The 2½” magnetic projection triode 3NP4 has a face as small as a compact and is only 10½” long.

**HERE'S THE OPPORTUNITY THAT MANUFACTURERS OF TELEVISION RECEIVERS HAVE BEEN AWAITING!**

**10 SIGNIFICANT FEATURES**

1. Flat 16” x 12” non-reflecting picture provides fatigueless viewing from less than 5 feet and upward!
2. Wide-angle visibility — square corners.
3. True photographic black and white picture quality — no discoloration.
4. Compact unit — suitable for table model cabinets.
5. Long-life, low-cost picture tube.
6. Manufacturers can most economically extend their product range into projection television by adapting their 10” EM chassis for use with PROTELGRAM.
7. Easy to service.
8. High contrast ratio and broad gray tone range.
9. Simple optical adjustment system.
10. Quality built after more than 10 years of development.

NORELCO PROTELGRAM consists of a projection tube, an optical box with focus and deflection coils, and a 25 kv regulated high-voltage supply unit, making possible large-size home projection. More than ten years of exhaustive research resulted in this ideal system for reproducing a projected picture. The optical components are designed to produce perfected projection for a 16” x 12” image, the optimum picture size for steady, distant observation and also for proper viewing at less than 5 feet.

Other NORELCO products include standard 10” direct-viewing tubes and special-purpose cathode-ray tubes for many applications.
PHOTOELECTRIC CUTTING MACHINE
Motor-driven tracer of Air Reduction Sales Company unit following intricate outline of paper template on table while oxyacetylene torches cut paper-mill pulp beaters in quadruplicate from three-quarter-inch low-carbon plate at Paper Calendering Company plant in St. Paul. For technical det... see p 122

SELLING RESEARCH IDEAS, by Waldo H. Kliever
Ideas born of research must be promoted and pushed to overcome man's inherent opposition to change

TELEVISION STATION COSTS, by William Foss
A budget plan for small stations, showing orderly additions to plant and equipment during normal growth

FREQUENCY STABILIZATION OF DIATHERMY UNITS, by Carl K. Gieringer
Differential relay in monitor circuit stops oscillator when frequency drifts outside of FCC-allocated band

VERSATILE TONE CONTROL, by William B. Lurie
Multiple R-C networks and cathode-resistor taps are switched simultaneously to give 121 different response curves

POWER AMPLIFIER FOR THE CITIZENS TRANSMITTER, by Walter C. Hollis
Complete construction details for increasing power of ELECTRONICS transmitter

PRECISION INTERVAL TIMER, by Sidney Wald
Intervals from 0.01 to 100 seconds are provided by novel discharge circuit

TELEVISION REMOTE VIEWERS, by Vin Zeluff
Two independent picture units and a slave unit for home receivers

CERAMIC PHONOGRAPH PICKUP, by L. Grant Hector and H. W. Koren
A phonograph pickup designed to utilize the properties of synthetic piezoelectric material

NEW SYNTHETIC PIEZOELECTRIC MATERIAL, by G. N. Howatt, J. W. Crownover and A. Drametz
Induced piezoelectric properties and production of barium titanate

HIGH-VOLTAGE SUPPLIES FOR G-M COUNTERS, by Alexander Thomas
Portable 900-volt d-c power supply using neon-controlled oscillator is described

CARRIER-FREQUENCY VOLTMETER, by Paul Byrne
Strength of signals received over power lines, telephone lines and cables is indicated in db

MULTICHANNEL RADIO TELEMETERING FOR ROCKETS, by Gene H. Melton
Electronic system developed for use in Aerobee high-altitude projectiles

DESIGN OF L-P RECORDS
Considerations, as presented at New York IRE section meeting, that led to development of microgroove records

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Circuit design data for mitigating the general problem in all kinds of electronic apparatus

MELTING-POINT CHART, by K. H. McPhee
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In designing their superb wire recorder for office and studio recording, Webster-Chicago needed a special meter-type, volume-level indicator for accurate input control. Ruggedness and accuracy were basic requirements. Because Marion has long been noted for fool-proof, trouble-free electrical meters and instruments, it was natural for Webster-Chicago to turn to Marion for this important component.

Marion soon developed a small, specially designed, panel-mounting type of meter for the amazing Webster-Chicago Wire Recorder. In doing so Marion played a vital part in helping Webster-Chicago record the human voice and other sounds on a wire.

When you have a problem that concerns electrical measuring or indicating, we invite you to turn to Marion. We have a long record of success in helping others. And, because we know the name "Marion" means the "most" in meters, we believe we can help you too.

THE NAME "MARION" MEANS THE MOST IN METERS

MARION ELECTRICAL INSTRUMENT COMPANY
MANCHESTER, NEW HAMPSHIRE
Export Division, 458 Broadway, New York 13, U.S.A., Cables MORHANEX
IN CANADA: THE ASTRAL ELECTRIC COMPANY, SCARBORO BLUFFS, ONTARIO

December, 1948 — ELECTRONICS
NOTICE

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LOS ANGELES • MONTREAL

Drafting, Reproduction, Surveying Equipment and Materials

Slide Rules • Measuring Tapes

ELECTRONICS — December, 1948
IT'S COMMONPLACE TODAY to pick up a telephone on shipboard and talk to a business associate on land. But little more than 30 years ago, this was just a dream.

Back in 1915, the spoken voice could travel to far places only by wire. Then telephone scientists developed the radiotelephone, and soon the spoken word was winging its way across the ocean. A further use of this new magic was soon proposed: could not the human voice be sent from shore to ships at sea?

Soon sub-chasers and other small Navy craft were talking to each other over equipment designed by Bell engineers. And in experiments starting in 1919, the men on two coastwise steamers talked through land stations to land telephones of the Bell System.

These early experiments covered fairly short distances. But in the meantime, telephone calls across the Atlantic by radio had become an ordinary occurrence. So... why not 'phone calls to ships way out in mid-Atlantic?

Of course, long-distance ship-to-shore radiotelephony brought up problems of varying distances and directions—problems not encountered in point-to-point transmission. Bell Telephone Laboratories solved these problems with the design of the "Leviathan's" equipment. For the first time, long-range marine radiotelephony became a reality.

Later, Bell Laboratories scientists developed selective ringing, which made it possible to dial particular ships at sea. The basic elements of practical marine radiotelephony had now been developed.
links the ship and the shore

In addition to producing radiotelephone equipment for the largest ocean liners, Western Electric for many years manufactured the 224, 226 and 227 type sets, which brought the benefits of radiotelephone facilities to coastwise vessels and small craft.

These sets provided power capacities ranging up to 100 watts. As the Bell System had tremendously expanded its chain of harbor stations, coastal craft were normally near a shore station. Hence these capacities were ample to maintain contact with land.

There still existed, however, no equipment specifically designed for tankers, freighters and smaller passenger ships plying the ocean lanes. This need has been filled by the introduction of the Western Electric 248A.

This new equipment provides 250 watts of transmitted radio frequency carrier power, resulting in greatly increased range. Provision is made for transmission and reception on the frequencies of the high-seas shore stations (as well as on the coastal harbor and ship-to-ship channels). Because of these two features, a ship equipped with the 248A, at practically any point on world trade routes, can establish contact with a land station.

The 248A combines this advantage with the compactness and simplicity of operation essential on smaller ships.

- Quality Counts -

Western Electric
Manufacturing unit of the Bell System and the nation’s largest producer of communications equipment.

Electronics — December, 1948
MITCHELL-RAND

the one dependable source
of supply for everything in
electrical insulation

*MIRAGLAS

WOVEN TAPES, TUBINGS
SLEEVINGS & CORDS
CLOTHS, ETC.

*MIRAGLAS-MICA COMBINATIONS

- VARNISHED TUBINGS
- SLEEVINGS & TAPES
- COTTON TAPES & SLEEVINGS
- VARNISHES—WAXES—COMPOUNDS

- Woven of Fiberglas Yarn

MITCHELL-RAND INSULATION CO. Inc.

51 MURRAY STREET • Cortlandt 7-9264 • NEW YORK 7, N. Y.

A PARTIAL LIST OF M-R PRODUCTS: FIBERGLAS VARNISHED TUBING, TAPE AND CLOTH • INSULATING PAPERS AND TWINES • CABLE FILLING AND POthead COMPOUNDS • FRICTION TAPE AND SPICE • TRANSFORMER COMPOUNDS • FIBERGLAS SATURATED SLEEVING • ASBESTOS SLEEVING AND TAPE • VARNISHED CAMBRIC CLOTH AND TAPE • MICA PLATE, TAPE, PAPER, CLOTH, TUBING • FIBERGLAS BRAIDED SLEEVING • COTTON TAPES, WEBBINGS AND SLEEVINGS • IMPREGNATED VARNISH TUBING • INSULATED VARNISHES OF ALL TYPES • EXTRUDED PLASTIC TUBING

December, 1948 — ELECTRONICS
FILTERED BY FILTRON... These planes, and others — that form "America's Mighty Armada," are equipped with electrical components which are FILTERED BY FILTRON... Some with as many as 27 FILTRONS per plane... These planes represent America's most advanced engineering and design — and FILTRONS represent the most advanced engineering and design of radio noise filters. FILTRONS are vital components not only in aircraft equipment, but wherever radio interference must be suppressed... FILTRON will design the RIGHT filter for your circuit conditions — and to meet your delivery requirements. All measurements are made in our new, modern, specially designed shielded Radio Noise Suppression Laboratory.

RADIO NOISE FILTERS FOR:
Electric Motors
Electric Generators
Electronic Controls
Electronic Equipment
Fluorescent Lights
Oil Burners
Signal Systems
Business Machines
Electric Appliances
Electronic Signs
Electronic Heating Equipment

100 amp & 200 amp 50 Volt Aircraft Filtrons, size 3 1/8" x 3 1/2" x 2 1/8"

2.5 amp Filtron for 50 V.D.C. operation size 1 3/4" x 1 1/4" x 7/8"

THE FILTRON CO., INCORPORATED
38-25 BELL BOULEVARD • BAYSIDE, NEW YORK CITY, N. Y.

LARGEST EXCLUSIVE MANUFACTURER OF RADIO NOISE FILTERS

ELECTRONICS — December, 1948
Hearing aids are smaller and lighter. Hearing aid performance is better... absolutely unaffected by moisture and humidity. Centralab's amazing Printed Electronic Circuit is an important reason and the Microtone hearing aid is important proof. When Microtone engineers switched to Filpec, here's what they found: Filpec cuts down size and weight by reducing the number of components needed... increases production by eliminating many assembling operations. For all the facts, write for Bulletin 976.

Centralab's Filpec is designed for use as a balanced diode lead filter, combines up to three major components into one tiny unit, lighter and smaller than one ordinary capacitor. Capacitor values available from 50 to 200 mmf. Resistor values from 5 ohms to 5 megohms. For complete information, write for Bulletin 976.
Electronic Industry

4 Great step forward in switching in CRL's New Rotary Coil and Cam Index Switch. Its coil spring gives you smoother action, positive indexing, longer life.

5 To CRL's line of high quality ceramic capacitors, these miniature disc Hi-Kaps have been added. Combine reliability, capacity. Order Bulletin 933.

6 Wide range of variations in CRL's Model "M" Radiohm simplifies production and inventory. Bulletin 697-A illustrates convenience, versatility!

7 Centralab's development of a revolutionary, new Slide Switch promises improved AM and FM performance! Flat, horizontal design saves valuable space, allows short leads, convenient location to coils, reduced lead inductances for increased efficiency in low and high frequencies. Rugged, efficient. Write for Bulletin 953.

8 CRL's Couplate consists of a plate lead resistor, grid resistor, plate by pass capacitor and coupling capacitor. Write for Bulletin 943.

LOOK TO CENTRALAB IN 1949! First in component research that means lower costs for the electronic industry. If you're planning new equipment, let Centralab's sales and engineering service work with you. Get in touch with Centralab!

Centralab
DIVISION OF GLOBE-UNION INC., MILWAUKEE, WIS.
IT PAYS TO LOOK AT COST PER PART
NOT PRICE PER POUND!

There's certainly nothing complicated-looking about the small stamped channel section of .042" gauge copper shown in the accompanying illustration. And that's what makes this story all the more interesting.

It is told by Mr. T. J. Newman, Manager of the Meter Devices Company, Canton, Ohio.

"Even a relatively simple application can cause trouble," says Mr. Newman, "a lot of trouble—if you are not using exactly the right metal for the particular job.

"In our case the problem centered around this small stamped channel, originally made of electrolytic copper with a Rockwell B 35/45. The part is bolted to a porcelain base and mounted on the test panel in a standard electric meter box. Used on the service box for test purposes, it allows the connection of a small feed-in wire off the main lines to supply the potential coils in the meter.

"Sounds simple enough. Yet complicated trouble came quickly. It started with cracks in the bends. And that resulted in a high percentage of rejections, along with expensively close inspection.

"It was then that we called in the Revere Technical Advisory Service. Acting on their recommendation, we exactingly tested potential taps made of OFHC Copper with Rockwell B 49/50. Results were so satisfactory that we placed a considerable production order.

"In doing so we frankly paid a premium for OFHC. But that premium is much more than offset by our saving in scrap and the all-around reduction in costs. Our potential taps now have no more cracks in the bends—there are no rejections whatever—and expensive inspection has been eliminated."

Thus the Meter Devices Company has learned, by its own exacting tests, that the premium purchase of OFHC Copper is a real economy. Once again it is proved that the real guide to economy is the cost of the finished part, not the price per pound of the metal of which it is made.

This progressive company is only one of the many modern industrial organizations that have profited by calling in the Revere Technical Advisory Service. Perhaps you would profit too. We suggest that you ask the nearest Revere Sales Office for more information.

REVERE COPPER AND BRASS INCORPORATED
Raised by Paul Revere in 1801
230 Park Avenue, New York 17, New York
Build a better mouse trap and the word gets around—but fast. Same with Hytron a-c/d-c tubes. Many years of experience. Many millions of tubes. Constant engineering cooperation with dozens of prominent radio set manufacturers. All help make Hytron a-c/d-c tubes better. Make it natural to think of Hytron when you think of the All-American Five.

The lowly a-c/d-c tubes must pack a heck of a lot of performance—at a price. Hytron tubes do. They offer the special advantage of being built to the strictest requirements of leaders in the small set field. GT or miniature—you, too, will find Hytron a-c/d-c tubes your best choice.
Developed by General Electric and proven by the thousands in the war, these compact units are now available for any commercial use. They find application in radar and industrial equipment where the normal capacitor discharge shape is not suitable and where an impulse having a definite energy content and duration is required. The network consists of one or more equal capacitor sections and the same number of inductance coil sections. Both capacitors and coils are hermetically sealed in the same metal container. Networks are treated with top quality mineral oil to provide stability of capacitance characteristics over a wide range of ambient temperatures. Sizes from which you can make your selection range from a 0.5-kw output rating to 4500-kw. Write for bulletin GEA-4996.

General Electric's new line of 3 3/4-inch thin panel instruments will save space and add to the appearance of your panels. They're dust-proof, moisture resistant, and vibrations normally encountered in aircraft and moving vehicles have no adverse effects. Especially designed for better readability, the scale divisions stand out by themselves. Lance-type pointers and new-style numbers mean faster reading. Available in square and round shapes, depth behind the panel is only 0.99 inches. Construction is of the internal-pivot type, with alnico magnets for high torque, good damping, and quick response. Check bulletin GEA-5102.
SIMPLIFY CONTROL WIRING
WITH THESE TERMINAL BOARDS

Easy-action hinged covers protect control wiring, help give your product a neat appearance. Hook-ups are easy with the hard-gripping connectors. Simply strip the wire end, screw down the connector on the bare wire. Blocks are durable, too, constructed of strong Textolite with reinforced barriers between poles to insure against breakage. Marking strips are reversible—white on one side, black on the other. These terminal boards are available with 4 to 12 poles, 2 inches wide, 1 3/4 inches high. Send for bulletin GEA-1497C.

HOLD OUTPUT VOLTAGE CONSTANT

This latest addition to G.E.'s line of automatic voltage stabilizers comes in 15-, 25-, and 50-va ratings. Output is 115 volts, 60 cycles. The small size of the unit makes it particularly applicable to shallow-depth installations in many types of equipment. You may have a job for this unit which will give you automatically stabilized output voltage at a low cost. There are no moving parts, no adjustments to make; long service is assured. Check bulletin GEA-3634B for more information about this and other G-E voltage stabilizers.

TO SHALLOW-DEPTH INSTALLATIONS IN MANY TYPES OF EQUIPMENT. YOU MAY HAVE A JOB FOR THIS UNIT WHICH WILL GIVE YOU AUTOMATICALLY STABILIZED OUTPUT VOLTAGE AT A LOW COST. THERE ARE NO MOVING PARTS, NO ADJUSTMENTS TO MAKE; LONG SERVICE IS ASSURED. CHECK BULLETIN GEA-3634B FOR MORE INFORMATION ABOUT THIS AND OTHER G-E VOLTAGE STABILIZERS.

GEA-1497C Terminal Boards

FOR YOUR COOLING FANS

Here's a fractional-horsepower fan motor suitable for many uses because of its compact design, low servicing requirements, and extreme quietness. Long, dependable operation is assured by sturdy, totally enclosed construction. These Type KSP unit-bearing motors are of shaded pole type design with low starting torque characteristics especially applicable to fans. A continuous oil circulation system furnishes good lubrication. You can use simple, hubless, low-cost blades with the special mounting arrangement. Write for bulletin GEC-219.

LOOKING FOR LIGHTWEIGHT SWITCHES?

Switchettes* are designed for applications which require a manually operated electric switch in a limited space. Though small, these switchettes are lightning fast in action and are built to withstand severe service. A wide variety of forms and terminal arrangements makes them particularly useful where special circuit arrangements are necessary. Switchette shown above has one normally open and one normally closed circuit, transferable when button is depressed. Check bulletin GEA-4888.

*Switchette is General Electric's trade name for these small snap switches.

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Insulation Resistance Another Factor in

No. 10
the last in a series of advertisements based on dielectric theory, testing and application, designed to aid in selecting electrical insulating materials. Insulation resistance and methods of testing are discussed.

Electrical insulation is, by definition, a material of such low conductivity that current flow through it is negligible for practical purposes. Whether a material is suited for insulation depends (among other things) upon the amount of leakage current allowed in a specific application.

Measurements of leakage currents are usually expressed as "insulation resistance": the ratio of d-c voltage across two electrodes, in contact with or embedded in the specimen, to the total current between them.

Resistance measurements are useful in comparing different materials as electrical insulation. Also, in testing specimens of the same material, they often show the presence of impurities, moisture or imperfections that are difficult to measure directly.

Two leakage current paths are usually considered: one through the body of the material, the other through a thin film of moisture or other semi-conducting substance deposited on the surface.

Insulation resistance is thus dependent upon both the volume and surface resistivities of the material as well as electrode configuration. Volume resistivity is the ratio of potential gradient in volts per centimeter, parallel to the current flow in the material, to current density in amperes per square centimeter; surface resistivity is the ratio of potential gradient in volts per unit distance parallel to current flow along its surface to current in amperes per unit of surface. Resistance measurements vary widely with temperature, humidity, voltage and time of conditioning, factors that must, therefore, be closely controlled in testing. Wide allowances on measured values should be set in using insulation resistance as a basis for specification.

TEST FOR INSULATION RESISTANCE

For separating insulation resistance to approximate surface and volume resistance, guarded mercury electrodes of the type shown in Figure 1 are used. Additional apparatus consists of a source of d-c potential, a galvanometer, suitable shunts, a calibrating resistance, reversing switches and keys.

The resistances are determined by the deflection method. Galvanometer deflections across the unknown resistance and the standard resistance are noted successively. The unknown resistance is then equal to the value of the standard resistance multiplied by the ratio of the deflection for the calibrating resistance to the deflection for the unknown resistance, also by the shunt ratio. By this method, we measure (1) the over-all insulation resistance with the guard electrode attached to the un-guarded electrode, and (2) the volume resistance, which is the resistance between the guarded and un-guarded electrodes when the guard electrode is maintained at about the same potential as the guarded electrode. This circuit arrangement (see Figure 2) insures that only the current flow through the guarded electrode registers on the galvanometer. Surface resistance is calculated from these measurements.

With volume and surface resistance known, we can calculate the respective resistivities from the following formulae:

\[
\text{volume resistivity} = \frac{RA}{t}
\]

when \( R = \) volume resistance
\( A = \) area of guarded electrode
\( t = \) average thickness of sample

\[
\text{surface resistivity} = \frac{R'c}{L}
\]

when \( R' = \) surface resistance
\( c = \) average circumference of the guarded electrode and of the inner edge of the guard electrode
\( L = \) distance between the electrodes

The report includes: a) over-all insulation resistance in ohms, b) volume resistivity in ohm-cm. units, c) surface resistivity in ohms, d) Centigrade temperature, e) percentage relative humidity, f) time of exposure to that humidity, g) voltage used, and h) type of electrodes.

![Figure 1—Arrangement of mercury electrodes used in testing insulation resistance of flat, solid materials.](image)

![Figure 2—Diagram of connections for determination of insulation resistance.](image)

December, 1948 — ELECTRONICS
Selecting Electrical Insulation Materials

A COMPLETE LINE OF INSULATION, BACKED BY YEARS OF RESEARCH AND PRACTICAL EXPERIENCE

In concluding this series—which has touched only the more important aspects of dielectric theory and application—we invite your inquiries for technical service on insulating problems and in the selection of insulation materials.

Mica Insulator Company has, for 55 years, specialized in the development and manufacture of electrical insulating materials. Our complete line offers a wide selection to meet specific requirements for increased efficiency of electrical equipment performance. Our Technical Service Department will gladly bring their experience to bear on your problems.

For your reference file...

SEND FOR CONVENIENTLY BOUND COPY OF THE COMPLETE SERIES

This convenient folder, in regular desk-file size, has been prepared in response to many requests. It contains reprints of all ten of the technical advertisements on dielectric theory, testing and application.

1. Short-Time Dielectric Strength Test
2. Step-by-Step Dielectric Strength Test
3. Three Theories of Dielectric Breakdown
4. Effects of Temperature and Moisture on Dielectric Breakdown
5. Effects of Frequency and Time on Dielectric Breakdown
6. Effects of Geometry of Electrodes and Ambient Medium on Dielectric Breakdown
8. Tensile Strength Test
9. Compressive and Flexural Strength Tests
10. Testing for Insulation Resistance

Designed to help you in the selection and application of electrical insulating materials, this series contains basic information you will want to keep handy. It treats the following subjects:

Write today for your copy of this useful reference folder. Simply ask for Folder E.

Insulator COMPANY
SCHENECTADY 1, NEW YORK

Atlanta • Birmingham • Boston • Chicago • Cincinnati • Cleveland • Detroit • Houston
Los Angeles • Milwaukee • New York • Philadelphia • Rochester • St. Louis • San Francisco

ELECTRONICS — December, 1948
The Chicago Transformer
New Equipment Line

Chicago Transformer's New Equipment Line fills an urgent need in the electronics fields for transformers designed exclusively to fit up-to-date circuit requirements. Here's why . . .

1. Voltage and Current Ratings of C.T. New Equipment Power Transformers have been selected to conform closely to the plate and filament loads of the tubes most widely used today. These units are conservatively rated . . . will deliver their full output with temperature rise well within RMA-recommended standards.

2. Line and Voice Coil Impedances of C.T. New Equipment Audio Transformers fit the accepted industry practice of standardized 600 and 150-ohm line impedances; 16, 8, and 4-ohm speakers.

3. High Fidelity at Full Rated Output. Frequency response within $\pm \frac{1}{2}$ db for virtually all output and input transformers, within $\pm 1$ db for all driver and modulation transformers, is guaranteed. Recommended frequency ranges fit three fields of general use—30 to 15,000 cycles, 50 to 10,000 cycles, and 200 to 3,500 cycles.

Add to these features the sleek, modern appearance and compactness of C.T.'s outstanding drawn steel case constructions—in two alternate base styles as illustrated—and you have the reasons why this is the only transformer line of its kind!

WRITE FOR CATALOG TODAY

CHICAGO TRANSFORMER
DIVISION OF ESSEX WIRE CORPORATION
3501 ADDISON STREET • CHICAGO 18, ILLINOIS
Ohmite Resistance "Know-How" represents the combined thinking of our entire staff of resistance specialists. Remember . . . it's available to you for the asking . . . to help solve your rheostat and resistor problems . . . to analyze your requirements and suggest the correct units to fit your specific application.

Years of experience in building dependable rheostats and resistors, in helping others solve specialized resistance problems, is your assurance that Ohmite "Know-How" can help you. We invite you to submit your problems to us.

Be Right with Ohmite
On this page are shown some of the many forms in which standard Ohmite rheostats can be furnished. All models have the distinctive, time-proved features of Ohmite design. They are all-ceramic in construction—ceramic parts insulate the shaft and mounting, and the resistance winding is permanently locked in place by vitreous enamel. Smoothly-gliding, metal-graphite brush provides contact with every turn of the resistance winding. Ohmite rheostats are known for their smooth, gradual, close control and their long, trouble-free life.

Write for Catalog and Engineering Manual No. 40, on your letterhead. It contains information on the complete Ohmite line, plus a wealth of helpful engineering information.

in TABLE MOUNTING CAGES
Used to prevent mechanical injury to the rheostat or human contact with electrically "live" parts. Tabletop mounting, ventilated enclosures.

with TOGGLE SWITCH and EXTRA LUG
Permits dual switching of rheostat and independent circuits. Rheostat winding is terminated at an extra lug located where the switch opens.

with TOGGLE SWITCH
Toggle switch is operated with a positive snap by the rheostat arm at either end position. Used for heavy duty applications.

with DEAD LUG OFF-POSITION
Opens the circuit at the high resistance position as the contact passes on to the lug, which is disconnected from the winding.

with SNAP-ACTION OFF POSITION
Opens the circuit at the high or low resistance position. The contact brush snaps into an insulated notch next to the lug, providing indexing.

with DEAD-SECTION OFF POSITION
Opens the circuit at the high or low resistance position as the brush passes off the lug onto an insulated section. Medium duty.

with TOGGLE SWITCH
Permits dual switching of rheostat and independent circuits. Rheostat winding is terminated at an extra lug located where the switch opens.

with SNAP-POSITION
Opens the circuit at the high or low resistance position as the brush passes off the lug onto an insulated section. Medium duty.

TANDEM ASSEMBLIES
Ohmite rheostats can be mounted with two, three, or more in tandem, for simultaneous operation of several circuits by one knob.

with BUSHINGS for special panel thickness
Rheostats can be furnished with extra-long bushings and shafts for panels over 5/8" and up to 2" in thickness. Five bushing lengths.

with SCREW DRIVER SLOT SHAFT
Shaft ends can be slotted for operation with a screwdriver, where few adjustments are needed. Minimizes tampering with setting.

with SNAP-ACTION OFF POSITION
Opens the circuit at the high or low resistance position. The contact brush snaps into an insulated notch next to the lug, providing indexing.

with DEAD-SECTION OFF POSITION
Opens the circuit at the high or low resistance position as the brush passes off the lug onto an insulated section. Medium duty.

with TOGGLE SWITCH
Permits dual switching of rheostat and independent circuits. Rheostat winding is terminated at an extra lug located where the switch opens.
VARFLEX Corporation, 308 Jay St., Rome, N. Y.

Please send me full information as well as a free sample of your new Varglas Tubing impregnated with G. E. Permafil. I am particularly interested in samples suitable for

Name: ________________
Company: ________________
Street: ________________
City: ________________ Zone: ________________ State: ________________
For the best "look-in" on television programming and transmission... they are installing

DU MONT LARGE-SCREEN

Picture Monitors

START AS SMALL AS YOU
WISH, WITH THE DU MONT

ACORN PACKAGE

TYPE 5108 12" PICTURE MONITOR

✓ Used in combination with companion unit, Type 5112-B Low Voltage Power Supply.
✓ Produces a comfortable-sized image on 12" picture tube for program monitoring of picture content.
✓ Operates from standard black negative composite picture signal with level in the range of 0.5 to 2.5 volts peak-to-peak. 1000-ohm input impedance.
✓ A 75-ohm input terminal is provided and is inserted across input terminal by means of toggle switch at rear.
✓ Type 5108-C fitted with 13½" x 17½" panel fitting into control consoles.
✓ Type 5108-D fitted with standard 14" x 19" relay rack panel.
✓ Overall dimensions, less panel: 10 11/16" h. x 16 3/4" w. x 18 3/4" d. Weight, 50 lbs. Resolution exceeds that of usual commercial equipment.

SUPERLATIVE rendition — that accounts for the growing popularity of Du Mont large-screen picture monitors.

Two models: Type 5108, 12-inch tube, 72-square-inch screen. Type 2116, 20-inch tube, 215-square-inch screen. The direct-view images are brilliant, sharp, and pleasingly contrasty yet retain the full range of all the half-tone values so necessary for pictorial beauty.

The 12-inch model in combination with Type 5112-B Low Voltage Power Supply unit, is intended primarily for control functions. The 20-inch giant-image monitor is ideal for use on a dolly in the studio, for visual cueing of actors and studio personnel during a performance. It may also be placed in the lobby, in the studio manager's office, in other executive offices, and in clients' rooms.

For superlative monitoring, as in every other TV function from camera to transmitter and again to receiver, make it DU MONT for "The First with the Finest in Television."

Details on request. Submit your telecasting plans for that Du Mont "know-how" guidance.

DU MONT

First with the Finest in Television

ALLEN B. DU MONT LABORATORIES, INC.

December, 1948 — ELECTRONICS
Announcing the new JOHNSON 167 VARIABLES
BETTER FOR UHF - VHF - LF

With the introduction of this new line of air variables, JOHNSON brings you many important design advantages never before available.

Outstanding of these is the use of perfected ceramic soldering which assures absolute — and permanent — rigidity and strength, absolute — and permanent — maintenance of capacities!

There are no eyelets, nuts or screws to work loose, causing stator wobble and fluctuations in capacity. JOHNSON ceramic soldering leaves a bond which is stronger than the rugged steatite end plates themselves. There’s nothing to come loose, because the stator terminals, mounting posts and rotor bearings are ceramic soldered!

Silent operation on the highest frequencies is assured with a split sleeve tension bearing that also prevents fluctuations in capacity.

These new variables are ideal for peak efficiency even under the severest conditions, such as portable — mobile operation. They are available in .030” and .080” spacings.

Two sets of stator contacts are provided for connecting components to either side of condenser without appreciably increasing inductance of the circuit. New bright alloy plating is used. It has high corrosion resistance, is easily soldered and possesses lower electrical resistance than other common platings.

These variables are available for all types of communications equipment having tuned circuits operating as high as 500 mc.

Features

1. Ceramic soldered for stability and strength
2. Soldered plate construction, heavy .005” plates, new bright alloy plating
3. Beryllium copper contact spring, silver plated
4. Split sleeve rotor bearings — no wobble to shaft
5. Steatite end plates
6. Long creepage paths
7. Low minimum capacity — maximum tuning range
8. Small size — end plate only 1 3/8” square

Other capacities and spacings available on special order.

SINGLE SECTION VARIABLES

<table>
<thead>
<tr>
<th>Cap. Per Section</th>
<th>Length Behind Panel</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.030” Spacing</td>
<td>0.080” Spacing</td>
</tr>
<tr>
<td>Cat. No.</td>
<td>Max. Min.</td>
</tr>
<tr>
<td>167-101</td>
<td>11 5.8</td>
</tr>
<tr>
<td>167-102</td>
<td>27 3.5</td>
</tr>
<tr>
<td>167-103</td>
<td>51 4.6</td>
</tr>
<tr>
<td>167-104</td>
<td>75 5.4</td>
</tr>
<tr>
<td>167-151</td>
<td>95 6.6</td>
</tr>
<tr>
<td>167-152</td>
<td>101 11.6</td>
</tr>
</tbody>
</table>

Also Available In .080” Spacing

DUAL SECTION VARIABLES

<table>
<thead>
<tr>
<th>Cap. Per Section</th>
<th>Length Behind Panel</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.030” Spacing</td>
<td>0.080” Spacing</td>
</tr>
<tr>
<td>Cat. No.</td>
<td>Max. Min.</td>
</tr>
<tr>
<td>167-501</td>
<td>27 3.5</td>
</tr>
<tr>
<td>167-502</td>
<td>51 4.6</td>
</tr>
<tr>
<td>167-503</td>
<td>99 6.8</td>
</tr>
</tbody>
</table>

Also Available In .080” Spacing

DIFFERENTIAL VARIABLES

<table>
<thead>
<tr>
<th>Cap. Per Section</th>
<th>Length Behind Panel</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.030” Spacing</td>
<td>0.080” Spacing</td>
</tr>
<tr>
<td>Cat. No.</td>
<td>Max. Min.</td>
</tr>
<tr>
<td>167-301</td>
<td>11 5.8</td>
</tr>
<tr>
<td>167-302</td>
<td>27 3.5</td>
</tr>
<tr>
<td>167-303</td>
<td>51 4.6</td>
</tr>
</tbody>
</table>

Also Available In .080” Spacing

BUTTERFLY VARIABLES

<table>
<thead>
<tr>
<th>Cap. Per Section</th>
<th>Length Behind Panel</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.030” Spacing</td>
<td>0.080” Spacing</td>
</tr>
<tr>
<td>Cat. No.</td>
<td>Max. Min.</td>
</tr>
<tr>
<td>167-201</td>
<td>10.5 2.8</td>
</tr>
<tr>
<td>167-202</td>
<td>26 4.3</td>
</tr>
<tr>
<td>167-203</td>
<td>51 6.5</td>
</tr>
</tbody>
</table>

Also Available In .080” Spacing

Write For NEW JOHNSON 167 VARIABLE CATALOG

JOHNSON... a famous name in Radio!
E. F. JOHNSON CO., WASECA, MINNESOTA

ELECTRONICS — December, 1948
Pictured here is a tuning-fork frequency standard with accuracy guaranteed to one part per million per degree Centigrade. The fork is temperature-compensated and hermetically sealed against variations of barometric pressure. This standard, when combined with basic equipment, facilitates accurate speed and time control by mechanical, electrical, acoustical or optical means.

The unit is available separately or in conjunction with complete timing instruments. Our engineers are ready to cooperate on any problem.
... looks like a Carbonyl Iron Powder year. Estimates show that practically all Television sets, and most of the Radio sets made in 1949 will contain cores made of Carbonyl Iron Powders. There must be a reason. Ask your coil winder. Ask your core maker. Ask any good designer...

G. A. & F. CARBONYL IRON POWDERS
An Antara® Product of General Aniline & Film Corporation
444 Madison Avenue, New York 22, New York
I-T-E wire-wound Oval Power Resistors

Modern resistors designed for modern applications...I-T-E Oval Resistor Assemblies...specially suited for installations where space is limited, such as in aviation, sound, radio, and other electronics applications. I-T-E "Ovals" are distinguished by their high unit-area wattage ratios, which are due in part to the heat dissipation qualities of the mounting brackets. An I-T-E Oval Resistor—or an assembly of oval units—has a much higher wattage rating than that of a conventional round resistor of comparable size.

And I-T-E Resistors are better-built for a longer life of dependable performance. Bases are best non-hygrosopic ceramics...resistance wires are purest obtainable...resistances are uniformly wound, mechanically tied, and silver-soldered at high heat for permanent, solid connections.

No matter what your resistor problem calls for—compactness, long life, dependability, or exact tolerances—be sure to investigate I-T-E Oval Resistors, the modern wire-wound Power Resistors. Complete technical information, as well as valuable application data, is contained in the new I-T-E Resistor catalog. Send for it today.

There's an I-T-E Resistor for Every Purpose

<table>
<thead>
<tr>
<th>I-T-E OVAL RESISTORS</th>
<th>Watts</th>
<th>Length</th>
<th>Maximum Recommended Resistance</th>
<th>Mounting Centers</th>
</tr>
</thead>
<tbody>
<tr>
<td>108 Oval</td>
<td>30</td>
<td>1½&quot;</td>
<td>10000</td>
<td>2&quot;</td>
</tr>
<tr>
<td>200 Oval</td>
<td>40</td>
<td>2&quot;</td>
<td>15000</td>
<td>2¾&quot;</td>
</tr>
<tr>
<td>316 Oval</td>
<td>55</td>
<td>3½&quot;</td>
<td>25000</td>
<td>4½&quot;</td>
</tr>
<tr>
<td>424 Oval</td>
<td>65</td>
<td>4¾&quot;</td>
<td>35000</td>
<td>5½&quot;</td>
</tr>
<tr>
<td>600 Oval</td>
<td>75</td>
<td>6&quot;</td>
<td>50000</td>
<td>6¾&quot;</td>
</tr>
</tbody>
</table>

POWER RESISTORS
The Leader In Technical Excellence
I-T-E CIRCUIT BREAKER CO., RESISTOR DIVISION, 19TH & HAMILTON STREETS, PHILADELPHIA 30, PA.

December, 1948 — ELECTRONICS
Accurate measurements are fundamental to the electronic industry.

-hp- precision instruments are basic tools for obtaining these measurements swiftly, surely and easily.

3 NEW -hp- INSTRUMENTS TO MAKE YOUR MEASURING JOBS EASIER

-hp- 400C Vacuum Tube Voltmeter
Wide range, 20 cps to 2 mc, 12 ranges, 0.001 v to 300 v, flat response, 10 megohms input impedance.

-hp- 415A Standing Wave Indicator
300 cps to 2000 cps. For use with bolometer or crystal rectifier. Previewed here for the first time.

-hp- 404A Battery-Operated Voltmeter
Light, compact, portable vacuum tube voltmeter. No ac power needed. 2 to 50,000 cps. 11 ranges, 0.003 to 300 v.

For brief details of these and other -hp- precision instruments, see following pages. For complete specifications, write direct to factory.
<table>
<thead>
<tr>
<th>FUNCTION</th>
<th>MODEL</th>
<th>FREQUENCY</th>
<th>CHARACTERISTICS</th>
</tr>
</thead>
<tbody>
<tr>
<td>HARDWARE</td>
<td>10</td>
<td></td>
<td>Binding Post</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td></td>
<td>Flexible coupler, ceramic insulated; permits misalignment of 1/32&quot; and/or 5°</td>
</tr>
<tr>
<td>LOW FREQUENCY STANDARDS</td>
<td>100A</td>
<td>100 kc, 10 kc, 1 kc, 100 cps</td>
<td>Accuracy 3 cps per mc per degree Centigrade</td>
</tr>
<tr>
<td></td>
<td>100B</td>
<td>100 kc, 10 kc, 1 kc, 100 cps</td>
<td>Temperature controlled; accuracy 0.001%</td>
</tr>
<tr>
<td>FREQUENCY DIVIDER</td>
<td>110</td>
<td>100 to 10 cps</td>
<td>Controlled by 100A or 100B. Multipliers also available up to 1 mc</td>
</tr>
<tr>
<td>RESISTANCE-TUNED OSCILLATORS</td>
<td>200A</td>
<td>35 to 35,000 cps</td>
<td>Output 1 watt into 500 ohms; 1% distortion</td>
</tr>
<tr>
<td></td>
<td>200B</td>
<td>20 to 20,000 cps</td>
<td>Output 1 watt into 500 ohms; 1% distortion</td>
</tr>
<tr>
<td></td>
<td>200C</td>
<td>20 to 200,000 cps</td>
<td>Output 10 volts into 1,000 ohms; 1% distortion</td>
</tr>
<tr>
<td></td>
<td>200D</td>
<td>7 to 70,000 cps</td>
<td>Output 10 volts into 1,000 ohms; 1% distortion</td>
</tr>
<tr>
<td></td>
<td>200H</td>
<td>60 to 600,000 cps</td>
<td>Output 10 mV into a 100 ohm load; 1% total distortion</td>
</tr>
<tr>
<td></td>
<td>200 I</td>
<td>6 to 6,000 cps</td>
<td>Frequency setting closer than 1%; output 10 volts into 1,000 ohms; 1% distortion</td>
</tr>
<tr>
<td></td>
<td>201B</td>
<td>20 to 20,000 cps</td>
<td>Output 3 watts at 1% and 1 watt at ½% distortion into 600 ohms</td>
</tr>
<tr>
<td></td>
<td>202B</td>
<td>½ to 50,000 cps</td>
<td>For low frequency studies. Output 10 volts into 1,000 ohms; 1% distortion</td>
</tr>
<tr>
<td></td>
<td>202D</td>
<td>2 to 70,000 cps</td>
<td>Output 10 volts into 1,000 ohms; 2% distortion</td>
</tr>
<tr>
<td></td>
<td>204A</td>
<td>2 to 20,000 cps</td>
<td>Portable, battery-operated; output 5.0 volts to 10,000 ohm load; 1% distortion</td>
</tr>
<tr>
<td>AUDIO SIGNAL GENERATORS</td>
<td>205A</td>
<td>20 to 20,000 cps</td>
<td>Output 5 watts, 1% distortion into impedances of 50, 200, 600, 5,000 ohms. Output VTVM and 110 db attenuator, 1 db steps</td>
</tr>
<tr>
<td></td>
<td>205AG</td>
<td>20 to 20,000 cps</td>
<td>Same as 205A, plus separate VTVM for complete gain measurements</td>
</tr>
<tr>
<td></td>
<td>205AH</td>
<td>1 to 100 kc</td>
<td>Output 5 watts, 1% distortion into impedances of 50, 200, 500, 5,000 ohm impedances. Output VTVM and 110 db attenuator, 1 db steps</td>
</tr>
<tr>
<td></td>
<td>206A</td>
<td>20 to 20,000 cps</td>
<td>Output 50 watts peak to peak; 1,000 ohm internal impedance; 70 db attenuator, 5 db steps</td>
</tr>
<tr>
<td>SQUARE WAVE GENERATOR</td>
<td>210A</td>
<td>20 to 10,000 cps</td>
<td>Same as 205A, plus separate VTVM for complete gain measurements</td>
</tr>
<tr>
<td>WAVE ANALYZER</td>
<td>300A</td>
<td>30 to 16,000 cps</td>
<td>Variable selectivity; measurement range 1 mv to 500 volts; 5% accuracy</td>
</tr>
</tbody>
</table>

HEWLETT-PACKARD

1782A PAGE MILL ROAD • PALO ALTO, CALIFORNIA

World Radio History
<table>
<thead>
<tr>
<th>FUNCTION</th>
<th>MODEL</th>
<th>FREQUENCY</th>
<th>CHARACTERISTICS</th>
</tr>
</thead>
<tbody>
<tr>
<td>DISTORTION ANALYZERS</td>
<td>320A</td>
<td>400 cps and 5 kc</td>
<td>Measures total distortion as low as 0.1%, 70 db attenuator, 1 db steps for comparison</td>
</tr>
<tr>
<td></td>
<td>320B</td>
<td>50, 100, 400 cps and 1, 5 and 7.5 kc</td>
<td>Same as 320A</td>
</tr>
<tr>
<td></td>
<td>325B</td>
<td>30, 50, 100, 400, 1,000 cps; 5, 7.5, 10 and 15 kc</td>
<td>Measures total distortion as low as 0.1%, input amplifier and complete VTVM each usable separately</td>
</tr>
<tr>
<td></td>
<td>330B</td>
<td>Any frequency 20 to 20,000 cps</td>
<td>Similar to 325B but measures at any frequency and includes AM detector</td>
</tr>
<tr>
<td></td>
<td>330C</td>
<td>Any frequency 20 to 20,000 cps</td>
<td>Similar to 320B, no AM detector. Meter has VU characteristics to meet FCC requirements for FM broadcasting</td>
</tr>
<tr>
<td>FM BROADCAST MONITOR</td>
<td>335B</td>
<td>88 to 108 mc</td>
<td>FCC approved. Monitors carrier frequency and modulation. High fidelity output for aural monitoring</td>
</tr>
<tr>
<td>ATTENUATORS</td>
<td>350A</td>
<td>Max 100 kc</td>
<td>110 db, 1 db steps; 5 watts, 500 ohm level. Bridged T type. Accuracy 1 db in 50 db at 100 kc</td>
</tr>
<tr>
<td></td>
<td>350B</td>
<td>Max 100 kc</td>
<td>Same as 350B but 600 ohm level</td>
</tr>
<tr>
<td>VACUUM TUBE VOLTMETERS AND ACCESSORIES</td>
<td>400A</td>
<td>10 cps to 1 mc</td>
<td>Nine ranges 0.03 to 300 volts full scale. Accuracy ± 3% to 100 kc, ± 5% to 1 mc. Average reading. Calibrated in rms.</td>
</tr>
<tr>
<td></td>
<td>400B</td>
<td>2 cps to 100 kc</td>
<td>Some as 40A with response flat to 2 cps. 10 megohm input impedance</td>
</tr>
<tr>
<td></td>
<td>400C</td>
<td>20 cps to 2 mc</td>
<td>Twelve ranges 0.001 to 300.0 volts full scale; accuracy ± 1% to 100 kc, ± 5% to 2 mc; 10 megohm input impedance; average reading; calibrated in rms volts; may be used as 54 db amplifier</td>
</tr>
<tr>
<td></td>
<td>404A</td>
<td>2 to 50,000 cps</td>
<td>Portable, battery-operated; eleven ranges; 0.003 to 300 volts full scale; accuracy ± 3% to 20 kc; 10 megohm input impedance</td>
</tr>
<tr>
<td></td>
<td>410A</td>
<td>20 cps to 700 mc</td>
<td>AC: six ranges 1 to 300 volts. DC: seven ranges 1 to 1,000 volts. Resistance: seven ranges 0.2 ohm to 500 megohms</td>
</tr>
<tr>
<td></td>
<td>415A</td>
<td>300 to 2,000 cps</td>
<td>Standing Wave Indicator for use with a bolometer or crystal rectifier; standard frequency 1000 cps, others on special order</td>
</tr>
<tr>
<td></td>
<td>455A</td>
<td>to 1,000 mc</td>
<td>Connects probe of 410A across 50 ohm transmission line. Type N fittings</td>
</tr>
<tr>
<td></td>
<td>458A</td>
<td>to 1,000 mc</td>
<td>Connects probe of 410A to open end of 50 ohm transmission line. Type N fittings</td>
</tr>
<tr>
<td>AMPLIFIERS</td>
<td>450A</td>
<td>10 to 3,000,000 cps</td>
<td>40 db and 20 db stabilized gain. Input impedance 1 megohm shunted by approximately 15 uuf.</td>
</tr>
<tr>
<td>ELECTRONIC FREQUENCY METER</td>
<td>500A</td>
<td>5 cps to 50 kc</td>
<td>Ten ranges, ± 2% accuracy. Input 0.5 to 200 volts</td>
</tr>
<tr>
<td>ELECTRONIC TACHOMETER</td>
<td>505A</td>
<td>300 to 3,000,000 rpm</td>
<td>Ten ranges, ± 2% accuracy</td>
</tr>
<tr>
<td></td>
<td>505B</td>
<td>5 to 50,000 rps</td>
<td>Same as 505A except calibrated in rps</td>
</tr>
<tr>
<td>SIGNAL GENERATORS</td>
<td>610A</td>
<td>500 to 1,350 mc</td>
<td>Calibrated output 0.1 microvolt to 0.1 volt. Internal pulse modulation. Direct calibration</td>
</tr>
<tr>
<td></td>
<td>616A</td>
<td>1,800 to 4,000 mc</td>
<td>Direct reading. Pulse modulation,CW and FM. Calibrated output 0.1 microvolt to 0.2 volts</td>
</tr>
<tr>
<td></td>
<td>650A</td>
<td>10 cps to 10 mc</td>
<td>Direct reading. Six bands. Output 3 volts to 600 ohm load. VTVM and output attenuator</td>
</tr>
<tr>
<td>POWER SUPPLY</td>
<td>710A</td>
<td>Any dc voltage 180 to 360 for 0 to 75 ma load; approximately 1% regulation. Also 6.3 volts, 5 amps ac.</td>
<td></td>
</tr>
</tbody>
</table>
Wherever There’s a CORE and COIL

Choose FERRANTI

Power and Audio Transformers Chokes • Filters

3 EXAMPLES OF OUR WIDE RANGE:

OPEN FRAME TYPE for mass production, minimum cost and weight for enclosed equipment.

ENCLOSED CASE, compound filled, for high moisture resistance. Standard cases up to 500 VA. Wide range of standard audio transformer units.

HERMETICALLY SEALED and compound filled cases. Glass or ceramic sealed terminals. Designed to meet JAN salt water immersion tests.

We offer ample modern facilities and intensive experience in up-to-date practice, including the latest core material developments, and components for 400 cycle power supplies. Our large accumulation of patterns, tools and dies often makes it possible to supply your specific requirements from standard parts, thus cutting your costs without sacrifice of quality. Whatever the type of unit, our bid will meet your needs. Submit your inquiries.

POWER SUPPLY UNITS AND ELECTRONIC ASSEMBLIES TO SPECIFICATIONS

Ferranti Electric, Inc.

30-A Rockefeller Plaza • New York 20, N. Y.
How Admiral Radio uses Centralab's Printed Electronic Circuit to build finer radios... to cut assembling time!

Here you see how Admiral engineers use Centralab’s custom pentode “Couplate” in their battery portable AC-DC receiver. In addition to this P.E.C. unit, this set contains five dependable CRL “Hi-Kap” capacitors.

*Centralab’s “Printed Electronic Circuit” — Industry’s newest method for improving design and manufacturing efficiency!

Imagine the time, the space, the material you save by using one unit instead of six. That’s just what Centralab’s amazing pentode “Couplate” is doing for Admiral Radio Corporation, Chicago. This complete interstage coupling circuit combines three resistors and three capacitors into one tiny, dependable P.E.C. unit. “Couplate” saves time for Admiral by eliminating many assembling operations. It saves space and material by reducing the number of components needed. What’s more it improves performance by minimizing the chance of broken or loose connections.

Integral Ceramic Construction: Each Printed Electronic Circuit is an integral assembly of “Hi-Kap” capacitors and resistors closely bonded to a steatite ceramic plate and mutually connected by means of metallic silver paths “printed” on the base plate.

You’ll want to see and test this exciting new electronic development. For complete information about Couplate, as well as other CRL Printed Electronic Circuits, see your nearest Centralab Representative, or write for Bulletin 999.

LOOK TO Centralab IN 1949!

Division of GLOBE-UNION INC., Milwaukee

"COUPLATE" is made of high dielectric Ceramic-X to give long life, low internal inductance, positive resistance to humidity and vibration. A circuit diagram of CRL’s Couplate is shown below.
The NEW "dag" CRT Wall Coating ... for all CRT glass envelopes

Here's an entirely new CRT Wall Coating, developed by Acheson Colloids specifically and solely for use on CRT glass envelopes.

"dag" CRT Wall Coating is very easily applied... adheres tenaciously to all types of glass... does not yield objectionable by-products on heating.

Prominent cathode-ray tube manufacturers have already found this opaque, electrically conductive "dag" CRT Wall Coating eminently satisfactory, especially in tubes intended for television reception.

Let Acheson Colloids help you with your CRT wall coating problem. Mail the coupon today for information on this or other electronic applications of "dag" colloidal graphite dispersions.

Give me information on "dag" colloidal graphite dispersions for:
- Wall coating of CRT's
- Electrostatic shielding
- Corona prevention
- Dry-film lubrication
- Copper oxide rectifier disc coating
- Electrical resistances
- Filament cement

Acheson Colloids Corporation
Port Huron, Michigan
**Hi-Q COMPONENTS**

**Specify** Hi-Q **for UNIFORMITY...**

**Hi-Q DISK CAPACITORS**

BPD Where space is a factor and the physical shape is more adaptable than tubular unit try these Hi-Q Disk Capacitors. Another example of accurate dependable miniaturization, this high dielectric by-pass, blocking or coupling Hi-Q Disk Capacitor has many applications. Available in three standard capacities. Type BPD-5: .005 mfd. guar. min. Type BPD-10: .01 mfd. guar. min. Type BPD-15: .015 mfd. guar. min. Illustration at right is actual size.

**Hi-Q MINIATURE G. P. TUBULARS**

G.P. By the use of our new Body 41, 5 mnf to 33,000 mnf capacity ranges are now available which will cover the majority of your by-passing problems. These Hi-Q Miniature G. P. Tubulars also provide closer coupling of leads thus insuring minimum inductance and highest self resonant frequencies. Illustration at left is actual size.

**Hi-Q COMPONENTS**

**BETTER 4 WAYS**

**PRECISION** Tested step by step from raw material to finished product. Accuracy guaranteed to your specified tolerance.

**UNIFORMITY** Constancy of quality is maintained over entire production through continuous manufacturing controls.

**DEPENDABILITY** Interpret this factor in terms of your customers' satisfaction... Year after year of trouble free performance. Our Hi-Q makes your product better.

**MINIATURIZATION** The smallest BIG VALUE components in the business make possible space saving factors which reduce your production costs... increase your profits.

**Hi-Q**

Electrical Reactance Corp.

FRANKLINVILLE, N. Y.

Plants: FRANKLINVILLE, N. Y. — JESSUP, PA.

Sales Offices: NEW YORK, PHILADELPHIA, DETROIT, CHICAGO, LOS ANGELES

ELECTRONICS — December, 1948

29
MACHLETT TUBE USERS GET MORE LIFE, BETTER VALUE

BECAUSE OF MACHLETT EXPERIENCE, SKILL AND "SINCERITY OF SERVICE"

• For over a half century Machlett Laboratories has pioneered and made notable contributions to the development of the electron tube art.

Today, through its modern plant, development laboratories and skilled personnel, it provides the best in tubes and service for Broadcasting and Industrial uses. No matter what your purpose—Broadcasting, Communication or Industrial electronics—you will find a Machlett tube to fill your needs—and fill them well. And, no less important than the tube itself, Machlett Service—valued by tube users for more than 50 years—will give you a new sense of value to apply to your tube procurement problem.

If you want better value—more satisfaction—try MACHLETT.

Note To Broadcasters: Machlett Laboratories now produce for the Western Electric Company its line of high power transmitting tubes—so well known and respected by all broadcasting engineers. Made by Machlett Laboratories, in close collaboration with Bell Telephone Laboratories, these tubes will continue to set the highest standard of performance in broadcast service. These tubes are distributed exclusively for the Western Electric Company by the Graybar Electric Company in the U.S.A. and by the Northern Electric Company in Canada and Newfoundland.

This new combination of Western Electric Company and Machlett Laboratories, two of the pioneers in the electron tube field is your best assurance of progress and performance in the further development of better tubes to fill your needs.
Equipment designers, broadcasters, operators of point-to-point services, and industrial users of power tubes are invited to write for complete information. The Machlett Electron Tube Data Book will be sent on request.

MACHLETT

Over 50 years of Electron Tube Experience

MACHLETT LABORATORIES, INC.
Springdale, Connecticut
3-Phase Regulation

<table>
<thead>
<tr>
<th>Model</th>
<th>Load Range Volt-Amperes</th>
<th>Regulation Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>3P15,000</td>
<td>1500-15,000</td>
<td>0.5%</td>
</tr>
<tr>
<td>3P30,000</td>
<td>3000-30,000</td>
<td>0.5%</td>
</tr>
<tr>
<td>3P45,000</td>
<td>4500-45,000</td>
<td>0.5%</td>
</tr>
</tbody>
</table>

* Harmonic Distortion on above models 3%. Lower capacities also available.

Extra Heavy Loads

<table>
<thead>
<tr>
<th>Model</th>
<th>Load Range Volt-Amperes</th>
<th>Regulation Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>5,000+</td>
<td>500 - 5,000</td>
<td>0.5%</td>
</tr>
<tr>
<td>10,000+</td>
<td>1000-10,000</td>
<td>0.5%</td>
</tr>
<tr>
<td>15,000+</td>
<td>1500-15,000</td>
<td>0.5%</td>
</tr>
</tbody>
</table>

400-800 Cycle Line

Inverter and Generator Regulators for Aircraft.

<table>
<thead>
<tr>
<th>Model</th>
<th>Load Range Volt-Amperes</th>
<th>Regulation Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>D500</td>
<td>50 - 500</td>
<td>0.5%</td>
</tr>
<tr>
<td>D1200</td>
<td>120-1200</td>
<td>0.5%</td>
</tr>
<tr>
<td>3PD250</td>
<td>25 - 250</td>
<td>0.5%</td>
</tr>
<tr>
<td>3PD750</td>
<td>75 - 750</td>
<td>0.5%</td>
</tr>
</tbody>
</table>

Other capacities also available.

The First Line of standard electronic AC Voltage Regulators and Nobatrons

General Application

<table>
<thead>
<tr>
<th>Model</th>
<th>Load Range Volt-Amperes</th>
<th>Regulation Accuracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>150</td>
<td>25 - 150</td>
<td>0.5%</td>
</tr>
<tr>
<td>250</td>
<td>25 - 250</td>
<td>0.2%</td>
</tr>
<tr>
<td>500</td>
<td>50 - 500</td>
<td>0.5%</td>
</tr>
<tr>
<td>1000</td>
<td>100-1000</td>
<td>0.2%</td>
</tr>
<tr>
<td>2000</td>
<td>200-2000</td>
<td>0.2%</td>
</tr>
</tbody>
</table>

The NOBATRON Line

Output Voltage DC Load Range Amps.
6 volts 15-40-100
12 volts 15
28 volts 10-30
48 volts 15
125 volts 5-10

* Regulation Accuracy 0.25% from 1/4 to full load.

General Specifications:

- Harmonic distortion max. 5% basic, 2% "S" models
- Input voltage range 95-125: 220-240 volts (-2 models)
- Output adjustable bet. 110-120: 220-240 (-2 models)
- Recovery time: 6 cycles: + (9 cycles)
- Input frequency range: 50 to 65 cycles
- Power factor range: down to 0.7 P.F.
- Ambient temperature range: -50°C to +50°C

All AC Regulators & Nobatrons may be used with no load.

*Models available with increased regulation accuracy.

Special Models designed to meet your unusual applications.

Write for the new Sorensen catalog. It contains complete specifications on standard Voltage Regulators, Nobatrons, Increvolts, Transformers, DC Power Supplies, Saturable Core Reactors and Meter Calibrators.
"Give us the tools . . ."

TO SURVIVE
America Must Have Better Tools

IN THE past twenty years the United States has failed to provide its workers with enough new tools and equipment.

To most Americans this statement will come as a shock—or will be doubted. We are quite complacent about our industrial equipment, for easily understood reasons.

Throughout the '30s we heard continuously the propaganda line that the United States had become a "mature economy." The job of equipping America with industrial plants and tools was said to be largely done.

Now, knowing that industry is spending billions to expand and rebuild its plants, many people assume that the result must be a first-class industrial system.

A further powerful inducement to complacency is the vastly worse industrial condition of most of the rest of the world. When Americans look abroad in almost any direction they see shattered plants and equipment. A natural reaction is that we are sitting pretty.

That is a dangerous reaction. Between depression and war, we have failed to build the tools and equipment we need. This condition is dangerous for three reasons:

1. FROM BITTER EXPERIENCE WE KNOW THAT NATIONAL SECURITY DEPENDS FIRST AND FOREMOST ON THE CAPACITY AND READINESS OF OUR INDUSTRIAL EQUIPMENT.

All of our plans for stabilizing prosperity assume a world at peace. The greatest menace to peace would be an unarmed America, unable or unwilling to keep herself strong and ready for defense—strong in spirit, in resources and in the all-important industrial plant and equipment.

2. WHETHER AMERICANS LIVE WELL—OR BADLY—DEPENDS DIRECTLY ON THE KIND AND QUALITY OF TOOLS USED BY AMERICAN WORKMEN.

This is true for all workers, and for every worker—from a garage mechanic and his wrenches to a steel mill gang and its rolling equipment. In a monumental study of "America's Needs and Resources" the Twentieth Century Fund found this fact: The improvement in the real income of the American people has more consistently followed the amount of power used in industry than anything else. What the workman worked with determined, more than any other factor, the size of his pay envelope, and what it would buy.

3. OUR SUCCESS IN STABILIZING PROSPERITY WILL DEPEND LARGELY ON WHAT WE DO ABOUT BUILDING NEW TOOLS AND EQUIPMENT.

About 30% of our industrial workers are employed in producing tools and equipment. Steady employment for them is essential to our over-all prosperity.

How far have we fallen behind in providing new plants and equipment?

Estimates vary. Here is one rough estimate: If we had built new industrial facilities during 1930-48 at the rate we did in the prosperous '20s, we would have spent at least $100 billion more than actually we did.

To get a better and more complete measure of this deficit, McGraw-Hill is undertaking a survey of American Business' Needs for New Plant and Equipment.

Businessmen all over the nation are being asked to answer questions like this: How much
money would you need to put your plant in first class condition? How much are you planning to spend for new plant and equipment? Where do you expect to raise the money? The results will be reported later in this editorial series. Already the survey shows we have fallen many billions of dollars behind.

Some shortcomings are apparent to everyone. They are revealed in a lot of rickety transportation facilities and in rundown buildings.

Many other deficiencies do not come into general view. They are, for example, the antiquated machines in our plants. Of the privately-owned machine tools in use in 1945—the last census of metalworking equipment was made by AMERICAN MACHINIST—54% were more than 10 years old. Their average age is higher today.

It is true that in recent years we have hit new highs in total national production. But we have done so by putting far more people to work than ever worked before... and by driving equipment to the limit of its waning endurance, sometimes beyond. It has not been done primarily in what is by all odds the best way to increase production—to use more and better and more modern tools and equipment.

Haven't we overcome much of this twenty-year deficit by rushing to build new plants since the end of the war?

No. For two clear-cut reasons:

1. The accumulated shortage is tremendous. The total of about $40 billion, which has been spent for industrial plant and equipment since VJ-Day, has not wiped it out.

2. Some key industries have had difficulty in getting the facilities they need. Take steel, for example—the industry that turns out our most basic industrial material. Its needs for new equipment are measured in billions of dollars. To pay for that equipment, it should have risk capital—money which people are willing to invest with a risk of losing for the sake of gain. For steel is an up-and-down industry. Earnings on its common stocks inevitably share both ways in those ups-and-downs.

Since the war, steel, in common with most of industry, has been unable to market new common stock successfully. Its outstanding stock is now selling for only about one-half the current net worth of the industry's present assets. With investors willing to pay only 50 cents on the dollar for its facilities, the industry can not readily sell stock to pay for new plant and equipment—at higher prices even than the old.

Why can't steel—and other industries—attract people who are willing to risk their money retooling America?

The full answer to that serious question must be left to future editorials in this series, for it involves many things... tax reform... mobilization of small savings... a new respect for corporate profits.

This first editorial seeks simply to emphasize two fundamentals:

First, our standard of living improves with the quality of our industrial equipment.

Second, American industry and American workmen badly need billions of dollars worth of better equipment now.

The American people must understand that not only our continued prosperity but also our security as a nation depends upon giving American industry more and better equipment.

"Give us the tools." This was Winston Churchill's cry for help to win the war. Only if we give American industry new and better tools will we have a chance to win abiding prosperity at home and good order abroad.

"Clocked" in Record Time

No. 102's at Five Star Company increase production by synchronizing output on basis of time required for manual operations.

Experience of the Five Star Company, West Chesire, Conn., shows how one manufacturer can profit from use of Universal Coil Winding Machines.

This company, manufacturing a variety of coils, uses the No. 102 Winders shown below to produce coils for electric clocks, winding six coils at a time from unrolling spools of No. 38 enameled wire.

Relay coils, ringer coils and switch coils are other bobbin-type coils wound on this machine which permits synchronization of winding time on the various heads with handling time per coil.

Coil size is accurately controlled by an electrically-operated counter which automatically stops each head upon completion of the coil. Steel-strap control of tension makes it possible to handle even the finest wires.

Other Universal Coil Winders in this plant are the No. 104 which winds paper-insulated coils and the No. 96 which winds cotton-interwoven coils for business machines.

Write for bulletins on Universal Coil Winders—No. 84, lattice-type; No. 96, layer-wound; No. 98, gutter-wound; No. 102, spool-wound, non-insulated; Nos. 104 and 105 paper-insulated, in stick form.

UNIVERSAL WINDING COMPANY, Dept. L, P. O. Box 1605, Providence 1, R. I.
There's a lot of satisfaction in working with radio engineers who know exactly what they need to get top efficiency from the transmitter. To their specifications Blaw-Knox applies an experience in antenna tower building that dates back to the days of "wireless"... Together we get results that reflect credit on our structural designers and the station's technical experts... If your plans call for more effective coverage or directional changes we would welcome an engineering interview at your convenience.

BLAW-KNOX DIVISION
OF BLAW-KNOX COMPANY
FARMERS BANK BUILDING
PITTSBURGH 22, PA.

Blaw-Knox 550' Heavy Duty Type H40 Tower supporting a Federal 8 square loop FM antenna 74' high. Station WTMJ-FM, Richfield, Wisconsin.
This preamplifier phasing control section of a medium power, low distortion restricted band audio-amplifier employed in a new printing plate engraving system couldn't operate satisfactorily on available line voltages. Robert H. Rigby Corp., solved the problem with a "built-in" SOLA Constant Voltage Transformer.

Unstable voltages varied the light output essential for satisfactory operation of this precision instrument. High voltages burned out the light source. "Built-in" SOLA Constant Voltage Transformers now provide a constant source of light and enable R. S. Wilder Company to guarantee the life of the lamps.

The H. C. Schildmeier Co. says, "We have found the SOLA Constant Voltage Transformer to be the solution to many of our troubles, by maintaining a constant output voltage to actuate a unit that is direct meter reading"... a SOLA CV transformer is a built-in component of every Seal Line Balancer produced by this company.

SOLA Handbook Bulletin DCV-102

A complete, and authoritative treatise on voltage regulation. Write for your copy.

SOLA

Transformers for: Constant Voltage • Cold Cathode Lighting • Airport Lighting • Series Lighting • Fluorescent Lighting • Luminous Tube Signs
Oil Burner Ignition • X-Ray • Power • Controls • Signal Systems • etc. • SOLA ELECTRIC COMPANY, 4633 W. 16th Street, Chicago 50, Illinois

Manufactured under license by: ENDURANCE ELECTRIC CO., Concord West, N. S. W., Australia • ADVANCE COMPONENTS LTD., Walthamstow, E., England • UCOM RADIO S.A., Buenos Aires, Argentina • M. C. R. & VERITABLE ALTER. Courbevoie (Seine), France

With power shortages playing hob with line voltages all over the country—isn't it about time that you too joined the parade of manufacturers who are featuring constant voltage as a built-in component in their products.
These Federal standard D-C Power Supplies are now available to meet a wide range of industrial and laboratory requirements for both filtered and unfiltered D-C power. All Federal D-C Power Supplies are powered by Federal long-life Selenium Rectifiers with no expendable parts that demand frequent replacement. Operation is dependable and economical. Federal D-C Power Supplies are conservatively rated. Heavy duty Selenium Rectifiers are able to withstand momentary overloads . . . provide D-C power immediately without heat-up period . . . operate quietly and efficiently with practically no maintenance. For prices and information on other Federal standard D-C Power Supplies, write Department E-313.

### FILTERED D-C RATINGS

<table>
<thead>
<tr>
<th>Code Number</th>
<th>A-C Input</th>
<th>D-C Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>FTR 3093-AS</td>
<td>115V/1P/60</td>
<td>22-30 Volts 6-2A</td>
</tr>
<tr>
<td>FTR 3128-BS</td>
<td>115V/1P/60</td>
<td>6-10 Volts 10-1A</td>
</tr>
<tr>
<td>FTR 3246-BS</td>
<td>115V/1P/60</td>
<td>6-10 Volts 10-1A</td>
</tr>
<tr>
<td>FTR 3198-BS</td>
<td>115V/1P/60</td>
<td>12-5 Volts 5-2A</td>
</tr>
<tr>
<td>FTR 3185-AS</td>
<td>115V/1P/60</td>
<td>12-7.5 Volts 7.5-1A</td>
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*Filtered and regulated

### UNFILTERED D-C RATINGS

<table>
<thead>
<tr>
<th>Code Number</th>
<th>A-C Input</th>
<th>D-C Output</th>
</tr>
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<tbody>
<tr>
<td>FTR 3300-DS</td>
<td>115V/1P/60</td>
<td>22-30 Volts 6-2A</td>
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<td>FTR 3342-AS</td>
<td>115V/1P/60</td>
<td>6-4 Volts 4-1A</td>
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<td>FTR 3345-AS</td>
<td>115V/1P/60</td>
<td>28-5 Volts 5-2A</td>
</tr>
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<td>FTR 3339-BS</td>
<td>115V/230V/1P/50-60</td>
<td>6-24 Volts 24-1A</td>
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<td>FTR 3340-BS</td>
<td>115V/230V/1P/50-60</td>
<td>5-70 Volts 70-1A</td>
</tr>
<tr>
<td>FTR 3352-BS</td>
<td>115V/230V/1P/50-60</td>
<td>5/10 Volts 10-1A</td>
</tr>
</tbody>
</table>

*Export Distributor: International Standard Electric Corp. 67 Broad St., N.Y.


Federal Telephone and Radio Corporation

SELENIUM and INTELIN DIVISION, 900 Passaic Ave., East Newark, New Jersey

December, 1948 — ELECTRONICS
Your customers will never think of this wire

... AND THAT'S GOOD!

When your product is internally wired with Rockbestos wire, cable or cord, your customers will probably never see the wire at all. Most likely, they'll never even give it a thought. There's no reason why they should. For Rockbestos' impregnated asbestos insulation is permanent. It won't bake brittle, crack or flow under high temperatures or conductor-heating overloads. It won't carry or support flame. It won't rot or swell from exposure to grease, oil or fumes. And, because of all of these things that it won't do, Rockbestos wire will make your product's name synonymous with dependable performance — will help bring new customers in and old customers back. Write for your copy of Catalog No. 10-F... today.

ROCKBESTOS PRODUCTS CORP., NEW HAVEN 4, CONN.

NEW YORK  CLEVELAND  DETROIT  CHICAGO
PITTSBURGH  ST. LOUIS  LOS ANGELES

ROCKBESTOS
THE WIRE WITH PERMANENT INSULATION
MORE THAN 50 GRADES OF G-E TEXTOLITE LAMINATED PLASTICS ARE AVAILABLE

G-E Textolite grade No. 11500 is used extensively in heavy-duty motors where high temperatures and high mechanical stresses have caused complete disintegration of cellulosic slot armor insulation. It is composed of cotton cloth and a phenolic resin and was developed for use as slot insulation for those applications that require a semiflexible material having a smooth, hard, glossy surface. It is made in thicknesses of 0.007 in. and 0.012 in.

TAKE YOUR PICK

G-E Textolite grade No. 11500 was developed to reduce insulation maintenance costs on heavy-duty motors. However, it isn't the only grade of Textolite manufactured. There are more than fifty grades available, and EACH has an INDIVIDUAL COMBINATION of properties.

Some grades excell in heat resistance, some in dielectric strength, others in loss factor. And you need this large assortment to select from if you want to produce your products in the most economical and satisfactory way.

Then, too, these many grades of Textolite are supplied in five different forms. Again you get a choice which can pay you dividends in many ways. Plastics Division, Chemical Department, General Electric Co., Pittsfield, Mass.

GET THE COMPLETE STORY!

Send for the new bulletin G-E TEXTOLITE LAMINATED PLASTICS which lists grades, properties, fabricating instructions and detailed information about the five forms of Textolite. Fill in and mail the coupon below for your free copy.

TEXTOLITE LAMINATED IS SUPPLIED IN FIVE FORMS

SHEETS, TUBES, AND RODS—These standard shapes are available in thousands of sizes. Up-to-date manufacturing methods facilitate quick deliveries.

FABRICATED PARTS—G.E. has modern fabricating equipment to machine Textolite laminated plastics parts to your own specifications.

MOLDED-LAMINATED PARTS—Textolite is custom molded directly to shape. Molded laminated products are among the strongest plastics parts produced.

LOW-PRESSURE MOLDED PARTS—Extremely large and irregular Textolite shapes are custom molded by the low-pressure laminating process.

POST-FORMED LAMINATES—Sheets of Textolite laminated plastics are custom formed into simple shapes by this very inexpensive method.

PLASTICS DIVISION, CHEMICAL DEPARTMENT
GENERAL ELECTRIC COMPANY (BA-12)
ONE PLASTICS AVE., PITTSFIELD, MASS.

Please send me the new G-E Textolite laminated plastics bulletin.

Name
Firm
Address
City State

GENERAL ELECTRIC

CD46-M1

December, 1948 — ELECTRONICS
The text is about Aerovox capacitors and their applications in television equipment. It describes the characteristics and benefits of higher-voltage electrolytics and oil-filled tubulars, as well as the Duranite capacitor, which is superior for high-voltage applications. The text emphasizes the importance of capacitor safety factors and the need for component performance in the new television industry. It encourages readers to send capacitance problems for engineering collaboration and to quote on capacitance requirements.

The text concludes with information about Aerovox Corporation, including sales offices and export addresses.
AMERICAN PHILLIPS SCREWS

Break Driving-Time Records on Trailers
...Stop Driver-Accidents...
Help Keep Sales Rolling in High

FASTEN FASTER with American Phillips Screws . . . the way plywood panels are fastened to trailer frames . . . with power drivers. **One man takes only 32 minutes to drive 522 screws!** That's 50% faster than slotted screws, with half the labor. And there are no corners too close . . . no angles too awkward. No costly accidents to workers or their work.

SELL FASTER . . . Buyers of all types of products are learning to recognize this "high sign" of quality construction . . . the American Phillips Screw with the universal cross-recess. Just tell them the whole story of American Phillips strength and vibration-resistance . . . and watch sales pick up speed! Write.

AMERICAN SCREW COMPANY, PROVIDENCE 1, RHODE ISLAND
Chicago 1: 589 E. Illinois St. Detroit 2: 502 Stephenson Building
THE TUBE THAT HAS DONE MOST FOR TELEVISION HAS 95% NICHROME* V METAL PARTS

This is the RCA Image Orthicon 5655—super-sensitive eye of the television camera. Developed primarily for studio use and applications employing artificial illumination, it is several times more sensitive to light at low levels than the fastest motion picture film.

Only 13\(\frac{1}{4}\)" long, it has over 150 precision-made parts, many assembled under microscopes.

These parts must remain unmagnetized by the strong magnetic fields of the focusing and deflection coils that surround the tube. Magnetized, they would produce fields of their own, and prevent proper operation.

When the parts are assembled, the glass housing of the tube is sealed. Temperature of the glass during sealing operations is raised to over 1600° F., temperature of the parts to as much as 900° F.

Under these conditions of manufacture, the alloy used must not only be entirely non-magnetic but possess high resistance to heat and oxidation. The only alloy that most satisfactorily meets these specifications is Nichrome V. That is why 95% of the metal parts in the RCA Image Orthicon 5655 are made of Nichrome V.

Driver-Harris manufactures over 85 alloys for the Electronic and Electrical fields. These are distinguished for giving exceptionally efficient, long and economical service—most particularly where requirements are unusually tough. So send us your specifications. As with the Image Orthicon, it is most probable a D-H alloy will best solve your manufacturing problems.

*Nichrome is manufactured only by Driver-Harris Company

HARRISON, NEW JERSEY

BRANCHES: Chicago, Detroit, Cleveland, Los Angeles, San Francisco, Seattle Manufactured and sold in Canada by

The B. GREENING WIRE COMPANY, LTD., Hamilton, Ontario, Canada

*F.M. Reg., U.S. Pat. Off.
We design, engineer, fabricate and install special High Vacuum process equipment.

In the High Vacuum field National Research Corporation offers you unified, under-one-roof control and responsibility. We not only build equipment, but also undertake development work for others in fields where the unique experience and ability of our own Research Division can be used to your advantage.

If you plan to profit from your own High Vacuum process developments—if you require assistance in developing your processes—you should become acquainted with the National Research Corporation, 70 Memorial Drive, Cambridge 42, Massachusetts.
Truarc inverted rings align shafts, save 20 minutes... $1.00 per unit

Production savings and sales advantages result from redesign with four Truarc rings

- Eliminate two drilling, two tapping operations, and the fabrication of two collars and four pins.
- Eliminate two set screws.
- Cut dis-assembly, re-assembly time 75%.
- Make for closer tolerances.
- Make drive shaft self-aligning: operation by user greatly simplified.
- Make more delicate adjustments easier for user.
- Streamline entire unit.
- TOTAL OVERALL SAVINGS, per unit... $1.00

Like the Skyview Camera Company of Olmsted Falls, Ohio, re-design with Truarc and you will cut costs and improve your product too. Wherever you use machined collars, nuts, bolts, snap rings, cotter pins—there's a Truarc ring that does a better job of holding parts together. All Waldes Truarc retaining rings are precision engineered, easy to assemble and dis-assemble, retain circularity always to give you a never-failing grip. They can be used over and over again. Send us your problem. Waldes Truarc engineers will be glad to show how Truarc can help you.

WALDES TRUARC

RETAINING RINGS

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

Send for new Truarc booklet, "New Development In Retaining Rings"

Waldes Kohinoor, Inc., 47-10 Austel Place
Long Island City 1, N.Y.
Please send booklet, "New Development In Retaining Rings" to:

Name: 
Title: 
Company: 
Business Address: 
City: Zone: State:

ELECTRONICS — December, 1948
Several avenues of profit are open to you in Arnold Permanent Magnets. You can improve the performance and overall efficiency of equipment. You can increase production speed, and in many cases reduce both weight and size. And most important, you can maintain these advantages over any length of production run or period of time, because Arnold Permanent Magnets are completely quality-controlled through every step of manufacture—from the design board to final test and assembly. You'll find them unvaryingly uniform and reliable in every magnetic and physical sense.

It's our job to help you discover and then fully attain these benefits. Arnold Products are available in all Alnico grades and other types of magnetic materials—in cast or sintered forms, and in any size or shape required. Our engineers are at your command—check with our Chicago headquarters, or with any Allegheny Ludlum branch office.

THE ARNOLD ENGINEERING CO.
Subsidiary of ALLEGHENY LUDLUM STEEL CORPORATION
147 East Ontario Street, Chicago 11, Illinois
Specialists and Leaders in the Design, Engineering and Manufacture of PERMANENT MAGNETS

December, 1948 — ELECTRONICS
The special problems inherent in television receivers have been given careful attention by Erie Resistor engineers in designing condensers for these applications. The components illustrated above have been correctly designed for efficient operation at high frequencies. The condensers have low series inductance and incorporate specially designed terminals and mounting arrangements. Of special interest is the high voltage Erie Double Cup condenser for power supply filtering circuits. Rated at 15 KV and having a capacity of .0005 mfd, these units are unusually compact and economical. Plastic coil and transformer forms are custom injection molded to customer's specifications.

We will be glad to send you technical data and samples on any of the condensers shown above. Our engineers are at your service to develop special ceramic or mica condensers for television applications.

"Ceramicon" is a registered trade name and refers to ceramic dielectric condensers manufactured by Erie Resistor Corp.
TRANSMITTERS

are equipped with

Adlake Relays

Raytheon Manufacturing Company's AM, FM and TV transmitters, including the famous “RF-3” 3-KW FM, “RA-5” 5-KW AM and the new “RTV-500” 500 watt TV and “RTV-5” 5000 watt TV equipment, employ Adlake Relays for control.

Silent and chatterless, Adlake Mercury Plunger Type Relays are an integral part of these streamlined transmitters which produce high fidelity modulation with a low noise level.

Besides silent operation, Adlake Relays bring these advantages to any job where relays are used:

- Hermetically sealed contact mechanism is impervious to dust, dirt and moisture.
- Liquid mercury-to-mercury contact prevents burning, pitting and sticking.
- Adlake design armors relays against outside vibration or impact; they are usable on either stationary or fixed equipment.

Whatever your relay needs are, there's an Adlake Relay to do the job. You'll like our free, illustrated folder giving full details. Write for it today to: The Adams & Westlake Company, 1107 N. Michigan, ELKHART, Indiana.

THE

Adams & Westlake

COMPANY

Est. 1857 • ELKHART, INDIANA • New York • Chicago

Manufacturers of Adlake Hermetically Sealed Mercury Relays for Timing, Load and Control Circuits

(Above) Relay panel in Raytheon's RF-3A 3-KW FM AMPLIFIER (shown below)
The right material for your job... right at your fingertips!

How to Save Production Hours and Dollars on Your Electrical Insulating Jobs...

One of the surest ways to reduce unit costs on any job is to be right the first time when selecting materials. Continental-Diamond's complete line of high strength electrical insulating materials makes proper product engineering easy.

There are trained C-D technicians on hand at all times to give you personal help in getting better, lower-cost applications. To be sure of being right the first time in the selection of materials, call your nearest C-D office whenever the need arises.

C-D HIGH-STRENGTH PLASTICS

DIAMOND FIBRE—Vulcanized Fibre.
VULCOID—Resin Impregnated Fibre.
DILECTO—Laminated Thermosetting Plastic.
CELORON—Molded High-Strength Plastic.
MICABOND—Bonded Mica Splittings.
IN manufacturing, specialization is as important as it is in medicine or any of the other professions. Since the founding of this organization, we have specialized in the development and manufacture of transformers and allied components. Whether your requirements are for large liquid-immersed units or small dry-type transformers, special designs made in our job shop or conventional designs manufactured on our mass production lines, Amertran engineering, experience, and adequate production facilities are at your disposal.

For electronic transformers, Amertran all the way!

**AMERTRAN "K" LINE** — A line of audio and power transformers and reactors available for mass production requirements. AmerTran has the production facility to maintain production schedules.

**MODULATION TRANSFORMERS AND REACTORS** — Supplied in matched units for every size of transmitter.

**"W" DRY TYPE TRANSMITTER COMPONENTS** — Economical self-cooled transformers and reactors for better rectifier construction and operation.

**HERMETICALLY SEALED TRANSFORMERS** — Highly resistant to moisture, shock, pressure and temperature variation. Either liquid-immersed or compound filled. Liquid-immersed type for high voltages reduces size and weight, with lower corona effect.

**THE AMERICAN TRANSFORMER CO.**
178 EMMET STREET • NEWARK 5, N. J.
It's your move! You are assembling a Home Entertainment Center or a Ham Shack and need fine loud speaker performance and cabinets for the ever expanding requirements of audio-video equipment. Designed by leading furniture stylists and electronics engineers, Customode's "building block" versatility enables you to create thousands of cabinet variations as you wish—when you wish. It's your move! Write today for literature and scale cut-up illustrations. Jensen Manufacturing Co., 6607 S. Laramie, Chicago 38, Ill.
sensitive
ALLIED RELAYS

FOR A LIMITED POWER SUPPLY OR PRECISE OPERATING CHARACTERISTICS

This new folder shows 24 small, compact Allied Relays with a carefully detailed table of characteristics and specifications. Write for YOUR free copy today.

ALLIED CONTROL COMPANY, INC.
2 EAST END AVENUE, NEW YORK 21, NEW YORK
You may build the best appliance of its kind on the market—but if it sets up local radio interference—you'll have tough sledding against today's keen competition. Your customers are demanding radio noise-free performance in the electrical equipment they buy.

The answer, of course, is to equip your products with C-D Quietones. Why Quietones? First, because they're the best-engineered noise filters—second, because they guard your product's reputation by giving long trouble-free service—third, because they’re designed and built to meet manufacturers’ specific needs—efficiently and economically.

How to produce Better, Westinghouse Electronic

For example: MOT-O-TROL

You can be sure if it's Westinghouse
Faster, Cheaper
Control

FOR THE JOB THAT DEMANDS
PRECISE CONTROL OF DRIVE SPEEDS

The textile industry supplies an excellent example of how Westinghouse Electronic Controls are helping to speed production of better products at lower cost.

The industry's trend toward high-speed, high-quality production runs developed a need for closer control of warper drives. The answer was found in Westinghouse Electronic Warper Drive—an adaptation of Mot-O-Trol—which applied the precision of electronics to maintain the rigid but necessarily gentle control over yarn tension and speed.

Many of Mot-O-Trol's unique features contributed to its ability to handle this tough control job. Its ability to provide a wide, stepless range of speed control for d-c motors from alternating-current sources; its ability to start motors, to bring them up to a preset speed smoothly and rapidly, to permit wide changes of speed at any time, to regulate speed under varying loads, to apply dynamic braking for timed stopping, to reverse the motor when necessary.

All of these remarkable Mot-O-Trol functions, plus many others, are the products of electronics. In which of them do you spot an opportunity to boost the efficiency of your men and machines . . . to produce faster, better and cheaper? For complete details ask for booklet B-3256. Call your Westinghouse representative or write to Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania.

Mot-O-Trol provides precise control in a packaged drive that needs no additional equipment. It can be mounted on or built into machines.

Westinghouse
PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

ELECTRONIC CONTROL
INSUROK is a registered trade-mark of The Richardson Company.

When it comes to serving industry through plastics, the names of Richardson and INSUROK command respect and attention in high places.

To our old friends, we offer assurance that past high standards of quality and materials and skilled workmanship will be zealously protected.

To new prospects, we offer an invitation—let us prove our claim that Richardson experience, talents and facilities can mean worthwhile benefits for you in meeting your plastics requirements.

The **RICHARDSON COMPANY**

**L**OCKLAND, **O**HIO • **F**OUNDED IN 1858

**S**ales **H**eadquarters: **M**ELROSE **P**ARK, **I**LLINOIS

CLEVELAND • DETROIT • INDIANAPOLIS • MILWAUKEE • NEW BRUNSWICK, N.J. • NEW YORK • PHILADELPHIA • ROCHESTER • ST. LOUIS

December, 1948 — ELECTRONICS
WE CAN HELP YOU WITH

**Energy-Storage Capacitors!**

Our experience—in engineering, designing, and building performance into energy-storage and discharge capacitors—may provide just the help you are looking for.

Do you make discharge welding or photographic flash-tube equipment? Radar equipment? Flash beacons, aircraft signalling, or similar devices? Or research tools, from spectrosopes to cyclotrons? We have furnished a large proportion of the capacitors used for all of these applications.

Unusual applications, too—like those listed below—are a specialty with us. Whatever your problem, let our engineers give you a hand. Apparatus Dept., General Electric Company, Schenectady 5, N. Y.

NEED SQUARE WAVES? Pulse-forming networks can provide them. Networks are used where the normal capacitor discharge wave shape is not suitable and where an impulse must have definite energy content and duration. The Type E network, produced by General Electric, consists of capacitor and coil sections, adjusted to close tolerances, and hermetically sealed in single metal containers. Built by the thousands for radar, they are now available for commercial use.

NEED ARTIFICIAL LIGHTNING? Potent artificial lightning bolts—at voltages up to 10,000,000—are not a usual need. But when required—for universities, laboratory testing, or exhibition—General Electric can build the capacitors. A typical example is the 100-kv d-e unit, about 3 feet in diameter and 2 feet high. Units can be stacked, as shown, for ease of installation and minimum space. In some instances as many as 100 separate units have been placed in series to produce 10,000,000 volt discharges.

**GENERAL ELECTRIC**

**Specialty Capacitors FOR**
- Motors
- Luminous-tube transformers
- Fluorescent lamp ballasts
- Industrial control
- Radio filters
- Radar
- Electronic equipment
- Communication systems
- Capacitor discharge welding

**Flash photography**
- Stroboscopic equipment
- Television
- Dust precipitators
- Radio interference suppression
- Impulse generators

AND MANY OTHER APPLICATIONS

(Even more are listed.)
Variable Resistors
to meet both your specifications and your budget

Write for Electronic Components Catalog RC-7
Sample controls gladly submitted to specifications to quantity users.

STACKPOLE

Fixed and Variable Resistors • Iron Cores (All standard and special types) • Switches (inexpensive line, slide and rotary-action types) • Sintered Alnico II Permanent Magnets . . . and hundreds of molded iron powder, metal, carbon and graphite products.

Electronic Components Division

STACKPOLE CARBON COMPANY • ST. MARYS, PA.
The magnificent new Collins 21B/21L 5/10 kw AM broadcast transmitter

The latest great contribution to modern AM broadcasting

The 21B/21L is the finest 5/10 kilowatt AM broadcast transmitter of which Collins engineering and manufacturing skills are capable. No compromise has been made for reasons of economy. Without deviation, our purpose has been to achieve the highest possible quality regardless of cost.

Yet the 21B/21L is competitively priced.

When furnished as the Collins 21B, this is a five kilowatt transmitter with provision for instantaneous reduction of power to 1,000 watts. It is designed to permit full 100% modulation of the carrier at frequencies between 30 and 10,000 cycles per second. The audio frequency response is constant, plus or minus 1.5 db, within this range.

Featured are utmost reliability, with fine components, conservatively rated; vertical chassis construction, and easy accessibility of components and wiring; precise motor tuning with eye-level metering throughout; adequate air cooling; dependable personnel and circuit protection.

The 21B may be converted to become the ten kilowatt 21L by inserting an additional power tube in a socket already installed, and making a few simple additions in the exciter and power amplifier cabinets. The 10 kw 21L (pictured above) may be purchased initially.

If you are contemplating the replacement of obsolescent 5 or 10 kw transmitter equipment, or the building of a new station of either of these powers, the very efficient, completely modern Collins 21B/21L should be your first consideration. We will welcome your inquiry for further information.
Pictured here is an all-Presto single channel recording system. Above is the block diagram, worked out for this equipment by Presto engineers.

When you need recording or transcription equipment you can't go wrong if you make the complete system 100% Presto.

For Presto is the world's foremost manufacturer of recording and transcription equipment and discs. And Presto's experience with countless installations, including all the big ones, will aid you in achieving greater efficiency and trouble-free operation.

The recorder is the 8DG with direct gear drive. The amplifiers are the 39-B three channel preamp, the 41-A limiter, the 92-A 60 watt recording amplifier, and the 89-A monitor.

Multiple channel installations consist of as many duplications of the basic channel as are needed with the addition of switch or patching facilities. When you think of recording, think of PRESTO.

World's Largest Manufacturer of Instantaneous Sound Recording Equipment and Discs
A BETTER SPEEDOMETER WAS BORN

Indiana's experience brings Better Designs, Lower Costs

Recently our engineers, working with those of King-Seeley Corp., helped design an entirely new permanent magnet for a greatly improved speedometer. This Indiana magnet, made of Cunife, weighs one third less than the previous magnet, yet has 30% more energy. It reduces bearing load by 50%, and is 750% more stable—is far more resistant to shock, temperature change, stray magnetic fields. And it costs less.

WE MAY HAVE YOUR ANSWER, TOO

For four decades, the pace-setting design techniques at Indiana have made possible new and better permanent magnets. This "packaged energy" improves performance, adds new functions, saves money in countless different products... as mechanical force in holding and separating devices... for changing electrical energy to mechanical motion and vice versa... for changing the apparent characteristics of materials. Indiana offers you the experience and know-how of more than 30,000 different applications. Let's get our engineers together on your problem. Write today.

THE INDIANA STEEL PRODUCTS COMPANY
PRODUCERS OF "PACKAGED ENERGY"
6 NORTH MICHIGAN AVENUE • CHICAGO 2, ILL.
BUSINESS BRIEFS

By W. W. MacDONALD

More About Mobilization: Since last month (Nov., p 64) we have learned that no less than four plans for further mobilizing the electronics industry in preparation for a possible war are being studied in Washington. Two of them, one apparently favored by the military and the other by a majority within the industry, appear to clash in basic principles.

The first envisions placement of contingent contracts involving performance of all the paper-work connected with planning but stopping short of actual additional production. It places the major planning responsibility upon industry but retains the power for direction and policing of the job within government circles. It visualizes use of a great many manufacturers as prime contractors rather than subcontractors.

The second plan revolves around the placement of leadership operation contracts for pilot quantities of needed military equipment. It places the major planning responsibility upon government but suggests that contracts be distributed by a civilian member of the industry. It favors initial use of some 40 or 50 companies as prime contractors, with other manufacturers serving as subcontractors.

From where we sit it looks like the answer is somewhere between two imperfect plans, both of which have their good and bad points.

It appears unlikely that any plan calling upon manufacturers to do a lot of paper work in peacetime for peanuts will be conducive to action. Some more effective method of sharing the planning load should be possible without appointing either an industry or a government czar. And any proposed limitation of the number of manufacturers who would work directly for government could not be expected to meet with enthusiasm on the banks of the Potomac.

Our leg-men down in the nation's capital think there will be two and possibly three committees at work on a compromise before long and so... still more on the subject later.

Major Users of industrial electronic indicating, recording and automatic control devices are the petroleum, chemical and public utility industries, in about this order. These three are so receptive, in fact, that we suspect our field is to some extent neglecting others ultimately destined to be as important, or more important, from the standpoint of potential business.

Automatic Electronic Control of batching operations is a job at which electronics shines in many industries. Next major trend, we think, may be automatic control of continuous operations, to which industry must lean more and more in the interest of lowered production costs.

Speaking Of Industrial Gear, Brown Instrument's George Muschamp uses a neat adjective to distinguish highly precise electronic indicating, recording and automatic control apparatus from the simpler mechanical and electrical variety. He calls it "sophisticated" apparatus.

Temporary Tough Sledding for f-m broadcast interests hinted at last month in this column (p 65) has led the FM Association to suggest to the FCC that when holders of construction permits surrender them for one reason or another they should not be permitted to reapply within two years. The Association, realizing that a snowball increases in size only when it continues to roll, wants people to push or get out of the way for those who will.

Speaking Of F-M, Dean Wissleder of Westinghouse has written us an interesting letter in which he says: "So far as f-m is concerned, I would warn anyone who tries to sound a death knell that..."
Consider the advantages... and Eimac Variable Vacuum Capacitors become the essential component in modern circuitry.

- Extremely compact size reduces equipment bulk. Type VVC 60-20 is less than one-sixth the size of air-dielectric capacitors with similar ratings.

- Structural rigidity eliminates electromechanical vibration.

- Low-torque tuning mechanism.

- Unaffected by dusty or humid atmospheres. Ideal for industrial application.

- Capacitance variation is linear with shaft rotation.

- Low temperature coefficient. Negligible change in capacitance due to temperature variance (.004 mmfd. per degree cent.)

Eimac variable vacuum capacitors are immediately available. In addition to the type VVC 60-20 illustrated here, there are types VVC2 60-20 and VVC4 60-20.

<table>
<thead>
<tr>
<th>Type</th>
<th>Capacity</th>
<th>R.F Peak Voltage</th>
<th>Maximum RMS Current</th>
</tr>
</thead>
<tbody>
<tr>
<td>VVC 60-20</td>
<td>10-60 mmf.</td>
<td>20-KV</td>
<td>40 amp.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VVC2 60-20</td>
<td>Parallel 20-120 mmf.</td>
<td>20-KV</td>
<td>80 amp.</td>
</tr>
<tr>
<td></td>
<td>Split-stator 5-30 mmf.</td>
<td>40-KV</td>
<td>40 amp.</td>
</tr>
<tr>
<td>VVC4 60-20</td>
<td>Parallel 40-240 mmf.</td>
<td>20-KV</td>
<td>160 amp.</td>
</tr>
<tr>
<td></td>
<td>Split-stator 10-60 mmf.</td>
<td>40-KV</td>
<td>80 amp.</td>
</tr>
</tbody>
</table>

EITEL - MccULLOUGH, INC.
206 San Mateo Ave., San Bruno, California

Export Agents: Frazier & Hansen, 301 Clay St., San Francisco, California
OSCILLOGRAPHES

by HATHAWAY

for EVERY purpose

S8-B General Purpose, 12 to 24 elements, for laboratory or field use, quick-change transmission for wide range of record speeds, automatic titling and numbering, automatic record-length control, tuning fork time marker, galvanometer attenuators, governor motor.

(Bulletin SP165)

S8-C General Purpose, 24 to 36 elements, otherwise same as type S8-B.

(Bulletin SP165)

S8-D General Purpose, 12 to 24 elements, similar to type S8-B except without automatic controls.

(Bulletin SP175)

S12A Small Portable, General Purpose, the smallest complete 12-element oscillograph.

(Bulletin SP167)

S6-A Geophysical, 12 elements.

S6-B Geophysical, 24 elements.

S14-A Student's Oscillograph, 6 to 12 elements, ultra-simple, low in cost.

(Bulletin SP183)

S15-A Portable Self-Powered, 6 elements, for use where very small size is essential and power is not available.

(Bulletin SP193)

SC16-A Cathode Ray, 6 elements, very high frequency response and writing speed, record speed to 6000 inches per second.

(Bulletin SP194)

RS9-A Automatic Oscillograph, 12 elements, for switchboard or portable use, for automatic recording of faults or staged system testing, high-speed starting.

(Bulletin SP196)

WHATEVER YOUR REQUIREMENTS MAY BE THERE IS A HATHAWAY OSCILLOGRAPH FOR YOU

WRITE FOR TECHNICAL BULLETIN

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

it is merely overexpanded for the moment. There are several reasons why it will come through with flying colors.

"People will buy f-m and a-m receivers because of vanity if nothing else. In summer daytime, f-m actually renders service at 100 to 150 miles from transmitters where a-m stations are ineffective. Most a-m broadcasters must offer their client f-m too in order to keep up with their competition."

Down in Birmingham an electroencephalograph, or brain-wave recorder, is reported to be picking up programs from local radio stations. Retaliation, no doubt, for the strain placed upon the machine by patients seeking relief from the effects of quiz programs.

C-R Tube Bottleneck may still be present in the television picture next spring but glassmakers are now keenly aware of the market waiting just around the corner and are busting a gut to serve tubemakers. Kimble Glass division of Owens-Illinois tells us, for example, that two years of progress have been telescoped into six months. Machine methods are taking the place of hand work, and 90 percent of the firm's 600 employees have had special training in such methods for the production of 10 and 121-inch envelopes.

We've Commented several times on the television installation and servicing problem, and stuck our neck out to the extent of saying that there will come a day in the not-too-distant future when dealers and servicemen will have to do most of it if sales are to keep up with demand. Now we are reminded by a reader that if and when this day comes the flat annual charge idea will probably go out the window.

At This Writing there are 70 brands of television receivers on the market. Statistics concerning the types of sets offered by manufacturers do not necessarily indicate what types the public will buy, and this fact should be carefully noted, but they are of some market significance so we offer
them here for what they’re worth.

Models offered by the 70 companies total 185, broken down as follows:

<table>
<thead>
<tr>
<th>Type</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>44%</td>
<td>table</td>
</tr>
<tr>
<td>35</td>
<td>console</td>
</tr>
<tr>
<td>10</td>
<td>commercial</td>
</tr>
<tr>
<td>9</td>
<td>kit</td>
</tr>
<tr>
<td>2</td>
<td>custom</td>
</tr>
</tbody>
</table>

List prices average $673, ranging from $59.50 (kit) to $2,495.

A check on optical systems indicates that of the 185 models 88 percent employ direct-view, 10 percent projection and 2 percent mirror-reflected image systems.

With respect to c-r tube sizes:

<table>
<thead>
<tr>
<th>Size</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>41%</td>
<td>10-inch tubes</td>
</tr>
<tr>
<td>22</td>
<td>12</td>
</tr>
<tr>
<td>16</td>
<td>15</td>
</tr>
<tr>
<td>9</td>
<td>10</td>
</tr>
<tr>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>20</td>
</tr>
<tr>
<td>2</td>
<td>16</td>
</tr>
<tr>
<td>1</td>
<td>16</td>
</tr>
</tbody>
</table>

Total number of tubes in the average model offered is 29, with 11 the smallest and 48 the largest.

Some 51 percent contain no a-m, f-m or s-w broadcast radio tuners. Of the 185 models:

<table>
<thead>
<tr>
<th>Type</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>19% provide a-m and f-m radio</td>
<td>15</td>
</tr>
<tr>
<td>15 f-m</td>
<td></td>
</tr>
<tr>
<td>10 a-m, f-m and s-w</td>
<td></td>
</tr>
<tr>
<td>3 a-m</td>
<td></td>
</tr>
<tr>
<td>1 n-m</td>
<td></td>
</tr>
<tr>
<td>1 a-m and s-w</td>
<td></td>
</tr>
<tr>
<td>1 f-m and s-w</td>
<td></td>
</tr>
</tbody>
</table>

Record players are included in 72 percent. Of the available models:

<table>
<thead>
<tr>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>62% tune 13 channels</td>
</tr>
<tr>
<td>24</td>
</tr>
<tr>
<td>20</td>
</tr>
<tr>
<td>12</td>
</tr>
<tr>
<td>7</td>
</tr>
<tr>
<td>5</td>
</tr>
</tbody>
</table>

Two Straws In The Wind within this issue of ELECTRONICS indicate that we may be entering an era in which research is made to pay for itself more rapidly than in the past. The first is Waldo Kliever’s significant suggestion for selling research ideas to management, sales and production (p 68). The second is the knowledge that Sono-tone paid much of the freight on further research in connection with piezoelectric barium titanate by quickly going into production on phonograph pickups (p 94) made of the new ceramic.

From vending machines to V-Bombs specialized relay design plus facility at solving problems involving circuit, relay and function enable Sigma to render valuable service.

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SENSITIVE - PRECISION - KEYING
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Send for the Mallory Capacitor Catalog, which contains useful data on all types of Mallory Capacitors—sizes, electrical characteristics, test measurements, mounting hardware.

Still cost no more. Mallory FP capacitors have given exceptional performance at prices comparable to ordinary capacitors. These new improvements have all been accomplished without extra cost to the user.
TELAUTO... The question of the bandwidth required to transmit intelligence at a given rate is, to judge by its many appearances in this column, a subject on which we're hipped. At any event we were much taken by Bill Tuller's discourse on the weather map and the telautograph, given at a recent communication symposium in Washington. It is customary to transmit weather maps by facsimile, using the familiar line-at-a-time scanning process. But this system ignores the evident fact that the map of the United States stays reasonably constant from day to day. What changes is the position of the isobar contours and associated symbols. Recognizing this fact, we might send the basic map through the mails and employ a telautograph (the gadget commonly seen in stores, banks and railroad stations which transmits handwriting by an electrically-actuated pen) to transmit, handwriting-fashion, the contours and symbols. The facsimile scanning system needs a bandwidth of several hundred cycles. The telautograph, freed from the necessity of transmitting anything but the essential information superimposed on the map, needs a bandwidth of only 15 cycles to do the job at the same speed. Tuller's point is that a transmission system set up to take account of the special characteristics of the information to be transmitted may be much more efficient than one which ignores said characteristics.

A logical extension of this philosophy applies to television. The background of many television scenes remains unchanged for considerable periods, and need not be changed in less time than, say, a quarter of a second. Suppose then that the background could be transmitted separately from the central subject matter. If a storage screen were available to retain the background it could be transmitted at a slow rate, that is, in a narrow band. The major part of the video band might then be reserved for depicting the smaller area comprising the central subject of the scene and the detail of this subject would be correspondingly enhanced. The detail of the background, being sent at a slow rate, could readily be made to match the high value possessed by the central subject. This proposal is easily stated, much more difficult to achieve in practice, and its application is limited to scenes having separately delineated subjects and backgrounds. But in the long run it may prove to be a practical method of enhancing the detail of television images.

BROAD... Progress in the design of broadband amplifiers for television, radar and pulse communication is so rapid that, for a change, the engineers are ahead of the demand. When electronic television came along in the early thirties, the tubes of the day permitted amplifying a band no wider than a few megacycles. Then came radar; in 1945 it was news that an amplifier having a bandwidth of 20 megacycles had been achieved. Now comes a new technique, called "distributed amplification" or "wave amplification". Several tubes are used in each stage, the capacitance of each tube being isolated in a separate section of a filter. In this way the output currents of the tubes are added while their capacitances are separated, and a wholly new order of bandwidth becomes possible. In one such amplifier, a bandwidth of 200 mc. with 9-db gain, is achieved in an amplifier using seven 6AK5 tubes in a single stage. Further progress must, in all likelihood, wait until someone finds a use for what is now available.

It is indeed encouraging when the techniques thus outstrip the applications. It gives the system engineers something to think about: a 200-mc amplifier can transmit at one crack all the signals in the pre-war frequency spectrum, all point-to-point, marine, mobile services, all standard broadcast, f-m, facsimile, all television, navigation, and amateur signals. Looked at another way, a 200-mc bandwidth can transmit messages at the rate of over a billion words per hour, or a ten word telegram once a day to every man, woman and child on earth. The amplifier exists. Any takers?
Selling Research Ideas

An idea born of research is useless unless pushed and passed on by those who come after, right through production of the resulting new or better product. Idea promotion requires convincing facts, good research reports, working models, repeated follow-ups and frequent research-design-sales meetings.

By WALDO H. KLEIVER
Director of Research
Minneapolis-Honeywell Regulator Co.
Minneapolis, Minn.

THERE ARE THOSE who would say that after research people have done their work it is up to management or someone else to see that its results are used. That would be lovely if it would work. I well remember thinking, when starting out in the business of research, that when something good was developed there would be no doubt about anyone being interested in it. How innocent!

After working on a number of problems I found that while I could develop what appeared to be good workable devices to satisfy the problems that had been assigned to me, everything seemed to end at that point. I would show the working models and everyone would say "How nice" or "That's wonderful," but that was all.

Even the people who had asked for the developments had in the interim become interested in other things and were not inclined to do anything about it.

There I was as helpless as the distinguished visitor trying to make a phone call from the insane asylum. After failing sadly to get results, he said in desperation to the operator, "Do you know who I am?" and she sweetly replied, "No, but I know where you are."

Something had to be done. In talking with others and doing considerable reading on the subject, it became obvious that the problem was not unique with me. One man confirms this as follows: "The research director's job, therefore, is not done when the product has been invented, designed, and proven in theory. He has to sell it, just as much as if he were a private inventor."

The Basic Problem

It is here that we bump into the thing called human nature. People are inclined to be interested in their own ideas; accepting someone else's ideas requires considerable effort, and there is also perhaps a little strain on individual pride. They have inertia; they don't want to be bothered. Whether it is for these or other reasons, it is generally conceded that one of the most difficult things in the world to sell is an idea.

And so we come face to face with the sales problem in research. Some people say this should be the function of top management. For this reason those who direct research are often included in top management or in meetings with management when decisions about new products are made. However, the director of research, the vice-president in charge of engineering, or someone in a similar position who is very close to the research work must still present the new ideas in such a way that they will appear sufficiently attractive financially and otherwise to promote the necessary interest. He must close the gap between the technical facts and their business significance.

The fact that any management maintains a research organization is evidence that it is interested in new ideas, but it is the right and duty of management to question

This paper was presented at the 1948 National Electronics Conference in Chicago.
Regular idea-evaluation meetings are one requirement for acceptance of good new ideas. In this typical Minneapolis-Honeywell research department meeting are, left to right: Glen Seidel, administrative engineer; Raymond O. Anderson, coordinator of research; Waldo H. Kliever, director of research; John E. Haines, vice-president; John W. Magoffin, market research department; George Muschamp, vice-president in charge of engineering of Brown Instrument Division.

These ideas and to require proof that they are economically sound.

In looking for solutions to this research-sales problem, one must go all the way back to the origin of the ideas. An idea originally suggested by those who will have to carry on with its future—an idea that fills a real need that is appreciated by everyone—will be accepted much more readily than an idea which enters a completely new field or replaces devices that have not been a source of extensive troubles.

New ideas may come from the customer, the sales department, management, the design engineering department, the research department, as by-products of work on other problems in research, and from inventors outside of the engineering and research departments.

It is helpful later, when the results of a project are considered for production, if those concerned with passing on it at that time are in at the early stages, provided not too much is promised at that time. However, the research department should have the right to carry on some investigations, especially those of a preliminary survey nature, without requiring extensive outside approval. Then, as the idea progresses, it should be reviewed more carefully in the light of technical feasibility, cost and market-ability. Ideas that prove unpromising should be eliminated as early as a reliable decision can be made.

The complete path of a good idea may be as follows: (1) Basic research; (2) applied research or development; (3) design engineering; (4) engineering test; (5) methods engineering; (6) production; (7) sales. That is a long and devious route involving many different people, and it is not surprising that it involves transfer problems.

**Attitudes to be Recognized**

Even the basic attitudes of various groups toward problems will differ. For example, in basic research the objective is information, while in applied research the objective is new products. Companies differ widely in the amount of basic research they do. Ideas often originate from basic research done in other organizations, including universities. Many companies sponsor basic research in universities or research foundations.

Basic research is very important, but this present study will be more concerned with selling the products of applied research. Applied research has been described as follows: "The pursuit of a planned program toward a definite practical objective—a preconceived end-result. It takes the results of fundamental or exploratory research and tries to apply them to a specific process, material, or device."

In the design engineering group the objective is still new products, but with more thought to how the new product can be manufactured and made to work reliably under field conditions. The research man is an optimist who takes ideas that everyone says are impossible of execution and shows how they can be made to work. The design engineer is a pessimist who takes ideas
that everyone feels are ready for production and finds the bugs which might cause later serious difficulties. This division of responsibilities has been defined' as follows: "The research man, if he is to be worth anything, must be able to find the grain of gold in the pan of gravel; the development engineer must be able to see the fly in the ointment. These attitudes—the one trained to look for what's wrong, the other to see the valuable features of a complete failure—make engineering and research complementary to each other, but also miles apart."

What about the attitude of the sales people toward new developments? They will want to know what the device does for the customer and how it compares with competition in performance and price. Don't bother them with telling how it works or how it is made.

For convincing management of the worth of the idea, dollar signs must be used, along with other pertinent information.

This diversity of methods of approach is necessary in the selling of research ideas. Know your people.

Quoting again, "There is no part of research more important than sales, and this means, in order of increasing importance, a good article, proper preparation of sales presentation, full knowledge of the financial situation of your customer, knowledge of the peculiarities of the personality of those to whom you sell, and most of all, personal contacts."

Transferring Ideas

Having reviewed a research project after preliminary survey, with due regard for marketability of the end products, the project people in applied research proceed with the serious business of producing the best solutions to the problem. Here we must be careful, in our zeal for results, not to restrict the necessary freedom of the people in research.

In general, the research departments will not come up with the kind of device expected; if they do, it is probably a sign that the research was not very thorough. Also, if the research department is alert there may be several possible by-products from the investigation which often are more important than the original objective. The freedom in applied research, however, is always tempered by the feeling that research is a serious responsibility and that there are general objectives to be kept in mind.

Another characteristic of good research people must be considered. A good research man will always see additional ways to make improvements on ideas and he will insist that he should have a little more time to study this or that, until the development goes on and on without end. When to transfer an idea from research into production design probably constitutes one of the most important problems in research management. Expressed another way, it is the problem of determining the state of perfection which should be required before transfer to the development team.

One procedure is to let the research man continue in his endless quest, with the director of research or the company management reviewing the work periodically. When any development has progressed to a point where it offers sufficient improvement over equipment in current use or in a new field to justify it, and when the device developed appears to be workable and saleable, the available information is extracted from research for conversion into production. We do not wait for the final perfect design, but often allow the research to continue on the same problem so that in one or two years we can obtain from it further improvements in products. It is much easier to justify spending money on further work on a project after it is bringing returns.

Requirements for Selling

When the director of research has selected an item to be considered for production he faces the two-fold problem of convincing management and sales that the new product should be manufactured and informing and convincing the production design engineering people that the work done in research is a good basis for the design of a product.

In the sale of research products,
as with other sales work, certain aids are essential:

(1) Basic facts. This is the most important requirement on the list. It includes not only information about what the device is and what it can do, including test results, but in the final form will also have to include a market analysis, along with cost estimates for manufacture and for design and tooling. The research department may or may not be responsible for the latter, but must certainly be interested to see that such information is available.

(2) Research reports. These should include illustrations, diagrams and complete well-organized information and technical data. Reports are also a useful adjunct to laboratory records, especially in connection with projects not contemplated for immediate production, and they help to clarify the thinking of the research people who write them. It is worth while to make these reports attractive and styled for easy reading. We have a business manager in the research department who makes it his business to see that the reports are written and are complete and comprehensible.

(3) Models. We strongly believe in making up working models because they help to convince skeptical people, especially the design engineers, that something usable is being presented, and make the idea more interesting and understandable. Models also help the research people, in that they give the concrete objective of producing a working model.

(4) Meetings. Most people are overburdened these days with conferences and meetings, but there still is a useful place for them. We believe that in getting together the interested parties and discussing a new product when it leaves research much can be gained. Many questions will be answered and mutual interest stimulated. The meeting may also point up channels for further research which are required or worthwhile.

(5) Field applications. The research department will usually be called upon to try out the idea on various problems in the field. Some of this type of work is good for the education of research people, for better knowledge of the product and for promoting confidence in the research work. In general, much of this application work in research should be avoided because it can easily grow to demand a considerable part of research time. Besides, it provides a good means of acquainting the production design engineering department with the problem if the application work can be done there.

One thought which must permeate all of the above sales methods is "Be specific". If possible, do not propose three ways for solving a problem and leave it to someone else to make the choice. The research department can generally inform themselves sufficiently well to be in the best position for recommending a definite solution. If research has not progressed to this point, it is better to study the matter further before making the sales presentation. This principle is probably not much different here than it is in any sales work.

Follow-Up

Having presented a new idea and obtained approval for production design, along with work priority assignments by the sales department and the design department where necessary, one could easily feel that now the research department can forget the matter. Such is far from being true. In most cases the matter would die quickly if so neglected, or in any case would take routes which have been shown in research to be blind alleys.

It is never possible to put all the information learned in research on paper. Experience has shown that a close collaboration and follow-up is needed for a long time after the transfer of an item from research to design. However, during this period the research department will have to be tolerant of changes in the ideas and in the device. Designers are creative workers also and will contribute ideas of their own. If this is not permitted, life becomes unpleasant and unpleasant for them and you wouldn't want that to happen. Unless research people have good reasons to argue with designers that one of the design proposals will lead to trouble, such modifications should be allowed. In general, the changes will be for the better. Incorporating many people's ideas into a product seems to lead to the best end result.

This brings us to some general considerations in the relationship of research with other departments in the company. The marketing of product ideas becomes much easier if the research department is well acquainted with the problems of salesmen, the problems of designers, the problems of field sales people and the problems of management. This might be called personnel relations work by research. It involves a helpful attitude toward other people's problems, rather than competition with these people. It involves instilling in contacts with others a feeling of confidence, rather than a spirit of jealousy or excessive pride.

If these interdepartmental contacts are properly handled, the research department and the director of research will find that others in the company are regularly coming to them with problems. Such contact is not only a helpful condition in guiding research work, but the spirit of it is a necessity for bringing research to that successful goal which includes actual products going out to benefit humanity.

REFERENCES

TELEVISION
STATION COSTS

Plans are suggested for a small station to which additional plant and facilities can be added in normal process of growth. Building costs are estimated and figures are given for equipment, beginning with bare essentials. Details show how to realize a maximum return for the investment

By WILLIAM FOSS
Consulting Engineer,
Washington, D. C.

The installation and operation of a well-equipped television station today runs into astronomical figures when compared with the cost of construction and operation of standard broadcasting stations. In the early twenties there were many stations actually put on the air for sums so ridiculously low as to seem unbelievable. The writer actually constructed several such stations at costs under $10,000, this expenditure being the maximum sum that the owners invested. These same stations and many others like them are now operating successfully, are affiliated with national networks, and have in many instances brought returns to their owners in sums of seven figures.

The television story is entirely different. Construction costs cannot be met for less than $100,000 and this sum represents a station such as a small town community could support. This size station would be limited by its incomplete equipment to very few hours of service per week and would probably have no studio. It would depend on mobile pickup equipment to televise sports and civic events, with possible additional programs from networks that are now fast growing, and from the projection of films.

In the design of suitable studio and projection facilities for television stations we face problems far more complicated and considerably more costly than those at standard broadcast stations. It is not unusual for a broadcast station to be able to find any number of buildings in average cities that can be made to accommodate the working force and supply studio space without the removal of a single partition. In television broadcasting, however, it is usually necessary either to build a new structure from the ground up or to perform a major operation in

Table I—Initial Studio Equipment Costs

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Installation</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remote equipment</td>
<td></td>
<td>$32,750</td>
</tr>
<tr>
<td>2 Camera chains complete</td>
<td>2,300</td>
<td>$19,750</td>
</tr>
<tr>
<td>1 Standard pickup truck</td>
<td>11,000</td>
<td></td>
</tr>
<tr>
<td>1 Auxiliary power supply</td>
<td>2,000</td>
<td></td>
</tr>
<tr>
<td>Audio equipment and spares</td>
<td>4,000</td>
<td></td>
</tr>
<tr>
<td>Studio lighting equipment</td>
<td>3,500</td>
<td>31,803</td>
</tr>
<tr>
<td>Projection room, consisting of 2 film camera channels with controls complete, 2—16 mm projectors, 1 slide projector, and 1 special picture projector</td>
<td>29,303</td>
<td>31,803</td>
</tr>
<tr>
<td>Equipment</td>
<td>2,500</td>
<td>34,303</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>$85,053</td>
</tr>
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</table>

Table II—Costs Including Control Equipment

<table>
<thead>
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<th>Equipment</th>
<th>Installation</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remote equipment</td>
<td>$19,750</td>
<td></td>
</tr>
<tr>
<td>Projection room</td>
<td>31,803</td>
<td></td>
</tr>
<tr>
<td>Studio lighting</td>
<td>3,500</td>
<td>31,803</td>
</tr>
<tr>
<td>Control room—1 program console, 1 master monitor, 1 line monitor, synchronizing, pulse and blanking equipment, power supplies and miscellaneous</td>
<td>$32,000</td>
<td>37,000</td>
</tr>
<tr>
<td>Equipment</td>
<td>5,000</td>
<td>37,000</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>$122,053</td>
</tr>
</tbody>
</table>
Complete 500-watt television transmitter and control console

the remodeling of an existing building at a cost which is comparatively high.

High Ceiling Necessary

The reason that remodeling a building for studio facilities is usually necessary lies in the fact that the ceiling must be high enough to provide room for a special lighting system which, of course, is not necessary in standard broadcast work. Since a television station consists of two complete and separate transmitters, namely, one for the transmission of the picture (the so-called video plant) and the other a conventional f-m plant, it is also necessary to treat the studio to obtain the proper acoustic effects.

The trend at present seems to indicate that television studios will not be built to accommodate large crowds of spectators since the emphasis is on the pictures being transmitted and these can be seen on adequate monitors or on outside television receivers. The arrangement is advantageous from the financial standpoint because it eliminates the necessity of supplying a finished show place to the public. This article will not attempt to supply in accurate detail either the finished plans of studios or the exact costs to be met. It is, rather, the intention of the writer to present such plans and costs in general that will stimulate in the mind of the reader ideas necessary to develop concrete plans that fit each individual case.

Tables of costs for equipment alone which will be supplied hereafter indicate the importance of designing in order to make every possible piece of equipment carry its share of the financial load. From these tables it will be noted that a properly equipped pickup truck will cost in excess of $49,000. If, for instance, a station is able initially to use the equipment in the truck both for the televising of remote events and for live programs at the studio location, a considerable saving can be made by designing a building so that the truck can be backed up to the studio and the equipment used in the studio with the truck functioning as the control room.

Truck Studio Control

Figure 1 shows such a plan. This plan represents a building so arranged that the shop on the first floor (A) can be used as a garage for the truck, in addition to functioning as a scene dock for props and scenery and a repair shop for general repair and maintenance work. It will also accommodate the truck when used as a control room, the truck being backed up to a large window in the studio when so used. The required investment necessary to give continuous service will be that necessary to equip a truck for handling remote programs and for equipping a projection room where films, slides, and other pictures can be televised.

The investment just mentioned
TABLE III—Equipment Costs with Studio and Control

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remote equipment</td>
<td>$19,750</td>
</tr>
<tr>
<td>Projection room</td>
<td>$31,803</td>
</tr>
<tr>
<td>Control room</td>
<td>$37,000</td>
</tr>
<tr>
<td>Studio</td>
<td></td>
</tr>
<tr>
<td>Video and audio equipment</td>
<td>$32,895</td>
</tr>
<tr>
<td>Lighting</td>
<td>$3,500</td>
</tr>
<tr>
<td>Treatment</td>
<td>$5,000</td>
</tr>
<tr>
<td>Installation</td>
<td>$1,000</td>
</tr>
<tr>
<td>Total</td>
<td>$163,948</td>
</tr>
</tbody>
</table>

does not include the transmitter, antenna, and their associated apparatus nor does it include a master control room where the dispatching, distribution, and main control of the program can be centralized. The transmitters and antennas will be discussed later. In lieu of this control room, simple switching devices may be designed and operated at the transmitter location, or they may be installed at the projection room location.

Table I indicates the equipment costs for the plan shown in Fig. 1, showing the projection room and truck but not including the control room and not including the transmitter and its related equipment.

Figure 1B shows the second floor plan of the same building. The film projection room is so designed that when the studio is to be equipped with its own apparatus a control room then can be built in. In case the whole operation is a consolidated one, the transmitter may also be installed in this presently available space.

Table II also indicates equipment costs for the plan shown in Fig. 1. In this instance the control room is equipped to dispatch and coordinate the operation of the remote equipment, the projection room, and network terminal facilities. However, the cost of equipping the studio is not shown in this table. Studio lighting will be necessary provided a room such as shown in Fig. 1 is used in conjunction with the equipment from a truck. A rough estimate of lighting costs may be obtained by using the cost figures $4.00 to $4.50 per square foot of studio floor space. A pipe-work grid should be installed on the ceiling for the purpose of hanging the overhead fixtures. This grid should be made up in squares, each grid not larger than seven feet.

Table III indicates equipment costs for the plan shown in Fig. 1 when the studio is so equipped as to operate from the control room, permitting the use of the remote equipment purely for pickup.

FIG. 1—First (A) and second floor plans (B) for initial construction of a small station

The main drawback with the first plan above described lies in the fact that when the station first goes into operation, the mobile equipment is tied up whenever a live program from the studio is necessary. A further drawback becomes immediately evident when the first studio is equipped. While the building of control equipment into the studio does free the mobile equipment to pick up programs for which it was primarily designed, station operators are still faced with a further serious drawback. This lies in the fact that adjacent or contiguous live
programs cannot be put on from the studio and it will therefore be necessary either to broadcast programs from the projection room or from the mobile equipment while studio scenery is being changed. If the studio is large enough to accommodate more than one scene at a time, the scene may be set up before the series of broadcasts starts and the cameras and associated apparatus may be moved to pick up each scene in succession. However, no scenes can be changed while the studio is on the air because of the noise caused in making such changes.

Figure 2A shows a first floor plan for the expansion of the same building to accommodate two studios and Fig. 2B shows the second floor plan of this enlarged building. In this plan two completely equipped studios with a master control have been provided in addition to the projection room which is necessary for the station operation from the start. In addition, the shop has been increased in size to accommodate props and scenery to be used in the two studios. The turntable shown installed in Studio A will be discussed separately.

Table IV indicates equipment costs for the plan shown in Fig. 2. Referring to the total cost as shown in Table III, it is seen that the cost of equipping a second studio will be an additional $45,395 or a total of $209,343. This additional investment will furnish a second studio and give the station the necessary flexibility which will

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remote equipment</td>
<td>$49,750</td>
</tr>
<tr>
<td>Projection room</td>
<td>31,803</td>
</tr>
<tr>
<td>Control room</td>
<td>37,000</td>
</tr>
<tr>
<td>Studio A</td>
<td>45,395</td>
</tr>
<tr>
<td>Studio B</td>
<td>45,395</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$209,343</strong></td>
</tr>
</tbody>
</table>
finally be needed to carry on continuous live programs.

The turntable mentioned above and indicated in Fig. 2 is important to this discussion for two reasons, first, to create a substantial saving when one studio alone is used; and second, to add additional flexibility resulting in increased facility in the station operation.

The cost of such a table when electrically driven varies from approximately $8,000 for a table 25 feet in diameter to approximately $11,000 for a 40-foot table. The wings or partitions segregating the table into three parts may be swung to vary the size of the settings or may be completely removed from the table when a rotating set is desired. The table is planned to be mounted flush with the floor of the studio and so designed that it can be loaded unevenly with a maximum loading of about 50 pounds per square foot.

This plan calls for a shop and scene dock behind the studio in which the main body of the table is located so that work can be done on the sets on the shop side of the table while televising is proceeding in the studio. If the table is to be installed in the studio before the second studio is built, a certain amount of flexibility can be expected with a construction saving of from $30,000 to $40,000, depending upon the size of the table.

Most manufacturers currently design and construct transmitters of only two sizes, namely the 500-w or so-called community transmitter and the 5-kw or metropolitan type. The transmitter may be installed either at the site of the studios or at a remote location which affords the radiation system a more favorable location for the purposes of propagating the wave.

Since television channels are located in the very-high-frequency band, the radiated signal is subject to shadowing by obstacles between transmitter and receiver. It is usually necessary, therefore, to take into consideration the possibility of shadows and reflections when selecting a site for the transmitter proper. Simply stated, if you can see it, you can hear it, although service may be rendered beyond the line of sight under some conditions.

**Transmitter Costs**

In Table V the costs of the transmitters and associated equipment have been set up. This table is approximately correct except that no consideration for the cost of land has been given.

It will be noted that both types of transmitters designed for channels

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**Table V—Transmitting Station Costs**

<table>
<thead>
<tr>
<th>Equipment Description</th>
<th>500-W Transmitter</th>
<th>5,000-W Transmitter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transmitter</td>
<td>2-6, 7-13</td>
<td>2-6, 7-13</td>
</tr>
<tr>
<td>Spare tubes and parts</td>
<td>3,000</td>
<td>5,000</td>
</tr>
<tr>
<td>Aural monitor</td>
<td>1,600</td>
<td>2,000</td>
</tr>
<tr>
<td>Visual frequency monitor</td>
<td>675</td>
<td>675</td>
</tr>
<tr>
<td>Picture demodulator</td>
<td>650</td>
<td>650</td>
</tr>
<tr>
<td>Waveform demodulator</td>
<td>900</td>
<td>900</td>
</tr>
<tr>
<td>Power supply</td>
<td>365</td>
<td>365</td>
</tr>
<tr>
<td>Adapter kits</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Rack cabinet</td>
<td>390</td>
<td>390</td>
</tr>
</tbody>
</table>

**Table VI—Test Equipment List and Costs**

<table>
<thead>
<tr>
<th>Equipment Description</th>
<th>Remote</th>
<th>Studio</th>
<th>Transmitter</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-in. oscilloscope</td>
<td>$195.00</td>
<td>$195.00</td>
<td>$195.00</td>
</tr>
<tr>
<td>3-in. oscilloscope</td>
<td>$550.00</td>
<td>$550.00</td>
<td>$550.00</td>
</tr>
<tr>
<td>Square-wave generator</td>
<td>$225.00</td>
<td>$225.00</td>
<td>$225.00</td>
</tr>
<tr>
<td>Capacitance—resistance bridge</td>
<td>$59.50</td>
<td>$59.50</td>
<td>$59.50</td>
</tr>
<tr>
<td>Voltmeter</td>
<td>$18.75</td>
<td>$18.75</td>
<td>$18.75</td>
</tr>
<tr>
<td>Audio oscillator</td>
<td>$500.00</td>
<td>$500.00</td>
<td>$500.00</td>
</tr>
<tr>
<td>Distortion and noise analyzer</td>
<td>$75.00</td>
<td>$75.00</td>
<td>$75.00</td>
</tr>
<tr>
<td>Video sweep generator</td>
<td>$1,000.00</td>
<td>$1,000.00</td>
<td>$1,000.00</td>
</tr>
<tr>
<td>Wavemeter</td>
<td>$75.00</td>
<td>$75.00</td>
<td>$75.00</td>
</tr>
<tr>
<td>V-t voltmeter</td>
<td>$59.50</td>
<td>$59.50</td>
<td>$59.50</td>
</tr>
<tr>
<td>3-in. oscilloscope (Tektronix type)</td>
<td>$795.00</td>
<td>$795.00</td>
<td>$795.00</td>
</tr>
</tbody>
</table>

**Total**                                   | $1,326.75| $1,467.25| $3,205.25

---

Typical small-studio control room with audio controls at left, video at right. The program director sits at the desk.
2 to 6 are less expensive than those designed for channels 7 to 13. Since the band including channels 2 and 6 represents frequencies from 54 to 88 mc and the band including channels 7 to 13 includes frequencies from 174 to 216 mc it is evident that tube design as well as transmitter design and construction is more expensive at the higher frequencies.

Relay Links
Where the transmitter and studio are situated at remote locations and also in cases where the remote equipment is functioning at sites away from the studio, it is present general practice to connect these units with relay circuits. Equipment has been developed and is operating successfully on several microwave channels. Notable in this category are circuits on approximately 2,000, 4,000, and 7,000 mc.

Since the equipment constructed for the higher frequencies can be manufactured in more compact fashion its high degree of portability renders it best for remote pick-up work. The 7,000-mc equipment is therefore most popular to serve as a truck-to-studio link while in many instances the lower frequencies have been used between studio and transmitter. For the purposes of this paper, an approximate price of $10,000 for each complete link, consisting of a transmitter at the originating point and a receiver at the incoming terminal, has been used.

Testing Equipment
A certain amount of test equipment with every television installation is an actual must. Operating crews cannot be expected to maintain the apparatus nor can they do the necessary trouble shooting without an adequate complement of this equipment. As stated above, the transmitter is often located at a different site from the studio and the remote equipment needs maintenance and repairs when in the operating location. Table VI lists equipment of this type.

The foregoing indicates the approximate equipment costs that a prospective television station builder may expect to meet but does not include the price of real property either at the studio or that necessary on which to construct the transmitter. It has been estimated, however, that the cost of constructing a building such as that shown in the plans illustrated above will be in the neighborhood of $66,000 for the first stage of construction and an additional $59,000 for the finished building.

The approximate costs have been so tabulated, however, that any combination of equipments can be correlated and the resulting costs obtained from the tables. For instance, it is evident that the type of station which can be most inexpensively constructed is one which is equipped to receive network programs only. Thus, by referring to Table II, the control-room item shows an equipment cost of $32,000 with an installation cost of $5,000, bringing the total to $37,000 and from Table V a 500-w transmitter operating on channels 2, 3, 4, 5; or 6 will cost approximately $66,900. If the transmitter and control room are located in the same building, the owner should then be able to construct a station for approximately $103,990 and with the additional test equipment shown in Table VI, an additional $3,205 will complete the station.

If, however, the prospective owner is considering a well-equipped station with two studios, projection room and remote equipment, Table IV furnishes figures showing a total cost of $209,343. Table V for a 5-kw transmitter operating on channels 7, 8, 9, 10, 11, 12, or 13 shows a total of $153,767. Such a station will probably be so constructed that the transmitter and studios at different locations and the remote equipment will be supplied with radio relay links, two such circuits costing approximately $20,000.

In addition to the items stated above, test equipment in the amount of approximately $7,500 will be needed, bringing the total expenditure for equipment installed to approximately $390,610. Some few organizations have already gone well beyond this amount in constructing stations but in this paper it has been the intention of the writer to point the way for the beginning of such an operation in a comparatively modest way rather than to describe the more elaborate procedures of the larger companies.

The writer wishes to thank the personnel of the following organizations for their assistance in compiling the data herein: Radio Corp. of America, General Electric Co. Allen B. DuMont Labs., Inc., Television Associates and Lester V. Johnson Associates.
Prior to the establishment of frequency allocations for short-wave diathermy units, frequencies anywhere in the range from about 10 to 60 mc were used by various manufacturers, depending on the type of applicator furnished. Since the therapeutic benefit is due to heat alone, all frequencies are equally effective in the treatment of tissue.

To suppress wasteful use of the frequency spectrum, three bands were assigned by the FCC for medical apparatus, in conformance with those adopted by the International Radiocommunications Conference, as follows:

<table>
<thead>
<tr>
<th>Band</th>
<th>Center Freq.</th>
<th>Tolerance</th>
</tr>
</thead>
<tbody>
<tr>
<td>13.5532-13.5667 mc</td>
<td>13.56 mc</td>
<td>13.56 ke</td>
</tr>
<tr>
<td>26.9573-27.2827 mc</td>
<td>27.12 mc</td>
<td>27.12 ke</td>
</tr>
<tr>
<td>40.6597-40.7003 mc</td>
<td>40.68 mc</td>
<td>40.68 ke</td>
</tr>
</tbody>
</table>

Although there is no limit to the amount of radiation permitted within these bands, harmonic radiation must not exceed 25 microvolts per meter at 1,000 feet.

The 13.56 mc band serves adequately for pads and inductive applicators, but is generally unsatisfactory for air-spaced plate applicators because the associated high reactance requires excessive patient-circuit voltages. The 27.12-mc band effectively operates all known types of applicators. The 40.68 mc band is usually unsatisfactory for inductive applicators because of excessive turn-to-turn voltages and resulting high dielectric loss, but is satisfactory for pads and spaced plates.

The wider frequency tolerance of the 27.12 mc band permits the design of simple self-excited oscillator circuits, obviating the complications and maintenance problems involved in crystal-controlled circuits.

Frequency-Shift Problems

The frequency stability of a self-excited diathermy oscillator circuit is affected by five major factors: (1) mechanical vibration or displacement of frequency-determining parts and components; (2) replacement of tubes; (3) replacement of parts; (4) frequency drift due to heating of oscillator circuit components; (5) frequency shifts due to patient-circuit loading and tuning.

Mechanical factors can be eliminated by building strong and sturdy circuit components and fastening them rigidly.

Changes due to tube replacement can be minimized by using a high tank capacitance so that variations in tube interelectrode capacitance will produce only small frequency changes. Here a limit is quickly reached due to the inefficiency of high-Q tank circuits, hence under the best practical conditions it is reasonable to expect up to a 50-kc shift in either direction due to interexchange of tubes of identical make. When tubes of different manufacturers are interchanged, at least three times this shift is sometimes experienced.

Frequency shifts due to circuit heating can run as high as 150 kc, but by proper design this can be limited to 20 kc.

Patient-circuit loading is the bugaboo of all short-wave diathermy design. Applicator and patient-circuit impedances may range from 5 ohms to 150 ohms of resistance and from +2,000 ohms to −2,000 ohms of reactance. Variable coupling is therefore necessary to couple a patient circuit efficiently to an oscillator. A coupling for a
Analysis of problems involved in building medical diathermy units that stay in FCC-allocated frequency band despite movements of patient or replacement of tube, and design of plug-in monitor that stops oscillator and sounds a buzzer when frequency drifts beyond predetermined acceptable limits for any reason.

5-ohm load will not transfer enough power for higher-resistance loads; on the other hand, if the coupling is set for the high-resistance load and a low-resistance load is connected, frequency shifts will occur.

Example of Suitable Design

The short-wave diathermy circuit in Fig. 1 was designed to meet all of the above requirements. It employs a single type UE468 oscillator tube operating on 27.12 mc with a power output of 300 watts. Use of one tube minimizes circuit complications and service factors by eliminating such matters as tube balance, excitation adjustments and balance, neutralization, and improper lineup of driver or power amplifier stages.

The Q of the tank circuit on full load is 90. The maximum frequency shift due to patient-circuit loading is ±50 kc (Δf = tank efficiency multiplied by f/4Q). This holds for the condition of critical coupling, which just loads the circuit to rated full load with the patient circuit tuned to resonance.

The single-ended tank circuit permits use of a high tank capacitance, giving a high ratio of tank capacitance to tube electrode capacitance. This in turn tends to minimize frequency change with interchange of tubes having otherwise tolerable interelectrode capacitance variations.

The output of the generator is adjusted primarily by the variable coupling control. The maximum possible coupling is designed to the critical value corresponding to the highest patient-circuit resistance to be treated under normal conditions.

The parallel-tuned output circuit, controlled by the tuning capacitor, gives ample tuning range to resonate all types of applicators. Since the main switch is embodied in the coupling control, the operator automatically increases the coupling control from zero coupling each time the unit is turned on. The output of the unit is metered by measuring the difference between the plate and grid currents, to indicate true power independent of patient-circuit tuning for any given load condition.

Frequency shift due to thermal drift is controlled by a bimetallic temperature compensator. The thermal shift is held to 20 kc, with the greater portion of this shift occurring during the first two minutes of operation. The generator operates well within the FCC limits if the initial frequency is set correctly and the output control is not advanced to a position which grossly overcouples the patient circuit to the oscillator. Incorrect operation is only possible when the output circuit is not tuned to resonance.

Trimmer C4 is used to adjust the frequency of the oscillator over a range of ±200 kc from the center frequency. This range is adequate

![FIG. 1—Basic circuit of short-wave diathermy unit operating in 27.12-mc band and using monitor circuit to stop the oscillator and sound a buzzer when frequency drifts beyond legal limits](image-url)
to compensate for frequency variations due to change of tubes or other components and mechanical instability.

**Frequency Monitor**

A monitor circuit insures that the unit will always operate within the band. It consists essentially of a thermally and mechanically stable high-Q resonant circuit which operates a sensitive relay through a rectifier tube. When the circuit is excited the relay completes the cathode circuit of the oscillator.

When the oscillator frequency deviates more than a predetermined amount from 27.12 mc, the voltage across the monitor circuit decreases to the point where the relay opens, interrupting the cathode circuit of the oscillator. At the same time a low-voltage buzzer is energized, notifying the operator immediately of the condition. The monitor circuit (covered in U. S. patent application) is set to allow operation in a band of ±100 kc; this is well within the FCC type approval limit of 70 percent of allocated channel width.

The uppermost curve in Fig. 2 illustrates the response of a simple resonant circuit energizing a relay through a rectifier to monitor a frequency band for various values of deviation from the frequency to which the circuit is tuned, expressed in effective resonant-circuit Q values. When the frequency deviates so that resonant-circuit response falls below the control level the relay will become deenergized. Such a method of control requires that the relay contacts be bridged by an auxiliary switch momentarily in order to start oscillations.

The lower solid curve in Fig. 2 shows that a 15-percent reduction in r-f excitation results in a 17-percent reduction in the pass band. This weakness of the simple system can be overcome by the use of a differential relay. One winding is connected to the resonant circuit, and the other winding is connected through a rectifier to a voltage proportional to the high-frequency exciting voltage of the resonant circuit, as in the monitor circuit of Fig. 1. These two windings are connected so their electromagnetic fluxes are adding in the magnetic circuit operating the relay armature.

The dotted curves in Fig. 2 illustrate the characteristics of such a differential circuit. A 15-percent reduction in excitation voltage here results in only a 7-percent change in frequency band width at the differential relay control level.

**Operation of Circuit**

When the main power switch in Fig. 1 is turned from OFF to HOLD, the oscillator tube and the rectifier in the monitor circuit warm up. Plate power is not, however, applied to the oscillator tube. During the brief period that the power switch is turned from the HOLD position to the ON position an auxiliary switch momentarily applies plate power to the oscillator tube. Oscillations start immediately, and if the frequency is within the operating band the monitor differential relay contacts close and hold the plate power on. If the oscillator frequency is outside the limits, the monitor relay will not hold the plate power on and a buzzer will operate.

Trimmer $C_1$ is adjusted by determining the low and high-frequency limits of the monitor and setting the trimmer at a point midway between these two limits. This is normally done after allowing the unit to warm up for two minutes, thus automatically compensating for the frequency shift due to initial heating.

**Harmonic Radiation**

The reduction of harmonic radiation of short-wave diathermy machines to limits prescribed by FCC allocations requires application of standard methods of shielding and filtering. In actual test it was found that a 40-millivolt 135-mc signal applied to the plate applicators would produce a field intensity equal to 25 microvolts per meter at 1,000 feet. This illustrates the degree of suppression required. Even though the actual signal voltage received by the field intensity meter decreases with the higher harmonics, the field intensity, as computed by the induced signal voltage and divided by effective length of the antenna, tends to stay high because the effective length of the antenna decreases directly with wavelength.

Harmonic tests are conducted preferably on open terrain. Field intensity meter readings are taken either 100 or 500 feet distant from the diathermy unit. The diathermy unit is mounted on a rotatable platform which is turned 360 degrees during a given reading. Maximum signals are recorded. The unit is connected to a gasoline-powered a-c generator and is tested with applicators under all conditions. Figure 3 shows typical results of tests performed on production units.
Versatile Tone Control

Treble and bass frequencies are independently boosted or attenuated in steps to provide 121 different response curve combinations for reproduction of speech or music. Gain at 500-cycle crossover is automatically held constant by switching in cathode followers.

The tone control described here originated largely with a desire to compensate for the limitations of recording techniques. With it, treble frequencies can be boosted or suppressed, and bass frequencies can be similarly treated independently, all in small steps.

The bass and treble controls each provide sharp rise or fall starting at 500 cycles or any other crossover frequency chosen. Bass control produces no substantial effect above crossover, and treble control produces no substantial effect below. The rising or falling slope is adjustable in steps of one db per octave up to a maximum of 5 to 7 db per octave. The overall volume level at the crossover frequency is unchanged by applying any bass or treble compensation, or by applying both simultaneously. All frequency-determining components are resistances or capacitances. All curves flatten off above 10 kc and below 25 cycles.

R-C Networks

Selective frequency boost is achieved by attenuating one group of frequencies and readjusting the overall level with flat amplifiers. The basic R-C networks used for this purpose are shown in Fig. 1, along with the networks used primarily for attenuation.

Treble boost (Fig. 1A) is obtained with a bass attenuation network having a gradual drop near the crossover and a sharp flattening off at the lower frequencies. When this curve is slid up the frequency axis until the sharp bend reaches the crossover frequency, it becomes treble boost.

Treble attenuation (Fig. 1B) gives an abrupt drop near the crossover frequency and a smooth flattening off at higher frequencies.

Bass boost (Fig. 1C) is obtained with a treble attenuation network having a gradual drop near the crossover and a sharp flattening off at the higher frequencies. When this curve is in effect slid along the frequency axis until the sharp bend occurs at the crossover frequency, it becomes bass boost.

Bass attenuation (Fig. 1D) gives an abrupt drop near the crossover frequency and a smooth flattening off at lower frequencies.

Any desired crossover frequency may be achieved by selection of resistance and capacitance values for the R-C networks. For example, doubling all indicated resistance values without changing the capacitances will shift the entire curve toward lower frequencies by a factor of two. Doubling all capacitances produces the same effect, while decreasing resistances or capacitances or both shifts the curve bodily toward higher frequencies.

The impedance any network presents may be altered by a factor N, without altering the frequency response curve, by multiplying all resistance values by N and at the same time dividing all capacitances by N.

Complete Circuit

The final tone control circuit is shown in Fig. 2, along with the response curve combinations obtainable and the control switch settings for each. Since all the required compensation cannot satisfactorily be provided in variable form in one network section, composite networks consisting of three such sections in tandem or cascade are used for bass and treble attenuation.
with provisions for tapping the composite network at the desired points.

The succeeding sections in any one network increase in impedance by a factor of four or five each time, so that succeeding sections do not furnish loading which would alter the frequency response characteristics of preceding sections.

Because of the nature of the basic bass boost section, the building up of a network from several such sections would add many bulky components. Instead, therefore, a switching arrangement was developed wherein three sections of 1.4, 2.8, and 2.3-db boost per octave were combined successively to give 2.8, and 2.8-db boost per octave in ten steps, and one switch for treble, giving from 5-db boost per octave to 6-db reduction per octave in ten steps, with no interaction between controls. The words per octave here refer to the number of octaves displacement from 500 cycles.

In order to achieve a constant volume level at the crossover frequency, a stepping gain control was added, ganged to the bass and treble switches, in the cathode circuits of two cathode followers. In this way, the proper amount of input signal is chosen for each position of the selector switch in order that the gain at 500 cycles may remain constant. In practice, this is easily achievable within one db if care is taken in selecting components.

Cathode Followers

The cathode followers serve the main purpose of transforming a high-impedance input signal down to a low impedance so that the networks may begin at low impedance and build up as described. It has been found that stray coupling between high-impedance networks can seriously alter the ideal frequency response curves. With capacitance values all larger than 400 micro-microfarads, a small unintended coupling capacitance (on a switch wafer, for example) will not pro-

[Diagram of tone control system]

FIG. 2—Complete tone control system. When inserted in an audio amplifier, its overall gain is zero at the 500-cycle crossover frequency. The inset tables give the positions of the contact arms of the two six-pole eleven-position control switches to provide the indicated bass and treble control curves. Treble curves were taken with bass control at B6 (neutral), and bass curves with treble control at T6.
duce a noticeable effect on the tone.

Amplification must be provided (not necessarily within the tone control) in order to re-establish the original volume level. At the same time, it is advisable to amplify and then again transform down to low impedance between the bass and treble controls. This serves the added purposes of isolating the bass and treble components electrically and keeping either from operating at too low a voltage level. All these networks are bound to have insertion loss at any frequency, and a total of 40 db of attenuation at 60 or 120 cycles (as provided by bass suppression and treble boost, before re-establishment of the 500-cycle level) could push the signal into the heater-to-cathode hum voltage level.

**Amplifier Design**

Choice of tubes for this tone control proved somewhat vexing. The 6SL7 twin high-mu triode would have been most convenient, but even a 6SL7W proved to be usually too microphonic, and always too rich in hum introduced through the heater circuit. The 6SN7 does not have enough gain; the 6SC7 has only one external cathode lead. The 6SF5 high-mu triode was found to be available and free from hum in a sufficient number, and so this type was decided upon.

In the amplifier stages, cathode resistors were left unbypassed to make the neutral amplification curve as flat as possible, at the sacrifice of some gain. A total of 12 db more of gain may be obtained by suitable bypassing of these two resistors. All plate supply circuits must be decoupled as shown, and all blocking capacitors must be large enough so that low frequencies are not attenuated.

The input signal level must be low enough so that, after boosting, neither the bass nor the treble signal will overload either level-restoring amplifier. A gain control is therefore provided directly at the input to the tone control. This is not intended as a main gain control for the entire control and program amplifier combination, but as an auxiliary which may be set according to the maximum level of the incoming signal.

In commercial recording, compression takes place before the mechanical limitations of recording techniques produce their tone-modifying effects. Therefore, the tone control should be used before a volume expander. This also lessens the danger of overloading the amplifiers in the tone control.

**Construction and Testing**

All parts were selected, using a resistance bridge and a capacitance bridge, from stock 1-watt resistors in RMA sizes and stock capacitors. In many cases resistance values were changed slightly from nominal values shown in order to achieve a smooth consistent family of curves. Assembly may be along lines conventional for low-level audio circuits. Compactness was achieved by wiring virtually all the resistors and capacitors on the two switches before installing the switches on the chassis. The tone control with its two switches, four tubes, a spare selected 6SF5 tube and a 3-tube a-m tuner were assembled on a 9x11-inch chassis, the audio amplifier and power supply being remote.

**Checking Response Curves**

A testing method was evolved for this type of work, which eliminated disturbing effects due to such factors as voltmeter frequency response, loading, signal generator variations, and distortion. As shown in Fig. 3, an audio oscillator with load resistor was fed to the input of the tone control, across which an electronic voltmeter was placed. The linear db scale on the Ballantine voltmeters simplified measurements since all data could be obtained directly in decibels and plotted immediately; any odd points could be immediately investigated. Each network was tested individually, after which the entire tone control was tested as a unit.

The output from the last 6SF5 was transformed down to low impedance in an auxiliary cathode follower (6J5) and another voltmeter was placed across the cathode follower cathode resistor. The oscillator was set for 500 cycles, its output set for midscale (10 db) on the input monitor meter, and the input gain control adjusted for midscale (10 db) on the output meter, on the 1 volt scale.

**Precautions**

Any change in oscillator output as frequency was changed was eliminated by always adjusting the oscillator output control so that the input meter read 10 db. A series of measurements was taken by setting the frequency, setting the oscillator output, and recording the output reading in db as the treble or bass control was varied throughout its range. The tone control net effect is the output reading in db minus 10.

Great care must be taken in planning this type of measurement since it is easy to overlook a cable lumped capacitance, which will change beyond recognition an otherwise desirable curve. It is also advisable to monitor, on a good oscilloscope or harmonic analyzer, the audio output from the tone control, to avoid recording false readings due to overloading and consequent waveform distortion.

The author wishes to express appreciation to Dr. Hugh F. Gingerich, to whom credit for the basic network design is due.
Power Amplifier for the Citizens Transmitter

Construction details and circuitry of a two-stage power amplifier for use in conjunction with the transmitter described in November 1947 Electronics. Simplified design of cavity resonators and mounts permits duplication of the unit with the use of hand tools only. No machining is necessary.

By WALTER C. HOLLIS
Project Engineer
Electrical Division
The W. L. Houston Corporation
New York, N. Y.

Part V

The unit illustrated is designed to be added to the Electronics Citizens transmitter to provide the higher power needed for covering greater distance and more reliable communication. With it, the quarter-watt output of the mobile transmitter is increased to 10 watts, a total gain of 16 db. Although intended primarily for fixed station operation, where a conventional 115-volt power line is available, the input requirements are sufficiently low as to permit mobile operation from a vibrator or dynamotor power supply.

The power amplifier consists of two stages of class-C grounded-grid amplification employing type 2C43 tubes. The complete circuit diagram is shown in Fig. 1.

The first stage is operated single ended and is driven through a type-N panel jack, J. Loop L₁ is a short length of tubing which approximately resonates out the grid-to-cathode capacitance of V₁. A wire shielded within the tubing provides one connection for the heater voltage and the other is returned to ground through an internal connection in V₁. Capacitors C₁ and C₂ are button mica types that maintain both filament connections and the three cathode d-c connections at the same r-f potential. The cathode r-f connection is provided through a built-in capacitor between the shell and cathode of the 2C43. Cathode resistor R₁ develops the required grid bias and serves as overload protection for the tube in case of drive failure.

Coupling

The output tank circuit is of the transmission-line type and consists of a length of short-circuited transmission line, L₂ resonating with the grid-to-plate capacitance of V₂, and a variable capacitor, C₃, located part way up the line. The resonant circuit thus formed is shunt fed through a pi filter consisting of C₃, C₄ and the inductance of the length of wire connecting these capacitors. Output from the first stage is fed to the second stage by means of an adjustable tap on L₂ through a length of transmission line, T₂.

The second stage consists of two 2C43 tubes, V₃ and V₄, operated in push-pull. Tubing L₃ and L₄ are similar to and serve the same purpose as L₁. Capacitors C₅, C₆, C₇ and C₈ have the same function as C₁ and...
C_. Resistors R_1 and R_2 provide grid bias and overload protection. The cathodes of V_1 and V_2 are driven by the output of V_1 through transmission line T_1. Amplifier V_1 is driven directly and V_2 is driven through an additional half-wave line, T_2, which serves as a phase inverter. This is one form of the balance-to-unbalance transformer (balun).

The output tank circuit consists of a length of short-circuited parallel transmission line, L_o, resonated by the grid-to-plate capacitance of V_1 and V_2 and a butterfly capacitor located part way up the line. The resonant circuit thus formed is shunt fed through pi filters consisting of C_m, C_m, C_m, C_m, and their respective connecting leads. The output of this stage is coupled out through J_2 by means of coupling loop L_m.

**Construction Details**

As shown in the accompanying photographs, the two stages of amplification are assembled within a sheet-metal shield box 7\(\times\)6\(\times\)4 inches, consisting of two L-shaped flanged parts and two covers.

The shield box is divided into four compartments by three partitions. One compartment each is used for the input cathode circuit of V_1, output resonant circuit of V_1, input cathode circuits of V_2 and V_3, and output resonant circuit of V_3 and V_3.

All parts for the shield box are made of 1/32-inch sheet brass and held together by 4-40 binding-head screws.

The layouts for the two L-shaped flanged parts are shown in detail.
Single-ended input stage at right uses components at left and mounts with output stage to form the metal cabinet.

in Fig. 2. Two partitions, which serve as ground planes, are shown in Fig. 3. The smaller partition, which shields the input of the first stage from the input of the second stage, is shown in Fig. 4. The two line assemblies are detailed in Fig. 5 and 6. Figure 5 shows assembly details of the input amplifier line assembly. Figure 6 omits these details as they were identical. Assembly is done exclusively with soft solder. Details of the covers are shown in Fig. 7. Two are required and screening is soldered over each opening on the inside surface. After all parts for the box are made, tapped holes on the flanges are spotted from the covers. Figure 8 shows all other details.

The grid fingers shown in Fig. 8 are centered and soft soldered over the holes in the ground planes (Fig. 3). They should be soldered on the side opposite the flange with the fingers protruding. Fingers similar to these may be purchased from James Millen Mfg. Co. as part No. 33446. Only the middle size is used. After all metal parts are made, they may be silver plated for improved conductivity, as was done with the model.

Assembly

All metal parts are held together by 4-40 screws and lock-washers. In addition to the parts called for in Figures 1 to 8, the following are required: four feed-through terminals, such as Vitroseal Corp. Terminal No. 1901-9LHT; about 18 inches of shielded wire, such as Precision Tubing's No. 20 (10/30) wire in silver-plated copper shields, 0.1495 O.D. x 0.011 wall thickness; three Millen type 33008 steatite...
Components and shields of the push-pull output stage, left, form the assembled unit at right, half of the cabinet.

octal sockets; six 6-32 fillister head screws, 1\(\frac{1}{4}\) inches long; about 18 inches RG-5/U cable; and one UG-18/U plug.

The shielded wire is soldered to the chassis and cathode mount as shown in the photographs to form \(L_1\), \(L_2\), and \(L_3\), respectively. The inner wire supplies the filaments of \(V_1\), \(V_2\), and \(V_3\). Filament and cathode connections are made through an octal socket.

The cathode bypass capacitors and bias resistor are mounted on the socket as shown in the photographs. The outer rim of each button mica capacitor is soldered to terminals 3, 5, and 8 of the socket and one is stacked above the other. The lug of the lower capacitor is soldered to terminal 2, which is connected to terminal I, providing a ground return to the shell of the 2C43. The lug of the upper capacitor solders to terminal 7 which connects to the filament lead. The bias resistors span terminals 1 and 5.

The resonant lines are assembled as shown in Fig. 5. The GE 1422 supports are secured to the brass tubing by means of 4-40 set screws. The purpose of the support is to take all stress off the fragile button mica capacitors. The rest of the assembly is readily completed by referring to the photographs.

The balun, \(T_n\), is an 81-inch length of RG-5/U cable with the inner conductors soldered to the cathode mounts of \(V_1\) and \(V_2\). One side of the outer shield is connected to the shield of transmission line \(T_1\). The inner conductor of \(T_1\) also terminates on the cathode mount of \(V_3\). Line \(T_1\) is a 6-inch length of RG-5/U cable terminated in a UG-18/U plug.

The first stage showed a power gain of 10 db with a driving power of 1 watt, and an output of 2.5 watts. The plate input was 22 ma at 500 volts. The second stage showed a gain of 6 db with an output of 10 watts. The input was 30 watts, yielding a plate efficiency of 33 percent. If lower power is desired, the first stage may be used alone.

**BIBLIOGRAPHY**


High accuracy of timing intervals from 0.01 to 100 seconds for industrial control applications is provided by permitting a capacitor to discharge through a voltage source of reversed polarity.

The electronic timer to be described eliminates these sources of error while retaining simplicity.

The formula which governs the discharge of a capacitance through a resistance is

\[ V = V_0 e^{-t/RC} \]  

where \( V \) = voltage across the capacitor after time \( t \) seconds \( V_0 \) = initial voltage across the capacitor \( C \) = capacitance in \( \mu \) Farads \( R \) = resistance in megohms \( e \) = 2.718

If we permit the capacitor to discharge to the point where \( v = (1/n)V_0 \) we have

\[ \frac{1}{n}(V_0) = V_0 e^{-t/RC} \]

or \( e^{-t/RC} = 1/n \)

Thus for a given \( R \) and \( C \) it always takes the same time to discharge the capacitor to a given fraction of the initial voltage. Note that this time is independent of the value of \( V_0 \).

**Modified Circuit**

By the simple expedient of discharging the capacitor through a voltage source of reversed polarity, it is possible to make \( V = 0 \) when the ratio \( 1/n = 1/2 \). This type of discharge is shown in Fig. 1. Making use of these facts in Eq. 1 results in the following

\[ e^{-t/RC} = 1/2 \]

\[ \log 1/2 = - t/RC \]

from which \( t = 0.693 RC \)

Thus, after 0.693 \( RC \) second, the voltage across the capacitor will be zero regardless of the initial voltage \( V_0 \).

In the circuit of Fig. 2, a miniature thyratron fires when its grid voltage passes through zero. A relay in the plate circuit pulls in and either energizes or interrupts a load circuit, depending on the contact arrangement. To repeat the cycle, the thyratron plate current is momentarily interrupted. This action permits the negative grid to regain control, holding off conduction until the capacitor discharge curve again passes through zero.

When the device is first connected to the a-c line, the 4-\( \mu \)F timing capacitor, \( C_1 \), is in a discharged state and consequently the thyratron fires as soon as the plate voltage derived from the 6AL5 power supply builds up. This action causes the plate circuit relay to pull in and \( C_1 \) charges to 200 volts negative, with respect to the cathode of the 2D21. The grid of the latter, being permanently connected to \( C_1 \), likewise goes 200 volts negative. The thyratron remains in a conducting state, since one property of gas-filled tubes is the loss of control by the grid once the gas ionizes.

The circuit is now ready for the initiation of a timing cycle. It is accomplished by momentarily interrupting the continuity of the plate circuit. When the toggle switch marked RECYCLE is thrown to either position, the plate circuit is interrupted for a period equal to the transit time of the switch element. For the ordinary toggle switch, this may amount to a few milliseconds.

The tube is thus extinguished, the relay is de-energized and the highly negative grid regains control. At the same time, the normally closed contacts on the relay change the circuit so that the timing capacitor starts to discharge through the decade resistor (marked \( \times 1 \) and \( \times 10 \)) and through the power supply. The action of the discharge circuit is clearly shown in Fig. 1.

When the potential across the capacitor reaches about 2 volts, the thyratron fires and the relay pulls in and remains that way until the
circuit is again recycled. If a load, such as photographic enlarging lamp is connected in series with the a-c line and another pair of normally closed contacts on the relay, the light will go on for the precise period of time determined by the setting of the resistor decade switches.

Accuracy

The accuracy of the timing interval which may be obtained with this circuit depends on two principal factors, slope of the discharge curve near the firing potential of the thyatron and tolerance of the timing resistors and capacitor. Both of these are not only controllable but highly stable.

The value of the slope of the discharge curve at the firing point can be shown to be $V_e/RC$ volts per second when $V_e$ is initial voltage across the capacitor, $R$ is given in megohms and $C$ in microfarads.

To ascertain the timing error due to variation in firing potential of the tube, assume a maximum grid voltage drift of plus or minus 1 volt.

For a timing interval of 1 second, $RC = 1/0.693$ or 1.44; $V_e/RC = 200/1.44 = 139$ volts per second.

A more useful concept is the number of seconds per volt. Thus, $1/139 = 0.0072$ second per volt. For the assumed variation in firing potential, we have a timing error of ±0.0072 second. Since we were considering an interval of one second, this is equivalent to an error of ±0.72 percent.

For a timing interval of 100 seconds, we have an inverse rate of 0.72 second per volt and again the error is $0.72 \times \frac{100}{100} = ± 0.72$ percent.

This shows that regardless of the timing interval, the percent error due to small variations in critical grid potential is fixed and, for most purposes, insignificant.

Resistance and capacitance tolerances affect the accuracy of timing directly since the measured interval is directly proportional to $RC$. If we consider equal tolerances on the capacitance and resistance, then the timed interval $t = k R (1 ± p) C (1 ± p)$ where $p$ = percent tolerance and $k = 0.693$. This leads to the relationship, $t = k[R C ± RC p^2]$.

For tolerances up to 10 percent, the second order term may be disregarded with the result that the resulting interval is in error by double the percent tolerance on either $R$ or $C$. Thus, to insure one-percent accuracy, one must use half-percent resistors and capacitor.

An interesting case of cancellation occurs when the tolerance of one component is on the high side and that of the other component is equally on the low side. Then $t = k R C (1 - p') = k[R C - RC p^2]$.

For example, if the resistance is 10 percent high and the capacitance 10 percent low, the product error is 1 percent low. For 20-percent components, the timing error would be on the low side by only 4 percent.

The present design will give electronically timed intervals which are repetitive to an accuracy of at least 0.75 percent and absolute within about 5 percent, from 1 second to 110 seconds in 1-second increments. By making use of the relationship, $t = 0.693 RC$ and using suitable values of $R$ and $C$, it is possible to extend the timing range considerably below and somewhat above that given. The plate circuit relay operates time limits the shortest possible timing operation. With ordinary relays, it is possible to go down to 0.01 second. There are two limiting conditions for measuring long intervals. One is the necessity for extremely large $RC$ values and the other the need for a steep discharge curve at the firing point.

Maximum Time Interval

With 400 volts on the plate of the 2D21, a 10-µF timing capacitor and a discharge resistance of 43.3 megohms, a maximum of 5 minutes might be successfully attained. It is believed, however, that a mechanical timer of some type would be inherently more suitable for such comparatively long intervals. The difficulties involved in procuring and maintaining extremely high stable $RC$ are well known and in spite of recent advances in insulation and hermetic sealing techniques, it is well to avoid such circuitry wherever possible.

Credit is due J. S. Russo, also of Aviation Equipment Engineering, who was instrumental in the development of this electronic timer.
The advent of television has brought unusual desires to many set owners like the author. One of these, the desire for a larger screen, has not been found too important after the first year of operation. More confining have been the limitations imposed by having only one picture tube in the home. This tends to involve constant attendance in the living room when duty, homework, mealtime and other activities require presence in other rooms away from the picture tube.

In answer to this second desire, three different remote viewers have been devised to provide video programs in other rooms. These viewers permit occasional monitoring of the evening programs while engaged in other tasks and also permit a large number of people to be entertained in several groups of convenient size. Having two or more screens for larger groups eliminates the confusion of assembling all available chairs in one room.

**Independent Seven-Inch Viewer**

The television receiver itself contains a seven-inch tube requiring electrostatic focus and deflection. For the first remote viewer, similar video and deflection circuits were assembled to form the unit shown in the block diagram of Fig. 1. This unit is an independent viewer that requires only a video signal of about two volts for picture operation. It contains cathode-coupled multivibrators for both vertical and horizontal oscillators, deflection amplifiers, a sync separator and, in the interests of economy, a single-stage video amplifier. For the same reason, d-c restoration is accomplished by utilizing the current through the grid resistor of the video amplifier tube.

An unterminated coaxial cable is used to carry the video signal to the remote viewers. A cathode follower was installed at the receiver for feeding the video signal at low output impedance to the cable.

It was considered desirable to investigate the possible design of simpler remote viewers. Here simplification of circuit connections and minimizing of changes in the receiver were indicated.

**Design Simplification**

Elimination of the extra tube for the cathode follower was desirable and found feasible. This was accomplished by inserting a 500-ohm resistor in the cathode circuit of the receiver's video amplifier and feeding the voltage developed...
Cathode loading of a video amplifier stage in a receiver permits feeding two different types of picture-tube repeaters. By the same method, a third type, a simple slave repeater, can be fed from one of the viewers or from a receiver having electrostatic deflection where a positive video signal of the proper voltage is available. If it is necessary to use a negative signal, the input can be made to the cathode of the remote’s video stage.

The circuits of several receiver models available show an unby-passed cathode resistor in one of the video amplifier stages. From this point, these sets can be connected to remotes with only a possible addition of a signal divider if the video level is too high.

The first remote viewer included its own sound channel, using the simple intercarrier system, for demodulating the f-m signal produced at 4.5 megacycles by the transmitter. This required four tubes and was found to be an unnecessary luxury. A single audio stage is used in the viewers illustrated. Each of these is fed by an audio line from the receiver.

An alternative would be to eliminate the audio tube and connect loudspeaker voice coils to the audio line with low-impedance pads for individual control of audio level at each viewer. The system shown was adopted because of simplicity in circuit arrangement, as well as because it allows any remote viewer to be operated at a higher sound level than the receiver.

The picture controls of the independent viewer are essentially the same as those in a conventional receiver. Width, height, brightness, focus, vertical and horizontal frequency and centering controls are provided. Sufficient variation of contrast is provided by a 100-ohm rheostat in the cathode circuit of the video amplifier.

**Simplified Seven-Inch Viewer**

Cathode loading suggested a means of designing a slave remote unit in which there would be no...
need for a sync separator, vertical oscillator or horizontal oscillator. The complete circuit of a slave remote is shown in Fig. 3.

The two 6SN7 tubes are operated as two-tube paraphrase vertical and horizontal deflection amplifiers feeding the appropriate plates of the cathode-ray tube. Sawtooth pulses for the two amplifiers are supplied from the cathode circuits of the deflection amplifiers in the receiver (or from the independent master remote).

The values shown in the schematic provide a raster whose corners just touch the periphery of the cathode-ray tube screen in the slave remote when the width and height controls of the master unit are adjusted for that condition. Different types of picture tubes that operate at higher or lower voltage would require slightly different sweep voltages to fill the screen. To minimize changes in the original receiver, it is best to vary only the values of components in the slave unit. In operation, the size of the slave picture varies directly with change in size of the master unit.

Four controls are provided on the front panel of the slave viewer. These are focus, contrast, brightness and audio gain. The vertical and horizontal centering controls are mounted at the rear of the chassis.

Figure 4 shows the connections of the cables to the deflection amplifiers in the receiver. Most commercial receivers have similar circuit arrangements of the deflection amplifiers. The cathode circuit of the first vertical amplifier usually contains a resistor that can be utilized as the load feed to the remote amplifier.

Usually the horizontal amplifier has the tube cathodes grounded, and a resistor is inserted as the cathode load. The values shown were found optimum for the par-
ticular receiver; others that use 6SL7 tubes will probably require a different value.

In some receiver designs, the second tube of the paraphase may have a cathode resistor which can be used without change. Since this tube is handling the opposite phase of the first, the slave viewer would then produce a mirror image of the picture. Reversing the deflection plate connections to the coupling capacitors of the slave unit will then give the proper image at the remote.

**Deluxe Ten-Inch Viewer**

It was felt that a larger and perhaps brighter picture unit was the next step. This need was quite adequately met by the General Electric 10FP4 picture tube, and an independent electromagnetic remote viewer using it was constructed. The circuit of this unit is shown in Fig. 5.

The blocking oscillator transformers and focus and deflection coils are RCA components and their circuits are the ones recommended for these parts, although the tube line-up is different from that employed in the RCA receivers.

Like the independent seven-inch viewer, the ten-inch remote contains a single-stage combined video amplifier and d-c restorer. Sync pulses are taken from the video cable by the 6SK7 sync separator at the left in the schematic diagram. Some misgiving was felt initially at the use of this simple grid-leak biased pentode circuit, but it has proven quite satisfactory.

The focus coil is arranged in the positive low-voltage line for convenience in mounting the filter capacitors. The plate current requirement of all tubes in the viewer is 150 milliamperes.

If the audio stage (not shown) is omitted, the values of the resistors shunting the focus coil may need to be changed and a bleeder resistor may be necessary in the power supply to keep the current through the coil sufficient for focusing.

Damping resistor $R$ can be composed of a fixed resistor of 5,000 ohms and a rheostat of 3,000 ohms. Less than 5,000 ohms causes the picture to fold back on itself at the left side. A value upward from 5,000 ohms controls trace linearity of the left side of the picture.
SEVERAL YEARS AGO, an investigation was begun in these laboratories of newly developed high dielectric materials. Potential use in capacitors for hearing aids was envisioned. As a result of this study it was predicted that some of the materials might show piezodielectric properties while under the influence of a direct-current polarizing field. The junior author, with the assistance of Joseph Crownover, then with this company, made an experimental study of the prediction. This work disclosed that such piezodielectric properties did exist and, furthermore, that permanent polarization remained, giving some of these materials permanent piezoelectric properties.

The application of such materials to numerous types of transducers such as microphones, vibration and pressure detectors, frequency-control units, modulation units and phonograph pickups was at once indicated. A project covering these and other related items of development was started. To make this project self-supporting it was decided to exploit the use of the material in a phonograph pickup cartridge at the start. A part of the general research was concerned with an investigation of various materials which showed the piezoelectric property from the point of view of picking out a material that represented the best combination of sensitivity, freedom from temperature variation and ease of handling. The material finally chosen was barium titanate in the form of a ceramic.

Properties of Barium Titanate

The property of permanent piezoelectricity for the materials studied occurs at temperatures below the Curie point. The Curie point corresponds to a maximum point in the dielectric properties of the material.

For the case of pure barium titanate this temperature is approximately 120 C. Sensitivity of the material shows negligible change between −70 and +70 C. The material is also independent of humidity effects. In addition to these properties of permanence, the material also lends itself to a symmetrical construction which contributes to the flatness of frequency response of a transducer. This property, in combination with permanence under varying conditions of temperature and moisture, makes it an ideal material for use in phonograph pickups.
Parts of the ceramic pickup for 78-rpm records are shown in their order of assembly. The sensitive element of the pickup is formed by the two ceramic strips that are soldered to the armature. Terminal strips and cushions hold it in shell.

**Phonograph Pickup**

Two synthetic barium titanate slabs are mounted between three electrodes and then made piezoelectric by applying high voltage to form a pickup that is unaffected by humidity or normal temperatures. The artificial piezoelectric is generally applicable as a transducer.
tracking at low frequencies, but in general the higher the compliance, the lower the sensitivity. The needle is therefore mounted on a short extension to give a reasonably high compliance. This extension is also used to give very high vertical compliance to provide freedom from surface noise and to lessen vertical shock. The proportioning of inertia (inductance), compliance (capacitance) and damping (resistance) is such as to give good transient response, which is required for clear reproduction of speech and music.

High-frequency response is provided by coupling the 7,000-cps needle-arm mode with that of the lowest mode of the system, which occurs at 2,000 cps. The provision of sufficient damping in the plastic pads smooths the resonances due to these modes to provide the response shown in the diagram.

Of great importance for proper tracking at high frequencies is the value of the effective mass of the pickup at the needle point. This mass is measured rather than calculated because of the many uncertainties and assumptions required in a system of distributed parameters. The measurement is made by observing the deviation in frequency, produced by the loading introduced by the pickup needle, of a reed driven electromagnetically. An inertia of four milligrams was measured at 10,000 cps.

The production pickup for 78-rpm records, tested on the 1,000-cps band of a standard test record, gives an open circuit output of 0.75 volt; it has a lateral compliance of 0.5 x 10^-4 cm per dyne or better. The active material in the pickup has an effective dielectric constant of 1,200, giving a total internal electrical capacitance of about 900 μuf. The internal generator voltage is directly proportional to the needle excursion amplitude plus a lift above 5,000 cps due to the effect described above. For nominal performance the pickup should work into a load resistance of one megohm.

A pickup for microgroove records, with a 0.001-inch radius needle tip and a tracking weight of 6 grams using the same materials, develops 0.25 volt at 1,000 cps on a standard test record. This 33⅓ rpm pickup has a compliance of 0.75 x 10^-4 cm per dyne. Models have also been made of a dual cartridge for playing both 78 and 33⅓ rpm records.

Manufacture of the Pickup

In describing the design and response of the pickup, its general construction was outlined. The accompanying labeled parts-view photograph indicates the construction of the pickup for 78-rpm records. The barium titanate used in the sensitive element is in the same class as that used commercially in ceramic capacitors, although the purer it is the better. Strips for the cartridge are cut from silver-frit coated sheets and solder-sweated onto the metal support. The metal wets the ceramic at high temperature and, in cooling, contracts more than it, thus putting the ceramic strips under longitudinal compression. The titanate is brittle, but by thus placing it under precompression, the assembled element can be handled safely during production and is negligibly subject to damage from rough handling in use.

The ceramic is then polarized by applying high voltages to electrodes. Polarization takes a few minutes of an hour, the exact time depending on the voltage used. However, some combinations of materials are very sluggish, even taking days to polarize.) Inasmuch as the barium titanate breaks down above approximately 100 volts per mil the charging voltage is limited by breakdown, although for rapid production the highest safe voltage is desirable.

After the units are polarized, they are tested for sensitivity. The pickup is then assembled and finally tested for response. In some production items a sampling technique can be used to test for quality, especially if a limited number of variables affect the final performance. However, in such production items as pickups where overall response is a function of every variable in the unit, sampling is inadequate; quality control must be maintained by checking each unit for its response. Efficient operation of the production line depends, in part, on a practically automatic means of testing each assembled pickup.

Barium titanate ceramic is a polycrystalline aggregate with a high dielectric constant. Other well known materials with comparable piezoelectric properties are Rochelle salt and ammonium dihydrogen phosphate. These latter materials are used in the form of single crystals. It would not ordinarily be expected that strong piezoelectric properties would be observed in polycrystalline aggregates of random orientation. The fact that a strong effect is observed in barium titanate ceramic may be explained on the assumption that the material exists in the form of transitional-type crystals intermediate between the ionic and valence types. It appears to be possible in this type of structure to orient the domains by means of an applied polarizing field.

The project in which the above work was accomplished is now being expanded to include a study of piezoelectric properties of single crystals of barium titanate and in their potential applications to other transducer problems.
To obtain dense, nonporous slabs of barium titanate from which highly sensitive synthetic piezoelectrics can be made, the temperature of this special kiln in which the material is fired is held constant to one part in a thousand.

New Synthetic Piezoelectric Material

Pure barium titanate, fired into a ceramic, can have piezoelectric properties induced into it permanently by applying a direct-current polarizing field. The design considerations for transducer elements made with the synthetic material, its properties and production are described.

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Barium titanate has been studied extensively recently because of its high dielectric constant and piezoelectric properties. It is a heterogeneous, randomly oriented polycrystalline, dense ceramic.

While this material has been used for several years as a high constant dielectric, in recent months it has attracted considerable attention for use in such piezoelectric transducers as microphones and phonograph pickups. In both these applications, a double-slabbled element is strained in bender fashion so that a mechanical lever advantage is gained. This article describes the bases of these applications and the method for making the material piezoelectric.

Size of Transducer

In fabricating transducer elements of the size used in microphones and phonograph pickups, two ceramic sheets of the desired size are bonded together, such as by soldering, after which leads are attached. These barium titanate ceramic elements, after being sub-

APPLICATION AND MATERIAL

The preceding article described the application of a new material to phonograph pickups. This article describes the material itself in greater detail. Together, they tell an interesting story.

Barium titanate, studied during the war, was found to have a remarkably high dielectric constant so it was produced as a substitute for mica in capacitors. Later a way was found to make it piezoelectric.

With the resumption of peace-time research, the properties of this material were further studied, and ultimate use in transducers of many kinds seems likely.
jected to high electric fields, exhibit induced piezoelectric properties.

The thickness to which the ceramic is extruded is determined by the practical optimum thickness of the transducer element, which has been found to be 0.010 inch, a compromise of low compliance on the one hand and voltage breakdown strength due to corona on the other hand. That such elements can have good frequency response is illustrated in Fig. 1A. Here the calculated midband and low-frequency responses are given for several microphone elements feeding through a 400-µuf cable to a 5-megohm load. The curves, calculated on the basis of the equivalent circuit included in Fig. 1A, are given for elements of five different widths, indicated by their capacitances.

Changing the width of the element has two effects upon the response. First, an increase in width decreases the longitudinal stresses in the material and hence the midband response is decreased. Second, increasing the width of the element has the effect of increasing the series capacitance and thus increasing the flatness of response at the low frequencies. To illustrate this point, note that the 1,600-µuf unit has the smoothest overall response, going down to half power (0.7 volt) at 17 cps. But this flatness is gained at the sacrifice of the midband level.

If the width of the unit is too small, not only is the low-frequency response sacrificed, but the midband response drops as well. This is illustrated by the curve of the 200-µuf unit in Fig. 1A. In Fig. 2 the midband response of an element is plotted as a function of its capacitance (width) for several cable loadings. From these graphs, we can expect the 400-µuf element to give the best results.

While the curves of Fig. 1A and Fig. 2 are calculated, actual tests of the frequency-response characteristics on microphone and Glen- nite pickup elements in Vibrasonic housings have been made and the results, as indicated in Fig. 1B and 1C, are comparable.

**Induced Piezoelectricity**

The ceramic is made piezoelectric, after it is fabricated into the transducer element, by applying a polarizing potential. The limiting factor on the usable charging potential is the dielectric strength of the titanate material. The breakdown voltage was found to be approximately 100 volts per mil, but when corona is completely eliminated, breakdown strengths approximating 200 volts per mil are obtained. A much smaller charging potential is capable of producing almost the same degree of polarization when exerted over a longer period.

The time delay for polarization to take place and the saturation can be understood from the nature of the polarizing action. Initially, individual cubic crystals are twinned within themselves (optical axes of different domains of a crystal are at 90 degrees to each other). When the polarizing potential is applied, the domains of one orientation grow gradually at the expense of the others so that, finally, the crystal approaches a single domain. This growth of one domain and shrinkage of the other can be seen with a microscope, using polarized light. Because in polycrystalline ceramic materials the orientation of some crystals may not favor the growth of one domain at the expense of the other, not all the crystals will contribute to the overall piezoelectric effect. It is interesting to observe that a single crystal of barium titanate that has been polarized has a sensitivity one order higher than does Rochelle salt.

Figure 3A shows the dielectric constant and tan δ of the material versus temperature. It will be noted that the dielectric constant is quite uniform through the normal temperature range. Figure 3B shows the piezoelectric modulus (sensitivity) over the temperature range from -60 to +140 C. There is a drop in sensitivity at low temperature (not shown) due to the lowering of the dielectric constant. The piezoelectric effect is lost if the material is heated above the Curie point, represented by the peak in the dielectric constant shown in Fig. 3A. The peak occurs at about 245 F, (120 C), therefore the maximum practical operating temperature has been found to be 212 F, which leaves some margin.

The manner in which the relative piezoelectric sensitivity is affected by charging time is shown in Fig. 4 for a bender-type element at various charging potential gradients. The sensitivity of elements is easily determined by observing its hysteresis loop on an oscilloscope.

**Physics of the Phenomena**

No complete theory has been advanced to explain the phenomenon of an induced piezoelectric effect. However, there does appear to be a close resemblance between the ability to produce the magnetic effects in ferromagnetic substances and these phenomena; that is, there exists small regions in which dipoles can be oriented in the same direc-
FIG. 3—Characteristics of piezoelectric ceramic are (A) dielectric constant, loss tangent and (B) sensitivity. Another type of ceramic shows nonlinear capacitance effects (C) illustrating the versatility of these new materials.

FIG. 4—Saturated polarization is reached sooner with higher potential gradients, but even small voltages polarize the material ultimately.

The piezoelectric effect, due to hydrostatic pressure, has been measured and found to be on the order of $100 \times 10^{-12}$ esu per dyne. If this general phenomenon exhibited by the material can be considered as conforming to properties of certain piezoelectric materials, it means that the piezoelectric ceramic material will exhibit primary pyroelectric effects. This would place a limitation on the use of barium titanate in high power mechanoelectric transducers, because application of high alternating potentials would heat the ceramic, possibly above its Curie temperature, in which event the induced piezoelectric effect would be lost. However, it can be used for low-powered devices, such as tweeters.

Producing the Ceramic

As in all ceramics, control of the composition of the raw material is highly important. However, for piezoelectric purposes this alone is insufficient. Several steps must be taken to remedy slight variations of impurities in the raw material. The necessity of processing barium titanate into thin sheets has called for a new ceramic method.

The raw materials are intimately blended by severe agitation and grinding with the vehicles and binders. The mixed suspension is then placed under vacuum to eliminate entrapped gases, which tend to lower the density and dielectric strength of materials made by typical methods.

The treated suspension is next spread evenly on a moving belt where it is dried and then removed to lower the density and dielectric strength properly. Ceramic sheets are then cut by an abrasive wheel into the sizes required for piezoelectric applications.

It is well to note that this process can be adapted to the fabrication of capacitors and other dielectrics. Sheets from 0.003 to 0.020 inch thick can be processed up to 16 square inches in area.

An additional ceramic of considerable interest, which is not piezoelectric at room temperature, is one having a high voltage coefficient of capacitance. Fig. 3C gives its capacitance versus voltage as well as its capacitance versus temperature. This ceramic material could facilitate the construction of a sweep-frequency generator. The frequency of an oscillator can be changed by applying biasing voltages to the ceramic capacitor. It has been found that a varying biasing potential can be conveniently used to modulate an oscillator. An inexpensive sweep-frequency generator for television testing purposes could be easily made with it. Thus it can be anticipated that ceramics will play an increasingly important part in the electronic industry.

REFERENCES

(1) Shephard Roberts, Dielectric and Piezoelectric Properties of Barium Titanate, Phys. Rev., p 390, June 1947. Observed anomalous polarizability effects in barium titanate at temperatures below the Curie point are attributed to hysteresis and remanence. At temperatures greatly below the Curie point, no anomalies are observed.


(4) E. L. Donley, Barium Titanate and Barium Strontium Titanate Resonators, REVUE, p 23, Jan. 1948. From measurements of polarized ceramics, vibrations as resonators, normally to the direction of polarization and radio-frequency fields, it is found that these ceramics have Q's of about 50 and higher, and that temperature coefficients of frequency of about one part in 100 per degree C at room temperature.

High-Voltage Supplies

Discusses several types and their adaptability to portable applications. Describes system found to be best suited for such applications and gives curves showing typical operation under normal operating conditions.

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During the past decade, a number of battery-operated lightweight power supplies for use with Geiger-Muller counters operating between 800 and 1,500 volts have been described, and data on their performance characteristics have been recorded. Where light weight has been the prime consideration, as for example, in cosmic-ray measuring equipment sent aloft in balloons, specially designed batteries are often required. These are of such small size that they are usually exhausted in the few hours required for a test.

For applications involving field service work, it is desirable that standard batteries be used. They must be light in weight but capable of supplying the equipment for several hours per day with intermittent use over a period of several months.

Metering

For all work with power supplies for G-M tubes, it is usually desirable to have a direct and fairly accurate indication of the voltage. In this way, the voltage may be checked with the data supplied by the manufacturer to insure that the operating point of the tube is on the Geiger plateau or level portion of the counter characteristic.

One of the simplest ways to obtain accurate voltage indication is to insert a sensitive meter in series with an accurately known bleeder resistance across the high-voltage output. With a high-voltage source of low internal resistance, such as a battery, the resistance and the meter may be switched out of the circuit except when the voltage is measured. With sources of high internal resistance, such as in portable electronic h-v supplies, the load regulation is poor and the bleeder should be in the circuit at all times during operation. The meter, however, when not being used as a voltage indicator, may be switched for use elsewhere in the apparatus, as, for example, for indicating the integrated counting rate in an amplifier circuit from the G-M tube.

For the sake of ruggedness, a meter drawing 50 μA at full scale appears to be desirable. With high-voltage sources of high internal resistance, the use of a 50-μA meter is also preferable to a 20-μA meter because of the improvement in regulation with variable G-M tube loads.

The need for metering the high voltage and its consequent ramifications, particularly when used in circuits of high internal resistance, presents a further problem, the efficiency of power transformation. In the sense that the bleeder power is useful, in that it makes possible a necessary voltage indication, the output power may now be considered the sum of the power dissipated in the bleeder, meter, and G-M tube circuit. The power expended in the meter and G-M tube circuit is negligible compared with the power dissipated in the bleeder. A bleeder current of 50 μA at 1,500 volts represents a power output of 75 milliwatts, a requirement which has a direct bearing on the battery size for the desired life. It also points to the need for good power transformation efficiency.

For example, suppose that four midget 671-volt batteries, each weighing 12 oz., are arranged in series-parallel to deliver 135 volts at 2.5 ma for a desired useful life of 325 hours. Suppose that at this battery input a voltage-multiplying circuit has been found that will deliver 50 μA at 1,500 volts representing a power output of 75 milliwatts, a requirement which has a direct bearing on the battery size for the desired life. It also points to the need for good power transformation efficiency.

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For G-M Counters

Midget batteries are now available up to 300 volts (Eveready No. 433). A high-voltage supply consisting of a multiple of 300-volt units has much in its favor. The units are fairly compact and extremely simple to install. The life is essentially the shelf life when used with normal G-M counter currents of less than 1 µA. Even when counting at a rate of 250,000 counts per minute, the current drawn by a small G-M tube is seldom more than 3 µA, which is still a negligible drain. Because of the low internal resistance, the metering may be done intermittently; hence there is no metering drain during operation. Disadvantages include lack of voltage variability, changes in voltage with battery age, and higher weight and replacement cost than that of some electronic circuit substitutes.

Charged Capacitors

Instead of using batteries, the possibility of storing a charge in a capacitor might be considered. Prior to taking the equipment into the field, a capacitor is charged to the desired operating voltage. Suppose that the total load and leakage current is 1 µA and the permissible voltage drop over 3 hours anticipated field use is 100 volts, and the G-M tube has a useful plateau 100 volts wide. The required capacitance is the ratio of change in charge to charge in voltage $\Delta V$. Then $C = \frac{i t}{\Delta V}$ where $i$ is the current and $t$ is the time. Substituting the values from the above example, a capacity of approximately 108 µF is required.

A single voltage unit might be arranged to charge a number of capacitors in parallel and discharge them in series, thus building up the voltage to the desired value. The best method proposed has been to connect the capacitors in series, and charge each one successively by switching the battery voltage with a pair of commutators mounted on a rotating shaft. The shaft may be spring driven or motor driven. Because of the inevitable losses in switching, the resulting voltage is not an integral multiple of the battery voltage and will, of course, vary as the battery ages. This calls for voltage metering. By suitable choice of shaft speed, number of commutator sections, and capacitor values, the percent ripple and the internal resistance can be made low and the metering circuit may be removed except when a voltage reading is required.

If a battery-powered electric motor is used to drive the commutator shaft, the problem of the weight of this battery in relation to its useful life enters in. The smallest electric motor is rated at 1/2,000 h-p or 373 milliwatts. The battery supplying this motor for 325 hours intermittent service weighs almost 3 lb.

For sake of comparison with other systems, the efficiency is computed when the voltage is being metered (when there is appreciable output power). Assuming a power transformation factor for the voltage-multiplying circuit of 75 percent, and as before, that the device is supplying 50 µA at 1,500 volts, the efficiency will be 15.85 percent.

At 900-volt operation, the efficiency is only 6.6 percent. The difficulty of adjusting the voltage and the relatively high power requirements of the motor make this system a doubtful solution to the problem.

Vibrators

Considerable interest is being shown among commercial and governmental agencies in the development of small high-voltage low-power devices employing mechanically vibrating reeds. These vibrators normally operate from a battery supplying 1/2 to 6 volts. The high voltage is obtained by the rapid collapse of the magnetic field produced in a transformer supplied by the same battery. The voltage is readily controlled by a series variable resistor in the low impedance side of the transformer.

One type of vibrator supply is reported to deliver 50 µA at 1,100 volts with an input drain of 250 ma at 3 volts. A battery delivering this input intermittently for 325 hours weighs 5 lb 10 oz. The power transformation efficiency is 7.34 percent.

Vibrator-type power supplies for

### TABLE I—Comparison of Portable High-Voltage Power Supplies

<table>
<thead>
<tr>
<th>Type</th>
<th>Limitations for Portable Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Straight Battery Operation (Using Eveready 300-volt midget batteries)</td>
<td>No voltage variability. Voltage changes with battery age. Heavy. Replacement cost high</td>
</tr>
<tr>
<td>Charged Capacitor (Large capacitor charged to desired voltage prior to taking equipment into field)</td>
<td>Leakage current causes voltage to drop between time charged and time when unit is used. Large capacitor needed (over 100 µF). Bulky, expensive, and annoying to charge before use</td>
</tr>
<tr>
<td>Capacitors in Series (Charging capacitors in parallel with low voltages and discharging them in series for desired high voltage)</td>
<td>A motor-driven switching system is required, with accompanying motor power requirements. Low efficiency at desired voltage. Discharge voltage depends on condition of charging battery. Switching losses</td>
</tr>
<tr>
<td>Vibrators (Vibrating reed causes periodic collapse of magnetic field in transformer)</td>
<td>Heavy low-voltage battery. Low power transformation efficiency for high-voltage low-power applications. Bulky Transformer losses. Low overall efficiency</td>
</tr>
<tr>
<td>R-F Power Supply (High frequency feeding into step-up transformer)</td>
<td></td>
</tr>
</tbody>
</table>

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automobiles have an efficiency between 60 and 75 percent. Unless the efficiency of the high-voltage low-power types can be made 15 percent or more, metered power supplies of light weight and relatively long battery life are not very practical by this method.

**R-F Power Supplies**

High-voltage r-f power supplies for cathode-ray tubes have been in use for some years and it is natural to consider the applicability of this type for portable G-M counters. Again the efficiency is the prime consideration.

In the r-f type of power supply, a feedback oscillator drives the primary plate coil closely coupled to a larger secondary coil.

A commercial coil unit was tried in a circuit employing a 1U4 oscillator and a CK1013AX cold-cathode rectifier. It became apparent that the rectifier did not perform properly in the frequency ranges tested, 80 to 400 kc. A filamentary type rectifier, a type 1654, performed satisfactorily, but the best B-battery efficiency secured was only 13.4 percent. A coil combination made from commercially available chokes gave approximately the same efficiency.

The chief source of loss occurs in the secondary winding. In order to keep the losses in the secondary small, the equivalent parallel resistance of the secondary at resonance must be large compared with the load resistance. As the output load is to be 30 megohms, the secondary must have at least this resistance. Quoting from an article by O. H. Schade (see bibliography), "... secondary circuits of such high impedance are too expensive and large for practical use."

If a sawtooth voltage is applied to the grid of a vacuum tube in the plate circuit of which there is a high inductance choke, the rapid changes in plate current induce large voltages across the winding in the choke. This induced fluctuating voltage may be rectified and smoothed to provide high d-c voltages.

As an alternative, a cold-cathode grid-controlled thyratron is arranged so that the RC-derived voltage periodically gains control and cuts off the plate current. This would have the great advantage of requiring no filament battery supply. Unfortunately, experiments with a CK1089 tube indicated that stable oscillations could not be secured with less than about 500 milliamps input.

A blocking type of audio oscillator was also tried, using the secondary of the transformer in the plate circuit and the primary as tickler feedback in the grid circuit. The efficiency of this system was relatively low.

Another way to generate a suitable sawtooth voltage is by means of a multivibrator. A pair of vacuum tubes, resistance and capacitance intercoupled, operate in a free-running flip-flop arrangement and the voltage developed in the output circuit of one tube drives the amplifier. Subminiature tubes of low power drain are excellent.

**Neon-Controlled Oscillator**

A very simple method which provides slightly better overall efficiency than the multivibrator is to use a neon bulb supplied through a resistor from the B-battery supply and shunted by a suitable capacitor. The sawtooth is generated by the voltage rise across the capacitor and sudden drop when this voltage reaches the ionization potential of the gas.

The proper choice of iron-core choke in the plate circuit is usually found by trial and error. Commercially available interstage audio transformers are often used with primary and secondary connected in series aiding. There is a marked difference in the performance of units supplied by different manufacturers, even among units whose design characteristics for their originally intended purpose are the same.

A rectifier capable of withstanding at least 2,000 inverse peak volts is desirable. In the unit to be described, the CK1013AX cold-cathode gas rectifier is efficient and has the advantage that no filament battery is needed. Voltage is supplied to the starter electrode through a 10-megohm resistor.

Where voltages over a wide range are required, a convenient control is to use a series variable resistor in the screen grid circuit of the output tube. In this way, variable voltages can be obtained at maximum efficiency.

A number of experimental circuits employing a neon-controlled oscillator operating at audio frequencies and driving a 1U4 or 1T5 were tried. For obtaining 1,500 volts or more, about 200 volts plate supply is required in addition to the 50 ma at 1.4 volts drawn by the filament. At 1,500 volts, an overall power transformation efficiency of 22 to 23 percent is normal.

![FIG. 2—Effect of battery aging on output voltage for two settings of output adjustment](image)
lower output voltages, the filament power drain is a larger factor and consequently the overall efficiency is less.

900-Volt Power Supply

Figure 1 is the circuit used for a 900-volt supply and on which the performance curves of Fig. 2 and 3 are plotted. In this case, the objective was a single-control constant-voltage supply that could be compared for cost and weight with three 300-volt batteries. The control is necessary in order to adjust for the slow drop in voltage over the useful life of the two midget 674-volt plate and neon supply batteries.

The frequency is determined by the time constant of the RC combination in the neon supply circuit, by the particular characteristics of the plate-circuit choke, and to a lesser extent by the supply voltage. The choke is a UTC 0-5 hearing-aid transformer with primary and secondary connected in series. The NE-2 neon bulb may be replaced by a NE-51, which is a based type of identical characteristics. In operation, the neon bulb glows sufficiently to act as a pilot light. Its characteristics do not appear to change with use. A half dozen NE-2 and a couple of NE-51 bulbs have been tried in the circuit with inappreciable differences in response.

In order to keep the battery drain over its useful life at about 1.1 mA or less, the output voltage control was placed in the plate circuit and the values of the screen dropping resistor and by-pass capacitor were adjusted until satisfactory operation was secured. The effect of battery aging on the output voltage at two settings of the variable resistor is plotted in Fig. 2. The introduction of resistance in the plate circuit decreases the efficiency of the circuit when a new battery is inserted. As the batteries age, the setting is advanced and the efficiency increases, permitting operation at 900 volts output over a fairly wide range in battery voltage. The overall power transformation efficiency at the 900-volt operating point when the batteries are new is 13.2 percent. For expended batteries (decreased to 97 volts), the overall efficiency is 17.0 percent.

Fig. 3A shows the output voltage regulation as a function of the external load, as would be produced by a G-M tube operating at high counting rates. This would be considered adequate for a G-M tube having a normal flat-plateau characteristic. If the G-M tube does not have a flat plateau, the voltage is returned to the proper operating potential by adjusting the resistance in the plate circuit. Such re-adjustment would be necessary only at counting rates of several hundred thousand counts per minute.

Battery-Aging Effects

The effect of changing filament voltage on output voltage is given in Fig. 3B. The data recorded was taken at 135 volts battery supply. At 105 volts battery supply, the curve is similar with very little change in output voltage as the filament battery decays from 1.5 to 0.8 volt.

A 0.01-uf capacitor was selected for convenient physical size and low cost as output smoothing capacitor. With the circuit delivering 900 volts the ripple is 0.3 volt.

The weight of all the components of Fig. 1 including batteries is 2.1 lb. Three 300-volt batteries weigh 2.8 lb. The two 674-volt batteries in the circuit may be used as low-current plate supply in associated amplifier circuits fed from the G-M tube. With a 900-volt battery pack, an additional low-voltage battery is required for the pulse-amplifying and recording circuits, adding another 0.7 lb to the weight of the battery pack system. The total cost of components is very nearly the same as the cost of a 900-volt battery pack. On the other hand, the battery replacement cost for the neon-oscillator circuit is about one quarter of the total replacement cost for the battery pack system.

Available literature on 674-volt midget battery characteristics indicates that the circuit of Fig. 1 should operate 300 hours at 6 hours per day intermittent use before the batteries must be replaced. The unit was tested continuously for 126 hours at 900 volts output without failure.

The high peak voltage which appears across the plate of the output tube suggests the possibility of early tube breakdown. A circuit similar to Fig. 1, but using the miniature type 1U4 tube and higher plate and screen voltage, delivered 1,900 volts output for several hours without evidence of voltage breakdown. Nevertheless, with a d-c voltage source, three type 1U4, with plate and screen connected together and tested at grid bias sufficient to limit the current to 1 ma, broke down between 1,500 and 1,700 volts. Apparently, the tubes withstand higher instantaneous voltages than would be indicated by tests made under static conditions.

In conclusion, the author wishes to extend his grateful acknowledgment to R. P. Ghelardi for his helpful counsel and encouragement during the course of this investigation.

BIBLIOGRAPHY

J. E. Berry, A Regulated Battery Operated High Voltage Supply, Rev. Sci. Instr., 12, p 126, 1941.
Strength of signals received over power lines, telephone lines and cables in the range between 20 and 500 kc is directly indicated in db, using a fixed-gain double-superheterodyne receiver. A built-in calibration oscillator is provided.

**FIG. 1—Functional block diagram**

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The carrier-frequency voltmeter to be described was developed primarily for making measurements on power lines, telephone lines and cables in the region between 20 and 500 kc. The specifications to which the instrument performs are based on the requirements of the Pacific Gas and...
The carrier-frequency voltmeter

Electric Company. Special features were suggested by engineers of the Bell Telephone System.

The instrument is essentially a fixed-gain double-superheterodyne radio receiver covering the required frequency range. The d-c output of the final detector operates a microammeter calibrated in db. A variable attenuator, connected between the input terminals and the first grid, provides a wide range of measurable voltages. An injection oscillator, in effect a signal generator, is included to facilitate calibration.

Circuit Details

Referring to the block diagram of Fig. 1 and the complete schematic of Fig. 2, the input filter is of the bandpass variety. The attenuator consists of a wire-wound section and a carbon-resistor section, and operates in 10-db steps.

The variable-frequency oscillator beats with incoming signals in the carrier-frequency range and produces a 1,500-ke signal at the input of an adjustable-gain i-f amplifier. Temperature stabilization of the vfo is accomplished by means of a variable capacitor consisting of two fixed plates about ½ inch by 1½ inches in size and an intermediate movable plate operated by a 24-turn spiral of thermostatic bimetal. The output of the 1,500-ke amplifier combines in a second detector with that of a 1,675-ke crystal oscillator to produce a 175-ke signal which is fed to a fixed-gain i-f amplifier. Output of the 175-ke amplifier goes to a third detector. The audio output of this detector drives an a-f amplifier operating a headset used for monitoring. The d-c output of the third detector operates the indicating meter, which is a 0-200 microammeter.

The injection oscillator delivers 0.77 volt (0 db) to the input circuit of the instrument, operating at 100 ke. A switch permits the output of the injection-oscillator monitoring diode to be read on the indicating meter for calibration purposes. Adequate signal input is provided so frequency calibration of harmonic points above 100 ke on the dial can be checked from the injection oscillator.

Performance Characteristics

The carrier-frequency voltmeter will handle from 77 microvolts to 77 volts at the input, or 80 db below to 40 db above zero level (1 milliwatt into 600 ohms). Selectivity characteristics are approximately 6 db down at 1 kc off resonance, 18 db down at 3 kc off resonance and 40 db down at 7 kc off resonance.

Input impedance is 10,000 ohms in the rejection band, and approximately 20,000 ohms in the pass band.
Multichannel Radio

Developed to transmit cosmic ray and other high-altitude data, the Aerobee telemetering system combines a high degree of flexibility and package design with light weight and small volume. Uses special circuits for transmitting voltage and pressure data.

Recently publicized work in high-altitude research has been highlighted by the development of the 3,000-mile-per-hour Aerobee sounding rocket. In order to collect data for high-altitude studies, a telemetering system with a high degree of flexibility, light weight, and small volume was needed.

One purpose of the Aerobee program is to measure cosmic rays at high altitudes, using Geiger tubes as the primary end instruments. These tubes feed scaling-down and thyratron circuits, the outputs of which consists of negative pulses of short duration and random timing. The telemetering system must then transmit these pulses as faithfully as possible and record them as a function of the cosmic rays.

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Additional requirements imposed upon the system include measurements of several different pressures in the missile, and a variety of d-c voltages, both positive and negative.

The Telemetering System

The basic telemetering system now being used is of the frequency-division type, utilizing six audio subcarrier bands whose oscillators are frequency-modulated by end instruments actuated by the intelligence to be transmitted. Frequency response for the bands is approximately 60 cps and is presently limited by the response time of the recording galvanometers used.

A method of measuring higher frequency components lies in the use of a multivibrator oscillating at 50 kc, which is frequency-modulated by the signal voltage. Response of this unit is good to 10 kc. The output of this oscillator modulates the radio transmitter directly and, for recording, a 50-ke discriminator is employed, the output driving a recording-camera-type oscilloscope. Frequency and amplitude may be read from the film obtained from this method.

The subcarrier oscillators are designed to be used in any band and give a varying frequency output as a function of the input intelligence. The simplest type of oscillator, for measuring pressures, utilizes an iron-core coil whose inductance is varied by a mu-metal slug attached to a flexible diaphragm to which the varying pressure is applied. Other types of oscillators are more complex in order to measure such variables as temperature, voltage and strains, but all perform in the same manner to give a frequency-modulated audio signal.

The outputs of the oscillators are adjusted to proper level, mixed together through an isolating network, and the complex voltage is applied to the grid of a reactance tube in an f-m transmitter, giving direct frequency modulation.

The ground station equipment for recording the transmitted signal consists of an f-m receiver, a set of audio discriminators, and a multichannel recording oscillograph. The receiver detects and demodulates the transmitted signal in normal f-m fashion, and the complex audio output is applied to a set of discriminators. These filters are of the band-pass type tuned to cover the respective subcarrier bands and have substantially flat-topped response inside the band, with steep skirts at each end. Each filter output is then passed through limiter and clipper stages and is fed to a tuned audio discriminator whose output is linear with frequency. A cathode-coupled push-pull power output stage drives a string in the oscillograph for the actual photographic record. A block diagram of the ground station equipment is shown in Fig. 1. Auxiliary equipment in the ground station includes a large disc-recorder for simultaneous recording and interpolation oscillators for calibrating the audio discriminators.

FIG. 1—Block diagram of ground-station equipment which receives and records telemetered information
The Aerobee telemetering system, as supplied to the user group, is broken down into two parts: the audio case and the r-f transmitter. These units are mounted separately in the missile and are connected by a cable.

The audio case is of aluminum construction, occupies a volume of 281 cubic inches and has a maximum weight of five pounds. The use of commutation and switching of oscillators increases the amount of data which may be transmitted and a maximum of fourteen oscillators is provided for in the unit. A complete audio unit is shown in Fig. 2.

The transmitter is also of aluminum construction, has a volume of 60 cubic inches and weighs 1 1/2 lb including cover and mounting plate. Figure 3 shows a front view of the transmitter. Excitation of the missile is employed to radiate the r-f signal and is accomplished by means of an insulated spike mounted in the nose. A slug-tuned loading coil couples the spike to the transmitter through a coax cable.

Power for telemetering is supplied from the missile power supply system, consisting of 28 volts of storage battery driving a bank of dynamotors, with three allotted to telemetering. These dynamotors furnish approximately 220 volts at 60 ma, although one may give as high as 400 volts to supply the transmitter final stage. Filament supply is taken from an 8-volt tap on the main battery and is adjusted to 6 volts by a resistor.

**Audio Chassis**

Three types of audio systems have been produced to date, with different electrical requirements for each one. Figure 4 shows the block diagram of the unit used in recent tests. Provision for the separation relay and commutating switch is included in all types and may be left out if not needed for the particular application at hand.

Two basic types of subcarrier oscillators are used: the TOL-1A inductance oscillator for pressure measurements, and the TOE-1A voltage-controlled oscillator for voltage measurements, including cosmic pulses. These units are dimensioned in a multiple system of
lengths, the TOE-1A being twice as long as the TOL-1A. Since both oscillators are the same width, two TOL-1A oscillators occupy the same space as one TOE-1A and these units may be interchanged in this fashion. A total of 10 TOE-1A oscillators may be used or 8 type TOL-1A oscillators in combination with 6 TOE-1A oscillators to give 14 channels of information. The vertical mounting panel in the case is drilled and tapped in universal fashion in order to take a variety of the two oscillators. Replacement or addition of oscillators on either side of the panel is readily accomplished in a short time.

The inductance-oscillator circuit for pressure measurements utilizes a single tube, the subminiature type 6K4. The pressure gauge forms the oscillator, a change in pressure varying the spacing of a mu-metal pad with respect to the iron-core coil. The gauge is mounted remotely from the oscillator unit and the two are connected together by a three-wire cable. Band selection is accomplished by tuning to the desired frequency by means of mica capacitors connected across the gauge coil and mounted in the oscillator unit. Current drain for the oscillator is approximately 3 ma at 108 volts while filament drain is 150 ma at 6 volts. The circuit is shown in Fig. 5.

The TOE-1A voltage-controlled oscillator is a four-section phase-shift oscillator using three tubes. The resistance of one leg of the phase-shift network is supplied by a modulator tube, which has its plate resistance varied by the voltage under measurement applied to the modulator grid. A miniature triode, the 6C4, is used for the modulator; a subminiature 828A pentode is used for the oscillator stage, and a 6K4 functions as a cathode follower.

Since the cosmic-ray instrumentation output is in the form of negative pulses, the TOE-1A oscillator operates over the range from zero to —10 volts. With zero input to the modulator, the oscillator frequency is at the top end of the band. For the —10 volt condition, the frequency shifts downward to the low end of the band, giving a total change of 15 percent in frequency. Pulsing of the oscillator is straightforward and has given very good results.

In addition to the cosmic-ray pulse service, the TOE-1A has also been used to telemeter the operation of the emergency fuel cut-off receiver in the missile by measuring the limiter-grid voltage and the output thyatron grid and cathode voltages.

Modulation sensitivity is a constant percentage function for all bands, the zero to —10 range giving full bandwidth in each case. Sensitivity in cycles per volt varies from 35 cycles per volt on band 1 to 200 cycles per volt on band 6. The circuit diagram is given in Fig. 6. B+ current drain for the oscillator is 3.5 to 4 ma at 108 volts and A+ drain is 450 ma at 6 volts. Band selection is carried out by installing four mica capacitors in the phase-shift network and tuning to exact frequency with a small mica capacitor in parallel with the input capacitor of the network.

Two separate regulated B voltage supplies, with OB-2 miniature regulator tubes, are used in the audio case. These tubes are fed from separate dynamotors whose output voltage may vary over a wide range, due to load conditions or drop in primary battery voltage. All oscillators operate at a common value of 108 volts and may be interchanged from one supply to the other, with no change in calibration, and with good stability.

Provision for extra data beyond the normal six channels is accomplished in two ways: commutation, and channel switching by means of a relay. For commutation, a motor-driven cam-type switch using a maximum of four Aero snap-action switches is used to switch outputs of the oscillators at a rate of approximately four samples per second. A long cam-section gives an identifying mark for the record.

The relay switching system serves to substitute oscillators during flight and is applied in regard to booster action. Booster pressure is measured until separation, at which time the relay coil, normally energized, is de-energized by a pull-out plug on the booster. The booster pressure oscillators are turned off while another set is turned on. By
grouping outputs and switching with the 3-pole, double-throw relay normally used, any desired oscillator-time sequence may be obtained.

Output voltages from all oscillators are fed to a terminal board where each voltage is adjusted to proper level by means of individual voltage dividers. Provision is made for commutating at the same board as well as grouping of outputs for the separation relay.

Connections to the audio case are accomplished by three plugs mounted on one end of the case. The largest, a 19-pin AN connector, connects all end instruments to their oscillators. The second plug, a 10-pin AN connector, supplies all power and control circuits, while the third, a 5-pin connector, connects the r-f transmitter to the case and furnishes power and audio input to the transmitter.

The Transmitter

The f-m transmitter (Fig. 3) is a multistage unit with a reactance-modulated oscillator, a frequency-doubler stage, and a 2E26 tetrode final amplifier. Miniature tubes are used in the low-power stages, and are readily replaced in case of failure.

The low-power stages are supplied with 200 volts with a current drain of approximately 40 ma, while the B voltage for the final amplifier may be 250 to 400 volts supplied from a separate dynamotor. Current drain varies between 50 and 85 ma between the above limits. Total filament drain is 1.4 amp at 6 volts.

Deviation of the transmitter is set at ± 65 kc for 1 volt rms input to the reactance tube grid and harmonic distortion is less than 2 percent for this condition.

Tuning is accomplished by means of silver-plated slugs in all coils except the final amplifier, eliminating the need for variable capacitors. Tuning of the transmitter is conventional and straightforward. A low impedance link and coax cable couple the output to the missile nose-spike.

To facilitate rapid production of complete systems for future use, emphasis was placed on simplicity of design. The units are produced in two definite phases. In the first, the units are assembled in large numbers and held in stock for future use. Separate calibration curves are supplied with each audio unit and they are used in the final phase, the calibration of the basic units.

Results of Firings

The first round, fired in November, 1947, reached an altitude of approximately 200,000 feet. It was found necessary to cut off the rocket motor during flight since the missile drifted out of the prescribed trajectory limits. An emergency cut-off receiver in the missile, triggered from the ground, was telemetered and the record proved of value in determining the point of cutoff, as well as operation of the receiver during the critical part of flight.

The second round, fired March 5, 1948, proved even more successful. This missile attained an altitude of 78 miles and a wealth of useful cosmic-ray data was obtained from the telemetering records. Four channels of intelligence were devoted to cosmic rays, one to missile aspect, and the sixth was commutated to telemeter four rocket motor pressure functions. All channels functioned without failure and signal strength from the missile held up well during the flight despite the fact that the r-f transmitter had low voltage applied to the final amplifier stage and was giving less than 5 watts output. A portion of the record of this flight, recorded at Almagordo station some 43 miles from the firing tower, is shown in Fig. 7.

The third round, fired in April, 1948, was designed to measure the magnetic field of the earth and reached the same altitude as round number 2. Data channels were similar to those in round number 2, with magnetometer output voltages substituted for cosmic-rays. Telemetering was successful for some 326 seconds of flight.

The telemetering unit described in this article was designed by the writer using the basic Applied Physics Laboratory subminiature f-m/f-m system developed by the Telemetering Group at The Johns Hopkins University. At present, the production of the Aerobee telemetering equipment is being done by the Pacific Division of Bendix Aviation Corporation.
The early orthoacoustic phonographs depended on the driving power of the turntable motor to produce the sound. The motor turned the record, the groove of which vibrated the needle, and the needle in turn drove the diaphragm in the throat of the horn. The grooves had to be rugged and the pickup stylus large in order to produce a loud acoustic output. Under these conditions the record had to be turned at high speed to provide sufficient frequency range.

Because the industry has developed high-gain electronic amplifiers, dynamic loudspeakers and sensitive phonograph pickups to the point where they are reliable consumer goods, it is no longer necessary to use a record designed to produce sound directly. Groove deviation need be only great enough to maintain the signal sufficiently above the surface noise; the stylus tip need only be large enough to provide tracking for low-compliance low-inertia electrical pickup cartridges. The analyses of these considerations, on which the long-playing record (ELECTRONICS, p 86, Sept. 1948) was designed, were presented in a paper by Peter C. Goldmark and René Snepvangers of Columbia Broadcasting System and William S. Bachman of Columbia Records before the New York Section of the IRE in September. Here is a discussion of the highlights of the paper; it will be published in its entirety in the Proc. IRE.

Design Factors Evaluated

The public's familiarity with phonograph records makes it desirable to solve the problem of providing uninterrupted music reproduction by using records as the basic medium. A study of the playing time for classical compositions shows the average to be about 40 minutes. Thus, if a record were to accommodate 20 minutes of playing time on a side, it would accommodate most compositions. One record would then replace an album of several and therefore save the consumer money and storage space, as well as 90 percent in total weight. For these reasons, the possibility of producing a long-playing record seemed desirable.

From geometric considerations, the maximum playing time was found to be obtained if the inside recording diameter was half the outside diameter. To use a smaller inside diameter would require a higher rate of revolution (to maintain the same minimum linear velocity at the innermost groove), thus decreasing the playing time. A larger inside diameter, reducing the number of grooves, would decrease the playing time more than the permissible decrease in record speed would increase it.

With a 12-inch record, the outside recording diameter of which is 11.5 inches, the inside diameter would thus be 5.5 inches. Although at this point the design of the record might be achieved by finding the linear velocity and the tip radius of the stylus necessary to reproduce the required high frequency, it is simpler to arbitrarily decide on a turntable speed (linear velocity). As low a speed as possible is desirable, but too low a speed would create serious problems of rumble. Because so much experience has been gained with transcription equipment operating at 33 1/3 rpm, this speed was chosen. At this speed, 230 grooves per inch are necessary to provide 20 minutes of playing time; the nearest practical value is 224 grooves per inch. The peak groove displacement for 224 grooves per inch is thus 0.0009 inch and the linear velocity of the innermost groove is about 9.6 inches per second.

The wide frequency response of frequency-modulated broadcasting and of professional wire recorders suggests that improvements in the frequency range of records are also in order. To meet this requirement, a frequency range from 30 to above 10,000 cps is desirable.

Relative Performance

By way of evaluating the long-playing record having these characteristics, its performance was compared to that of conventional 78-rpm records and transcriptions. To establish an analytical basis for comparison, the condition where the radius of the reproducing stylus and the minimum radius of curvature of the recorded wave are equal was arbitrarily chosen as the limiting condition, and the corre-
A needle tip of one-mil radius, a tracking weight of about 6 grams and 224 grooves per inch characterize pressings that can contain from 30 to above 10,000 cps.

Choice of groove width and spacing of long-playing records is based on considerations of playing time of classical compositions, minimum linear velocity, tracking, maximum deviation, and cost.

The corresponding frequency termed the limiting frequency. This condition is reached when
\[ f_L = \frac{V}{2\pi(R_{eff}D)^{1/2}} \]

where \( f_L \) is the limiting frequency, \( V \) is the linear velocity, \( R_{eff} \) is the effective radius of the reproducing stylus, and \( D \) is the groove deviation. This equation shows that, if the deviation is very small, the limiting frequency can be very high.

The limiting frequencies for the three types of records are tabulated in the accompanying diagram. If the frequency is greater than the limiting value, the deviation for equal radius of needle tip and groove modulation must be made less than maximum. This consideration establishes a usable deviation as a function of frequency.

The percent usable deviation for the inside groove of the three types of records is also shown in the diagram as a function of frequency. Full deviation is 0.002 inch for 78-rpm records, 0.0011 inch for transcriptions and 0.0009 inch for L-P records; inside groove diameters are respectively 4.8 and 9.6 inches.

Another way to evaluate the records is on the basis of the amplitude-frequency content of the recorded material. The diagram shows the most probable energy distribution curve for a 75-piece orchestra as determined by Fletcher. The recording characteristic of the L-P record is also shown, together with the NAB recording characteristic for comparison. (The L-P characteristic has a slight bass lift to reduce rumble and hum level.)

The most probable recording velocity distributions can be obtained by adding ordinates (in db) of the two curves. The resultant curve shows that the most probable amplitudes lie below the maximum limits determined by the limiting frequency and usable deviation for all three types of recording. However, L-P records lie further from the required curve than the others and can be expected to have less distortion.

Phonograph Pickups

As indicated earlier, the possibility of using the L-P recording system depends on technological development of pickups that require very low driving force at their stylus and have high sensitivity. The use of Vinylite as the record base reduces the surface noise so that even with the small recorded groove deviations the signal-noise ratio is acceptable. The use of lightweight pickups further improves this ratio so that a dynamic range of 45 db with an acceptable background noise level is obtained.

The development of suitable pickups was a part of the overall program. The needle radius should be 0.001 inch plus or minus 10 percent. A downward tracking force not exceeding 6 grams is desirable. The theoretical compliance, measured at the point of the stylus, for low-frequency tracking of 78-rpm records with this low tracking force is 0.87 x 10^{-6} cm per dyne and, for L-P records, it is 0.39 x 10^{-6} cm per dyne.

Crystal cartridges producing about 0.5 volt rms at reference frequency and level can be built within these limitations. It was also found that r-f modulation pickups (like Cobra) and variable-reluctance type pickups (like GE) are also suitable for design as L-P pickups. The rapidity with which suitable pickups have been developed commercially verifies the basic assumption that the art has progressed to the point that this new approach to recording is justified.—F.H.R.
HUM REDUCTION

Intensive investigation of problem results in useful circuit design data for minimizing hum from alternating magnetic fields, electrical leakage, input circuit wiring and heater-cathode leakage current

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Sources of hum fall into two broad classifications: hum arising from causes external to the tube which act either upon the tube or upon the components of the circuit, and hum arising within the tube as a result of its characteristics. The first classification covers hum from alternating magnetic and electrostatic fields and from leakage and stray capacitances in the circuit wiring, while the second includes heater-to-cathode leakage and the action of the heater field within the tube.

The most common sources of alternating magnetic fields are transformers and chokes. There are also fields surrounding the wires carrying the heater current and the a-c primary supply, but these fields are extremely small by comparison. The intensity of the field in air at a distance of one inch from a single wire carrying one ampere is in the order of 0.08 gauss, while the stray flux from transformers may be more than a hundred times greater than this value.

The amount of stray flux for a specific transformer is determined by the design of the core and is practically constant over the normal load range. It is difficult to assign a general value to the magnitude of stray flux since it is dependent largely upon the quality of the transformer. However, the order of magnitude for average-quality transformers is 5 to 10 gauss at a distance of two inches from the core in the active portion of the flux pattern.

Figure 1 shows the flux pattern for a transformer with E-type core laminations. This pattern is quite similar to that of an air-core coil, except for modification due to the iron core of the transformer. The pattern is represented as if the transformer were suspended in air. The presence of a chassis of magnetic material will have little effect upon the portion of the field which is two inches or more above the chassis, but the field in the region of the chassis will be extended due to the lower reluctance path. Some advantage may be gained in this respect by the use of vertical-mounting transformers in preference to the half-shell types of construction.

The flux concentration point at which the major portion of the flux leaves and enters the core is located at the ends of the core segment on which the winding is made. This point is further from the chassis in the vertical-mounting transformers, thus reducing the extension of the field. The directional properties of the stray flux are also more favorable in transformers of the vertical-mounting type than in transformers of the half-shell type regardless of the material used in the chassis.

Hum in Receivers

An alternating magnetic field was applied to each tube of three different receivers, which ranged from communications types to commercial five-tube table models and

FIG. 1—Stray flux pattern for transformer with E-type core laminations

FIG. 2—Tube with concentric type construction

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Common Sources of Hum and Their Solutions

<table>
<thead>
<tr>
<th>Cause of Hum</th>
<th>Maximum Hum Level at Grid</th>
<th>Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modulation of plate current</td>
<td></td>
<td>Proper orientation of tube with respect to power transformer</td>
</tr>
<tr>
<td>by stray flux from power transformer</td>
<td></td>
<td>Selection of proper size plate load resistance. (See text)</td>
</tr>
<tr>
<td>Glass pentode</td>
<td>2.00 mV</td>
<td>Use of double-ended tube. Adjusting ground position on secondary of filament transformer</td>
</tr>
<tr>
<td>Glass triode</td>
<td>0.30 mV</td>
<td>Adequate bypassing of cathode for power frequency. Use of low cathode impedances</td>
</tr>
<tr>
<td>Metal pentode</td>
<td>0.10 mV</td>
<td></td>
</tr>
<tr>
<td>Metal triode</td>
<td>0.02 mV</td>
<td></td>
</tr>
<tr>
<td>Heater-to-grid leakage across socket</td>
<td>10 to 15 μV for each grid resistance and each volt rms of heater above ground</td>
<td></td>
</tr>
<tr>
<td>Leakage or induced voltages in closed loops of the input circuit</td>
<td>Up to 75 μV</td>
<td></td>
</tr>
<tr>
<td>Heater-cathode leakage</td>
<td>Currents of 0.04 to 1.8 microampere</td>
<td></td>
</tr>
</tbody>
</table>

included both f-m and a-m reception. The antenna was disconnected and the gain control advanced all the way. The field intensity was then increased until the hum level became audible above the noise. This was repeated individually for each tube in the set.

It was found that in most cases a field of 50 gauss rms would produce audible hum when applied to the r-f amplifier, converter, i-f amplifiers, or the first audio stage. The power-output stage, and the detector or discriminator stage in circuits employing separate tubes for detector and first audio were not affected by fields as high as 150 gauss rms.

Since it has been shown that a representative figure for escape flux from a power transformer is 5 to 10 gauss, it would seem that the tube itself offers no particular problem as to hum. In many cases this may be true. However, the value of 5 to 10 gauss was given for a distance of two inches from the core of the transformer, and the field intensity increases inversely as the square of the distance from the transformer. The fields in the immediate vicinity of the transformer are therefore quite high, and placement of critical tubes in this region should be avoided.

In addition, the final measurements in the test outlined were made aurally, and the hum components, both 60 and 120 cycles, were less audible than the higher-frequency noise which was used as a reference. In the fields of audio work this is a legitimate criterion, but in measurement and control equipment the hum must be considered on the basis of its rms value.

A considerable amount of data has been taken on several different tube types under varying field intensities and circuit conditions. A few representative figures may be quoted for general guidance. An arbitrary unit (microvolts-per-gauss referred to the grid) has been selected since it takes into account the gain of the tube under test as well as the strength of the field, and in addition is more easily referred to the signal level at which the tube is expected to operate.

The hum level of the pentode-type amplifier does not increase linearly with an increase of field intensity, but varies at a rate somewhere between the first and second power of the field intensity, depending upon the reference level of the magnetic field. Thus, for glass-type pentodes, a hum level of about 250 microvolts-per-gauss (referred to the grid) may be expected at field intensities of around 45 gauss, while at 5 gauss the figure drops to around 20 microvolts-per-gauss. Values for comparable metal-type pentodes are in the order of 5 microvolts-per-gauss and increase only slightly between 5 and 45 gauss due to shielding effect of the metal envelope. Triode types show hum levels of around 30 microvolts-per-gauss at 45 gauss, and 7 microvolts-per-gauss at 5 gauss.

The orientation of the tube elements in a magnetic field determines largely the influence that the field will have upon the output of the tube. A tube of concentric-type construction is shown in a cutaway view in Fig. 2. A major portion of the electron stream can be considered bidirectional along a line which is perpendicular to the plane of the grid side rod supports at the cathode. The magnetic field will deflect the electron stream a maximum when the flux is perpendicular to the path of the electrons. These maximums occur when the flux vector is coaxial to the tube, or when perpendicular to the tube axis and in the plane of the grid side rods. As a general rule, metal tubes and glass tubes which have nonmagnetic side rods show a maximum in the direction normal to the tube axis, while those with magnetic side rods have a maximum in the axial direction, the difference between the two conditions being in the order of 6 to 10 decibels in voltage. Example: Axial Flux Hum Normal Flux Hum Voltage at Voltage at Plate of Tube Plate of Tube 6S7GT 1.5 0.5 6S7 0.02 0.04

The minimum hum condition for all types occurs when the flux vector is perpendicular to the tube axis and normal to the plane of the grid side rods. The minimum is down 30 to 40 decibels from the maximum in glass types and 10 to 20 decibels in metal types, the difference arising from the distortion of the field in the metal type which prevents a sharp minimum.

Since the minimum occurs only

![FIG. 3—Equivalent circuit for a tube operating in a magnetic field with no signal on the grid](image-url)
when the flux is directed perpendicular to the tube axis, rotation of the tube socket is not effective in removing hum when the flux vector is parallel to the tube axis. It is possible to rate a transformer on the basis of the direction of stray flux vectors in the area adjacent to the transformer, normally occupied by tubes. In this respect the vertical-mounting transformer is superior to the half-shell type, since more of its flux is perpendicular to the usual tube mounting axis in the space occupied by the tube elements.

If a tube is operated in an alternating magnetic field, the hum output is a function of the strength of the field, the constants and voltages of the circuit, and the characteristics of the tube. Consider a tube operating in a magnetic field without a signal on the grid. The equivalent circuit is shown in Fig. 3. The effect of the field upon the tube may be considered as a change in the static plate resistance of the tube. The sign is shown as positive since only in comparatively rare tube designs is the static plate resistance decreased by application of the magnetic field. In this circuit: $R_e = $ load resistance, $R_s = $ static plate resistance, $\Delta R_s = $ change in static plate resistance at peak flux, $E_s = $ d-c plate supply voltage, $E_{se} = $ static plate voltage, $E_{se} = $ peak-to-peak hum output voltage and $I_s = $ static plate current.

Let the subscript 1 refer to normal operation (that is, operation in the absence of a magnetic field) and subscript 2 refer to operation at peak flux value. Then:

$$E_{se} = (I_{s2} - I_{s1})R_l$$  \hspace{1cm} (1)

$$I_{s1} = \frac{E_{bb}}{R_L + R_b}$$  \hspace{1cm} (2)

$$I_{s2} = \frac{E_{bb}}{R_L + R_b + \Delta R_b}$$  \hspace{1cm} (3)

Substituting Eq. 2 and 3 in Eq 1

$$E_{se} = \left( \frac{E_{bb}}{R_L + R_b} - \frac{E_{bb}}{R_L + R_b + \Delta R_b} \right)R_L$$  \hspace{1cm} (4)

$$E_{se} = \frac{E_{bb} R_{L} \Delta R_b}{(R_L + R_b)(R_L + R_b + \Delta R_b)}$$  \hspace{1cm} (5)

$$E_{s1} = \frac{E_{bb} R_b}{R_L + R_b}$$  \hspace{1cm} (6)

$$\Delta R_b = K R_b$$  \hspace{1cm} (7)

where $K$ is a function of static plate voltage and flux density.

Substituting Eq. 6 and 7 in Eq 5

$$E_{se} = \frac{KE_{bb} R_b}{R_L + R_b + KR_b}$$  \hspace{1cm} (8)

$$K R_b < < (R_b + R_L)$$  \hspace{1cm} (9)

Eq 8 may be written

$$E_{se} = K \left( \frac{E_{bb} R_b}{R_L + R_b} \right)$$  \hspace{1cm} (10)

Experiment has indicated that $K$ is a function of $1/E_b$ within the normal limits of $E_b$, encountered in a resistance-coupled amplifier. If the peak value of flux remains constant, for a specific tube:

$$KE_b = \text{a constant}$$  \hspace{1cm} (11)

Then

$$E_{se} = \frac{R_b}{(R_b + R_L)} \times \text{a constant}$$  \hspace{1cm} (12)

If the tube is a triode, the static plate resistance $R_s$ is fairly constant for different values of $R_s$, and in addition $R_s$ is usually much larger than $R_e$. Equation 12 indicates that if this is the case, $E_{se}$ is reasonably independent of the circuit values.

In the case of a pentode, $R_s$ decreases with an increase of $R_L$ and since $R_s$ and $R_e$ are of the same order of magnitude:

$$E_{se} = \text{a function of} \quad \frac{R_e}{(R_L + R_b)} \times \text{a constant}$$  \hspace{1cm} (13)

It will be noted that this expression for hum output voltage is quite similar to the familiar formula for output signal voltage:

$$E_s = \frac{\mu E_b I_s}{R_s + R_e}$$  \hspace{1cm} (14)

in which case $\gamma E_s$ represents the constant. The major difference is that $R_s$ in the hum formula is static plate resistance, $E_s/I_s$, while $R_s$ in the signal-voltage formula is dynamic plate resistance.

It has been shown that in the usual application for triodes ($R_L \gg R_s$ or $R_b$) the output hum level is relatively independent of the plate load resistance, as is also the gain. Hence, for triodes, the hum level referred to the grid is constant for a given value of flux.

In pentodes, $R_s$ varies inversely with $R_L$, and $R_s$ remains practically constant over the flat portion of the plate characteristics. Thus, if $R_s$ is increased, assuming $R_L$ and $R_{eb}$ of like magnitude, the gain in—

![FIG. 4—Variation of hum with gain in a typical pentode amplifier](image)

Input circuits for single and double-conductor shielded input cable. Reduced hum is achieved with double-conductor cable.
creases by an amount less than the increase in $R_{in}$, but the hum output increases directly as $R_{in}$. The hum level referred to the grid of a pentode increases, therefore, with an increase of the plate load resistance as demonstrated in Fig. 4.

The output from metal types was approximately 40 decibels down in voltage from that of glass types. The placement of a close-fitting iron shield over the glass tube reduces its hum to within 2 or 3 decibels of the metal type.

The wave form of hum output for the metal type is for the most part fundamental, with a small amount of second harmonic, while for the glass type it is second harmonic with varying amounts of higher-order even harmonics. This represents an advantage for the metal type when viewed from an audibility standpoint, since a 120-cycle note is much more readily heard than a 60-cycle note. A 60-cycle note, to sound as loud as a 120-cycle note, must be much more readily heard than a 60-cycle note.

Electrical Leakage

The leakage impedance between socket pins contributes hum to stages with a-c heaters to a degree dependent upon grid-circuit impedance, pin placement, socket material and heater-to-grid capacitance. Consider a voltage divider made up of the leakage impedance from heater to grid pin ($Z_{teatey}$) and the impedance from the grid to ground ($Z_{vrid}$). The voltage which appears across this divider is determined by the wiring of the heaters, and the portion of this voltage which appears at the grid is determined by the ratio of grid-circuit impedance to leakage impedance. Since normal $Z_{vrid}$ is much smaller than $Z_{teatey}$, the voltage at the grid is almost directly a function of the grid-circuit impedance and inversely a function of the leakage impedance.

Isolantite-type sockets have the highest leakage impedance, which is almost entirely capacitive reactance. Next best are polystyrene, mica-filled Bakelite and black Bakelite, in that order, with varying amounts of resistive components. Since the leakage impedance is predominantly capacitive even in the worst sockets, the elimination of harmonics in the heater supply is of great importance. The leakage impedance decreases for the higher-order harmonics. In addition, the gain of the stage is usually greater. Thus a sine-wave heater voltage appears as a sine-wave output at the plate, but a complex wave at the heater is reproduced with greater harmonic content at the plate. Representative values of hum to be expected from this source are 10 to 15 microvolts at the grid for each volt of heater potential above ground with a 1-megohm grid impedance.

When one pin of the heater is grounded there is a single source of leakage voltage, which arrives at the grid leading the heater voltage by 90 degrees. When the heater is above ground in a series string, the leakage from both pins arrives in phase at the grid. However, if the heater is operated from the secondary of a power transformer with the center-tap grounded, the leakage from the two pins arrives at the grid out-of-phase, but with different magnitudes. This partial bucking effect may be utilized completely by grounding the heaters through the center tap of a potentiometer with the outside arms connected to the heater supply, and then adjusting the ground tap for cancellation of the two leakage voltages.

Double-ended tubes such as the 6J7 offer a distinct advantage in the problems of hum from leakage since their grid connections are well removed from the heaters. As an example, the 6J7 has one-tenth the hum of the 6SJ7 in this respect.

Input-Circuit Wiring

Careful attention to the wiring of input circuits will frequently reduce the hum of low-level amplifiers. Figure 5 shows the equivalent circuits for single and double-conductor shielded input cable. Units $C_1$ and $C_2$ are leakage capacitances to the a-c line in the amplifier and in the auxiliary equipment. For the single-conductor cable a closed circuit is made which has a portion of the grid-return lead in the loop. This closed circuit may act either as an electrical-leakage path or as a magnetic loop, depending largely upon the line connections and the size of the leakage capacitances.

The resistivity of ordinary shield braid over a single conductor is roughly 0.003 ohm per foot. Capacitors $C_1$ and $C_2$ then must be rather large to produce an appreciable voltage drop along the shield. However, in the case of a grounded line, $C_1$ becomes a direct connection and $C_2$ may be as high as 0.1 microfarad due to the line-isolation capacitors in certain types of equipment. With a grounded 115-volt line, 0.1-microfarad leakage will produce 50 microvolts across three feet of shield.

Frequently the leakage path of
$C_1$ and $C_2$ is shorted out by a ground strap between the two chassis or some other direct connection. In this case the closed circuit acts as a magnetic loop subject to the stray flux of the equipment. Hum levels as high as 75 microvolts at the grid have been encountered in tests from this source.

The use of two-conductor shielded cable as shown isolates the input circuit from any closed loop which the shield may make with auxiliary equipment, and thereby prevents a voltage drop which may appear along the shield from being reflected through the pickup impedance to the grid. This principle can also be applied to the use of ground straps.

The careful elimination of all closed loops in the grounding connections will frequently reduce the hum level of the equipment. Ground connections inside the chassis follow the same pattern, so that the cathode-grounding point and the ground end of the grid circuit should always be connected at the same point on the chassis and should be independent of other circuits, except at the chassis point.

**Sources Within the Tube**

The heater is the only tube element intentionally carrying alternating current at the power frequency. The heater for indirectly-heated-cathode types is coated with a ceramic-like material to insulate it from the cathode sleeve which encloses it. Of several possible ways for alternating current exciting the heater to act upon the other elements and cause hum, the most important and probably the only one that causes noticeable hum in receiving tubes is leakage current between heater and cathode. Modulation of the plate current by the alternating field of the heater is negligible in modern receiving tubes.

Extensive work is being done to establish the nature of heater-cathode leakage current but the information is not yet complete. It may be stated that the current is due mainly to a combination of three phenomena: capacitive coupling between heater and cathode, direct (more or less resistive) leakage between them and emission from the cathode and the heater. Three frequently occurring waveforms of heater-cathode leakage current are shown in Fig. 6 and these indicate that this current is rich in harmonic content.

If the cathode is grounded, current will not affect operation. The same holds for an adequately bypassed-cathode-resistance condition. However, there are numerous cases such as cathode followers, phase inverters, and detectors where the heater-cathode leakage current will cause a voltage drop across the cathode resistance if the heater is returned to ground. To present satisfactory design data it is necessary to consider this current.

The heater-cathode impedance is so large when compared with the normally used cathode resistance that the current source may be considered as a constant-current generator. In tubes which are manufactured with an aim to minimizing heater-cathode leakage current, current of 0.04 microampere is common where the heater voltage is 6.3 volts rms and where the cathode is returned to one end of the heater through a resistance. In some types such as output tubes, where hum requirements are less severe, this current may be as high as 1.0 microampere. Fortunately the degenerative action of an unbypassed cathode resistance tends to lessen the effect of the leakage current.

A frequently used circuit in f-m sets is the ratio detector. The schematic circuit is given in Fig. 7. The ground is connected either at point X or at point Y. The former is called a balanced ratio detector. The hum due to heater-cathode leakage current is 3 or 4 times greater with a balanced circuit than with the unbalanced circuit obtained when point Y is grounded. The hum increases, of course, with increased resistance values. Also, the larger the resistances, the greater the difference between the balanced and the unbalanced circuit. This is due to the loading effect of the diodes.

The increased use of the higher-frequency television and f-m bands has presented an unusual problem of hum arising in the local oscillator. Figure 8 shows a circuit diagram of a typical high-frequency local oscillator. The a-c heater supply causes the heater-to-cathode capacitance, $C_{hx}$, to vary at the power frequency. This arises from either thermal variations of the heater insulation or from mechanical vibration of the heater, possibly from a combination of the two.

Since the heater-to-cathode capacitance appears in series with the grid-to-cathode capacitance, $C_{hx}$, across a portion of the grid tank, any repeating variation of $C_{hx}$ will cause the oscillator frequency to vary. At the higher frequencies the capacitance in the grid tank is extremely small so that a small change of $C_{hx}$ will vary the oscillator frequency enough to produce an f-m signal in the i-f strip. It has been estimated that a heater-cathode capacitance change of one part in two million in television channel 13 will produce audible hum at the loudspeaker.

Figures 9 and 10 show two methods for minimizing hum from this source. In Fig. 9 the heater and cathode of the oscillator tube are operated at the same r-f potential. This method has proved satisfactory up to 200 mc. The tuned-grid tuned-plate circuit of Fig. 10 enables the cathode to be operated at ground potential.
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Melting-Point Chart

Metals, alloys and ceramics commonly used in electron tubes are covered. Critical temperatures are given in degrees Fahrenheit and centigrade.

By K. H. McPhee

Research Division, Vacuum Tube Laboratory
Collins Radio Company, Cedar Rapids, Iowa

The melting point chart is a thermometer-type graph upon which are placed the melting points of metals, alloys and ceramics most commonly used in electron tubes.

A linear scale representing degrees F is located on the left side of the central thermometer. A linear scale representing degrees C is located on the right side of the thermometer. Any line drawn through the thermometer, normal to its length, designates a C reading and the F equivalent. Above 2,000 C, the scale is condensed.

Pure metals are shown opposite their respective melting points on the right side of the thermometer. Ceramic materials and metal alloys are similarly shown on the left.

The melting temperature shown for ceramic bodies is that temperature above which no crystalline phase normally exists. No attempt has been made to indicate their progressive softening characteristics.

Uses

When a specific material is being considered for use because of desirable electrical, chemical or other properties, the melting point is easily obtained. Conversely, where the temperature range within which materials must work is known suitable ones can be quickly selected.

Fabrication techniques may employ soldering, brazing, or welding, and the most suitable method for a particular material is frequently determined from the chart. Similarly, where sequential heating operations are planned it is useful.

The chart also facilitates rapid conversion between F and C scales.
The Mallory Inductuner* tunes in the telecast clearly and keeps it in line

Frequency drift—which in television means a gradual blur and weakening of the picture, and results in irritated calls for the service man—is one of the problems that Mallory recognized in the early days of television.

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*Registered trademark of P. R. Mallory & Co., Inc. for Inductance tuning devices covered by Mallory-Ware patents.
Inside base of an antenna switching tower showing one of six stacked switching arms. The remotely controlled motor is mounted in the large box in the center.

**British Valves at Work**

*McGraw-Hill World News*

*With a frequency accuracy of one part in a million and occasional effective radiated power output of 1,500 kw from six transmitters, the BBC transmitting station at Skelton, England, incorporates many ingenious and effective methods for band and antenna switching. The station operates on the short-wave bands and it was constructed specifically for the purpose of transmitting to European countries, Latin America and certain parts of the Pacific.*

*These transmissions are radiated in some thirty-six languages, and the service continues through day and night, changing frequencies and directions as demanded by conditions of propagation and location of areas to be served. The station was built during the war and designed to ensure reliable transmissions despite enemy jamming efforts.*

*In all, there are 51 antenna arrays strung between 31 masts ranging in height from 200 to 350 feet. The remote antenna switching system is perhaps the most interesting feature of the station. Any one of the six transmitters may be connected between a certain number of arrays, thus enabling the output of a transmitter to be beamed to any part of the world.*

*A picture of one of the giant multipole switches is shown. These towers are forty feet high and built in six levels, each being connected to a certain transmitter. The switching arm is controlled by an electric motor. The antenna arrays are in the form of stacked horizontal arrays.*

*The master oscillators are not crystal controlled, but excellent stability is possible through the use of double temperature control where the temperature inside the frequency determining unit is controlled and the temperature of the room housing the unit is also constant. The oscillators operate at comparatively low frequencies and the frequency is multiplied in harmonic generators with a switching arrangement for optimum flexibility.*

*Another ingenious design feature is the mounting of tuned circuits on trucks. These units are wheeled into the rear of the transmitter cabinet, and contact is made by spring-loaded copper blades of generous area.*

*The audio driver delivers 1,200 watts to the class B modulators and each of the latter can dissipate up to 75 kilowatts on its anode. Each tube takes 2.5 amperes of grid current on drive peaks. The modulation transformer carries up to 20...*
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IS ON YOUR STAFF...
but not on your payroll

. . . HE OFFERS A FULL LINE OF NATIONALLY
KNOWN INSULATING MATERIALS

The IMC Engineer offers two services to help you solve electrical assembly problems:

1. A complete line of nationally advertised insulating materials.
2. Expert advice and engineering service on the best application of these materials.


Whatever your insulation problem, call in your nearby IMC Engineer. He is trained in the application of electrical insulation, and can usually suggest an answer from his experience and the complete line of products he represents. Every one of these products is superior in quality and designed for full satisfaction in application and service.

INSULATION MANUFACTURERS CORPORATION

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MILWAUKEE 2
312 East Wisconsin Avenue

*CLEVELAND 14
1231 Superior Ave., N. E.
DAYTON 2
1315 Mutual Home Building

*Local Stocks Available
Representatives in:
MINNEAPOLIS 3 1208 Harmon Place
*World Radio History
DESIGNS as intricately curved as that at the right can be produced in a single operation with the Air Reduction Sales Co. photoelectric cutting machine shown below and on the front cover.

A silhouette or outline drawing of the desired shape is placed on the table at the left in the photo, under the photoelectric tracing head. An optical unit in the head projects a small spot of light downward on the pattern, and phototubes responding to the reflected light drive a steering motor that keeps the spot positioned half on the black line and half on the white paper while traveling around the pattern at the desired cutting speed. The oxyacetylene cutting torches on the other end of the pantograph bar cut the desired pattern from the sheet of boiler plate or other material under the torches.

The number of torches used can be varied at will. Three are shown in use, cutting out large washers, while four are in operation on the front-cover setup for cutting paper-mill pulp beaters from 4-inch low-carbon plate 4 ft wide and 8 ft long.

There are no limitations to the variety of designs that may be cut with electronically controlled tracing equipment. Cutting accuracy is greater than with manually guided or automatic mechanical tracing spindles, and the low cost of paper patterns permits economical operation even on orders for single pieces. Paper patterns are easily stored, in contrast to storage problems for the carefully machined metal templates otherwise needed.

The electronic tracing device contains two phototubes, an amplifier tube, a lamp, associated circuit components and optical lenses, and three motors that control movement of the head—the steering motor, the tracer driving motor and a motor that raises or lowers the head in response to a manually operated switch. The tracing wheel controls the direction of movement of the head, but does not track over the outline of the template except where it may intersect the outline.

Changing tubes is a touchy proposition when those involved cost about $5,000. Tubes are wheeled into position and lowered slowly into their sockets by truck mechanism.

Amperes peak current in the primary at a peak voltage of over 7,000. The modulation choke has an inductance of about 13 henrys at 14 amperes.

The final stage is a class C push-pull stage using two water-cooled tubes in a balanced bridge circuit. The filaments of these tubes carry 460 amperes at 32 volts, and their anodes are capable of dissipating 150 kw with voltages around 20,000. The tubes are 3 ft 6 in. high, and they are wheeled in and out of the transmitter on special trolleys for safety in handling and ease of replacement.

Each transmitter is controlled from a small metal desk where the engineer may fire up his transmitter from a cold start and keep constant check on its efficient operation. Complete monitoring equipment is, of course, provided.

Power for the station is obtained from the Electricity Authority at 11 kv, 3-phase, 50 cps. Also, three 500-kw diesel-engine-driven alternators are available for emergency operation.

For some 22 hours a day, a radiated power of 1,500 kw is sent out to Europe and Asia, while from other beam networks services are transmitted to North America, Central and South America at night, and to the Fleet in the Pacific. The longest circuit on which direct transmission is achieved with ex-
For the finest sound, just pick from this line...

**Western Electric**

- **757A** — Dual unit system, 30 watts, 60-15,000 cycles.
- **7288** — 12" direct radiator, 30 watts, 60-10,000 cycles.
- **7544** — 12" direct radiator, extra high efficiency, 15 watts, 60-10,000 cycles.
- **7548** — 12" direct radiator, for outdoor use, 50 watts, 60-10,000 cycles.
- **755A** — 8" direct radiator, 8 watts, 70-10,000 cycles.
- **755B** — 10" direct radiator, 20 watts, 65-10,000 cycles.

★ NO MATTER what your loudspeaker needs may be, one of these five Western Electric types will fit like a glove!

If you're looking for superlative reproduction, you can't beat the dual unit 757A, with its unequaled combination of efficiency, frequency response and power capacity.

If you want the finest in direct radiators, you'll get just that in any one of the four Western Electric types — simply pick the power you need.

All types are available for immediate delivery.

Call your nearest Graybar Representative or write to Graybar Electric Company, 420 Lexington Ave., New York 17, N. Y.

**Western Electric**

— QUALITY COUNTS —

THE ELECTRON ART

Edited by FRANK ROCKETT

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Tube Maps Magnetic Fields

Paths of magnetic lines of flux can be traced with a mercury vapor diode having a perforated tantalum (or other nonmagnetic) anode and a coaxial cathode. With an anode potential of 10 to 15 volts (approximately the ionization potential of the mercury) and a cathode current of about 10 ma (although operation is satisfactory over a wide current range), the electrons are focused into tight helical beams whose axes follow the magnetic flux paths even in fields as weak as 0.01 weber per square meter. Ionization of the vapor along the paths makes them visible.

The action of the tube, which is being studied by S. J. Tetenbaum under the direction of Prof. S. G. Lutz at New York University, can be seen from Fig. 1. Electrons from the cathode are accelerated toward the anode. Because of the magnetic field, only those electrons whose initial trajectories are nearly tangential to the magnetic flux continue undeflected through the perforations in the anode. The low radial velocities of these electrons enables the magnetic field to confine them to tight helical beams whose axes follow the magnetic flux paths quite accurately. The only cumulative distortion is a slight drift in the direction of the curvature axis of the field; it is minimized by the low electron velocity.

FIG. 1—Gas diode shows magnetic lines in flux; diameters of electron beams are least in regions of highest flux

Radome Design Limitations

Housings for aircraft radar and radio antennas are often made of low-pressure molded plastic. The two conflicting requirements for the contours of these laminated structures, that they do not interfere (1) with the airfoil design of the airplane or (2) with the focusing of the radar beam, make their design and fabrication difficult. As pointed out by F. H. Behrens of the Air Material Command before a seminar of The Society of The Plastics Industry in June at Washington, D. C., the services and industries working on these problems have developed means for reconciling them to some extent.

Classification of Radomes

Radomes can be classified into types according to the constructional means used to minimize distortion of the radar beam. The radome absorbs appreciable power from the radiated field and also distorts it by reflection, refraction and diffraction. The radome may reflect sufficient energy back into the antenna to cause signal instability. At most radio frequencies the antenna housing is sufficiently thin compared to a wavelength to cause no distortion. However, at microwaves the thickness of the radome is comparable to a wavelength so that reflected and refracted energy from the inner and outer surfaces are not in a phase relation to produce cancellation.

There are four principal wall constructions in use: (1) thin wall, (2) thick wall, (3) double wall, and (4) sandwich. The sandwich construction is the most extensively used.

Thin walled construction is used

The tube can be used to delineate leakages about magnetic structures or as a means of visually demonstrating the patterns of magnetic fields. By successively exposing a photographic film in a darkened room as the tube is moved about a magnet, the field can be mapped, as in Fig. 2. A paper describing this tube in greater detail was presented at the National Electronics Conference, Nov. 1948.

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In January, 1946, at the I. R. E. National Convention in New York City, a preliminary engineering model of the type 202-A FM-AM Signal Generator was displayed for the first time. Many well known FM and television engineers, invited to comment frankly on performance specifications, suggested refinements and features which they believed would be most desirable in the finished design. Utilizing this valuable information, Boonton Radio Corporation's engineers worked another full year before they were ready to place their approval on the final design—the type 202-B FM-AM Signal Generator. The advantages of this essential instrument were recognized immediately. Since its enthusiastic reception, the 202-B has increased in popularity and today it is generally accepted as the acknowledged standard of FM-AM signal generator performance. Practically every well known radio manufacturing concern is now placing increasing numbers of this versatile instrument in full time use, assisting their engineers and research staffs to design and produce better, lower cost radio and television receiving equipment.

If you have an FM or television instrument requirement, let us acquaint you with full particulars and technical data concerning the Type 202-B FM-AM Signal Generator. Write for Catalog F.
The double walled radome consists of two thin walls, one within the other, and accurately spaced to neutralize reflections by ribs that also increase its strength. Because of the poor strength and diffraction around the ribs, this type is little used.

The sandwich construction consists of two thin walls, one within the other as in the double walled type, but spaced and fully stabilized by a low density core material bonded between the thin skins. This arrangement neutralizes reflections and provides tremendous strength with low weight.

Streamlining and Transmission

Unless the radome is sufficiently streamlined it produces intolerable drag on a modern aircraft. Unless it presents sufficient undistorted transmission to the radar beam, the radome limits the accuracy of the radar equipment. Thus streamlining is limited by the critical angle of incidence at which the radar waves will pass through the wall. The relative orientation of the rays and the sloping surface of the radome establish this angle. The upper limiting angle of incidence is a function of the dielectric properties of the material used for the radome and of the wall configuration to which it is designed. In general, the lower the dielectric constant and the loss factor, the greater the freedom in streamlining.

A detailed study can be conducted to good accuracy to determine the angles of incidence and polarizing directions throughout the radome, thereby providing design data for grading the wall thickness. By this means an efficient, streamlined radome can be designed, but its final performance depends on the tolerance to which it can be molded.

Fabrication Limitations

Fabrication of radomes is beset by many problems and several improvements are necessary such as: (1) harder finishes that are less subject to erosion by rain, (2) close control of outline, thickness and uniformity of material, (3) elimination of lap joints in window areas of critical types of radomes, (4) fabrication of controlled graded thicknesses, and (5) elimination of hand tailoring of the core in various types of sandwich radomes.

The properties of laminated resins used for radomes need improvement also so that they will bond more strongly to glass fiber, withstand elevated temperature, have greater mechanical strength, lower dielectric constant and loss factor, and be sufficiently viscous so that voids will not form between laminations. Most current development is directed to improving sandwich domes. Voids are avoided by premolding skins which are then accurately supported during sandwich fabrication by molds. The core is introduced by heating a prepared foaming batter.

In conclusion, the speaker stated that the future of airborne radar depends to a great extent on satisfactory solution of these problems. (Ed. Note: see also Part II of "Radar Scanners and Radomes" by W. M. Cady, M. B. Karelitz, and L. A. Turner, vol 26, MIT Radiation Lab. Series, McGraw-Hill, 1948.)

Series Overmodulation

By ROBERT E. BAIRD
Chief Engineer, KWSC
Pullman, Wash.

Amplitude modulation in excess of 100 percent can be produced with a series modulator without creating sideband splatter. Several methods have been described for accomplishing such overmodulation (for example: Overmodulation Without Sideband Splatter, O. G. Villard, Jr., ELECTRONICS, p 90, Jan. 1947) and for exceeding 100 percent modulation on positive peaks without exceeding it on negative peaks. Broadcast stations in some localities overmodulate within the five-percent differential allowed by the FCC by slightly unbalancing their class-B linear amplifier. The simple method that is to be described here rounds the negative peaks so that overmodulation cannot occur on them even though over 200 percent modulation may be produced on positive peaks. In this way the break in the carrier that would cause sideband splatter is avoided.

Modulator Tube is Variable Resistor

Series modulation has considerable merit in itself because there are no reactances in the modulator. All that is needed is the proper tube and a power supply giving a little more than twice the rated voltage of the r-f amplifier. Figure 1A

(Continued on p 160)
What we mean by...

RIGID QUALITY CONTROL

A DEFINITION OF SHERRON METHODS IN THE BUILDING OF CUSTOM MADE ELECTRONICS PROJECTS

HERE IN THE SHERRON electronics laboratory we initiate our design and development procedures. Every detail of a project's embryonic phase is explored by thoroughly seasoned physicists, engineers and technicians. Here the pattern for the finished product is accurately defined to assure trouble-free performance.

THE SHERRON electro-mechanical laboratory serves in the fabrication of mechanical components for... computers, vacuum tube structures, mechanical equipment for electronoptics, special precision wave guides, precision tuning units, precision drive mechanisms, servo mechanisms. Staffed by graduate mechanical engineers, equipped with the newest precision machines and tools, this laboratory is invaluable in closing up the margin for error in the electronic equipment we manufacture.

SHERRON ELECTRONICS COMPANY
Division of Sherron Metallic Corporation
1201 FLUSHING AVENUE • BROOKLYN 6, NEW YORK

RECENT SHERRON PROJECTS INCLUDE

COMMUNICATIONS
• Trans- Receivers for various uses
• Television — FM — AM — Transmitters
• Navigational Devices, including Homing Equipment, Radar, etc.
• Micro-wave techniques and Radio Relay Links
• Ample Test Equipment to assure successful operation of above

ELECTRONIC CONTROL EQUIPMENT FOR
• Drone Aircraft Guided Missiles
• High Gain Amplifiers
• Computers and Calculators
• Servo Equipment
• Velocity Propagation measurement
• Test Equipment including Instrumentation for above

VACUUM TUBE CIRCUIT DEVELOPMENT
• New applications for existing vacuum tubes
• Precision test equipment for vacuum tubes

CONTROL OF MEASURING DEVICES
• Flow indicators
• Sorting, Counting
• Measurement of chemical titrations
• Surface strains, stresses, etc.

INSTRUMENTATION
• Bridge measurements
• Null detectors
• Vacuum tube voltameter-ammeters
• Multi-wave shape generators

TELEVISION
• Television Signal Synthesizer
• Sync Generators
• Monoscope
• Shapers — Timers
• Wide band oscilloscopes
• Air monitors
• Field intensity equipment
• Television test equipment
NEW PRODUCTS
Edited by A. A. McKENZIE

New equipment, components, tubes, testing apparatus and products closely allied to the electronics field. A review of catalogs, handbooks, technical bulletins and other manufacturers' literature

Ceramic Pickup
SONOTONE CORP., Elmsford, N. Y.
Titone ceramic pickups for 78 and long-playing records use synthetic barium titanate piezoelectric elements. The pickup for 78-rpm records has a 0.0027-inch radius needle tip, requires a tracking weight of 22 grams, has a lateral compliance of $0.5 \times 10^{-4}$ cm per dyne or better, and delivers an open-circuit output of 0.75 volt at 1,000 cps. The pickup for L-P records has a 0.001-inch radius needle tip, requires a tracking weight of only 6 grams, has a lateral compliance of $0.75 \times 10^{-4}$ cm per dyne, and delivers 0.25 volt at 1,000 cps on a test record. Both pickups have permanent sapphire needles and wide frequency responses. Mounting and electrical adapters are available so that the cartridge can be used in standard tone arms.

Supermidget Relay
POTTER AND BRUMFIELD MFG. CO., 549 W. Washington Blvd., Chicago, Ill. A new type of miniature relay weighing only 0.33 ounce eliminates all nonfunctional parts. The core parts are formed to act as current-carrying elements and contacts, one part providing the armature and movable-contact arm while another part is extended to provide a stationary contact arm and mounting. Another stationary contact can be mounted on the insulating bakelite front of the coil form with two screws. Contacts are heavy silver plating applied directly to the iron magnetic parts. They are rated for 100 milliamperes d-c at 50 volts for maximum life. Coils are wound to any desired resistance up to a maximum of 1,600 ohms.

Television Signal Standard
MEASUREMENTS CORP., Boonton, N. J. Model 90 television standard signal generator has a master oscillator, buffer, and modulated power amplifier. Output circuits are overcoupled to permit modulation frequencies up to 5 megacycles. Carrier range is continuously variable from 20 to 250 megacycles. Video modulation operating from a standard RMA composite signal has a bandwidth of 4 mc at 3 db. A mutual-inductance balanced attenuator is provided.

F-M Monitor
GRAYBAR ELECTRIC CO., 420 Lexington Ave., New York 17, N. Y. The Western Electric model 5A f-m frequency and modulation monitor provides continuous indication of center-frequency error, percentage of modulation, a visible alarm for overmodulation, program monitor, and noise detector for measurement of transmitter a-m noise. Extension meters can be added. Write for brochure WECO-T2437.

Coils and Springs
WEBSTER SPRING CORP., 97 South 5th St., Brooklyn 11, N. Y. The coils and springs illustrated indicate the scope of the company's manufacturing possibilities. In addition, solenoids and i-f transformers can be furnished on order in small or large quantities.

Submidget Switches
GENERAL CONTROL CO., 1200 Soldiers Field Road, Boston 34, Mass. New lever switches have shielding between switch assemblies and single-hole mounting or two sets of four holes on standard
WHY IT'S TO YOUR ADVANTAGE TO STANDARDIZE ON RAYTHEON SUBMINIATURE TUBES

For Special Purpose Applications

Raytheon Filamentary Subminiatures increase the reliability of your product by decreasing its size. They are flat. Batteries can be little instead of big, because of extremely low filament drain.

Raytheon Subminiatures plug into standard sockets, (over one and a half million in use), or can be soldered or welded into the circuit.

Raytheon Tubes are readily available from stock. Over half a million of the tubes described on this page are available at all times. They are standard throughout the world — more are in use today than all other makes combined!

Raytheon offers you unsurpassed application engineering service, backed by nine years of production and application experience.

### NEW TUBES

This chart gives you at a glance the characteristics of representative Raytheon Subminiature Tubes

<table>
<thead>
<tr>
<th>Type No.</th>
<th>Remarke</th>
<th>Maximum Diameter</th>
<th>Maximum Length</th>
<th>Filament Or Heater Voltage</th>
<th>Nutal Conductance</th>
<th>Power Output</th>
<th>VOLTAGE REGULATORS</th>
</tr>
</thead>
<tbody>
<tr>
<td>HEATER CATHODE TYPES</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>CK5673/CK5680X</td>
<td>Characteristic of 4XS</td>
<td>0.400</td>
<td>1.5</td>
<td>6.3</td>
<td>300</td>
<td>5000</td>
<td>100</td>
</tr>
<tr>
<td>CK5672/CK5688X</td>
<td>Triode, UHF Output, % work at 200 Mc</td>
<td>0.400</td>
<td>1.5</td>
<td>6.3</td>
<td>300</td>
<td>5000</td>
<td>100</td>
</tr>
<tr>
<td>CK5674/CK5684X</td>
<td>Diode, resistance to one half 4XS</td>
<td>0.315</td>
<td>1.5</td>
<td>6.3</td>
<td>130</td>
<td>300</td>
<td>150</td>
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<tr>
<td>CK5676X</td>
<td>Triode, high mu.</td>
<td>0.400</td>
<td>1.5</td>
<td>6.3</td>
<td>300</td>
<td>4000</td>
<td>200</td>
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<tr>
<td>THERMAL TYPES</td>
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<tr>
<td>2231-22</td>
<td>RF Pentode for polsradios</td>
<td>0.300-0.400</td>
<td>1.5</td>
<td>6.3</td>
<td>300</td>
<td>500</td>
<td>75</td>
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<tr>
<td>2233-26</td>
<td>Output Pentode for polsradios</td>
<td>0.250-0.350</td>
<td>1.5</td>
<td>6.3</td>
<td>250</td>
<td>400</td>
<td>75</td>
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<tr>
<td>2241-36</td>
<td>Triode for pocket radio</td>
<td>0.250-0.350</td>
<td>1.5</td>
<td>6.3</td>
<td>250</td>
<td>400</td>
<td>75</td>
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<td>2259-25</td>
<td>Triode Magneto for polsradios</td>
<td>0.250-0.350</td>
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<td>6.3</td>
<td>250</td>
<td>400</td>
<td>75</td>
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<td>2265-26</td>
<td>Triode, high mu.</td>
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<td>6.3</td>
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<td>4000</td>
<td>200</td>
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</table>

### NEW TUBE CHART

- **Raytheon Technician Tube-like 5651**
  - CK5651X
  - 0.400
  - 1.0
  - 0.0

- **Voltage reference tube-like 5651**
  - CK5651X
  - 0.400
  - 1.0
  - 0.0

- **High voltage rectifier**
  - CK5651X
  - 0.400
  - 1.0
  - 0.0

### NEW FEATURES

- **Write for Socket and Mounting Notes for Flat Press Subminiature Tubes.**
centers. Total depth of the frame behind the panel is 21 inches to 2 21/32 inches depending upon the contact arrangement.

**Bus Receiver**

**GENERAL ELECTRIC CO., Syracuse, N. Y.** The f-m fixed-tuned receiver shown is used in buses or other vehicles that are a part of the programming-advertising combination sometimes known as “car-card radio”. Crystal controlled at the frequency of the desired station, the receiver operates from the bus battery, is connected to four or eight speakers, and is used with a dipole mounted externally over the driver’s seat.

**Basic Oscilloscopes**

**JAMES MILLEN MFG. CO., INC., Malden, Mass.** The three models of rack panel oscilloscopes have been designed as basic units to which other units, such as sweep circuits, pulse generators, and amplifiers can be added for any laboratory or industrial use. Models 90902, 90903, and 90905 use two-, three-, and five-inch tubes, respectively.

**Small Wet Cell**

**THE VITAMINE CO., 227 West 64th St., New York 23, N. Y.** A new rechargeable nonspill wet-cell battery model 2A-3.00 weighs six ounces. It has a four-ampere capacity and has been designed to operate under low-temperature and low-pressure conditions.

**Microwave Calorimeter**

**DE MORNAY BUDD INC., 475 Grand Concourse, New York 51, N. Y.** Measurement of absolute r-f power in a series of frequency bands between 2,600 and 26,500 megacycles is now possible. Accuracy of 2 watts at average power readings of 100 to 500 watts is attained by the calorimetric principle.

**Educational F-M**

**GENERAL ELECTRIC CO., Syracuse, N. Y.** A new f-m broadcast transmitter type BT-11-B operates in the 88-to-108-megacycle range, but is designed for a power output of ten watts or less for noncommercial educational work. Coverage ranges from 5 to 10 miles depending upon the installation. The unit employs a Phasitron modulator, has 21 tubes, and weighs 280 pounds.

**Standing-Wave Meter**

**KAY ELECTRIC CO., Pine Brook, N. J.** The modified Megamatch displays reflected energy in bandwidths of 30 mc anywhere between 10 and 500 mc, and can be used for most work up to 1,000 mc. Price of the modified unit, which uses a special coaxial detector and delay line, is $895 f.o.b.

**Multiple Recorder**

**LEEDS AND NORTHRUP CO., 4934 Stenton Ave., Philadelphia 44, Pa.** A new Speedomax recorder automatically logs as many as 160 separate thermocouple temperatures in succession at a rate of 4 (continued on p 178)
Now audiodisc* lacquer provides permanent resistance to humidity

Excessive humidity has long been one of the industry's major problems—both to the manufacturer and to the recordist. Humid conditions in factories have frequently held up production and caused excessive spoilage. Also, discs which have absorbed too much moisture make poor recordings. The noise level increases progressively while recording and the cut gets greyer and greyer.

Air conditioning has been tried by several producers, but this does not prevent moisture absorption during transportation and storage. The real solution lies in the formulation of a lacquer which will provide permanent resistance to humidity. This has now been successfully accomplished by our research laboratory. Here are the facts:

1. **The Improved Audiodisc Formulation** has eliminated all production difficulties due to excessive humidity. During the past summer no trouble was encountered, even with humidity as high as 90%.

2. **Countless Tests** in our "weather room" have proved the new Audiodiscs to be remarkably resistant to moisture absorption. Discs subjected to a temperature of 90° at 80% to 90% humidity for many weeks show no increase in noise level while recording. Ordinary discs, under the same conditions, show a noise level increase of from 15 to 25 db. The most conclusive proof of all, however, has come from the field—for during the past summer, one of the most humid on record, our customers have reported no difficulties in recording or reproduction due to humid conditions.

3. **This "Weather-Proof" Feature** has been achieved without any basic change in our lacquer formulation. Recordists will therefore continue to note the outstanding qualities in recording, playback and processing which have made for Audiodisc leadership.

This improved humidity-resistant lacquer is now used on all Audiodiscs. It is your assurance of finer, all-weather recording—with the same consistent, uniform quality which has characterized Audiodiscs for a decade.

*Audiodiscs are manufactured in the U.S.A. under exclusive license from Pyral, S.A.R.L., Paris.

Audio Devices, Inc., 444 Madison Ave., N.Y.C.

Export Dept: Rocke International, 13 East 40th Street, New York 16, N.Y.
NEWS OF THE INDUSTRY
Edited by WILLIAM P. O’BRIEN

Magnetic recording standards; train television demonstrated; FCC abandons operator license changes

Park Strollers View World Series

ONE of the largest group installations of television sets ever made brought the recent World Series to an estimated 100,000 viewers on Boston Common. Over one hundred RCA Victor 721TS receivers with 52-sq-in. screens were set up by RCA Service Company technicians.

For this mass installation of sets, a special receiver was installed atop the Ritz Carlton Hotel to pick up the telecast from WBZ-TV and feed a microwave transmitter that beamed the program directly to the control tent on the Common. A five-foot-diameter parabolic reflector on the hotel roof was aimed at a similar dishpan atop the control tent to provide ghost-free and interference-free transmission to the sets at the tent. The signal was converted back to a standard television signal and fed through a total of three miles of coaxial cable to the 100 individual sets.

Each set was mounted on a 71-ft stand with a special shadow box to cut down sunlight, so that as many as a hundred people at a time were able to sit and stand in front of each set and view the game satisfactorily despite full daylight.

Ultrafax Progress Report

THE PRESENT status of a new technique for transmitting enormous quantities of written, printed, or drawn material in an extremely short time was demonstrated by Radio Corporation of America at the Library of Congress, Washington, D.C., on October 21, 1948. The system shown consists of a somewhat unconventional scanning device employing a flying-spot cathode-ray tube and a photomultiplier tube, a 7,000-megacycle relay link, and a projection kinescope at the receiving end to expose a 16-mm moving film. The experimental transmitter uses a 35-mm film on which is recorded the desired intelligence. An important feature of the system is the rapid development of the film at the receiver. For demonstration purposes a small unit built by Eastman Kodak was used that moved the exposed film through a hot developing bath, delivering a dry positive film, suitable for viewing, in 40 seconds. Already developed but not demonstrated is a three-channel machine for printing up enlarged paper copies of the received messages.

To date, the photographic aspect of the system lags somewhat behind the electronic equipment which is essentially simpler and represents the refinements of known techniques. However, certain developments, such as a flying-spot scanner with a narrow beam have been essential. The radio transmission speed was pointed up by the transmission of the whole of the book, “Gone with the Wind” page by page, in two minutes and twenty-one seconds. Photographing the pages and reprinting them at the receiver would take substantially longer.

The functioning of the system on
Can be welded, brazed, or soldered to case, forming a strong, permanent, hermetic seal that eliminates moisture problems and often permits more compact, light-weight design.

General Electric is now offering to other manufacturers the glass bushings that it has used so successfully on capacitors, rectifiers, modulator and instrument transformers, and other electrical equipment. These bushings are cast of an exceptionally stable, low-expansion glass. Metal hardware is a special nickel-alloy steel, fused to the glass in casting. Bushings are attached directly to the apparatus without gaskets—by soldering, welding or brazing the metal bushing flange to the metal case.

The resulting joint between bushing and equipment is permanent, vacuum-tight, and of high mechanical strength. It is especially desirable for equipment subject to vibration, shock, fungus growth or severe changes in temperature. These glass bushings are currently available to meet dry, 60-cycle, flashover values of from 10 to 50 kv, and in current ratings of 25 and 50 amperes (large sizes up to 800 amperes). They may be single or multi-conductor and can be provided with a top flange to permit mounting tube sockets directly on the bushings. Diameters range from 1\(\frac{1}{8}\) to 3\(\frac{3}{8}\) inches and weights from 2\(\frac{1}{2}\) oz. to 4 lb.
an economic basis is predicated upon the establishment of nationwide microwave relay links also necessary for television. It was suggested that transatlantic service might begin soon if government services could maintain a chain of relay airplanes, spaced about every 200 miles between North America and Europe.

Although the reproductions obtained at the receiver were reasonably good, it has been pointed out that greater clarity and a goal of "a million words a minute" will only be possible using bandwidths of 10 megacycles as compared with the five-megacycle width employed for demonstration purposes.

### Magnetic Recording Standards

**Announcement** of a proposal of three recording speeds for magnetic tape was recently made by the National Association of Broadcasters' Recording and Reproducing Standards Committee. The group’s proposal involves adoption of a primary—standard magnetic tape speed of 15 inches per second for a frequency response of 50 to 15,000 cycles, a secondary standard of 7.5 inches per second, for a frequency response of 50 to 7,500 cycles and a supplemental standard of 30 inches per second for all wide-range standards. The latter essentially corresponds to the European standard 77 mm (30.318 inches) established by the German magnetophone.

The committee also agreed that the minimum playing time per reel should be 33 minutes. Maximum permissible noise level was set at 40 db below peak signal level. Zero db level was set at 2-percent distortion.

It is expected that the standards will be ready for submission to the NAB board of directors for final adoption at the regularly scheduled November meeting.

### Industry to Present Views to FCC

The RMA has appointed a committee to confer with FCC Chairman Coy, and to offer the RMA’s assistance in expediting an FCC decision in the matter of the recent temporary freeze on television station applications.

The committee consists of president Max Balcom; W. R. G. Baker, director of the RMA Engineering Department and vice-president of GE; H. C. Bonisig, vice-president of Zenith Radio Corp.; Allen B. Dumont, president of Allen B. Dumont Laboratories, Inc.; Frank W. Folsom, executive vice-president of RCA Victor; Paul V. Galvin, president of Motorola Inc.; and L. F. Hardy, vice-president of Philco Corp.

### Radio Network for Farmers

An F-M network with no wires whatsoever, known as the Rural Radio Network Inc., has been established by ten farm organizations to serve about 118,000 farms in New York State. Stations are linked together only by direct radio pickup of each other’s programs. Stations now on the air, with frequency assignments and distance to the adjacent station they feed or

(Continued on p 217)

**Hospital Television**

Nurse tunes in television receiver, a gift of the Baltimore Rotary Club, while iron lung patients watch their individual mirrors

POLIO victims in an iron lung ward at the Baltimore Children's Hospital School recently had installed for them a Stromberg-Carlson 12-inch screen television receiver. Special mirrors were erected above the patients’ heads so that all could see the screen.
IN THE TRANSMITTER, a Type 1N34 SYLVANIA GERMANIUM DIODE rectifies the audio modulating voltage, to provide a variable d-c bias for automatic gain control. Use of such a circuit helps prevent over-modulation while maintaining a high average audio level. The result —voices of the train crews are transmitted clearly, evenly.

IN THE RECEIVER, another SYLVANIA GERMANIUM DIODE, Type 1N34, provides a delayed noise-gate action which suppresses undesired noise interference in the receiver output. Hence, only signals of usable amplitude will actuate the squelch circuits and the receiver is kept essentially silent in the absence of a carrier.

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Sylvania Electric Products Inc.
Electronics Division, Dept. E-1012
500 Fifth Avenue, New York 18, N. Y.

Gentlemen:
Please send me your literature on Germanium Diodes and Duo-Diodes, including the series of Engineering News Letters showing their applications in television circuits. I am also interested in receiving literature covering applications of your other products in the fields of (check one):

☐ Communications and Industrial Electronics
☐ Radioactivity
☐ Radar and Microwaves

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Position:
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Electronic Devices; Radio Tubes; Cathode Ray Tubes; Photolamps; Fluorescent Lamps, Fixtures, Wiring Devices; Electric Light Bulbs.
AKRA-OHM PRECISION RESISTORS
for "miniaturization" programs

These new Shallcross Akra-Ohm Wire-Wound Precision Resistors have been designed to meet the needs of modern, miniature equipment. Standard tolerance is ±1%; and closer tolerances can be furnished on special order.

The units offer unusually high and accurate resistance values in small space and are light enough to be suspended by their own tinned copper leads, or may be secured with mounting screw.

Other Shallcross Akra-Ohm Precision Resistors include types, shapes, mounting arrangements and ratings for every close-tolerance requirement and are designed to meet JAN specifications. Write for Bulletin RG, giving complete precision resistor data in convenient chart form.

Complete Service measurement facilities
IN A SINGLE INSTRUMENT

The improved Shallcross 614-A Service meter covers a wide range of measurements. These include d-c and a-c voltage, capacitance, and d-c resistance. Also it can be used for approximating an artificial load. Auxiliary scales provide an inductance range of 1 to 100; 1,000, 10,000 henries, and an a-c resistance range of 25 ohms to 3 megohms. Only two switches are used for 25 ranges. The instrument is self-contained, housed in a metal case with handle and weighs only 12½ lbs. Write for details.

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Band and frequency changing is expedited by the use of mobile tank circuits. A rail system guides trucks accurately to their contacts in the transmitter cabinet.

Excellent results at the receiving end is 14,000 miles using a 100-kw channel, the full output of one transmitter. The average shutdown time since the station was commissioned in 1913 has been less than 0.04 percent.

Graphical Iron Core Reactor Design

By Morton R. Whitman
Engineering Department
Thordarson Electric Manufacturing Division
Chicago, Illinois

Reactor designers are usually plagued by the mutually hostile requirements of speed and an optimum balance of the parameters involved in the design of reactors which carry both direct and alternating currents.

An optimum balance means the use of readily available parts and standard production techniques, a minimum of material in construction, low operating noise level and good thermal and insulation characteristics.

The principal difficulty in this problem arises from the nonlinearity of the magnetic material used in core structures. This makes impossible the derivation of an explicit formula which could give accurately say, the size and weight of a specified reactor. The purpose...
Aircraft receiving and transmitting sets must operate constantly and without interruption in varying climatic temperatures, and must be able to withstand engine vibration. Burden of this performance falls upon the relay units within the sets.

BH Extra Flexible Fiberglas Sleeving is used on Automatic Electric Manufacturing Company's R-30 relay unit because it meets a specific insulation requirement fully and completely.

Here is what the Automatic Electric engineers found:

"In the R-30 relay, BH Extra Flexible Fiberglas Sleeving—fungicide treated—insulates the wires which are soldered to a stationary terminal strip on one end and the moveable armature-mounted terminal strip on the other end. Flexibility is essential. Stiffening of the sleeving would tend to put a drag on the armature and thus vary the pull-in and drop-out. BH Sleeving is not only flexible, but also stays flexible when subject to climatic changes in temperature."

BH Extra Flexible Fiberglas Sleeving remains flexible as string because no hardening varnish or lacquer is used in its manufacture. It is heat resistant to 1200°F. if required. Cuts without fraying and won't deteriorate. Use it in your plant, in your product.

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I am interested in BH Non-Fraying Fiberglas Sleeving for (product) operating at temperatures of ___°F. at ___ volts. Send samples so I can see for myself how BH Non-Fraying Fiberglas Sleeving stays flexible as string, will not crack or split when bent.

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

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December, 1948 — ELECTRONICS
Designed for a wide variety of laboratory measurements, especially those where high sensitivity and a long scale arc are required. Electrostatically and magnetically shielded, Model 622 is ideally suited for precise measurements of potential and current at the very low energy levels frequently encountered in nuclear physics, electronics and electro-chemical research. Microammeters, milliammeters, millivoltmeters and voltmeters are available in single and multi-range D-C types; milliammeters and voltmeters in thermo and rectifier types for RF and A-C.

Complete information on Model 622 is available from your nearest WESTON representative, or by writing... WESTON Electrical Instrument Corporation. 618 Frelinghuysen Avenue, Newark 5, N. J.
WITH our recent announcement of the Type 1182-T Video Frequency Monitor, complete transmitter monitoring equipment by General Radio Company for TV as well as FM stations is now available. The FM Monitor has FCC approval, and the TV equipment meets all of the tentative proposed specifications of the FCC.

Simple to install, practically self-explanatory in operation, direct-reading in frequency deviation, these monitors have the same high accuracy and stability and years of reliable operation ahead of them that all G-R broadcast monitoring instruments have provided since the beginning of broadcasting.

This equipment can be bought with confidence... confident that it will give trouble-free operation with the minimum of routine maintenance. The G-R trade mark insures that.

**TYPE 1170-A FM MONITOR**

For both FM and audio channel monitoring of TV stations, features:

- **Transmitter Ranges:** either 30 to 162 Mc or 160 to 220 Mc.
- **Continuous Monitoring:** center frequency indication continuous, requires restandardization only once a day.
- **Remote Monitoring:** equipped with circuits and terminals for remote indicators of Centex, Frequency Indication, Percentage-Modulation Meters, Over-Modulation Lamp, 600-Ohm Unbalanced Aural Monitor, Recorder and with the Type 1932-A Distortion and Noise Meter will measure distortion.
- **High Stability:** 200 cycles (2 parts per million) or better with daily check of electrical zero of meter.
- **Low Input Power:** 1 volt at high impedance, amplified to several hundred volts for high-level operation.
- **Low Residual Distortion:** less than 0.2% at 100 k.c. swing; accurate for measurements to as low as 1/2 per cent. 75-25 KC Deviation provided with a single internal adjustment for either TV or FM monitoring. TYPE 1170-A FM MONITOR... $1625

**TYPE 1182-T VIDEO MONITOR**

For video channels of TV transmitters, features include:

- **Transmitter Range:** 54 to 220 Mc.
- **Deviation Range:** 3-0-3 and 6-0-6 kc for all present TV channels.
- **Deviation from assigned channel is shown continuously on large-scale meter, unaffected by TV video modulation.**
- **High Accuracy:** crystal frequency when monitor is delivered is within ± 0.001% (10 parts per million). Adjustment provided to set monitor in agreement with frequency measuring service.
- **High Impedance Input Circuit** for channels 2 to 6; coaxial line for channels 7 to 13.
- **Remote Frequency Deviation Meter** terminals provided. THREE SPARE CRYSTAL POSITIONS selected by panel switch.

TYPE 1182-T VIDEO FREQUENCY MONITOR... $675

WRITE FOR COMPLETE ENGINEERING DATA
here is to suggest empirical techniques for doing these things. Model theory offers a useful approach to this problem. It generalizes the results obtained on a sample and makes possible, in effect, the extrapolation of the data so obtained. The precision of data obtained in this way depends on how accurately a unit holds to scale with this sample, or prototype. Nevertheless, even if the scale factor is omitted from consideration, the results are significant from a design point of view.

An important result of the kind discussed is the relation: weight equals $kLI$ where weight is that of either core iron or total core and coil weight (adjustment of the constant $k$ can be performed to suit one requirement or the other since in a line of geometrically similar reactors the winding weight will be a relatively fixed percentage of total core and coil weight); $L$ is the inductance, and $I$ is the direct current in the winding. An alignment chart is presented in Fig. 1 to expedite use of this relationship. The chart is not intended to give actual design figures but can be made to do so by reference to the data on an arbitrarily selected prototype unit and appropriate vertical displacement of the axes. Greatest accuracy can be secured by choosing as prototype...
Fairchild Precision Potentiometers

long life  
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December, 1948 — ELECTRONICS
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DESIGN SIMPLIFIES SERVICE
Conventional circuit design, fewer numbers and types of tubes, plus open mechanical construction simplify tube stocking problems and speed maintenance. The entire transmitter portion of the Type 364A is built on a drawer-type chassis, instantly withdrawable from the front of the panel.

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Compact design requires only 15 inches of rack space for installation, frequently utilizing space already available.

.005% FREQUENCY STABILITY WITHOUT TEMPERATURE CONTROL
Through the use of a newly developed crystal, troublesome thermostatic temperature controls and crystal ovens are no longer necessary to provide adequate frequency stability.

SIMPLIFIED CONTROL FOR REMOTE LOCATION
Modulation over a single telephone pair and carrier control by means of a simplex circuit allow the transmitter to be readily located at a remote point.

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Air Express can bring you supplies and equipment from any U.S. point—overnight. And that’s better than old-style magic! Air Express is the fastest way you can find to ship or receive. No delays, because shipments go on every flight of the Scheduled Airlines.

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True case history: Rubber equipment users regularly get replacement parts by Air Express so machines won’t stand idle. Recent shipment: 102-lb. carton picked up 5 P.M. the 18th in Noblesville, Ind. Air-rail to Dallas, delivered 9 A.M. following day. 799 miles, total cost only $26.78. Any distance inexpensive, too. Phone local Air Express Division, Railway Express Agency, for fast shipping action.

A second relation gives the weight in terms of the time constant, $L/R$, of the reactor. Here, $R$ is the simple ohmic resistance of the winding—$L/R$ equals $KW/3$. The form of this equation makes graphical representation very simple. Measurements of the time constant and the weight on a single unit are used as the co-ordinates of a point on log-log paper. A straight line drawn through this point with a slope equal to $\alpha$ completes the graph. A typical curve is shown in Fig. 2.

The curves must be used with caution since generally they are valid only when conditions of similarity to the prototype are maintained. Varying insulation requirements, cooling considerations and other considerations introduce error. Nevertheless, the curves are useful for estimating purposes and for reducing the number of steps in the preliminaries to actual design.

Filter reactors—for use with polyphase rectifier systems operate at considerably lower excitation levels than corresponding single-phase systems for the same output voltage. Since permeability is an increasing function of the excitation up to some maximum characteristic of the material used, the polyphase filter reactor will in general be different from the single-phase unit. The difference will not be so large, however, that the charts will not be of some use for both.

An illustration of the use of the curves will be given here. Assume we wish to design a reactor of 5 henrys at 1 amp d-c. The insula-
This small, compact CLARE RELAY

WILL SWITCH 1250 WATTS WITH AN INPUT OF 1 WATT!

This new CLARE Type "JMS" Relay is a sensitive relay for switching heavy a-c loads with small d-c controlling currents ... as high as 1250 watts can be switched with a 1-watt input.

It combines the outstanding features of the larger CLARE Type "CMS" Relay with the small size and light weight of the CLARE Type "J" Relay and employs a new-type Micro precision switch of unusual efficiency and compact design.

The CLARE Type "JMS" Relay is especially suitable to locations subject to sudden jolts, constant vibration or tilting. It may be provided with either one or two Micro snap-action switches, or with one switch and a pileup of twin-contact springs. For installations where quick removal or replacement may be desirable, it may be fitted and wired to a standard radio type plug.

This new relay is a development of CLARE's unceasing effort to keep pace with every industrial relay requirement. Our engineers and sales representatives are constantly at your service to provide just the relay to meet your specific need.

For full information on the CLARE Type "JMS" Relay, look up the CLARE office in your classified telephone directory ... or write for Bulletin 102 to C. P. Clare, 4719 West Sunnyside Avenue, Chicago 30, Illinois. In Canada: Canadian Line Materials Ltd., Toronto 13. Cable Address CLARELAY.

**STANDARD SPECIFICATIONS**

- **Contacts**: Snap-action, enclosed. Varying capacity: 10 amperes at 125 volts; 5 amperes at 250 volts.
- **Residual**: Lock Screw (Adjustable).
- **Mounting**: May be mounted on relay bases or strips as well as mounting bars or individual mounting brackets.
- **Dimensions**: Overall length: 2¼"; width: 1½"; height: 2".
- **Weight**: Net: 4 oz. (approx.); Shipping: ½ lb. (approx.)

Write for Clare BULLETIN 102
ULTRA SENSITIVE D. C. AMPLIFIER

The Model 53 Breaker-type D.C. Amplifier was developed for the measurement of d.c. and low frequency a.c. voltage in the microvolt and fractional microvolt region. It is compact, portable, and makes an excellent replacement for the suspension galvanometer. The output of the amplifier is sufficient to operate standard meters and recording devices directly.

It has been employed for the amplification of infra-red detectors, thermocouples, voltaic photocells, and the like, both in research and industrial applications.

An Electronic Replacement
For Sensitive Galvanometer Systems

Among the advantages of this amplifier are the following:
1. Noise level that approaches the theoretical limit imposed by Johnson noise.
2. Extremely low zero drift (less than 0.005 µV after warmup).
3. Freedom from the effects of vibration such as found in moving vehicles.
4. Response characteristics permitting overall amplification flat from 0 to 10 cycles per second.
5. Reliability, as demonstrated by units which have been in continuous operation for several years.

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For Complete Information Write Dept. 50.
Trained hands expect a pipe organ to respond immediately to any demand—from complete silence to a powerful crescendo. To meet these demands, hundreds of magnets and solenoids must have controlled d-c voltage on tap at all times.

In a growing number of installations, General Electric selenium rectifiers—specially designed and built for pipe organs—are supplying the smooth, constant voltage this application calls for. Over the full load range, these rectifier units give instant response—operate silently—at low cost.

Tell G.E. your problem of d-c supply. When you strike an unusual rectification problem—or even when the routine problem of deciding which type of rectifier is best for your purpose—call on General Electric for an answer. Because General Electric makes all three—selenium, copper oxide, and Tungar—General Electric engineers can give you an impartial solution. Because G-E engineers know rectifiers—from the postage stamp size to ten-ton monsters—they can give you the kind of practical solution you want. For information, write to A8-1231, General Electric Company, Bridgeport 2, Connecticut.
While it's "in the Design Stage"...

The time to select relays is at the start of circuit design. Frequently, manufacturers save time and money—develop a better product, by consulting Leach during the first stages of their designing. Here's how—

Leach manufactures thousands of types of relays, for thousands of applications. Many are production items which may offer you savings in delivery time and unit cost. Through a slight change in circuit design you may gain the advantages of a standard type, at considerable savings and do a better job.

For your specific requirements, consult the competent staff of Leach electrical engineers. Custom designs are their stock in trade. Remember, for Better Controls through Better Relays, look to Leach. Write today.

Remote Control for Radio Tuning

BY S. WALD
Aviation Equipment Engineering
Engineering Products Department
Radio Corporation of America
Camden, New Jersey

A noticeable trend in architecture and planning for modern homes is the increased use of built-in broadcast receivers. Their popularity has encouraged the author to investigate the possibilities of remote tuning devices and their application to standard broadcast receivers. The unit discussed in subsequent text and illustrated in the accompanying diagrams has been found to be highly effective, providing for both push-button and continuous remote tuning.

The schematic of the system is shown in Fig. 1. Alternating plate and grid voltages are applied to two miniature thyatrons in a push-pull circuit. The voltage between grid and cathode of each tube lags the corresponding plate voltage by approximately 115 degrees. Thus, each tube fires during a little less than one-half of the positive plate voltage excursion.

The induction motor working...
Better Tubes—Longer Life—Increased Production through DPI HIGH-VACUUM ENGINEERING

YOUR present rotary exhaust machines can be completely automatic in operation, yielding increased production for any size tube.

Converted to DPI vacuum equipment, your machines will have a fractionating oil diffusion pump and a small mechanical pump under each separate port. Tubes are rough pumped through automatic solenoid valves.

Protective devices with automatic controls will seal off the pumps and isolate the trouble in case of faulty tubes. Seal-off pressure will reach $5 \times 10^{-6}$ mm of mercury before getter is flashed.

DPI-engineered rotary exhaust machines produce cleaner tubes faster, by continuous pumping throughout the cycle—eliminate large backing pumps and rotary slide valve.

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Manufacturers of Molecular Stills and High-Vacuum Equipment; Distillers of Oil-Soluble Vitamins and Other Concentrates for Science and Industry

ELECTRONICS — December, 1948
HIGH VACUUM PUMPS

Kinney High Vacuum Pumps are performing modern-day miracles in industrial production. Already they have greatly improved countless products and have made possible many spectacular new developments. Further miracles continue to unfold almost daily. Kinney Pumps are playing a vital part in producing pharmaceuticals, dehydrating foods, coating lenses, sintering metals, exhausting lamps and tubes, and performing many other low pressure operations. The high pumping speed, long life, and dependability of Kinney High Vacuum Pumps have indeed put vacuum processing on a full production basis. Investigate the new possibilities—and increased profits, too—in low pressure processing with Kinney High Vacuum Pumps.

Write for Bulletin V-45

KINNEY SINGLE STAGE PUMP. 8 sizes with displacements from 13 to 702 cu.ft. per min. for low absolute pressures to 10 microns or better. Also Compound Pumps in 2 sizes (15 and 46 cu.ft. per min. displacements) for low absolute pressures to and below 0.5 micron.

MIRACLES DO HAPPEN! WITH KINNEY HIGH VACUUM PUMPS

TUBES AT WORK (continued)

FIG. 1—Schematic diagram for remote tuning device using miniature thyatrons. Resistor R, is adjusted for no motor rotation with points A and B shorted

winding being connected in the mid-tap of the transformer secondary receives two 65-degree duration pulses for each cycle of a-c power. This is equivalent to a direct-current with a superimposed 120-cycle voltage. Since the other motor winding is excited from the line at 60 cycles, no rotation results.

If we now consider an unbalanced condition of the input bridge consisting of the two 50,000-ohm potentiometers, an error voltage in phase with the plate voltage will be impressed equally and in phase on both grids. The resulting grid voltage will cause one tube to increase its angle of plate current flow while the other will decrease.

The function of the 2-mf capacitor connected in parallel with one of the motor windings is to improve the 60-cycle power factor of the motor so that the output torque for moderate error voltages is increased while the volt-ampere load on the transformer is reduced. The 2-mf capacitor connected in series with the a-c line and the exciting winding produces 90-degree phase-shift for induction motor action.

While the d-c in one of the motor...
Another FEDERAL achievement for better designed and better operating equipment.

More watts per cubic inch in your cabinet space... made possible by Federal's 26-volt RMS square and rectangular Selenium Rectifier plates. By materially reducing the number of plates required for a given output, this important advance in the art of Selenium Rectifier design and manufacture offers engineers and designers new opportunities for savings in space and weight. Now greater power—with the efficiency and dependability inherent in Federal Selenium Rectifiers—may be had without sacrificing compactness.

This is just one more example of Federal's leadership in Selenium Rectifier development. When you specify Federal Selenium Rectifier stacks, whether square, rectangular or round, you can be sure that Federal will help you see the job through. Our engineers are interested in every application, and are always ready to give you the benefit of more than a decade of Selenium Rectifier experience. For information, write to Department E-213.

Federal Telephone and Radio Corporation

Electronics — December, 1948
Feeding an R. F. potential through the wall of a cavity oscillator presented many difficulties. Not only was space at a premium, but extreme changes in humidity, temperature and other service conditions had to be met.

**THE ANSWER**

C.T.C. 1795B Insulated Feed-Thru Terminals fulfilled every requirement. Design-features like these show you why: Rugged construction that will stand loosening under vibration or shock... approved phenolic insulating material, JAN type LTS-E-4... brass bushings, cadmium plated... brass thru-terminals, silver plated for easy soldering.

**SPECIFICATIONS**

The 1795B mounts in a $\frac{3}{4}$" hole, and has an over-all length of approximately $\frac{3}{4}$". C.T.C. Feed-Thru Terminals are available in additional sizes. The 1795A is similar to the 1795B, but with an over-all length of 1". Also similar in design and function are X1771A and X1771B, but larger in size and mounting in a $\frac{3}{4}$" hole. Breakdown voltages, at 60 cycles R.M.S., are:

- 1795A... 3800V  X1771A... 8200V
- 1795B... 3200V  X1771B... 6000V

Catalog No. 200 contains details of C.T.C. standard electric and electronic components, together with full information on our custom-engineering service. Write for it today.

---

**FIG. 2**—The continuous tuning potentiometer is calibrated in frequency. The switching may be accomplished by a multi-position rotary switch or a bank of push-buttons.
Operate accurately over wide Temperature Range

The steep negative curve of Globar Type F Resistors points up their sensitivity over a range from -50° C to 100° C. Actually this range can be extended beyond 150° C. This pronounced and important characteristic of Globar Type F Resistors makes them particularly useful for stabilizing circuits possessing a positive temperature coefficient of resistance.

Functioning electrically, Globar Resistors have no mechanical parts to get out of adjustment. They retain their inherent characteristics over long periods of time. They may be used on A.C. or D.C. circuits. Typical applications are:

**RADIO CIRCUITS**—Type F Resistors eliminate the high initial inrush of current, preventing pilot light burnouts and insuring long tube life performance characteristics.

**RESISTANCE THERMOMETER**—Type F Resistors are ideal for Remote Control and Indication of Temperatures.

**MOTOR GENERATORS**—Globar Type F Resistors serve as voltage regulators by compensating for the positive temperature—resistance of copper field coils.

**ELECTRIC METERS**—Globar Type F Resistors provide automatic temperature corrections. To do the job most efficiently for which they are intended, Globar Resistors are designed to meet the specific needs of each application. This means that complete information on your circuit must be supplied. Globar Resistors can be made to specifications in a hurry. Samples sent on request. Dept. V-128, The Carborundum Company, Globar Division, Niagara Falls, N.Y.

"Carborundum" and "Globar" are registered trademarks which indicate manufacture by The Carborundum Company

ELECTRONICS — December, 1948
SPECIFICATIONS
BALLANTINE MODEL 300 ELECTRONIC VOLTMETER

RANGE: .001 to 100 Volts, r.m.s. (.00001 to 10,000 Volts, with accessories)
ACCURACY: ± 2% at any point on the scale.
FREQUENCY: 10 cycles to 150,000 cycles.
STABILITY: Permanent calibration — unaffected by variation in line voltage, tubes, etc.
METER: Logarithmic Voltage scale and uniform decibel scale.
AC OPERATION: Will operate on 105-125 Volts, 50-60 cycles. (Battery operated models also available)

The Model 300 Voltmeter is a valuable tool for measurements in communication and "weak current" engineering. Its unusual sensitivity, accuracy and stability make it ideal for work in the audio, carrier, and supersonic ranges. Logarithmic meter indication assures uniform accuracy of reading over the whole scale while permitting range switching in decade steps. There is but one scale to read for all ranges. Output jack and output control are provided so that the voltmeter can be used as a high-gain stable amplifier.

Accessories include Model 220 Decade Amplifier, which supplies standardized gains of 10x and 100x, and the Model 402 Multipliers which supply additional ranges of 1,000 and 10,000 Volts.

Descriptive Bulletin No. 12 Available

Protection For TV Antennas

NBC ENGINEERS have enclosed in Plexiglas housings the microwave antennas mounted high on the Empire State and RCA Buildings in New York. These Plexiglas igloos house five-foot parabolics which pick up television signals from baseball parks and arenas, or from mobile units elsewhere in the metropolitan area. Video cables then carry the signals to transmitters of television stations.

Primary purpose of the new housings is to shield the parabolic antennas from high winds and the destructive cascades of ice which plunge down in winter from the 300-foot tower above.

For strength, the dome-shaped Plexiglas igloos protect NBC's microwave television antennas.
The Pictures Arrive in

**PERFECT SHAPE**

Over ATV Lead-In Lines

**Lead-in lines** play an important part in television and FM reception. To be sure of the best performance of your set, specify ATV\(^*\) lines for your set.

The effects of attenuation and impedance mismatch on FM and Television reception are minimized by Anaconda Type ATV lead-in lines.

The satin-smooth polyethylene insulation of Type ATV line sheds water readily, thus avoiding subsequent impedance discontinuities. This material also has exceptionally high resistance to corrosion. Count on Anaconda to solve your high-frequency transmission problems—with anything from a new-type lead-in line to the latest development in coaxial cables.

A Type ATV Lead-In for Every Need

Anaconda offers a complete selection of Type ATV lead-in lines for 75, 125, 150 and 300 ohms impedance unshielded and shielded lines of high impedance. For an electrical and physical characteristics bulletin, write to Anaconda Wire and Cable Company, 25 Broadway, New York 4, N.Y.

---

ANNOUNCING...

A COMPLETE LINE OF ASTATIC LONG-PLAYING PICKUPS and CARTRIDGES that includes JUST WHAT YOU'RE LOOKING FOR!

• Want a two-in-one pickup that plays both LP and 78 RPM Records with the simple switching of cartridges... so simple that a child can make the change in a few seconds? Or, perhaps you are looking for comparable reproduction quality, with more emphasis on economy? Regardless of whether your requirements point to cartridges employing ceramic elements or magnetic-type units... whether you prefer permanent or replaceable needles, metal, sapphire or diamond... whether cost is first or secondary... whatever the conditions to be met—there now is a unit of Astatic precision engineering and construction that will exactly fill the bill. Space permits mention here of only a few. Why not write for new brochure, giving complete information, illustrations, on the Astatic Long-Playing Equipment Line?

FL-33 CRYSTAL PICKUP—Incomparable reproductions, utility and convenience. Employs LP-33 Crystal Cartridge for LP Records and LP-78 Crystal Cartridge for 78 RPM Records. Change cartridges in a second, like slipping modern mountain pen from its cap, nothing else to do. Special anti-resonance base mounting.

510-QT-33 CRYSTAL PICKUP—Same as 510-QT-33. Its transparency allowed quick inspection of the apparatus within, and simplified visual aiming of the antennas. Components are rubber-gasketed and assembled with stainless steel bolts.

A door in each structure gives access to the microwave equipment, which may be rotated and swiveled to permit accurate aiming at the point of program origin. To prevent development of excessive heat in the summer, or freezing condensation in cold weather, each housing has its own "air-conditioning" treatment. Forced air, which may be heated electrically in winter, enters through a floor register and is exhausted through hinged louvers in the side of the platform on which each antenna is mounted.

Servo Physical Tester

BASED ON PRINCIPLES used in wartime gun computers and rate setters, a servo-mechanical physical tester for plastics has been developed at MIT. It has a steel arm which pulls plastic test specimens with a force equal to that of an elevator car. This tremendous force is controlled automatically by mechanisms of featherweight sensitivity.

Tubes at Work (continued)

tops are reinforced with an extra thickness of the acrylic at their crowns, where the ice might strike a direct blow. Except for this limited area, the curved shape of the structures guarantees that they will receive at worst a glancing blow.

First of their kind to be tested in actual use, these housings are made of shatter-resistant Plexiglas 3-inch thick. Plexiglas was chosen because it passed microwaves without perceptible distortion; it was easily formed to exact curvature and dimensions; although light in weight, it combined great shatter-resistance with inherent resiliency; it was virtually impervious to extremes of weather and continued exposure to sunlight; and finally, its transparency allowed quick inspection of the apparatus within, and simplified visual aiming of the antennas. Components are rubber-gasketed and assembled with stainless steel bolts.

December, 1948 — ELECTRONICS

156 World Radio History
Special silver layer gives low-loss high conductivity electrode surfaces

Special ceramic body gives low loss under R.F. load

Tag electrode soldered to outside silver layer gives even current distribution

Glazed sheds give ample flash-over path in all conditions of humidity

Aero-dynamic shape gives improved cooling, particularly with forced draught

Heavy rod with double spider mounting gives reliable heavy current connection to inside silver layer

Tag Mounting Type

Examples from a wide range of Types

<table>
<thead>
<tr>
<th>Type</th>
<th>HLS2031</th>
<th>HLT2021</th>
<th>HLC2011</th>
<th>HLC2014*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacitance</td>
<td>200mmF</td>
<td>330mmF</td>
<td>500mmF</td>
<td>1250mmF</td>
</tr>
<tr>
<td>Max. R.F. Load</td>
<td>70KVA</td>
<td>50KVA</td>
<td>25KVA</td>
<td>40KVA</td>
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<tr>
<td>Peak Voltage</td>
<td>7.5KV</td>
<td>7.5KV</td>
<td>7.5KV</td>
<td>7.5KV</td>
</tr>
<tr>
<td>Max. R.F. Current</td>
<td>30 Amps</td>
<td>30 Amps</td>
<td>30 Amps</td>
<td>30 Amps</td>
</tr>
<tr>
<td>Body Dimensions</td>
<td>1(\frac{1}{2}) x 3(\frac{1}{2})</td>
<td>(\frac{1}{2}) x 3(\frac{1}{2})</td>
<td>(\frac{1}{2}) x 3(\frac{1}{2})</td>
<td>(\frac{1}{2}) x 3(\frac{1}{2})</td>
</tr>
</tbody>
</table>

* Lead-through type, all other examples tag type.

U.I.C. of England, pioneers in the manufacture of Ceramic Transmitter Capacitors, are foremost in the application of aerodynamic principles to capacitor design. The new aerodynamic shape of U.I.C. "Hi-Load" Capacitors gives optimum cooling in still air. With forced draught their high R.F. ratings can be multiplied. All three types of mounting assist cooling and cater for a variety of applications, such as single stand-off tag fitting, parallel and series banking for very large powers, and lead-through types for anode by-pass.
When you specify seamless tubing—whether it’s for instrument pointers, Bourdon gauges, metal-shielded wire, mechanical pencils, or any one of a number of products—here, at Precision, accuracy is our watchword. Inside diameter, outside diameter, wall thickness—all dimensions are held to close tolerances, often exceeding those specified. In this way the over-all accuracy you want in your finished products is consistently carried out in our part of their manufacture.

Sizes of Precision Tubing cover a range of outside diameters from 0.500" to 0.010", with wall thicknesses down to 0.0015". Available in aluminum alloys, brass, copper, nickel, monel, or other non-ferrous alloys—each length of Precision Tubing can be preformed to the shape you specify... ready on good delivery.

When Precision Counts—Count on Precision

FIG. 1 (A) Conventional series modulator and (B) series modulator with auxiliary tube to suppress negative peaks

shows the basic circuit. The modulator operates like a class-A audio amplifier in that the grid never swings positive. In action, the modulator tube behaves as a variable resistance (with half the supply voltage across it when no audio signal is applied) in series with the modulated r-f amplifier. The variation in resistance acts at audio frequency, approaching zero resistance on positive peaks so that the full power supply voltage (twice the rated voltage of the r-f amplifier) appears across the modulated stage. On negative peaks, cutoff is approached (or reached) so that the tube impedance approaches (or reaches) infinite resistance.

Modified Power Supplies

In practice it is found that, because the tube is not absolutely linear, it needs considerably more than half the power supply voltage across it in order to stay in the linear portion of its characteristic and still achieve 100-percent modulation on positive peaks without distortion. As much as 20 percent of the power supply voltage may still be across the modulator tube when 100-percent undistorted positive peaks are being handled by the modulated tube. (This remaining voltage could be considerably reduced by designing a tube for the purpose. The 6AS7G might prove very good in a low power modulator.)

By using several tubes in parallel,
You, as a Communications Engineer, will be interested in the four Aerocom products illustrated below. They are designed and built to solve your communications problem. They are the result of engineering knowledge and experience gained during 18 years of manufacturing communications equipment for more than 200 installations throughout the world.

**WEATHERPROOF LOW FREQUENCY ANTENNA TUNER.** Sturdily constructed; using heavy aluminum sheet and rustless hardware. Ample ventilation provided, yet insect and vermin proof. Suitable for 1-2 kw carrier, 200-415 kcs; coupling coil matches either coaxial or 2 wire line. Illustration shows cabinet with protective and weatherproof (no gaskets) covers removed. Locking facility provided.

**AUTOMATIC KEYER** provides continuous or interrupted identification signals for beacon or aerophare service. Small, compact (6-3/8" x 9" x 7") and fully enclosed, this keyer will give long trouble-free service. Two synchronized cams, which can be milled to your specifications, provide several keyer combinations. Motor -- 105/115 v-50/60 cy.

**METEOROLOGICAL INSTRUMENTS** -- Aerocom’s group assemblies; anemometer and wind direction indicator on mast for outside installation, and reading instruments in cabinet or standard rack panel, give constant and reliable weather information. Instruments available: wind direction, wind speed, Kollsman station barometer (altimeter), 24 hour clock, or any combination thereof. Mast assembly may be remotely located from instruments.

**LINE MATCH INDICATOR:** Made in two models (a) LMI-72 for coaxial lines and frequencies from 0.2 to 10 mcs; (b) LMI-500 for balanced pair lines and frequencies from 0.2 to 2 mcs., or 2 to 20 mcs. These instruments permit adjustment of load for optimum line match. Sturdy and rugged, engineered for field use.

FOR OVER EIGHTEEN YEARS CONSULTANTS, DESIGNERS, AND MANUFACTURERS OF STANDARD OR SPECIAL ELECTRONIC, METEOROLOGICAL AND COMMUNICATIONS EQUIPMENT.
Where electrical contact is required to a moving part, laminated precious metal rings offer unusual operating characteristics at a real saving in cost over solid precious metal rings.

Silver or Gold, or Platinum, or Palladium, or their alloys, bonded to the required base metal, such as copper or bronze, make possible...

- **Uniform contact resistance**
- **Low noise level**
- **Selected temper for essential wearing quality**
- **Mechanical strength**
- **Corrosion resistance**

These rings are now being used in special electric motors, calculators, and computers, radar, and fire control instruments, potentiometers, and other electro mechanical devices.

Our engineers will be pleased to make recommendations to meet your requirements. We would also be pleased to submit quotations to cover your specifications.

**Experimental Equipment**

To demonstrate the feasibility of the method, a transmitter using type 10 tubes and having series modulation was modified for the purpose. With conventional 100-percent modulation, 400 volts appeared across the r-f stage and about 600 across the modulator. On 200-percent modulation with suppressed negative peak, about 250 volts appeared across the r-f stage and 750 across the modulator. The ideal values for these respective conditions would be 500-500 and 333-667.

More detailed data were obtained from a transmitter having a single-ended 304TI r-f stage and 304TI's in the modulator. Transformer coupling into the modulator tubes was found necessary to provide a low-impedance d-c grid return. Although a power supply capable of providing nine times the unmodulated carrier power on positive...
Kollsman offers additional AC units for remote indication or control applications

SYNCHRONOUS MOTORS—For timing applications where variable loads stay in exact synchronism with constant or variable frequency source. Synchronous power output up to 1/100 H.P.

SYNCHRONOUS DIFFERENTIAL UNITS—Electro-mechanical error detector with mechanical output for use in position or speed control servo systems. Also a torque-producing half speed synchroscope. Small combination unit with two variable frequency synchronous motors and differential gearing.

Output: Speed = \( \frac{N_1 - N_2}{2} \); torque up to 1.0 oz/in.

DRAG CUP MOTORS—Miniature 2-phase motors with high torque/inertia ratio and extremely fast stopping, starting and reversal characteristics. Suitable for many special applications requiring torque of 0.4 oz/in. or less.

MOTOR DRIVEN INDUCTION GENERATORS—Combination of a 2-phase, high-torque, low-inertia induction motor and an induction generator. Used as a fast reversing servo motor. Available with maximum stall torques of 1.0 (unit shown) to 6.7 (other units) oz/in.

TELETORQUE UNITS—Precision built selsyn type units for remote indication. Accurate to ±1 degree. Actuated by units producing as little as 4 gr/cm of torque.

GEARED INDUCTION MOTORS—Miniature 2-phase servo motors with gear reducer. Desirable motor features: Maximum torque at stall with low wattage input and high torque/inertia ratio. Gear reducer conservatively rated at 25 oz/in. Maximum torque with gear ratios from 5:1 to 75,000:1 available.

Because of their high responsiveness and precision, Kollsman Special Purpose Motors are particularly suited to systems requiring extremely accurate remote indication or positive electronic control. The units shown above are only representative of a complete line which includes many similar units in various voltages and frequencies. Among them, the instrumentation or control engineer will find, in many instances, the device that fills his specifications exactly.

Reliable performance, light weight and compact size are characteristics of the entire line. In each unit is to be found the same ingenuity of design and care in manufacture that has for twenty years made Kollsman the outstanding leader in the field of aircraft instrumentation.

For full information on any or all of these Special Purpose Motors, write to: Kollsman Instrument Division, Square D Company, 80-64 45th Avenue, Elmhurst, N.Y.
It is triply to your advantage to rely on WILCO for electrical contacts, thermostatic bimetal and contact assemblies.

**FIRST** . . . WILCO offers you a wide range of electrical contacts in silver, tungsten, platinum, sintered powdered metals and in alloys and combinations of these — in solid and composite studs, rivets, screws and steel-backs.

**SECOND** . . . the facilities of THE H. A. WILSON COMPANY permit you to secure both electrical contacts and thermostatic bimetal from a single source for use as parts of the same device . . . contact assemblies designed and manufactured under one roof . . . combining the superfine quality of WILCO contact materials and WILCO thermostetal to meet the highest performance standards.

**THIRD** . . . you obtain the cooperation of the WILCO Sales and Engineering Departments . . . who are thoroughly familiar with both electrical contact and thermostetal application . . . and thoroughly equipped to help you achieve your objectives of reduced costs, improved performance or new product development. Whatever your requirements for contacts or contact assemblies, WILCO engineers will gladly help you meet them successfully.

**WILCO PRODUCTS INCLUDE:** THERMOSTATIC BIMETALS: All temperature ranges, deflection rates and electrical resistivities. ELECTRICAL CONTACTS: Silver, Platinum, Tungsten, Alloys, Sintered Powdered Metal. SILVER CLAD STEEL: For industrial use. NI-SPAN C* Constant Modulus Alloy; also low and high expanding Ni-Span Alloys. JACKETED WIRE: Silver on Steel, Copper, Invar and many other combinations. SPECIAL ALLOYS: Including high conductivity, high strength, Copper Alloys. ROLLED GOLD PLATE AND GOLD FILLED WIRE.


Peaks may seem excessive, the fact that this power need be provided only on such peaks means that, in practice, the filter capacitors can be relied upon to supply the peaks; the power transformer and filter chokes need be but little larger than for a conventional modulator. The heavier the modulation, the smaller the power dissipated in the modulator tubes. Thus considerable increase in peak power is made possible with negligible increase in power supply. In addition, because series modulation is used, a heavy modulation transformer and speech amplifiers are omitted; a voltage amplifier is
This new automatic voltage stabilizer supplies a constant 115 volts

We want to get in touch with any manufacturer whose product will operate better if supplied from a stabilized voltage source.

General Electric has recently announced three new automatic voltage stabilizers that provide steady, dependable output voltages, despite varying input voltages. Rated 15, 25, and 50 volt-amperes, these stabilizers are instantaneous (recovery time: 3 cycles), entirely automatic, and have no moving parts. They deliver 115 volts output (± one per cent for fixed, unity power factor loads) with the input voltage varying from 95 to 130 volts.

These units will operate continuously at no load or short circuit without damage to themselves. They will limit the short circuit current to approximately twice normal full load current. Dimensions are 9⅛ x 3⅛ x 2⅜" high—making possible shallow depth installations. Other standard G-E stabilizers are available in ratings from 100 to 5000 va.

Drop us a line if you see a possibility for these new automatic voltage stabilizers in your product. Please give us all the information you can—and if possible, a circuit diagram or description of the load, so that we can help you in evaluating the application. Simply address your nearest G-E Apparatus Sales Office or Apparatus Department, General Electric Company, Schenectady 5, N. Y.
TELEVISION STANDARD SIGNAL GENERATOR

MODEL 90

SPECIFICATIONS:

• CARRIER FREQUENCY
  RANGE: Continuously variable from 20 to 250 megacycles, in eight ranges.
  ACCURACY: Crystal frequency standard permits setting to .01%. Dial scale may be set to .1%.
  STABILITY: Warm-up drift less than .05%.
  LEAKAGE: Less than 10 microvolts.

• MODULATION
  Continuously variable from zero to 100%.
  ENVELOPE: Sinusoidal, or composite television. Bandwidth to 3 db is 4 Mc.
  Rise time from 10% to 90% modulation 0.15 microsecond. Overshoot less than 5%.
  INPUT IMPEDANCE: 75 ohms ± 10% (RMA Standard).
  INPUT LEVEL: 1.5 volts peak to peak minimum level for 100% modulation. Black negative polarity.
  MODULATION PERCENTAGE: Zero to 110%; plate modulation.

• OUTPUT
  LEVEL: Continuously variable from 0.3 microvolt to 0.1 volt balanced to ground (measured at 100% modulation level).
  IMPEDANCE: (a) 107 ohms line to line (balanced).
  (b) 53.5 ohms line to ground (unbalanced).
  (c) Suitable pads may be employed to alter these impedances.

• DIMENSIONS
  OVERALL: Height—58 1/2"; Width—28 1/4"; Depth—25 1/8".
  WEIGHT: Model 90—302 pounds.
  External Voltage Regulator 92 pounds.
  POWER SUPPLY: 117 volts, 60 cycles.

THE FIRST COMMERCIAL WIDE-BAND, WIDE-RANGE SIGNAL GENERATOR EVER TO BE DEVELOPED

The Model 90 employs a master oscillator, buffer amplifier and modulated power amplifier. The push-pull buffer eliminates incidental frequency modulation.

Features: A self-contained crystal calibrator and individually calibrated dial scales permit frequency settings to a high degree of accuracy. A built-in video modulator with manual or automatic dc inserter, designed to operate from a standard RMA composite signal. Continuous monitoring is provided by built-in oscilloscope.

This signal generator meets the most exacting standards required for high-definition television use.

ADDITIONAL DATA ON REQUEST

THE ELECTRON ART

A SPECIALLY-DESIGNED TETRODE or a standard pentode can be operated with the second grid acting as the anode of an oscillator and the plate acting as an electron reflector; the potential of the reflector controls the transit time and hence the frequency of oscillation, as described by Jerome Kurshan in a paper entitled The Transitron, An Experimental A.F.C. Tube, presented before the National Electronics Conference in November and published in the RCA Review for December.

Used as the local oscillator in an f-m receiver (88-108 mc) with automatic-frequency control, an experimental tube showed a sensitivity of 100 ke per volt, thus counteracting warmup drift at the high-frequency end of the band by a factor of 4.5. Tests of commercial miniature tubes in the accompanying circuit showed that the 6BE6 with its third (r-f signal) grid as reflector and biased to at least 20 volts negative was one of the strongest oscillators. The 9001 gave the greatest control sensitivity, but oscillated very weakly; the 6AK5 performed most reliably but had low control sensitivity. A special Transitron tube was built sufficient to drive the modulator. The modulator is as shown in Fig. 2A. The accompanying tabulation gives data taken with it for two conditions: (1) two 304TL's in parallel, one having reduced audio excitation, and (2) three 304TL's in parallel, again with one having reduced excitation.

Although this method of suppressing the negative peak so that amplitude modulation in excess of 100 percent can be obtained without sideband splatter may not be desirable for high-power transmitters, it is economical for some uses of low-power transmitters. For example, using this method, the watt-hours at the increased voltage, with appropriate batteries, obtainable from such portable equipment as that used by the forestry fire wardens can be increased without increasing the weight of the equipment.
CUT THE HIGH COST OF COILS

with Belden CELENAMEL*

You can cut your fine-wire coil production time very substantially because Belden Celenamel* has eliminated the need for a stripping operation.

You save money, too, because you eliminate the greatest cause of rejections.

NO STRIPPING NECESSARY!
It is unnecessary to remove the Celenamel* insulation, in soldering operations. Simply dip the leads in a lead-tin bath at 600°F to 700°F or apply soldering iron directly.

Available in sizes 39 and finer.

* Trade-Mark Registered.
Celenamel* magnet wire—a copper wire insulated with a film of cellulose acetate combined under heat with other resinous materials. The film so produced is tough, flexible, continuous, and of high dielectric strength. The insulation additions produced with Celenamel* have close and uniform tolerances.

Belden WIRED FOR INDUSTRY
We show here 3 of our standard types of rheostats—(1) type 2462 F, a most compact 10 watt model which fits into exceptionally small space (only 3/4 inch from back of panel); (2) our rugged type M 25 watt rheostat which offers exceptional heat dissipation for size; and (3) the widely used line—type B 50 through F 500—available in 50, 100, 150, 300 and 500 watts, all designed with massive winding core, exceptionally rugged terminal screws and other exclusive advantages.

As one of the oldest manufacturers of rheostats and resistors we ask you to consult with our engineers about your specific requirements.

We show here 3 of our standard types of rheostats—(1) type 2462 F, a most compact 10 watt model which fits into exceptionally small space (only 3/4 inch from back of panel); (2) our rugged type M 25 watt rheostat which offers exceptional heat dissipation for size; and (3) the widely used line—type B 50 through F 500—available in 50, 100, 150, 300 and 500 watts, all designed with massive winding core, exceptionally rugged terminal screws and other exclusive advantages.

As one of the oldest manufacturers of rheostats and resistors we ask you to consult with our engineers about your specific requirements.

HARDWICK, HINDLE, INC.
Rheostats and Resistors
Subsidiary of
THE NATIONAL LOCK WASHER COMPANY
NEWARK 5, N. J. Established 1886 U.S.A.
Viewed from any angle

...KARP builds finer metal cabinets

No matter how you look at it, you'll find many reasons why Karp-built cabinets, housings and enclosures will add value to completed equipment assemblies.

We will follow your designs with fidelity, or our design specialists can suggest design ideas which will enhance appearance, achieve ruggedness, save space or weight. Our work insures uniformity and accuracy— which mean production economy both in the fabrication and in your own assembling operations.

At your service is our staff's combined "know-how" gained in 23 years of specialization. Our tool and die department is so complete that we often save customers special die costs. We make our own dies and do all our own finishing. We do all kinds of welding—including spot-welding of aluminum with electronic timing controls.

It's the hard-to-do type of craftsmanship that brings out the best in our trained minds and skilled hands. We invite your inquiries on any sheet metal fabrication.

Any Metal • Any Gauge • Any Size
Any Quantity • Any Finish

KARP METAL PRODUCTS CO., INC.
215 - 63rd STREET, BROOKLYN 20, NEW YORK

Custom Craftsmen in Sheet Metal
Would

INSTANTANEOUS

recording of electrical phenomena from D.C. to 100 c.p.s. help in your research?

It's a fact — permanent, instantaneous ink-on-paper recordings by Brush Oscillographs make their use almost unlimited!

Accurate recordings of voltages, pressures, radiation intensity and countless other phenomena can be made over a frequency range of D.C. to 100 c.p.s. Either A.C. or D.C. signals can be measured. Whenever desired, recordings may be stopped for notations on chart-paper.

Investigate Brush measuring devices before you buy . . . they offer more for your money. Why not have a Brush representative call? At no obligation, of course.

Just call or write — today — you'll find it worth a few seconds' time!

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The Colpitts oscillator circuit shown in the diagram was used to test commercial tubes in this AFC circuit. For f-m receivers with a standard i-f of 10.7 mc, the local oscillator normally ranges from 99 to 119 mc. Miniature tubes are most suitable for this range. Also, the Colpitts circuit, using the interelectrode capacitances for feedback and with the cathode grounded, is the simplest to use at these frequencies. For transit-time control, it is important that the cathode be at ground potential.

Unfortunately, neither end of the tuned circuit is at ground. It is necessary for this application that there be an r-f field between the second grid and the reflector, otherwise the transit of the electrons would effectively terminate when they passed the second grid (anode), because thenceforth they could not induce voltage in the resonant circuit. Practically, it is simplest to have the reflector at r-f

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Light-duty motor, type H3. Torque rating .018 pound-inch at 3.6 rpm. at 60 cycles.

Medium-duty motor, type HS. Torque rating from .20 pound-inch at 6 rph. to .50 pound-inch at 1 or 2 rph. at 60 cycles.

Medium-duty motor, type B. Torque rating of various models from .015 pound-inch at 60 rpm. at 60 cycles to .375 pound-inch at 1 rpm.

Count on a Telechron synchronous electric motor for the absolute accuracy and dependability so vital in automatic timing, switching, control and recording instruments. These self-starting motors are engineered and precision-built for long, continuous service in an almost limitless range of industrial applications.

Because they operate in perfect synchronism with any commercial frequency, they have to be accurate. . . can't run faster or slower. The replaceable, high-speed rotor unit is sealed in to keep out dust, and lubricated by Telechron's exclusive oiling system for long life. Fields are mounted externally for easy service and lower operating temperatures.

Telechron motors are available in many different types, torque ratings and terminal-shaft speeds. Torque ratings are conservative. Motors are available for all standard commercial frequencies.

These motors give you the advantages of the longest engineering and manufacturing experience in the field. They're built by the largest producer of synchronous electric timing motors for over 25 years. Everybody is Underwriters Laboratories approved. Telechron application engineers are always glad to discuss your special requirements. Address Motor Advisory Service, Dept. M, Telechron Inc., Ashland, Massachusetts.

For accurate long-life instruments PICK TELECHRON MOTORS

Telechron motors are meeting the need for greater accuracy and dependability in many industrial applications. They include:

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THE FIRST AND FAVORITE SYNCHRONOUS ELECTRIC TIMING MOTOR

ELECTRONICS — December, 1948
In the field of electronics and the electrical goods industry, MOSINEE stands for paper-base processing materials with scientifically controlled chemical and physical properties, high quality standards and dependable uniformity... with good dielectric strength, high tensile or tear strength; proper softness or stiffness; creped with controlled stretch or flexibility; specified pH for maximum-minimum acidity or alkalinity; accurate caliper, density, liquid repellency or absorbency... or other technical characteristics vital to your quality standards and production requirements.

MOSINEE PAPER MILLS COMPANY • MOSINEE, WIS.

"Essential Paper Manufacturers"

SURVEY OF NEW TECHNIQUES

MINIATURIZATION of airborne equipment is now being carried on by the Air Materiel Command at Wright Field, Patterson, Ohio with the objective of reducing electronic gear to 20 percent of its present size, but without impairing performance. By redesigning tubes to subminiature size, the same characteristics are being obtained in 80-percent less space for amplifiers, 90-percent less space for rectifiers. The size and weight of transformers has been reduced to a third their present values.

In addition to these and other reductions in sizes of components, the compactness of the assembled equipment contributes to the reduction in overall bulk.

Printed radio circuit techniques are used to minimize the sizes of low-level circuits; cooling, using liquid Freon, enables parts in high-level circuits to be grouped more compactly and at the same time protects the equipment from atmospheric effects (fungus and oxidation) and reduces the possibility of burnouts so that the equipment will outlast conventional gear. The need for more electronic equipment in modern high-speed aircraft and the reduced space for such equipment makes this miniaturization necessary for expanded applications of electronics in aviation.

A NEW HEARING AID A-BATTERY extends the life of such subminiature batteries to 80 hours (4.25 ampere-hours under ASA test). Hearing aid A-batteries using two pen-sized flashlight cells gave 8 hours service and have been improved so that they give 24 hours service. Although the new National Carbon Co. unit is the size of these dual pen-cell batteries (A on accompanying graph) used in single-unit hearing aids, it has the life of the larger cell (see B on graph) which are used in old-style hearing aids having...
Exclusive Manufacturers of Communications Network Components

TOROIDAL COIL FILTERS
AND TOROIDAL COILS DESIGNED
FOR CRITICAL APPLICATIONS

Extremely sharp side band suppression filter. Available in either low or high pass.
Size: 2 1/2 x 4 x 2 1/2.

S-105 Wideband Filter

Wide band sharp cutoff band pass.
Size: 2 x 3 1/2 x 6 3/8.

Tone channel filter for extremely high crossover attenuation requirement.
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Crystal filter for narrow band pass applications too critical even for toroidal coils.

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"A N" CONNECTORS

Ruggedness for AIRCRAFT SECURITY . . .

Stronger shells, stronger insulation, lowest resistance contacts with wiring solder pockets aligned for quick, convenient connections. Built to quality standards beyond the already rigid specifications for AN Connectors. Amphenol pioneered in the engineering of this rugged and efficient line of connectors for use in military aircraft. To be sure of top performance, specify Amphenol AN Connectors and Fittings.

Write for the new AN Catalog A-1. It's abundant with the latest connector information and contains timesaving listings and indexes for the engineer and buyer. Mail your request on company letterhead to Department 13-B.

AMERICAN PHENOLIC CORPORATION
1830 SOUTH 54TH AVENUE, CHICAGO 50, ILLINOIS
COAXIAL CABLES AND CONNECTORS - INDUSTRIAL CONNECTORS, FITTINGS AND CONDUIT - ANTENNAS - RADIO COMPONENTS - PLASTIC FOR ELECTRONICS

Comparison of two E-batteries commonly used in hearing aids (A) and (B) with new cell (C)

A PLASTIC BASE for printed circuits is being used by Telex, Inc., Minneapolis, manufacturer of hearing aids. The chief advantages in using plastic bases are lightness, flexibility, durability, and moisture resistance. Conductors and resistors are etched into the surface of the plastic by the silk-screen process and then the circuit is hermetically sealed. The new printed circuit used a 0.025 inch thick piece of polystyrene (Styron) which
Here's on-the-job proof of instrument performance!

largest hydroelectric development in the world . . . employs WESTINGHOUSE INSTRUMENTS

Westinghouse instrument specialists are available in the field for consultation on your instrument problems. Call your nearest Westinghouse office, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania.

Send for booklet B-2209-A, Communication Instrument Booklet B-3283, or Switchboard Instrument Booklet B-4363.

The Coordinated Design and Styling of Westinghouse instruments contribute greatly to the space-saving arrangement and excellent appearance of this installation.

For such complex and exacting instrument applications, reliability is a "must". Every part of Westinghouse instruments is completely designed and manufactured by Westinghouse to insure proper relation with all other parts. This undivided responsibility and attention to all details assures you of unfailing performance.

What are YOUR electrical measuring problems?

Would they include—reliable performance . . . styling . . . size . . . readability . . . or different types of service . . . portable . . . switchboard . . . panel . . . recording?

The vast lines of Westinghouse electrical measuring instruments provide you with the answers to all of these problems. Every Westinghouse instrument is backed up by more than 60 years of skill, "know-how", and experience in every field of industry.

Westinghouse Instruments Also Provide You With

- Dials that stay white under all conditions.
- Magnets that stay permanent.
- Springs that remain constant for life.
- Pivotswith high shock capacity and low friction.
- Magnets that remain permanent.
- Quick delivery of more different ratings and types.
- Complete Nationwide Service.

YOU CAN BE SURE. . . IF IT'S
Westinghouse

Electrical Measuring Instruments for ANY Job

Shipshaw No. 2 of the Aluminum Company of Canada on the Saguenay River in Quebec, Canada, is the largest hydroelectric development in the world contained in a single powerhouse. Twelve giant hydro units, with a total generating capacity of 1,200,000 horsepower, are controlled from the complex board, shown above.
PAMARCO tensions are the low-cost answer to lower coil winding costs. The free-running action of the PAMARCO tension practically eliminates wire breakage, shorted turns; allows higher winding speeds. Their compact size permits many more simultaneous coil winds on any machine. Simple thumb screw adjustment makes it possible for the operator to rapidly adjust for any gauge wire...no tools or special skill are required.

* The economies effected with PAMARCO tensions are a proven fact in hundreds of installations. For detailed information call or write today without obligation.

THE ELECTRON ART

...IN THE NEW YORK TRANSFORMER CO., INC.
WINDING DEPT., PAMARCO DE-REELING TENSIONS
REDUCE WINDING COSTS AND REJECTS*

measures 1½ inches in length by 1½ inches wide. The one-piece Telex "99" hearing aid circuit using this polystyrene base weighs 5 ounces including batteries, while the plastic base itself weighs only ¼ of an ounce.

Radiations similar to cosmic rays will be generated by the 1,000,000,000 electron-volt accelerator to be completed in 1951 at Stanford University, Calif. The prototype electron accelerator (ELECTRONICS, p 144, Nov. 1947) was 12 feet long and produced 6 mev. The full-scale wave guide accelerator, being developed under direction of Dr. W. W. Hansen, will be 160 feet long.

Sensitivity of the zeus ionization chamber circuit can be increased by using a new subminiature tube having a maximum grid current rating of $2 \times 10^{-13}$ amperes. The tube's filament, rated at 1.25 volts and 10 ma, is designed for operation directly from a dry cell. The new CK571AX tube has a slightly higher mutual conductance and gain than the CK5697/CK570AX, which was originally designed for the zeus circuit (see ELECTRONICS, p 182, Nov. 1947 and p 196, Jan. 1948), and can therefore be used in this circuit. This new Raytheon tube can be employed in various portable instruments for measuring radioactivity.

Magnetic pole face shims for the synchrocyclotron now being built by the Carnegie Institute of Technology are radically different from conventional design. In addition to the series of steps usually machined into the profiles of pole tips, deep concentric grooves are being milled near their edges. As a result, the new design extends the useful radius of the magnet to 96.5 percent of the actual shim radius (compared to 85 to 90 percent heretofore possible). In this way the 150-ton cyclotron will be able to produce 400-mev particles with only 160-ton pole pieces having 141.65-inch, 30-ton shims. (Existing machines in the same energy class require from 2,000 to 4,000 tons of steel.) The design constituted the thesis of M. H. Foss, for which he was awarded his doctorate last June.
NEW ELECTROLYTICS
fully dependable
TO 450 VOLTS AT 85°C

for TELEVISION'S exacting applications

Designed for dependable operation up to 450 volts at 85°C, these new Sprague electrolytics are a good match for television's severest capacitor assignments. An extremely high stability characteristic is assured, even after extended shelf life, thanks to a special Sprague processing technique. Greatly increased manufacturing facilities are now available.

Your inquiries concerning these new units are invited.

SPRAGUE ELECTRIC COMPANY - NORTH ADAMS, MASS.
You can stand pat with windings by COTO-COIL. There is no gamble because there's nothing that can beat them.

We place our 31 years of experience at your service, plus unexcelled facilities for producing the coils you're looking for.

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BOBBINS • PAPER INTERLEAVE
ACETATE INTERLEAVE • COTTON INTERWEAVE
TAPED FORM WOUND
UNIVERSAL SINGLE OR MULTI-PIE CROSS WOUND

We welcome the hard to please

COTO-COIL CO., INC.
COIL SPECIALISTS SINCE 1917
65 Pavilion Ave., Providence 5, R. I.

SECONDARY PRODUCTS
(continued from p 130)

seconds per point. In case of trouble thermocouples can be cut out in banks of 20 at a time. When a temperature reaches a preset limit an alarm sounds.

Subminiature Tube
RAYTHEON MFG. CO., Newton, Mass., has added type CK571AX electrometer tube to its subminiature line. The filament is designed to be operated directly from an ordinary battery cell and draws 10 ma at nominal rating of 1.25 volts.

Besides its applications in the 2-tube zeus circuit it may be used in single tube circuits, and is particularly useful in radioactivity measuring instruments.

Tape Recording Head
THE INDIANA STEEL PRODUCTS CO., 6 N. Michigan Ave., Chicago 2, Ill. Model TD-704 magnetic tape recording head, used for both recording and playback, is designed for high-impedance circuits and gives best results with a track 0.2 inch
Complete terminal equipment occupies a double cabinet 7' wide x 2' 4"
deep x 6' 6" high, and aerials may be up to 100' from the main equipment.

Write for our Bulletin No. 511 which gives further facts and figures.

Where the installation of wires or cables is hazardous or uneconomical,
Standard Time-sharing Multiplex provides a thoroughly reliable telephone trunk system, easy to install and maintain. Each equipment deals with up to 24 channels, handling any kind of A.F. traffic in the 300-3400 c/s range, including teleprinter and automatic telephone signals. Time-sharing Multiplex ensures low crosstalk and noise levels, and fading does not affect speech levels. An UHF carrier is used and the normal line-of-sight range (approx. 35 miles) may be extended by automatic repeaters.

Standard Telephones and Cables Limited
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Radio Division

ELECTRONICS — December, 1948
TRANSFORMER CANS
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We are also equipped to fabricate special sizes and shapes (round, square and rectangular) of transformer cans to your own specifications. Tell us your requirements and we will be glad to submit estimates.

Important: All Craft Transformer Cans are drawn in one piece.

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MANUFACTURING CO.
3949 W. Schubert Ave., Chicago.

Stainless Steel Specialists

NEW PRODUCTS (continued)

wide. Using tape with a coercive force of 300 oersteds at a speed of 7½ inches per second, operating bias level at 40 kc is 1.7 ma and the audio signal current for standard recording level is 0.15 ma.

Tone Generator

RADIO CORP. OF AMERICA, Camden, N. J. Type WA-26A portable tone generator is designed for use in broadcasting studios in equalizing remote telephone lines. The circuit is an R-C type allowing selection of ten frequencies from 50 to 15,000 cps. Output is metered and calibrated in dbm.

High-Voltage Generator

HIGH VOLTAGE ENGINEERING CORP., 7 University Road, Cambridge, Mass., announces the model L Van de Graaff high-voltage generator which provides adjustable constant potential up to 250,000 volts. A voltmeter reads terminal

December, 1948 — ELECTRONICS
Have the facts at your fingertips

With this compact folder, you can obtain information on TAMCO products readily. When you want approximate physical properties, a chemical analysis, or commercial applications of specific products—clear concise charts provide them at a glance. That's why you will want this helpful booklet whether you are interested in TAM ceramic, chemical or metallurgical products. Address your request to our New York City office.

More detailed information on Titanium or Zirconium products is available also upon request. These data have been compiled to meet the demand for authentic information on these products from the source most closely identified with their development. It may prove advantageous to discuss certain problems and applications with our sales engineers.

* When you write for your reference folder, let us know if our Field Engineering can be of assistance at this time.

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TITANIUM ALLOY MANUFACTURING COMPANY
Executive and Sales Offices: 111 BROADWAY, NEW YORK, N.Y. General Offices and Works: NIAGARA FALLS, N.Y.
Western Union's new Telefax Receiver, the Desk-Fax model, is a compact facsimile telegraph sending and receiving system for desk use. Accurate timing is one of the fundamentals of its ingenious operation and the new device is wired for dependable Haydon timing. A ±1600 series motor is used to drive the scanning stylus from left to right by means of a drum and cord. The synchronous motor operation permits constant speed stylus movement and both sending and receiving units run at the same speed.

Western Union pioneers in communications, Haydon in the science of timing...developing devices and motors which make possible progress in all fields of industry. In addition to producing timing motors and a wide range of standard timers, Haydon also specializes in design engineering and production of custom-built timing devices for specific volume applications. Wherever timing is important, Haydon is ready to assist.

Wire or write for a Haydon representative to call. If it’s time for timing, it’s time for Haydon. An Engineering Data Catalog is available. For quick reference, see Haydon Catalog, Sweet's File.

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HAYDON

MANUFACTURING COMPANY, INC.

TORRINGTON CONNECTICUT

SUBSIDIARY OF GENERAL TIME INSTRUMENTS CORPORATION

Motor-Starting Relay

POTTER & BRUMFIELD SALES Co., 549 W. Washington Blvd., Chicago 6, Ill. The MS4A, a 3 h-p motor-starting relay, is fitted with large silver cadmium oxide contacts for high current loads. It is available with 800-ohm winding for 115-volt 50 to 60-cycle motors or with 2,100 ohm coil for 230-volt 50 to 60-cycle motors.

Recording Sound Analyzer

SOUND APPARATUS Co., 233 Broadway, New York 7, N. Y. Frequency analysis of a complex wave from 25 to 750 cps is recorded on a 4-inch wide calibrated scale by the FR and FR-I recorders in conjunction with the General Radio 760-A sound analyzer. Full scale
THE football star who eludes the players of the rival team and sends the pigskin hurtling down the field to a goal has "the extra something that spells top performance."

For outstanding service in every rectifier application specify Seletron Selenium Rectifiers. They have the "extra something" that spells top performance.

From the large power stacks to the miniature units for radio and television, Seletron uniformity and precision methods of manufacture insures user satisfaction. Efficient—dependable, durable under the severest service conditions.

Furnished in a wide variety of voltages and currents to meet the individual requirements.

**Seletron**

**SELENIUM RECTIFIERS**

**Built on Aluminum**

**MINIATURE SELETRON Rectifiers**

**SPECIFY SELETRON MINIATURE Selenium Rectifiers FOR RADIO AND TELEVISION APPLICATIONS**

The complete family of miniature Seletron Rectifiers is designed for use on a nominal 115 A-C line, to provide direct current for radio, television sets, amplifiers, and other low power applications. Instant starting, small size, long life and simplicity of installation are a few of many features of the Seletron Family.

**CODE NUMBER**

<table>
<thead>
<tr>
<th>SL1</th>
<th>SM1</th>
<th>SP1</th>
<th>SR1</th>
<th>SQ1</th>
</tr>
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<tbody>
<tr>
<td>75 ma.</td>
<td>100 ma.</td>
<td>150 ma.</td>
<td>200 ma.</td>
<td>250 ma.</td>
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**Plate Height**

- 7/8"
- 1"
- 1 1/2"
- 1 3/4"
- 1 5/8"

**Plate Width**

- 1 1/8"
- 1 1/16"
- 1 1/16"

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To insulate magnet wire so that it will give long, dependable, satisfactory service, all you have to do is to purchase the finest silks, cottons,nylons, glass and celanese. Wrap these insulations in precise layers around a metal core drawn to tolerances of specified exactness and you have a really high grade magnet wire.

At Wheeler Insulated Wire Company, in Bridgeport, we've been doing this since 1905. Users of Wheeler Insulated Wire products have come to recognize our magnet wire as being of good basic design and engineering, made by skilled workmen and subject to rigid inspection. They know these qualities are to be found in every pound of magnet wire they purchase from us.

The Wheeler Insulated Wire Company can place at your disposal a staff of experienced wire engineers. Let us help you with your wire problems. There's no obligation for this service. Write today for complete information.

NEW PRODUCTS (continued)

width is calibrated linearly in equal 20, 40, 60 or 80-db divisions. The recorder is separately usable as a sound, power, or voltage level recorder.

Anti-Feedback Amplifier
DAVID BOGEN CO., INC., 663 Broadway, New York City. The HX50 amplifier incorporates the new anti-feedback control, making microphone placement less critical. A dual tone corrector controls bass and treble ranges. Bass control is from -20 to +20 db at 60 cycles. Treble control of +20 to -20 db at 10,000 cycles is also provided. The unit has three microphone channels and one phone input.

Geiger Counter
NUCLEAR INSTRUMENT & CHEMICAL Corp. (formerly Instrument Development Labs., Inc.) 223 West Erie St., Chicago 10, Ill. Model D-46 Q-gas Geiger counter uses a formulated gas for detection of soft ionizing radiation like that from C⁰ or S⁰. Anode potential used is 1,450 volts. The pulse output will operate a scaling unit with an input sensitivity of 0.25 volt.

Voltage Regulators
SORENSEN & Co., Inc., 375 Fairfield Ave., Stamford, Conn. The new type 5 and 10-kva voltage regulators are available in either 115 or 230-volt models. Regulation ac-
TO SERVICE PRESENT AND FUTURE T-V SETS...

THE MEGA-LINE OF INSTRUMENTS COVERS ALL CHANNELS

Think that statement over before you spend even a few dollars for any sweeping oscillator...

With any Mega-Sweep you can cover any proposed frequency... When any future channel, even above 500 megacycles, is added you will not have to fuss around with special adjustments or added equipment... or buy new equipment... The MEGA-SWEEP covers it with ease and accuracy...

THE MEGA-SWEEP

Wide Range Sweeping Oscillator... DISPLAYS PASS BAND... Features: Frequency Range—50 kilocycles to 500 megacycles and up to 1000 mc... Frequency Sweep Adjustable from 30 megacycles to 30 kilocycles throughout the complete spectrum... Continuously variable attenuator... Low amplitude Modulation while sweeping—less than 0.1 DB per megacycle... Precision wavemeter. High and low level output. Sweep voltage output for driving oscilloscope. Price $395.00 f. o. b. factory

THE MEGA-MARKER SR

For Rapid and Accurate Alignment of Television Receivers. The MEGA-MARKER SR. provides a precise source of frequencies (accuracy .01%) at the sound carrier in each of the twelve television channels. MEGA-MARKER SR. can also be used alone for the alignment of the local oscillator for all twelve channels. The single-dial control gives a rapid and efficient means of frequency selection. The MEGA-MARKER SR. facilitates the alignment of the r. f. channels in the same manner that the MEGA-PIPPER and MEGA-MARKER facilitate the i. f. alignment. MISC. 117 volt 60 cycle Size 8 x 16 x 8 Weight 15 pounds Price $195.00 f. o. b. factory

THE MEGA-MARKER

Precision variable marker oscillator having a range of either 19 to 29 or 29 to 39 megacycles for the television i. f. band. Crystal oscillator for the alignment of intercarrier i. f. and discriminator (4.5 mc). A large easily read dial provides over 12 inches of calibrated scale length. Thus it may be read to accuracies of 0.02 megacycles. Included in the MEGA-MARKER is a crystal oscillator which provides accurate check points. The MEGA-MARKER is a valuable accessory for television applications of the MEGA-SWEEP and MEGA-MATCH. For a high order of stability the regulated power supply of the MEGA-SWEEP or the MEGA-MATCH is used. Weight 5 lbs. size 7 x 10 x 6 Price $60.00 f. o. b. factory

THE MEGA-PIPPER

The MEGA-PIPPER is a new production and service alignment instrument. By the use of this unit in conjunction with the MEGA-SWEEP or MEGA-MATCH it is possible to quickly and accurately align television i. f. amplifiers. The MEGA-PIPPER gives four precise crystal positioned pips. These pips establish the picture and sound i. f. carrier points, and also the adjacent channel carrier points. Thus the MEGA-PIPPER is an instrument which will save many hours of time spent in alignment. Inasmuch as the pips are fed directly into an oscilloscope, the pips are visible at all times, even in the traps where the highest precision is desired. Self contained power supply. Weight 15 lbs. Price $150 f. o. b. factory

WRITE FOR FULL SPECIFICATIONS

KAY ELECTRIC CO., 25 MAPLE AVENUE, PINE BROOK, N. J.

Also Manufacturers of the Megalyzer, Mega-Match and Mega-Pulser.
Fishing reel gears must operate smoothly at a speed of 3000 revolutions per minute or more, when a cast is executed. These gears must also withstand the strain of hauling in a fighting fish of unpredictable size and strength, thus rendering a dual purpose: speed and velvety smoothness in one direction—strength and durability in the other.

Instruments and machines have individual gear problems. For over a quarter of a century, Quaker City Gear Works has solved thousands of them and produced millions of gears of every description up to 60" in diameter for manufacturers in many diversified industries.

Aircraft controls, dental drills, electric clocks, gauges, indicators, heat controls, machine tools, radar, radios, washing machines and motion picture projectors are but a few of the many conveniences of modern progress which depend upon the heartbeat of Quaker City Gears. Your gear problem is our business, our large productive capacity is at your service.

YOUR INQUIRIES WILL RECEIVE PROMPT ATTENTION

The heart of the Outdoorsman Castomatic reel illustrated above is but one of many gear trains developed by our engineers and produced in our fully equipped plant.

Quaker City Gear Works
INCORPORATED
1910 N. Front Street, Philadelphia 22, Pa.

Loudspeaker Unit
Tarrytown Metalcraft Corp., 82 Chestnut St., Tarrytown, N. Y. The Han-D-Vox speaker unit is available in both indoor and outdoor models for theatre installations. Enclosed in a cast-aluminum case, it contains a 4-inch permanent-magnet speaker and a constant-impedance sound control or L-pad whereby line impedance is matched and maintained.

Code Machine
Ultradyne Electronics, Oswego, Oregon. Designed for radio telegraph instruction, the radio code machine RCM-1 sends at speeds between 4 and 80 words per minute. The many available types of tape serve particular functions of instruction, and although the overall accuracy is 0.5 percent. Line frequency changes between 50 and 60 cycles do not affect output voltage or performance of either regulator. For further information ask for catalog S-348.
For wider frequency range...top writing rates...increased brightness...it's DU MONT

High-voltage Oscillography

The basis is the Type 5RP-A Cathode-ray Tube operating at an accelerating potential up to 29,000 volts maximum. This achieves: (1) Greatly increased brightness; (2) Observation or recording of traces hitherto invisible; (3) Vastly increased writing rates even better than 400 inches per microsecond;

(4) Optical magnification by projection lenses such as Du Mont Type 2542. Although deflection sensitivities are slightly less than those of low-voltage cathode-ray tubes, high-voltage oscillographs produce smaller spot size and higher brightness, thereby presenting a finer, better resolved trace.

And here's the Du Mont selection of high-voltage oscillographs:

Type 281-A: Devoid of internal deflection amplifiers, there are no frequency response limitations within the ratings of its Type 5RP-A tube. Phenomena have been recorded photographically at writing speeds of 85 inches per microsecond.

Type 250-H: Covers range from d-c to 200 kc. Potentials containing both d-c and a-c components may be examined. Many special features for general usage include: linear time-base of unusual flexibility; automatic beam control on driven sweeps; internal calibrator of signal amplitude. This is a high-voltage oscillograph with maximum accelerating potential of 13,000 volts. Recordable writing rate of approximately 40 inches per microsecond.

Type 248-A: Frequency range of 20 cps to 5 mc. Specifically intended for investigation of pulses containing high-frequency components of recurrent or transient nature. For this purpose it provides these necessary characteristics: High frequency recurrent sweeps; short-duration driven sweeps; timing markers; signal delay network. Accelerating potentials up to 14,000 volts at recordable writing rate of approximately 69 inches per microsecond.

Type 280: A precision time-measuring oscillograph with range of 10 cps to 10 mc. Sweep speeds as high as 0.25 microsecond/in. are available. Duration of any portion of signal measured on 0.25 microsecond/in. sweep to an accuracy of ±0.01 microsecond. Intervals greater than 5 microseconds read on calibrated dial to accuracy of ±0.1 microsecond. Ready application to precise measurement of duration of waveform of various components in the composite television signal. Accelerating potential adjustable from 7,000 to 12,000 volts. Recordable writing rates up to 63 inches per microsecond, with commercially available equipment.

Type 250-H: Covers range from d-c to 200 kc. Potentials containing both d-c and a-c components may be examined. Many special features for general usage include: linear time-base of unusual flexibility; automatic beam control on driven sweeps; internal calibrator of signal amplitude. This is a high-voltage oscillograph with maximum accelerating potential of 13,000 volts. Recordable writing rate of approximately 40 inches per microsecond.

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LITERATURE ON REQUEST
NEW PRODUCTS (continued)

Speed of a tape may be 5 wpm, the characters are keyed individually at between 15 and 20 wpm. Brochures are available.

Tele and F-M Antenna
TRICRAFT PRODUCTS CO., 1535 N. Ashland Ave., Chicago, Ill. Model 500 f-m and television antenna shown weighs only 2½ pounds and is provided with 300-ohm line to the receiver.

Carrying Case
RADIO CORP. OF AMERICA, Harrison, N. J. Especially designed for transporting test and measuring equipment, the new carrying case
HiVolt Supplies are self-contained in hermetically sealed metal containers. They are designed to transform low voltage AC to high voltage—low current DC.

- **PS-30** 30,000 VDC; 1 Ma.; dimen. 7" x 7" x 7"
- **PS-10** 10,000 VDC; 2 Ma.; dimen. 3 3/4" x 4 9/16" x 8"
- **PS-5** 5,000 VDC; 5 Ma.; dimen. 3 3/4" x 4 9/16" x 6"
- **PS-2** 2400 VDC; 5 Ma.; dimen. 3 3/16" x 5 1/2"
- **PS-1** Capacitor 1000 VDC; dimen. 3 3/4" x 3 3/16" x 5 1/2"

**High Voltage-Low Current DC Power Supplies for**

- Television
- Radiation Counters
- Photoflash Devices
- Electrostatic Precipitators
- Spectrographic Analysers
- Oscilloscopes, etc.

*Write for descriptive literature*

Plasticon Capacitors, Pulse Forming Networks and HiVolt Power Supplies are available at all leading jobbers.
See why Leaders in TELEVISION choose MYCALEX 410 insulation

In television seeing is believing... and big name makers of television sets are demonstrating by superior performance that MYCALEX 410 molded insulation contributes importantly to faithful television reception.

Stability in a television circuit is an absolute essential. In the station selector switch used in receivers of a leading manufacturer, the MYCALEX 410 molded parts (shown here) are used instead of inferior insulation in order to avoid drift in the natural frequency of the tuned circuits. The extremely low losses of MYCALEX at television frequencies and the stability of its properties over extremes in temperature and humidity result in dependability of performance which would otherwise be unattainable.

Whether in television, FM or other high frequency circuits, the most difficult insulating problems are being solved by MYCALEX 410 molded insulation... exclusive formulation and product of MYCALEX CORPORATION OF AMERICA. Our engineering staff is at your service.

Specify MYCALEX 410 for:
1. Low dielectric loss
2. High dielectric strength
3. High arc resistance
4. Stability over wide humidity and temperature changes
5. Resistance to high temperatures
6. Mechanical precision
7. Mechanical strength
8. Metal inserts molded in place
9. Minimum service expense
10. Cooperation of MYCALEX engineering staff

MYCALEX CORP. OF AMERICA
"Owners of 'MYCALEX' Patents"

Plant and General Offices, CLIFTON, N. J. Executive Offices, 30 ROCKEFELLER PLAZA, NEW YORK 20, N. Y.
WG-274 is an aid to a-m, f-m and television servicing. Extra storage compartment at right provides space for test leads, adaptors, probes and other accessories. List price is $16.95.

Wiring Connector

ARK-LES SWITCH Corp., 55 Water St., Watertown 72, Mass., has developed a new disconnect terminal designed to speed the wiring of electrical equipment. A flat blade staked to the connecting wire snaps into a rigid receptacle in which it is retained by spring pressure. The unit features low contact resistance. The terminal assembly illustrated lists at a rating of 20 amperes, 125-250 volts a-c.

Electric Motor

MISSION ELECTRIC MFG. Co., 132 West Colorado Blvd., Pasadena, Calif. The new electric motor with 0.005-horsepower rating has an rpm rating of 5,000 to 20,000 under load and 10,000 to 40,000 free speed. The unit weighs less than 11 ounces.

Photocounter

POTTER INSTRUMENT CO., INC., 136-56 Roosevelt Ave., Flushing, N. Y. Model 310 photoelectric counter can be used at rates up to 6,000 per minute. Last digit of the number is registered on neon glow lamps and the rest of the digits are indi-
Components which are contributing an essential service in the progress of radiation instrumentation.

10 mil-filament subminiature tubes

VX-41A
Electrometer

VX-32B
Triode

VX-21
Diode

1B85
The new 1B85 Thyrode is a thin rib re-enforced aluminum self-quenched, beta-gamma counter tube operating at 900 volts. Wall thickness 50 mg/sq. cm.

RMA TYPE 1B67 has been assigned to the standard laboratory mica window self-quenched, beta thyrode which operates at 1200 volts. Window thickness 2.0 to 2.6 mg/sq. cm. Other thicknesses on request.

The new 1B87 sub-miniature Thyrode is designed to operate at 900 volts with a plateau greater than 100 volts and a nominal background counting rate of 12 counts per minute.

Hi-Meg resistors

Hi-meg resistors vacuum sealed, from 10^8 ohms to 10^11 ohms measured to within 1% accuracy are a symbol of reliability in all ion chamber radiation measuring instrument and electrometer circuits.

NEW PRODUCTS (continued)

Hi-Meg

Dec. 185

192
McGraw-Hill Industrial Mailing Lists are a direct route to today's purchase-controlling executives and technicians in practically every major industry. These names are of particular value now when most manufacturers are experiencing constantly increasing difficulty in maintaining their own lists.

Probably no other organization is as well equipped as McGraw-Hill to solve the complicated problem of list maintenance during this period of unparalleled changes in industrial personnel. These lists are compiled from exclusive sources, based on hundreds of thousands of mail questionnaires and the reports of a nation-wide field staff, and are maintained on a twenty-four hour basis. Investigate their tremendous possibilities in relation to your own product or service. Your specifications are our guide in recommending the particular McGraw-Hill lists that best cover your market.

DIRECT MAIL DIVISION
585 WEST 42nd STREET
NEW YORK, N. Y.
VIBRATIONLESS

Cyclohm
Capacitor Type Induction Motors

Here is a capacitor type motor that is precision built for quiet, smooth performance—accurate bearing alignment...perfect rigidity. The Cyclohm 29 Size is the outstanding value in motors for recording, tape pulling, facsimile work and many other jobs. Available in non-synchronous, and two types of synchronous—reluctance torque and hysteresis torque. Capacitor can be used either on or alongside motor. Ball bearings or sleeve bearings. 1/100 to 1/10 horsepower; various speeds, voltages and frequencies available. Write today for complete information.

CYCLOHM MOTOR CORPORATION
DIVISION HOWARD INDUSTRIES, INC.
5-17 46th Road, Long Island City 1, N. Y.

NEW...IMPROVED
PRECISION ATTENUATORS
by TECH LABS

The units illustrated represent a complete redesign of our older precision attenuators for laboratory standards. Flat for all frequencies in the audio range. Reasonably flat to 200 k.c. up to 70 db.

Manufacturers of Precision Electrical Resistance Instruments
BERGEN BLVD., PALISADES PARK, N. J.
Tel: LEonia 4-3106

WHEN SPACE IS A FACTOR ....

STANDARD'S CRYSTAL Type 20 is the answer

Because

...it meets ±0.005% stability over -55° to +90° C. range...it is hermetically sealed in dry nitrogen...of its proven consistent superiority in stability and activity...of its low price.

Let us send you our FREE catalog showing the STANDARD line of frequency control units. For your super-sonic and ultra-sonic crystals, you can rely on STANDARD.

STANDARD PIEZO CO.
Office & Development Laboratories
CARLISLE, PENN. A.
NEW PRODUCTS (continued)

with output range from 0 to 1,700 watts and also 0 to 4,600 watts. Group control is conventionally arranged with coupling to a common shaft.

Echo Depth Sounder

Kaar Engineering Co., Middlefield Road, Palo Alto, Calif. The ES-29 electronic echo depth sounder has an indicator scale calibrated to 100 fathoms plus, and a power drain of about 30 watts. It is available for input voltages of 6, 12, 32 and 110 volts d-c. The unit uses an ultrasonic transducer of the inboard crystal type which both transmits and receives ultrasonic waves.

Voltage Stabilizer

Raytheon Mfg. Co., Waltham, Mass. The VR-6000 miniature 5-watt stabilizer operates at an input voltage of 95 to 130 volts a-c, 60 cycles, single phase. Output is 120 volts stabilized to ±0.5 percent.

Transformer Assembly

Spellman Television Co., Inc., 130 W. 24th St., New York 11, N.Y., has developed a high-voltage corona shielded, tuned transformer assembly which includes an octal socket.

FOUND! A WAY TO CUT PRODUCTION COSTS 25% AND STILL IMPROVE QUALITY

ALPHA TRI-CORE Rosin-filled SOLDER

Three cores for the price of one! Speedier action! More operations per pound of solder! Test after test in radio plants has proved that Alpha Tri-Core is more efficient and more economical than conventional solders. Our engineers will be glad to demonstrate these dollar-saving features in your plant. There is no obligation; just call on us.

CHECK THESE FEATURES

Alpha TRI-CORE ROSIN-FILLED Solder

* 99.9% pure, water-white rosin used exclusively!
* Non-activated! No rejects due to corrosion!
* Adapted to your production needs; an American solder designed for American production; manufactured and stored here ready for delivery!
* No toxic, obnoxious fumes!
* 25% more joints per hour per pound of solder!
* Cut your solder cost with Tri-Core's — 5 to 15% less tin and still get better results than possible with other solders using more tin.
* Tri-Core available in diameters as large as 1/4", and heavier—down to .020" and finer.

for delivery!
QUANTITATIVE MEASUREMENTS ON HIGH IMPEDANCE CIRCUITS

MODEL 102
PHANTOM REPEATER

AN INSTRUMENT AMPLIFIER WITH 200 MEGS.—6.0 MMF INPUT IMPEDANCE

The Phantom Repeater bridges voltmeters and cathode ray oscilloscopes, which have inputs of 1 megohm and 30 mmf, onto signal circuits of 50,000 ohms and higher—such as a pentode amplifier stage with its high resistance plate load—without the loss of voltage and high frequency response which would result if the measuring instruments were connected directly.

Input Impedance: 200 megohms shunted by 6 mmf. Output Impedance: 300 ohms. Gains of 1.00, 10.0, and 100. Frequency Range from 5 cps to 150,000 cps within 2%. Background noise equivalent to 40 to 70 microvolts at the input.

Descriptive Bulletin Sent Upon Request

KEITHLEY INSTRUMENTS
7960 LORAIN AVENUE
CLEVELAND 2, OHIO

Over 20 years of fabricating experience

PLASTIC FABRICATING

BAKELITE SHEETS, RODS, TUBES.

BAKELITE AND FIBRE FABRICATED PARTS.

PUNCHING, DRILLING, MILLING, AND ENGRAVING

Mail Us Your Prints or Samples for Quotations

ELECTRICAL INSULATION CO., INC.
12 VESTRY ST., NEW YORK 13, N. Y.

Acme Electric engineers will cooperate with your engineering department by providing specially designed transformers for power supply and other applications in an effort to improve the reception and reproduction qualities of your sets.

Acme Electric can produce transformers of special characteristics from standard parts which means that our enormous manufacturing facilities and quality controlled production results in buying economies for you.

Send us specifications and application outline.

ACME ELECTRIC CORP.
3112 WATER ST. CUBA, N. Y.
NEW PRODUCTS (continued)

for use with 1B3-8016 type tube. Adjustable filament voltage allows the tube to be used for voltages from 1 kv to 20 kv. The unit is designed to operate in conjunction with r-f step-up coils of approximately 200-ke frequency.

Voltage Stabilizer
RAYTHEON MANUFACTURING CO., Waltham, Mass. A new model in the VR-6000 line of voltage stabilizers is hermetically sealed and oil-filled. Power rating is 15 watts.

The unit provides 115 volts stabilized to plus or minus 1 percent for inputs of 95 to 125 volts in the frequency range 57 to 63 cycles.

Oscillator Improvement
KAY ELECTRIC Co., Maple Ave., Pine Brook, N. J., has added tone

A horn or speaker of conventional type may resemble a Racon horn or speaker in outward appearance. But close examination of a Racon unit reveals internal differences—refinement of design, better mechanical construction, sturdier materials and other special features that represent ADVANCED ENGINEERING. It is these exclusive features that give you superior performance in any Racon unit. Higher efficiency over wider ranges. Freedom from distortion. Uninterrupted service. The long life that protects your investment.

1—RACON-RE-ENTRANT TRUMPET RE-33. Designed to deliver highly concentrated sound over long distances. Air column 3½", inside tone arm aluminum castings; bell, heavy aluminum spinnings; center reflecting section, RACON PATENTED ACOUSTIC MATERIAL to prevent resonant effects. Ruggedly built. Length 16", bell diam. 18". Swivel ratchet or U bracket mounting.

2—RACON RE-ENTRANT RADIAL TRUMPET SR-35R. Has all of the construction features of RE-35 such as non-vibratory center section, heavy aluminum castings, etc. All reflecting surfaces of RACON PATENTED ACOUSTIC MATERIAL to prevent resonant effects prevalent in all large reflecting surfaces. Delivers sound with even intensity over a 360° circumference. Length 16"; width 17". Type SR-60R length 34½"; width 36".

3—PERMANENT MAGNET HORN UNITS. Highly popular in all types of service. Many improvements. Two groups with Alnico V Magnets and Alnico Blue Dot Magnets. Steel parts plated to prevent corrosion. Also fitted with corrosion proof metal or plastic diaphragms. Voice coil impedance on all units: 15 ohms. Special ohmages on request.

NOW FURNISHED WITH WATERPROOF CASING
All units may now be had with heavy spun aluminum cases, forming a hermetically sealed, watertight housing for outdoor use, at slight extra cost.

Write for Catalog of complete Racon Line
RACON ELECTRIC CO., INC.
52 E. 19th Street New York, N. Y.

RACON
Speakers
Horn Units
Horns
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, 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.

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.

KENYON, one of the oldest names in transformers, offers high quality specification transformers custom-built to your requirements. For over 20 years the KENYON "K" has been a sign of skillful engineering, progressive design and sound construction.

KENYON now serves many leading companies including: Times Facsimile Corporation, Western Electric Co., General Electric Co., Schulmerich Electronics, Sperry Gyroscope Co., Inc.

Yes, electronification of modern industrial machinery and methods has been achieved by KENYON’S engineered, efficient and conservatively rated transformers. For all high quality sound applications, for small transmitters, broadcast units, radar equipment, amplifiers and power supplies — Specify KENYON! Inquire today for information about our JAN approved transformers.

Now — for the first time in any transformer catalog, KENYON’S new modified edition tells the full complete story about specific ratings on all transformers. Our standard line saves you time and expense. Send for the latest edition of our catalog now!

KENYON TRANSFORMER CO., Inc. 840 BARRY STREET NEW YORK 59, N.Y.

WILKOR Ceramic Resistors assure you greater...

DURABILITY ACCURACY STABILITY COMPACTNESS RELIABILITY

Write for specification sheet. Samples available for quantity users.

KENYON TRANSFORMER CO., Inc. 840 BARRY STREET NEW YORK 59, N.Y.

WILKOR PRODUCTS, INC. 3835 WEST 150TH STREET CLEVELAND 11, OHIO

Manufacturers of Carbofilm RESISTORS
NEW PRODUCTS (continued)

modulation to the Mega-Marker Sr. oscillator for television testing. The modulation may be switched on or off. By its use, the local oscillator may be aligned by using only the Mega-Marker Sr. and the television sound channel and loudspeaker.

Single-Bearing Motor

ELECTRO-ENGINEERING PRODUCTS Co., Inc., 4824 W. Kinzie St., Chicago 44, Ill., has developed a single bearing motor to provide accurate lineup in air gap. It is of the four-pole type with a no-load speed of 1700 rpm and a full-load speed of 1550 rpm. The unit is designed for such applications as wire recorders, turntables and fans.

Fuse Protection

THE CLEVELAND CONTAINER CO., 6201 Barberton Ave., Cleveland 2, Ohio. The Cosmalite enclosing tube for the indicating secondary fuse illustrated protects the fuse chamber, fuse link, and all operating parts.

Binary Scaler

GENERAL ELECTRIC Co., Syracuse, N. Y. Model 4SN1A1 binary scaler, designed for use in nucelonic and computer applications, counts electrical impulses at speeds up to 200 ke in either binary or decade operation. A 5 to 20-volt negative input pulse of 1 microsecond dura-

AN ENTIRELY NEW
Dependable
AUTOMATIC DEHYDRATOR
BY Andrew
For pressurizing coaxial systems with dry air

WRITE FOR BULLETIN 85

Now, for the first time, here is an automatic dehydrator that operates at line pressure! This means, (1) longer life, and (2) less maintenance and replacement cost than any other automatic dehydrator.

Longer life because the compressor diaphragm operates at only 1/3 the pressure used in comparable units, vastly increasing the life of this vulnerable key part.

Reduced maintenance and replacement costs because new low pressure design eliminates many components.

Operation is completely automatic. Dehydrator delivers dry air to line when pressure drops to 10 PSI and stops when pressure reaches 15 PSI. After a total of 4 hours' running time on intermittent operation, the dry air supply is turned off and reactivation begins, continuing for 2 consecutive hours. Absorbed moisture is driven off as steam. Indicators show at a glance which operation the dehydrator is currently performing.

Output is 1 1/4 cubic feet per minute, enough to serve 700 feet of 6 1/4" line; 2500 feet of 3 1/2" line; 10,000 feet of 1 3/8" line or 40,000 feet of 7/8" line. Installation is simple, requiring only a few moments.

Important! Not only is this new differently designed Andrew Automatic Dehydrator completely reliable, but it is available at a surprisingly low price.

ELECTRONICS — December, 1948
TRANSIENT EVENTS ARRESTED

The first Avimo Oscillograph Recorder was a specially built Camera designed to provide Records of Cathode Ray Traces to a scale which permitted accurate measurement, side by side on continuous film, so that precise relationships could be determined. Success in this specialised field led to demands for Cameras to record other kinds of transient events, so that within the Avimo range listed below there are, to-day, Instruments to meet nearly any requirement of the Research or Laboratory worker. The wide experience gained in the course of this development is at your disposal and Avimo engineers will be glad to submit suggestions if you will state your problem.

<table>
<thead>
<tr>
<th>GROUP</th>
<th>FUNCTION</th>
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<tbody>
<tr>
<td>A. Continuous Recording.</td>
<td>For recording oscillograph traces on 35 mm. or 70 mm film.</td>
</tr>
<tr>
<td>B. Single Shot.</td>
<td>For use where phenomena are constant.</td>
</tr>
<tr>
<td>C. Combined Continuous and Single Shot.</td>
<td>Provides the functions of Groups A or B as desired.</td>
</tr>
<tr>
<td>D. Drum.</td>
<td>For high-speed drum recording of high-frequency phenomena on 35mm. film.</td>
</tr>
<tr>
<td>E. Multi-Channel Recorders.</td>
<td>With built-in Cathode Ray Tubes for continuous recording of up to 15 traces.</td>
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<td>F. Instrumentation Cine.</td>
<td>Provides a pictorial record of several variants over a period of time.</td>
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</table>

There is no reasonable limit to the film speeds which may be provided and recorders of Groups A, B, C & D may be used in conjunction with any standard oscillograph.

AVIMO LIMITED
TAUNTON (SOM.), ENG.

Only $975

Never before a value like this 3½ KW bombard or high frequency induction heater... for saving time and money in surface hardening, brazing, soldering, annealing and many other heat treating operations. Is Portable... mounted on four rubber coasters. Width 14½"; depth 27"; height 42½"; weight 300lb.

Operates from 220 volt line. Complete with foot switch and one heating coil made to customer's requirements. Send samples of work wanted. We will advise time cycle required for your particular job. Cost, complete, only $975. Immediate delivery.

Scientific Electric Electronic Heaters are made in the following ranges of power: 1-2-3-5-7½-10-12-½-15-18-25-40-60-100-250 KW.

Scientific Electric
Division of "S" CORRUGATED QUENCHED GAP CO.
105-119 Monroe St., Garfield, N. J.

SEND BLUEPRINTS AND SPECIFICATIONS—NO OBLIGATION!

Check BAER FIBRE for accurate dimensioning, uniform surface, mechanical and electrical qualities, and low cost per piece. See how efficiently a BAER FIBRE terminal board, bushing, gasket, washer or other shape can simultaneously solve your electrical or mechanical problem...improve your product...and save you money! BAER FIBRE is precision fabricated to your specifications.

LITERATURE ON REQUEST
N. S. BAER COMPANY
MONTGOMERY ST., HILLSIDE, N. J.
tion and 0.1 minimum rise time will produce an output pulse of 50 volts, peak to peak. Resolution time is 5 microseconds and output impedance is 27,000 ohms.

**Tube Tester**

HICKOK ELECTRICAL INSTRUMENT Co., 10527 Dupont Ave., Cleveland 8, Ohio. Model 533 DM display tube tester is a dynamic mutual conductance type. Flexibility is provided by a system of selector switches.

**Small Blower**

GLOBE INDUSTRIES, INC., 125 Sunrise Place, Dayton 7, Ohio. The MB-1 blower unit comprises a 0.01-hp aircraft-type d-e motor with centrifugal impeller. At rated voltage, the unit will produce 20 cubic feet per minute. The unit operates at 11,000 rpm with an in-

New! All inclusive!

New York Transformer Co., Inc.

**STANDARD LINE OF TRANSMITTER COMPONENTS**

FOR AM, FM AND TV—LABORATORY AND INDUSTRIAL APPLICATIONS

- PLATE TRANSFORMERS TO 10 KVA
- FILTER REACTORS
- 115/230 VOLT, 50/60 CYCLE SUPPLY
- RUGGED INTERNAL CONSTRUCTION, SUPPORTED CORE STRUCTURE
- EYE BOLTS ON LARGE UNITS FOR EASY HANDLING
- FILAMENT TRANSFORMERS TO 15,000 VOLT TEST
- PLATE FILAMENT TRANSFORMERS LOW VOLTAGE
- AIEE SURGE TEST ON HIGH VOLTAGE UNITS
- EFFICIENT MAGNETIC AND ELECTRO-STATIC SHIELDING
- UNIFORM STREAMLINED APPEARANCE
- STURDY STEEL CASES

Here is one of the finest and most complete lines of standard transmitter components available today. Built to the same well-known high standards as N·Y·T custom-built units, they bring to the design engineer the full economy of standardized construction. Superbly constructed, inside and out, each unit fully reflects the years of experience that have made the name NEW YORK TRANSFORMER synonymous with quality, integrity and dependability wherever inductive components are used.
SLICE
Rising Time Costs with Solder Pre-Forms

Eliminate time-consuming manual solder operations in your assembly processes. Pre-formed rings, washers, discs, pellets, squares, etc., complete with flux, save time, trim labor costs, insure cleaner, more uniform, sturdier bonds. We meet your specifications in the widest variety of solder alloys. Consult with us on any solder or brazing problem.

(Literature on Request).

Soldering Specialties
Dept. C, Summit, N. J.

—high accuracy plus!

IN-RES-CO wire wound resistors are engineered for the manufacturer maintaining a reputation of top quality and performance in his equipment. They cover a full range from 1 watt to 10 watts and .01 ohm to 1.5 megohm. Conservative ratings assure maximum long life; trouble free service. Write for catalog today on company letterhead.

PENN RIVET & MACHINE COMPANY
254 Huntingdon Street
PHILADELPHIA 33, PENN.
NEW PRODUCTS (continued)

*Here's your supply of N.Y.T TELEVISION COMPONENTS

put of 14.5 watts. A fan unit is also available separately. Motor can be used as part of a vibrator unit in a stall warning system for planes.

**Phono Amplifier**

**Bell Sound Systems, Inc., Columbus 7, Ohio. Model 2122 high-fidelity radio-phonograph amplifier has four input circuits, built-in preamplifier for each of two magnetic pickup inputs, as well as bass and treble boost. Peak power output is 15 watts. Response is essentially flat from 30 to 15,000 cycles. Send for sheet Lit 4849-2A.

**Precision Switch**

**Unimax Switch Division of the W. L. Maxson Corp., 460 W. 34th St., New York 1, N. Y. Type DMX universal precision switch has spst silver contacts capable of handling

Available Now!

N.Y.T. facilities are now expanded to supply all types of inductive television components in quantity. Estimates will be supplied promptly on standard units or types wound to your exact specification. In addition to television components, N.Y.T. offers complete manufacturing service on power transformers, chokes, and audio transformers. Modern plant and winding equipment assures finest quality at low cost. Call or write today for information.

**NEW YORK TRANSFORMER CO.**

ALPHA • NEW JERSEY
High speed machine-winding of electric motor armatures necessarily exposes magnet wire to some rugged treatment.

The all-around (in the groove and out) "windability" of ESSEX EXTRA TEST MAGNET WIRE in this and other exacting applications cannot be excelled.

ESSEX WIRE CORP.  
FORT WAYNE 6, INDIANA

Plants: Anaheim, Calif.; Detroit, Mich.; Fort Wayne, Ind.; Warehouses and Sales Offices: Atlanta, Ga.; Boston, Mass.; Chicago, Illinois; Cleveland, Ohio; Dallas, Texas; Dayton, Ohio; Detroit, Mich.; Kansas City, Mo.; Los Angeles, Calif.; Milwaukee, Wis.; Newark, N.J.; Philadelphia, Pa.; Portland, Ore.; St. Louis, Missouri; San Diego, Calif.; San Francisco, California

KOTRON  
STRIP-TYPE  
SELENIUM RECTIFIERS

PATS. PEND.

100 MA. UNIT
- Max. A. C. line input 130 volts rms
- Max. Inst. peak current 1000 Ma.
- Max. inverse peak voltage 260
- Average operating temp. 105°F
- Dimensions: 4-1/16" x 1-1/16" x 5/32"
- Other Sizes: 75 Ma. and 200 Ma.

Kotron’s metallic rectifying elements are mounted in one plane. Plates cannot contribute heat to each other. Result—Cooler Operation...longer life...increased circuit efficiency. Wafer-thin Kotron saves space, mounts easier.

Write for Complete Technical Data, Prices and Delivery

GRAPHALLOY  
THE SUPREME CONTACT MATERIAL  
BRUSHES  
CONTACTS

in BRUSHES  
for high current density ✔ low contact drop ✔ low electrical noise ✔ self-lubrication

in CONTACTS  
for low resistance ✔ non-welding character

GRAPHALLOY works where others won’t! Specify GRAPHALLOY with confidence.

* A special silver-impregnated graphite

GRAPHITE METALLIZING CORPORATION  
1055 NEPPERHAN AVENUE, YONKERS 3, NEW YORK

December, 1948 — ELECTRONICS
NEW PRODUCTS
(continued)

10 amperes at 125 volts, either a-c or d-c. It features a focused-flux alnico magnet, a ceramic baffle chamber and an arc-resistant molding on base and cover.

Precision Pot
TECHNOLOGY INSTRUMENT CORP.,
1058 Main St., Waltham, Mass. The new 2-in. potentiometer illustrated has a linearity of 0.2 percent and has a maximum electrical rotation of 320 degrees. Designed particularly for computer and similar applications, the units are available only on special order.

Welding Water Control
ROBOTRON CORP., 56 Manchester,
Highland Park (Detroit) 3, Michigan. The Robotector model 22B01A protects an idle welding transformer from excessive condensation and acts as a simple fail-safe electronic circuit. Further details are given in a catalog sheet.

Metal Locator
FISHER RESEARCH LABORATORY,
INC., Palo Alto, Calif. The new M-Scope conveyor belt locator detects metal objects as small as a dime on conveyor belts and automatically interrupts the power circuit to stop the line. The unit pictured will accommodate a belt 2 ft

with STEEL — the small extra first cost of test samples pays off in assurance of efficiency and durability of the finished product.

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varying supply of high resistance water
exactly fitted to your needs. Where the
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ganic, Barnstead Water Stills provide the
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such exacting uses as on screens of
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to de-ionize the water first and then
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61 Sherman St. Malden, Mass.

December, 1948 — ELECTRONICS
NEW PRODUCTS

(continued)

Hand Hearing Aid
DICTOGRAPH PRODUCTS, 580 Fifth Ave., New York, N.Y. The Hearette is a hand-held type of hearing aid that is intended both for people with slight hearing loss and those with normal hearing who may wish to use a selective system in auditoriums or other places where noise level is high.

Kilovoltmeter
BETA ELECTRONICS CO., 1762 Third Ave., New York 29, N.Y. Series 121 multirange kilovoltmeters have full-scale range of 15 and 30, and

For Inverting D. C. to A. C. . . .
Specially Designed for operating A. C. Radios, Television Sets, Amplifiers, Address Systems, and Radio Test Equipment from D. C. Voltages in Vehicles, Ships, Trains, Planes and in D. C. Districts.

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This book codifies information on the properties and characteristics of most electronic components. The first part lists fixed components such as wires, cables, resistors, etc., the second deals with electromechanical devices and the third section is devoted to vacuum tubes and cathode ray tubes.

VACUUM TUBE AMPLIFIERS
Vol. 18. Edited by George F. Valley, Jr., M.I.T.; and Henry Wallman, M.I.T. 753 pages, illustrated, $10.00

Here is a complete analysis of important types of amplifiers together with their design principles and constructional techniques. The amplifiers discussed provide special characteristics such as very high gain, large bandwidth, or precise response.

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Vol. 19. Edited by Britton Chance, E. F. MacNichol, University of Penn.; F. C. Williams, Manchester University; W. W. Hughes, Columbia University; and B. Sayre, Alabama Polytechnic Institute. 776 pages, illustrated, $10.00

A detailed description of the generation and use of precisely controlled voltages and currents, introducing methods of wave shaping by linear circuit elements and negative feedback amplifiers. The properties of vacuum tubes as non-linear circuit elements and their application to waveform manipulation are presented in detail.

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25 and 50 kilovolts at 50,000 and 25,000 ohms per volt. Applications include nuclear research, electrostatic precipitation measurements, flocking or abrasive techniques and television.

Molded Capacitors

SPRAGUE ELECTRIC CO., North Adams, Mass. Prokar capacitors operate continuously at high temperatures without deterioration owing to a new plastic impregnant. Rated for service between minus 50 and plus 125 C, the new units are described in bulletin 211.

F-M and A-M Tuner

BROWNING LABORATORIES, INC., 742 Main St., Winchester, Mass. The instrument type f-m and a-m tuner model RJ-20 comprises two independent tuners with a common audio amplifier. The f-m section has 32 db of quieting with a 10 microvolt signal. The a-m section has a variable-width i-f from 8 to 18 kilocycles adjustable from the front panel. Audio output is at 20,000 ohms.

Audio Transformers

STANDARD TRANSFORMERS CORP., Elston, Kedzie & Addison Streets, Chicago 18, Ill. The HF and WF series of high-fidelity audio transformers have frequency responses plus or minus 1 db from 20 to 20,-
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STACK SET SCREWS
WITH THE
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The KNURLED cup point of this popular "Unbrako" Socket Set Screw makes it a Self-Locker... because
the keen edges of the counter-clock-wise KNURLS
positively prevent creep, regardless of the most
chattering vibration. A real fastener, if ever there
was one... it positively won't shake loose! Sizes
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Knurling of Socket Screws originated with
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These 3 simple steps add realism to your music
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are space-saving... provide outstanding
advantages over other rectifiers in many
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These advantages can be quickly trans-
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- Plastic Shell—More economical than
  previous metal type and yet it retains
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gives a lower lead-to-
  load capacitance, permitting its use
  in circuits of very high frequency.

- Small Size—Requires no more space
  in circuit than an ordinary 1/4 watt
  resistor.

- No Heater Connections—Eliminates
  hum sometimes associated with vac-
  uum type rectifiers.

- Easy Installation—Insulated shell
  and only two leads to connect.

- Quick Recovery—Returns to normal
  quickly after sudden applications of
  excessive voltage when not accom-
  companied by excessive current, provid-
  ing the source of high voltage is
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- Low Shunt Capacitance

Five types of G-E Germanium Diodes
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GENERAL ELECTRIC
210 December, 1948 — ELECTRONICS
000 cycles, and plus or minus 2 db from 30 to 20,000 cycles respectively. Hum pickup, leakage reactance, as well as harmonic and intermodulation distortion have been reduced to a minimum.

Electromanometer
SANBORN Co., 39 Osborn St., Cambridge, Mass. The electric manometer illustrated is used for graphic registration of rapidly fluctuating pressures as well as steady pressures. Standard ranges are 0-to-1 mm of mercury to 0-to-400 mm. Negative and mean pressures can also be measured.

Carbon Resistors
INTERNATIONAL RESISTANCE Co., 401 N. Broad St., Philadelphia, Pa. The new type deposited carbon resistors, DCF for applications up to 1 watt, and DCH for applications up to 2 watts, are made by depositing pure crystalline carbon film on specially compounded ceramic rods. They are available in 1, 2 and 5-percent tolerances. Resistance ranges are: type DCF, 200 ohms to 5 megoohms; type DCH, 500 ohms

NEW PRODUCTS  (continued)

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Spirally wound kraft and fish paper Coil Forms and Condenser Tubes.

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Quality-conscious engineers in every field have now found out, in actual use, the remarkable efficiency, the amazing smoothness of frequency response, and the clearly superior performance of the new, improved 1948 Altec Lansing speakers.

This complete, all-purpose line, fundamentally re-engineered and incorporating new scientific discoveries resulting from original Altec Lansing research, offers the highest obtainable quality now available in the electronic industry.

The clear superiority of Altec Lansing speakers is substantiated by frequency response curves, made on measurement equipment that has earned the approval of conservative, unbiased audio scientists.

An illustrated brochure, fully describing the 1948 Altec Lansing line, containing frequency response curves for each speaker, will be sent on request. Write to address nearest you.

161 Sixth Avenue,
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Model 204A Regulated Power Supply

The Model 204A Regulated Power Supply will provide from 0-500 volts of well regulated and well filtered D.C. The output voltage is continuously variable without switching and either positive or negative side may be grounded.

Specifications:

Output Voltage
- High Voltage: 0-500 Volts D.C. continuously variable (Without switching)
- Current: 300 Ma.
- Low A.C. Voltage: 6.3 Volts A.C. at 6 amps, center-tapped, unregulated

Regulation
- Within 1% for voltage between 30-500 volts, from no load to full load.
- Within 1% for line voltage variations from 105 to 125 volts at full load current for any voltage between 30-500 volts and within 2% at 10 volts.

Hum Voltage
- Within 10 Millivolts at any voltage or load within ratings

Line Input
- 105-125 Volts A.C. 50-60 cycles.

Output Terminations
- High and low voltage outputs available from front and rear of unit. Positive or negative terminal of high voltage output may be grounded as desired.

Detailed specifications will be forwarded upon request without obligation.

Electronic Measurements Company
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Proof of the pudding is in the eating. Tinymites are the largest selling miniature paper capacitors in the world.

- Good for 100°C
- Leads CANNOT pull out
- CAP. from .0001 to 2 MFD from 100 volts to 1000 volts.

Send for list and prices.
to 20 megohms. See technical bulletin B-4 for further data.

Literature

Carrier Systems. Lenkurt Electric Co., 1113 County Road, San Carlos, Calif. Form CX42 is a 12-page booklet providing a comprehensive illustrated listing of carrier telephone and telegraph systems. Also included is a description of signaling equipment and test apparatus for system maintenance.

Sound Services. Reeves Sound Studios, Inc., 304 E. 44th St., New York 17, N. Y. A recent brochure describes and illustrates the wide variety of sound recording facilities, experience and technical knowledge available for turning out films or disc production.

Nuclear Charts. Westinghouse Electric Corp., Box 1017, Pittsburgh 30, Pa., has prepared six lithographed wall charts in two colors illustrating the important areas of nuclear physics. Measuring 25 by 36 inches and made of heavy stock, the charts are accompanied by a 32-page book of supplementary information. Complete set may be purchased at the above address for $1.00.

Classroom Radio. Radio Manufacturers Association, 1317 F St., N. W., Washington 4, D. C. The present thinking of radio manufacturers and educators specializing in audio education is summarized in a recent booklet. Contents cover utilization, teaching with radio, considerations for purchase and technical considerations.

Electronic Controls. Wheelco Instruments Co., 847 W. Harrison St., Chicago 7, Ill. Bulletin 26500 contains an illustrated and de-
PRECISION POTENTIOMETERS
Toroidal and Sinusoidal

For use in computing and analyzing devices; generation of low frequency saw tooth and sine waves; controls for radio and radar equipment; position indicators; servomechanisms; electro medical instruments, measuring devices—tele-meters; gun fire control where 360° rotation, high precision and low noise levels are essential.

The type RL14MS sinusoidal potentiometer is illustrated. It is wound to a total resistance of 35,400 ohms and provides two voltages proportional to the sine and cosine of the shaft angle. It will generate a sine wave true within ±.6%. Overall dimensions are 4 1/8" diameter x 4 11/32 long plus shaft extension 1" diameter x 1 1/16" long.

Write for Bulletin F-68

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Newton Upper Falls 64, Massachusetts

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ADAPTABLE FOR EVERY REQUIREMENT
Par-Metal Equipment offers many features, including functional streamlined design, rugged construction, beautiful finish... plus ADAPTABILITY. Eliminate need for special made-to-order units on many jobs.

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Professional techniques and years of specialization are reflected in the high quality of Par-Metal...

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TELEVISION MONOSCOPE SIGNAL SOURCE
Model PT 102

• Composite Video Signal
• Wide Band Video Amplifier, 6 DB down at 10MC
• Dual outputs for feeding two 75 or 100 lines
• Black positive or Black negative output.
• Resolution greater than 600 lines

INPUT: Vertical and Horizontal Driving pulses, Camera and Kinescope Blanking Pulses.

OUTPUT: Composite Video Signal, 1 volt, 100 ohm line 115 volts 50/60 c.p.s. Complete with tubes and includ-ing high and low voltage power units.

9 FERRY STREET
NEW YORK 7, N.Y.

Polarad Electronics Company

Television engineers and consultants to the nation’s great television stations.

December, 1948 — ELECTRONICS
NEW PRODUCTS (continued)

Descriptive listing of standard instrument models including indicators, controllers, recorders, and combustion safeguards. A separate price list is also available.

Precision Switches. Unimax Switch Division of the W. L. Maxson Corp., 460 W. 34th St., New York 1, N. Y. A 20-page booklet on precision switches provides engineering data on force and movement specifications, dimensions and electrical ratings.

High-Voltage Supply. Instrument Development Laboratories, 223-233 West Erie St., Chicago 10, Ill. A single sheet illustrates and gives technical data on the model 1090 high-voltage supply which delivers 0 to ±5,000 volts continuously variable, for ionization measurements and other low drain applications. Output voltage variation is less than 0.1 percent for a line voltage change of 95 to 130 volts.

Instrumentation System. Automatic Temperature Control Co., Inc., 5212 Pulaski Ave., Philadelphia 44, Pa. Detailed engineering and application data on the Acotran instrument system for electrically measuring mechanical motions or displacements may be found in the 8-page catalog R-10.

Shipboard Radar. Radiomarine Corp. of America, 75 Varick St., New York 13, N. Y. Booklet MS-15 completely describes and illustrates the CR-101 radar designed for commercial shipping. Dimensional diagrams and specifications are given.

Ham Inductors. E. F. Johnson Co., Waseca, Minn. Now available is a new catalog dealing with air-wound ham inductors and plug-in swinging link assemblies. Instructions are provided which enable the amateur to select the correct coil and link for individual application.

Dry-Type Transformers. Lindberg Engineering Co., 2444 West Hubbard St., Chicago 12, Ill., recently released bulletin 1110 which gives applications, design and construction of a standard line of dry-type transformers, and also covers types for special applications.

Do you have complete data on the revolutionary new HELIPOT—the helical potentiometer-rheostat that provides many times greater control accuracy at no increase in panel space? or on the equally unique DUODIAL that greatly simplifies turns-indicating applications? If you are designing or manufacturing any type of precision electronic equipment, you should have this helpful catalog in your reference files...

It Explains—the unique helical principle of the HELIPOT that compactly almost four feet of precision slide wire into a case only 1 3/4 inches in diameter—over thirty-one feet of precision slide wire into a case only 3 1/3 inches in diameter!

It Details—the precision construction features found in the HELIPOT... the centerless ground and polished stainless steel shafts—the double bearings that maintain rigid shaft alignment—the positive sliding contact assembly—and many other unique features.

It Illustrates—describes and gives full dimensional and electrical data on the many types of HELIPOTS that are available... from 3 turn, 1 1/2" diameter sizes to 40 turn, 3" diameter sizes... 5 ohms to 500,000 ohms... 3 watts to 20 watts. Also Dual and Drum Potentiometers.

It Describes—and illustrates the various special HELIPOT designs available—double shaft extensions, multiple assemblies, integral dual units, etc.

It Gives—full details on the DUODIAL—the new type turns-indicating dial that is ideal for use with the HELIPOT as well as with many other multiple-turn devices, both electrical and mechanical.

If you use precision electronic components in your equipment and do not have a copy of this helpful Helipot Bulletin in your files, write today for your free copy.

THE HELIPOT CORPORATION, 1011 MISSION ST. SOUTH PASADENA 2, CALIF.

ELECTRONICS — December, 1948
An Engineer's Dream Come True!

When you hear the Newcomb "Red Knob" record compensator for the first time, we are sure you'll agree it's really a "Dream Come True." These two great Newcomb Amplifiers with the "Magic Red Knob" do wonders in eliminating needle scratch and record distortion while retaining the maximum natural brilliance.

Of course, it's not only this remarkably effective scratch control that gives you the extreme quality achieved by these two amplifiers. Their measured performance is superb. In every respect, they represent the ultimate in technical perfection, and in addition, there's a listening quality that even performance curves do not tell. That's why we ask you to be sure and hear these two Red Knob Amplifiers before you buy.

Both have built in Pre-Amplification for G.E. or similar variable reluctance type pickups, plus inputs for AM-FM radio and crystal pickups, and the finest of tone controls.

Both are individually, and completely, custom tested to insure each unit will be "Laboratory Perfect." A "Certificate of Performance" accompanies each amplifier. Look for it. It is your assurance of individual perfection.

See your Newcomb Distributor or write for detailed specifications.

Newcomb AUDIO PRODUCTS CO.
DEPT. H, 6824 LEXINGTON AVE., HOLLYWOOD 38, CALIFORNIA

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CURTIS TYPE "K" LOCK-IN TERMINAL BLOCKS
Curtis Type "K" Lock-In Terminal Blocks—factory-assembled from 1 to 18 terminals assure dependable "lug security." Solder-type spade lugs are rigidly held in position when binder screws are tightened. No danger of terminals pulling or dropping out of position...yet any terminal may be easily and quickly removed by loosening screw. Screws insulated to ground.

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5 North Crawford Ave., Chicago 24, Illinois
Factory—Milwaukee 10, Wisconsin

An Engineer's Dream Come True!

When you hear the Newcomb "Red Knob" record compensator for the first time, we are sure you'll agree it's really a "Dream Come True." These two great Newcomb Amplifiers with the "Magic Red Knob" do wonders in eliminating needle scratch and record distortion while retaining the maximum natural brilliance.

Of course, it's not only this remarkably effective scratch control that gives you the extreme quality achieved by these two amplifiers. Their measured performance is superb. In every respect, they represent the ultimate in technical perfection, and in addition, there's a listening quality that even performance curves do not tell. That's why we ask you to be sure and hear these two Red Knob Amplifiers before you buy. Both have built in Pre-Amplification for G.E. or similar variable reluctance type pickups, plus inputs for AM-FM radio and crystal pickups, and the finest of tone controls.

Both are individually, and completely, custom tested to insure each unit will be "Laboratory Perfect." A "Certificate of Performance" accompanies each amplifier. Look for it. It is your assurance of individual perfection.

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THEORY OF SERVOMECHANISMS
Vol. 25. Edited by H. M. JAMES, Purdue Univ.; N. B. NICHOLS, Taylor Instrument Co.; and R. S. PHILLIPS, Univ. of Southern Calif. 375 pages, illus., $5.00

Here is a coherent description of the theory and mathematics involved in standard methods of servomechanism design, showing application of current techniques, and providing an introduction to a new technique. It covers frequency response design considerations, servo loci, attenuation vs. log-frequency plots, phase-angle vs. log-frequency plots—and exhibits the latest method which depends upon minimization of rms error within which the mechanism produces a desired result in the presence of electrical noise and other disturbances.

TECHNIQUE OF MICROWAVE MEASUREMENTS
Vol. II. Edited by C. G. MONTGOMERY, Associate Professor of Physics, Yale University. 937 pages, illus., $10.00

The four sections of this book provide a thorough analysis of the methods and apparatus deemed most useful in measuring the properties of microwave devices. The book is written in a manner that will be useful both as a textbook and reference. It is a coherent description of the theory and mathematics involved in standard methods of servomechanism design, showing application of current techniques, and providing an introduction to a new technique. It covers frequency response design considerations, servo loci, attenuation vs. log-frequency plots, phase-angle vs. log-frequency plots—and exhibits the latest method which depends upon minimization of rms error within which the mechanism produces a desired result in the presence of electrical noise and other disturbances.

PULSE GENERATORS
Vol. 5. G. N. GLASOE, Rensselaer Polytechnic Institute; and J. V. LEVACQZ, Johns Hopkins Univ., 737 pages, $9.00

This detailed discussion of the techniques of pulse generation presents a comprehensive survey of the rapid advancements made in this field. It covers the theoretical and practical aspects of the generation of power pulses, the practical methods of pulse-generator design, including hard-tube pulseras, line-type pulseas, and solid-state pulseas. Pulse transients, pulse transformers, and pulse transducers in the range of 180 megawatts and pulse durations from .03 to 10 microseconds are considered, covering pulse formation, pulse power, circuit efficiency, etc.

MICROWAVE RECEIVERS
Vol. 33. Edited by S. V. VAN VOORHIS, Assoc. Professor of Physics, Univ. of Rochester. 611 pages, illus., $8.00

This analysis of wide-band receivers presents a thorough description of the various component circuits and equipment—individual circuit types, diodes, microwave mixers, local oscillators, automatic frequency control systems, l-f input circuits, amplifiers, and detectors. With this comprehensive groundwork, the book takes up the important circuit combinations.

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December, 1948 — ELECTRONICS
Studio-to-transmitter microwave antenna which beams programs from Ithaca studio to Connecticut Hill transmitter site for rebroadcast over Rural Radio Network receive from, are: WSLB, Ogdensburg on 106.1 mc, and 75 miles from WVBN, Turin, on 107.7 mc and 72 miles from WVCV, Cherry Valley on 101.9 mc and 56 miles from WVCN, De Ruyter on 105.1 mc.

Each station in the net has a 250-watt GE f-m broadcast transmitter with effective radiated power of 1,300 watts. A trailer is used extensively for on the spot broadcasts, thus making any pasture in the state a broadcast point. This jeep-drawn unit has a 50-watt transmitter operating on 152.75 mc, either from an a-c line or its own 3-kw gas engine-driven generator. A 40-foot collapsible antenna on the trailer provides dependable relaying up to 50 miles to the nearest RRN station, where the remote pickup is picked up and rebroadcast for the network.

Headquarters for the statewide chain are at Ithaca, N. Y. From this point a GE studio-to-transmitter link operating on 940.5 mc beams programs to a transmitter.
The GRAY TRANSCRIPTION ARM 103-LP, with Selected GE Variable Reductance Cartridge with 1 mil Diamond Stylus, has been especially designed for use with the new LP Micro-Groove Records. Due to such features as adjustable stylus pressure, frictionless motion, self-leveling base and the accommodation of any standard cartridge, arm obsolescence is precluded. Arm, with 1 mil Diamond Stylus Cartridge, $77.95.


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154 WEST 14th St., NEW YORK 11, N. Y.
site at Connecticut Hill, 9½ miles southwest. There the programs are put on the air and picked up simultaneously by master receivers at other stations, for immediate re-broadcast on their own channels. Each station can also originate programs for pickup by others in the network.

Certificates of Merit

At ceremonies held in several regions recently, presidential certificates of merit were awarded as testimonials for outstanding service in technological research and development during World War II.

The following were the recipients:

- Henry B. Ahajian of L. H. Terpening Co.;
- George W. Bailey of the IRE;
- William L. Barrow of Sperry Gyroscope Co.;
- H. H. Benning of Aircraft Radio Corp.;
- Harold H. Beverage of RCA;
- K. C. Black of Aircraft Radio Corp.;
- Hendrik W. Bode and Ralph Bown of Bell Labs.;
- Herbert E. Bragg of NIDRC;
- Henri Busignies of Federal Telecommunication Laboratories;
- John F. Byrne and F. C. Cahill of AIL;
- Howard A. Chinn of CBS;
- F. S. Cooper of Haskins Laboratories; Inc.;
- W. F. Davidson of Consolidated Edison Co.;
- H. D. Dodlittle of Hahleit Laboratories;
- O. S. DuFond of Philibus Laboratories, Inc.;
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- Donald G. Fink, editor-in-chief, Electronics, E. G. Fubini of AIL;
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- B. L. Havens of Watson Scientific Computing Laboratory;
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- William P. Short of Federal Telecommunication Laboratories;
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- J. C. Schelling of Bell Labs;
- William P. Short of Federal Telecommunication Laboratories;
- Hector R. Skiffter of AIL;
- Ernest Weber of Polytechnic Institute of Brooklyn;
- Browder J. Thompson (posthumously);
- Vladimir K. Zworykin, Loren F. Jones and Hugh H. Spencer of RCA.

Australian Mobile F-M

First installations of mobile f-m equipment for public works and police authorities in Australia were recently completed by Amalgamated Wireless (Australasia) Ltd. and Phillips' Australian branch plant. Regular f-m entertainment programs, however, are at least a year away.

Train Television

A successful demonstration of television reception aboard a moving train was made during the recent World Series by Bendix Radio Division of Bendix Aviation and the Baltimore and Ohio Railroad, along the Washington-New York route. Only when the train

The fine quality midget meters formerly manufactured by the MB Manufacturing Company are now being produced by International Instruments, Inc., — a new name for the established line of midget meters of unexcelled accuracy.

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Special antenna mounted atop roof of train for television reception must not extend more than 15 3/4 inches because of railroad's clearance pattern. Larger portion is used for the 54 to 88-mc band; smaller antenna is for 174 to 216 mc passed under bridges or steel structures or was out of range of transmitters was there any indication that the receiver was operating under unusual circumstances.

A special antenna known as a ram's horn doublet was mounted atop the car. The a-c power necessary for the set's operation was obtained by using a standard Bendix train radio inverter.

RMA Mobilization Plan

To spread the military preparedness production load broadly throughout the radio industry, the RMA industry mobilization policy committee has presented a plan to the Munitions Board. Aim of the plan is to create as many prime contractors as possible and get the industry as a whole back into government business. The new committee has as its chairman Fred R. Lack of Western Electric Co.

Included in the detailed recommendations is the proposal that the government appoint a four-man committee consisting of three military officers and a representative of industry to properly coordinate and channel current procurement. It was also recommended that the government appoint an industry advisory committee to act as consultants and technical advisors to the four-man procurement committee.

Radiation Detection Display

INSTRUMENTS FOR radiation detection in the industrial, medical and biological applications of nuclear

An ADC 115A (Industrial Series) impedance matching transformer, picked at random from stock, was submitted to tests to compare its performance with that of other makes of 1st line transformers. Here are the results. Compare performance of the ADC transformer with that of other makes.

FREQUENCY RESPONSE

It may be noted that although the permeability of magnetic materials drops at low flux densities, the ADC transformer has sufficient reserve inductance to allow for this even at low power levels. At 40 db below maximum power level it exceeds the response guarantee. Insertion loss at 1,000 cps was 0.75 db.

LONGITUDINAL BALANCE

The most common interference voltages encountered in telephone line transmission are longitudinal; that is, the induced voltages in both wires are in phase with respect to ground. These can be removed from the signal voltage only by means of a well balanced line transformer. Illustration "A" shows the test circuit used to measure the degree of removal of these interference voltages. Level reduction on the ADC 115A transformer was 67 db at 100 cps and 56 db at 10,000 cps.

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ELECTRONICS — December, 1948 221
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December, 1948 — ELECTRONICS
energy are being given a comprehensive display at a conference on electronic instrumentation in nucleonics and medicine in New York, November 29 through December 1. The Atomic Energy Commission’s exhibit will include 22 types of basic instruments manufactured by 20 commercial companies.

The purpose of the conference is to show the problems facing utilization of atomic energy and the need for cooperation among electronic engineers, physical scientists and medical doctors. Over twenty papers are being presented by various authorities in the atomic energy research and development field.

South American Television

TRANSMITTING EQUIPMENT for South America’s first television station was recently sold by General Electric Co. to Cesar Ladeira, one of the founders of Radio Televisao do Brazil. Television service, expected to be functioning within a year, will be operated in collaboration with Radio Mayrink Veiga, PRA-9, of Rio de Janeiro.

The transmitter will have 5-kw power rating, which will make it comparable in strength to stations operating now in the U. S. The system will operate on American standards of 525 lines, 30 frames and 60 fields in black and white.

The laboratory includes a high-voltage section, a pilot plant, a chemical and metallurgical area, and a photo-technical department.

Technical Information Committee

A SPECIAL COMMITTEE on Technical Information has been formed by Vannevar Bush, chairman of the Research and Development Board, to promote effective exchange of research and development information among the departments of the National Military Establishment. Detlev W. Bronk, president of Johns Hopkins University, is chairman of the new group. Other members include: John E. Burdick, Dean of Humanities, MIT; Herman Henkle, director of the...
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NEWS OF THE INDUSTRY (continued)


No Change in Operator License Rules

LAST YEAR'S PROPOSAL to provide for three classes of radio operator licenses has been abandoned by the FCC. The Commission finds no justification for the proposed rules or for any substantial changes in present rules, provided that qualifying examinations are kept up to date in relation to developments in the broadcast radio art through appropriate periodic revisions.

British TV System to Stay

To PREVENT THE SETS now in use from becoming obsolete, the British Broadcasting Corporation's television advisory committee has advised the Postmaster General to make no technical changes which would involve a change in the present television system.

The London television station will continue to operate for a number of years on the present 405-line system. The same system is being adopted for the Midlands station and is proposed for other British stations. Frequencies for vision and sound will be in the neighborhood of 60 mc. Alternative radio and cable links are being provided to make television available to more of the population.

BUSINESS NEWS

RADIO CORP. OF AMERICA and its subsidiaries have been granted a license under the radar development patents owned by Raytheon Mfg. Co., Waltham, Mass.

NUCLEAR INSTRUMENT CHEMICAL CORP. is the new name of Instrument Development Laboratories, Inc., Chicago, Ill. Products include instruments for nuclear and radioactivity measurement.

RANSBURG ELECTRO-COATING CORP., Indianapolis, Ind., has available a
The days of "file and fit" went out when volume methods came in. The modern assembly line in large production plants is in itself so dramatically arresting a spectacle that the "feeder lines", of which there are hundreds in every volume industry, are lost sight of. Just as mighty rivers exist only because of the less majestic tributaries, so the production line is dependent upon sources of supply so unvarying in flow and quality, that every part is ready and right to "fall into place" with mechanical precision and constant supply. Our production line has been standardized to a degree of uniformity attainable only through long-time development of machines, controls and skilled workmen.

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NEWS OF THE INDUSTRY (continued)

16-mm film covering their electrostatic detearing and spray finishing processes.

CLAROSTAT MFG. CO., INC., has moved from Brooklyn, N. Y., to a block-long plant in Dover, N. H., providing over 250,000 sq ft of floor space to expand operations and add various radio-electronic specialties to its line.

WESTERN ELECTRIC CO., INC., recently opened a new plant on a 50-acre tract two miles east of Allentown, Pa., for the manufacture of tubes and other precision electronic equipment. Cost of the plant, which will employ about 2,500 people, is estimated at over $10,000,000.

MEKELEK, INC., Highland Mills, N. Y., was recently organized for the production of electronic devices, particularly sound apparatus.

WORLD INDUSTRIES, INC., Dayton, Ohio, has been incorporated to manufacture electronic and other products and to operate research and development laboratories.

LENNOX INDUSTRIES, INC., Cleveland, Ohio, has been incorporated for the manufacture of electronic devices.

FAIRCHILD RECORDING EQUIPMENT CORP., New York, N. Y., was recently formed to combine the manufacture and sale of a new magnetic tape recorder with Fairchild Camera and Instrument Corporation's line of recording and sound equipment.

STROMBERG-CARLSON CO. recently broke ground atop Pinnacle Hill, Rochester, N. Y., for television station WHTM. The tower will also be able to support two f-m antennas
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The new Photo-electronic Counter was designed for industrial applications in which mechanical counters do not count accurately or wear rapidly because of counting speed. One of the well-known Potter electronic counter decades is used to scale down the operating speed of a reliable electromechanical register. In the Model 310, the photo-electric "eye" is located inside the cabinet and the light enters through a small window at the rear. In the Model 312, the photo-electric "eye" is housed separately for remote counting. Small objects as well as closely spaced parts can be accurately counted since the width of the photo-electric beam is only 1/2 inch, and does not require complete interruption for actuation. Another version, the Model 311, uses an electromagnetic pick-up coil for counting shaft rotation without contact.

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* Compact—completely self-contained, no wiring required, easy to install
* Flexible—self-contained "eye", separate "eye" or electromagnetic pick-up coil may be used for actuation
The No. 90711 Variable Frequency Oscillator

The No. 90711 is a complete transmitter control unit with 6SK7 temperature-compensated, electron coupled oscillator of exceptional stability and low drift, a 6SK7 broad-band buffer or frequency doubler, a 6A67 tuned amplifier which tracks with the oscillator tuning, and a regulated power supply. Output sufficient to drive an 807 is available on 160, 80 and 40 meters and reduced output is available on 20 meters. Close frequency setting is obtained by means of the vernier control arm at the right of the dial. Since the output is isolated from the oscillator by two stages, zero frequency shift occurs when the output load is varied from open circuit to short circuit. The entire unit is unusually solidly built so that no frequency shift occurs due to vibration. The keying is clean and free from all annoying chirp, quick drift, jump, and similar difficulties often encountered in keying variable frequency oscillators.

LECTROHM, INC., Chicago, Ill., has moved to larger quarters at 5939 Archer Ave. in that city, to increase production of vitreous enamel resistors and electric solder pots.

GENERAL ELECTRIC RESEARCH LABORATORY has built its fourth betatron, a 50-million volt device for producing high-energy x-rays for use in cancer treatment.

PERSONNEL

LELAND J. HAWORTH, associated with the Brookhaven National Laboratory since August 1947, has been promoted from acting director to director of this atomic research center. During the war he served with the MIT Radiation Laboratory in radar development.

NEWBERN SMITH, a member of the National Bureau of Standards staff since 1935, has been appointed chief of the NBS Central Radio Propagation Laboratory.

HAROLD P. KNAUSS has resigned as director of research and development at the Mound Laboratory, Miamisburg, Ohio, to become head of the department of physics at the University of Connecticut. During the war he worked on submarine detection at Harvard Underwater Sound Lab and at Submarine Signal Co.

TIMOTHY E. SHEA, after 28 years with Western Electric's engineer-
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<td>770-6</td>
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**NEWS OF THE INDUSTRY (continued)**

T. E. Shea  
T. M. Lihmatainen

Toivo M. Lihmatainen, formerly associated with Sylvania Electric Products Co., has been appointed to the staff of the Electron Tube Laboratory, National Bureau of Standards, to work on the engineering and development of microwave tubes.

Sydney Cramer, former television development engineer with GE, has joined Paramount Pictures television group in the same capacity.

Rodney D. Chipp, previously with NBC, has been promoted from assistant chief engineer to director of engineering for the DuMont television network.

H. U. Hjemstad, former vice-president in charge of manufacturing and engineering at Federal Enterprises, Inc., has been appointed assistant to the president of Sola Electric Co., Chicago, Ill.

G. Lester Jones, formerly associated with automatic pilot development at Sperry Gyroscope Co. and prior to that, chief engineer of Sperry Products Co., was recently appointed chief engineer of Lear, Inc., Grand Rapids, Michigan.

Howard R. Boyle, formerly affiliated with Sylvania Electric Products and Sperry Gyroscope Co., has been appointed chief engineer of the key station of the Far East
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J. Sieger  W. H. Bennett

WILLARD H. BENNETT, former director of physical and applied research at the Institute of Textile Technology, was recently named head of the Physical Electronics Section of the Atomic and Molecular Physics Division, National Bureau of Standards. He will engage in basic research on cathode emission processes and the physical properties of negative atomic ions.

RANDALL MCGAVOCK ROBERTSON, formerly research associate of the Norton Co., and associated during the war with the MIT Radiation Laboratory airborne radar group, has been appointed acting director of the Physical Sciences Division of the Office of Naval Research.

CHARLES S. RICH, formerly secretary of the AIEE technical program committee, has been named editor of the Institute's official publications, Electrical Engineering and Transactions, to succeed G. Ross Henninger who recently resigned.

A. K. WRIGHT, chief radio engineer of the Tungsol Lamp Works, Inc., Bloomfield, N. J., was recently appointed a member of the Joint Electron Tube Engineering Council.

Robert Finlay, wartime procurement engineering counsel for the...
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Frank W. Walker, formerly national president of the Associated Police Communications Officers and vice-chairman of Panel 13 of the RTPB, was appointed radio communication engineer in the state of Michigan by Motorola, Inc.

Raleigh J. Wise, Telefax research engineer for Western Union Telegraph Co., has been awarded the 1948 Longstreth Medal from the Franklin Institute for his development of a dry electrosensitive recording blank.

Ralph A. Krause, senior engineer consultant to Brookhaven National Laboratory, N.Y. and formerly assistant to the president of Raytheon Mfg. Co., has been named director of research at Stanford Research Institute, Stanford University, Calif.

Jay C. Fonda, former engineering consultant, has joined the Morris F. Taylor Co., manufacturers' representitives, as sales engineer.

D. Gordon Clifford, one of the development engineers who worked on the klystron and formerly chief engineer of Industrial & Commerce Electronics, is now field engineer at Lenkurt Electric Co., San Carlos, Calif., manufacturers of carrier telephone and telegraph equipment.

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NEW BOOKS

Frequency Analysis, Modulation, and Noise

This book is unique in that three virtually unrelated fields are under study. The first, frequency analysis, is obviously stimulated by the author's dissatisfaction with the brevity it usually receives in texts designed to present a variety of mathematical methods at the engineer's level. A total of 140 pages is devoted to the subject; the basic Fourier transforms, in series and integral form, are developed in swift, palatable form, and much attention is given to simplifications which result from various types of symmetry. In addition, a variety of problems is treated to illustrate applications of the Fourier technique, most noteworthy perhaps being those that deal with detail and bandpass requirements in television and pulse receivers.

The portion on modulation is much shorter than the other two, and accordingly not as comprehensive. Instead of attempting a swift course through the entire present status of the art, the author has chosen to organize and expand special items which so far have been treated only in periodical literature. For example, the technique of resolving an arbitrary sideband distribution into symmetrical and antisymmetrical components is treated in some detail, while on the other hand little is said about the means for generating or detecting various modulation types, or about such topics as single sideband, suppressed carrier, and pulsed code.

The final section on noise constitutes the greatest portion of the book, and meets a need long felt by communications engineers who, concerned with noise problems, must refer to the scattered publications of Nyquist, North, Ferris, Schottky and many others. In this book the fundamental contributions of these workers are integrated into a broad, coherent presentation. In an introductory chapter, the author chooses to outline the several types of noise, state the formulas which

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NEW BOOKS (continued)

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This is one of the series of Technical Monographs published in England. Like others of this series, it comprehensively covers its subject. Following a general introduction discussing the factors influencing musical reproduction and the distinction between synthetic and natural sources of music, the author discusses in order: acoustics of music, classification of instruments, electrostatic, electromagnetic and photoelectric tone generators, and finally amplifiers and tone control circuits.

Although the basic principles of most of the more successful instruments in the field are described, no detailed circuits with values are given. For the true electronic experimenter, the lack of values is no drawback and the focus of attention on principles is a decided advantage. However, for the home experimenter and musician with only a passing acquaintance with electronics, the lack of complete circuits with values is a decided disadvantage. The copious list of literature mitigates this shortcoming somewhat.

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Electrical Eye Circuits and Relays. By A. Edelman, chief engineer, Photobell Co. Published by Eby Specialty Sales Co., New York, N. Y., 24 pages, 1948, paper-bound, $1.00. Principles of photoelectric detectors, optical systems, amplifiers, power supplies and relays are presented for technicians. Typical circuits are shown, along with suggestions for maintenance.

Election-Optics. By Dr. Paul Hattem, American Photographic Publishing Co., Boston, Mass., 1948, 216 pages, $3.50. This translation from the German (originally published in 1945) has had two additional chapters added, one on electron microscopes at the time of publication (1941) and another on nuclear accelerators and radiological applications at this second edition. Primarily for laymen and electrical engineers who have not specialized in electronics, this book describes electron lenses, television tubes and how electron optics is used in amplifiers.

Understanding Television. By Orrin E. Dunlap, Jr., Greenberg: Publisher, New York, N. Y., 286 pages, $3.00. History, process of seeing by television, what television performers should know, questions and answers, glossary, bibliography and list of stations on the air, written for the layman. Liberally illustrated.

Radio and Television Law. By Harry P. Warner, Matthew Bender & Co., 149 Broadway, New York, N. Y., 1948, 1,095 pages, in looseleaf binder, $30.00. Reference book on radio and television broadcasting industry's legal and regulatory structure, explaining the laws in plain language and tracing the legal, financial and technical history of an a-m, f-m and television station in turn from first filing of the application with the FCC on through going on the air and receiving a regular license. Covers what can and can't be broadcast, transfer and assignment of licenses, network regulations, possible amendments to Communications Act, control of radio advertising, and many related topics.

National Electrical Safety Code. National Bureau of Standards Handbook 526, issued March 1948, 408 pages, $1.35 from Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. Contains five parts of fifth edition of code, as approved by ASA; parts 6 is now being revised. The five parts cover mandatory (shall), advisory (should) and desirable (recommended) practices for electrical supply stations, electric supply and communication lines, electrical equipment and lines, and radio installations.

Radio Components Handbook. Written and published by the staff of Technical Advertising Associates, Cheltenham Pa., 211 pages, $1.50 intended to bridge gap between formal textbook and general handbook. Covers design, application and specification of each type of component in turn, plus an opening chapter on general design principles. Sponsored by The Foster Transformer Co., The Magnetic Co. and Ward Leonard Electric Co. makes the low price on this book possible.

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**BACKTALK**

(continued)

A rectifier circuit is drawn with symbols understood in another way, and the result is rather confusing. If the symbols are understood as described above, the diagrams will be simpler.

Equation 3 should read

\[ i = \left( \frac{E}{R} \right) \cos \phi \left[ \sin (\alpha - \phi) - \sin (\alpha_0 - \phi) \right] \exp - \cot \phi \left( \alpha - \alpha_0 \right) \]

In the middle of the third column on p 92 is the statement: “and flows in branches 1A and 2A of the rectifier...” A glance at Fig. 5A shows that it is actually branches 1B and 2A.

Equation 11 should read

\[ \tau = \frac{2L}{R_S} = N^2 \phi_1 - \phi_s = \ldots \]

S. F. HEDSTROM
L. F. BORG
ASEA Ludvika
Sweden

**Insert One Zero**

DEAR SIRS:

In my wide-band phase shifter article in the May, 1948 ELECTRONICS, the lower of the two capacitors immediately adjacent to the input transformer in Fig. 3 on p 84 should be labelled 0.000892 instead of 0.00892. The mistake, I am sorry to say, is mine.

The circuit is the example given by Dome in his December, 1946 ELECTRONICS article, referenced in mine, and it is hoped that anyone undertaking serious work with these networks will refer to the Dome article.

OSWALD G. VILLARD, JR.
Department of Electrical Engineering
Stanford University

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A condenser checker anyone can afford to own. Measures capacity and leakage from 0.0001 to 1000 MFD on calibrated scales with test voltage up to 500 volts. No need for tables or multipliers. Residues resistance 500 ohms to 2 megohms. 110V 60 cycle transformer operated complete with rectifier and magic eye indicator tubes. Easy quick assembly with clear detailed blueprints and instructions. Small convenient size 9" x 6" x 4 1/4". Wt. 4 lbs.

$19.50

Nothing ELSE TO BUY

**Heathkit SIGNAL TRACER KIT**

Reduces service time and greatly increases profits of service. 1000 cycle AC rectifier, crystal diode to follow signal from antenna to speaker. Locates faults immediately. Internal amplifier available for speaker testing and internal speaker sensitivity tests available for additional cost. Internal transformer for VTVM on panel allows visual tracing and gain measurements. Also tests phonograph pickups, microphones, PA systems, etc. Frequency range 1000 cycles to 200 Mc. Complete ready to assemble. 110V 60 cycle transformer operated. Supplied with 3 tubes, diode probe, 3 color panel, all other parts. Easy to assemble, detailed blueprints and instructions. Small portable 9" x 6" x 4 1/4". Wt. 6 pounds. Ideal for taking on service calls. Complete your service shop with this instrument.

$24.50

Nothing ELSE TO BUY

**Heathkit OSCILLOSCOPE KIT**

New improved model of the famous Heathkit Oscilloscope. Building an oscilloscope is the finest training for television and newest servicing technique and you save two-thirds the cost. All the features and quality of instruments selling for $100.00 or more. Supplied complete with cabinet, two color panel, 5BP1 tube, 2 5Y3 tubes, 2 6517 tubes and 884 sweep generator tube. Transformer supplies 1000V negative and 350 volt positive. Sweep generator 15 cycles to 30 M. cycles. Has vertical and horizontal amplifiers, Oil filled filter condensers for long life. Complete blueprints and instructions included.

$39.50

Nothing ELSE TO BUY

**The NEW 1948 HEATHKIT 5 INCH OSCILLOSCOPE KIT**

The most essential tool a radio man can have, now within the reach of his pocketbook. The Heathkit VTVM is equal in quality to instruments selling for $75.00 or more. Features 500 microamp meter, transformer power supply, 1% glass enclosed divider resistors, ceramic selector switches, 1 megohm input resistance, linear AC and DC scale, electronic AC reading RMS. Circuit uses 6SN7 in balanced bridge circuit, a 646 as RF oscillator, and a 747 as transformer power supply rectifier. Included is means of calibrating without standards. Average assembly time less than four pleasant hours and you have the most useful test instrument you will ever own. Ranges 0-3, 0-10, 0-100, 0-1000, and 0-10,000 volts AC and DC. Ohmmeter has ranges of scale times 1, 100, 1000, 10K and 1 megohm, giving ranges .1 ohm to 1000 megohms. Complete with detailed instructions. Add postage for 8 lbs.

$39.50
TOGGLE SWITCHES

- 45,000 SPDT, with center off position.
- 10,000 DPDT, with center off position.
- 3700 DPDT, with center off position.
- 5000 SPDT, with center off position.

CIRCUIT BREAKERS

- 3500 15 Amp, 125 volt, 5 amp, 250 volt
- 1000 10 Amp Single Pole
- 1000 SPNC 10 Amp 125 volt. 5 amp, 250 volt
- 2000 SPNO 10 Amp 125 volt, 5 amp, 250 volt
- 1000 15 Amp Single Pole

SPECIAL METERS

- FREQUENCY METER, 350 to 450 cycles, Cont.

TERMINAL BOARDS

- 4 Conn. 334" Lx 6" W x 8 1/2" H
- 6 Conn. 4 1/2" L x 2 1/2" W x 1 3/4" H
- 1 Conn. 4 1/2" L x 2 1/2" W x 1 3/4" H
- 1 Conn. 4 1/2" L x 2 1/2" W x 1 3/4" H
- 1 Conn. 4 1/2" L x 2 1/2" W x 1 3/4" H
- 1 Conn. 4 1/2" L x 2 1/2" W x 1 3/4" H

OVER 50,000 METERS IN STOCK

- We have a wide range of meters in stock, including vintage and specialty types. This is just a small selection of what we have available.

- We also have a variety of terminal boards and switches for different applications, such as marine switchboards and control panels.
STANCOR FILAMENT TRANSFORMER
NO. 240. New. Heavy duty Stancor No. 315 supplies 5V at 6 Amps, 5V at 3 Amps and 5V at 1 Amp. Input 12V at 280 MA. Shipping Wgt. 7 lbs. Each $1.00

BC 746 TRANSMITTING TRANSFORMER
NO. 243. New G.E. Transformer supplies 2.5V at 100 KVA. Has 3KV input, 120V 60 cy. primary. Shipping Wgt. 13 lbs. $9.50

RCA SATURABLE REACTOR TRANSFORMER
NO. 246. New RCA No. CRV30531 AC current 750 MA DC current 2 Amperes. A cased type. Shipping Wgt. 4 lbs. Each $1.95

NO. 247. New cased 110 V 60 cy. Power Transformer. Supplies 440V Ct. at 60 MA, 6.3V at 24, and 12.6V at 1 Amp. Excellent for military sets. Shipping Wgt. 6 lbs. Each $1.95

RCA INPUT TRANSFORMER
NO. 248. Heavy duty RCA No. CRV30539 Input has primaries 600 to 1200 and 25 ohms secondary 25000 ohm A.C. T. Shipping Wgt. 2 lbs. Each $1.00

REPLACEMENT POWER TRANSFORMER
NO. 251. Excellent value transformer at use of one of largest transformer companies, 110V 60 cy. Primary supplies 75V 3 cy. at 150 MA. 6.3V at 91A. Shipping Wgt. 3 lbs. Each $2.95

FEDERAL POWER TRANSFORMER

HEAVY DUTY 6-12-24 VOLT VIBRATOR
NO. 253. A heavy duty vibrator used on army transmitter, and 30 emperors at 6 Volts 220 cycles with contacts for 12 and 24 Vats, Synchronous relay used in industrial applications. Shipping Wgt. 3 lbs. $1.50

4 CHANNEL PUSH BUTTON TUNER
NO. 254. Permeability tuner from BC 738 containing duty first detector, and oscillator coils. Covers 2 to 5 MC. Complete unit includes transformer and shipping Wgt. 2 lbs. $2.50

CONDENSER SPECIAL
NO. 255. An ideal oil filled power supply filter used in army 16 tube transmitting set. Has 1.5, 2.5 and 3.5 MF all at 600V D.C. rating. Shipping Wgt. 3 lbs. Each $1.50

STANDARD BRAND TELEVISION CONDENSER
NO. 256. .05 MF at 7300V, rating. Excellent Television coupling Condenser with mounting bracket. Shipping Wgt. 3 lbs. each $3.50

BC 746 TUNING UNIT
NO. 257. Plug in transmitter tuning unit from army Waltie Talkie. Contains antenna and tank coils, tuning condenser, transmitting and receiving crystal, and original transmitter foundation. Shipping Wgt. 1 lb. Each $1.00

T30 THROAT MICROPHONE
NO. 258. Makes excellent contact microphone, instrument or vibration pick-up. Shipping Wgt. 1 lb. Shipping Wgt. 1 lb. Extension cord with switch for above $ 5.50 each

BRAND NEW ARMY AIR FORCE ASTROGRAPH
NO. 259. The case of this unit makes the finest tool and service kit ever designed. Ply- wood construction. Case 11 x 10 x 5 high. With 8 covered compartments in the bottom for repair parts, leather handle, steel reinforced brass hinges. Also excellent as a camera, phonograph, movie projector, camera, shell case, fishing kit, picnic kit, etc. The astrograph itself, (which cost the government $25.00) may be an excellent contact printer, and can be used for a foundation for enlarger, strip map holder, etc. The case alone worth twice the give-away price of the instrument. AN27/ ARNS ANTENNA
NO. 260. Standard blind landing antenna system complete with case, in original carton. Shipping Wgt. 14 lbs. $9.50

NO. 261. New blade type antenna complete with case assembly, in original carton. Shipping Wgt. 9 lbs. $7.50

AT38A/ APT ANTENNA SYSTEM
NO. 262. New blade type antenna complete with case assembly, in original carton. Shipping Wgt. 11 lbs. $7.50

BENDIX MTS15 TRANSMITTER CONTROL BOX
NO. 265. Starter control box has starting and stopping order, indicator lamp, cable and wooden case. Shipping Wgt. 3 lbs. Each $5.50

BC 6708 REMOTE CONTROL BOX
NO. 266. Starter control box used for Bendix antenna system. Shipping Wgt. 3 lbs. Each $1.95

BC 22 RELAY ASSEMBLY

HEINEMANN CIRCUIT BREAKER
NO. 267. Heavy duty type 7 Amp. 24 Volt D.C. Many uses around ship. Shipping Wgt. 2 lbs. Each $1.00

CUTLER HAMMER MOTOR FIELD CONTROL
NO. 285. Rated 10 ohms. 3.2 Amps. Maximum 6 1/2" diameter with knob and mounting feet. Can be used to regulate generator output voltage. Shipping Wgt. 5 lbs. Each $2.50

PENN THERMO RELAY
NO. 288. Thermos Relay with a range of 45 to 100 complete with case. Shipping Wgt. 6 lbs. Each $3.50

ONE KILOWATT ADJUSTABLE ANTENNA LOADING COIL
NO. 289. Huge porcelain coil 4" diameter. Pulled to size to fit any adjustable type for outdoor use, built for army to withstand hard usage. Complete with cord and PFL-100 Deepleg Wgt. 2 lbs. Each $2.00

MC 432 VHF ANTENNA LOADING UNIT
NO. 278. Contains 2 pole, 5 position rotary switch with silver knife edges, variable condensers, and coils for matching VHF and UHF. Shipping in a case with 50 ohm line. Many useful parts. Shipping Wgt. Each $1.50

COLLINS AUTOTUNE CONTROL HEAD
NO. 276. Brand new controls used on the ART/13, 100 Watt, Transmitter types 7, 8, 10, and 11 available. Get a spare while available at new cost is over $225.00 each. Shipping Wgt. 3 lbs. Price any type mention when ordering. $3.50

MC 432 VHF ANTENNA LOADING UNIT
NO. 278. Contains 2 pole, 5 position rotary switch with silver knife edges, variable condensers, and coils for matching VHF and UHF. Shipping in a case with 50 ohm line. Many useful parts. Shipping Wgt. Each $1.50

ONE KILOWATT ADJUSTABLE ANTENNA LOADING COIL
NO. 289. Huge porcelain coil 4" diameter. Pulled to size to fit any adjustable type for outdoor use, built for army to withstand hard usage. Complete with cord and PFL-100 Deepleg Wgt. 2 lbs. Each $2.00

300 MA SELENIUM RECTIFIERS
NO. 290. Rated 300 MA at 36 Volts, complete with mounting brackets and tightening screws. Shipping Wgt. 1 lb. 3 FOR $1.00

805C SCR 522 POWER SUPPLY
NO. 277. Complete dynamotor power supply for the SCR-522, operates from 25 Volts. Complete with controls, filters, etc. 250V at 60 MA. Shipping Wgt. 4 lbs. Each $8.75

DM 35 12 VOLT DYNAMOTOR
NO. 274. New input 12 Volt 18.7 Amperes. Supplies 675 Volts at 275 MA or 1/2 above voltage from 6 volts. Excellent for auto use. Shipping Wgt. 11 lbs. Each $7.50

FE 86 DYNAMOTOR
NO. 275. Makes excellent home lighting plant, or hand crank. Reduction gear allows hand crank. Shipping Wgt. 6 lbs. Each $3.95

GN 58 HAND GENERATOR
NO. 274. Rated 250 watts at 120 Volts. Shipping Wgt. 3 lbs. Each $5.50

ASTROGRAPH
NO. 279. Contains 2 pole, 5 position rotary switch with silver ceramic sliders for adjustments. Shipping Wgt. 60 lbs. Each $3.50

ONE KILOWATT ADJUSTABLE ANTENNA LOADING COIL
NO. 289. Huge porcelain coil 4" diameter. Pulled to size to fit any adjustable type for outdoor use, built for army to withstand hard usage. Complete with cord and PFL-100 Deepleg Wgt. 2 lbs. Each $2.00

DM 64A 12 VOLT DYNAMOTOR
NO. 269. Input 12V at 5 Amps. Output 275 Volts 150 MA. Shipping Wgt. 7 lbs. Each $5.50

DM 32A COMMUTATOR DYNAMOTOR
NO. 270. Part of 250 Watt Semiconductor Receiver. Input 28 Volts, output 250V at 60 MA. Shipping Wgt. 4 lbs. Each $5.00

DM 21 12 VOLT DYNAMOTOR
NO. 271. For use in Army BC 312 Communication Receiver. Input 12 Volts, output 225 Volts at 90 MA. New, original cartons. Shipping Wgt. 3 lbs. Each $5.50

DYAL INSTRUMENT CORPORATION
BENTON HARBOR 14, MICHIGAN

HOW TO ORDER

FOR ALL QUANTITIES LIMITED SUBJECT TO PRIOR SALES.

STANNOYRM

FOR LIGHTWEIGHT PORTABLE TELEGRAPH OL

THE DYN..
**LARGEST STOCK OF**

**TUBES**

IN THE COUNTRY

ALL BRAND NEW—STANDARD BRANDS

MINIMUM ORDER $5.00

QUANTITY PRICES ON REQUEST

<table>
<thead>
<tr>
<th>Type</th>
<th>Price</th>
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<th>Price</th>
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(ALL TUBE TYPES IN STOCK NOW—SUBJECT TO PRIOR SALE—PRICES SUBJECT TO CHANGE WITHOUT NOTICE)

NIAGARA RADIO SUPPLY CORP.

Driby 9-1132-3-4

All Prices F.O.B.

N. Y. C.

ELECTRONICS — December, 1948
NEW GUARANTEED SURPLUS

AUTOSYNS

Pioneer

AT-1, AT-14, AT-20,
AY-30, AT-54.
AY-101D,
etc.

Prices on Request

SYNCHROS

Navy Types

1G, 1F, 1CT, 5G, 5F, 5CT,
5DG, 5HCT, 5SF, 5HSF,
etc.

Prices on Request

SELSYN SPECIAL

W.R. KN-3056-LJ

Size 5. 115 v. 400

cycles. Use on re-
duced 60 cycles.

Stock #SA-182.
Price $3.75 each

Kollmans

775-01 Selsyn

Ideal for Ham use as transmitter or re-
ceiver. 6-12 volts 60 cycles. 26 volts 600

Price $1.75 each

Phase Shift Coupler — 4 motors single
rotor 0-360° phase shift. (Use in complex
wave synthesis.) Stock #SA-115.
Price $3.75 each

INVERTER

SPECIALS

400 Cycles

Three Phase

Holtzer Cabot MG-155—Input 25 volts DC
at 32 amps. Output three phase 115 volts
600 cycles at 750 V.A. Output. Also sec-
ond output of 25 volts 400 cycles at 250
V.A. Voltage and frequency regulated.

Stock #SA-131.

Price $99.50 each

Leland SD-105-02(12258)—Input 25 volts DC
at 60 amps. Output three phase 115 volts
100 cycles at 750 V.A. 6.5 amp P.F. Second
output voltage of 125 volts 400 cycles at
100 V.A. Stock #SA-194.
Price $97.50 each

Quotations on request for the following inverters.

General Electric 5AS131J11A—(PE-218)
Navy Type CR-21L-AK G.E. 24S121L12

General Electric 5DB1312A
Holtzer Cabot MG-119H
Holtzer Cabot MG-199F
Wincharger PL7/AF
Pioneer 12113-1A
Pioneer 12117-3

Price $90.00 each

SPERRY PHASE ADAPTOR — 661102

315 volts. Used for operating 3
phase equipment from single phase source.

Stock #SA-194.
Price $6.75 each

ALSO IN STOCK

SINUSOIDAL POTENTIOMETERS
SINE COSINE GENERATORS

(Diehl Types FJE-43-9 and FJE-43-1)

PIONEER TORQUE UNITS

KOLLMSAN COMPASS SYSTEMS

AIRCRAFT TACHOMETER SYSTEMS

AMPLIDYNES - MAGNESYS

DC SERVO MOTORS

SERVO AMPLIFIERS

GYROS - AUTOPILOTS

LP-21-LM Compass Loops

New

Original Cartons

Stock #SA-59.
Price $9.50 each

G.E. 10 RPM DC
Motor 5BA 10FJ12

Output 40 lb. in
at 10 rpm. 24 V.
3.5 A. P.F.
Series wound.

Price #9.75 each

Delco PM Motor—5068571

Alnico field. 127 volts DC. 10,000 rpm. 1" x 1.5" x 15/16"

Price $79.50 each

12V D.C. Motor
John Oster B-9-2

1.4 amps.
6000 rpm.

Price $4.00 each

Blower Assembly

MX-215/APG

John Oster C-22-1L

28 V. DC, 1900 RPM.
100 H.P. 22 L.R

Price $4.00 each

BEAM ROTATOR

1 rpm. 25 v. DC or 40 v.

60 cy. operation. Re-
versible. 3/4" diam. x 4"

Price $8.50 each

Synchron 10 RPM Timing Motor—24 V.

Price $8.50 each

AC SERVO MOTORS

Pioneer—CK-2 and 10047-2A for 400 cy.

Kollman—715-02 for 400 cyles

Diehl—PV-12.2 PFE-2111G (CDA-211052)

and ZP-180-14 for 60 cycles.

Prices on Request

110 RPM MOTOR

G.E. 5BA11815D. 27 V. 0.6 amp. 1 oz/ft.

Torque 1/8" diam. x 1/4" X. Operates on
AC or DC. Stock #SA-39.

Open account shipments

to rated concerns.

All prices F.O.B. Paterson, N. J.

4 Godwin Ave.

258

Servo Tek Products Co.
Incorporated
Surplus Division

December, 1948 — ELECTRONICS

Write for complete listing,
or call ARmory 4-3366

Paterson, N. J.
Searchlight Section

Raytheon Rectichargers
Input: 115 volts AC, 60 cycles, 1 Ph...
Output: 48 V. DC at 3 ampere regulated and adjusted.
Charges 24 to 24 battery or may be used direct as battery eliminator.
The Raytheon Recticharger is designed to supply current at constant voltage to any load within its rating, and in addition to supply current to a storage battery connected across its load, of sufficient amount to maintain full charge.
The function of the battery is to supply surge current due to sudden changes in load and to act as a "stand-by" source of power in event of commercial power failure.

BRAND NEW ....... $69.50

Electronic Craft

5 Waverly Place

ELECTRONICS — December, 1948

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Page 5: GE Battery Charger
Page 6: Shock Mounts
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Page 11: Paraboloids
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Page 13: ACME Hi-Volt Transformers
Page 14: Radar Antennas
Page 15: Motor Generators
Page 16: Brand New War Surplus Machines Built by Ailsa Chambers Co. to U.S. Navy Specifications, etc.
RELIANCE Wishes its many friends
a VERY MERRY CHRISTMAS

MINIMUM ORDER $5

Arch St. Cor. Croskey, Philadelphia 3, Pa.
Telephone Rittenhouse 6-4927

RELIANCE MERCHANDIZING CO.
### 1 K.W. Power Supply Kit

<table>
<thead>
<tr>
<th>Model</th>
<th>Current</th>
<th>Voltage</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>2500-2000 Volts @ 500 MA</td>
<td>2.95</td>
<td>$3.49</td>
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<tr>
<td>200-0-2000 Volts @ 500 MA</td>
<td>2.95</td>
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### Full Wave Bridge Type

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<th>Model</th>
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<tr>
<td>INPD</td>
<td>up to 18 AC</td>
<td>12 Volts</td>
<td>0.98</td>
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<tr>
<td>INPC</td>
<td>up to 12 AC</td>
<td>10 Amps</td>
<td>3.45</td>
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<tr>
<td>INPE</td>
<td>up to 12 AC</td>
<td>8 Amps</td>
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<td>INPF</td>
<td>up to 12 AC</td>
<td>5 Amps</td>
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<tr>
<td>INPG</td>
<td>up to 36 AC</td>
<td>8 Amps</td>
<td>7.95</td>
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<tr>
<td>INPH</td>
<td>up to 36 AC</td>
<td>5 Amps</td>
<td>5.95</td>
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<td>INPI</td>
<td>up to 36 AC</td>
<td>3 Amps</td>
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<td>INPJ</td>
<td>up to 36 AC</td>
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<td>INPK</td>
<td>up to 36 AC</td>
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### OIL Condensers

**Nationally Advertised Brands**

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<th>Capacity</th>
<th>Voltage</th>
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<tr>
<td>.25 mf.</td>
<td>600v</td>
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<td>1 mf.</td>
<td>1000v</td>
<td>1.10</td>
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<tr>
<td>2 mf.</td>
<td>2500v</td>
<td>2.15</td>
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<tr>
<td>5 mf.</td>
<td>5000v</td>
<td>4.95</td>
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<tr>
<td>10 mf.</td>
<td>1000v</td>
<td>4.95</td>
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<tr>
<td>20 mf.</td>
<td>2000v</td>
<td>9.95</td>
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<td>50 mf.</td>
<td>5000v</td>
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### High Capacity Condensers

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<td>10,000 mf.</td>
<td>25 WDC</td>
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<tr>
<td>20,000 mf.</td>
<td>25 WDC</td>
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</tr>
<tr>
<td>30,000 mf.</td>
<td>25 WDC</td>
<td>$12.95</td>
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<tr>
<td>40,000 mf.</td>
<td>25 WDC</td>
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<tr>
<td>50,000 mf.</td>
<td>25 WDC</td>
<td>$16.95</td>
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<tr>
<td>60,000 mf.</td>
<td>25 WDC</td>
<td>$18.95</td>
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<tr>
<td>70,000 mf.</td>
<td>25 WDC</td>
<td>$19.95</td>
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### Filter Chokes

**Hi-Voltage Insulation**

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<th>Wire</th>
<th>Current</th>
<th>Voltage</th>
<th>Price</th>
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</thead>
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<td>8 by @ 100 ma.</td>
<td>0.90</td>
<td>0.30</td>
<td>$2.49</td>
</tr>
<tr>
<td>10 by @ 100 ma.</td>
<td>0.90</td>
<td>0.30</td>
<td>$3.49</td>
</tr>
<tr>
<td>25 by @ 150 ma.</td>
<td>0.90</td>
<td>0.30</td>
<td>$7.95</td>
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</table>

### RADIO TUBES

**New! Standard Brands**

<table>
<thead>
<tr>
<th>Model</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>12A7</td>
<td>12S.75</td>
</tr>
<tr>
<td>12A8</td>
<td>12S.75</td>
</tr>
<tr>
<td>12A9</td>
<td>12S.75</td>
</tr>
<tr>
<td>12A9D</td>
<td>12S.75</td>
</tr>
<tr>
<td>12A10</td>
<td>12S.75</td>
</tr>
<tr>
<td>12A11</td>
<td>12S.75</td>
</tr>
<tr>
<td>12A12</td>
<td>12S.75</td>
</tr>
<tr>
<td>12A13</td>
<td>12S.75</td>
</tr>
<tr>
<td>12A14</td>
<td>12S.75</td>
</tr>
<tr>
<td>12A15</td>
<td>12S.75</td>
</tr>
</tbody>
</table>

### TRANSFORMER

**115 V. 60 Cu.**

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>12A4</td>
<td>12S.75</td>
</tr>
<tr>
<td>12A5</td>
<td>12S.75</td>
</tr>
<tr>
<td>12A6</td>
<td>12S.75</td>
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<td>12S.75</td>
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<td>12A9</td>
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<tr>
<td>12A10</td>
<td>12S.75</td>
</tr>
<tr>
<td>12A11</td>
<td>12S.75</td>
</tr>
<tr>
<td>12A12</td>
<td>12S.75</td>
</tr>
<tr>
<td>12A13</td>
<td>12S.75</td>
</tr>
<tr>
<td>12A14</td>
<td>12S.75</td>
</tr>
<tr>
<td>12A15</td>
<td>12S.75</td>
</tr>
</tbody>
</table>

### Specials of the Month

- **Input**
  - Greater Values Than Ever Before In Our New... (prices and details)

### Announcing!

**50 Watt Power Supply Kit**

- **1-Transformer:** Fri: 103/250v
  - 600 $5.75
  - 300-0-300v @ 500 MA

**Construction:**

- Sec: 1120-0-1120v @ 500 MA
  - 2.5 V @ 10 Amps
  - 12 V @ 14 Amps
  - 10 A @ 3.000v
  - 30 A @ 0.25 AMPS... $32.50

- **Filter Chokes** @ $7.95 ea.
  - 2
- **Condensers 3 Mfd.** @ 2000v
  - 6.95
- **8-66 Tubes** @ $.89 ea.
  - 2
- **Plate Caps Ceramic** @ $1.20 ea.
- **Pair Hash Filter Chokes** .79

**Extra Special Buy**

- **$49.50**
SYNCHROS
If Special Repeater, 115 volts, 400 cycle. Will operate on 60 cycle at reduced voltage. Price $15.00 each net.
ICT Control Transformer, 90/55 volts, 60 cycle. Price $22.50 each net.
2J1GI Control Transformer, 57.5/57.5 volts, 400 cycle. Price $2.00 each net.
2J1H1 Selsyn Differential Generator, 57.5/57.5 volts, 400 cycle. Price $3.25 each net.
5G Generator, 115 volts, 60 cycle. Price $25.00 each net.
Size 5 Generator, Army Ordnance Drawing No. C-78414, 115 volts, 60 cycle. Price $14.00 each net.

PIONEER TORQUE UNITS
Type 12073-1-A. Price $17.50 each net.

D. C. ALNICO FIELD MOTORS
5067127, Delco, 27 V., 250 R. P. M. Price $2.90 each net.
5069600, Delco, 27 V., 250 R. P. M. Price $4.00 each net.
5069466, Delco, 10,000 R. P. M. Price $3.00 each net.

WRITE FOR COMPLETE LISTINGS

INSTRUMENT ASSOCIATES
147-57 41st AVENUE Telephone INdependence 3-1919 FLUSHING, N. Y.

December, 1948 — ELECTRONICS
**L & N INDICATORS - CONTROLLERS - RECORDERS**

Rebuilt...Thoroughly re-conditioned...Mechanically, electrically checked and adjusted...Instruments shipped ready to put into actual use.

---

**SURPLUS BARGAINS - NOW!!**

- **SELENIUM RECTIFIERS**
  - New—Fresh Stock—Not over 6 mos. old.
  - Full wave phase...reliable, inductive load...continuously rated...construction designed for 2500 hours.

<table>
<thead>
<tr>
<th>Model</th>
<th>R.M.S. Input</th>
<th>Max. D.C. Output</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1A-1</td>
<td>24 V @ 3 A</td>
<td>25 A</td>
<td>$13.50</td>
</tr>
<tr>
<td>1A-2</td>
<td>24 V @ 5 A</td>
<td>10 A</td>
<td>$28.50</td>
</tr>
<tr>
<td>1A-3</td>
<td>24 V @ 10 A</td>
<td>5 A</td>
<td>$57.00</td>
</tr>
<tr>
<td>1A-4</td>
<td>24 V @ 15 A</td>
<td>3 A</td>
<td>$87.50</td>
</tr>
<tr>
<td>1A-5</td>
<td>24 V @ 25 A</td>
<td>1 A</td>
<td>$137.50</td>
</tr>
</tbody>
</table>

---

- **WESTON Model 622—New!**
  - D.C. Portables...1/2 of 1% accuracy...
  - High sensitivity...Moulded bakelite case...A famous instrument at a real low price.

<table>
<thead>
<tr>
<th>Type</th>
<th>Range</th>
<th>Line</th>
<th>Your Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-30</td>
<td>1 Volt</td>
<td>Your</td>
<td>$5.95</td>
</tr>
<tr>
<td>0-60</td>
<td>2 Volts</td>
<td>Your</td>
<td>$11.70</td>
</tr>
<tr>
<td>120-240</td>
<td>5 Volts</td>
<td>Your</td>
<td>$23.50</td>
</tr>
</tbody>
</table>

---

- **WHSE PORTABLE GALVANOMETER**
  - Type PX-12-7 M.A. movement...special scale, solid connecting terminals, contains a 1 volt internal cell which can be easily replaced...

<table>
<thead>
<tr>
<th>Price</th>
<th>10 for $27.50</th>
</tr>
</thead>
</table>

---

- **GE STEPDOWN TRANSFORMER**
  - Pri—115/210 V 60 cycles, Sec—38/400 V 60 cycles...

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>115 V</td>
<td>$50.00</td>
</tr>
<tr>
<td>210 V</td>
<td>$90.00</td>
</tr>
</tbody>
</table>

---

- **POWER TRANSFORMER**
  - Pri—440/220 V 60 cycle, Sec—115/115/165 V...

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>440 V</td>
<td>$250.00</td>
</tr>
<tr>
<td>220 V</td>
<td>$125.00</td>
</tr>
</tbody>
</table>

---

- **RHEOSTAT**
  - Type RH Input: 115 V, 10%. Output: 115 V Max. Ampt. .6. A. Made as line voltage corrector 10% of input voltage, or can be connected to give plus or minus 25% of input. Can also be re-connected to be used as an isolated transformer for control.

<table>
<thead>
<tr>
<th>Ohms</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>$5.00</td>
</tr>
<tr>
<td>9</td>
<td>$6.50</td>
</tr>
<tr>
<td>15</td>
<td>$9.00</td>
</tr>
</tbody>
</table>

---

- **STRUTHERS-DUNN RELAYS**

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>24 V</td>
<td>$5.00</td>
</tr>
</tbody>
</table>

---

**ALL PRICES INDICATED ARE FOR OUR WAREHOUSE NYC. SHIPMENTS WILL BE MADE VIA RAILWAY EXPRESS UNLESS SUFFICIENT POSTAGE IS INCLUDED OR OTHER INSTRUCTIONS ISSUED. WE WILL REFUND EXCESS POSTAGE IN STAMPS.**

---

**POWERTRON Electrical Equipment Co.**

117 Lafayette Street

New York 13, N. Y.

**Phone: WOrth 4-8610**
Inter-Communication Sets  
Manufactured by Dictograph

Designed to bring to homes and offices the convenience of two-way conversation without the use of telephones, household electric current, or wires.

It can be set up in any two rooms you wish... being limited only by the length of the wire you use. Inter-Communication Sets will operate efficiently up to 800 feet using 14-gauge wire. Operates off three 1.5 volt flashlight batteries per unit.

BRAND NEW, Pair  
$9.95

Heavy Duty  
TRANSFORMERS

Primary: 55 V. Secondary: 110 V. 230 Amps., 5 KVA. Dimensions: 9/16’x7’.5”x10’. Two transformers can be put in series to operate on 110 V input, giving secondary of 20 V. 238 Amps. Two transformers can be put in series to operate on 230 V input, giving secondary of 10 V. 119 Amps. Rates F.O.B. Boston. Orders accepted from rated concerns on open accounts. Net 30 days.

Like New  
$75

Cotrell System  
PRECIPITATOR  
Cotrell System

These machines, manufactured by the Torit Mfg. Co. of St. Paul, Minn., are used for extraction of any dust from the air. They consist of a suction blower driven by a 1/10 HP Motor, Type K, 220/440-5-60, 3475 RPM, and the entire unit is housed in a heavy steel case with louvers for dust intake.

PRICE $100

DUST COLLECTORS

Like New  
PRICE $75

MOTORS

General Electric Electric Motors: Type 128P: 6 V.; H.P.; no base; range logarithmic; 230 Volts, 5000 Amps. separate excited at 110 Volts. (100 Speed) Ball Bearings. Brand New in original factory cases.

BRAND NEW, INDIVIDUALLY  
Cased $12.50 each

Like New  
PRICE $75

Like New  
$2.50

G. E. Motor Starting  
Reactors

Type 11K2840G2

Rated at 440 Volts, 3 Phase, 60 Cycles, 5 HP, Continuous Duty, 5 HP, 1725 RPM. Contained in steel case. Price $9.90

Like New  
PRICE $365

General Electric  
Automatic COMPENSATOR

Type C18704-H1; A, 4800-9070, 220 Volts, 3 Phase, 60 Cycles; 75 H.P.; Control Voltage 220. Condition Like New  
PRICE $365

IMPOSSIBLE TO LIST ALL OF OUR ITEMS AND COMPONENTS. TELL US YOUR NEEDS. All prices F.O.B. Boston. Orders accepted from rated accounts on open accounts. Net 30 days.

Electro Sales Company

Dept. E-12, 110 Pearl Street, Boston, Mass.

December, 1948 — ELECTRONICS
ELECTRONICS - December, 1948

HIGH VOLTAGE MICA CAPACITORS

<table>
<thead>
<tr>
<th>Code</th>
<th>Manufacturer</th>
<th>Voltage (KV)</th>
<th>Capacity (MFD)</th>
<th>Price ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>F2L</td>
<td>188.05</td>
<td>80</td>
<td>0.001</td>
<td>0.50</td>
</tr>
<tr>
<td>F3L</td>
<td>188.05</td>
<td>80</td>
<td>0.0005</td>
<td>0.50</td>
</tr>
<tr>
<td>G4</td>
<td>188.05</td>
<td>22.50</td>
<td>0.6015</td>
<td>3.50</td>
</tr>
<tr>
<td>G4</td>
<td>188.05</td>
<td>12</td>
<td>0.0001</td>
<td>0.50</td>
</tr>
<tr>
<td>F4</td>
<td>188.05</td>
<td>80</td>
<td>0.0015</td>
<td>2.00</td>
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<td>F4</td>
<td>188.05</td>
<td>80</td>
<td>0.0006</td>
<td>3.00</td>
</tr>
<tr>
<td>F5</td>
<td>188.05</td>
<td>5</td>
<td>0.002</td>
<td>3.00</td>
</tr>
<tr>
<td>F5</td>
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<tr>
<td>F6</td>
<td>188.05</td>
<td>80</td>
<td>0.0005</td>
<td>3.00</td>
</tr>
</tbody>
</table>

MEGOMH METER

Industrial Instruments Model 121-5I 50 cycle ac 60 cycle Input, Direct reading from 1000 to 10,000 ohms, with external supply. Brand new $1.75.

U. H. F. COAX. CONNECTORS


Precision 15 Meg. 1% Accuracy Resistor, Non-inductive, 1 watt, hermetically sealed in glass 3Ff; each; 10 for $3.00.

OIL CONDENSERS

<table>
<thead>
<tr>
<th>Code</th>
<th>Type</th>
<th>Voltage (KV)</th>
<th>Capacity (MFD)</th>
<th>Price ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1200</td>
<td>5</td>
<td>110/220</td>
<td>0.50</td>
<td>1.40</td>
</tr>
<tr>
<td>500</td>
<td>5</td>
<td>110/220</td>
<td>0.75</td>
<td>1.40</td>
</tr>
<tr>
<td>250</td>
<td>5</td>
<td>110/220</td>
<td>1.00</td>
<td>1.40</td>
</tr>
<tr>
<td>150</td>
<td>5</td>
<td>110/220</td>
<td>1.50</td>
<td>1.40</td>
</tr>
<tr>
<td>100</td>
<td>5</td>
<td>110/220</td>
<td>2.00</td>
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<tr>
<td>75</td>
<td>5</td>
<td>110/220</td>
<td>2.50</td>
<td>1.40</td>
</tr>
<tr>
<td>50</td>
<td>5</td>
<td>110/220</td>
<td>4.00</td>
<td>1.40</td>
</tr>
<tr>
<td>35</td>
<td>5</td>
<td>110/220</td>
<td>5.00</td>
<td>1.40</td>
</tr>
<tr>
<td>25</td>
<td>5</td>
<td>110/220</td>
<td>6.00</td>
<td>1.40</td>
</tr>
<tr>
<td>15</td>
<td>5</td>
<td>110/220</td>
<td>8.00</td>
<td>1.40</td>
</tr>
</tbody>
</table>

1 KW TRANSTOR or Stepdown Transformer

10000/250 volts 90 cycle input. Output variable plus or minus 4 cycles. Brand new. $1.95.

MIDGET VARIABLE BARGAINS

<table>
<thead>
<tr>
<th>Code</th>
<th>Type</th>
<th>Voltage (KV)</th>
<th>Capacity (MFD)</th>
<th>Price ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>150F</td>
<td>3</td>
<td>110</td>
<td>0.005</td>
<td>5.00</td>
</tr>
<tr>
<td>250F</td>
<td>3</td>
<td>110</td>
<td>0.010</td>
<td>5.00</td>
</tr>
<tr>
<td>300F</td>
<td>3</td>
<td>110</td>
<td>0.015</td>
<td>5.00</td>
</tr>
<tr>
<td>400F</td>
<td>3</td>
<td>110</td>
<td>0.020</td>
<td>5.00</td>
</tr>
<tr>
<td>500F</td>
<td>3</td>
<td>110</td>
<td>0.025</td>
<td>5.00</td>
</tr>
<tr>
<td>600F</td>
<td>3</td>
<td>110</td>
<td>0.030</td>
<td>5.00</td>
</tr>
<tr>
<td>700F</td>
<td>3</td>
<td>110</td>
<td>0.035</td>
<td>5.00</td>
</tr>
<tr>
<td>800F</td>
<td>3</td>
<td>110</td>
<td>0.040</td>
<td>5.00</td>
</tr>
<tr>
<td>900F</td>
<td>3</td>
<td>110</td>
<td>0.045</td>
<td>5.00</td>
</tr>
</tbody>
</table>

PHASE SHIFT CAPACITOR


WIRE WOUND RESISTORS

<table>
<thead>
<tr>
<th>Type</th>
<th>Value</th>
<th>Capacity</th>
<th>Price ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>250 ohm</td>
<td>1/4 watt</td>
<td>0.75</td>
</tr>
<tr>
<td>10</td>
<td>1000 ohm</td>
<td>1/4 watt</td>
<td>1.25</td>
</tr>
<tr>
<td>220</td>
<td>10000 ohm</td>
<td>1/4 watt</td>
<td>2.95</td>
</tr>
<tr>
<td>10K</td>
<td>100000 ohm</td>
<td>1/4 watt</td>
<td>12.50</td>
</tr>
<tr>
<td>100K</td>
<td>1000000 ohm</td>
<td>1/4 watt</td>
<td>62.50</td>
</tr>
</tbody>
</table>

PEAK ELECTRONICS CO.

188 Washington St., New York 7, N. Y.

PHONE CO-7-8443
DEPARTMENT EA
SEND FOR BULLETIN
TRANSMITTING MICA CONDENSERS

SPECIAL LOW PRICES FOR IMMEDIATE SALE AND DELIVERY

We have literally hundreds of thousands of these top quality standard type transmitting mica condensers in stock for immediate delivery at a fraction of their original cost. Every condenser is brand new and carries the name of a fine nationally known manufacturer.

Despite the unusually low prices, these mica condensers, like all Wells Components, are fully guaranteed. Be sure to order sufficient quantities for your requirements.

<table>
<thead>
<tr>
<th>STYLE &quot;AA&quot;</th>
<th>STYLE &quot;A&quot;</th>
<th>STYLE &quot;B&quot;</th>
<th>STYLE &quot;C&quot;</th>
<th>STYLE &quot;D&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>STYLE &quot;AA&quot; CONDENSERS</td>
<td>STYLE &quot;A&quot; CONDENSERS</td>
<td>STYLE &quot;B&quot; CONDENSERS</td>
<td>STYLE &quot;C&quot; CONDENSERS</td>
</tr>
<tr>
<td>.0015</td>
<td>5000</td>
<td>1.20</td>
<td>1.00</td>
<td>.0015</td>
</tr>
<tr>
<td>.00125</td>
<td>5000</td>
<td>1.10</td>
<td>.90</td>
<td>.00125</td>
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<td>.001</td>
<td>5000</td>
<td>.90</td>
<td>.70</td>
<td>.001</td>
</tr>
<tr>
<td>No. 803A.</td>
<td>2500</td>
<td>.40</td>
<td>.30</td>
<td>No. 803A.</td>
</tr>
</tbody>
</table>

This is only a partial listing. Write or wire for information on types not shown and for receiving set micas.

We advise distributors to order immediately from this ad. Our standard jobber arrangement applies.

Manufacturers and Distributors: Write for our complete Mica Condenser Listing No. 103A.

WELLS SALES, INC.
320 N. LA SALLE ST., DEPT. SL, CHICAGO 10, ILL.
REGULAR STACK SPECIALS!

- 5-Meter Walkie-Talkie
  - Model HT-322 Transceiver; simple, popular communications equipment. Operates from 52-65 mc. Uses only two tubes, types 43 and 30. Includes a mc crystal in a crystal oscillator circuit. Range 5 to 20 miles, depending upon location and altitude. Operates from single battery (voltage applied) available from fir, or other sources. Supplied with handset, battery, and carry case. Complete, NEW. Price, EACH $22.00

- Telescoping Antenna for above $30.00

- DECK ENTRANCE INSULATORS
  - Bowl and Flange Type
    - MANUFACTURED BY OHIO BRASS CO. FOR ARMY AND NAVY USE. HAND-FORMED, HAND-INSULATED METAL BOWL MADE OF 1/8" DIAMETER. THREE HOLE BOWL AND GAFFER GAFFER, MADE TO MEET ALL SPECIFICATIONS. NEW, price each $2.25
    - Spare porcelain bowl, only, each... $1.50

- 32 VDC 110 AC CONVERTER
  - Made by Katz Engineering, for marine or farm installations. Motor type, compact and ruggedly built for continuous duty. Rubber shock mount on frame, with complete input and output filtering. Output: 110 volts, 60 cycles AC, 256 WATTS, but will operate efficiently on 60 to 200 volts. New units only.
  - Price, EACH $39.95

- AMPLIDYNE MG SET
  - MOTOR 110/220, 60 C.A.C.
  - FOR AUTOMATIC OR MANUALLY CONTROLLED HEAVY EQUIPMENT. General Electric Generator is Type V-3870-175. Small blower, 540 rpm. Motor is 1/10 HP, 1725 rpm. Genera...
  - Price, EACH $60.00

- DAK—DIRECTION FINDERS, WITH AUTOMATIC BEARING INDICATORS.
  - The DAK is a highly engineered DF receiver, and this particular model includes an automatic bearing indicator, with stand and operator's microphone. Sighter is a square 8 pattern on a large scope tube which is calibrated in degrees. An immediate indication of the direction of the received signal is thereby obtained; the digital setting of the possibility of human error in determining exact east west point. The following, sufficient for 5 complete DAK installations plus major component spares, are available: 1. 7206/16 Transmitter, 1. 628, and 608. 628 FM mobile installations. New, with tubes and complete crystals. Excellent condition. "Price, Each... $600.00

- POWER RECTIFIER PP-1/FRC, 600 Volts. Complete with tubes and complete crystals. Export packed. Includes a wide variety of rectifier tubes. Price, EACH $50.00

- RADIO TRANSMITTERS, RECEIVERS
  - Immediate Delivery from Stock


- RADIO TRANSMITTER T-5/FRC, 600 Watts output, Freq. Range 2 to 18 Mc. Operates from PP/FRC described below. Available, in 1-case. Excellent condition... $500.00

- POWER RECTIFIER PP-1/FRC, 600 Volts. Complete with tubes and complete crystals. Export packed. Includes a wide variety of rectifier tubes. Price, EACH... $50.00

- RCA 8023/HP Ship Transmitter. 200 watts (conservative) Al, A2, & A3. Operates from 110V. AC, 60-60 cycles, to 1,000 mc, continuous. New, with tubes and complete crystals. Excellent condition. Price, EACH... $500.00

- RCA 7023/6TA-2, Large Airport Switchboard. With separate power supply (SB-14/6TA). Price, EACH... $30.00

- TS-69/AP METER COMPLETE, EACH... $250.00

- B-353 Transmitter, 400 WATTS, 100-200 Mc. Excellent condition. Price, EACH... $400.00

- Complete, EACH... $42.50

- TCR—Radiomarine Transmitter, 125 watts (conservative) A1, A2, & A3. For ship or shore station radio telephony, 4 channels in 2 to 3 MHz band controlled by remote control box supplied. Complete, in 1-case. Excellent condition. Price, EACH... $500.00

- TCR—Radiomarine Transmitter, 350 watts (conservative) Al, A2, & A3. For ship or shore station radio telephony, 4 channels in 2 to 3 MHz band controlled by remote control box supplied. Complete, in 1-case. Excellent condition. Price, EACH... $500.00

- TELEMARINE COMMUNICATIONS COMPANY

- All Material Offered Subject to Prior Sale
#2—THERMOSTAT G. E. 10 AMP.

Adjustable to within 1/10° in range 125°F. to 185°F., with scale and knob. Connections for any two terminals. Mounts flat. Ideal for use on any two terminals allowing either side without danger of charring. Suitable for transistors, radios, etc., may be bent for use in series or parallel.

#92A—Extra-cost feature is linear amperi ratio. Every section down to one ohm is wound for same current as the whole Rheostat. 2 to 93 amperes, no drop. Price: 85c. ea.

#99A—HEATER VULCAN D5

Ring 2" O.D., 1" I.D. 3/8 thick, fully grooved, with outstanding porcelain bushing. Insulators 1/4" high for two terminal leads, 415V, 3/4" designed for two in series on 110V. Excellent for small component heaters, wax heaters, small enough to hold and pour from heat to protect from breakage, easily installed in any pot or ladle. 3/8" diameter, 75c. each. PRICED AT 59c. ea.

STOCK UP ON AIRCRAFT LAMPS AT THESE EXCEPTIONAL BARGAIN PRICES

<table>
<thead>
<tr>
<th>Quant.</th>
<th>Price</th>
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<tr>
<td>2080</td>
<td>1/2 Ohms Type C 3/4&quot; .25</td>
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<td>1120</td>
<td>1 Ohm Type C 1&quot; .25</td>
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<tr>
<td>880</td>
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<td>440</td>
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<td>3 Ohms Type C 3 1/2&quot; .25</td>
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<td>110</td>
<td>4.7 Ohms Type C 4 3/4&quot; .25</td>
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<tr>
<td>.25</td>
<td>4400 Ohms Type C 4400&quot; .25</td>
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TERMS

20% deposit on C.O.D. orders. Stocks in all items. Schools. All shipments F.O.B. New York. 20% deposit on C.O.D. orders.

EXCESS INVENTORY CORP.

56 LISPENDARD ST.

New York 13, N. Y.

December, 1948 — ELECTRONICS
BUFFALO RADIO SUPPLY, one of America's largest electronic distributors, is in a position to supply most of the requirements of foreign purchasers directly from stock in the Electronics, Communications, Test Equipment and Export Markets. Export inquiries are solicited both from Export Houses and from Foreign Gov't. Purchasing Commissions here and abroad. Expense can be reduced and requirements filled with a minimum of delay by contacting Buffalo Radio Supply initially.

1949 MODEL MUTUAL CONDUCTANCE TUBE TESTER with new 9 pin socket to handle all future tube developments...

No possibility of good tubes reading "Bad" or bad tubes reading "Good" as on dynamic conductance testers. Attractive panel and case equal to any on the market in appearance... Large 4½" meters... Front panel... Pictures... Tube base types—voltages from .75 volts to 117 volts and complete switching flexibility allow all present and future requirements simultaneously... Only $12.95. Satisfaction guaranteed or money refunded if returned prepaid within 5 days.

GENERAL ELECTRIC 150 WATT TRANSMITTER Cost the Government $1800 • Cost to you—BRAND NEW $100.00

This is the famous transmitter used in U.S. Army bombers and ground stations, during the war. Its design and construction has been proved in service, under all kinds of conditions. The entire frequency range is covered by means of plug-in-tuning units which are included. Each tuning unit has its own oscillator and power amplifier coils and condensers, and antenna tuning circuits—all designed to operate as two units. Dials are operated by a received signal from a similar set elsewhere. Originally designed by "TERRIFIC POWER"—(20 watts) on any two instantly selected, easily pre-adjusted frequencies from 435 to 500 Mc. Transmitter uses 5 tubes including Western Electric 316A as final. Receiver uses 10 tubes in-cluded in this unbelievable offer are such accessories as a 4' electric furnace high speed grinding wheel; a cotton buffing wheel with a large supply of buffing compound, and a 4½" steel wire scratch brush. Your cost $6.00. Sole export agent. Distributor inquiries invited...

SCR-274N COMMAND SET

The greatest radio equipment value in history A mountain of valuable equipment that includes 3 receivers that use plug-in coils, and that consequently can be changed to any frequencies desired without conversion. Also included are also two Tuning Control Boxes; 1 Antenna Coupling Box; four 28V. Dynamos (tightly converted to 240 Volt, 30A. per minute), or two 40-Watt Transmitters including crystals, and Preamplifier and Modulator. 29 tubes supplied in all. Only a limited quantity available, so get your order in fast. Removed from unused equipment in guaranteed electrical condition. A super value at $34.95, including crank type tuning knobs for receivers...
To avoid shipping errors, kindly order by type #.

<table>
<thead>
<tr>
<th>Type/ Current Price</th>
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<tr>
<td>3137-11 11 AMP. 65.00</td>
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<tr>
<td>3B7-6 6 AMP. 48.90</td>
</tr>
<tr>
<td>3B13-6 6 AMP. 81.50</td>
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<tr>
<td>3B13-4 4 AMP. $56.00</td>
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With mounting brackets

<table>
<thead>
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<tr>
<td>36-15 MFD 450 VDC 3.00 22.00</td>
</tr>
<tr>
<td>15 MFD 450 VDC 2.50 18.50</td>
</tr>
</tbody>
</table>

Input Output

FOR TYPES 3B 1.20 per set

For Types BI through BRI. and Type Cl $ .35 per set

• 4 prong Plug- In type.

All TXF Types are Tapped

For 0-30 V.D.C. Weston W/shunt 4.95

For 0-8 V.A.C. G.E. 3W Round 2.95

For 0-120 A.D.C. Weston W/Shunt 3.25

For 0-30 A.D.C. Weston W/Shunt 2.95

Terms:

Cash.
COMMUNICATION DEVICES CO.

OFFERS

CLEAN ELECTRONIC SURPLUS!

F. M. Point-To-Point RADIO LINK

Our large stocks of SCR-528 (20.0-27.9 Mc) transmitters and receivers are complete with all components and accessories export packed for immediate delivery, weight 163 lbs. Write for our bulletin describing its minute completeness!

Complete WALKIE-TALKIES

Model MAB

Range 2.3 to 4.5 Mc, complete with seven tubes, two xtals, mike, headset, case, antenna, and accessories. Clean, and complete with export packed batteries.

Quantities available.

A FEW LEFT

TDE TRANSMITTER

An all-band (300-18,100 kcs) two section transmitter in one steel cabinet complete with tubes and M.G. with outputs of 125 watts A-1, A-2; 35 watts’phone. In 115 or 230 Volt DC models. Tested, clean, and complete.

OTHER TRANSMITTERS—

High power RCA and Press Wireless medium frequency transmitters. Quantities of VHF low power transmitters. ALL NEW!

ALSO FROM OUR CATALOGUE—

Model Sl, Radar, NEW; Radio Direction Finders complete; Gibson Girls export packed complete; Brand new 6 & 12 volt vibrapacks; Various type whip antennas; 220/110 Stepdown transformers all ratings.

WHIP ANTENNAS

AN-131-A, has threaded base, 10'6" long, folds into 8 interconnected sections for stowing. NEW, each...$1.49

Offerings subject to prior sale.

Catalog on request.

COMMUNICATION DEVICES CO.

2331 Twelfth Avenue at 133rd St.

New York 27, N. Y.

Cable: Communidev Tel: WA-6-6606, 7

ELECTRO IMPULSE LABORATORY

66 Mechanic St., Red Bank, N. J.

Red Bank 6-4247
COAXIAL CABLES AND CONNECTORS

**"UHE" COAXIAL CABLE CONNECTORS**

83-15P
83-1R
83-1T

<table>
<thead>
<tr>
<th>No.</th>
<th>An. No.</th>
<th>Description</th>
<th>Price</th>
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<td>83-15P</td>
<td>(P158)</td>
<td>Plug, 250 ea.</td>
<td>250.00</td>
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<tr>
<td>83-16P</td>
<td>(P159)</td>
<td>Plug, 250 ea.</td>
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</tr>
<tr>
<td>83-18G</td>
<td>(UG176U)</td>
<td>Reducing adapter for RG 29, 56 or 58/U. Use with 83-15P or 83-15PN</td>
<td>1.00</td>
</tr>
<tr>
<td>83-1R</td>
<td>(S0098)</td>
<td>Receptacle, 250 ea.</td>
<td>250.00</td>
</tr>
<tr>
<td>83-1AP</td>
<td>(M1356)</td>
<td>Adapter, 250 ea.</td>
<td>250.00</td>
</tr>
<tr>
<td>83-1T</td>
<td>(UG176U)</td>
<td>Junction, 250 ea.</td>
<td>250.00</td>
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Minimum Quantity — 100 of a type

**COAXIAL CABLES**

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<tr>
<th>Type</th>
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<tr>
<td>RG12U</td>
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<tr>
<td>RG28U</td>
<td>per 1000 ft.</td>
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<tr>
<td>RG30U</td>
<td>per 1000 ft.</td>
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</table>

Prices based on a minimum quantity of 500 ft.

**SOLID SAVING SALE!**

Take advantage of the solid savings in every item! You pay less for saving you may because solid saving in every order!

<table>
<thead>
<tr>
<th>LIFE ELECTRONIC SALES</th>
<th>91 Gold St., N.Y. 7, N.Y.</th>
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<tr>
<td>Tel: Dibby 9-4154</td>
<td>------------------------------</td>
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**WESTINGHOUSE HIPERSIL CORES**

OVER 60,000 UNITS IN 20 DIMENSIONS. SEVERAL GAUGES: UP TO 16,000 UNITS IN SOME SIZES. AVAILABLE FOR IMMEDIATE DELIVERY. SEND FOR LIST WITH COMPLETE DESCRIPTIONS.

**RAYTHEON MFG. CO.**

Surplus Sales Dept., Waltham, Mass. Tel. Waltham 5-5860—Ext. 2

** SIGNAL GENERATORS**

**GENERAL RADIO**

805-A

**FERRIS**

16-C

**BOONTON**

155-A

**BOONTON**

140-A

**IMMEDIATE DELIVERY - RECONDITIONED GUARANTEED**

Subject to Prior Sale, T.O.B., N. Y. C.

**THE NATIONAL INSTRUMENT COMPANY**

FAR ROCKAWAY NEW YORK

December, 1948 — ELECTRONICS
Our policy of quantity buying, low overhead, enables us to offer tremendous savings to you. Just check these parts and convince yourself that the "SENCO WAY" is the smartest way!

**SPEAKER Specials**

Nobody but SENCO has these top-quality, precision-built speakers at these low, low prices.

- $ MINIMUM ORDER $1
- N7 Webster Crystal Cartridge, Fresh stock of brand new, a $7.95 saving!

**ELECTRONICS - December, 1948**

- **Hary expenses that add to your price-you. Just check these parts and convince us to pass along large savings to you.**
- **Our policy of quantity buying, low overhead, enables us to offer tremendous savings to you.**

**Shipment weights. Include sufficient postage-excess will be refunded.**

**For this Month Only!**

- **Limited Edition**
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**LIMIT 4 TO A CUSTOMER**

**NEW RA38 POWER SUPPLIES**

- 115V, 60 cyc. input adjustable output 0.15-
- 000V, A.C. or D.C. @ 500 Mils. Complete with extra set of new tubes and remote control. Shipping weight 2100 lbs.

- **Write for quantity discount**

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- **WRITE FOR QUANT
MARINE EQUIPMENT—NAVAL & COMMERCIAL

Particular Partial


USA-Mackay ship transmitter, 60 watts cw, 0.8-32 m. supplied complete w/110 V dc motor generator and spares for both m/g and XMTL. NEW, export packed, $115 per set.

ET-5121K—50 watts radio telephone, 250 watts cw, 2.0-29.0 m. Inc. Operators, etc. from 110 A.C. Condenser: EXCELLENT. One only at $850.00.

INSULATORS—Standoffs, Feedthroughs and Strains. We have thousands of orders. Please advise size and quantity as desired.

THK—500 watts cw Navy Transmitter, 2.0-25.0 mc.

AIRCRAFT EQUIPMENT

Particular Partial

ANS-5—510 Mca. Airborne Radar. Brand new early search and homing set, including transmitter, indicator switching unit, rectifier power unit, control unit, etc. Mfr. Bendix

A—Blind Landing Eptq. 90-180 Mc. complete, new with test oscillators and spares for same.

CRYSTALS—2890-3500 Mc, mounted in range converters, etc., by Bendix: diameters bet. prong centers: 2.0 cm.

FT-270-D—Federal 300 Watt cw transmitter. 300 W.A.C. operation 2.6-26.9 McS. Price $275.00.

METER MULTIPLIERS—PRECISION


TYPE D—Reversible magnetic starters, 1 to 2 hp., 110, 250, 440 V. A.C. Mfr. Westinghouse.

We carry an extensive stock of marine and aircraft electronic accessories.

Your requests for quotations are invited

All material is offered subject to prior sale, f.o.b. our warehouse. Terms: Cash

COMPASS COMMUNICATIONS CO.

37 Montgomery Street

Phone: Delaware 2-4656

Jersy City 2, N. J.

Do you have any surplus electronics for sale? Highest prices paid.

Money back guarantee on defective material. Subject to prior sale.

VETERANS SALVAGE CO. INC.

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Passaic 3-6370

Clifton, N. J.

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Money back guarantee on defective material. Subject to prior sale.

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Passaic 3-6370

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Money back guarantee on defective material. Subject to prior sale.

VETERANS SALVAGE CO. INC.

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Passaic 3-6370

Clifton, N. J.

Do you have any surplus electronics for sale? Highest prices paid.

Money back guarantee on defective material. Subject to prior sale.
Brand New — SURPLUS MATERIAL— Unused
DECEMBER SPECIALS

RELEYS (Con’t)
C1023—LEACH #1054, coil 260 ohms, 24 volts D.C. Heavy
24 ma. contacts, two pole single throw. Price $ .45
20 volts @ 2 ma. 63 Volts @ .6A, 2.5 Volts @ 1.75A.

WIRE! WIRE!
At Giveaway Prices
Thousands and thousands of feet available of various
types and sizes.

VINELITE, AEROGLAS COTTON BRAIDED

ROCKBESTOS

<table>
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<tr>
<th>Size</th>
<th>Price per M.</th>
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SHIELDED

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SOLID TINNING

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<tr>
<td>25</td>
<td>$5.00 lb.</td>
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</tbody>
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Write for Latest Catalog Listing Thousands of Relays, Resistors, Condensers, Switches, Etc.

EDLIE ELECTRONICS, INC.
154 GREENWICH STREET
NEW YORK 6, N. Y.

GRAIN OF WHEAT LAMPS

Graziano 572
Vibrating Reed Type. Range 48-62 cycles.

Television Masks—Soft white Rubber for 10 tubes. Fits snugly
over tube face and has 6" x 8" opening. PRICE $ 75.00
each.

Watt-Hour Totalizer. GE Type MD-3 120 Volts, 60 cycle,
2 Cir., 3 W.

Germanium Crystals 1N21
Remote Control Receiver AN/CW-2. Brand new—complete with
following tubes: 3-6L7, 1-6SN7, 1-6SG7, 1-6J5. For 26
Volt Operation.

RELAYS

all brand new and shipped in their original packing.

C1020—G.M. RELAY P.D.P.T. plus S.P.S.T. Normally open coil
30 ohms 6 V. D.C.

C1035—STUDHURS DUNN #6/3X104 D.P.S.T. Coil 12 Volts D.C.
Contacts 25 Amperes at 12 Volts D.C.

C1014—AIRCRAFT-TYPE STARTER RELAY. Hermetically sealed
coil 12 Volts 18 ohms. Very heavy contacts.

Write for Latest Catalog Listing Thousands of Relays, Resistors, Condensers, Switches, Etc.

EDLIE ELECTRONICS, INC.
TELEPHONE Digby 9-3143

DECEMBER SPECIALS

REMOTE CONTROL, RM82A, similar to EE-5
for wall mounting. New $7.95

Transformer, 115 V.A.C. 60 cycle, output 5 volts at
120 ma., ideal for welding etc. Good condition
$12.95

HADESTEEL, HS-2B 8000 ohms Brand New
EXTENSION CORD, C1007 with 4-50 plugs
New $1.75

Headset, 11820 complete with matching trans
mitter, cord, control unit. Brand New $25.00

SOUND POWERED CHEST SETS New $6.95
SOUND POWERED HANDSETS New $6.95
TYPewriter FIELD SETS New $15.00

IDEAL MOBILE POWER SUPPLY
PE27—Heavy duty vibrator power supply, 6,
12, or 24 volt input, 525V, 90 ma; 105V, 22ma.;
6-15-100 D.C. precision ammeter, Weston 45 with
shunts New $29.95

RMA-1 ALTIMETER INDICATOR—Basic
movement 0-1 ma., 5 ma. shunt. 270 scale.

120V. D.C. voltmeter, Weston 505 with 4
Type 342/350 precision multipliers. New $49.00
 Weston Type 341/351 precision multipliers, 5
megohms, 5000 volts New $69.00

WESTPORT RECTIFIER, full wave midget Sel-
ction 1.0 mm. round  New $12.95

0-15-150 D.C. precision ammeter, Weston 45 with
external multiplier New $7.95

0-150-150 D.C. precision ammeter. Weston 45 with
external multiplier New $12.95

0-150-300 D.C. ammeter. Weston 45 with
external multiplier. Weston 45 with
external multiplier New $12.95

0-150 D.C. ammeter, Becher 31/4 square
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