications, standardized designs are available at substantial savings. Westinghouse Electric Corporation, Specialty Transformer Department, Sharon, Pa. J-70611

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TRANSFORMERS

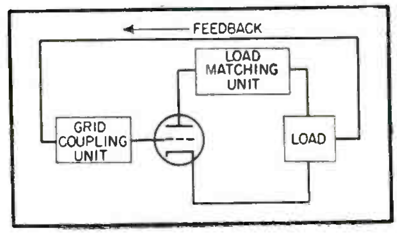

FIG. 3—Oscillator circuit in which the load circuit is tuned to the same frequency as the plate tank circuit when loaded. Grid drive is obtained from the load

frequency as the plate tank circuit when loaded and the grid drive is obtained from the load. When the oscillator is unloaded, the load circuit is tuned to a frequency considerably different from the oscillator frequency and the load voltage is low. Since the grid voltage is derived from the load, the grid drive voltage is also low. The result is a low drive voltage at no-load and a high drive voltage at full load. Thus the tube is operating under desirable conditions at both extremes of loading. With this circuit the grid current can be allowed to approach full rated value at full load.

Conclusion

The previous discussion has set forth a number of factors which when given careful consideration by the designer and user of electronic heating equipment, will result in a more effective utilization of electronic tubes. Proper selection and application of electronic tubes for r-f heating can be summarized in two statements: Choose the right tube for the job and keep it within its ratings under all conditions of operation. Provide a healthy environment for the tubes.

Electronics Aids Sugar-Beet Growth

An electronically-operated singling machine has been developed in France and put to use as an aid to sugar beet growers. The device thins out the plants at predetermined intervals. In front of the hoe is a feeler and an electronic arrangement which compensates for gaps where the seed has not taken hold by leaving the next few plants closer together.

Engineering Data

on ARNOLD TAPE-WOUND CORES

PROPERTIES OF . . .

DELTAMAX

4-79 MO-PERMALLOY

SUPERMALLOY*

Manufactured Under License Arrangements with Western Electric Co.

BULLETIN TC-101
August 15, 1951

THE ARNOLD ENGINEERING COMPANY

SUBSIDIARY OF ALLEGHENY LUDLUM STEEL CORPORATION

General Office & Plant: Marengo, Illinois

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W&D 3611

THE ELECTRON ART

(continued from p 142)

ment of the mutual inductance for the close-coupled loop method.

Any undesirable transfer of primary loop constants into the receiving loop may be shown to be negligible by reference to the expressions for the total receiving loop constants: R_2' and L_2'

$$R_2' = R_2 + \left(\frac{\omega M}{Z_1}\right)^2 R_1 \quad (3)$$

$$L_2' = \left(L_2 - \frac{1}{\omega^2 C_2}\right) - \left(\frac{\omega M}{Z_1}\right)^2 \left(L_1 - \frac{1}{\omega^2 C_1}\right) \quad (4)$$

where the subscript 1 refers to constants in the primary loop, the subscript 2 refers to constants in the receiving loop, the R's are resistances and the L's are inductances and Z_1 is primary circuit impedance. Evidently, in both expressions the second term is small compared with the first term, where R_1 contained in Z_1 is in the order of thousands of ohms and ωM is in the order of a few ohms.

For any particular setup this should be demonstrated to be the case and if necessary the primary series resistance should be raised and the primary loop inductance should be reduced. Such demonstration is effective by receiving an independent signal and noting whether the reading is steady while bringing the primary loop into position. It is evident that if this reading remains constant, an arbitrary comparative calibration by means of such a primary loop may be obtained using a known field where the above described spaced loop method may be used to obtain the known field.

If it is desired to calibrate such a jig-mounted calibrating loop directly by means of Eq. 2, then the mutual inductance may be used. Measurement of the mutual inductance may be the most straightforward if the receiving loop is of odd shape. Otherwise calculation may be the simpler and more accurate method.

The value of R should be greater than four times the reactance of the primary loop at the highest used frequency, to keep the error below approximately 3 percent. With one six-inch turn in the primary loop, a value of R between 500 and 2,000

NEW WIDE BAND D.C. AMPLIFIER

MODEL 120

A precision instrument designed for use as a preamplifier in conjunction with an oscilloscope, vacuum tube voltmeter or other instruments.

SPECIFICATIONS

FREQUENCY RESPONSE: Within $\pm$ 1 db between D.C. and 100,000 cycles per second.

GAIN: Approximately 100.

INPUT CONNECTION: Double channel, can be used for single ended and push-pull signals or as a differential amplifier.

INPUT IMPEDANCE: One Megohm shunted by approximately 15mmf in each channel.

DUAL INPUT ATTENUATOR: One to one, 10 to one, 100 to one and "off" positions in each channel immediately adjustable.

OUTPUT CONNECTION: Push-pull or single ended.

OUTPUT IMPEDANCE: Less than 50 Ohms single ended or 100 Ohms push-pull.

HUM AND NOISE LEVEL: Below 40 microvolts referred to input.

LOW DRIFT due to regulated heater voltage in input stage.

MOUNTING: Metal cabinet approximately 7" wide by 7" high by 11" deep.

Write for descriptive literature on the Model 120 D.C. Amplifier and other Furst laboratory instruments including Regulated Power Supplies.

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RELAYS and CIRCUIT SELECTORS

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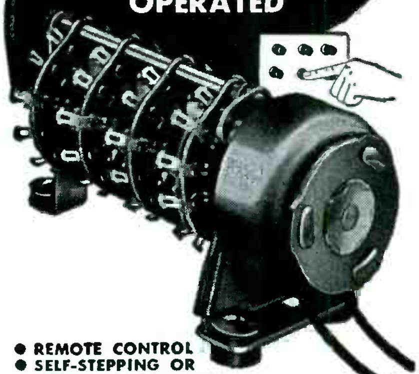

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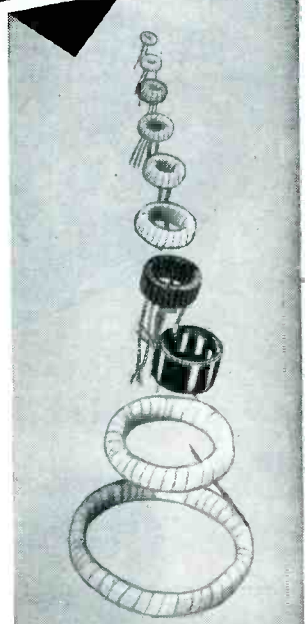

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ohms is recommended and may be chosen precisely to make the value of field strength equal the signal generator output voltage or some round multiple of the output voltage.

In Eq. 2 the voltage V may be measured directly by measurement of loop output, and E, which is constant with frequency, may then be obtained by dividing V by the known effective height of the receiving loop for a given frequency. The ratio of E to e_g is constant for other frequencies and may be adjusted to unity or to a round number by the choice of R.

Coil Characteristics

Data for two sample jig-mounted calibration coils is presented in the curve of Fig. 4. For the low frequency range the receiving loop contained 36 turns with an effective diameter of 5.25 inches whereas the primary jig coil contained 25 turns of 3-inch mean diameter, a measured mutual inductance of 39 microhenrys and a series resistance of 2,320 ohms, resulting in $E = e_g$.

For the high-frequency range the receiving loop contained 2 turns with an effective diameter of 8.25 inches whereas the primary jig coil contained one turn of approximately 5-inch effective diameter, a measured mutual inductance of 0.15 microhenry and a series resistance of 655 ohms, resulting in $E = e_g$.

The mean deviation of the values shown in Fig. 4 for the low range loop is less than one percent and for the high range loop is less than two percent.

The signal generator was carefully checked for output voltage calibration. All resistors and associated measurements were also checked. The standard or known field of Fig. 4 was obtained by the general arrangement of Fig. 1, except that a signal generator was used in place of the transmitter and a series resistor of 122 ohms replaced the thermocouple meter. The primary loop was of one turn, six-inch diameter and of 20-mil solid enamelled copper wire.

The method described, which employs a loop closely coupled to the loop antenna being calibrated, is more convenient to use than the

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Water Absorption	%	0–0.10	0–0.05	0–0.05	0–0.05	0.0–5.0	0.0–1.0	0.0–1.0	0.–0.05	0.0–0.05	3.0
Color	——	Off White	Off White	Cream	Cream	Light Tan	Mottled Tan	Grey to Light Tan	White	White	Pink
Flexural Strength	lbs./sq. in.	20,000	20,000	21,000	21,500	7,000	11,200	11,500	23,000	26,400	10,000
Tensile Strength	lbs./sq. in.	6,000	6,500	7,000	8,000	2,500	4,000	4.000	7,500	8,000	3,000
Compressive Strength	lbs./sq. in.	75,000	77,000	81,500	80,000	31,000	35,000	45,000	90,000	100,000	20,500
Impact Strength	Ft. lbs./sq. in.	1.55	1.65	2.25	2.00	.75	.85	.95	1.90	2.50	1.45
Linear Coefficient of Thermal Expansion	20 to 100 °C	$6.5x10^{-6}$	$6.5x10^{-6}$	$6.5x10^{-6}$	$6.0x10^{-6}$	$3.5x10^{-6}$	$2.0x10^{-6}$	$1.5x10^{-6}$	$4.5x10^{-6}$	$3.5x10^{-6}$	$2.70x10^{-6}$
	20 to 400 °C	$8.0x10^{-6}$	$8.5x10^{-6}$	$7.8x10^{-6}$	$7.0x10^{-6}$	$4.0x10^{-6}$	$3.0x10^{-6}$	$2.5x10^{-6}$	$5.5x10^{-6}$	$4.2x10^{-6}$	$3.5x10^{-6}$
Safe Limit of Heating	°F.	2,350	2,350	2,350	2,300	2,400	2,350	2,250	2,250	2,250	2,000
	°C.	1,285	1,285	1,285	1,260	1,315	1,285	1,232	1,232	1,232	1,090
Dielectric Strength	Volts/mil	200	210	225	250	——	120	125	235	240	< 100
Volume Resistivity 20°C.	Ohm–Cm.	> $1x10^{13}$	> $1x10^{13}$	> 10^{14}	> 10^{14}	——	——	——	> 10^{14}	> 10^{14}	> 10^{13}
200°C.		$4.6x10^{12}$	$6.0x10^{12}$	——	$2.26x10^{13}$	——	——	$3x10^{10}$	$4x10^{13}$	$1x10^{13}$	$4.5x10^{11}$
300°C.		$8.0x10^{10}$	$9.0x10^{10}$	$1x10^{11}$	$3.10x10^{12}$	——	——	$8x10^{8}$	$1.0x10^{11}$	$1.5x10^{12}$	$7.5x10^{9}$
500°C.		$8.6x10^{7}$	$1.3x10^{8}$	$2x10^{9}$	$1.81x10^{10}$	——	——	$7x10^{7}$	$9.0x10^{9}$	$3.0x10^{10}$	$2.5x10^{7}$
700°C.		$1.2x10^{7}$	$9.4x10^{7}$	$1.7x10^{8}$	$1.64x10^{9}$	——	——	$4.5x10^{6}$	$2.6x10^{7}$	$6.0x10^{8}$	$2.0x10^{6}$
Te Value	°C.	> 700°	> 700°	> 700°	> 700°	——	> 700°	> 700°	> 700	> 700	> 700
Dielectric Constant	At 1 MC.	6.0	6.25	5.85	6.3	——	6.5	6.0	7.5	9.0	5.2
Power Factor	At 1 MC.	0.0013	0.0012	0.0011	0.00065	——	0.012	0.011	0.0008	0.0010	0.010
Loss Factor	At 1 MC.	0.0078	0.0075	0.0065	0.004	——	0.078	0.066	0.006	0.009	0.052
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R-F Standard Capacitors For Minute Increments

BY JOHN A. CONNER
Naval Research Laboratory
Washington, D. C.

AT THE PRESENT TIME there is a growing interest in the measurement of minute magnitudes of capacitance at radio frequencies. These measurements assume a great importance in such activities as the study of the inter-electrode capacitances of vacuum tubes and the study of oscillator stability. Capacitance values as small as 0.01 μμf are being measured regularly in the radio laboratory, utilizing techniques that are well established.[1] Some specialized radio-engineering activities have undertaken the problem of measuring capacitance magnitudes in the order of 0.001 μμf and even smaller. The importance of measuring minute values of capacitance is necessarily magnified as higher-frequency phenomena are encountered and where increased circuit-stability is demanded.

In conducting a laboratory study of the capacitor elements of h-f selective circuits and their frequency- drift compensation properties, a definite limitation has been found in the available techniques for measuring minute capacitance increments. The desirability of having a standard capacitor, capable of producing precise magnitudes of minute capacitance increments, was apparent. This paper is intended to present the basic analytical conclusions for the development of such a device.

Basic Arrangement

The basic electrode configuration chosen for a standard of minute capacitance increments is the simple coaxial-cylinder arrangement. This form was selected because of its mechanical simplicity, its linear capacitance variation

(with inner-electrode insertion) and the restricted extent of its fringing-flux fields. The errors introduced due to mechanical discrepancies (departures from the theoretically ideal, concentric-cylinder geometry) were investigated in general terms and a specific design was derived which will provide a useful standard of capacitance increments. For the purpose of analysis these discrepancies were divided into radial and axial deviations from the ideal electrodes. The principle radial discrepancies and

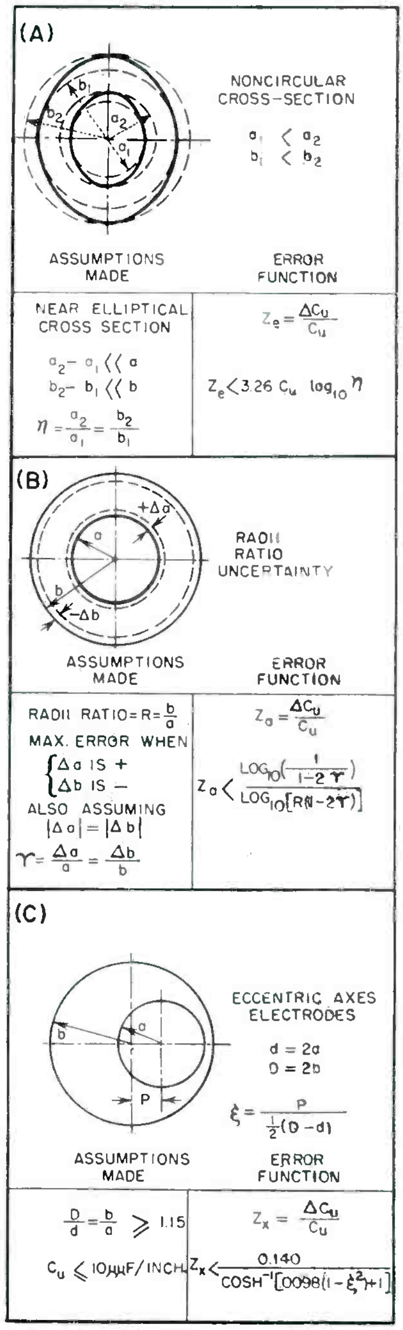

FIG. 1—Error functions for three deviations from ideally shaped electrodes for standard capacitor

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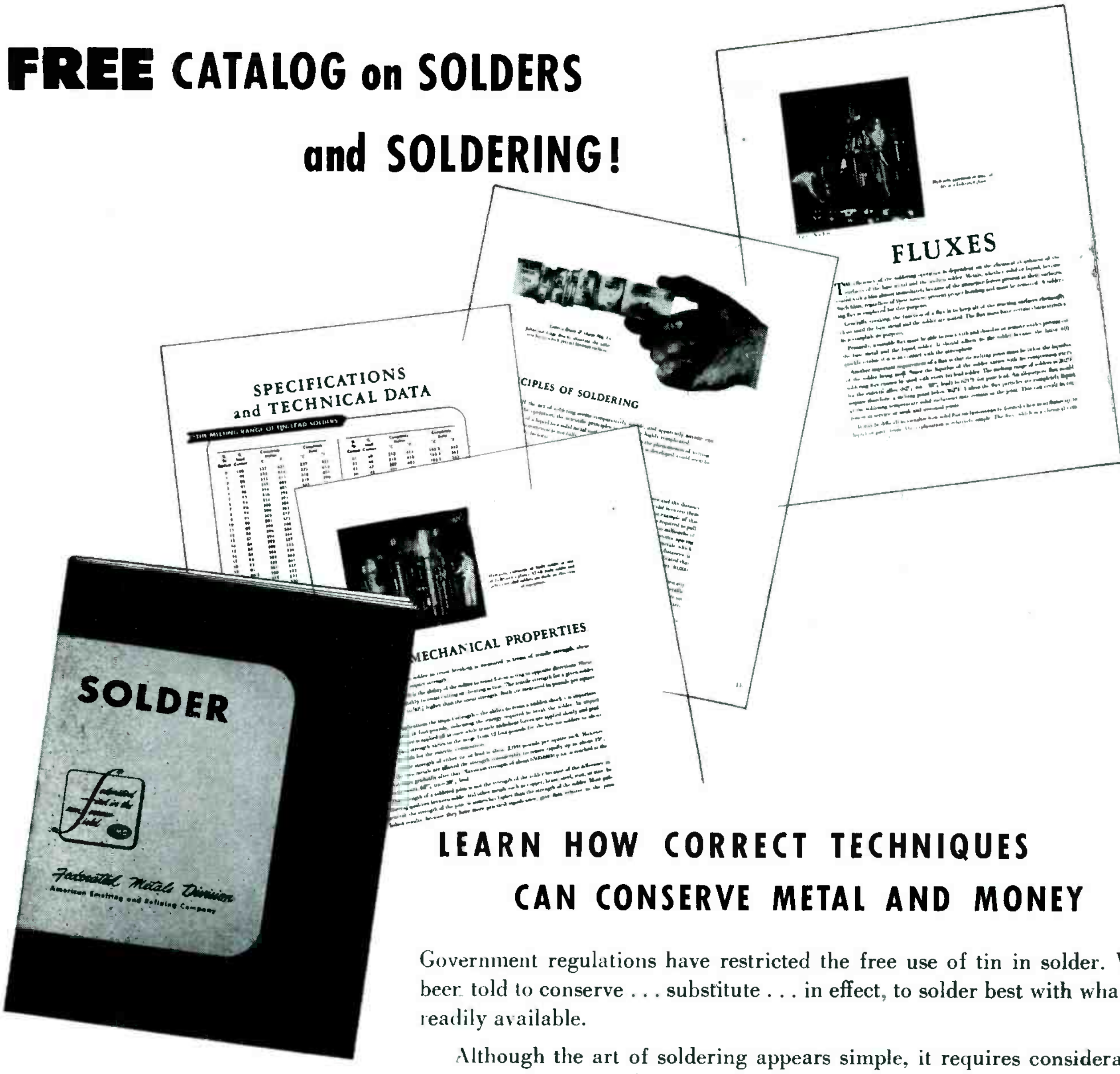

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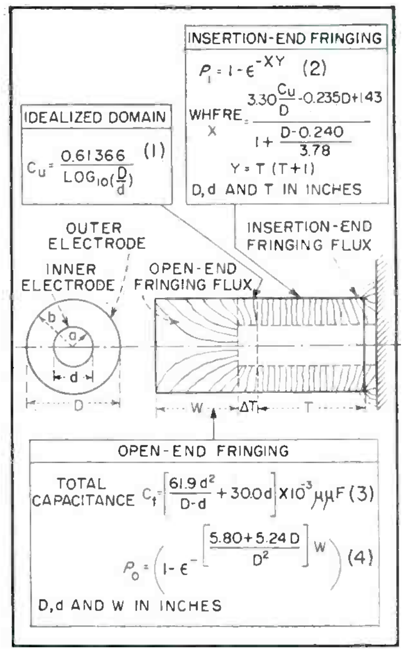

FIG. 2—Diagram and equations show cause and effect of fringing flux

the corresponding error functions which were derived, are briefly summarized in Fig. 1 and are essential modifications of the classical equation for the capacitance between ideal concentric-cylinder conductors:

$$C_u = \frac{0.61366}{\log_{10}\frac{b}{a}}\ \mu\mu\text{f per in.} \qquad (1)$$

where a and b are the inner and outer electrode radii respectively.

One principal design consideration arises from the need to determine the extent and significance of the fringing flux between coaxial electrodes. Figure 2 shows an electric-field configuration for a simple coaxial-cylinder capacitor. It must be determined, for any given capacitor design, just how long the inner-electrode insertion T must be in order to guarantee an acceptable degree of capacitance linearity over a range of insertion ΔT.

An additional investigation is prompted by the need to keep the open end of the outer electrode removed from the extremity of the inner electrode. After making a large number of actual capacitance measurements using cylindrical electrodes, three empirical equations were derived which give sufficiently accurate limiting equations of the capacitance variations involved. The observed capacitance per unit length (of T) increases in

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value as T is increased, until the idealized value of C_u is reached at infinity. The observations made showed that this variation can be described by Equation 2, shown in Fig. 2, where ρ_t is the ratio of the idealized to the actual capacitance per unit length. If a value of T is chosen which will make ρ_t differ from unity by a negligible amount then the error in C_u will be negligible.

The proximity of the open end will subtract capacitance from the idealized capacitance (with decreasing values of the length W) according to the relations of Eq. 3 and 4 (Fig. 2), where C_t is the total accumulated (fringing) capacitance and is the relative amount of the total at any given value of W. With these equations, the error resulting from the use of electrodes of a finite length can be determined to a sufficient degree of accuracy.

Final Design

Using the above analysis of the manner in which mechanical discrepancies are reflected into capacitance errors, it becomes possible to design a precision coaxial-cylinder capacitor which will provide minute capacitance increments. For capacitor-stability studies a standard was required with 0.2 μμf per inch adjustability at radio frequencies up to 5 mc. A minimum inner-electrode diameter of $\frac{3}{16}$ inch was chosen as a basis for design. As Eq. 1 dictates an electrode-radii ratio of approximately 1,200, an outer electrode of 225 inches (18.75 ft) would be required for a simple coaxial-cylinder capacitor to provide 0.2 μμf per inch of inner-electrode insertion. Because of this impractical electrode diameter, a

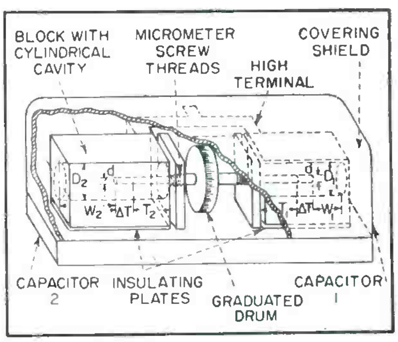

FIG. 3—Mechanical arrangement of a differential, coaxial-cylinder capacitor

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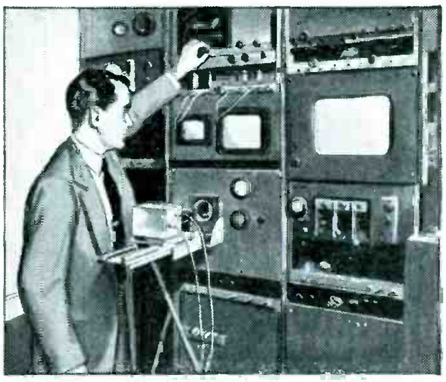

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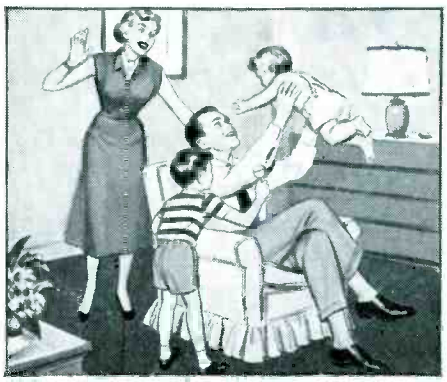

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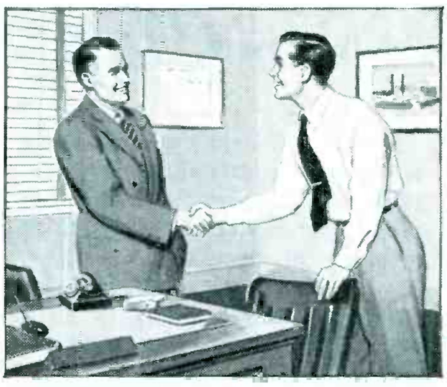

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design dilemma is reached which necessitates the adoption of a new approach. The utilization of a differential-capacitor arrangement seems capable of satisfying the two conflicting aims; (1) to maintain a sufficiently large inner-electrode diameter for low inductance and mechanical rigidity, and (2) to provide a reasonably small maximum outer electrode diameter. Figure 3 shows the mechanical arrangement of a differential, coaxial-cylinder capacitor designed to satisfy these design criteria.

In this unit, two concentric-cylinder capacitors are arranged coaxially with a common inner-electrode at ground potential. The longitudinal insertion of this inner electrode into one outer-electrode cavity removes its opposite extremity by an exactly equal amount from the second cavity. The unequal outer-electrode diameters provide two different capacitances per unit length, $(C_u)_1$ and $(C_u)_2$, so that the effective (total) capacitance per unit length is simply,

$$(C_u)_T = (C_u)_1 - (C_u)_2 \qquad (5)$$

If $(C_u)_1$ and $(C_u)_2$ have relative errors Z_1 and Z_2, the relative error in $(C_u)_T$ for additive errors will be Z_T, where

$$Z_T = \frac{(C_u)_1}{(C_u)_T} Z_1 + \frac{(C_u)_2}{(C_u)_T} Z_2 \qquad (6)$$

The capacitance error of a constituent capacitor enters as a component of the composite error in proportion to the ratio of the corresponding capacitance to the total effective capacitance. Consequently, it is undesirable to have two differentially-coupled capacitors with large individual capacitances and small capacitance differences. As a recommended empirical relationship between the magnitudes of

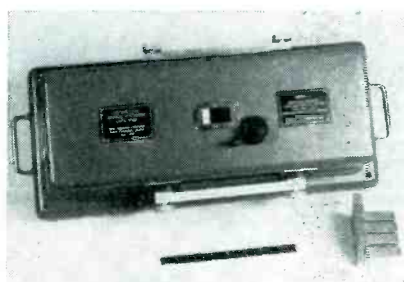
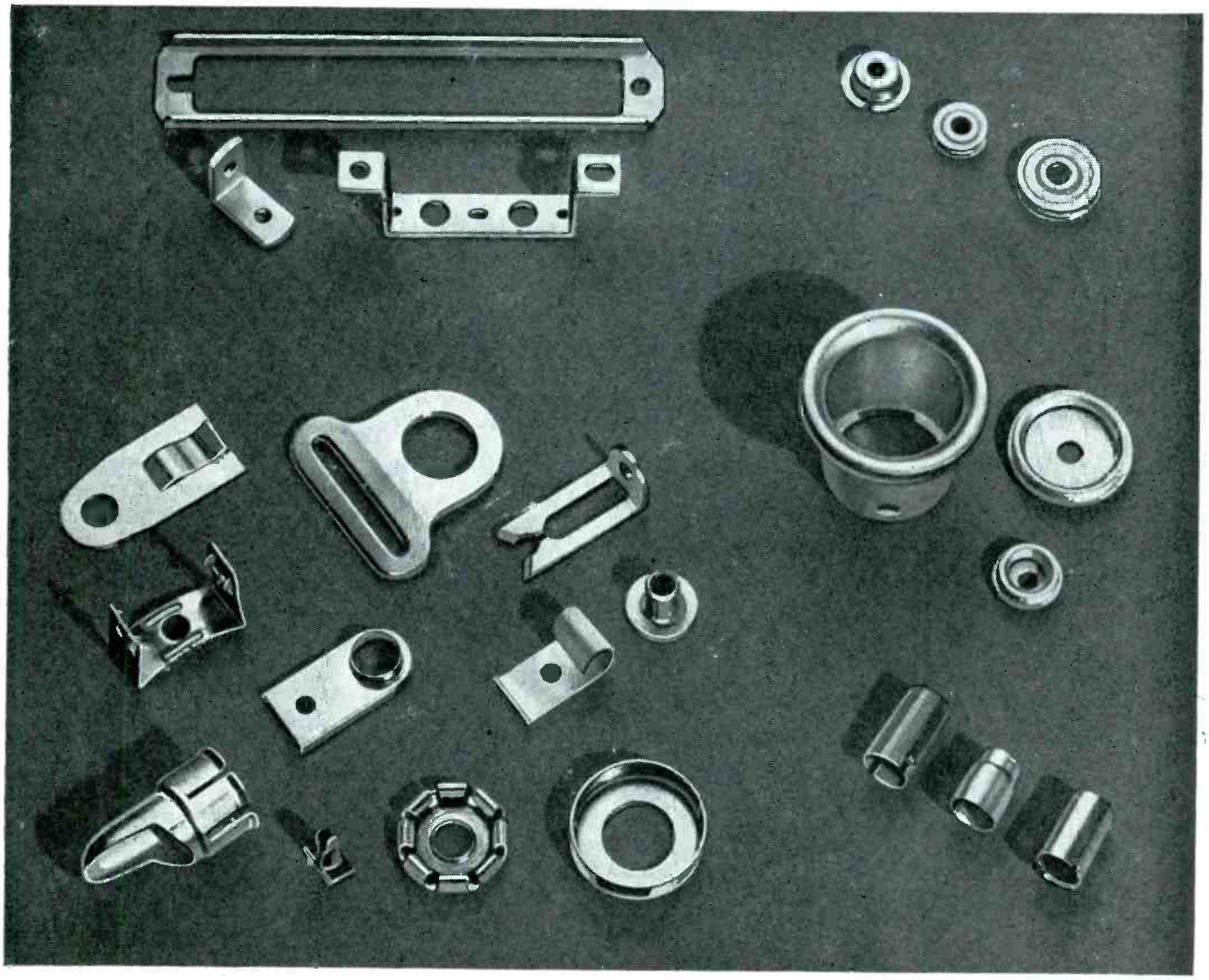


FIG. 4—Assembled capacitance standard using differential principle



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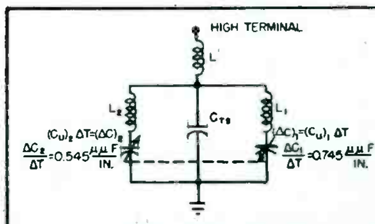
$(C_u)_T$ and $(C_u)_1$ it is suggested that for precision-capacitor design,

$$(C_u)_1 \leqq 5\,(C_u)_T \qquad (7)$$

A differential, concentric-cylinder capacitor of the type described has been designed and constructed. Figure 4 illustrates the completed capacitance standard. This device produces a linear capacitance-variation at the rate of 0.200 μμf per inch of inner-electrode insertion. A detailed error and calibration analysis for this capacitor shows that at low frequencies the error in capacitance per unit length C_u, is less than 1.0 percent with a residual capacitance uncertainty of 0.00015 μμf.



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CAPACITOR 2	CAPACITOR 1
d=0.1875″ ± 0.0001″	d=0.1875″ ± 0.0001″
ΔT= 1.0″ TOTAL	ΔT= 1.0″ TOTAL
D_2 = 2.508″ ± 0.0005″	D_1 = 1.250″ ± 0.0005″
T_2 = 2.25″	T_1 = 1.50″
W_2 = 2.75″	W_1 = 1.50″

FIG. 5—Equivalent circuit for differential standard capacitor of the dimensions shown

Figure 5 shows the equivalent circuit of the unit. The physical dimensions are also tabulated. The efficacy of the design of this capacitor must be tested primarily on the basis of the theoretical and empirical justification of its electrode geometry. The limits of error prescribed for such a device can be satisfied in terms of the error functions given in this paper.

This resume of the errors inherent in coaxial-cylinder capacitors provides a basis for the design of a large variety of standard capacitors. The summarizing equations were derived with a view toward eliminating, as much as possible, any duplication of effort on the part of anyone interested in the design of a specific coaxial-cylinder standard capacitor. Particular attention was given to the design of incremental-standard capacitors with variations of less

Cathode-ray TUBES you should know

1. TYPE 5YP-

2. TYPE 3RP-A

3. TYPE 5RP-A

4. TYPE 3JP-

5. TYPE 5XP-

Whether you relate each Du Mont cathode-ray tube with its appropriate silhouette, or find the right Du Mont Type number for each performance category, the result (See Below) is the same.

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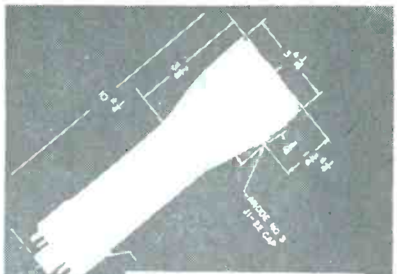
2. TYPE 3RP-A 3" — Flat-face, short, general-purpose. Very short, 3-inch tube. Special configuration of vertical-deflection plates overcomes the problem of trapezoidal distortion usually associated with tubes of short length and wide deflection angle. Flat face minimizes errors owing to parallax.

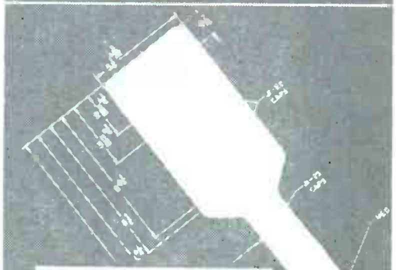
3. TYPE 5RP-A 5" — General-purpose, high-voltage. The *Standard* tube for high-voltage oscillography. May be operated at accelerating potentials as high as 25,500 volts, to provide the high light output and resolution required for detailed analysis of rapidly rising wave fronts or other phenomena that exhibit extremely high writing rates.

4. TYPE 3JP- 3" — General-purpose, high light-output. A short, 3-inch, intensifier-type tube that may be operated at potentials as high as 4000 volts. The Type 3JP-A provides high light output and excellent resolution with high deflection sensitivity.

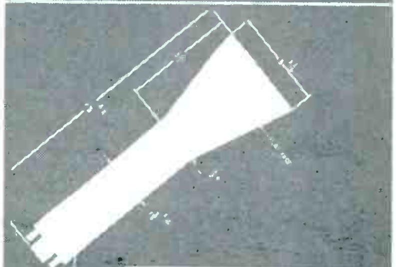
5. TYPE 5XP- 5" — High-voltage, high-sensitivity. High-voltage tube having a high-vertical-sensitivity electron-gun and deflection-plate structure similar to that of the Type 5YP-. Overall accelerating potentials of as great as 25,500 volts may be applied to achieve the light output and resolution required for the study of high-speed phenomena. High vertical-deflection sensitivity greatly simplifies problems of wide-band deflection amplifier design.



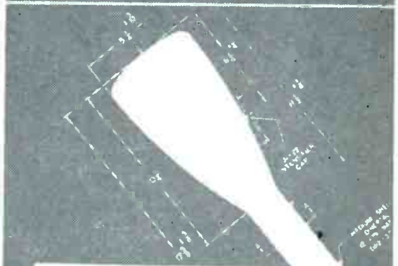
3"—GENERAL-PURPOSE, HIGH LIGHT-OUTPUT



5"—HIGH-VOLTAGE, HIGH-SENSITIVITY



3"—FLAT-FACE, SHORT, GENERAL-PURPOSE



5"—GENERAL-PURPOSE, HIGH-SENSITIVITY

5"—GENERAL-PURPOSE, HIGH-VOLTAGE

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than ten micromicrofarads per inch. The capacitor described in this paper is to be used in capacitor and dielectric-material studies. It is believed that, in providing a tool for the rapid and accurate measurement of minute capacitance-increments, a wide variety of new radio-frequency measurement techniques will be made possible.

A New Damper Diode

By MAX BAREISS

Chief Design Engineer
Tung-Sol Lamp Works, Inc.
Bloomfield, New Jersey

MOST modern television receivers use the type 6W4GT (or 25W4GT) diode as a damper in the horizontal-deflection circuit. This tube was introduced especially for this application and features a d-c current of 125 ma with a low voltage drop, a high inverse-peak-voltage rating, and a heater-cathode voltage rating of 500 volts.

Recent circuit developments brought on a simplification of the conventional horizontal-deflection circuit, the main objective being a reduction in cost. By using a higher impedance deflection yoke, the costly deflection transformer was eliminated. However, this circuit requires the damper diode to be so connected that its cathode is essentially connected to the plate of the deflection output pentode and is therefore subjected to a high surge voltage between cathode and ground. The plate of the diode in this application receives practically only the d-c plate voltage of the deflection output tube. If the 6W4GT is used in this circuit, it is necessary to use a well-insulated transformer to supply the heater, which is connected to the cathode. In addition to the cost factor, the increase in cathode to ground capacitance is very undesirable.

Therefore, there was a need for producing a tube similar to the 6W4GT but with improved heater-cathode insulation, so that its cathode could be operated with at least 3,000 volts surge above its heater, thus eliminating the need for the special heater transformer.

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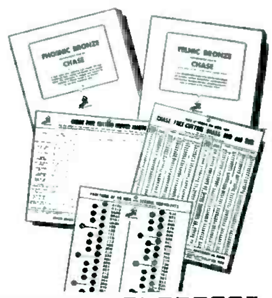
- Weldability



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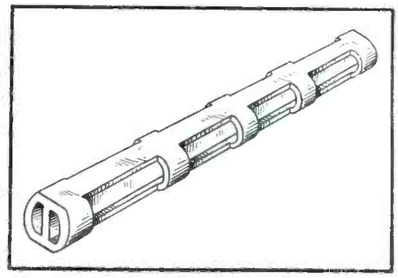

FIG. 1—Enlarged drawing shows insulator that separates filament and cathode of new damper diode tube and permits greatly increased heater-to-cathode voltage rating

ings of any commercial tubes made up to now are 500 volts d-c, as shown for the 6W4GT and a few other diodes. These ratings are known to be quite severe. Tests were made on some of these tubes with the wave shapes of the tv receiver, that is, a pulse of 15 percent duration of a frequency of 15,600 cycles, and breakdown occurred at about 2,000 volts after a short time of testing. The possibilities of improvement seemed to be very few. The heater core was pure tungsten, which is the best material known for this purpose. The insulation material was the purest alumina obtainable. Tests to improve its purity by prefiring at even higher temperatures showed no improvement. Increasing the thickness of the insulation coating gave only a small improvement in break-down voltage. The method of applying the coating to the core wire has been optimized by all tube manufacturers during the last 15 years, so that no appreciable gain could be expected by further refinements of coating technique.

Most present heaters are made of an evenly coated core wire folded into a bundle of more or less parallel strands. The coating at the bends chips away at bending and is often replaced with a similar material. It has been found by many tests that a coating thickness of about 0.005 inch gives best results. The number of folds to be used with a given wattage and resistance rating is not as critical as it might appear. One would expect that a larger number of strands would give a lower heater temperature and higher break-down voltage. However, more strands give poorer heat transfer from the inner strands, while the outer strands have more points of contact with

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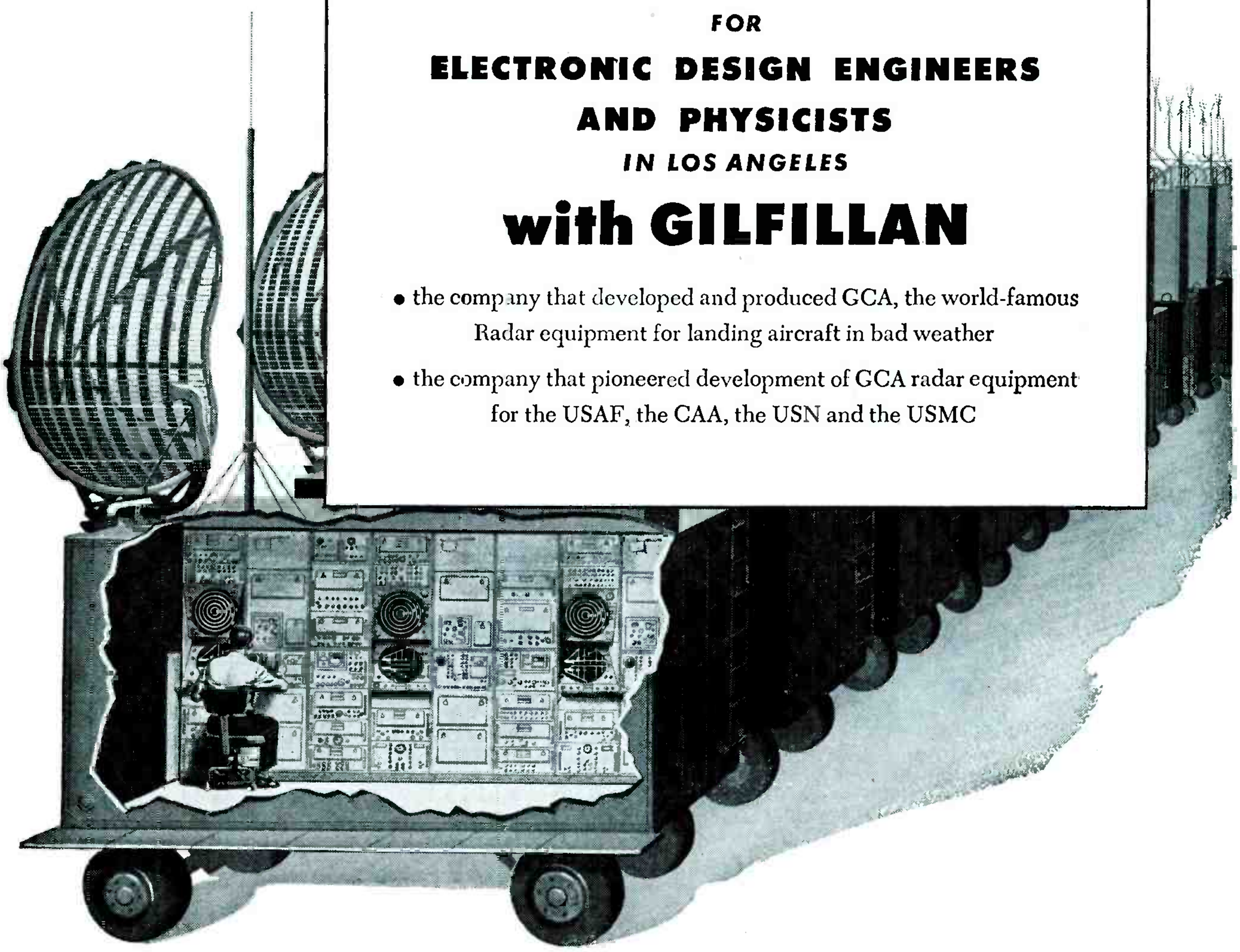

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the cathode sleeve, due to the tighter fit of the heater.

Another common form of heater design is the helical or double helical wire coated after forming. It was hoped that the even spacing between heater and cathode, together with an application of the insulating coating by spraying so as to produce a rough surface with a minimum area of direct contact to the cathode, might give an improvement in break-down voltage. However, tests showed an improvement of only a few hundred volts.

New Heater Design

Therefore, in order to meet the demand for the radical improvement in insulation, it became apparent that a drastic step had to be taken in designing a new heater. A good possibility for a solution appeared to be the use of two insulators in series. A thin-walled alumina tube was tried, which fitted between cathode and heater of a 6W4GT, and a few tubes were made that stood up with 4,000 volts surge between heater and cathode. The difficulty was in a heating time of about 30 seconds which was undesirable not only for the user of the tube, but also it made the tubes very difficult to process during manufacture. Also, the alumina tube was of such wall thickness that there was no hope of producing it in quantity at a reasonable cost.

After many trials, however, a new form of ceramic insulator was designed which overcomes all the difficulties mentioned above. The cooperation of the Stupakoff Ceramics and Mfg. Co. was enlisted in

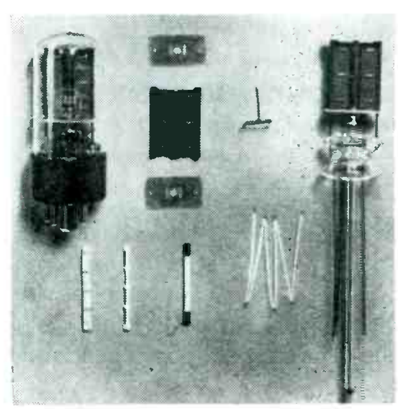

FIG. 2—Photograph shows completed diode and disassembled component parts

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this work to assure the practicability of this design. A sketch of it is shown in Fig. 1. It is made of pure alumina by extruding and machining. The outside cross section is shaped so that it fits into a lockseam cathode sleeve. The outside wall is cut so that most of the heat from the heater can be radiated directly to the cathode sleeve, while keeping the heater from direct contact with it.

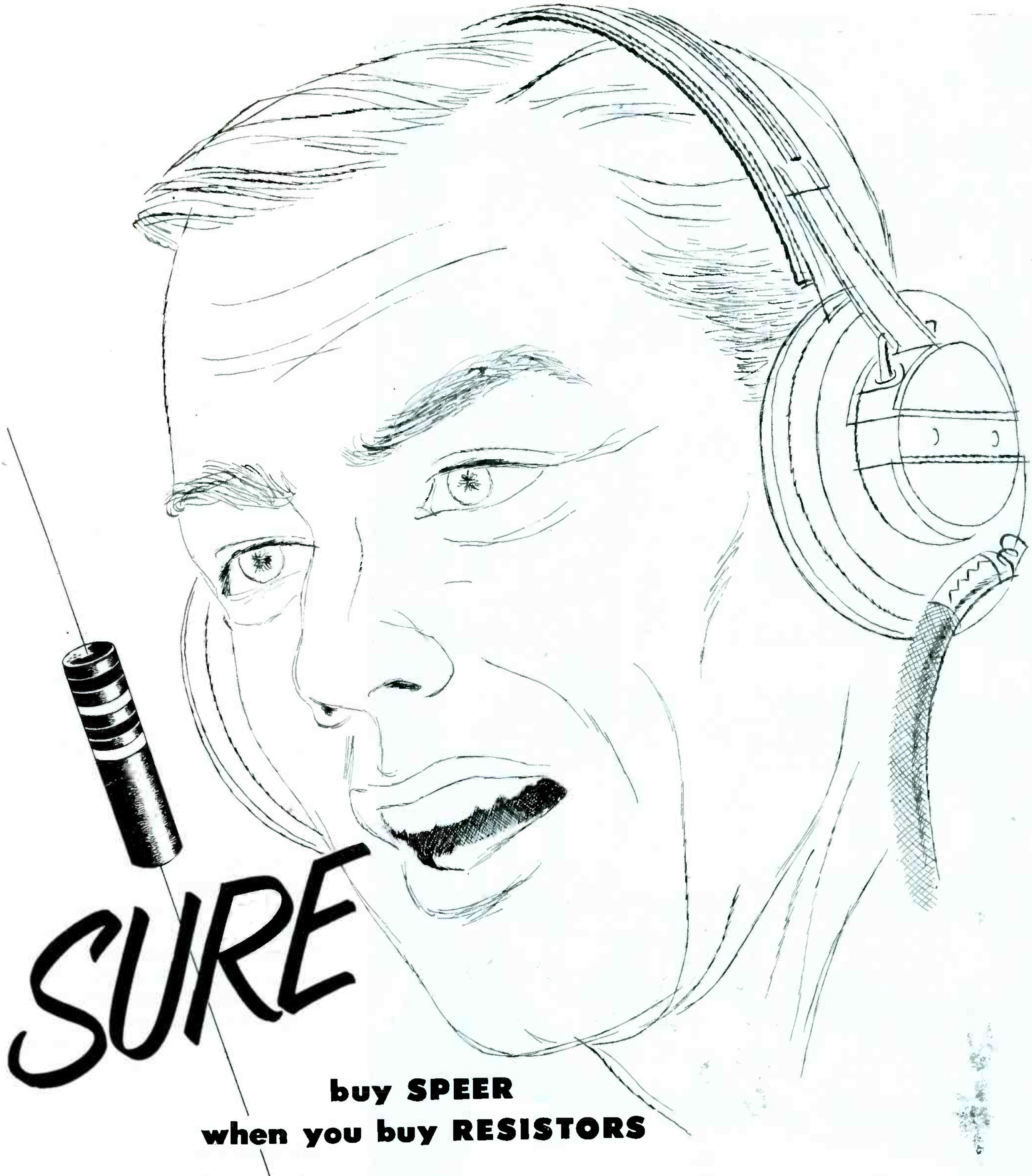
The most essential part of the insulator is the center web. Not only does it give the necessary mechanical support, but the resulting short heating time indicates that it speeds up the heating up process by reflecting heat into the cathode sleeve. The heater proper is a multistranded coated tungsten wire which is threaded into the two longitudinal holes of the insulator. The insulator is made a little longer than the cathode sleeve as this was found to reduce the danger of breakdown at the ends. The insulator is held in place by a ceramic cement at its lower end, tying it to the heater and heater leads. In this way, heater, insulator and cathode sleeve can expand independent of each other, as required during heating and cooling of the tube.

The heating time of the cathode assembly using this ceramic is 16 sec, which is about normal for tubes not using ceramics as insulators. Thus, its successful operation when used in series heater circuits is assured.

The cathode is designed with such an operating temperature as to give good life without undue processing difficulties. The main problem for production was found to be the control of coating texture. Only tubes with just the proper cathode coating will withstand the high inverse peak voltage tests.

Plate-Cathode Spacing

Having solved the heater insulation problem, it now became clear that the cathode-to-plate spacing of the 6W4GT was insufficient to withstand surge voltages of 4,000 volts with any degree of safety. In order to allow a rating of 4,000 volts maximum design center (RTMA system) for a production type, it was considered necessary to have some experimental tubes, made



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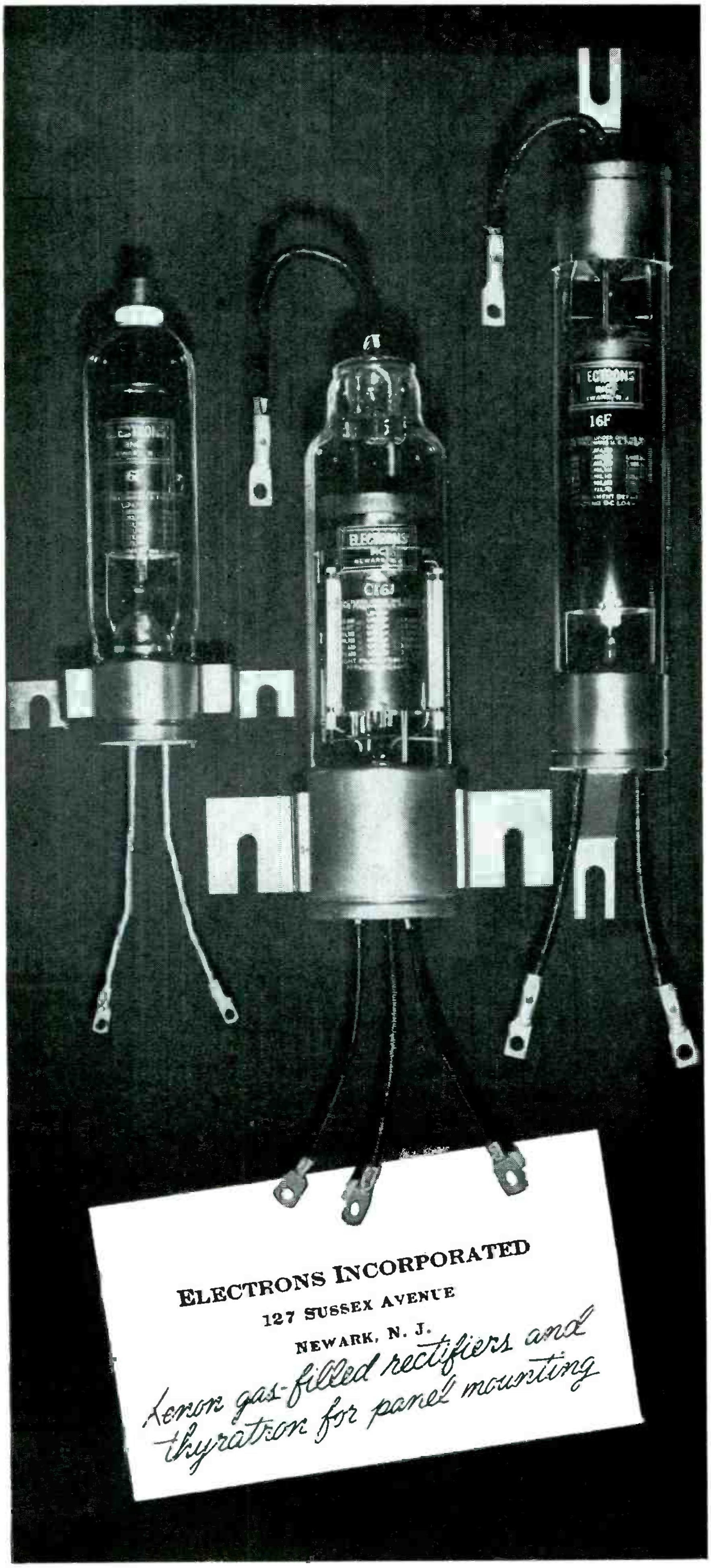

under strict laboratory control, withstand a short test of 6,000 volts.

In order to obtain sufficiently high plate-to-cathode breakdown voltage, the plate-to-cathode spacing was increased slightly over that of the 6W4GT. When this was first considered, the possibility of having to limit the plate current rating because of the increased plate dissipation was anticipated. However, extensive tests have proven that the same current rating as that of the 6W4GT is satisfactory. The plate is made from heavy stock, bright on the inside to hold in the heat of the cathode, carbon coated on the outside to permit maximum plate dissipation. Its shape is similar to that commonly used on the 6W4, except that the ends of the plate barrel are flared out in order to reduce the field strength at those points.

The electrodes are mounted on a conventional flat press stem. The lead wires are so arranged that the cathode lead is brought out on one side of the press, while heater and plate leads emerge on the other side. The base is provided with leakage barriers both inside and outside, which makes it possible to retain the single-ended basing design of the 6W4GT. It is obvious that in connecting a socket for the new type, socket clips adjacent to the cathode connection cannot be used as tie post in the receiver. A picture of a finished tube and its component parts is shown in Fig. 2.

We gratefully acknowledge the cooperation and many valuable suggestions given to us by George Fyler of Motorola, Inc.

Floating-Core Capacitor AFC System

MANY electromechanical automatic frequency systems employ motors, with associated control circuits, and elaborate gear boxes. The system described here eliminates all these, and requires but a small fraction of the driving power usually needed for old systems.

Basis of the system is a metal core which can move freely inside a tube of insulating material, filled with fluid. The core is moved electromagnetically to effect changes in

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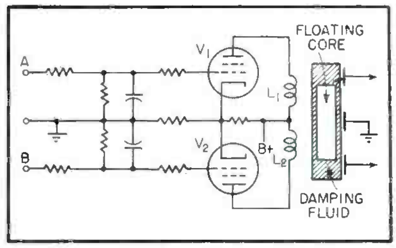

FIG. 1—Circuit of control for floating-capacitor for automatic electromechanical frequency control system

capacitance. The fluid damps the movement of the core and the floating action reduces the influence of gravity and extraneous mechanical vibrations.

Figure 1 shows the circuit used in conjunction with the floating-core capacitor afc system. When there is no correction signal at A or B, V_1 and V_2 are just cut off, the coils L_1 and L_2 are not energized, and the core remains at rest. In case of a frequency deviation, and depending on the sign of the deviation, one of the tubes will draw current through the action of a discriminator. Thus one of the coils will be energized and the position of the core is varied until the two frequencies to be compared are synchronized.

According to the original article describing this development (*Communication News*, p 112, Dec. 1950) the advantages of this system are as follows: (1) Absence of initial friction results in a high sensitivity. (2) The mass of the floating body is small so that hunting will not occur. (3) The speed of control is proportional to the frequency deviations. (4) The large gear box necessary in conjunction with alternative methods is replaced by fluid damping. (5) The operation of the floating core is not influenced by mechanical vibrations. (6) Small dimensions and weight. (7) The electrical circuit required for driving the core can be kept small.

Disadvantages include: (1) Leakage or evaporation of the fluid may occur which causes the formation of air bubbles. (2) After prolonged operation the fluid may become polluted, which might result in sticking of the floating body. (3) Special care must be taken during manufacture of the floating-core device.

Experimental units have been

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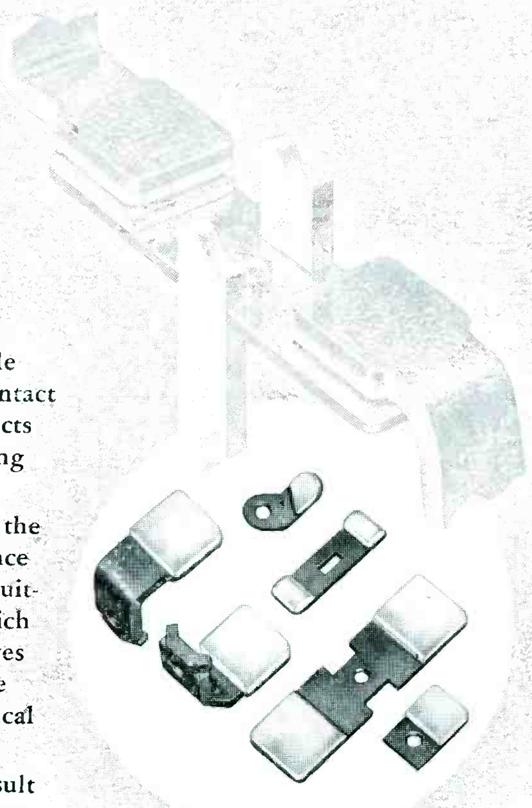

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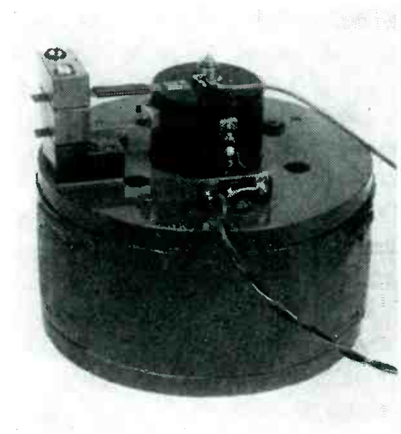
manufactured by the Philips Telecommunication Industries laboratories, of Hilversum, Holland, and found to fulfill the characteristics expected of them. One model provides a change in capacitance per electrode of 10 to 15 $\mu\mu$f. Special attention has been paid to the selection of just the right fluid for the device, and experimental and theoretical analyses of the mechanical aspects of the floating core have been performed. A complete description of the development is presented in the above reference.

Barium Titanate Accelerometer

ALTHOUGH piezoelectric crystals have been used in the past as sensing elements in mechanical shock experiments, practical difficulties have prevented their wide adoption. However, recent developments in the field of ceramics have made available piezoelectric materials that are both sensitive and easily fabricated. One of these, barium titanate ($BaTiO_3$), is used in the National Bureau of Standard's piezoelectric compressive acceleration pickup.

Physical Characteristics

The pickup is composed of a ceramic disk 1/16 inch thick and 3/8 inch in diameter, stacked between a suitable base and a block of metal used for mass-loading the disk. The com-



Photograph shows barium titanate accelerometer connected to magnetic vibrator

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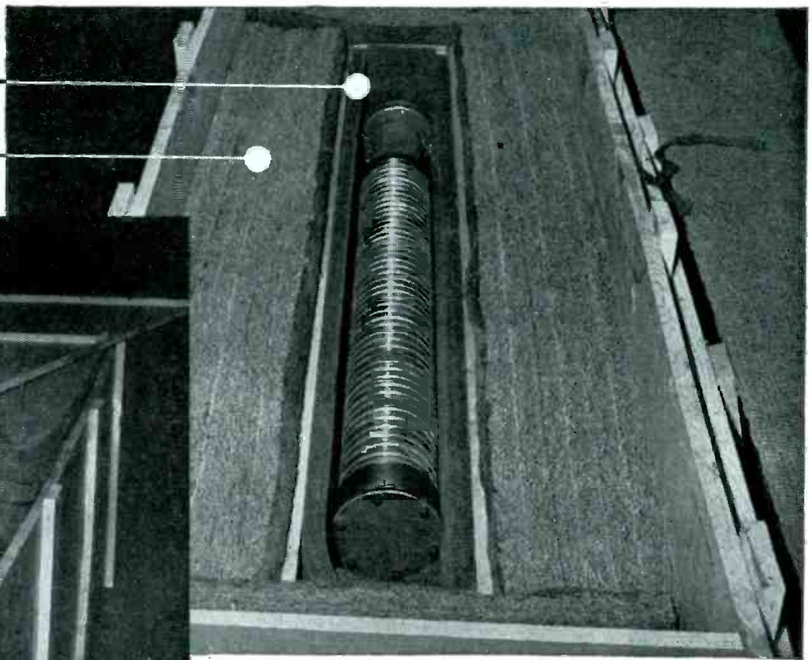

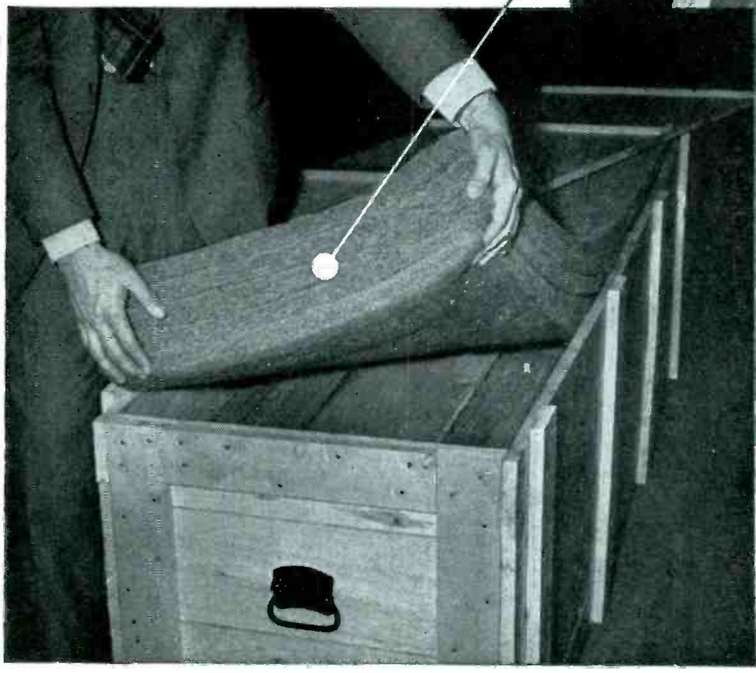

Photographs courtesy of High Voltage Engineering Corporation.

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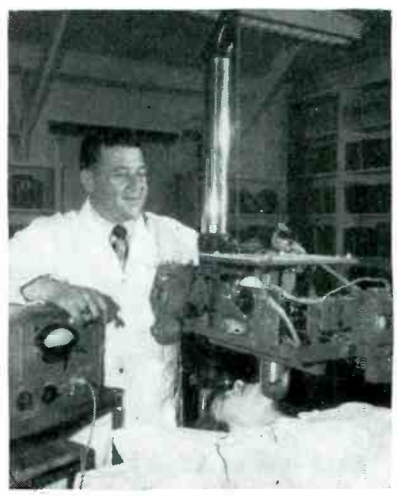
plete unit weighs less than 1/16 ounce. As a result of the stacking any acceleration imparted to the base produces a proportionate change in pressure on the piezoelectric disk tightly confined by the mass-loading block.

The voltage generated is proportional to the acceleration of the device being measured and is independent of its characteristic frequency up to the mechanical resonance of the accelerometer. This resonance has been extended to above 20,000 cps by using a small and rather monolithic structure. As a voltage source this particular pickup has an almost purely capacitive internal impedance of about 500 $\mu\mu$f and a sensitivity of approximately 2 millivolts per *g*.

Calibration measurements indicate that the accelerometer has a response flat within 20 percent over the range 50 to 6,000 cps, and rising to a slight peak between 10,000 and 18,000 cps. The peak appears due to calibration difficulties rather than to the property of the accelerometer.

MACHINE MAPS THYROID GLANDS



Pictures of thyroid glands may be made automatically on living patients by means of the gamma-ray sensitive instrument shown. X-ray instruments have thus far been unable to accomplish this task. The machine automatically traces the patient's thyroid on a piece of drawing paper. The instrument is shown in use on a simulated patient in a UCLA laboratory

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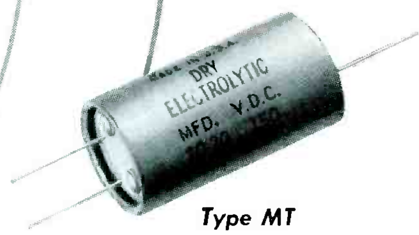

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PAPER·MICA·SILVER·ELECTROLYTIC CAPACITORS

SANGAMO ELECTRIC COMPANY

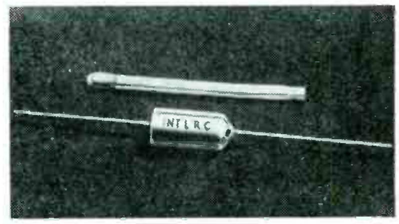
SPRINGFIELD, ILLINOIS

IN CANADA: SANGAMO COMPANY LIMITED, LEASIDE, ONTARIO SC51-9

NEW PRODUCTS

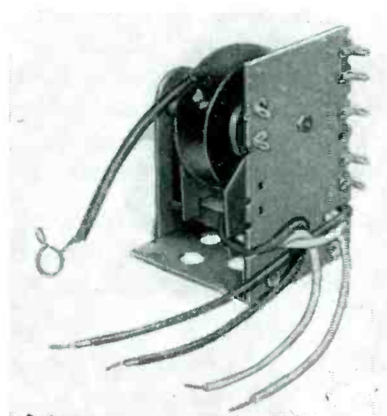
(continued from p 146)

double-throw, rated at 10 amperes, 28 volts d-c. Designed to rigid MIL specifications, the units exceed many of the requirements of temperature, vibration and shock tests.



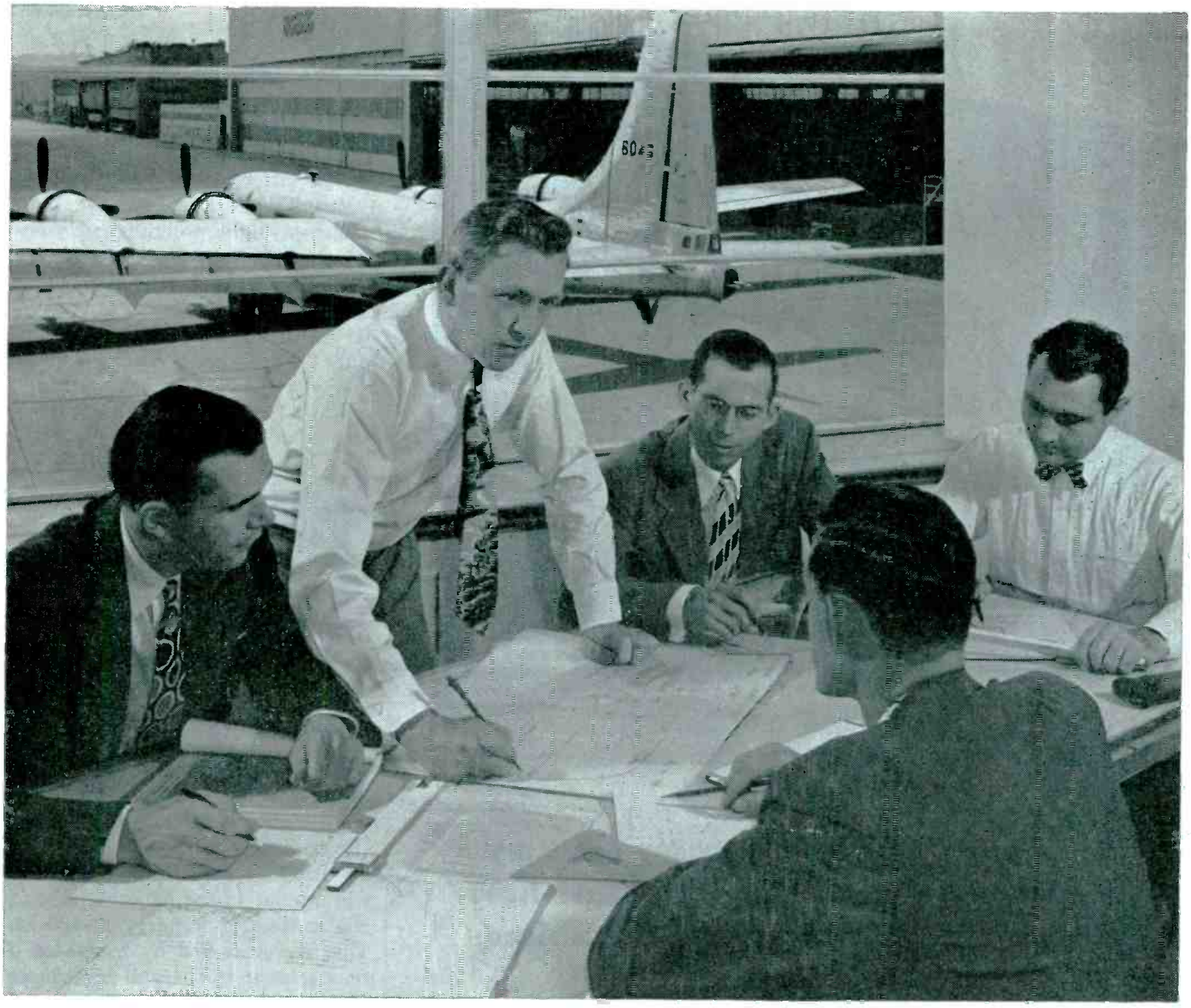
Selenium Rectifiers

INTERNATIONAL RECTIFIER CORP., 6809 S. Victoria Ave., Los Angeles 43, Calif., has developed a new line of hermetically sealed selenium rectifiers assembled in half-wave cartridges with current ratings from 300 μa up to 60 ma. The individual cartridges accommodate up to 400 cell elements with d-c voltage ratings up to 8,000 volts per cartridge. The units are capable of withstanding 100-g acceleration, and are ideally suited for airborne applications. They can be operated in ambient temperatures ranging up to 100 C.



H-V Transformer

RADIO CORP., OF AMERICA, Harrison, N. J. Type 228T1 horizontal-deflection-output and high-voltage transformer was designed for use with electrostatic-focus picture tubes having a horizontal deflection angle of approximately 66 deg, and operating at voltages as high as 16



They have a right to be proud!

These men have realized ambitions that they've carried with them since they began to build engineering careers. They're Boeing men. And that sets them a little apart. For Boeing is a renowned name in aviation. It stands for bold pioneering in aeronautical research and design . . . for leadership in the building of advanced commercial and military airplanes . . . and for trail blazing in the development of guided missiles, jet propulsion and other fields.

Today, there are many grand career opportunities at Boeing for high-caliber men who can measure up.

Needed in Seattle are experienced and junior aeronautical, mechanical, electrical, electronics, civil, acoustical and weights engineers for design and research; servo-mechanism designers and analysts; and physicists and mathematicians with advanced degrees.

It's important, long-range work. The world's hottest jet bombers . . . the fascinating new field of guided missiles . . . the revolutionary new Boeing gas turbine engine—these are among the challenging assignments awaiting you. Here are outstanding research facilities and the men who have built Boeing to world eminence.

1 More housing is available in Seattle than in most other major industrial centers.

2 Salaries are good—and they grow with you.

3 The Northwest is a sportsman's paradise—great fishing, hunting, sailing, and skiing country—with temperate climate all year.

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Or if you prefer the Midwest, *there are similar openings available at the Boeing Wichita, Kansas, Plant. Inquiries indicating a preference for Wichita assignment will be referred to the Wichita Division.*

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JOHN C. SANDERS, Staff Engineer—Personnel
Dept. H-10
Boeing Airplane Company, Seattle 14, Wash.

Engineering opportunities at Boeing interest me. Please send me further information.

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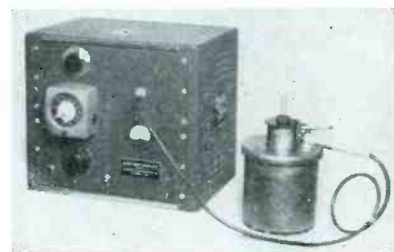
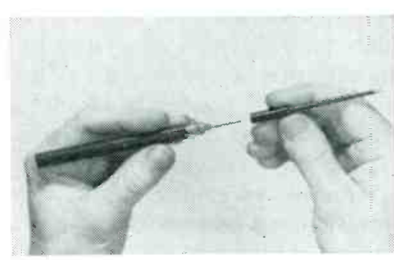
BOEING

kv. The horizontal-deflection-output tube may be either a 6BQ6-GT or a 6AU5-GT. When the former is used a B-supply of 280 v is needed; for the latter, a B-supply of 300 v. Utilizing a ferrite core for high efficiency, light weight and compactness, the unit has two separate filament windings. One provides power to the filament of the rectifier tube for the h-v supply; the other, for the focusing-voltage supply.



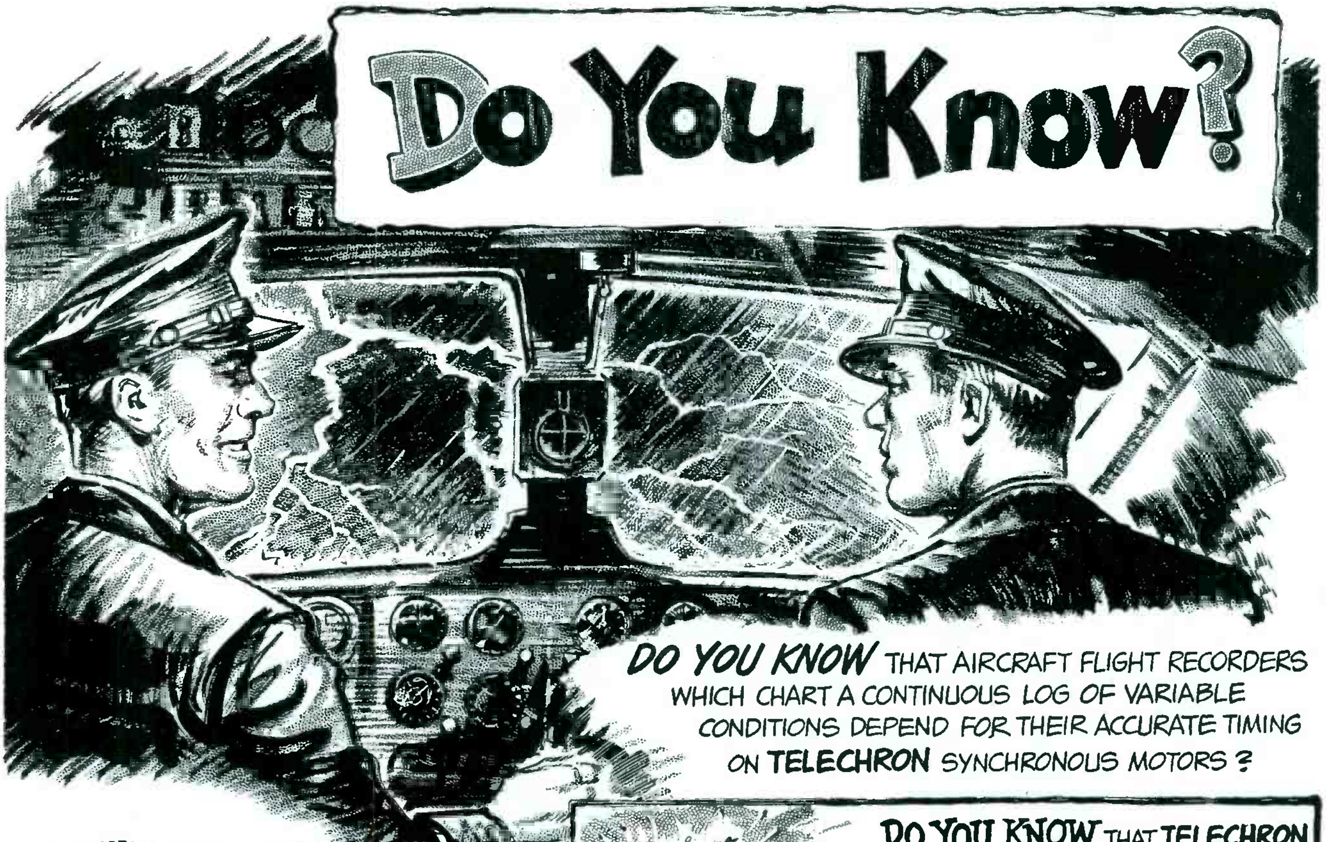
Ultrasonic Generator

ULTRASONIC ENGINEERING CO., P. O. Box 46, Maywood, Ill. Model 800 industrial and pathological laboratory ultrasonic generator contains a v-t oscillator which, at full power, will develop in the neighborhood of 500 watts of r-f energy at 800 kc. This power is fed by means of a coax cable to the crystal transducer mounted in the aluminum vessel shown at right. Output power of the generator is continuously variable from zero to full by means of the knob at the lower left of the panel. Coils of the oscillator are of the plug-in type, thus permitting coupling to transducers of different frequencies. Crystals are available at frequencies from 450 to 2,000 kc.

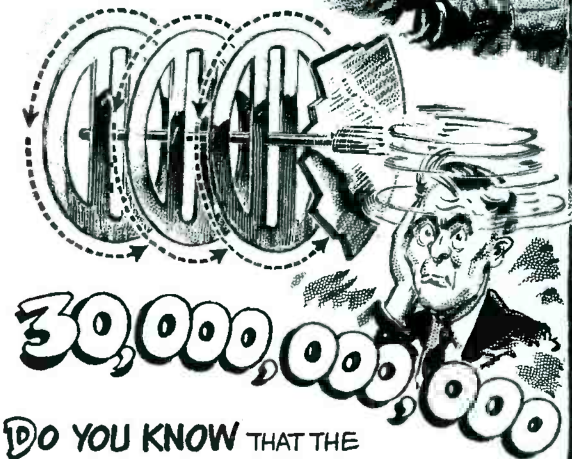


Test Prod Adaptors

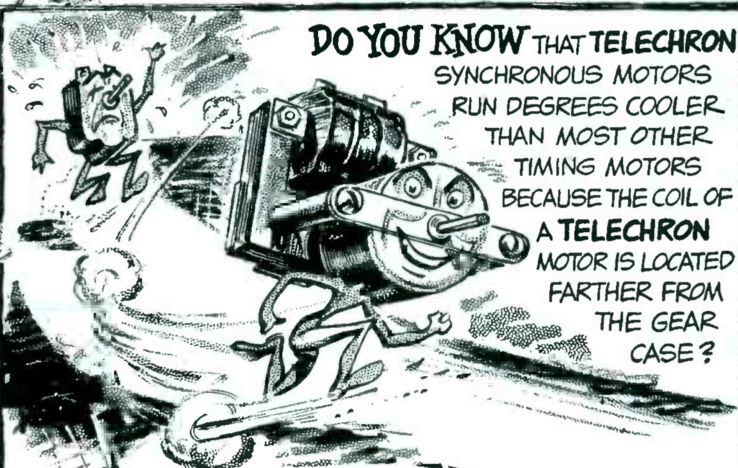
UNITED TECHNICAL LABORATORIES, Morristown, N. J. A new test prod adaptor is specially designed for



DO YOU KNOW THAT AIRCRAFT FLIGHT RECORDERS WHICH CHART A CONTINUOUS LOG OF VARIABLE CONDITIONS DEPEND FOR THEIR ACCURATE TIMING ON **TELECHRON** SYNCHRONOUS MOTORS?

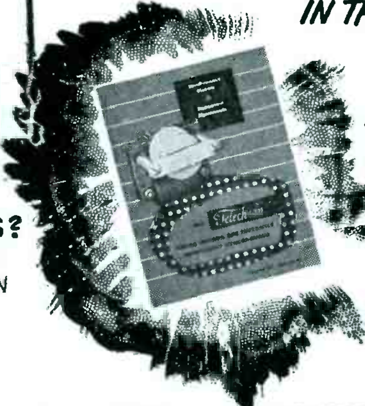


DO YOU KNOW THAT THE ROTOR SHAFTS OF MANY **TELECHRON** SYNCHRONOUS TIMING MOTORS HAVE MADE MORE THAN **30 BILLION** CONTINUOUS REVOLUTIONS AND THAT THE MOTORS ARE STILL OPERATING AS ACCURATELY AND DEPENDABLY AS WHEN THEY WERE NEW?



DO YOU KNOW THAT **TELECHRON** SYNCHRONOUS MOTORS RUN DEGREES COOLER THAN MOST OTHER TIMING MOTORS BECAUSE THE COIL OF A **TELECHRON** MOTOR IS LOCATED FARTHER FROM THE GEAR CASE?

READ ALL ABOUT TELECHRON MOTORS IN THIS BULLETIN



WRITE FOR BULLETIN IS-110 WHICH CONTAINS CHARTS, TORQUE RATINGS AND COMPLETE SPECIFICATIONS ON **TELECHRON** SYNCHRONOUS MOTORS FOR USE IN TIMERS, TIME SWITCHES, RECORDING AND CONTROLLING INSTRUMENTS, COST RECORDERS, CYCLE CONTROLLERS, ETC.

TELECHRON DEPARTMENT,
GENERAL ELECTRIC COMPANY,
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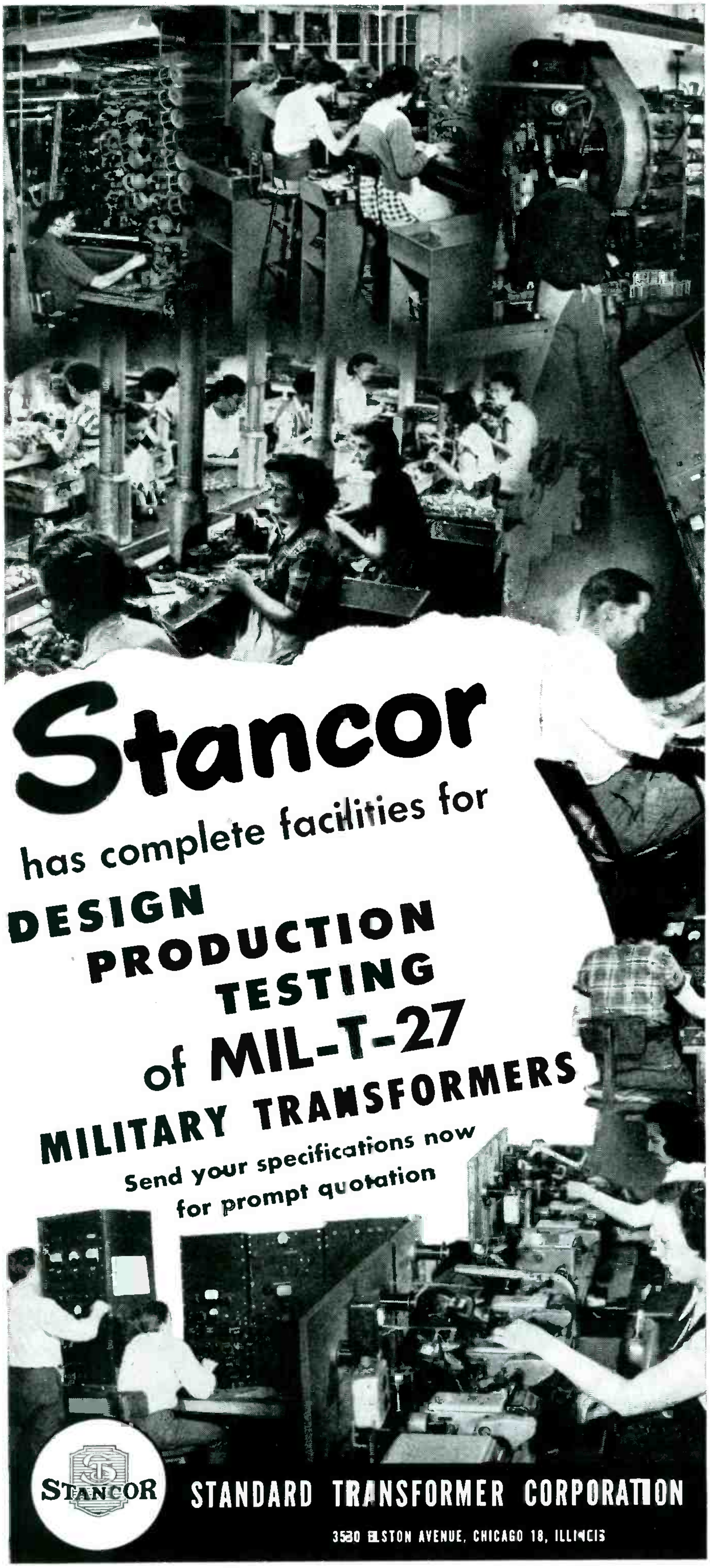
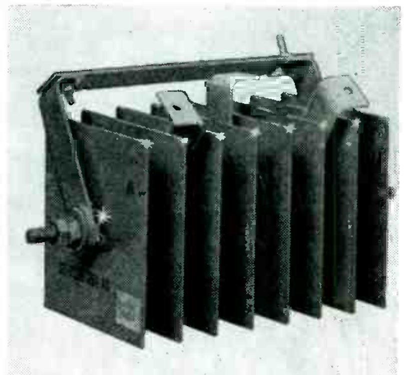
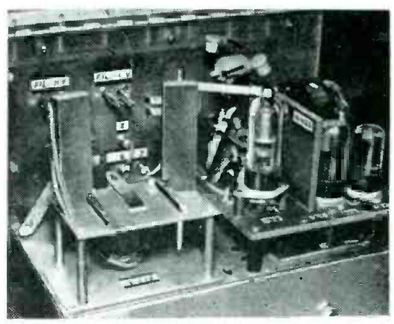


use with standard RTMA test points or the phonograph needle type so that any point in miniaturized or other compact electronic circuits may be conveniently contacted by a self-holding prod. The Klipzon type L Longie adaptor provides a slender, insulated point for reaching into crowded circuits without danger of shorts, shock or accidental disconnect. A unique self-holding point permits measurements with both hands free for circuit adjustment, soldering or other work.



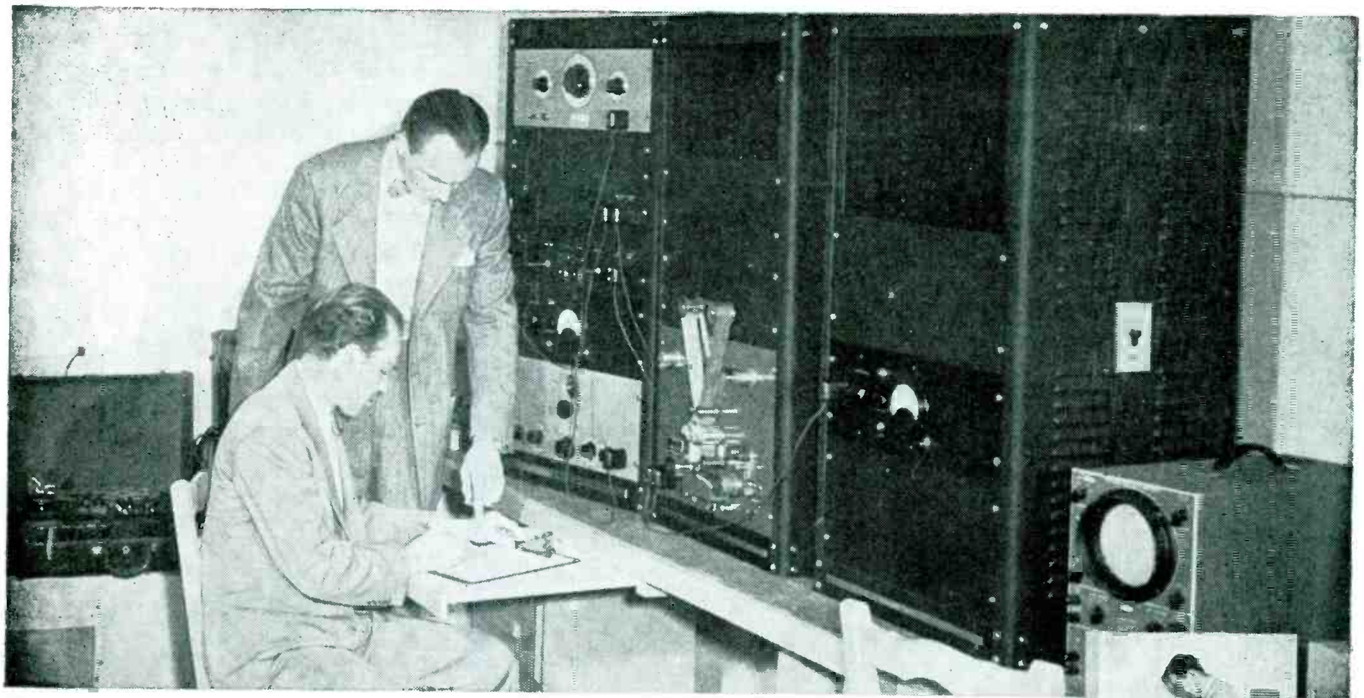
Power Rectifier

SARKES TARZIAN INC., 415 North College Ave., Bloomington, Ind., has announced availability of a recently developed selenium rectifier that is capable of operating without derating in ambient temperatures of 90 C. The new power rectifier illustrated is guaranteed for a minimum of 1,000 hours of continuous operation.



Identification Tape

LABELON TAPE CO., 100 Anderson Ave., Rochester 7, N. Y. Made of two layers of acetate with a white waxy substance sandwiched in be-



SOUND RECORDING TAPE engineers at work in the 3M Hollywood Engineering Laboratory.

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FOR A "SOUND SOLUTION" TO ANY TAPE RECORDING PROBLEM

Eighty 3M engineers in the field—backed by twenty technical experts in the 3M laboratories—stand ready to help you with any tape recording problem.

This 3M Service Organization works daily with radio station engineers, electronic engineers and industries using tape recordings in process or quality control. The same electronic and engineering know-how that produced and perfected the famous "SCOTCH" Sound Recording Tape offers you technical assistance on every phase of sound recording.

If you are using sound recording equipment in your radio station, laboratory or business, call upon the 3M Service Representative in your community. He'll be glad to help you make better recordings—more easily. If you are contemplating the use of tape recordings, he'll be glad to analyze your requirements and aid in the selection of equipment.

Call him today—or, if you prefer, write directly to Minnesota Mining & Mfg. Co., Dept. AE-101, St. Paul 6, Minn. No obligation, of course.

"SCOTCH" Sound Recording Tape gives you these EXTRA construction features . . .

- **REEL TO REEL UNIFORMITY**—controlled coating assures consistent output.
- **THINNER CONSTRUCTION**—resists temperature and humidity changes.
- **NO CURLING OR CUPPING**—tape lies flat on recording head unaffected by humidity.
- **UNIFORM TAPE SURFACE**—no "dropouts" on recordings due to surface irregularities.
- **LONGER TAPE LIFE**—special lubricating process reduces friction.
- **GREATER SENSITIVITY**—more output on your present machine setting.

tween, this new pressure-sensitive tape can be written on with any blunt instrument, and makes a water-proof, oil-proof, smudge-proof and acid-resistant label. It will adhere to almost any clean surface and can be transferred from one surface to another repeatedly without leaving a sticky residue or destroying its adhesive qualities. The tape is ideal for identifying electrical circuits or wires pulled through conduits, switches, controls, spare parts, panelboards and the like.

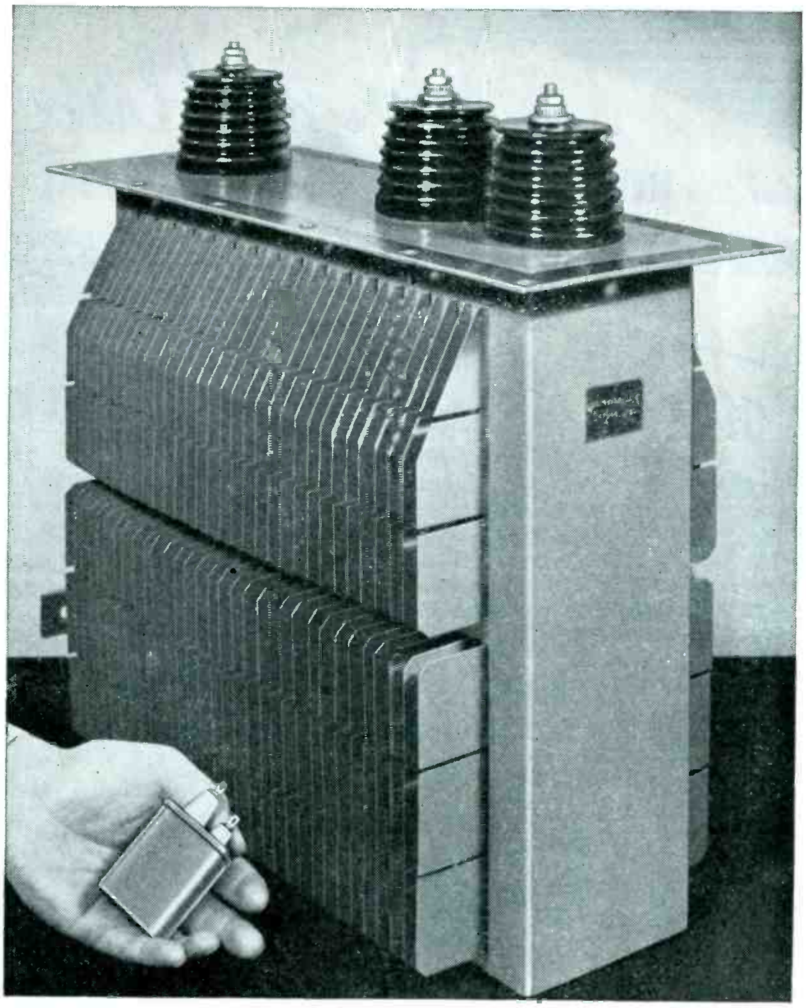
Attenuator Switches

SHALLCROSS MFG. CO., Collingdale, Pa., has introduced a line of attenuator switches including 12 round, single-deck units in one- and two-pole types with up to 60 contact positions and with rotations ranging from 144 to 360 degrees. Average resistance of the silver alloy contacts of 0.003 ohm is maintained throughout a life of upward of a million operations. Typical conservative ratings are 1 ampere at 25 volts; ½ ampere at 50 volts; ¼ ampere at 110 volts, and 0.2 ampere at 220 volts. All are obtainable with or without detent mechanism.

Scintillation Scaler

NUCLEAR RESEARCH AND DEVELOPMENT, INC., 1094 Sutter Ave., St. Louis 5, Missouri. Model S-1001

pulse-forming Network Capacitors are dependable



for guided missiles—aircraft—land and sea radar equipments

The keystone to good service on network capacitors is complete information. Your G-E representative has a check-list of twenty-three questions that must be answered to assure you of dependable capacitor performance. And on important propositions, to simplify your design problems, it is highly desirable that a design engineer be called into the discussions as early as possible. Arrangements for such consultations can be made through any Apparatus Sales Office of the General Electric Company.

Whether you expect a service life of 10,000 hours or just 60 seconds, G.E. networks, designed to meet exacting specifications, will give you the reliable performance you require.

Pulse networks are a highly specialized field of capacitor engineering and experience is an important part of proper design work. G.E. has built networks for every type of pulse radar equipment since the inception of radar.

Since 1944, G.E. has been running continuous life tests on many types of networks to obtain more complete research data. These tests are being used to establish life limitations under various conditions of highly critical temperatures and voltages on all types of dielectrics, bushings, materials for coil forms and treating processes. Take advantage of this wealth of information and experience. Your inquiry addressed to Capacitor Sales Division, 42-304, General Electric Company, Pittsfield, Mass. or your nearest Apparatus Sales Office, will receive prompt attention.

General Electric Company, Schenectady 5, N. Y.

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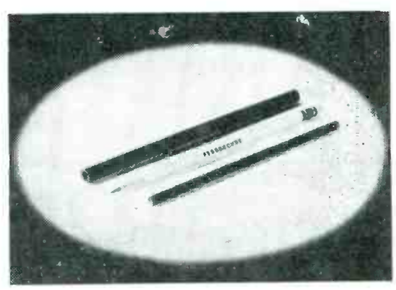
407-304

scintillation scaler incorporates 3 basic features that are an absolute necessity for successful scintillation counting. (1) a fast linear amplifier with a rise time of 0.25 μsec and a variable amplification from 0 up to 2,000; (2) a true electronic discriminator that accepts pulses from −100 to +50 v; and (3) a well regulated h-v supply that is variable from 500 to 2,000 v and is regulated to 0.005 percent per 1 volt change in line voltage between 95 and 130 v. The scaler portion uses the Higinbotham scale of 128, which incorporates 6SN7 tubes and has a resolving time of 2 μsec. The unit may also be used for Geiger and proportional counting.

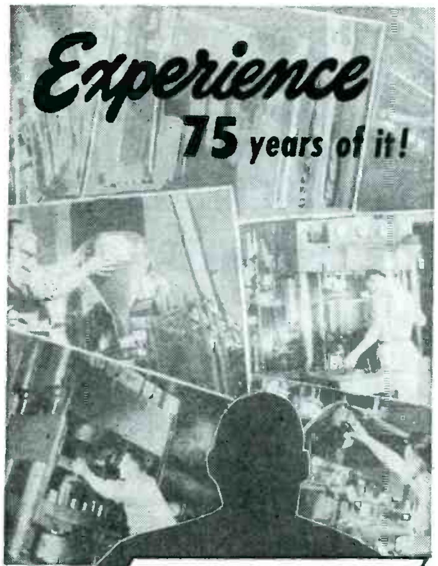
New Tetrodes

AMPEREX ELECTRONIC CORP., 25 Washington St., Brooklyn 1, N. Y., has available three new tetrodes. Type AX-9907/6077 is a high-freqency, water-cooled tetrode especially suitable for the final stage of tv transmitters. The tube may be employed up to a maximum frequency of 220 mc, and has a maximum plate dissipation of 3 kw, maximum plate voltage of 5 kv and maximum plate current of 1.1 amperes. This tube is also available in an air-cooled version, type AX9907R/6076. The type AX-9908/6079 is radiation cooled for communications applications. It operates at a maximum frequency of 75 mc and has a maximum plate dissipation of 500 w. Maximum plate voltage is 5,000 v and maximum plate current is 600 ma.



Ferrite Core Antennas

FERROXCUBE CORP. OF AMERICA, Marshall St., North Adams, Mass., are manufacturing magnetic cera-



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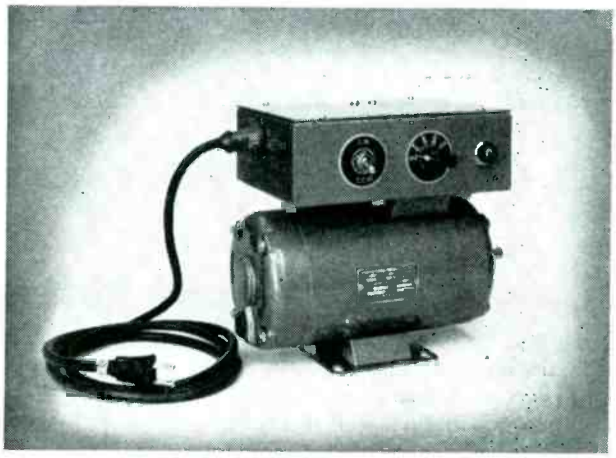
Auburn Button Works, Inc.
550 McMaster Street, Auburn, New York
Founded in 1876 Telephone 3-5320

3 & 5 Speed SYNCHRONOUS MOTORS

ESPECIALLY SUITED TO LABORATORY USE



Laboratories, experimental and testing departments no longer need several motors for supplying different speeds; nor are complicated gear or other drives required.

Elinco can supply multiple-speed motors with which change of speed is practically instantaneous at the flick of a switch; instantly reversible, too, even from forward at one speed to reverse at a different speed.

Now, one unit can do the job of five . . . saving in original equipment investment and changeover time. Especially designed for experimental, servo, electronic power and audio mechanisms, as well as for general laboratory use.

115 Volt 60 Cycle Single-Phase Multiple-Speed Motors

MOTOR	SPEED	NOM. H.P. RATING	FULL LOAD POWER INPUT	START TORQUE INCH LB.	PULL-IN TORQUE INCH LB.	PULL-OUT TORQUE INCH LB.	CAP VALUE MFD.
GH-371 3 Speed	900	1/100	59	.95	.86	.90	5
	1800	1/60	77	.70	1.00	1.05	5
	3600	1/40	123	.50	.90	.90	8
GGH-492* 3 Speed	900	1/50	125	1.70	1.50	1.60	10
	1800	1/30	174	1.35	2.00	2.30	10
	3600	1/20	250	.90	1.50	1.90	16
GGH-449 5 Speed	600	1/200	64	.50	.65	.65	6
	900	1/100	59	.95	.86	.90	5
	1200	1/75	61	.70	1.25	1.35	6
	1800	1/60	77	.70	1.00	1.05	5
	3600	1/40	123	.50	.90	.90	8

*This motor must be externally cooled if used for continuous duty.
Models GH 371 and GGH 449 available with or without control box; Model GGH 492 motor only.

When ordering or requesting information on other models, a detailed description of your requirements will assist us in sending proper information promptly.

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PARKER AVENUE STAMFORD, CONN.

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- SHUNT
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- TOTALLY ENCLOSED
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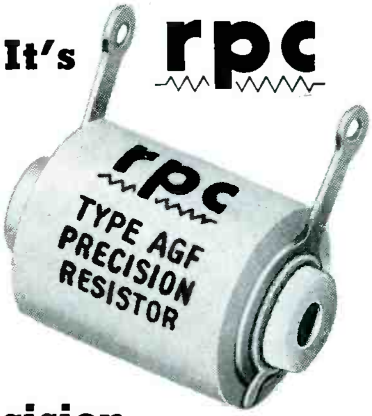
- STABILIZED HYSTERESIS

MOTORS AND GENERATORS

It's **rpc**



for

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RPC Resistors are high quality units designed to meet the most stringent requirements. They are widely used in large quantities by laboratories, instrument manufacturers, and the Armed Forces and their suppliers. Sizes available are in accordance with JAN-R-93, RB10 to RB14 and RB51. Terminals may be wire leads if required. Resistance tolerance to 0.02% is available. All resistors are treated against humidity and fungus growth.

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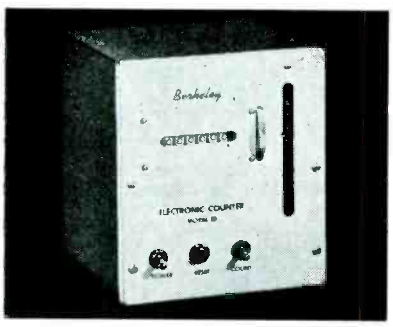
mic antenna rods in diameters from ¼ in. to 1 in. and in lengths up to 8 in. With single-layer windings of insulated wire these rod assemblies are used on portable radios in place of collapsible rod antennas or built-in loops. Because of their unusually high Q, set sensitivity is considerably increased over the usual air loop. Because of the compactness of ferrite core antennas, they may be mounted almost anywhere in set cabinets using a minimum of space.

Mobile Receiver

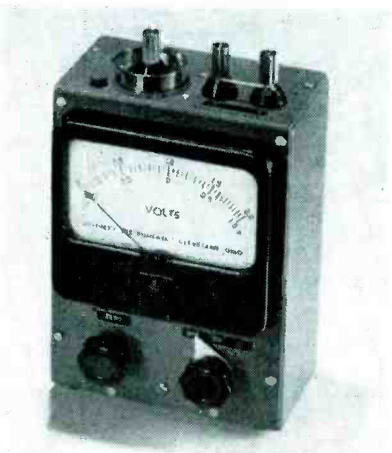
SONAR RADIO CORP., 59 Myrtle Ave., Brooklyn 1, N. Y. Model SR-9 mobile receiver is a 9-tube superhet unit designed for dependable 2-way operation in civil-defense and other medium-range radio communications. Power output is 3 watts; output impedance, 4 to 8 ohms; antenna input impedance, 35 to 75 ohms; overall sensitivity, better than 0.5 μv. Weight is approximately 3 pounds, and price, $72.45.



Electronic Counter

BERKELEY SCIENTIFIC CORP., 2200 Wright Ave., Richmond, Calif. Model 10 electronic counter has been developed to satisfy the need for a rugged industrial type counter

that will operate reliably in the range beyond the capabilities of standard mechanical counters. Any mechanical, optical or electrical occurrences that can be converted to electrical impulses may be so counted at rates up to 6,000 per minute. However, the instrument will actually differentiate between any two occurrences as close together as 20 μsec. The unit uses selenium rectifiers in the power supply and all wiring has been moisture and fungus proofed to insure reliability and long operating life. All circuits have been developed around one tube type, the 12AU7, to facilitate replacement. All counters are factory tested to insure proper operation over a line voltage range of 105 to 130 v. Power consumption is approximately 25 w.



V-T-Electrometer

KEITHLEY INSTRUMENTS, 3868 Carnegie Ave., Cleveland 15, Ohio. Model 200 vacuum-tube voltmeter is accurate within 1 percent at full-scale reading; accuracy of low-scale readings being held to within 5 percent of the reading. The increased accuracy was achieved by recalibration of the scale to compensate for nonlinear characteristics of the vacuum tubes. The improved instrument is expected to have an enhanced value wherever a self-contained d-c voltmeter with an extremely high input impedance is required. Some of the unit's current uses include measuring voltages of charged capacitors, measuring piezoelectric potentials, in measuring d-c amplifier and f-m

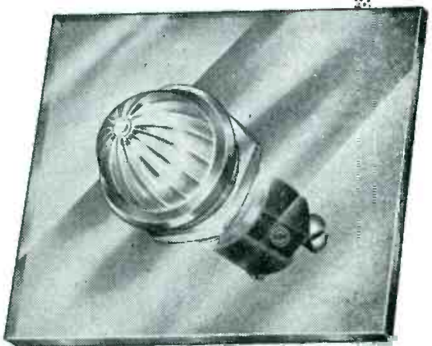
FOR YOUR PANEL

DIALCO

A NOVEL and UNIQUE CIRCUIT INDICATOR

DESIGNED FOR NE-51 NEON LAMP
For 110 or 220 volt circuits

The required resistor is an integral part of this assembly —"built-in."



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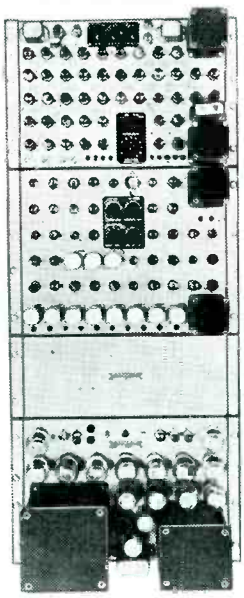
COLOR TV

SYNC SIGNAL GENERATOR TYPE 2201

(field sequential system for CBS color)

for Broadcasting and Production Testing



- All binary dividers. No blocking tube or locked oscillators
- Camera color drive pulse provided to operate studio camera equipment—absolutely stable under all operating conditions
- Meets all RTMA and FCC specifications with margin to spare
- Gating pulse to blank out two color fields—will produce any one of three colors
- Built-in bar and dot generator for checking sweep linearity

Price $2150.00 FOB Plant. Cabinet extra

Write for further technical details on 2201 Sync Generator and 2301 Color Monoscope.

Manufacturers of a complete line of TV and Radar Test Equipment

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- high heat resistance
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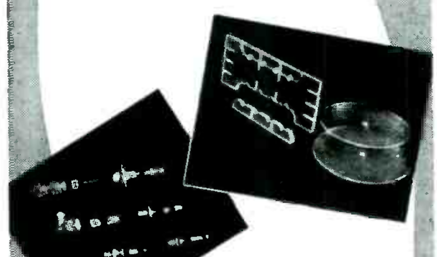
Rexolite 1422 has been specifically designed and developed to meet the growing need for a lightweight — low cost U. H. F. insulating material.

Rexolite 1422 is available for immediate delivery as centerless ground rod in any diameter up to 1". Also cast in larger diameter rods and sheets.

Meets JAN-P-77 and MIL-P-77A specifications.

The unusual chemical inertness and physical properties of Rexolite 1422 allow its use where other materials fail.

For use in: **connectors, coaxial connectors, waveguide, antennas, leads and spacers, spreaders and air wound coil supports, coil forms.**



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Manufacturers of Non-strip wire, High Temperature Electrical Tubing and other extruded plastic products.

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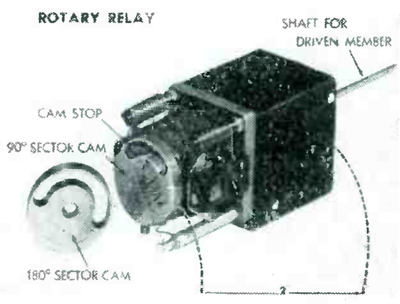
CAMBRIDGE 39, MASS.

discriminator potentials, and in conjunction with a known resistance to measure currents as low as 10^{-11} ampere in photocells and dielectric leakages.

Three-Speed Tape Recorder

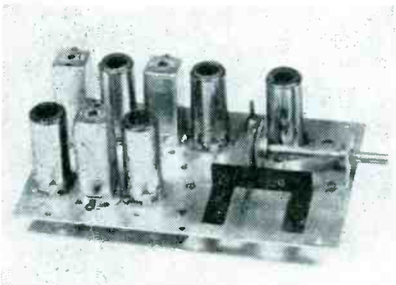
BELL SOUND SYSTEMS, INC., 555 Marion Road, Columbus 7, Ohio, has introduced model RT-65-B portable three-speed RE-CORD-O-fone tape recorder. It records for immediate playback on 1⅞-in., 3¾-in. and 7½-in. speeds. The amplifier in the unit is designed for high-quality frequency response of 70 to 8,000 cycles ±3 db. Output is 3.5 watts. Telephone jacks are provided for direct connections to any amplifier or p-a system. There is also an output of 3.2 ohms and high impedance for headphone monitoring. Power supply is 80 watts, 117 volts, 60 cycles a-c.



Rotary Switch Actuating Mechanisms

GENERAL PRECISION LABORATORY, INC., Pleasantville, N. Y., has developed a series of light, compact, rotary switch actuating mechanisms that provide intermittent pulsed reciprocating rotational motion of up to 330 deg, with torques tailored to suit individual require-

ments. The drive consists of a miniature motor in a special circuit permitting rapid reciprocal switching up to 10 complete cps. The device has applications in the field of microwave switches and phase shifters whose material elements require low torque rotary drive mechanisms, in high or low voltage switching, and in similar fields where a rapid rotary action with no lateral thrust is needed. The unit requires no holding current and can be operated from all commonly available power supplies with negligible power drain.

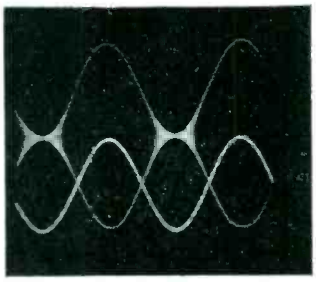


F-M Tuner Chassis

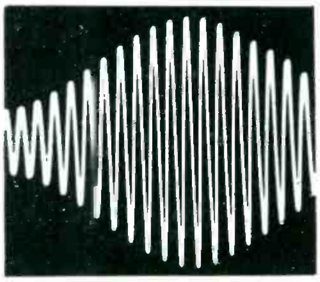
COLLINS AUDIO PRODUCTS CO., P. O. Box 368, Westfield, N. J. The type RD-1C f-m tuner chassis has high-permeability tuning cores run through electro-plated glass coils made especially for h-f operation. The whole tuner may be held in the palm of a hand and no separate i-f amplifier is needed. Antenna input is 300 ohms; sensitivity averages 20 μv; i-f is standard 10.7 mc; and audio output is approximately 1 volt. Voltage requirements are: filament—6.3 v a-c at 1.4 amperes; B voltage—100 v d-c at 35 ma. Price is $29.95.

Scintillation Detector

NUCLEAR RESEARCH AND DEVELOPMENT, INC., 1094 Sutter Ave., St. Louis 5, Mo. Model SC-2 scintillation detector incorporates a 5819

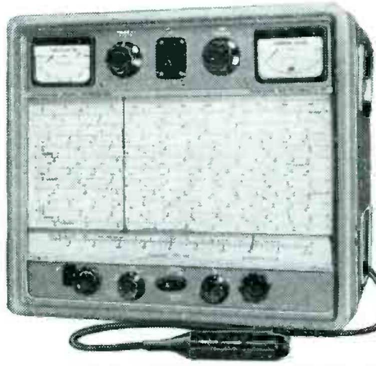


320 kc modulated 400 cps; audio on second beam.



24 kc modulated 60% 1 kc.

100% MODULATION . . . .



. . . A.M. WITHOUT F.M.

Excellent amplitude modulation is a feature of the Standard Signal Generator TF 867 — a.m. accompanied by minimum spurious f.m. — less than 100 cps below 5 mc, 1,000 cps above. Other features are:

Wide range — 15 kc (or less) to 30 mc in 11 bands on full vision scale. **Crystal accuracy** — 0.01% 1 mc harmonic source built-in. **Easy tuning** — discrimination 1 part in 10,000 on total 15 ft. scale length. **High output** — 4 volts down to 0.04 microvolts. **Flexible modulation** — internal 400 and 1,000 cps, 0-100%, external 50-10,000 cps ± 2db.

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Specialists in SMALL quantities of custom built transformers from milliwatts to 50 KVA, single or polyphase— designed and manufactured to best meet your exact requirements.

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CHOPPERS
YOU CAN DEPEND ON!

made by AIRPAX . . . pioneers in the field!

A589 . . . 6 volt, 400 cycle drive, used widely by the industry. Highly reliable, field-proven, tested and approved by many major electronic and aircraft firms.

A580 . . . 120 volt, 400 cycle drive, supplied to 0 phase angle or with 80° to 90° lag. Most versatile . . . repeated tests show life in excess of 1000 hours.

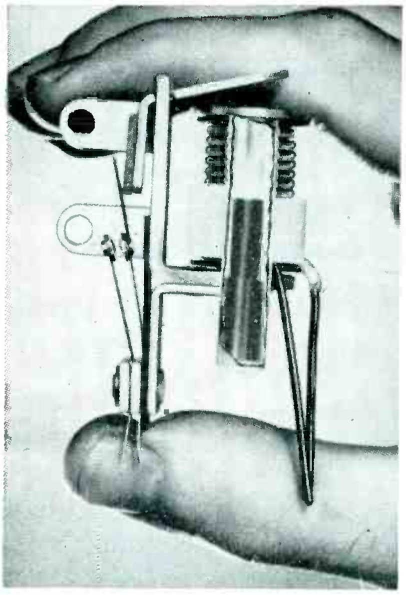
A587 . . . 26 volt, 400 cycle drive . . . the phase of closure and break is held to close limits for interchangeable use as either modulator or demodulator.

A586 . . . 6 volt, 60 cycle drive, 45 phase lag. Here's a chopper so reliable that you can put it into service and forget it for thousands of hours!

DESIGNERS AIRPAX PRODUCTS COMPANY ENGINEERS

MIDDLE RIVER, BALTIMORE 20, MD.

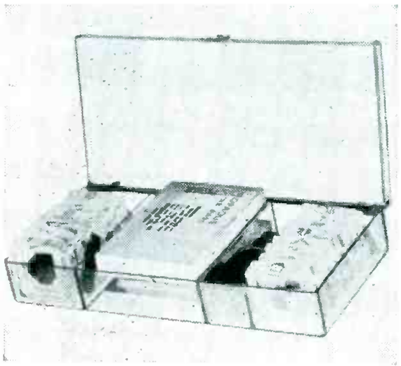
photomultiplier tube. The necessary dropping resistors are mounted on the base of the tube socket, and a cathode-follower preamp circuit may be installed if desired. The SC-2 uses a NaI-Thallium activated crystal especially mounted in a polystyrene holder to provide maximum optical transmission, and is an extremely efficient end-window gamma counter. It gets from 25 to 100 times the efficiency of a normal Geiger counter. The unit comes complete with cable, ready to be used in conjunction with any commercial scaler or count-rate-meter employing a pulse amplifier, discriminator and well-regulated high-voltage supply.



Small Time-Delay Relay

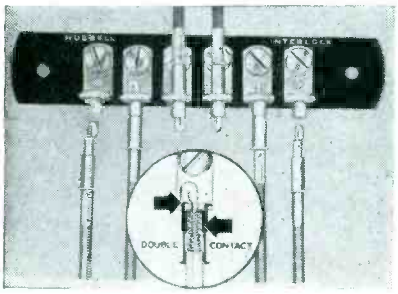
HEINEMANN ELECTRIC Co., 307 Plum St., Trenton 2, N. J. Overall dimensions of the Silic-O-Netic time-delay relay are only $1\frac{5}{8}$ in. × $2\frac{1}{2}$ in. × $\frac{3}{4}$ in. yet it has a rated capacity of 10 amperes at 120 volts a-c. It uses a hydraulic-magnetic operating principle. Instead of the fixed solid core of conventional relays, it has a sealed tube which extends through and below the relay coil. The tube, in turn, is filled with a viscosity-stable silicone liquid, and holds a movable iron core. When the coil is energized the movable core is drawn up into the magnetic field, but the rate of rise is controlled by the silicone liquid, introducing a precise time

delay. The relay operates on the increased magnetic flux caused as the core reaches the pole piece at the top of the tube.



Symbol Stamps

JOHN GRIFFIN Co., 2157 James Ave., St. Paul 5, Minn., has available a kit of 20 rubber stamps that eliminate the repetitious drawing of symbols that appear many times on each circuit diagram. They are precision made so that when they are first touched to an ink pad and then to tracing paper they leave a perfect impression of an electronic symbol. They are not mounted on wood but on ¼ in. thick Plexiglas so the user can see exactly where the impression is going to appear on the drawing. There are two crosslines scribed on the Plexiglas for aligning symbol to construction lines on the drawing. Price per set is $25.



Interlocking Electrical Connectors

HARVEY HUBBELL, INC., Bridgeport 2, Conn., has introduced a new line of Interlock connectors featuring novel locking and outstanding contact characteristics. The special electrical feature of these self-locking connectors is known as

"double contact". There is frictional contact as in any other type of connector, and there is knife-edge contact effected by the locking contacts in plug and outlet, and held under constant coil spring pressure. The plugs and outlet illustrated are suitable for all wiring connections and terminal strips. Fast automatic locking action represents a saving in wiring and assembly time. The connector is rated at 10 amperes, 110 volts. Data sheets, test reports and samples are available on request.

Replacement Transformer

RAM ELECTRONICS, INC., South Buckhout St., Irvington-on-Hudson, New York, have announced the type X045 flyback transformer for replacement and conversion purposes. It is specifically designed as a replacement transformer for all tv receivers orginally using 1B3 or 6BG6 tubes. For 16 and 20-in. round and rectangular tubes, it generates 12.5 to 14 kv and 13.5 kv respectively, with horizontal sweep more than ample for 20-in. picture tubes.

Literature

Induction Heater. General Electric Co., Schenectady, N. Y. Bulletin GEA-5594 deals with the type HM20L 20-kw induction heater designed for annealing, brazing, soldering and hardening. The unit described is available either with or without variable power adjustment. Chief features, dimensional diagrams and complete technical specifications are included.

Tape Recording Equipment. Magnecord Inc., 360 North Michigan Ave., Chicago, Ill., has issued an illustrated catalog to describe the versatility of its line of magnetic tape recording equipment for professional use, and to make known to a wider field its facilities for building special equipment to individual requirements. The catalog makes explicit mention of the company's conversion and adaptation equipment. All equipment is coded, and a special page lists and describes such accessories as special switches, spooling mechanisms and adapter panels.

Nuclear Instruments. Nuclear Research Corp. 2707 Federal St., Philadelphia 46, Pa. Bulletin DU-201 fully describes two new demonstration units, known as DU-1A and DU-2A, which are inexpensive, lightweight, modern instruments to be used in demonstrating nuclear radiation processes. The instruments dealt with can be used in the detection of cosmic rays, alpha, beta and gamma particles, the inverse square law of a point source of radiation, the properties of absorbers in the presence of various types of nuclear radiation, the properties of G-M tubes and the statistical nature of nuclear radiation and its indication on a rate meter.

Tube Manual. Sylvania Electric Products Inc., Emporium, Pa., has published a revised and enlarged eighth edition of its Technical Manual in a new snap-open loose-leaf format. It contains comprehensive technical data on more than 500 receiving tube types, standard tv picture tubes, as well as 84 pages of general information on vacuum-tube operation. Data on 60 new receiving tube types are included. Price is $2.00 per copy. New data sheet pages on future receiving tube types will be issued free to manual holders.

Teflon Shapes. John L. Dore', Inc., 5406 Schuler St., Houston 6, Texas. A line of Teflon sheets, rods, tubes, packing sets, gaskets, special molded shapes and tapes are technically described in catalog No. 711. The material described is finding a variety of uses in the electrical industry including spacers for coax cables, inserts for coax connectors, and insulation for high-frequency, high-temperature and high-voltage wires and cables.

Static Magnetic Memory. Alden Products Co., 117 North Main St., Brockton, Mass. Available upon request are three booklets that

THE

HI-GAIN Industrial POCKETSCOPE®

BY WATERMAN

MODEL S-14-A

Wt. 12 ¾ lbs.
12" x 5¾" x 7"

Another Waterman POCKETSCOPE providing the optimum in oscilloscope flexibility for analyses of low-level electrical impulses. Identified by its hi-sensitivity and incredible portability, S-14-A POCKETSCOPE now permits "on-the-spot" control, calibration and investigation of industrial electronic, medical and communications equipment. Direct coupling without peaking, used in the identical vertical and horizontal amplifiers, eliminates undesirable phase shifting. Designed for the engineer and constructed for rough handling, the HI-GAIN POCKETSCOPE serves as an invaluable precision tool for its owner.

Vertical and horizontal channels: 10mv rms/inch, with response within —2DB from DC to 200KC and pulse rise of 1.8μs. Non-frequency discriminating attenuators and gain controls with internal calibration of trace amplitude. Repetitive or trigger time base, with linearization from ½cps to 50KC with ± sync. or trigger. Trace expansion. Filter graph screen. Mu metal shield. And a host of other features.

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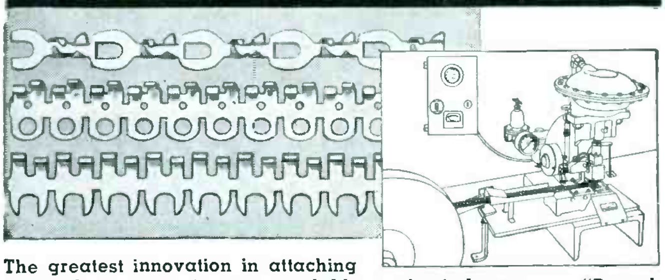
Also RAKSCOPES, LINEAR AMPLIFIERS, RAYONIC® TUBES and other equipment

WATERMAN PRODUCTS

Now Terminals Can Be ATTACHED & SOLDERED *in ONE Automatic Operation!*



The greatest innovation in attaching terminals to wires is now available to the industry . . . "Pre-soldered" TANDEM TERMINALS! Made in various sizes and types, these remarkable, production-proved terminals (supplied on reels) can be applied at rates up to 1200 per hour by a new Terminal Attaching Machine that cuts off, clinches and solders terminals in one instantaneous operation. Handling of loose terminals, solder and flux are eliminated to reduce costs and boost production on long runs. Standard types available. Send for detailed information, enclose sample of wire and terminal now used. Address Dept. E.

For ordinary runs in moderate quantity we continue to produce

SEPARATE TERMINALS for ELECTRIC WIRES

We also make SMALL METAL STAMPINGS Exact to Customer's Prints. Modern Plant and Equipment. Moderate Die Charges. Precision Work. Prompt Service.

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LARGE OR SMALL
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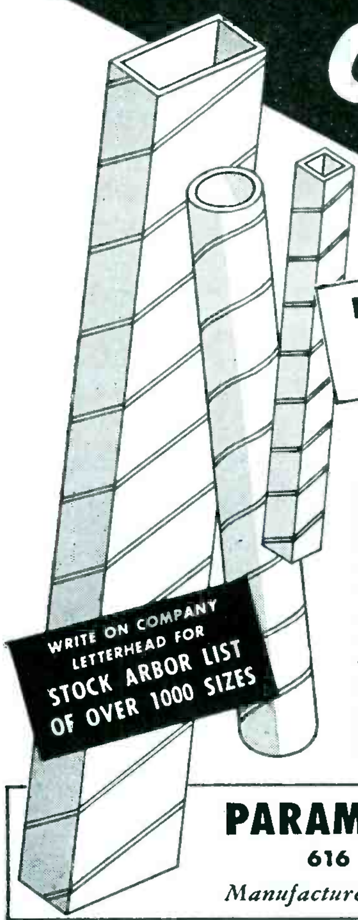

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Lengths from ½" to 30"
Inside Perimeters, .450" to 25"

PARAMOUNT Paper Tubes facilitate coil winding—insure coil accuracy and stability. Proved by use, they have become standard with leading manufacturers of electrical, radio and electronic products. Here you are sure to obtain the exact size and shape you need for coil forms and other uses . . . from stock arbors, or specially engineered to your specifications. *Hi-Dielectric. Hi-Strength.* Kraft, Fish Paper, Red Rope, or any combination, wound on automatic machines. Tolerances plus or minus .002" • *Also* Shellac Bonded Kraft Paper Tubes for absolute moisture resistance.

PARAMOUNT PAPER TUBE CORP.

616 LAFAYETTE ST., FORT WAYNE, IND.

Manufacturers of Paper Tubing for the Electrical Industry describe the potential use, operating characteristics and some application techniques of the static magnetic memory, a storage device that requires no mechanical movement in recording, no power to maintain storage information, and that has a variable information handling rate ranging from 0 to 30,000 pulses per second.

Manufacturing Facilities. Polarad Electronics Corp., 100 Metropolitan Ave., Brooklyn 11, N. Y., is now distributing an eight-page illustrated booklet dealing with its development and production capabilities for measuring instruments and communication and tv broadcast equipment. Plant equipment and manufacturing accomplishments, together with engineering know-how are described.

Mercury Switches. Micro-Switch, Division of Minneapolis-Honeywell Regulator Co., Freeport, Ill., announces a new condensed catalog Hg-1 on a line of mercury switches. The publication covers the five most popular designs of Honeywell mercury switches, with selection and application aids, and complete electrical ratings and data for the use of these switches in both a-c and d-c applications.

Bridging Amplifier. Keithley Instruments, 3868 Carnegie Ave., Cleveland 15, Ohio, has issued a 4-page bulletin describing the model 102 Phantom Repeater, a bridging amplifier for test instruments with an unusually high-impedance input. Complete specifications are listed, plus hook-up diagrams of several typical applications, including simultaneous measurement of voltage and wave-shape inspection, connecting an oscillograph to high-impedance circuits with negligible voltage loss, and increasing the sensitivity of almost any voltmeter or cro.

Picture Tubes. Allen B. DuMont Laboratories, Inc., 750 Bloomfield Ave., Clifton, N. J., has released a 12-page publication listing the latest-type picture tubes, including the type 30BP4 30-in. Teletron. Comprehensive technical information is given for the various Tele-

tron types with complete data on the 17FP4 and 20GP4 electrostatic-focus types. The booklet also provides complete ion-trap-adjustment directions for all Teletrons, and basing details for both electrostatic-focus and magnetic-focus types.

Photoflash Capacitors. Cornell-Dubilier Electric Corp., South Plainfield, N. J. A single-page bulletin covers a line of low-voltage photoflash electrolytic capacitors that will maintain their original capacitance value after several hundred thousand discharges. The units described are rated from 25 to 150 volts, with nominal capacitances from 40 to 250 μf, and have dimensions of from $\frac{5}{8} \times 1\frac{15}{16}$ in. to $1 \times 2\frac{1}{2}$ in.

Distribution Transformers. Acme Electric Corp., Cuba, N. Y. Bulletin AC-186 gives details on a completely enclosed line of dry-type, air-cooled transformers. The class B insulation used in the line of 3-phase 60-cycle transformers described gives ample protection for operation at a temperature rise of 80 C.

Carrier Dialing. Lenkurt Electric Co., Inc., 1105 County Road, San Carlos, Calif. Auxiliary equipment designed to add dial-signaling channels to existing H-1 carrier systems is described in a new folder, form H1D-P10. Besides giving a detailed description of the $8\frac{3}{4}$ in. high units—which provide full-duplex carrier-frequency dial signaling at 10 to 14 pulses per second—this publication includes an allocation chart showing how the dial operation utilizes frequencies not essential to H-1 voice channels. Further data is provided to show circuit arrangements, typical transmission characteristics, and various options available to accommodate particular installations.

Tape Recording. Radio Corp. of America, Camden, N. J. Form 2J8024 is a 16-page illustrated brochure describing new magnetic tape recording equipment for professional broadcast use. It fully describes the basic type RT-11A

magnetic tape recorder, as well as the console type RT-12A equipment and custom-built recording and editing equipment available in either rack or console combinations. Features, uses, specifications and test and performance data are given. Copies are available to broadcast station engineers requesting it on their letterhead.

Recording Potentiometer. Minneapolis-Honeywell Regulator Co., Wayne and Windrim Aves., Philadelphia 44, Pa. Instrumentation data sheet 10.0-7 describes a new high-speed ElectroniK recorder that features a one-second pen speed specially designed to measure the rapid change variables encountered in many laboratory and test applications. The sheet describes the applicability, operating characteristics and method of operation of the instrument and contains four illustrations.

Multirange Meter. The Automatic Coil Winder & Electrical Equipment Co. Ltd., Winder House, Douglas St., London, S. W. 1, England. A four-page folder discusses the model 8 universal Avo-Meter that features a wide range of resistance measurements, ability to measure high voltages and a-c current, and provides external accessories to further extend its range. Complete technical data given include resistance, sensitivity, scaling and accuracy. Information on terminals, operation, leads and prods and accessories is included.

Electrical Resistance Testers. James G. Biddle Co., 1316 Arch St., Philadelphia 7, Pa., has available bulletin 21-85 describing three low-cost Megger electrical resistance testers: the 705-CL midget insulation tester, the CVM-type insulation tester and the 760-S and 760-B midget circuit-testing ohmmeters. Illustrations, facsimile scales, specifications and prices are shown.

Measuring Device. Institute of Inventive Research, 8500 Culebra Road, San Antonio 6, Texas, has prepared a booklet dealing with its development program on the

Vibrotron, a rugged new measuring device of high precision, designed for fields of industrial instrumentation. The Vibrotron, the booklet relates, is a fine wire vibrating in a magnetic field and generating a-c of the same frequency as the natural frequency of the wire; vibration being sustained by a feedback circuit. The many possible applications of the device are described.

Magnetic Relays. The North Electric Mfg. Co., Galion, Ohio. Temporary bulletin 1R511 gives an illustrated description of a line of magnetic relays for industrial controls. Specifications, operating characteristics, dimensional drawings, general applications and a table of available contact forms are included.

Multimeasurement Device. Mogens Bang & Co., Old Saybrook, Conn., has available pamphlet No. 525/E describing the D1SA Universal Indicator, an electronic device for measurements of both static and rapidly alternating forces, pressures, distances and vibrations. Examples of measurements are shown photographically and the device's principle of operation is completely covered.

Cartridge Directory. The Astatic Corp., Conneaut, Ohio, has published a new phonograph cartridge directory and replacement guide. It includes illustrations of all the company's cartridges and needles, together with complete performance data on each. Cartridges made by competitors are listed alphabetically and numerically, and the recommended Astatic replacement for each is indicated.

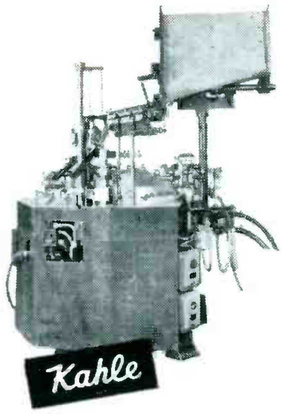
Tachometer Indicators. Metron Instrument Co., 432 Lincoln St., Denver 9, Colorado. Technical data sheet No. 42 R describes the new multiple-head, single-range, fixed installation tachometer indicators for monitoring speeds of many remotely located machines from one convenient location. Chief features, applications, installation information, servicing and ordering instructions are given.

Kahle

SPECIALISTS IN HIGH-SPEED

electron tube machinery

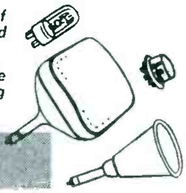
Kahle's 20 years of experience eliminate trial orders and experimental set-ups. Standard toolings for all tube manufacturing eventualities *already* have been tested and approved. This means that Kahle can assemble machines for everything from sub-miniature to largest TV picture tubes to your exact specifications . . . *at lower costs!*



#1902 AUTOMATIC BULB MAKING MACHINE for producing SUB-MINIATURE round bulbs with molded shoulder, constriction and tabulation. 12 index positions, 24 heads. Capacity: approximately 2400 per hour.

Machinery for all types of electron tubes and related glass products.

Consultations invited. Write today for our new catalog with complete details.



Kahle ENGINEERING CO. 1309 Seventh St., North Bergen, N. J.

VACUUM TIGHT GLASS-TO-METAL

HERMETIC SEALS

SPECIAL DESIGNS

AND ALL STANDARD TYPES

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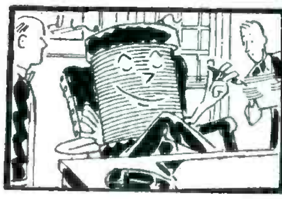

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*Very important coil

- Form Wound
- Paper Section
- Acetate Bobbin
- Bakelite Bobbin
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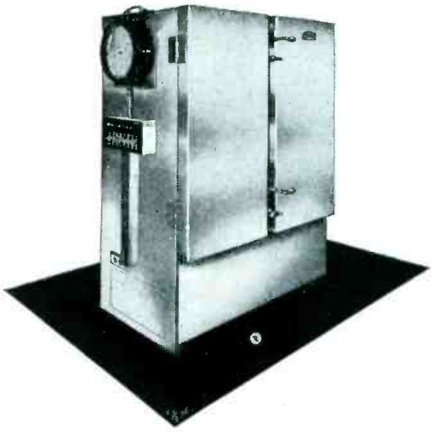
- Coils for High Temperature Applications

ALSO, TRANSFORMERS MADE TO ORDER

Every Dano Coil gets special treatment, careful inspection and testing in all vital stages of production because every Dano Coil is a *Very Important Coil*—to you for performance, to us for reputation.

THE DANO ELECTRIC CO.
MAIN ST., WINSTED, CONN.

HUMIDITY TESTS



Bowser Relative Humidity Testing Units provide and automatically maintain humidity conditions from 20% to 95% at temperatures from +35°F. to +170°F. (Dry Bulb). These units are ruggedly built for extended service, yet feature the close tolerance control required for the testing of aircraft and electronic parts and equipment. The Bowser Humidity Unit is ***stainless steel throughout.*** Special accessories can be provided to meet specific requirements.

Bowser's complete line of testing, processing and storage equipment meets all MIL, JAN, USAF, AN and other Government test specs. Our Engineering staff is always available, and invites you to take advantage of Bowser's long continuous experience, the most versatile in its field.

✓ CHECK AND MAIL TODAY

BOWSER TECH. REFRIG., Terryville, Conn.

Send information on test equipment checked:

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- ☐ Altitude
- ☐ Walk-In Rooms
- ☐ Fungus Resistance
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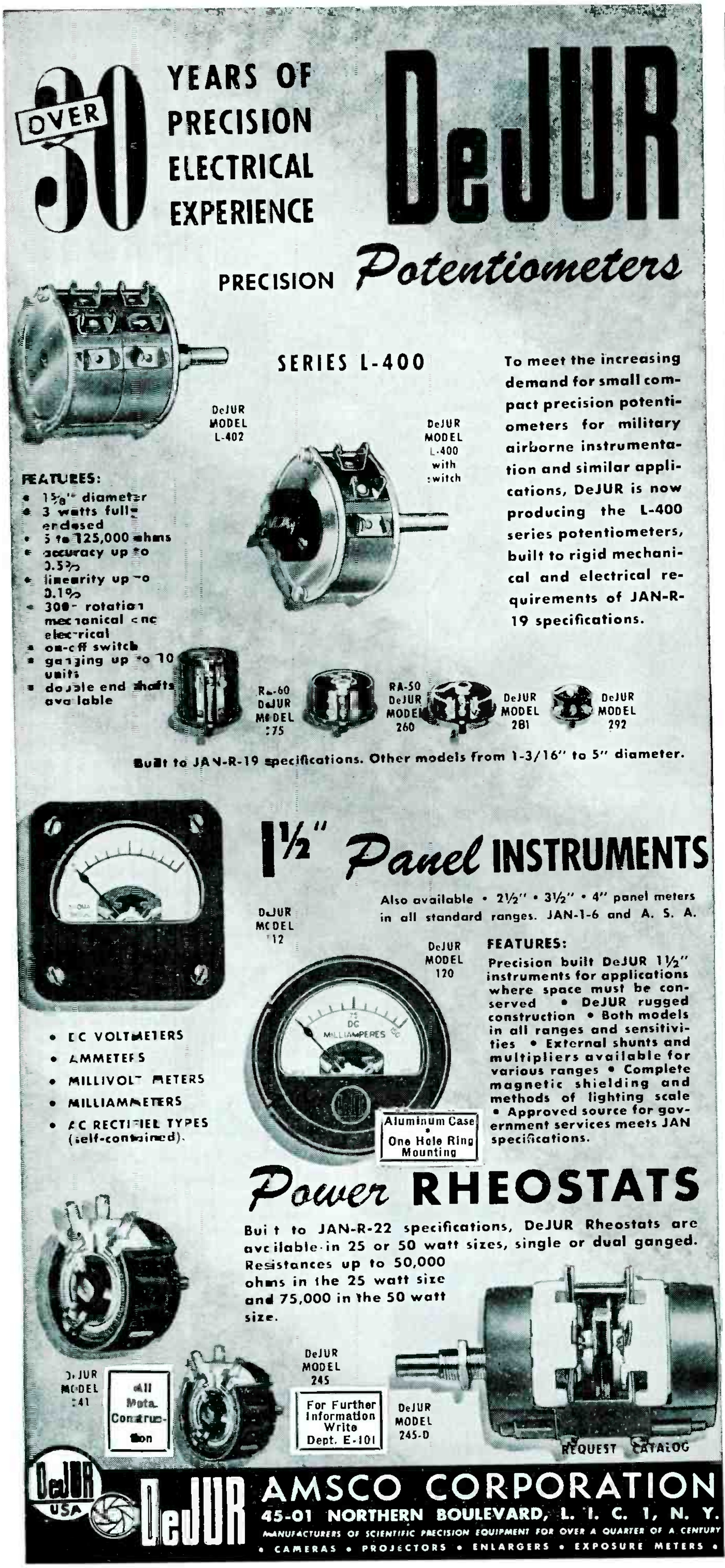


NEWS OF THE INDUSTRY

(continued from page 150)

not have range voice channels on l-f, m-f or vhf. Eventually all INSACS will transmit on 122.2 mc. Owing to equipment shortages, only about ten percent are now so equipped.

New RTMA Standards Published

FOUR new recommended standards were recently issued by the RTMA engineering department for inclusion in the standards handbook. They should be filed in the section indicated by the number prefixes. The new standards are as follows:

GEN-104—Color Marking of Thermoplastic Insulated Hook-up Wire. (Price 25 cents)

TR-113-A—Metal Encased Fixed Paper Dielectric Capacitors For D-C Application. (Price 65 cents)

TR-115—Symbols and Designations for Single Line Diagrams for Audio Facilities. (Price 60 cents)

REC-115-A—Molded Mica Capacitors. (Price 50 cents)

All are available from the Radio-Television Manufacturers Association, 1317 F St., NW, Washington 4, DC.

BUSINESS NEWS

AMPEREX ELECTRONIC CORP., Brooklyn, N. Y., is building a new 100,000-sq-ft plant in Hicksville, L. I., N. Y., for the manufacture of advanced design electron tubes.

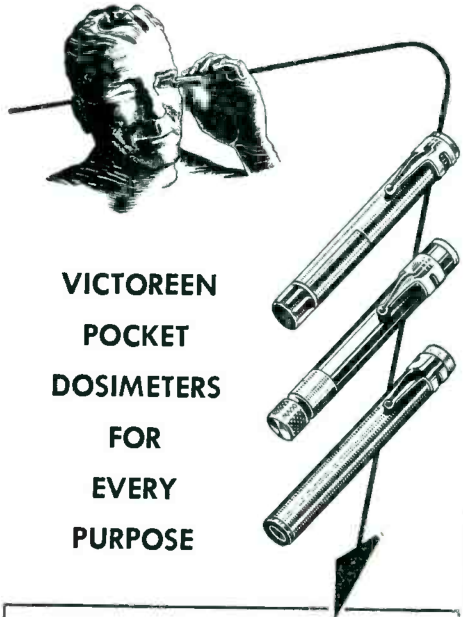
RAYTHEON MFG. CO., Newton, Mass., has begun construction of a new plant at Quincy, Mass., as a further expansion of its receiving tube division.

INDUSTRIAL DEVELOPMENT ENGINEERING ASSOCIATES, manufacturer of the Regency booster, recently built a new factory in Lawrence, Indiana.

GENERAL CONTROLS CO., manufacturer of automatic controls, is constructing a 24,000-sq-ft addition to its engineering building in Glendale, Calif.

BATTELLE INSTITUTE, Columbus, Ohio, has begun construction of an 80,000-sq-ft building for research

TAKE A GOOD LOOK!



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Model	Type	Full Scale Sensitivity	Conditions
362	Indirect	0.2 r	AC or below daily Tolerance Rate
541	Direct	0.2 r	AC or above daily Tolerance Rate
547	Direct	5. r	Emergency
548	Direct	50. r	Trained personnel —Emergency
534	Direct	5. and 50. r	Civil defense, etc.
506	Indirect	100. r	Untrained personnel —Emergency
507	Indirect	200. r	Untrained personnel —Emergency

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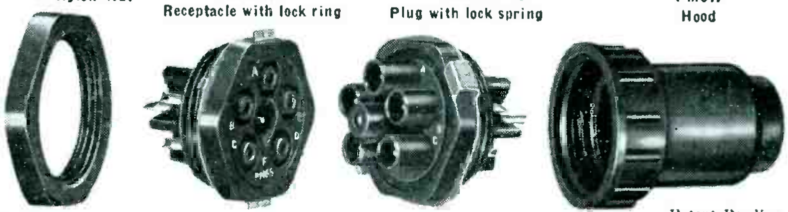

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Telephone or write for additional information on the above or other connectors or for consultation on your special connector problems.

*Trade Mark

Type	No. of Contacts	A.W.G. Wire Size	Maximum Current	Maximum O.D.	VOLTAGE BREAKDOWN •	
					At Sea Level	At 50,000
PM1	1	#20	5a	3/4"	7000 V. D.C.	1600 V. D.C.
PM6 ▼	6	#20	5a	1-7/32"	7000 V. D.C.	1600 V. D.C.

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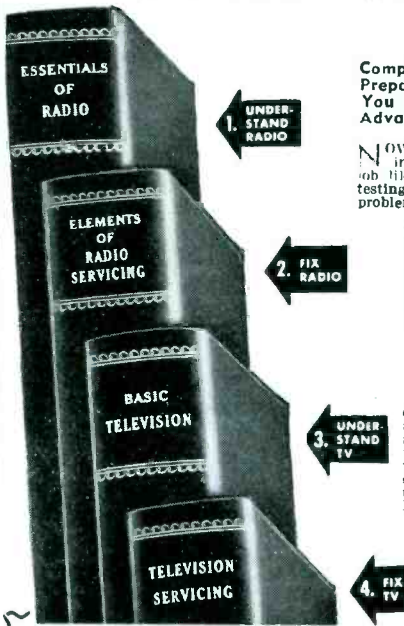

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services in behalf of the nation's defense effort.

AEROVOX CORP., New Bedford, Mass., recently acquired Wilkor Products Inc., Cleveland, Ohio, as a precision resistor subsidiary.

HARMAR CO., Cincinnati, Ohio, component manufacturers, have acquired the entire surplus inventory of electronic devices, component parts and end products from Heath Co., Benton Harbor, Mich.

RADIO CORP. OF AMERICA recently opened a new 136,000-sq-ft plant in Cincinnati, Ohio, for the manufacture of miniature and subminiature tubes.

BILL JACK SCIENTIFIC INSTRUMENT Co. will produce electronically controlled aerial cameras and electronic instruments for high-speed aircraft in initial operations at its new Anza Village plant in Riverside, Calif.

ESSEX WIRE CORP. has purchased a 200,000-sq-ft building in Birmingham, Alabama, to manufacture an entire line of bare and weatherproof ACSR strand and insulated wires.

POLARAD ELECTRONICS CORP., Brooklyn, N. Y., has added another floor at its same location, increasing its manufacturing space to 27,000 sq ft. The added space will be devoted to production of military equipment.

PERSONNEL

MARVIN HOBBS, formerly chief of the Munitions Board Office of Electronics Programs, has been named advisor to the chairman of the Munitions Board. In this capacity he will coordinate all phases of the Department of Defense planning to meet the requirements for military electronics production.

GORDON GROTH, for the past two years president of the Electra Mfg. Co., Kansas City, Mo., has been appointed executive vice-president of the Erie Resistor Corp., Erie, Pa.

K. R. PATRICK, formerly general manager of the engineering prod-

ucts department, RCA Victor Co., Ltd., has been elected president and managing director of Canadian Aviation Electronics, Ltd., Montreal, Canada.

EDWARD U. CONDON, formerly director of the National Bureau of Standards, has been made director of research and development of Corning Glass Works, Corning, N. Y.

E. U. Condon

H. Pratt

HARADEN PRATT, formerly vice-president of the American Cable & Radio Corp., was recently appointed to the newly created post of telecommunications adviser to President Truman.

HENRY FOGEL, previously associated with Tele-Tone Radio Corp. as chief engineer in the advanced development section, was recently appointed chief of the product engineering division of Radio Receptor Co., Inc., Brooklyn, N. Y.

DANA W. ATCHLEY, JR., formerly director of engineering of Tracerlab, Inc., Boston, Mass., has been appointed coordinator of technical research at United Paramount Theatres, Inc., New York, N. Y.

LOUIS J. KLEINKLAUS, associated with radio station WQXR since 1940, was recently appointed chief engineer of the station. At the same time Athan Cosmas was named engineer in charge of WQXR's a-m and f-m transmitters.

SOLOMON ZIMMERMAN, until recently with the product engineering division of Teletone Radio Corp., has been appointed to the development engineering staff of JFD Mfg. Co. Inc., Brooklyn, N. Y.

RAY A. MORRIS, with Industrial Development Engineering Associates,

Indianapolis, Ind., as assistant sales manager since December, 1950, was recently named chief engineer of that organization.

FRANCIS J. BURGER, associated with Emerson Radio & Phonograph Corp. for the past 18 years, has been appointed chief radio engineer of the company.

GARDINER G. GREENE has been appointed vice-president in charge of the Electronics Division of The Gabriel Co., Cleveland, Ohio. He was formerly president of Workshop Associates, Needham, Mass., one of Gabriel's divisions.

G. G. Greene

C. J. Breitwieser

C. J. BREITWIESER, formerly chief of electronics and head of the engineering laboratories at Consolidated Vultee Aircraft Corp., San Diego, Calif., has been named executive assistant to F. R. Hensel, vice-president in charge of engineering at P. R. Mallory & Co., Inc., Indianapolis, Ind.

E. W. RITTER, manager of the Electronic Tube Division of Westinghouse Electric Corp., Pittsburgh, Pa., has been named a vice-president of the corporation.

OTTO C. BIXLER, previously associated with Airesearch Mfg. Co. as an electrical development engineer on aircraft and guided missile applications of special electronic equipment, has been appointed director of engineering of Magnecord Inc., Chicago, Ill.

RICHARD HODGSON, president of Chromatic Television Laboratories, Inc., and director of television development for Paramount Pictures Corp., has been named a consultant to Gen. Hoyt S. Vandenberg, Chief of Staff, U. S. Air Forces, on research and development.

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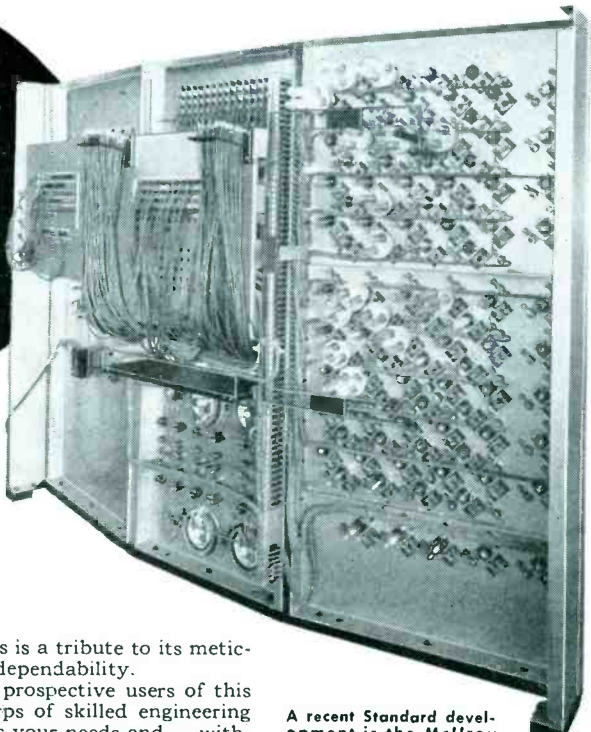

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NEW BOOKS

(Continued from page 152)

Regulating *Theory*, instead of *Design*.

It is possible that Volume II of this series would tend to round out the requirements for an actual design text. However, it would seem to this reader that an interlace of the two volumes would have made the presentation more valuable as a textbook outside of the original GE courses in which the material was originally presented. There is certainly a need for such an integrated text in our college servomechanism courses.

Due to the very comprehensive treatment of the mathematical considerations of servomechanisms, this text will find considerable more use as a more advanced reference book for the practicing engineer than it will as a classroom text. Its value as a textbook is enhanced when used in conjunction with such excellently integrated books as "Theory of Servomechanisms," which is MIT Radiation Lab Vol. 25, and "Servomechanism Fundamentals" by Lauer, Lesnick and Matson. Not one of these books is as complete in the mathematical approach as this volume, but they both are more definitely design texts.

All in all, this reader would recommend "Servomechanisms and Regulating System Design" as a worthy adjunct to any engineering reference library for the servo field.—OSCAR E. CARLSON, *Servo-Tek Products Co., Paterson, N. J.*

Propagation of Short Radio Waves

EDITED BY D. E. KERR. *Volume* 13, *MIT Radiation Laboratory Series. McGraw-Hill Book Co., New York*, 1951, 728 *pages*, $10.00.

THIS book is concerned with propagation phenomena at frequencies above 100 mc. Above this frequency, propagation is substantially independent of the ionosphere. The electrical properties of the earth or the sea and the nature of the troposphere above the surface are primarily responsible for the propagation characteristics of radiation in this frequency range.

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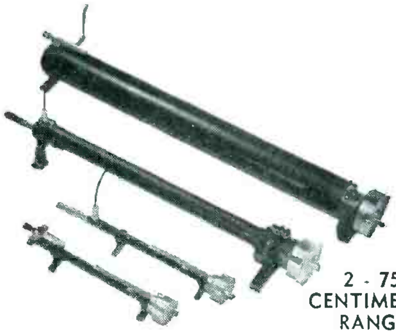

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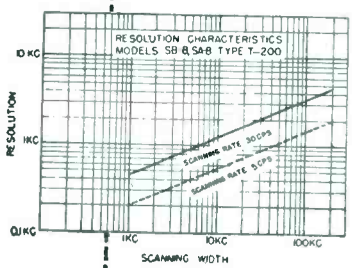

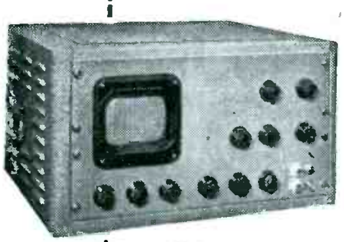

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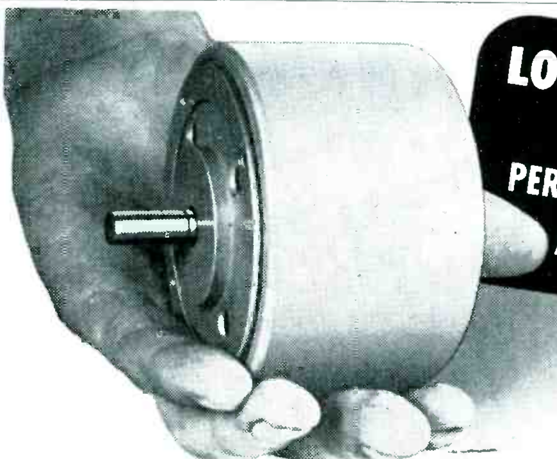

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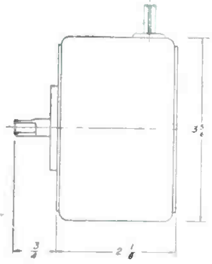

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conditions, the refractive index of the atmosphere above the earth decreases in such a way as to result in a radio horizon that is somewhat greater than the optical horizon. However, under certain meteorological conditions, a temperature inversion can exist in a layer of atmosphere and cause the refractive index to vary with height in such a way as to produce ducts. Radiation of sufficiently high frequency can be trapped in these ducts and guided around the surface of the earth in a fashion analogous to that of a waveguide. Under these conditions, propagation can occur over distances that are many times as great as the distance to the radio horizon.

The first half of the volume is concerned with phenomena of this nature. After a brief introductory chapter, the theory of the horizontally stratified atmosphere is treated in great detail, using the methods of geometrical optics and of physical optics. There is an extensive theoretical discussion of the various shapes of modified index profiles. The case of propagation under conditions of standard refraction is thoroughly treated and expressions are given for computing the field strength as a function of the various parameters involved. A number of graphs to simplify the computations are included as part of the text. These graphs are supplemented by some additional graphs in an envelope at the back of the book. These graphs are large enough to be read with reasonable accuracy.

The case of nonstandard refraction is given a brief numerical discussion. Some curves have been included to orient the reader to the magnitudes involved.

The theoretical chapter is followed by one on the meteorology of refraction. This chapter is essentially a self-contained treatment of those parts of meteorology which are pertinent to the propagation of short radio waves. Many soundings are displayed to illustrate the conditions that can be encountered. Chapter 4 summarizes the experiments on transmission phenomena and their correlation with meterological conditions. Chapter 5 con-

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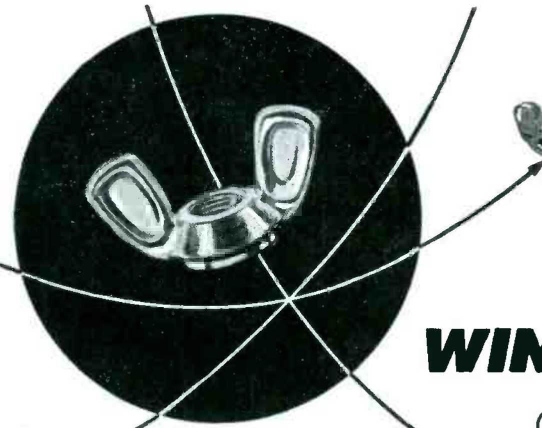

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siders the effect of reflections from the earth's surface in somewhat greater detail and, among other things, discusses surface roughness and errors in radar height measurements.

The latter part of the book will prove of great interest to the radar systems engineer. Chapter 6 discusses the echoing area of ships and aircraft as well as scattering from idealized surfaces. The properties of sea return and of ground clutter are considered at length. As in the rest of the book extensive experimental data have been included along with the theory.

Chapter 7 discusses meterological echoes and will be of interest to anyone who has observed a radar scope during rain or storm. The eighth chapter treats atmospheric attenuation by oxygen, water vapor and rain.

Although the phenomena of diffraction behind hills and trees have been omitted, on the whole the book under review covers its field in a comprehensive fashion. The authoritative manner in which the problems of propagation above 100 mc are treated will make this book the standard reference on the subject for some time to come.—HENRY JASIK, *Airborne Instruments Laboratory, Mineola, New York.*

Basic Electrical Measurements

By MELVILLE B. STOUT, *Professor of Electrical Engineering, University of Michigan. Prentice-Hall, Inc., New York*, 1950, 504 *pages*, $7.75.

IN his preface to this book, the author admits that selection of material for a book on electrical measurements is a difficult task at best. It is the type of subject that can be broken down into minute segments, any one of which could easily constitute the subject for a complete book.

In general, the compromise adopted by Stout is excellent. The book is intended as a text for undergraduate courses in measurements, and as such it should serve admirably. Carefully-planned thought-provoking problems are provided at the end of each chapter.

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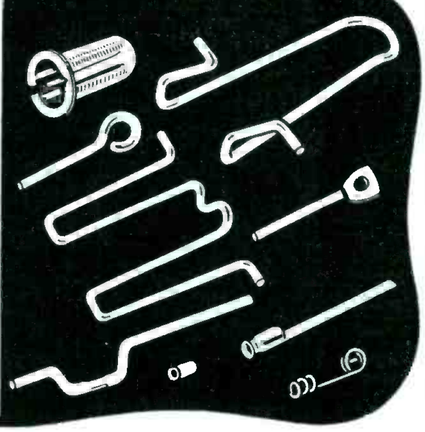

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806 Packer Street, Easton, Pa.

a very great extent on commercial instruments which, because of the very nicety that makes them desirable or necessary, are quite expensive. This book reduces somewhat the need for working models by including photographs of all the standard pieces of equipment that comprise the widely-used old standbys in the measurements business.

An attempt has been made by the author to make his subject interesting—in the sense that a novel is interesting. The reviewer would hesitate to comment on the success or failure of this attempt, but the author deserves a medal for such a courageous effort. The material is presented in logical order, progressing smoothly from the development of units, through descriptions of experimental procedures and errors, to first basic measurements and thence to automatic bridges, high-frequency measurements, magnetic measurements and a discussion of electrical indicating instruments in general.—J.D.F.

THUMBNAIL REVIEWS

MUSICAL ACOUSTICS. By Charles A. Culver. The Blakiston Co., Philadelphia, Third Edition, 1951, 215 pages, $4.25. Presentation of elementary laws of acoustics applying to production and transmission of musical sounds, intended primarily as a college text for a course dealing with physical basis of music. The first nine chapters cover the physics of music: Nature and Transmission of Sound; Interference; Hearing; Resonance; Pitch; Quality; Musical Intervals and Temperament; Consonance and Dissonance; Musical Strings. Four chapters deal with the basic types of instruments: Stringed Instruments; Vibrating Air Columns; Wind Instruments; Vibrating Rods and Plates. Three final chapters cover: Acoustics of Rooms; Electronic Musical Instruments; Recording and Reproduction of Music.

GAS DISCHARGE LAMPS. By J. Funke and P. J. Oranje of the Research Laboratories of the Philips Industry. N. V. Philips' Gloeilampenfabrieken, Eindhoven, Netherlands, 1951, available from Elsevier Pub. Co., 250 Fifth Ave., New York, 270 pages, $4.50. Survey of basic types of discharge lamps, with characteristics, principles, advantages and disadvantages of each. Major types covered, each with a separate chapter, are: sodium lamps; high-pressure mercury vapor lamps with natural cooling; high-pressure mercury lamps with forced cooling; low-pressure tubular fluorescent lamps; gas discharge lamps for luminous advertising; stroboscopic lamps and flash tubes. Deals primarily with Philips products, though the text includes references to developments in other countries.

THE RADIO AMATEUR'S LICENSE MANUAL. Amateur Radio Relay League, West Hartford, Conn., 27th edition, 1951, 96 pages, $.50. Guide to preparing for FCC amateur license examinations, including details of the six classes of amateur license, scope of examinations, sample questions with answers and map of U. S. call areas.

BACKTALK

(continued from page 154)

agreed with the observed variation of frequency with temperature. The problem has since been solved by using stable capacitors of another type and balancing their small temperature dependence with that of the associated resistors. The loss in materials cost was negligible, but the loss in man-hours was certainly not.

Nowhere in the manufacturer's brochure or in similar catalog descriptions is frequency dependence mentioned nor is there any hint that their behavior should be so different from that of other capacitors at an entirely reasonable frequency. Our attention has since been called to an article entitled "Ceramic Dielectrics" in the August 1948 issue of ELECTRONICS where frequency dependence is mentioned. Figure 4 of that article indicates that zero-temperature-coefficient capacitors are within specified tolerance only at radio frequencies. The omission of such basic information from brochure and catalog specifications is not understandable.

WILLIAM A. BAUM
Mount Wilson and Palomar Observatories
Pasadena, California

Distributed Amplifiers

DEAR SIRS:

IN THEIR ARTICLE entitled "Millimicrosecond Oscillography" (July, p 106), Messrs. Yu Kallmann, and Christaldi make the statement "It is important to point out that uniform amplification with respect to frequency variation cannot be obtained in a stage of distributed amplification when the receiving end of the plate line is open." I have built several distributed amplifiers in the past few years, always leaving plate lines open at the receiving end when driving a capacitive load. The only difference in performance observable between a terminated and unterminated output is an increase by a factor of two in gain and maximum voltage swing in the latter case.

The two reasons given in the article for the statement quoted above appear to be two aspects of the same reason. It is true that the steady-state impedance seen by the plates in a line terminated only at

one end varies from tube to tube and is a function of frequency. It does so because of the reflected wave adding to the wave being generated. This reflected wave has no effect, however, on the output since it is traveling toward the sending end where it will be absorbed in the termination. The wave propagated toward the receiving end, with each tube making its contribution in phase, depends only on the plate current variations and the characteristic impedance of the line. It is independent of the reflected wave so long as the plate resistance of the tubes is high compared to the line impedance. Voltage doubling occurs with reflection from the open end.

Another approach to the problem is a consideration of the current wave. One-half of the plate current of each successive tube is added in phase as a wave progresses toward the output. The termination sees only this current. It knows nothing of the steady-state impedance at the various plates.

G. G. KELLY

Physics Division
Oak Ridge National Laboratory
Oak Ridge, Tenn.

Dipole Formulas

DEAR SIRS:

IN AN ARTICLE entitled "Detecting Tramp Metal in Logs and Iron Ore", by C. W. Clapp in the March 1951 issue of ELECTRONICS it is stated that a formula for the dipole moment of a metal sphere in an alternating magnetic field has been recently found by H. Poritsky.

The solution of this problem has been given by W. R. Smythe in his book "Static and Dynamic Electricity", N. Y., 1939, and also by M. Divilkovsky in *J. Physics USSR* Vol. 1, 1939. The solution of the more general problem of the ellipsoid has been published by M. Jouguet in *Comptes Rendus,* Paris, April 12, 1943.

In *Wireless Engineer* for December 1946, I showed that the dipole moment can be replaced by an equivalent circuit consisting of a single ring of the same diameter as the sphere. The resistance and

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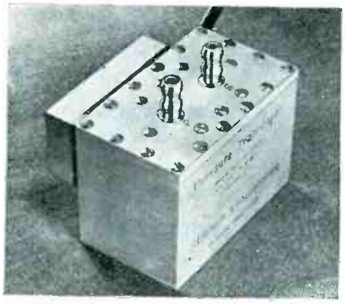

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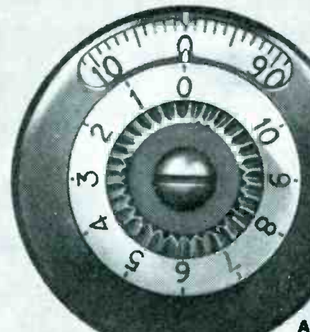

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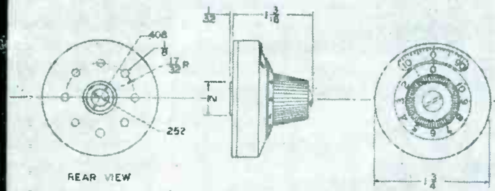

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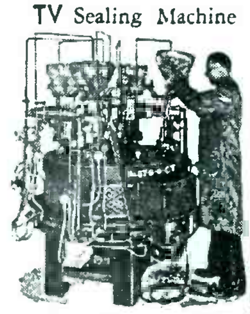

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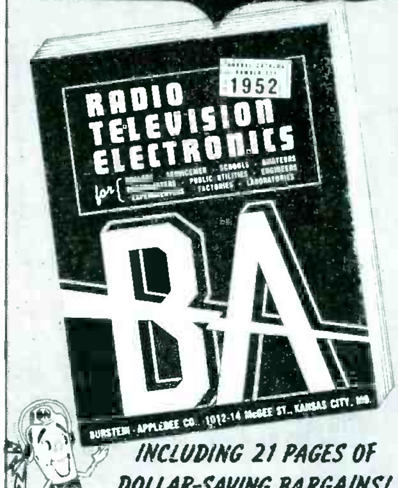

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reactance of the ring are such that the magnetic moment of the induced ring current is the same as that of the dipole. This equivalent circuit has obvious advantages in practical problems such as the design of eddy-current metal detectors.

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Loose-Leaf Electronics?

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A SWEDISH READER

Loran

MR. DONALD G. FINK,
EDITOR

DEAR DON:

BACK in the electronic circle—Department of Defense Production—after a seven year "sabbatical leave" in the Labour Department—I am speedily catching up with developments via the contents of your fact-full magazine.

Your name at the mast head brings back memories of our trip to Labrador in the Sikorsky with Commander MacMillan. There is a point connected with that trip—or was it a subsequent one?—I would like to clear up.

I believe we coined the word LORAN together on that trip. Up to that time—July or August 1942—it was just LRN.

As I remember the situation, Commander MacMillan, Lt. Commander Harding, Joe Waldschmitt, you and I were sitting on the rocks at the site we eventually selected for number three station near Battle Harbour.

Someone observed that the point was unnamed so I suggested LORAINE from LRN. Harding said it was a bit feminine for such a barren rocky spot and put forward LORAN, the masculine form of LORAINE.

To name the system and the point, I chiselled the word LORAN on a well-positioned rock. We adopted it unanimously and decided to refer to the system by that name. Harding said he would arrange this at Washington.

All I know is that LORAN was quickly adopted to name the system. I don't know if the point of land became identified on the maps by that name.

JACK ARGYLE
(Marconi Oldtimer and ex Lt. Cmdr. RCNVR)
Ottawa, Canada

(Editor's Note: The story told by Jack Argyle is exactly correct. The official decision to adopt the word LORAN was actually taken at a meeting of Division 11 at the Radiation Laboratory sometime after the Labrador trip. Larry Harding brought forth the proposal at that time, and I think he is generally given credit for originating the term.—D.G.F.)

Electronics Quiz

LAST MONTH'S problem was submitted by J. E. Eckert of the RCA Laboratories Division at Princeton, New Jersey. It involved a plurality of 1-ohm resistors connected in square fashion, as shown in Fig. 1. The problem was to find the impedance seen across any one of the resistors. The solution, as furnished by Eckert, is as follows:

Imagine a current of 1 ampere injected into a point and flowing out of infinity, as illustrated in Fig. 2A. Remove this current and then

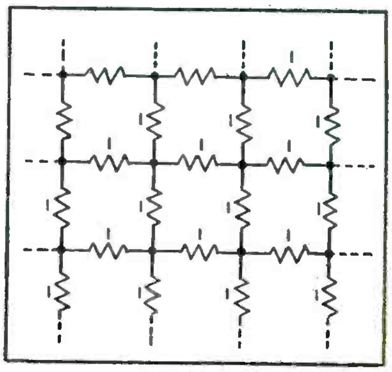

FIG. 1—Original quiz problem printed in September issue

take a current of 1 ampere out of point B and flowing in at infinity as shown in Fig. 2B. According to the superposition theorem we may add these two currents algebraically, and we find that we have a total of $+\frac{1}{4}a + \frac{1}{4}a$ or $\frac{1}{2}a$ total flowing through the 1-ohm resistor between terminals, which gives a voltage drop of $\frac{1}{2}$ volt across the 1-ohm resistor. This means that the impedance is

$$Z = \frac{V}{I} = \frac{0.5}{1.0} = \tfrac{1}{2}\text{ ohm}$$

An alternative solution is illustrated in Fig. 2C. Voltage V is impressed across A and B. It can be

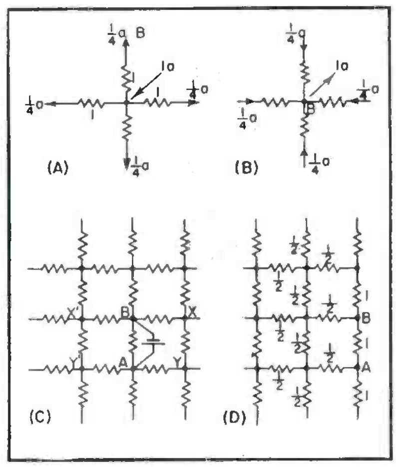

FIG. 2—Two solutions for Electronics Quiz problem shown in Fig. 1

seen that the potential at point X is equal to potential at X', and the potential at Y equals the potential at Y'. Consequently, the circuit can be folded back on itself and points X and X' can be connected together, while points Y and Y' can be similarly connected together. All symmetrical junctions can be connected so that the circuit of Fig. 2D holds true. The resistance seen looking into terminals A and B (for only a very few terms) is

$$R_{AB} = \frac{1 \cdot \left[2\left(\frac{\frac{1}{2} \cdot 2}{2+\frac{1}{2}}\right) + \left(\frac{\frac{1}{2} \cdot 1+\frac{1}{2}}{\frac{1}{2}+1+\frac{1}{2}}\right)\right]}{1 + \left[2\left(\frac{\frac{1}{2} \cdot 2}{2+\frac{1}{2}}\right) + \left(\frac{\frac{1}{2} \cdot 1+\frac{1}{2}}{\frac{1}{2}+1+\frac{1}{2}}\right)\right]} = 0.54 \text{ ohms}$$

So it can be seen that if more terms were added in the series, it would reduce the impedance looking in, until the value of 0.5 ohm is obtained with an infinite number of resistors.

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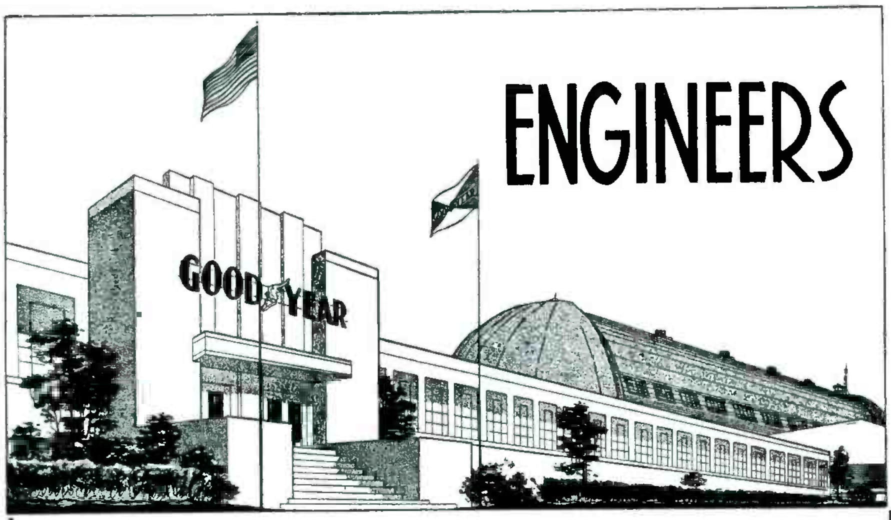

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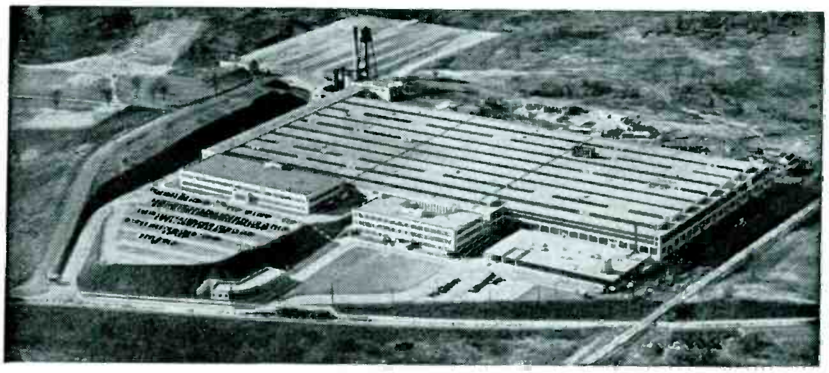

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TS-35/AP X-band Signal Generator. Pulsed and C.W. freq. range. 8400-9600 mcs. This unit will measure power and frequency. 115v 60-2600 cyc.
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TS-102/AP	TS-110/AP	IE-36
TS-47/APR	TS-164/AR	TS-59/APN
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AN/APS-3 Airborne X-band Search and Homing radar. Complete. Contains RF head, modulator, synchronizer, control boxes, plugs, antenna, etc. 115v 400 cyc. Excellent condition $875.00

SQ 10 CM PORTABLE RADAR. this set is a very compact search radar. complete installation available. brand new in carrying cases with complete maintenance spares including extra trans. rec. ind. tech data as follows:

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pulse rate: 800 cyc	accuracy ±5°
range: 3, 15, 45 miles	power output 1 KW
pulse width: 1 microsec.	beam width: 8° horiz. 15° vert.
300 yds. min. range, all ranges	presentation: A,B,P.P.I.

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Type	Input Volts	Output Volts	Amps	Price
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PE-125	12v/24v	475	.200	14.50
DM-32	28	250	.060	3.75
DM-33	28	570	.160	2.95
DY-12	12	275	.110	
		500	.50	
PE-73	28	1000	.350	10.00
PE-94	28	300	.260	
		150	.010	
		14.5	.5	2.25
PE-97	Vibrator Power Supply			8.95
PE-98	12v	300v		35.00
800-1	Inverter 28v	110v	800 cyc	40.00
PE-103	6 & 12	500	.160	35.00
PP-18-AR	Vibrapack			15.95
RA-42	(for BC-639 Receiver)			29.95
ATR	Inverter 12v	110v AC	125 watts	14.95

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Range Max. 100 Mi. Min. .25 Mi.	P.R.R. 200 Per Sec.
Azimuth Mech. 360° Automatic 360° Accuracy ±3° Scanning Manual Automatic	Pulse Width 2 Micro Sec. Beam Width 3° Horiz. 13° Vert.
Presentation 7" P.P.I 5" A Scope	
I.F.F. not provided but has provision for. Frequency 1074-1086 Mcs.	Power Input 1100 W at 115V 400 Cyc. and 180 W at 27V D.C.
Power output 150 K.W.	Weight: 1,518 Lbs.

AN/PPN-1 EUREKA! Ground portable, beacon responder. Unit will work into the AN/APN-2 transponder for purposes of homing. C.W. communication can also be carried on between plane and ground. Unit comes complete with xmitter, receiver, power pack, phones, etc. Brand new in knapsack. AN/APN-2 EQUIPMENT CAN BE SUPPLIED ON ORDER.
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RT-39/APG-5 10 CM LHTR R.F. head & modulator. Low power approx. 2 KW. Lighthouse tube rec & trans w/T.R. tunable. New..................$135.00
SCR-510 Freq. Modulated Portable Transceiver. Covering range of 20.0-27.9 mcs in 80 channels 100KC apart. Complete equipment consisting of BC-620 transceiver, power supply PE-97A. T-17 mike, handset, AN-45 antenna, battery operated or 6 or 12v input. Excellent condition..................$69.95
SCR-610 similar to SCR-510 except for freq. range which is 27.0-38.9 mcs. Excellent condition...$79.95
AN/APA-11 Pulse Analyzer to work with Search Receiver for analysis of received pulsed signals. PPS pulse width, wave shape, can be displayed on an CR tube. Unit can also be used as a standard oscilloscope for general servicing work. Input is 115v-400-2600 cyc. but can be changed with the addition of a 60 cyc. transformer. Very good condition.
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COMMAND EQUIPMENT

ARC-5 | 274N | OTHERS

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ARA 500-1500KC. Good	$24.95
R-28/ARC-5	29.95
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455B 6-9 mcs. Good	19.95
BC-454 3-6 mcs w/tubes. new	16.95

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TYPE O 5.3-7 mcs. New	9.95
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AN/CRW Receiver for Remote Control	5.95
BC-1206 Beacon Receiver 200-400KC. 28v in. Excellent	4.95
MN/26-Y Compass Receiver. Very good	24.95
BC-433G Compass Receiver, 200-1750KC in 3 bands. Excellent	39.95
HS-33 headsets, good	4.95
BC-1016 Tape Recorder. Complete. New	459.50
CFI Unit with 200KC Xtal. New	14.95
BC-733D receiver with tubes	29.95
BC-329 Transmitter. Excellent	89.95
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1U4 .89
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6C5 .79
6C6 .79
6C8G .98
6CB6 .98
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6D8 .89
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6F6 .95
6F7 .89
6F8G .95
6G6G 1.15
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6H6GT .79
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6J5GT .69
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6T7G 1.20
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6U5G .95
6U6GT .98
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7A7 .85
7A8 .89
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7B5 .85
7B6 .85
7C4 .79
7C5 .85
7C6 .85
7C7 .85
7E5 .75
7E6 .59
7E7 .89
7F7 .85
7H7 .85
7K7 1.20
7L7 .98
7N7 .98
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7V7 .95
7W7 1.05
7X7 1.10
7Y4 .75
7Z4 .85
12A .65
12A6 .73
12A7 1.05
12A8GT .79
12AH7GT 1.27
12AL5 .93
12AT6 .73
12AT7 1.25
12AU6 .95
12AU7 1.15
12AV6 .73
12BA6 .85
12BE6 .87
12C8 .79
12F5GT .79
12H6 .82
12J5GT .55
12J7GT .82
12K7GT .79
12K8 .89
12Q7 .69
12SA7GT .93
12SC7 .99
12SF5 .89
12SF7 .89
12SG7 .79
12SH7 .73
12SJ7 .79
12SK7 $ .98
12SL7 1.05
12SN7 .98
12SQ7 .85
12SR7 .85
12Z3 .85
14A4 .98
14A7 .95
14B6 .95
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14F8 .95
14H7 .95
14J7 .95
14N7 .95
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26 [illegible]
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32 .95
32L7GT .89
33 .93
34 .89
35/51 .83
35A5 .89
35B5 .89
35C5 .98
35L6GT .85
35W4 .69
35Y4 .75
35Z3 .85
35Z4 .73
35Z5 .69
36 .79
37 .79
38 .60
39/44 .40
41 .75
42 .75
43 .75
45 .89
45Z3 .89
45Z5 .80
46 .82
47 [illegible]
48 .98
49 [illegible]
50A5 .95
50B5 .95
50C5 .95
50L6GT .85
50Y6 .85
53 .98
56 .65
57 .80
58 .85
59 .95
70L7 .95
71A .75
75 1.25
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77 .60
78 .79
80 .73
82 .89
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117N7 1.35
117P7 1.35
117Z3 .89
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Max. A.C. Input Volts RMS	Max. D.C. Volts Output	Cell Size in Inches		Max. D.C. Amps. Output Continuous	Order by This Number	Price
SINGLE PHASE BRIDGE						
0-18	0-14.5	1¾"	x1¾"	1.3	18B4D1S1	$ 3.95
"	"	2-3/16"	x2-3/16"	2.4	18B4E1S1	4.95
"	"	3⅜"	x3⅜"	6.6	18B4F1S1	7.95
"	"	4½"	x5"	13.0	18B4K1S1	12.95
"	"	5"	x6"	17.5	18B4J1S1	15.45
"	"	4½"	x5"	26.0	18B4K1S2	22.50
"	"	4½"	x5"	39.0	18B4K1S3	37.50
"	"	4½"	x5"	52.0	18B4J1S3	47.50
"	"	4½"	x5"	70.0	18B4J1S4	54.50
0-40	0-34	1¾"	x1¾"	0.60	40B4D1S1	4.95
"	"	2-3/16"	x2-3/16"	1.2	40B4EW1S1	6.95
"	"	3⅜"	x3⅜"	3.2	40B4FW1S1	9.75
"	"	4½"	x5"	6.0	40B4K1S1	14.95
"	"	5"	x6"	9.0	40B4JW1S1	17.50
"	"	4½"	x5"	12.0	40B4K1S2	28.75
"	"	5"	x6"	18.0	40B4JW1S2	34.50
"	"	4½"	x5"	25.0	40B4J1S3	42.50
"	"	4½"	x5"	34.0	40B4J1S4	54.25
"	"	5"	x6"	36.0	40B4JW1S4	62.25
0-120	0-100	1¾"	x1¾"	0.60	40B4D3S1	12.45
"	"	2-3/16"	x2-3/16"	1.2	40B4EW3S1	14.95
"	"	3⅜"	x3⅜"	3.2	40B4FW3S1	24.50
"	"	4½"	x5"	6.0	40B4K3S1	32.50
"	"	5"	x6"	9.0	40B4JW3S1	42.50
CENTER-TAP						
10-0-10	0-8	1¾"	x1¾"	1.2	20C2D1S1	2.35
"	"	2-3/16"	x2-3/16"	2.4	20C2EW1S1	3.10
"	"	3⅜"	x3⅜"	6.4	20C2FW1S1	4.25
"	"	4½"	x5"	12.0	20C2K1S1	6.95
"	"	5"	x6"	16.0	20C2J1S1	8.95
"	"	4½"	x5"	24.0	20C2K1S2	14.75
"	"	4½"	x5"	36.0	20C2K1S3	19.65
"	"	4½"	x5"	48.0	20C2J1S3	27.50
"	"	4½"	x5"	64.0	20C2J1S4	34.50
"	"	4½"	x5"	80.0	20C2J1S5	42.50
"	"	4½"	x5"	84.0	20C2KW1S7	49.50
"	"	5"	x6"	96.0	20C2J1S6	55.50
"	"	4½"	x5"	128.0	20C2J1S8	67.50
3 PHASE BRIDGE						
0-120	0-150	1¾"	x1¾"	0.90	40B6D3S1	24.50
"	"	2-3/16"	x2-3/16"	1.8	40B6EW3S1	29.50
"	"	3⅜"	x3⅜"	4.75	40B6FW3S1	42.50
"	"	4½"	x5"	9.0	40B6K3S1	79.50
"	"	5"	x6"	12.5	40B6J3S1	86.75

SPECIAL RECTIFIERS ON REQUEST

TRANSFORMERS—115V 60 CY HI-VOLTAGE INSULATION

2700 @ 2 MA; 6.3v @ .6A; 2.5v @ 1.75A.. $ 4.45
2500v @ 15 MA.............................. 3.49
2000-0-2000v @ 800 MA...................... 24.95
1540v @ 5 MA; 340-0-340 @ 300 MA...... 4.35
925v @ 10 MA; 525-0-525v @ 60 MA; 2x5v @ 3A; 6.3v @ 3.6A; 6.3v @ 2A; 6.3v @ 1A 4.85
415-0-415v @ 60 MA; 5v @ 2A; 115/230 Dual Pri 4.25
400-315-0-100-315v @ 200 MA; 2x6.3v @ 9A; 5v @ 3A; 2.5v @ 2A.............. 5.35
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
0-17.4/21.6/25.8v @ 400 MA; 6.4v @ 5A; 2.6v CT @ 2.5A Pri 115/230.......... 3.85
12.6v CT @ 10A; 11v CT @ 6.5A......... 6.35
3x10v @ 7A.............................. 6.95
6.5v @ 12A; 6.3v @ 2A; 115v @ 1A...... 3.50
6.5v @ 8A; 6.5v @ 6A; 2.5v @ 1.75A..... 4.17
6.3v @ 1A; 2.5v @ 2A. $2.29 4-0-4v @ 1A .87
6.3v CT @ 1A............................ 1.29
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

FILTER CHOKES HI V INS

.025 HY @ 1.36A.. $1.98
3 HY @ 50 MA.... .39
5 HY @ 70 MA/.2 HY @ 350 MA. Dual 2.39
10 HY @ 55 MA... .89
10 HY @ 250 MA.. 3.95
10 HY @ 100 MA.. 1.29
13 HY @ 130 MA.. 1.59
15 HY @ 70 MA... 1.39
10/20 HY @ 85 MA $1.49
15 HY @ 100 MA.. 1.69
15 hy @ 800 ma.... 6.95
5.3 HY @ 225 MA. 2.79
6.6 HY @ 175 MA. 2.10
8 HY @ 150 MA... 1.79
200 HY @ 10 MA.. 2.95
325 HY @ 2 MA... 2.95
600 HY @ 1 MA... 2.95
9/60 HY @ 50/400 MA 9.95

OIL CONDENSERS—DC RATINGS

3x.1	MFD	600v	$ .59	.1	MFD	2500v	$1.15
.25	"	"	.35	.25	"	"	1.25
.5	"	"	.45	.5	"	"	1.35
1	"	"	.69	2	"	"	3.45
2	"	"	.85	.01	"	3000v	1.25
2x2	"	"	1.15	.05	"	"	1.30
4	"	"	1.29	.1	"	"	1.35
6	"	"	.98	.25	"	"	2.75
8	"	"	2.49	.5	"	"	2.85
10	"	"	2.79	1	"	"	2.95
3x.1	"	1000v	.85	2	"	"	4.25
.5	"	"	.89	4	"	"	6.95
1	"	"	.67	1	"	3600v	3.98
2	"	"	1.75	.25	"	4000v	3.49
4	"	"	1.85	.5	"	"	3.75
8	"	"	3.55	1	"	"	3.95
14	"	"	3.85	2	"	"	5.75
20	"	"	4.25	3	"	"	5.89
.5	"	1500v	1.02	.1	"	5000v	2.75
1	"	"	1.19	.25	"	"	2.95
2	"	"	1.69	1	"	"	3.10
4	"	"	2.69	.1	"	7000v	3.75
.1	"	2000v	1.75	.02	"	7500v	2.25
.25	"	"	1.92	.03	"	"	2.35
.5	"	"	1.95	.05	"	"	2.35
1	"	"	2.09	.1	"	"	4.95
2	"	"	2.85	2x.1	"	"	7.95
4	"	"	4.45	.02	"	12000v	12.95
8	"	"	4.95				

HIGH CAPACITY CONDENSERS

2x3500	MFD	25v	$3.47	2000	MFD	35v	$ .57
2500	"	3v	.35	100	"	50v	.45
3000	"	25v	2.45	4000	"	30v	3.25
650	"	80v	1.29	2350	"	24v	2.25
2000	"	15v	1.69	10000	"	25v	4.57

PHONE DIGBY 9-0347

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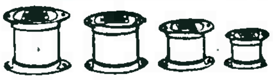
HIGH POWER TR. MICA



.00047 20KV
.015 3KV
.0012 20KV

G-1 TYPE	G-2 TYPE	G-3 TYPE	G-4 TYPE
.0001 6KV	.0001 10KV	.0001 20KV	
.00015 5KV	.00015 10KV	.0003 20KV	
.0002 6KV	.0002 10KV	.0004 20KV	.0002 30KV
.0008 6KV	.000247 12KV	.00045 15KV	.0025 25KV
.0047 6KV	.0003 10KV	.0005 20KV	.004 15KV
.005 5KV	.000375 10KV	.001 20KV	.005 8KV
.01 4KV	.0004 5KV	.0011 20KV	.01 15KV
.032 2KV	.0005 10KV	.0024 15KV	TYPE #56
.04 1KV	.00065 10KV	.004 12KV	.000155 30KV
.051 1.5KV	.001 6KV	.25 1.6KV	.000533 30KV
.08 1.5KV	.003 6KV	.25 6KV	.0004 30KV
.09 1.5KV	.003 8KV	.001 20KV	.001 30KV

OTHER H.V. MICAS

.0001	12.5KV	.01	7KV
.007	15KV Type 75A	.02	8 5KV
.01	5KV		

Type "F" and "NIF" GLASS FERRULE RESISTORS

Ohms	Watts	Ohms	Watts	Ohms	Watts
1	15	1000	50	6300	40
2.	20	1000	90	6500	120
2.2	15	1250	20	7500	15
4	90	1500	20	8000	90
5	15	1500	50	8200	40
6.2	15	1500	120	10.000	15
10	15	1600	40	10.000	40
15.	50	1800	15	10.000	90
20	15	2000	15	12.000	15
20	90	2000	20	12.500	15
26.	20	2000	50	12.500	90
32	90	2000	90	12.500	120
40:	90	2000	120	13.000	20
40.	12	2500	15	15,000	120
50	15	2500	20	16.000	M-O-M
60.	20	2500	50	16.000	50
100	15	2675	38	16.000	90
100.	50	3000	20	20.000	50
125	90	3000	50	20.000	120
150.	50	3100	40	25.000	90
160	20	3100	90	25.000	120
200.	50	3150	15	35,000	120
270	20	3150	90	40.000	90
400	20	3300	20	50.000	MFC
600	40	4000	20	1000.000	120
630	90	4000	50	300,000	MFC
800.	50	4500	20	500,000	M-O-M
1000	13	5000	40	600K	MFC
1000	15	5000	50	4.0 Meg.	MFB
1000	20	6000	50	40.0 Meg.	M-O-M
1000	40	6000	120	100. Meg.	MVP

NOISE FILTERS

MALLORY NF.1-1	SOLAR EA-125L
MALLORY NF12-6 EG	SOLAR EB 102
MALLORY NF12-7	SOLAR ED-101
SPRAGUE JX-51	SOLAR EF-100
SPRAGUE JX-51A	SOLAR EF-103
SPRAGUE JX-51B	SOLAR EF-104
SPRAGUE JX-55D	SOLAR EL-109
SOLAR EA-107	SOLAR EL-111
SOLAR EA-109	SOLAR EL-113
SOLAR EA-121	SOLAR FL 14, EV106
SOLAR EA-142	SOLAR FL16, EV-125

LEVER SWITCHES

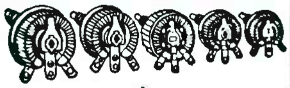
Over 100 Varieties in Stock of Mossman #4101 Series

1% PRECISION RESISTORS

Standard Brand

Ohms	Ohms	Ohms	Ohms
6.	500	5910	72K
24.	636	6000	75K
28.	680	6550	76100
34.6	733	6800	83700
35.7	743	7000	90K
38.6	750	7500	100K
40.	946	15K	110K
47.7	1000	17K	115K
75.	1250	18380	120K
78.8	1260	19500	125K
80.	1280	20K	130K
88.	1477	20500	135K
100	1485	21K	140K
107.85	2000	22K	145K
110	2142	29500	220K
125	2170	30K	235K
200	2500	32K	260K
215	2800	33800	347K
225	3460	37500	390K
248	3500	38140	500K
280	3760	39K	750K
286	4280	40500	800K
300	4500	47710	1.0 Meg.
370	5000	60K	4.0 Meg.
400	5294	61K	10.0 Meg.
450	5470	61430	
	5500	70K	

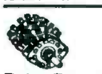
POWER RHEOSTATS



Ohms	watt	ea.	Ohms	watt	ea.
.5	25	1.98	225	50	2.53
.5	50	2.81	250	25	2.23
.5	150	5.93	250	50	2.53
1	50	2.81	300	50	2.53
2	50	2.81	300	100	4.27
2	100	4.68	350	25	1.98
2	225	6.59	350	100	4.26
2	300	8.42	370	25	1.98
3	100	4.67	378	150	6.59
3	225	6.58	400	25	1.98
3x3	300	19.95	400	75	3.90
4	225	6.60	500	25	1.98
5	25	1.97	500	75	3.95
5	100	4.68	500	50	2.53
6	25	2.23	500	100	4.39
6	75	3.90	500	150	4.68
7	25	1.98	585	150	6.60
8	50	2.53	750	25	2.23
10	25	2.23	750	150	5.95
10	100	4.27	1000	25	1.98
12	25	2.23	1000	150	5 93
12	50	2.53	1200	225	7.20
15	25	1.98	1250	50	2.66
15	75	3.90	1250	150	6.59
15	100	4.38	1500	25	2.53
20	50	2.53	1500	50	2.65
25	25	2.23	1800	150	6.24
50	25	1.98	2000	25	2.23
50	50	2.53	2000	50	2.53
60	25	1.98	2250	150	6.24
75	25	1.98	2500	150	6.24
75	75	3.90	2500	25	2.23
75	100	4.39	2500	50	2.53
80	50	2.53	2500	100	4.68
80	500	12.46	3000	25	2.39
100	25	1.98	3000	100	4.68
100	50	2.53	5000	25	2.53
100	100	4.39	5000	50	2.85
125	25	2.53	7500	50	2.85
150	50	2.53	7500	100	5.31
175	25	2.53	10000	50	3.12
185	25	1.98	10000	100	5.51
200	25	1.98	15000	25	3.29
200	100	4.27	20000	150	8.43

Specify whether shaft required is for knob or screwdriver adjust.

SELECTOR SWITCHES



Pole	Pos	Deck	Type	Each
1	11	1	Bak-n/shtg	.60
1	21	3	Bak-n/shtg	.89
2	2	1	Cer-shtg	.50
2	6	2	Bak-n/shtg	.60
2	11	2	Bak-n shtg	.75
3	4	2	Bak-/shtg	.58
5	3	2	Cer-n/shtg	.98
6	11	6	Bak-n shtg	1.95
10	5	5	Cer-shtg	2.25
16	2	4	Bak-n/shtg	1.35

Many other types in stock

"AN" CONNECTORS

Large Variety Available At Great Savings
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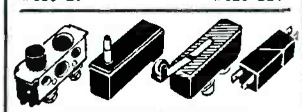
#926-A14	#926-C1
#926-B	#926-C5
#926-B1	#926-C10
#926-B7	#926-C24



MICROSWITCHES

CR-1070-C103-B3	"R-R12T"
CR-1070-C103-E3	"YZ"-7RST-1"
CR-1070-D103-A3	"WZ-7RST-1"
CR-1070-C123-C3	"YZ-2YST"
CR-1070-D123-D3	"B-RS36"
CR-1070-D102-N3	"B-RS10"
TYPE "Q"	"WZ-2RQTC1"
"4MC3-1B"	"BZ-3RQTC"
"YP-5 "A"	"T-AZRPH"
"AZBPS"	"YZ-RS13"
"HRD7-1ATB"	"BZ-2RQ91"
"BZ-R37"	"BZV-2RQ9 TN3"
TYPE "D"	"AHB-201"
B-17	"TAAZGPD"
"WZ-2RT"	"TAAZG PWDA"
"YZ-2RT"	YZ-2RSTC
"2-AZG"	YZ-2RS
"WZ-RL8"	
"WZ-R8LT"	
"R-RL2T"	

OIL CONDENSERS

Mfd.	Voltages Avail.
.1	3-6-20K
.25	2-3-3½-4-5K
.5	600-1½-3K
1	600-1-1½-2-5-6
2	400-600-1-1½-2 3-4K
4	600-700-1-1½K
6	400-600-1½-2K
8	600
10	600-2½K
15	600-1K
30	90-vac. 3-ph
100	230-vac. 3-ph
3x4	500
3x8	600
4x3	600
4x8	600
3x10	90-vac

Special Prices on Request

BATHTUBS

Mfd.	Voltages Avail.
.033	400
.05	2-4-600
.1	4-6-1K
.15	600
.25	2-4-600
.35	400
.5	4-6-1K
.75	600
1	1-2-4-6-1K
2	4-600
4	50-100
8	500
25	25-50-75
40	25
50	25
100	15
200	12
300	6
2x.01	2-400
2x.02	6-1500
2x.045	600
.046x.055	600
.2x.05	6-1500
1x.05	200
.1x.5	400x50
2x.1	4-600
2x.16	600
2x.2	600
2x.25	4-600
.3x.5	500
2x.5	4-600
1.x.05	500
1.x.1	300
1.x.5	200
2x1	600
2x10	25
2x200	9
3x.001	600
3x.05	600
3x.1	4-600
3x.25	4-600
3x.5	100-600
.015x.03x.045x.06x.12/	600

Also available CHANNEL Types. Special Prices on request.

SHOCKMOUNTS

100P-1....	1 lb.	.15
100P-2....	2 lb.	.15
100PR-2...	2 lb.	.15
100P-3....	3 lb.	.15
100P-6....	6 lb.	.20
150P-4....	4 lb.	.20
150PH-8...	8 lb.	.45
100PL-1...	1 lb.	.15
150P-7....	7 lb.	.25
156P-6....	6 lb.	.35
200PD-15..	15 lb.	.59
200PHN-35	35 lb.	.75
204P-112...112	lb.	.98

TERMINAL BOARDS

5 terminal	.98
8 terminal	1.67
12 terminal	2.49

TYPE "J" POTENTIOMETERS

TYPE "J" $1.50
TYPE "JL" $1.75
TYPE "JJ" $2.95

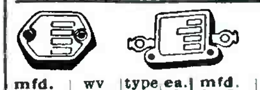
ohms	ohms	ohms	ohms	ohms
50*	2500*	100 K*	500-500*†	130 K-130K*
65*†	4000†	100 K†	600-600†	150 K-150K†
200†	5000†	125 K*	1500-1500†	250 K-250K†
300†	10 K*†	200 K*	2000-2000*†	350K-5K†
400*†	15 K*†	250 K*	2000-50K*	350K-25K†
500†	20 K*†	250 K†	2200-24K†	300K-300K†
600*†	25 K*†	500K*†	20K-2000†	350K-350K*
750†	30 K*†	1meg*	25K-10K†	800K-75K*
1000*†	50K*†	1meg†	35K-5000†	1meg-1meg†
1500*†	80K†	2meg	50K-50K*	2meg-2meg†
2000*†		2meg†	100K-100K*	4meg-4meg†

TYPE "JJJ" $4.95

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



mfd.	wv	type	ea.	mfd.	wv	type	ea.
.0001	600	4	.36	.0015	600	4	.36
.0003	600	4	.36	.00162	600	4	.42
.00005	600	4	.29	.002	600	4	.39
.00005	2500	9	.57	.002	1200	4	.72
.0001	600	4	.29	.0025	600	4	.39
.0001	2500	9	.57	.003	600	4	.43
.00015	600	4	.36	.004	600	4	.45
.0002	600	4	.29	.005	1200	9	.99
.00025	600	4	.29	.0047	600	4	.47
.0005	600	4	.29	.005	2500	9	1.85
.0005	2500	4	.75	.006	600	4	.54
.0005	2500	9	.77	.01	600	4	.65
.0006	2500	9	.85	.01	1200	9	1.41
.0007	600	4	.36	.02	600	4	.92
.00075	300	4	.36	.02	1250	9	2.12
.0008	600	4	.36	.025	600	4	1.03
.0009	600	4	.36	.03	300	4	.99
.001	600	4	.36	.03	600	4	1.34
.001	1200	4	.54	.043	600	4	1.75
.001	1200	9	.57	.05	300	4	1.19

(Many other sizes in stock)

"UG" and "UHF" CONNECTORS

UG-9/U	UG-25/U	83-1F
UG-10/U	UG-27/U	83-1J
UG-12/U	UG-27/AU	83-1AP
UG-14/U	UG-57/U	831RTY
UG-15/U	UG-58/U	83-1SP
UG-16/U	UG-87/U	83-1R
UG-18/U	UG-88/U	83-1D
UG-19/U	UG-123 U	83-1SPN
UG-20/U	UG-185 U	83-22R
UG-20/U	UG-206/U	CN 49120
UG-21B/U	UG-260 U	CN 49121A
UG-22/U	UG-290 U	CN 49151
UG-24/U	83-1AC PRICE [illegible]	

Jones Connectors

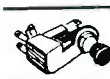
P-101-¼	.25
P-101-½	.30
S-101-D-MOD ...	.33
S-302-AB	.13
S-304-CCT	.25
P-306-AB	.16
P-306-CCT-L	.33
S-306-FHT	.24
S-308-AB	.21
P-312-AB	.24
P-312-CCT-L	.42
P-315-FHT	.40
P-315-EB	.30
P-315-CCE	.40
S-315-AB	.36
S-318-AB	.43
P-324-FHT	.74
P-324-EB	.6[illegible]
S-330-AB	.84
S-404-AB	.33
P-406-AB	.33
S-406-CCT	.58
S-408-CCT	.69
S-2408-SB	.53
P-2412-SB	.61
S-2412-CCE	.87
S-502-DB	.97
P-508-CE	2.55
P-510-CE	3.04
P-512-CE	3.52

Jones BARRIER STRIPS

2-140-Y	.13
6-140-Y	.33
10-140-¾W	.53
19-240	.38
18-240	.66
4-141-W	.30
4-141-¾W	.30
7-141-Y	.49
12-141-Y	.82
13-141-Y	.89
15-141-Y	1.02
2-142-Y	.20
4-142-Y	.36
8-142	.48
3-150	.53
4-150-Y	.83
4-151	1.30
5-151	1.60
4-152	1.89
2002	.04
2008	.07
8-54	.22
8-6	.18
4-140-Y	.23
17-240 on 21.....	.63
20-160-R/L	.51
20-161-R/L	.52

Many other types in stock

MALLORY PUSH SWITCH



#2001	S.P., make cont., non-L........	.52
#2003	S.P.D.T., non-lock	.56
#2003L	S.P.D.T., lock.................	.56
#2004	D.P., make 2 non-L............	.64
#2004L	D.P., make 2 lock.............	.64
#2006	D.P.D.T., non-lock	.78

HUNDREDS OF OTHER ITEMS AVAILABLE

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NEW YORK'S RADIO TUBE EXCHANGE

TYPE	PRICE	TYPE	PRICE	TYPE	PRICE	TYPE	PRICE	TYPE	PRICE	TYPE	PRICE
OA2	$2.00	2J38	17.95	5CP7A	15.00	328A	9.95	725A	9.95	884	1.95
OA3	1.50	2J39		5D21	27.50	350A	7.95	726A	6.95	885	1.75
OB2	3.00	2J42	150.00	5JP1	27.50	350B	5.95	726B	56.00	889R	199.50
OC3	1.75	2J49	109.00	5JP2	19.50	357A	20.00	726C	69.00	913	12.95
OD3	1.50	2J50	69.50	5JP4	27.50	368AS	6.95	728AY	27.00	914	75.00
C1A	4.95	2J61	75.00	5LP1	18.95	371B	1.95	730A	28.95	931A	6.95
C1B	6.95	2J62	75.00	5LP1A	19.50	385A	4.95	801A	1.00	954	.35
1B21A	2.75	2K25	47.50	6C21	29.50	388A	2.95	802	4.25	955	.55
1B22	3.95	2K28	37.50	C6A	3.95	393A	8.95	803	5.95	956	.69
1B23	9.95	2K29	27.50	C6J	9.95	394A	8.95	804	13.50	957	.29
1B24	17.95	2K41	99.00	7BP7	7.95	MX408U	.75	805	5.95	958A	.69
1B26	2.95	2K45	199.50	7DP4	10.00	417A	17.95	806	25.00	959	.69
1B27	19.50	2V3G	2.10	12AP4	55.00	434A	17.95	807	1.69	975A	17.95
1B32	4.10	3B24	5.50	15E	2.95	446A	1.95	808	3.50	991	.45
1B38	33.00	EL3C	5.95	15R	.95	450TH	45.00	809	2.45	E1148	.29
1B42	19.95	3C24	1.95	NE16	.45	450TL	45.00	810	11.00	1280	1.95
1B56	49.95	3C31	5.95	FG17	6.95	464A	9.95	811	3.15	1611	1.95
1B60	69.95	3C45	13.95	RX21	3.95	471A	2.75	813	8.95	1613	1.38
1N21	1.35	3DP1A	10.95	35T	4.95	527	15.00	814	3.95	1616	2.95
1N21A	1.75	3E29	15.50	45 Special	.35	WL530	22.50	815	3.50	1619	.89
1N21B	4.25	SN4	5.50	RK39	2.95	WL531	12.50	816	1.45	1620	5.95
1N22	1.75	4A1	1.75	VT52	.35	700A/D	25.00	829	9.95	1622	2.75
1N23	2.00	4B26	10.95	RK72	1.95	701A	7.50	829A	11.95	1624	2.00
1N23A	3.75	4C27	25.00	RK73	1.95	703A	6.95	829B	15.95	1625	.45
1N23B	6.75	4C28	35.00	100TH	9.00	705A	3.95	830B	11.50	1851	1.85
1N27	5.00	4E27	17.50	FG105	19.00	706AY	48.50	832	6.95	2050	1.85
1N48	1.00	4J25	199.00	F123A	8.95	706CY	48.50	832A	9.95	2051	1.80
1S21	6.95	4J26	199.00	203A	8.95	707A	17.95	833A	49.95	8012	4.25
2B22	4.95	4J27	199.00	211	.75	707B	27.00	834	7.95	8013	2.95
2B26	3.75	4J30	395.00	217C	18.00	714AY	7.95	836	4.95	8013A	5.95
2C34	.35	4J31	99.00	242C	10.00	715A	7.95	837	2.95	8014A	29.95
2C40	20.00	4J32	99.00	249C	4.95	715B	15.00	838	6.95	8020	3.50
2C43	27.00	4J33	99.00	250TL	19.95	715C	25.00	845	5.59	8025	6.95
2C44	.90	4J37	99.00	274B	3.00	717A	1.75	849	52.50	9001	1.75
2D21	1.75	4J38	89.00	304TH	15.00	718AY/EY	48.50	851	80.50	9002	1.50
2E22	3.75	4J39	99.00	304TL	14.50	719A	29.50	860	4.95	9003	1.75
2E30	2.75	4J41	99.00	307A	4.95	721A	3.95	861	39.50	9004	1.75
2J26	27.75	4J52	350.00	310A	7.95	722A	3.95	866A	1.79	9005	1.90
2J27	29.95	C5B	2.95	311A	7.95	723A/B	14.95	869B	37.50	9006	.35
2J31	29.95	5BP1	6.95	312A	3.95	724A	4.95	872A	3.95		
2J32	69.95	5BP4	6.95	323A	25.00	724B	6.95	878	1.95		
2J36	105.00	5CP1	6.95	327A	3.95						

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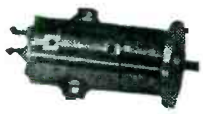

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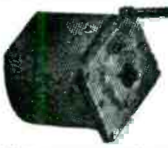

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Wincharger PU-7/AP Input 28 VDC at 160 amps. Output 115 v. 400 cy. 1 ϕ at 2500 VA. Voltage and frequency regulated. Cont. duty. Stock #SA-164. **Price $99.50 each.**

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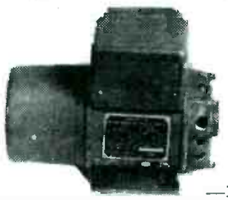
Pioneer 12130-4-B (3 ϕ) Input 28 VDC at 14 amps. Output 115 v. 400 cy. 3 ϕ at 100 VA. Voltage and frequency regulated. Made 1949. Stock #SA-304. **Price $89.50 each.**



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Type 10047-2A. 2 ϕ 400 cycle low inertia. 26 v fixed phase. 45 v. max. variable phase. Stock #SA-90. **Price $12.50 each.**

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AS-217/APG 15B. 12 Cm dipole and 13 inch Parabola housed in weatherproof Radome 16" dia. 24 v. DC spinner motor for conic scan. Stock #SA-95. Shipping wt. 70 lbs. Original boxes.
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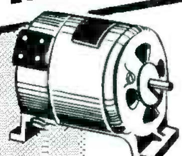

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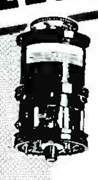
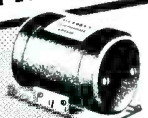
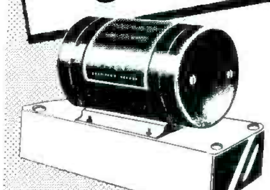


DYNAMOTORS



POWER UNITS



BLOWERS

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MANUFACTURER	TYPE OR NO.	VOLTAGE	RPM	DIMENSIONS	SPECIAL INFORMATION
Stewart Warner	....	6VDC	....	2¼"x2¾"	¼"x½" Lg. shaft
John Oster	B-9-2	12VDC 1.4A	5600	2¼"x3¾"	¼"x7/16" Lg. shaft. Shunt Wd.
General Ind.	62800	13VDC 9A	6800	2⅛"x4"	¼"x¾" Lg. shaft. 1/12 HP
Emerson	D-26-BT	24VDC 24A	100	2¼"x5½"	160 Ft.-Oz. torque
Redmond	7-N	24VDC .96A	6000	2¾"x3¼"	Complete blower assembly
F. A. Smith	40H	115VAC 60 Cy	....	6"x5½"x5"	100 CFM blower ($12.95)
Western Elect.	FL	115VAC 400 Cy	6700	3¼"x4"x4½"	25 CFM blower
Signal Elect.	D-4272	24VDC .66A	2100	2¼"x2⅞"	¼"x1" shaft. 1/190 HP
General Elect.	5 BA50MJ64	24VDC 13A	....	3⅞"x7½"	Shunt wound
Stromberg	D-4496	24VDC .45A	....	2½"x3⅛"	¼"x¾" shaft. .003 HP
Amglo	....	24VDC	....	1½"x2⅛"	Telephone ringing circuit motor
John Oster	A-16B-26R	26VDC	....	1½"x2⅛"	3/16"x5/16" shaft. Series Rev.
John Oster	DEST-8-1R	27VDC 1.4A	3800	2¼"x4⅝"	⅜"x¾" shaft. 1/40 HP
Delco	5069267	27.5VDC .25A	6000	1⅝"x2½"	¼"x1⅛" shaft. 1½ Oz-In Tq.
Western Elect.	KS5996-LO4	28VDC	....	2"x2⅞"	3/16"x7/16" shaft. Series Rev.
Bendix	MO5B	28VDC 1.75A	3200	1½"x2½"	¼"x1⅛" shaft. Series Rev.
Bendix	E-11500-1	28VDC 1A	9000	1½"x2½"	¼"x1⅛" shaft. Series Rev.
Fractional Mtrs.	SH-280	28VDC 3.1A	3900	3¼"x5½"	¼"x⅝" shaft. Used in ART 13
Electrolux	20100	28VDC .1A	....	2"x2 15/16"	5/32"x⅝" shaft. 20 Deg. rotation
John Oster	A-21-E-12R	28VDC .4A	....	1½"x2⅜"	3/16"x⅜" shaft. Series Rev.
Emerson	D-26-BV	28VDC 3.1A	3900	2½"x3½"	¼"x⅝" shaft. 1/20 HP
Electrolux	16876	28.5VDC 1.8A	2200	3¾"x5"	¼"x1¾" shaft. 1/35 HP
Western Elect.	KS 9303	50-60VAC 175 Cy	....	2½"x3½"	....
General Elect.	2J1H1	57.5VAC 400 Cy	....	2¼"x3¾"	Selsyn differential
General Elect.	2J1G1	57.5VAC 400 Cy	....	2¼"x3½"	Selsyn transmitter
General Elect.	5BN38HA10	80VDC .25A	3000	2⅞"x5⅛"	¼"x¾" lg. shaft
General Elect.	2J1F1	115VAC 400 Cy	....	2¼"x3"	Selsyn generator
Diehl	11-1	110VAC 60 Cy	....	4"x5¼"	Synchro repeater selsyn
Bendix	....	110VAC 60 Cy	....	3¼"x5½"	Synchro differential selsyn
Bendix	....	110VAC 60 Cy	....	3¼"x5½"	Synchro transmitter selsyn

MANUFACTURER	TYPE OR NO.	INPUT	OUTPUT	DIA.	LGTH.	SPECIAL INFORMATION
Eicor	ML3415-254	27.5VDC 1.5A	250VDC .060A	4"	8⅜"	With bracket mounting
Eicor	ML3412-42	13.8VDC 2.45A	220VDC .070A	3⅜"	5¼"	No mounting
Western Elect.	DM53AZ	14VDC 2.8A	220VDC .080A	2¾"	4½"	With base plate
Westinghouse	1171187A	27VDC 1.4A	285VDC .060A	2⅛"	4½"	No mounting
General Elect.	5DY82AB52	27VDC 1.5A	285VDC .060A	2¾"	4½"	No mounting
Western Elect.	1171091B	27VDC 1.6A	285VDC .075A	2¾"	4½"	No mounting
Redmond	5047	27VDC 1.75A	285VDC .075A	2¾"	4½"	No mounting
Eicor	ML3415-254	27.5VDC 1.5A	10CVDC .150A	3½"	5½"	With base plate
Eicor	ML3420-194	27.5VDC 4.0A	325VDC .200A	3⅜"	6½"	With base plate
C.Q.R.	355D2BA	27.9VDC 1.25A	220VDC .070A	3⅜"	5⅜"	No mounting
Continental	DM310A	28VDC .5A	100VDC .01A	2¾"	4½"	No mounting
C.A.Y.	DM32A	28VDC 1.1A	250VDC .060A	2¾"	4½"	With base plate
Pioneer	PE86M	28VDC 1.25A	250VDC .060A	2¾"	4½"	With base and filter
Bendix	DA-1A	28VDC 1.6A	230VDC .100A	3⅜"	5½"	No mounting
Redmond	DM5 3A	28VDC 1.4A	220VDC .080A	2¾"	4½"	With base plate
Redmond	5056	28VDC 1.4A	250VDC .060A	2¾"	4½"	With base plate
Eicor	ML-3420-90	28VDC 3.3A	400VDC .125 A	3½"	6½"	With base plate
Continental	DM33A	28VDC 5A	575VDC .160A	3½"	7½"	Cont. duty. No mounting
Winco	41S6	13VDC 13A	250VDC .060A	4"x	8⅜"	With base plate
		13VDC	300VDC .225A	....	....	Intermittent
Continental	DMX310A	12VDC 2.8A	150VDC .100A	2¾"	4½"	Cont. Duty. No mounting
Airs	VA 137	115VAC 60 Cy	90-135VAC 7.6A	3¾"	5¾"	⅜"x1" Shaft. Ind. Volt Reg.
				DIMENSIONS		
Pioneer	PE 55	12VDC .16A	500VDC 0.2A Cont.	7¼"x12⅛"x13½"		Pwr. Unit W/DM 19G DYN, Filter and Mounting
Westinghouse	PE 94C	28VDC 10.5A	300VDC .260A 150VDC .010A 14.5VDC 10A	8¼"x6½"x12½"		Pwr. Unit W/DA3A DYN, Filter and Mounting

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BC-348 RECEIVER PARTS

for Models C, E, H, K, L, M, P, R.

Dial Mechanism assemblies. 1st, 2nd, 3rd, 4th I.F. transformers. C. W. osc. and xtal filter trans. with xtals. All R.F. coils. Front panels. Shock mounts. Large quantity misc. hardware sub assemblies, etc. Write your requirements.

MISCELLANEOUS EQUIPMENT

TS-127/U Lavoie Freq. Meter—375 to 725 MC.
TS-47 APR Test Set—40 to 500 MC.
213-A DuMont C.R. Modulation Monitor.
BC1203 APN-4 Test Set.
6255A H.P. Interpolation Osc.
TS-23/APN Test Set.
TS-487/U Peak to Peak VTVM.

G. E. SERVO AMPLIFIER

Type 2CV1C1 Aircraft Amplidyne control amplifier. 115 volts—400 cycles. Dual channel. Employes 2-6SN7GT and 4-6V6GT tubes. Supplied less tubes.
New $22.50

LINEAR SAWTOOTH POTENTIOMETER

W.E KS-15138

Has continuous resistance winding to which 24 volts D.C. is fed to two fixed taps 180° apart. Two rotating brushes 180° apart take off linear sawtooth wave voltage at output. **Brand New**.... $5.50

8,000-VOLT TRANSFORMERS

Primary: 115 V., 60 cycles.
Secondary: 8000 V., C.T., 800 V.A.
Brand new in sealed cans.... $27.50

CRYSTAL DIODE

Sylvania 1N21B. Individually boxed and packed in leaded foil. Brand new........ $4.25

SYNCHRO DIFFERENTIAL GENERATOR

Ford Inst. Co. Type 5SDG. Brand New.... $22.50
Electrolux Torque Motor........ $16.50

MOTOR GENERATORS

2.5 KVA Diehl Elec. Co. 120V D.C. to 120V A.C. 60 cy. 1Ph., .4PF. Complete with Magnetic Controller, 2 Field Rheos and Full Set of Spare Parts including Spare Armatures for Generator and Motor. Full spec. on request. New........ $285.00

2 KVA O'Keefe and Merritt. 115V DC to 120V AC, 50 cy. Idles at 3 Ph. syncs motor on 208V, 50 cy. New. Export crated........ $165.00

1.25 KVA Allis-Chalmers. 230 DC to 120 AC. 60 cy, 1 Ph. Fully enclosed. Splashproof, Ball Bearings, centrifugal starter. New, complete with kit of Spare Parts........ $175.00

M.G. 164, Holtzer-Cabot Motor: 440V, 3Ph, 60 cy., .90A, 1/3HP, 1750 RPM. Generator: 70V, 3Ph, 146 Cy., .140KVA. Exciter: 115DC, 1A. New... $67.50

Type CG-21302. 440V AC, 60 cy, 3Ph, 1500 VA to 875 DC and 300V DC. New........ $69.50

INVERTERS

Onan MG-215H. Navy type PU/13. Input 115/230, 60 cy, 1 Ph. Output 115, 480 cy, 1 Ph. 1200W and 26V DC at 4 amps. New........ $295.00

G.E. Model 5D-21NJ3A. Input: 24V, DC, Output: 115V, 400 cy., 485 Va. New........ $29.50

Leland Elec. Co. Model PE206A. Input: 28V. DC, 38 Amps. Output, 80V., 800 cy, 485 VA. New. $22.50

G.E. J8169172. Input: 28V. DC, Output: 115, 400 cycles at 1.5 KVA........ $32.50

DYNAMOTORS

Navy-Type CAJO-211444, 105/130V DC to 13V DC at 40A or 26V DC at 20A. Radio Filtered. Complete with Line Switch. New........ $89.50

Eicor. 64V DC to 110V AC, 60 cy. 1 Ph. 2.04 Amps. New........ $24.50

Eicor. 32V DC to 110V AC, 60 cy, 1 Ph, 0.43 Amps. New........ $22.50

Type PE94C. For use with SCR522 Transmitter-Receiver. Brand new in export cases........ $15.00

Carter 6V DC to 400V DC at 375 mils. New.. $39.50

AMPLIDYNES

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........ $34.50

Edison type 5AM31NJ18A. Input: 27 volts, 44 Amps., 8300 RPM. Output: 60V DC at 8.8 amps. 530 Watts. New........ $22.50

SMALL D.C. MOTORS

G.E. Model 5BA50LJ2A. Armature 27V D.C. at 8.3A. Field 60V DC at 2.3A. RPM 4000. H.P. 0.5. New........ $27.50

Electrolux Corp. of Canada. P/O vent fan assembly for SCR-602-T6. 1/35HP, 28.5V, 2.15 amps., 2200 RPM. Price........ $16.50

Oster type E-7-5, 27.5V, 1/20HP, 3650 RPM. Shunt wound. Price........ $15.00

Dumore Co, Type EBLG, 24V DC., 40-1 gear ratio, for use with type B-4 Intervalometer. Price. $17.50

RADAR ANTENNAS

Type SO-1 (10CM.) Complete assembly with reflector, waveguide nozzle, drive motor and synchros, etc. New in original cases........ $279.50

Type SO-3 (3 CM.) Surface Search type complete with reflector, drive motor, synchro, etc., but less plumbing. New in original cases........ $189.50

Type SO-13 (10 CM.) Complete assembly with 24" dish with feedback dipole. Complete with synchros, drive motor, gearing, etc. New in original cases........ $149.50

Also in stock—spare reflectors, nozzles, probes, right angle bends for SO-1 antennas.

400 CYCLE TRANSFORMERS

AUTO. 400 cy. G.E. Cat No. 80G184. **KVA** .945S—520P. Volts 460/345/230/115. New. $4.95

FILAMENT. 400/2600 cy. Input: 0/75/80/85/105/115/125V. Output: 5V3A/5V3A/5V3A/5V3A 5V6A/5V6A/6.3V6A/6.35A. New........ $2.95

THYRATHRON POWER. 400/1600 cy. Raytheon UX-8876. 400/1600 cy. Pri: 115. Sec: 50-0-50V at 1.5A, 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

Plate. Thordarson #T46889. 1650 VA. Pri: 105-120V. 500 cy. 1 PH. Sec: 5600V. Center tapped. 1.5KV insulation. Brand new........ $49.50

PLATE & FIL. WECO KS9555. 400 cy. Pri: 115V. Sec #1: 930-0-930. Sec #2: Three 6.3V windings........ $3.95

FILAMENT. 400/2400 cps. WECO KS9553. Pri: 115V. Sec: 8.2V1.25A/6.35V1.5A Elecstat shdld. Wt. 0.5 lbs. New........ $1.95

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/6.35V0.8A (ins. 1500V)/5V2A/5V2A........ $4.95

RETARD. 400 cy. WECO KS9598. 4 Henry 100MA. $1.75

60 CYCLE TRANSFORMERS

FILAMENT. Raytheon Hypersil Core, Pri: 115V. Sec: 6.3V22A/6.3V2.4A/6.3V2.25A/6.3V0.6A Ins. for 1700V........ $5.95

High Rectance Trans. G. E. type Y-3502A.—60 cy., Voltage 11200-135. Inductance H.V. Winding 135 Henries. Output: Peak Voltage 22.8KV. Cat. 8318065G1. New........ $89.50

High Voltage Trans. Westinghouse Pri: 115, 60 cy. Sec: 15,000 C.T., 60 MA. Good for Hi-Pot test set up........ $29.50

PULSE TRANSFORMERS

PULSE. WECO KS-9563. Supplies voltage peaks of 3500 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.. $5.00

PULSE. WECO KS-161310, 50 KC to 4MC. 1¾" Dia. x 1⅞" high, 120 to 2350 ohms. New..... $1.95

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

HIGH VOLTAGE CAPACITORS

.25 MFD., 20KV	$26.50
.25 MFD., 15KV	22.50
.5 MFD., 25KV	34.50
1 MFD., 15KV	34.50
1 MFD., 7.5KV	12.50

SOUND POWERED PHONES

Western Electric No. D173312, Type O. Combination headset and chest microphone. 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........ $10.00

U. S. Instrument Co. No. A-260. Complete with 20' cable and plug. Brand new........ $13.50

W. E. type TS-10M Handset. New........ $16.50

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

SWEEP GENERATOR CAPACITOR

High speed ball bearings. Split stator silver plated coaxial type 5/10 mmfd. Brand new........ $2.50

WESTERN ELECTRIC CRYSTAL UNITS

Type CR-1A/AR. Available in quantity—following frequencies—fundamentals.
5910—6450—6370—6470—6510—6610—6670—6690—6940—7270—7350—7380—7390—7480—7580—9720—Kilocycles.

$1.25 each

All prices indicated are F O B Bronxville, New York. Shipments will be made via Railway Express unless other instructions issued.

ELECTRONICRAFT

INC.

27 MILBURN ST. BRONXVILLE 8, N. Y.
PHONE: BRONXVILLE 2-0044

All merchandise guaranteed. Immediate delivery, subject to prior sale.

All Prices Subject to Change Without Notice

METERS

3MA DC 2½" R—Simpson black scale........$3.35
500 Microamps, DC—2½" round—Sun........ 4.30
1 ma. DC Fan type—4" scale (rem. from equipt) 3.95
500 ma. DC 2½" R.—General Electric......... 2.95
2 amp. RF 2½" Sq.—Simpson.................. 3.15
5 amp. AC 4½" R.—JBT....................... 4.11
10 amp. RF 3½" R.—Simpson.................. 4.95
50 amp. AC 3½" R.—General Electric......... 4.11
3 amp. RF 3½" R.—Weston.................... 6.00

MAGNETRONS

2J21A	2J37	3J31	706BY
2J22	2J38	4J31	706CY
2J26	2J39	4J33	706GY
2J27	2J40	5J23	714AY
2J31	2J41	5J29	718AY
2J32	2J48	700B	718BY
2J33	2J49	700C	720B/C/DY
2J34	2J56	700D	725A
2J36	2J61	706AY	730A

KLYSTRONS

2K23	2K33	417A	723A/B
2K25	2K45	707A	726A
2K26	2K54	707B	726B
2K29	2K55	723A	5611

OIL-FILLED HIGH VOLTAGE ISOLATION TRANSFORMERS

Pri. 400V 60 cy. Sec. 115V 200VA Insulated for 50KV DC—G. E. Form EIR—36"H x 13"D......$125.00
Pri. 115V 60 cy. Sec. 115V 250VA Insulated for 35 KV DC—G. E. Form EIR—29"H x 12½" D.$125.00

VOLTAGE DIVIDER

G.E. Cat. 8248886G-1 and 9001934G-1 17,246,400 ohms 35KV 70:1 ratio wire wound shielded oil-filled 40"H x 12"D........................$77.50

2φ LOW INERTIA SERVO MOTORS

KOLLSMAN Type 937-0240—85/68V 100 cy 5 watts 2650 RPM—new $12.95
DIEHL, Type FPE-25-11 75V 60cy 4 watts — new $34.50

OIL FILLED CONDENSERS

MFD	VDC		Price	MFD	VDC	Price
2	600		$ .69	.1	2500	$ .69
4	600		1.65	1-1	2500	3.85
4	600	R'd	1.65	32	2500	15.80
6	600		1.85	3/.2	4000	2.95
8	600	R'd	1.85	1	5000	4.88
10	600	R'd	1.95	.01-.03	6000	1.65
8-8	600		1.95	.1	7000	1.79
1	1000		.62	.045	16KV	4.70
2	1000		.89	.05	16KV	4.95
4	1000		1.85	.075	16KV	8.95
8	1000		2.45	.25	20KV	18.95
1	1500		.89	50	220VAC	4.95
4	1500		2.95	7	660VAC	4.25
.1-.5	2000		.87	8	660VAC	4.50
1	2000		1.95			

HIGH VOLTAGE TRANSFORMERS

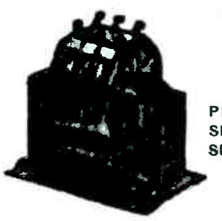
G.E.—Pri. 115V 60 cy Sec. 6250V 80 MA—12.5 KV Ins. $18.50
G.E.—Pri. 115V 60 cy. Sec. 6250/3850/2600V 56 MA 12.5 KV Ins.....................................$18.50
Raytheon—Pri. 115V 60 cy. Sec. 8500/6450V CT 43 MA Hermetically sealed..........................$22.50

CRYSTAL DIODES

1N21	$1.19	1N23	$1.49	1N34	$ .79
1N21A	1.69	1N23A	3.25	1N38	1.66
1N21B	4.00	1N23B	5.25	1N45	.94
1N22	1.09	1N27	1.79	1N52	1.05

ANTENNAS

AT-38A/APT (70 to 400MC)..................$13.70
AT-49/APR-4 (300 to 3300MC)................ 13.70
DZ-2 Loop antenna with pedestal............ 22.50
AN-74B (125 to 150MC)...................... 3.25
AN-65A (P/O SCR-521)....................... 1.50
AN-66A (P/O SCR-521)....................... 1.75
AIA-3CM conical scan...................... 125.00
ASB Yagi—5 element 450 to 560MC............ 7.00
ASB Yagi—Double stacked 6 element.......... 12.70
ASA Yagi—Double stacked 370 to 430MC....... 29.40



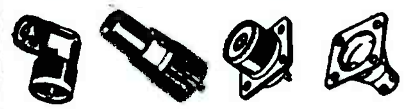
WESTINGHOUSE HYPERSIL TRANSFORMER

PRI-115V. 60CY ¾ KVA
SEC #1 - 240V - 1.56A
SEC #2 - 240V - 1.56A
WT. 30 LBS.

$14.50 EACH

Terms 20% cash with order, balance C. O. D. unless rated. All prices net F.O.B. our warehouse, Phila., Penna., subject to change without notice.

COAXIAL CONNECTORS



83-1AC	$ .42	83-1R	$ .40	83-22AP	$1.10
83-1AP	.30	83-1RTY	.65	83-22R	.68
83-1F	1.30	83-1SP	.50	83-22SP	1.15
83-1H	.10	83-1SPN	.50	83-168	.15
83-1J	.80	83-1T	1.30	83-185	.15

FULL LINE OF JAN APPROVED COAXIAL CONNECTORS IN STOCK

UHF		N	BN	BNC	
UG-7	UG-23	UG-37	UG-102	UG-175	UG-254
UG-12	UG-24	UG-57	UG-103	UG-176	UG-255
UG-18	UG-27	UG-58	UG-104	UG-185	UG-260
UG-19	UG-27A	UG-85	UG-106	MX-195	UG-264
UG-21	UG-29	UG-86	UG-108	UG-197	UG-274
UG-21B	UG-30	UG-87	UG-109	UG-201	UG-275
UG-22	UG-34	UG-88	UG-146	UG-206	UG-276
UG-22B		UG-98	UG-166	UG-236	UG-290
			UG-167	UG-245	UG-291
			UG-171		UG-306

M-358	MC-277	PL-259A	PL-325
M-359	MC-320	PL-274	SO-239
M-359A	PL-258	PL-284	SO-264
M-360	PL-259	PL-293	TM-201

93-C	49120	D-163950	ES-685696-5
93-M	49121A	D-166132	ES-689172-1

TYPE "J" POTENTIOMETERS

Resis.	Shaft	Resis.	Shaft	Resis.	Shaft
60	SS	5K	1/4"	50K	3/8"
60	9/16"	5K	3/8"	50K	1/2"
100	SS	5K	1/2"	100K	SS
200	SS	10K	SS	150K	1/2"
250	1/8"	10K	3/8"	200K	3/8"
500	SS	10K	1/2"	250K	SS
500	5/16"	15K	SS	250K	3/4"
500	1/2"	15K	1/2"	250K	3/8"
500	5/8"	20K	SS	500K	SS
650	1/2"	25K	SS	500K	1/4"
1K	SS	25K	1/4"	500K	7/16"
2K	3/8"	30K	1 1/8"	1 Meg	SS
2500	SS	40K	SS	2.5 Meg	SS
4K	SS	50K	SS	5 Meg	SS
5K	SS	50K	1/4"		

DUAL "JJ" POTENTIOMETERS

50	SS	500	SS	1 Meg	SS
100	SS	1K	SS	2.5 Meg	SS
250	SS	2500	SS	5 Meg	SS
330	SS	10K	SS	1K/25K	3/8"

TRIPLE JJJ POTENTIOMETERS

100K/100K/100K—⅜" 20K/150K/15K—⅜"

SOUND POWERED TELEPHONES

U. S. NAVY TYPE M HEAD AND CHEST SETS
U.S.I. A-260 W.E. D-173013
A.E. GL832BAO
ANY TYPE—$14.88 EACH
TS-10 Type Handsets......................$8.92 ea.

F. W. BRIDGE SELENIUM RECTIFIERS

AC Volts Input — 18		AC Volts Input — 40	
DC Volts Out — 14.5		DC Volts Out — 34	
1.3 Amps	$3.85	0.6 Amps	$4.60
2.4 Amps	4.95	1.2	5.95
6.6 Amps	7.75	3.2	8.95
13.0	12.75	6.0	15.50
17.5	15.75	9.0	17.50
26	22.75	12	26.95
39	35.50	18	32.50
52	38.50	25	42.50
70	49.50	36	55.50

130 VAC ½ WAVE STACKS

75MA	$ .88	150MA	$1.30	250MA	$1.75
100MA	1.10	200MA	1.57	400MA	2.60

GENERATORS

• Eclipse-Pioneer type 716-3A (Navy Model NEA-3A) Output—AC 115V 10.4A 800 to 1400cy. 1 φ; DC 30 Volts 60 Amps. Brand New....................$38.50
• Eclipse-Pioneer type 1235-1A. Output—30 Volts DC 15 Amps. Brand New—Original Packing...$15.50

THYRATRONS & IGNITRONS

OA4G	FG-41	FG-271	722A
C1A	FG-57	393A	873
1C21	FG-67	394A	884
2A4G	FG-81A	GL-415	885
2B4	91	KU-610	1665
2D21	FG-95	KU-623	1904
3C23	FG-105	KU-628	2050
3C31	FG-166	KU-634	2051
4C35	FG-172	WL-652	5550
C5B	FG-178	WL-672	5551
5C22	RX233A	WL-677	5552
C6J	FG-235A	WL-681	5557
FG-17			5560
FG-33			

TEST EQUIPMENT

• I-222A Signal Generator..................* $79.50
• I-72K Signal Generator.................... $48.50
• Vibrotest Mod. 218 Megger...............* $45.00
• C-D Quietone Filter Type IF-16 110/220V AC/DC 20 Amps...................................* $9.00
• TS-127/U Freq. Meter w/spares.............. $69.50
• TS-143/CPN Oscilloscope.................* $95.00
• Dumont 175A Oscilloscope................*$225.00
• LM-20 Frequency Meter...................* $49.50
• Gen. Radio 757-P1 Power Supply..........* $27.00
• TS-6/AP Frequency Meter.................* $42.00
• I-130A Signal Generator.................* $85.00
• A.W. Barber Labs. VM-25 VTVM............* $86.00
• TS-10A/APN Delay Line Test Set............. $45.00
• TS-19/APQ-5 Calibrator..................... $75.00
• 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
• 3 CM. Pickup Horn Antenna.................. $9.95
• I-138A Signal Generator—10 cm...........*$185.00

All Items New Except Where Noted * (Exc. Used Condition)

MISCELLANEOUS EQUIPMENT

Amperex 1B98 Gamma Counter.................$ 9.87
Powerstat 1226—115/230V Input—0-270V out @ 9 amp.................................. 37.00
EIMAC 35 TG Ionization Gauge................ 5.95
ATR Inverters 6VDC to 110 VAC 60 cy 75W... 22.95
ID-6/APN-4 Indicator........................ 29.50
R-7/APS-2 Receiver.......................... 49.50
R-78/APS-15 Receiver........................ 49.50
FL-8 1020 cycle filter...................... 1.75
RM-29 remote control unit................... 8.95
RM-14 remote control unit................... 8.95
RTA-1B 12/24 V dynamotor.................... 40.00
BC-1206-CM2 Receiver........................ 12.95
CY-230/MPG-1 Radar Console.................575.00
G.E. Type JP-1 portable current transformer.. 32.50
ASB-4 Radar equip. Complete................. 69.75
T-9/APQ-2 less tubes........................ 16.50
RCA AVR-15 Beacon Recvr..................... 15.50
TBY Trans-Recvr............................. 29.95
Pioneer Type 800-1B Inverters—28VDC to 120V 800 cy 7 amp AC (used)................... 22.65
G.E. Inverter—28VDC to 120 VAC 800 cy 750VA 1 φ.................................. 39.50
Navy SD-3 Radar complete..................1200.00
Navy DP-14 Direction Finder complete........385.00

PULSE TRANSFORMERS

UTAH 9262 9278 9280	UTAH 9318 9340 9350
G.E. 68G-627	Westinghouse 232-AW2
G.E. 68G828	Westinghouse 232-BW-2
G.E. 68G929G1	AN/APN-4 Block Osc.
G.E. 80G13	Philco 352-7149
G.E. K-2469A	Philco 352-7150
G.E. K-2744B	Philco 352-7071
AN/APN-9 (901756-501)	Philco 352-7178
AN/APN-9 (901756-502)	Raytheon UX-7350
AN/APN-9 (352-7250)	W.E. D-161310
AN/APN-9 (352-7251)	W.E. D-163247
Westinghouse PH-1	W.E. D-163325
Westinghouse 132-AW	W.E. D-164661
Westinghouse 139DW2F	W.E. KS-9563

AN/APA-23 RECORDER

Sweeps any receiver through its tuning range and permanently records frequency and time of received signals on paper chart. Power input—(motor) 27V DC 1.5A, and (recorder) 80/115V AC 60-2600 cy 135W.

Originally designed to record pulse or sine-wave modulated signals received by AN-APR-1, AN/APR-2, AN-APR-4, AN/APR-5, BC-348, S-27, SX-28. BRAND NEW $147.50

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 E3-200-67P, 7.5 KV, "E" Circuit 3 microsec. 200 PPS, 67 ohms Imped. 3 sections.........$6.75
7.5 E4-10-60-67P, 7.5 KV, "E" Circuit 4 sections, 16 microsec. 60 PPS, 67 ohms Imped.........$8.25
15 E-4-91-400-50P, 15KV "E" circuit .91 microsec. 400 PPS, 50 ohms imped. 4 sections.......$12.00
15-A-1-400-50P, 15KV, "A" Circuit, 1 microsec. 400 PPS, 50 ohms imped.........................$37.50
15 E7-2-200-50P, 15KV "E" Circuit, 2 microsec. 200 PPS, 50 ohms Imped., 7 sections........$42.00

SYNCHROS

Size 1, 3, 5, 6, 7 and 8 generators, motors, control transformers, differential generators, and differential motors in stock.

AY-101D	5F	M	C-69406-1
AY-120D	5G	N	C-78248
AY-130D	5N	X	C-78249
1CT	6DG	2J1F1	C-78410
1F	6G	2J1G1	C-78411
5B	7DG	2J1H1	C-78415
5CT	7G	C-44968-6	C-79331
5D	A	C-56701	C-78254
5DG	B	C-69405-2	C-78670

SEND FOR COMPLETE LISTING

SYNCHRO CAPACITORS IN STOCK

LECTRONIC RESEARCH LABORATORIES

715-19. ARCH ST. PHILA. 6, PA.

Telephones - **MARKET 7-6771-2-3**

SUPERIOR VALUES FROM

AMERICA'S LARGEST ELECTRICAL CONVERSION HOUSE

HIGH FREQUENCY CONVERSION EQUIPMENT

ONAN 400 CYCLE MG SET. Motor: 7½ H.P. operative at 220/440 V 3ϕ, 60 cy. V belted to self-excited alternator with output of 4KVA, 115 Volts, single ph. 400 C.P.S. Alternator is self-excited with secondary output of 14 VDC 40 amp. With Voltage Regulator built-in. Price $592.00
With single phase Motor....$642.00

ELECTRIC SPECIALTY FREQUENCY CHANGERS Type BFS52/BFRS354 Input: 220 Volts, 3 Ph. 60 cy. 3600 RPM. Output: 250 Volts, 20 Amps, single ph. 180 Cyc. 5000 VA. 3000 Watts. Brand New. Compact ball bearing units for operation of Hi-cycle equipment. SPECIAL PRICE $160.00

ONAN 800 CYCLE MG UNIT. Employing 5 H.P. Motor operative at 220/440 Volts, 3ϕ, 60 Cy. V belted to self-exc. generator with output of 1.5 KVA, 115 Volts, single ph. 800 CPS, and secondary output of 500 Watts 28.5 VDC 17.5 amperes. PRICE....$280.00

INVERTER UNIT PE206A. Input: 27.5 VDC, 28 amp. Output: 80 Volts, single ph. 800 CPS. 500 VA. Price $19.00

RLX DUAL GENERATORS. Flange mounted. Output: 500 Watts; 1300-2600 Cycles, also 12-14 VDC 750 Watts. Price $25.50

ELECTRIC SPECIALTY HIGH FREQUENCY CONVERTER UNIT. Primary: 32 VDC, 16 amperes, 3000 R.P.M. Ball Bearings. Secondary: 350 volts, 1500 cycles. .75 amps. 275 V.A Single Ph. Built-in frequency control. Specially Priced at....$30.00

BENDIX POWER MG SET. Consists of G.E. 2 HP Rep-Ind Motor, 115 volts, single phase, 60 cyc. directly connected to Bendix alternator with output of 120 volts, 700 cyc., 600 watts and DC output of 14.5 volts, DC, 22amp. Brand new. Price....$225.00

CONTINENTAL DC/AC SET. Motor: 1.5 HP. 230 VDC 3440 RPM. Output: 120 VAC, 6.6 amps. .8 KW. 800 cyc., 1 ph., also output of 14 VDC, 4 amps., Model CG21637. Compact 2-bear. units. Completely rebuilt. Price $89.00
Also available with input of 440-3-60 and same output. Price $101.50

WINCHARGER PU-16/AP INVERTER. Type MG750. Input: 28 volts, 60 amp. Output: 115 volts, 6.5 amp., 400 cyc., 1 ph. Brand new. Price....$69.50

HOLTZER-CABOT MG 221. Compact 2 bear. units for low current 400 cyc. Operates at 32 VDC. 8.5 amp. Output: 110 volts, 1.0 amp., 1 ph., 100 watts, 400 cyc. Brand new. Price $69.50

HOLTZER-CABOT MG 218. Operates at 115 VDC, 2.3 amp. with same output. Price....$79.50

LELAND INVERTER TYPE MG 4A. DC Input: 27.5 volts, 38 amp., 6000 RPM. Output: 115 volts, 1 ph., 400 cyc., 500 VA. Like new and fully guaranteed. Price $39.50

GENERAL ELECTRIC MODEL 5D21NJ3A. Input: 27 volts, 35 amp. Output: 115 volts. 485 VA, 1 ph., 400 cyc. Price $31.50

LOUIS-ALLIS 3 UNIT MG SET. Consists of 5 HP motor operative at 220/440-3-60 directly coupled to alternator with output of 115 volts, 1 ph., 400 cyc. and with exciter unit all mounted on steel base. Brand new. Price $565.00

HOLTZER-CABOT TYPE CAJ-211168 MG UNITS. Compact 2 bear. operative at 115 volts, 1 ph., 60 cyc., ½ HP. Output: 115 volts, 4 amp., 233 cyc., 3 ph., also 24 VDC at 5 amp. Brand new. Price....$36.00

NORMAND ELEC. CO. (BRITISH MFG.) MG UNIT. Motor: 220 VDC, 8.8 amp., 2 HP. 4200 RPM. directly connected to H. F. alternator with output of 1400-2800 cyc., 1200 watts. Exc. 24 VDC. Price....$70.00

MARCONI MG UNIT. ¼ KW, operates at 110 VDC to deliver 110 VAC, 300 cyc., supplied with field rheostat for variable frequency output. Price....$70.00

PIONEER MG UNIT. Input: 115 VDC, 3.4 amp. Output: 140 VAC, 1.2 amp., 350 cyc. Complete with field rheostat for variable frequency output. Price $60.00

ESCO MG UNIT. Operative at 120 VDC, 25 amp., 4 HP. Delivers 115 VAC, 1 ph., 1050 cyc., 2 KW. An exceptionally fine machine for laboratory use. Can be used with field rheostat for frequencies up to 2000 cycles. Price $175.00

ESCO INVERTER UNIT. Prim: 12 VDC, 20 amp. 1800 RPM. Sec: 140 VAC. 1 amp., 140 VA, 360 cyc. With field rheostat for frequency outputs up to 800 cyc. Price $69.50

HOLTZER-CABOT MG UNIT. Operates at 115 VDC. 8.2 amp. to deliver 55 VAC, 6 amp., 195 cyc., 3 ph., 1950 RPM with field rheostat for frequencies up to 400 cyc., 3 ph. Price....$80.00

HOLTZER-CABOT MG UNIT. Motor: 120 VDC, 5 amp., 2500 RPM. Output: 75 VAC. 9 amp., 500 cyc., 675 VA. 1 ph. Price....$49.00

GENERAL ELECTRIC HIGH FREQ. MG SET. Consists of 3 HP motor operative at 220-3-60, directly connected to alternator with output of 220 VAC. 22.7 amp., 1 ph., exciter unit rated at .5 KW, 110 VDC. 3 units are directly coupled. Price....$295.00

G.E. MG SET MODEL 5LY56AB5A. Motor: 1.1 HP. 250 VDC, 4 amp. Generator: 600 watts, 125 VAC, 4.8 amp., 500 cyc., 1 ph. Price $79.50

HOLTZER-CABOT HIGH FREQUENCY MG SETS. Compact 2 bearing units with input of 120 VDC, 7 amps. Output: 120 Volts, 3ϕ 320 Cycles. Has shaft extension permitting use as dual generator. Price $112.00

WESTINGHOUSE HIGH FREQUENCY UNITS. Operate with input of 115 VDC to deliver 17 VAC. 1050 to 1650 cycles. An excellent value....$25.50

ESCO DUAL FREQUENCY UNITS. Motor operates at 120 VDC, 10 amperes. Delivers 70 Volts at 120 Cycles or 200 Volts at 720 Cycles. Price....$95.00

GE MG UNITS. Motor: 110 Volts, D.C. 31.5 Amperes, in a single compact unit with output of 120 Volts, 20.8 Amp. single ph. 500 cycles. Like New. Price....$95.00

WESTINGHOUSE HIGH FREQUENCY UNITS. Input: 115 Volts, D.C. 2.7 Amps. Output: 14.4 Volts, obtained with built-in controller on end of unit. .139 Amp. 450-2550 Cycles. Frequency variation is Price $48.50

GE DUAL OUTPUT MG SETS. Consist of Motor rated 3 H.P. 230/440 V. 3ϕ, 60 Cy. directly coupled to 2 generators. Output .5 KW. 220 Volts, 2.27 Amp. 525 Cycles. Also .5 K.W. 110 Volts, D.C. 4.55 Amp. 3 separate units mounted on common bed plate. Price $150.00

WESTINGHOUSE 180 CYCLE ALTERNATORS. 750 V.A. Output: 110 Volts, 3 Phase, 180 C.P.S. 3000 R.P.M. Separately excited at 110 VDC. Price..$44.00 Also available with built-in exciter. Price....$78.00

GENERAL ELECTRIC HIGH FREQUENCY UNIT. Operating at 440-3-60 .75 amp. Output. 70 Volts, 3 ph. 148 cyc. 220 Watts, 1.8 amperes. An ideal unit for experimental work or for operation of equipment. SPECIAL PRICE $34.50

GE HIGH FREQUENCY MG SETS. Motor: 250 VDC 4 amp. Alternator: 600 watts, 125 single ph. 4.8 amp. 500 cycles. Brand new. Price....$90.00

MARCONI MG UNITS. Operative at 110 VDC to deliver 500 VAC, 6 amp. 3 K.W. 240 CYCLES. Extending shaft permits driving complete unit to obtain dual self-excited generator. Price....$89.00

HOLTZER-CABOT 500 CYCLE MG SET. Motor: 230 VDC GENERATOR: 5 KVA 230 VAC, 1ϕ 500 Cyc. Rebuilt. Price $271.50

CROCKER-WHEELER 500 CYCLE MG SET. Compact 2 bearing Unit. Operative at 120 VDC, 7.3 amps. Output: 250 Volts, 5 amp. 500 cycles. Rebuilt. Price $88.88

ESCO HV UNITS: Operative at 11.5 VDC 28 Amp. Output: 575 VDC .25 Amp. also 55 VAC. .91 Amp. 1ϕ. 500 Cycles. Price....$36.75

GENERAL ELECTRIC 400 CYCLE UNITS. Operate at 26 VDC. 100 Amp. Output: 115 VAC. 1ϕ. 400 CPS. 1500 V.A. With filter system built-in. Price....$29.50

LOUIS ALLIS FREQUENCY CHANGER SETS. Pri: 25 H.P. 220/440-3-60: Sec. 15/10.8 K.W. 3300/2200 RPM. 30/220 Volts 35/35 Amps. 2 ph. 500/360 C.P.S. Price $1050.00
Pri: 10 H.P. 220/440-3-60: Sec: 7.5 K.W. 440/220 V. 17/8.5 Amp. 3000/1200 RPM. 360/180 Cycles. 2 ph. Price $750.00

We can supply these units for 400 cycle output and with transformers to supply 3 phase, wye output. Write for further information.

BENDIX ECLIPSE 800 CYCLE AERO UNIT. Input: 24-28 VDC, 75 amps. Output: 115 V. 10.5 Amp. 800 C.P.S. Complete filter system mounted thereon. Price $22.50

ONAN 2 BEARING MG UNITS. Motor: 115/230 Volts, single phase, 60 cy. Generator: .6 KVA 115 Volts, 5.3 Amps. 480 C.P.S. Price....$165.00

ECLIPSE 800 CYCLE GENERATORS. Flange mounting with spline shaft. Output is 115 VAC 10.4 Amp. 90% P.F. 800 Cycles, 1200 V.A. with secondary output of 28.5 VDC. 60 Amperes. Self excited. Price $39.00

BRITISH MADE 500 CYCLE MG SETS. Motor: 230 Volts. 3 PH—50 Cycles, Alternator: 5 K.W. 180 Volts. 27.8 Amp. 500 Cycles. Excitation—110 VDC. When used at 60 Cycle current. Output is 600 cycles, 220 Volts. Price....$353.00

WINCHARGER PU-7/AP; Input: 28 VDC, 160 Amps. Output: 115 VAC. single ph. 2500 V.A. 400 C.P.S. Frequency and Voltage regualtion built-in. Price $87.00

British Alternators. 1.5 KVA., 230 Volts, 1ϕ, 400 CPS. sep. exc. Price....$115.00

ONAN 400 CYCLE MG SET. Motor: 5 HP, 220/3/60 Generator: 2 KW. 115 volts, single phase, 400 CPS, self excited with secondary output of 26 volts DC, 200 watts. V-belt drive. Price....$635.00

HERE IS EXCEPTIONAL VALUE

Robins and Myers Motor Generator Units. Operate at 110 Volts, AC, single phase, 60 cyc. and deliver 22/40 Volts, DC. Can be used with field rheostat to supply 24/28 VDC for the operation of aero equipment from lighting line. Rated at 40 watts but will deliver 200 watts for intermittent operation. Gear head built into one end rotates external shaft at 225 RPM. An exceptional value at $18.75 each. With field rheostat $20.00. Also available for operation at 115 VDC at $12.50 and with rheostat at $13.75 each. Both units have 1/4 HP Motor. Stock up on these sets while they are available. Special price on quantity. Rebuilt.

Esco AC Motors: built-in magnetic brake for quick reversing. Double shaft, ball bearings. Rated: 2½ HP—30 minutes, marine duty: 440-3-60. Brand new in original cases. **SPECIAL PRICE** $34.00

ESCO DC/AC MG SETS. Motor: 115 Volts, 1½ HP line start; built in voltage regulator, frequency control, filtered; ideal for television, radar or any application requiring constant voltage and frequency. Output: 115 V.A.C. 1ϕ, 60 Cyc. 460 V.A. Brand New....$120.00

WE CAN FURNISH M.G. SETS OF ANY SPECIFICATIONS. SEND US YOUR REQUIREMENTS.

GEN. ELECTRIC AMPLIDYNES

Model 5AM73AB89; Input: 115 VAC. 1ϕ, 60 cyc. 9 amp. Output: 375 K.W. 250 VDC. 1.5 amp....$86.00

Model 5AM65FB2A; Input: 115 VAC, 3ϕ, 60 cyc. 5 amp. Output: 500 watts, 250 Volts, 2 Amp....$144.00

Model 5AM49AB30; Input: 440 Volts, 3 phase, 60 cyc. 1 amp. output: 115 Volts, D.C. 3.25 amp. 3450 RPM. $88.00

Model 5AM31NJ18A; Input: 27 VDC, 44 amp. 8300 RPM. Output: 60 VDC, 8.8 amp. 530 watts....$12.95

Model 5AM78AB10; Input: 32 VDC, 60 amp. 2 H.P. 2200 RPM; Output: 250 Volts, D.C. 3 amperes; 750 Watts $190.00

Model 5AM45DB26; Input: 440 V. 3ϕ, 60 cyc. Output: 125 V.D.C. 1.0 Amp....$55.00

Model 5AM49AB7A; Input: 440 Volts, 3ϕ, 60 Cyc. Output: 375 Watts. 250 V.D.C. 1.5 Amp. Price.$100.00

WESTINGHOUSE AMPLIDYNE TYPE MG SETS

Motor: Type CS, Fr. 204, 208 v, 3 ph., 60 cyc., 4 amps, 1.5 HP, directly connected to 2 DC gen. (1) 125 VDC, 2.8 amp., .35 KW. Gen. (2) 250 VDC, 2 amp., sep. exc. 35 volts. The 3 units are contained in one housing. Brand new. The generators have similar characteristic of an amplidyne with a set of control fields and are completely enclosed with rubber gaskets on the enclosing covers, which can be removed for increased KW output. An exceptional value at $183.00

Crompton-Parkinson Alternators. 3 KVA. .7 PF. 110 VAC, 1ϕ, 60 cy. 1800 RPM. sep. exc. Price....$170.00

DC Manual Controllers, mfg. by Marconi Co. of England. Enc. type. For starting duty of 24 VDC Motors, rated at .7 HP. A really hard-to-get unit at a give-away price. SPECIAL....$4.60

PIONEER DYNAMOTOR. Type PS250. Input: 12 VDC, 4.9 amp. Output: 350 VDC. .100 amp., brand new. Price $14.00

BRITISH DC/AC MG UNITS. Operate at 100/110 VDC, 4 amps., 3000 RPM. Output: 230 VAC, .87 amp., 50 cyc. Wt: 132 lbs. Brand new. Price....$42.50
With field rheostat for 60 cyc. output. Price....$50.00

G.E. 3 PH. TRANSFORMERS. 3 KVA, 418/429/440 Pri. 140 volts. 3 ph. Sec. Price....$45.50

G.E. SELSYN MOTORS. Model 2JD65FA2. 120/55 volts. 60 cyc. Price....$18.50

BOGUE ELECTRIC AC/DC MG SET. Consists of 5 HP motor in center directly connected to 2 12 volt 160 amp. generators. Will deliver 24 volts at 160 amp. or 12 volts at 320 amp. Condition like new. Price $375.00

LOW FREQUENCY MOTOR GENERATOR. Burke. Variable frequency, 2-12 cycles, single phase, 300-800 amperes, 25-5 volts, ball bearings. Price....$385.00

WINCHARGER WIND GENERATOR. 12 volts. 250 watts, complete with all fittings including propeller. Excellent for battery charging. Price....(New) $70.00

GARDNER DRY TRANSFORMER. 3.42 KVA, 230/115 to 5.7 volts, 600 amperes. Price....$48.75

RAYTHEON VOLTAGE STABILIZER (CONSTANT VOLTAGE TRANSFORMER). Input 190-260 volts. Output 230 volts, 250 VA. Price....$31.75

RAYTHEON CONSTANT VOLTAGE TRANSFORMER. .5 KVA. Input 180-269 volts. Output 220-230 volts. Price $67.50

ACME AIR-COOLED TRANSFORMER. Primary: 500 volts. Secondary: 14,840 volts with C.T., 3 phase, 60 CPS. 18.2 KVA, brand new. Price....$390.00

RAYTHEON VARIABLE VOLTAGE TRANSFORMER. Primary: 220 volts, 3 phase with output by selector snap switch giving voltage outputs from 140 to 220. Brand new. Price....$35.00

WESTINGHOUSE TRANSFORMER CONTROLLER. Contains 300 watts, 120-220 volt transformer with multi-taps. The transformer with tap switch alone is worth more than the special price....$6.25

IDEAL AC/DC M-G UNIT. 110 V. 1ϕ, 60 cy. Input: 110 VDC 2.28 amp. .25 KW output. 2 bearing unit thoroughly rebuilt and guaranteed. With rheostat. Price $55.00

GE DC Generators. Consists of three separate generators in one unit. 3600 RPM. Delivers 1200 V., 450 V. .25 a. and 115 V. 1.3 amp. Price....$24.00

G.E. Motor Starting Reactors Type 11K2840G2: Rated at 440 V. 3 Ph. 60 Cy. 16.8 Amp. Only a 3 Pole Double Throw Switch is necessary with this unit to make a 15-20 HP compensator starter. Useful for any purpose requiring three phase choke. **SPECIAL PRICE**..$16.00

GE DC Generators. Type SD. Sh. wdg. .5 KW. 18 VDC. 27.8 amp. 1725 RPM. Price....$30.00

Watthour Meters. 110/110 Volt DC operation. Used but in A1 condition. 5 amp....3.75 10 amp....$4.35 15 amp....$5.00 25 amp....$6.00

ALLIS-CHALMERS MG UNIT. .94 KVA, input 24 VDC, 63 amperes. Output 120/60/1, 7.82 amperes, 3600 RPM. New. Price....$149.90

IF IT'S FROM ONE FREQUENCY TO ANOTHER; FROM DC TO AC OR AC TO DC; IF IT'S ONE VOLTAGE TO ANOTHER, THEN CALL ON US.

Established in 1922

WILLIAM I. HORLICK COMPANY

Tel. HAncock 6-2480

409 ATLANTIC AVE. BOSTON, 10, MASSACHUSETTS

Electrolytics

29¢ ea.
10 for $2.75

MFD.	VOLT
2x 8	450
2x10	450
2x15	450
2x16	450
2x20	350
2x20	450
20–20	400/25
20–20	350/25
20– 8	500
20–10	350/300
24–24	400
30–30	350
40–40	400
40–40	450
40–40	475–400
40–10	450
40–10	450/350
40–15	450
40–20	150
40–20	150/25
40–35	450/350
40–50	400 300
50–30	150
50–40	300–250
A. C. COND. NON-POLARIZED	
13–15	220–1.20
20–24	110–1.00
26–30	220–1.35
43–65	110–1.25
43–48	110–1.25
50–75	110–1.25
53–60	220–1.50
61–69	320–1.60
64–72	110–1.25
72–87	110–1.25
75–84	110–1.25
88–106	110–1.50
107–129	110–1.65
130–157	110–1.75
130–150	70–1.50
130–180	110–1.85
158–191	110–1.85
161–180	110–1.75
189–210	110–1.95
200–220	110–1.95
270–300	110–2.10
324–360	110–2.40
378–420	175–3.00
432–480	110–2.75
485–540	110–2.85

MINICAPS PIGTAIL

Mfd.	Volt	Price
2	50	$.10
4	50	.10
4	100	.15
4	150	.10
4	220	.18
5	25	.10
5	50	.10
5	150	.10
8	25	.15
8	100	.18
8	150	.18
8	350	.20
10	50	.18
10	150	.20
12	450	.23
16	100	.20
16	150	.22
16	300	.30
16	450	.40
20	25	.10
20	50	.15
20	80	.18
20	350	.30
24	350	.30
25	25	.10
30	300	.25
30	450	.30
40	150	.22
40	450	.40
50	25	.22
50	50	.25
50	150	.39
100	50	.60
250	15	.50
500	8	.60
500	25	.75
1000	6	1.20
2000	6	1.35
1200	1.5	1.10
8–8	450	.60
8–16	450	.65
10–10	150	.30
10–10	450	.35
16–16	450	.70
20–20	150	.40
20–20	450	.50
40–20	450	.55
50–50	150	.40
50–30	150	.35
70–70	175	.85

400 CYCLE TRANSFORMERS
115-V 400 CYCLE INPUT

Ratings	Price Each
6.3V/1.8A P/O APG2	$1.49
6.4V/2.5, 400VCT/35Ma. 6.4/.150a	3.95
6.4V/7.5, 6.4/3.8. 6.4/2.5a	3.49
780V/27v/4.7, 6.3/2.9, 1.25/.2a	2.49
6.4V/8a. 6.4V/1A	1.95
6.3V, 9.1A, 6.3VCT/6.5a, 2 x 2.5/3.5a	2.49
5V/2a, 6.3V/2a, 5V/2a, 6.3/.5a	2.99
5V/15A, 5000V Ins	3.95
6.3/2.7, 6.3/.66, 6.3VCT/21A	5.95
760V, 6.3V, 6.3V, 5V. 320V, 6.3V/20A 6.4/7.5, 6.4/3.8, 6.4/2.5	2.95
592V/118Ma, 6.3/8, 1a, 5V/2 W.E.	4.95
6.3V/9.1, 6.3VCT/.65a, 2 x 2.5V/3.5A	2.95
6VCT/.00006 KVA	.98
6.4V/8a. 6.4V/1a	1.49
526VCT/.50a, 6.3VCT/2a, 5VCT/29	3.49
2300VCT Large Qty	2.25
600VCT/36Ma	1.49
2.5V/1.75, 5V/3A, 6.5V/6.5, 6.5/2. For SCR729	3.95
360VCT/20Ma, 1500V/1Ma, 2.5V, 6.3/2.5, 6.3V/.6a, P/o 729A	3.95
2 x 2.5V/5A, 2.5V/10A, P/O APT 4	4.95
2 x 2.5V2.5a, 6.3V/2.25a, 1200V, Tap 1000V—750V, P/o AN/APS-15	4.95
742.5V/50MA, 709V, 47MA, 671V/45Ma	2.95
640VCT/250MA, 6.3V/.9, 6.3V/.6, 5V/6A	3.95
6.3V/9.1a, 2.5V/3.5a, 6.3VCT/65a, 2.5V/3.5a	3.25
9800V or 8600V/32MA	12.50
4540VCT/250MA	7.50
5V/3a, 6.3V/2a	1.75
5000V/290MA, 5V/10A	12.50
2200V/350	5.45
2.5V/5, 5200V/2MA	14.95
13.5KV/3.5MA	11.50
734VCT/.177a, 1710VCT/177a	6.95
6.3V/9A, 7.7V/.365A	2.79
2.5/20A	4.85
6.3V/12a, 6.3V/2a, 6.3V/1a, P/o AN/APQ-5	5.85
6.4VCT/7.5, 6.4VCT/3.8, 6.4VCT/2.5a	4.35
6.3V/2.7, 6.3V/.66A, 6.3VCT/21A	2.95
6.5V/12A, 250V/100MA, 5V/2a, P/o AN/APS-15	3.50
650VCT/50MA, 6.3VCT/2A, 5VCT/2A, P/o, R58/ ARQ8	2.45
2400CT/5MA, 640V/.5MA, 2.5V/1.75A	3.85
15.35VCT/1A	1.95
6.3/.9, 6/3V/.6.5V/6, 640/200MA	4.95
2 x 14CV/00014A, 12QV/00012a, P/o APG2	1.95
3640V/400Ma, P/o APT4	7.95
23.5V Tapped 22V/47MA	1.95
600VCT/36Ma	1.95
780V, 27V/4.3. 6.3V/2.9, 1.25V/20A	3.95
6.4V/11 Amp. P/o APQ7	2.25
2 x 6.3V/1.25a, P/o APQ13	1.95

DYNAMOTORS

Type	Input Volts	Input Amps.	Output Volts	Output Amps.	Radio Set	Price
PE86	28	1.25	250	.060	RC 36	$2.95
DM416	14	6.2	330	.170	RU 19	6.95
DM33A	28	7	540	.250	BC 456	4.95
DM42	14	46	515	.110	SCR 506	4.95
			1030	.050		
			2/8			
PE101C	13/26	12.6	400	.135	SCR 515	5.95
		6.3	800	.020		
BD AR 93	28	3.25	375	.150		4.45
23350	27	1.75	285	.075	APN-1	3.50
ZA0515	12/24	4/2	500	.050		3.65
B-19 pack	12	9.4	275	.110	MARK II	8.75
			500	.050		
D-104	12		225	.100		12.69
			440	.200		
DA-3A	28	10	300	.060	SCR 522	
			150	.010		
			14.5	.5		
5053	28	1.4	250	.060	APN-1	3.95
PE73CM	28	19	1000	.350	BC 375	
CW21AAX	13	12.6	400	.135		
	26	6.3	800	.020		
			9	1.12		9.95
BD77KM	14	40	1000	.350	BC 191	12.95
PE94	28	10	300	.200	SCR 522	
			150	.101		
			14.5	.5		

INVERTERS

PE 218-E: Input: 25 28 vdc. 92 amp. Output: 115 v. 350-500 cy 1500 volt-amperes. Dim: 17"x6½"x10". New $49.50

PE 218-H: Same as above except size; 16½"x6"x10". New $49.50

PE 206: Input; 28 vdc. 38 amps. Output: 80 v 800 cy. 500 volt-amps. Dim: 13"x5½"x10½". New....$12.50

RC 145 IFF GROUND STATION EQUIPMENT

RC 145 includes:
Receiver and Transmitter BC 1267A;
Power Unit RA 105A;
and Indicator Panel 1-221A.

The 8 tube transmitter delivers 1 KW peak power between 157-187 mc. using PP 2C26 tubes, an 829 modulator, and several pulse forming and clipping tubes. There is plenty of room to install crystal oscillator, multipliers and modulators. The lecher line plate circuit and antenna coupler are adjustable from the front panel. Both receiver and transmitter can be matched independently to the antenna in use by adjustments on the front panel. The dials are not calibrated in frequency.

The receiver is a 13 tube superhet, as follows: RF stage—6AK5; RF stage 6AK5; Mixer—6AK5; H. F. Osc.—6C4; Five IF Stages—6AG5; Second Det.—6H6; Tuning Eye—6E5; Video Amp.—6AG5; Cathode Follower—6AG5.

The I.F. frequency is 11 mc. and is stagger tuned to bandwidth of 4 mc. Power is supplied to the receiver from the main power supply. There is a jack for audio output from the second detector. Receiver dials are not calibrated in frequency. Tuning range 157-187 mc.

The indicator panel has controls for turning on and off a beam antenna rotating motor and various tubes and circuits to indicate the position of the antenna. Includes 1 selsyn motor. (8 tubes)

The power required is approx. 450 watts at 117 volts 60 cycles. The power supply is fused on the front panel. and circuit breakers are used in the HV and Fil. primaries. (7 tubes). The relay rack measures 39 5/16" high, 26¼" wide and 20½" deep. There is a blower mounted in the top of this rack. In all, there are 36 tubes supplied with the equipment. The weight of the entire equipment is approximately 400 lbs.

These units are brand new.

Price $390 ea.

Wavemeter for above $75.00
Dipole Array for above $85.00

CRYSTALS Low Freq.

FT-241. A holder ½" Pin spacing, for ham and general use. Xtal controlled. Signal Generators, Q-5'RS. S.S.B. Exciters (Nov. QST) marked in army Mc harmonic frequencies—Directions for deriving fundamental frequencies enclosed. Listed below by fundamental frequency, fractions omitted.

370	419	445	485	512	391	447
372	420	446	486	513	392	448
374	422	455	487	514	393	450
375	423	458	488	515	394	451
376	424	459	490	516	395	453
377	425	461	491	518	396	454
379	427	462	492	519	397	455
380	429	468	493	520	398	456
381	430	469	494	522	400	457
383	431	470	495	521	401	463
384	433	472	496	525	402	465
385	434	473	497	526	403	498
386	435	474	502	527	404	500
387	436	475	503	529	405	501
388	437	476	504	530	406	538
412	438	477	505	531	407	540
413	440	479	506	533	408	
414	441	480	507	534	409	each
415	442	481	508	536	411	$1.49
416	443	483	509	537	each	
418	444	484	511	390	59c	

FULL WAVE BRIDGE SELENIUM RECTIFIERS

18 VAC IN. 14 VDC OUT.
2A $2.95
4A 4.89
6A 6.90
8A 7.49
12A 9.79
24A 18.34

36 VAC IN. 28 VDC OUT.
1A $3.95
2A 5.79
4A 9.89
8A 13.69
12A 19.49
24A 34.53

54 VAC IN. 42 VDC OUT.
2A $6.95
4A 14.49

120 VAC IN. 100 VDC OUT.
2A $14.45
8A 42.50
12A 65.15

SPECIAL RECTIFIERS ON REQUEST

Hi-Current Chokes
.1 HY—12 Amp—40 Ohms $14.95
.01 HY—2.5 Amp—Cased $2.25

Low-Voltage Transformers Primaries 115v, 60 Cycle
36V-40V at 3.5 amps...$3.75
24v-1.5A 1.55
8v-1.5A .... .98

Transmitters 40-Watt Output

These Famous V.F.O. Drivers Available

4—5.3MC. $5.95
5.3—7MC. 5.95
274N (ARC5)
Used. Good Cond.

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 Hdsets. Used, excellent...$9.95

T.V. Transformer, 7" or 9" scope, 3000v / 5 MA, 720vct /200 MA. 6.4 / 8.7A, 6.4 / 6A, 5/ 3A, 1.25/ 3A, 115V 60 cy Input. Price $3.95

A-62 PHANTOM ANTENNA

This antenna is a Signal Corps type, and may be used for pre-tuning rigs for either single wire, doublet, or co-axial fed antennas. Unit consists of two coils, two resistors, variable condenser and indicating lamps, completely enclosed in circular can, 3" in diameter, 6½" high, having bracket for wall mount, or rear of can. Used chiefly by Signal Corps for tuning mobile equipment.

TUBES!

LARGE QUANTITIES AVAILABLE

01-A	7E5	615	EF50
1B26	7E6	704-A	F-127
2C21	10Y	705A	FC258A
2C22	12A6	724B	
2X2/879	12K8Y	800	GL532
3BP1	12SF7	801-A	FC271
2C24	12SR7	804	GL562
3C30	15P	815	GL623
3D6	28D7	836	GL697
3CP1	30 (Spec.)	837	ML100
3D21-A	45 (Spec.)	843	QK59
3DP1	39/44	860	QK60
3EP1	35/51	861	QK61
3FP7	227A	874	QK62
3O5	225	876	VR91
5BP1	268-A	1005	VR130
5BP4	355-A	1619	VR135
5CP1	417	1624	VR137
5FP7	530	1629	VU120
5J30	531	1961	VU134
6C	532	9002	WL532
6SC7	559	9004	WN150
7C4	562	CEQ72	WT260

PRECISION RESISTORS

1.01	128	2230	30000
3	150	4300	33000
5	200	5000	35000
5.05	250	7500	40000
10.1	300	8500	50000
18	430	10000	55000
43.5	468	12000	57000
50	800	17000	75000
75	920	17300	We ship
82	1000	20000	type in
120	1100	25000	stock
125	1450		

Above Ea.......30¢ Ten For $2.50

100000	150000	200000
120000	170000	220000

Above Ea.......40¢ Ten For $3.50
1,000,000 ohms .... Each 75¢

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Mfd.	Volt.	Price
5	50	$0.45
650	80	1.95
15	220 AC	2.20
1	500	.40
0.5	750 AC	1.59
0.5	1000	.69
2x0.5	1000	.70
1	1000	.75
1.5	1000	.85
2	1000	.90
4	1000	1.75
3x.01	1200	1.35
1	1500	1.30
1.5	1500	1.40
2	1500	1.45
2x0.1	2000	1.10
0.15	4000	1.20
2x0.1	4800	1.20
0.1	6000	2.39
2x0.1	7000	1.75
.015	16000	8.95
.0016	15000	5.95
.25	20000	
1	25000	
.5	25000	
1	7500	

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Magnesyn Instrument Field Tester AAF 43G-23330 Spec. 40772 To test individual mag. Ind. & Xmitters, for isolating Faults in magnesyn systems. Brand new.$125.00

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RG 28/U, 50 ohm imp. pulse cable Corona min. starting voltage 17 KV
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RADAR — COMMUNICATIONS

10 CM RESEARCH EQUIPMENT

Coaxial Wavemeter, W.E. Transmission Type, using type "N" fittings. Calibrated between 3400-4500 MC $99.50
LHTR. LIGHTHOUSE ASSEMBLY Part of RT39 APG 5 & APG 15 Receiver and Trans Cavities w/assoc. Tr. Cavity and Type N CPLG. To Recvr. Uses 2C40, 2C43, 1B27. Tunable APX 2400-2700 MCS. Silver Plated $49.50
BEACON LIGHTHOUSE cavity 10 cm. Mfg. Bernard Rice .... $47.50 ea.
MAGNETRON TO WAVEGUIDE Coupler with 721A Duplexer Cavity, gold plated $45.00
SIGNAL GENERATOR using 417A klystron, 2700-3300 mc. Output approx. 50 mw. 115 vac power supply. With tubes, new $425.00
REGULATED POWER SUPPLY for GL 446 type lighthouse tubes (2C40, etc.) 115 vac. 60 cycles. Panel Mounting. Less tubes $32.50
COAX CRYSTAL MOUNT, type N connectors $17.50
RT-39/APG-5 10 cm. lighthouse RF head c/o Xmtr.-Recvr-TR cavity compl. recvr & 30 MC IF strip using 6AK5 (2C40, 2C43, 1B27 lineup) w/Tubes.
721A TR BOX complete with tube and tuning plungers $12.50
McNALLY KLYSTRON CAVITIES for 707B or 2K28. Three types available $4.00
TS 268 CRYSTAL CHECKER $35.00
F 29/SPR-2 FILTERS. Type "N" input and output $12.50
WAVEGUIDE to 7/8" Rigid Coax "Doorknob" adapter choke flange, silver plated broad band $32.50
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
MAGNETRON COUPLING FOR TYPE 720 MAG. to 1½" x 3" Waveguide $35.00
AS14A/AP-10 CM Pick up Dipole with "N" Cables $4.50

7/8" RIGID COAX—3/8" I.C.

RIGHT ANGLE BEND, with flexible coax output pick-up look $8.00
SHORT RIGHT ANGLE bend, with pressurizing nipple $3.00
RIGID COAX to flex coax connector $3.50
STUB-SUPPORTED RIGID COAX, gold plated 5' lengths. Per length $5.00
RT. ANGLES for above $2.50
RT. ANGLE BEND 15" L OA $3.50
FLEXIBLE SECTION. 15" L Male to female $4.25
FLEX COAX SECT. Approx. 30 ft $16.50

1.25 CM RESEARCH EQUIPMENT

Complete 24,000 MC RF Head, including 2K33 Klystron, 3J31 Magnetron and Magnet, all plumbing, and associated circuitry, in standard A-N Pressurized housing. New, $1100.00.

Low Power Load $20.00
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
Mitered Elbow, cover to cover $4.00
TR-ATR-Section. Choke to cover $4.00
Flexible Section 1" choke to choke $5.00
"S" Curve Choke to cover $4.50
Adapter, round to square cover $5.00
Feedback to Parabola Horn with pressurized window $27.50
90° Twist $10.00
"K" Band Directional Coupler .... $49.50 ea.

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QCU Magneto striction head RCA type CR 278225—New $95.00
Stainless Steel streamlining housings for above $18.50
QBG Driver Amplifier, New $200.00
QCU Magneto striction head, coil plate assembly, new $14.50
QCQ-2/QCS Magneto striction head coil plate assembly $14.50
QCG2 Sonar complete set—Write for details.
QC-RCA magneto striction head assy. consists of coil, plate, nickel diaphragm plate, milled steel body unassembled $65.00
Supersonic Oscillator RCA 17-27 Kc. Rec. Driver, Osc. 115 v 60 cy. AC. Designed for use w/200 watt drive. New less tubes $39.50
WEA-1 Console, Consists of Rec. Ind. Osc. Remote training control 200 watt driver amp. 17-27 kc range $450.00
QBF Sonar mfg. WE complete console consists of 10-40 kc rec. driver osc. Ind. & control unit, and driver amplifier 22-28 kc. Write
QJA Sonar QBF w/OJA adapter kits w/cathode ray tube indication. Write.

3cm Research Equipment 1" x ½" WAVEGUIDE

1" x ½" waveguide in 5' lengths, UG39 flange to UG40 cover, silver plated .... $7.50 per length
Rotating Joint supplied either with or without deck mounting.
UG 40 choke flanges .... $17.50 each
Micrometer Head Wavemeter (Ordnance absorption type) supplied with calibration curve .... $85.00 each
2J42 Magnetron Pulse Modulator, 14Kw max. rating 7Kw min. Plate voltage pulsed 5.5kv. 6.5 Amp. 1001 duty cycle, 2.5 usec pulse length max. filament 6.3v .5 amp. Includes magnetron mtg. and blower. Requires 3C45 and 2-3B24. New $75.00
TS-268 Crystal Checker $35.00
Bulkhead Feed-Thru Assembly $15.00
Pressure Gauge Section 15 lb. gauge and press nipple $10.00
Pressure Gauge, 15 lbs $2.50
Dual Oscillator-Beacon Mount, P/O APS 10 Radar for mounting two 723A/B klystron with crystal mts. matching slugs, shields $42.50
Dual Oscillator, Mount. (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, type "N" take off 20 DB calibrated $17.50
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
CU 105/APS 31 Direction Coupler 25 DB $25.00
723AB Mixer—Beacon dual Osc. Mut. w/xtal holder $12.00
Waveguide Section 12" long choke to cover 45 deg. twist & 2½" radius. 90 deg. bend $4.50
Twist 90 deg. 5" choke to cover w/press nipple $6.50
Waveguide Sections 2½ ft. long silver plated with choke flange $5.75
3 cm. mitred elbow "E" plane unplated $12.00
UG 39 flanges .... 85¢
UG 40 chokes $1.00
90 degree elbows #E or H plane 2½" radius $12.50
90 degree twist 6" long—UG39 to UG40 .... $8.00
45 degree twist $8.00
40KW X Band radar, complete as described and illustrated in July, 1951, Electronics—APS-4 under belly assembly, less tubes $375.00

1¼" x 5/8" WAVEGUIDE

Tunable Termination—Precision adjust $65.00
Low Power Termination $25.00
Magic Tee $45.00
90 Degree Elbows, E or H plane $12.50
Waveguide Lengths, cut to size and supplied with 1 choke, 1 cover, per length .... per ft. $2.00
Bi Dir-Coupler WG output calibrated—25 db nominal $17.50
Flex sections, 12" Rubber Coated $14.50
Mitred Elbow H Plane UG51-UG52 .... $12.00
6" St. sect. choke to choke $3.50
APQ 13 Constant Z Rotat. Jnt $22.50
CG 98B/APQ-13 12" Flex. Sect. 1¼" x 5/8" OD $10.00
Wave Gd Run 1¼" x 5/8" Gd. consists of 4 ft. sect. w/RT angle bend on one end. 2" 45 deg. bend on other end $8.00
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D-172155 .... $2.25
D-172307 .... $1.70
D-168687 .... $ .95
D-171812 .... $ .95
D-171528 .... $ .95
D-162356(308A) $1.50

THERMISTORS

D-166288 .... $1.50
D-167332 (tube) $1.50
D-170396 (bead) $1.50
D-167613 (button) $1.50
D-164699 for MTG .... "X" band Guide $2.50

PULSE EQUIPMENT

MIT. MOD. 3 HARD TUBE PULSER: Output Pulse Power 144 KW (12 KV at 12 Amp). Duty Ratio: .001 max. Pulse duration: .5, 1.0, 2.0 microsec. Input voltage: 115 v 400 to 2400 cps. Uses: 1-715B, 4-829-B, 3-'72's, 1-'73. New $110.00
APQ-13 PULSE MODULATOR. Pulse Width .5 to 1.1 Micro Sec. Rep. rate 624 to 1348 Pps. Pk. pwr. out 35 KW Energy 0.018 Joules $49.00
TPS-3 PULSE MODULATOR. Pk. power 50 amp, 24 KW (1200 KW pk): pulse rate 200 PPS, 1.5 microsec. pulse line impedance 50 ohms. Circuit —series charging version of DC Resonance type. Uses two 705-A's as rectifiers, 115 v. 400 cycle input. New with all tubes $49.50
APS-10 MODULATOR DECK. Complete, less tubes $75.00

PULSE NETWORKS

15A—1-400-50: 15 KV, "A" CKT. 1 microsec 400 PPS, 50 ohms imp. $42.50
G.E. #6E3-5-2000-50IP2T, 6KV "E" circuit, 3 sections .5 microsecond, 2000 PPS, 50 ohms impedance $6.50
G. E. #3E (3-84-810) (8-2.24-405) 50P4T; 3KV "E" CKT Dual Unit; Unit 1, 3 sections, 84 Microsec. 810 PPS, 50 ohms imp.: Unit 2, 8 Sections, 2.24 microsec. 405 PPS, 50 ohms imp $6.50
7.5E3-1-200-67P. 7.5 KV, "E" Circuit, 1 microsec 200 PPS, 67 ohms impedance, 3 sections $7.50
7.5E4-16-60, 67P, 7.5 KV, "E" circuit, 4 sections 16 microsec, 60 PPS, 67 ohms impedance $15.00
7.5E33-200-6FT, 7.5 KV, "E" Circuit, 3 microsec 200 PPS, 67 ohms imp. 3 sections $12.50

PULSE TRANSFORMERS

G.E.K.-2745 .... $39.50
G.E.K.-2744-A, 11.5 KV High Voltage, 3.2 KV Low Voltage @ 200 KW oper. (270 KW max.) 1 microsec, or 1/microsec. @ 600 PPS $39.50

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TS 102/AP
TS 62/AP
TS 36/AP
TS 12 UNIT 2
Q. METER
TS 69/AP
TS 33/AP
CW60-ABM
LU-1
LU-3
TS 159
TS 226
TS 250/APN
TS 89
1-203-A
TS 11/AP
BC 438
CS60-ABW
1-158
1-222
1-185
TS 268/U

Send For Further Info. & Price Others

MICROWAVE TUBES

MAGNETRONS

Tube	Frq. Range	Pk. Pwr. Output	
2J27	2965-2992 mc.	275 KW	$25.00
2J31	2820-2860 mc.	265 KW	38.50
2J21-A	9345-9405 mc.	50 KW	12.50
2J22	3267-3333 mc.	265 KW	25.08
2J26	2992-3019 mc.	275 KW	37.50
2J32	2780-2820 mc.	285 KW	
2J38 Pkg.	3249-3263 mc.	5 KW	39.50
2J39 Pkg.	3267-3333 mc.	87 KW	39.50
2J49	9000-9160 mc.	58 KW	75.00
2J61	3000-3100 mc.	35 KW	75.00
2J62	2914-3010 mc.	35 KW	75.00
3J31	24,000 mc.	50 KW	85.00
5J30			
718DY	2720-2890 mc.	250 KW	35.00
720BY	2800 mc.	1000 KW	75.00
725-A	9345-9405 mc.	50 KW	50.00
730-A	9345-9405 mc.	50 KW	50.00
700 A, B, C, D			35.00
706 AY, BY, DY, EY, FY, GY			55.00

KLYSTRONS

723A 723A/B—2K25 726A

"CW" MAGNETRONS

QK 62 3150-3375 mc.
QK 59 2675-2900 mc.
QK 61 2975-3200 mc.
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AN/APS-6-(AIA)

RT 17/APS-6 . . . A 3 C.M. package designed for aircraft interception . . . night fighter radar work for use with a conical scan antenna, pictured and described below. Package consists of 725A magnetron and magnet, 1B24 duplexer, 724 ATR, 723 A/B local oscillator and beacon oscillator, complete transmitter-receiver, RF plumbing, IF strip using 6AK5's and 6AL5's. Miniature tubes used throughout, enclosed blower, pressurized housing. A complete 3 CM RF package of the latest design, using miniaturized components.

Less receiving type tubes...... $425.

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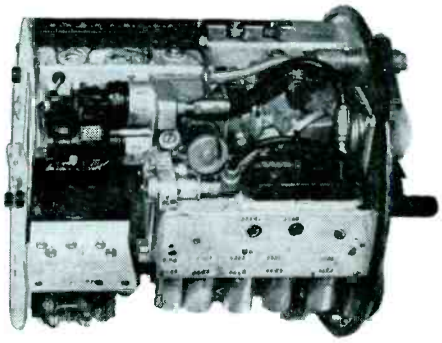


The AN/APS-6 SPIRAL SCAN ANTENNA

The AN/APS-6 (AIA) system imposes unusual requirements on the scanner. This radar is used for airborne detection of aircraft under blind conditions, and therefore requires a search over a solid angle in the forward direction. The beamwidth is about 5°.

The scan is spiral, and one turn of the spiral is described in 1/20 sec, which causes the plane of polarization to gyrate at this speed. The beam is made to spiral outward from 0° (straight ahead) to 60° and back again in 2 sec by the nodding of the antenna in relation to the yoke which forms the forward end of the horizontal main shaft. By throwing a switch the operator can halt the nodding of the antenna, which then executes a conical scan to permit accurate homing. A single motor, rated at 600 watts mechanical output, provides power for the nod and spin motions. The data takeoffs are a 2-phase sine-wave generator for the spin angle and a potentiometer for the nod angle, both being mounted on the main gear case to obviate the need of slip rings. The gear case is unusual in airborne practice in that it is oil-filled........................ **$375**

POWER EQUIPMENT

50KW Diesel
Generator

Delco Generator
Mod. #1-3659

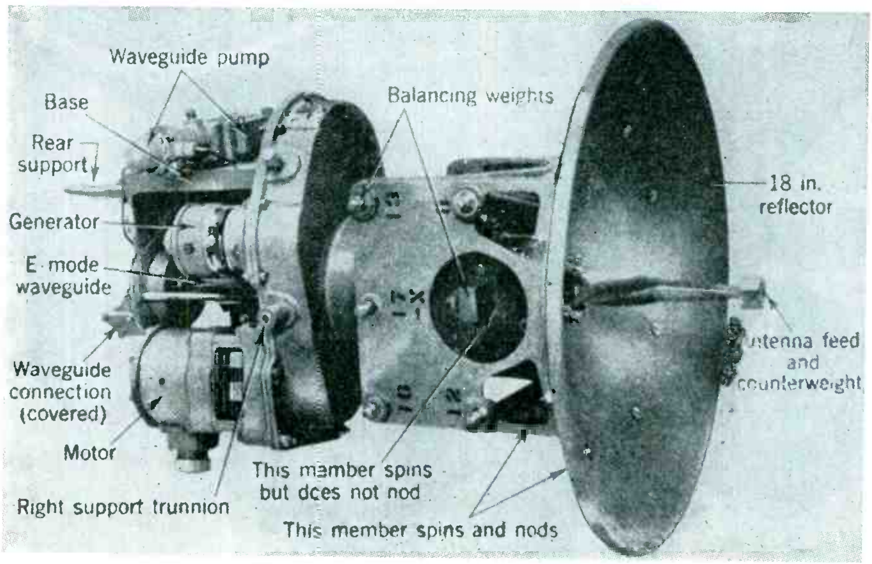
50KW 120 Volt
DC 500 Amperes
1500 RPM

Stab Shunt wound
60° C Rise

Navy Spec.
#17-C-7

Cummins Diesel

SBMH 63
Model HGD
Eng. #45751



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RADAR SETS

APS-2, Airborne, 10 CM Major Units, New

APS-4, Airborne, 3 CM, Compl.

APS-15, Airborne, 3 CM, Major Units, New

SD-4, Submarine, 200 MC, Compl., New

SE, Shipboard, 10 CM, compl., New

SF-1, Shipboard, 10 MC, Compl., New

SJ-1, Submarine, 10 MC, Compl., Used

SL-1, Shipboard, 10 MC, Compl., Used

7.5 KVA Gasoline generator sets, Type PE99, 115 volts, 60 cycle, single phase AC, unused..........................$550.00

115 Ampere circuit breaker, ITE MODEL KJ.....$15.00 each

Stepdown Transformer, Pri. 440/220/110 VAC, 60 Cy. 3KVA, Sec., 115 Volts, 2500 volts insulation. Size 12" x 12" x 7".$39.50

Plate Transformer, Pri. 115V 60 Cy. Single phase AC Sec., 17,600 Volts @ 144 MA. Oil emmersed......................$95.00

VOLTAGE REGULATOR

Mfg. Raytheon: Navy CRP-301407; Pri: 92-138 v. 15 amps. 57 to 63 cy. 1 phase. Sec: 115 v. 7.15 amp. .82 KVA. .96 PF. Contains the following components:

Regulator Transformer: Raytheon UX9545. Pri: 92-138 v. 60 cy. 1 PH. Sec: 200/580 v. 5.55/5.26 amps. 400 c rms test.

Filter Reactor: 1 56 hy. 5 amps. 4000 v. Raytheon UX9547.

Transformer: Pri: 186 v. 5 amps; Sec: 115 v. 7.2 amps. Size, 12" x 20" x 29". Net wt. approx. 250 lbs. Entire unit is enclosed in grey metal cabinet. New, as shown..................$99.50

SN, Portable, 10 CM, Compl., Used
SQ, Portable, 10 CM, Compl., Used
SO-1, Shipboard, 10 CM, Compl., Used
SO-7, Portable, 10 CM, Assault Radar
SO-8, Shipboard, 10 CM, Compl., Used
Mark 4, Gunlaying, 800 MC, Less Ant., Used
Mark 10, Gunlaying, 10 CM, Compl., New
CPN-3, Beacon, 10 CM, Major Units, Used
CPN-8, Beacon, 10 CM, Complete New Less Ant., New
SCR-533, IFF/AIR, 500 MC, New
SCR-545, Early Warning Radar Trailer, Complete
SM Radar, 10 CM, Early Warning, Used

SCR 277 RANGE TRAILER

Trailer, consisting of a complete low frequency radio range installation, including portable tower, gasoline generator, communications equipment. This unit is standard and approved. Write for details and price.

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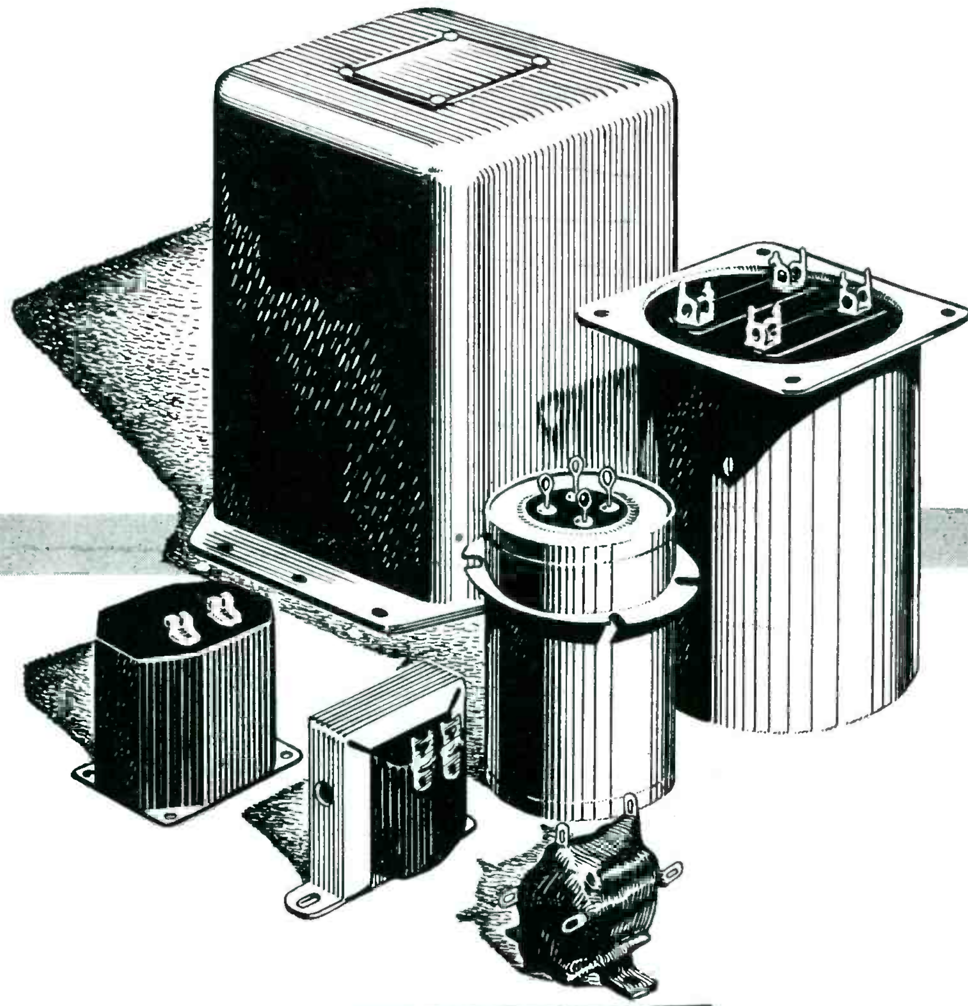

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GUARDIAN 6VDC, SPST n.o. 40 ohm, #R31 .98
23025 RBM 48VDC, SPDT, 8000 ohm, 6 ma #R428 1.50
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55251 TELECHRON, 24VDC, SPST n.o. (1A) 300 ohm, #R174 .90
55340 PRICE, 24VDC SPST n.o. (1A) 300 ohm #R170 .90
55342 TELECHRON, 24VDC. Makes 3 Breaks One, (2As, 1C) 300 ohm. Anti-Capacity Arms, Low Loss Bakelite Insulation #R171 1.25
55526 COOK, 24VDC. Makes 2, Breaks One, (1A, 1C) 300 ohm Ceramic Insulation, #R107 .95
55528 G.E. 12VDC, 6PST n.o. (6As), 150 ohm, #R426 1.50
55531 COOK, 12-24VDC. Makes 4, Breaks 2 (2As, 2Cs), 150 ohm #R405 1.25
55589 RBM, 24VDC, DPST n.o. (2As), 300 ohm, #R245 1.25
55836 G.E. 24VDC, SPDT, (2As), 250 ohm, #R402 ea. 1.25
55837 G.E. 24VDC. Double Make, 300 ohm, #R108G 1.00
55837 RBM. Same as #R108G, #R108R 1.25
55837 ALLIED. Same as #R108G, #R108... 1.50
D163221 AMER. TOTALIZATOR, 24VDC, DPDT 300 ohms, Anti-Capacity Arms, #R134 1.25
GUARDIAN, 24VDC, SPST, n.o. 300 ohms, Anti-Capacity Arm, Ceramic Insulation, #R106 .59
23012-O RBM, 24VDC, SPDT, 250 ohms, #R172 1.25
7251 ARC 24VDC, SPDT, 300 ohm #R406... 1.25
7252 ARC, 24VDC, DPST, n.o. (2As) 300 ohm, Anti-Capacity Arms, Ceramic Insulation, #R354 1.25
A13415 CLARE, 12VDC, DPST, n.o. (2As) 120 ohms, #R246 1.25
A21577 CLARE, 24VDC, DPST n.o. (2As) 250 ohms, #R352 1.25
P3 LEACH (Pair on Bakelite Strip) Each relay; 6VDC, SPDT, 125 ohms, #R353..pr. 2.25
ZH77628-1 AUTOMATIC, 12VDC, Make One, Break Two (1B, 1C) 640 ohms Dual Telephone Type Contacts #R244 .85
7472679 G.E. 3VDC, SPST, n.c. (1B) 30 ohms, #R59A .59
2VDC SPDT, 125 ohms, #R173 .69
73A23 ALLIED, 24VDC. Make 3, Break 1, (2As, 1C) 300 ohms, #R403 ea. 1.25
TB 302 PRICE, 24VDC. Make 3, Break 1, (2As, 1C) 300 ohms, #R404 ea. 1.25
B10059-11 CLARE, 24VDC, 4PDT, 300 ohm, #R426 1.50
RIO COOK, 12-24VDC, 3PST n.o. (3As), One contact 10A, 250 ohm, #R427 1.50

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ALLIED B04A115 110V 60Cyc, DPST n.o. 10A Contacts #R430 2.49
LEACH 1154 50V 60Cyc, DPST n.o. 10A Contacts #R431 2.49
ABT C1070 110V 60Cyc, Coin Release Mechanism #R362 .69
GUARDIAN 24VAC, Makes, Breaks 1 (1A, 1C) 5A Contacts #R273 1.10
GUARDIAN 24VAC, SPST n.o. 5A Contacts #R274 .98
12VAC DPST, n.o. 5A Contacts #R275...ea. .98
CLARE, 110V 50-60 cyc. Makes 2 Breaks 1, Quick Acting, Octal Plug-in Base #R161.. 3.25
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AUTOMATIC ELECTRIC Similar to #R159 with RB51 Cover DPDT #R160 3.49

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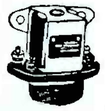

B5A ALLEN BRADLEY 24VDC SPST 50A 100 ohms, #R105 $1.95
B5A HART Cat. #692R4 SPST 50 A, 150 ohms, #R105H 1.95
B5A SQUARE "D" 24VDC SPST 50A, 150 ohms, #R25 2.25
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B8 CUTLER HAMMER 6041H139A, 24VDC, SPST 200A, 10 ohms, #R130 3.95
B8 AUTO LITE SPEC #32424A, 24VDC, SPST 200A, 6 ohms, #R128 2.75
D1 ECLIPSE D1EA 53528, 24VDC SPST 200A, 6 ohms, #R126 2.95
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G.E. CR2792D116W2 Plastic Enclosed, 12VDC, SPST 100A, 30 ohms, #R23B 5.50
EPCO S47D, 12VDC, SPST 30A, 35 ohms #R122 2.95
RBM BN5, 24VDC SPST 50A, 200 ohms #R224 1.95
G.E. CR2800384A3, 24VDC, SPST, 200A, 50 ohms, #R59B 3.95
G.E. CR9533K 100A2, 24VDC, 2 switchettes, DPST n.c. & SPST n.c. long throw #R132 9.95
GUARDIAN 34585 Dual Latching 24VDC ea section: Double Make & Break & Alternate Double make, Break. 100A contacts, 24 ohms #R223 8.75
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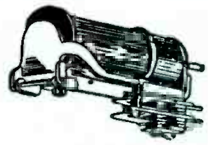

107 COOK, 3-6VDC, 6 make, 1 break (5As, 1C), 12 ohm. Part of BC654, #R407.....$ 2.95
5035A7 AUTOMATIC, 1300 ohm, 8MaDC, SPST n.o., (1A), #R103 1.25
A18258 BENDIX (Cook 102) 8-12VDC, Copper Slug, Slow Release, SPDT, 200 ohm, Part of SCR 522, #R365 2.49
P32505 STROMBERG-CARLSON 12VDC, SPDT n.o. (2As), 200 ohm, Anti-vibration contacts. Part of ABK, #R92 1.49
P32504 STROMBERG-CARLSON 6VDC, SPST, n.o. (1A), 100 ohm, Anti-vibration contacts. #R02 1.49
R5229A1 AUTOMATIC 6VDC, 3PST n.o. (3As), 75 ohms, Slow Release, #R412 2.50
R5021A1 AUTOMATIC 1300 ohm, 20maDC, SPST n.c. (1B), #R413 2.95

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A11996 CLARE (H77519-1) 24VDC, 3PST n.o. (3As), 2000 ohm, #R94 $ 1.75
6385 ARC 12VDC, SPST n.o. (1A), 10A contact, 200 ohm, Part of ARC5 or SCR 274N, #R13 1.50
C58180 BENDIX, 12VDC, DPDT & SPST n.c. (2C, 1B) 150 ohm. Part of SCR522, #R58 2.00
A22268 CLARE, 12VDC, SPST n.o. (1A), 200 ohm, #R411 1.50
5586 W.E., 12-24VDC, SPST n.o. (1A), 300 ohm, #R414 1.25

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W.E. (Whelock) KS9665-RX956 2000 ohm, 9 ma. Makes 2, Breaks 2 (1A, 1B, 1C) #R426 4.95
KURMAN 1500 ohm, 12 ma, SPDT, Small Compact #R427 .98
KURMAN 3300 ohm, 7 ma, Makes 3, Breaks 1 (3A, 1B) Long Telephone Type #R243 2.95
AUTOMATIC 5035A7 1300 ohm, 8 ma, SPST n.o. Long Telephone Type #R103 1.25
CLARE K102 3500 ohm, 6 ma, SPDT, Short Telephone Type #R30 3.49
DUMONT 5000 ohm, 5 ma, SPST n.o. #R230 .98
RBM 23025 8000 ohm, 6 ma, SPDT #R428 1.50
SIGMA TYPE 4F 8000 ohm, SPDT (1C). Can be adjusted to operate on 0.5 ma, #R425 $3.95

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BO13D35	24VDC, SPST, double make, 240 ohm	#RO6	1.25
BO9D28	6VDC, 3PDT, 14 ohm	#R225	2.25
BJ6D36	24VDC, DPDT, 255 ohm	#R420	1.55
BJX-42	12or24VDC, SP DPLE break, 240 ohm C.T.	#R226	1.25
55837	24VDC, Double make, 300 ohm	#R108	1.50
BO1535	24VDC, Double make & Break 240 ohm	#R238	1.30
BO1332	12VDC, 80 ohm, Coil & Frame only (no contacts)	#RC358	.40
BOYX3	1VDC, SPST, n.o. 1 1/2 ohm	#R35:	1.50
BOY13D	20VDC Double make & break 550 ohm	#R360	1.95
AR	12VDC, SPST n.o. 75 ohm	#R429	1.00
BO6A115	110V 60 Cyc, DPDT, 10A Contacts	#R429	3.49
BO4A115	110V 60Cyc, DPST n.o. 10A Contacts	#R430	2.49
BOY6D42	87VDC, DPDT, 10,000 ohm, 9 ma, 10A Contacts	#R433	3.49
BN12D34	24VDC, 4PDT, 277 ohm, 10A Contacts	#434	3.49
BJU (Electrical Latching)	6VDC, 4PDT, 16 Ohm ea Coil, Dustproof Shield, 11 Pin Plug Base	#R435	6.95
AN13D33	24VDC, SPST n.o., 175 ohm, 50A Contacts (Electrical & Mechanical Specifications Identical to CN13D33)	#R436	1.95
SKH-CC-CC38	18-24VDC, 4PDT, 680 ohm, Hermetically Sealed	#R437	3.95

DIFFERENTIAL 803476 DUAL 8000 ohm 2.5 ma. coils. Armature pivoted between poles, all contacts normally open. SPDT 5A, contacts Hi-speed. Suitable for P.P., bridge or balanced circuits where differential action is required #R362.........$4.95

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12S-2P
12S-2S
12S-3P
12S-3S
12S-4P
12S-4S
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15 MILLIAMPS, SIMPSON 26, 3½" round flush bakelite case (JAN type MR25W015DCMA) @ $6.00
20 MILLIAMPS, GENERAL ELECTRIC DO-53, 3" square flush bake case ....@ $5.50
25 MILLIAMPS, GENERAL ELECTRIC DO-41, 3½" round flush bake case.............@ $5.50
113 MILLIAMPS, BURLINGTON, 31 B, 3½" round flush bakelite case, special 3 color scale, no calibrations, caption "Power Indicator"....@ $3.00
150 MILLIAMPS, GENERAL ELECTRIC DO-41, 3½" round flush bake case.............@ $5.50
150 MILLIAMPS, TRIPLETT, 2" square flush bake case, black scale.................@ $3.95
150 MILLIAMPS, GRUEN 508, 2½" round flush bakelite case ....@ $3.95
150 MILLIAMPS, ELECTEL # 350, 3½" round flush bakelite case made by Elect. Div. of US Time Corp. ....@ $4.00
150 MILLIAMPS, BEEDE, 3½" round flush bakelite case ....@ $4.00
200 MILLIAMPS, MARION, 3½" round flush bakelite case, knife edge pointer...........@ $4.00
200 MILLIAMPS, SIMPSON 26, 3½" round flush bakelite case (Jan type MR35W200DCMA) @ $5.95
300 MILLIAMPS, GRUEN GW-529, 3½" round flush bakelite case (JAN type MR35W300DCMA) @ $4.95
500 MILLIAMPS, DEJUR AMSCO 312, 3" square flush bakelite case.................@ $5.00
800 MILLIAMPS, DEJUR AMSCO # 310, 3" round flush bakelite case S. C. # 3F980.......@ $4.50
1000 MILLIAMPS, WESTERN ELECTRIC D-55049, 3½" round flush bakelite case, concentric style movement with 190° scale length........@ $4.00

D. C. AMMETERS

1 AMP, WESTINGHOUSE NX-35, 3½" round flush bakelite case (JAN type MR34W001DCAA) @ $6.00
5 AMP, GENERAL ELECTRIC DO-40, 3" round, non-flanged, ring mounted flush bakelite case @ $4.95
10 AMP, GENERAL ELECTRIC DO-40, 3"round, non-flanged, ring mounted flush bakelite case @ $4.95
30 AMPS, GENERAL ELECTRIC DW-51, 2½" round flush bakelite case (JAN type MR24W030-DCAA) ....@ $4.50
30-0-30 AMPS, GENERAL ELECTRIC DW-51, 2½" round flush metal case ....@ $4.50
50-0-50 AMPS, GENERAL ELECTRIC DO-41, 3½" round flush bakelite case, black scale, with lum. markings ....@ $5.50

A. C. AMMETERS

0-3 AMPS, SIMPSON 55, 3½" round flush bakelite case ....@ $8.10
0-10 AMPS, SIMPSON 55, 3½" round flush bakelite case ....@ $8.40
100 MILLIAMPERES, WESTON 476, 3½" round flush bakelite case, 400 cycles...........@ $7.50
150 MILLIAMPERES, GENERAL ELECTRIC AO-22, 3½" round flush bakelite case........@ $5.50
250 MILLIAMPERES, GENERAL ELECTRIC AW-41, 2½" round flush bakelite case. Made for Daco, red blocking on scale...........@ $3.50

A. C. VOLTMETERS

8 VOLTS, WESTON 476, 3½" round flush bakelite case ....@ $4.95
15 VOLTS, WESTINGHOUSE NA-35, 3½" round flush bakelite case, (JAN MR35W015ACVV) @ $5.50
40 VOLTS, WESTINGHOUSE NA-33, 2½" round flush metal case, black scale lum. markings, calib. for 400 cycles.................@ $3.50
40 VOLTS, WESTINGHOUSE NA-33, 2½" round flush metal case, black scale lum. markings. (These were originally calib. for 400 cycle use but have been adjusted for 60 cycle)....@ $3.95
75 VOLTS, WESTON 517, 2" round flush metal case, ring-clamp type mtg. non-flanged..@ $3.50
300 VOLTS, BURLINGTON 22A, 2½" round flush metal case ....@ $6.00
300 VOLTS, TRIPLETT 232-C, 2½" round flush metal case ....@ $6.00

We specialize in electrical Instruments. Over 75,000 meters in stock. Send for our latest circular showing our complete line of Surplus-New-Guaranteed meters.

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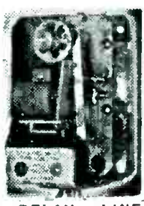
338 Canal St., N. Y. 13, N. Y.
Worth 4-8217

Orders accepted from rated concerns, public institutions and agencies on open account, others please send 25% deposit, balance C.O.D. or check with order. All prices FOB our warehouse, N.Y.C.

REVERSIBLE REMOTE CONTROL DRIVE

A.C. motor driven unit designed for 'lazy man' control of 1951 Zenith TV. Operates from 115 volts 60 cycle; but, self incorporated transformer permits low voltage control leads. Includes attractive plastic hand grip switch with black & white control buttons, one for each direction. Motor drives worm gear which is moved against a nylon gear by solenoid. Made this way so that TV set could be tuned manually. Output to ¼ inch shaft is approximately 4½ RPM. Intermittant duty. Includes 17 feet three wire control cable with plug. Brand New. ACT NOW! Our limited supply going fast at $10.95



EAGLE ADJUSTABLE TIME DELAY RELAY. 110 volt 60 cy with double throw Micro Switch. Can be set from 1½ to 58 minutes. Includes attractive 3¼ x 4½ x 2¾ black cover. Made to sell for $26. SALE PRICE $6.95

DELAY LINE 15-E4-91-400-50P. Sprague #S92-5245, H623, 4x5x7 inch oil filled with 3½ inch insulators. 0.91 Microsecond, 15KV.........$9.90

PULSE FORMING LINE. Millen flexible type, 23½ inches long, form 2 microsecond pulses, Zo-1000 ohm, our #388 ....$3.75

COAXIAL CONNECTORS

J 201	$4.50	UG85/U	$.60
M358	1.30	UG87/U	.60
M359	.35	UG88/U	1.50
PL258	.70	UG89/U	1.50
PL259A	.50	UG105/U	1.25
PL274	1.30	UG106/U	.10
SO239	.45	UG173/U	.35
UG9/U	.60	UG175/U	.18
UG12/U	.60	UG176/U	.18
UG21/U	.60	UG260/U	1.50
UG27/U	.60	UG275/U	4.50
UG28/U	2.00	UG290/U	1.50
UG58/U	.60	UG203/U	.45

PULSE TRANSFORMERS

7P26, Westinghouse $4.50
9C1756-501, RCA, 15/16 dia. x 1⅝" high, 165 turns on primary, 330 turns secondary, core is ¼" stack of .007 inch "F" laminations, Magnetic Metals Co. Audio 58, used to form 7.3 microsecond pulses, 1744 in stock $1.50
9C1756-502, RCA, same core & can as 501, 100 to 200 turns, used to form 2.2 microsecond pulses. 870 pieces in stock $1.50
A117012, Bendix, 1 ⅞ x 1 7/16 x 1 13/16" can, nine terminals. Hypersil core $1.50
C12A-1318, Jefferson, 50 millihenry & 10 millihenry, 2¾ x 3 x 3½...$1.95
D161310, WE frequency response 50Kc to 4 Mc. Video input, 120 to 2350 ohm. Perm. core...............$2.50

K2468B. GE Magnetron pulsing bifilar 250KVA peak power at ¼ microsecond pulse. 1000/1' duty cycle. 3.85 KV into 50 ohm pulse cable socket gives 17.3 KV to built-in Mag. socket. Only 31 in stock. Cost $223. SALE PRICE $18.00

CONVERTER. Electronic Labs Model 1485, 26 VDC input, 115 volts, 60 cy., 50 watts output, complete with NSB 1341 vibrator $9.95

CHOKE, Conservatively rated 165 MA, 5 Henries, 160 ohm dc. 2 Inch High, 3 ⅝" Mtg. Ctr. Worth $3. **SALE PRICE** 89 cents. #1A-158.

UTAH X124T3 TYPE PULSE TRANSFORMERS

UTAH 9287D

Windings: three
D.C. res: 4.2, 4.4, 4.8
L: tot. pri. 3.2 mh
true pri. 1.6 mh
Leakage 17 micro H
Dist. capacitance between windings: 90
Zo: 430 ohms
Turns: 100
Core: 16 strips .002" hypersil wound in three turns
Optimum pulse width: 0.9 microseconds
Sharpest pulse: (B.O.) 0.25 microseconds

Write for prices, giving exact quantity required.

HIGH VOLTAGE GLASS-METAL SEAL

10¢ each. $7.50 per 100. $65 per 1000

AN CONNECTORS

Over 2500 Different Types in Stock—See June Electronics for Price Schedule, Page 311

POWER POTENTIOMETERS

Ohm	Watt	Bushing	Shaft	Cat. No.	Price
2	25	5/8S	1/8SD	O-H	$1.04
3-3	25	1/2	1/2	I	1.04
15	25	3/8	1"	C	1.04
15	25	3/8	1 1/8	D-245	1.04
15	25	1/2	1 1/4	D-I	1.04
20	25	1/2	1/2F	D-245	1.04
25	25	1/2	1/2F	C	1.04
25	25	3/8	1"	D-245	1.04
25	25	1/2	3/8S	I	1.04
30	25	3/8	1"	C	1.04
50	25	3/8	1 1/8	D-245	1.04
50	25	5/8	1/8SD	O-H	1.04
75	25	1/2	7/16	O-H	1.04
100	25	3/8	1"	D-245	1.04
100	25	1/2	1/2	H	1.04
350	25	3/8	1 1/8	O-H	1.04
500	25	3/8	11/16	D-245	1.04
800	50	3/8	7/16F	O-J	1.24
1K	25	1/2	1/2	O-H	1.17
3K	25	3/8	1 3/16	D-245	1.20
5K	25	1/2	1/8SD	I	1.24
5K	25	3/8	7/8FS	D-245	1.24
20K	25	1/2	1/8SD	D-245	1.40

10 AMPERE FILTER

60 db att. .15 to 30 Mcs. permalloy core. D170738 ....$3.00

SERVO MOTOR

400 cy 2 phase, 40:1 gear train, low inertia 10047-2A $12.50

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2102 MARKET ST.
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WITHIN FOUR BLOCKS OF B&O AND PENNSYLVANIA STATIONS
PHONE LOCUST 7-5285

Buy TOP Radio-Electronic Values!

TRANSMITTING MICA CAPACITORS

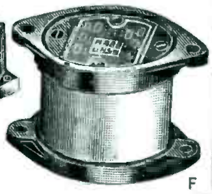

A B C

Stock No.	Cap.	Test Volts	Fig.	Type No.	Price Each
5493A*	.01	1000	B	1445	35¢
5494A	.02	1000	B	1445	30¢
5495A	.006	1200	A	A 2	35¢
5496A	.0001	1500	C	BE 15	20¢
5497A	.0005	1500	C	BE 15	20¢
5498A	.004	2500	B	4	40¢
5499A	.001	5000	A	F	40¢
5600A	.0036	5000	A	A2	60¢

*Supplied with Meter Bracket

Standard Brand. MFR. Name on Request


D

E

F

HEAVY DUTY

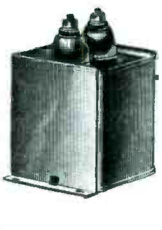
TRANSMITTING MICA CAPACITORS

5601A	.15	1000V	E	XS	90¢
5602A	.00007	2500V	E	3	90¢
5603A	.00005	3000V	E	15L	1.00
5604A	.0001	5000V	E	F2L	1.00
5605A	.0008	5000V	E	F2L	1.00
5606A	.000025	10,000	D	PL-341	1.95
5607A	.00015	10,000 D.C.W.	F	PL-315	7.95

Standard Brand. MFR. Name on Request

OIL FILLED CONDENSERS

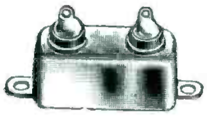
Stock No. 5134A



3 MFD—4000 VOLT For BC-610. 2 Ceramic Insulated Screw Terminals 3¾" x 4½" x 6½" High Can. .... **$4.95 ea.**

.045 M F D.—16,000 Volt Vitamin "Q". One Ceramic Insulated Screw Terminal 1¾" x 3½" x 4¾" High Can. Stock No. 5399A **$4.95 ea.**

OIL FILLED BATHTUB CONDENSERS



Stock No.	Capacity & Voltage	Lug Arrangement	Type No.	Price Each
5166A	.01-600V	Side	306-91	10¢
354A	.05-600V	Top	XDMRTWG	15¢
5167A	.1-600V	Side	306-357	20¢
544A	3 x .1-400V	Side	DYR 6111	25¢
2908A	2 x .02-600V	Top	DYR 600 22	15¢
2911	2 x .1-600V	Top	DYR 6011	25¢
5172*	2 x .1-600V	Top	306-361	25¢

* Can is common ground—Other types and sizes available

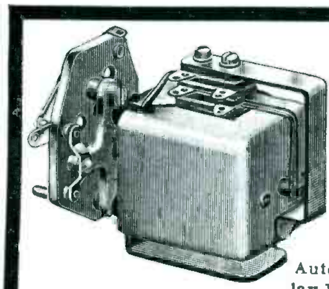
Standard Brand. MFR. Name on Request

STRIP HEATERS

Stock No. 5492 A Price each **95¢**

24 Volt—150 Watt Chromalox Strip Heaters. Manufactured by E. L. Wiegand Co., 1½" x 12" x ⅜" thick.

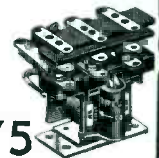
Standard Brand. MFR. Name on Request



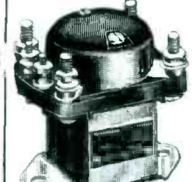
ART–13 RELAYS

Circuit Control Relay K-105. Used in output of 813 Final. Micalex Insulation. 28 V.D.C. Coil. Collins Part No. 410-1800-00. Stock No. 5487 A

Each **$4.95**



Autotune Motor Control Relay K-101 3 P.D.T. Contacts. 28 Volt Coil. Collins Part No. 405 N B 201. GM Type J. Stock No. 5485 A each **$1.75**



SOLENOID CONTACTORS

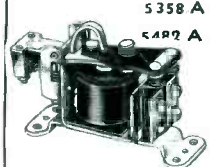
200 Amp. S.P.S.T. Normally Open Contacts

Stock No.	Mfg. & No.	Voltage	Resistance	Price Each
4201 A	Leach 7220.32	32VDC	234 OHMS	$4.00
4202 A	Leach 7220.24	24VDC	132 OHMS	5.00
4203 A	Leach 7220.3.24	24VDC	132 OHMS	4.00
4204 A	Guardian 3 3804-B78	24VDC	132 OHMS	4.00

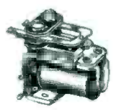
50 Amp. S.P.S.T. Normally Open Contacts

5358 A Allen Bradley X101147 D.P.S.T. N.O. D.B. 24 VDC 60 OHMS $1.95

5482 A Leach 7064-12C S.P.S.T. N.O. D.B. 12 VDC 40 OHMS $1.95



MISCELLANEOUS RELAYS



Stock No.	Manufacturer and Mfg. No.	Contacts	Voltage	Coil Resistance	Price
563A	Automatic Electric R-25	S.P.S.T. Handle 2 Amp	12 VDC	75 OHMS	$.95 ea.
4210A	Guardian TC-195	4 P.D.T.	10 VDC	6 OHMS	1.75 ea.
	2 Poles N.O.; 2 Poles N.C.—Slow Acting-Copper Slugged—1.5 AMP Contacts				
4213A	C.P. Clare A20545	S.P.S.T. N.C. 4 insulated leads with solder lugs	12 VDC	45 OHMS	.95 ea.
5483A	Automatic Electric R-22	D.P.D.T. & S.P.S.T. N.O.	12 VDC	40 OHMS	1.25 ea.
5484A	G.M. Type 27 Cat. #12957-1	3 P.D.T.	28 VDC	150 OHMS	1.50 ea.
5488A	Leach 1024	D.P.S.T. N.O.	12 VDC	95 OHMS	1.50 ea.
5489A	Guardian 35935 & Automatic Electric R-30	5 P.D.T.	20-30 VDC	100 OHMS	1.50 ea.
5490A	Ward Leonard 13L21	Magnetic Relay	48 VDC	600 OHMS	2.50 ea.
5491A	Guardian G38273	D.P.S.T.	28 VDC	125 OHMS	1.50 ea.
5259A	G.E. K—275849	S.P.S.T. D.B. N.O.	12 VDC	70 OHMS	.75 ea.
102248A	Automatic Electric R-45 operates continuous duty on 6 VDC	S.P.D.T. & S.P.S.T.	24 VAC intermittent	25 OHMS	.60 ea.

ECLIPSE VOLTAGE REGULATOR

5608A Bendix, Eclipse V.R. 1365 Model 2 Style A — volts set at 115 — **$4.95 ea.**

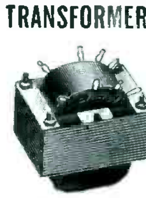
AMPHENOL & CANNON CONNECTORS & FITTINGS

Stock No.	Price Each	Stock No.	Price Each
AN-3102-12-5P	30¢	AN-3060-6	15¢
AN-3102-145-7P	40¢	AN-3050-20	10¢
AN-3102-165-1P	45¢	AN-3057-24	50¢
AN-3102-20-8P	70¢	GK-C3-32S-VAR3	15¢
AN-3102-36-1P	1.25	GK-9-32S	20¢
AN-3102-36-1S	1.50	GK-12-32S	25¢
AN-3102-28-20S	1.20	FK-L15-23¾" B	45¢
AN-3102-16-4S*	40¢	FK-10-32S VAR2	50¢
97-3106-22-10P**	50¢	SK-C16-32S	25¢
97-3106-195-POS 2	50¢	RWK-59A-1	25¢
AN-3108-16-10P	90¢	DP-C6-34	25¢
AN-3108-20-4P	1.15	DP-C8-34	25¢
AN-3053-8	.05¢	DP-CB-33	25¢

* Insulated Leads w/ Solder Lugs—Cap & Chain attached.
** Cable Clamp Included

6.3 VOLT FILAMENT TRANSFORMERS

Stock No. 5254 A



Three 6.3 Volt Secondaries 115 Volt— 60 Cycle Primary 1600 Volt Insulation

6.3 Volts @ 4.9 Amps.
6.3 Volts @ 4.5 Amps.
6.3 Volts @ 1.1 Amps.

Each Price **$2.65**

Horizontal Half Shell Mounting. 2¼" x 2 13/16" Mounting Centers. 2 13/16" x 3⅜" Core Size. 2½" above Chassis. Solder Lug Terminals—All Terminals Marked.

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- **RADIOTELEPHONES**
- **TELEPHONE EQUIPMENT**
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  —TRANSMITTING
  and other Special Purpose Tubes
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  —RECTIFIERS
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Special Lots of Equipment

100—Sets—mobile ground station, **model SCR-284**
100—Switchboards, portable, 12-line, **model BD-72**
125—Switchboards, portable, 6-line, **model BD-71**
100—Receiver, direction finder, complete, **model MN-26**
12—Shipboard Transmitters, 115 and 230 V dc, **model TDE**

TRANSMITTING STATIONS

1 KW—200-500 kcs, complete with 440 volt, 3 ph. 50-60c. power supply **Price $2,500.00**

800W—(400 watts phone) Western Electric, 10-channel, automatic dial selection, 2.0-200 mcs, with 220 volt, 1 ph, 50-60c, power supply. SAME TRANSMITTER AS USED ON S.S. "QUEEN MARY"—**Brand New. Price $4,000.00**

1 KW—FM Broadcast station, complete with monitor, all tubes, antenna and waveguide, Mfr. G. E. **$1,500.00**—at location, N. Y. C.

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WE GUARANTEE EVERYTHING WE SELL

CERTIFIED AN CONNECTORS

LATEST SPECS

3100 – 3101 – 3102 – 3106 – 3108
3057 CLAMPS – CONDUIT COUPLINGS

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DESIRABLE

Select Surplus

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- TDE Navy model radio transmitters with 230 volts, D.C. power supply, complete with tubes, ready for operation. New.
- SF Ships' radar units complete with all components.
- TCS, Collins type Navy and mobile type transmitters-receivers complete with remote control, antenna coil, cables, key, microphone, for 110 volt, A.C. and 12 or 24 volt D.C. Refinished, checked out and guaranteed for operation.
- ET-8023-D1 Radiomarine Corporation telegraph transmitters.
- BC-348 — BC-312 unconverted receivers for 24 and 12 volt operation. Checked out, excellent, guaranteed.
- BC-221 A.K. Frequency meters with modulation.
- BC-221 Frequency meters without modulation.
- TS-174-U Frequency meter with modulation 20-250 mcs.
- LM-15 Frequency meters (Navy version of BC-221 A.K.) with modulation and A.C. power supply.
- I-100A Test sets for SCR-269.
- Telephone or power line insulators, glass Hemingray No. 40, heavy duty.
- W-110 B Army field telephone wire.
- RC-58-B Army Tape Facsimile transmitters-receivers.
- Link radio transmitters-receivers 1498 including remote control and antenna, reconditioned.
- Link-50 UFS transmitters, receivers including remote control and antenna. New.
- BD-72 army field telephone switchboards, twelve lines. Reconditioned, like new.
- BD-71 army field telephone switchboards, six lines. Reconditioned, like new.
- Army Field Telephones, Type EE8. Excellent.

WE HAVE OUR OWN MANUFACTURING AND LABORATORY FACILITIES AND INSPECT AND GUARANTEE ALL ITEMS BEFORE SHIPMENT.

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TS-1ARR	TS-203/AP	TS-226A	BC-906/D
TS-3A/AP	TS-87/AP	TS-233/TPN-2	BC-949/A
TS-8A/U	TS-89/AP	TS-288	BC-1060/A
TS-10A/APN-1	TS-96/TPS-1	TS-270A/UP	BC-1066/A
TS-12	TS-98/AP	TS-323	BC-1201/A
TS-13	TS-100	I-56	BC-1203
TS-14	TS-101AP	I-95/A	BC-1287/A
TS-15B/AP	TS-102/AP	I-106/A	BC-1277
TS-16/APN	TS-108/AP	I-122	BE-67
TS-19	TS-110/AP	I-145	LAD
TS-27/TS	TS-118/AP	I-177	LAF
TS-32A/TRC-1	TS-125/AP	I-178	LAG
TS-33	TS-131/AP	I-208/A	LU2
TS-34	TS-153	I-212	LU3
TS-34A	TS-155A/AP	I-222/A	OAA-2
TS-35A	TS-170/ARN-5	I-225	TTS-4BR
TS-36	TS-173/UR	I-233	TTX-10RH
TS-45/APM-3	TS-174	IE-21/A	TSS4SE
TS-47/APR	TS-175	IE-36	TSK4SE
TS-51/APG-4	TS-184/AP	IF-12/C	
TS-62	TS-197/CPM-4	BC-221	
TS-69/AP	TS-204/AP	BC-376	

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DM-64	12	275	150	11.50
DM-65	12	400	440	22.50
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TCS-Rcvr	12	225	100	11.50
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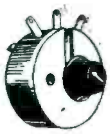

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20	C-6363	1.00	60	PDLM	1.35
25	PM	1.05	111	PDLMS	1.50

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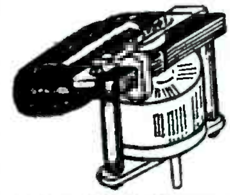

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400 V					.50			.50			.60			.65	.80		.75	←CHANN	ELS		
600 V	.45		.45		.55	.60	.70	.60	.65	.75	.65	.75	.85	.75	.90		.85	←CHANN	ELS	1.25	
50 V																				.60	
100 V																.30	.35			.65	.70
200 V				.30	.25				.25					.25	.35		.35	.65	.60		
400 V	.25		.25	.35	.25	.35	.40	.25	.30	.35	.30	.35		.30	.45		.40		.85		
600 V	.30	.40	.30	.40	.30	.40	.45	.30	.35	.40	.35	.40		.35	.60	.50	.65	1.65	1.65		
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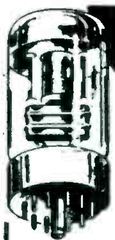

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1R5	0.90	6C6	0.75	12A6	0.48
1S4	0.86	6D6	0.68	12SH7	0.96
1T4	0.86	6H6	0.94	12SK7	0.98
5U4G	0.80	6J5	0.60	12SQ7GT	0.90
6AB7	0.90	6J5GT	0.51	12SR7	0.90
6AC7	1.20	6K6GT	0.91	35Z4GT	0.85
6AL5	1.00	6K7GT	0.70	35Z5GT	0.75
6AQ5	1.40	6SG7	0.90	50L6GT	0.90
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807	1.75
808	1.70
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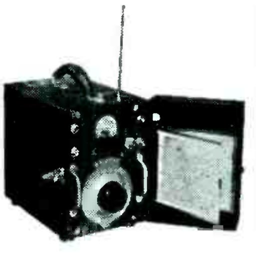
NEW—BC—906
FREQ. METER—NEW



Range 150-225 MC—Bat. operation with precision velvet vernier dial, tuning charts, 0-500 D.C. microammeter, diode-Triode and plug-in antenna. Contained in black aluminum carrying case 12½ x 8¾x6½.
Price $21.95

Large quantities of bathtub, channel and upright oil conds. from 25 V to 25KV. Trans. & Rcvng. micas. Standard brand pots and 25 Watt rheos. Inquiries solicited.

WANTED

Condensers of all types in any quantity. Also other standard components. Top prices.

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ELECTRICAL STEEL

We can offer about 26,000# of Hi-Grade Strip—.005 x 12⅜" "Hipersil" 3¼% Transformer grade — In Coils weighing about 900# each—Material new and prime but outside wrap weather discolored.

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1815 Franklin Detroit 7, Michigan
Phone—WOodward 1-8277

INSULATED TUBING and SLEEVING

Electro has been quite fortunate in being able to purchase a large variety of insulation sleeving of all types. This stock is fresh stock and available for immediate delivery at approximately one half the regular price. Some sizes are limited in quantity therefore we suggest your placing your order at once. All insulation is offered subject to prior sale. Advise us if you wish us to substitute sizes if your size is out of stock.

Size	I.D.	Color	Type	Per 100'	Per M'
	.0156"	Green	Var. Cam.	$1.75	$11.00
	.0156	Black	Extr. Plas.	.75	5.40
20	.034	Black	Var. Cam.	1.75	13.50
20	.034	Yellow	Tri.Sat.Glass	3.75	32.50
20	.034	Brown	Tri.Sat.Glass	3.75	32.50
14	.072	Black	Var. Cam.	2.10	17.50
12	.089	Black	Sat. Glass	1.10	7.00
12	.089	Orange	Extr. Glass	4.75	42.50
12	.089	Orange	Var. Cam.	2.20	18.00
12	.089	Black	Var. Cam.	2.20	18.00
11	.101	Black	Extr. Plas.	1.10	7.00
11	.101	Black	Var. Cam.	2.55	21.50
11	.101	Black	Sat. Glass	5.00	46.00
11	.101	Yellow	Sat. Glass	5.00	46.00
11	.101	Yellow	Dbl. Sat. Glass	7.50	60.00
10	.112	Black	Var. Cam.	2.75	23.50
9	.124	Black	Var. Cam.	3.00	26.00
8	.141	Black	Var. Cam.	3.15	27.50
8	.141	Black	Extr. Plas.	1.40	10.00
8	.141	Clear	Extr. Plas.	1.40	10.00
8	.141	Yellow	Cel. Extr.	3.15	27.50
7	.158	Black	Var. Cam.	3.45	30.50
6	.178	Black	Sat. Glass	6.15	57.50
6	.178	Clear	Extr. Plas.	1.65	12.50
6	.178	Orange	Var. Cam.	3.80	34.00
6	.178	White	Extr. Plas.	1.65	12.50
6	.178	Black	Var. Cam.	3.80	34.00
5	.198	Black	Var. Cam.	4.10	37.00
5	.198	Black	Extr. Plas.	1.85	14.50
5	.198	White	Extr. plas.	1.85	14.50
4	.224	Clear	Extr. Plas.	2.00	16.00
4	.224	Black	Sat. Glass	7.00	64.00

Size	I.D.	Color	Type	Per 100'	Per M'
3	.249	Black	Extr. Plas.	$2.25	$18.50
3	.249	Black	Tri. Sat. V. C.	5.25	48.50
3	.249	White	Extr. Plas.	2.25	18.50
3	.249	Black	Sat. Glass	6.55	61.50
2	.278	Clear	Extr. Plas.	2.65	22.50
2	.278	Black	Var. Cam.	5.15	47.50
1	.299	Clear	Extr. Plas.	3.00	26.00
5/16"	.3125	Clear	Extr. Plas.	3.10	27.08
5/16"	.3125	Black	Neo. Hose	10.00	......
0	.347	Yellow	Var. Cam.	6.60	62.00
0	.347	Black	Var. Cam.	6.60	62.00
3/8"	.375	Black	Dbl. Sat. V. C.	8.90	81.00
3/8"	.375	Black	Extr. Plas	3.60	32.00
3/8"	.375	Yellow	Var. Cam.	8.00	76.00
3/8"	.375	Black	Sat. Glass	8.90	85.00
3/8"	.375	Black	Var. Cam.	3.60	32.00
7/16"	.438	Black	Extr. Plas.	4.00	36.00
7/16"	.438	White	Extr. Plas.	4.00	36.00
15/32"	.469	Clear	Extr. Plas.	4.50	41.00
1/2"	.500	Black	Extr. Plas.	5.00	46.00
5/3"	.625	Clear	Extr. Plas.	6.85	64.00
11/16"	.688	Black	Extr. Plas.	8.75	Quot. on req.
3/4"	.750	Clear	Extr. Plas.	9.50	
13/16"	.813	Clear	Extr. Plas.	10.00	
7/8"	.875	Black	Extr. Plas.	12.50	
7/8"	.875	Clear	Extr. Plas.	12.50	
1"	1.000	Clear	Extr. Plas.	15.00	
1"	1.000	Black	Extr. Plas.	15.00	
1-1/8"	1.125	Black	Extr. Plas.	17.50	
1-1/8"	1.125	Clear	Extr. Plas.	17.50	
1-1/4"	1.250	Black	Extr. Plas.	20.00	

MINE DETECTOR SCR 625

Detects metallic objects (ferrous or non-ferrous) to a depth of approx. 6 ft. Find outboard motors on the bottom of lakes, locate underground piping, treasure, metallic fragments in lumber, etc. New, complete with inst. book. $65.00. Used but like new $45.00

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Emerson Type D26BT, 24VDC, 24A 100RPM 160 oz/in torque 12.95
A.C. Gilbert, trim tab motor, 24VDC. 2.95
Diehl, C78889, 115VAC 60cy, 3ph, 1/40HP, 3450RPM (used) 3.95
G.E. Selsyn 2J1G1, 57.5/57.5V 400cy. 9.95
G.E. Selsyn 2J1F1, 115/57.5V 400cy. 12.95
G.E. Selsyn 2J1H1, 115/57.5V 400cy. 12.95
Pioneer Bendix Autosyn AY-20. . . . . 14.95
Pioneer Bendix Autosyn AY-59D1. . . . . 12.95
Pioneer Bendix Magnesyn CL-6. . . . . 9.95
Oster, D-4-2, 24VDC, 1/60HP, 1800RPM 9.95
Oster, VRS-1B, 6VDC, 1.8A, 5000RPM 8.95
Eicor, ML2310-52, 24VDC, 0.32A, 1800RPM . . . 4.95
G.E. PM Generator, Model 5BY9F8, 140VDC, .025A 1800RPM 8.95
Oster, ES-2-1, Motor for 7G Selsyn. 7.95
Ohio Elec. CP35220, 115VAC, 1ph, 60cy, 1/40HP. 3400RPM 12.95
Alliance, 451-1182, 27.5VDC 1/90HP, 7500RPM 6.95
Delco, A7155, 27VDC, 2.4A, 1/30HP 3600 RPM 9.95
Gillette, Elec razor motor 115VAC 60cy 1.95
White Rogers, 6905X, 24VDC, .65A, 50 oz/in torque 12.95
Oster, C-2P-1L, Blower, 28VDC, 1/100HP, 7000 RPM 12.95
Oster, C-2BP-1A, 27.5VDC, 1/100HP, 7000RPM 8.95
Westinghouse, 1171391, 27VDC, ⅛HP, 5800RPM 9.95
Elec Ind, Type 203, 115VAC, 1ph 60cy, 1/75HP 1800 RPM 11.95
Eastern Air Devices, J31, 115VAC, 400cy, 1/50 HP 9.95
G.E. Model 5BA10AJ40, 24VDC, 140RPM, 0.55A, 10 oz/in torque 12.95
Gen'l Ind, 23026, 115VAC, 60cy, 1ph 80RPM. . 3.95
Univ Elec, Model 523, 115VDC, 1.2A, 5000RPM 5.95
Delco, A7501B, 27.5VDC, ¼HP, 11A, 6000RPM 17.95
Pump Eng, 1454-ME, 24VDC, 95A, 2.25HP, 4000 RPM 27.50
Pioneer Autosyn, PR-51505-1-2320-1A. 9.95
Fasco Blowers, 115VAC, 60cy 50 CFM 9.95
W.E. KS5603, 24-28VDC, 1/100HP, 0.6A, 5000 RPM 3.95

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G.E. #CR2791-B100J4, 3PDT, 6VDC, 15A Contacts $1.25
Allied DO9D28, 3PDT 6VDC, 15A contacts. $1.35
Leach Type 1054ARV, 3PST on make, SPST on break, 20-32 VDC, 15A contacts. $1.25
G.E. #CR2791-B100F3, DPDT 24 VDC 5A contacts 75c
Price #311, DPDT, 28VDC, 10 Amp cont. 1900 ohm coil 95c
G-M #13020, DPST on make, 3PST on break, 24VDC, 15A contacts $1.25
Allen Bradley X89309, SPST double make, 24VDC, 200A $2.50
A-B Bulletin X95545, type B6B, SPST Double Make. 24 VDC, 200 Amp. $2.50
Dunco Thermal Time Delay 115 VAC 60 Cy, SPST. 1 min delay. $1.95

WESTINGHOUSE HQS PHASE SELECTOR RELAYS, for selective Pole Carrier Relaying, 3 unit per set $95.00

Pioneer Gen-E-Motor Dynamotor #SS2669. Input 18V; Output 450V @ 150MA. $3.95

CUNVERTERS PU-16/AP, input 28VDC; output 115 VAC 400 cy. 6.5A. $59.50

INVERTERS PU-7/AP, input 28VDC; output 115 VAC 400 cy. 6.5A. $59.50

INVERTERS PE-218, input 28VDC; output 115VAC, 400 cy. at 1.5 KVA. $29.95

WIRE WOUND RHEOSTATS
Standard Brands

#241D, 250/250 ohms 50W w/½" shaft. . . . . .95¢
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#50D, 30/30 ohms 50W w/½" shaft. . . . . .95¢
Model J, 16/16 Ohms 50W w/½" shaft. $1.25
Model J, 0.5 ohms 50W. 95c
Model J, 5 Ohms 50W. 95c
Model J, 75 ohms 50W. 95c
Model J, 150 ohms 50W. 95c
Model J, 800 ohms 50W. $1.25
Model J, 1000 ohms 50W. $1.25
Model J, 5000 ohms 50W. $1.45
Model H, 60 Ohms 25W. 75c
60 Ohms 25W. 65c
Model H, 100 Ohms 25W. 75c
Model H, 175 Ohms 25W. 75c
Type PR, 15 Ohms 25W. 75c
All size potentiometers and rheostats in stock. Write us your requirements on all carbon or wirewound.

BC-375E Transmitter complete w/tuning units. Brand New $50.00

HEAVY DUTY COPPER OXIDE RECTIFIERS

HAMMETT ELECTRIC RECTIFIERS MODEL SPS-100B. Input: 220 volts 60 cy 3 ph 13A. Output: 15 volts at 130 Amperes, 30 volts at 65 amperes, cont. duty. Complete w/volt and ammeters. Like new. Special. $195.00

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Surplus lots purchased.
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WANTED

(Additional Wanted Ads on Page 337)

WANTED

Tubes, Test equipment, Condensers, & general inventories. Highest prices paid.

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DYNAMOTORS • SELSYNS • AUTOSYNS • INVERTERS • TRANSMITTERS
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Please send list stating condition and lowest price.
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We are in dire need of: TS-125's, TS-155's, TS-13's, TS-34's, TS-117's, TS-268's

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Name ....

Address ....

SEE COLUMBIA ELECTRONICS AD ON PAGE 367

PANEL METERS

large stock guaranteed accuracy

Legend: G.E.—General Electric, W.—Weston, W.H.—Westinghouse, W.E.—Western Electric, G.R.—Gruen, W.L.—Western Limited, H—Hoyt, S—Simpson, T—Triplet.

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150 T 2" Rd.	$6.95	150 S 3" sq.-Rd.	$9.95
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100 W 3" Rd.	16.95	500 WH-GE 3"	9.95

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500 Mils. WL 2" sq.	$4.45
2. Amps. S 2" sq.	4.95
3. Amps. S 2" sq.	4.95
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10V W 3" Rd.	$9.95	300V W 3" Rd.	$12.95
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150V W 2" Rd.	7.95	300V GE 3" sq.	10.95
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Weston 301 3" Rd. 10-50-100-200-300-400-500 each	9.95
W'house NX-35 3" Rd. 15-25-50-100-150-200-300-500-750 ea.	5.95
Simpson 2" Rd.-Sq. 1 Mil. 100-200-300-500 ea.	5.95
Hoyt 2" Rd. 0-1 Mil	4.95
Hoyt 3" Rd. 0-1 Mil	5.95
Gruen 2" Rd. 0-1 Mil	4.95
Triplet 2" Rd. 100-200-300-500 Mil ea.	3.95

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W'house NX-35 3" Rd. 1A-2A-5A ea.	$5.95
*W'house 10A-30-50A ea.	6.95
W'house NX-35 3" Rd. 100A-200A-300A	12.95
GE 2" Rd. 30 amps	4.95

*With ext. shunt.

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W 3" Rd. 1000 ohm/V 50-100-150-200 ea.	10.95
W 500—1KV ea.	12.95
Wh. 3" Rd. 10-25-50-80 ea.	6.95
WH 3" Rd. 150-200-300 ea.	7.95
W 2" Rd. 25-50-100-150 ea.	7.95
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*With w/ext. mult.

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New Bathtub Condensers Original Pack

2x.1—600v—4 top term.	.29¢
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.1—600v—2 top term.	.27¢
2x.5—400v—3 top term.	.25¢
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Amertran "TRANSTATS" Voltage Regulator

11.5 KVA 50/60 cy. Commutator range 0-115 V. Max. Amps. 100. Reconnection diagram available for 230 V. 50 A operation. BRAND NEW. Factory Cases ... $225.00

SUPERIOR POWERSTAT

Type 1126-3Y, Pri.: 230V, 3 ph, 60 cy. Output: 0-270 Volts 7 KVA. May be separated and used as three 0-115V, 1 ph, 60 cy, 2.0 KVA units. Brand New ... $100.00

Transtat .25 KVA. Fixed winding 115/1/60. Commutator range 103-126 V. Max AMPS. 2.17 ... $9.45
.5 KVA Fixed Winding 115/1/400 Commutator range 92-115 V Max Amps. 5.5 ... $4.50

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All have 115V 400 cy Primary

- **Raytheon UX8547.** Sec: 1000V @ 2.5 Ma; Sec 2: 6.15 V @ 700 Ma ... $3.95
- **Federal RA6404-1.** Sec #1 550/0/165/550 @ 200 MA; Sec #2 & 3: 5 V @ 3A; Sec #4: 6.3 V @ 2A; Sec #5: 25 V @ 2.2A ... 4.00
- **W. E. #KS-8986.** Sec #1: 990 VCT @ 420 MA; Sec #2: 875 VCT @ 420 MA; Sec #3: 780 VCT @ 420 MA ... 7.95
- **RCA 901695-501.** Sec #1: 790 V @ 400 MA; Sec #2: 5.18 V @ 6 A; Sec #3: 5.18 V @ 2 A ... 4.00
- **Sperry 702523.** Sec #1: 740 V @ 12 MA; Sec #2: 2.5 V @ 3A; Sec #3: 2.5 V @ 3A; Sec #4 & 5: 6.3 V @ 2.25 A ... 3.25
- **Sperry 702719.** Sec #1: 700 VCT @ 315 MA; Sec #2: 200 VCT @ 100 MA; Sec #3: 6.3 V @ 15 A; Sec #4: 18 V @ 600 MA; Sec #5: 5 V @ 6 A ... 7.95
- **Thordarson.** 2 Volts at 5 Amperes ... 2.95
- **Raytheon UX8302C.** Sec #1: 6.3 V @ 4.7 A; Sec #2: 5 V @ 3 A; Sec #4: 6.3 V @ 600 MA ... 3.50
- **W. E. #D-11646.** Sec #1: 5 V @ 2 A; Sec #2: 2.5 V @ 5 A ... 3.50

TRANSFORMERS
All have 115V 60 cy Primary

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- **Inst. #1100-856600.** Sec #1: 11 V @ 2.5 A ... 2.25
- **Sub Sig U-7420.** Sec #1: 225 V @ .18 A; Sec #2: 6.3 V @ 2.5 A ... 3.25
- **Bendix 530178.** Sec 1: 1.5 Volts @ 0.005 A ... 1.25
- **Amertran 7180.** Sec #1: 2.5 VCT @ 10 A ... 2.95

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- **Amertran 23882.** Pri: 4000/1000 Ohms; Sec: 4000 ohms; DB Level plus or minus 28 ... 1.35
- **Federal RA-6403-1.** Pri: 8000 ohms @ 9 MA; Sec: 600 ohms ... 1.35
- **Federal RA-6408-1.** Pri: 2500/2000 ohms; Sec: 600 ohms ... 1.35
- **Zenith 95G39.** Pri: 2000 ohms 40 H; Sec: 60 ohms; Ratio: 8.3 to 1 ... 1.35
- **Hammond 12238.** Pri: 3000 Ohms; Sec: 12000 ohms CT. Ratio: 1 to 2 ... 1.65
- **N. Y. T. C. 5804.** Pri: 2300 ohms CT; Sec: 2000/1800/1500/1300 250 MA ... 2.25
- **Pacent 27A.** Single Plate to Single Grid. 3 to 1 ratio ... 1.65
- **CTC #564394.** Pri: 3500 ohms; Sec: 7 ohms ... 1.00
- **Hammond 12940.** Pri: 3000 ohms; Sec: 12000 ohms CT; Ratio: 1 to 2 ... 1.65
- **MWC #12-182-1.** Pri: 1500 ohms 50 H. Output to Voice Coil. 1.4/0.7/0.3/0.1V ... 1.00
- **Federal W15-40.** Pri: 300 ohms; Sec: 250,000/680,000 ohms; Ratio 1 to 27.3 ... 1.00
- **Federal RA6407-1.** Pri: Tapped unbalance, 15000 ohms @ 0.006 ADC; Sec: 1770 ohms CT. Response 200 to 5000 cy. 1.5 DB level. 55 W ... 1.25

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- **W. E. Oscilloscope #ES677584-1.** SC#4G1670A/T5 ... .95
- **Bendix Overload Dwg.** #CAL-2030-1 ... 1.65
- **W. E. Network Assembly D-159989** ... 1.00
- **W. W. Network Assembly D-43867** ... 4.95
- **Stancor Modulation A-3871.** Pri: 4500 ohms; Sec: 8500 ohms. Class A ... 1.35
- **Raytheon Pulse WX5137.** Pri: 4 KV 1 MU; Sec: 16 KV 16 A ... 5.25
- **G. E. #68G457.** Pri: 1/1.5/3.6/8/10 Volts; Sec: 50-50 Volts 100 W ... 1.65

GC-9 XMITTER. With spare parts kit. Frequency range 3-18 MC and 300-600 KC. Band switching 109 w output. Brand new in original mfg. crates. Comes with tubes and spare parts kit. Comes in three units: high and low frequency xmitter and rectifier. Dimensions: 14" deep x 27" long x 29¼" high. Netwt . 137 lbs. Shpg. wt. approx. 250 lbs. Finished in black crackle shock mounted. Has 7 meters for indicating plate and grid current, also antenna current. Operates 110V 800 cycles. Single phase and 24V DC. Contains 2—803 tubes, 1—807, 1—801, 2—837, 1—5Z3, 2—1616. Comes with maintenance manual and test data ... $99.50

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- 3000-3675 KC ... 1.00
- 3675-4525 KC ... 1.00
- 4000-4900 KC ... 1.00
- 4900-6000 KC ... 1.00
- 6000-7350 KC ... 1.00
- 7350-9050 KC ... 1.00

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- 1330-2040 KC ... 1.00
- 2040-3000 KC ... 1.00
- 3000-4525 KC ... 1.00
- 4000-6000 KC ... 1.00
- 9050-13.575 KC ... 1.00

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- 195- 290 KC & 290 435 KC ... $1.65
- 200- 380 KC & 2000-3700 KC ... 1.65
- 530-1000 KC & 2000-3700 KC ... 1.65
- 540- 830 KC & 2040-3000 KC ... 1.65
- 540- 830 KC & 3000-4525 KC ... 1.65
- 400- 600 KC & 6000-9050 KC ... 1.65
- 540- 830 KC & 5200-7700 KC ... 1.65

OHMITE R.F. CHOKE, Z-0, 2 Millihenries, 1000 MA ... 60¢
HAMMARLUND R. F. CHOKE, RFC-250, 250 millihenries ... 95¢
TANK COIL, miniature, slug tuned 4397 .5 KC ... 95¢
HAMMARLUND COIL & PADDER ASS'Y. f/Super Pro 100, 200-400 KC ... $1.35

REACTORS AND CHOKES

- Raytheon #U11010. Rated 10H @ 1.2 A DC ... $49.95
- G.E. Cat. #7479974. Rated 2.5H @ 2.3 A DC ... $37.50
- G.E. Cat. #7479964. Rated 50H @ .025 A DC ... $27.50
- Ind #CK3016. Rated @ 20H @ 60 MA DC ... $2.95
- Thordarson #T48853. Rated 6H @ 80 MA DC ... $1.50
- Raytheon #U-7423. Rated 1.2-1.6H @ 0.0 MA DC $2.25
- Raytheon #UX8887D. Rated 30H @ .03 A DC ... $5.25
- G.E. Cat. #7472403. Rated 5H @ .035 A DC 4 KV Test ... $2.35
- Thordarson #T45921. Rated 7H @ 0.9 A DC 10 KV Test ... $19.50
- Raytheon UX9114A. Rated 0.100H @ 1.4 A DC ... $3.00
- Zenith 95G40. Rated 150H @ 1.0 MA DC ... $2.25
- Raytheon UX9116. Rated 0.30H @ 2.0 A DC ... $3.00
- Raytheon WX-5148. Dual. Rated 1.75/1.75 @ 0.25/0.25 A DC ... $3.50

HEAVY DUTY TRANSFORMERS

- G.E. Cat. #7479965. Pri: 230V 60 cy Sec: 16.4/8.2 VCT: 11/5.5V @ 60A. 8½H 9½L 6½W ... $25.00
- G.E. Cat. #79G365. Pri: 203.5V 60 cy Sec: 6.3V @ 250 Amperes ... $39.50
- G.E. Cat. #7479971. Pri: 230/208V 50/60 cy; Sec: 1365/1300/1235VCT 735VA. 7½ x 5½ x 8½ ... $29.50
- G.E. Cat. #7479972. Pri: 230/208V 50/60 cy; Sec: 2450/2350/2210VMS. 2.85 KVA ... $49.50
- G.E. Cat. #7475695. Pri: 115V 60 cy. Sec: 3530/3720/3910 V. M.S. 1.31 KVA ... $47.50
- Maloney Elec. REL10383. Pri: 115/230V 50/60 cy. Sec: 0/21000 Volts @ 100 MA DC, Half Wave. 0.1 Filled. 16"D 16"W excl. of ins ... $125.00

CONTROL BOXES

- BC-450A, Radio Control Box ... $4.95
- BC-602A, Radio Control Box ... 1.25
- BC-606C, Interphone control box ... 95¢
- BC-451A, Radio Control Box ... 2.95
- CW-23012, Remote tuning control for RU RCVRS. 1.25
- RL-9, Interphone Control Box ... 1.25
- RM-52, Remote Control Unit ... 2.95
- CJP-23330, Pilot's Control Unit ... 2.95
- C2/ARR2 Radio Control Box ... 1.25
- CBY-62017, Junction Box f/RU Rcvrs ... 1.25
- MI-22A, Station Control Box ... 1.25
- CW-23087, Receiver Switch Box f/RU ... 1.25
- CW-23097, Xmtr Control Box f/GF Equip ... 1.25
- CW-23098, Exr. Control Box f/GF Equip ... 1.25
- J23:ARC4, Junction Box for ARC4 Equip ... 1.75
- C26/ARC5, Remote Dial Assy f/ARC5 ... 1.45
- C51/ARC4, Channel Sel. Sw. f/ARC4 ... 1.75
- C38/ARC5, Rcvrs Control Box f/ARC5 ... 1.75
- C30/ARC5, Channel Control f/ARC5 ... 1.75
- C48/ARC5, Switch Box f/ARC5 ... 1.75

FUSES AND FUSEHOLDERS

- 4 Amp 250V 3AG Fuses ... $1.50/c
- 5 Amp 250V Midget Fuse ... 2.00/c
- 6 Amp 250V Midget Fuse ... 2.00/c
- 10 Amp 5000V Indicating ... 40.00/c
- 15 Amp 250V 3AG Fuses ... 2.00/c
- 15 Amp 125V Midget Fuse ... 2.00/c
- 30 Amp 250V 4AG Fuses ... 1.50/c
- 30 Amp 250V 3AG Fuses ... 2.00/c
- 30 Amp 250V Plug Fuse ... 4.50/c
- Buss Type HKP Fuseholder ... 15.00/c
- Buss Type HCM Fuseholder ... 15.00/c
- G.E. EL-1 60A Fuseholder ... 1.35 ea

RECTIFIERS

- IT&T Selenium, WE. KS9020, 20 plates 1" dia. Input 18VAC Output 15VDC @ .25A ... $2.75
- IT&T Selenium, Half Wave, #FE4, 4 plates 1⅝" dia. Input 18VAC Output 7.5VDC @ .45A ... $1.00
- Westinghouse #103B Copper Oxide, Half Wave, 4 plates 1⅝" D. Input 4VAC Output 3VDC @ .25A. $1.75
- G.E. Model 6RS5F10, Selenium, Full Wave, 24 plates 1" D. Input 54VAC Output 36VDC # .2A ... $3.95
- B-L #BL202S1, Selenium, Full Wave, 24 plates 1" D. 220VAC Output 180VDC @ .0075A ... $3.95
- Westinghouse #854029A. Copper Oxide 13 plates 3⅝" D. Bridge, Input 65VAC Output 45VDC @ .32A. $9.95

HIGH VOLTAGE CAPACITORS

- Cat. #26F628 rated 0.1 Mu-F @ 12KV DC ... $ 9.95
- #7520 rated 2 x .1 Muf @ 7500 VDC ... 17.50
- Cat. #14F64 rated 0.25 Mu-F @ 20KV DC ... 17.50
- Cat. #14F71 rated 0.25 Mu-F @ 32.5KV DC ... 35.00
- Cat. #A7548 rated 2x.25 Mu-F @ 6000 VDC ... 12.50
- CD Paper rated 0.5 Muf # 25KV DC ... 45.00
- #RC-2151 rated 2x.5 Muf @ 9000 VDC ... 25.00
- Cat. #120063 rated 0.65 Mu-F @ 12.5KV DC ... 15.00
- Type FP rated 1.0 Mu-F @ 10KV DC ... 32.50
- Cat. #14F63 rated 1.0 Mu-F @ 15KV DC ... 37.50
- Cat. #AE6734 rated 1.0 Mu-F @ 25KV DC ... 75.00
- #TK60020 rated 2.0 Muf @ 6000 V DC ... 22.50
- Cat. #14F338 rated 4.5 Muf @ 7500 V DC ... 35.00
- Cat. #14F13 rated 5.0 Muf @ 10KV DC ... 45.00

ELAPSED TIME METERS

- Mfd. by R. W. Cramer Co. Type RT-2H. 0-10,000 hours by tenths. 115 Volts 60 cy ... $9.75
- Mfd. by G.E. Model 8KTYD33, 0-10,000 hrs. by tenths. 115 V., 60 cy, 3" sq ... $14.95
- Mfd. by G.E. Model 8KT8Y60. 0-10,000 hrs. by tenths. 115 V., 60 cy ... $14.50

SPECIAL BUYS OF THE MONTH
METERS

- 0-3 VDC, Simpson Model 25 ... $3.95
- 0-5 VDC, Readrite "2" ... $1.75
- 8-16 VDC, Stewart Warner ... $1.35
- 0-30 VDC, G.E. Type DW-41 ... $4.25
- 0-30 VDC, Weston Model 301 ... $8.95
- 16-32 VDC, Stewart Warner ... $1.35
- 0-100 VDC, Simpson Model 25 ... $4.95
- 0-100 VDC, Westinghouse RX33 ... $5.95
- 0-150 VDC, Hoyt Model 17L ... $4.95
- 0-1 MADC, G.E. Model DO-40 ... $7.95
- 0-1 MADC, Simpson Model 126 ... $5.95
- 0-1 MADC, Roller Smith TD ... $6.95
- 0-1 MADC, G.E. Type DW-53 ... $6.95
- 0-10 MADC, G.E. Type DO-40 ... $7.95
- 0-10 MADC, Weston Model 267 ... $14.50
- 0-10 MADC, Westinghouse QX37 ... $14.50
- 0-10 MADC, DeJur-Amsco #310 ... $5.95
- 0-15 MADC, W. E. #CW22132 ... $7.95
- 0-20-200 MADC, Westinghouse QX37 (dual movement) ... $16.50
- 0-80 MADC, W.E. #D-170198 ... $7.95
- 0-100 MADC, Weston Model 267 ... $14.50
- 100-0-100 MADC, Weston 301 ... $8.95
- 100-0-100 MADC, Beede 361A (used) ... $2.50
- 0-200 MADC, G.E. Type DO-41 ... $7.95
- 0-300 MADC, G.M. Labs MT-31C ... $7.50
- 0-1000 MADC, DeJur-Amsco #310 ... $6.35
- 0-1000 MADC, Beede 3"Rd ... $5.95
- 0-1 ADC, Westinghouse NX-35 ... $7.95
- 0-2 ADC, Westinghouse NX35 ... $7.95
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- 0-15 VAC, G.E. Type AO-22 ... $7.95
- 0-150 VAC, Hickok Type 57M ... $5.25
- 0-150 VAC, Westinghouse NA35 ... $9.95
- 0-150 VAC, Weston Model 476 ... $10.50
- 0-250 VAC, Westinghouse QA-37 ... $16.95
- 0-10 MADC, G.E. Type AW-42 ... $7.50
- 0-300 MADC, Burlington 422B ... $5.75
- 0-500 MADC, G.E. Type AO-22 ... $8.95
- 0-3 AAC, Burlington #22C ... $5.75
- 0-50 AAC, Weston Model 476 ... $10.50
- 0-75 AAC, Triplet Model 331 ... $7.95
- 0-2 ARF, Simpson Model 136 ... $6.25
- 0-2.5 ARF, Burlington #33C ... $6.25
- 0-2.5 ARF, Simpson Model 138 ... $5.95
- 0-3 ARF, G.E. Type DO-44 ... $7.95
- 0-4 ARF, G.E. Type DW-52 ... $7.25
- 0-5 ARF, Weston Model 425 ... $10.50
- 0-10 ARF, Westinghouse NT-35 ... $8.95
- 0-20 ARF, G.E. Type DO-44 ... $8.95
- 0-3000 RPM, Stewart Warner 63000 ... $12.50
- 48-52 & 58-62 Frequency Meter JBT Model 30F $12.95
- 50-70 Cycles Frequency Meter Weston Model 814 $17.50
- 57-63 Cycles, Freq. Meter, Frahm Type MF7 ... $14.95

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- Type CS, 120V/60cy/1ph 15 Amp., 2 Wire, new .. $9.50
- Type CA, 120/60cy/1ph 15 Amp., 2 Wire, new ... $9.50

W.E. Test Set 1-115 ... $9.50

W.E. Sine Wave Generator KS5913L02 16V 2 Ph. 1725 RPM, driven by W.E. motor KS5913L01. 115V 60 cy. 1 Ph. 1/50 HP 1725 RPM ... $17.95

G.E. VOLTAGE REGULATOR MODEL 3GVD11B6, for use w/115V 60 cy supply, 23-35KV complete w/10 Tubes ... $49.95

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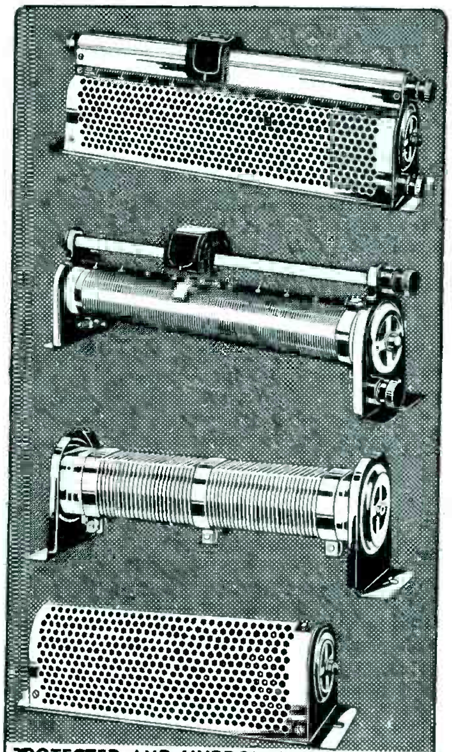

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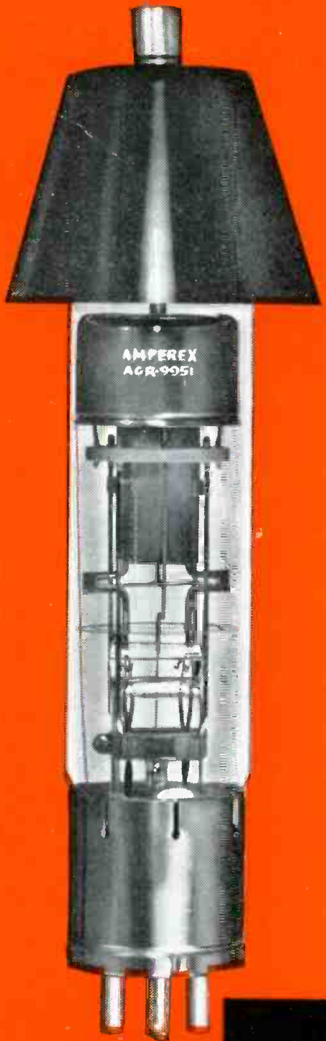

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FREQUENCY RANGE (cps)	25 to 150		25 to 150	
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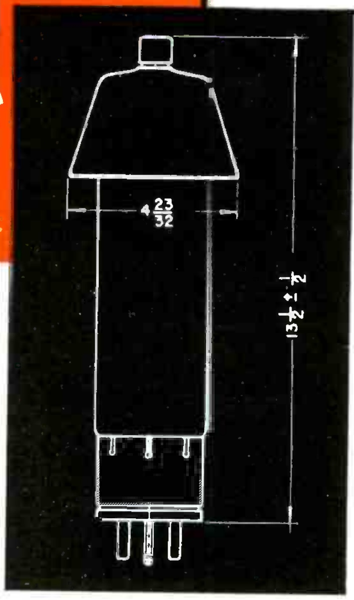

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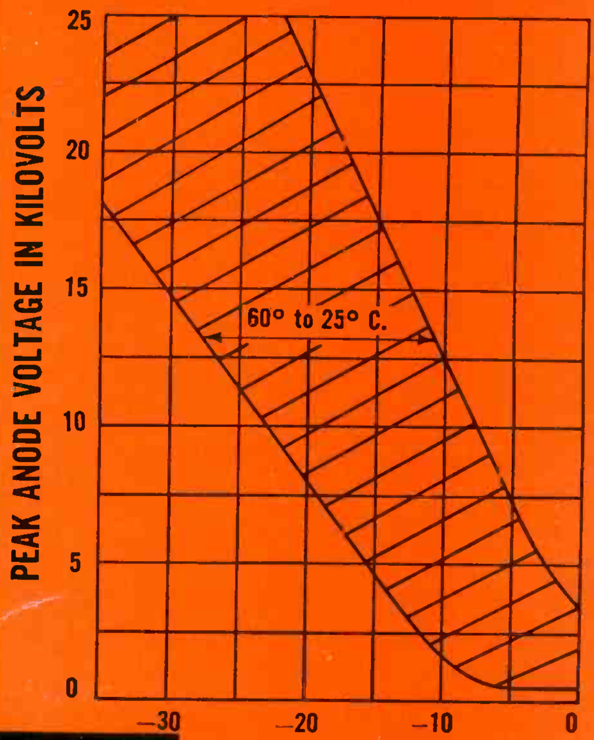

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