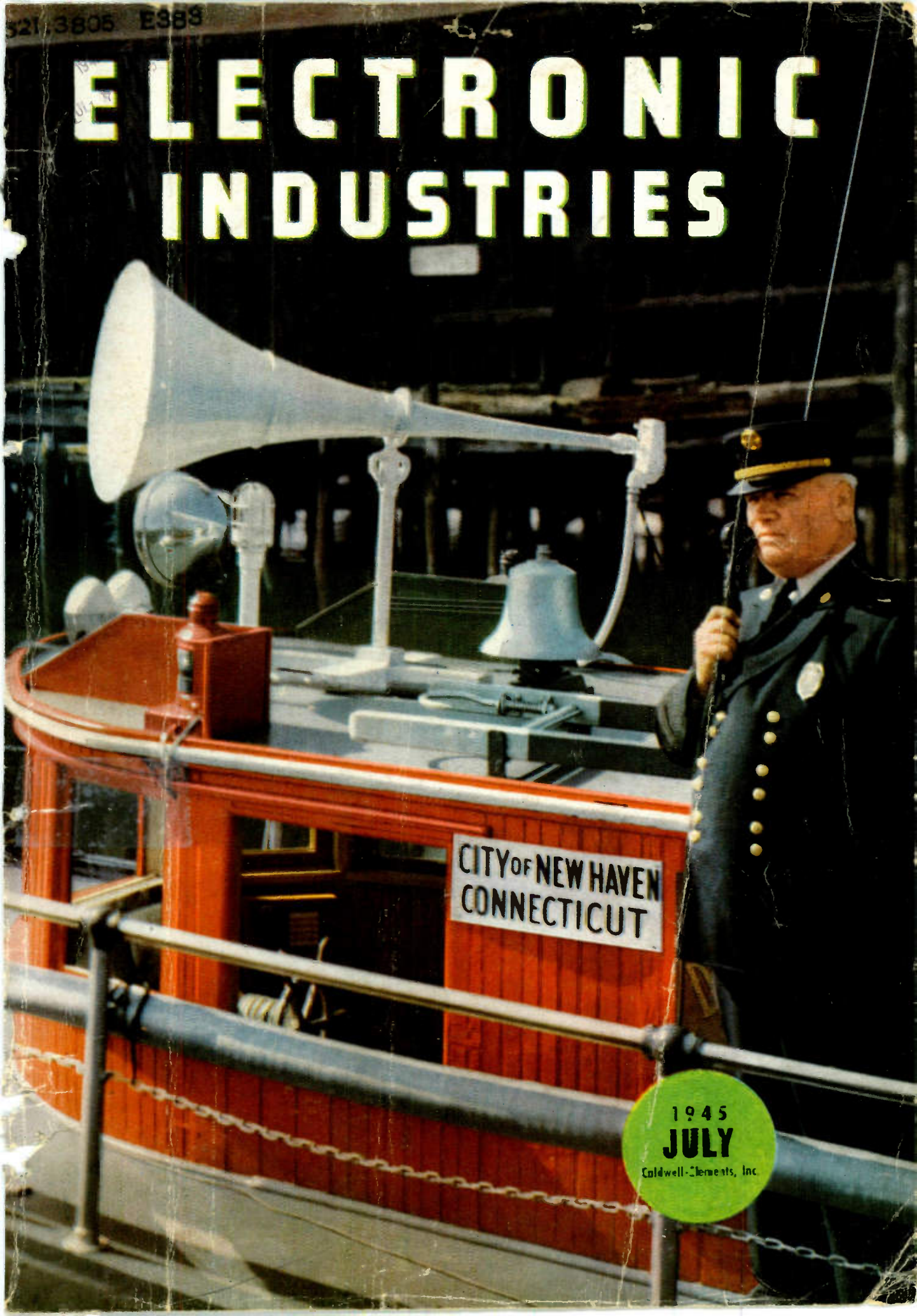
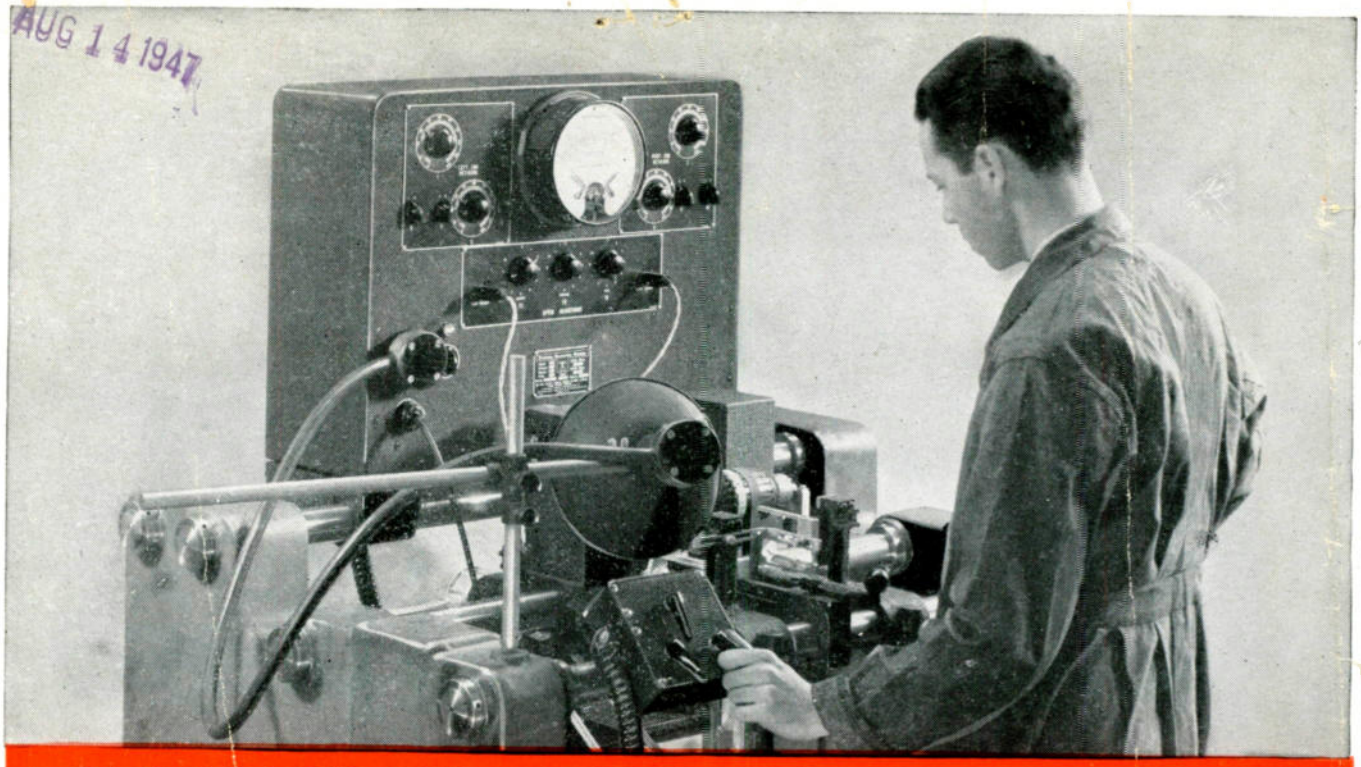
ELECTRONIC INDUSTRIES



1945
JULY
Caldwell-Clements, Inc.



PRECISION SWITCHES

Speed Precision Balancing

With this Mallory-equipped Gisholt Dynetric Balancing Machine, an operator can quickly locate and measure unbalanced forces in high speed rotating parts. By means of a stroboglow lamp and electronic circuits, precise measurements—that once took hours—are now obtained in a few seconds.

Ten Mallory Circuit Selector Switches assure swift, smooth control of all circuits in this balancing machine. Each Mallory switch is a *standard* part, yet each includes *special precision* features: low-resistance, self-cleaning silver-to-silver contacts; "hill-and-valley" index for smooth, positive switching action; heavy moisture-proof insulation; sturdy one-piece terminals.

In this Dynetric Balancer, Mallory Type M Potentiometers are used in the amplifier circuits to adjust grid bias. This potentiometer is not a special item—it's another *standard* part from the diversified line of Mallory precision products—switches, resistors, volume controls, condensers, jacks, plugs and other parts.

While the new circuits you're planning are still on the "bread-board", you can probably save time and money by specifying *standard* Mallory parts, built for *precision*. It's easy to draw up specifications when you use the latest Mallory catalog. Ask your nearest Mallory Distributor for a free copy.
Or write us today.

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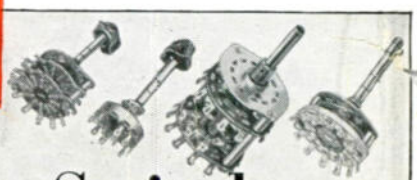
P.R. MALLORY & CO. Inc.
MALLORY



Industrial and Electronic Switches

ELECTRONIC INDUSTRIES

Including INDUSTRIAL ELECTRONICS

★ IN THIS ISSUE JULY, 1945 ★

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Why AMPEREX

WATER AND AIR COOLED TRANSMITTING AND RECTIFYING TUBES

Colloquially speaking, we of *Amperex* have "broken our necks" to provide dependable service to our customers during these war years. This statement, we feel sure, will be supported by those who have made us their source of tube supply. Important to note is that the "Amperextra" of dependable service has been matched by the "Amperextra" of dependable quality. In commercial broadcasting — AM, FM, Television — in electro-medical apparatus, in communications systems, in industrial applications, *Amperex* tubes have delivered and still are delivering high efficiency over a longer period of time. The *Amperex* Application Engineering Department, another "Amperextra", will be glad to work with you on present or postwar problems. *This is Service.*

Many of our standard tube types are now available through leading radio equipment distributors.

AMPEREX
. . . the high performance tube

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WASTEPAPER IS VITAL WAR EQUIPMENT . . . SAVE EVERY SCRAP

Weigh the Advantages

of MOLDED OIL PAPER CAPACITORS

NOTE THESE FACTS

Molded oil-paper capacitors, first used as a "make-shift" for mica units, have now earned a place of their own in electronics—meriting their serious consideration in new product designs. With greater capacitance in any case size, properly processed molded paper capacitors have extremely low series resistance and can carry relatively large R.F. currents. Their high shunt resistance, maintained thru the moisture-proof sealing of all units, suits them to A.F. applications at all usual plate voltages.

CAPACITANCES: 1000 to 50000 mmfd.
WORKING VOLTAGES: 120 to 800 v.d-c
SIZES: CN20 and CN35

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THE COVER

• Our cover this month shows a rather striking example of an unusual use for high power sound installations, here used on a fireboat by the city of New Haven. The equipment is supplied by General Electric of Bridgeport, using the system of C. F. Dilks, as described in Electronic Industries.*

Notwithstanding the many new forms of communications that have been developed during the past few years for many applications, the ideal communication system still uses the ear as a receiver, since no additional equipment is needed at the receiving point and those addressed are free to go about their work without handicap.

High levels

In many locations the necessity for intensely high sound levels, sometimes even more than is easily obtainable by direct amplification, has brought about new developments. In these cases the use of tube amplifiers to actuate special devices that modulate the flow of a steady air stream is one method of getting sound systems having the equivalent levels of many hundreds of watts.

Even when competing with really cheap sources of audio frequency tone for signalling, such as fog horns and whistles, the old rule that the amount of intelligence imparted by a communication path depends on the bandwidth, makes such competition keen. Voiced signals when of sufficient intensity to be easily heard are faster and require less concentration on the part of the listeners than code signals and are vastly better than the cumbersome use of written orders.

The old objection to the use of verbal orders for giving instructions on any important job has been obviated by the correlation of a good PA system with one of the numerous voice-recording devices which make all orders spoken over the system permanent on film, tape, wire or discs. In systems using tape and wire, long-playing records are possible, so that an eight to twelve-hour day can be completely covered on a single record. The combination of these two divergent applications of electronics will do much toward eliminating the cumbersome and time-consuming system wherein all orders must be transmitted in written form.

*Sound Coverage for Airports, May 1943, page 76; Sound Amplification by Air Modulation, Nov. 1944, page 84.

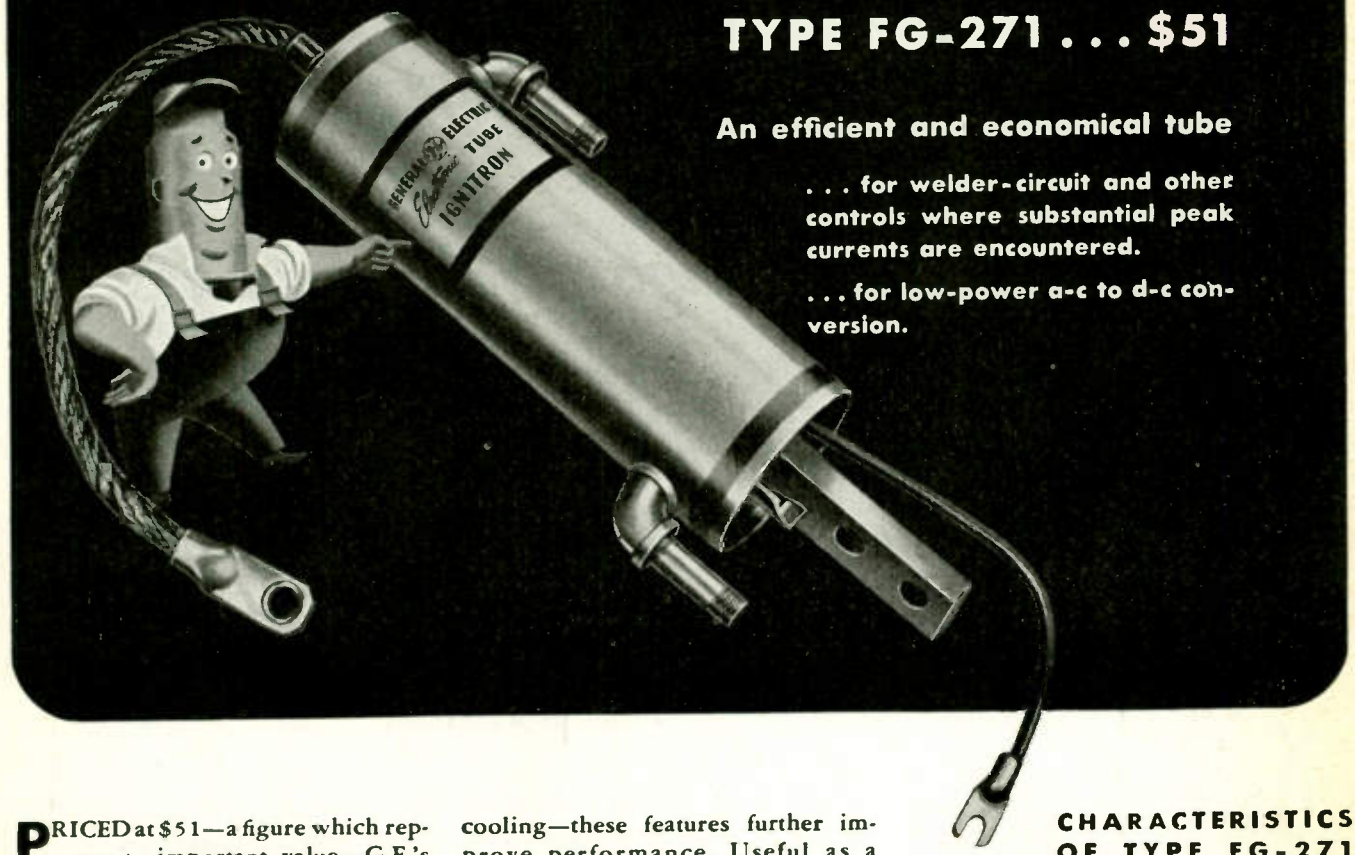
STEEL-JACKETED, WATER-COOLED
IGNITRON

TYPE FG-271 . . . $51

An efficient and economical tube

. . . for welder-circuit and other controls where substantial peak currents are encountered.

. . . for low-power a-c to d-c conversion.



PRICED at $51—a figure which represents important value—G.E.'s Type FG-271 ignitron is one of the most capable, reliable electronic tubes in the industrial field for current control or conversion purposes.

● *Be sure to ask for your free copy of G.E.'s new Booklet ETI-21, "Ignitron Tubes and How They Are Used." Just off the press, this 24-page profusely illustrated booklet, complete with selected circuits, tells the full story of ignitrons, their characteristics and performance ratings, and how they serve industrially.*

Steel-jacket construction plus mercury-pool type cathode give Type FG-271 the qualities of sturdiness, large peak-current capacity, and long life which are typical of the ignitron group. Special sealed design, low-current ignitor points, uniform water-cooling—these features further improve performance. Useful as a welder-control tube, Type FG-271 also is adapted to other controls involving heavy maximum currents. In addition, the tube handles rectification in low-power circuits efficiently.

The FG-271 offers you (1) a wide range of useful application, (2) economical first cost, with no mechanical maintenance charges, (3) length of service measured in years, from actual records of thousands of G-E ignitrons in industry. Basic ratings are given at the right. For further information see your nearest G-E office or distributor, or write *Electronics Dept., General Electric, Schenectady 5, N. Y.*

CHARACTERISTICS OF TYPE FG-271

Steel-jacketed, water-cooled ignitron tube with mercury-pool cathode. Sturdy, compact, easy to install. For welder-control service, a popular application of Type FG-271, ratings are: max kva demand 600, with corresponding avg anode current 30.2 amp—max avg anode current 56 amp, with corresponding kva demand 200. (These ratings are for voltages of 600 v rms and below.) Ignitor requirements are 200 v and 30 amp. . . . Ratings for current conversion will be supplied upon request, in which case please include a brief description of the application or circuit.

Hear the G-E radio programs: "The World Today" news, Monday through Friday, 6:45 p. m., EWT, CBS. "The G-E All-Girl Orchestra," Sunday 10 p. m., EWT, NBC. "The G-E House Party," Monday through Friday, 4 p. m., EWT, CBS.

There are 265 Main Supply Outlets for G-E Electronic Tubes, Backed Up by Centrally Located Stocks in 26 Large Cities from Coast to Coast

GENERAL ELECTRIC

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Top salaries plus high royalty earnings

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Excellent laboratory in fine building located in beautiful Southern New England community

IN order to carry out a highly developed program of growth and expansion, we seek to augment the staff of our creative engineering laboratories with outstanding talent...and are prepared to do the things necessary to obtain it.

Applications are therefore invited from key engineers, research men and physicists experienced in industrial electronics, industrial control equipment, the design of automatic machines and allied fields. There are openings to satisfy the chief engineer, department head, project engineer, research engineer and the basic research scientist.

Salaries will at least equal those paid by other leading companies in the field, *but in addition, each candidate will receive a graduated percentage royalty on the sale of all products he develops. A portion of this royalty continues even if he later leaves the company.*

The conditions under which you will work are ideal. Our laboratory—housed in a splendid building—is well-equipped. You will be furnished with everything necessary to carry out the projects under your direction. The laboratory is located in one of the most charming residential communities of southern New England within commuting distance of New York—fine homes, excellent schools, modern shops and stores.

In order to receive fullest possible consideration, your application should present a detailed and comprehensive account of your experience and accomplishments, with particular emphasis on patents you may have obtained and contributions you have made to the origin or improvement of devices or techniques in your field.

The engagement of any candidate, of course, must be in accordance with War Manpower Commission and wage and salary regulations. If your present status precludes a change in position at this particular time, contractual arrangements can be made for you to join the staff at a later date.

We choose not to reveal the name of this corporation in this advertisement but every candidate interviewed will have the fullest opportunity of learning everything he wants to know about us. Further, your letter of application will be seen only by principals and will be held in the strictest confidence. All our staff knows of this advertisement.

Please address your letter to
Box 7593, ELECTRONIC INDUSTRIES
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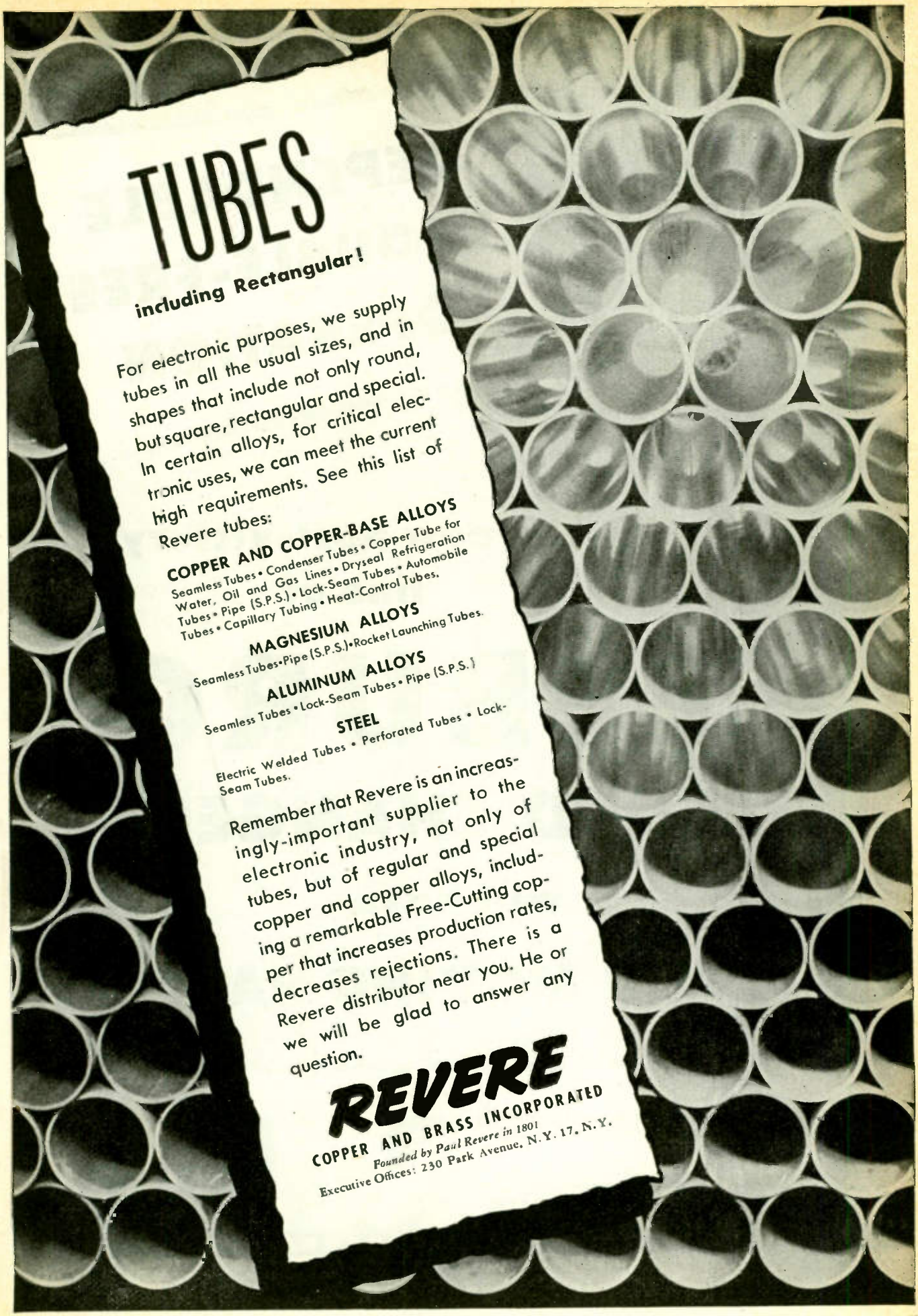
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including Rectangular!
For electronic purposes, we supply tubes in all the usual sizes, and in shapes that include not only round, but square, rectangular and special. In certain alloys, for critical electronic uses, we can meet the current high requirements. See this list of Revere tubes:
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Seamless Tubes • Condenser Tubes • Copper Tube for Water, Oil and Gas Lines • Dryseal Refrigeration Tubes • Pipe (S.P.S.) • Lock-Seam Tubes • Automobile Tubes • Capillary Tubing • Heat-Control Tubes.
MAGNESIUM ALLOYS
Seamless Tubes • Pipe (S.P.S.) • Rocket Launching Tubes.
ALUMINUM ALLOYS
Seamless Tubes • Lock-Seam Tubes • Pipe (S.P.S.)
STEEL
Electric Welded Tubes • Perforated Tubes • Lock-Seam Tubes.
Remember that Revere is an increasingly-important supplier to the electronic industry, not only of tubes, but of regular and special copper and copper alloys, including a remarkable Free-Cutting copper that increases production rates, decreases rejections. There is a Revere distributor near you. He or we will be glad to answer any question.
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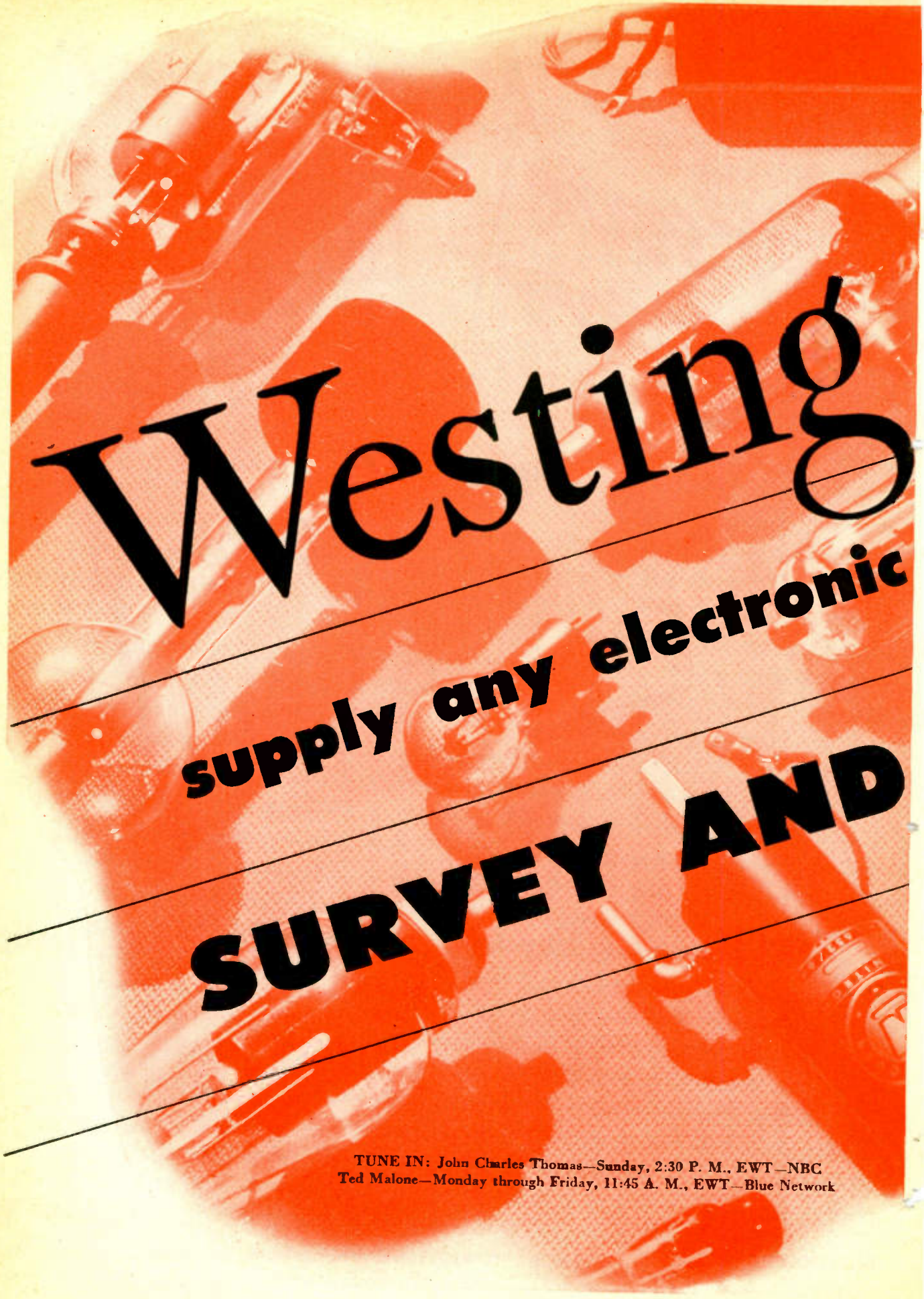
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supply any electronic
SURVEY AND
TUNE IN: John Charles Thomas—Sunday, 2:30 P. M., EWT—NBC
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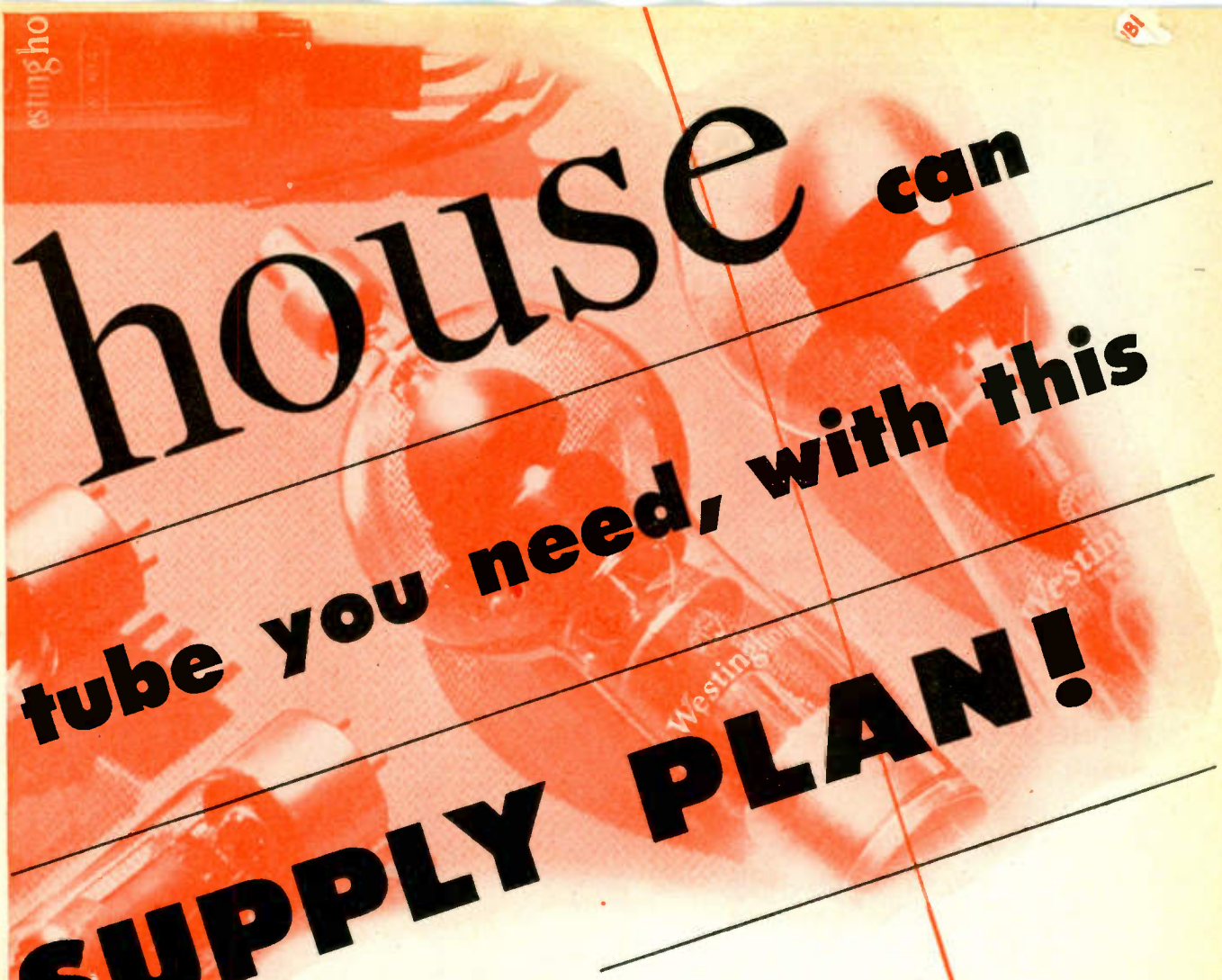


house can tube you need, with this SUPPLY PLAN!

HERE'S WHAT WE DO:

WESTINGHOUSE MAKES A TUBE SURVEY OF YOUR PLANT

A Westinghouse tube representative will inspect your electronic equipment and determine the type, the manufacturer, and the catalogue number of each tube and its estimated life. This analysis will cover all of the tubes you use, regardless of make.

WESTINGHOUSE MAKES A TUBE SURVEY OF OTHER PLANTS IN YOUR AREA

A Westinghouse tube representative will make a tube survey of the other plants in your area which have electronic equipment.

WESTINGHOUSE BASES ITS LOCAL TUBE STOCKS ON THESE SURVEYS

With these surveys your Westinghouse tube distributor has an accurate picture of tube requirements of your entire area. He bases his tube stock on these surveys. This stock will include not only Westinghouse tubes but also the tubes of other makes which your equipment requires.

HERE'S WHAT YOU GET!

A copy of the completed survey of your electronic equipment.

A complete report on the tubes used in your plant.

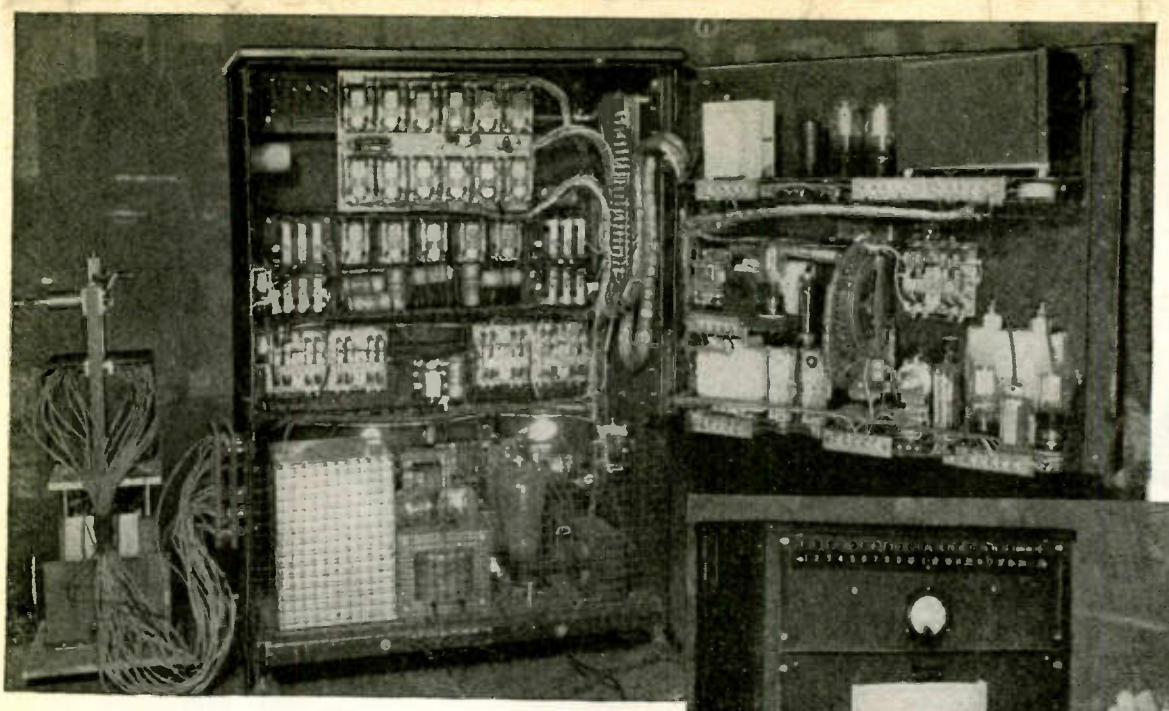
Prompt delivery on these tubes from the Westinghouse tube warehouse in your area.

If you would like us to make a survey of your plant . . . call your local Westinghouse representative or write Westinghouse Electric Corporation, Lamp Division, Bloomfield, New Jersey.

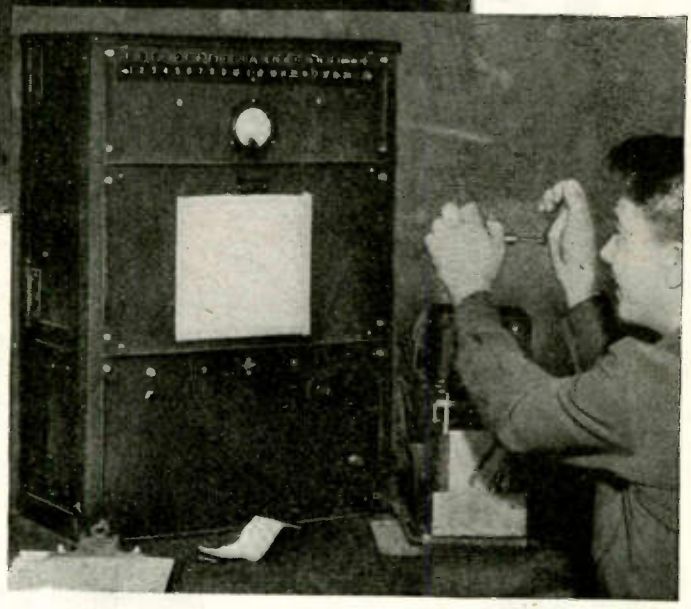
Westinghouse

Electronic Tubes at Work

ONE CALL DOES IT ALL



Rear view of new **FOSTER** "ROBOT" TESTING APPARATUS. Open panel reveals complex electrical units.



Front view of "ROBOT." Controls are few and easy to operate. High-precision readings visible at a glance.

FOSTER AUTOMATIC "ROBOT" ELIMINATES HUMAN ELEMENT IN TRANSFORMER INSPECTION

This is the new Foster "Robot"—an ingenious Foster development designed to eliminate fallible human judgment in the final test and inspection of Foster transformers.

The "Robot" is never tired. Its judgment never fails. It has no memory, and no conscience—it accepts or rejects automatically. All in one operation this stern mechanism tests core loss, turns ratio, leakage resistance and winding resistance. All Foster transformers must meet the "Robot's" requirements, both for usual running conditions as well as a high specified safety margin. And the "Robot" does this vital work faster, more accurately and more uniformly than was ever possible before.

Designed to meet the heavy demands of Foster's wartime commitments, the new Foster "Robot" will continue as an integral part of Foster testing equipment after the war. It is one more assurance that your peacetime Foster transformers will maintain the highest possible standard of performance. And, because it is a time-saver, the "Robot", together with Foster's other streamlined techniques, will actually save you money.

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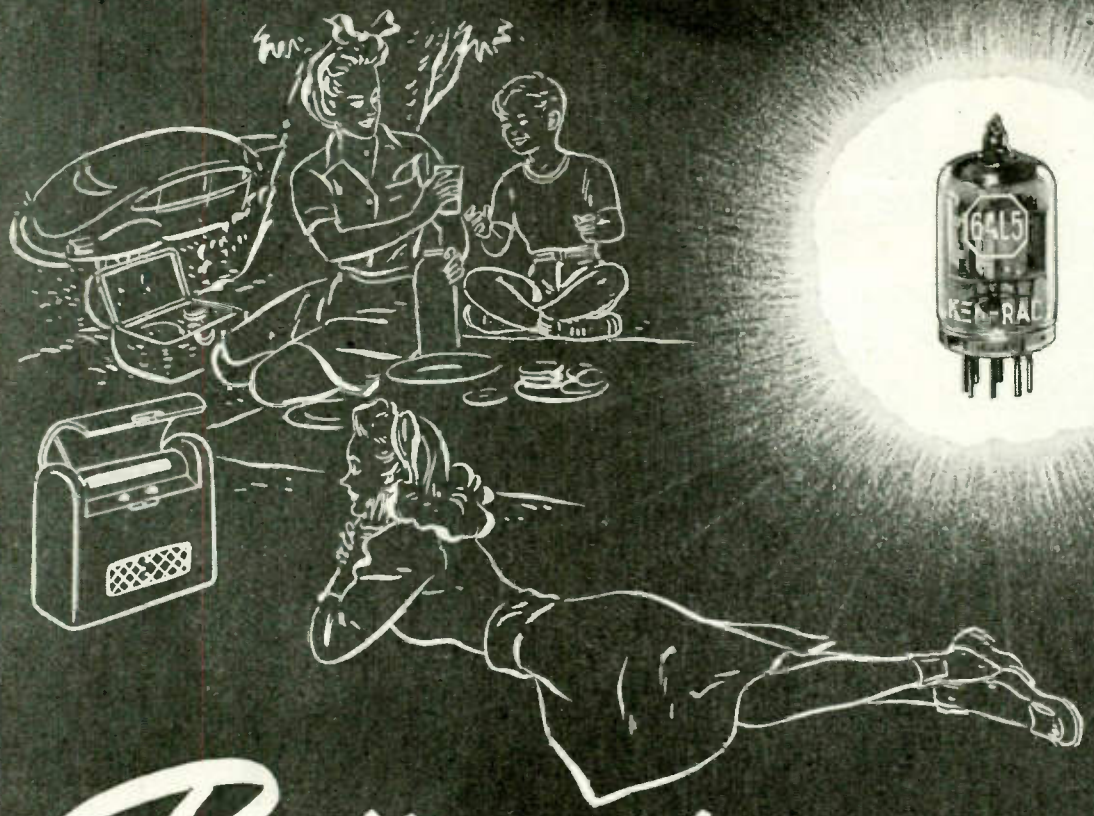
KEN-RAD

Little Giant MINIATURE TUBES



Better than ever

● Wherever compact power is essential, Ken-Rad Miniature Tubes are serving staunchly . . . Now this famous make of tubes, improved still further by important new research and manufacturing facilities, will meet *better than ever* the exacting specifications being laid down by designers, builders, and users of electronic equipment.

Write for your copy of "Essential Characteristics" the most complete digest of tube information available.

KEN-RAD

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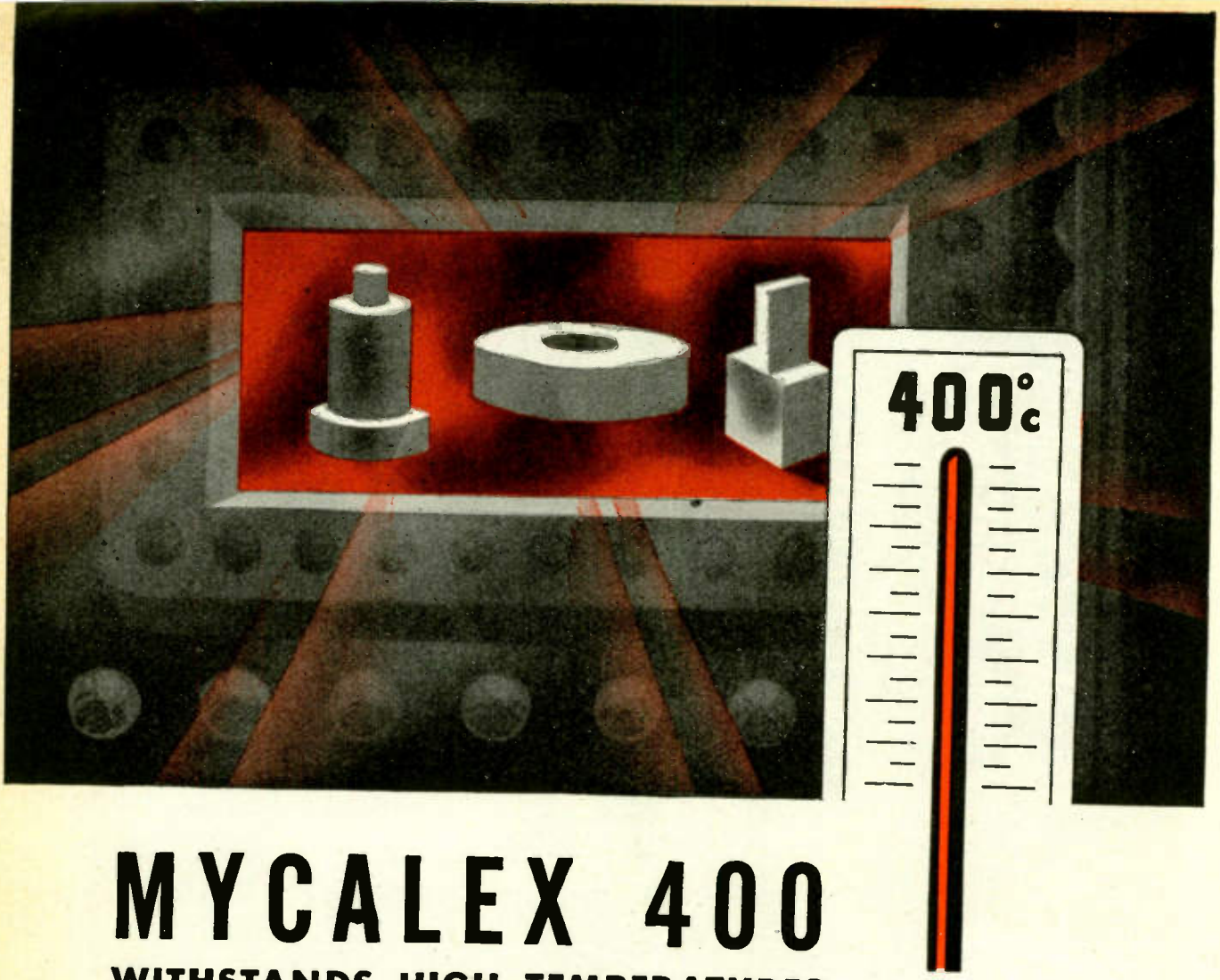

MYCALEX 400

WITHSTANDS HIGH TEMPERATURES

An outstanding characteristic of MYCALEX 400 is that it can withstand temperatures above 400° C. without softening or any permanent change in dimensions or properties.

Thus MYCALEX 400 has proved of great value as a low loss insulator in communications and other high frequency apparatus intended for use at elevated operating temperatures.

MYCALEX 400 is inorganic, free of carbonization . . . impervious to oil and water . . . not subject to cold flow. It meets all Army and Navy specifications as Grade L-4 material (JAN-I-10). It combines low loss factor with machinability to close tolerances. In sheets and rods. Fabricated to specifications.

SINCE 1919
MYCALEX
THE INSULATOR
TRADE MARK REG. U. S. PAT. OFF.

OTHER MYCALEX CORPORATION PRODUCTS

●

MYCALEX K

A series of ceramic capacitor dielectrics, with dielectric constant selectable from 8 to 19. Low power factor, high dielectric strength. Meets Army and Navy requirements as Class H material (JAN-I-12). To specifications.

MOLDED MYCALEX

Low loss, high temperature injection molded insulation. Molded in union with metals in irregular shapes. High production rates result in economical prices.

MYCALEX K and MOLDED MYCALEX will also withstand 400° C.

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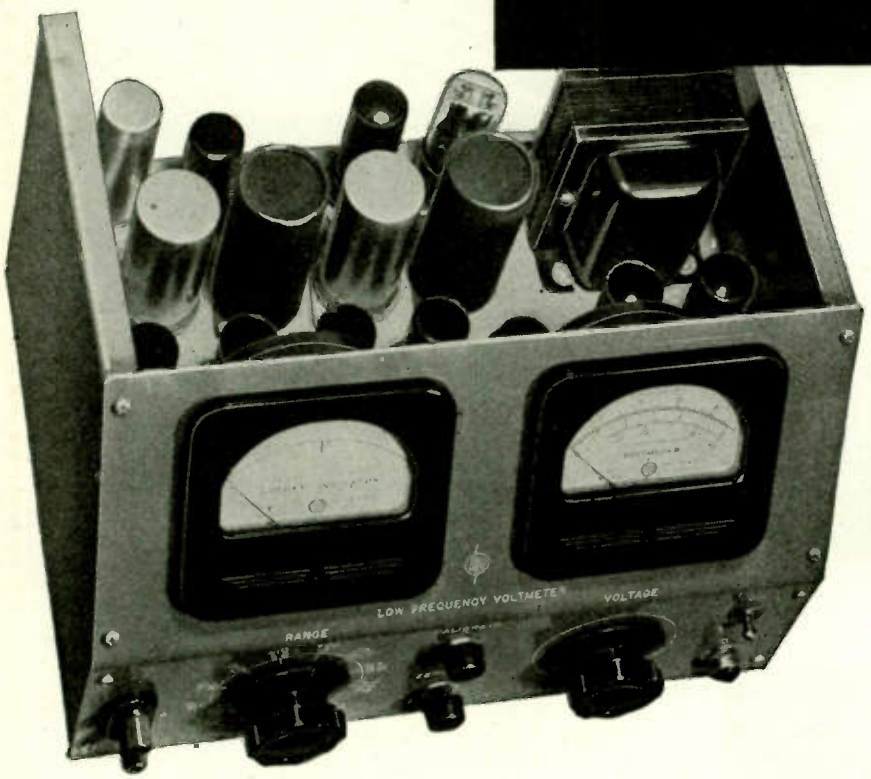
Just the place for "FP" CAPACITORS

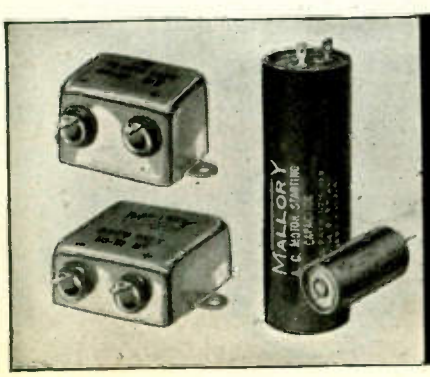


WHEN it comes to top chassis mounting, no other capacitors have ever matched the all-around excellence of Mallory "FP" Capacitors. That's why, *as a matter of course*, the Hewlett-Packard Co., of Palo Alto, California, uses them in this finely-constructed Low Frequency Vacuum Tube Voltmeter.

Mallory "FP" Capacitors are precision-built, thoroughly dependable, noted for their long life. The smallest capacitors available for a given electrical rating, they save chassis space, permit highly compact circuit designs. Moreover, they are easy to install and service.

Compact size, low cost, completely standard features—these have combined with *uniform quality* to win for Mallory "FP" Capacitors the official approval of RMA and the confidence and respect of engineers everywhere. There's a place for them in *your* equipment too. Contact your Mallory distributor or write us direct for the latest Mallory Catalog.

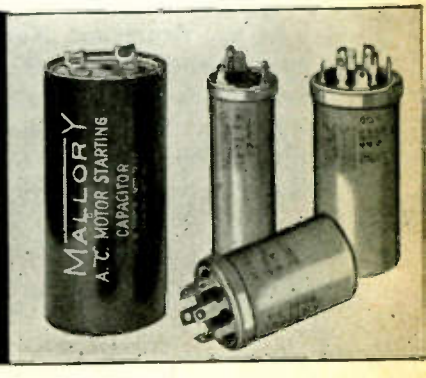
P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

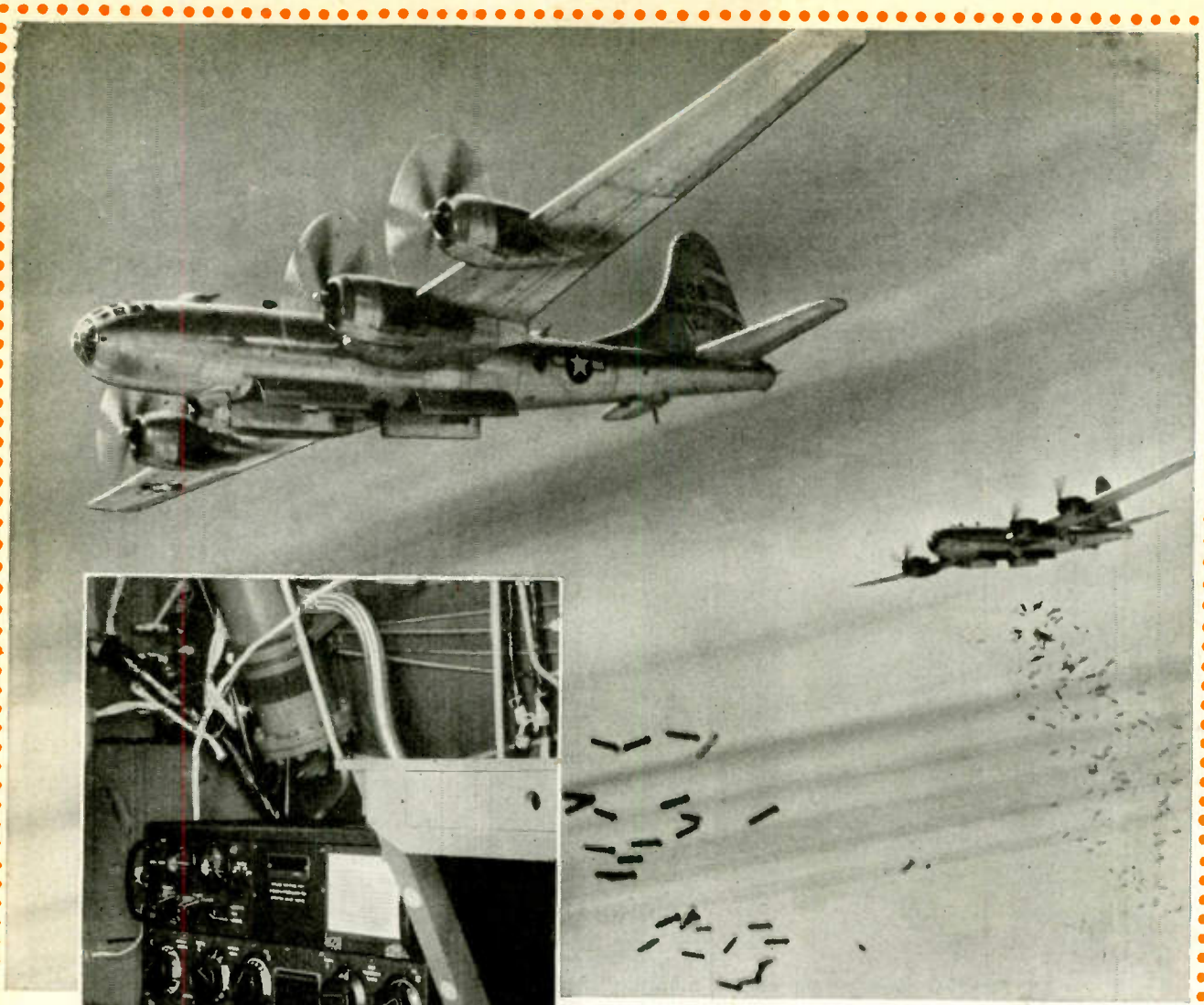


P.R. MALLORY & CO. Inc.

MALLORY

Electrolytic, Film and Paper CAPACITORS





The Collins-designed transmitter as operator sees it from his station in a Superfortress. Boeing—Wichita Photo.

Superfortresses blast and roast Japs. Official photo U.S.A.A.F.

In the Boeing B-29 from the first

THE FIRST MESSAGE from the Army's first Boeing Superfortresses over Japan, on the Yawata mission of June 15, 1944, was transmitted by a Collins radio transmitter of the type shown above. From that time on, this transmitter has been standard equipment for all the Superforts, as it is also for the larger Naval aircraft.

As the Army and Navy demand increased, requirements exceeded the capacity of the extensive Collins facilities, and other manufacturers of radio equipment were drawn into the production program, aided by Collins engineers. Total deliveries have been very large.

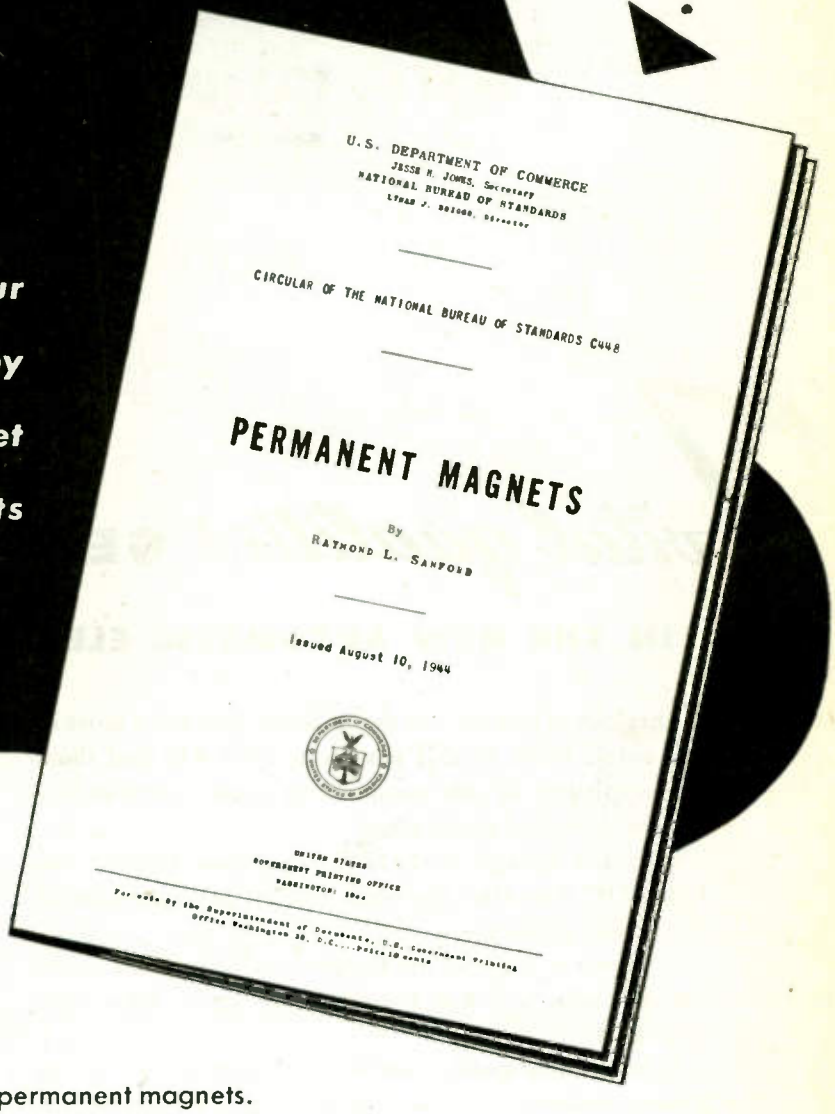
Collins engineering and production have gained much valuable experience during the war in providing reliable radio communications under all operating conditions in practically every quarter of the globe. This experience will be available to commercial and personal users as soon as military requirements permit. Collins Radio Company, Cedar Rapids, Iowa; 11 West 42nd Street, New York 18, N. Y.

IN RADIO COMMUNICATIONS, IT'S . . .

COLLINS

YOURS!

Just write us, on your letterhead, for your copy of this valuable booklet on permanent magnets



● As a service to industry, The Arnold Engineering Company is "lending a hand" in the distribution of what Arnold engineers believe to be a very informative study on the subject of permanent magnets.

This 39-page book of permanent magnet theory, design data and references was published by the government. Arnold is pleased to make it available to you free of charge and without obligation. Write for it today!

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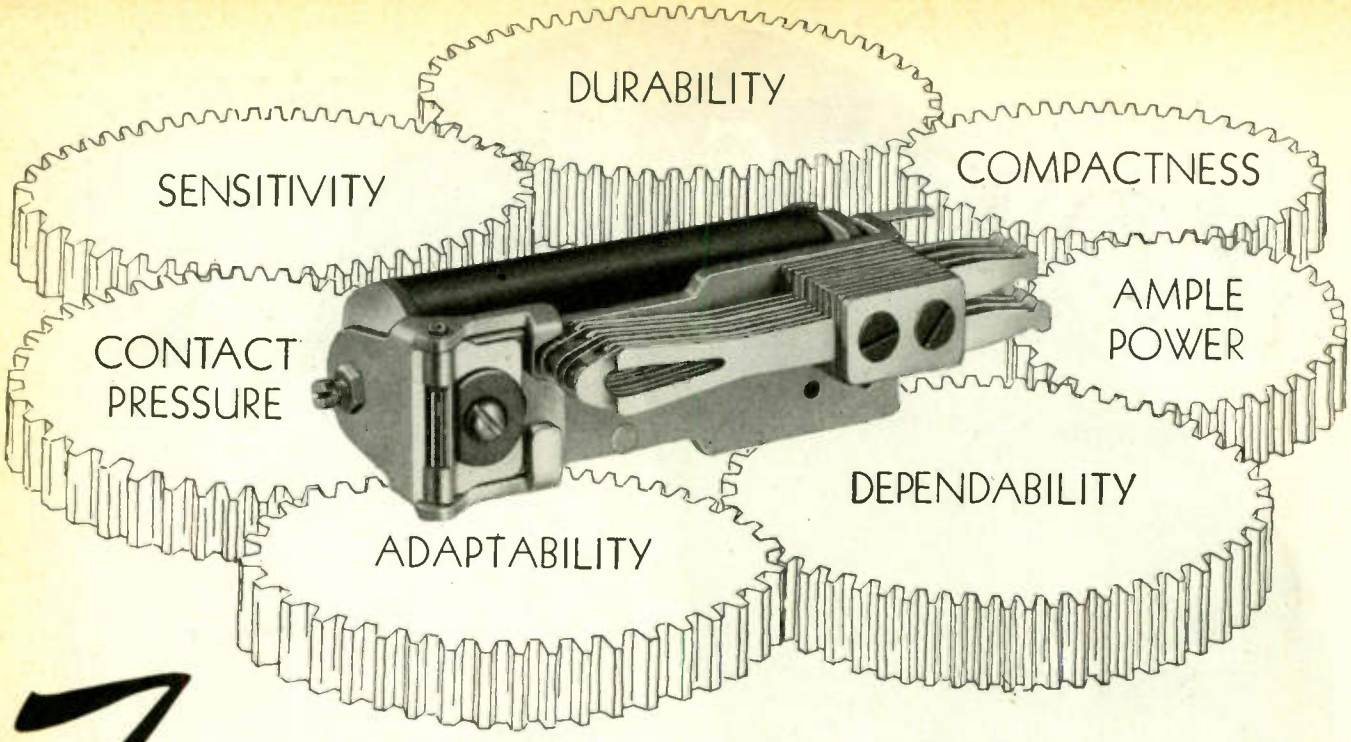
147 EAST ONTARIO STREET, CHICAGO 11, ILLINOIS

Specialists in the Manufacture of **ALNICO PERMANENT MAGNETS**



7 *vital qualities* GEARED TOGETHER

IN THE NEW AUTOMATIC ELECTRIC CLASS "B" RELAY

• Check over one by one the qualities you want most in any relay. Here, in this new relay, you will find them all—combined to give outstanding performance in any electrical control application.

Sensitive enough to operate on minute current, the Class "B" has also the high contact pressure needed for perfect closure—

Compact enough for multiple mounting in small space, yet with ample power for operating up to 28 contact springs—

With inbuilt quality needed for long service under tough conditions, and the dependability provided by dual circuit paths through independent twin contacts—

It will pay you to get the full story on this remarkable new relay. It is one of the forty basic types described in Automatic Electric's catalog 4071-D. Write today for your copy.

ONLY THE CLASS "B" RELAY HAS ALL THESE DESIGN FEATURES:

Twin Contacts—providing dual circuit paths for maximum reliability.

Efficient Magnetic Circuit—for sensitivity and high contact pressure.

Unique Armature Bearing—for long wear under severe service conditions.

Compact Design—for important savings in space and weight.

Versatility—Available for coil voltages to 300 volts d-c and 230 volts a-c, and with contact capacities up to 28 springs; also with magnetic shielding cover if desired.

Relays AND OTHER CONTROL DEVICES *by* AUTOMATIC ELECTRIC

AUTOMATIC ELECTRIC SALES CORPORATION
1033 West Van Buren Street • Chicago 7, Illinois

In Canada: Automatic Electric (Canada) Limited, Toronto

PARTS AND ASSEMBLIES FOR EVERY ELECTRICAL CONTROL NEED

Who sets the *Quality Standard* FOR TRANSMITTING TUBES

QST #1 Filament and Grid support wire is *miked and weighed to meet specifications since slightest variations affect tube characteristics and performance.

QST #2 Quantitative analysis of Filament Sprays and Chemical Getters is made to insure correct ratios of the active ingredients.

QST #3 Although triple-distilled the Mercury used in United tube is further processed to prevent contamination by minute traces of impurities.

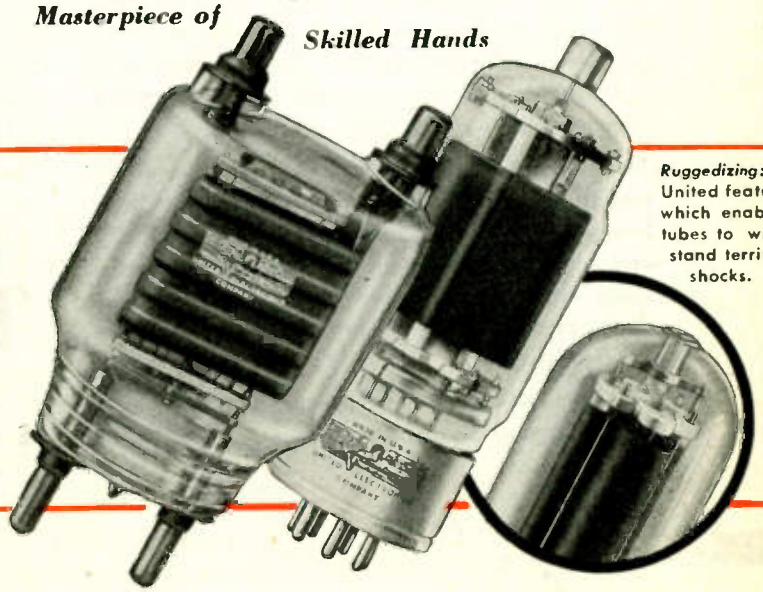
STEP-BY-STEP, from raw material to final product, nothing is taken for granted at United. For instance, all raw materials that enter into the evolution of a United tube are checked and tested with searching chemical and metallurgical care in our own laboratory pictured above. These tests complement our regular inspections for exacting mechanical standards.

Such vigilant Quality Standard Tests of raw materials are essential to assure the sterling qualities of United Tubes. For the name United carries a great responsibility with engineers everywhere. It is a *trusted standard* for comparing transmitting tubes which must be zealously guarded and always maintained.

But the final test rests with you, so let United tubes prove themselves by actual performance. Try them when you make your next replacements. Write for a copy of our latest catalog. Order direct or from your Electronic Parts Jobber.

*Quality Standard Test

Masterpiece of Skilled Hands



Ruggedizing: A United feature which enables tubes to withstand terrific shocks.

ARMY NAVY

UNITED

ELECTRONICS COMPANY

NEWARK, 2 NEW JERSEY

Transmitting Tubes EXCLUSIVELY Since 1934

more efficient ...in miniature

ACTUAL SIZE

The modern high speed grinder can perform many tasks that are impossible with the old fashioned grindstone. Like the miniature electronic tube, it is a striking example of the modern trend of increased efficiency with reduced size.

TUNG-SOL foresees great possibilities in the use of miniature tubes. In most circuits miniatures do a better job than large tubes. Their lower capacity and high mutual conductance and their shorter leads with resulting lower lead inductance make them practically essential for many high-frequency applications.

The added advantages of miniatures are their small size and reduced weight.

TUNG-SOL engineers will be ready to assist the manufacturers of radio sets just as they have assisted the Navy and Signal Corps by designing and planning circuits and selecting tubes best suited to give the most efficient performance. Your future plans will be held in strictest confidence.

TUNG-SOL

vibration-tested

ELECTRONIC TUBES

TUNG-SOL LAMP WORKS INC., NEWARK 4, NEW JERSEY

Also Manufacturers of Miniature Incandescent Lamps, All-Glass Sealed Beam Headlight Lamps and Current Intermittors

THERE'S a good deal more to an efficient, dependable electrical coil than a routine winding. Basic engineering, for one thing. Engineering that *thinks* right from the conception of each problem.

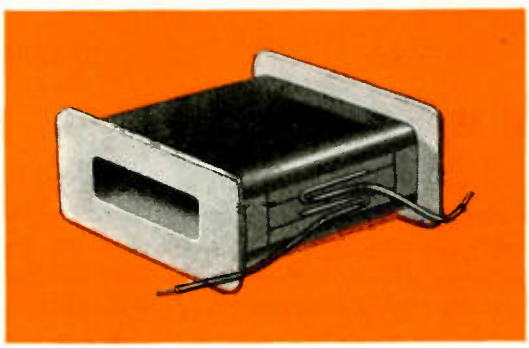
The proper relationship of many variables must be analyzed, weighed. Anaconda coil engineers put emphasis on the correct type, size, shape, insulation, cost, as well as winding.

The quality of the magnet wire also is important. Anaconda controls it from raw copper, through fabrication, to application on the finished coil.

This means that as a coil producer Anaconda also has the advantage of its long experience in making magnet wire. By the same token, Anaconda magnet wire production benefits by Anaconda coil experience.

Add to these features Anaconda's excellent manufacturing facilities and expertly trained personnel.

Anaconda engineering service for coils and magnet wire is always yours for the asking. Contact any sales office. 45301



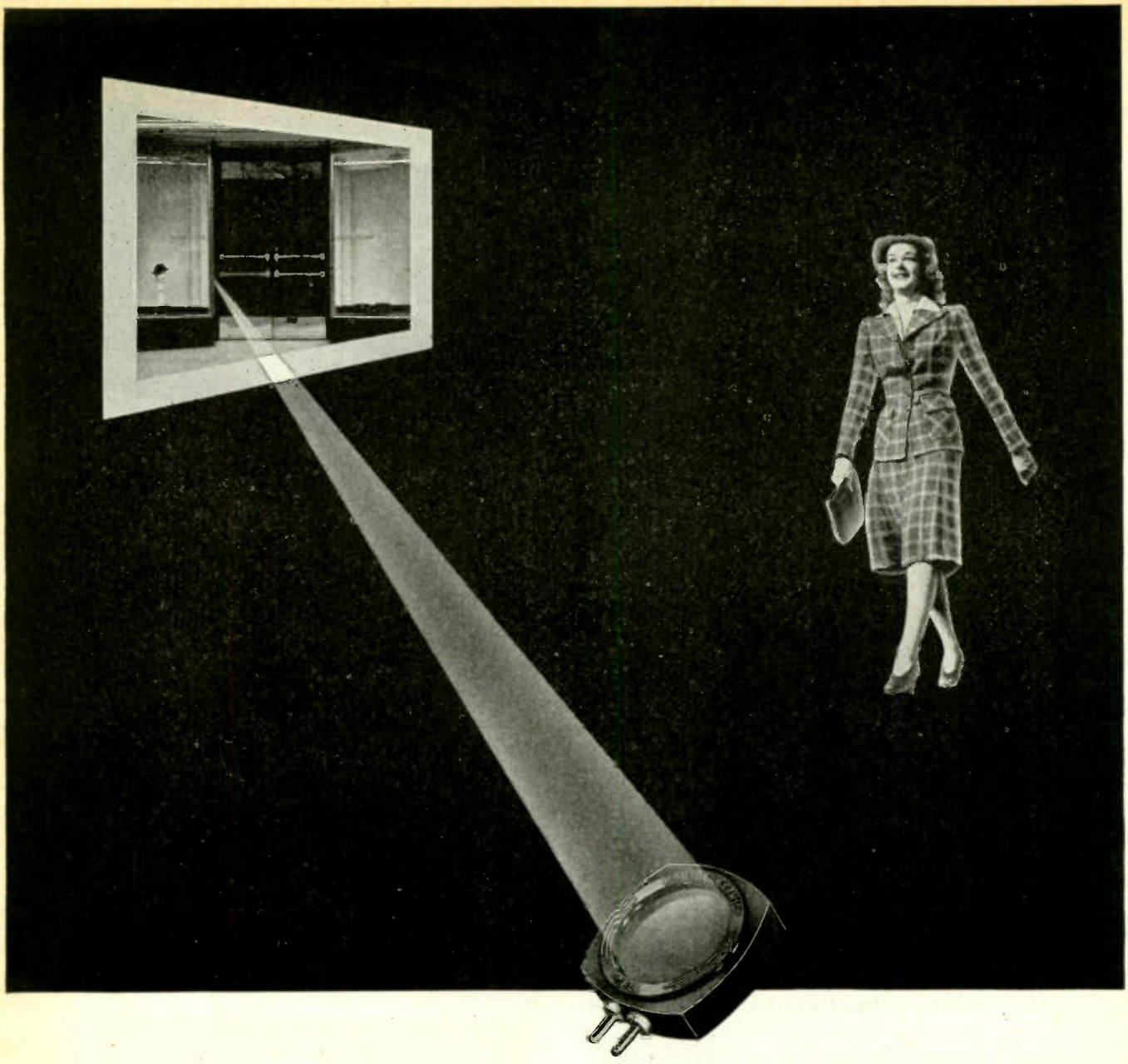
Magnet wire and coils

ANACONDA

ANACONDA WIRE & CABLE COMPANY

GENERAL OFFICES: 25 Broadway, New York City 4 — *Subsidiary of Anaconda Copper Mining Company*

CHICAGO OFFICE: 20 North Wacker Drive 6 • Sales Offices in Principal Cities



How to beat a woman—TO A DOOR

One way to startle the lay public into awed pleasure is to show them a door opened by means of a photo*cell*.

The practical beauty of this stunt is that you can do it over and over again without failure, even where shattering vibrations exist as part of normal operating conditions. For the Luxtron* photo*cell* is really rugged.

Another advantage is that Luxtron photo*cells* convert light into electric energy for the direct operation of meters and meter relays without amplification. They are lightweight, too. They are a good way to beat competition to a customer.

If you have any control problem that has defied solution with a simple, durable piece of apparatus, perhaps Bradley can throw some light on it—and make that light do the work for you. Write for literature and samples.

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

Another "Coprox" Rectifier

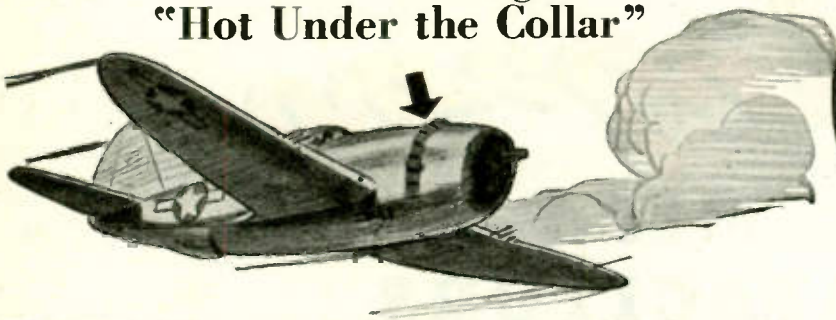
This center tap, full wave rectifier for high frequency current is one of a useful group of copper oxide rectifiers developed by Bradley. Illustrated "Coprox" bulletin mailed on request.

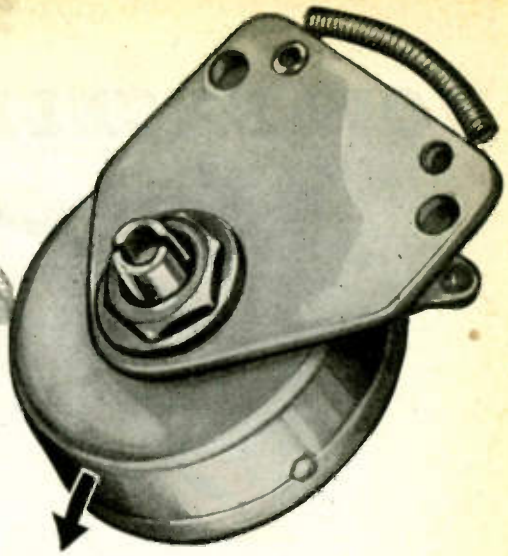
PHOTOCELLS—MASTERS OF LIGHT **BRADLEY** ***MASTER OF PHOTOCELLS***

BRADLEY LABORATORIES, INC., 82 MEADOW STREET, NEW HAVEN 10, CONNECTICUT

MALLORY POTENTIOMETERS

Help Keep Aircraft Engines from Getting "Hot Under the Collar"



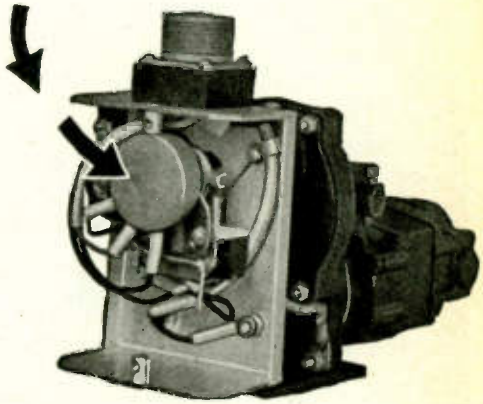


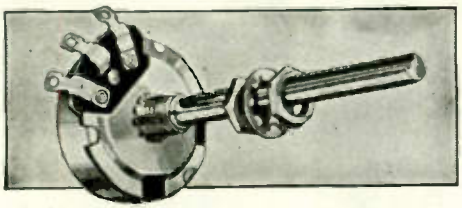
FLEXIBLE shaft power units, built by Lear Avia, Inc., Piqua, Ohio, for operating aircraft cowl flaps, radiator shutters and exit flaps, use Mallory "M" Type wire-wound Potentiometers as remote indicating controls. Ruggedly constructed and electrically efficient, these precision potentiometers are specified for equipment that must give top performance under tough conditions.

If your product requires potentiometers or resistors, capacitors or switches, jacks, plugs, vibrators, power supplies or rectifiers—see your nearest Mallory Distributor. He has these *standard* precision electronic parts in stock ready for your use. Ask him for the Mallory catalog, or write us today.

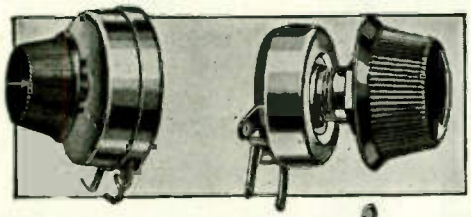
Make it a policy to consult Mallory for engineering assistance while your designs are still in the blue print stage.

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



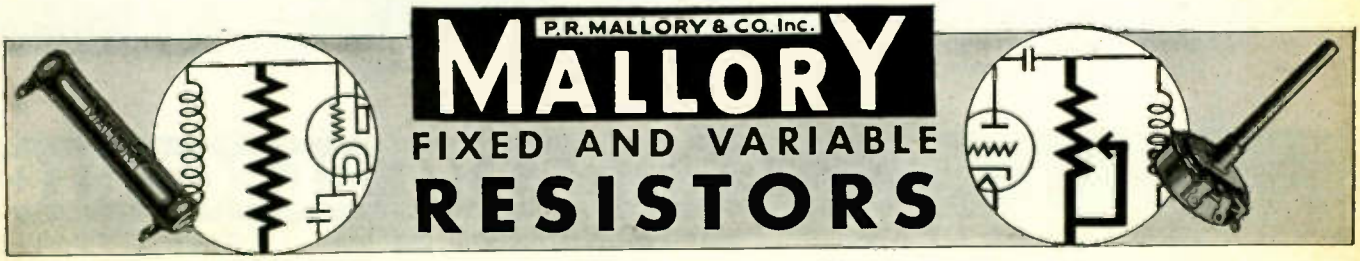


VARIABLE CARBON RESISTORS—In standard and midget types from 5,000 ohms to 9 megohms. Noiseless in operation. Rugged terminal construction and improved resistance to humidity.



VARIABLE WIRE-WOUND RESISTORS—Available in three standard types, from 0.5 to 150,000 ohms, 2 to 9 watts. Single and multiple units, with or without AC switch.

FIXED AND ADJUSTABLE WIRE-WOUND RESISTORS—Available from 1 to 100,000 ohms and 10 to 200 watts. Maximum wattage dissipation. Resistant to humidity.

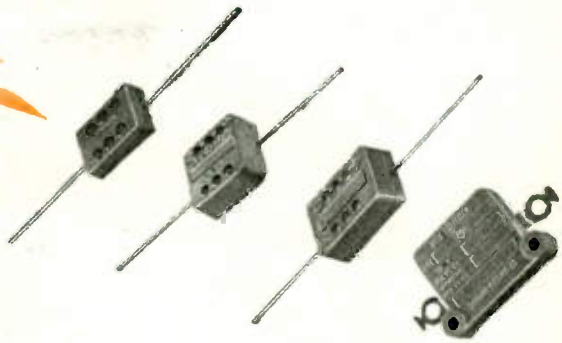


Cartridge IMPREGNATION

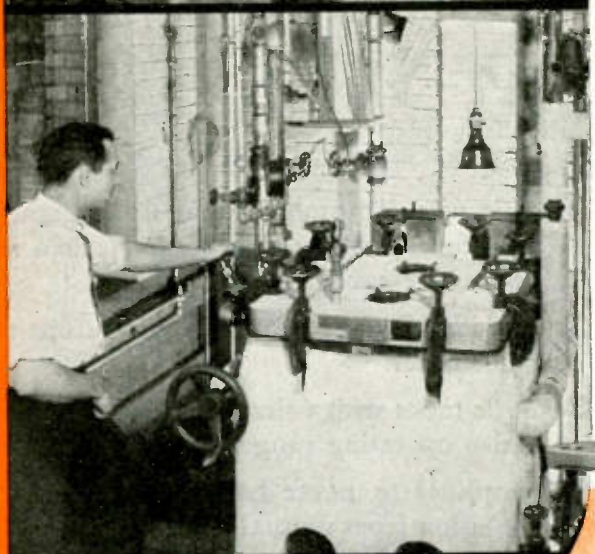
THE processing of the capacitor cartridge before moulding is a very important step in controlling the quality of the finished capacitor. Not only must all traces of air and moisture be removed from the cartridge, but the cartridge must also be treated to insure permanence of the desired characteristics, such as power factor and insulation resistance, when once these have been attained.

These conditions are achieved by subjecting the cartridges to a high degree of vacuum for the removal of moisture and air, and by impregnating them with moisture resistant waxes or varnishes, in special vacuum impregnating tanks. To assure that the prescribed electrical characteristics are obtained, various waxes and varnishes may be used. All excess wax is removed by centrifugal force so that it does not interfere with the proper moulding of the plastic case in the subsequent operation. The plastic case additionally seals the capacitor against atmospheric conditions, thus further contributing to the long, trouble-free life of capacitors in service.

By maintaining constant vigilance in each of the manufacturing processes, the Sangamo standard of excellence is assured for Sangamo Mica Capacitors.



• Impregnating and spinning equipment for vacuum wax impregnating mica capacitor cartridges and spinning off excess wax.



• Impregnating tank for vacuum impregnation of capacitors and capacitor cartridges.

Wondering about tube testers?

...Here's what Simpson has ready and waiting for your postwar needs

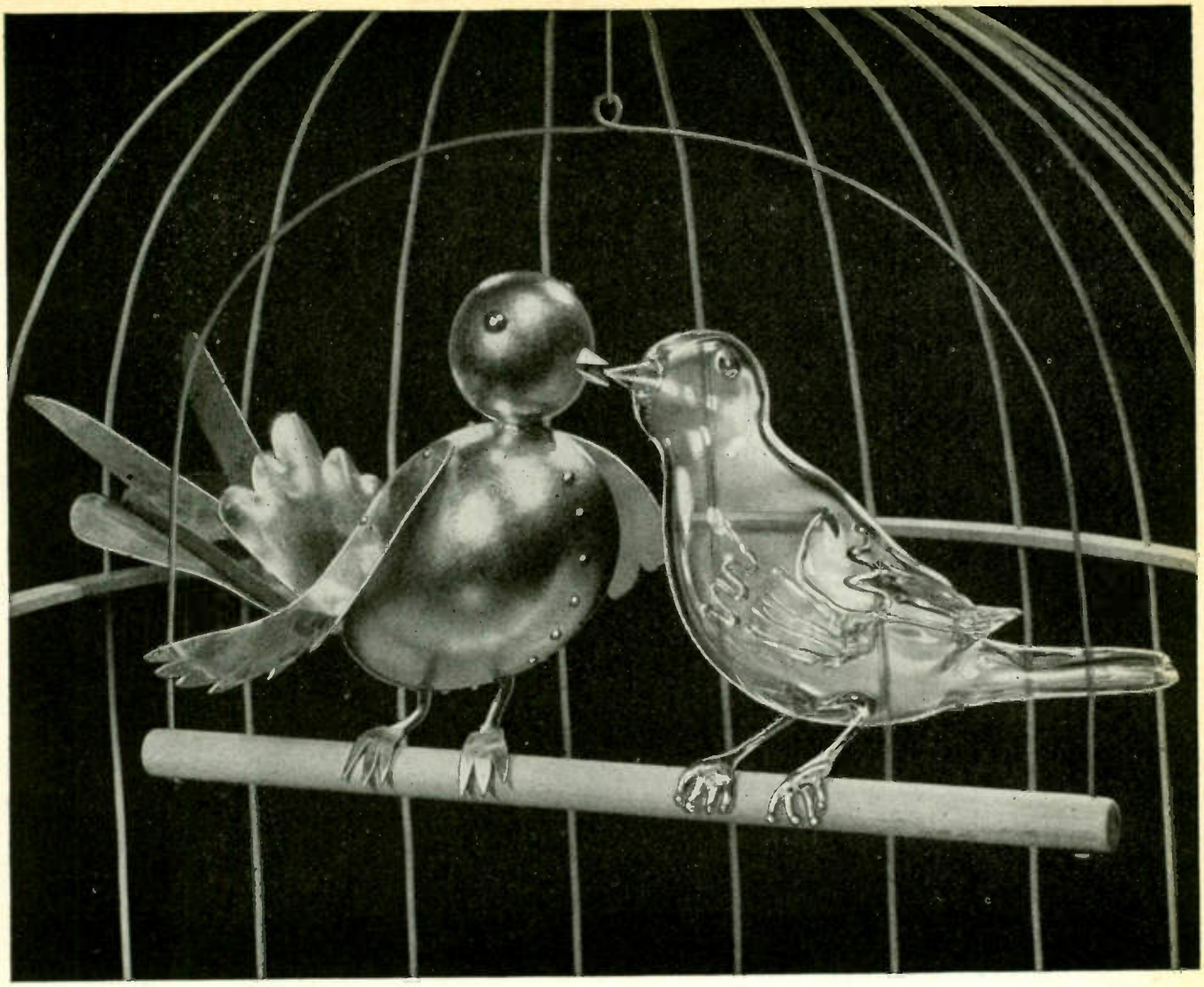
Sensational? Yes . . .

1. This new Simpson Mutual Conductance Tube Tester tests tubes with greater accuracy than any commercial tube tester ever designed.
2. Provides greater flexibility for future tubes than any other tester.
3. Tests tubes with voltage applied automatically over the entire operating range.
4. Simplifies as never before the interpretation of tube condition from mutual conductance readings.

SIMPSON ELECTRIC COMPANY
5200-18 Kinzie Street, Chicago 44, Ill.

Simpson

INSTRUMENTS THAT STAY ACCURATE



IT'S THE MATING SEASON FOR GLASS AND METAL . . .

thanks to Corning Metallizing!

CORNING has long been interested in the mating qualities of glass and metal. Out of this interest has developed a metallizing process which can be accurately *controlled* . . . and which lasts.

Corning's metallizing process, combined with the excellent mechanical and dielectric properties of Corning's glasses, produces hermetic seals between glass components and metal by ordinary soldering methods or furnishes accurate and constant capacitances and inductances or electrostatic shielding.

Metallized glass as developed by Corning offers a wide variety of new applications in the field of electronics. Perhaps you have a problem where the union of glass and metal can help. Why not write us about it? Address Electronic Sales Department, I-7, Bulb and Tubing Division, Corning Glass Works, Corning, New York.

CORNING *means* Research in Glass

Electronic Glassware

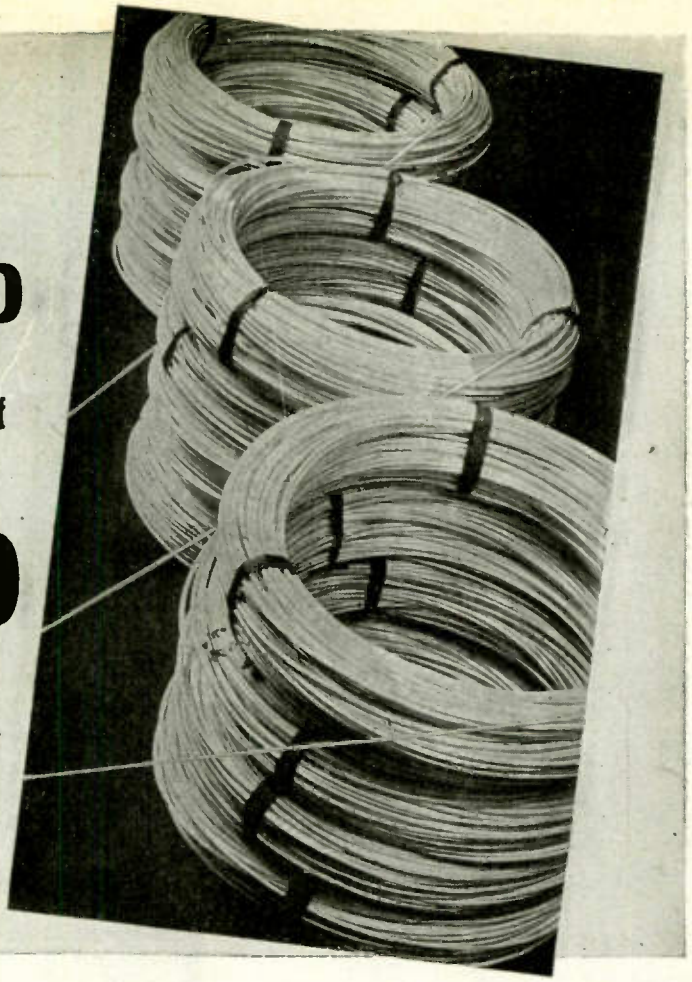
VYCOR CORNING PYREX

"PYREX", "VYCOR" and "CORNING" are registered trade-marks and indicate manufacture by Corning Glass Works, Corning, N. Y.

WILCO
NOW EQUIPPED

for large scale production of

JACKETED WIRE



WILCO wire, tubing and other products are used in various electronic applications for the Army and Navy. In response to the wartime demand for these various products, the H. A. Wilson Company has enlarged its plant, increased its manufacturing facilities, added essential new equipment and developed new products and techniques. Both present and future customers will find these new WILCO developments of great advantage.

The H. A. Wilson Company manufactures and is interested in receiving inquiries regarding the following typical products—

WILCO JACKETED WIRE

Silver (Fine, Sterling or Coin)
Silver Jacketed Copper
Silver Jacketed Invar
Silver Jacketed Brass
Silver Jacketed Steel
Gold Jacketed Silver (Fine, Sterling, Coin)
Gold Jacketed Brass or Bronze
Copper Jacketed Monel
Nickel Jacketed Copper

WILCO JACKETED TUBING

Silver Tubing (Fine, Sterling or Coin)
Gold Tubing (any Color or Karat)
Silver Jacketed Brass or Bronze (one or both sides)
Gold Jacketed Silver (one or both sides)
Gold Jacketed Brass or Bronze (one or both sides)

WILCO STRIP MATERIAL

Silver (Fine, Sterling or Coin) on Brass or Bronze (Inlay or Overlay)
Gold on Silver (any Karat on Fine, Sterling or Coin)
Gold on Brass or Bronze

Other WILCO products include Electrical *Contacts*—

Silver. Platinum, Tungsten, Alloys, Powder Metal. *Thermostatic Bimetal* (High and Low Temperature with new high temperature deflection rates.) *Precious Metal Collector Rings*—For Rotating controls. *Silver Clad Steel. Rolled Gold Plate. Special Materials.*

Let us analyze your problems.

THE H. A. WILSON COMPANY

105 Chestnut Street, Newark 5, N. J.

Branches: Detroit • Chicago

WILCO

HERMASEAL

HERMETICALLY SEALED TRANSFORMERS —DEPENDABLE IN SEA WARFARE!

SPECIFY HERMASEAL AND GET ALL TEN

- ★ Uniform Characteristics
- ★ Correct Terminations
- ★ Vacuum Immersion Test
- ★ Vacuum Impregnation—Varnish or Wax
- ★ Vacuum Filling—Oil or Wax*
- ★ Strong Mechanically
- ★ Soldered by Induction Heating
- ★ Infra-red Pre-heating
- ★ Continuous Inspection
- ★ 42 years Experience

*May now be specified instead of compound filling.

HERMASEAL BY AMERTRAN

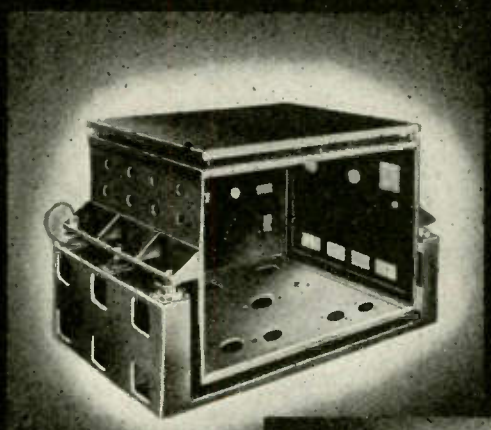
THE AMERICAN TRANSFORMER CO., 178 Emmet St., Newark 5, N. J.

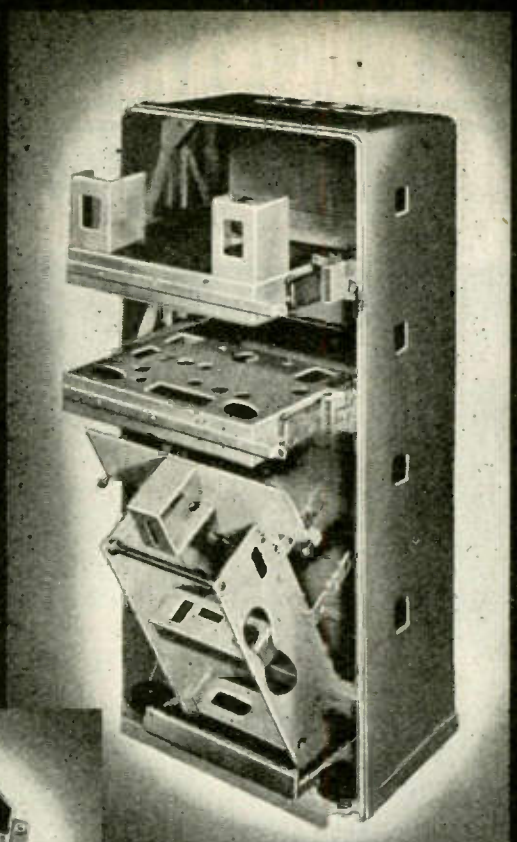
Pioneer Manufacturers of Transformers, Reactors and Rectifiers for Electronics and Power Transmission

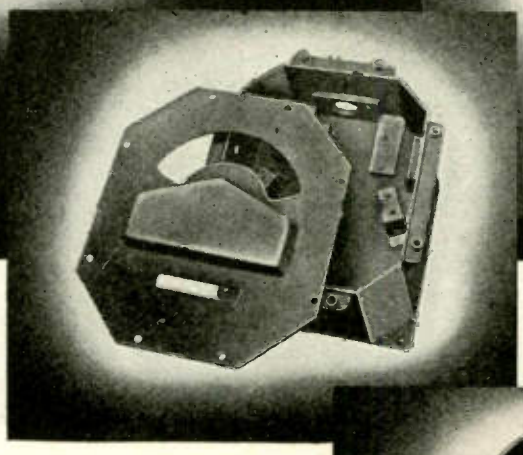
AMERTRAN

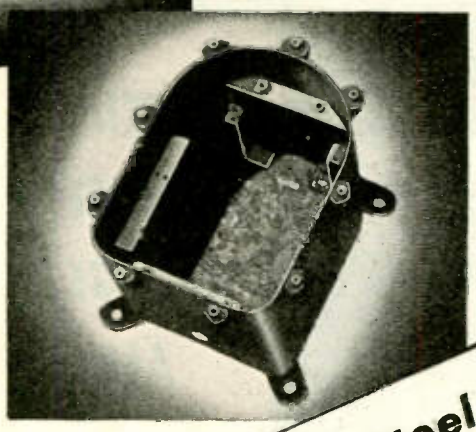
MANUFACTURING SINCE 1901 AT NEWARK, N. J.

Sheet Metal Fabrication









Illustrated are just a few examples of Cole Steel Equipment "know-how." Our complete stamping—welding—plating—finishing—and packing departments are at your command. Whatever your problem . . . instrument housings, water-tight boxes, chassis . . . we're geared to design, fabricate, and finish to your exact specifications.

●

Send for our brochure
"THE PLANT BEHIND YOUR PLANT"

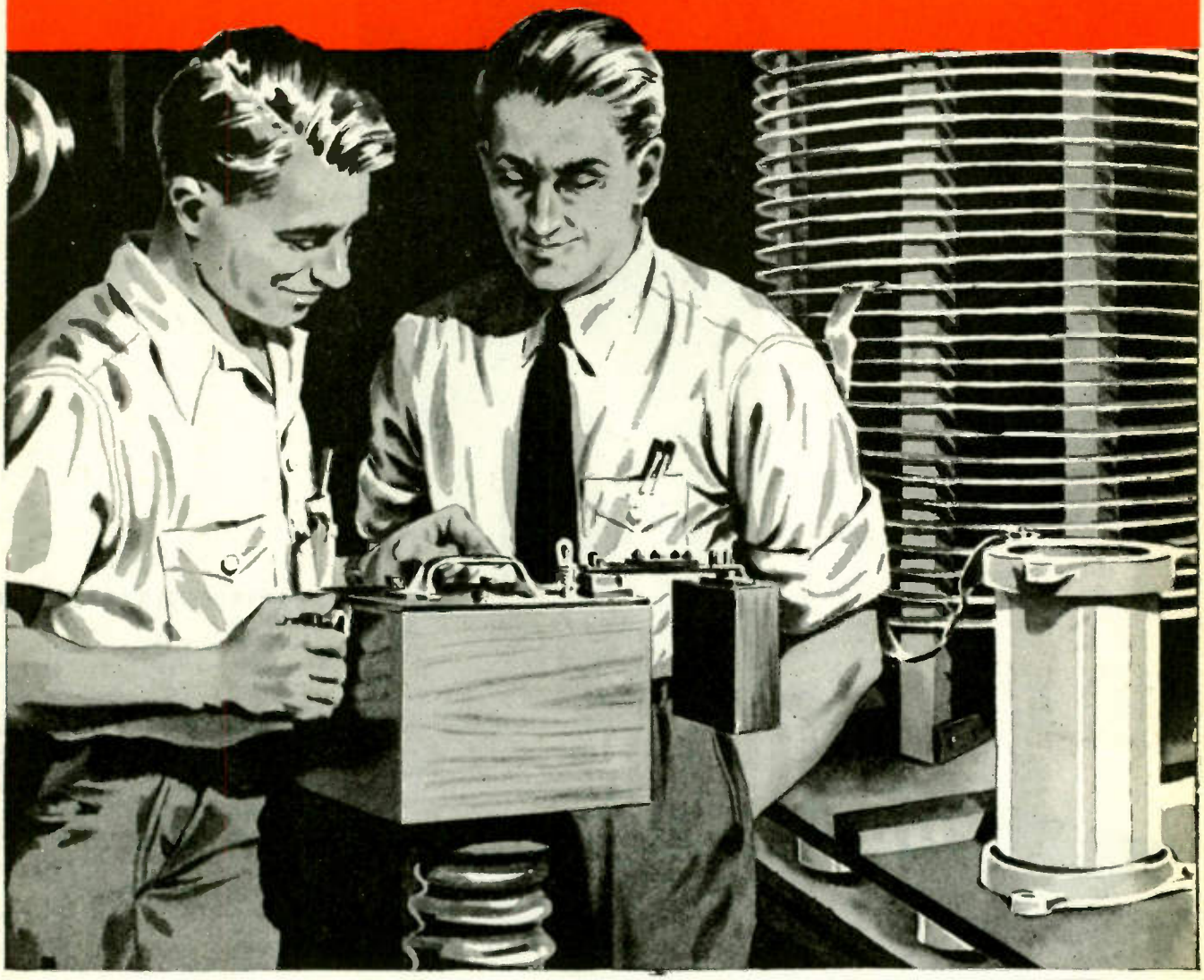
COLE

STEEL EQUIPMENT COMPANY

349 Broadway, New York 13, New York Factory: Brooklyn, New York

Cole Steel office equipment will again be available after the war

checked by men who know



Here this Cornell-Dubilier series 50 capacitor is checked to make sure that the current and frequency ratings are correct.

This is one of many routine production tests to safeguard the quality and reliability of C-D Capacitors.

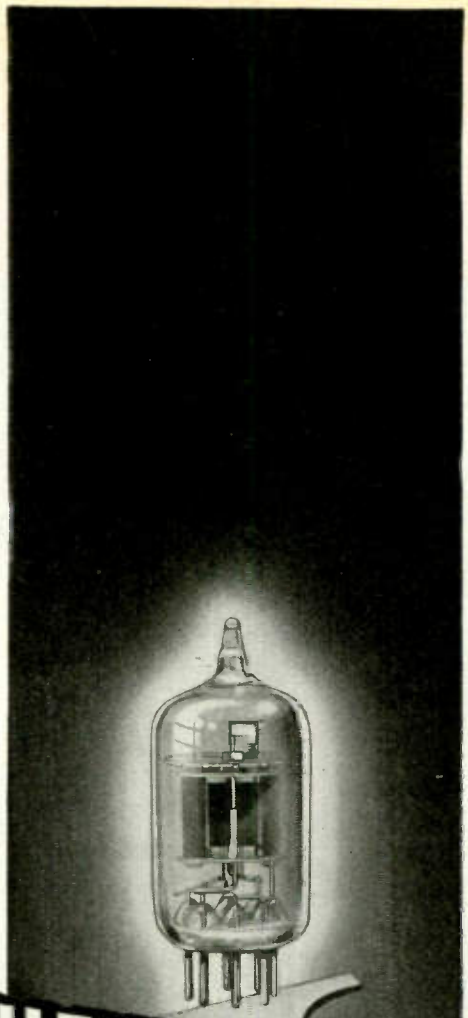
It is responsibility, not novelty, that makes C-D craftsmen so intent on the outcome of this test. This capacitor has a reputation to live up to . . . it must be capable of sustained performance, continuously, under heavy duty.

This preoccupation with the details that make for perfection has rated C-D capacitors the finest by men who know and use them. The name Cornell-Dubilier is their guarantee of better-than-specified quality. You, too, can depend on them.

If you have a capacitor problem, one of our basic innovations in design, engineering or manufacture may be the answer. Write to Cornell-Dubilier Electric Corporation, South Plainfield, N. J. Other Plants at New Bedford, Brookline, Worcester Mass. and Providence, R. I.

CORNELL-DUBILIER CAPACITORS

MICA · DYKANOL · PAPER · ELECTROLYTICS



RAYTHEON

Type 6N4 Miniature U-H-F Triode

SPECIFICATIONS OF 6N4

DIMENSIONS:		
Maximum Overall Length	1¾	inches
Maximum Seated Height	1½	inches
Maximum Diameter	¾	inches
RATINGS:		
Heater Voltage	6.3	volts
Heater Current	0.2	amps.
Maximum Plate Voltage	180	volts
Maximum Plate Dissipation	3	watts
DIRECT INTERELECTRODE CAPACITANCES:*		
Grid to Plate	1.1	μμf
Input	3.0	μμf
Output	1.6	μμf
TYPICAL CLASS A CHARACTERISTICS:		
Plate Voltage	180	volts
Grid Voltage	−3.5	volts
Plate Current	12	ma
Amplification Factor	32	
Transconductance	6000	umhos

** Approximate — with close fitting shield connected to cathode.*

• An important contribution by Raytheon tube-design engineers to the efficient generation of ultra high frequency power is a miniature triode designated as type 6N4.

This cathode type tube combines the desirable features of reduced interelectrode capacitances and lead inductances with high transconductance. Thus the inevitable internal losses are minimized, making the 6N4 particularly adaptable as an amplifier, doubler, or oscillator at frequencies up to approximately 500 megacycles.

The foregoing characteristics can be used to advantage in many types of equipment which may not be publicized. However, such important functions as those performed by the local oscillator in a u-h-f television or FM receiver are readily visualized possibilities.

In addition, Raytheon type 6N4 will be an ideal tube for civilian "walkie-talkies" and other portable radio equipment of the future. It has moderate heater power requirements and performs efficiently in the 460-470 megacycles region of the spectrum which is expected to be approved, by the Federal Communications Commission, for civilian use.

Whether or not Raytheon type 6N4 fits your particular plans, be sure to consider Raytheon High-Fidelity Tubes for your postwar products. There's a Raytheon tube that will fill your need efficiently and dependably.

All Four Divisions Have Been Awarded Army-Navy "E" with Stars

RAYTHEON

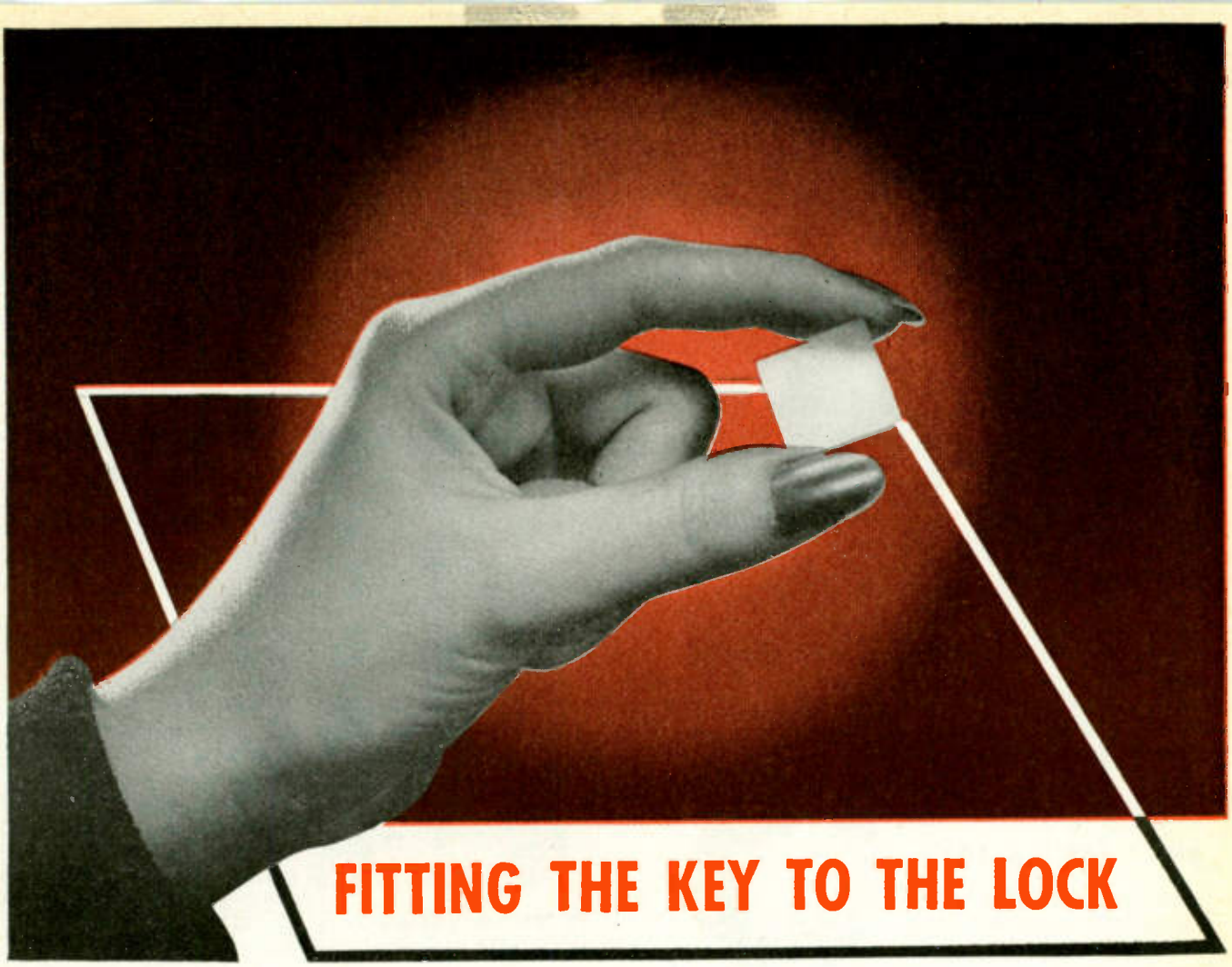
MANUFACTURING COMPANY

Radio Receiving Tube Division

NEWTON, MASSACHUSETTS · LOS ANGELES
NEW YORK · CHICAGO · ATLANTA

Listen to
"MEET YOUR NAVY"
Every Saturday Night
AMERICAN BROADCASTING CO.
Coast to Coast
181 Stations

DEVOTED TO RESEARCH AND THE MANUFACTURE OF TUBES AND EQUIPMENT FOR THE NEW ERA OF ELECTRONICS



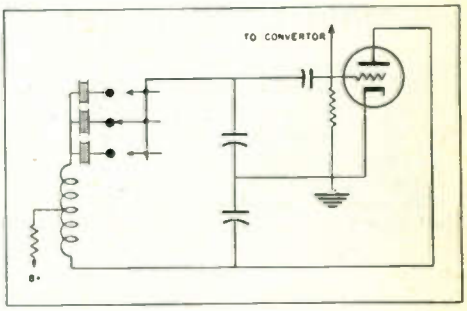
FITTING THE KEY TO THE LOCK

Deriving the most from frequency control and selection circuits employing quartz crystals calls for a recognition of the fact that a crystal is also a circuit element and, as such, is influenced by and in turn influences other circuit characteristics. It is a case of fitting the key to the lock.

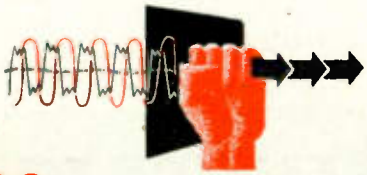
The interdependence of crystal and tube in any circuit application poses design problems that are common to the crystal engineer, the tube engineer and the circuit engineer. Solutions are more readily arrived at by a pooling of specialized knowledge.

As manufacturers of crystals *and* tubes, the North American Philips Company has an intimate knowledge of both. Our engineers are therefore particularly well equipped to cooperate with circuit design engineers in any application problems involving the use of crystals. As an example, the circuit shown at right was suggested by our crystal applications laboratory as one means of employing crystal control in a push-button tuned receiver.

Although the armed forces have first call on our crystal production facilities, we invite inquiries from manufacturers interested in the utilization of low-cost precision quartz crystals for industrial and commercial applications. A booklet "How Quartz Crystals are Manufactured" is available on request.



Crystal-controlled oscillator circuit for push-button tuned receivers, using the series resonance of the crystal as the control factor. No adjustment is required over a frequency range as great as 2 to 1.



Norelco Reg. U. S. Pat. Off.

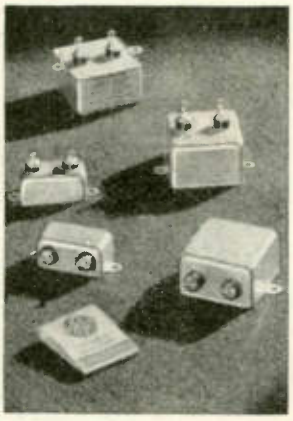
Electronic Products by **NORTH AMERICAN PHILIPS COMPANY, INC.**

OTHER PRODUCTS: Amplifier, Transmitting, Rectifier and Cathode Ray Tubes; Searchray (Industrial X-ray) Apparatus; X-ray Diffraction Apparatus; Medical X-ray Equipment, Tubes and Accessories; Tungsten and Molybdenum products; Fine Wire; Diamond Dies. ●We invite you to visit our office and showroom when in New York City.

Dept. H-7, 100 East 42nd Street, New York 17, N. Y.
Factories In Dobbs Ferry, N. Y.; Mount Vernon, N. Y. (Metalix Div.); Lewiston, Maine (Elmet Div.)

ELECTRONICS DESIGNER'S

CAPACITORS FOR GI JOBS



G-E fixed paper-dielectric capacitors built to the exacting requirements of (proposed) Joint Army-Navy Specification JAN-C-25 are now available in Characteristic F, in case styles CP-50, -51, and -52. These small compact "bathtub" capacitors, hermetically sealed in metallic cases, are built to withstand the severe conditions encountered by electronic equipments for the armed services.

Single-, dual-, or triple-section units can be supplied for voltages of 600 or 1000 volts, in sizes from 0.05 to 2 microfarads. All units provided with solder-lug "B" terminals. Ask for Bulletin GEA-4357.

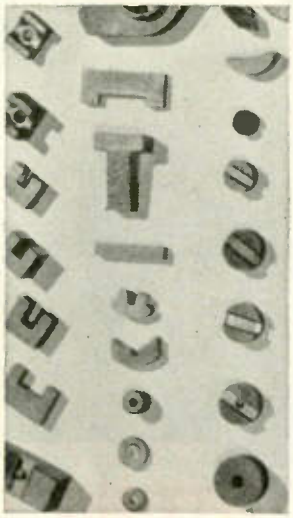
LITTLE INSTRUMENTS THAT CAN "TAKE" A LOT

Internal-pivot construction of G-E small panel instruments makes for compact construction. Accuracy is high, and construction strong. These instruments will withstand momentary overloads of ten times their rated capacity, are resistant to vibration and to temperature, giving accurate reading in the ambient temperature range from —50 C to 70 C. This line (DW-51 and DW-52) includes 15 d-c voltmeters, 10 d-c ammeters, 14 d-c milliammeters, 8 d-c microammeters, 9 r-f ammeters, and 9 r-f milliammeters, all calibrated to cover a wide range of applications in shielded and unshielded types. Send for Bulletin GEA-4064.

INDUSTRIOUS TUBES FOR INDUSTRIAL USES

From the ignitron, supplying hundreds of amperes, to the tiny photo tube that inspects sheet metal at speeds as high as 1000 feet per minute, you'll find G-E tubes putting electronics to work, on all sorts of industrial jobs.

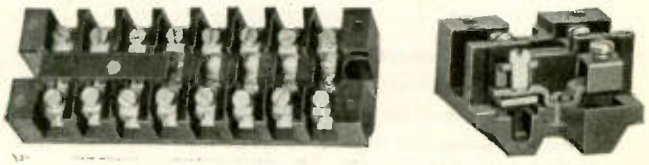
Phanotrons convert a-c to d-c. Kenotrons and ignitrons convert a-c to d-c, and also serve as high-speed circuit interruptors. Thyratrons give "trigger action" or controlled rectification; pliotrons act as amplifiers. Photo tubes are applied to a wide range of control and measurement functions. Ballast tubes, vacuum switches, and indicator tubes complete the G-E line, which is sufficiently broad to cover nearly any electronic application. Send for Bulletin ETI-12.



ALNICO MAGNETS—POWERFUL AND PERMANENT

Alnico magnets make possible compact designs of electronic and electric equipment, because of their high energy content per unit volume. They are highly resistant to demagnetization by vibration, heat, or stray magnetic fields. Sintered alnico lends itself to large-quantity production of small magnets both simple and intricate in shape. Cast alnico, available in five different grades, including the high-energy alnico 5, is best suited for magnets weighing more than 1/10 lb. Ask for Bulletin GEA-3682B on sintered alnico magnets.

TERMINAL BOARDS FOR EASIER CONTROL WIRING

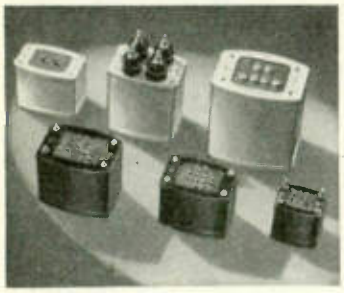


With G-E Type EB-2 terminal boards, you just strip the wire end, and screw the connector down on the bare wire. These solderless pressure connectors will take one No. 8 Awg stranded conductor, two No. 12 stranded, or three No. 12 solid conductors. Type EB-1 is the same as EB-2, except for connectors, which are the conventional washer-head screw type. Both boards are molded from strong, durable Textolite, both are available in 4-, 6-, 8-, and 12-pole sizes, and both come equipped with marking strips. Covers are available.

For small wires, a fabricated terminal board (EB-3) is available in sizes ranging from 4 to 38 poles. Send for Bulletin GEA-1497A.

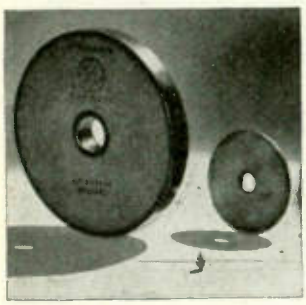
GENERAL ELECTRIC

DIGEST



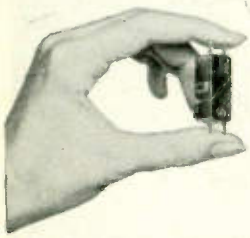
TRANSFORMERS AND REACTORS SEALED AGAINST SALT WATER

G-E compound-filled hermetically sealed transformers and reactors are built to withstand the rigorous salt-water immersion and salt-spray tests, as specified by the Signal Corps, Air Forces, and Navy. This hermetic sealing also keeps out dust, dirt, and micro-organisms. The line includes transformers for plate and filament supply; also microphone, input, interstage (or grid), and modulation transformers and output units for the audio-frequency range. Reactors are included for filter, modulation, microphone, and plate circuits. Standard hermetic cases vary from approximately two cubic inches to 150 cubic inches in volume. Send for Bulletin GEA-4280.



RESISTORS IN WHICH I VARIES AS E^4

In Thyrite*, G.E.'s nonlinear, silicon-carbide resistance material, current varies as a power of the applied voltage (I varies as E^n). Doubling the voltage in a wire-wound resistor doubles the current. Doubling voltage in Thyrite increases the current 16 times, where the exponent (n) of the Thyrite is 4. Because of this characteristic, Thyrite has solved many problems in electronic circuits, by protecting them against voltage surges, stabilizing power voltages, controlling voltage-selective circuits, etc. Thyrite is usually supplied in disk or rod form, in diameters ranging from 0.25 in. to 6.00 in. Send for Bulletin GEA-4138A.



A LITTLE SWITCH FOR BIG JOBS

The G-E Switchette weighs less than one-third of an ounce; its case measures only ½ by 21/32 by 1¼ inches, yet it is rated 230 volts; 10 amperes a-c.

Low-inertia moving parts, and high, contact pressure assure fast, positive action even where vibration is severe. The spring-return button can be actuated manually, or by cam or bellows. Switchettes are available in three general-purpose double-break contact arrangements with terminals on top or at ends. Switchettes are designed to meet the 50-hour Government salt-spray test, and operate from sea level to 50,000 feet altitude. Bulletin GEA-3818A describes more than 100 types and arrangements.

*Trade-mark reg. U.S. Pat. Off.

Smashing the Swastika does not mean total Victory. There is still the Rising Sun to be taken care of . . . But, the victory in Europe is one *step* nearer to conversion to peacetime pursuits.

Here at JENSEN total conversion will be merely a matter of continuing to produce outstanding, improved, high quality acoustic equipment. This is a continuing tradition at JENSEN . . . One example of advancement will be JENSEN Loud Speakers with *ALNICO 5*.

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Let specialists who are experts produce the cable assemblies, wiring harnesses or bonding jumpers required in units you manufacture. Turn the job over to Whitaker —and it will be *right from the start.*

Throughout every stage of our production we make exacting inspections, tests and checks. (Illustration above shows positive continuity check of assemblies being made for an electronic manufacturer).

Whitaker Can Wire It

In addition to an engineered wiring service, Whitaker also offers a quality line of standard cable requirements . . . Write us for complete information.

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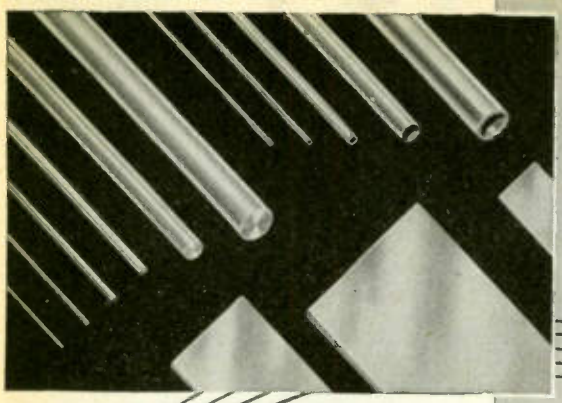
1920—Silver Anniversary—1945

Kovar, the alloy that seals to glass, available as wire, rod, tubing, strip or foil



Solve Your Sealing Problems ...

with KOVAR*-Glass Hermetic Seals

ILLUSTRATED are some of the various forms in which Kovar —the alloy that seals to glass—are available from STUPAKOFF. Kovar—a cobalt, nickel, iron alloy, was developed specifically for sealing to hard glass and has been used commercially for that purpose since 1936.

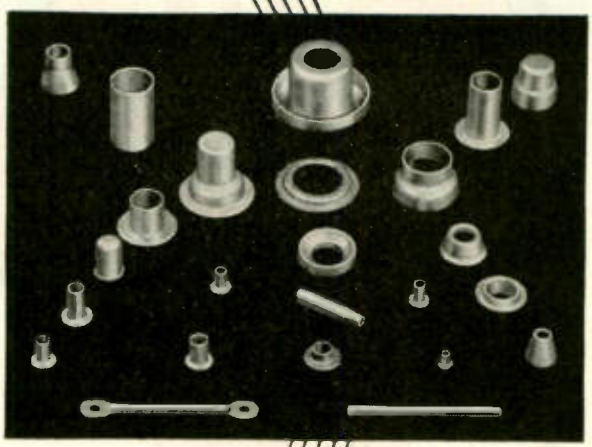
Kovar forms a seal to hard glass through a heating process, in which the oxide of Kovar is dissolved into the glass. The result is a pressure and vacuum tight seal, effective under all atmospheric conditions.

To manufacturers equipped for glass working, STUPAKOFF supplies Kovar as wire, rod, tubing, strip or fabricated into cups, eyelets, leads or special shapes.

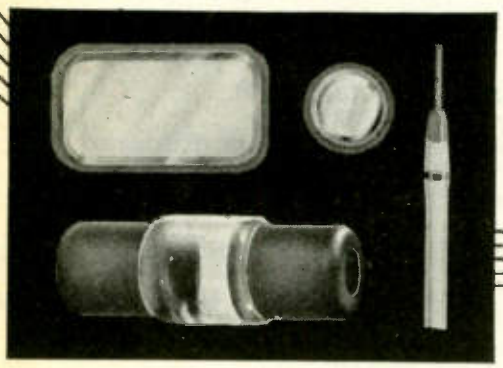
Completed seals are available as terminals with single or multiple, solid or hollow electrodes which can be quickly and easily soldered to a metal container. STUPAKOFF also manufactures meter windows, gauge glasses, graded seals and seals for special applications.

STUPAKOFF engineers will be glad to assist in developing Kovar-glass hermetic seals for your product. The booklet, "Kovar —The Ideal Alloy for Sealing to Glass," will be sent on request.

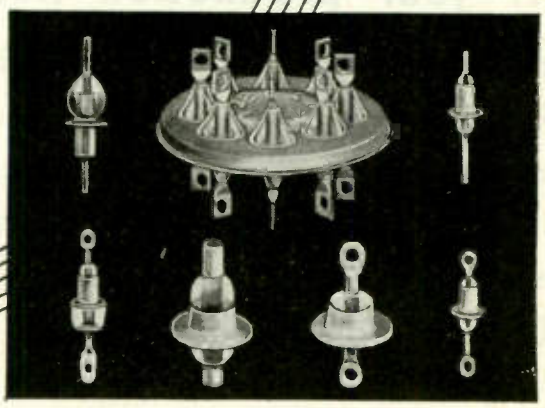
★ ★ Buy More Bonds ★ ★



Kovar fabricated into cups, eyelets and special shapes



Kovar-Glass meter windows, gauge glasses, and special seals



Complete Kovar-Glass terminals with single or multiple, solid or hollow electrodes

*TRADE MARK 337962 REGISTERED IN U. S. PATENT

ARMY (E) NAVY "FOR GREAT ACHIEVEMENT"

STUPAKOFF CERAMIC AND MANUFACTURING CO., LATROBE, PA.

Products for the World of Electronics

RMA RADIO MANUFACTURERS ASSOCIATION MEMBER

ERIE CERAMICONS* Unexcelled as GENERAL PURPOSE CONDENSERS

* Ceramicon is the registered trade name of silvered ceramic condensers made by Erie Resistor Corporation.

CHARACTERISTICS			
CAPACITY RANGE IN MMF	JAN-C-20 STYLE	ERIE STYLE	MAXIMUM OVERALL DIMENSIONS
1 to 51	CC20 CC21	A K	.200 x .400 .250 x .562
52 to 110	CC25 CC26	B L	.200 x .656 .250 x .812
111 to 360	CC35 CC36	C M	.265 x 1.125 .340 x 1.328
361 to 510	CC40	D	.375 x 1.110
511 to 820	CC45	E	.375 x 1.560
821 to 1100	CC45	F	.375 x 2.00

ALMOST a decade has passed since the need for extremely stable capacitors with dependable operating characteristics led Erie Resistor to develop and introduce Ceramicons*. These silvered ceramic condensers immediately found wide acceptance throughout the entire communications field.

Augmented by the tremendous requirements of war, millions of Ceramicons, subjected to the severest service tests, have proved unexcelled in dependable performance, particularly as general purpose condensers, where a moderate degree of capacity change with temperature is permissible.

As general purpose condensers Erie Ceramicons have proved superior to other types of condensers in a great many applications. For example, Ceramicons are ideal as coupling condensers, particularly plate to grid, where high insulation resistance is of paramount importance.

Ceramicons may be selected from any one of 10 standard temperature coefficients, ranging from P120 to N750.

The capacity range for equivalent physical size is given in table above. We will gladly send you samples of Erie Ceramicons for your general purpose applications.

★ Buy More Bonds ★

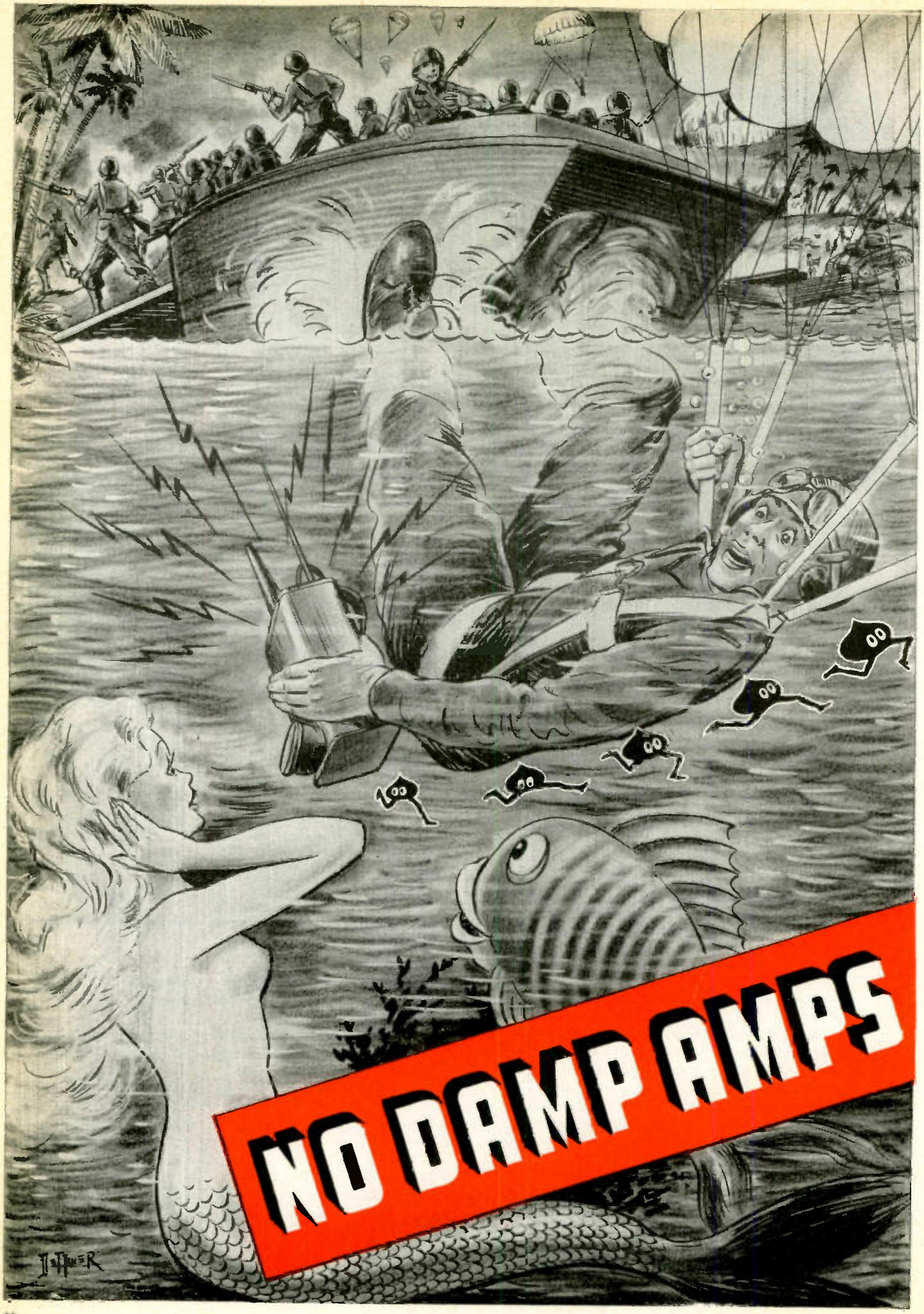
Electronics Division

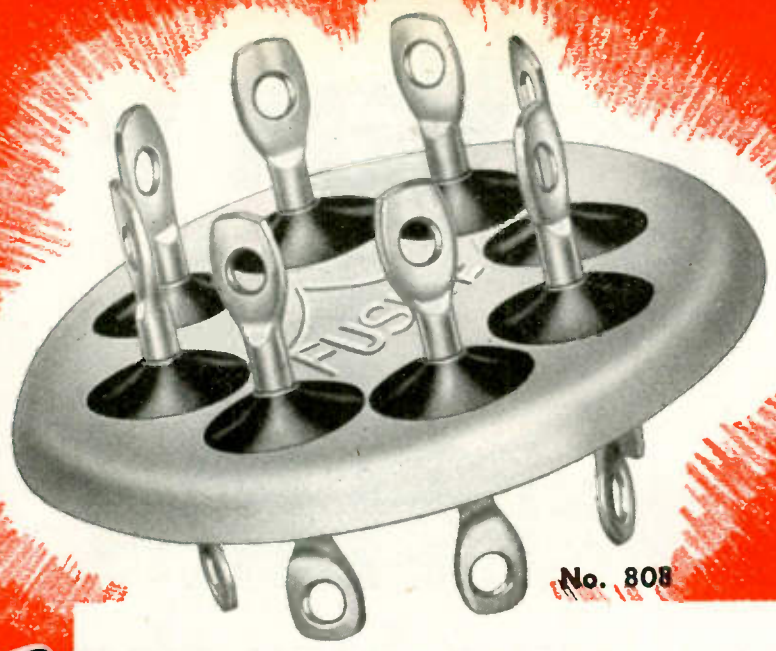
ERIE RESISTOR CORP., ERIE, PA.

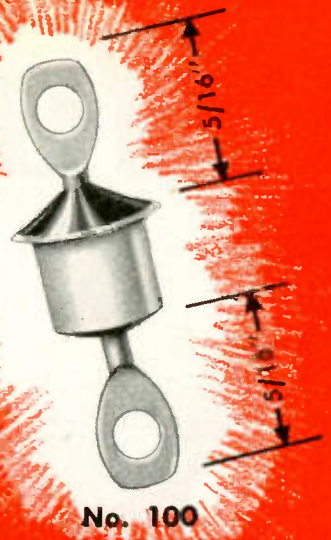
LONDON, ENGLAND · · TORONTO, CANADA

ARMY E NAVY

FOR HIGH ACHIEVEMENT IN WAR PRODUCTION


NO DAMP AMPS



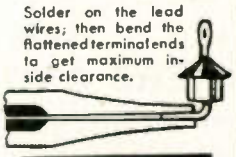


No. 100 SINGLE FLANGE DIAMETER 5/16" (App.)	600 SERIES 1" DIAMETER (.952)	800 SERIES 1¼" DIAMETER (1.235)
INSERTS IN ◉ 3/16" HOLE	602	802
	603	803
	604	804
	605	805
	606	806
		807
		808

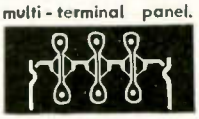
LANDING . . . feet first is a first-class feat, in war or peace. To land business now and postwar, consider **FUSITE** hermetic terminals. They make it so much easier for you to hermetically seal your electronic component parts. **FUSITE's** pass the salt water and thermal immersion cycling tests. Another **FUSITE** feature is the flattened and pierced terminal ends. Maximum distance from disc to terminal end is only 5/16". This means **FUSITE** hermetic terminals are stronger, sturdier, more compact. When space inside the "can" is limited, **FUSITE** fits in nicely. See "Production Hint" how to do it. Discover for yourself how **FUSITE** hermetic terminals save parts and labor, down costs and up production. Write for samples. Today! This mark FUSITE is your assurance of the best in hermetic terminals . . . plus the additional satisfaction of improving the performance of your product.

PRODUCTION HINT

Solder on the lead wires; then bend the flattened terminal ends to get maximum inside clearance.



Hole punched and adapter socket formed to receive multi-terminal panel.



Fusite multi-terminal panel used as cover for container. A single sealing operation.

WITH FUSITE SEALS

A LANDING RAMP,
IS WHAT THEY TRAMP,
THE MOBILE STUFF GOES WHEELING!
BUT, ACTIVE AMPS,
CAN'T STAND THE DAMP
SO THEY GET *FUSITE SEALING!*

GLASS TO METAL

FUSITE

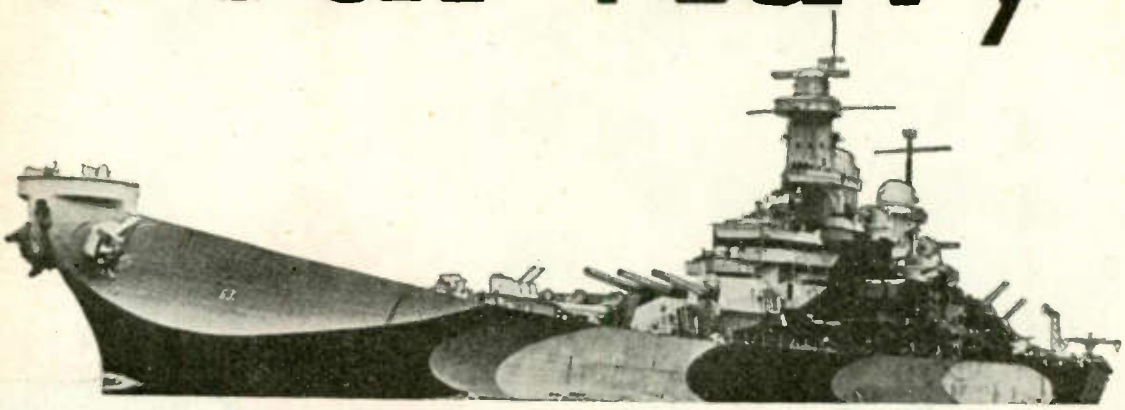
HERMETIC TERMINALS

NO DAMP AMPS!

CINCINNATI ELECTRIC PRODUCTS COMPANY

CARTHAGE AT HANNAFORD, NORWOOD, CINCINNATI 12, OHIO

Your Navy



Official U S Navy Photo

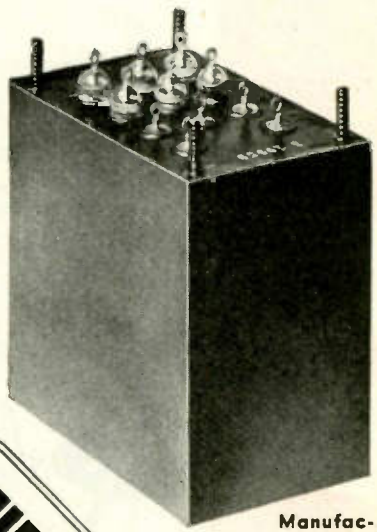
accepts nothing less than Perfection

That's why **KENYON HERMETICALLY SEALED TRANSFORMERS AND REACTORS** have been selected to play their part in the great forward march of the world's greatest Navy which demands and accepts nothing less than perfection of all its personnel and resources.

The construction employed in the unit illustrated will meet present government specifications from any branch of the armed services. **KENYON'S** high standard of quality has been diligently maintained to insure a product of perfection.

Designs available employ both glass-to-metal and steatite-to-metal sealed terminals.

Overall dimensions and mounting dimensions conform to the **KENYON** T-line case except that the mounting is single ended at top or bottom. It may be necessary to increase case height.



Manufactured for the Navy to their specifications RE 13A 553 B

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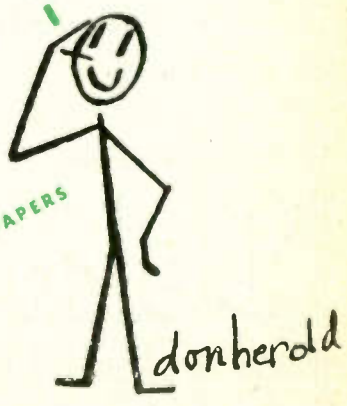
SPECIALISTS IN THIN GAUGE INSULATING PAPERS



FOR ALL ELECTRICAL APPLICATIONS --

BH EXTRA FLEXIBLE FIBERGLAS SLEEVING

WON'T HARDEN, CRACK OR ROT!

SNUB TEST

Proves BH Non-Fray Feature

Make this test yourself. Tap a piece of ordinary saturated sleeving on your desk top and see how easily it frays. Then do the same with BH *Extra Flexible* Fiberglas Sleeving. It only fuzzes a little—doesn't break down—doesn't fray.

THE RESULT

BH *EXTRA FLEXIBLE* FIBERGLAS SLEEVING

2 WAYS BETTER

NON-FRAYING • NON-STIFFENING

WHY give a few cents worth of electrical insulation a chance to be the weak link in *your* product? Use BH *Extra Flexible* Fiberglas Sleeving—the *one* insulation with *all* these advantages:

It is *permanently* non-fraying, non-stiffening and non-burning, by virtue of the exclusive BH process. It will not dry out, crack or rot, retaining its original unusual resistance to high and low temperatures, moisture, oil, grease and chemicals *indefinitely*.

If you want an all-purpose sleeving that simplifies assembly and maintenance and gives longer maximum protection, standardize on BH *Extra Flexible* Fiberglas Sleeving. Available in all standard colors and sizes from 5/8" to No. 20, inclusive. Write for free samples today and compare by actual test!

HOW TO KEEP CUSTOMERS COOL AT 1200°F!

Direct contact with heat up to 1200°F does not harm BH Special Treated Fiberglas Sleeving, the non-burning, unsaturated, flexible-as-string sleeving that stays supple and won't fray when cut. Made in natural color only—all standard sizes. Get this *extra* protection now and keep customers' temper cool, too!

ALL BH PRODUCTS AVAILABLE IN STANDARD 36" LENGTHS and 500-FT. COILS

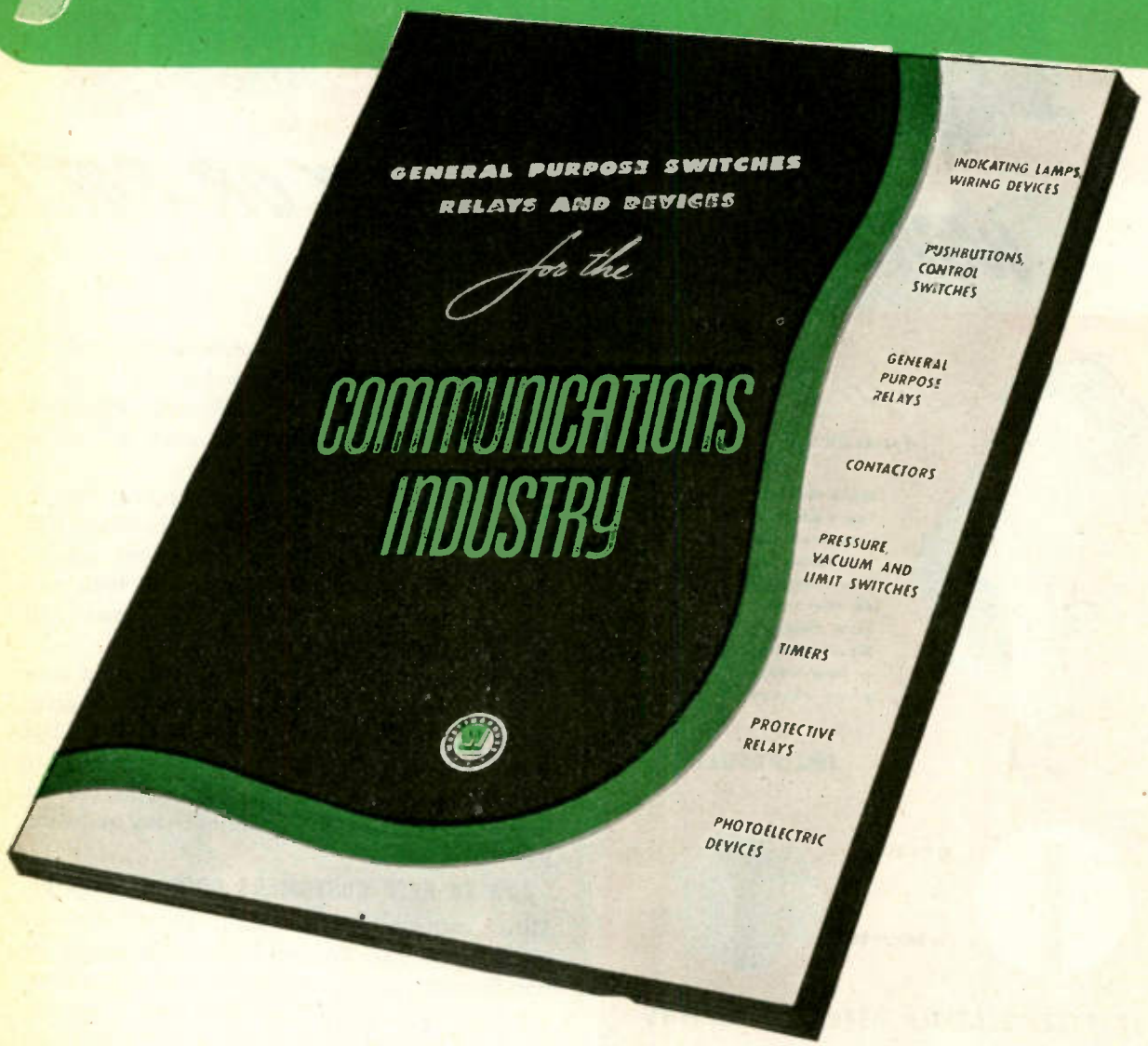
BH PRODUCTS

ALSO SLOW-BURNING IMPREGNATED MAGNETO TUBING • SLOW-BURNING FLEXIBLE VARNISHED TUBING • SATURATED SLEEVING • A.S.T.M. SPECIFICATIONS

BENTLEY, HARRIS MANUFACTURING CO.

Dept. I, Conshohocken, Penna.

Components for your industrial—duty *ELECTRONIC DESIGNS*



This new book includes complete engineering data applying to Westinghouse "industrial-duty" contacting devices already proved useful to communications and electronic engineers.

It shows devices refined over many years to meet the rigid demands of the engineer responsible for his plant's performance — devices that will help gain acceptance for your equipment.

A free copy of this fact-packed book is waiting for you at your nearest Westinghouse office. Ask for descriptive data SA-802. Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa. J-94670

Westinghouse
PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

. . . one of many Westinghouse contributions to progress in electronic and communications equipment design.

This informative collection of technical data is just one of many Westinghouse services developed especially for those designers who must win *engineers'* approval for their product.

Here is a quick check list of some of the Westinghouse products described in this book... what they are, where to use them, what they will do.

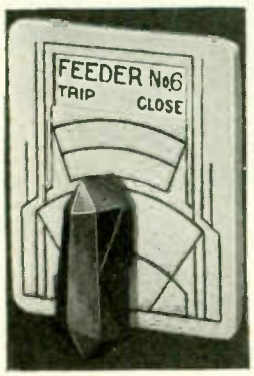
Your nearest Westinghouse office will be glad to work with you in applying these products to your own designs.

A QUICK CHECK LIST OF WESTINGHOUSE PRODUCTS IN THIS BOOK

Indicating Lamps

Whether for racks, miniature panelboards and desks or for full size, erect switchboards, a Westinghouse indicating lamp — especially designed for the purpose—is available. In round, rectangular and large sizes, all are available in various colors and for 25 to 250 volts. The rectangular Minalite (illustrated) is readily visible from extreme angles. Compact, attractive.

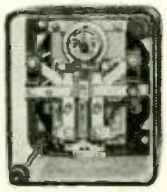
Pushbuttons and Control Switches



Westinghouse heavy-duty pushbuttons permit interchangeability of pushbutton, rotary selector switch, and indicating lamp units providing almost unlimited combinations of functions. Control switches—Minatrol, Type W and auxiliary styles — are widely accepted for their simplicity, ruggedness, adaptability and reliable operation. Available with removable handles, crank arm, solenoids, stay-put or return-to-neutral mechanisms in combination with variety of contacts for all control circuits.

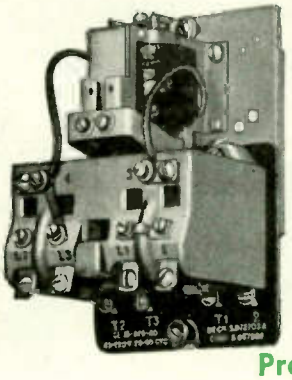
EQUIPMENT FOR THE COMMUNICATIONS INDUSTRY

Timers



Standard electronic timers are adjustable from .1 to 45 seconds. Mechanical timers or relays accurately driven by synchronous motors are adjustable from 2 seconds to 50 minutes for industrial duty.

Contactors



"De-ion" breakers used on many of these contactors, are recognized as a Westinghouse development of unusual significance to quickly and positively extinguish arcs drawn between opening contacts. Applications range from the smaller contactors to large oil circuit breakers.

Protective Relays

As segregated in this book, protective relays are those which think and act for themselves. Included are thermostatic flow switches (for liquids), and relays which may be adjusted to operate on varying degrees of overload, underload, overvoltage, undervoltage, temperature and reverse current.

Thermostat Catalog . . . new Westinghouse catalog helpful in problems involving the control of heat. These thermostats are also used in the newer applications by electronic engineers as time-delay relays.

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ALBION CAN SHIP ALL THE COILS YOU NEED."

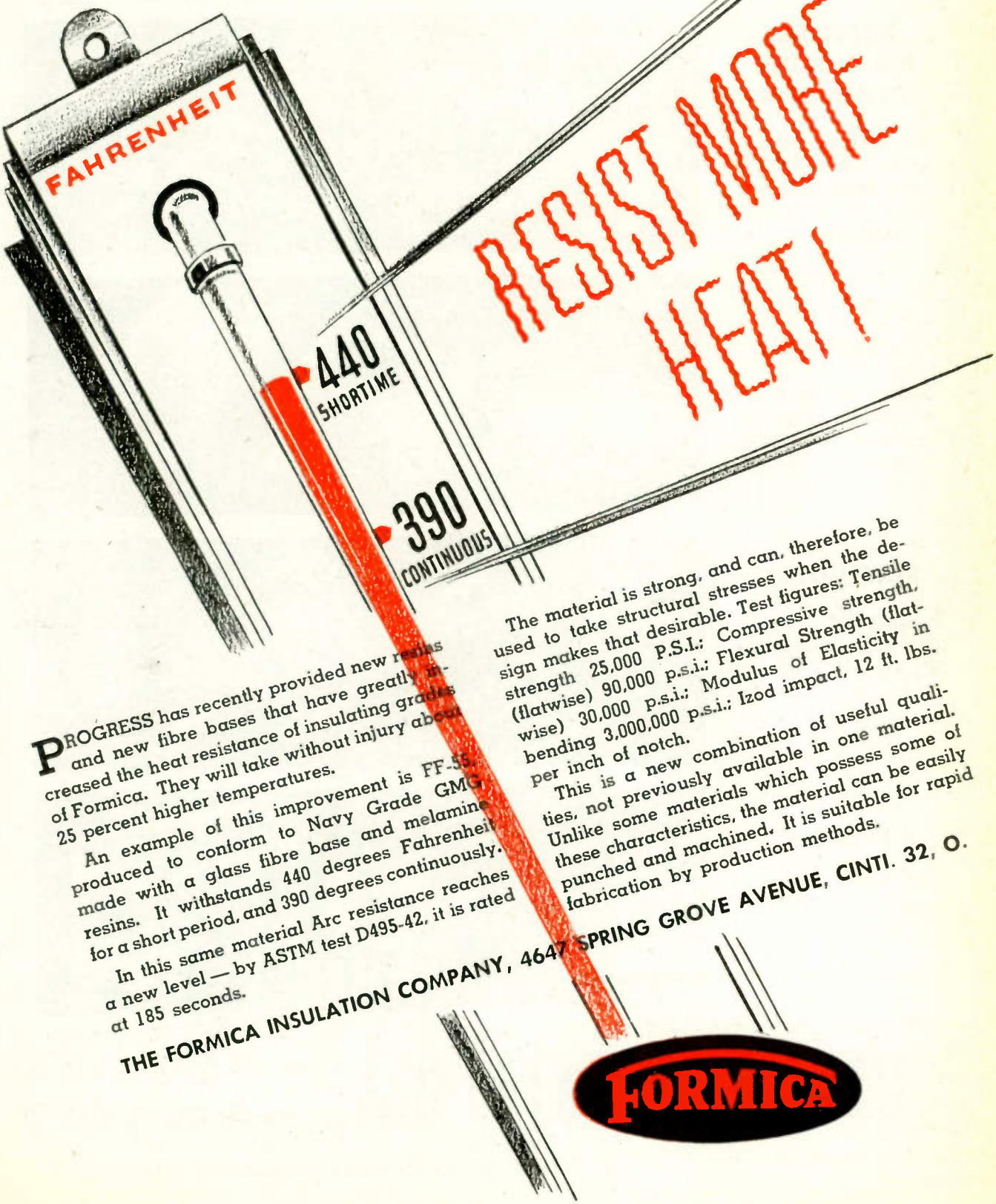
SUPER-QUALITY COILS AT REASONABLE PRICES

More and more every day, the industry is turning to Albion for fast, quality and quantity production of coils, chokes, and transformers. That's because here you benefit from the unbeatable combination of management "know how," skilled workmanship, streamlined facilities, and central location. Your requirements will be given prompt and thoughtful attention.

ALBION
COIL COMPANY
ALBION, ILLINOIS

R. F. AND TRANSMITTING COILS AND CHOKES;
I. F. TRANSFORMERS

New Formica Grades



PROGRESS has recently provided new resins and new fibre bases that have greatly increased the heat resistance of insulating grades of Formica. They will take without injury about 25 percent higher temperatures.

An example of this improvement is FF-55, produced to conform to Navy Grade GMG made with a glass fibre base and melamine resins. It withstands 440 degrees Fahrenheit for a short period, and 390 degrees continuously.

In this same material Arc resistance reaches a new level — by ASTM test D495-42, it is rated at 185 seconds.

The material is strong, and can, therefore, be used to take structural stresses when the design makes that desirable. Test figures: Tensile strength 25,000 P.S.I.; Compressive strength (flatwise) 90,000 p.s.i.; Flexural Strength (flatwise) 30,000 p.s.i.; Modulus of Elasticity in bending 3,000,000 p.s.i.; Izod impact, 12 ft. lbs. per inch of notch.

This is a new combination of useful qualities, not previously available in one material. Unlike some materials which possess some of these characteristics, the material can be easily punched and machined. It is suitable for rapid fabrication by production methods.

THE FORMICA INSULATION COMPANY, 4647 SPRING GROVE AVENUE, CINTI. 32, O.

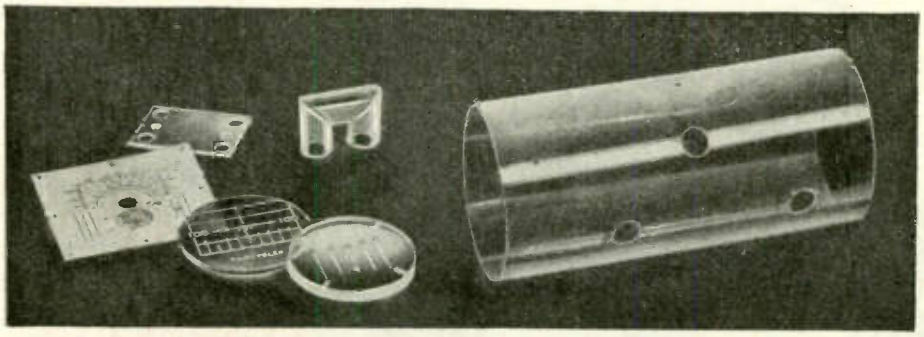
FORMICA

PLASTIC PARTS

. . . . PRODUCED TO YOUR SPECIFICATIONS

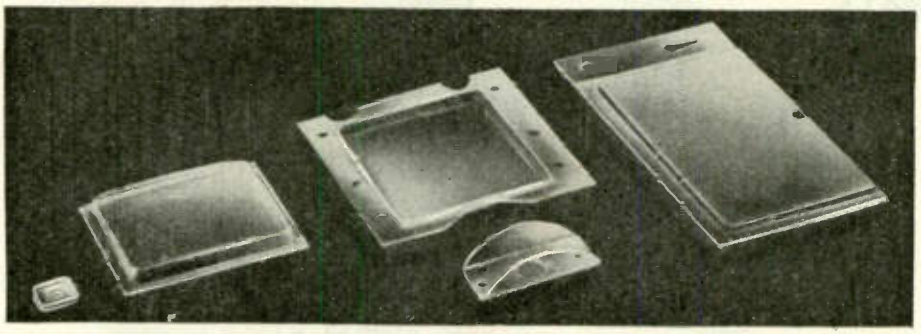
PRINTING
DIE CUTTING
CEMENTING

Wide experience by all known processes in the application of printing, engraving, silk screening, die cutting and cementing of all thermoplastics.



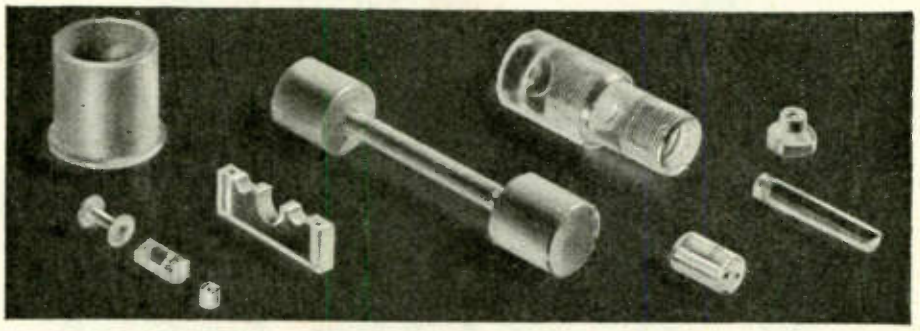
FORMING

Specialists in deep drawing radio dial windows, embossing, swaging and bending in Acetate, Vinylite and Acrylics.



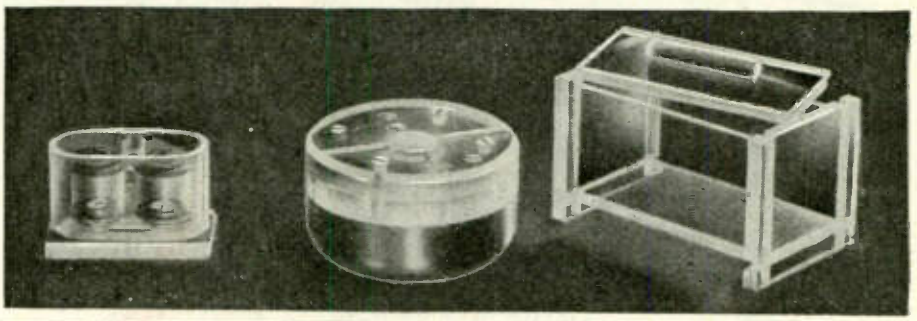
MACHINING

Precision threading, screw machine, milling, drilling, turning of Polystyrene, Acrylics, Phenolics, Nylon, Tenite; sheets, tubes and rods; through spindle capacity up to 2½" rod.



ASSEMBLY

Our engineers can assist you in problems of design and assembly of your plastic units.



PRINTLOID, *Inc.*

93 Mercer Street
New York 12, N. Y.

BEACH PARTY

. . . . where all the guests are gate-crashers

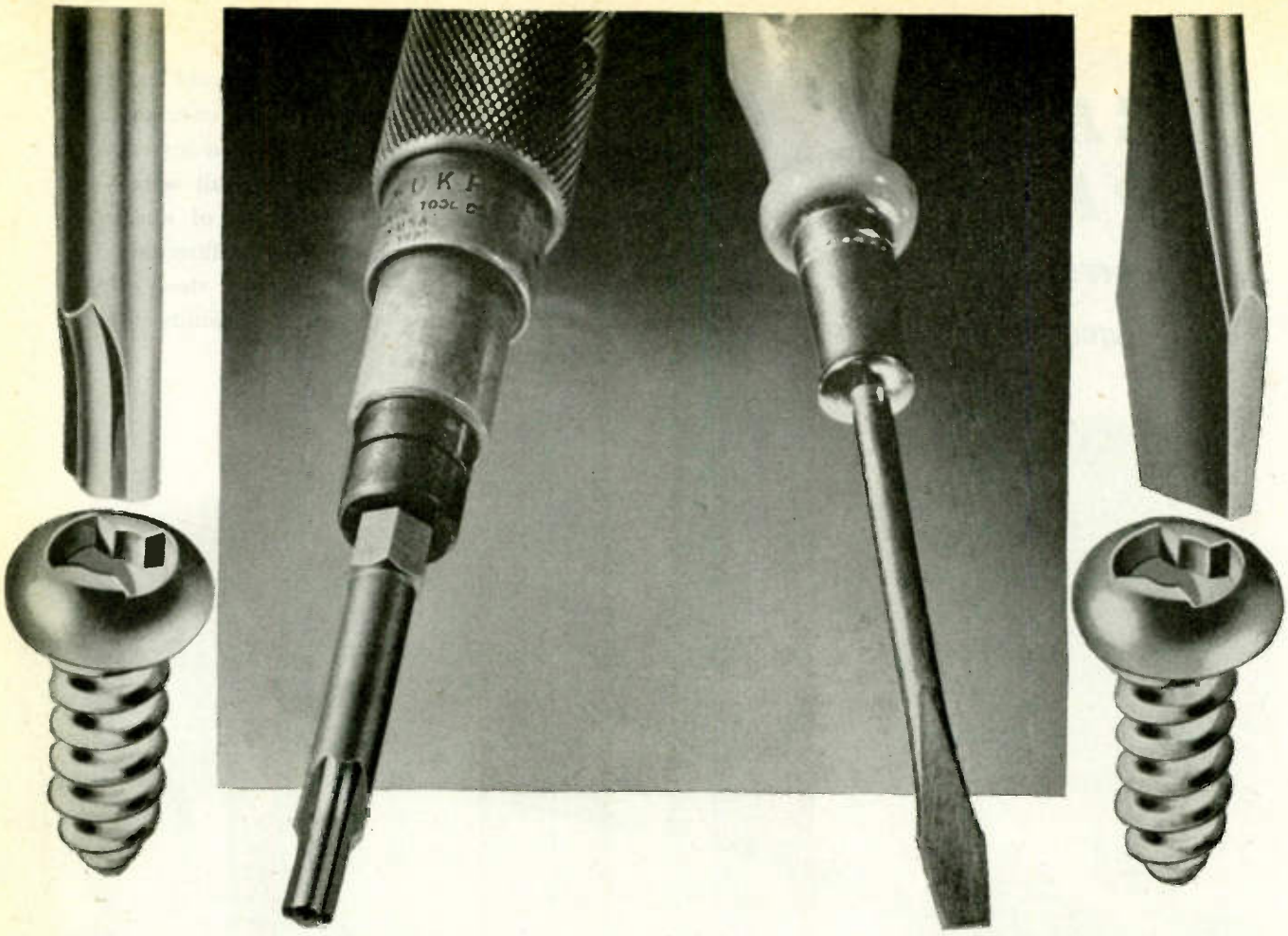
FROM one Pacific island to another, until Tokyo itself is taken, grim American warriors will continue to visit the enemy without invitation. And with our invasion forces will go Spencer precision-made assault wire — light, highly flexible and strong — to warn of enemy infiltration . . . to speed reinforcements to a threatened sector. Proved under fire, Spencer precision steel and alloy wire is your guarantee of superior quality, unexcelled performance.

Photo U. S. Signal Corps.

★ ★ ★ ★ SPENCER *Precision* WIRE ★ ★ ★ ★ ★ ★ ★

FINE STEEL AND ALLOY WIRE

Spencer Wire Company
WEST BROOKFIELD PLANT
WEST BROOKFIELD • MASS.



TYPE "A" POWER BIT FOR

SAFER, FASTER, LOWER COST ASSEMBLY

AN EASY-TO-HIT TARGET. The visibility of CLUTCH HEAD'S wide roomy recess substitutes operator confidence for slow-down hesitation. Saves "breaking-in" period.

NO DRIVER CANTING. The Center Pivot column guides the bit directly into full-depth dead-center entry. Makes straight driving automatic.

NO "CHEWED-UP" HEADS to stop or slow up the line. Definite grip also protects manpower and material against slippage.

NO RIDE-OUT TENDENCY. With CLUTCH HEAD the driving contact of bit and recess walls is all-square. No "kick-out" as in tapered driving. Disposes of end pressure as a fatigue factor and slippage hazard.

EFFORTLESS DRIVING steps up speed for smoother, higher production. Checks out end-of-the-shift lagging.

DRIVE EXTRA THOUSANDS OF SCREWS with the rugged Type "A" Bit . . . without interruption for tool change.

NEW BIT LIFE IN 60 SECONDS. No back-to-the-factory shipment. Simple 60-second application of the end surface to a grinding wheel restores this bit to original efficiency.

THE COMMON SCREWDRIVER FOR

SIMPLIFIED FIELD SERVICING

THE ONLY MODERN SCREW on the market that is basically designed for operation with a common screwdriver.

FIELD SERVICE "HEADACHES" ELIMINATED. No time wasted hunting special tools. No needless multiple tool expense.

WIDTH THE ONLY FACTOR. The only requirement is that the screwdriver blade be reasonably accurate in width. Thickness of the blade is secondary.

CLTS NON-OPERATING TIME. This simplified servicing expedites adjustments in the field to keep your product in consistent operation . . . an important selling point to users.

TYPE "A" HAND DRIVERS TOO. The same rugged bit is available for field service. While not essential, this bit has special advantages found in no other similar tool.

THE CLUTCH HEAD LOCK-ON enables service men to withdraw screws undamaged and saved for re-use, the reverse action securely locking the screw to the end of the Type "A" Bit. The same Lock-On feature operates in replacing screws, permitting of easy one-handed reaching to hard-to-get-at spots . . . frequently saving disassembling of surrounding units.

CLUTCH HEAD SCREWS

Investigate what these exclusive CLUTCH HEAD *features mean to you in reconversion. Write for details, illustrated Brochure, package assortment of screws, and sample Type "A" Bit.*

UNITED SCREW AND BOLT CORPORATION

CHICAGO 8 CLEVELAND 2 NEW YORK 7

READ THE LATEST NEWS!...

About IRC Type BT and BW RESISTORS

Here's a brand new file size Engineering Bulletin, just off the press! It offers you essential authentic information on IRC Type BT (Insulated Metallized) and BW (Insulated Wire Wound) Resistors. Concise, easy-to-read and an excellent ready-reference source, it contains eight pages of "meaty" material that will save you valuable time by quickly answering many of your resistance problems. Interesting construction facts, characteristics data, JAN Type Numbers, dimensional drawings, as well as a complete list of resistance values are compactly presented in this new BT-BW Bulletin. It should be in every Engineering and Design file. Write for your copy today. Address Dept. 2-G.

• PREFERRED FOR PERFORMANCE •
IRC
FIXED & VARIABLE RESISTORS

INTERNATIONAL RESISTANCE CO.

401 N. Broad St. Phila. 8, Pa.

IRC makes more types of resistance units, in more shapes, for more applications than any other manufacturer in the world.

Scope in application–

- INDUSTRIAL ELECTRONIC EQUIPMENT
- FIXED COMMUNICATION INSTALLATIONS
- MOBILE AND AIRBORNE TRANSMITTERS
- EXPERIMENTAL AND RESEARCH USE
- CARRIER CURRENT INSTALLATIONS

E-E Power Oscillators serve ever-widening requirements!

Specifically engineered to meet the diversification of present-day needs, these E-E vacuum tube units offer high functional efficiency. They are ruggedly designed to maintain inter-electrode spacing, whether utilized in industrial fixed or mobile applications.

Virtually immune to mechanical shock and vibration, integrated materials and component parts are subject to rigid inspection and selection to insure long tube life with maximum performance.

E-E 808, illustrated, is recommended as Class B or C amplifier, modulator or oscillator. This triode is suitable for plate voltages to 1500. Carrier output, Class C, 140 watts. Write today for Data Book describing the complete E-E line of quality vacuum tubes

ELECTRONIC ENTERPRISES• INC

ELECTRONIC ENTERPRISES

GENERAL OFFICES 65-67 SEVENTH AVENUE, NEWARK, N. J. EXPORT DEPT. 25 WARREN STREET, NEW YORK CITY, N. Y. CABLE ADDRESS: SIMONTRICE, N. Y.

"Ring Out, Brave Land"

...LET'S CREATE NEW MARKETS

Only by the creation of new markets, can we, as a nation, keep a high standard of living.

No longer is it sufficient to exploit only the existing markets, many of which are already worn thin. To create new markets should be the goal of all Industry —not only from a sense of duty to the peoples of this country, but from a plain common-sense dollars and cents viewpoint.

One of the best and surest ways to accomplish the most good for the nation—and more sales for the electric appliance industry—is the intensive development of our natural resources.

THE TVA PLAN HAS SHOWN THE WAY

It's hard to put TVA into words. It is not just the generation of electric power, nor flood control alone, or merely soil conservation. All these are a part of TVA—but basically it is the growth of a people and the growth of the soil they live on. It has metamorphosed a stunted region and backward people into a new economy—profitable both from a humane as well as a commercial standpoint.

Cheap electricity, a prime result of TVA, has been one of the important elements that have enabled the people of the TVA region to become prosperous and to lead a life more in keeping with the American way. And inevitably, it *created an entirely new market* for the sale of electrical appliances and machinery.

A market, for instance, that showed a 374% increase in the sale of electric ranges over the preceding year; water heaters by 774%, refrigerators by 329%! This, from a former undeveloped "poor market" area!

Every one of the electric farm machines, washers, refrigerators, ranges, radios and other appliances that went into the Tennessee Valley provided work and income for the dealers, distributors and service men who sold, installed and maintained them; jobs and profits for the workmen and manufacturers who produced them—Yes and for you and us.

ESTABLISH A MISSOURI VALLEY AUTHORITY

Now that TVA has shown the way, what is more logical than to follow up with an MVA? The Missouri River Basin, about one-sixth of the land area of the nation, has problems similar to the Tennessee Valley. It presents a definite challenge to a forward-looking nation. *And an unprecedented profit opportunity for the manufacturers of electric machinery and appliances!*

So let us urge Congress to set up a Missouri Valley Authority to develop all the resources of this vast region for the benefit of all the nation. Let us urge Congress to act immediately, so that when the war is over, the plans will have been made, and we can go forward. For further information, send for free booklet.

First of a series of advertisements designed to encourage the creation of new markets

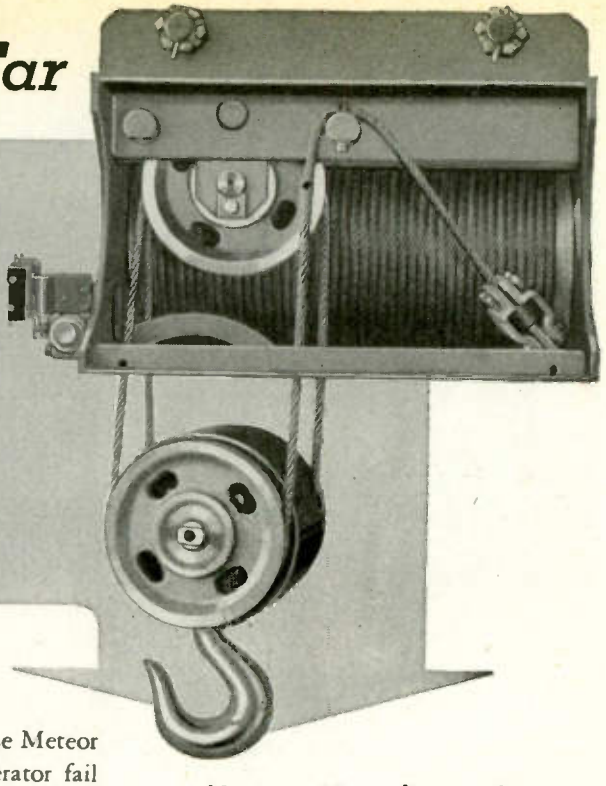
GENERAL TRANSFORMER CORPORATION

1250 West Van Buren Street • Chicago 7, Illinois

This Hoist Can't Go Too Far

MICRO SWITCH

SNAP-ACTION Takes Care of That



There's a limit to how far a hoisting operation can safely go. These Meteor Electric Hoists protect themselves automatically, should the operator fail to stop the hoist in time.

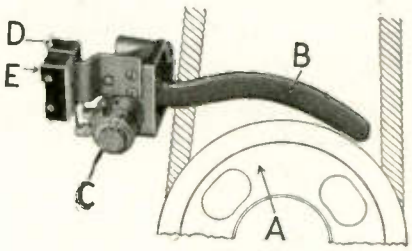
Chisholm-Moore Hoist Corporation of Tonawanda, New York, use two Micro Switch snap-action switches in the safety limit which make it impossible to jam the lower hook block into the drum.

When the hook block reaches its uppermost limit of travel, it raises a limit lever. This is mechanically connected to the two Micro Switch snap-action switches which break the pilot circuit, stop the flow of current to the motor, and apply a quick-acting motor brake.

These streamlined Meteor Electric Hoists, backed by 50 years of hoist building experience, make use of Micro Switch products in a design which utilizes all space to advantage . . . avoids all cumbersome bulk and excess weight.

This use of these dependable, long-lived, snap-action switches is typical of the increasing use which every branch of industry is finding for Micro Switch products. In some applications their sensitivity, the small operating force and small travel required to operate them are important. In other applications the ability of these tiny switches to handle substantial amounts of power at line voltages without the use of relays is of prime importance. Their millions of accurate repeat operations make these switches valuable components of the highest type of industrial products.

Here is How It Works



Two roller lever actuated switches are used.

When hook block "A" reaches the uppermost point of travel it strikes lever "B" which is connected by a shoft to cams "C". One cam is set slightly ahead of the other in order that one switch may be operated first.

Operotion of switch "D" opens the pilot circuit of the holsting motor. Should the gear train continue to move in excess of a predetermined amount, the second cam operates switch "E" which closes the lowering pilot circuit, momentarily reversing the motor. This lowering circuit is again opened as soon as the hook is lowered a small amount.

DO YOU NEED A SWITCH TO...

control temperatures, help to package products, bottle fluids, record airplane flights, make change, dispense drinks, heat water, contral electronic tubes, or steer ships? Micro Switch snap-action switches successfully contral many such aperations . . . and thousands more. Micro Switch engineers, experienced in the application of millions of these precise, snap-action switches fo products for both war and peace, will be glad to show you how they can add long life and reliability to your product at lower cost. Write for the Micra Switch Handbook-Catalag today.

LET'S ALL BACK THE ATTACK  *BUY EXTRA WAR BONDS*

MICRO TRADE MS MARK SWITCH

A DIVISION OF FIRST INDUSTRIAL CORPORATION

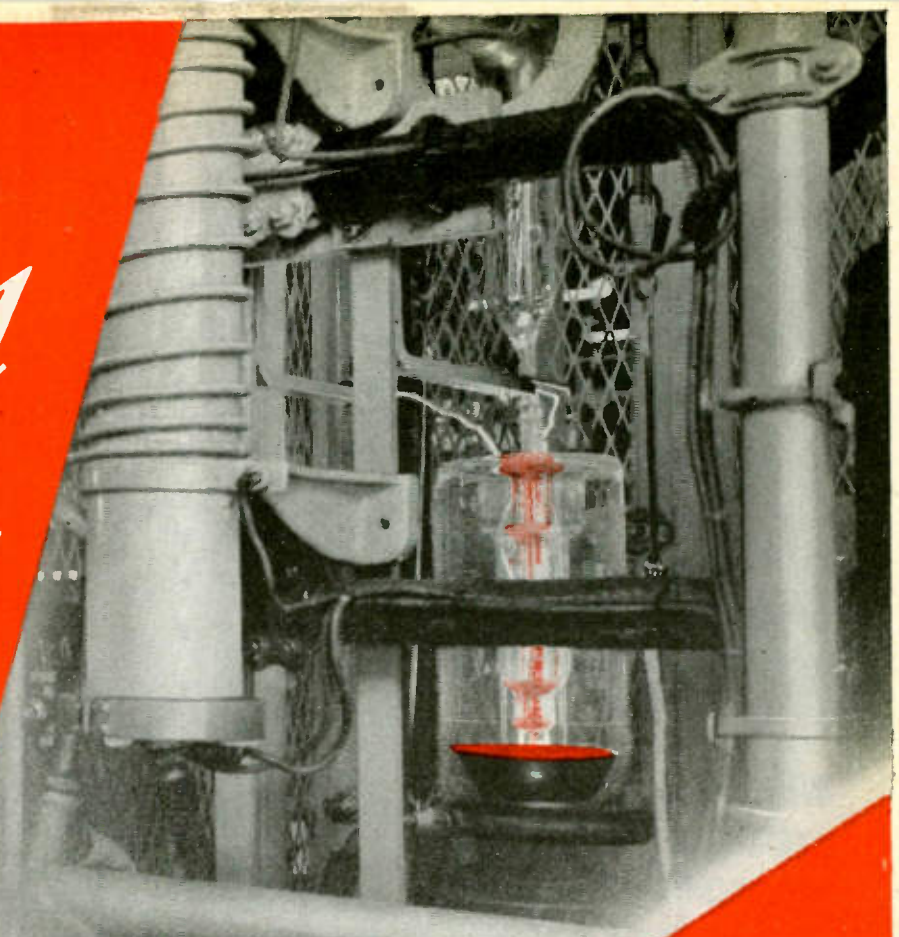
Freeport, Illinois, U. S. A., Sales Offices in Principal Cities

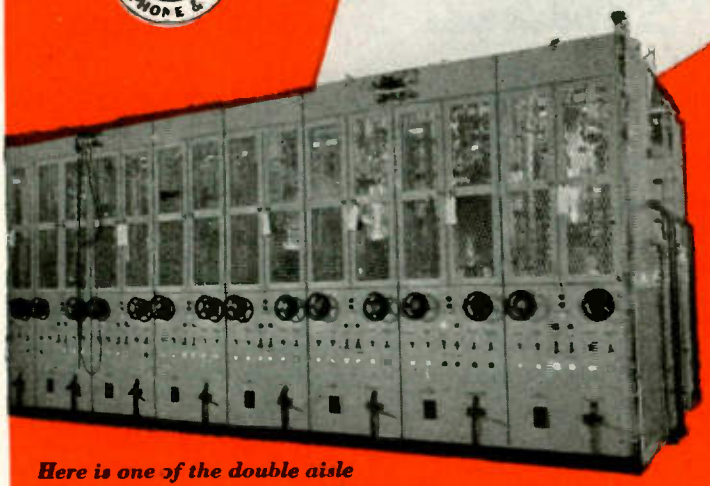
The basic switch is a thumb-size, feather-light, plastic enclosed, precision, snap-action switch, underwriters' listed and rated at 1200 V. A., at 125 to 460 volts a.c. Capacity on d.c. depends on load characteristics. Accurate reproducibility of performance is maintained over millions of operations. Basic switches of different characteristics are combined with various actuators and metal housings to meet a wide range of requirements.

Federal Tubes...

come CLOSER to the

PERFECT VACUUM





Here is one of the double aisle exhaust banks where 16 high power tubes can be exhausted at one time, each with individual control.

Always in the forefront of tube research and development, Federal makes another advance and now has added exhaust units of entirely new and original design to its production equipment.

This latest Federal achievement produces a tube that is substantially closer to the perfect vacuum—a tube with greater efficiency and longer life.

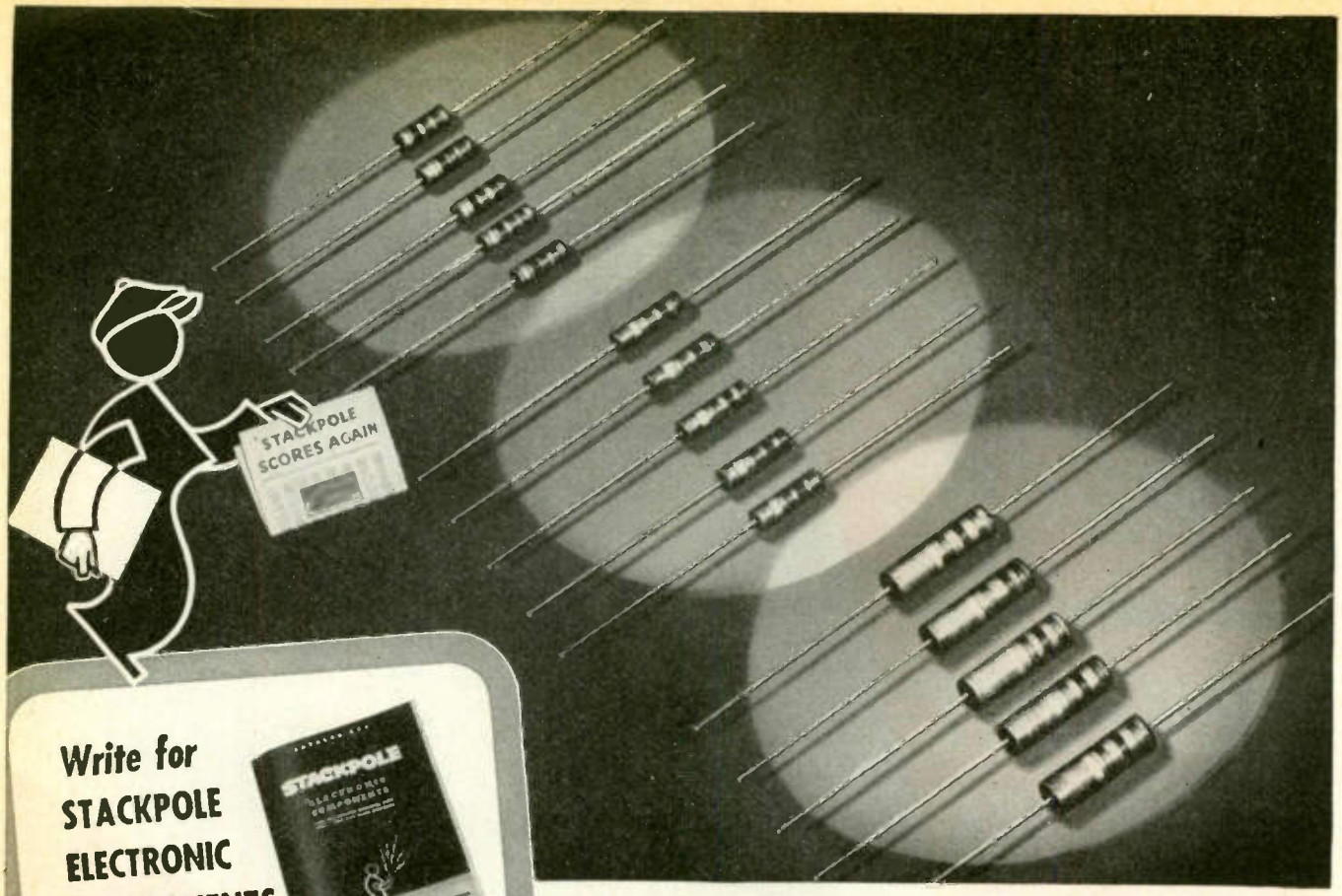
Arranged in banks of eight and operated with identical control equipment, these units exhaust uniformly every size of Federal tube—assuring a consistent and high standard of quality.

For any communication and industrial power tube need, turn to Federal now—test its reputation that "Federal always has made better tubes."

Federal Telephone and Radio Corporation

AN IT&T ASSOCIATE

Newark 1, N. J.



Write for STACKPOLE ELECTRONIC COMPONENTS Catalog

Whether for today's needs or post-war engineering, write today for your copy of this 36-page Catalog RC 6 replete with helpful engineering data.

FIXED AND VARIABLE RESISTORS
IRON CORES
LINE, SLIDE, ROTARY ACTION SWITCHES

OTHER STACKPOLE PRODUCTS

BRUSHES and CONTACTS
(All carbon, graphite, metal and composition types)
RARE METAL CONTACTS
WELDING CARBON PRODUCTS • BEARINGS
BRAZING BLOCKS • ANODES
ELECTRODES • CARBON PILES
PACKING, PISTON, and SEAL RINGS
RHEOSTAT PLATES and DISCS
SPECTROGRAPHITE NO. 1
CARBON and MOLDED METAL POWDER SPECIALTIES

INSULATED RESISTORS

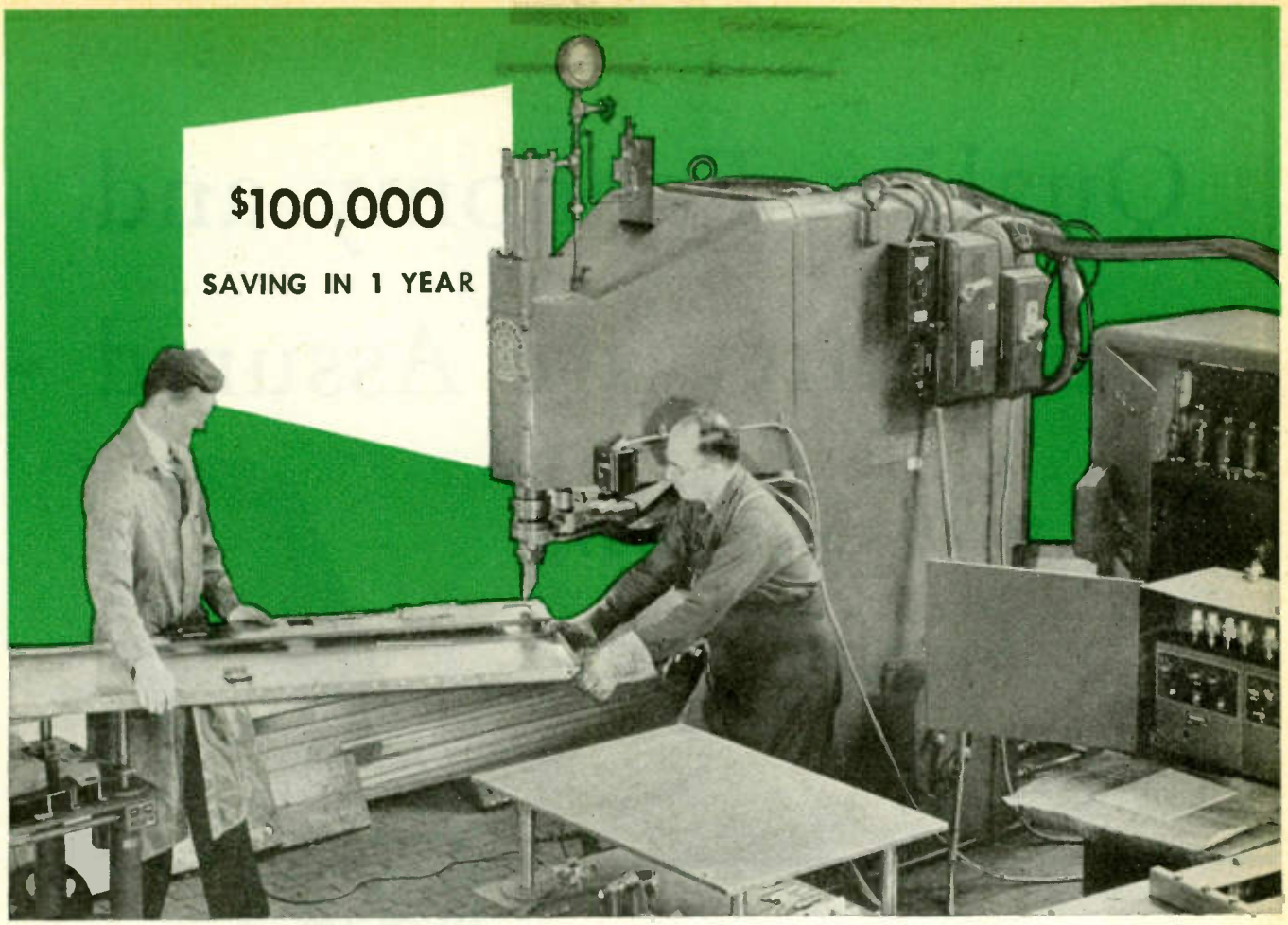
Designed to Match War Standards Specifications

Integrally molded in one operation under laboratory controlled production standards, Stackpole Type CM Resistors in ⅓-(RC-10): ½-(RC-21): and 1-watt (RC-30) sizes have been specifically designed to meet the newly issued Army-Navy specifications. The construction of these new resistors is such that they offer an exceptional degree of stability under load—the average change being less than 5% after 1000 hours under test at full load. In addition to having highly satisfactory humidity characteristics well within today's exacting requirements, Stackpole Type CM Insulated Resistors meet up-to-the-minute salt water immersion specifications.

Samples to any required tolerance on request.

STACKPOLE

STACKPOLE CARBON COMPANY, ST. MARYS, PA.



here's what came out . . . when electronics went in

A manufacturer of metal cabinets recently installed resistance welding with electronic control—to replace other forms of fabrication.

Here's what came *out* of his fabrication costs in one year: *600 tons of steel, 10,000 man-hours of labor, 3,000 pounds of welding rod.* The total saving amounted to $100,000.

The reasons? Resistance welding with precision electronic control permitted use of lighter gauge stock in the whole structure—with strength and tolerances maintained. This, in turn, permitted better-planned shearing that greatly reduced scrap losses.

Resistance welding control is but one of the many ways electronics is serving industry as a production tool—speeding fabrication, cutting costs, improving products.

For full information on electronic applications for your industry, consult your nearest Westinghouse office. Or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa. J-91080

ELECTRONIC CONTROL for resistance welding equipment provides accurate control of weld time, heat and timing sequence. Through the precision of electronic tubes, accurately controlled electric current may be sent stabbing through metal as many as 1,800 times per minute.

TUNE IN JOHN CHARLES THOMAS, SUNDAY—2:30 EWT, NBC.

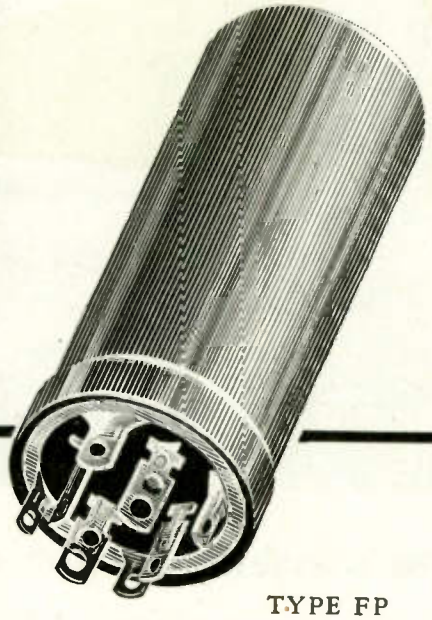
Westinghouse
PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

Electronics at Work

ELECTRONIC EQUIPMENT FOR INDUSTRY AND HOME • ELECTRONIC TUBES • RADIO AND TELEVISION

Quality, Economy and Durability are Assured

with Capacitors by Magnavox



TYPE FP

Improved processing technique insures fine performance, long life, economy, speedy delivery

FOR 34 years Magnavox has served the radio industry—supplying the finest quality components and perfecting advanced engineering techniques.

★★ *Engaged now in supplying demands of the armed services, Magnavox will again serve the radio industry in the traditional manner after conversion.*

★★ Specializing in FP (fabricated plate) Electrolytic Capacitors, Magnavox is able to effect a full standardization program with all the advantages that it provides. Our technical department is available for individual consultation regarding capacitors for special applications.

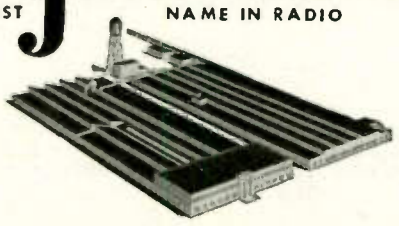
★★ *Thirty-four years experience, plus the additional advantages of new Magnavox developments and the superb equipment in our modern six-acre plant, is your guarantee of the best in quality components now and in reconverted civilian production.*

The MAGNAVOX Company, Components Division

★ ★ ★ ★ Fort Wayne 4, Indiana

Magnavox

THE OLDEST NAME IN RADIO

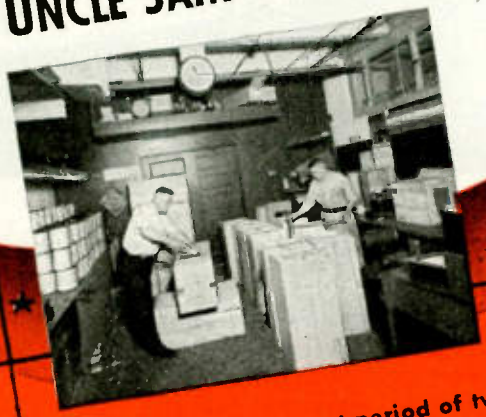


SPEAKERS · CAPACITORS · SOLENOIDS · ELECTRONIC EQUIPMENT

Several thousand miles of wire produced on time for government use are shown in the above photograph.

MILES

OF GLASS BRAIDED WIRE FOR UNCLE SAM PRODUCED ON TIME



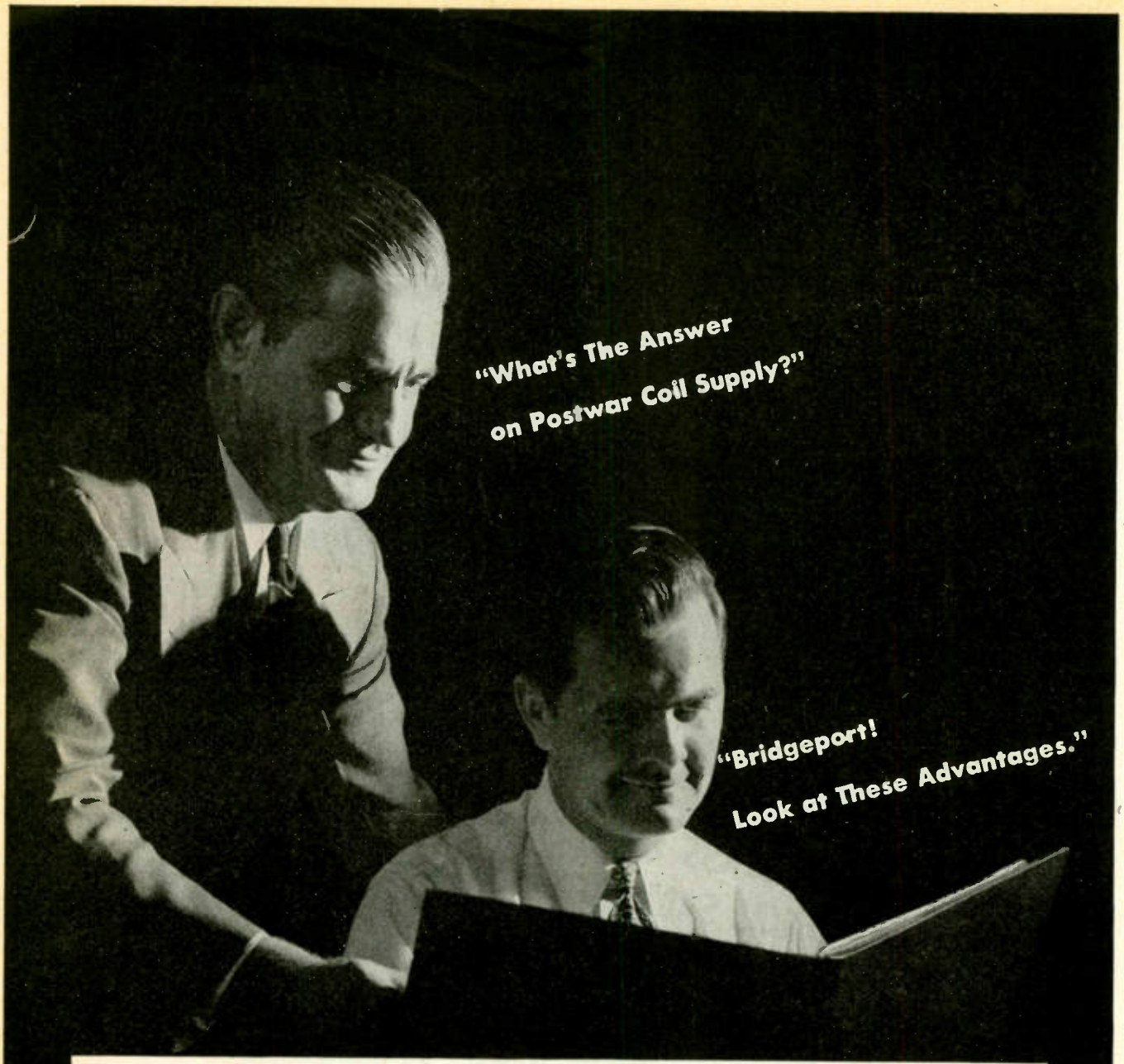
Packing the wire for government-designated supply depots.

Within the short period of two weeks, several thousand miles of special WL-Type glass braided wire were turned out to fill an urgent need of our air forces—the best illustration we know of how Runzel endeavors to meet production schedules ON TIME—all the time.

We invite your inquiries regarding the use of our products and services to fill civilian needs, as soon as conditions permit . . . for radio, for coin machines, and for all types of electronic usages.

Runzel
CORDS · WIRES · CABLES

RUNZEL CORD & WIRE CO.
4723-31 MONTROSE AVENUE · CHICAGO



Yes, Here's Why Bridgeport's the Answer to Postwar Coil Supply Problems

Bridgeport has the personnel and facilities. Right now, they're turning out highly important search coils and variometers for the armed forces. After their war job is done, the same skilled technicians will be able to give you the benefits of this experience in high production of quality radionic equipment.

And look at Bridgeport's central location! Because it is located near the population center of America, Bridgeport can give you fast, trunk line service to any part of the country. Place your order with Bridgeport NOW to insure early postwar delivery.

BRIDGEPORT

MANUFACTURING COMPANY
Bridgeport, Illinois

R. F. Coils • R. F. Chokes • I. F. Transformers
Transmitting Coils • Transmitting Chokes

HERMETICALLY SEALED

against humidity and fungus

—another G-E "FIRST" in electric-instrument design

● The Pacific war area is probably the toughest instrument-proving ground in the world. To meet the requirements of such severe service, G-E engineers have designed a 2½-inch panel instrument that *IS hermetically sealed*. No detail has been overlooked to make this critical radio component impervious to the tropical conditions of high humidity, extreme temperature, and fungus growth.

Sealed Throughout. Vacuum-tight sealing assures a hermetic enclosure: Thick, strain-free glass is fused to a metal ring by a glass-to-metal seal; then, this assembly is sealed to a steel case. The two terminals are sealed, glass-to-metal; then, this assembly is sealed to a steel base. Lastly, the steel base is sealed to the steel case by a synthetic-rubber gasket, which is treated with a special sealing compound and compressed and secured by a crimped-over metal ring.

Filled with Inert Gas. The final assembly is evacuated, filled with an inert gas through a tube in the base, and is sealed off at a pressure slightly above atmospheric.

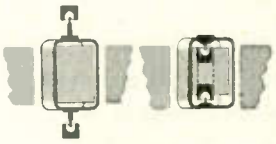
Internal-pivot Design. The combination of this hermetic enclosure and the combat-proved G-E internal-pivot element makes an outstanding instrument. It is not only sealed against jungle humidity and fungus, but it is also well able to withstand thermal shock, mechanical shock, and fatigue vibration and still maintain its rated accuracy.

For advance information, ask the nearest G-E office for Booklet GEA-4429, or write to General Electric Co., Schenectady 5, N.Y.

Type DW-61 d-c voltmeters, ammeters, milliammeters, and microammeters

Type DW-62 radio-frequency ammeters and milliammeters

AN INTERNAL-PIVOT DESIGN



External Pivot **Internal Pivot**

For thinness—pivots are mounted on the *inside* of the armature

For sturdiness—parts that require a definite location in relation to each other are securely fastened together to assure permanent alignment

High factor of merit—resulting from a featherweight moving element and high torque

Plus Hermetic Sealing—Another G-E First

HEADQUARTERS FOR ELECTRICAL MEASUREMENT

Buy all the BONDS you can—and keep all you buy

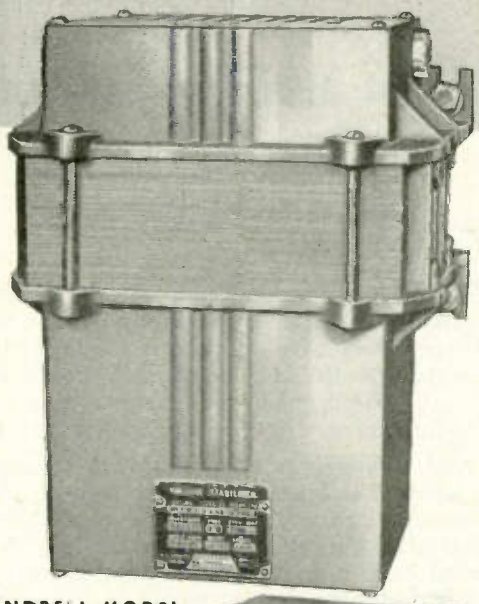
GENERAL ELECTRIC

602-85-6200

RAYTHEON VOLTAGE STABILIZERS

Keep Varying Input Voltages Uniform

at ±½% of 1%



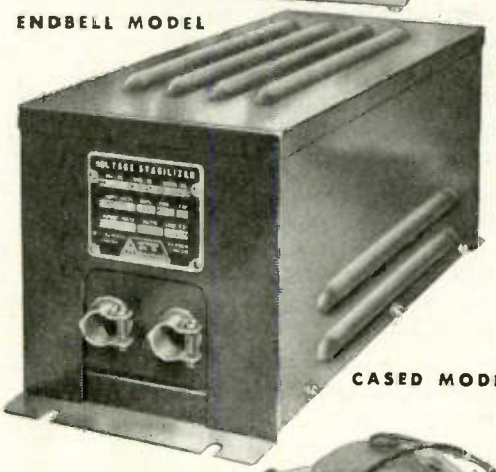
ENDBELL MODEL

Built into new equipment or incorporated into equipment already in use, Raytheon Voltage Stabilizers improve the operation of electrical equipment by stabilizing varying input voltages to ±½% of 1% within 2 cycles.

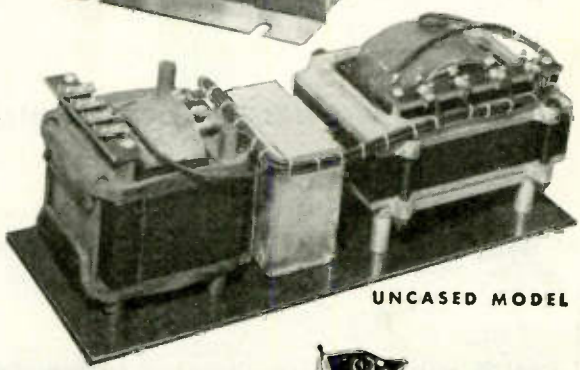
Because they have no moving parts . . . nothing that wears out, they require no adjustments or maintenance. Simply hook them up and Raytheon Voltage Stabilizers will give years of trouble-free service.

Many models and ratings are available for practically every application requiring uniform voltage. All stabilize voltages at any load within ratings to ±½%.

Standard Raytheon Voltage Stabilizers may be had for controlling A. C. input variation of 95 to 130 volts or 190 to 260 volts. Write for bulletin DL48-537. It gives dimensions, operating characteristics and other important data.

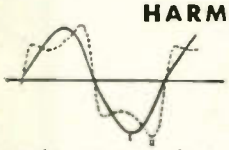


CASED MODEL



UNCASED MODEL

HARMONIC CONTENT



The high magnetic density in one of the transformers introduces harmonics in the output voltage wave. The actual harmonic content is usually unimportant except when instruments are being calibrated.

The output wave form is illustrated in the accompanying figure and table.

ANALYSIS OF OUTPUT VOLTAGE

Curve No.	Input Volts	Percentage Harmonic 1st	3rd	5th	7th
I	95	99.4	7.1	2.2	Trace
II	131	96.8	24.0	7.0	3.6

Tune in the Raytheon radio program: "MEET YOUR NAVY," every Saturday night on the Blue Network. Consult your local newspaper for time and station

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MANUFACTURING COMPANY
Electrical Equipment Division
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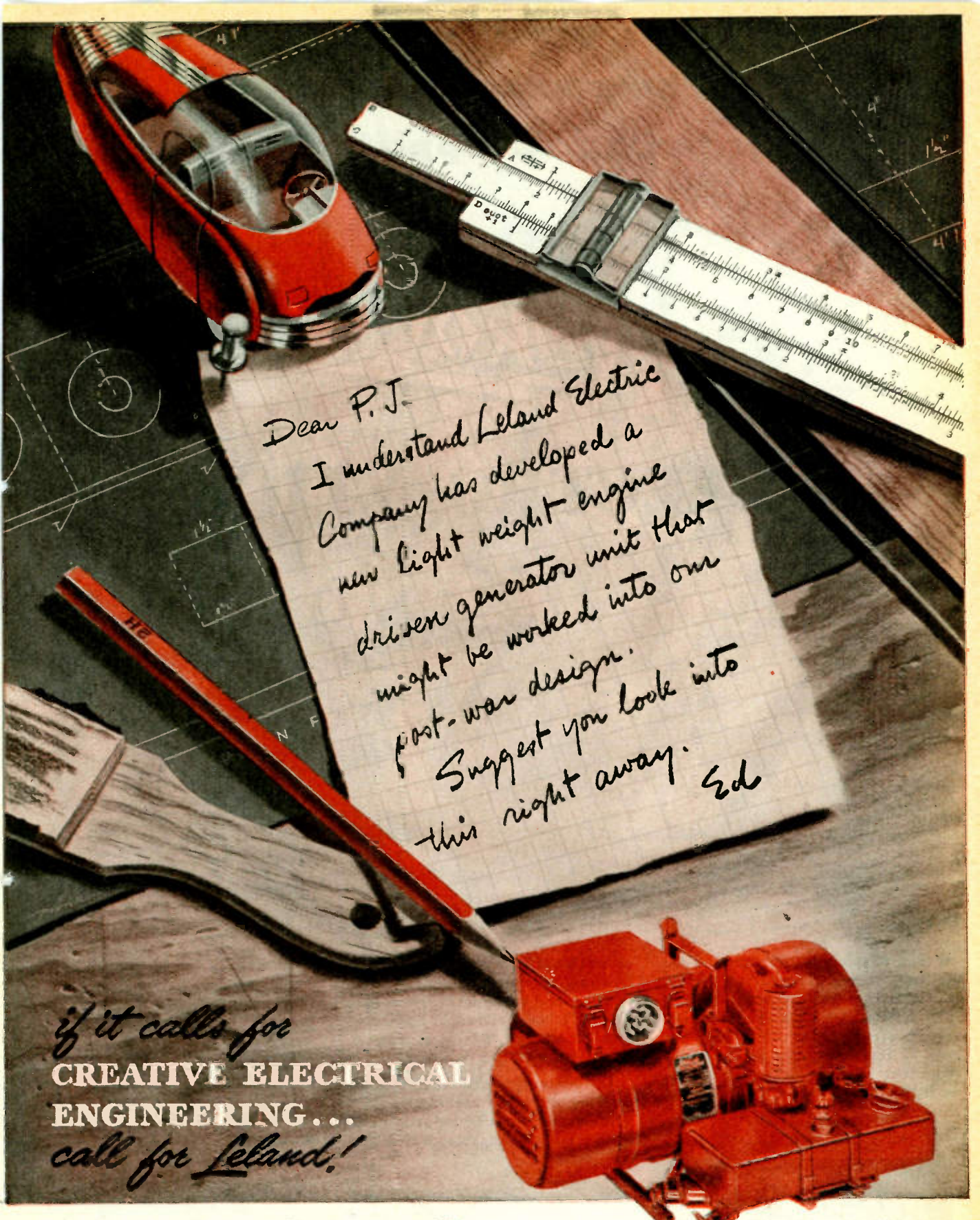

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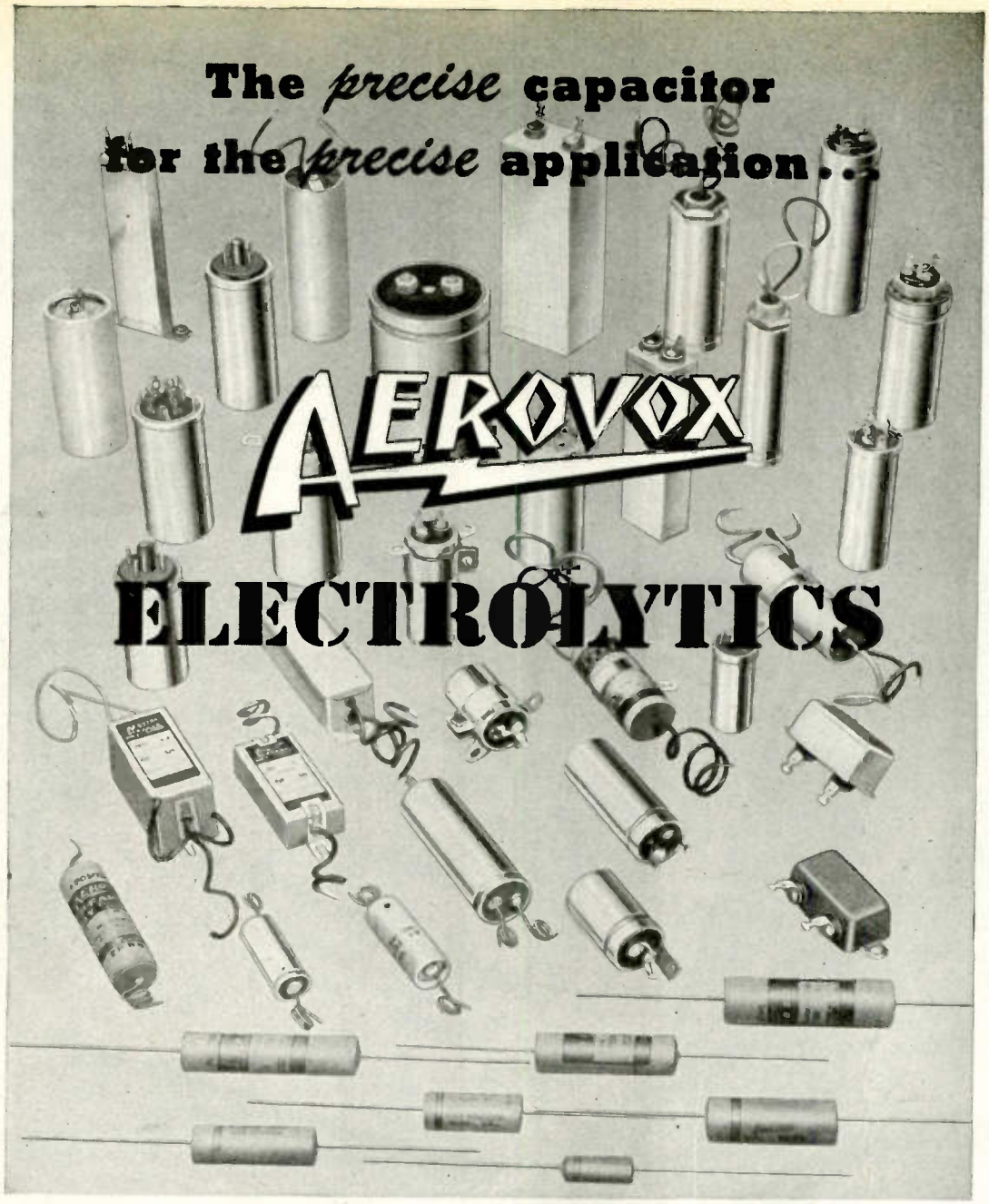

● The electrolytic capacitor has its own special field of application in electronic, radio and electrical equipment. This type provides the equipment designer with *an unusually lightweight unit* of high capacitance in a compact container. Also, it effects considerable savings. BUT . . .

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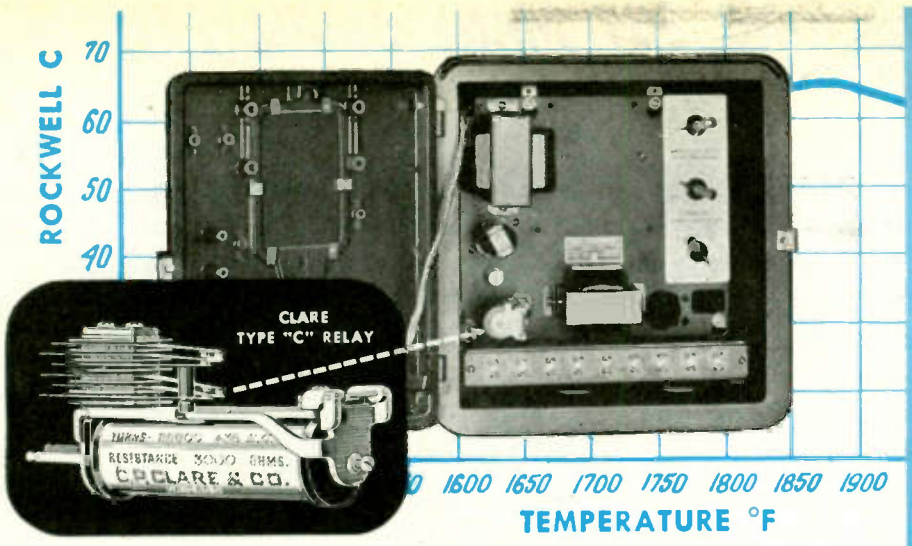
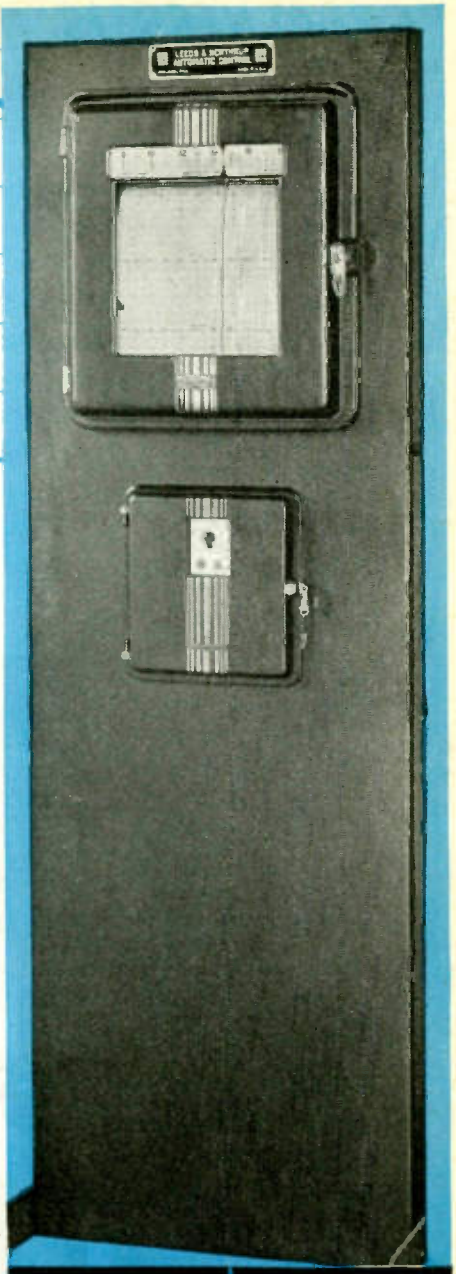




CLARE "Custom-Built" RELAYS

Help Micromax Electric Controls Maintain Precise Furnace Temperatures

Clare Type "C" Relay is used to regulate the flow of electric energy in the Micromax Electric Control. This product of Leeds & Northrup Company of Philadelphia, Pa., proportions the duration of "on-heat" to "off-heat" which provides the precise, even heat control demanded in the operation of electric furnaces, ovens and baths.

To maintain precise temperature the Micromax Electric Control employs two electrical balances: one to measure temperature; the other to carry out control action. A knob on the control instrument is set to prevent temperature from overshooting the control point . . . especially important when a furnace is being brought to temperature under a full heat-head.

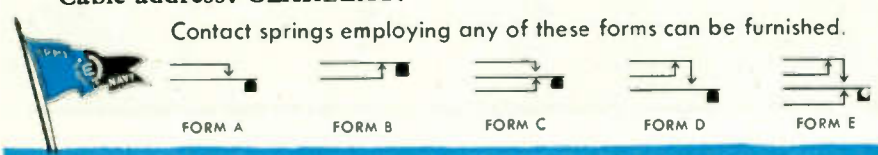
Whenever the temperature leaves the control point, a Clare Relay modifies the on-off action of the contactor to readjust heat-input and restores balance in the control circuit.

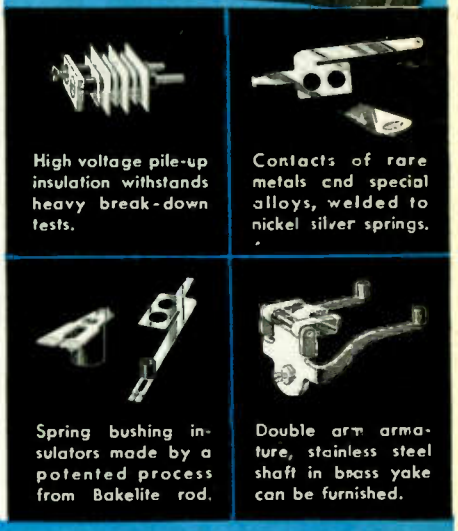
Leeds & Northrup engineers chose a Clare Relay for this important part of their control unit because the flexibility of Clare "custom-building" gave them the sensitive, positive action, the absolute dependability, and the accuracy to meet most exactly their requirements.

This use of Clare "Custom-Built" Relays to operate delicate controls is typical of the way in which engineers and designers everywhere are finding Clare the exact relay for the unusual application. The Type "C" Relay offers you a design that permits a wide range of contact ratings, the choice of five different contact forms or any combination of them, either flat or hemispherical contacts of rare metals or special alloys, coil windings to match the circuit and application.

What is your problem? Let Clare "custom-build" a relay to your specifications. Investigate the possibilities for higher efficiency and reduced relay costs. Send for the Clare catalog and data book. Address C. P. Clare & Co., 4719 Sunnyside Avenue, Chicago 30, Illinois. Sales engineers in all principal cities. Cable address: CLARELAY.

Contact springs employing any of these forms can be furnished.





High voltage pile-up insulation withstands heavy break-down tests.

Contacts of rare metals and special alloys, welded to nickel silver springs.

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Double arm armature, stainless steel shaft in brass yoke can be furnished.

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"GREATNESS IS NOTHING BUT MANY SMALL TRIFLES"

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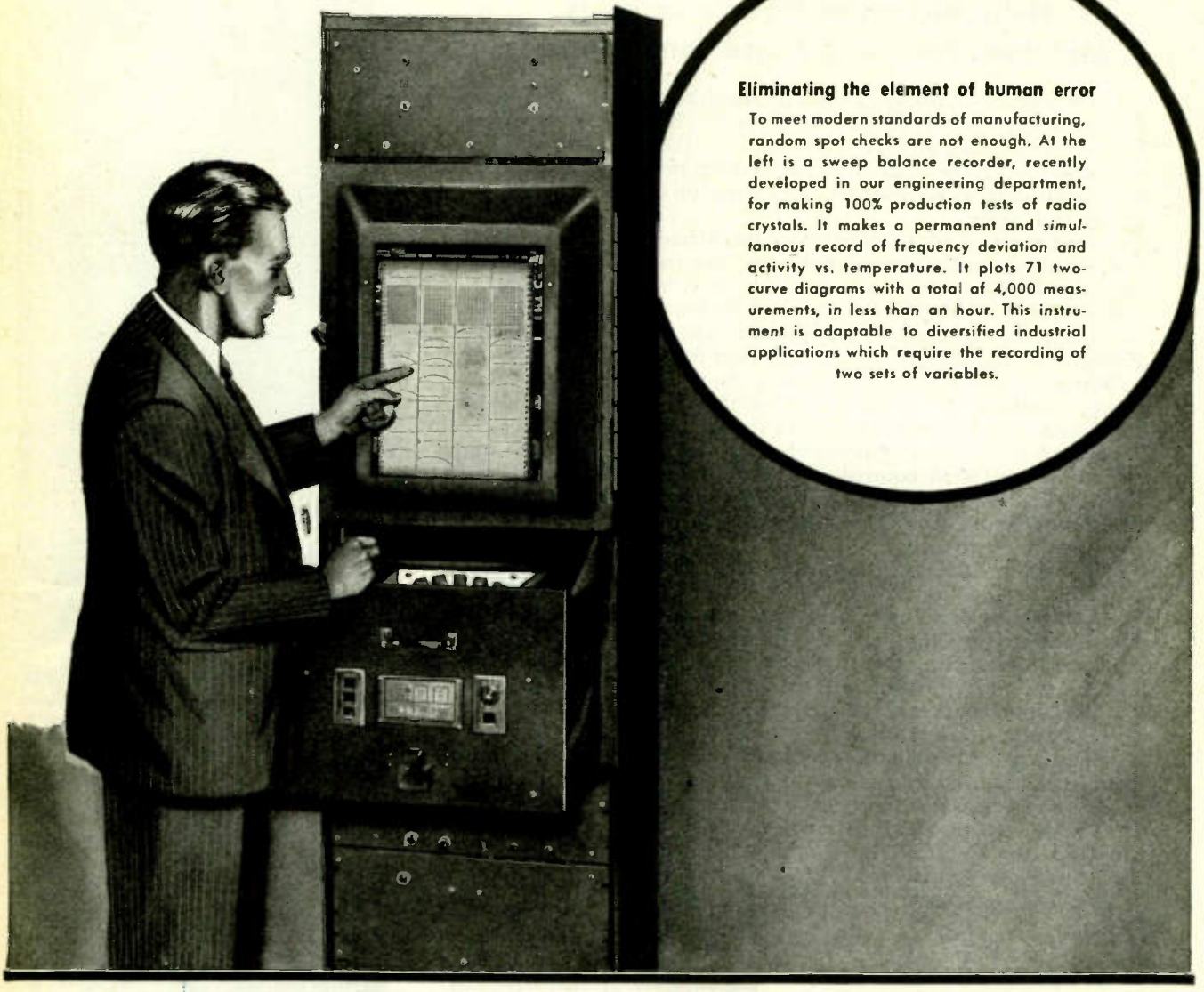
The precision required of Connecticut Telephone & Electric Division's production keeps us on our toes . . . developing new and better manufacturing methods . . . devising improved techniques of quality control. One example is the crystal tester developed by our engineers which gives us a quality check in quantity.

This is one of many special instruments in Connecticut Telephone & Electric Division's plants. Each is designed to assure our armed forces of better products. Each one contributes its trifle of greater dependability and higher accuracy to the electronic and communications equipment you will use after the war.



Eliminating the element of human error

To meet modern standards of manufacturing, random spot checks are not enough. At the left is a sweep balance recorder, recently developed in our engineering department, for making 100% production tests of radio crystals. It makes a permanent and *simultaneous* record of frequency deviation and activity vs. temperature. It plots 71 two-curve diagrams with a total of 4,000 measurements, in less than an hour. This instrument is adaptable to diversified industrial applications which require the recording of two sets of variables.

CONNECTICUT TELEPHONE & ELECTRIC DIVISION

GREAT AMERICAN INDUSTRIES, INC. • MERIDEN, CONNECTICUT

★ *This speaks for itself: Utah is its own transformer supplier for speakers, vibrators, wire recorders, etcetera.*

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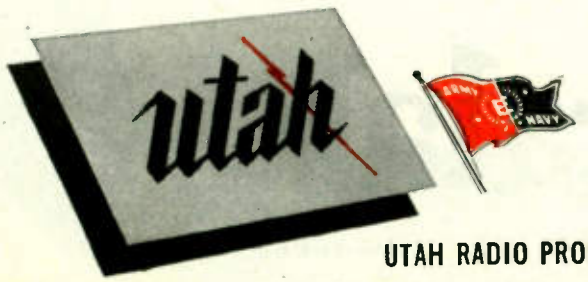
It's like putting a big liner into water. Like a launching. Only here at Utah, we don't take time for celebration. Radio makers and electronics dealers appreciate the highly specialized product that has been manufactured . . . the way a skipper appreciates a fine craft. Radio listeners, like ships' passengers take all this precision for granted.

Here at Utah our workers (assisted by Utalins*) begin with nothing but the raw materials from which they make the tools that turn out Utah radio parts and electronic devices. At each step in manufacture . . . punch press, electroplating, welding, coil winding . . . from the beginning through to the finished product, Utah workers check, re-check, test and prove to Utah standards. When Utah says . . ."OK—SHIP" products of quality that stand up under every condition known to man leave to broadcast Utah performance around the world.

*Utah's Helpers



UTAH RADIO PRODUCTS COMPANY, 820 ORLEANS ST., CHICAGO 10, ILL.

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- 25,000 cycles of operation without contact failure
- Fixed stops to limit rotation
- 20° indexing

Centralab medium duty power switches are now available for transmitters (has been used up to 20 megacycles) power supply converters and for certain industrial and electronic uses.

It is indicated in applications where the average Selector Switch is not of sufficient accuracy or power rating. Its accuracy of contact is gained by a square shaft, sleeve fit rotor, and individually aligned and adjusted contacts. It is assembled in multiple gangs with shorting or non-shorting contacts. Torque can be adjusted to suit individual requirements. Furnished in 1 pole . . . 2 to 17 positions (with 18th position continuous rotation with 18th position as "off"); and 2 or 3 pole . . . 2 to 6 position including "off".

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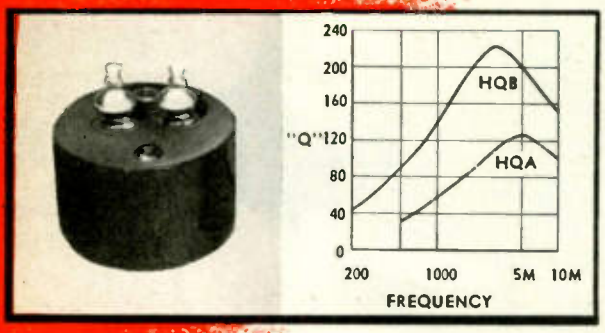
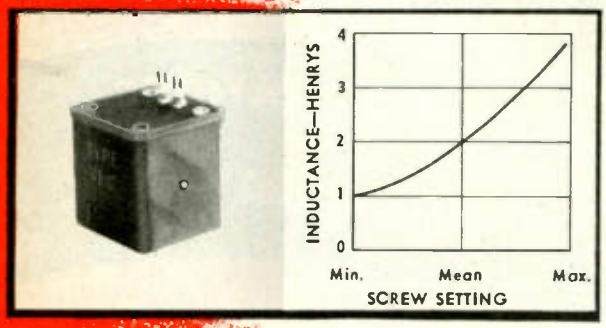


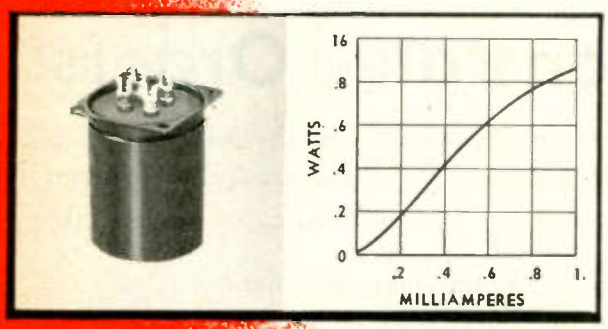
HQA AND HQB HIGH Q INDUCTORS

This series of toroid wound high stability inductors are available from 5 Mhy. to 2 Hys. Voltage stability is excellent, hum pickup is very low. Temperature effects are negligible. HQA units 1-13/16" in diameter by 1-3/16" high.



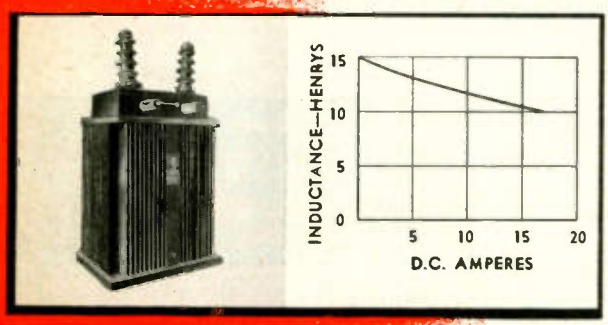
TYPE VI-C VARIABLE INDUCTORS

These inductors are available in optimum values from 10 Mhy. to 10 Hys. They are tunable over a wide range by inserting an Allen Head wrench in the adjusting screw. Units measure 1¼" x 1-7/16" x 1-7/16".



SENSITIVE SATURABLE INDUCTORS

UTC Saturable Inductors cover a wide range of application for magnetic amplification and control. These units are supplied to specific requirements. The curve shown illustrates a high sensitive type, showing DC saturation vs. AC watts into load.



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Industrial Uses of Scanning Technique

The introduction of television scanning processes to industrial problems may open up an entirely new method of attack for many special measurements. In one form or another, such scanning may become an important part of research technic.

In one plan there is the opportunity to unite the two methods of analyzing mechanical action—visual and oscillographic, because it is not difficult to combine, in alternate sequence, a visual picture of the position of certain mechanical parts and an oscillogram of one or more effects taking place at the same time on the same or adjacent parts of the screen.

The setup would be more elaborate than many in prewar use, but it is in reality no more complex than many of the newer industrial tests that are finding present-day utility.

Radio Industry Unites for FM-Tele Action

The prospect that engineering tests and studies may delay action on FM and television until late in 1945 (or even into 1946), imperiling the whole postwar start of both new services, has brought about a united front in the radio industry. All hands now urge immediate FCC authorization of Alternate No. 1. (Even though for FM this involves a needless shift away from the present setup).

The FM and television broadcaster groups (FMBI and TBA) initiated the move to get immediate action on No. 1 as the best compromise. RTPB panels have supported this position. The independent pioneer FM manufacturers have petitioned FCC for prompt authorization. And RMA members have discussed similar action.

As the result of this united industry demand for immediate approval of Alternate 1, it is to be hoped that FCC may consider ratification of the No. 1 arrangement at the earliest moment—in July if possible.

Pasteurized Meat?

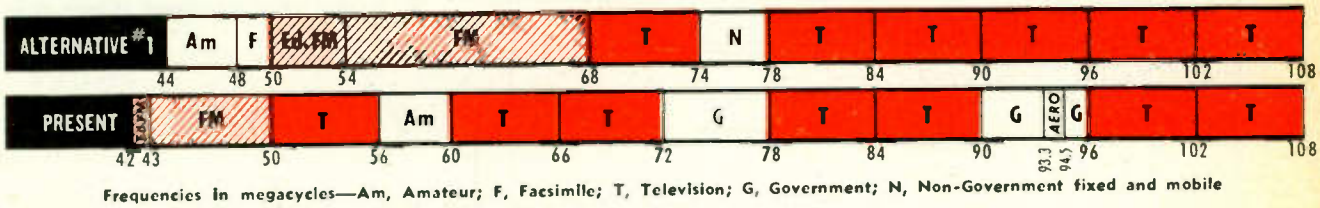
Experiments have been carried out to sterilize meats suspected of harboring virus of the hoof-and-mouth disease. Several schemes have been tried. Dielectric heating for a short time immediately prior to freezing, seems to hold some promise. Bones, fats, sinews and red meat, however, all have different dielectric properties and so heat up at different rates. If this hurdle can be overcome, we may see the pasteurizing of meat become another of the expanding electronic industries.

FDR's Early Aid to American Radio

Among the many tributes paid to Franklin D. Roosevelt's memory, we have seen no mention of the debt which all radio owes him for his timely insight and swift action, in radio's infancy, circa 1919. In that year Captain (now Admiral) S. C. Hooper discovered that the Alexandersen patents were to be sold abroad, a step which would have stripped the U. S. of technical control of the new radio art. Hooper in alarm went to Admiral Bullard, who in turn reported the danger to the young Assistant Secretary of the Navy, F. D. Roosevelt.

From that point on, official action was swift, and shortly, at the request of President Wilson himself, the contracts to sell the patents were cancelled, and instead, a U. S. radio patent pool was formed, with Admiral Bullard on the board. But back of this critical nick-of-time move, which made radio preeminently an industry with American leadership, stood the vision and quick action of FDR!

FM-TELE ALTERNATIVE NO. 1 ON WHICH RADIO GROUPS UNITE—AND PRESENT SET-UP



Frequencies in megacycles—Am, Amateur; F, Facsimile; T, Television; G, Government; N, Non-Government fixed and mobile

Here is the FCC's No. 1 Alternative for FM and television, which all groups in radio—broadcasters, manufacturers and engineers—are now petitioning the Commission to adopt without delay. For comparison, the present set-up in the same frequency channels, is also shown. There seems a possibility that the new FM-tele allocation may be made official by FCC during the present month. (Engineers have further proposed, however, that if No. 1 is to be adopted, a slight modification would start FM with its present band, so that existing FM sets could continue to receive future FM broadcasts in part, at least).

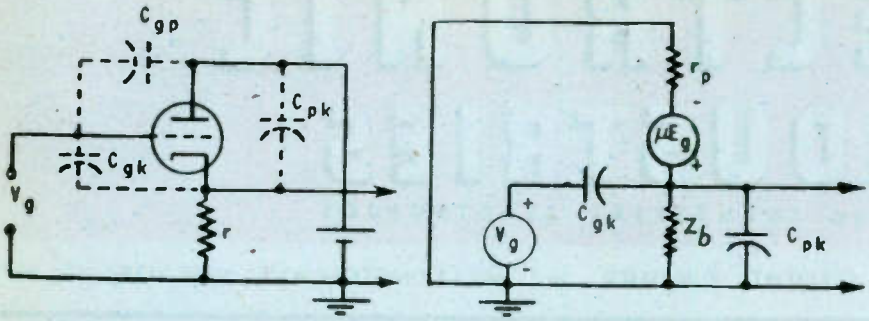


Fig. 1. Basic circuit of a cathode-follower amplifier stage. Such a stage utilizes a form of the feedback principle for its operation. Fig. 2. Equivalent plate circuit of the cathode-follower amplifier with an impedance load circuit

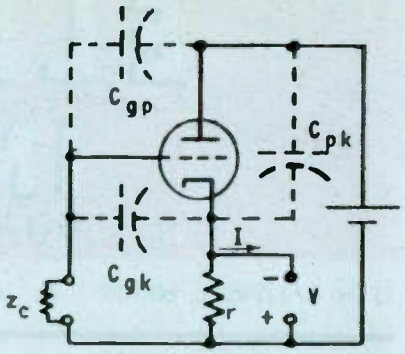


Fig. 5. Basic test setup which can be used for the determination of the effective output terminal impedance (or admittance)

FEATURES OF CATHODE

by HERBERT J. REICH
Department of Electrical Engineering,
University of Illinois, Urbana

Characteristics and applications of such units together with practical design data covering special conditions

● The cathode-follower amplifier, shown in basic form in Fig. 1, is a single-stage inverse-feedback amplifier. It is characterized by high input impedance, low output impedance, and voltage amplification less than unity. Like other inverse-feedback amplifiers, it is capable of handling high input voltage without producing excessive nonlinear distortion. Applications of the cathode-follower amplifier include the following:

1—As an input stage in a multistage amplifier. In this application its high input impedance makes it useful when the flow of current through the source of input voltage is objectionable. A typical example is in cathode ray oscilloscope amplifiers.

2—As a coupling stage in video amplifiers. When a cathode-follower stage is used in coupling two high-gain stages, its high input impedance and low output impedance make possible high amplification over a wide frequency range.

3—As an impedance-matching stage. Since the output impedance of a cathode-follower stage may be made very low by proper choice of the tube, it may be matched to a cable or other low-impedance load. The input may be matched

Fig. 3. Voltage amplification of the cathode-follower amplifier with non-reactive load, derived for several values of μ. The gain approaches unity when r_b is large

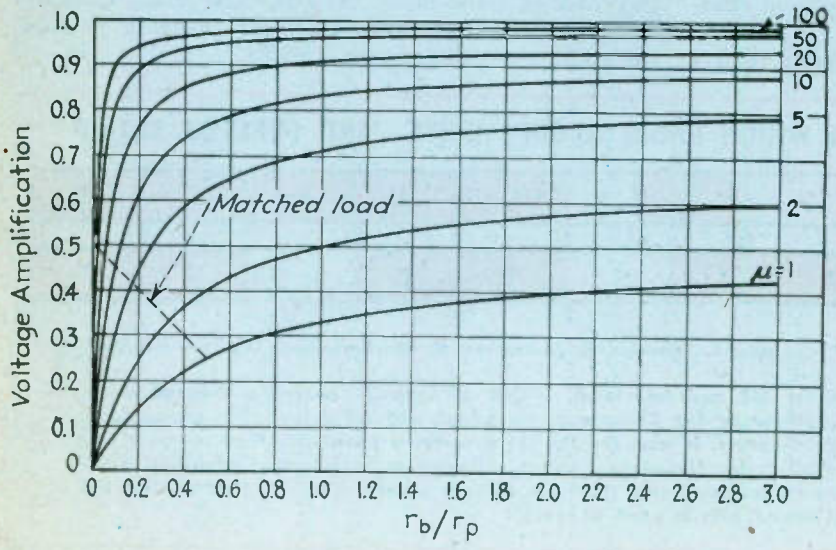
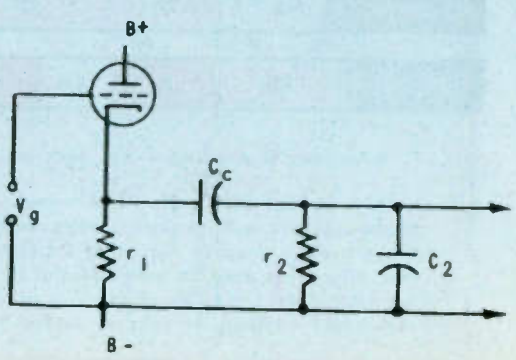


Fig. 4. RC-coupled cathode-follower amplifier. C_2 includes input capacitance of next stage



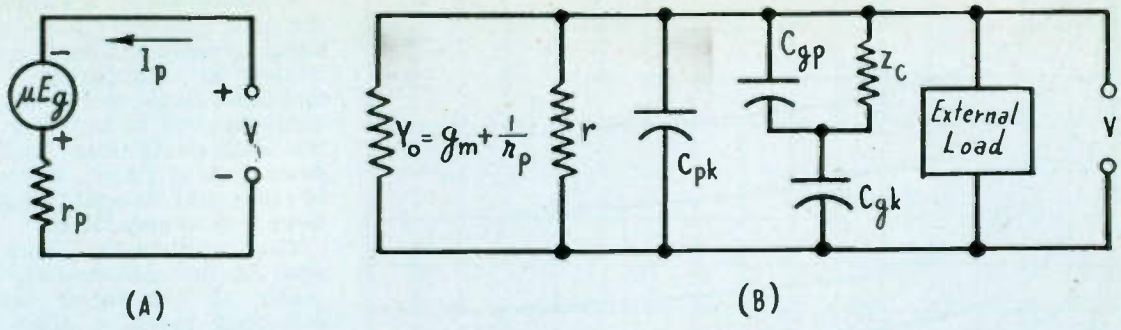


Fig. 6. Equivalent circuit of cathode-follower amplifier when excited across its output terminals. The condition for the tube only is shown at (A). For the entire amplifier stage, the passive network (B) holds. A low output impedance results with the usual operating conditions with this type of excitation

FOLLOWER AMPLIFIERS

to a high-impedance source by proper choice of the input coupling resistor. The advantage of the cathode-follower amplifier over a transformer in impedance matching is its wide frequency range. It has the disadvantage, however, that only relatively low power or current output can be delivered to the load without danger of nonlinear distortion.

4—As a means of obtaining a variable output voltage from a high-impedance source. Because of its low output impedance, a cathode-follower amplifier may be shunted by a low-resistance voltage divider for gain control purposes. The high input impedance prevents current drain from the source of input voltage.

5—As a driver stage in Class B amplifiers. The cathode-follower amplifier meets the requirements of high input impedance, low output impedance, and high current output that must be satisfied by a driver stage in order to avoid high nonlinear distortion, and it can be used over a wide frequency range.

6—As an output stage in applications in which the output voltage must be essentially independent of external impedance connected across the output terminals of the amplifier. Since the output impedance readily may be made as low as a few hundred ohms, the output voltage will be practically unaffected by impedances of the order of several thousand ohms or greater.

7—The fact that the output voltage of a cathode-follower stage is in phase with the input voltage (both being measured relative to the grounded terminal) is occasionally useful.

1—Voltage amplification

Fig. 2 shows the equivalent plate circuit of a cathode-follower with impedance load z_b. The load z_b is made up of r and any external load or coupling impedances that may shunt or replace r. (Since the heaters and the negative side of the plate supply voltage are usually grounded, the heater-to-cathode capacitance is usually in parallel with C_{pk} and r.) Solution of the equivalent circuit shows that the voltage amplification is

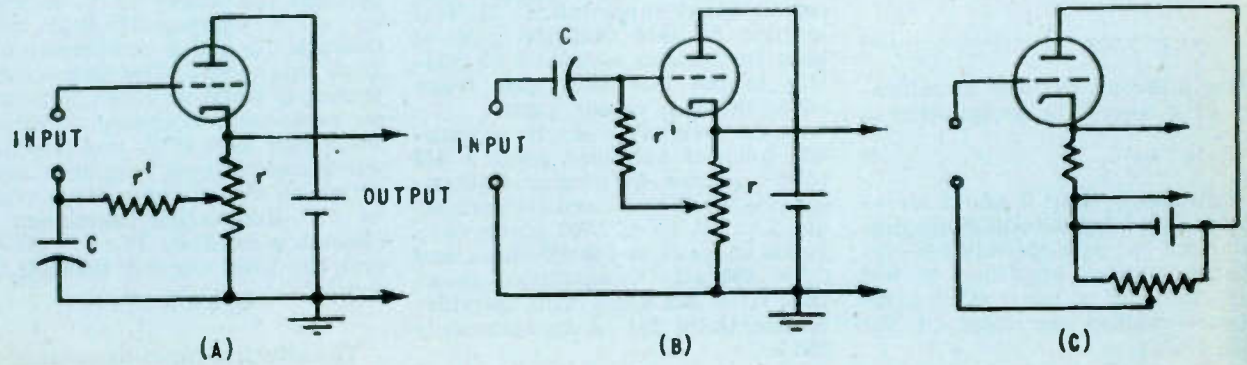
$$A = \frac{(j\omega C_{gk} r_p + \mu) z_b}{j\omega(C_{gk} + C_{pk}) r_p z_b + r_p + (\mu + 1) z_b} \qquad (1)$$

For values of r or z_b that are generally used, the effect of the interelectrode and wiring capacitances upon the voltage amplification usually is negligible at frequencies below about 1 mc. Eq. (1) then reduces to

$$A = \frac{\mu z_b}{r_p + z_b(\mu + 1)} \qquad (1a)$$

Examination of Eq. (1a) shows that A approaches the limiting value $\mu/(\mu + 1)$ as the ratio of z_b to r_p becomes infinite. Curves of A

Fig. 7. Three typical amplifier stage arrangements. In each, the bias of the tube can be adjusted when the output load resistance is higher than required for correct bias. The resistance of r' should be large, compared to the reactance of C at lowest frequency to be amplified



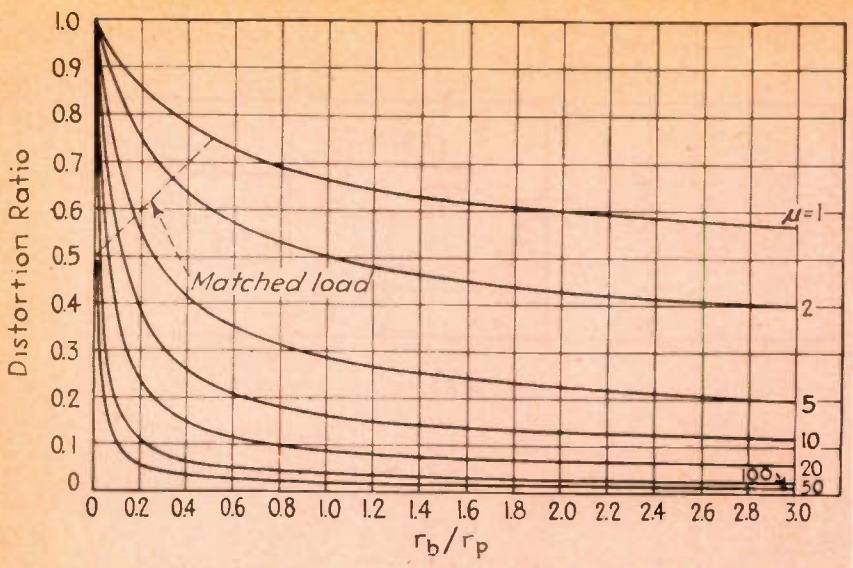


Fig. 9. Curves comparing the non-linear distortion in a cathode-follower stage with that found in a conventional stage using the same tube and load resistance

vs. r_b/r_p derived from Eq. (1) for nonreactive loads at several values of μ are shown in Fig. 3. (The significance of the dotted line for matched load is explained in Sec. 6.) For values of μ and r_p found in ordinary tubes, A is of the order of 0.9 or higher when r_b is equal to 10,000 ohms.

Fig. 4 shows a resistance-capacitance - coupled cathode - follower amplifier stage. C_2 is the sum of the effective output capacitance of the given stage (approximately $C_{pk} + 0.1C_{kk}$, as will be shown in Sec. 3) and the effective input capacitance of the following stage. The voltage amplification at frequencies in and above the mid-band range can readily be found from Eq. 1 if it is noted that the load is the parallel combination of r_1, r_2, and C_2. In the mid-band range the effect of C_2 is negligible and z_b is the resistance of r_1 and r_2 in parallel. The mid-band amplification A_m can therefore be determined from Fig. 3 or Eq. 1a by using $r_1r_2/(r_1 + r_2)$ for r_b. If this substitution is made in Eq. 1, we obtain

$$A_m = g_m r_h' \qquad (2)$$

where

$$r_h' = r_h/(g_m r_h + 1) \qquad (2a)$$

and

$$r_h = \frac{1}{1/r_1 + 1/r_2 + 1/r_p} = \frac{r_1r_2r_p}{r_1r_2 + r_1r_p + r_2r_p} \qquad (2o)$$

The midband voltage amplification of a conventional amplifier is

$$A_m = g_m r_h \qquad (3)$$

Comparison of Eqs. 2 and 3 shows that the mid-band voltage amplification of a cathode-follower resistance-coupled amplifier is less than that of a conventional resistance-coupled amplifier in the ratio $1/(g_m r_h + 1)$.

At frequencies above the mid-band range the load consists of the parallel combination of r_1, r_2, and C_2 and the effective load impedance is $\frac{1}{1/r_1 + 1/r_2 + j\omega C_2}$. Substitution of this value of z_b in Eq. 1 gives for the voltage amplification at high frequencies:

$$A_h = \frac{g_m r_h'}{1 + j\omega C_2 r_h'} = \frac{A_m}{1 + j\omega C_2 r_h'} \qquad (4)$$

For a conventional resistance-coupled amplifier the amplification at frequencies above the mid-band range is

$$A_h = \frac{A_m}{1 + j\omega C_2 r_h} \qquad (5)$$

Inspection of Eqs. 4 and 5 shows that at any value of A_h/A_m, $\omega r_h'C_2$ for a cathode-follower stage is equal to $\omega r_h C_2$ for a conventional stage. Since r_h' is normally much smaller than r_h, the product of the effective capacitance C_2 and the upper limiting frequency of uniform response is much greater for a cathode-follower stage than for a conventional stage. A considerably higher frequency limit may therefore be attained with a cathode-follower stage, even when the stage is followed by a high-gain stage having a larger value of effective input capacitance. It is of interest to note that the gain at high frequencies is down 3 db relative to the mid-band gain when $\omega C_2 r_h'$ or $\omega C_2 r_h$ equals unity.

As an example, consider a cathode follower amplifier using a 6J5 tube operated at normal voltages. Assume that the circuit constants are $\mu = 20$, $r_p = 7{,}700$ ohms, $r_1 = 10{,}000$ ohms, $r_2 = 100{,}000$ ohms, and $C_2 = 250$ $\mu\mu$f. Computation shows that $r_h' = 352$ ohms. This amplifier is essentially flat to approximately 500 kc.

A conventional amplifier using the same tube and circuit constants has a voltage amplification approximately 12 times as great in the mid-band range, but is flat only to approximately 42 kc. The gain of the cathode-follower amplifier is down 3 db at 1.8 mc, whereas that of the conventional amplifier is down 3 db at only 152 kc.

The amplification and phase shift of the cathode-follower amplifier at frequencies below the mid-band range is given by the relation $A_l = A_m \frac{1}{1 + 1/j\omega r_l C_c}$ (6)

where $r_l = \frac{r_1r_2(\mu + 1) + r_1r_p + r_2r_p}{r_p + r_1(\mu + 1)}$ (6a)

Eq. 6 is the same as for conventional amplifiers. (Note that A_m and A_l are smaller than in a conventional amplifier, however, in the ratio r_h'/r_h.)

2—*Input admittance*

A complete analysis of the input admittance of the cathode-follower amplifier is beyond the scope of this paper. Such an analysis indicates, however, that capacitance which invariably shunts the load causes the input conductance to become negative at frequencies in excess of a few megacycles. The magnitude of the negative conductance increases with frequency, approaching a limiting value $g_m^2/4(k_p + k_b + g_m)$ at frequencies of the order of 100 megacycles.

Values of negative conductance observed in actual circuits are sufficiently high so that oscillation may take place in resonant input circuits. At these frequencies suitable oscillatory circuits may be formed merely by the distributed capacitance and inductance of the grid coupling circuit. Oscillation may usually be prevented by the use of a resistance of one or two hundred ohms in series with the grid.

An expression for the effective input capacitance at frequencies lower than a few megacycles can be readily derived. Examination of Fig. 1 shows that the interelectrode-capacitance current flowing through the source of V_g is made up of a component that flows through C_{gp} and a component that flows through C_{gk}. The former component is equal to $V_g j\omega C_{gp}$. The latter component is caused to flow by the vector sum of V_g and the voltage across r, which is equal in magnitude to AV_g and opposite in phase to V_g. Hence this component of current is equal to $jV_g(1 - A)\omega C_{gk}$ and the total current through the source is $j\omega V_g\left[C_{gp} + (1 - A)C_{gk}\right]$.

The effective input capacitance is

$$C_i = C_{gp} + (1 - A)C_{gk} \qquad (7)$$

When z_b is zero, A is also zero and C_i has its maximum value, $C_{gp} + C_{gk}$. As z_b is increased, A approaches $\mu/(\mu + 1)$ in magnitude; for nonreactive load A is real and C_i approaches its minimum value, $C_{gp} + C_{gk}/(\mu + 1)$. In many practical cathode-follower circuits A approximates 0.9 and C_i has the approximate value $C_{gp} + 0.1\ C_{gk}$. For a conventional amplifier the effective input capacitance is

$$C_i = C_{gk} + (|A| + 1)C_{gp} \qquad (8)$$

which has a maximum value $C_{gk} + (\mu + 1)Cg_{gp}$ at infinite load impedance and a minimum value $C_{gk} + C_{gp}$ at zero load impedance. Comparison of Eqs. 7 and 8 shows that the effective input capacitance of a cathode-follower stage is very much lower than that of an ordinary amplifier stage. The grid-plate capacitance of voltage-amplifier pentodes is of the order of 0.005 $\mu\mu$f and the grid-cathode capacitance is of the order of 6 $\mu\mu$f. Hence effective input capacitances of less than 1 $\mu\mu$f may be readily obtained with such tubes.

Circuit analysis indicates that at frequencies greater than a few megacycles the capacitance C_b shunting the load resistor r causes the effective input capacitance to depart from the value given by Eq. 7. C_i approaches the limiting value $C_{gp} + C_{gk}C_b/(C_{gk} + C_b)$ at frequencies of the order of $g_m/(C_{gk} + C_b)$. This value of C_i is normally less than that given by Eq. 7, but may be greater if C_b is large. If C_b were zero, C_i would approach zero as the frequency became very high. Examination of Fig. 1 shows that this is to be expected, since the reactance of C_{gk} is negligible at very high frequency and the input is then shunted only by the parallel combination of r and the plate-cathode path of the tube. Actually, C_b can never be zero, since r is shunted by C_{pk} and distributed circuit capacitances.

3—Output impedance

The effective output terminal impedance or admittance can be determined by finding the current that flows as the result of application of an alternating voltage V to the output terminals, as shown in Fig. 5. Under the assumption that the circuit is linear, i.e., that the equivalent plate circuit theorem is valid, any current flowing in the plate circuit as the result of application of additional exciting voltage to the grid circuit is independent of the current that flows as the result of V. The grid excitation voltage may therefore be assumed to be zero and the grid circuit to contain only the internal impedance Z_r of the source of grid-excitation voltage.

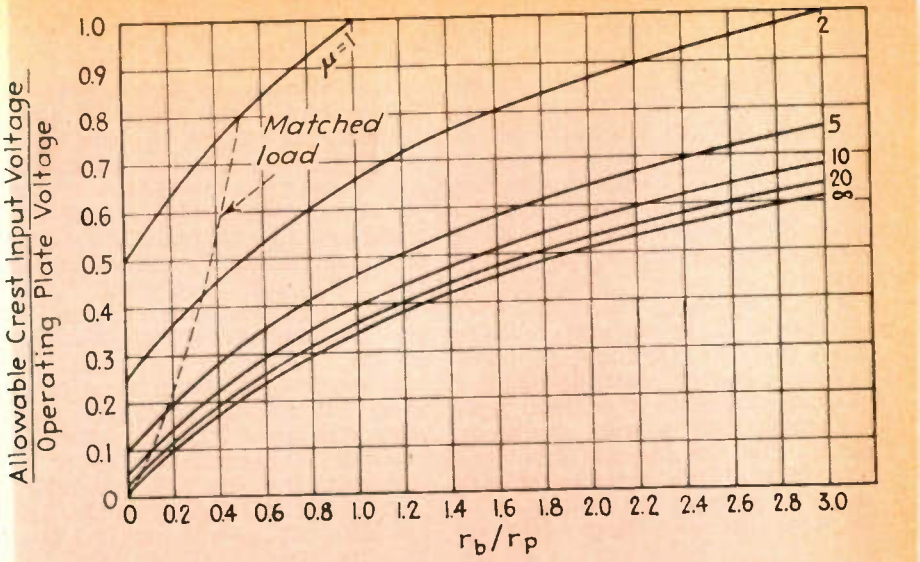


Fig. 10. Curves giving ratio of allowable crest input voltage to operating plate voltage. Large input voltages are permissible if μ is low and r_b/r_p is high

It can be seen from Fig. 5 that the output terminals are shunted not only by the plate-cathode path of the tube, but also by r, by C_{pk}, by the parallel combination of C_{gp} and z_c in series with C_{gk}, and by any external load or coupling circuits connected between the terminals. If the output admittance of the tube itself is known, it may be added to the admittances of any or all of the other paths to find the resultant admittance. Application of the equivalent-plate-circuit theorem to the circuit of Fig. 5 yields Fig. 6A for the equivalent plate circuit of the tube alone. The effective admittance of the tube alone is seen by Fig. 6a to be

$$Y_o = I_p/V = (V + \mu E_g)/r_p V \qquad (9)$$

The alternating grid voltage E_g is equal to the impressed voltage V less the voltage drop through z_c resulting from the flow of current through the grid-cathode capacitance C_{gk}. Since the capacitance of C_{gk} is of the order of 4 $\mu\mu$f, its reactance is about 40,000 ohms at 1 megacycle. If z_c is non-reactive and less than about 10,000 ohms in magnitude, the alternating grid voltage E_g exceeds 0.97V at frequencies below this value. Little error then results from assuming that E_g is equal to V, and Eq. 9 becomes

$$Y_o = g_m + 1/r_p = g_m \qquad (10)$$

The reduction of E_g resulting from impedance drop in z_c at high frequencies when z_c is large reduces Y_o below the value given by Eq. 10. This effect is, however, usually small or entirely absent.

Eq. 10 shows that, between the output terminals, the tube behaves like a conductance of value somewhat greater than the transconductance. Between these terminals, therefore, the cathode-follower amplifier may be represented by the passive equivalent circuit of Fig. 6B. Actual values of g_m are large enough so that the output terminal impedance Z_o, i.e., the reciprocal of Y_o, may be smaller than 170 ohms with single tubes and does not exceed 1,000 ohms, under the assumptions made in the derivation of Eq. 10. Very low output impedance may be obtained by the use of two or more tubes in parallel.

In many applications the admittance of the load and of the capacitances that shunt the output terminals is so small in comparison with the tube admittance Y_o that they have little effect upon the resultant admittance. Eq. 10 then gives a close approximation to the overall admittance. The interelectrode capacitances and cathode-to-ground wiring capacitance may begin to have an appreciable effect upon the resultant output admittance at frequencies above a few megacycles.

4—Amplifier circuits

Fig. 7 shows three practical cathode-follower circuits in which the grid bias can be adjusted to the correct value when r exceeds the value required to give the correct grid bias. The resistance r′ should be large in comparison with the reactance of C at the lowest frequency to be amplified. Circuits (A) and (C) are superior to circuit (B) when high input impedance is of primary importance. Under the assumption that the reactance of C is negligible in comparison with r′ the input conductance of circuit (B) at low frequency changes from $1/r'$ to $(1 - A)/r'$ as the slider of the voltage divider is moved from

the grounded end to the cathode end. A serious disadvantage of circuits (A) and (C) is that the dc potential of the input terminals is above ground. The proper bias can also be obtained by connecting the lower input terminal to a tap on a voltage divider across the voltage supply.

Fig. 8 shows a video amplifier incorporating a cathode-follower input stage to give high input impedance and a cathode-follower coupling stage to give high amplification over a wide frequency band. The low effective input capacitance of the cathode-follower stage T_3 prevents the falling off of amplification and large shift in

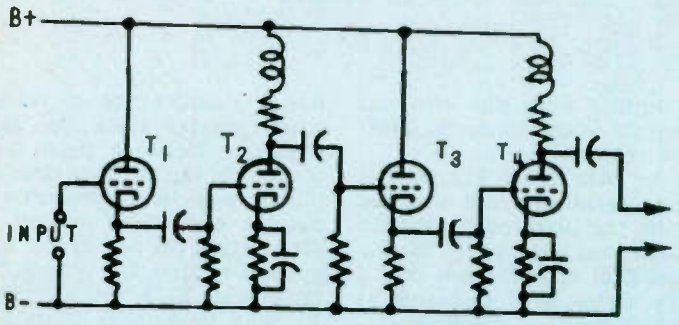


Fig. 8. Video amplifier incorporating cathode-follower input and coupling stages, giving good response over a wide frequency band

phase of the output voltage of the preceding high-gain stage T_2 at high frequencies; the low effective output impedance of the cathode-follower stage T_3 prevents the input capacitance of the following high-gain stage T_4 from causing similar effects.

The combined use of the cathode-follower stages and inductance in the plate circuits of the high-gain stages makes possible uniform amplification throughout a frequency range extending from low audio frequency well into the radio-frequency range. In spite of the reduction in amplification produced by the cathode-follower stages, higher amplification over a wide band may be obtained than by the use of conventional stages alone.

5—Choice of tubes

In general, pentodes such as the 6AG7 and 6AG5 are the most suitable for use in cathode-follower amplifiers. The low interelectrode capacitance and high transconductance of such tubes result in low effective input capacitance and low output impedance. Low- and medium-mu triodes, on the other hand, use higher grid bias and can therefore handle higher grid swing and deliver correspondingly higher output voltage.

The cathode-follower amplifier, in common with other inverse-feedback amplifiers, has low non-linear distortion. The curves of Fig. 9 show that the ratio of the distortion factor of a cathode-follower amplifier to that of a conventional single-stage amplifier having the same tube and load.[1] The curves show that this ratio is low for high values of amplification factor.

It should be borne in mind, however, that high-mu tubes have high plate resistance. Since low load impedance is desirable in order to minimize the effect of interelectrode capacitances at high frequencies, the use of a high-mu tube may result in a low ratio of load impedance to plate resistance, which is favorable to high non-linear distortion. For this reason it may sometimes be desirable in video-amplifier circuits to use tubes having only medium values of amplification factor and relatively low plate resistance, such as the 6J5.

6—Amplifier design

Usually the best method of predicting the performance of a cathode-follower stage and of determining the optimum bias and the maximum allowable input voltage is to use graphic analysis. The graphic analysis of cathode-follower amplifiers, which has been admirably treated by Shapiro (see bibliography) is beyond the scope of this paper. A number of interesting general facts, however, will be pointed out.

In choosing r, it should be borne in mind that a low value is desirable in order to minimize the effect of tube capacitance and in order to prevent large direct voltage drop in the resistance. A high value is desirable, on the other hand, in order to make possible high excitation without excessive non-linear distortion and in order to make the amplification nearly unity. The best value in a given amplifier will depend upon which of these factors is the most important in the application for which the amplifier is designed. A value of approximately 10,000 ohms is satisfactory in many applications, and there is usually little or no advantage in the use of larger values.

7—Overloading conditions

An analysis based upon Eq. 1a and Fig. 1 shows that the ratio of the crest input voltage E_{im} to the grid swing E_{gm} of a cathode-follower amplifier is given by the following equation where $k = r_b/r_p$:

$$E_{im}/E_{gm} = \frac{1 + k(\mu + 1)}{1 + k} \qquad (11)$$

Excessive distortion occurs as the result of grid-circuit overloading, i.e., clipping caused by cut-off on negative peaks or the flow of grid current through the grid coupling resistor on positive peaks. The greatest input voltage can be handled when the bias is approximately half the cut-off grid voltage. Clipping then commences simultaneously on both peaks when the crest alternating grid voltage becomes approximately equal to the bias.

An expression for the maximum allowable crest input voltage of triode cathode-follower amplifiers can be obtained from Eq. 11 by making use of the fact that the bias which causes clipping to commence simultaneously on both peaks of input voltage in triode amplifiers is roughly equal to

$$E_{bo}(k + 1)/(k + 2)\mu,$$

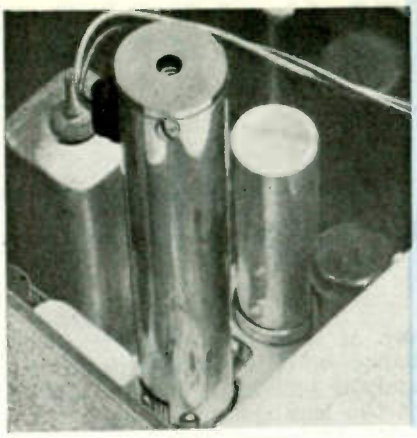
where E_{bo} is the operating plate voltage (not the plate supply voltage) and $k = r_b/r_p$.[2] Substitution of this value of bias for E_{gm} in Eq. 11 gives the following expression for the maximum crest input voltage of triode cathode-follower amplifiers:

$$\text{Max. } E_{im} = \frac{1 + k(1 + u)}{1 + k} E_c = \frac{1 + k(1 + u)}{u(2 + k)} E_{bo} \qquad (12)$$

(*Continued on page* 170)

[1] Distortion factor is defined as the ratio of the square-root of the sum of the squares of the amplitudes of the harmonics and intermodulation components of the output to the amplitude of the fundamental component. Feedback changes the distortion factor in the ratio—1/(1—AB), where A is the amplification without feedback and B is the portion of the output voltage that is fed back (see, for instance, H. J. Reich, Theory and Application of Electron Tubes, 2nd edition, Sec. 6-30). In the cathode-follower amplifier $A = \mu r_b/r_p + r_b$ and $B = -1$. (Note that A is the amplification when the input is impressed between grid and cathode.) For these values of A and B the ratio $1/(1-AB)$ becomes $(k+1)/1+k$ $(\mu+1)$, where $k = r_b/r_p$.

[2] See, for instance, H. J. Reich, Theory and Applications of Electron Tubes, 2nd Edit., Sec. 7-19.



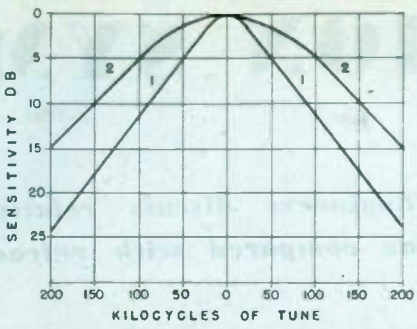


Fig. 2 (left)—Solenoid operated remote tuning unit in shield can. Fig. 4 (above)—Effect of HF oscillator detuning on response of two types of receivers.

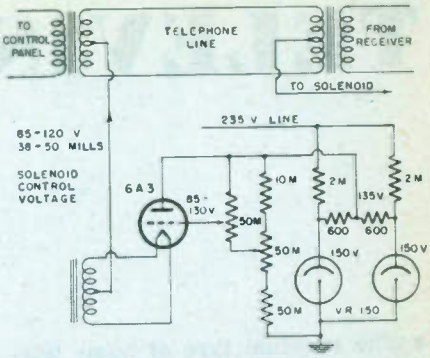


Fig. 5 (right)—Control scheme circuit. Low side of solenoid is grounded to complete simplex circuit

REMOTE CONTROL TUNING

Simplex circuit controls solenoid operated capacitor

● In a centrally located communications traffic office, reception conditions are sometimes quite bad due to the amount of power and other electrical equipment in use nearby. If the receiver can be located at a distance in a quiet spot and the audio frequency signal after reception brought in to the traffic office over a standard telephone loop, performance is much improved. However, tuning instructions telephoned to a guard located at the point of reception do not produce entirely satisfactory results as it is difficult by this means to get the exact point of optimum tuning.

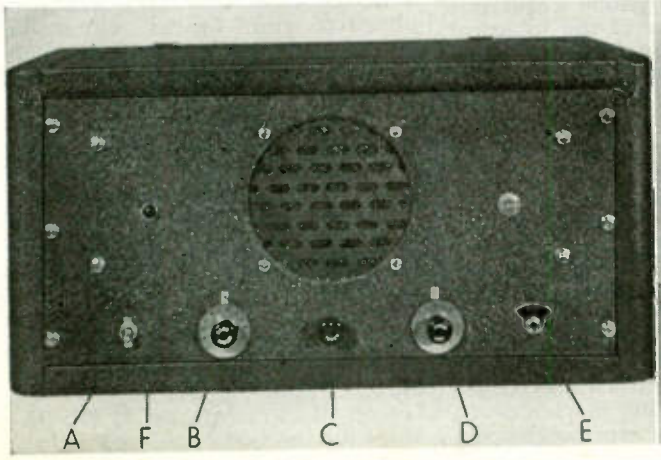
To give the operator at the traffic office a certain amount of control over the receiving set tuning, a remote tuning attachment manufactured by the Electronic Products Co., Ltd., of Vancouver, Canada, is used by the Royal Canadian Air Force. This remote tuner is intended to vary the frequency of the receiver approximately 20 kc on each side of the tune point for the purpose of clearing up the signal after the receiver has been tuned by the operator at the receiving point.

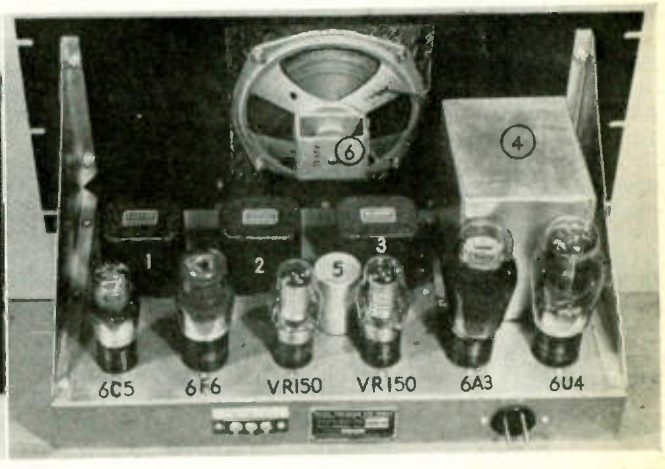
The remote tuning attachment, Fig. 2, consists of a solenoid controlling a 4 mmfd variable condenser. This condenser is connected in parallel with the oscillator tuning condenser of the remotely controlled receiver. The capacity of this condenser is varied by varying the voltage applied to the coil of the solenoid, which in turn raises or lowers the movable plate of the condenser. Upon installing this unit in a receiver it is necessary to readjust the trimmer condenser of the oscillator section of the receiver. To transmit the signal, a receiver-to-line transformer is connected in the plate circuit of the receiver output tube. Its secondary matches a standard 600-ohm line impedance.

At the control station there is a control panel. This includes an input transformer by which the signal is placed on the grid of a 6C5 amplifier tube. The output of this tube is resistance coupled to a 6F5 output tube which operates a loudspeaker or a pair of earphones through a jack. An ordinary telephone line can be used for the transmission of the audio signals

(*Continued on page* 178)

Fig. 1 (left)—Control panel for remote tuning of receiver. Control A—on-off switch; B—Band spread control and voltage regulated power switch; C—Tuning control; D—Volume control; E—Phono jack; F—Pilot light. Only final adjustments can be made with remote control unit. Original station tuning must be done at receiver. Fig. 3 (right)—Chassis view of remote control unit showing 6 in. pm speaker on 19 in. panel





TELEVISION SYMPOSIUM

Engineers discuss relative merits of direct view as compared with refractive and Schmidt systems

● The eventual type of home television receiver that will be most popular with the public likely will depend upon public preferences and the particular kind of service the home owner wants. Certainly, both the familiar direct-view type and the still untried projection type will be built, the latter either designed around the Schmidt system advocated by RCA and several others, or around a refractive lens system. Each of the three methods has advantages and disadvantages both from an engineering and manufacturing viewpoint and in the eyes of the public. In an effort to let in more light on the subject, the New York Section of the Institute of Radio Engineers called together a panel of experts, middle of June, who outlined their versions of each type, pro and con, and later answered questions fired at them from the well-filled auditorium of the Engineering Society Building.

The symposium was opened with a talk by George Adair, chief engineer of the Federal Communications Commission. He reviewed briefly the allocations plan and the three alternative proposals for FM and television allocation between 40 and 108 megacycles. He also emphasized the Commission's allocation of a 480 to 960 megacycle band for television which could be used for television relay work and high fidelity and color television experiments. The military allocations around 520 megacycles are to be vacated as quickly as possible so that these frequencies would be available for television.

The FCC will not permit the sound channel of a television station to operate alone during periods when the video carrier is not being used. This was made clear by Mr. Adair who said that the Commission felt that television should render a service on the frequencies allotted to it and should not be permitted to run sound programs alone. The widespread interest in television, as characterized by 117 applications for commercial stations, said Mr. Adair, was a good indication of the future of this art.

The Schmidt optical system as used in the RCA home television receiver which has been demonstrated (see the April issue of Electronic Industries) was described by Dr. I. G. Maloff of the Advanced Development Department of RCA. An optical projection system using a Schmidt mirror was demonstrated in which a test pattern was used to show the uniformity of focus and overall resolution of the system. The advantages of the Schmidt optical system were described as (1) high light gathering power; (2) freedom from off-axis aberrations; (3) freedom from chromatic aberration; (4) relatively simple component parts to the optical system; and (5) probable economy as compared to other methods.

Schmidt optics

The simplicity of the Schmidt optical system is due to the fact that only the spherical aberration and curvature of field need be corrected for by the addition of another lens. This lens is made very weak in power, and in this way introduces extremely small aberrations of its own. The lens is asymmetrical and because of its complex surface is more easily molded from plastics than ground from glass. These molded plastic correcting lenses for the Schmidt system are Lucite, and can be made inexpensively. The spherical mirror is glass and its top surface aluminized.

Dr. Maloff described the typical Schmidt projection system as having a cathode ray tube about one third the diameter of the spherical mirror and a correcting lens about twice the diameter of the tube. The curvature of the tube face is half the radius of the curvature of the mirror. Typical magnifications are 6 to 8.

Lens systems

The characteristics of refractive or lens projection systems for television were discussed by Dr. K. Pestrecov of the Scientific Bureau of the Bausch and Lomb Optical company. He described the problems of projecting a television image in a home receiver by the use of lens because of low brilliance on the fluorescent screen, and the wide angle of field required of the lens system.

Mr. Pestrecov said that an f/1.5 to f/.1 lens would probably be necessary to do an adequate job. He stated that he doubted if a lens faster than f/.1 could be made satisfactorily for the job. From data which he presented, it was brought out that an f/.1 lens at a magnification of 8 has approximately the same efficiency as the Schmidt system proposed for home receivers. The importance of the degree of image magnification on expressing the efficiency of an optical system was emphasized. Under certain conditions the refractive optical method of producing projection pictures might prove to be the answer particularly where low magnifications are involved, he added.

Direct viewing

The use of a large diameter picture tube for direct viewing of an image 13½ x 18 in. was described by Dr. A. B. DuMont of the DuMont Laboratories.

Dr. DuMont emphasized that with a direct view tube 20 in. in diameter this size picture can be obtained on a face which is relatively flat, and that the highlight values are about 20 foot lamberts as compared to about 3.5 foot lamberts for the best projection television system giving the same size picture. The improved contrast range which is possible with a direct view tube also was emphasized and figures which he quoted gave a 35 to 17 contrast range in favor of the direct view tube. The greater angle of viewing was given as plus or minus 80 degrees for a direct view tube as compared to about plus or minus 15 degrees for a projection system.

The lower anode voltage required on the 20 in. tube was also emphasized. The 20 in. tube which has been demonstrated by DuMont Laboratories operates at 15,000 volts, whereas the projection tubes of the 4 and 5 in. variety are operating between 28 and 30 kv. Longer life was forecast by Dr. DuMont for the large size tube, figures

given being for over 1,000 hours for these large types as contrasted to about 1/2 to 1/3 that amount for projection tubes.

The spot size problem in the 20 in. tube is simpler than obtaining the necessary small spot size in 5 in. tubes. The spot size of course is one of the factors which determines the resolution power of the tubes.

Another point brought out in favor of the direct view tube was the simpler focus problem in which the 20 in. direct view tube is focused by electrical control only. Projection tubes of course require optical adjustments of the various parts such as the lens or mirror system relative to the tube, and also the viewing screen as well as an electrical adjustment of the voltage.

Color television

Dr. Peter Goldmark of the Columbia Broadcasting System described the advancement that Columbia is making towards color receivers. He stated that Columbia is working on a new transmitter operating at 485 megacycles with a 525 line full color picture, and expects this equipment to be in operation soon. A 10 mc video band width will be required for the picture and a 25 per cent better horizontal resolution is expected with this wider band.

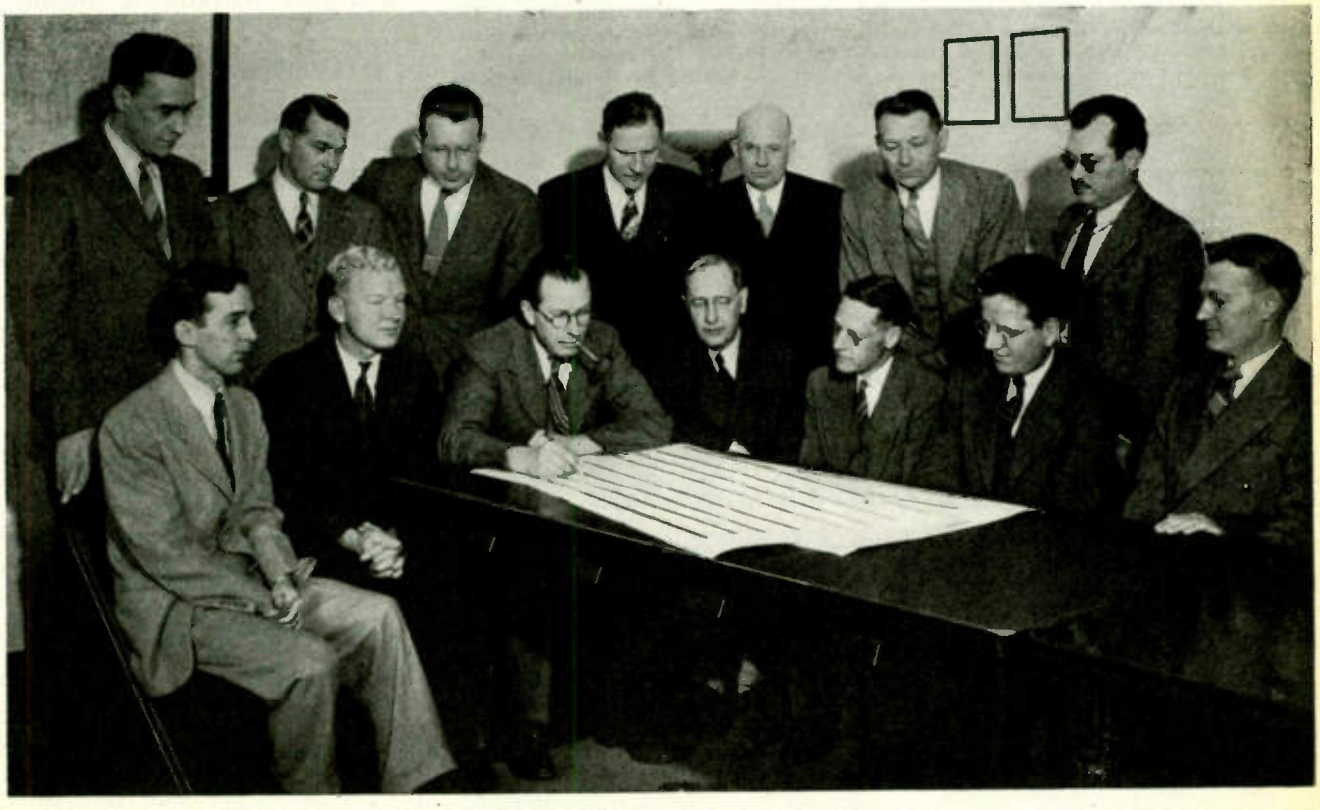
Better color

Dr. Goldmark stated that considerable improvement has been made in sychronizing the color disk and that it is noiseless in operation. He also stated that Columbia is developing a direct view receiver with a 7 in. tube and a plastic lens to produce an image equivalent to that obtainable on a 10 in. diameter tube. Two projection receivers are also being developed, he said, one using a Schmidt optical system, the other conventional lens optics.

Further Columbia developments include a directional antenna for frequencies in the neighborhood of 480 megacycles, complete with a self-contained rotating mechanism which is proposed to orient the array to the best receiving direction. Dr. Goldmark stated that it was the opinion of Columbia that the problems of ghosts and shadows at 480 megacycles would be approximately the same as those at 50 megacycles and that he felt it would be necessary for an antenna array to be directed toward the station which was to be received at any particular time. He stated that the directional antenna would occupy approximately the same volume as the present 50 megacycle double dipole double reflector array.

In connection with a question regarding the development of antenna systems for apartment houses and similar multiple dwellings, F. J. Bingley, Chief Television Engineer for the Philco corporation stated that at the recent convention of the Television Broadcasters Association, 26 television receivers were operated from two antennas mounted on top of the Hotel Commodore in New York City. One of these antennas was used to pick up the DuMont television station WABD while the other was used on the National Broadcasting company station WNBT. Two transmission lines connected the antennas to booster amplifiers which in turn distributed the output through 26 transmssion lines, one to each of the receivers. Mr. Bingley cited this example as the probable way in which the apartment house problems would be solved.

FEDERAL COMMUNICATIONS COMMISSION ALLOCATION ENGINEERS



Back row, left to right: C. M. Braum, C. H. Owen, J. H. Woffard, John A. Russ, L. C. Quaintaince, E. W. Allen and V. R. Simpson. Seated, left to right, C. B. Plummer, T. E. Daniels, George P. Adair (Chief Engineer), Dr. L. P. Wheeler (Technical Service Information Chief), G. E. Nielsen, K. A. Norton (Army Air Forces), Howard C. Looney. It is expec.ed that allocation of the complete spectrum will be completed this month

MODERN MEASUREMENT

By T. H. JOHNSON, Chief Physicist
Ballistic Research Laboratory
Aberdeen Proving Grounds, Md.

Numerous electronic devices aid ordnance design and permit checking ammunition at Aberdeen and in field

● The primary concern of the artilleryman is to hit his target, and if that is accomplished, it doesn't matter much how fast the projectile was going when it left the gun. On the other hand, there are many factors involved in hitting the target. These include the angle of the gun; the air density; the wind velocity; the shape, weight, and surface of the projectile; and finally, the muzzle velocity.

If you only observe the impact point, all of these factors come into play, but if muzzle velocity is measured directly, a direct check is obtained on what is going on inside the gun. These factors include the burning of the powder, the friction in the bore of the gun, and the sealing of the bore by the rotating band. If the projectiles are not hitting their target, a measurement of the velocity determines whether the trouble is inside or outside the gun. This requirement for a velocity measurement applies not only to the proof officer on the proving ground but also to the artillery officer on the firing line. In the advance base, there is also need to check both ammunition lots and the condition of the weapons issued for battle.

At the proving ground, it is also necessary to measure velocities to obtain the data from which firing tables are constructed. These tables give not only the range as a function of gun elevation for the standard velocity, but they also include the variations in range for variations from standard of velocity, air density, wind, and projectile weight. In order to evaluate each of these differential effects, measurements are required. Another important characteristic of a projectile is the drag due to air resistance, and this is determined by measurements of the change of velocity between two points on the trajectory.

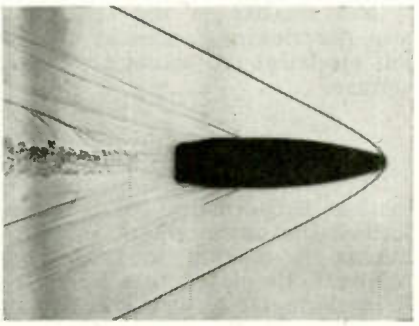


Fig. 5. Spark photograph of a .50 cal. bullet used for accurate position finding

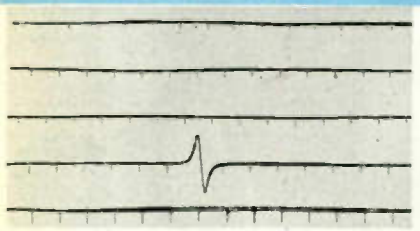
In general, velocity is not a quantity that is subject to direct observation. It is usually inferred from a measurement of the time required for the projectile to travel between two points at a known distance apart.

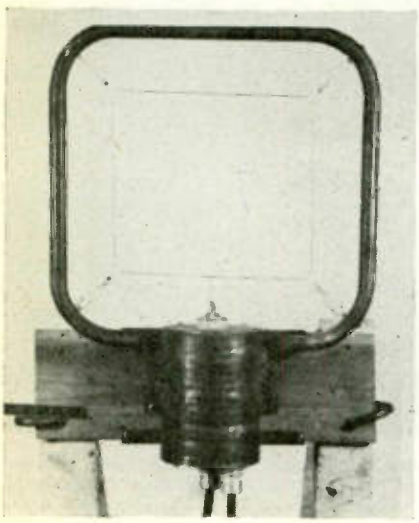
$$v = s \div t$$

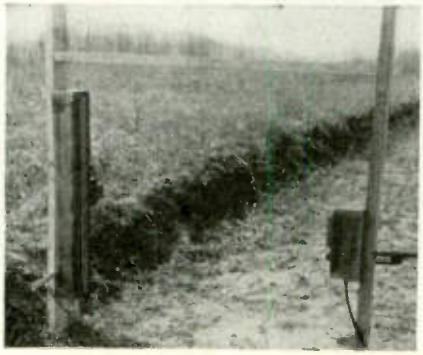
There are, therefore, two parts to the measuring device. First, we must have a pair of screens at an accurately determined distance apart, each of which generates a signal at the instant the projectile passes through it; and second, we must have an accurate means of measuring the time interval between the two signals.

In order to analyze the dispersion of the ammunition, it is necessary to measure velocities to about 1 ft. per sec. or .04 per cent. That is to say, a base line of 100 ft. between the two screens must be measured with an error of less than .04 ft.

Fig. 1 Top left. Oscillograph record of signal from solenoid screen. The sharp voltage reversal gives an accurate reference mark. Small vertical lines are time marks. Fig. 2 Bottom left) Pick up screen for electrostatic chronograph. The solenoid screen is quite similar. Fig. 3 Top right. Telephoto screen for field use. This equipment can be used anywhere to check ammunition and no proving ground installation is required. Fig. 4 Lower right. Photoelectric screen for small arms. Two slits, a fluorescent lamp and a photocell complete this simple installation







OF PROJECTILE SPEEDS

(about ½ in.) and the time of flight between the two screens, which is about 1/24 sec., must be measured with an error of less than 1/60,000 sec. As regards knowing the distance, the problem is not so much one of obtaining a measurement as it is in designing a screen having a position that is definite to within ½ in. In the measurement of time, it is clear that a special device is called for

Fig. 6. Spark photography stations in aerodynamics range permit speed plotting

to achieve the required accuracy.

Several different types of screens have been used. The Boulengé screen consists of a lattice of fine wires strung on a wooden frame. The wire is continuous and it carries an electric current. When the projectile pierces the screen, the wire is broken, and the cessation of current in the circuit marks the time of passage. This screen is subject to several obvious errors. The screen can be bowed outwards by the projectile before breaking occurs and in varying degree. Also, the broken wires may remain connected through the projectile for an uncertain time. The error in a screen of this type can be several inches.

Aberdeen screen

The Aberdeen screen consists of two foils or wire screens separated by a sheet of paper or other insulator, and a potential is established between the two screens. When the projectile pierces the screen, connection is made between the two sides, and a signal is generated. While more accurate than the Boulengé screen, this device is subject to some uncertainties of contact which may amount to an inch or more. Both the Aberdeen and Boulengé screens have the further disadvantage that they disturb the flight of the projectile, and they cannot be used if measurements of range are also to be made.

The solenoid screen consists of a coil of about 100 turns of wire, accurately wound on a wooden frame. The projectile is fired through the coil at right angles to its plane. Before loading, the projectile is magnetized by placing it inside a solenoid through which a large current is passed by the discharge of a condenser.

When the magnetized projectile is fired, the rate of change of magnetic flux in the solenoid screen induces an electromotive force in the coil, which varies with time in the manner shown by the oscillogram in Fig. 1. As the projectile enters the coil, the flux increases, causing a positive emf. When the magnetic center of the projectile reaches the center of the coil, the rate of change of flux is zero, the emf swings in the opposite direction. The rapid crossover from + to − occurring as the magnetic center of the projectile passes through the plane of the coil is used as the signal from which time is measured.

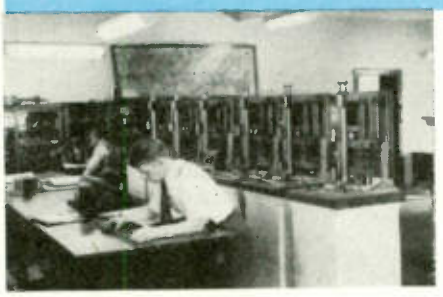
The solenoid coil has the advantage that it does not interfere with the flight of the projectile and it is accurate, for although one does not know just where the magnetic center of the projectile is, one may be sure that it is the same for each successive coil. Also, it has been shown that the time of occurrence of the signal is not sensitive to the distance from the center at which the projectile passes through the coil.

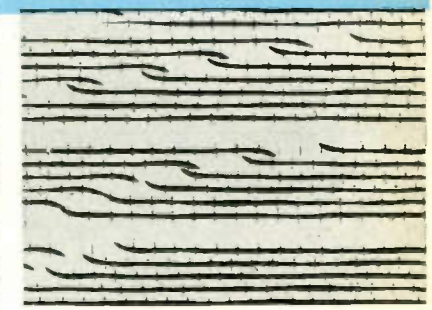
Electrostatic screen

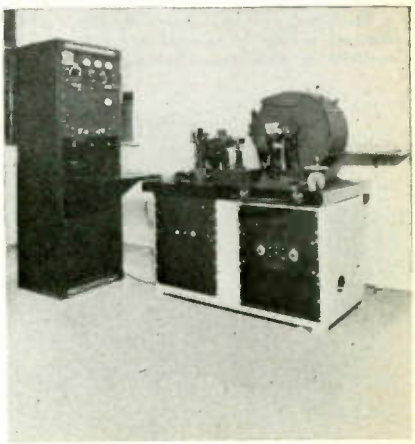
The use of these screens is limited, however, to projectiles made of magnetic steel, and it has not been possible to use them for some of the armor-piercing, high-velocity projectiles made of light metal with a heavy non-magnetic case.

The electrostatic screen Fig. 2 is useful when the solenoid screen fails. It consists of an insulated loop antenna which picks up the changes in potential due to the passage of an electrostatically-charged projectile. Projectiles are usually charged to a certain degree by air friction, but the effect can be intensified by deliberately spraying charge onto the projectile from

Fig. 7 Top left. Boulengé chronograph units connected to ranges in adjoining room. Marks made on a falling rod at time of first and second impulse show elapsed time. Fig. 8 Bottom left. Aberdeen chronograph measures time by sparks through paper in an accurately revolving wheel. Fig. 9 Bottom right. Drum camera chronograph. Light beam falling on revolving film makes a trace. Oscillograph galvanometer mirror moves beam when pulsed. Fig. 10 Top right. Portion of drum camera record. The vertical lines mark 1 millisecond intervals. Each turn makes a line







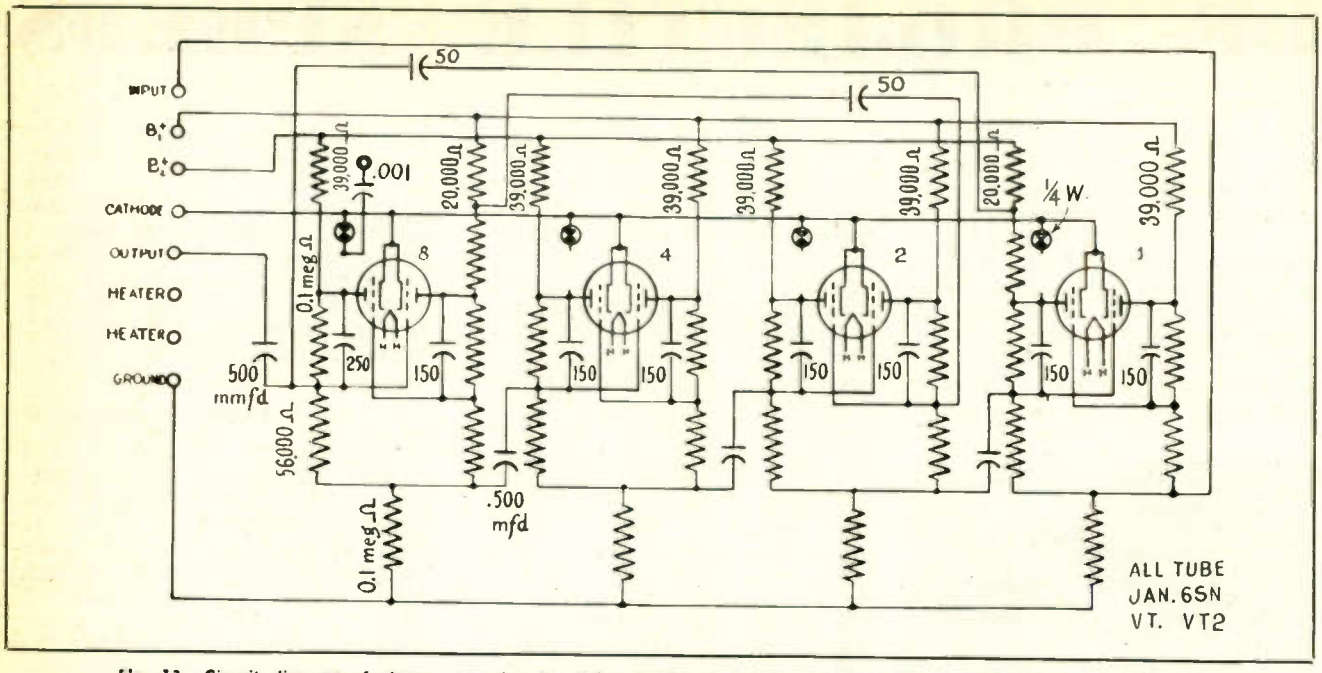


Fig. 12. Circuit diagram of chronoscope decade. Using the binary counter scheme of Wynn Williams, it shows the time elapsed in discrete numbers by means of lighted neon lamps. Marked 1,2,4,8, their sum in each row gives correct count

a brush discharge before it approaches the antenna. The signal generated in this case is proportional to the field strength, and hence, it rises to a broad maximum as the projectile reaches the center of the antenna. However, if this signal is differentiated electrically, the resulting signal exhibits the cross-over characteristic of the magnetic solenoid screen, with the attendant accuracy of that type of signal. These screens, however, have the limitation that they cannot be used with tracer ammunition since all electrical charges are quickly discharged by the burning powder in the base of this type of projectile.

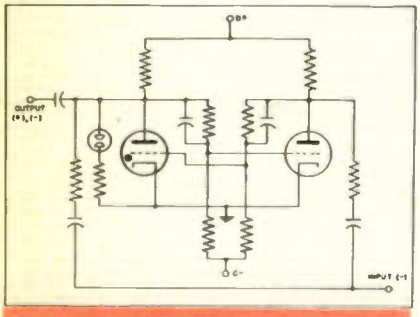
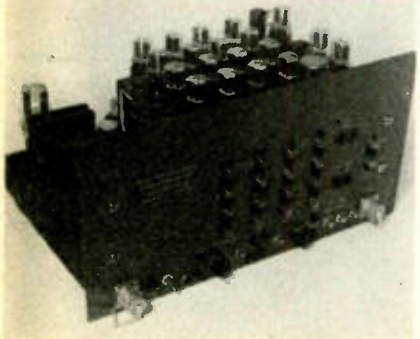


Fig. 11. Unit circuit of counter chronoscope. Circuit is stable with either tube conducting.

Fig. 13. Portable counter chronoscope used with telephone screen in combat areas to check ammunition. This model contains 4 decades



Photoelectric screens (Fig. 4), in various forms also are used. The telephoto screen (Fig. 3) consists of a photocell placed behind a slit and an objective lens which casts the image of the projectile upon the plane of the slit. When the image of the projectile silhouetted against the sky passes over the slit, the photo-electric current is reduced and a signal is generated. This is amplified and differentiated, and the timing is generally measured between the resulting positive pulses generated by the sharp increase of light at the base of the projectile.

Time measurements

For measurements of small arms projectiles in closed ranges, the photo-screen (Fig. 4) may consist of a fluorescent lamp and photocell. In this case, the optical system consists simply of two slits, the lamp and the photocell. For very accurate determinations of position, a spark photograph of the shadow of the projectile is taken. Where the projectile comes into the field of view, a signal is picked up on an antenna which after a suitable time delay, fires a spark and a silhouette image of the projectile is obtained on a photographic plate (Fig. 5). The same plate contains the shadow of a plumb line whose position is known with extreme accuracy, and by careful measurement, the exact position of the projectile can be determined to a fraction of a millimeter. Successive sparks from two or more such stations also afford signals for marking the time intervals.

Up to the end of the last war and even now in many ordnance testing establishments, the time of flight between screen signals was generally measured by the Boulengé chronograph (Fig. 7). In this instrument, the distance of free fall under gravity is used as the basis of the time measurement. This is expressed by the well known equation:

$$s = \tfrac{1}{2}\, gt^2 \text{ or } t = \sqrt{\frac{2s}{g}}$$

The signal from the first screen breaks the current in a magnet, allowing a weight in the form of a long rod to fall. The second signal allows another weight to fall which strikes a trigger plate, causing a knife to fly out and strike the rod-shaped weight, which has generally attached to it a replaceable strip of soft metal. The dead time of the instrument is determined by tripping both weights simultaneously. Then: $t = t_1 - t_0 = \sqrt{\frac{2s}{g}} - \sqrt{\frac{2s_0}{g}}$, where both s and s_0 are measured from the nick made by releasing the knife without tripping the weights.

Under the conditions of measurement, an error of .001 in. in s corresponds to an error of 1/20,000 sec. in time. The actual errors are somewhat greater than this, and an accuracy of about 10 ft. per sec. is the best that can be realized in the velocity measurement. How-

ever, the system has the advantage of simplicity, and the constant of gravity can be relied upon from day to day.

The Aberdeen Chronograph is also a simple instrument but depends upon a source of 60-cycle power, accurately controlled as to frequency. Fig. 8 shows one of these instruments with its small drum driven by a synchronous motor. A strip of paper thrown into the drum is held against the circumference by centrifugal force, and it is marked by sparks which strike through the paper from a sharp point adjusted to be close to the paper. These sparks can be triggered by signals from screens of any of the types just described. The paper speed is exactly 1500 cms. per sec., and an error of ¼ mm., therefore, corresponds to 1/60,000 sec., the accuracy required for 1 ft. per sec. accuracy in muzzle velocity with a 100 ft. screen distance.

Drum camera

The Drum camera Fig. 9 is another very reliable, but more cumbersome, method of measuring time. Here, a photosensitive paper or film is attached to the outer surface of a cylindrical drum, which rotates at high speed and at the same time, moves slowly along its axis to prevent overlapping of the record. A light beam reflected from an oscillograph galvanometer mirror makes a trace on the paper, and deflections caused by the screen signals are recorded.

On the same record, another galvanometer driven by a standard 1000-cycle frequency generator produces time marks at 1 millisecond intervals. The timing galvanometer is generally arranged to deflect in the direction of motion of the paper and with such an amplitude that in one direction, the light spot is moving across the slit at the same speed as the paper. Thus, during that phase of the motion, the light beam is on one area of the paper for a relatively long time, and an intense bright line is produced. A record of this type is shown in Fig. 10.

A refinement of this technic consists of photographing the spot of a cathode ray tube on the drum camera. The signals from the screen are applied to the transverse deflecting plates of the CR tube, and time marks are made by deflecting the beam in the same direction, at 1 millisecond intervals, to form short pips on the trace. The accuracy of such a record is about 2 microseconds.

During the past few years, the so-called electronic counter chronoscope (Fig. 11) has been used on an ever increasing scale. This device is based upon an electronic counting circuit first used by Wynn Williams in England for counting radio-active rays registered by a Geiger counter. It has the great advantage that the time, in units of ten or even one microsecond, can be read from its dial directly and without any measuring, just as you would read the answer from an adding or calculating machine.

The complete instrument consists of three parts, a crystal-controlled oscillator which supplies consecutive pulses at intervals of 1/100,000 sec., a gate circuit which is opened by the signal from the first screen and is closed by that from the second screen, and a counter which registers the number of pulses which get through the gate while it is open.

A pair of triodes are linked together as a trigger circuit which has two stable states. The left side may have a positive grid and the plate circuit be conducting a saturation current while the right side is completely cut off by a negative grid, or the circuit can be in the opposite state, with the right side conducting and the left side cut off. The circuit reverses from one state to the other wherever negative pulse is applied at the input.

Negative pulses

It is important to note that negative, and not positive, pulses will effect the turnover. If, for example, the left side is conducting, positive pulses applied to the right-hand grid are short-circuited by the impedance of the left-hand plate, which is low since that tube is conducting. Of course, positive pulses applied to the left-hand grid do not tend to reverse the state of the circuit since that grid is already positive.

A negative pulse, on the other hand, applied to the left-hand side is shunted only by the non-conducting plate of the right side, and since this is a high impedance, it is not attenuated. Hence, it effects a reduction in the plate current on the left. This reduction generates a positive potential on the right grid, which turns on the plate current on the right and this, in turn, generates a negative voltage on the left grid, which reinforces the original negative pulse. Similarly, when the right side is conducting, it again takes a negative pulse to bring the circuit back to the original state.

Now, let us look at this circuit as a generator of pulses which might be used to actuate a second unit of similar design. For each reversal from conduction on the left to conduction on the right a positive pulse is generated at the output, but, as already seen these would be ineffective if applied to another similar circuit. On the opposite reversal, negative pulses are generated. Thus, only half as many

(*Continued on page* 170)

Fig. 14 Counter for aerodynamics range giving time in units of .625 microseconds to show slowing of bullet in its flight

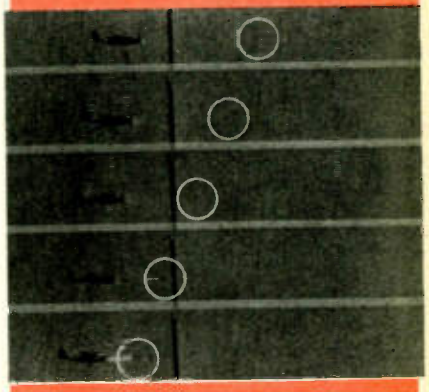


Fig. 15. Film from ribbon frame camera used in photograph flight of projectiles. Rocket is shown fired from airplane

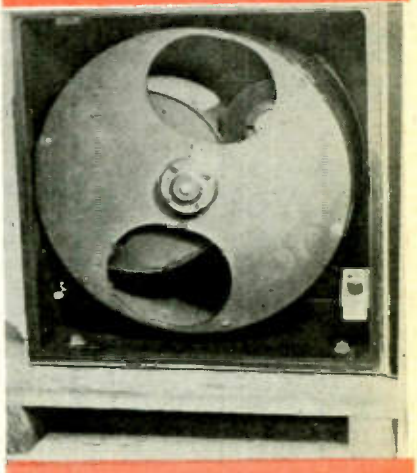


Fig. 16. Shutter and film winding mechanism of ribbon frame camera. Slits in turning drum act as focal plane shutters

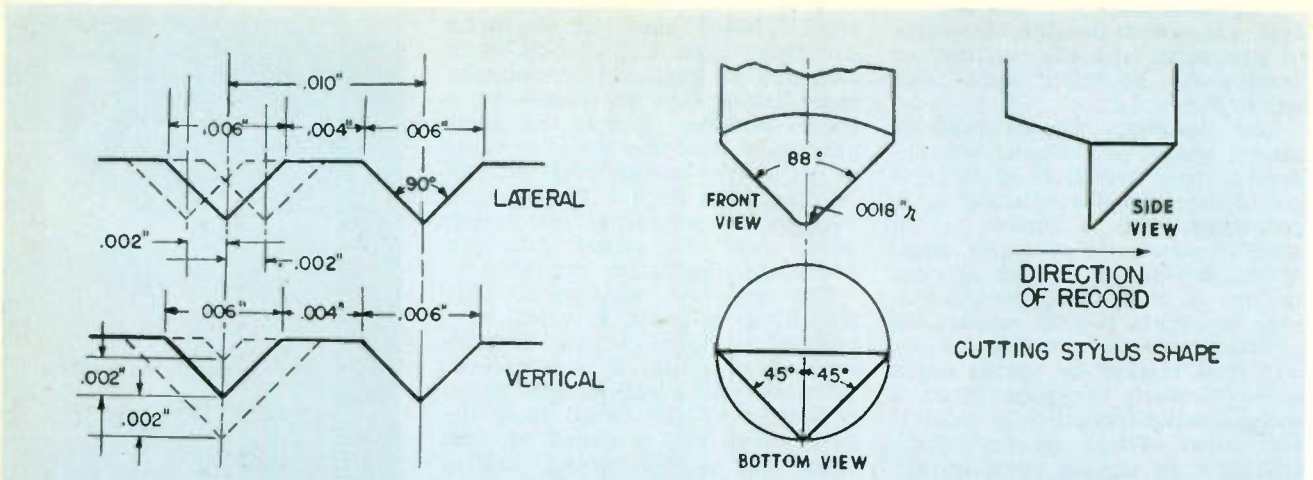


Fig. 1—Cross sections of adjacent grooves of a lateral and a vertical record having the same groove pitch and depth of modulation. Fig. 2—Approximate shape of a typical recording stylus. Trailing faces at 45 deg. scrape the groove sides when lateral and forward speeds are equal

PHONOGRAPH DYNAMICS

By W. S. BACHMAN, Engineer
General Electric Receiver Division, Bridgeport, Conn.

Groove spacing restricts amplitude of reproduction while cutter, stylus shape, and mechanical Q limit fidelity

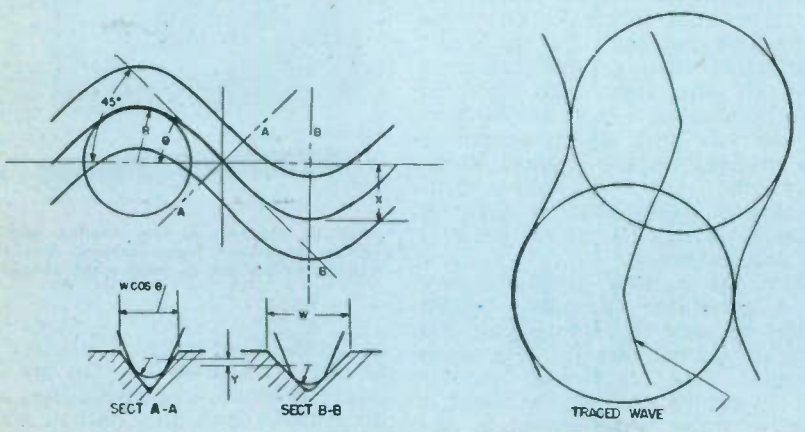
● Phonograph records for entertainment purposes are principally made by cutting a spiral groove on a disk of suitable material. The tip of the cutting stylus is made to vibrate in accordance with the speech or music signals, causing a modulation of the spiral groove. This modulation may be either lateral, in which the cutting stylus vibrates along a radius of the disk, or vertical, wherein the depth of penetration of the cutting stylus into the disk is varied.

To produce copies of the original recording, it is usual to plate the cut disk after making its surface electrically conductive by sputtering or silvering. This results in a metal negative which may be used as a stamper or may be used to produce a mother from which other stampers are made. Since the sputtered or silvered surface is too soft to serve for many pressings, it is also necessary to "front plate" the stamper with some hard metal, such as chrome or nickel. This extra layer of metal on the working surface and the subsequent wear of that surface have much to do with the choice of shape for a reproducing stylus.

As in other communications systems, the amplitude of a phonograph reproducer is limited and depends on the spacing between adjacent grooves. This is clearly so if lateral recording is considered, and it may be shown that vertical recording suffers from the same limitation.

Fig. 1 is a comparison between a lateral and vertical recording system. This assumes a 90 deg. included angle on the face of the cutting stylus. Using the same average penetration it is seen that both require the same groove spacing to accommodate the same depth of modulation without interference. Of course, if the included angle of the cutting stylus face were reduced, vertical recording would have the advantage of more grooves per inch, but it is clear that the amplitude is limited both by the groove spacing and the average depth of penetration, the former being the limiting factor in an economical system.

Fig. 3 (Left)—Illustrating the reduction in the included angle of the cut groove at the velocity peaks. Fig. 4 (Right)—Sharp change of direction of the reproducing stylus when the radius of curvature of the groove is equal to the effective stylus tip radius



Since lateral recording is used in all present day commercial pressings for home use, this discussion will be concerned with that method, although most of the considerations apply as well to vertical recording. The cutting stylus commonly used has the shape shown in Fig. 2. At low frequencies the limitation on the amplitude of cut is the adjacent modulated groove. Assuming .006 in. groove width at the surface of the record and .010 in. groove spacing, a peak displacement of .002 in. would be permissible without interference between adjacent grooves.

Lateral velocity limit

As the frequency increases, another limitation is imposed which is a function of the peak lateral velocity of the stylus with respect to the groove velocity. When these two are equal, the angle between the recorded wave and the unmodulated groove is 45 deg. as shown in Fig. 3.

Now reference to Fig. 2 reveals that there is an angle of 45 deg. between the front face of the cutter and the trailing faces, and also 45 deg. between the front face and the tangent to the groove being cut. Thus, at this critical value of stylus to groove velocity ratio, the slope of the recorded wave is parallel to the trailing face. Any increase in lateral velocity will cause interference between the trailing edge of the cutting stylus and the cut groove. The angle between the trailing face of the cutting stylus and the tangent to the unmodulated groove is called the clearance angle. In this case it is 45 deg. with no modulation, and 0 deg. when the lateral velocity equals the groove velocity.

Assuming that a sinusoidal wave having a peak displacement of .002 in. is recorded, the displacement x at any time is,

$$x = .002 \sin \omega t$$

the lateral velocity

$$V \quad \text{is,}$$

$$V = \frac{dx}{dt} = .002\ \omega \cos \omega t$$

Assuming also that the minimum usable record radius is 2 in., and the speed of rotation is 78 rpm the groove velocity is

$$V_0 = \frac{2\pi \times 2 \times 78}{60} = 16.4 \text{ in./sec.}$$

This may be equated to the peak permissible lateral velocity (.002ω)

$$.002\omega = 16.4$$

$$\omega = \frac{16.4}{.002} = 8180$$

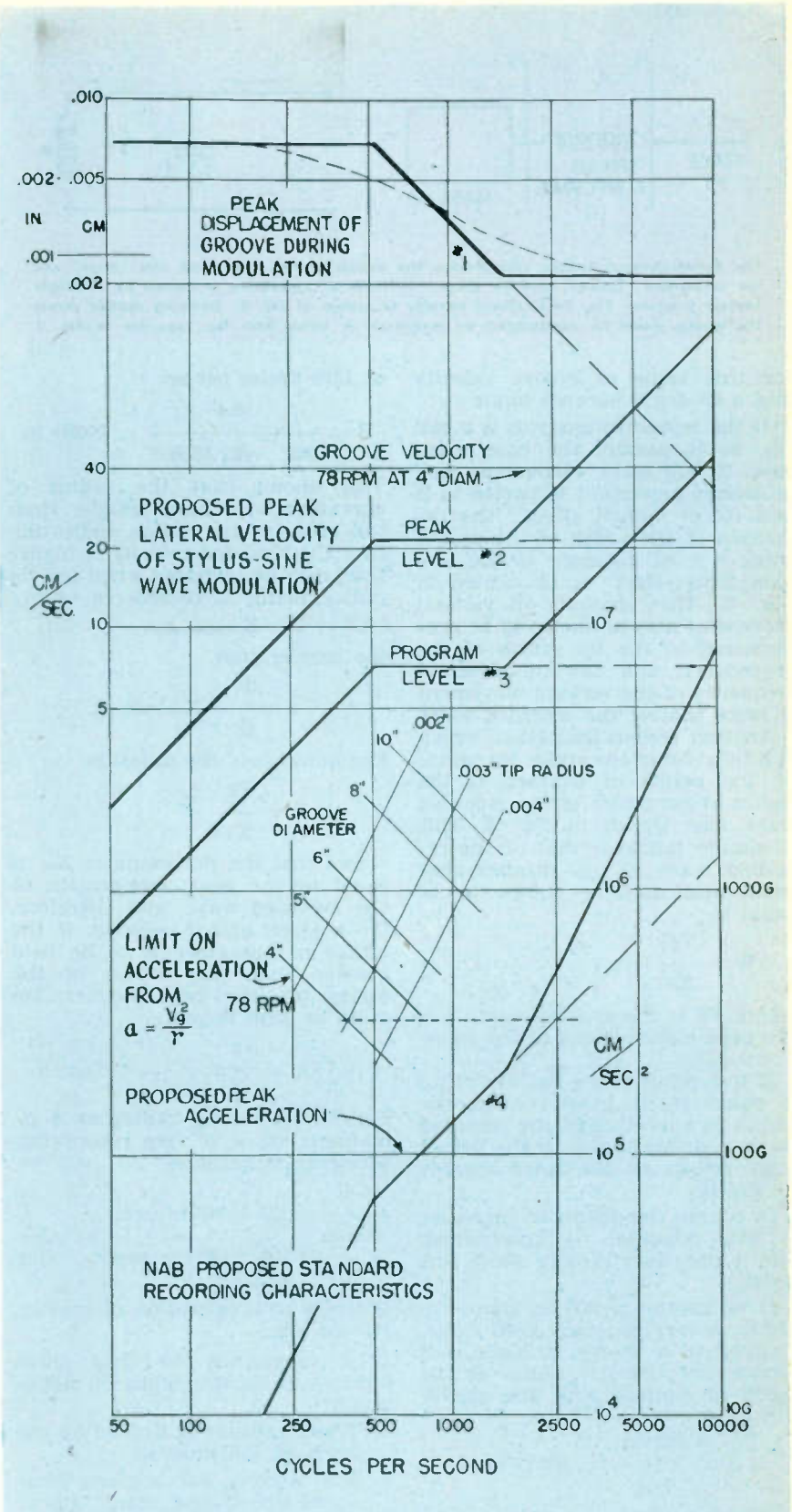


Fig. 5—Plot of groove displacement, curve #1; its first derivative, peak velocity, curve #2; program level about 10 db lower, curve #3; the second derivative, peak acceleration curve #4; also shown are the limits on acceleration imposed by the effective radius of the stylus tip

$$f = \frac{\omega}{2\pi} = \frac{8180}{2\pi} = 1300 \text{ cycles/sec.}$$

Thus it is seen that the peak displacement of .002 in. cannot be maintained above 1300 cycles/sec.

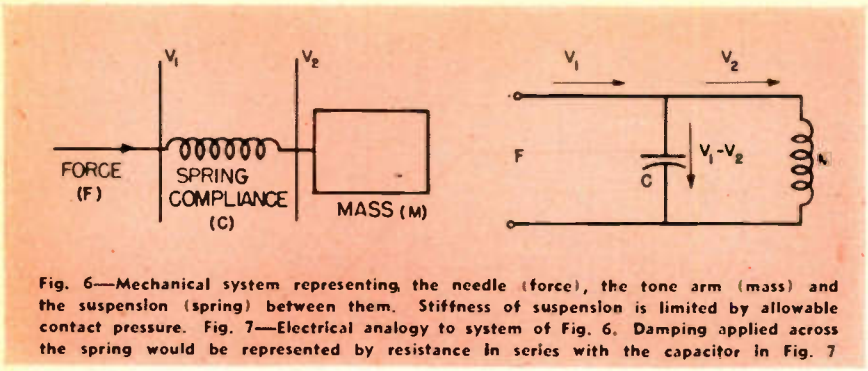


Fig. 6—Mechanical system representing the needle (force), the tone arm (mass) and the suspension (spring) between them. Stiffness of suspension is limited by allowable contact pressure. Fig. 7—Electrical analogy to system of Fig. 6. Damping applied across the spring would be represented by resistance in series with the capacitor in Fig. 7

for this value of groove velocity and a 45-deg. clearance angle.

If the reproducing stylus is a ball tip, as is usually the case when new, it will have vertical as well as lateral movement imparted to it because of "pinch effect," the reduction of the width of the groove when it is at an angle to the zero axis. This effect* is illustrated in Fig. 3. The amount of vertical movement may be shown to be proportional to the tip radius of the reproducer, and the fundamental frequency of the vertical movement is twice that of the recorded wave.

Another serious limitation, which is a function of the stylus tip radius at the points of contact, is the radius of curvature of the recorded wave also shown in Fig. 3. This minimum radius is that of the recorded wave at its displacement peak, and may be shown to be equal to

$$R = \frac{Vg^2}{X\omega^2} \quad \ldots\ldots\ldots\ldots (1)$$

where Vg is the groove speed, X is the peak displacement of the wave, and $\omega = 2\pi$.

If the radius of the ball stylus tip is equal to or greater than the radius of curvature of the recorded wave, a discontinuity in the traced wave results as illustrated roughly by Fig. 4.

Of course, the distortion increases as this condition is approached, and it rises very rapidly above this point.

If we assume a .003 in. stylus tip radius, a very generally used value, running in a 90-deg. unmodulated groove, the effective radius in the plane of contact with the groove will be

$$r = \frac{.003 \text{ in.}}{\sqrt{2}} = .00212 \text{ in.}$$

Suppose that we calculate the smallest radius of curvature of the wave limited by the clearance angle as described above and which has a maximum displacement .002 in. at 1300 cycles per sec.

$$R = \frac{16.4^2}{.002 \times (2\pi\ 1300)^2} = .00201 \text{ in.}$$

This shows that the radius of curvature is actually smaller than the effective tip radius, indicating that the recorded velocity is higher than may be tolerated when the tip radius factor is considered. Since

$$V = X\ \omega \cos \omega t,$$

the acceleration

$$a = \frac{dv}{dt} = X\omega^2 \sin \omega t$$

Examination of the equation

$$R = \frac{Vg^2}{X\omega^2}$$

shows that the denominator $X\omega^2$ is equal to the peak acceleration of the recorded wave, and therefore, for a given groove velocity, if the radius of curvature is to be held greater than the radius of the stylus tip, the peak acceleration must be kept below

$$a = \frac{Vg^2}{r}$$

For a .003 in. tip radius at 4 in. diameter on a 78 rpm record this acceleration becomes

$$\frac{16.4^2}{.00212} = 128 \times 10^3 \text{ in./sec.}^2$$
$$= 322 \times 10^3 \text{ cm./sec.}^2$$
or 328 g

Where g = acceleration of gravity, 980 cm./sec.^{2}

To summarize we find three limitations on the depth of modulation:

1. The amplitude is limited by the pitch of the grooves.
2. The velocity, for a given rotational speed and mean groove diameter, is limited by the clearance angle of the cutting stylus.
3. The acceleration is limited, for a given groove speed, by the tracing stylus diameter at its points of contact with the groove.

Since the signal to noise ratio increases as the depth of modulation is raised, it is only natural that the ceilings indicated above are closely approached and often exceeded in cutting records.

Recording characteristics

The National Association of Broadcasters has set up tentative standards for recordings for radio broadcasting, and since many modern recordings are made to them, or nearly so, it is of interest to examine them in the light of the limitations analyzed above.

The two curves 2 and 3 in Fig. 5 are based on the recommended standards of the National Association of Broadcasters Recording and Reproducing Standards Committee. The lower one corresponds to "program level" which is equivalent to a lateral velocity of 5 cm/sec at 1000 cycles. The upper one corresponds to the contemplated program peaks which, experience has shown, run about 10 db (approximately 3 to 1) above the sine wave load handling capacity of the system. These curves all show the maximum sine wave values.

Curve 1 shows the peak displacement from the unmodulated groove position. It is seen that this is about .00266 in. at the lower frequencies, somewhat greater than the value discussed previously for .010 in. groove spacing. This is reasonable, for the probability of opposite peaks on alternate grooves occurring at the same radial position is not very great.

This displacement is maintained up to 500 cycles. From 500 to 1580 cycles the displacement drops linearly with frequency. From 1580 cycles upward the displacement is held constant. It should be mentioned that the actual characteristic does not have the sudden changes in slope indicated on these curves, but is smooth as indicated by the dashed line. The sharp cornered curves are plots of the asymptotes of the actual characteristic, since it is much easier to indicate the crossover points in this way. It should also be noted that a rise in displacement at the low frequency end, recommended by NAB, has been omitted for simplicity.

Curve 2 is the first derivative of curve 1. Since the velocity is the rate of change of displacement $\frac{dx}{dt}$ this then is a plot of the velocity of the recorded wave. A line indicating the groove speed of a 78 rpm record at a radius of 2 in. is also indicated, and curve 2 reaches this value at 3000 cycles. Of course, at the outside of a 12 in. record, curve 2 would cross at 8700 cycles. Thus

* Distortion in Tracing Phonograph Records, Pierce and Hunt
Journal Acous. Soc. Amer. 10, 14 (1938)

the bearing of groove speed on the allowable recording level is illustrated. Fortunately, the probability of difficulty from this source is not very great, for the distribution of energy in speech and music is such that the recording velocity on program material levels off very nearly along the dashed extension of curve 2.

The acceleration of the recorded wave is indicated in curve 4,

$$a = \frac{dv}{dt} = \frac{d^2x}{dt^2}$$

which is the derivative of the velocity characteristic. The magnitude of these accelerations is indeed startling, and for comparison the scale is indicated also in terms of the number of times g (the acceleration of gravity) each value represents.

In the foregoing analysis it was shown that the minimum radius of curvature of the recorded wave is proportional to the square of the groove velocity and inversely proportional to the acceleration. Thus, for a given radius of contact with the groove and groove speed, it is possible to find the allowable acceleration.

$$\text{Maximum acceleration} = X\omega^2 = \frac{Vg^2}{r}$$

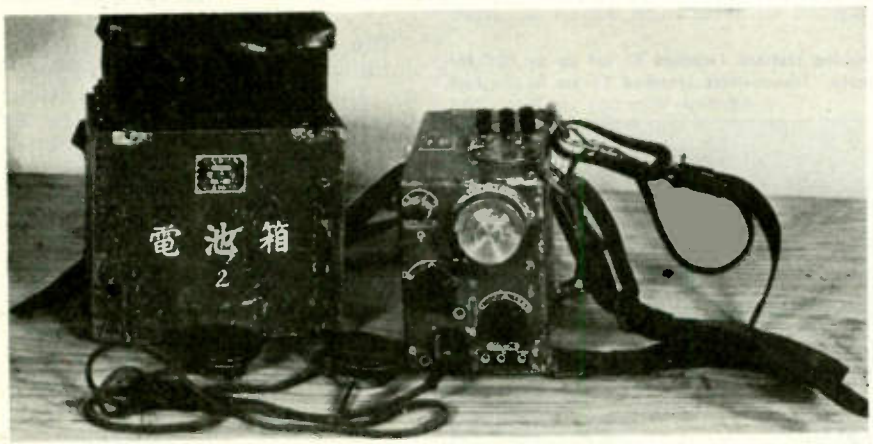
Several values are indicated for various tip radii in a 90 deg. groove, and the range from inside to outside of the record. Here it is seen that, at the inside of the record, frequencies as low as 2000 cycles are subjected to serious distortion when traced with, say, a .003 in. tip radius stylus. The dotted line shows the maximum allowable acceleration for a .003 in. tip radius stylus at 4 in. groove diameter running at 78 rpm. Some relief might be had by using a smaller tip radius, but this causes other difficulties.

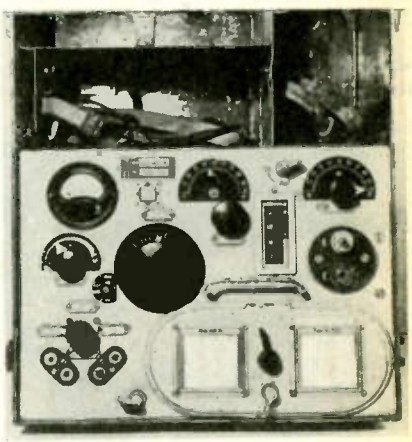
Groove wear

As mentioned in the introduction, the front plating of the stamper, and the wear it suffers in production causes an increase in the radius of the bottom of the groove on the pressed record. If the stylus radius is smaller than that of the groove, it will be intermittently driven by one side or the other, and will give an unnecessarily high "scratch" level in the reproduction. Although .003 in. radius is too small for some commercial pressings, it

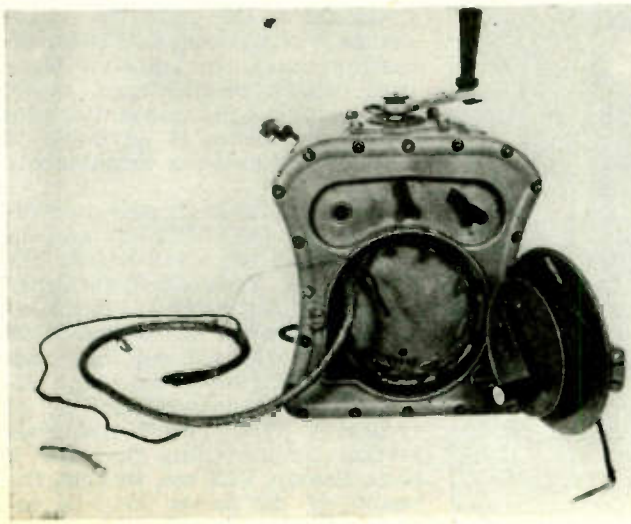
(*Continued on page* 124)

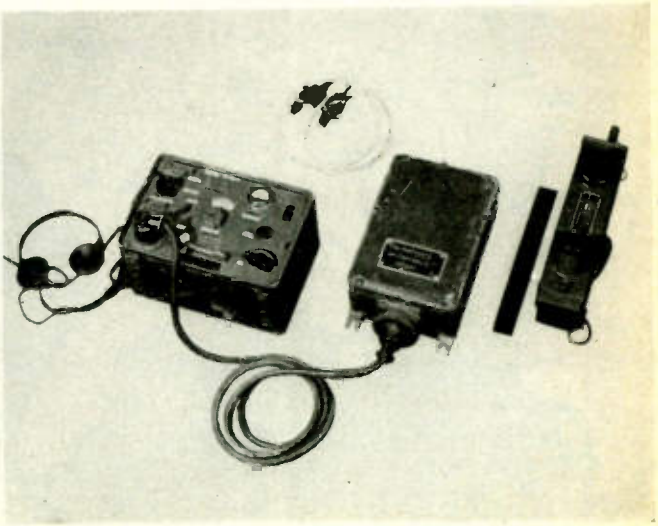
CAPTURED ENEMY RADIO EQUIPMENT





Above (left) Japanese Walkie-talkie with a frequency range of 2.5—4.5 mc powered by a 1.5, 135 volt battery. Set is comparable to our model SCR 194. (Right) German man pack receiver, intercept and monitoring type covers four bands 100 to 6670 kc, and is used with pack transmitter in forward echelon. Below (left) German emergency transmitter for sea rescue, prototype of our BC-778. Note antenna reel, lead in, ground wire and crank. (Right) German Handie-talkie compared with our SCR 585 at right. The one foot ruler shows the relative size.





MEASUREMENT TECHNIC

By HOWARD D. EVANS
Electronic Industries, Washington Bureau

Methods and equipment that will be used by FCC and industry engineers in determining FM and tele interference

● In an effort to determine the amount of interference that will be encountered in future FM broadcasting on new allocations, the Federal Communications Commission in June launched a three months' program to monitor a selected group of broadcasting stations for interference from ground radiation, shadows, sporadic E and tropospheric effects.

The program being conducted at the present time by the government technical experts in conjunction with industry engineers is based on the broadcasting of present stations and new stations that are expected to start operating within the next thirty days. The system also uses some emissions from stationary radar stations.

For the most part, the system covers the eastern states, but lines have been extended as far west as Nebraska and into the southern region; however, the focal point at the present time is New York city.

The monitoring program is designed to determine which of three alternative allocations in the 44-108 mc region will best serve the public. The plan will attempt to cover the entire field with some tests (mobile) being conducted on small local stations. George P. Adair, chief engineer for FCC, late in May enlisted the aid of twenty-five radio engineers who formed a sub-committee to direct the actual recording monitoring in the program.

Map showing location of the monitoring and measuring stations (marked R) set up by FCC for tests to determine interference at various frequencies. Transmitters (marked T) are in the East

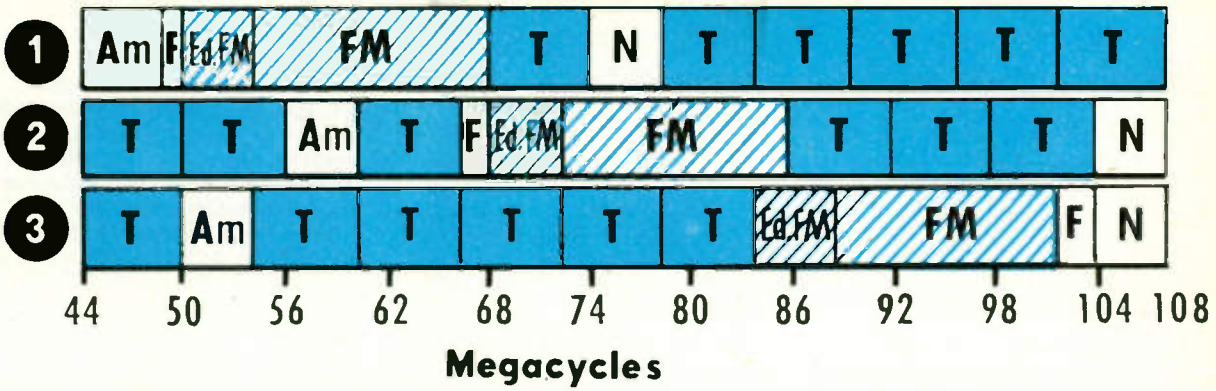
Recording sites

The following list shows the recording sites that are being used by the Federal Communications Commission, and the stations or transmitters that will be the object of the monitoring program:

Recorder Site	Transmitters: Paxton		New York City		
	WGTR	RADAR	W2 XMN	WABD	RADAR
Princeton, N.J.	—	—	42.8	83.75	105
Philadelphia	—	—	42.8	83.75	105
Laurel	44.3	—	42.8	83.75	105
Roanoke	44.3	—	—	83.75	105
Atlanta	44.3	—	—	83.75	105
Montgomery	44.3	—	—	83.75	105
Detroit	44.3	101	—	83.75	—
Allegan	44.3	101	—	83.75	—
Iowa City	44.3	101	—	83.75	—
Grand Island	44.3	101	—	83.75	—

The Radar frequencies are approximate, as no frequencies can be selected until more definite information is available on the units. Inasmuch as the directivity of antennas is comparable to FM broadcast antennas, the units are being used without modifications, except that terrain at the transmitter sites sometimes makes it advisable to increase the antenna height above normal.

One unit has been placed at Alpine, N. J., near W2XMN, and directed along the southwestern line of recorders. The antenna furnished with the unit has been placed between crossarms of the W2XMN tower. The second unit has been placed at Paxton (Mass.) and directed along the western line of recorders. The lowest frequency station for recording Sporadic E is at Paxton, 44.3 mc, so that the results of the survey may be co-



In this chart, showing FCC's three Alternatives for the 44-108 mc portion of the radio spectrum, AM stands for Amateur; F, Facsimile; Ed FM, Educational FM; T, Television; N, non-governmental fixed and mobile stations. Additional chart appears on page 73

RADIO INDUSTRY UNITES ON ALLOCATION ALTERNATIVE NO. 1

FCC's proposal of three alternate allocation plans for FM and Television, with the prospect that engineering tests and studies may delay action until late in 1945, imperiling the whole postwar start of FM and video, has brought about a united front in the radio industry, urging immediate FCC authorization of Alternative No. 1. The FM and television broadcasting groups (FMBI and TBA) initiated the move to get immediate action on No. 1 as the best compromise. RTPB meetings supported this position. The independent pioneer FM manufacturers petitioned FCC for prompt authorization, and RMA members were discussing similar action.

As the result of this united industry demand for immediate approval of Alternate 1, it is learned that FCC may consider ratification of the No. 1 arrangement early in July.

ordinated with previous measurements.

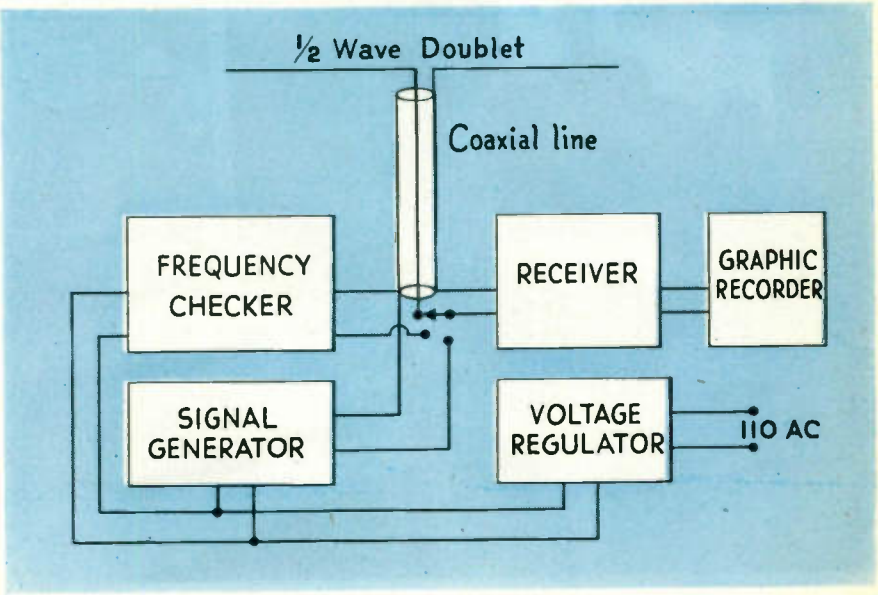
For continuous tropospheric measurements, W2XMN at Alpine has been chosen, because path distances more nearly coincident with WABD are required for comparable results. For this purpose the original antenna array at W2XMN will be satisfactory. This may be changed if the engineering committee determines that Alpine rather than Schenectady represents better terrain for making a comparative coverage survey.

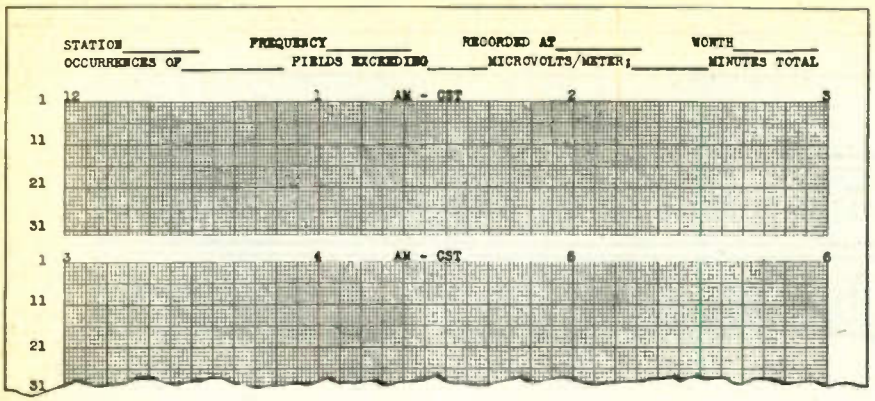
The question of comparative coverage on three frequencies has been brought up several times, but the general opinion of engineers involved was that the present concern is with tropospheric and sporadic E propagation effects. Hence no extensive coverage survey for the evaluation of comparative shadow effects and ground wave attenuation over various types of terrain is now being made. The FCC advises that it is the intention of the commission that such a survey be made, and feels that Schenectady is the proper place for it. This location provides the simplest solution, since but one additional transmitter and antenna are required, for which modified radar units can be used. Other possible locations having FM transmitters in the 40-50 and 72-84 mc ranges are New York city and Philadelphia, but it is doubtful that stations reasonably near and with antennas comparable in height to the present antennas can be found to which the radar equipment can be adapted for furnishing the third frequency, as is the case at Schenectady.

The New York and Philadelphia stations have the further disadvantage that higher noise levels may obscure the signals throughout a large percentage of the area, particularly for the highest frequency, where a lower power is available. Extensive mobile and fixed location measurements are being made by commission engineers over a period of several weeks at the selected locations.

In addition to the above coverage survey the industry has agreed to continuous comparative measure-

Block diagram showing the nature of the equipment being used in monitoring-measurement tests by FCC and industry engineers. For complete list of the instruments being used see text of article





FCC styles this form an Occurrence Sheet, five being required for a complete record of five different levels. Character of propagation interference will be entered and charts currently analyzed

ments on two or more frequencies at other locations. All frequencies are being measured at the same locations and distances from the transmitter so that the highest frequency will be above the noise level at all times but stations will be far enough apart so that fading will occur at all frequencies. Recording equipment at these sites will be set up and during certain periods as agreed, recordings and analyses of each will be taken.

Equipment at each of the recording sites that were listed above and at any other sites that have been chosen for continuous recording is as follows:

Hallicrafters S27 receiver or equal—1 per frequency

RF converter, sensitivity of 1 μv or better, 40-50 mc output—1 per frequency above 48 mc

Esterline - Angus graphic recorder or equal—1 per frequency

Raytheon voltage regulator or equal —125 watts

Ferris 18C signal generator or equal —1 per frequency

Frequency indicator for accurate tuning in the absence of signals —(GR 620AR or Hallicrafters HT7 and receiver for WWV)—1 per frequency

Halfwave doublet antenna and lead-in—1 per frequency.

Antennas are erected at a height of thirty feet or as near there as practical, since it is not possible to correct for height for waves arriving at various vertical angles. A separate half-wave doublet is being used for each frequency, erected broadside to the transmitter and so as to have as little effect as possible on the other antennas. Antennas supported end to end are found to be satisfactory for the western line of recorders even though the 83.75 mc antenna will not be exactly broadside to WABD.

Lead-ins are coaxial cable, either beaded or solid polystyrene, or of twisted pair if coaxial is not available. Open wire lines and rubber insulated coaxial are not being used.

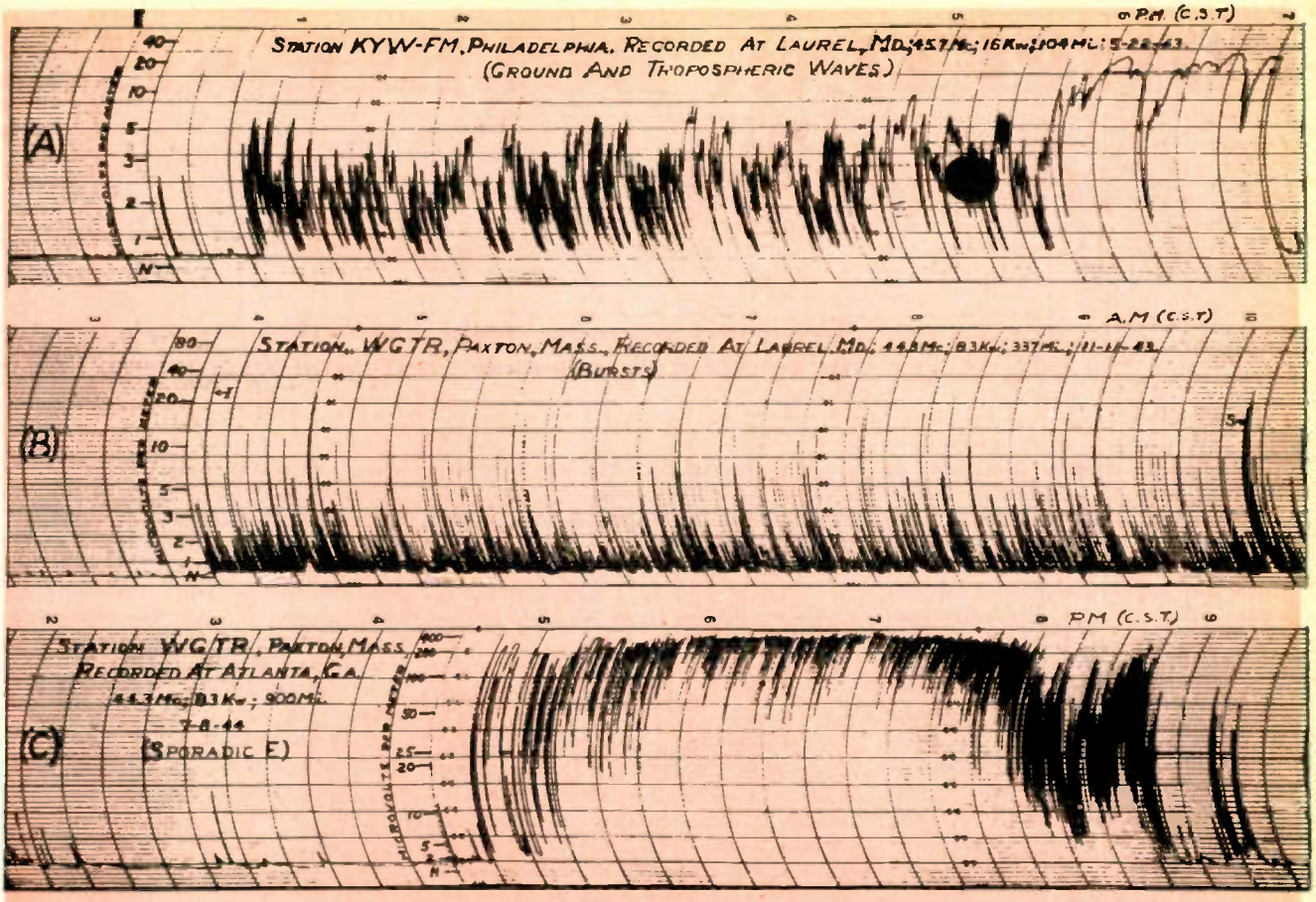
Calibration method

The ratio of field strength to recorder input is obtained for each recorder by setting up a constant field at or near the desired frequency by a small transmitter placed as far as practical from the antenna in the direction of the station to be recorded, noting the input microvolts indicated by the recorder, removing the recorder antenna and substituting the antenna of a field strength meter in its place, measuring the field at that point, replacing the recorder antenna and rechecking the recorder indication for constancy of field. The ratio thus obtained for each recorder will remain essentially constant throughout the period of recording and does not need rechecking unless changes are made in the antenna or lead-in.

Calibration of recorder input vs. graphic meter indication has been made at sufficiently frequent intervals so that the microvolts indicated at any level on the chart will be within five per cent of the indication for the previous calibration. The meter indication will be logarithmic and calibration is made in steps of 1, 2, 5, 10, 20, 50, etc., μv throughout the range of the recorder. Each calibration is dated and marked with the ratio used for converting recorder input microvolts to field strengths in microvolts per meter.

The recorders are operated on CST (mean solar time for the 90th meridian: i.e., CWT minus one hour, EWT minus two hours) which is standard for all FCC projects. Recorders are being operated at the speed of three-fourths inch per hour, unless the signal variation is so rapid that record analysis is made too difficult. The recorders are monitored continuously so that any indication can be identified and marked on the record, and so that the recorder sensitivity can be

General view of one corner of one of the FCC monitoring stations showing arrangement of equipment used in monitoring and measuring



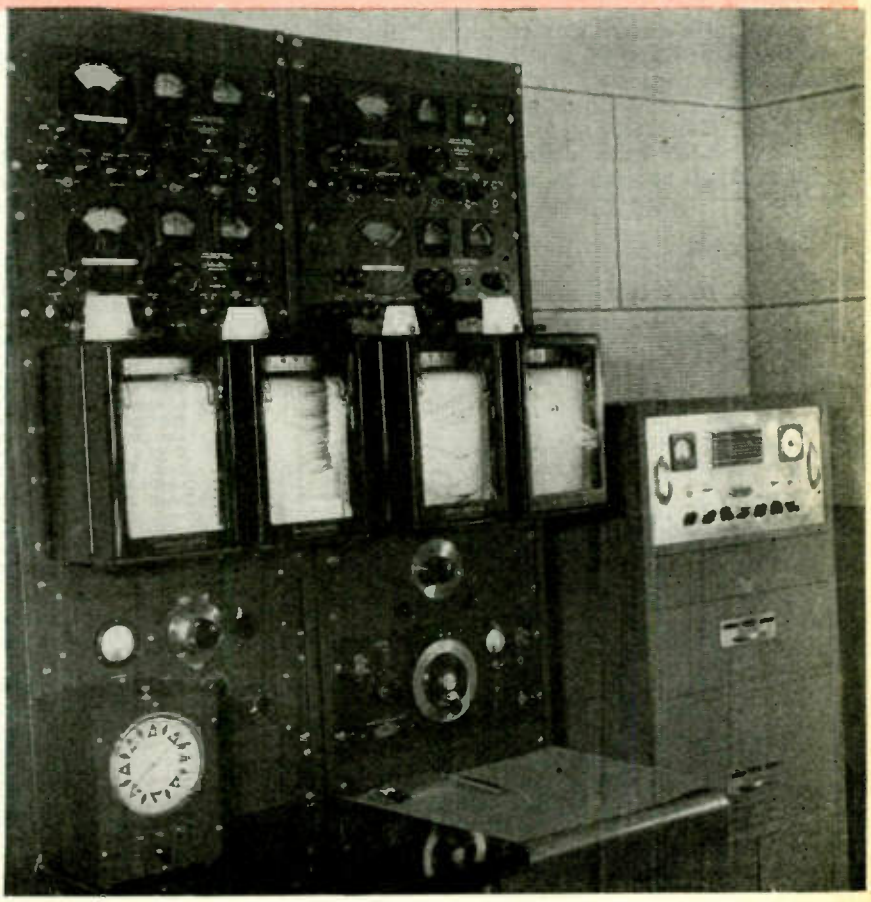
These charts, previously made during FCC's continuous monitoring program, show the kind of records that are used in determining the nature of interference

decreased if the signal intensity becomes too high for the normal recorder range. In this case the rf attenuator is left in its new position until the period of high signal strength is over and the recorder then calibrated with the attenuator in this position. The period covered by the special calibration is marked on the chart. The record rolls are to be marked at the beginning and the end with the recording with station call letters and frequency, and the date.

First tests that were conducted by the FCC showed that interference from automobile ignition showed up very clearly on the charts and that this possibly had much to do with interference problems that have been noticed in the past.

For this test, most of the FM stations involved have been asked to operate on an eighteen-hour daily schedule and to continue this schedule until the FCC has had sufficient time to conduct the coverage survey. In some cases audio recordings will be made, but this will only be at various intervals and will not be classified or held

(Continued on page 194)



Another view of some of the monitoring-measuring equipment. Program does not include audio recordings, though some will be made

COMPUTING DOUBLE-STUB

By ROBERT C. PAINE
Production Test Engineer
Boonton, N. J.

The chart permits ready evaluation of stub lengths in double-stub impedance testing of transmission lines

● There are many methods of matching the impedance of transmission lines to their loads for the elimination of standing waves and maximum energy transfer, each of which has its characteristic advantages. A common method uses short sections of line of "stubs" connected across the line as reactance correcting elements. These stubs, consisting of short sections of transmission line, are assumed to be pure reactance, a reasonably accurate assumption, since the losses generally are very low. They can be open or short-circuited at the end opposite the transmission line connection. A short-circuited stub is usually more desirable as it is less subject to radiation and is more easily adjusted whenever readjustment may be necessary.

The use of a single stub requires that the impedance of the load be known if connection of the stub is to be made at a definite point on the line.[1] However, by using two stubs connected at a definite interval apart, it is possible to adjust the line to match a load of unknown impedance without having to change stub positions. This is especially advantageous with concentric lines where the load impedance may not be definitely known in advance and it is impractical to change the position of stub connections.

Description of chart

The calculation of double stubs is simplified by the use of the chart shown in Fig. 1. This chart is based on the properties of lines which, when terminated by other than their own characteristic impedance or admittance, exhibit standing waves of voltage and current. The apparent input impedance of such a line varies in a cyclic manner according to its load and the length, in wavelengths at any given frequency, from the load to input terminals.

In this chart the ratios of maximum to minimum voltage (or current) of standing waves have been designated as Q and shown by the concentric circles. Each circle represents impedance or admittance at points spaced along a given line in degrees of wavelength, as indicated by the radial lines, a half wavelength being equal to 180 deg. Impedance, Z, or the corresponding admittance, Y, at any point is shown by the component parts of resistance, R, and reactance, $\pm jX$, or conductance, G, and susceptance, $\pm jB$. The circles whose centers lie along the center line of the chart are loci of constant R or G and the arcs whose centers lie along an imaginary vertical axis to the right are loci of constant X or B.

The characteristic impedance of the line is assumed to be without reactance and to have unit value. The chart then shows impedance at any point in terms of this unit value; that is, actual impedance equals $(R \pm jX)$ times Z_o, the actual line impedance, and actual admittance equals $(G \mp jB)$ times Y_o, the actual line admittance.

As an example of the reading of this chart, consider a line terminated by Z_L, a pure resistance load such that $Z_L/Z_o = (R + jX) = 4 + jO$. This point is spotted in on the chart at $R = 4$, $X = O$, which falls on the $Q = 4$ circle at 0 deg. This is a point of maximum impedance (as well as maximum voltage) on the line.

As the line increases in length from 0 deg., its input admittance

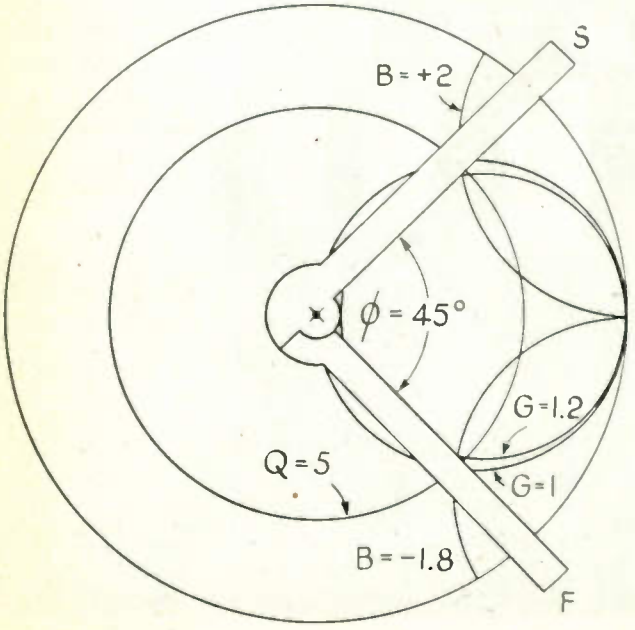


Fig. 3—To use the Chart shown in Fig. 1, the indicator is set for any desired line angle between stubs where it may be conveniently clamped with a paper clip. It is then pivoted about the center to find a common Q circle on which it intersects two G circles, one equal to the conductance of the load and one equal to the conductance of the transmission line considered as unity

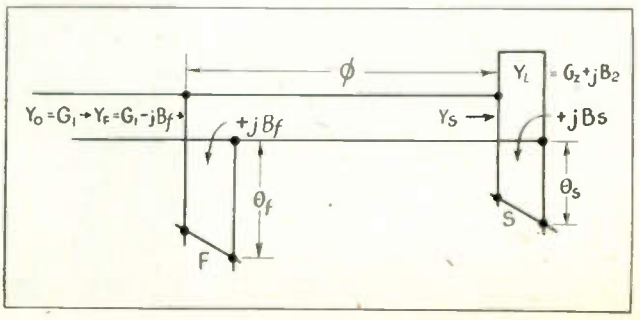


Fig. 2 (Below)—Schematic showing the theory of matching a load to a transmission line with two reactive stubs. These stubs are connected at fixed points on the line and can be adjusted as necessary to match an unknown load

LENGTHS FOR LINES

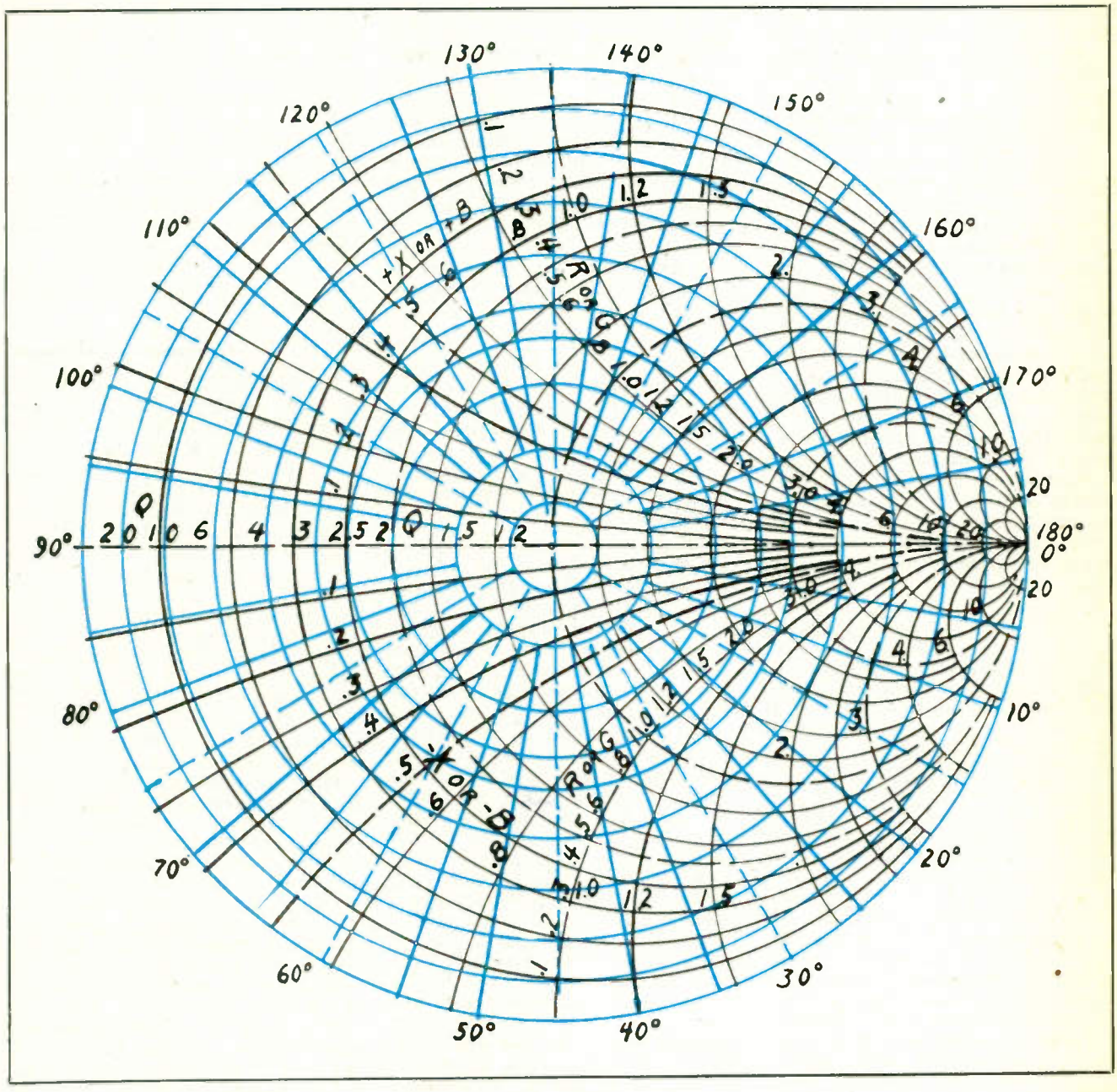
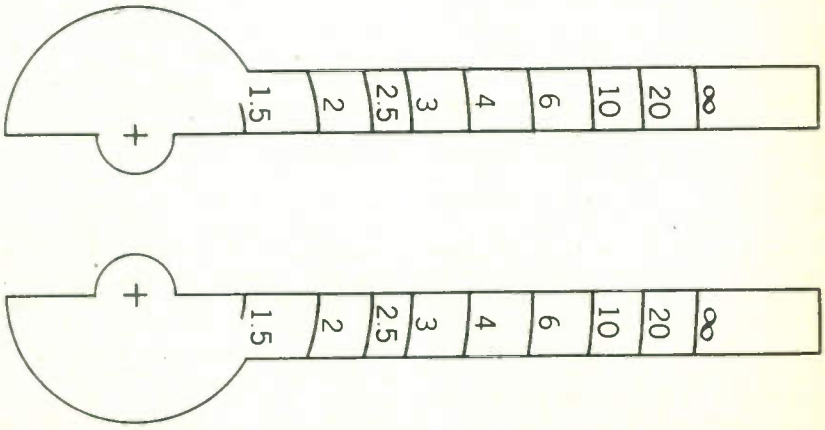


Fig. 1 — Radio transmission line chart with indicator arms (below) for calculating double stubs for impedance matching. Chart Copyrighted by Robert C. Paine



point, rotating in a clockwise direction around the Q = 4 circle, passes through negative (or capacitive) values to a minimum impedance value of pure resistance, G = .25, X = 0, or Z/Z_o = .25 at 90 deg., or at ¼ wavelength; this point is also a point of minimum voltage equal to 1/Q or ¼ of the terminal voltage; beyond 90 deg. the input impedance passes through positive (or inductive) values to a point of

maximum impedance of $4Z_o$ again at 180 deg. or at ½ wavelength. In the same manner, if we consider the equivalent admittance of this same line, it starts at $Y/Y_o = .25 + j0$ or $Y = .25Z_o$ at the 90 deg. point, passes through positive susceptance values to $Y/Y_o = 4 + j0$ at the 180 deg. point or at ¼ wavelength, and then through negative susceptance to reach $.25Z_o$ again at the 90 deg. point or ½ wavelength.

In this example the load impedance is a pure resistance. If it is a complex impedance it is spotted on the chart at the intersection of the appropriate R and X arcs. The corresponding angular position then represents the load terminal of the line and the Q circle on which it falls represents the standing wave ratio for such a load. The impedance at any point is found as before by following around the Q circle the required distance in degrees. The admittance value corresponding to a given impedance always appears 90 deg. away. Incidentally, the chart can be used thus to convert any impedance value to its corresponding admittance value.

Line matching

Fig. 2 illustrates the principle of line matching with double stubs. The length, θ_s, of the stub, S, at the load end is so chosen that its susceptance, B_s, changes the net admittance of the load end, Y_n, sufficiently for it to be seen at the distance, ϕ, as having a conductance, G_1, equal to the line conductance. At this point a susceptance, B_f, is also seen, but this is neutralized by a stub, F, of the same absolute value of susceptance, B_f, but of opposite sign. If the required stub is to have a negative, or inductive, susceptance it can be a shorted stub of less than ¼ wavelength, or an open stub of between ¼ and ½ wavelength. If the susceptance is required to be positive, or capacitive, the stub can be an open one of less than ¼ wavelength, or a shorted one of between ¼ and ½ wavelength. Shorted stubs only have been shown in Fig. 2.

The susceptance of the required stubs can be found on the chart with the aid of the angle measuring indicator as shown in Fig. 3. This figure illustrates a problem in which the load Y_L has an admittance of $Y_L/Y_o = 1.2 + j1$, to be matched to the line admittance of $Y_o/Y_o = 1 + j0$ by two stubs separated by a distance of $\phi = 45$ deg. This angle is, of course, equal to 360 deg. times the linear distance between stubs divided by the length of one wave.

The indicator arms are set for the required line angle of 45 deg. by the degree markings on the outer circle. It is then rotated clockwise until the forward, or F, arm intersects the $G = 1$ circle in such a manner that the second, or S, arm intersects the $G = 1.2$ circle on the same Q circle—in this case on the $Q = 5$ circle. The S arm also intersects the $B + 2$ arc on the $Q = 5$ circle, showing that the S stub must change the susceptance at the load to this value. Then the susceptance of the S stub must equal $+2 - (+1)$ or $+1$, and the net admittance at the load is $Y_s = (1.2 + j2)Y_o$. At a distance of 45 deg. this is seen as

$$Y_F = (1 - j1.8)Y_o.$$

The susceptance of -1.8 at this point can be neutralized then by a susceptance of $+1.8$, which produces a correct matching of admittances at this point and no standing waves appear between here and the generator.

The length of the required stubs can be computed from the formula, $B_{sh} = \cot\theta$ and $B_{op} = \tan\theta$, B_{sh} and B_{op} being the susceptance of the shorted and open stubs, respectively, in terms of unit admittance and θ the wavelength of the stub in degrees. The wavelength of the required stubs can also be computed from the chart. If shorted stubs are to be used, they start with a susceptance of ∞ at the extreme end, or at 0 deg. on the outer ($Q = \infty$) circle. Following this circle in a clockwise direction, it is seen that $B = +1$ falls at 135 deg., thus the S stub in the above example should have a wavelength of 135 deg. It is found that $B = +1.8$ falls at 151 deg., which is the required length of the F stub. If open stubs are to be used, they start with a susceptance of 0 at 90 deg. on the outer circle of the chart. For open stubs, S should be 135 deg. — 90 deg., or 45 deg., and F, 151 deg. — 90 deg., or 61 deg. in wavelength. These calculations are, of course, based on stubs having the same characteristic impedance as the given transmission line.

The actual length of the stubs in linear measurements depends on the velocity of waves on the given transmission line; this is nearly 3×10^8 meters per second for air spaced lines, but considerably less for lines having solid dielectrics. Wavelength of a stub = V/f, V being the velocity of the wave along the particular type of line, and f, the frequency in cycles. For example, a 135 deg. stub at 50 mc, for a line having a velocity of 95 per cent of the velocity in free space, would have a length of $135/360 - (95\%3 \times 10^8/50 \times 10^6) = 2.14$ meters.

In some cases two alternative solutions may appear on the chart, for example, consider a load $Z_L = (75.5 + j69)$ ohms to be matched to a line of $Z_o = 70$ ohms. This load value given in impedance terms can be converted to admittance by aid of the chart as has been mentioned before. It appears on the chart as $(75.5 + j69)/70$ or $1.08 + j.99$ and is spotted on the $Q = 2.5$ circle at 150 deg., the equivalent admittance falls 90 deg. away at 150 deg. — 90 deg., or 60 deg. on the same Q circle where $Y_L/Y_o = .5 - j.47$. This load is to be matched to the line by double stubs, S at the load, and F at 60 deg. away.

Alternative solutions

By rotating the indicator, two possible solutions appear on the chart. The first pair of values lie along the $Q = 2$ circle; $Y_s/Y_o = (G - jB) = .5 - j.07$ at 85 deg. and $Y_F/Y_o = 1 + j.7$ at 145 deg. For this solution the stub, S, must have a susceptance of $-.07 - (-.47) = +j.40$, or a length of 111.5 deg. for a shorted stub, and stub, F, a susceptance of -7, or a length of 55 deg. for a shorted stub. A second pair of values give an alternative solution along the $Q = 5.3$ circle where $Y_s'/Y_o = .5 + j1.22$ at 143 deg. and $Y_F'/Y_o = 1 - j1.85$ at 23 deg. Then stub S′ must have a susceptance of $+ j1.69$ and stub F′, a susceptance of $+ j1.85$.

The examples have shown the S stub connected at the load; however, it can be connected at any point. To illustrate, take two stubs connected at points 25 deg. and 70 deg. from the load required to match a load of $Y_L/Y_o = .6 + j.8$ to the line. This value is found on the $Q = 3$ circle at 135 deg., but the stub S, being 25 deg. from the load, looks into the value found on the $Q = 3$ circle at 160 deg., which is $1.52 + j1.35$. This can be considered as the net load and is the value to be matched to the line as in the previous examples. For a 45 deg. spacing of stubs, the chart shows the required pair of values on the $Q = 4.1$ circle; $1.52 + j1.8$ at 160.5 deg. and $1 - j1.55$ at 25.5 deg. The susceptance of stub S should then be $1.8 - 1.35$, or $+ j.45$ and that of stub F, $+ j1.55$.

The chart shown in Fig. 1 is accurate enough for many purposes. However, for greater accuracy it can be reproduced to a larger scale. It can be redrawn by considering the radius of the outer ($Q = \infty$) circle as unity; then the radius of each Q circle equals $(Q-1)/(Q+1)$. Each R or G circle has its center to the right of the center of Q circles at a distance of $R/(R + 1)$ and

(*Continued on page* 194)

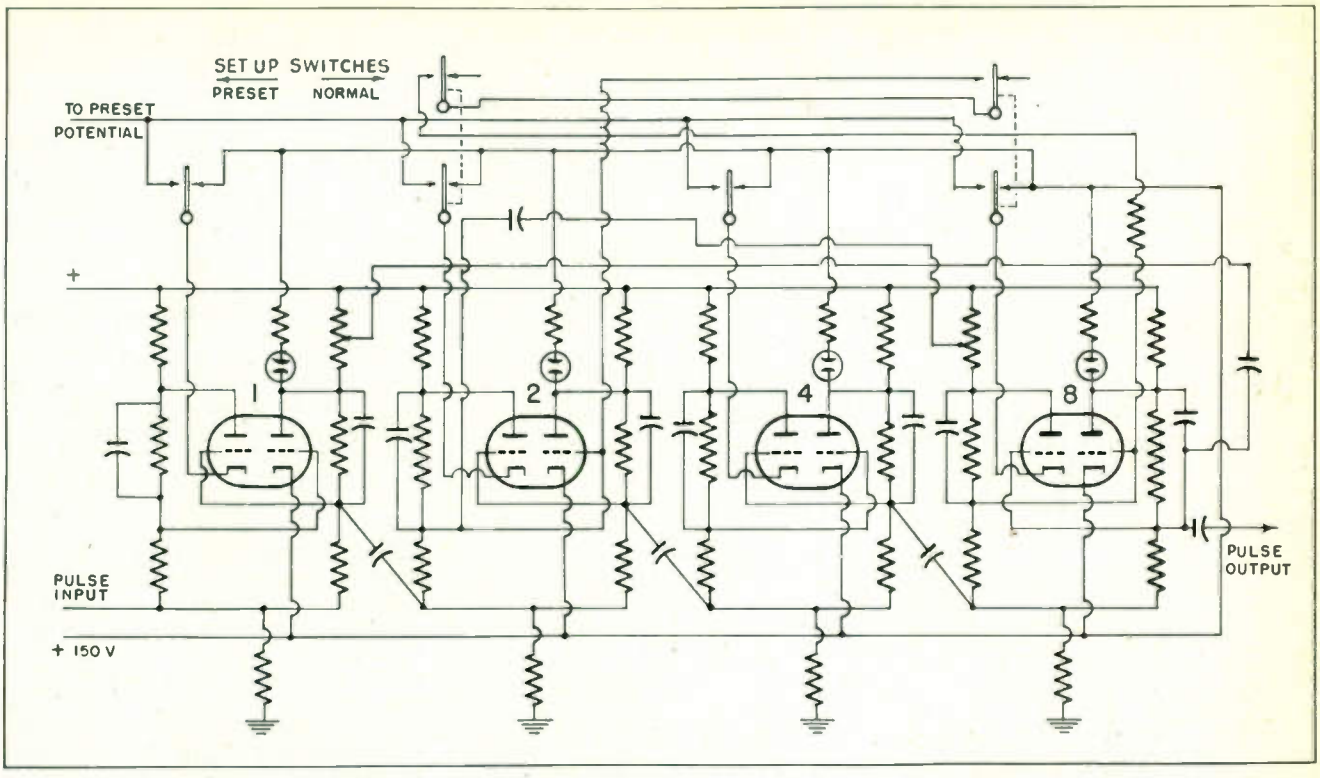


Fig. 3. The circuit for a simple decade counter using four of the elementary scale-of-two counting pairs. This circuit takes a series of pulses applied to the input lead and at the end of every tenth puke delivers a single pulse to the next decade connected on to the output circuit

PRESET INTERVAL TIMER

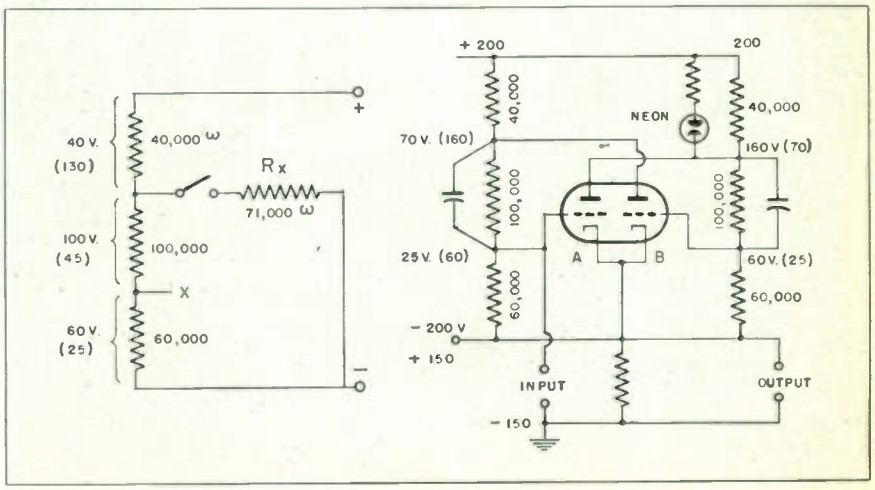
The establishment of precise interval controls for industrial processes has been made possible by combining precision electronic counters with frequency standards

● Many systems of counting have been devised since the beginning of recorded history and each ancient nation had its own method of putting down words or figures to denote quantity. The decimal system, now in use by all civilized nations, has simplicity and universality in adding, multiplying, subtracting, division, and in the more complicated processes of computing quantities and value.

In many scientific developments the problem of counting objects rapidly makes frequent appearance. Electrical counters of the magnetic ratchet type find universal use where relatively slow counting rates are to be handled, below 5 to 10 counts per second. For totalizing a series of equally spaced impulses, a geared mechanism as in an electrical clock is useful, but here again, the trouble of getting such a mechanism up to speed and of eliminating the coasting motion after shut-off, reduces the accuracy for most uses. Moreover, it is not useful in the recording of extremely small intervals—a few microseconds up to a substantial part of a second. Therefore, as is usual when greater speed and precision in any test are needed, some electron tube circuit is developed for it.

Several methods have been devised, operating on distinct principles. In one arrangement, a series

Fig. 1. Left. Simple resistance network wherein potentials are altered as shown by enclosure of shunting resistor. Fig. 2. Right. Two of these networks are cross-connected with control tubes to provide the basic binary system which delivers a single pulse for every two received. Compounding these frequency division units makes possible the counting of large numbers of objects



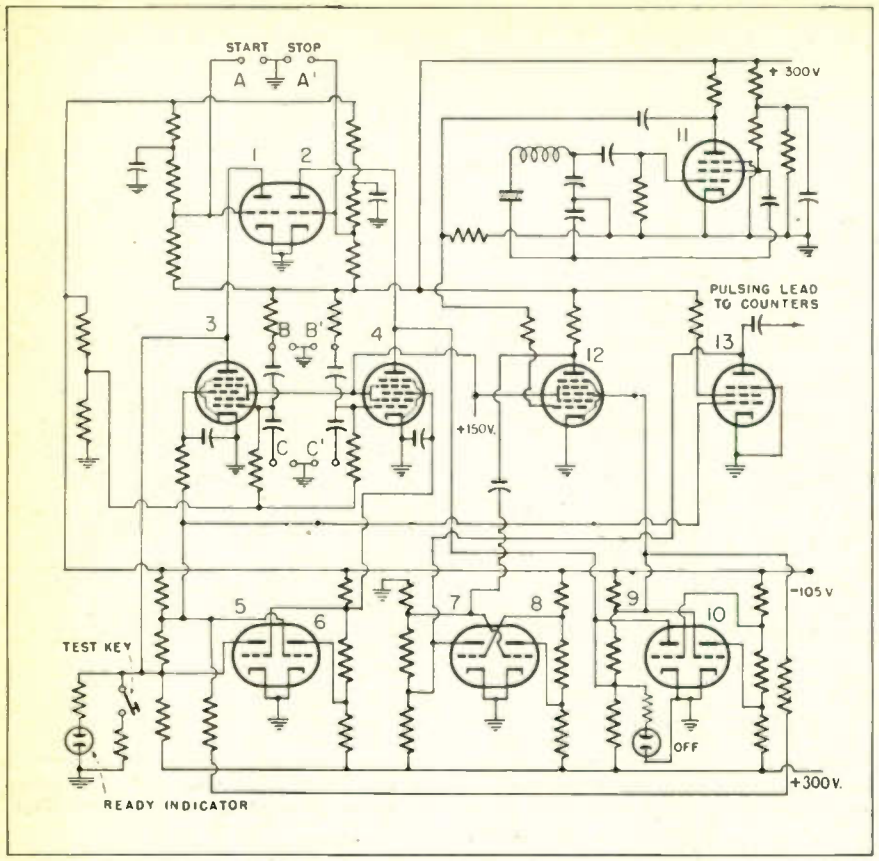


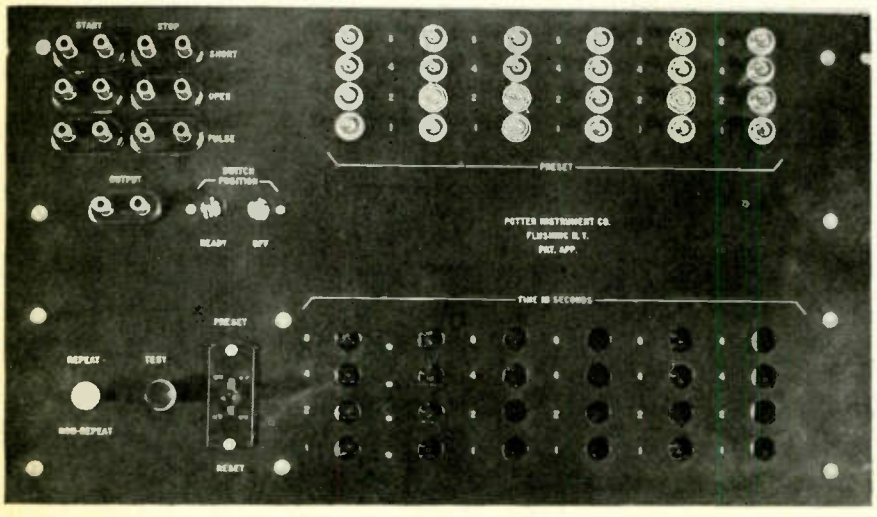
Fig. 6. The circuit shown here is used to start and stop the count of the cycles from a 100,000 cycle crystal which is used as the source of pulses. The control tubes start and stop these pulses without introducing transients interfering with the accuracy of the counting process

of electron tubes is arranged to operate in succession, each tube in the series when operated acting to sensitize the next tube, so that it, too, will operate on the next pulse. In another, the use of special cathode ray tubes, with a decade arrangement of targets is disclosed. Special thyratrons (or other gas filled tubes) with multiple electrodes operating in succession on receiving a series of pulses have been suggested.

A still different approach uses a binary principle, that is: counting by two's. Scale-of-two counters were first developed for counting cosmic ray discharge rates, but since then alternate uses have been expanded greatly.

After the advent of precise pulse counting circuits using electronic circuits, a great many applications showed up for which they are uniquely fitted. These uses fall naturally into two main categories —those using pulses with accurately known intervals, as from a tuning fork or a crystal oscillator, and those counting irregular pulses, as might come from counts of traffic or of the random cosmic rays that enter a certain space.

Fig. 4. A complete interval timer using six decades of the counting circuits shown in Fig. 3, which permits preset intervals to be established up to a total of ten seconds to the nearest five microseconds. Total count is indicated on neon lamps shown at the bottom right



Preset Timing

In the first case, the problem of accurate measurement of time intervals is accomplished, and in the second, an accurate count is totalled up. Now comes a third accomplishment from the same type of circuit, a circuit that starts or stops a process after a predetermined number of counts having fixed or random intervals. Industry has many problems of this nature, cutting off a press after some precise number of operations, such as 34761, or cutting off a zipper after say 713 units have been clipped in. As before, the pulse intervals may have a definite value or may be random.

A group of special binary counting instruments having extreme speeds and precision have been developed by the Potter Instrument Company of Flushing, New York, having many uses in industrial measurements and process control as well as in research projects in numerous fields.

These circuits work on the principle of frequency dividers. That is, for every two pulses applied to the input, one pulse is delivered into an output circuit. If the latter output pulse is applied to a second device, it in turn would deliver one pulse for every fourth pulse applied to the input circuit of the first unit. This successive counting of the pulses gives a series of 2, 4, 8, 16, 32, etc.

Consider the resistance network shown in Fig. 1. Here, 200 volts are applied to the terminals as shown. When the resistance marked R_x is open, one milliampere will flow through the three voltage divider resistors in series, with the values shown. If now the switch is closed connecting the 71,000 ohm resistor R_x to the negative tap on the power supply, the voltages across all resistors change, the values of these voltage drops then appearing being those shown in parentheses. The point to notice is that the potential of the point X, with respect to the negative terminal, has dropped from 60 volts to 25 volts. This voltage change is sufficient to alter the operating characteristics of a vacuum tube from normal current to full cut-off.

Next assume that two of these networks are set up in conjunction with two triodes both operating from the same 200-volt power supply and that the point X on each circuit is connected to the grid of one of the triodes in such a way that the 35-volt variation in the drop across the 60,000-ohm resistor is used to control the bias of a tube to change its plate current from its normal value to cut-off.

In this actual circuit the 71,000-ohm resistors become the internal plate resistances of the tubes, as in Fig. 2. When one triode reaches cut-off, the 71,000-ohm equivalent circuit in the other network is opened. Vice versa, the latter triode circuit functions to open up and close the 71,000-ohm resistance in the first tube circuit.

Study will show that under these conditions, only one tube can operate at a time, and whenever one tube operates, the other tube is shifted to cut-off. That is, these two conditions are represented in Fig. 2 by all the voltages inside of the parentheses or else by those values those outside of them. Once one of the tubes has operated, it will remain conductive until a sufficiently strong pulse is applied to the opposite tube, whereupon it operates, causing the first tube to go to cut-off whereupon the other set of voltages are found. This circuit is generally known by the descriptive term, "flip flop." The complete connections for a typical circuit are shown in Fig. 2.

Fig. 2 also contains an input circuit over which "operating pulses" are transferred and an output circuit that delivers the derived pulses to the next counting pair circuit. These input and ouput circuits operate from a negative voltage power source with a level of 150 volts below the cathode value. Counting is effected only when negative pulses are applied to the input circuit.

As long as any voltage is applied, one or another of the tubes will be operated, since there are only two possible circuit operating conditions. If tube A is conducting, tube B is non-conducting and vice versa. There can be no intermediate operating conditions where both tubes A and B are conducting that lasts more than an extremely short interval of the order of one microsecond or less.

Preset at start

It will be noted from this circuit that due to this symmetry, it is quite possible for either tube to become conductive when the voltages are first applied. The quickest tube to heat will take control, preventing the other from establishing conduction. In counting work it is necessary to take care that a particular one of the tubes in each primary pair operates first. Let us say tube B is selected to operate first.

By splitting the cathodes of all counting pairs into two separate circuits, a potential can be applied to one set that will insure that they operate first under all conditions. The net result is that when the circuit is first turned on, tube B in each one of the flip-flop circuits is conducting and stays in that condition until a pulse is applied to the input circuit, whereupon tube A operates. When this tube operates, a neon lamp in its own plate circuit is caused to light. This lamp, mounted on the front panel indicates that this pair has operated. In Fig. 3, four pairs of tubes are shown complete. These pairs comprise a single decade counter. The complete operation of such a decade is as follows. When the power supply is first turned on, the A tubes in each pair are made conductive by establishing zero bias on their cathodes. The cathode of the alternate tube is therefore at cut-off or about 25 volts negative. When the input circuit receives its first pulse, tube 1B conducts and turns off tube 1A, connecting a neon lamp, which is visible from the front panel. The voltage across the neon lamp increases from 40

(*Continued on page* 130)

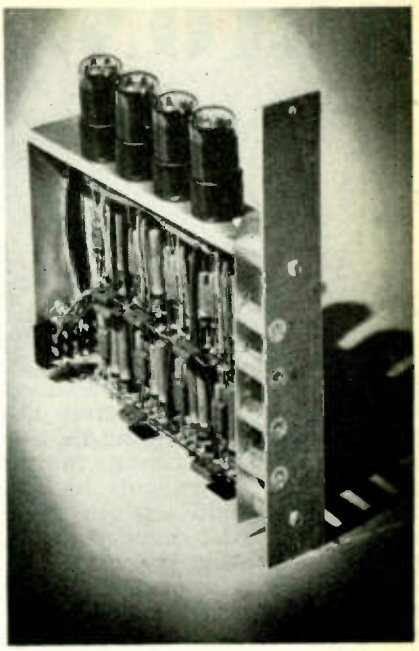
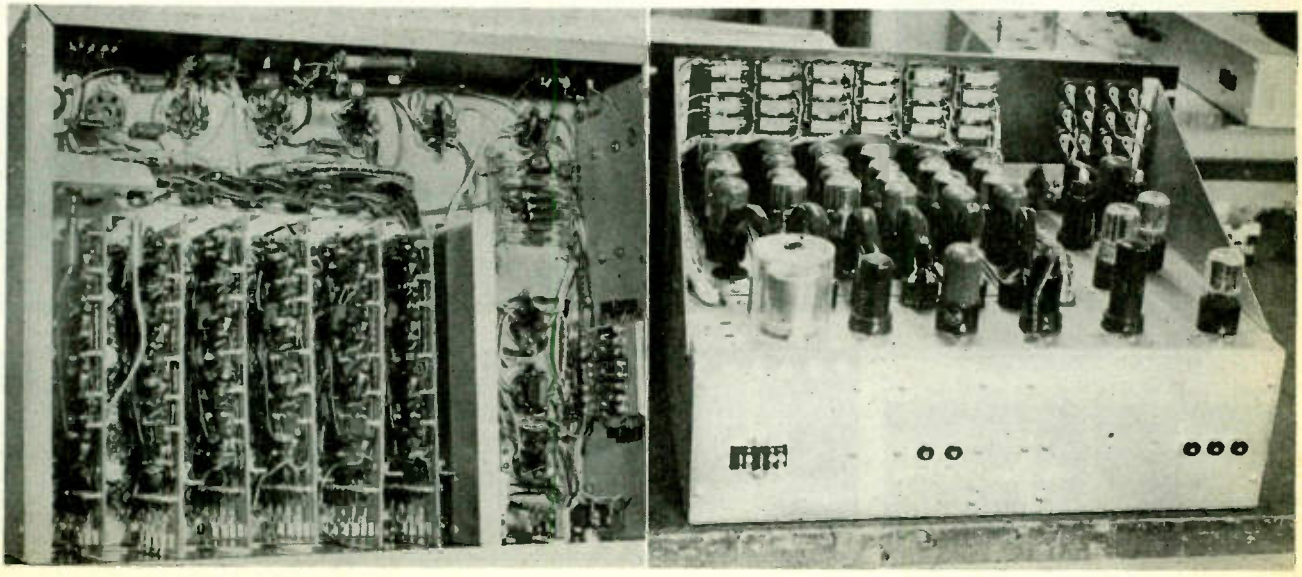


Fig. 5. A unit assembly of the counter which may be combined with others of a similar form to count desired total number of operations

Figs. 7 and 8. The photographs below illustrate the bottom and rear of the chassis of instrument shown in Fig. 4. Although a large number of tubes are needed when large counts are to be handled, the use of self-contained decade units simplifies their assembly, testing and servicing



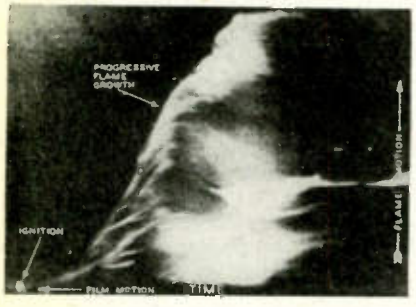
DETONATION INDICATOR

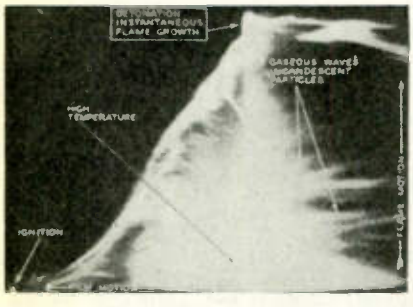
Important fuel savings obtained in plane operation by monitoring gasoline explosion during flight

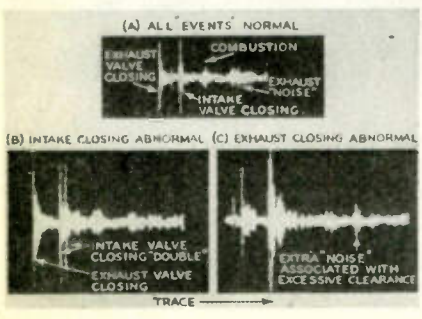
● By picking up and amplifying cylinder vibrations electronically, dangerous detonating conditions in an airplane engine can be detected while they occur. This gives the pilot a means of watching his engine operation and permits him to save substantial amounts of fuel and avoid conditions which cause rapid erosion and burning of valves, cylinder heads and pistons.

Detonation is a change in the rate of burning of the fuel charge in an internal combustion engine. In normal combustion the flame travels out across the combustion chamber at the rate of 25 to 75 feet per second. When detonation occurs, the rate of movement of the flame front jumps to approximately 4,000 or 5,000 feet per second, and frequently the pressure wave travels across the combustion chamber several times during one firing of the cylinder. This tremendous increase in the speed of burning is accompanied by extremely high local temperatures and a violent increase in maximum pressure.

Fig. 1. Photograph of flame propagation in cylinder of engine taken through a slit on a moving film. The sudden flame growth at detonation can be seen in Fig. 2 below







Despite the wealth of information that has been gathered concerning operation of aircraft engines, it is understandable that in flight, operating conditions may change by a considerable proportion and there exists therefore a region of unknown performance regarding detonation. It has become obvious to engineers and operators of airplanes that the ability to control the detonation point at all times would permit a great increase in efficiency.

As a result, early investigations were made with pressure type pickup units for detecting the extreme pressures resulting from detonation. With this type of pickup, however, it was necessary to bore a hole through the cylinder wall into the combustion chamber.* Further study established the fact that vibrations transmitted through a metallic patch provide a better signal and eliminate the objection to drilling through the cylinder wall.

Indicator development

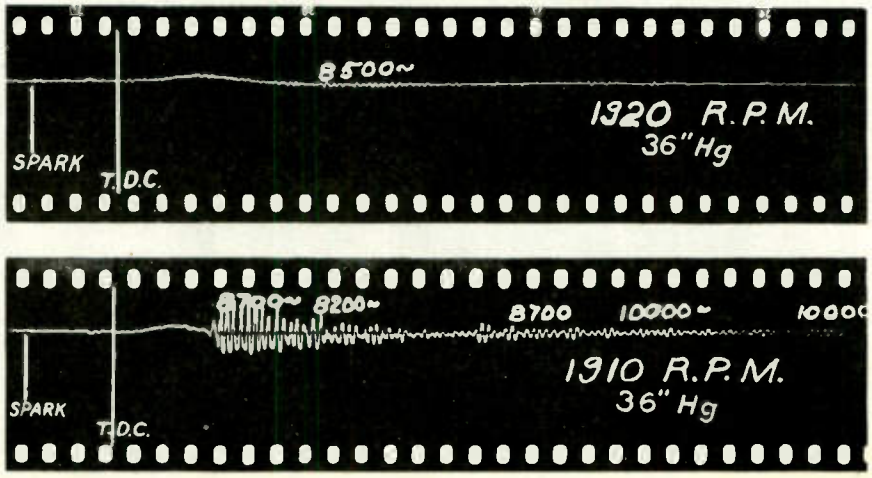
In 1937, a group of four aircraft organizations (Sperry Gyroscope Co., Inc.; Wright Aeronautical Corporation; Bureau of Aeronautics, U. S. Navy; and National Advisory Council for Aeronautics) financed laboratory development work at the Massachusetts Institute of Technology on a detonation indicator which would not detract in the least from the reliable characteristics of the engine cylinder when used in flight. Such a device was successfully developed and is now being manufactured by Sperry.

In an automobile, the cylinder wall vibrations at audible frequencies take the form of a knock or ping. However, in aircraft, where the noise level is high, it is impractical to determine the presence of detonation by audible means and therefore a pickup attached to the cylinder wall is used to detect these vibrations.

While on a test block it is easy to amplify the vibrations and then

*Internal Combustion Engine Analysis, Electronic Industries, June 1943, pp 64

Fig. 3 (lower left) shows oscillographs of one normal and two abnormal engines taken with detonation indicator. Fig. 4 (below) indicates the frequencies of the noises occurring in normal operation (upper strip) and detonating condition (lower strip)



FOR AIRPLANE ENGINES

investigate them by means of an oscilloscope. It was found desirable for use in flight to develop a simpler means of detecting high amplitude vibrations such as take place when an engine is knocking.

For installation in airplanes, the method chosen was to connect a lamp into an amplifying circuit in such a manner that when the amplitude of the vibrations exceeded a certain value the lamp would flash.

In conjunction with this simple system it developed in many cases, however, that the noise caused by the valve closing action in the engine created even higher vibration amplitudes than the detonation, thereby producing false indications. In order to eliminate such valve closing noises, a commutator was connected in the circuit in such a manner that it permits the amplifying and lamp flashing circuits to operate only during the firing stroke of each cylinder.

The entire system then consists of pickups attached to each cylinder, a commutator, an amplifier, an indicating lamp, a wiring harness and a switch to permit the pilot to have pickups for all the cylinders in the circuit at once or to select any one cylinder's pickup for individual study.

The pickup, which operates on the magnetostriction principle, consists of a fairly heavy steel housing attached to the cylinder wall by a center stud. Clamped firmly inside the housing is a coil with a small cylindrical core of alnico. When the cylinder wall vibrates, the inertia of the pickup is great enough to produce corresponding distortions in the the wall of the shell of the pickup. Such distortions create a variation of pressure on the alnico core, thus changing the magnetic field inside the coil and inducing a voltage therein.

Amplifier

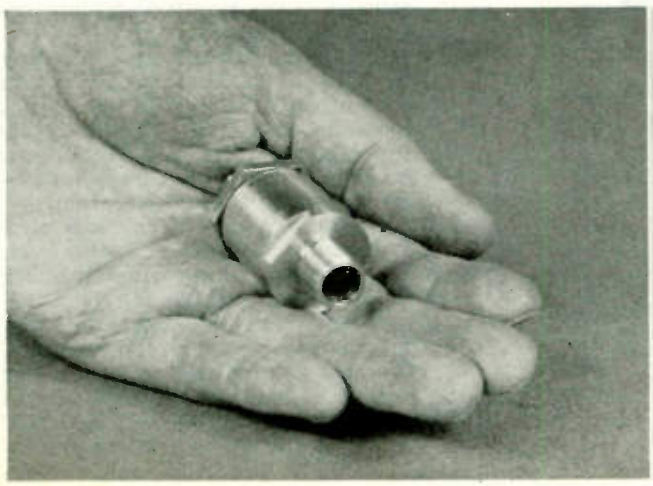
The resulting voltage variations are impressed on the grid of the first 12SJ7 tube in a four-stage resistance coupled amplifier. The output of this amplifier is connected to a lamp on the dashboard of the plane. After the system has been installed on any given engine it is necessary to adjust the sensitivity of the amplifier so that the lamp will not light in normal operation but will light when the engine is detonating. This is done by providing an adjustable resistance unit which can be inserted between grid and ground of the first amplifier tube. When the proper resistance has been found by means of this unit, it is taken out and a fixed resistance of the same value put in its place.

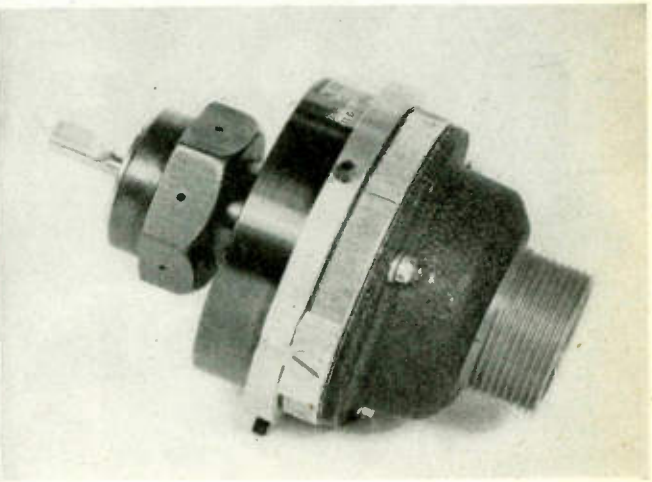
The commutator consists of a brush assembly and a ring of commutator bars or segments equal in number to the number of cylinders in the engine. Each segment of the ring is connected to one pickup unit and the common brush of the commutator is connected to the amplifier. The commutator is attached to the tachometer drive on the engine and rotates at one-half engine speed. During installation the unit is adjusted for timing so that the pickup is connected shortly after ignition occurs in each cylinder and disconnected during that portion of the cycle when the valves are striking their seats. Some commutators are provided with a timing lock ring which is held at a fixed position by set screws when correct timing is achieved.

It is interesting to note that the commutator shell is being manufactured by the lost wax method wherein a metal mold is first made of the shell. Wax is poured into this metal mold and allowed to harden. This wax model is then covered with dental investment (fine plaster of paris). This is permitted to harden, forming a mold. The wax is melted out, and aluminum is cast in this mold to form the commutator shell. Bakelite is then molded in the shell and around the commutator bars and

Fig. 5. Dashboard mounted detonation indicator. Flashing lamp reveals detonation

Fig. 6 (left). Magnetostriction pickup which is bolted to cylinder wall by single stud. Vibration in cylinder is transmitted to pickup causing distortion in its shell. This creates pressure on core of coil inside pickup. Fig. 7. Adjustable commutator which is attached to the engine tachometer drive. It only permits contacts after valve closing noises have occurred to prevent masking detonation





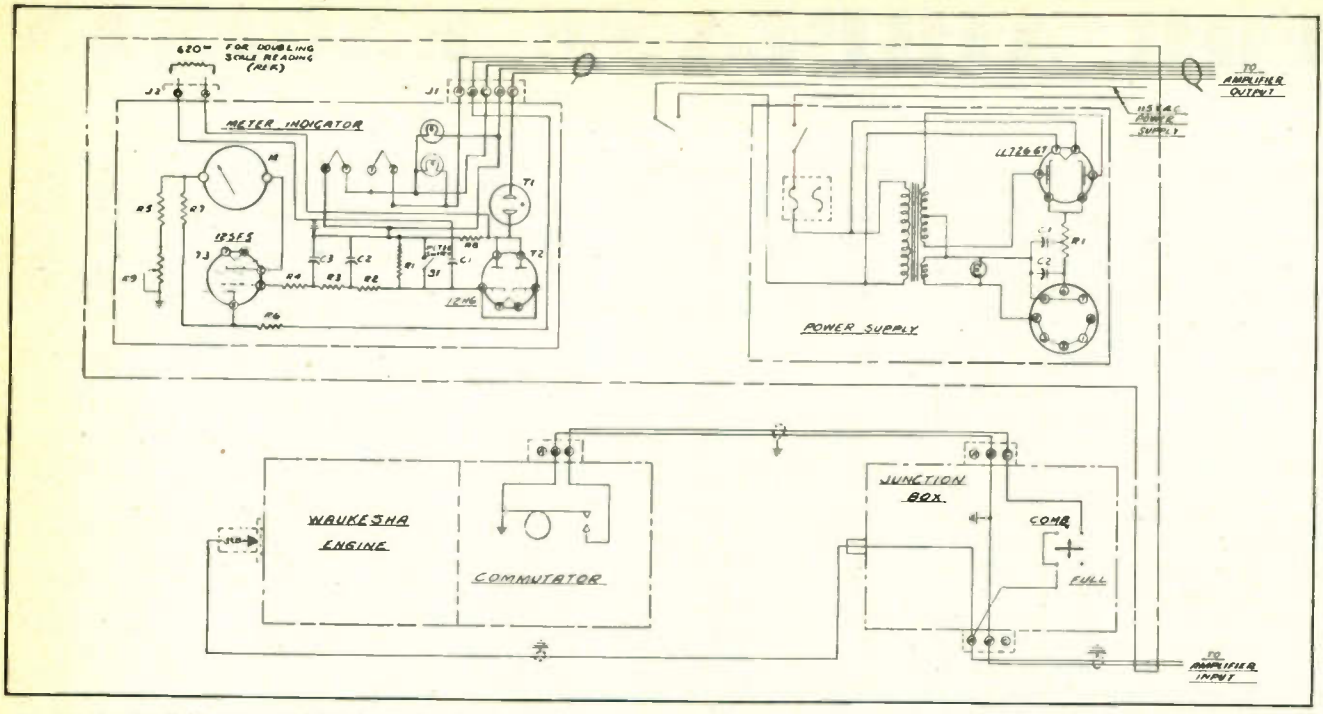


Fig. 8. Circuit diagram of M.I.T.-Sperry Knockometer and power supply being used in connection with a small test engine. The signals which are strong enough to flash over neon lamp T1 are rectified in T2 and then accumulated in the integrating circuit R2, C2, R3, C3

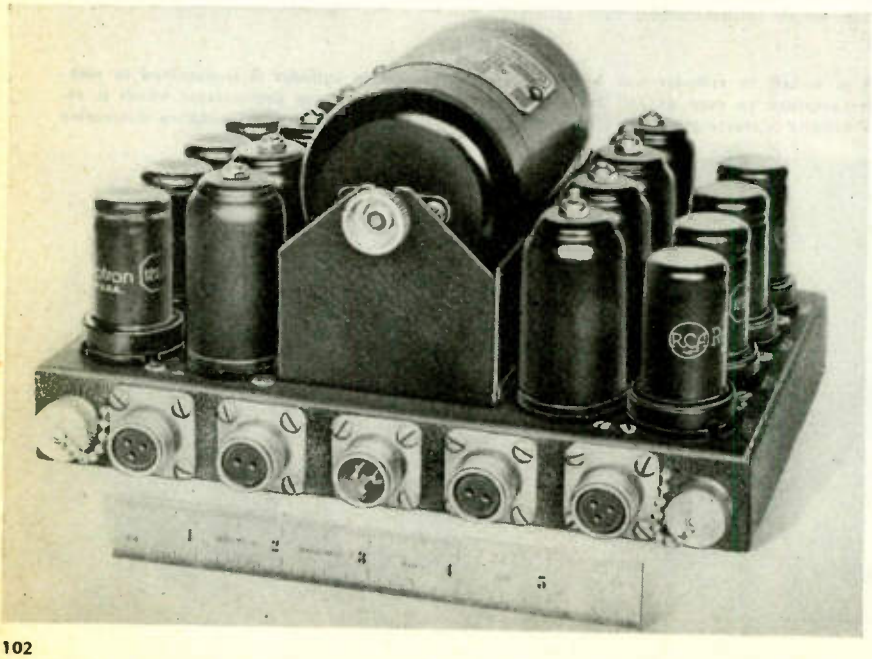
connecting wires. The inside of the commutator against which the brush bears is then machined down to get a smooth contact surface.

The amplifier is of unusual mechanical design in that all circuit components are of the plug-in type, the amplifier chassis containing only the sockets and the high voltage supply filter. Amplifiers are built either single or double for multi-engine airplanes.

As may be seen from the circuit diagram, the output of the four-stage amplifier is applied to a 12H6 double diode rectifier tube. Here the positive half of the output current is bypassed to ground and the negative half is put through a voltage divider circuit and applied through R23, R24 and R1 to the grid of No. 2 amplifier tube to provide automatic volume control. This is necessary because of the great variations in output at different engine speeds requiring some means whereby the non-detonating output levels can be held fairly constant.

The cylinder selector switch, which is designed for instrument panel mounting, provides the operator with a means of checking for detonation in any cylinder. In addition to a numbered position for each cylinder, there is an "all" position for which all pickups are in operation. For any other position of the selector switch, all pickups except the one indicated are grounded.

Fig. 9. Chassis of dual amplifier used in connection with multi-engined planes. Beside the tube row there is a row of plug in circuit elements for rapid changing



Valve test button

The selector switch also contains a test button in the center of the dial pointer which may be pressed momentarily to give a partial check on the operation of the equipment. Pressing the test button bypasses the commutator, permitting the vibrations due to valve operation to light the indicator. At the same time it inserts an additional resistor in the circuit and increases the amplifier gain.

In flight installations operating on 28 volts dc, the selector switch is omitted as the pilot could not correct conditions in a single cylinder without affecting the others. A bright incandescent lamp indicator is used to attract attention.

The power supply consists of a dynamotor and filter combination which plugs into the amplifier chassis. Either a 24-volt or a 12-volt supply may be plugged in without requiring any circuit changes. For test stand use, an ac power supply is available which operates from the 115 volt 60 cycle mains.

Due to the many possible installations on various types of air-

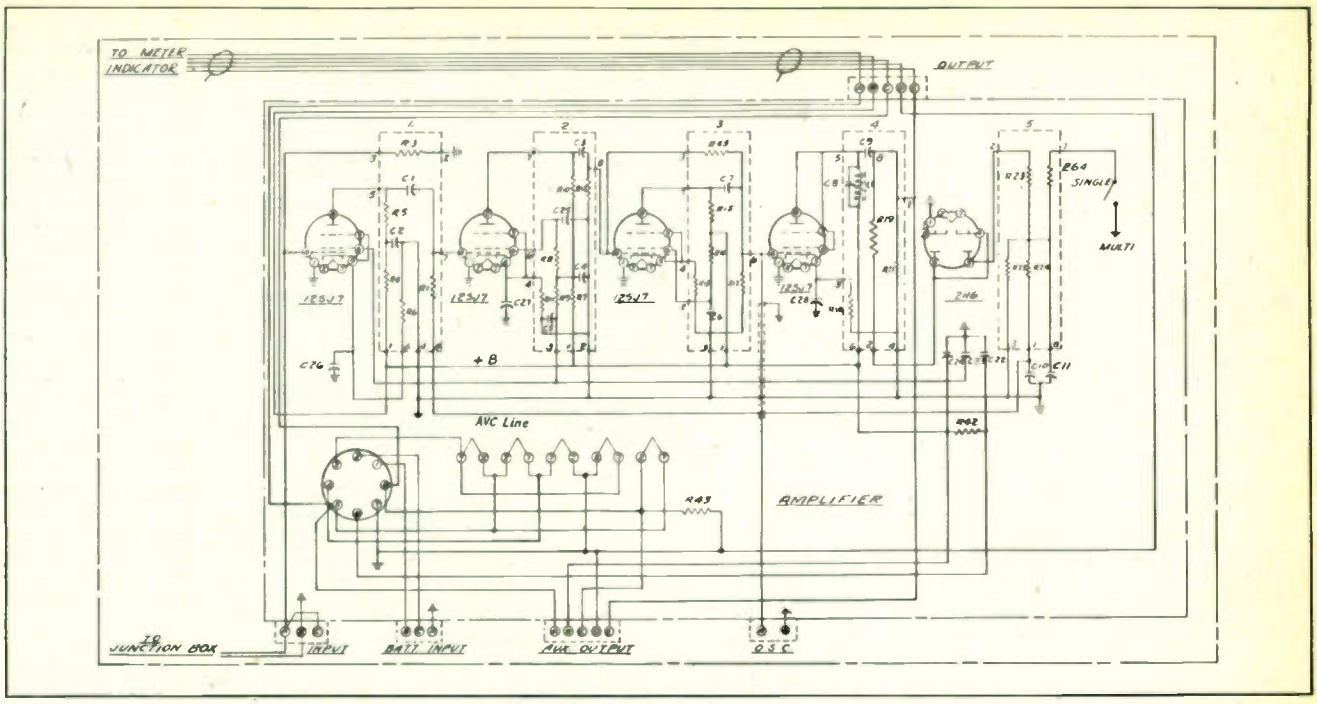


Fig. 10. Circuit diagram of 4 stage resistance coupled amplifier used in conection with knock testing equipment. The dotted outlines between the tubes indicate the contents of the various plug in circuit elements. Only two styles of tubes are used for simplicity

planes and engines, a number of different harnesses and connecting cables are available.

While the presence of this equipment on an engine permits the pilot to use the leanest possible mixture at all times without incurring detonating conditions, and while it has been definitely determined that the absence of detonation increases engine life and decreases the requirements for overhauling, the amount of detonation which can be tolerated without damage to an engine has not yet been found. Obviously this requires a great deal of test work as an engine must be torn down and rebuilt after each test to determine the extent of the damage which it has suffered.

In connection with the work done on this problem, a detonation scale has been established, consisting of five grades, the first indicating one flash every five to ten seconds; the second, one every two to five seconds; the third, intermittent flashes 50 to 60 per cent of the time; the fourth, continuous but light flashes, and the fifth, continuous but brilliant flashes.

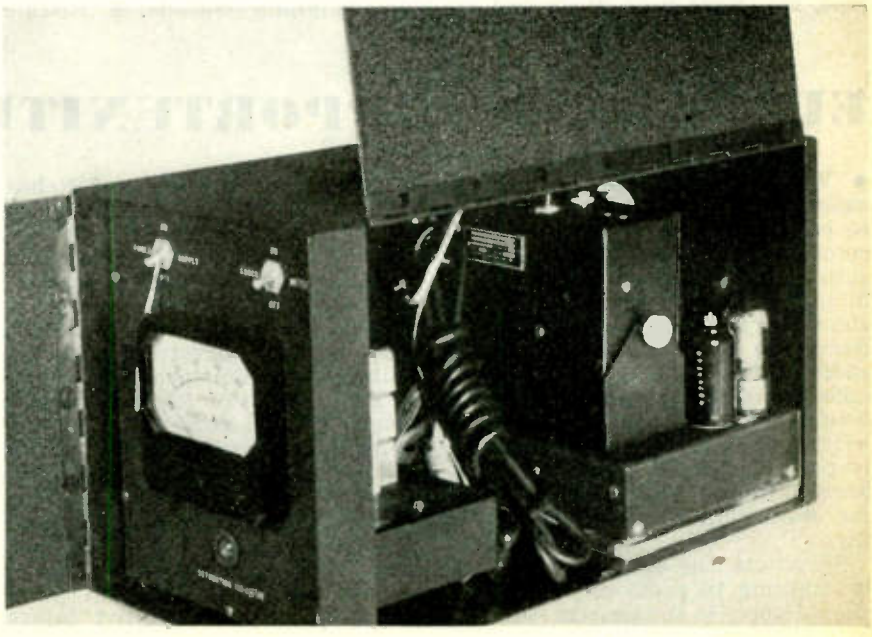
To help in such knock investigations, a new instrument known as the M.I.T.-Sperry Knockometer has been constructed for measuring intensity of detonation or knock. As this instrument determines detonation intensity directly, it eliminates human errors prevalent in other methods. The accurate reproducible data which may be obtained makes this particularly valuable for fuel rating and design investigation.

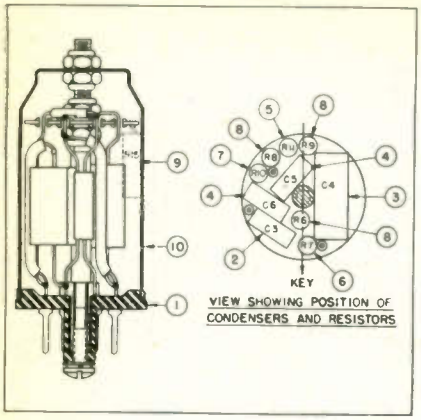
In this instrument the detonation vibrations are picked up, commutated, amplified and transmitted in the same manner as with the detonation indicator and are then applied to an integrating circuit. This circuit contains a neon bulb which acts to permit the passage only of the higher voltage pulses which are to be integrated, a 12H6 rectifier tube and a resistor capacitor combination R2, R3, R4, C2, C3. The integrated voltage is applied to a vacuum tube voltmeter. By means of this scheme, the duration, intensity and frequency of the flashes are summed up to produce a deflection on a voltmeter.

It has been found that the results obtained by this means are much more accurate than those obtained visually or by ear and often do not agree with such sensory results. This merely serves to point out the inability of the human senses to make accurate measurements, particularly when different operators are involved.

One of the important and interesting by-products obtained

Fig. 11. Knockometer developed to permit exact measurement of intensity and duration of knocks. This equipment substitutes for visual and aural observations





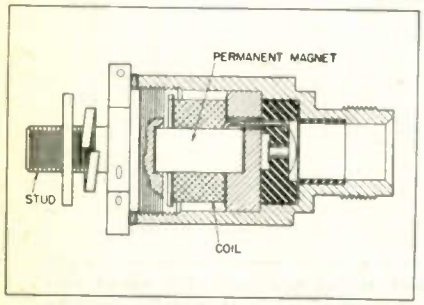


Fig. 12 (above). Plug in circuit element consisting of a number of resistors and capacitors compactly mounted on standard base. Fig. 13 (below). Cross section of magnetostriction pick-up attached to cylinder wall. Coax cable screws in at right

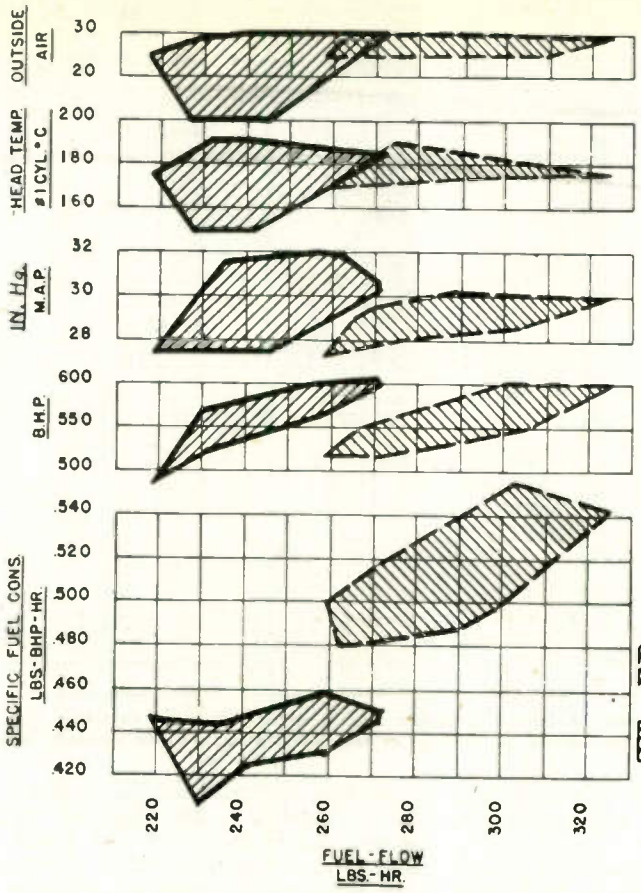


Fig. 14. Chart indicating improvement in operating economies obtained in tests extending for 18 days. The areas cover the ranges over which results of individual tests fell. Besides effecting savings of about 1/6 in fuel, head temperatures were reduced. Furthermore the manifold pressure was maintained slightly higher. The lessened fuel consumption indicated in this chart would result in monetary savings of many thousands of dollars per airplane when realized in actual practice

through the use of the detonation indicator has been that it has shown up malfunctioning of various parts of an engine before serious damage could cause the engine to break down.

In many cases, immediate shutdown and overhaul has revealed serious defects which might have endangered the pilot and the plane. Furthermore, such things as broken piston rings, fractured knuckle pins, etc., have been discovered on highly experimental engines where the saving of the only experimental part available meant a large saving in development time of the engine model.

Other interesting phenomena have been observed during flight. For instance, in one test airplane, when climbing with a full rich mixture at 1900 rpm, 600 brake horsepower, heavy detonation was observed, although this is an operating condition considered routine and entirely safe by both the engine manufacturer and the airlines. The detonation became heavier if the mixture was made leaner. This condition was reproduced several times and it is evident that prearranged cruising or climb conditions even in full rich may not necessarily produce safe engine operation. Many other highly interesting and hitherto unrealized facts have been brought to light by the use of this equipment. (HGS)

ELECTRONIC OPPORTUNITIES FOR VETS

• World War II has truly been called an electronic war and it is to be expected that when veterans come back to more peaceful pursuits a percentage will have germinated the electronic inoculation they have received into a full-blown desire to keep connection with radio in some form. For them Brigadier General David Sarnoff, president of Radio Corp. of America, has written some sound sense in a newly published booklet entitled, "Opportunities in Radio and Electronics for Returning Service Men." He says:

"Veterans who desire information or training in radio or electronics should apply to the nearest regional office of the Training and Rehabilitation Division of the Veterans' Administration or to any of several hundred 'Guidance Centers' that are being established in schools and colleges throughout the country. Applications for jobs should be made to the nearest office of the United States Employment Service.

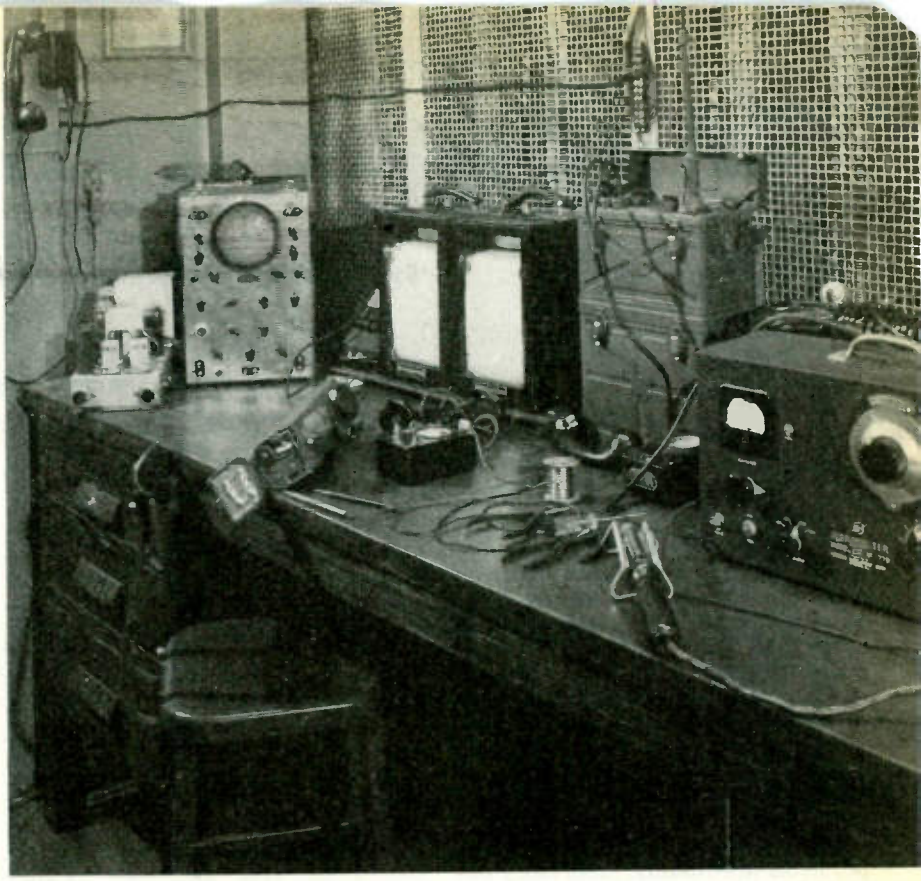
"The 'GI Bill of Rights' provides government support for schooling for at least one year and up to four in elementary, business, high or higher schools; provided that the veteran was discharged under conditions other than dishonorable, that he has served 90 days or more, or was discharged within such period for service-incurred injury or disability, and that his education or training was impeded, delayed, interrupted or interferred with by reason of entry into the service.

"Such training must be initiated not later than 2 years after discharge or after the termination of the war (whichever is later) and shall not extend beyond 7 years after the termination of the war.

"After satisfactory completion of 1 year's training, a veteran may apply for additional training not to exceed the time the person was in active service on or after September 16, 1940, and before the termination of the war, exclusive of any period he was assigned for

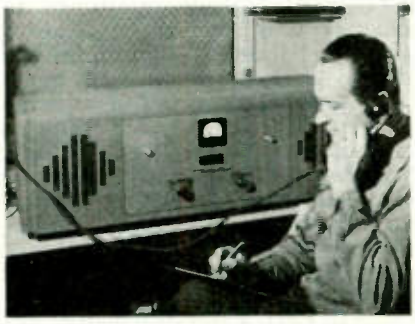
(*Continue on page* 146)

Above: Emergency duplex units used to bridge across break in telephone lines. Equipment operates on FM. Below: Dictaphone recorder permits keeping messages or technical notes



Repair and test section of the Pullman car electronic field laboratory of the Rock Island Railroad. From left to right there are illustrated an audio amplifier, a 5-in. oscillograph, a Handi-talkie, a recording voltmeter and ammeter, a Walkie-talkie and a microvolter, beside the usual assortment of small tools and meters. The hanging phone (upper left) connects to the radios

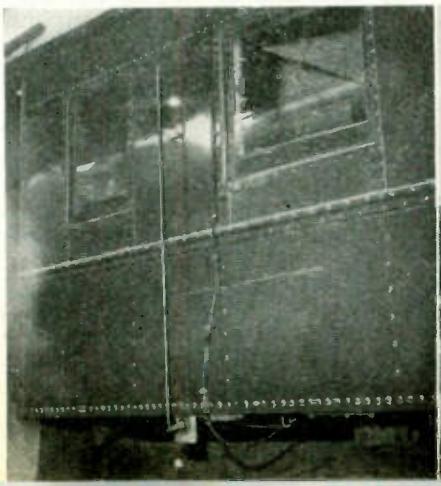
RAILROAD RADIO LAB

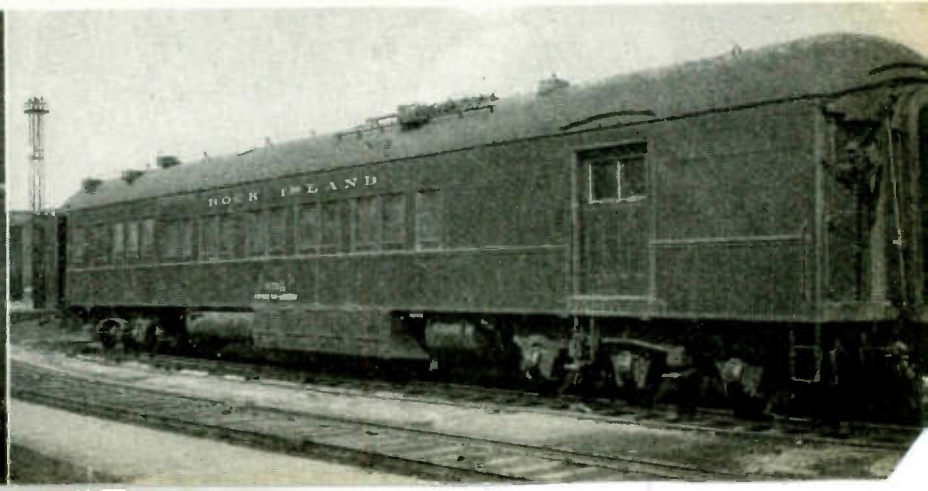


Electronic field test car developed by Rock Island and Galvin facilitates testing of railroad radio equipment

Remote control transmitter and receiver console which operates the set used to contact the bases and certain stations of the Rock Island. The loudspeaker or a push-to-talk handset can be used by the engineers. This console is located in a small office which includes a desk

Left: One of two side mounted antennas for the 30 to 40 mc transmitter-receiver. Although not high, these give excellent coverage over medium-long distances. Right: Electronic field laboratory mounted in a Pullman car. The 160 mc turnstile antenna is at right while the one at the left is for general use. The car has a 5 kw gasoline electric generator in a sound proofed room, some transmitters and receivers, laboratory and office. It sleeps and feeds 13 people and is air conditioned. This car can be pulled behind the fastest passenger trains





TROPICAL TREATMENT

By WILFRED F. HORNER* and F. RUSSELL KOPPA**

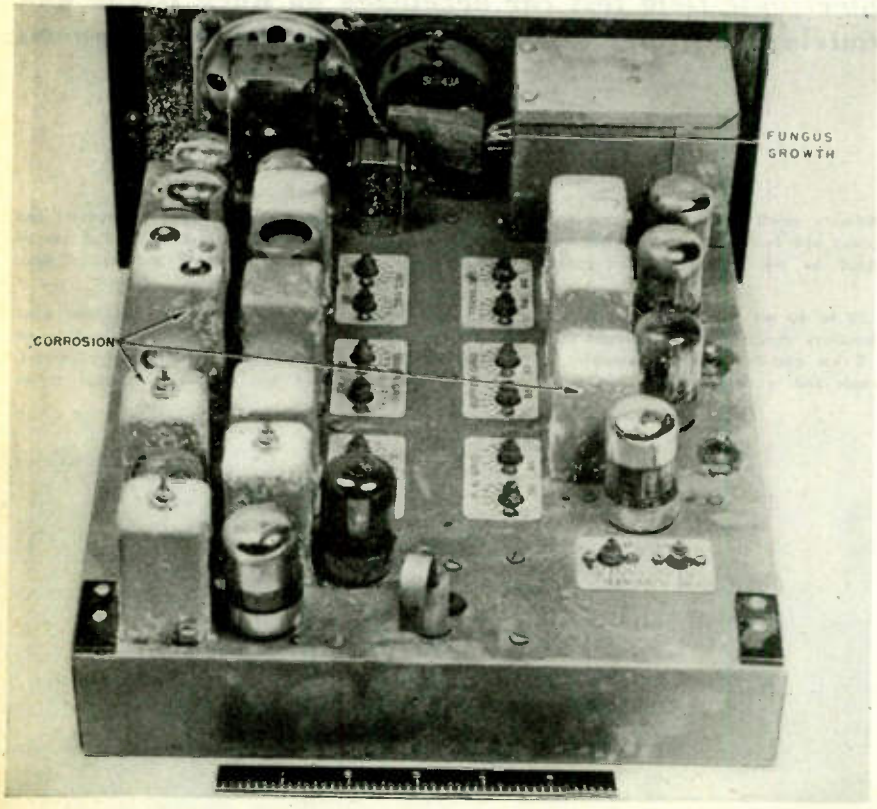
Laboratory technics for discovering the cause and cure of fungus growths—Practical application of preventives

● Millions of dollars of vital military equipment are lost annually due to tropical deterioration. Even more important is the loss of operating efficiency. Deterioration of equipment may result from high humidity and moisture, bacterial and mold action, chemical activity, or a combination of these factors. Methods used to combat these failures are an integral part of our war program and are known as "tropicalization."

To understand and combat these problems adequately, laboratory experimentation is essential. All conditions to which equipment in the field are subject can readily be duplicated. Ambient conditions of temperature, humidity, and exposure to a variety of microorganisms are possible. Various materials, processing of materials, effectiveness of the processing, and other factors are evaluated. Close cooperation between production and laboratory is desirable since production facilities are effectively controlled and supplemented by trained laboratory personnel.

Laboratory testing of materials is conducted according to a rather definite procedure. The fungi used in testing have been collected from various parts of the United States and from numerous battle fronts in order to simulate a variety of conditions and localities. Fungi were isolated from the soil and from materials on which they were found growing. Many molds isolated from equipment in battle areas were found to be of the same genus and species as those existing in this area. The differences were principally those of varieties.

This Signal Corps photograph of a typical piece of military equipment shows quite clearly the deleterious effect of fungus growth and corrosion that attack equipments that are untreated



In the laboratory various nutrient-agar media have been investigated to determine which were best for general growth of the fungi. Several good formulations have been adopted.

Molds used for testing are taken from vigorously growing stocks. The stock cultures are prepared by inoculating sterile nutrient-agar "slants" with spores from a pure culture. After inoculation, stock cultures are incubated at 30 deg. C. for five to fourteen days before they are ready for use. The length of time of incubation depends on the particular species involved. Once a stock culture has reached its peak of growth, it is kept at room temperature and is usable for inoculation purposes for a period of ten or more days. To maintain a good stock, frequent subculturing is necessary.

Untreated materials are tested to determine their resistance to moisture and fungus; these serve as control tests. To determine the effectiveness of commercial moisture and fungus proof treatments (referred to as "M.R.T.") samples are subjected to mycological tests. Materials are frequently processed in the laboratory by dipping, spraying, brushing, or vacuum impregnating with a vehicle containing a fungicide. After the treated material has dried, some samples are exposed to heat, water or moisture vapor before tested for fungus resistance.

Treated and untreated samples are tested by soil burial, natural exposure, and by inoculation with mycelial mats, spore suspensions, or spore sprays. Nutrient agar, non-nutrient agar, or nutrient solutions are used in the inoculation test procedures.

Test samples are subjected to temperatures between 77 and 86 deg. F. and 70 to 100 per cent relative humidity. Samples on nutrient agar are incubated for nine

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**Director Chemical Laboratory, Engineering Department, Belmont Radio Corp., Chicago, and Instructor Department of Chemistry, Schurz Jr. College, Chicago.

# of MILITARY EQUIPMENT

to fourteen days; non-nutrient agar samples are incubated for fourteen to twenty-one days. Soil burial tests require a period of thirty or more days for testing, while natural exposure tests require three to four weeks.

Interpretation of the results is the most important part of mycological testing. Some observations can be made with the naked eye; usually, however, a 30X magnification is essential. Specimens are observed for the presence of filaments and "fruiting bodies" (conidiophores) on the surface and cut edges. If a growth is present, its effect on the material is considered with a view to the ultimate use of the material.

Fungicide properties

Some fungicides produce a zone of inhibition around the material (this is a clear area in which there is no growth), while others do not. The extent of this phenomenon depends on the vehicle, the kind of fungicide, and the quantity of the fungicide. The most important feature of an effective fungicide is not the production of a zone of inhibition, but, rather, protection against moisture and fungus growth without altering the basic features of the material. Thus, the absence of a zone does not necessarily limit the usefulness of the fungicide.

Fungicides, usually organic compounds, are defined as those agents used to destroy fungi or prevent their growth. Most of the so-called fungicidal compounds are fungistatic in their action, namely, prevent the development of filaments or the germination of spores. True fungicides kill the filaments and spores. Fungicides are used both as preventatives and eradicants. The preventative approach is the easier of the two and the most commonly used.

Fungicides fall into two classes:

A. Metallic or heavy metals. (Some postulate that these fungicides denature the proteins in the filaments and spores.)
   1. Copper compounds (such as copper naphthenate).
   2. Zinc compounds (such as zinc naphthenate).
   3. Mercury compounds (such as phenylmercuric stearate, phenylmercuric salicylate, pyridylmercuric stearate).

B. Non-metallic. (This group may denature the proteins and also inhibit enzyme production.)
   Aromatic compounds. (e.g. phenol compounds as salicylanilide, pentachlorophenol, tetrabromorthocresol, dihydroxydichlorodiphenylmethane).

All agents (fungicides) used to kill fungi are rather likely to be toxic to other organisms, including personnel, to a greater or lesser degree.

The use of a fungicide alone does not solve the problems of tropicalization. Moisture and moisture absorption is an even greater problem (and of greater importance) than fungus growth. Numerous types of materials have been used to combat moisture and fungus difficulties. Such materials as lacquers, varnishes, waxes, wax-resin bases, silicone-resin bases, and others have been used. The ultimate use of a product determines the nature of the treatment.

Humidity vs. temperature

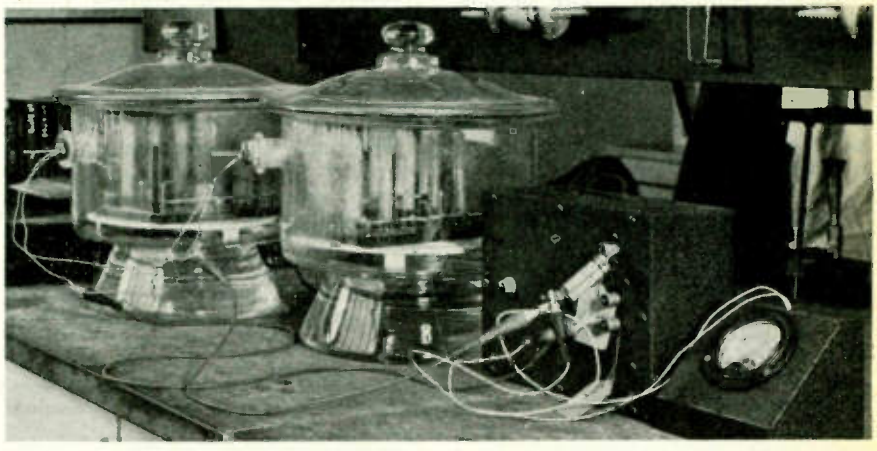
Probably the simplest and most effective way to protect materials in storage is to reduce the relative humidity by increasing the temperature ten to fifteen degrees Centigrade.

The following table indicates the change in relative humidity with changes in temperature:

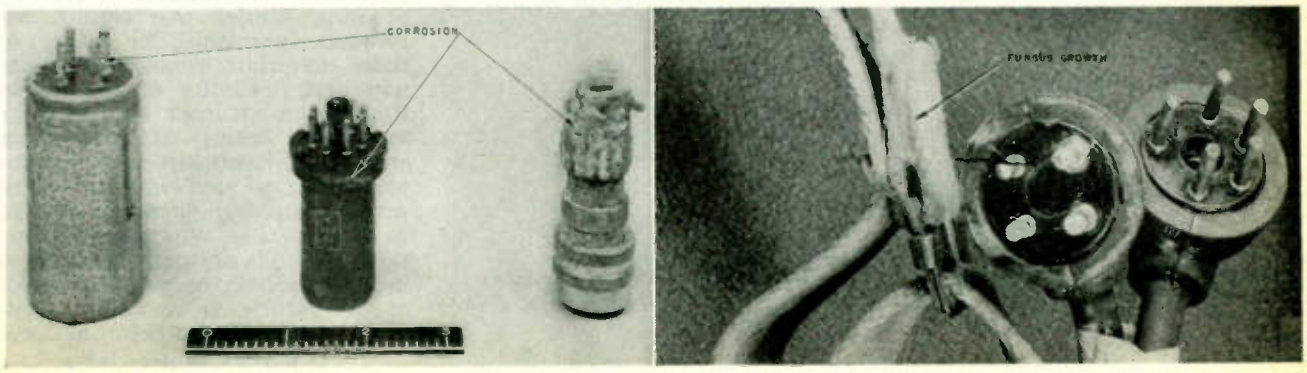
Initial Relative Humidity	Resulant Relative Humidity with 5° rise	10° rise	15° rise
60	51	43	37
70	59	51	42
80	68	58	48
90	76	66	55
100	85	73	63

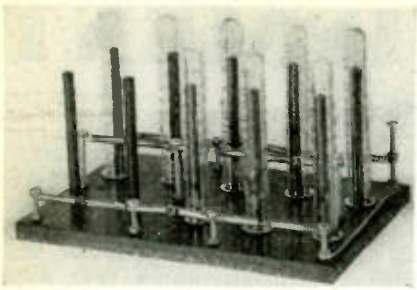
Under conditions of high humid-

Part of the laboratory equipment used in studying electrical corrosion tests resulting from fungus growths. For photographic purposes, dessicators had been removed from the chambers

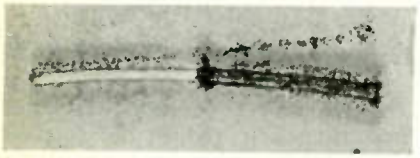


Below are shown effects of fungus growth on vibrator, tube and cable connector, and, right, battery box connectors, not properly treated

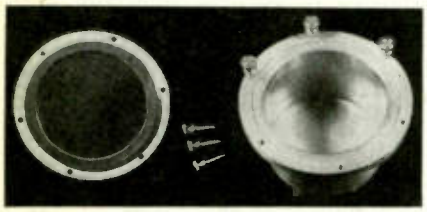




Electrical "corrosion jig" constructed of bakelite and brass; various samples under test appear



Heavy fungus growth that appears on braid and insulation of untreated hook-up wire



Standard Thwing-Albert cup used to measure water vapor transmission. A film is sealed in place by the rubber gasket of the top

ity the corrosion of fine copper wire is an important cause of failure of electrical equipment. The permeability of an insulating film to water vapor is thought to be one of the factors closely associated with the problem of corrosion. A brief discussion of the measurement of vapor transmission of insulating films follows.

Several films of samples to be tested are prepared by coating one side of a water-vapor permeable base. These films, after drying at least twenty-four hours, are used to cover the tops of Thwing-Albert Vapometer cups with known exposed areas. In our method (similar to A.S.T.M. Designation: D 697-42T—Method B) the cups contain a weighed quantity of water. These cups are placed in a desiccator over a powerful drying agent, phosphorus pentoxide, and the apparatus is maintained at room temperature (25 deg. C.).

After six or seven hours the cups are reweighed. The difference in weight indicates the amount of water passed through the film. The thickness of the sample film can, in certain cases, be calculated from the weight of the film and the specific gravity of the dried insulating material. In some cases it may be more convenient to measure the film thickness with a Magne-gage or a GE film thickness gage.

Lacquer, varnish, and wax films containing various percentages of fungicides have been tested. The fungicides incorporated in these vehicles were tetrachlorophenol, pentachlorophenol and phenylmercuric salicylate. Data indicate that the incorporated fungicide has little effect on the vapor transmission of the insulating material. Waxes transmit the least amount of water vapor; lacquers pass the most.

A study has been made to determine if fungicides incorporated in lacquers, varnishes, and waxes increase the corrosion of fine copper wires. Accelerated corrosion tests have been conducted under conditions of one hundred per cent humidity and fifty degrees Centigrade (50 deg. C. or 122 deg. F.).

Control methods

The outer surfaces of clean, thirteen by one hundred millimeter, Pyrex test tubes are dipped into the test material and allowed to drain and dry for at least twenty-four hours. Two bare, No. 34 gage copper wires (carefully spaced 3/32 inch apart) are spirally wound over the coating. A second coating of the test material follows. Thus, the copper wire is imbedded in the test material.

The lower part of each wire is held in place by individual strips of Scotch tape, which at the same time serves as a control film. Samples thus prepared are mounted in the "corrosion jig" (see photograph) and placed in a desiccator over distilled water. The apparatus is then placed in a thermostatically controlled oven at 50 deg. C. A potential of three hundred volts dc is applied between the two copper wires for a period of at least two hundred hours.

Control lacquers, varnishes, and waxes (i.e. containing no fungicide) and those containing various percentages of tetrachlorophenol, pentachlorophenol, phenylmercuric salicylate, and pyridylmercuric stearate have been tested.

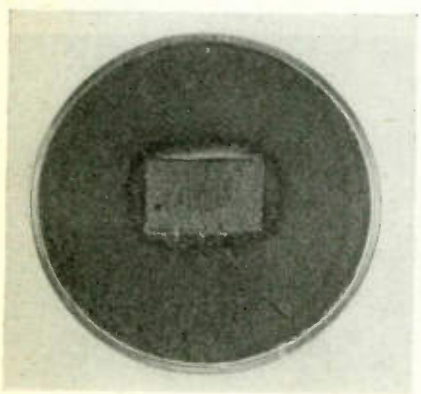
Green deposits surrounding the positive wires indicate that corrosion beneath the Scotch tape had occurred within twenty hours. At the end of two hundred hours, microscopic examination (30X magnification) indicated no destructive corrosion of any copper wire sample imbedded in the lacquer, varnish, or wax. Slight discoloration, however, of all wires occurred. In many cases green corrosion products were evident; frequently a brown-black discoloration—similar to a copper oxide color—could be seen. Wire residues from waxes impregnated with tetrachlorophenol were darker and more extensive than those from pentachlorophenol.

Results indicate that fungicides incorporated in lacquers, varnishes, or waxes in quantities sufficient to render them fungicidal do not destructively corrode fine copper wires. Where prolonged testing had completely destroyed one of the wires, deterioration always occurred beneath the Scotch tape. In such cases the electrical performance of that part of the wire imbedded in the test material was not markedly affected.

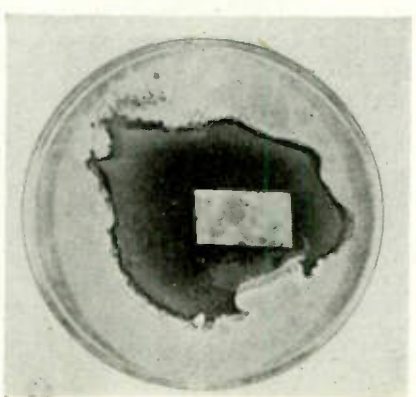
In fungus-proofing component parts, the choice of vehicle is important. For example, in fungus-proofing fabrics one cannot use lacquers, varnishes, or waxes as these materials would destroy the nap and flexibility of the fabric. However, a saturant — such as a wax-resin base — is satisfactory since the treatment renders the part fungus- and moisture-proof without altering or destroying its basic properties. Where the properties of a part are not altered by a lacquer, varnish, or wax, the choice of the vehicle to be used is generally based upon other considera-

(*Continued on page* 150)

Fungus grows up to but not on cotton duck treated with non-volatile type of fungicide



Zone of inhibition around strap leather properly tropicalized with volatile fungicide



SELF-FORGING WELDER

By C. H. STRANGE,
Chief Development Engineer
Stevenson, Jordan & Harrison, Inc., New York, N. Y.

Damped oscillatory discharge using air core welding transformer prevents residual magnetism difficulties

● While the idea of making spot welds by the sudden discharge of energy stored in a large capacitor is well known and equipment using this principle has been on the market for some time, several hurdles have stood in the way of making equipment that was at the same time inexpensive and effective.

One of these, of course, has been that if an ordinary mercury vapor tube was used to block the discharge circuit of the storage condenser during its charging period, this tube, when made conducting would only permit discharge in one direction. While it is easy to use a pair of tubes, this adds to the expense and complication of the circuit.

One solution of this problem was achieved in double mercury pool tubes previously described in Electronic Industries[1] which, once a discharge has been initiated, become so ionized as to permit conduction in either direction.

Another problem has been connected with the presence of iron in the welding transformer. When the welding current ceases, there is apt to be considerable remaining magnetism in the core of the transformer. As this remaining magnetism is variable and affects the discharge, it causes erratic changes in the welds. Besides, in the cus-

(*Continued on page* 166)

[1]High Frequency Welding, Nov. 1943, pp. 101

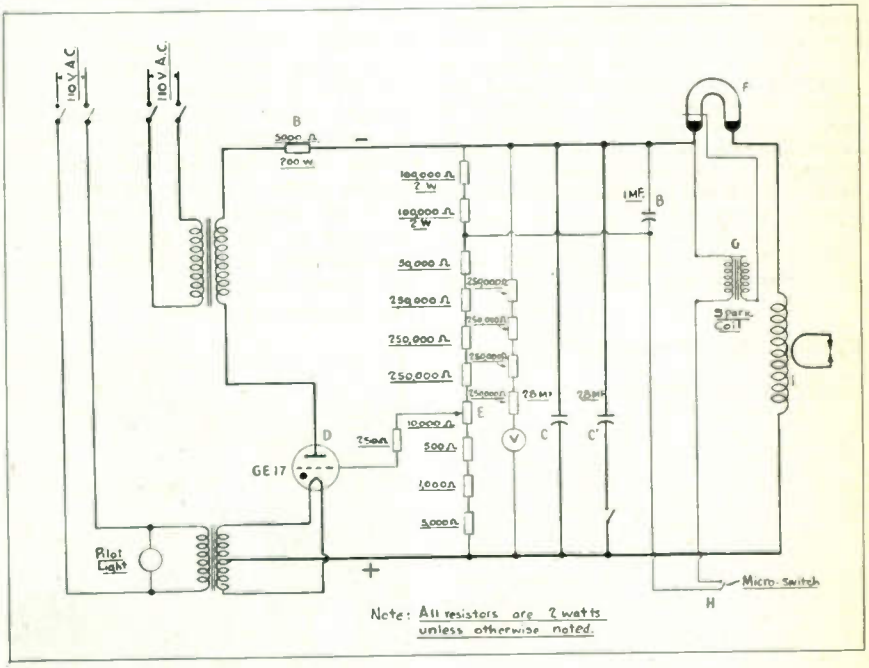
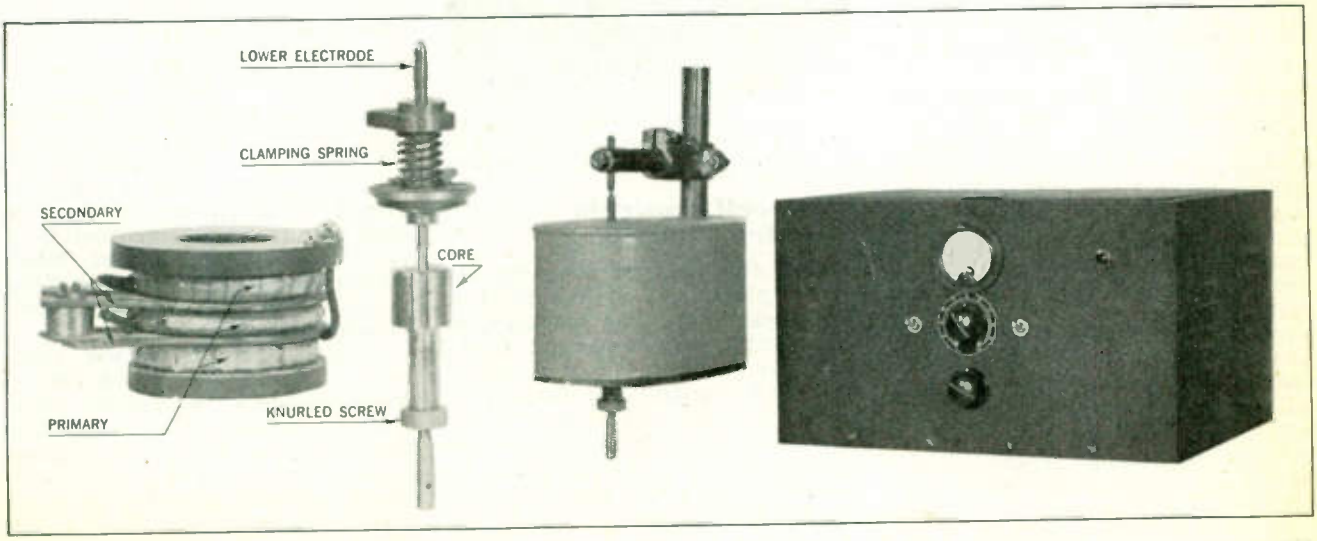


Fig. 1—Circuit of capacity discharge welder. Two 28 mfd. capacitors C and C' store the welding energy obtained through Thyratron rectifier. Fig. 2—Details of the welding transformer showing means for developing forging pressure. Control box at right



TUBES ON THE JOB

MODERN TUBE TESTING

Line width, light output, plate alignment, base-to-shell alignment, uniformity of cathode surface, astigmatism, presence of gas, and screen condition are a few of the items checked in more than 30 tests performed on special test consoles at the Dobbs Ferry, N.Y. plant of North American Philips Co., Inc. The 3-in. cathode ray tube in the center of the panel is under test. The console design is of unusual interest in that it incorporates an efficient grouping of the test instruments in front of the operator and presents the meters on the sides at the proper angle for reading without parallax errors, thus speeds up all operations

Radar for Tracing Migrating Birds

Radar, now used in tracking enemy planes, will in postwar times be put to the more peaceable task of following the migration flights of their feathered prototypes. Prof. Maurice Brooks of West Virginia University tells of his plans to use electronic equipment, installed on a high mountain-top in his state, to obtain data on the height, speed and direction of flight of wild geese, hawks and other birds large enough to register their presence on the radar screen.

Prof. Brooks states that he got the idea of using radar for this purpose from an ornithological friend who is at present a naval officer in the Pacific. The radar on his ship has often detected the presence of albatrosses, man-o'-war birds and other large species, at ranges as great as five or six thousand yards, when the bird themselves were invisible. It is expected that peacetime bird-scouting with radar will gather much information hitherto unobtainable, especially about birds migrating at night or in hazy or cloudy weather, when visual observation is limited or even wholly impossible.

Cathode Ray Tube Plots Own Curves

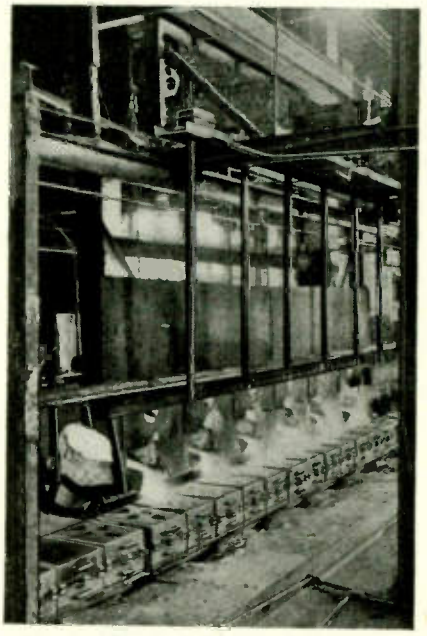
Characteristic curves of individual electron tube performance can be determined and produced quickly by means of cathode ray tube apparatus developed in the research laboratories of Sylvania Electric Products Inc., at Emporium Pa. "Families" of curves are scanned on a cathode ray tube screen in rapid succession. The operators simply place a tube in the circuit and take a photographic record of the curves directly from the cathode ray tube screen. Complete sets of accurate individual tube curves may be scanned and recorded in a matter of minutes. The time required to do the same job by conventional engineering methods would be many man-hours. Operation of the equipment requires no engineering training or special skill and operators can produce thousands of curves daily. These individualized characteristic curves prove useful in the design of new or special equipment. It is planned to use this scheme also in regular tube production as a means of closer control of the performance characteristics.

Method developed by Sylvania engineers for making photographic records of families of characteristic curves of various vacuum tubes

Photocell Controls Foundry Pouring

With the help of recently designed photo cell equipment it is now possible for one operator, in the plant of the American Brake Shoe Co., working from a remote station, to control the pouring of several ladles simultaneously in less time than was needed to pour one by the former method, and all hazards encountered in hand pouring are eliminated.

As each group of empty molds moves into position before the ladles, a Photoswitch control unit mounted directly above, watches through a viewing tube. When the molds are in place, the operator, through push button control of the hydraulic actuating mechanism, tips the ladles of molten iron and the whitehot metal flows into the molds. As the metal reaches the riser of each mold, a brilliant light is thrown off—a signal to the watching "eye" that the mold is full. The ladle drops back instantly, and the pouring automatically stops.



Photocells, located above ladles in foundry of American Brake Shoe Co., determine when pouring is complete and control whole operation

Ultraviolet Lamps Kill Air-borne Bacteria

Where air-borne bacteria is the cause of illness or mortality, or where the reduction or elimination of bacteria will reduce spoilage, special ultraviolet lamps can be used to advantage, reported L. B. Veloz, Sterilamp Specialist, Westinghouse Lamp Division, New York, to the American Society of Agricultural Engineers.

Sterilamps are finger size, tubular quartz-like glass and emit a selected band of ultraviolet radiations in the bactericidal portion of the spectrum. Available in various lengths, the lamps are cold cathode, low pressure mercury vapor arc type for ac operation only. The 30

in. size consumes about 16 watts and has a useful operating life of 5,000 to 6,000 hours. The lamps differ from sunlamp and high pressure mercury vapor lamps in two respects: 1) they emit very little visible light, and 2) 80 per cent of their energy is emitted at a wavelength so short it could not pass through the glass of the sunlamp or the high pressure mercury vapor lamp.

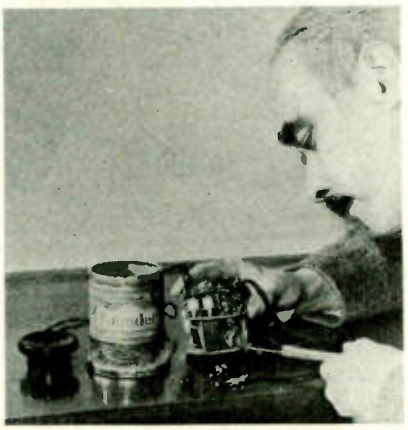
One of the most important agricultural applications of the Sterilamp is in the poultry industry because of the tremendous losses poultrymen suffer every year as the result of mortality due to diseases. In all phases or stages of this business, in the hatching, brooding, raising and egg laying, there is one common problem involved which is not overcome by good housekeeping or sanitary technics. This is preventing or reducing air-borne cross infection between the chicks or flock, which is so largely responsible for the epidemic spread of disease in poultry houses.

Sterilamps, when properly installed in the hatching compartment, reduce to a minimum the possibility of cross contamination between the hatching chicks due to the rapidly circulating air within the hatching compartments. The use of these same lamps is also recommended in the incubator room because, in the great majority of cases, contaminated air from the hatching compartments is exhausted into this room which serves as a fresh air supply for the incubator. An equally important reason is that this highly contaminated air can act as a source of infection for the rest of the plant. It is further recommended that the lamps be used in the sexing, shipping, and sorting rooms for the complete protection of the chicks against airborne infection until they are shipped.

Battery of Sterilamps installed over cages used to house small animals in laboratory production of serums insure maintenance of antiseptic conditions, prevent infection and spread of disease

WELDING CONTROL

By way of broadening and simplifying the application of industrial resistance welding, Westinghouse engineers have developed eleven standard basic units from which it is possible to factory assemble more than 150 different combinations to meet widely diversified needs of industry, and largely eliminate the need for custom-built controls for specific application



Tiny secret radio receiver, made from salvaged parts and used by Dutch citizens for newscasts

Secret Radios for Underground

During the occupation of Holland, the Dutch were forbidden by the Germans to possess radios under penalty of imprisonment in a concentration camp or even death. In spite of this, it is estimated that 3,000 illicit sets were made in the city of Eindhoven, Holland, from materials taken from the Philips Radio Works while air raids were in progress. The two-tube clandestine radio receiving set shown could be concealed in a tobacco tin. Ingeniously designed, this ac radio receiver embodies a new development in a selenium rectifier, used to take the place of the customary rectifier tube.

Sets such as this were often made to operate from a bicycle generator as the Nazis shut off the electric current during British broadcasting hours and batteries were not available. Sets were also concealed in lamps, water and bottles, cracker, cigar and tobacco boxes.

The stealing of parts for the manufacture of these illicit sets was in line with the coordinated sabotage movement which had reduced production in Holland by four-fifths. Patriots also constructed small clandestine transmitter sets which were used to contact the underground and the British Secret Service. A Nazi operating a small quartz saw set up in one of the factory laboratories unknowingly made many of the crystals needed for these sending sets.

Dielectric Defrosting of Frozen Produce

The time needed to defrost large quantities of frozen produce intended for baking or processing in Great Atlantic and Pacific Tea Co. food stores will be reduced from days to minutes by the application of standard dielectric heating methods, according to H. W. Gilb, director of the Company's national bakery division, and Dr. William Cathcart, head of the bakery laboratories.

The importance of this application can be judged when it is realized that a barrel of frozen strawberries, for example, must stand in room temperature for seven days before it can be emptied into the cooker. Even then, the heart of the barrel load may still be frozen if many cold barrels are kept close enough to insulate each other. In a large plant, the storage space alone necessary to keep seven days' supply of defrosting barrels at hand becomes an important item of cost.

The dielectric oven will cut down

(*Continued on page* 124)

A&P food stores bakery laboratories use high frequency heating equipment for quickly thawing frozen foods, thereby saving much time

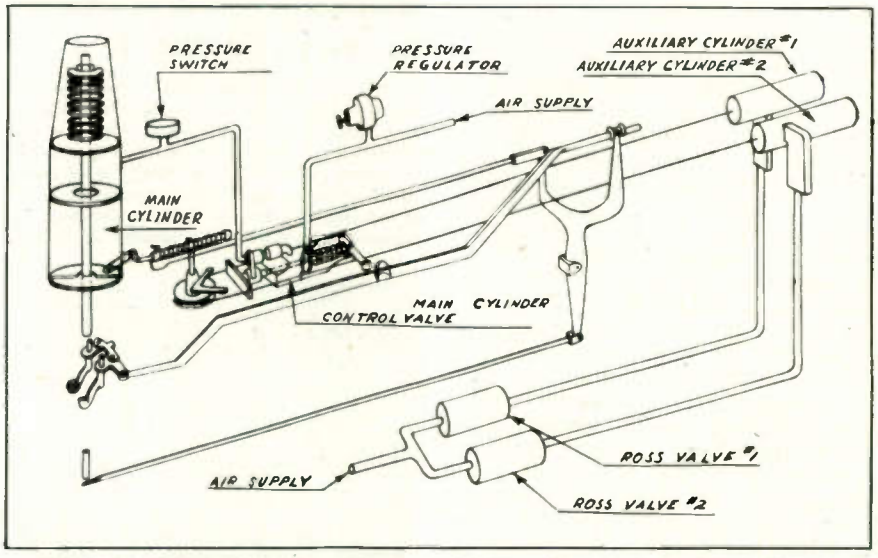
ELECTRONIC CONTROL OF

By THOMAS A. DICKINSON
Consolidated Vultee Aircraft Corp., San Diego, Calif.

Sequence control unit permits increase in efficiency of 20 per cent and saves 35 per cent in cost of parts

● The efficiency of Model 2002 Erco automatic riveting machines has been greatly increased at Consolidated Vultee Aircraft Corp. by means of an electronic sequence control unit which has been invented and perfected by Walter Mandel, an electrical engineer.

Before the Mandel unit was developed, it was necessary for the operators of Model 2002 Erco machines to control complicated flush riveting processes by means of pedals; and, since the speed and accuracy of these operations depended entirely upon the alertness and good judgment of the operator, mistakes occasionally were made, causing unnecessary losses in both time and materials. With the Mandel unit, the Erco machine operator is required only to depress a single foot lever; then the entire punching and riveting sequence is accomplished without further human assistance.



Schematic of the riveting machine showing arrangement of electronically controlled valves

Sequence of operation

Function of the unit is to actuate a series of electrical circuits so that parts of the machine will be operated in the proper sequence. With reference to the accompanying schematic diagram, events take place in the control unit and the machine as follows:

(1) The foot switch is closed by the operator and relay P is energized, closing contacts P-1.

(2) Closing contacts P-1 energizes the solenoid, opening Ross valve No. 1.

(3) Air entering auxiliary cylinder No. 1 actuates the shift mechanism—moving the die button into the punching position, locking the punch, shifting the piston stop block under the main piston, and opening the main cylinder control valve.

(4) Air entering the main cylinder drives the plunger down into the die bottom, whence it continues to descend—contacting the material and forcing the die over the punch until it is halted by the piston block.

(5) When air pressure in the main cylinder increases sufficiently, pressure switch O closes.

(6) Closing pressure switch O energizes relay B, closing contacts B-1 and B-3.

(7) Closing contacts B-1 energizes relay X.

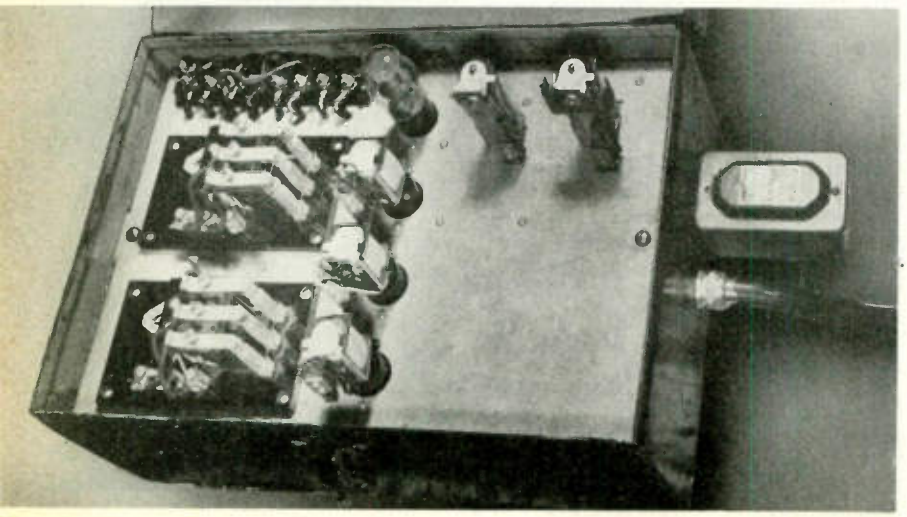
(8) Energizing relay X opens contacts X-1.

(9) Opening contacts X-1 deenergizes relay P.

(10) Opening contacts P-1 deenergizes the solenoid of Ross valve No. 1 and allows air to exhaust from auxiliary cylinder No. 1.

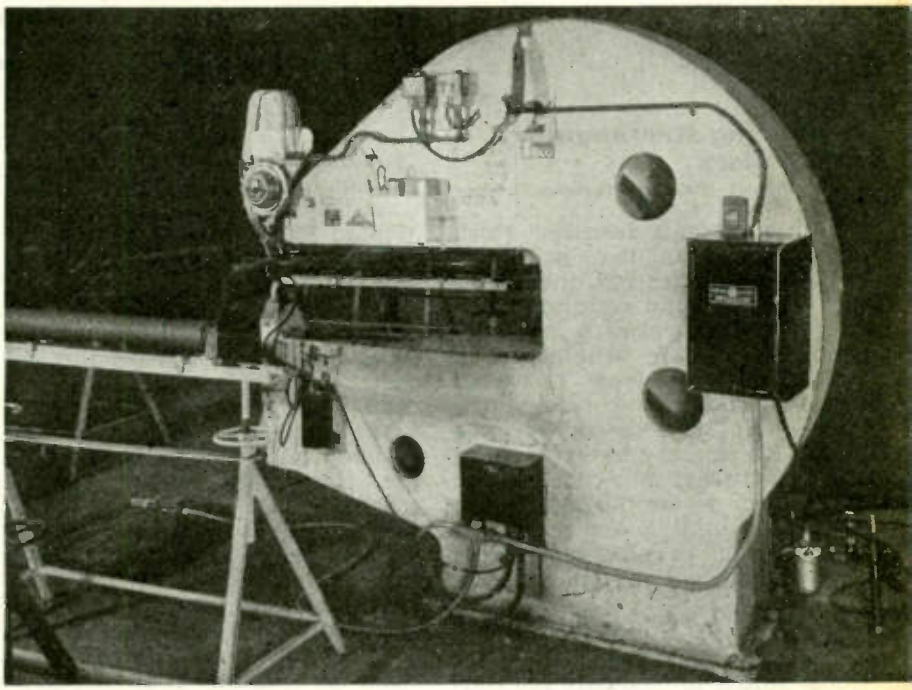
(11) When the air pressure in auxiliary No. 1 is reduced, the spring in the main cylinder control valve

Close-up of the Mandel electronic sequence control unit as applied to automatic riveter



AUTOMATIC RIVETER

Since the sequence of operations associated with this riveter can be applied in principle to other machines, a description of the operating schedule will follow, together with a detailed analysis of the complete circuit operation of the tubes and relays. As shown in the schematic diagram of the mechanical arrangement, this press first punches the hole and then inserts and upsets the rivets, all operations being actuated by air pressure. The problem is the completion of each part of the job before the next stage is started. The electronic solution to this problem illustrates the tying up of two distinct fields of control, the earlier air pressure operated methods and the newer electronic methods.
—Editor.



Complete Erco automatic riveting machine to which electronic control has been applied with the result that the number of airplane panels produced per day has been stepped up from 8 to 12½

opens the exhaust for the main cylinder; then the main cylinder spring returns the plunger to its normal position.

(12) When air pressure in the main cylinder is reduced, pressure switch O opens.

(13) Opening pressure switch O de-energizes relay B.

(14) De-energizing relay B closes contacts B-2.

(15) Closing contacts B-2 energizes relay A.

(16) Closing contacts A-2 energizes the solenoid of Ross valve No. 2.

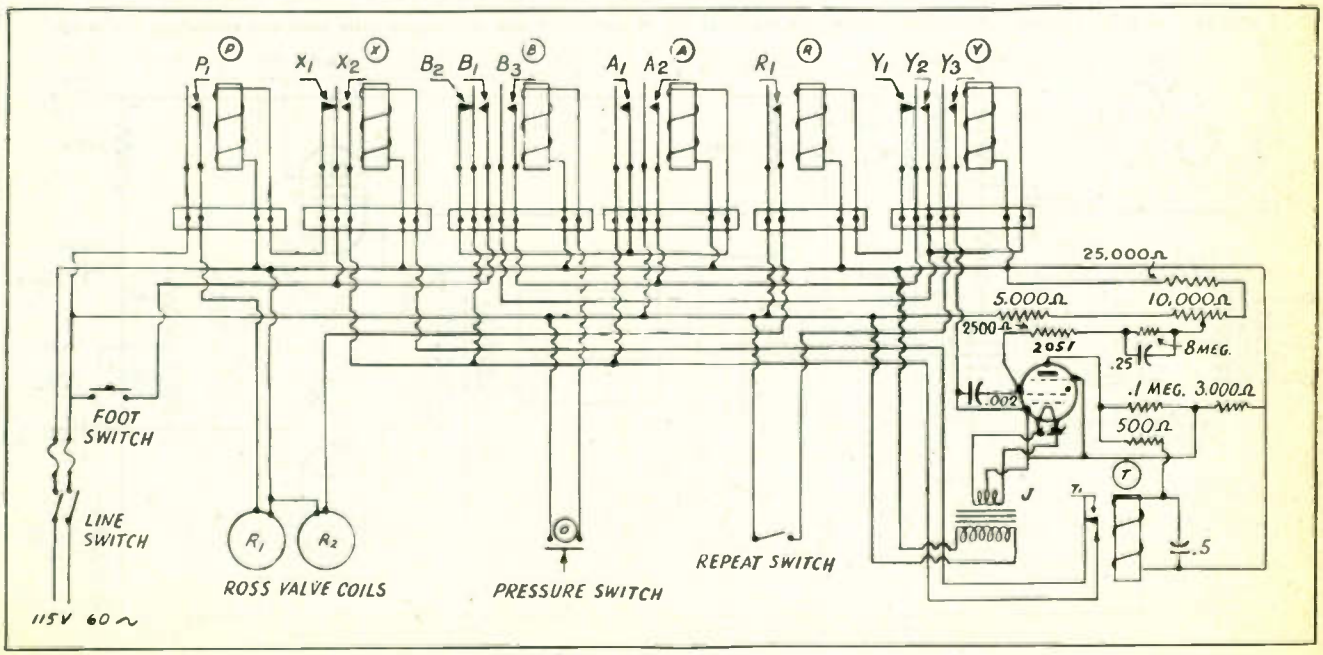
(17) Air entering auxiliary cylinder No. 2 actuates the shift mechanism—moving the rivet shoe into alignment with the rivet set, removing the main piston stop block and punch lock, and opening the main cylinder control valve.

(18) Air entering the main cylinder moves the piston down, causing the rivet set to enter the rivet shoe and guiding the rivet shoe and rivet to a position directly above the punch. Continuing the descent, the rivet enters the work and pushes the punch out of the work ahead of it. The punch comes to rest at the top face of the anvil, and at the extreme end of the stroke the rivet head is formed.

(19) When the air pressure in the main cylinder is sufficiently high, pressure switch O closes.

(*Continued on page* 190)

Schematic of the Mandel electronic control unit circuits by means of which a complicated sequence of operations becomes automatic



SURVEY of WIDE READING

Electronic news in the world's press. Review of engineering, scientific and industrial journals, here and abroad

Producing Rectangular R.F. Pulses

W. R. Piggott (Wireless Engineer, London, March 1945)

An apparatus is described which generates rectangular pulses of radio-frequency energy, the amplitude, duration and recurrence frequency of the pulses being independently variable. The output of a Marconi-Ekco type TF 390 F/3 signal generator, covering the ranges 1.6 to 2.4 megacycles and 18 to 100 megacycles, is applied to an additional unit consisting of a generator for rectangular pulses of variable duration and recurrence frequency and of a low capacitance electronic switch (see figure below).

Electronic switch

It is the function of the electronic switch to modulate the continuous radio frequency wave so that during a given time interval it is equal to a known fraction of the known input provided by the h. f. oscillator and for other times it is zero; its operation should be independent of probable changes in operating conditions.

These requirements suggest the use of a neutralized push-pull cathode-follower circuit as the electronic switch. Normally the tubes are biased beyond cut-off by the current through R_6. Leakage through stray capacitances and through the grid-cathode capacitances of the tubes is made zero by adjusting the neutralizing capacitors C_n which feed out-of-phase potentials into the cathode loads. Mullard EF 50 tubes having a mutual conductance of 6.5 mA/V were used; as is well known, the output of a cathode-follower circuit employing high mutual-conductance tubes is nearly independent of operating conditions and its amplification factor is close to unity.

The maximum undistorted amplitude available is proportional to the plate voltage and to the cathode load. For large cathode loads it approaches half the applied plate voltage, and for a cathode load of 1,000 ohms it is more than 20 volts when the plate potential is 350 volts. Pulses of from 5 to 10 microseconds and longer could be obtained; it is felt, however, that narrower pulses may be produced.

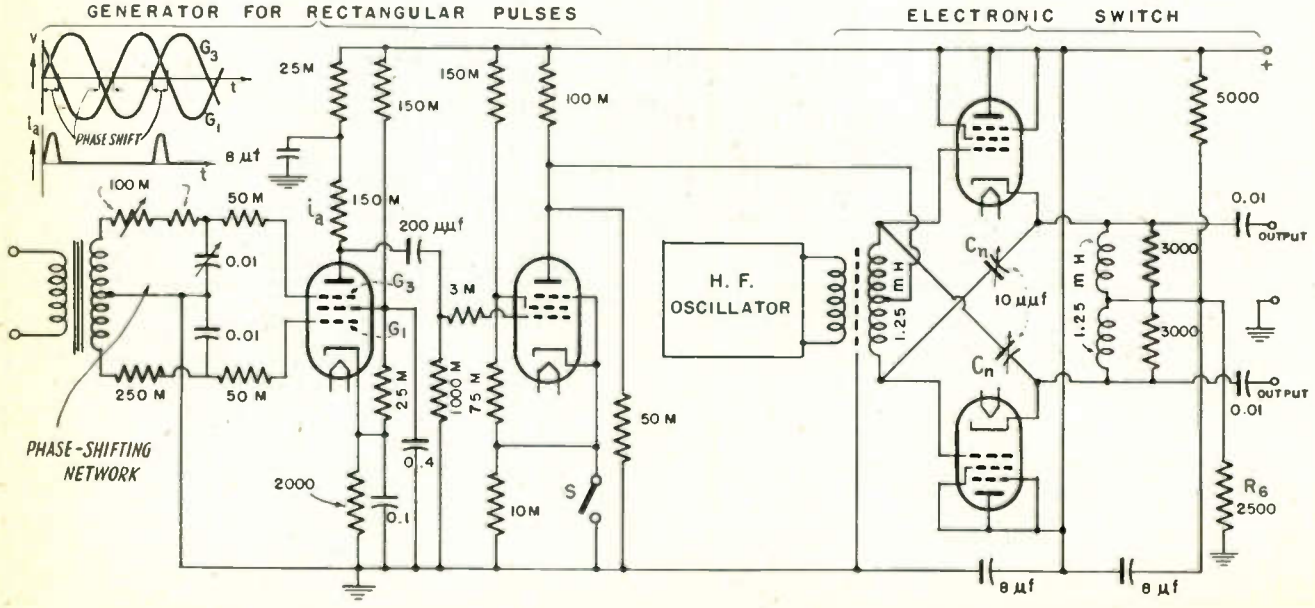
If desired a balanced attenuator can be inserted between the cathode load and the output terminals of the unit to enable the output voltage to be varied over wide ranges of amplitude. For an unbalanced output, the cathode load is replaced by a rf transformer.

Pulse generator

The cathode follower circuit is controlled by the rectangular pulses provided by the associated generator. A conventional bridge type phase-shifting network supplies out-of-phase biases to the control grid G_1 and the suppressor grid G_3 of the first generator tube. (See insert on left-hand top corner of figure.) The screen grid voltage of this tube is small and the bias across the cathode resistor is adjusted so that, when no phase shift is introduced by the bridge network, the plate current is zero.

The plate load is made as large as possible in order to obtain a short dynamic grid base, and the amplitudes of the grid inputs, shown as G_1 and G_3, are very large compared with the dynamic grid base. Consequently no plate current can flow when either grid is appreciably negative and the duration of plate current flow will be proportional to the phase shift introduced by the network; for zero phase shift the two voltages will be of opposite polarity, the tube being cut off at all times. The plate current pulses i_a are also shown in the diagram. The second tube circuit of the rectangular pulse generator amplifies the output of the first tube and renders them more rectangular. Obviously, the phase shift and therewith the pulse duration can be adjusted by variation of the capacitor and the resistor in the phase-shift bridge; a convenient ratio of maximum to minimum pulse length is about 10:1. The rectangular pulse generator may be

Rectangular rf pulse generator: rf oscillator, switch to modulate the rf oscillations and rectangular-pulse generator controlling the switch



driven by a tube oscillator or connected to the power supply. The narrowest pulse width available for a given af voltage is inversely proportional to the frequency. The amplifier should be capable of handling frequencies up to the inverse of the pulse width.

Applications

The equipment has particular applications in the case of the problem of the pulse field-strength measurements and measurements of the transient behavior of extended systems such as transmission lines and antennas.

It is suitable to test the response characteristic of a complex system to any type of transient or continuous signal and a method to adjust a system so as to exhibit a given response characteristic is described.

Titrimeter

E. M. Buras (Industrial and Engineering Chemistry, Analytical Edition, February, 1945)

The titrimeter with adjustable range and sensitivity described is basically a dc voltmeter with a range of approximately 10 volts and a sensitivity of ± 0.0001 volt. It may be adapted to give pH readings over a range of -1 to 15.

The line-operated instrument incorporates a voltage regulator providing the power needed; a 5 volt variation in line voltage causes a 0.06 volt change across a 5 watt capacitive load. A twin diode 7A6 operating as a full wave rectifier and associated filter, a voltage regulating tube and a voltage divider follow the power supply. The last section of the instrument is a 6F8 coupled as single-stage current amplifier of the cathode follower type and a meter connected in a bridge circuit. Circuit details, calibration, circuit characteristics, and many applications are described.

A 100-kv Electron Microscope

L. Marton (J. Applied Physics, March, 1945)

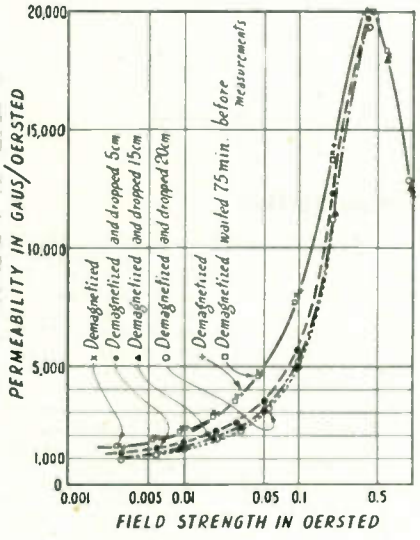
A transmission type electron microscope with magnetic lenses is described. Details of mechanical construction are given; two micrographs illustrate its performance.

Effect of Vibrations on Permeability

H. Fahlenbrach (Naturwissenschaften, Berlin, Vol. 31/32, Page 371)

The effect of elastic vibrations on the permeability of ferromagnetic materials is studied. It has been known that an increase in permeability occurs if a magnetic field is applied while the material is subjected to mechanical vibrations.

In the course of investigations it has been established that apart from the increase in permeability under the influence of the forced mechanical vibrations, there is also a decreasing effect observed with iron-nickel alloys, iron-silicon alloys and iron-aluminum alloys, indicating that this is a property common to all ferromagnetic substances. It has been proved for the mentioned materials that forced elastic vibrations (for instance, insertion of parts into coils, winding of sheet metal samples, etc.) after



demagnetizing result in a considerable decrease in permeability at small values of the magnetic field. The decrease is permanent but vanishes completely upon demagnetization. Also, the permeability in the demagnetized condition is permanent at room temperature. At temperatures over 200 deg. C a transition to the vibrated condition takes place. The figure shows the permeability values for a ring-shaped sample wound from a 0.35 ribbon of an iron-silicon alloy having high permeability.

The phenomenon may be explained by the assumption of a different distribution of the elementary domains with respect to the crystallographically preferred directions of magnetization in the demagnetized (preference for directions with small angles to the direction of magnetic flux) and vibrated condition, and the effects on the displacement of boundaries.

Low-Frequency Voltmeter

C. A. Beevers and R. Fuerth (Journal of Scientific Instruments, London, March, 1945)

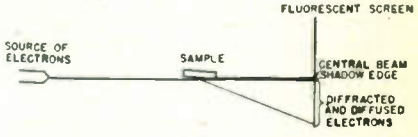
A voltage of 1 μV to 100 μV having a frequency of 1 to 10 cycles can be measured. The instrument was designed for encephalographic purposes but may be applied to small and slow fluctuations of pressure, light intensity or temperature.

A three-stage, push-pull, resistance-capacity coupled amplifier, capable of amplifying 1 to 10 cycle voltages with an amplification factor of about 100,000, controls the grid potentials of two reactance tubes which vary the frequencies (approximately 5 mc) of two Hartley oscillators in opposite directions. A mixer tube provides the difference frequency, for instance 500 cycles, of the two oscillator outputs. Voltage change of 1 μV produces change of pitch of a whole tone.

Distinguishing Between Conducting and Insulating Films

E. I. Alessandrini (Journal of Applied Physics, February, 1945)

The electron diffraction camera offers a means to distinguish between conducting and insulating surface films on conducting objects



The position of the sample to be investigated is such that the electrons just graze the surface film (see figure). Differently shaped patterns will appear on the fluorescent screen depending on whether or not the surface of the sample is conducting.

AUTOMATIC RIVETER

(*Continued from page* 113)

(20) Closing pressure switch O energizes relay B, closing contacts B-3.

(21) Closing contacts B-3 energizes relay Y, opening contacts Y-1.

(22) Opening contacts Y-1 deenergizes relay R, opening contacts R-1.

(23) Opening contacts R-1 deenergizes the solenoid in Ross valve No. 2, allowing air to exhaust from auxiliary cylinder No. 2.

(24) When the air pressure in auxiliary cylinder No. 2 is reduced, the spring in the main cylinder returns the plunger to its normal position. (NOTE: If the foot switch remains closed and the repeat switch remains open, the cycle of operation is complete and the machine becomes inoperative. If the foot switch is open, relays X, A, and Y return to their normal positions. If the foot switch remains closed and the repeat switch is closed at or before the end of operation No. 24, the following events take place:)

(25) The energizing of relay Y closes contacts Y-2 and Y-3, and causes the timing circuit to become inoperative.

(26) When the plate current of the thermionic tube reaches a value sufficiently high to operate relay T,

(*Continued on page* 190)

NEW PATENTS ISSUED

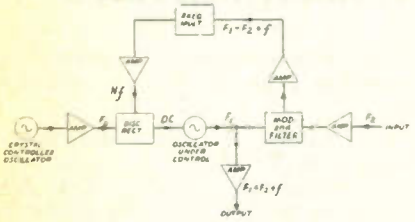
Stabilizing Difference Frequencies

The frequency difference f between the output frequency F_1 and the input frequency F_2 is to be maintained constant; the output frequency F_1 should be a pure sine wave and free of undesired frequency components. To meet these requirements, an oscillator is controlled to generate only the desired frequency F_1; also the oscillator output is effectively separated from the input circuit to prevent distortion of the output wave by interaction.

Operation of the circuit will be understood by a consideration of the accompanying diagram. The crystal controlled oscillator operates at the frequency F_D equal to Nf, the multiple N of the difference frequency f produced by the modulator and frequency multiplier. Any deviation of the frequency multiplier output Nf from the frequency F_D of the crystal controlled oscillator will result in an adjustment of the oscillator frequency by means of the discriminator-rectifier circuit. The discriminator is sensitive to any shift in the respective phases of the input voltages and therefore will respond to small shifts in frequency. It will be seen that a shift in either the output or the input frequency (F_1 or F_2) will result in a controlling action of the discriminator circuit so that the difference f between these frequencies is maintained constant.

By increasing the multiplying factor N the sensitivity of the control is proportionally increased because the phase difference between frequencies Nf and F_D will be N times the phase difference between the input frequency F_2 and the output frequency F_1. This provides extremely close frequency control within a fraction of a cycle.

It is sometimes desirable to quickly

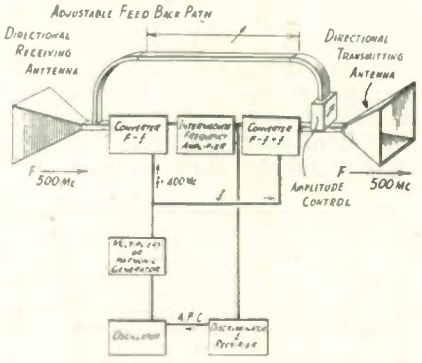


change the difference frequency f. This can be accomplished by varying the frequency F_D of the crystal controlled oscillator, the frequency difference f being equal to F_D/N.

To further separate input and output waves, each may be multiplied in a separate circuit and then heterodyned to give the wave of frequency Nf.

In actual applications these systems have been found very effective for isolating unwanted modulation products in highly sensitive self-tuning detector networks used in measuring instruments.

F. R. Dennis and E. P. Felch, Jr., Bell Telephone Lab., Inc., (F) February 28, 1942, (I) February 20, 1945, No. 2,369,663.



Relay Station

Only one oscillator is used at the repeater station to provide the waves for the heterodyning of the incoming signal to the intermediate signal and for the reconversion of the intermediate signal to the original higher frequency for retransmission. With this arrangement, incoming and outgoing frequencies are necessarily identical and independent of local oscillator frequency.

The frequency of the local oscillator is controlled by a voltage derived from the intermediate frequency section of the device so that the intermediate frequency is maintained constant and no side band clipping is introduced in the intermediate frequency section which may have to handle a wide frequency band.

The first conversion in the station requires only a small amount of energy from the local oscillator and the remainder is used for high level conversion in the heterodyning circuit preceding the transmitting antenna.

An adjustable feedback path may be provided to compensate for the feedback through space from the transmitting to the receiving antenna. It is preceded by an amplitude control and its electrical length made variable so that phase and amplitude of the energy fed back to the input can be regulated.

B. Trevor, RCA, (F) May 27, 1942, (I) February 13, 1945, No. 2,369,268.

FM Receiver

If a pre-emphasized signal is to be received, a circuit to compensate for the distortion introduced at the transmitter must be incorporated into the receiver. For this purpose, the invention provides a filter having the same amplitude-frequency characteristic as the pre-emphasis network in the transmitter, and a reactance tube which controls the frequency of the local oscillator and shifts the generated frequency in such direction as to reduce the frequency swing in the intermediate frequency range with an increase in filter output voltage. The filter circuit used in the receiver may be identical with the pre-emphasis circuit in the transmitter which simplifies its design.

Faithful reproduction will be secured by this system. Assuming the higher frequencies to be amplified by the pre-emphasis network at the transmitter, they should be reduced at the receiver. If the two networks have identical amplitude-frequency characteristics, more voltage will be produced by the filter at higher frequencies, reducing the frequency swing and thus reducing the audio amplitude, as desired.

The same result may be secured if the intermediate frequency swing is increased with increased filter output voltage provided the amplitude-frequency characteristic of the filter is complementary to the pre-emphasis network in the transmitter.

H. Tunick, RCA, (F) December 20, 1941, (I) November 7, 1944, No. 2,362,000.

Reactance-Amplitude Converter

It is desired to convert minute variations in reactance into large variations in current or voltage, for example, in connection with the capacitance changes produced by the pick-up head of a phonograph. A special capacitative pick-up for phonographs to be used with the circuit is described.

If the two tuned circuits in the leads of control grids 12 and 13 are resonant to the same frequency, the tube 10 will act as an oscillator at this frequency. As is well known, if the two control grids 12 and 13 are excited by voltages of the same frequency but varying phase, the average value of the discharge current through the plate load will vary as a function of the phase difference between the grid control voltages. A similar effect is obtained by variation of the capacitance or inductance of either of the tuned circuits.

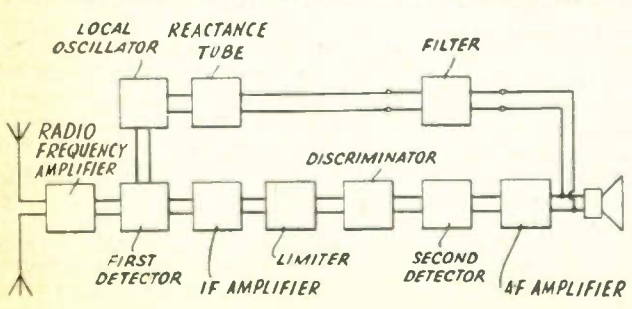
In the figure, 41 is the pick-up capacitance of the phonograph which is varied by the movements of the needle following the record groove. Obviously, a small change in the capacitance of capacitor 41 may result in a large percentage change in the impedance of the combined impedance of coil 17 and capacitors 40 and 41, the combined impedance being the difference between capacitive and reactive components.

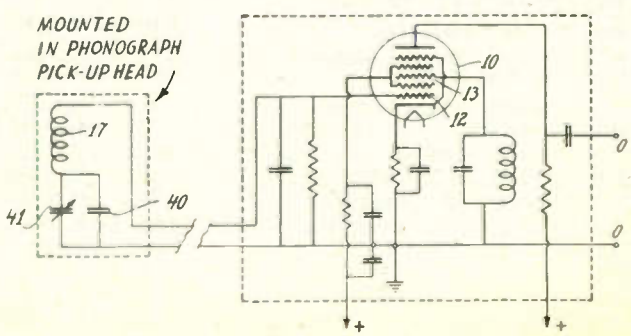
Alternatively, the pick-up capacity serves to control the frequency of a small oscillator mounted in the pick-up head. The varying frequency output is then applied to one of the control grids of the converter tube, while a resonant circuit tuned to the center frequency is connected to the other control grid. Variations of the output current corresponding to the frequency deviations will be obtained in the plate circuit.

Alternatively, a constant frequency oscillator provides the input to one control grid of the converter tube, the other grid being connected to a resonant circuit incorporating the variable pick-up capacitance.

W. H. Unger, Patents Research Corp., (F) April 29, 1941, (I) January 23, 1945, No. 2,368,052.

Below: Illustrating Patent No. 2,362,000, FM Receiver—Right: Illustrating Patent No. 2,368,052, Reactance-Amplitude Converter





ASSOCIATION NEWS

Happenings of the month concerning industry organizations

RMA Adopts Standard Code Symbol Markings

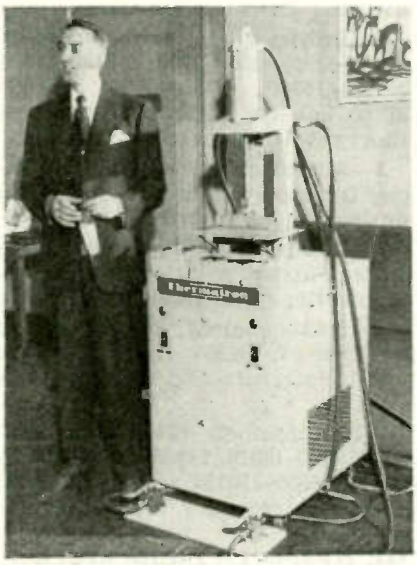
The standard code marking system, a long time under consideration by Radio Manufacturers Association, has been adopted for member manufacturers. Though the use of the system is voluntary it is expected that it will be widely used. Under the plan each manufacturer is assigned an exclusive code symbol, starting with 101 for Admiral and ending with 343 for Zenith. To his code symbol each manufacturer then adds a code symbol indicating the year of manufacture and another to indicate the week produced.

FMBI Again Picks Damm

Walter J. Damm, general manager of radio station WTMJ, Milwaukee, again heads FM Broadcasters, Inc. He was re-elected president of the organization at a meeting held in Chicago the last week in May. At the same time, Ted C. Streibert, President of WOR, New York, was re-elected vice-president, and L. W. Herzog continues as secretary-treasurer.

Philco Men Head Phila IRE Section

David B. Smith, director of research for Philco Corp., and Palmer M. Craig, chief engineer of Philco's Radio Division, have been named chairman and secretary-treasurer, respectively, of the Philadelphia section of the Institute of Radio Engineers. Craig was re-elected and is also chairman of the Radio Manufacturers Association committee on home receivers.



Electronic Plastic Bonding

Mr. Robert Saslaw, consulting electronic engineer, demonstrating at the June meeting of the Society of the Plastics Industry, the electronic bonding of plastic sheets varying in thickness from .002 to .040 in. Process requires between one and three seconds

Chicago Exposition

Chicago's "Products of Tomorrow Exposition" has received the green light from the Office of Defense Transportation and it is expected that a definite date for the opening will soon be assigned. The present plan is to hold the exposition some time early in 1946.

NAB Handbook

National Association of Broadcasters is preparing for early publication an engineering handbook to serve as a practical technical guide for the operating engineers of broadcast stations. The plan is to prepare the handbook in loose-leaf form and to include data on the technical problems encountered in the day-to-day operation of AM, FM, television and facsimile broadcast stations of all powers. The book likely will appear early in 1946.

Study Radio Interference

An agreement for international cooperation, looking toward the ultimate establishing of standards in connection with the complex problems of radio interference has been set up between the American Standards Assn., the British Standards Institution, and the Australian Standards Assn. through the medium of the United Nations Coordinating Committee. The American Standards Assn. recently advised the New York Office of the United Nations Standards Coordinating Committee that it is prepared to collaborate with the British Standards Institution and the Australian Standards Assn. with the ultimate objective in mind of arriving at an international basis for the suppression of radio interference.

Instrument Society

A new national society to be known as The Instrument Society of America was organized in Pittsburgh on April 28th at a conference attended by delegates from fifteen measurement and control instrument societies that have been growing in different industrial centers throughout the country. The purpose of the Society will be to advance the arts and sciences that are connected with the theory, design, manufacture and use of instruments. The society is non-professional, and offers membership to any person, firm or institution interested in its objectives. Pro-tem officers were elected as follows: President, A. F. Sperry (Chicago); Vice-President, C. F. Kayan (New York); Treasurer, C. E. Fry (Pittsburgh); Secretary, Richard Rimbach (Pittsburgh).

IRE Building Fund Committee Members

Not all the committee members are here but those that are include, left to right: Melville Eastham (Chief Engineer, General Radio Co.), Administrator IRE Building Fund; Ralph R. Batcher (Consulting Editor Electronic Industries), Chairman Public Relations Committee; W. G. R. Baker (Vice-president, GE), Chairman Initial Gifts Committee; Walter Evans (Vice-president, Westinghouse), Chairman Advisory Committee; L. C. F. Horle (Consulting Engineer), Administrator

Plan 4 Million Tubes Per Month

The War Production Board plans to give the radio owner who needs new tubes preference over the purchaser of a new set. Disclosing plans for channeling production of new tubes into the replacement market, WPB officials told an advisory committee that home radios are in such poor condition that the average set needs about 1½ tubes. Thus officials said, if a million tubes are available for replacement, 666,666 sets will be restored. However, if these million tubes are used in the production of new five-tube sets, only 200,000 new receivers would be placed on the market.

Officials said they are planning to authorize the production of four million tubes a month for civilian use. However, until military orders and cutbacks become more apparent it seems unlikely that this level can be reached. Civilian tube allotments for 1944 were 19 million tubes, averaging 1.2 million to 1.8 million per month. Production for receiving sets during March and April totaled 25.9 million tubes.

FCC "Proposes" Low Frequency Allocation

Following a few days after Federal Communications Commission made public frequency allocations for that part of the radio spectrum between 10 kc and 30 million kc, proposed allocations for the remainder of the spectrum below 25 kc were released. Before they can become official, however, there is to be a series of public hearings, first of which was held June 20. It is hoped to complete final allocations before the Rio Conference which is slated for Sept. 3.

Highlights of the proposal for dividing up the frequencies below 25 kc are:

1—Addition of 15 kc to the lower end of the present broadcast band, enlarging that band to include from 535 to 1605 kc, to provide an additional channel at 540 kc with the top limit remaining as is at 1600 kc.

2—Provision of 120 channels (6000-6200, 9500-9700, 11700-11900, 15100 - 15300, 17700 - 17900, 21500 - 21700 kc) for direct international shortwave broadcasting.

3—Allocation of certain frequencies for use by amateurs and others during time of disaster.

4—Increased emphasis on the requirements of aviation radio communications and navigational aids.

5—Establishment of a greater number of "SOS" frequencies for use by aircraft and small surface craft.

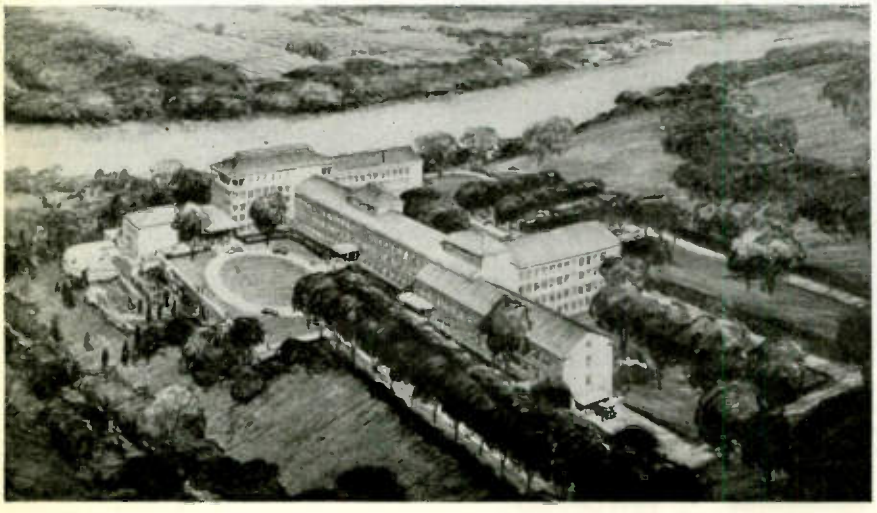
7—Six channels (2495-2505, 4990-5010, 9990-10010, 14985-15010, 19985-20015, 24985-25015) are set aside for standard frequency broadcasts.

GE Research Laboratory

A new building for the General Electric Company's Research Laboratory, which will afford some 50 per cent more space than present facilities provide, will be erected near Schenectady, at a cost of $8,000,000. The site includes 219 acres in suburban Niskayuna, about 4½ miles from the main plant and offices.

The new building, in the general shape of the letter T, will vary from two to five stories in height and will include 200,000 sq. ft. of laboratory working space in addition to an auditorium seating 300, a dining room, conference rooms, etc. One third of the laboratory space will be devoted to service facilities, machine shops and specialty shops such as glass blowers, all in a convenient central location.

Architect's drawing of the projected GE research laboratory to be located near Schenectady



PERSONNEL

Royal V. Howard has been elected vice-president in charge of engineering for both Associated Broadcasters, Inc., and the Universal Broadcasting Co., San Francisco. Associated owns and operates stations KSFO and international stations KWID and KWIX. Howard has just returned to his home city after a year of overseas duty in London and Paris for the Army.

Royal V. Howard

Arthur J. Sanial

Arthur J. Sanial has been appointed chief engineer of Atlas Sound Corp., Brooklyn, N. Y. He has had a long career in the electronic industries having been connected with Bell Telephone Laboratories, Fox Film Corp., Arma Mfg. Co., RCA., Guided Radio, Powers Electronics and Communications.

Murray G. Crosby has joined The Paul Godley Co., consulting radio engineers, Upper Montclair, N. J. He has been a research engineer for the Communications Division of RCA Laboratories for the past 20 years. In that position he specialized in frequency modulation and has over 100 patents, among them being the reactance - tube automatic - frequency - control type of frequency modulator used in frequency - modulation transmitters marketed by the Radio Corp. of America and the General Electric Co. He is author of a number of basic technical articles on the subjects of frequency modulation.

Murray G. Crosby

Lt. Col. John F. Rider has returned to his desk as head of John F. Rider Publisher, Inc. For the past 17 months he has been stationed at Ft. Monmouth, N. J., as acting director of the Publications Agency for the Signal Corps.

"HYTRON Tubes Are Good—SO WHAT!"

Sure, Hytron tubes are good — so what! All tubes made for Uncle Sam are good. They have to be, or he wouldn't accept them.

But Hytron goes further. Not satisfied just to meet Uncle Sam's JAN-1A specifications, it always sets factory testing specifications to tighter tolerances than the Services require. In this way, Hytron assures top quality despite slight meter inaccuracies and the human element. When more uniform adherence to specifications can be attained, tests simulating actual equipment performance are added.

This same insistence on the best will continue after the war. Then, too, we shall say, "Hytron tubes are good — so what! They have to be good to be good enough for you."

OLDEST EXCLUSIVE MANUFACTURER OF RADIO RECEIVING TUBES

HYTRON CORPORATION ELECTRONIC AND RADIO TUBES

SALEM AND NEWBURYPORT, MASS.

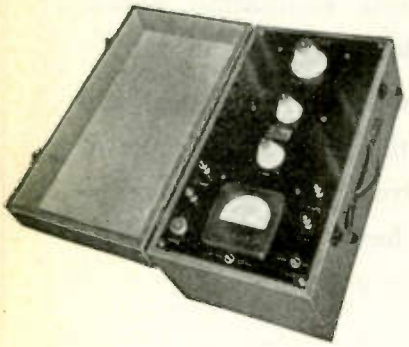
BUY ANOTHER WAR BOND

WHAT'S NEW

Devices, products and materials the manufacturers offer

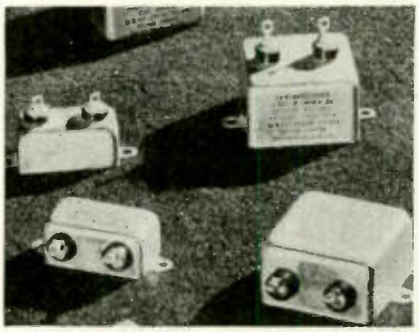
LF Crystal Unit

Bliley Electric Co., Erie, Pa., has developed a new low frequency crystal unit that will maintain its frequency within considerably narrower limits than were heretofore obtainable. In this unit, the FM6, a resonant pin assembly has been employed. The steel pins are mechanically resonant to the crystal frequency or some multiple of that frequency so that any damping effect of the clamping pins is negligible. The internal assembly is protected against moisture and humidity by means of a captive gasket seal employed between the aluminum shell and laminated phenolic base. The FM6 is intended for such applications as frequency standards, timers, measuring equipment, frequency meters, carrier current and other applications where an accurate source of low frequency is required.



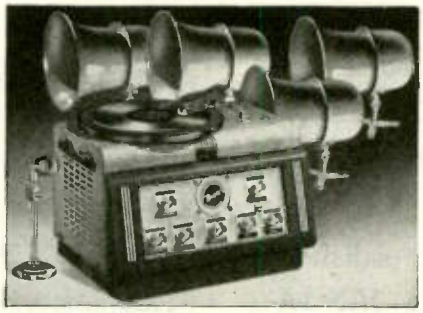
Portable Kilovoltmeter

A new addition to the line of portable kilovoltmeters made by the Shallcross Mfg. Co., Collingdale, Pa. (No. 759), has 5 ranges that provide 1, 2, 5, 10 and 20 kilovolts dc at full scale. Accuracy is ±2 per cent. Several new features include a polarity reversing switch; binding posts so that an external meter may be used if full scale accuracy better than 2 per cent is required. The resistance multiplier section is adjusted within 0.1 per cent so that, if required, more accurate meters may be used with the external connection. This also permits the individual taps of the multiplier to be used as accurate high resistance standards. The instrument is mounted on an engraved bakelite panel and is housed in a golden oak case 10 3/16 x 10 1/2 x 10 in.



Fixed Paper Capacitors

The General Electric Co., Schenectady 5, N. Y., is manufacturing three new fixed paper-dielectric capacitors. All are available in single-section (two bushings, case isolated), dual-section (two bushings, case grounded), and three-section designs (three bushings, case grounded). The cases are of drawn construction, hermetically sealed, with two mounting lugs included as an integral part. With a capacitance tolerance of ±10 per cent for single-section units, or ±20-10 per cent for 2 or 3-section units, sizes range from 0.05 to 2.0 microfarads in ratings of 600 or 1,000 volts. Units range in weight from 2.3 to 5.8 oz.

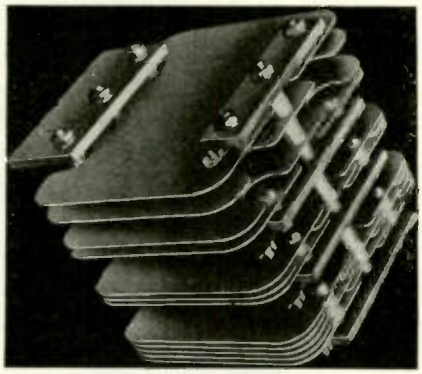


Public Address System

Allied Radio Corp., Chicago, is currently featuring a powerful, all-purpose amplifying system which delivers 60 watts output. The amplifier includes four individually controlled microphone channels, two individually controlled phono channels, universal output for matching any arrangement of speakers, individual controls for high and low frequencies, optional phono top, etc. The amplifier is available separately or with any combination of speakers and microphones, depending upon individual requirements.

Silver Coating Crystals

A new method of applying a thin conductive silver coating to quartz crystals has been developed by the Metaplast Co., 205 West 19th Street, New York. The coating is applied simply by dipping the crystals in a series of solutions. The ease of control is such that it can be applied by any inexperienced operator. Several hundred crystals may be coated simultaneously, the whole procedure taking only a few minutes. The coating is extremely thin and adherent. The thickness may be varied by adjustment of the concentration of the solutions, and frequency adjustment may be made by electroplating upon the coating.

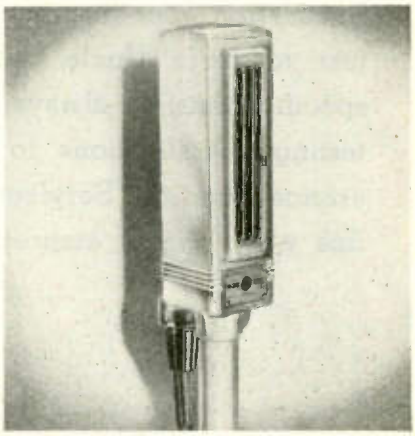


Air Spaced Capacitors

The Technical Radio Co., 275 9th St., San Francisco, is producing air-spaced, multi-section capacitors, with capacitances of 20, 40, 120 and 230 mmf. The overall dimensions of the unit, designed originally for the output section of a pi-network, are 5 3/8 in. x 5 1/4 in. Mycalex insulation is used throughout. Typical spacing is .080 in., but capacitors with spacing to .220 in. can be supplied. Plates and spacers are made of aluminum; mounting feet are brass.

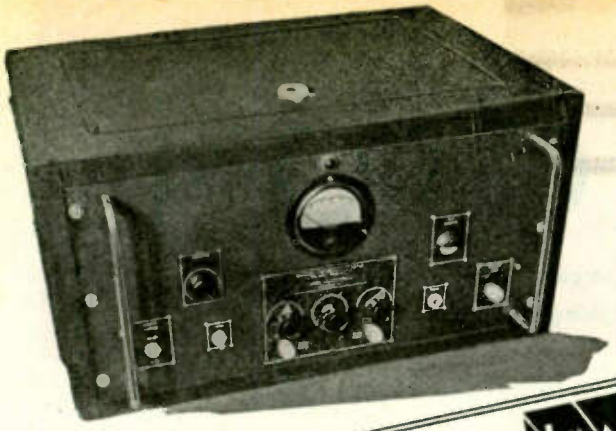
Transparent Tape

A transparent, flexible thermo-plastic tape has been developed by the Irvington Varnish and Insulator Co., 6 Argyle Terrace, Irvington, N. J., for electrical insulation, and protection of wiring, cables, and equipment against abrasion. The tape is heat sealing, flame resistant, flexible at low temperatures, and resists attack by acids, alkalies, moisture, oil, grease and corrosive fumes. With proper adhesives, it may be bonded to fabrics, metal, ceramics, wood and other materials.



Velocity Microphone

The Inglewood, Calif., plant of the Universal Microphone Co. is re-issuing its revamped Model 808 velocity microphone. The sensitive element consists of a thin 5 mm ribbon, powered with 4 magnets. Response is bi-directional. No sound pickup occurs at the sides of the mike. Impedance is 40,000 ohms, for operation direct to grid of tube; frequency response 40-10,000 cps.; output level 63 db below 1 v per bar. It includes 25 ft. of rubber covered, low capacity cable with locking type connector.



UHF HARMONIC FREQUENCY GENERATOR

PROVIDES output voltages which are multiples of 10 or 40 megacycles with CRYSTAL-CONTROLLED accuracy.

RECOMMENDED FOR: the calibration of receivers, wavemeters, or using internal beat detector for calibration of oscillators and signal generators.

WRITE FOR FULL DETAILS

U H F

Lavoie Laboratories

RADIO ENGINEERS AND MANUFACTURERS
MORGANVILLE, N. J.

An Open Letter on your War or Post-War UHF Problems . . .

This letter is your invitation to consult with us on your present or reconversion problems in the UHF field.

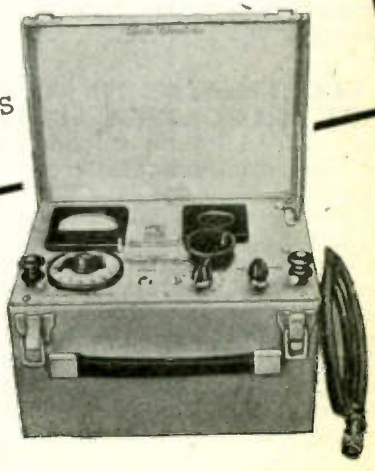
Your immediate plans may consist simply of ideas on which you require technical advice - or you may need help in re-design or ways and means to lower production costs.

Regardless of your particular requirements, our specialized knowledge of UHF, plus a plant especially equipped for UHF production, should be invaluable in accomplishing your objective quickly, accurately and economically.

There is no cost or obligation involved in talking it over. Your inquiries will have our prompt and careful attention.

Very truly yours,

LAVOIE LABROATORIES



UHF PRECISION FREQUENCY METER

Completely portable Accuracy 0.1%
Battery or AC-Operated

Models available from 100 to 1500 megacycles with 2 to 1 frequency coverage on each model. Available only on high priority

WASHINGTON

Latest Electronic News Developments Summarized by *Electronic Industries'* Washington Bureau

MAP FUTURE OF RADIO INDUSTRY— Slated just as this issue of ELECTRONIC INDUSTRIES went to press (and after our deadline so its results could not be published) was the extremely important "reconversion" planning meeting of the WPB Radio-Radar Industry Advisory Committee. At this session the WPB and the Army and Navy had assembled the latest revised estimates of procurement requirements for the Pacific War with the Army Air Forces figures substantially decreased due to the very large cutbacks in airplane production. The Advisory Committee, composed of the leading figures in the radio-electronic manufacturing industry, considered the actual military schedules and how the industry can best fill these orders; the formulation of a pattern for the quickest and simplest return to peacetime production; and what would happen to the industry in military production and civilian output in view of the lack of components, especially tubes, capacitors and electrolytics if L-265 and other WPB orders were immediately revoked. The latter eventuality was considered with respect to the possibility of an earlier surrender of Japan than now anticipated.

CIVILIAN RECEIVERS SOONER THAN "PRESUMED"—WPB Operations Vice-Chairman Boeschenstein, under whom falls the Radio-Radar Division, recently indicated to a Congressional Committee that home set production will come sooner than "presumed" and that the smaller radio manufacturers, who are not capable of manufacturing the complex radio and radar apparatus for the military services, will be the first given the "green light" for civilian operations provided manpower, materials and tubes and condensers are available.

SEE POSSIBLE INDUSTRY BLACKEYE —Larger companies, he noted, were still overloaded with radio and radar equipment of complex types. But other highly competent WPB officials warned that flooding of the market by the smaller manufacturers (who will return to former business fields after making a quick profit) with cheap, low-quality receivers, produced from makeshift components, will give the industry a "blackeye" and injure its long-range future.

FCC LIKELY TO APPROVE ALTERNATE ALLOCATION NO. 1—In view of the virtually united front of the broadcasting industry and the radio manufacturers in advocacy of an immediate decision on the allocations for FM and television, the FCC is expected to act speedily in the adoption of alternative No. 1 for the 44-108 mc band. This would give FM 50-68 mc; television channels No. 1 and 2 at 68-74 and 78-108 mc; amateurs 44-48 mc; and facsimile 48-50. The move for the immediate adoption of this alternative allocation resulted from the industry's united front—first it came from the joint petition of the Television Broadcasters Association and Frequency Modulation Broadcasters Inc. and was followed by similar endorsements of this move from the Radio Technical Planning Board, Radio Manufacturers Association and the Educational Broadcasters. The FMBI-TBA unanimity had a very strong effect upon the FCC as heretofore these groups have been on opposite sides of the allocations fence.

INTERFERENCE TESTS CONTINUE — While certain elements in the FCC still desired to carry on the engineering tests of Sporadic E—and they were started in June and will be continued in July—, the Commission majority was well aware that the allocations determination was all-important for both the manufacturing industry and the broadcasters because of reconversion now being "around the corner." The FCC feels, it was understood, that the industry's support of a definite allocation is most desirable and noted it meant a division of responsibility for the assignment of these new services between the industry and itself.

US RADAR BETTER THAN AXIS— American-produced radar "is better, by and large," than that of the enemy and is an outstanding development of the war for the US Army, Air Forces and Navy in its unerring accuracy for anti-aircraft defense, bomber and fighter plane effectiveness and naval shelling. This was the tribute of one of the nation's leading scientists, Dr. Vannevar Bush, Director of the Office of Scientific Research and Development, who lauded with the highest compliments the work of the National Defense Research Committee and MIT's Radiation Laboratory in placing this nation in the forefront in this field.

REDUCE RADAR RESEARCH—The NDRC also was praised for its solution of communication problems for bombers, tanks, submarines and the ground forces which have been of "prime importance" in combat "team" operations. "In the field of electronics there are large postwar implications," Dr. Bush stated. "The whole development in that field will render air transport a very different thing" as one example. He felt that the developments in radar and electronics would have been a large task if spread over 15 years in peacetime but have been far greater when compressed into the brief period of the war. Because of the one-front war, NDRC is cutting down on 1946 radar research from $42,118,342 to $25,000,000 and radio coordination from $9,165,400 to $6,000,000.

DR. BUSH'S VIEW ON FM— Frequency Modulation has a very large future in commercial use in the opinion of the OSRD Director. He felt that there would probably be a junking of all present-type radio stations and building of new types of stations and receiving sets. The public can get away from static and get very fine quality, Dr. Bush told the House Appropriations Committee, through FM sets and "I think the public will be willing to pay to get it."

National Press Building
Washington, D. C.

ROLAND C. DAVIES
Washington Editor

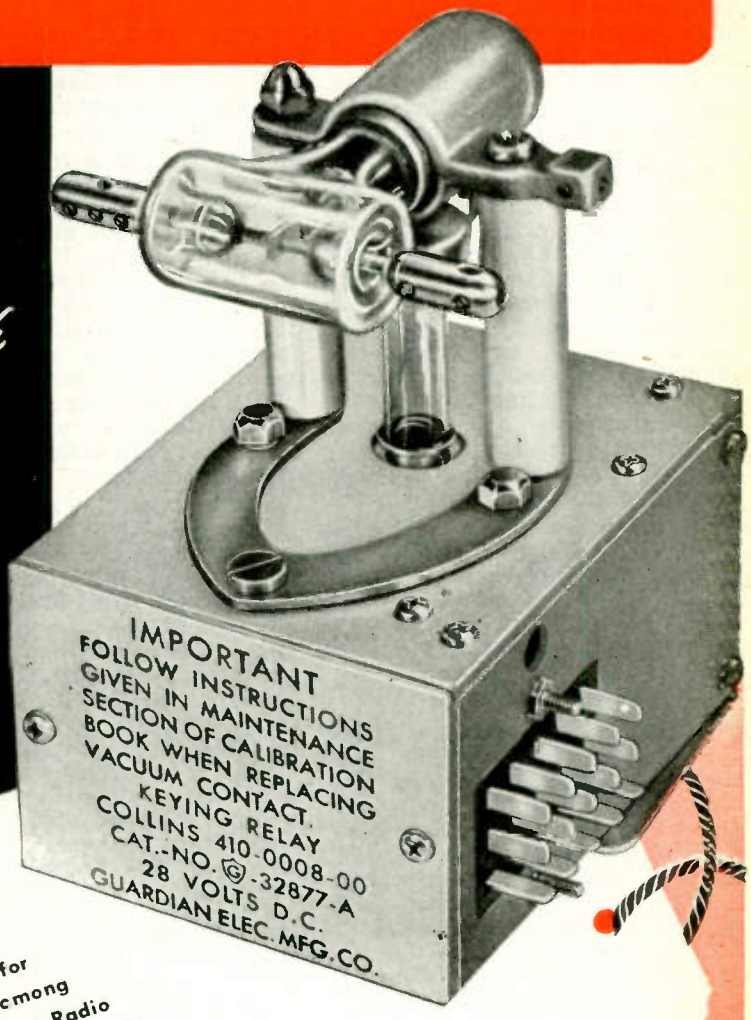
An Original GUARDIAN *Development*

designed for and in conjunction with the Collins Radio Company

The New Vacuum Switch

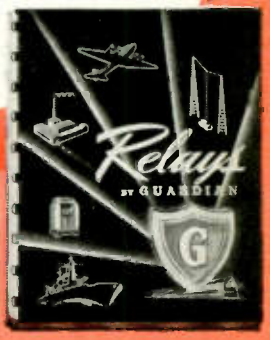
KEYING RELAY

for High Frequency—High Voltage—High Altitude Applications



The confidential development of this vacuum switch keying relay involved design ingenuity and ability to produce immediate results. It called for cooperation and a meeting of minds among Guardian engineers and those of Collins Radio Co., the U. S. Navy, Sperti, and General Electric. Then quantity production and the responsibility of being the sole source of supply for many months followed successful development of the relay. The same confidential treatment, the same engineering ability on electrical control, the same production capacity is yours for the asking. Write.

GUARDIAN ELECTRIC
1622-H W. WALNUT STREET CHICAGO 12, ILLINOIS
A COMPLETE LINE OF RELAYS SERVING AMERICAN INDUSTRY



A request on your business letterhead will bring you Guardian's new catalog.

NEW BOOKS

High-Frequency Induction Heating

By Frank W. Curtis. Published by the McGraw-Hill Book Company, Inc., New York, 1944.

235 pages with 249 illustrations. Price $2.75. This book gives the basic technical details pertaining to the application of high frequency induction heating, to the treatment of metal parts such as hardening, brazing, soldering, annealing, forging, melting, etc. The text is mainly confined to application details and deals but briefly with the theoretical aspects of the equipment. It does, however, give simple explanations of the apparatus and the functions of the parts. While the book is concerned mainly with the treatment of metals with induction heating equipment, one chapter is included on the subject of dielectric heating of non-conductive materials. A large number of particular applications are described and illustrated together with the work coils used which will serve as examples to users of this equipment when faced with the problem of setting up heating coils for new items.

TUBES ON THE JOB

(*Continued from page* 111)

the thawing time for such a quantity of berries to one hour, with level defrosting throughout the barrel. As precise time schedules are worked out for various foods, the likely technic, revealed Dr. Cathcart, will be to place cartons or barrels on conveyor belts which will pass through the oven at a speed to be determined by the type of food being defrosted. "The net results of our efforts," Gilb said in announcing his findings, "will be to enable the industry to move perishables from producer to consumer in better condition than has ever before been possible."

The floor and ceiling of defrosting "oven" as developed with Federal Telephone and Radio Corp. engineers, consist of insulated metal plates or electrodes which are connected to a high frequency generator.

Defrosting by electronic means is so rapid, Dr. Cathcart pointed out, that there is no chemical breakdown in the structure of the food such as occurs under normal thawing procedure. The method has been applied successfully to the thawing of frozen eggs, and will save thousands of hours of waiting time annually at A and P bakeries.

PHONOGRAPH DYNAMICS

(*Continued from page* 89)

is satisfactory in general, and is quite widely used in practice.

Of course, the frequency above which this type of distortion occurs, increases as the groove diameter is increased, as may be seen from the curve. Unfortunately, the climax of most musical selections occurs at the end, putting the greatest demand upon the system at the smaller groove diameters where it is least capable of handling it without distortion.

This is a peculiar type of distortion in that it is frequency selective. In ordinary non-linear systems, such as a rectifier, all of the input frequencies are subjected to the non-linearity. If for simplicity, we assume two input frequencies, the non-linearity causes the output to contain harmonics of the two input frequencies, and, most important, additional frequencies which are the sums and differences of the two input tones and their harmonics, also called cross modulation products.

These tones, not necessarily being harmonically related to the original tones, are usually very annoying and discordant. In the phonograph it is likely that the cross modulation occurs only between the higher frequency components of the signal. It would seem that if the lower frequency tones were not subjected to the non-linearity, there is a good possibility that no combination tones would be produced between them and the distorted high frequencies.

There is one very disagreeable effect of this tracing distortion, which, although it may not appear too seriously in the electrical output of the reproducer, certainly does appear in its acoustical output. By this is meant the scraping and rattling noise which usually is heard when the needle is tracing a record with the volume control turned down. It is clear that if the radius of the reproducing stylus is greater than that of the recorded wave, a discontinuity results, the traced curve having a cusp. This sudden change in velocity at the extremes of excursion results in infinite acceleration. Since the reproducer has finite mass the force developed between the stylus and the record would be necessarily infinite. Fortunately neither the record nor the stylus are perfectly rigid bodies, so the force developed is finite though not necessarily small.

Under these conditions the reproducer stylus is subjected to shock excitation by the record. The force exerted upon the record by the stylus causes some elastic deformation of the groove walls, assuming a light weight pickup, or actual damage to the record when traced with a massive pickup. There is a possibility of resonance between the elasticity of the record material and the effective mass at the stylus tip.

Both vertical and lateral accelerations are applied to the stylus, and the lateral forces have equal vertical components because of the nearly 45 deg. slope of the side walls. If these forces exceed the downward bearing weight of the pickup, the needle will lose contact with the groove giving rise to further discontinuities in the traced wave. It is not surprising then, that considerable noise would result from the mutually opposing forces of the record and reproducer under the stimulus of discontinuous waves.

It is fortunate that, in the electrical output of the reproducer, only the odd harmonics appear in the lateral system. This is because all of the even harmonics are eliminated by the symmetry of the traced wave. In this respect the lateral system is superior to vertical in which even as well as odd harmonics are present. If the acceleration were held to a value which precluded waves with cusps below 3000 cycles, the harmonics caused by frequencies above this would lie outside of the audio pass band, assuming 8000 cycles as the upper limit of the desired audio range, although different tones would still be present.

Because of the importance of this type of distortion it would seem to be essential to monitor the program material for acceleration, since this is the most serious limitation of the system. Although the acceleration possibly would not provide a practical signal for volume indication, it should be checked and kept within a definite ceiling just as strictly as broadcast program material is held to 100 per cent modulation.

Reproducer design

From tests made in the Brush Development Labs.* on the torque necessary to overcome the drag of the stylus in tracing a record, it was found that above a bearing weight of 30 grams the drag increased more rapidly than linearly, indicating a change from sliding friction to cutting friction. From this and the results of many life tests it has been established that a bearing weight of 1 oz. is satisfactory for long record life. Since the groove walls have approximately 45-deg. slope to the horizontal,

(*Continued on page* 128)

*Some Problems of Disk Recording, S. J. Begun, Proc. IRE, Vol. 28, No. 9, Sept. 1940

One operator makes more than 500 sound electrical connections per hour by this simple sure **BURNDY** indenting method

YOU can cut connecting time as much as 50% merely by changing to HYDENT (indent type) connectors These one-piece connectors are *indented* onto the wire or cable by means of the Burndy HYPRESS. The operation is fast and sure — no solder—no flame to damage insulation. HYDENT connections are strong and highly efficient. The HYPRESS—automatic or manually operated—makes a uniformly firm indent that is easily and quickly inspected. Send for literature today, or have Burndy engineers submit costs based on your production needs. Write to Burndy Engineering Co., 107-K Bruckner Blvd., New York 54, N. Y.

Headquarters for CONNECTORS

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★ TELEVISION TODAY* ★

New Developments in the Video Field

Television and FM Ask Alternative No. 1

Helping to clarify the situation brought about by the FCC proposal for the use of one of three "alternatives" in the 44-108 mc band for FM and television, both Television Broadcasters Association and FM Broadcasters, Inc., have urged, through resolutions, that the No. 1 alternative be adopted forthwith. This would give television the bands between 68-74 and 78-108 mc; 174-216 mc has already been made official. Under this arrangement the FM people would get the 50-68 mc spot for which many, including inventor Armstrong himself, have been plugging. See diagram on page 73, and the story of the proposed propagation and interference tests on page 91.

Jersey HF Tele

North Jersey Broadcasting Co., Clifton, N. J., has been granted a construction permit for an experimental television station to operate at five kw. Frequencies to be used are 514000 - 530000, 900000 - 920000, 1302000-1325000 kc.

Tele for Motorola

Galvin Mfg. Corp., Chicago, is preparing for the production of home television receivers. In the company's annual report to the stockholders issued early in May, President Joseph E. Galvin said: "I think television is coming much faster than a lot of people concede, and Motorola is ready to deliver television receivers as soon as television arrives on the commercial basis."

Television Theater

Toledo (Ohio) may have a theater designed and equipped for television showings. Anthony Wayne Development Co. has completed plans for such a venture.

Hotel Room Tele

Radio in hotel rooms is pretty common, of course. Now the Hotel New Yorker in New York is planning on television for some of its rooms. At least the hostelry's executives have gone so far as to conduct a survey among patrons to find out whether such a service might be desirable.

DuMont Capital Tele

Plans of Allen B. DuMont Laboratories, Inc., for the establishment of a Washington broadcasting station have moved forward apace. The construction permit has been received and plans completed for the establishment of a station in the Hotel Harrington. Director of Research Dr. Thomas T. Goldsmith, Jr., and members of his staff are at present conducting field strength tests and compiling propagation data covering the territory. The station will broadcast under the call letters W3XWT.

Oregon Asks Tele

As of June 1, Federal Communications Commission had a backlog of 116 applications for television stations to pass upon. Latest application and the first from the state of Oregon came from the Oregonian Publishing Co. in Portland which has asked for channel 4. A bid for another New York city station also has been filed. Palmer K. and Lois Leberman ask for channel 10. The application from Oregon makes that State the 32d to enter the television picture.

Raytheon Relay OK'd

Raytheon Mfg. Co., which a short time ago applied to FCC for certain high frequency channels and permission to build five experimental radio relay stations to function between New York and New England, has been given the green light on the project. They are to be class 2 point-to-point stations and experimental work contemplates the transmission and relaying of high definition and color television, high-fidelity FM programs, telephone, telegraph and facsimile as well as aeronautical safety communications, aircraft traffic control and the automatic reporting of the positions of aircraft. Frequency bands are to be specified later. Stations will operate at 100 watts.

Rent Tele Sets

Before the war some British companies carried on a business of renting television receivers for home use. It is reported in "Sylvania News" that a similar plan has been projected for the American market. The plan proposes that renters sign up for at least a quarterly period and pay, in addition, a reasonable installation fee.

MONITORING REMOTE TELEVISION PICKUPS

This is part of the extensive monitoring equipment used by NBC engineers and technicians on remote pickups for television, this particular installation being one that is used frequently in broadcasting Madison Square Garden sports events. This is the "suit-case" type of equipment

*Title registered U. S. Patent Office.

HARVEY 206 PA

A Two-Range Source of Laboratory D.C. Power

The HARVEY Regulated Power Supply 206 PA is the latest contribution to the radio and electronics industries by HARVEY of CAMBRIDGE. It is designed to fill the need for a constant source of laboratory D.C. power between the ranges of 500 to 1000 volts.

The HARVEY 206 PA operates in *two ranges: Low range* — 500 to 700 volts at ¼ amp. . . . *High range* — 700 to 1000 volts at ⅕ amp. . . . Regulation is 1% or better . . . Output is constant even though line voltage varies between 95 and 130 volts . . . Output is constant within 1% from no load to full load in each range.

These important factors plus many other safety and convenience features make the HARVEY 206 PA your best bet for operation with constant frequency oscillators, measurement equipment, pulse generators, amplifiers and other equipment requiring regulated D.C. voltage. *For details get in touch with* HARVEY of CAMBRIDGE.

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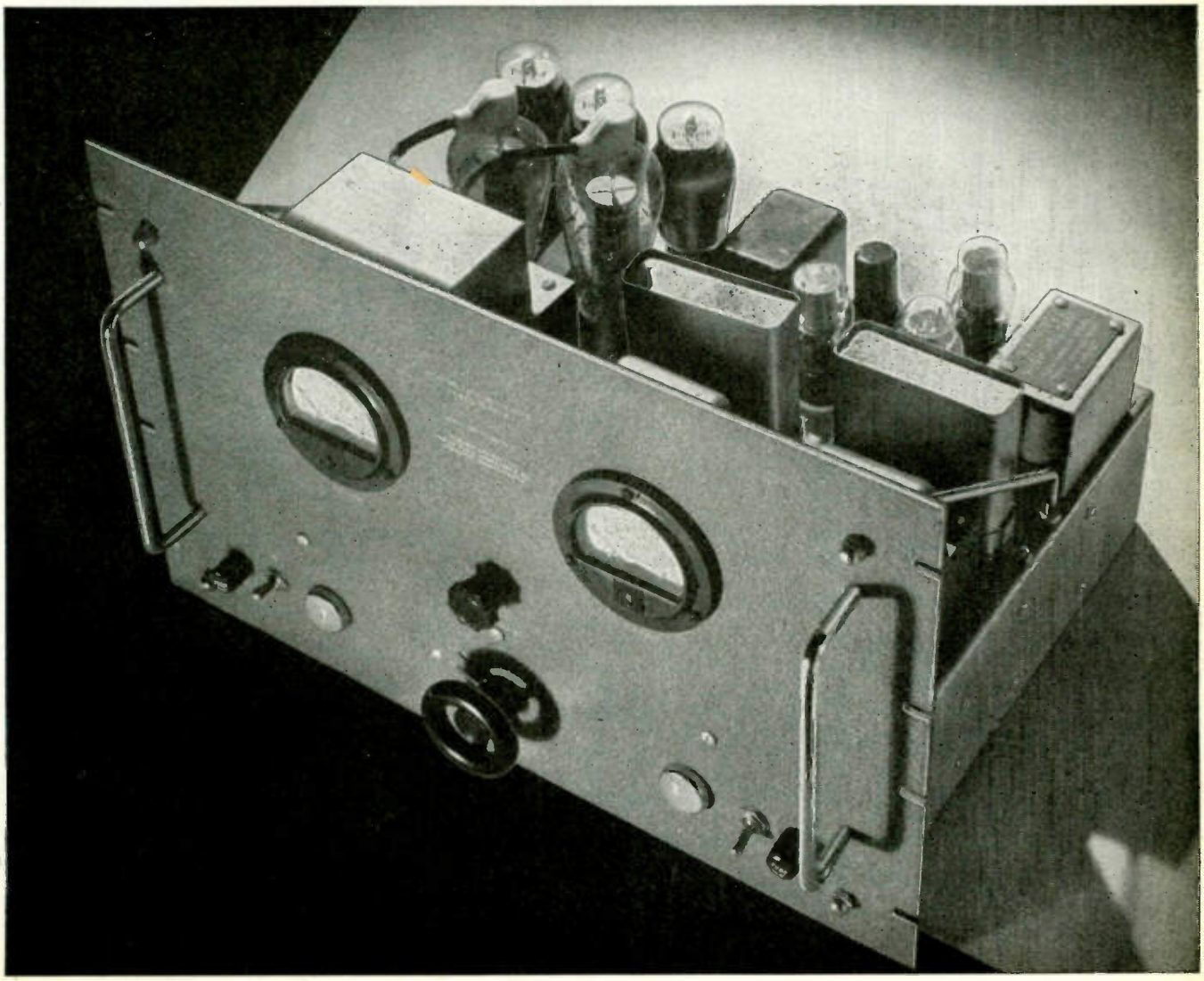


NEW BULLETINS

Electric Tachometers

A 12 page pamphlet describing electric tachometers has been published by the General Electric Co., Schenectady, N. Y. Three types are listed. The first type, with a speed range of 300 to 4,000 rpm consists of a dc generator whose shaft is connected to the shaft to be measured and an indicating or recording voltmeter with a properly calibrated dial. In the second type an ac generator is used and speeds range from 10 to 15,000 rpm. The third style, with speed range from 6,000 to 60,000 rpm consists of a phototube, lamp and amplifying equipment to furnish the indicating voltage. Dimensions and other application design specifications are given for each type of techometer. The bulletin number is GEA-4324.

Alnico Magnets

A design pamphlet on sintered alnico magnets is available from the General Electric Co., Schenectady, N. Y. (Bulletin GEA-3682-B). B-H and external energy curves are given for alnico as well as for tungsten, cobalt and chromium magnetic alloys and the reasons for the smaller required size of alnico magnets are explained. Resistance to demagnetizing influences are shown. Mechanical properties and design tolerances also are listed. Included in the last twelve pages is a catalogue of alnico magnet shapes for the production of which dies are available, giving unit and quantity prices for magnets in the rough, finish ground and magnetized to saturation. The booklet contains illustrations and some photos of the manufacturing process.

X-Ray Diffraction

Many illustrations of X-ray diffraction patterns together with analyses of their meaning are given in a new brochure of the Picker X-ray Corp., 300 Fourth Avenue, New York. Identification of crystalline substances, separation of substances with the same chemical formula but different structures and studies of the effect of working on materials are all shown. In addition the X-ray apparatus is described and characteristics are given. Also listed are a Laue camera, two sizes of powder cameras and a back reflection camera for use with the X-ray equipment.

PHONOGRAPH DYNAMICS

(*Continued from page* 124)

lateral forces exerted by the stylus will have vertical components of the same magnitude.

The stiffness of the suspension is thus limited to a value which will permit the maximum displacement to be obtained without exceeding 28 grams. The compliance (reciprocal of stiffness) must be greater than

$$C = \frac{1}{S} = \frac{.004 \text{ in.}}{\text{oz.}} = .37 \times 10^{-6} \text{ cm/dyne}$$

As was pointed out previously, the stylus is subjected to a vertical movement resulting from "pinch effect." It is clear, therefore, that the reproducer must have mobility in this plane as well. Since the order of vertical movement is ± .0005 in., the stiffness in this plane may be approximately 8 times as great as that in the lateral plane. The acceleration, to which the stylus is subjected, fixes the allowable effective mass at the needle point.

Since $f = ma$

where f is the downward bearing force in dynes.

m is the dynamic mass at the needle point

a is the maximum probable acceleration, say, 1000g

$$m = \frac{f}{a} = \frac{28 \times .98 \times 10^3}{10^6} = 27.4 \times 10^{-3} \text{ gms.}$$

There is a limit also to the mechanical resistance (damping) which may be used to suppress undesired vibration. Since the velocity maximum is the order of 20 cm/sec the maximum allowable mechanical resistance, r, will be

$$r = \frac{f}{v} = \frac{28 \times .98 \times 10^3}{20 \text{ cm/sec}} = .137 \times 10^6 \text{ mech. ohms}$$

Merely satisfying these limitations is not enough, however, for resonance in the mechanical system may further increase the force at the needle point. Consider the simple mechanical system in Fig. 7.

For analysis it is convenient to convert the mechanical system to an equivalent electrical circuit. This makes use of the analogy between force and voltage, motion and current, mass and inductance, compliance (reciprocal of stiffness) and capacitance, friction and resistance, etc.

In this mechanical system we see that there are two motions, that of the initiating force, and that of the mass. The spring, which joins them, transmits the force, but not the motion. Because of the two motions, the electrical circuit will have two currents, and the force, or voltage, will be coupled to the mass, or inductance, through the spring, or capacitor.

Fig. 7 is an electrical circuit which satisfies the requirements of the analogy. The compliance (c) replaces the capacitor, and the mass (m) replaces the inductance. The total current is represented by V_1 which is the motion of the applied force, and the current through the inductance is represented by V_2, the motion of the mass. The capacitor current, $V_1 - V_2$, is the difference between the two motions.

Thus the mechanical system in Fig. 6 may be represented by a parallel resonant electrical circuit. The behavior of such a circuit is familiar to electrical engineers. If constant current is fed into a parallel resonant circuit, and the frequency varied, the voltage which is developed across the circuit will rise to very high values at resonance, limited only by the quality, or Q, of the circuit elements. In the mechanical circuit the analogy is that constant motion is imposed upon the system, due to the positive drive of the stylus by the record. At the resonant frequency of the system the force developed at the driving point rises to a value limited only by the mechanical Q of the system. Q, in mechanical systems, is, as in electrical networks, proportional to the ratio of stored to dissipated energy per cycle. It is important to observe that the Q of mechanical systems is usually much higher than that of electrical circuits.

Now the mechanical system in Fig. 6 is a schematic representation of a pick up suspension and the dynamic mass of the tone arm. Assuming an effective tone arm mass of say 50 gms. and the limiting compliance of $.37 \times 10^{-6}$ cm/dyne in the suspension we have:

$$\omega = \frac{1}{\sqrt{mc}} = \frac{1}{\sqrt{50 \times .37 \times 10^{-6}}} = 232$$

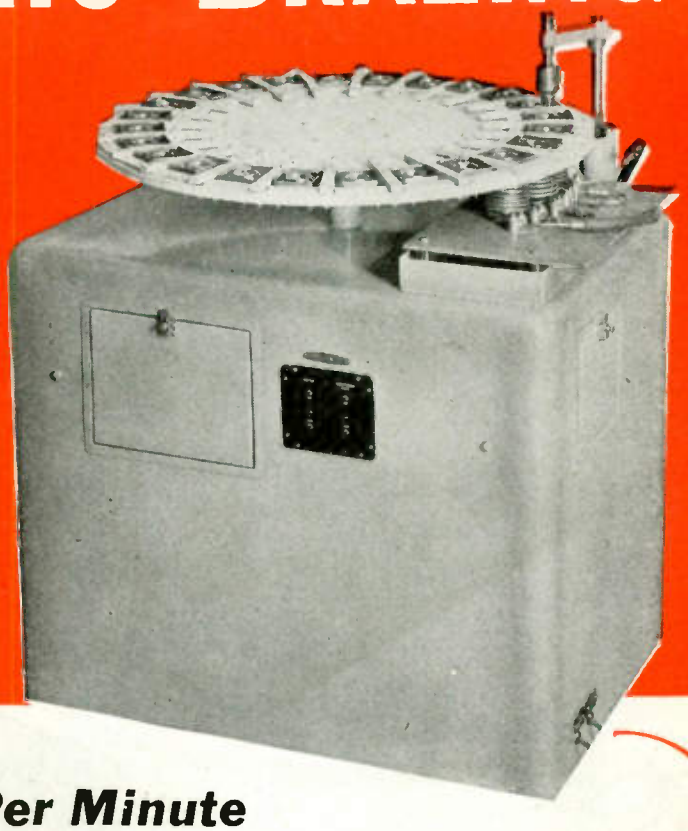
$$f = \frac{\omega}{2\pi} = 37 \text{ cycles.}$$

At this frequency the force exerted on the record is limited only by the damping introduced in the mechanical system. Since most mechanical systems have several modes of vibration, it is not unusual to find several frequencies at which the needle point impedance rises to high values.

The solution of the damping problem depends to a large extent upon the type of voltage generating element employed, such as piezoelectric crystal, moving coil, or

(*Continued on page* 190)

ELECTRONIC BRAZING UNIT with 24 Station INDEXING Work Carrier



Delivers 5 Complete Assemblies Per Minute

HERE'S a striking example of how Scientific Electric Engineers increased brazing production output by designing a special automatic machine to operate in conjunction with Electronic heating.

A manufacturer of weather-proof control box covers was already using electronic heat to speed up production in the brazing operation involved. But greater production was urgently needed. Each assembly was being inserted and removed from a single heater coil . . . one at a time.

To increase output Scientific Electric engineers designed this compact circular, 24 station indexing work carrier which operates from the 18 KW electronic generator at the left.

The operator merely loads the stations as they come around empty. Heat is applied by three water-cooled induction coils under three of the work positions. The coils are followed by the vertically operating ejecting mechanism and a complete assembly is ejected from the carrier each 12 seconds.

The carrier, which is operated by a small motor can be applied to any of our electronic generators depending upon the heat input requirements of the work to be handled. Normal output of the unit illustrated is at 200 to 600 kc.

Workpiece output up to 20 per minute can be obtained and carriers, custom tailored to your requirements, can be delivered within 30 days. Send us your requirements today.

Scientific Electric Electronic Heaters are made in these power sizes... and a range of frequencies up to 300 Megacycles depending upon power requirements.

3 KW	18 KW
5 KW	25 KW
7½ KW	40 KW
8 KW	60 KW
10 KW	80 KW
12½ KW	100 KW
15 KW	250 KW

Scientific Electric

Division of

"S" CORRUGATED QUENCHED GAP COMPANY

119 MONROE ST. SCIENTIFIC ELECTRIC GARFIELD, N. J.

Manufacturers of

Vacuum Tube and Spark Gap Converters Since 1921

PRESET TIMER

(*Continued from page* 99)

volts to 130 volts which is sufficient to light it.

A complete counter decade consists of four of the stages outlined. The input signal applied to the first pair sets up a condition so that tube 1B is operated on alternate pulses. This goes on no matter what else happens in the next stages in these series. That is, tube 1B is conductive after pulses 1, 3, 5, 7 and 9. In other words, it takes two incoming pulses to produce one cycle of operation in the first counter unit. When a count is made, a large pulse will be evident at several points in the circuit, when the current is changing from one condition to another. Such a pulse may be picked off through a condenser and applied to a decade stage which operates on every second pulse if received. Therefore, the second stage will operate in the "on" condition during the period while the pulses 2 and 3 and 6 and 7 are applied to the first tube.

The third stage of the series also operates on every second pulse count circuit, and therefore operates when the incoming pulses reach 4, 5, 6 and 7 counts. At the count of 7 it happens that all three stages are at "on" condition. The next pulse that comes along releases all of them and a pulse is generated during this release which kicks up the 8 unit. The following pulse will operate the No. 1 counter again and since the 8 is still up, the total count is 9.

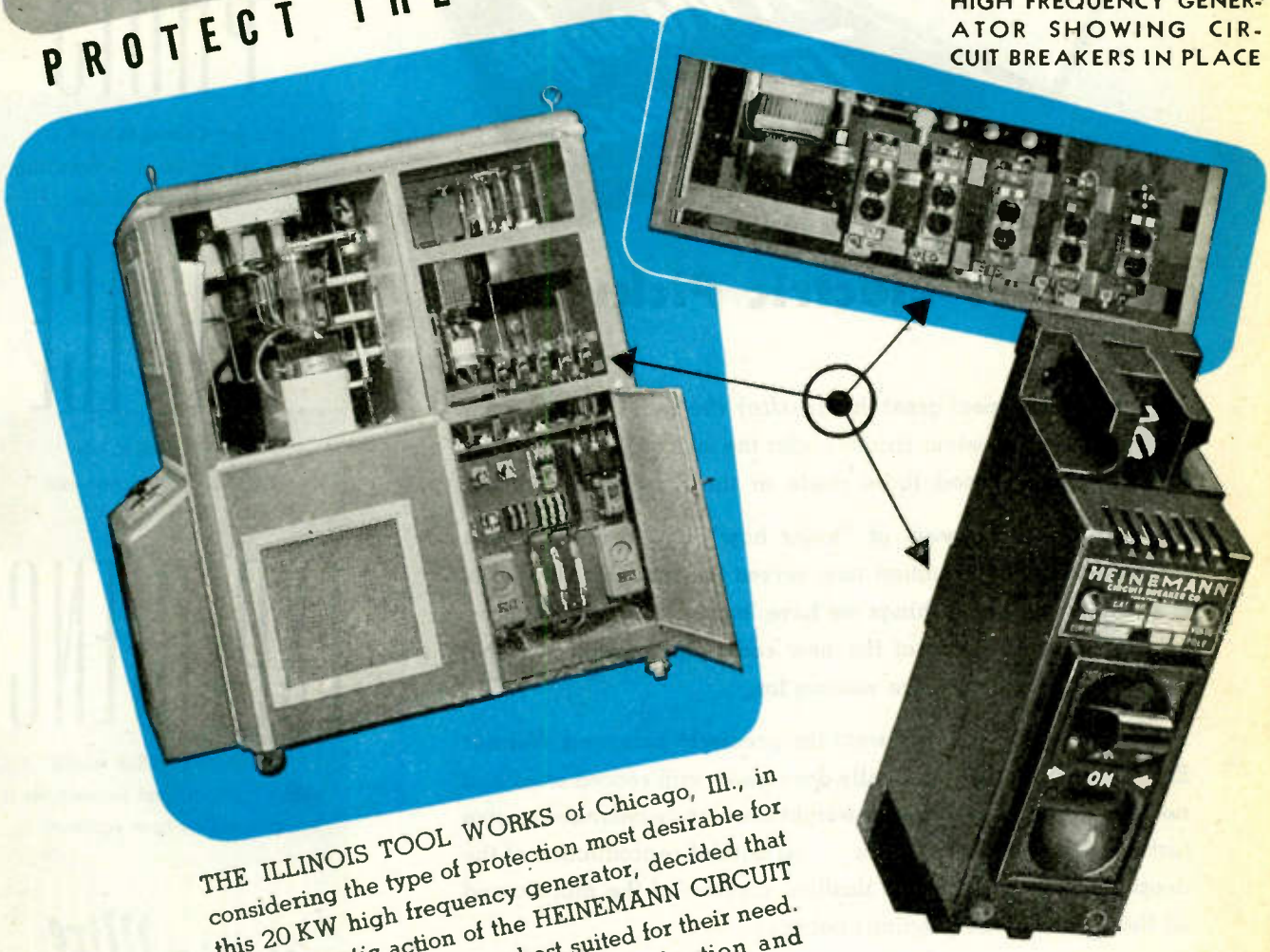
Should the condition require it, there is no need of stopping the count at 9, and the count would continue up to 15 if desired. However, when the counts are more than 10, it is usually preferable to go to a decade system and stop the count at 9 and transfer the tenth pulse to another decade arrangement. This permits continuing the count past 10. In other words, after each time that the first decade reaches 9, the first counting pair brings up a number two count. Normally, pulses from the number "2" pair have no effect on the number "8" pair except when the latter is operated. After number "2" releases number "8," a pulse from "8" is transferred back to release number "2," whereupon all counting pairs are restored and a single pulse is transferred to the tens decade. This is done as follows: The ninth pulse received establishes a conducting condition for both stages 8 and 1, another operating path from the No. 1 decade to the No. 8 decade so that the latter is released.

(*Continued on page* 134)

HEINEMANN
MAGNETIC CIRCUIT BREAKERS

PROTECT THE PRODUCTS OF SCIENCE

CLOSE-UP OF PART OF HIGH FREQUENCY GENERATOR SHOWING CIRCUIT BREAKERS IN PLACE



THE ILLINOIS TOOL WORKS of Chicago, Ill., in considering the type of protection most desirable for this 20 KW high frequency generator, decided that the *magnetic* action of the HEINEMANN CIRCUIT BREAKER made it the one best suited for their need.

This generator, built for both induction and dielectric heating, demanded *instantaneous* suspension of the current in case of short circuit, but also required that the current should not be interrupted for temporary harmless increase of load.

The construction of the HEINEMANN CIRCUIT BREAKER (the high speed latch, the time-delay mechanism and other features) makes it the ideal protective device for any type of scientific equipment. We urge you to investigate its possibilities for YOUR equipment.

SEND FOR CATALOG SHOWING COMPLETE LINE AND ENGINEERING DATA

HEINEMANN
CIRCUIT BREAKER CO.
Subsidiary of Heinemann Electric Co., Est. 1888
PLUM STREET TRENTON, N. J.

Be Ready with Webster Electric Pickups

We are led to expect great things *after the war.* Science has indeed made marvelous strides under the lash of Mars. Probably few advances exceed those made in the field of electronics.

Webster Electric's years of "know how" in the field of high fidelity sound reproduction now serves the war effort well. In due time many of the things we have learned will become alive as worthy components of the new radio-phonograph sets that many thousand homes are waiting for.

Then, as always, you will want the precisely balanced Webster Electric pickup that practically does away with record wear and needle changing . . . its light weight accurately balanced to give just the right needle pressure . . . its faithful reproduction of the deep tones of the bass, the thrilling soprano of the piccolo and all the colorful tone shadings between.

These, Webster Electric will then have ready for you . . . ready so that the new, streamlined designs for which the public waits will have the clean, high quality tone reproduction that Webster Electric pickups have always given.

To this end we invite you to keep in touch with Webster Electric. Let us cooperate with you in preparing these fine new products for the post-war markets.

Let's All Back the Attack
Buy Extra War Bonds

(Licensed under patents of the Brush Development Company)

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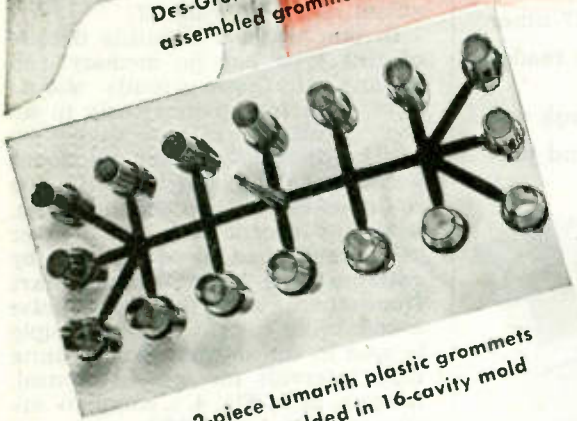
Lafayette Radio

Write today for our bargain flyers and special bulletins

PERHAPS YOU WOULDN'T THINK OF USING *Plastics* HERE

Des-Grommet components and assembled grommet



Eight 2-piece Lumarith plastic grommets are injection molded in 16-cavity mold

A product designer did . . . producing a new and improved grommet design using a special flame resistant Lumarith* CA formulation.

THERE ARE sound reasons why Jan De Swart of Victory Manufacturing Company turned to Lumarith plastics when he developed the "Des-Grommet" for use on U. S. naval vessels. In abrasion tests using braided metal cable the Lumarith grommet showed less deterioration than did grommets made of lead, and caused far less wear to the braided cable than steel grommets did.

By taking full advantages of the physical characteristics of Lumarith, the Des-Grommet is designed to be self-locking, capable of blind installation (from one side of partition), and adjustable to as many as five different wall thicknesses. A special *non-burning* formulation of Lumarith CA (cellulose acetate) was used to meet Maritime Commission requirements for fireproof material.

The use of Lumarith in place of metal reduces production time and manufacturing costs. Grommets are injection molded in a matter of seconds—using multiple cavity molds. Finishing and polishing operations are reduced to a minimum. No machining, plating or enamelling is required.

The development of the Des-Grommet is a good example of the right approach to plastics. It is the type of project that the technical staff of Celanese is prepared to help you accomplish with your product. Your inquiries are invited. Celanese Plastics Corporation, a *division of Celanese Corporation of America*, 180 Madison Avenue, New York 16, New York.

LUMARITH*

A Celanese Plastic*

*Reg. U. S. Pat. Off.

PRESET TIMER

(*Continued from page* 130)

A pair of decades (totalling 8 twin triodes) will count up to 99 directly. In each case the answer is derived from totalling the numbers indicated on the neon lamps. Each pulse received by the "tens" decade sets up a similar series of operations and the count progresses through as many decades as desired.

A neon lamp is provided in the plate circuit of one tube of each pair so that a visual indication of the count appears. It is necessary to add up the numbers associated with these neon lamps. For instance, a count of seven would produce lighted neon lamps: four, two and one, etc.

Since the tubes are of the high vacuum type they will operate as fast as needed for this service. It makes no difference whether the succession of pulses comes at the rate of a million per second or only one per second if minor changes in the time constants of the circuits are introduced.

Process timing control

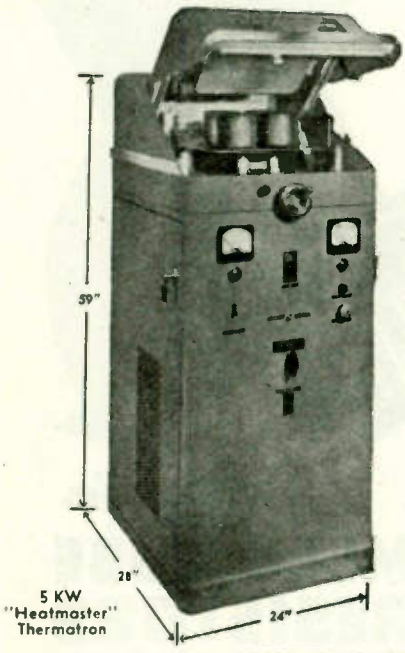
In most measurement problems it is only necessary to record the interval during which some action occurs. The total elapsed time is therefore read off the neon lamps from all of the decades. For control work, however, it is less important to measure the elapsed time than it is to stop some process after a definite interval, or else after a definite number of impulses appear. One of the most valuable features of this counter is the use of a series of switches whereby any interval can be set up. A process can thus be terminated instantly after a definite number of pulses has been run off.

In one sense, a counting decade of this type has no memory and if any of these circuits should have been set up previously in an "on" position, rather than the neutral or "off" position, the count would go along starting with the count so established. For instance, if in any decade unit the number "4" circuit had been set up by switches, the count would start from there and the next pulse would bring in a 5. This principle is used in the setting up of definite time intervals for process control. Assume, as in Fig. 4, a complete instrument is equipped with six counting decades.

For example, if the required interval is 123,456 units of time, switches on the front panel are thrown, associated with the number 876,544 (which is the complement of the required interval, to add up to a total of 1,000,000).

(*Continued on page* 138)

RADIO RECEPTOR'S NEW "MASTER" SERIES THERMATRON ATTRACTING WIDE ATTENTION



5 KW "Heatmaster" Thermatron

The new "Master" Series of THERMATRON electronic dielectric heat generators, headed by the popular 5 Kilowatt output "Heatmaster," is now enlarged by the addition of two new models. They are the "Heatmaster, Jr.", with an output of 2½ Kilowatts, and the "Weldmaster" and "Weldmaster, Jr.", especially designed for sealing and bonding thermoplastic sheets, with outputs of 1 Kilowatt and 500 Watts respectively. According to *Radio Receptor* engineers, each of these machines fills a definite place in the new industry which is growing up around electronic heating.

The "Heatmaster" illustrated gives a new high value per dollar in electronic heating, and has the additional advantage of occupying little floor space. As shown, it incorporates a built-in, highly shielded "oven," or electrode cage, automatically operated, and designed especially for the plastic and rubber industry. It is also supplied without the "oven" so that it may be used with external electrodes in connection with conveyor belts or other applications. Floor space is only 24" x 48".

The "Heatmaster, Jr." embodies the same excellence in design, manufacture and the use of highest class standard components including the new type radial fin tubes as the "Heatmaster," but has an output of 2½ Kilowatts or a BTU output of 8550 per hour as against the 17,000 BTU's of the larger model. The same safety features and simplicity of control as characterize the larger model are found in the "Heatmaster, Jr." Both models are available at 27.4 mc frequency, and at 15 and 5 mc as may be required. Other frequencies can be supplied. The larger model operates on 200 volt 60 cycle three-phase current, while the smaller unit runs on 200 volt 60 cycle single-phase.

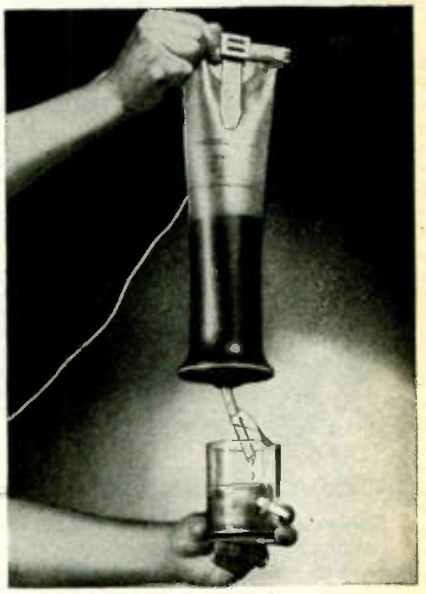
A folder describing the complete THERMATRON line will be forwarded on request.

"Desalter" Life Saver Produced on THERMATRON Machines

The Permutit Company's "desalter," which makes sea water potable in 20 minutes and which has been supplied by the hundreds of thousands to Army and Navy fliers who may be possibly forced down at sea, is known to many. It is one of the outstanding developments of the war. But what is not generally known is that the Gemloid Corporation of Elmhurst, Long Island, which makes a large proportion of these "desalters," uses THERMATRON in their assembly. THERMATRONS of the "Weldmaster" series are designed especially to weld, seal or bond thermoplastics such as Vinylite, of which these bags are made. Both the "Weldmaster" of 1 KW output and the "Weldmaster, Jr.", which has an output of 500 watts, are designed for welding or bonding thermoplastics. The Permutit "desalter" is a tough, collapsible, non-corrodible plastic bag with a simple strap closure and built-in filter that can be used over and over again. This product is the forerunner of many other plastic products to be manufactured economically on THERMATRON electronic heat welders by Gemloid and other plastics products makers.

Already, manufacturers of such products as raincoats, shower curtains, baby pants, tobacco pouches, cosmetic bags and other articles of widespread use, are displaying great interest in this new production method which offers so many outstanding advantages.

Radio Receptor Company's laboratories offer manufacturers a complete service in the adaptation of electronic dielectric heating equipment in their manufacturing processes. While the plastic industry has been among the first to grasp the possibilities of this new tool, many other industries are searching out its potentialities and are making plans to use THERMATRONS as soon as they become more generally available.


Permutit Desalting Bag

Look to COMCO for VHF

Customized

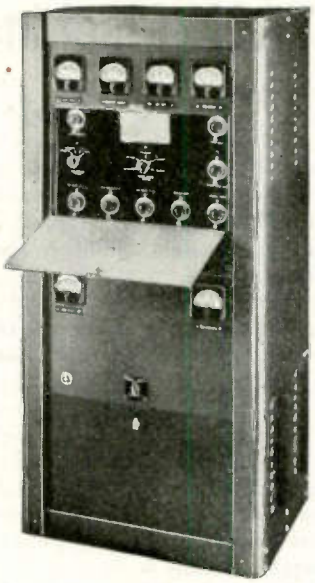
Radio and Electronic Equipment

Test-Proved for Dependable Performance

The Comco system of testing and inspection maintains a continuous and rigid control of quality. The finest scientific devices and instruments in the hands of experienced technicians insure positive protection against all usual causes of sub-standard performance. It is no accident that COMCO *customized* equipment has become widely known for unvarying quality and dependable performance.

COMCO VHF TRANSMITTER MODEL 170

Reliable VHF, 50 watts output. Frequency range 100 to 160 Mc. Cabinet size: Width 23"; depth 18"; height 48". COMCO Model 127AA Transmitter also available for operation on a frequency range of 200 to 550 kc.



COMCO VHF RECEIVER MODEL 132

Compact VHF crystal controlled, fixed frequency, superheterodyne. Single channel reception; 5¼-inch relay rack panel mounting. 12 tubes. Frequency range 100 to 160 Mc. Medium and low frequency receivers also available.

WRITE! *Just a note on your company letterhead outlining your exact requirements. We'll give you the benefit of our specialized experience. We can supply a wide variety of* customized *equipment on priority NOW. We are accepting non-priority orders for post-war delivery.*

MANUFACTURERS OF RADIO COMCO & ELECTRONIC EQUIPMENT

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★ Clarostat pioneered the plug-in metal tube resistors found today in many compact AC-DC radio sets. These handy resistors serve as voltage reducers and also as resistance networks for supplying a plurality of voltages. Clarostat also makes voltage regulator ballasts in perforated metal cases, either as plug-ins or for permanent mounting.

If you are seeking such handy, accurate, dependable resistors for your electronic or electrical assemblies, please bear in mind that Clarostat means outstanding experience, engineering and production facilities.

★ **Consult Us . . .**

Send those resistance, control or allied problems to us for engineering collaboration, specifications, quotations.

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Through full utilization of new war-time advancements in production methods, manufacturing facilities, and engineering techniques, Jefferson Electric is prepared to meet tomorrow's transformer needs with a product capable of maximum application to postwar technical developments.

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JEFFERSON ELECTRIC

TRANSFORMERS

PRESET TIMER

(*Continued from page* 134)

That is, the "four" switch on the unit decade, the "four" switch on the ten decade, the number "5" switch on the hundreds decade and the number "6" and "7" and "8" switches on the thousands, ten thousands and hundred thousands decades are operated. This in turn sets up these figures among the pairs of tubes in the counter, so that when the count starts, it continues from the point starting with the number 876,544 and counts up to 1,000,000. At this point a special control tube operates and actuates a relay or other device applicable to the process. The operation of this latter tube can be made either to restore all counters and tubes to the starting condition, so that a second interval of the same duration can be immediately started, or the whole process can be delayed until a repeat key is operated manually.

The photograph Fig. 4, illustrates the appearance of the instrument where the pre-selection switches and the indicating neon lamps are mounted on the front panel. The four double triodes appearing in each decade are arranged as a single unit, Fig. 5, so that groups of the decades units can be assembled side-by-side when large counting intervals are to be provided for. Although a large number of tubes are found in the circuit, the circuits associated with most of them are duplicated. This provides the greatest simplicity in production and servicing.

The whole plan of applying the circuits to counting involves the distribution of a series of pulses which may be from any one of a number of sources, so that each pulse is applied to operate the right counting stages or decades. For instance, when changing over the count from say 9,999 to 10,000, four separate counting units must be operated by the same pulse. It is also necessary to apply and transfer the incoming pulses so as to avoid the introduction of any type of transient. The control circuit which applies the starting and stopping pulses to the counting decades is shown in Fig. 6. Here also a source of timing pulse from a crystal oscillator is provided when a standard of time is needed. A convenient crystal frequency for this purpose is 100,000 cycles which produces a series of pulses at ten microseconds intervals.

A crystal oscillator circuit using tube (11) is generating currents of, say 100,000 cycles per second, continuously. It is necessary to convert these sinusoidal variations into a series of sharp pulses of relatively short duration, say two

(*Continued on page* 142)

THIS conversation might easily occur at our reception desk because here under one roof and management we produce both small motors and molded plastics in large quantities for use in widely different products.

YES, YOU CAN BUY *BOTH* AT GENERAL INDUSTRIES

Take small motors. We've built *Smooth Power* units for many years for our own line of velvety operating recorders, record-changers and turntables. We supply standard or designed-to-order *Smooth Power* drives and assemblies for automotive devices, controls and other small electric products. Our customers include leading manufacturers in a wide range of industries.

Now about molded plastic parts. We have the equipment for small and large work in any quantities. Our engineers, mold makers and machine operators have the combined "know-how" to deliver better plastic parts quicker and at prices in line with our established high quality. If you visit our factory (and you'll be welcome) you'll be amazed at the diversity of our work and at the length and quality of our customer list.

Yes, you can buy both small motors and molded plastics for your postwar products from General Industries. We suggest a general discussion now, to be followed by details when our war work has been finished. It will be appreciated if you will address the specific division . . . *motors* or *molded plastics*.

THE GENERAL INDUSTRIES COMPANY
ELYRIA, OHIO

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No. 3 of a Series

MODERN COIL WINDINGS

"with yarn"

This machine produces a coil of the familiar "cotton interweave" type where appearance or special applications require such construction. Glass or silk yarns are also used as a binder and insulator instead of cotton when their special qualities require it.

Our engineering department will be glad to recommend the type of winding best suited to your requirements.

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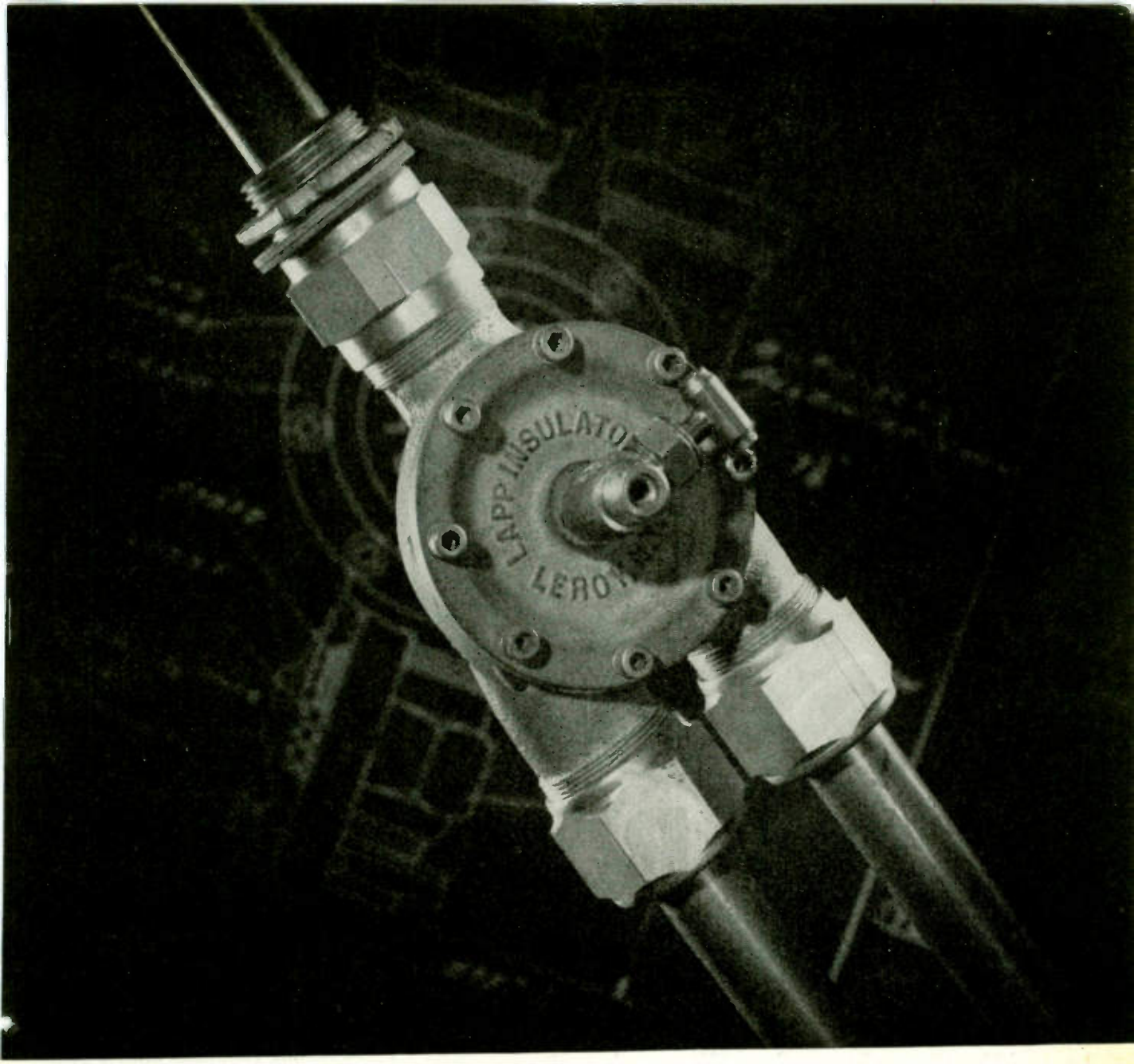


Electronic Parts: ENGINEERING AND PRODUCTION

The gadget above is a junction box for a co-axial gas-filled transmission line. It is one of a series of coupling units, end seals and other fittings for high-frequency transmission—designed and built by Lapp.

To this type of construction, Lapp brings several innovations and improvements. For example, such a line from Lapp parts is genuinely leak-proof. Every gasket is under spring loading, so there's no leakage created by vibration or thermal change.

Whether or not you're interested in gas-filled transmission lines, you ought to know about Lapp. Here is an organization of engineers and manufacturers with broad basic knowledge of ceramics and their application. With experience in hundreds upon hundreds of special-purpose electronic parts, we have been able countless times to improve performance, or reduce costs, or cut production time through the application of our specialized skills to design and manufacture of parts involving porcelain or steatite and associated metal parts.

For quick and efficient assistance on a war production subcontract—or for the competitive advantage Lapp-designed and Lapp-built parts will give to you in the postwar battle—an inquiry to Lapp now may pay you dividends. *Lapp Insulator Co., Inc., LeRoy, N. Y.*

Lapp

PRESET TIMER

(*Continued from page* 138)

microseconds, recurring at the original rate. The output of the oscillator is therefore transferred so as to control the operating rate of a trigger pair (tubes 7 and 8). The plate of tube 7 delivers these sharpened pulses to the counting decades. It is also required that these pulses be delivered immediately after the start signal is given and continue until the stop signal appears.

Both of these requirements are handled by the control tube (12) which transfers the crystal oscillations to the pulse sharpening pair (7-8) only when its No. 3 grid is biased correctly for operation.

The latter grid is under control of tube (9). This tube is part of a "flip flop" switching pair (9-10) which was conditioned or made ready at the start by a circuit which made section (10) conductive and section (9) at cut-off. At the same time tubes (6) and (13) were both made conductive as well.

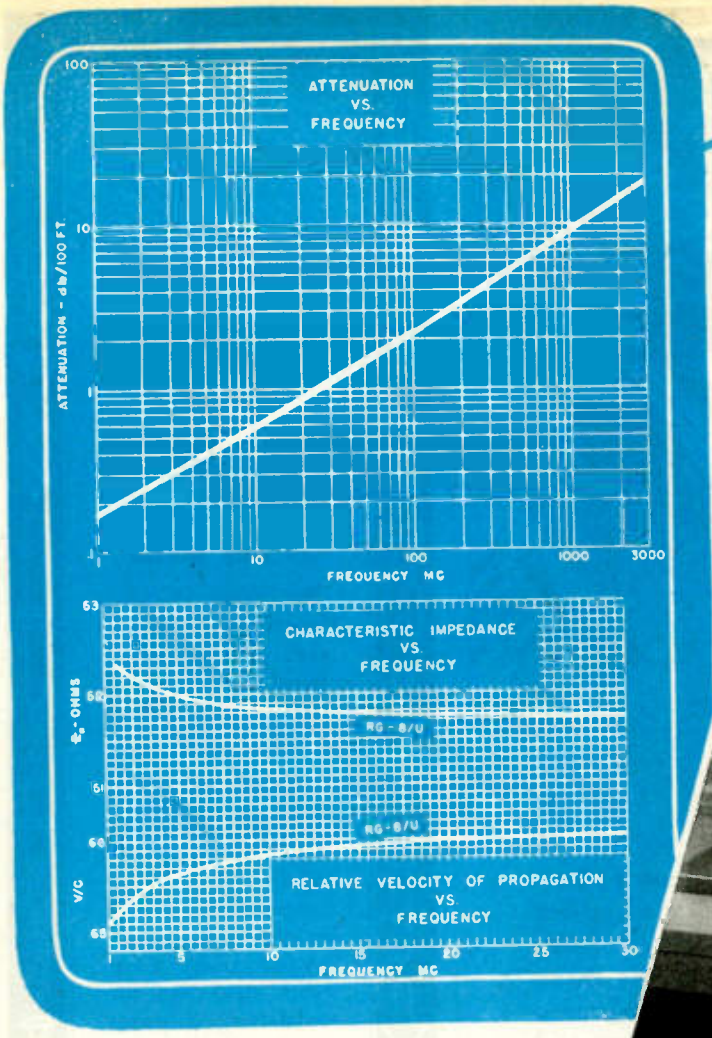
When tube (9) is not conducting the voltage on its anode, which is paralleled with the anodes of tubes (2) and (4), is high. Similarly, when tube (5) is not conducting the voltage on its anode, paralleled with the anodes of tubes (3) and (1), is also high. When the starting pulse is applied to the grids of tubes (1) and (3), the output circuit of (3) upsets the balance between tubes (5) and (6) so that the former is operated and the latter is released. This places a cut-off voltage on tube (13), which had previously been conducting with enough current passing through it to shunt the effectiveness of tube (7) for passing the sharpened pulses from the crystal oscillator into the counter decades.

Counting continues until a stopping pulse to tubes (2) and (4) causes the operation of tube (9) releasing tube (10). The grid of (10), now having a cut-off bias of about —30 volts, is paralleled with the grid No. 3 of tube (12). This latter tube is now cut-off, interrupting the stream of pulses to the counter decades.

This condition holds until the circuit is reset by the manual reset of a key, whereupon the original conditions are re-established. The primary purpose of tubes (1) and (2) is to transform incoming start and stop pulses into differentiated versions of those pulses, which have a sharply defined wave front, so that the point where transfer is accomplished is more precisely located.

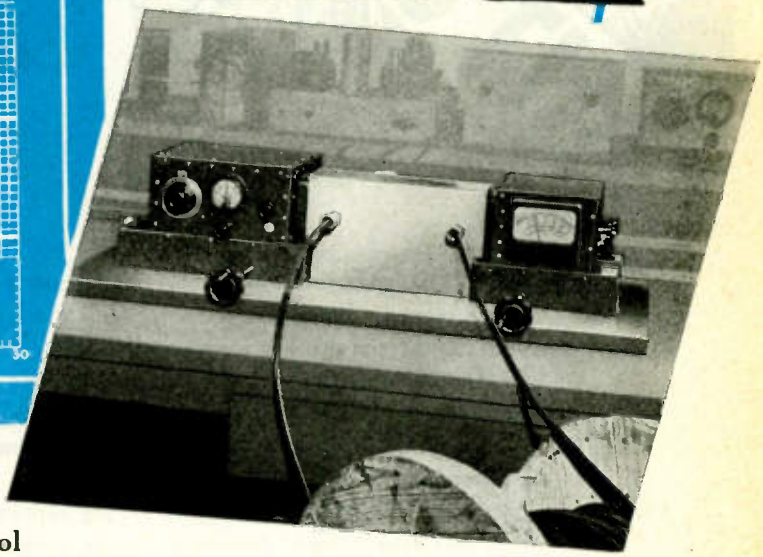
The basic principles of the scale of two counters were originated by Wynn-Williams in the early 30's for the purpose of counting cos-

(*Continued on page* 146)



HERE'S PROOF...

How Federal H-F Cable Quality is Controlled by *Actual Test*



Precision engineering—plus careful control of all manufacturing operations . . . from raw materials to finished product—mean complete reproducibility in any given Intelin Cable type . . . and overall superior cables.

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Intelin's Attenuation Meter is an example of such equipment. It's a precision instrument . . . accurate to .1 db . . . developed by Intelin to provide a constant check on production quality and "measured" data for the equipment designer.

For additional information regarding Intelin RG-8/U . . . write *today* for Report E-53—and for cable you can count on . . . *always* specify INTELIN.

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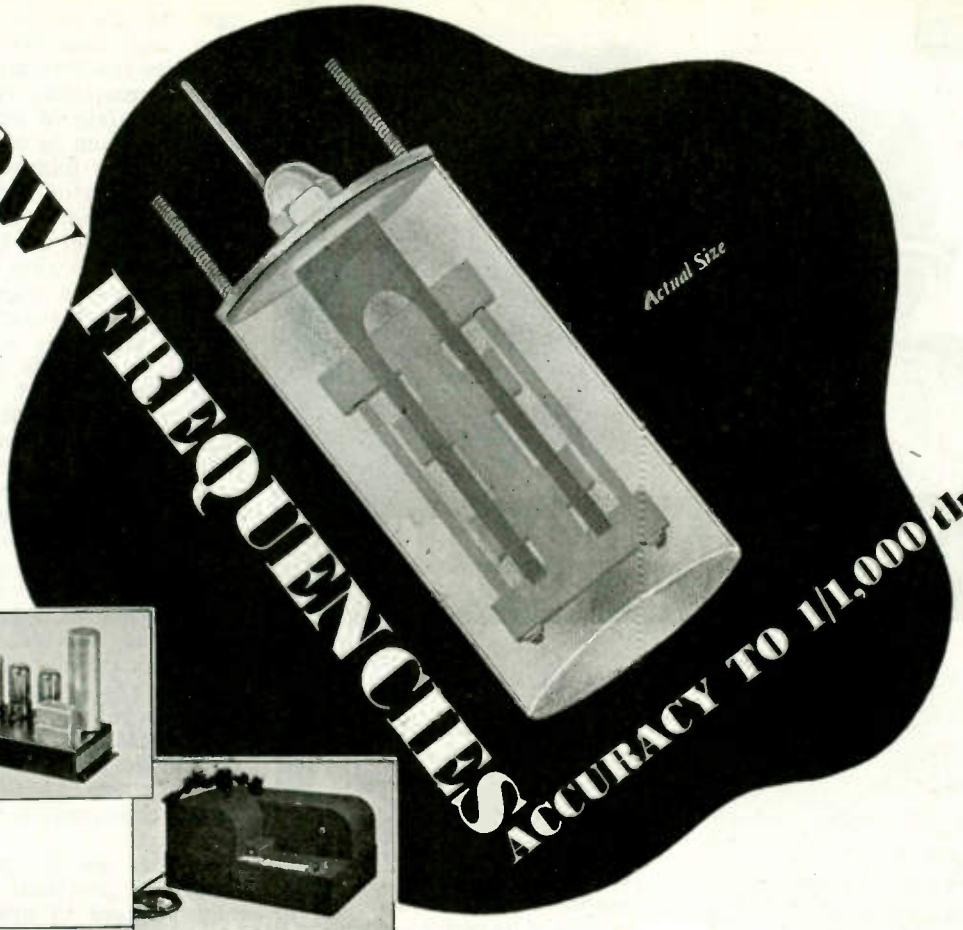

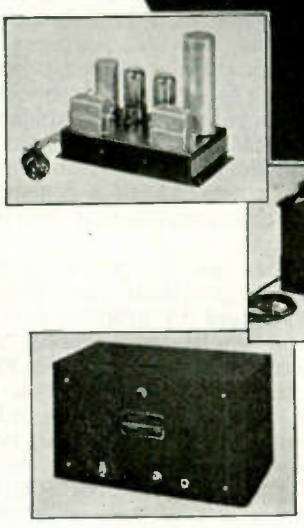

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(60 cycle) for use with external power supply

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Records time intervals with resolution to .001 second

BOTTOM
FREQUENCY STANDARD
(120 cycles) with self-contained power supply

These tuning forks which include new engineering principles, provide frequencies from 120 to 1,000 cycles directly with an unqualified guarantee of accuracy to 1 part in 100,000 over a wide temperature range. (Better than 1 second in 24 hours). Closer tolerances are obtainable on special order.

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The dependability of these frequency standards is being demonstrated for myriad purposes in all climates and under all working conditions.

If you have need for low frequency standards of exceptional accuracy, your inquiries are invited.

American Time Products, Inc.

580 Fifth Ave. **New York, N. Y.**

Dist. of Western Electric & Watch Master Watch-rate Recorders

PRESET TIMER

(*Continued from page* 142)

mic ray discharges. This application has also been extended to measure the intensity of any radioactive emanation, even to protecting the safety of workers in rooms where radium is continually handled. It may happen that the slow accumulation of radioactive materials for floors and walls may sometimes be a health hazard. The discharge rate of those services becomes a guide to the importance of this hazard and to establish the time when it is desirable to replace those surfaces with new material.

In another application, the decade counter becomes a standard of frequencies. When used with a crystal it will replace the multivibrator. As a frequency divider it can be made to produce a ten to one division or any other reduction ratio in successive stages, providing a source of a large number of frequencies for test purposes. This frequency division is accomplished without the chance of the circuit jumping to a wrong frequency or a new ratio if the synchronizing signal becomes too strong or too weak. In the case of a multivibrator, such occurences may frequently happen.

Another use of such a system is that of a precision time delay. It may be used to produce intervals of time up to ten seconds, using six decades as illustrated in Fig. 4. As a time delay and interval generator, one less than one million different time intervals can be established by the equipment of Fig. 4 by manipulating the switches. The versatility of this equipment is such that many new applications are being continually developed in many fields of research.

OPPORTUNITIES FOR VETS

(*Continued from page* 104)

education or training under the Army Specialized Training Program or the Navy College Training Program or as a cadet at one of the Service Academies provided that in no event shall the total period of education or training exceed 4 years.

"The GI Bill of Rights authorizes allowances for 4 years at not more than $500 a year for training and education, plus monthly subsistence of $50 a month for single veterans and $75 a month for those having dependents.

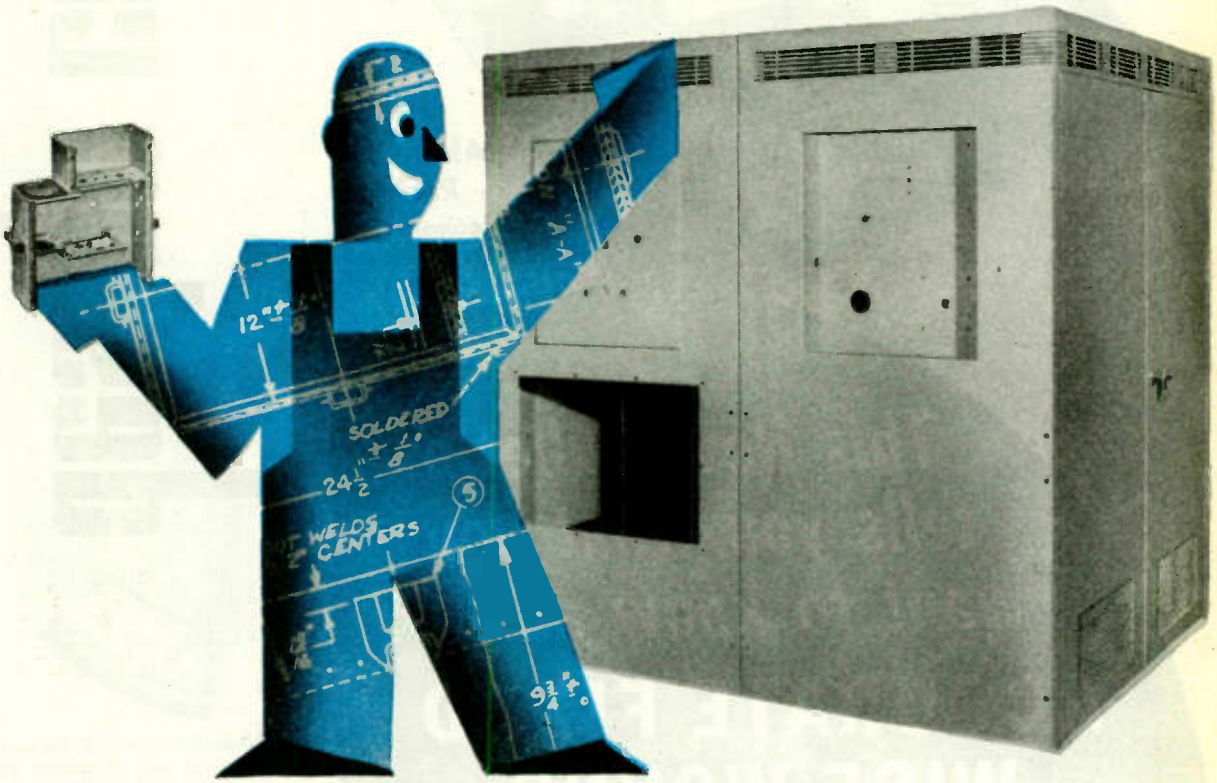
Army

"New inductees in the Army, who are interested in radio-electronics, should discuss that fact with the Classification Officer at their Reception Center. If they have the

(*Continued on page* 150)

TINY OR TITANIC

No Job in Metal is Too Big or Too Small for KARP



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ACCURATE FIXED WIRE WOUND RESISTORS

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design counts

Remember the old flatiron? It did its job, of course; but just compare it with the modern electric iron which has been brought to its present high level of utility by careful application of design.

Here at **THE WARD PRODUCTS CORPORATION,** design is one of the most carefully considered factors in the manufacture of antennas. It is only through superior design that durability, styling and the benefits of superior production can be best brought to the user. For the finest antennas for all applications — for home and automobile use — look to **WARD.**

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WARD *Antennas*

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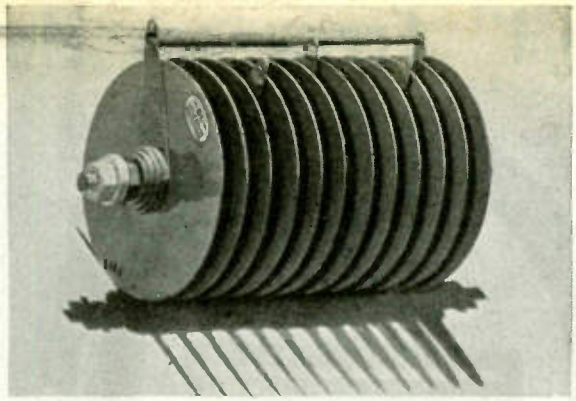


POWER CONVERSION

from AC *to* DC *with* B·L RECTIFIERS

B-L SELENIUM AND COPPER SULPHIDE ELECTRICAL RECTIFIERS are used wherever direct current is required from an alternating current source. These rectifiers are compact—durable—silent; have no moving parts; are simple to install, require no maintenance. Ratings from milliwatts to kilowatts.

B-L RECTIFIER TRANSFORMER ASSEMBLIES *are built for many standard applications:*

B-L Laboratory Rectopacs for supplying the required voltage of direct current from the alternating current source.

•

B-L Heavy Duty Portable Railroad Battery Charger, for use in terminals.

•

B-L Fast Battery Charger for "no removal" automotive battery service.

•

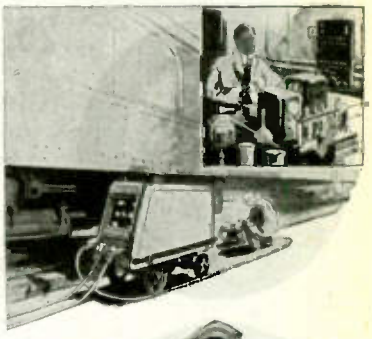
B-L Battery Booster for use in charging batteries and keeping them charged.

•

B-L Cathodic Protection for pipe lines.

•

B-L Filterpacs, eliminating the need of batteries, in operating 6-volt DC electrical equipment.



Consult us if you have a Power Conversion Problem. Twenty-five years of B-L specialized skill in AC-DC conversion problems is available to you. Write for Bulletin 38-b.

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Designers and Manufacturers of Selenium and Copper Sulphide Rectifiers, Battery Chargers, and DC Power Supplies for practically every requirement.

OPPORTUNITIES FOR VETS

(*Continued from page* 146)

necessary background, and if requisitions are on hand for new inductees for the Signal Corps, they are likely to be given preference for such assignments. If a soldier in the Army wants to get into radio work, he should discuss his desires with the 'Information and Education Officer' on his post. If he is leaving the Army, he should discuss his plans with the Interviewing Officer at the Demobilization Center."

TROPICAL TREATMENT

(*Continued from page* 108)

tions, as heat resistance, method of application, compatibility of the fungicide, etc.

Equally as important as the vehicle is the choice of a fungicide. Important in the choice of a fungicide are such factors as compatibility with the base material, ability to withstand exposure to heat and moisture, toxicity in manufacture, and use of the treated material. For parts subject to frequent handling a non-toxic fungicide should be used.

Once the choice of vehicle and fungicide has been made, attention must be given to the concentration of the fungicide in the vehicle. The following concentrations of the most common fungicides have been found to be satisfactory:

Copper naphthenate ...	3—5%
Mercurials	1%
Chlorinated phenols....	10%
Salicylanilide	7—8%

Lacquer vs. Wax

It should be noted that a fungicide may be effective in the above concentrations in one vehicle and not in another. Eight per cent of salicylanilide incorporated in a lacquer or varnish is an excellent fungus-proofing material; on the other hand, this concentration in wax is difficult to attain.

There is a tendency today to minimize the use of waxes in the treatment of component parts. Substitute processes utilize lacquers, varnishes, or vehicles composed of a resin and wax base; quite frequently, a silicone-resin base is used. In addition to fabrics and felts, the processing of leathers, paper, etc., is effectively accomplished by spraying (in a well ventilated booth) with a fungicidal lacquer or varnish. A pressure type spray gun should be regulated to give a round wet spray of small diameter. A mist type spray, which has a tendency to leave a porous film that is not very moisture resistant, should be avoided. Electrical contacts, waxed components,

(*Continued on page* 154)

THORDARSON

celebrates its 50th Anniversary by joining hands with

MAGUIRE INDUSTRIES

Throughout the past half century, the name "THORDARSON" has been a synonym for highest quality in transformers and other electrical equipment.

Under the banner of Maguire Industries, this tradition of leadership will be maintained in even fuller measure.

Thordarson's new plans include outstanding improvements in present lines . . . new products and services to meet the expanding needs of the radio and electronic industries . . . vigorous and liberal merchandising policies . . . and a generally forward-looking viewpoint with regard to all of the industries we are privileged to serve.

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THORDARSON
ELECTRIC MFG. COMPANY
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AN HOUR ON THE BENCH SAVES NINE ON THE JOB

Bench assembly and repair means speed-up in production. The use of Cannon Multi-circuit Connectors in the wiring of electrical equipment is the ultimate in assembly efficiency—time saved on the job, less skilled labor, better critical work under better conditions.

Bench wiring by Jean Wheeling, of the Curtiss-Wright Corporation, Columbus, Ohio

Various parts of electrical assemblies may be manufactured in different factories and put together and into operation simply by inserting a Cannon Plug into a Cannon Receptacle. The connection will be firm, tight and solid—yet quickly disconnected for replacement or repair.

There are more than ten thousand connector sizes, types and kinds listed in the Cannon catalogs. Thousands of special and intricate circuit requirements may be met right from stock with Cannon Plugs.

Wherever quick, complete and sure electric connections must be made—whether for a single element or a maze of circuits—use a Cannon Connector. Nothing less is so surely satisfactory. Nothing better can be had.

Write for condensed Cannon Catalog. It gives you a general introduction to the Cannon line. Address Department A-122, Cannon Electric Development Co., 3209 Humboldt St., Los Angeles 31, Calif... *Below is pictured a wall mounting, typical of the famous Cannon AN line of plugs.*

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Cannon Electric Development Company
Los Angeles 31, California

Canadian Factory and Engineering Office: Cannon Electric Company, Limited, Toronto, Canada

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MANUFACTURING CO. • PHILADELPHIA

COMPLETE MANUFACTURERS FROM START TO FINISH

10 POINTS OF *Superiority*

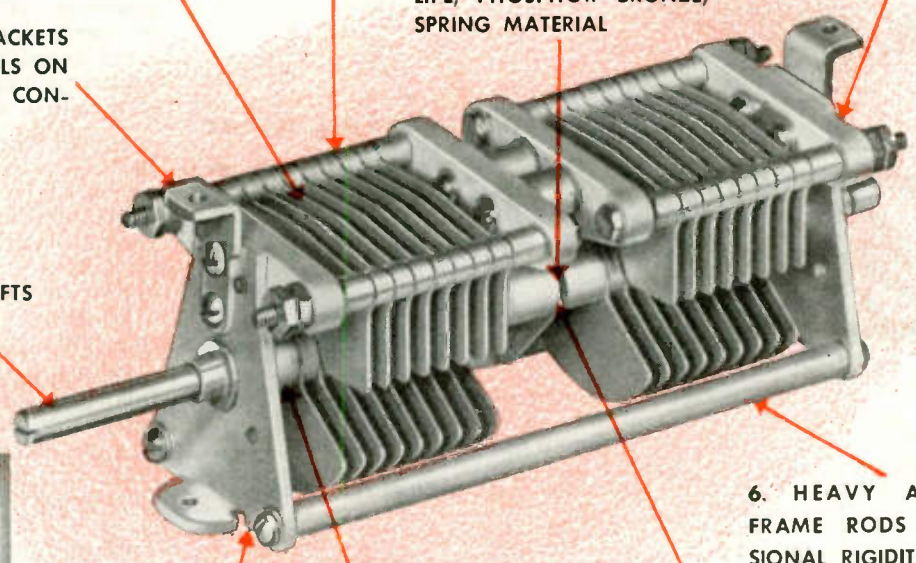
7. GRADE L4 STEATITE LOW LOSS INSULATION CORRECTLY PLACED FOR LONG LEAKAGE PATH AND SMALL DIELECTRIC LOSS

9. STATORS MOUNTED ON TOP SIDE FOR LOW STRAY CAPACITY

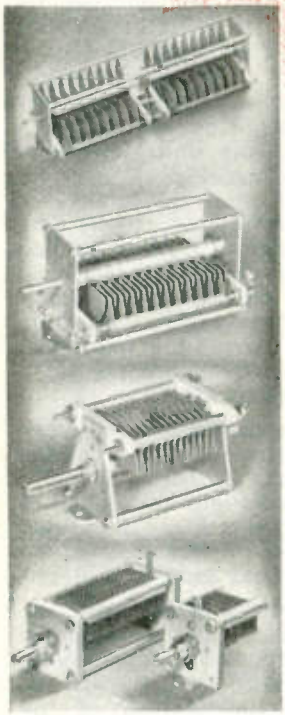
10. THICK, ROUNDED EDGE, ALUMINUM PLATES FOR MECHANICAL STABILITY AND INCREASED VOLTAGE BREAKDOWN.

8. LOW RESISTANCE ROTOR CONTACTS OF LONG LIFE, PHOSPHOR BRONZE, SPRING MATERIAL

1. REMOVABLE BRACKETS FOR MOUNTING COILS ON TOP OR MOUNTING CONDENSER INVERTED



2. STAINLESS STEEL, GROUND STOCK, SHAFTS



6. HEAVY ALUMINUM FRAME RODS FOR TORSIONAL RIGIDITY.

CATALOG NO. 100FD20

3. HEAVY END PLATES FOR STRENGTH

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4. PERFECTLY ALIGNED ROTOR SHAFTS FOR CALIBRATION ACCURACY

C - Plate spacing		.125" - .500"
	Maximum frame dimensions	5½" x 5-13 32"
D - Plate spacing		.080" - 250"
	Maximum frame dimensions	4½" x 4"
E - Plate spacing		.045" - .125"
	Maximum frame dimensions	2⅝" x 2-19 32"
H - Plate spacing		.030" & .080"
	Maximum frame dimensions	1½" & 1-9 16"

Type "F" single and dual condensers are stocked with plate spacings of .045 to .075" in 19 different models. Maximum capacity range is from 34 mmf. to 255 mmf. and the ratios of maximum to minimum run from 7:1 to 15:1. Maximum frame dimensions 2-1 16" by 2".

JOHNSON

a famous name in Radio

E. F. JOHNSON COMPANY • WASECA • MINNESOTA

TROPICAL TREATMENT

(*Continued from page* 150)

clear plastic insulators and parts, relays, variable capacitors, selenium rectifiers, and movable electrical contacts should be masked, using masking tape, boxes, or shields. Masking greases and compounds should be avoided.

Component parts which cannot be readily reached by an overall spray or which require extensive masking should be coated by brushing. Soldered connections are brushed.

Small parts (as coils, terminal boards, etc.) may be dipped before assembly. This type of treatment is particularly applicable where large quantities of parts are to be processed quickly. Vacuum impregnation is a dipping process.

In production, much difficulty has been encountered in the proper maintenance of wax processing tanks, particularly those involving vacuum impregnation. Most of the fungicides incorporated in waxes are volatile; as a result, the fungicidal content of the wax decreases in a relatively short period of time.

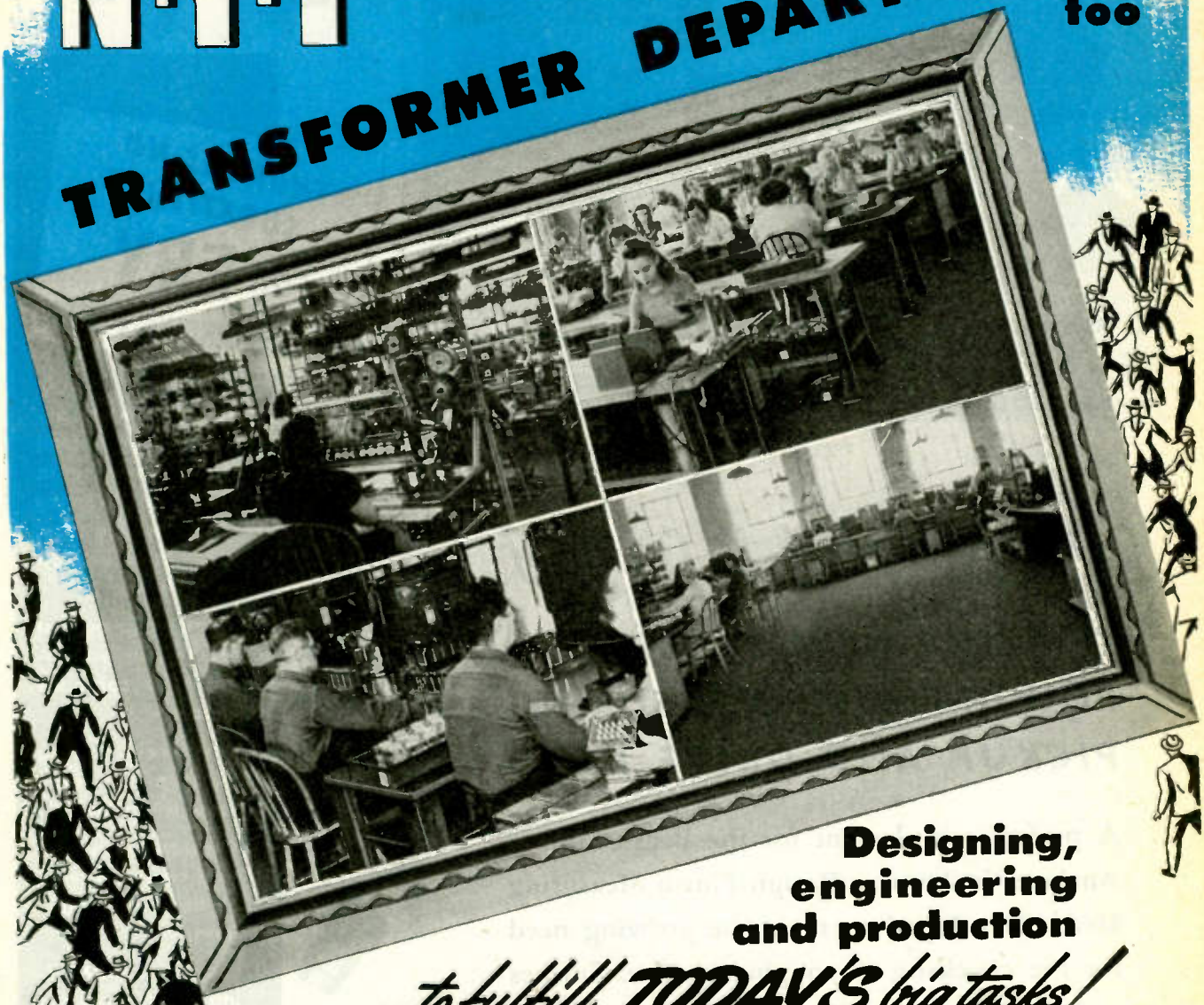
Recognizing the importance of this phenomenon, laboratory investigations were conducted to determine optimum temperatures for processing and the duration of effectiveness of a particular batch of wax. In these investigations daily chemical analyses (to determine the fungicide concentration remaining in the wax) were correlated with mycological tests (to determine at what fungicide concentration protection ceased). As a result revisions in vacuum cycling were made, chemical and biological controls are conducted periodically, and the fungicide concentration maintained above the minimum level by the weekly addition of a fungicide concentrate.

If desirable, drying processes may be hastened by the use of drying ovens or banks of infra-red lamps at temperatures not exceeding 60 deg. C. (140 deg. F.). If varnish coatings are too heavy or dried too rapidly, they may tend to blister.

New procedures recommend the incorporation of fluorescent materials into the body of the fungicidal varnish and lacquer. These are obtained from the supplier of the varnish and lacquer and greatly facilitate inspection of the tropicalized equipment. Fluorescent materials utilized in this manner are chemical compounds which in ordinary light appear colorless but under the influence of ultra-violet light ("black light") glow with a characteristic color. Consequently, ultra-violet light inspection in a dark or semi-dark room will distin-

(*Continued on page* 158)

N-Y-T can be your TRANSFORMER DEPARTMENT, too



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Now, more than ever, leading electronic and electrical manufacturers are relying on N-Y-T facilities to meet entire transformer, choke and filter requirements. The multiple advantages—release of valuable floor space, reduction in tooling, minimum inventories and alleviation of labor shortages—are vital reasons for this current trend.

More important, however, is N-Y-T specialization in transformers. Emphasizing plant and equipment applicability — with coordinated tooling, channelized engineering and product design collaboration — transformer solutions are high in efficiency and low in unit cost.

These factors — backed by an enviable record in Army, Navy and Air Corps critical production — justify the receptance of this "personalized" N-Y-T Transformer Department.

Address inquiries to Department N

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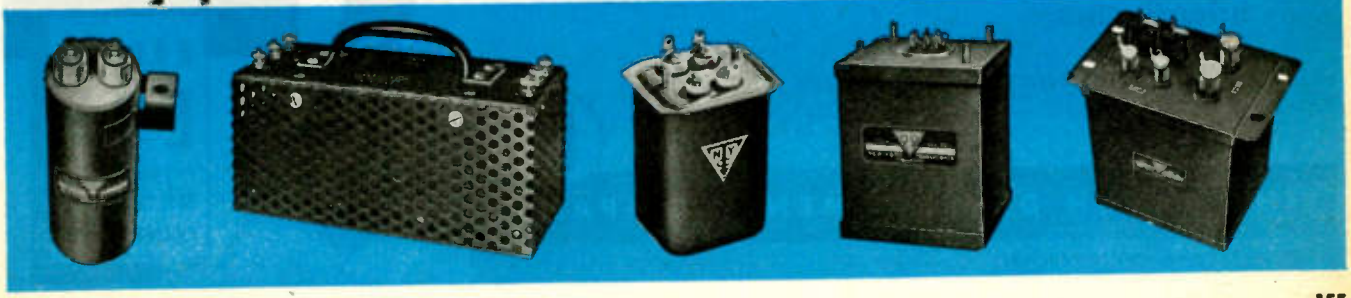

Announcing

THE NEW BRUSH ROUGH-FINISH MEASURING PICKUP AND DRIVE HEAD

A perfect complement for the Brush Surface Analyzer is the new Rough-Finish Measuring Head. Developed to meet the growing need for the checking of rougher surface finishes and waviness, it accurately measures irregularities from 100 to 3,000 microinches, peak to valley.

This new Pickup (Model BL-101) and Drive Head (Model BL-102), when used with the Brush Surface Analyzer, extend its usefulness and range of measurement from 1 to 3,000 microinches.

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THE BRUSH DEVELOPMENT COMPANY

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The spring binding post offers unique advantages that can't be duplicated:

1. No screw cap to tighten or come loose with vibration.
2. Constant, even pressure on the wire at all times in all positions.
3. Easy one-hand feeding of wire into the post.
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Replace with Eby Spring Binding Posts — Write today.

HUGH H. EBY
INCORPORATED
18 W. CHELTEN AVE.
PHILADELPHIA, PA.

TROPICAL TREATMENT

(*Continued from page* 154)

guish tropicalized from non-tropicalized equipment and, at the same time, detect incomplete coverage in tropicalized equipment.

Complete protection from the deleterious effects of moisture and fungus growth is insured by hermetically sealing small component parts. This is accomplished by enclosing the part (which is sometimes tropicalized) in a glass container. A metal cap soldered to the end of this glass container seals the part from the air. A similar packaging method involves the heat-sealing of small component parts in clear plastic bags after air has been evacuated from the container.

Completed assemblies which have been properly tropicalized and inspected should be dated by stamping both the month and year in which the tropicalization treatment was applied. Dating must be accurate to within one month.

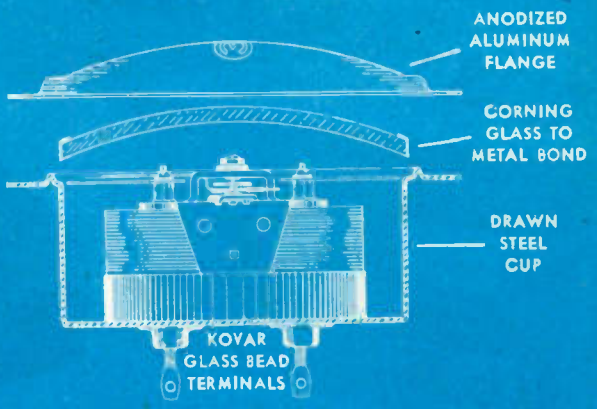
Certain safety precautions must be enforced wherever moisture-proofing and fungicidal processing is being performed. Adequate ventilation is essential because many of the materials used in processing emit obnoxious fumes and odors which may induce headaches, dizziness, nausea, and even dermatitis among the personnel.

Personnel should be thoroughly instructed regarding tropicalization processing. This instruction should include training in the proper methods of application of moisture and fungus-proofing materials as well as personal hygiene. Adequate attention must be given to the problems of suitable garmenting—as the use of masks, aprons, gloves, arm shields—and sanitary measures to be employed. Personnel should be cautioned against scratching exposed skin surfaces during processing and instructed as to the need for frequent and thorough cleansing of hands.

Dermatitis is a serious problem occasionally encountered among those processing and handling equipment. These skin disorders may result from either the solvents or fungicide. Some common solvents which may cause difficulty are hexalin, benzol, xylol, and many alcohols.

Among the fungicides the chlorinated phenols are more toxic than the mercurials; salicylanilide is relatively non-toxic. Acute poisoning is frequently encountered and may become evident within a few hours to several days after exposure to the irritant. The appearance of initial symptoms are dependent upon previous skin disorders, allergies, and the sensitivity of the individual. With proper medical attention the disorder quickly re-

(*Continued on page* 162)



YES! *They're totally sealed.* The Marion design and glass-to-metal sealing process assure true hermetic sealing. And the bond between the metallized glass rim and the steel case is capable of withstanding extreme thermal shock.

YES! *They're interchangeable.* Magnetic shielding permits interchangeability on any type of panel without affecting calibration. The Type HM 2 is directly interchangeable with AWS Types MR 24 and 25. The Type HM 3 is directly interchangeable with AWS Types MR 34 and 35.

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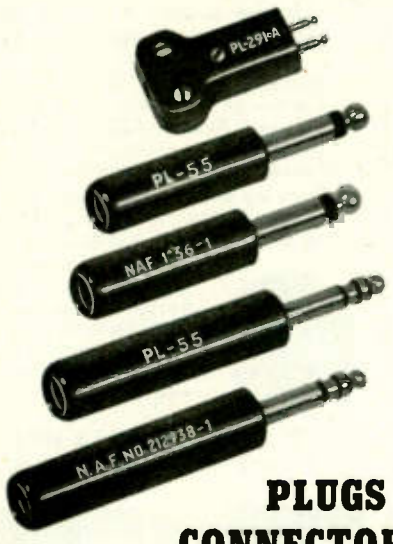

PLUGS & CONNECTORS

Signal Corps · Navy Specifications

Types:		PL			NAF
50-A	61	74	114	150	
54	62	76	119	159	
55	63	77	120	160	1136-1
56	64	104	124	291-A	
58	65	108	125	354	No.
59	67	109	127		212938-1
60	68	112	149		

PLP		PLQ		PLS	
56	65	56	65	56	64
59	67	59	67	59	65
60	74	60	74	60	74
61	76	61	76	61	76
62	77	62	77	62	77
63	104	63	104	63	104
64		64			

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REMLER

SINCE 1918

Announcing & Communication Equipment

TROPICAL TREATMENT

(*Continued from page* 158)

sponds to treatment. However, it cannot be too strongly emphasized that when proper precautions are taken, these disorders do not appear.

Poison possibilities

In rare instances poisoning symptoms do not appear for months; this is known as chronic poisoning. It may evidence itself by such symptoms as loss of color, appetite, and weight; listlessness; dizziness; headaches; nausea; bleeding of gums and nose; purpura; menstrual disturbances; and anemia. Permanent injury to organs may result from chronic poisoning. Once started the condition may progress without further exposure to the poison. The most severe cases of poisoning may result in delirium and subsequent death.

It has been the authors' experience that where sufficient common-sense precautions are observed, industrial hazards are negligible.

Packing precautions

To prevent corrosion and fungus growth from occurring in packed equipment during storage and transport further protection is necessary. Equipment can be packed in air-tight containers which are sealed after the air has been evacuated from the container. To further decrease the moisture content inside the packaged unit, drying agents like silica gel are used.

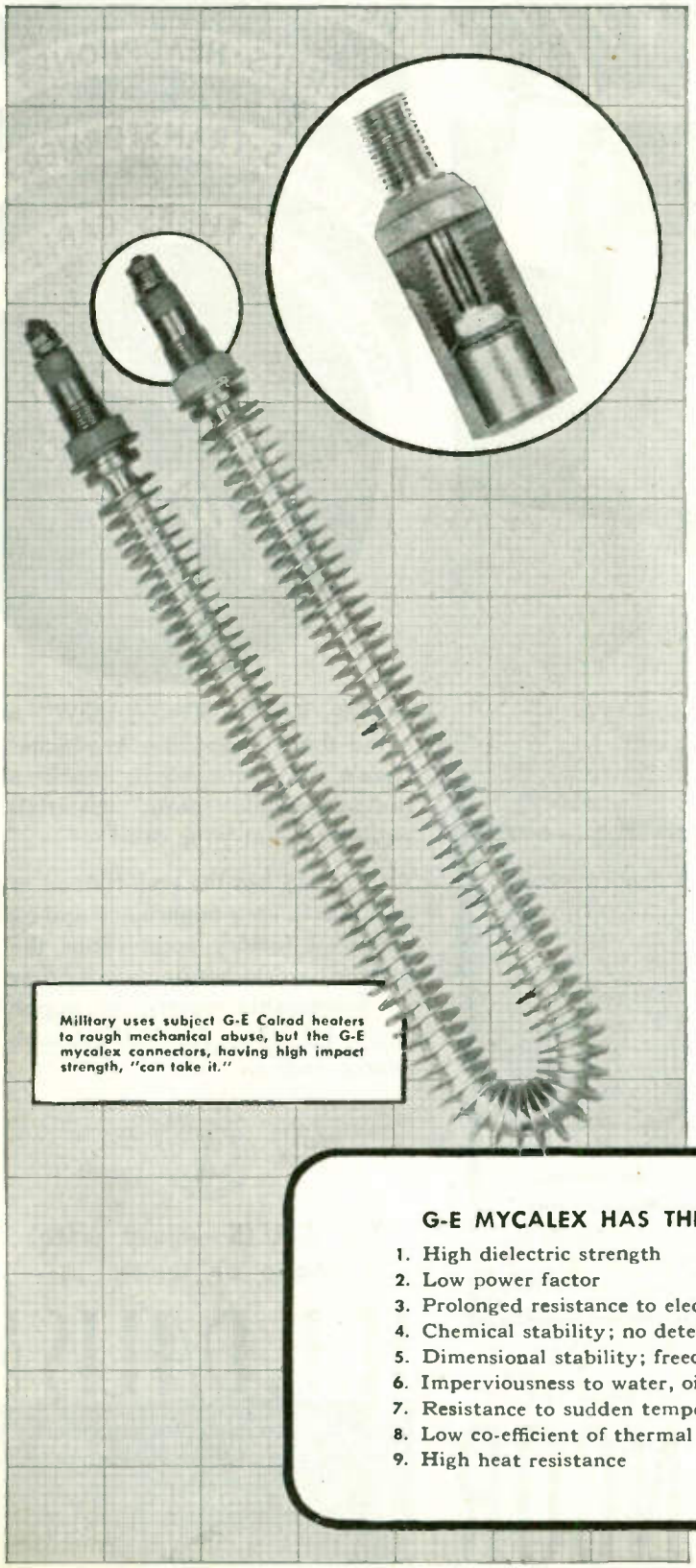
Recent methods incorporate chemicals with the silica gel to indicate when the drying agent has absorbed so much moisture that it is no longer effective as a drying agent. Cobalt chloride is such a chemical. When the silica gel is dry the added cobalt chloride is blue in color; when moist and no longer effective as a drying agent the material becomes pink or red. The introduction of a volatile fungicide inside the container affords additional protection against mold growth. Occasionally entire units are wax coated after packaging.

In addition to the above measures, it has been shown that proper handling, storing of equipment, continuous use, periodic inspection and drying out of equipment are other factors which contribute toward protection against corrosion and mold growth.

The authors are indebted to Miss Helen M. Conlon and Mr. Eugene Wesselman for their assistance. The photographs were taken by Mr. Bert Cannon.

How G-E Mycalex keeps the Calrod dry

AN IDEAL SEAL—IT'S MOISTURE PROOF—IT'S PERMANENT



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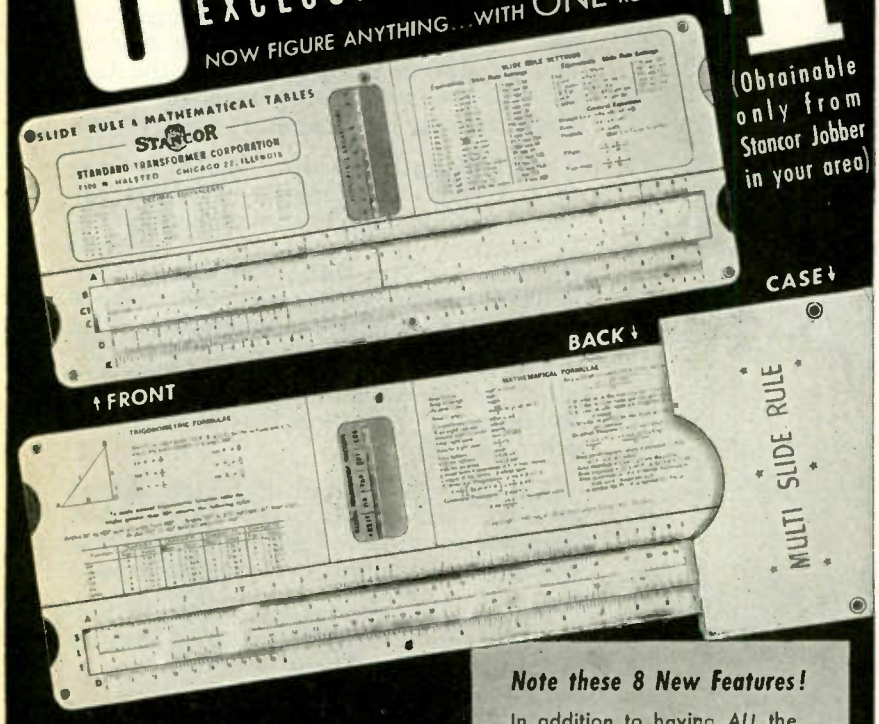

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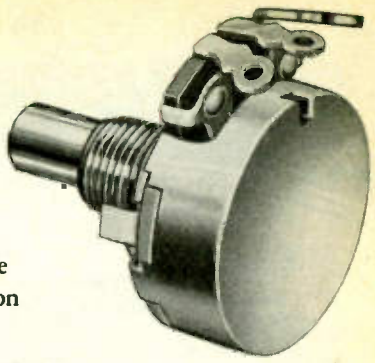

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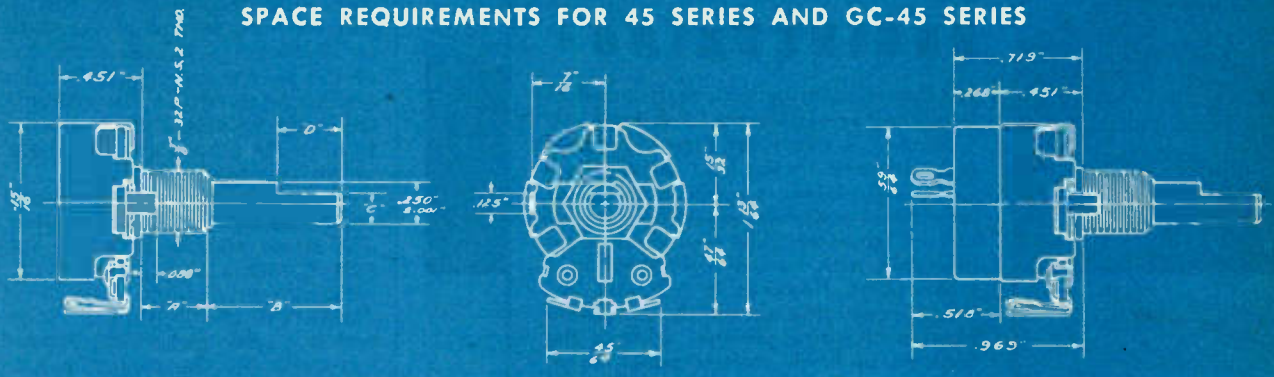

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SELF-FORGING WELDER

(*Continued from page* 109)

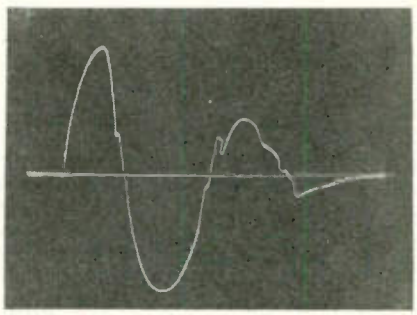
tomary stored-energy welding system there is often a relatively long period of decay of the current. This long period restricts the speed with which successive welding operations may be made.

Certain solutions of these problems have been incorporated in the new bench type welder illustrated in Fig. 1. Referring to the circuit diagram, it may be seen that the pair of 28 mfd capacitors C and C^1 connected in parallel are charged through a 5,000 ohm resistance and an FG 17 thyratron rectifier tube. The resistance, of course, is used to limit the initial current rush. At the end of a period of from one quarter to one second, the capacitors are charged and the weld can be made. The voltage to which they are charged can be predetermined by changing the grid voltage on the thyraton by means of the resistance divider E. While the resistance divider is connected across the storage capacitors, its total resistance is so high as not to affect appreciably their charge.

At one time of this charging, a 1 mfd capacitor B is also charged up. When it is desired to perform a weld, the microswitch H is closed, thereby permitting B to discharge through the primary of the spark coil. The secondary of the spark coil, with an output of about 10,000 to 12,000 volts, is connected to one of the pool cathodes of the double pool tube F, while the other side, the high voltage side, is connected to a sleeve placed outside the glass above the mercury pool.

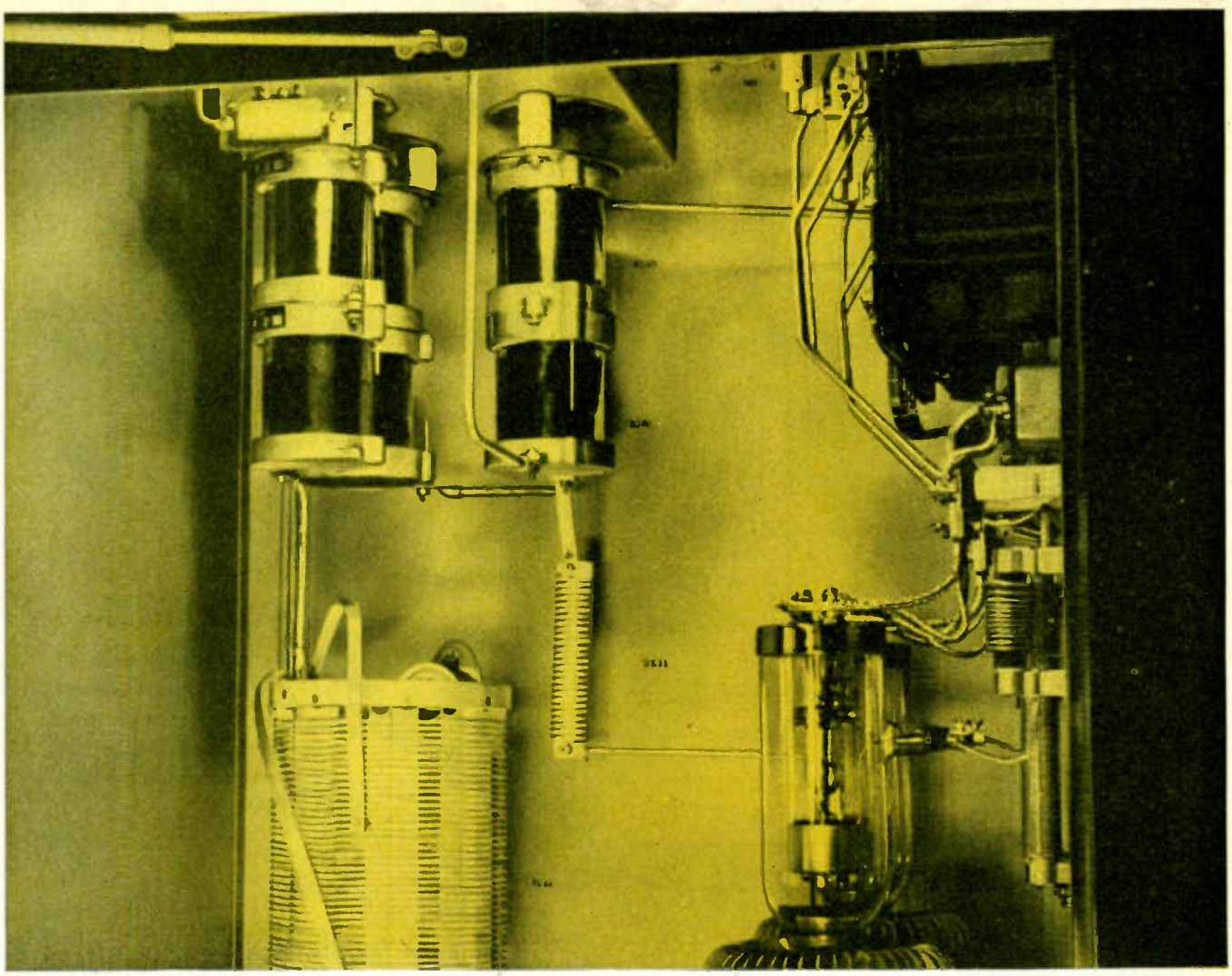
The high voltage field created by this potential ionizes the mercury and starts the discharge in tube F and through the primary of the welding transformer. The resulting discharge is oscillatory with a rather rapid decrement depending naturally on the circuit constants and the reflected resistance of the weld.

Fig. 3—Oscillograph of damped welding current



It will be noted that an air core welding transformer is used. This welding transformer, Fig. 2, is constructed of three pancakes of 72 turns each, constituting the primary, and two horseshoe shaped, edgewise wound, copper bars form

(*Continued on page* 170)



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BROADCASTING, as an industry, is celebrating its 25th Anniversary this year. There were Faradon Condensers in many of the first broadcast transmitters. There have been Faradon Condensers in every RCA Broadcast Transmitter since—and in every RCA aviation, police, communications and military transmitter.

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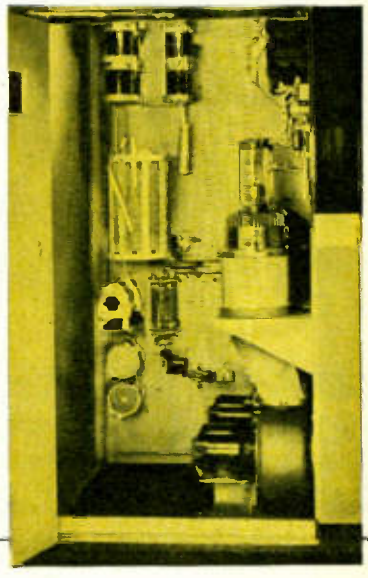

Right and Above — *Power-amplifier cubicle of the new RCA 5/10 KW Broadcast Transmitter. In the design of this modern, streamlined transmitter, particular stress is placed on absolute reliability. Faradon Condensers, manufactured by RCA, are used throughout.*

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1025- 4	12	9	9	1025-16	24	15	15
1025- 5	18	9	6	1025-17	24	18	12
1025- 6	18	9	9	1025-18	24	18	15
1025- 7	18	12	9	1025-19	24	18	18
1025- 8	18	6	6	1025-20	24	12	9
1025- 9	18	15	9	1025-21	42	9	9
1025-10	18	12	6	1025-22	36	12	9
1025-11	18	15	12	1025-23	30	15	9
1025-12	18	12	12	1025-24	42	12	9

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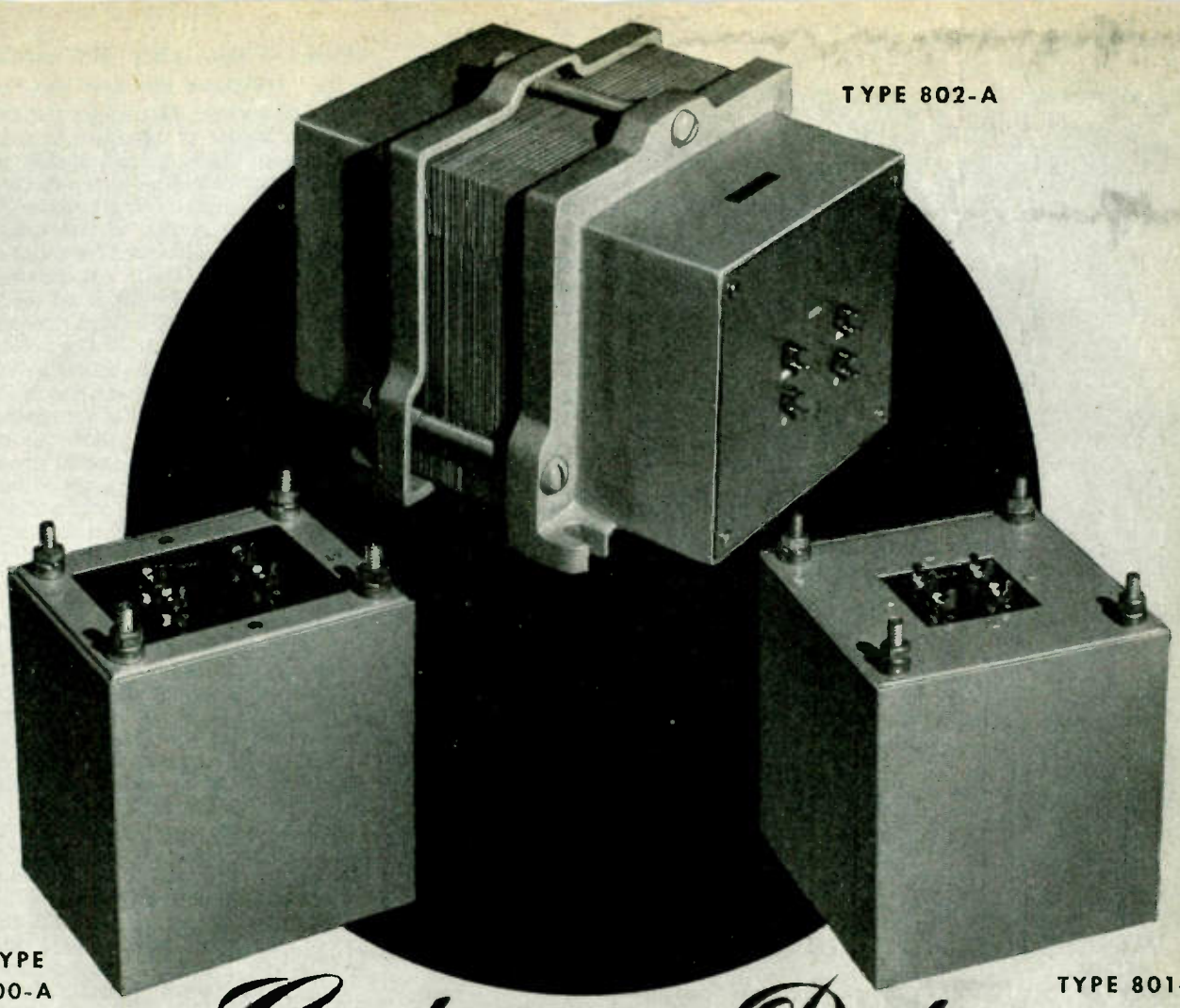

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SELF-FORGING WELDER

(*Continued from page* 166)

the secondary. The upper electrode of the welder is mounted in rather standard fashion on a heavy post and arm, while the lower electrode is placed on a shaft extending through the center of the welding transformer. Mounted on this shaft is a core, preferably of powdered iron, which can be adjusted up and down by means of a knurled screw. The solenoid action of the welding transformer on this core furnishes the welding pressure on the bottom electrode, and by this scheme the pressure is made to follow the current wave form. The initial contact pressure to clamp the piece being welded is furnished by a spring shown in Fig. 2. In this model the forging pressure is of the order of a maximum of 100 lb.

An interesting feature is that due to the disposition of the two electrodes and the manner in which they are connected to the welding transformer's secondary by flexible copper cables, there is no magnetic force tending to separate the electrodes such as exists in the type of welder having heavy current carrying parallel conductors.

The short heating cycle of this welder permits concentration of the welding energy at the spot desired with very little dissipation of heat in surrounding material and thus, some materials are welded more easily with less distortion, deformation, discoloration or crystal growth and longer life of the electrode. With this welder it has been found possible to weld small wires of many different materials, light gage aluminum sheet .006 in. thick, .020 in. nickel wire to .005 in. nickel sheet, bonderized steel, copper to copper, and tungsten to tungsten wires and various combinations of these metals.

CATHODE-FOLLOWER

(*Continued from page* 78)

Curves of Max. E_{in}/E_{bo} vs. r_b/r_p for triodes are shown in Fig. 10 for various values of μ. Fig. 10 shows that large values of input voltage can be used if μ is low and r_b/r_p is high. Since, as already pointed out, low r_b is desirable in order to minimize capacitance effects, high r_b/r_p requires low r_p, which is also obtained in low-mu tubes. The 6J5 tube, used with a 10,000-ohm load resistance, can handle a crest input voltage equal to approximately 0.6 E_{bo}. It can be seen from Fig. 10 that a tube with higher μ, such as the 6SF5, gives very little increase in allowable input voltage. The tube with higher mu has the disadvantage, moreover, of requiring a much larger load resistance.

8—Impedance-matching

When a cathode-follower ampli-

(*Continued on page* 174)

SYLVANIA NEWS

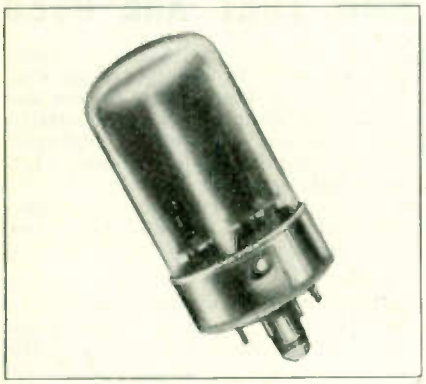
ELECTRONIC EQUIPMENT EDITION

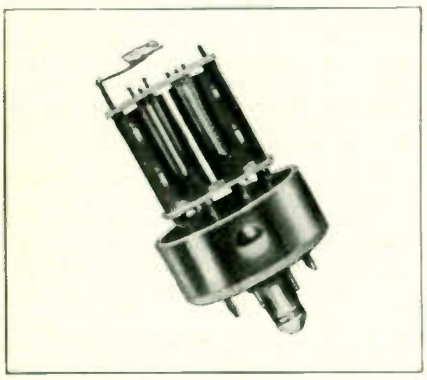
JULY *Published by* SYLVANIA ELECTRIC PRODUCTS INC., Emporium, Pa. 1945

NEW TUBE HAS SEPARATE CATHODES

Construction Permits Use As A Discriminator

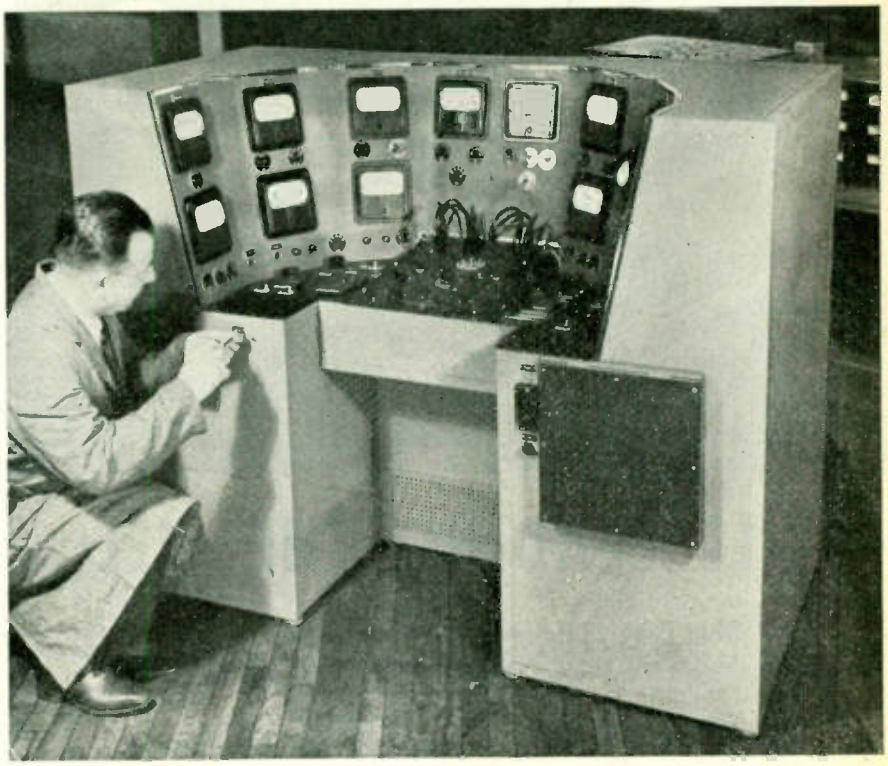
Sylvania Type 7K7 is a duo-diode high-mu triode differing from the usual diode-triode by having two separate cathodes, one for the triode and the other for the diodes.





This difference permits the tube to be used as a discriminator.

The cut-away view shows that although the construction looks like a duo-triode the second plate is really a shield around the two diodes.



SYLVANIA RADIO TUBE BRIDGE SET INSURES PERFECT PERFORMANCE

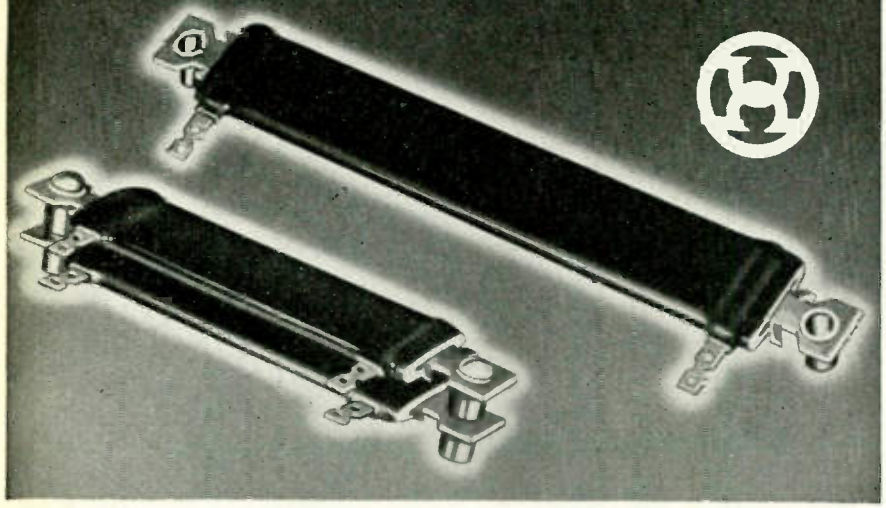
Measures Static And Dynamic Characteristics Of Vacuum Tubes

As ultra-high frequencies and a very wide range of intricate electronic applications make strict demands on tube performance and circuit designs, an accurate testing of tube and circuit characteristics becomes of the greatest importance.

One of Sylvania Electric's latest essential radio vacuum tube bridge test sets for precision engineering data is pictured above. Manufactured at Sylvania's plant at Williamsport, Pa., this equipment measures static and dynamic qualities of radio tubes, such as plate current, filament voltage and current, screen current, gas current, plate resistance, power output, mutual conductance, and amplification factor, as well as the characteristics of electronic devices.

The set is compact, fully shielded, with well-filtered, self-contained power supplies, complete with voltage regulators except AC and DC filament voltages.

HARDWICK, HINDLE



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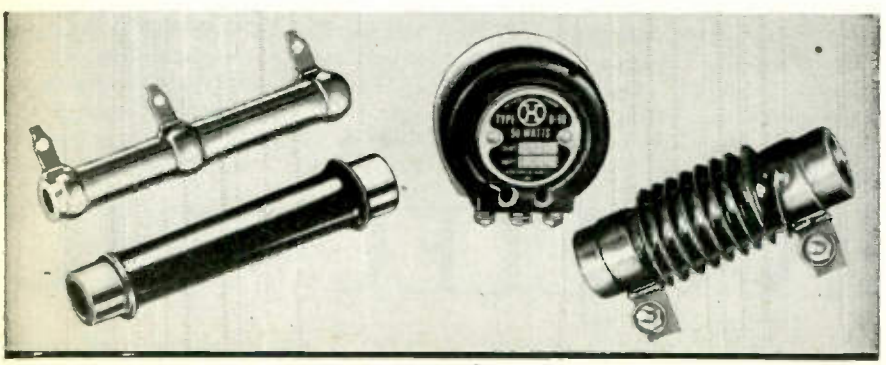

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Obviously, we have had to postpone our booklet. However, as soon as official release can be obtained to describe the many fascinating applications of our products, we *will* publish our booklet, a copy of which will be yours for the asking.

In the meantime, we will welcome descriptions of uses of fractional horsepower motors and generators, if they can be released, and will be delighted to place your name on our mailing list for "Fractional H.P. Motors and Generators . . . and How They Are Used" when we are able to publish it.

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2044 A.D.

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CATHODE-FOLLOWER

(*Continued from page* 170)

fier is used in impedance matching, the load resistor r need be used only if the external load does not provide a path for the direct plate current. The admittance of the external load must then be equal to the resultant admittance of the tube and r. Often, however, the effective output impedance of the tube is so small in comparison with r that the external load is nearly matched when its admittance is equal to the tube admittance, as given by Eq. 10. Hence

$$r_L/r_p = 1/(1+\mu) \qquad (13)$$

where z_L is the impedance of the external load.

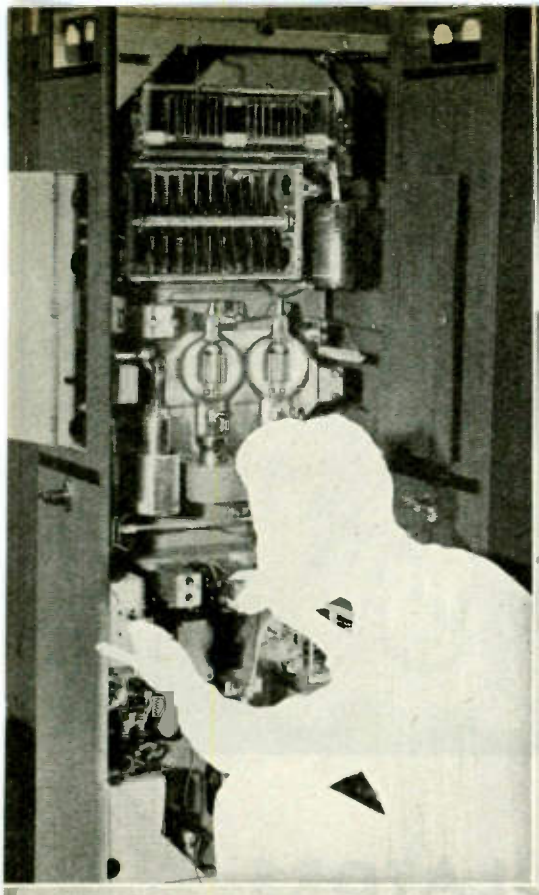
The dashed lines in Figs. 3, 9, and 10 show values that satisfy this relation when the load is non-reactive. It can be seen from Fig. 10 that, except at very low μ, the ratio of load resistance to plate resistance and the allowable grid swing are both very low. Fig. 9 shows that the reduction of non-linear distortion resulting from inverse feedback is also small. Non-linear distortion may, therefore, be excessive unless the input amplitude is very low.

Although the crest input voltage that may be impressed without grid overloading may be made of the order of one-fourth the plate supply voltage by the use of a high - transconductance, low - mu tube, such as the 2A3, the non-linear distortion resulting from low ratio of load impedance to plate resistance may still be large unless the input amplitude is small in comparison with this value. This may present a problem if the source cannot be shunted with a voltage divider.

The problem may sometimes be solved by the use of two cathode-follower stages in succession. The first stage uses a tube that can handle a large input voltage, such as the 6J5. The second stage, which uses a high-transconductance tube, is matched to the load, the input voltage to this stage being adjusted to a sufficiently low value by means of an adjustable tap on the load resistor of the first stage.

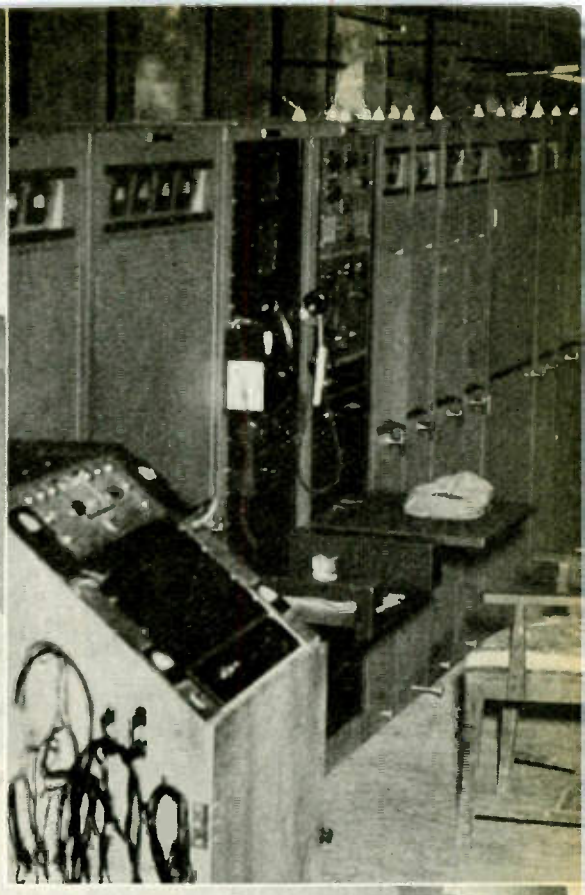
The low allowable grid excitation of a cathode-follower matching stage imposes a limitation upon the power and current that can be delivered to the load. This disadvantage is not avoided by the use of the two-stage circuit, since the first stage merely makes possible the reduction of excitation of the matching stage without the use of a voltage divider across the input source.

(*Continued on page* 178)



AACS Domestic Station showing a pair of Eimac 450-T tubes

AACS Ground Station China-Burma-India Theatre

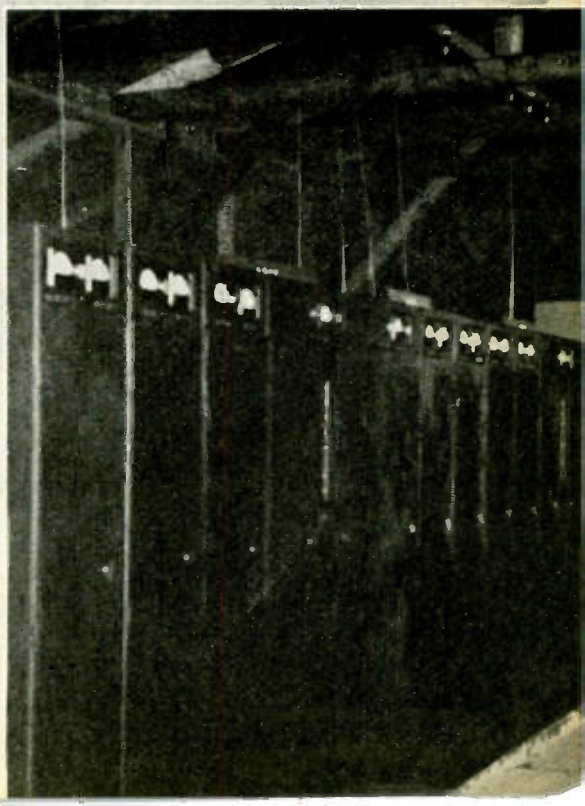


AACS* BLAZES THE TRAIL FOR SAFE FUTURE WORLD AIR TRANSPORTATION

World-wide aviation communications are an established fact today. Almost overnight a great radio network has been created. The actual physical difficulties involved were great enough, to say nothing of the variety of extreme operating conditions encountered and overcome. Needless to say, the equipment employed must be dependable, both from a standpoint of construction and performance capability.

The establishment of radio ground stations on every continent and in fifty-two different countries...overcoming the widest extremes in operating and climatic conditions (from 40 degrees below zero to 140 degrees above)...stations in jungles ...in deserts...in mountains and towns...and to have these stations constantly operating at near peak levels is a tribute to the equipment employed. On this page are shown three AACS Stations located at widely separated spots on the globe.

AACS Station on an island in South Pacific



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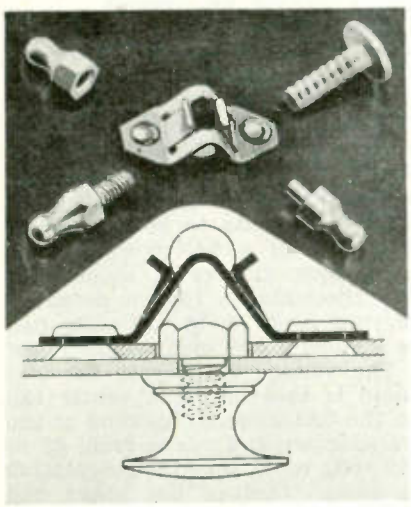
PM Driver Units

University Laboratories, 225 Varick St., N. Y. 14, is producing permanent magnet driver units with molded diaphragm flexing surfaces, heatproof voice coil suspensions, and hermetically sealed dust covers. Rim centering of voice coil assembly in the magnetic gap, instead of the use of aligning pins, results in permanent positioning of the voice coil assembly, which permits a smaller magnetic gap opening, and results in an increase in magnetic flux density in the gap. Rating is 25 watts, impedance 15 ohms, frequency 100 to 6000 cycles.



Spring Steel Latch

A new spring steel speed nut latch No. 1663 has been developed for instant attachment and removal of box covers, access doors, panels and inspection plates. The spring arms of the speed nut snap over ball or grooved studs to provide firm attachment, yet studs may be quickly withdrawn. The nut is available in five material thicknesses to provide the desired degree of pull-out tension. Three styles of ball studs are available—drilled and tapped for 6-32 screws, threaded shank (6-32 thread) and plain shank for riveting. These, as well as the grooved stud, are provided in various lengths to suit application requirements. Manufactured by Tinnerman Products, Inc., 2111 Fulton Road, Cleveland 13, O.

Soldering Iron

The Hexacon Electric Co., 157 W. Clay Ave., Roselle Park, N. J. is producing soldering irons for battery operation in 100 or 200 w sizes, wound for 12 or 24 v, with 6 ft. or 12 ft. cords, and the conventional plug cap or battery clips. They are equipped with scale-resistant element cores.

CATHODE-FOLLOWER

(*Continued from page* 174)

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REMOTE CONTROL TUNING

(*Continued from page* 79)

to the remote control panel provided its impedance does not exceed 3,000 ohms.

Remote control of the solenoid voltage is obtained by means of a simplex arrangement, consisting of a connection to a center tap on the line side of the receiver-to-line and the control panel-to-line transformers. The return for this circuit is through the ground.

The remote control panel box contains a power supply. Raw 235 volt dc from a 5U4G full wave rectifier is dropped to 150 volts by 2,000 ohm resistors and held there by a pair of VR150 regulator tubes (see Fig. 5). Series 600 ohm resistors connected to the 150 volt point permit 135 volts to be applied to the plate of a 6A3 power triode. This same voltage is divided by two rheostats so that a potential varying from 85 to 130 volts can be applied to the grid of the triode.

The voltage to operate the solenoid is taken from a center tap on the 6A3 filament winding of the transformer and varies from 85 to 120 volts when the grid potential is changed. One of the above two rheostats is adjusted by knob C (see Fig. 1), and controls the tuning, whereas the other is adjusted by knob B and changes the total voltage range through which C can be changed in order to adapt it either to high or low frequencies. Under these conditions the grid voltage is from zero to 10 volts positive with respect to the filament and the line current is from 38 to 50 milliamperes.

Of course, detuning of the oscillator section of the receiver has an adverse effect on the sensitivity as shown in Fig. 4, but in practice this has not been found objectionable.

PROJECTILE SPEEDS

(*Continued from page* 85)

negative pulses are generated by this circuit as are fed into it.

Consider now four of these circuits connected together as shown in Fig. 12. The first negative pulse

(*Continued on page* 182)

THE CORRECT ANSWER TO YOUR RECTIFIER PROBLEM IS HERE

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Selecting the rectifier best suited for a particular d-c application is not a decision that can be made on a "guess" basis. Construction, basic materials, operating characteristics, weight, size, cost and life expectancy are all factors that should be considered.

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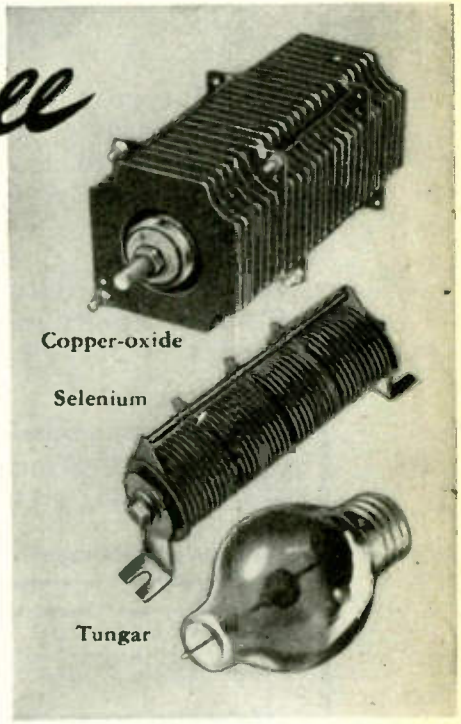
When blueprints call for rectifiers choose the correct size and type from the G-E line. If you're not sure of what is best for your need let G-E engineers help you. Years of experience qualify them to recommend the rectifier which will give you the most economical, most efficient and most reliable performance. Whether they recommend copper-oxide, selenium or Tungar you can be sure their selection is impartial because G.E. offers all three.

For more information write to Section A754-124, Appliance and Merchandise Dept., General Electric Co., Bridgeport, Conn.



Hear the General Electric radio programs: "The G-E All Girl Orchestra" Sunday 10 p.m. EWT, NBC. "The World Today" news every weekday 6:45 p.m. EWT, CBS. "The G-E House Party" Monday through Friday 4:00 p.m. EWT, CBS.

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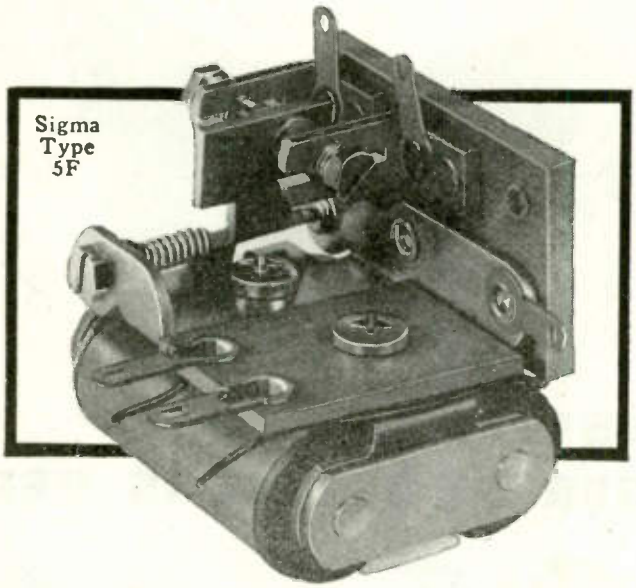

Sigma type 5 relays, with a maximum sensitivity of less than 1 milliwatt, have an ability to stand punishment equalled by very few relays of *any* type.

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A Type 5 relay of 10,000 ohm coil resistance has the following performance:—

Nominal Adjustment		Contact Pressure	
Pull on	Drop out	Normally open	Normally closed
0.3 Ma	0.2 Ma	15 grams	10 grams
0.7 Ma	0.3 Ma	45*-55* grams	20 -30* grams
1.5 Ma	0.7 Ma	60*-80* grams	40*-60* grams

*Adequate for aircraft vibration (10 g's or more)

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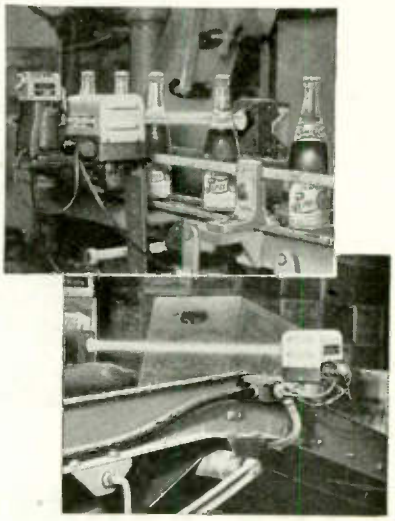

In the field of counting mass-produced articles Electronic devices insure the utmost accuracy, reliability, and economy. In the business of bottling, where profits are a fraction of a penny on each unit, the system devised by the Durant Manufacturing Company maintains a stock count at all times from the initial bottling process through a count of the cases as they leave the factory for shipment. This is only one of the many ways in which United Cinephone Electronic Controls are used in modern production; a necessity in the forthcoming postwar era of highly competitive business.

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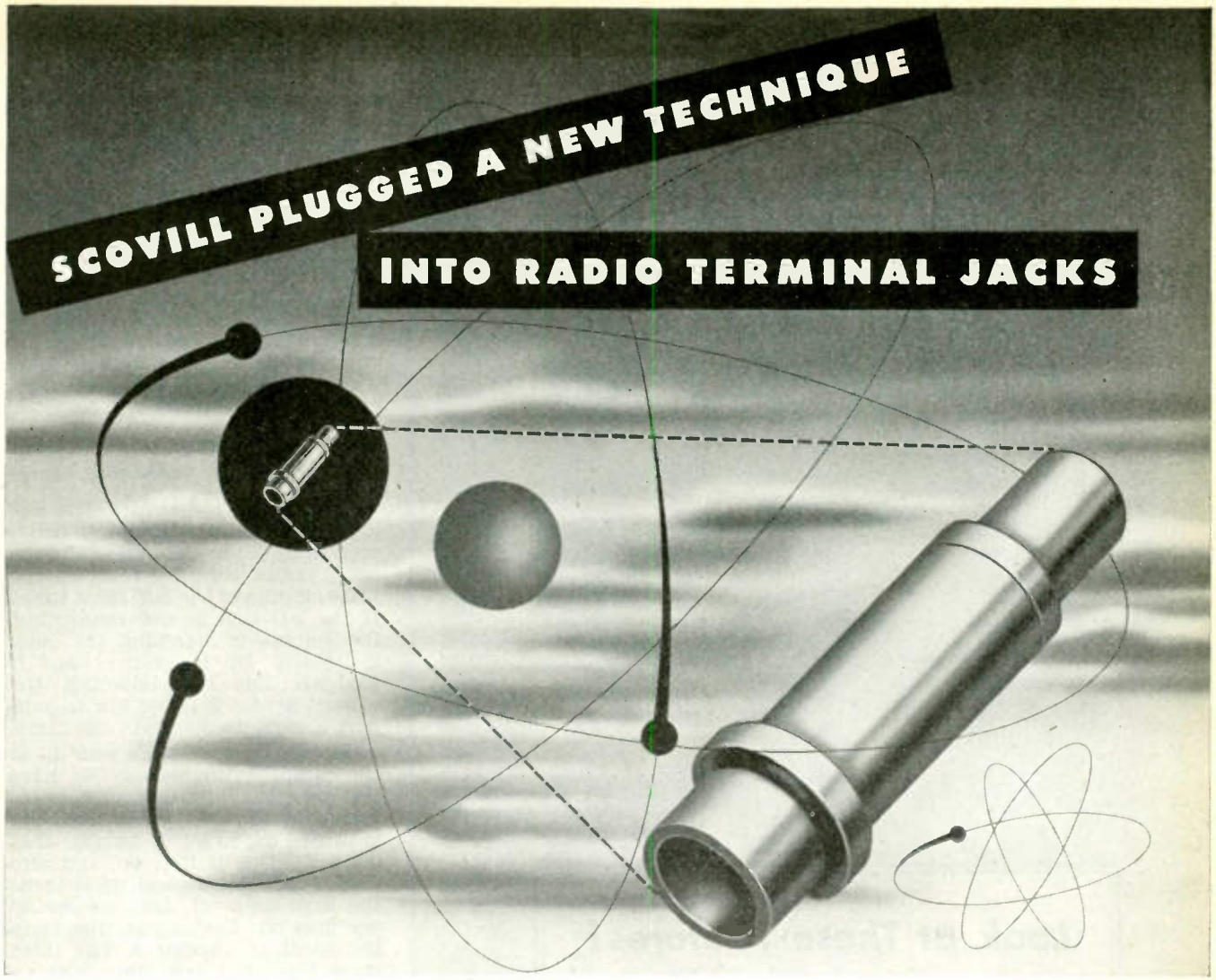

. . . *and disconnected a tie-up*

Terminal jacks for war-needed radios — screw-machined from rod stock — were lagging behind other parts. Expediters called on Scovill to break the bottleneck.

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PROJECTILE SPEEDS

(*Continued from page* 178)

at the input produces a reversal of the first stage, and at the same time, an ineffectual positive pulse is delivered to the second stage. The second negative pulse brings the first stage back to its initial condition, and a negative pulse is delivered to the second stage, causing a reversal there. The third pulse reverses the first stage without affecting the second; the fourth restores first and second stages to their intial condition and delivers a negative pulse to the third stage, causing it to reverse, and so forth.

Indicator lamps

The state of the circuit after any number of pulses has been delivered to it can be determined by the neon lamps connected across the plate circuits of the left-hand tubes. If the left tube is non-conducting, the voltage is high and the lamp is lighted. On the other hand if the left side is conducting, the voltage across it is too low to support a glow discharge in the lamp.

Suppose now we start with all of the lamps extinguished. We have just seen that the first state is reversed by the first pulse. Its lamp is turned on, so let us number that lamp 1 — One if it is on, and zero if it is off. The second pulse turns the first lamp off, and the second one goes on. Let us give that lamp the cardinal number 2. The third pulse turns the first lamp back on again without affecting the second lamp. $2 + 1 = 3$. The third lamp is turned on by the fourth pulse while the first two are extinguished. That lamp should have the cardinal number 4. The fifth pulse turns on the first lamp again. $4 + 1 = 5$. The sixth pulse turns on the second lamp and extinguishes the first without further affecting the third lamp. $4 + 2 = 6$. The seventh pulse leaves 1, 2, and 4 on. The eighth turns on the fourth lamp, to which the cardinal number 8 must be assigned, and extinguishes 1, 2, and 4.

The ninth pulse turns on the first, giving $8 + 1$, and the tenth would turn on the second lamp and extinguish the first were it not for two little condensers shown in Fig. 12, one of which sends a negative pulse from the second stage to the eighth which turns it off, and the other sends a positive pulse from the eighth stage back to the second which counteracts the negative pulse generated there by the extinction of the first stage and prevents it from going on.

Thus, the tenth pulse restores the circuit to zero, and it is ready to begin over again on the eleventh pulse. At the same time, a nega-

(*Continued on page* 186)

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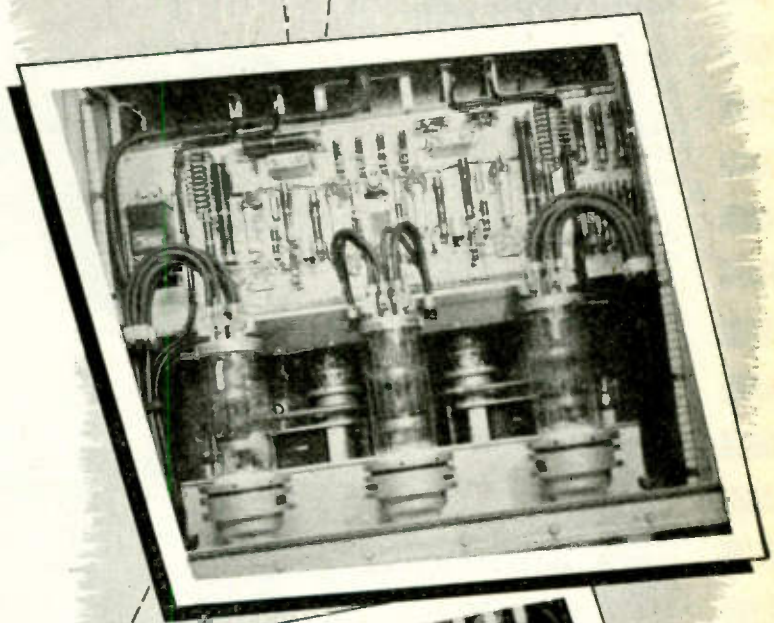

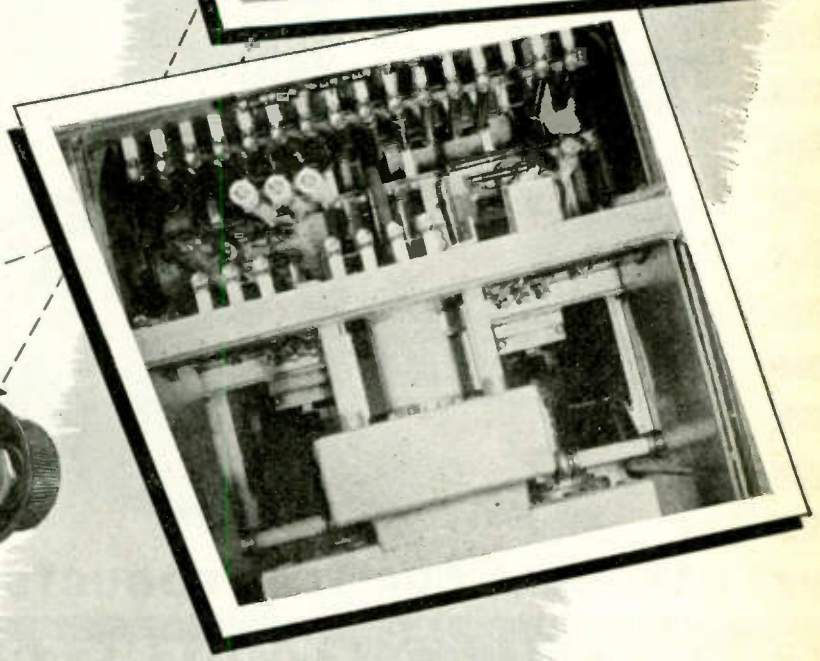

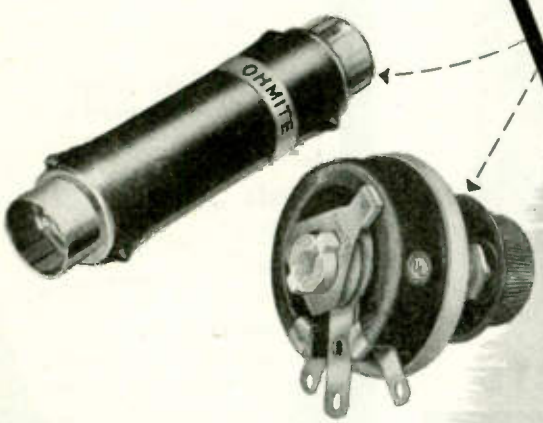

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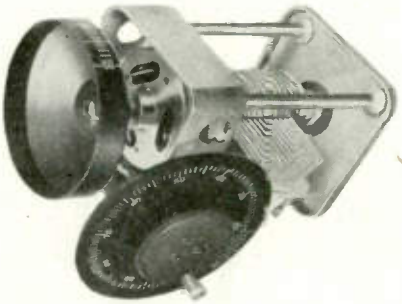
PRECISION CAPACITORS *by* CARDWELL

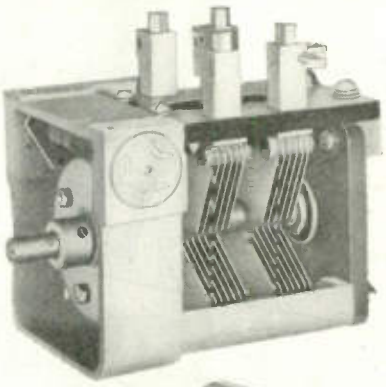
An outstanding Cardwell wartime achievement is the development of precision worm drive capacitors, of maximum stability and resettability, for use in various types of frequency meters.

Although not standard catalog items, the three types illustrated are typical of the possible variations of this general design which is widely used in Cardwell instruments built for the Army and Navy. Perhaps one of them is the answer to your design needs for an S.L.F. type precision capacitor of highest quality.



PART No. 4.080
21-220 mmfd.;
airgap .030"

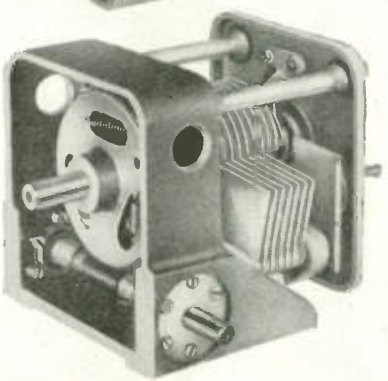
As used in S. C. Frequency Meter covering range of 125-20,000 KC, 125-250 KC low band fundamental, 2 MC-4 MC high band fundamental.



PART No. 4.400
8-130 mmfd. per section;
airgap .020"

Used in ATSC Frequency Meter covering fundamental range of 85-200 MC and to 1000 MC harmonically.

Four studs support special trimmer and compensator capacitors which are not shown.



PART No. 4.200
15-125 mmfd.;
airgap .027"

In another ATSC Frequency Meter, this condenser tunes the oscillator over fundamental range of 20-40 MC and to 250 MC harmonically. Has adjustable compensator and trimmer.

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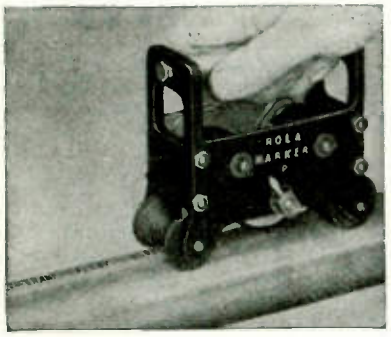
A new Megatherm with a nominal output of 1 kw, for high-frequency heating of dielectric materials, has been developed by the Industrial Electronics Division of Federal Telephone and Radio Corp., 67 Broad St., N. Y. A foot switch opens the oven door, leaving the operator's hands free to insert the work in the oven. Application of power to the work is controlled by a single or double push-button located on either side of the cabinet. Duration of the heating cycle is controlled by an automatic timer. The flexible output circuit permits processing of a wide range of load weights, heights and materials. The unit is equipped with a cord and plug for use at any 220-volt, single-phase 60-cycle ac outlet, and supplies 3500 BTU per hour at its operating frequency of 27 megacycles. Other frequency ranges are available for special purposes, and where necessary, the equipment can be provided for use with other power supply systems. Total power taken from the line is 2 KVA, with an overall efficiency of 55 per cent and a power factor in excess of 90 per cent.



Tubing Marker

This new marking assembly is used for marking round tubes, bars, pipes, rods, etc., with a repeated impression. The die cylinder is preceded and followed by "V" rollers for guiding the impression to the top of the round metal piece. For changes in diameter there is a simple adjustment by wing nut. One model covers the range of diameter variations from ⅜ to 2 in.; another from ¾ to 3 in. Permanent dies, interchangeable complete dies or parts of dies or interchangeable individual type pieces may be used in the die cylinder as the imprinting medium. Maker is Adolph Gottscho, Inc., 190 Duane St., New York.

PROJECTILE SPEEDS

(*Continued from page* 182)

tive pulse goes out on the output line and can be used to feed a second circuit constituting the next decade; it, in turn, feeds a third and then a fourth decade. Four such decades have a capacity of ten thousand counts and when pulsed from a 100 kc oscillator, can measure time up to 1/10 sec. The time so recorded is accurate to 1/100,000 sec.

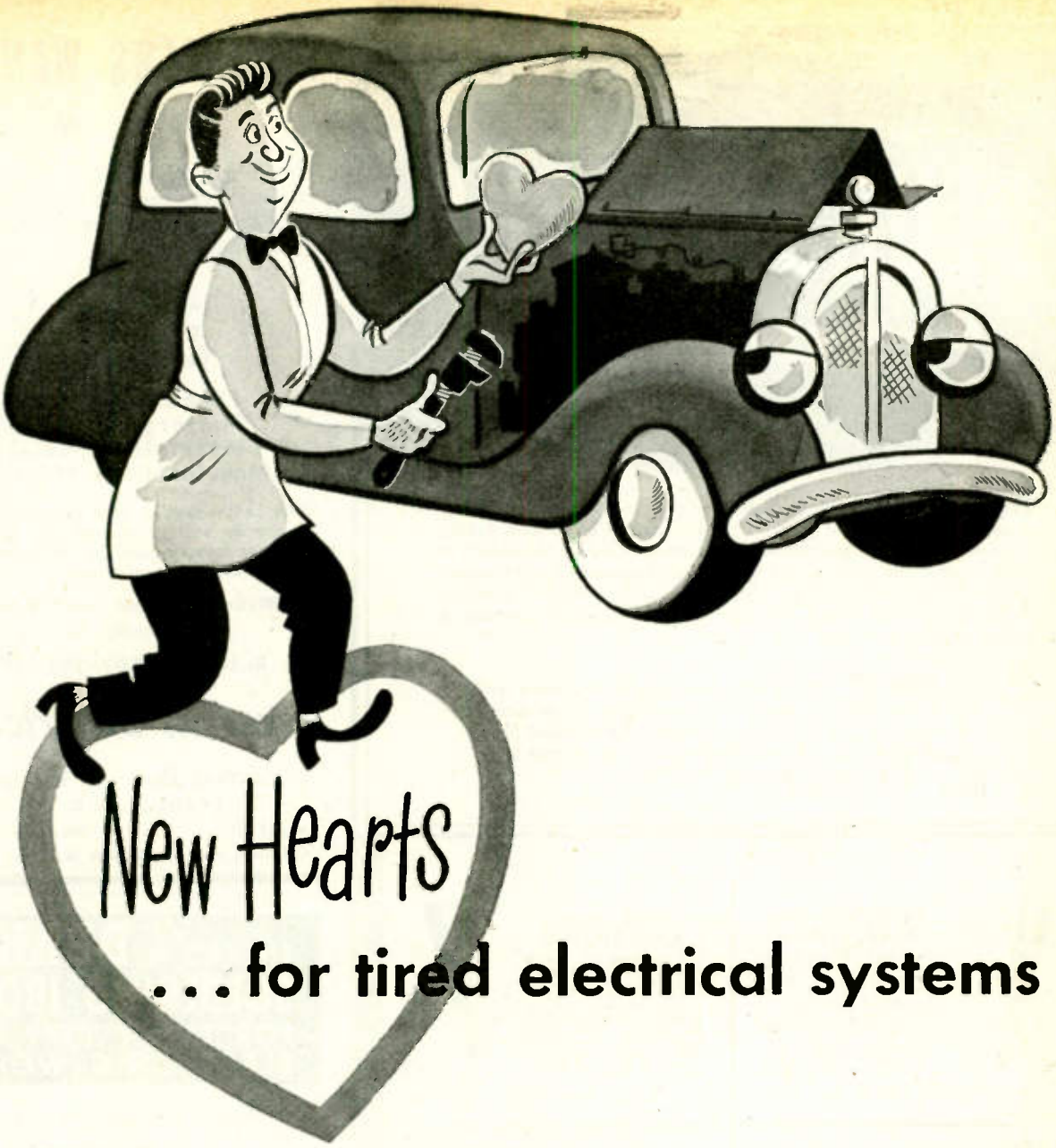
Fig. 13 shows a small portable model of the counter chronoscope which has been designed for field use in connection with the telephoto screens already described. This type of equipment is used to a large extent by ballistic and technical service teams which have been trained at the Ballistic Research Laboratory and are now operating in the theaters of combat, where they keep a constant check on the condition of our guns and the quality of the ammunition. Not only have these men made significant contributions to the accuracy of our gun fire but they have also saved millions of dollars of ammunition which may have been improperly stored and would have been thrown away as too inaccurate for use without their calibrations. They have also added hundreds of rounds to the useful life of our guns by determining just when the gun tubes have reached the end of their accuracy life.

Chronoscopes of the same type, but geared to count at a higher frequency, are used for more accurate time measurements in the aerodynamic range at the Ballistics Research Laboratory. The unit shown in Fig. 14 combines six chronoscopes which measure the time in units of 1/1,600,000 sec., for determining the changes in velocity as the projectile moves down the range and is slowed down by air resistance.

From measurements of this type, the best shape of the projectile can be determined, and the exact behavior of all types of projectiles studied down to the last detail. The exact position of the projectile, as well as its aspect or yaw angle, is determined at the beginning and end of each measured time interval by spark photographs of the type already shown. At 3200 ft. per sec., the projectile moves less than 1/32 in. during one unit of time, and with this technic, the velocity can be determined to one part in 10,000 by measuring the time of flight over a path length of 20 ft.

Each different type of weapon presents its own special problems in velocity measurements. Facility in taking the measurements and reducing the results is important, but frequently it is necessary to resort to the motion picture camera

(*Continued on page* 190)



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General Products coils are good coils—fully up to their tough jobs. That's why we at Wheeler Insulated Wire Company are proud to supply the coil windings that go into them.

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Built in accordance with latest Signal Corps and Navy specifications, Amalgamated Plugs and Jacks are tropicalized to make them fungus resistant, waterproof and moistureproof when called for. Insulators of these components are designed to withstand extremes of temperatures for −67°F to +167°F, at humidities up to 100%. We also specialize in producing Plugs which will bear up under the high heat met in rubber molding cord sets.

NOTE: Amalgamated Engineers will gladly consult with you on the design and development of Plugs and Jacks for special applications — present or postwar.

PLUG PL-55 and N.A.F. 1136-1

Long sleeve, two-conductor plug, mate to Jack JK-34-A. Withstands minimum of 60 cycles AC, potential of 500 volts effective, applied between any two terminals for not less than two seconds. Meets minimum insulation value of 2000 megohms between conductors at 68°F at humidities up to 100%.

JACK JK-26, N.A.F. 215284-2

Two-conductor Jack, mate to PL-54. Tropicalized. Withstands 60 cycle AC potential of 500 volts effective, applied between any two terminals for not less than two seconds. Meets minimum insulation value of 2000 megohms between conductors at 68°F, at humidities up to 100%.

PLUG, STYLE "A"

Two-conductor, special type plug for use with Neoprene or Buna S molded cords. Same specifications as PL-55.

JACK JK-48

Light duty, two-conductor Jack, mate to Plug PL-291 and Plug 291-A.

PLUG PL-204

Hand set. A special plug wherein both a modified plug, PL-55 and PL-68, are held in place by a phenolic case. Same specifications as PL-55 and PL-68.

PLUG PL-54, PL-540, PL-354, N.A.F. 215285-2

Short sleeve, two-conductor plug, mate to Jack JK-26. Same specifications as PL-55.

PLUG, STYLE "D"

Two-conductor, special type plug for use with Neoprene or Buna S molded cords. Same specifications as PL-55.

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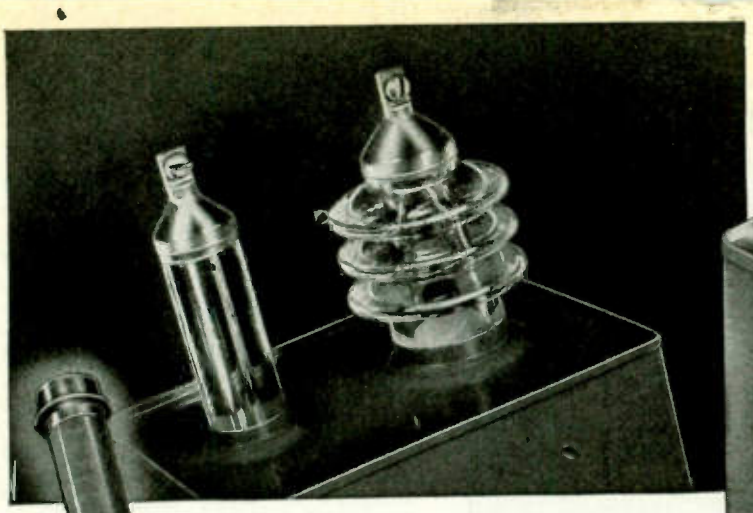
DRAKE ELECTRIC WORKS, INC.
3656 LINCOLN AVE. CHICAGO, ILL.



GLASS-TO-METAL SEALS

The old problem of protecting various capacitor and resistor types against leaks and moisture is solved by a unique glass-to-metal seal pioneered and perfected by Sprague. Glass capacitor bushings are sealed direct to the metal container and do not require adjacent metal rings with "matched" coefficients of expansion. On Sprague *KOOLOHM Resistors, the units are encased in glass tubes which are sealed directly to the metal ends. The resulting seals are leak-proof, shock-proof, humidity-proof, and fungus-proof.

*VITAMIN Q

HIGH-VOLTAGE, HIGH-TEMPERATURE PROBLEMS SOLVED

When you've got both high voltage and high temperature to contend with in a capacitor application—well, ordinarily, you'd have a problem on your hands. Once again, however, Sprague engineering supplies the answer. Although extremely compact, Sprague Capacitors impregnated with *VITAMIN Q operate satisfactorily at thousands of volts at ambients as high as 105° C. Insulation resistance at room temperature is more than 20,000 megohms per microfarad — *or at least five times better than previous types!*

ARMY E NAVY

A Step Ahead!

Sprague engineering progressiveness is no better exemplified than by the three outstanding achievements depicted here. And remember, such developments are only the high spots! Equally important is the fact that similar, if less startling, engineering superiority is evidenced in every one of the hundreds of Sprague Capacitor and *Koolohm Resistor types that are regularly produced. Even small points of departure from the conventional often make a startling improvement in results—and no type or design produced by Sprague is so humble as to fail to receive regular engineering attention in a constant effort to surpass for Tomorrow that which is "best" Today.

SPRAGUE ELECTRIC COMPANY
North Adams, Mass.

SPRAGUE

PIONEERS OF RADIO-ELECTRONIC PROGRESS

PERMITS 200° C. CONTINUOUS OPERATION

Many types of electrical equipment can now be designed for 200° C. continuous operation, thanks to the Sprague wartime development of *CEROC 200, a flexible ceramic (inorganic) insulation for copper, nickel, and other types of wire. Smaller equipment can be designed to do bigger jobs. *CEROC 200 dissipates heat rapidly and has an extremely good space factor. You'll be hearing a lot about *CEROC 200 in days to come!

**Trademarks Reg. U. S. Pat. Off.*

PROJECTILE SPEEDS

(*Continued from page* 186)

with subsequent careful measurement of the film. This technic, which is well known in horse racing also, involves placing a clock where it may be photographed on the same frame. Ground markers are required for reference in correlating the positions on successive frames, and a second camera taking pictures from another angle is required to reduce the directions to absolute distances. The clock dials for the two cameras must of course be synchronized.

A refinement of this technic is realized in the ribbon frame camera designed by Kapp and Bowen of the California Institute of Technology. Fig. 15 shows a series of pictures taken with one of these cameras in connection with velocity measurements of rockets fired from airplanes. By special adjustments on the camera, the ribbon shaped frame of the camera is lined up with the trajectory, and successive frames show the progressive change in position of the projectile. With this camera 180 frames per sec. are taken each with an exposure of 1/3000 sec. The mechanism is shown in Fig. 16. A large drum which rotates at 30 rps. carries six narrow slits which constitute focal plane shutters. Inside this drum is film winding mechanism which transports the film at the right speed to separate one exposure from the next.

PHONOGRAPH DYNAMICS

(*Continued from page* 128)

magnetic armature, etc.

While this analysis contains a great deal of material which is well known to those engaged in phonograph work, it does attempt, however, to draw attention to the importance of the acceleration limitation in reproducing records, and suggests that it would be very desirable to monitor the acceleration when recording. Measurements on commercial pressings show accelerations in the order of 2000 g. This, of course, includes the accelerations due to tracing discontinuities as well as the recorded wave acceleration, as the means of separating the two are not immediately apparent. Accelerations of this order, however, have been observed near the outside of 12 in. records, where the tracing distortion should theoretically represent a small part of the measurement.

AUTOMATIC RIVETER

(*Continued from page* 115)

contacts T-1 opens.

(27) Opening contacts T-1 deenergizes relay X.

(28) Opening contacts X-2 deenergizes relay A. (NOTE: Contacts X-1 closes in accordance with the

(*Continued on page* 194)

NATIONAL RECEIVERS ARE THE EARS OF THE FLEET

OFFICIAL U. S. NAVY PHOTOGRAPH

MOVING IN ON PELELIU

A flotilla of rocket-firing LCI's, out in the foreground clouded in rocket smoke, have smothered the Jap beach defenses. Cannon firing "Alligator" tanks plow through calm water, to blast the way for assault troops. This is D-day on Peleliu, and the Americans have come to stay.

Three out of four of the Navy's ships — landing craft or larger — are equipped with receivers designed by National.

HRO

NC-200

NATIONAL COMPANY

MALDEN MASS, U. S. A.

NATIONAL RECEIVERS ARE IN SERVICE THROUGHOUT THE WORLD

Here's why SPERTI HERMETIC SEALS are A "MUST" IN THE TROPICALIZATION OF ELECTRONIC MILITARY EQUIPMENT

1. **EFFECTIVELY SEAL OUT DUST,** sand, salt spray, fumes, fungus, injurious atmosphere.

2. **GLASS PATH WILL NOT CARBONIZE.** Have wide thermal operating range and high insulation leakage resistance.

3. **SPECIAL PROCESS** insures maximum acceptability to solder. Simple and easy to attach.

Sperti Hermetic Seals have been an important factor in increasing the life expectancy and usefulness of vital military equipment of many kinds. Write, today. Outline your problems. Let us show you how Sperti Hermetic Seals can help you solve them.

THE HELP YOU'VE BEEN LOOKING FOR!

Now available. Skilled assembly service for soldering terminals into cover plates. Send drawings and specifications for quick quotation. For full information, phone, wire or write.

Sperti INCORPORATED
Cincinnati, Ohio

SPERTI ELECTRONICS

RESEARCH • DEVELOPMENT • MANUFACTURING

JONES 2400 SERIES PLUGS and SOCKETS

P-2406-CCT

S-2406-SB

A new series of Plugs and Sockets designed for highest electrical and mechanical efficiency. Improved Socket Contacts provide 4 individual flexing surfaces which make positive contact over practically their entire length.

The Contacts on both Plugs and Sockets are mounted in recessed pockets greatly increasing leakage distance, increasing voltage rating. Molded BM 120 Bakelite insulation. Plug and Socket contacts are silver plated. The finished appearance of this series will add considerably to your equipment.

The 2400 Series are interchangeable with all units of the corresponding No. 400 Series.

Send today for general catalog No. 14 listing and illustrating our complete line of Plugs, Sockets and Terminal Strips.

HOWARD B. JONES COMPANY
2460 W. GEORGE ST. CHICAGO 18

for dimensional accuracy!

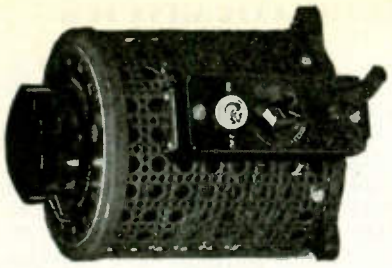
METAL STAMPINGS

DKE

Specialized DKE experience — over 20 years in the field—is now available for the production of stamped metal parts. All types of cups, sleeves, flanged shapes, intricate single pieces or fabricated components are included. High quality workmanship to exacting specifications—with any desired finish — is embodied in every job.

INQUIRIES INVITED

THE ENGINEERING CO.
DANIEL KONDAKJIAN
27[t] WRIGHT ST., NEWARK, N. J.



Variable Transformer

For voltage control of small power applications in the 1 kva range, Superior Electric Co., of Bristol, Conn., has added the 116 and 216 models to its standard line of Powerstat variable transformers. These new units are smaller adaptations of other single phase units but have an extra large aluminum brush heat radiator and a new type brush pressure adjustment spring to assure a low brush temperature rise and reduced probability of damage from overloads. Due to an improved core and coil design and use of all aluminum mechanical construction, types 116 and 216 are compact and light in weight but have high continuous current rating per pound. Both are available cased or uncased for rear of panel or table mounting. The cased units have a protective screening and totally enclosed terminal box with input cord and plug, an outlet, and an "on-off" switch. Uncased models are less screen and terminal box. A terminal strip is provided with eyelets for either screw or solder connection. Although the 116 model operates on a single phase 115 volt input and the 216 type is designed for single phase 230 volt operation, any desirable combination of series, parallel, or polyphase connection can be supplied.

Tube Tester

A new tube tester is being manufactured by Superior Instruments Co., 227 Fulton St., New York 7, N. Y. It tests all tubes up to 117 volts, including Bantam junior, hearing aid, thyratrons, single ended, floating filament, etc. Detects shorts and leakages up to 3 megohms. Works on 90 to 125 volts, 60 cycle ac.

Vacuum Indicator

A new type vacuum indicator has been developed by the Continental Electric Co., Geneva, Ill., that may be operated from a 110-120 volt ac outlet. It is scaled to read pressures of a vacuum system from .25 to 250 microns, and is accurate to plus or minus 2 per cent throughout the scale, with constant voltage. Meter may be read from a distance if desired. Gage is unaffected by changes in barometric pressure.

AUTOMATIC RIVETER

(*Continued from page* 190)

explanation given for operation No. 31.)

(29) Opening contacts A-2 de-energizes relay Y.

(30) Opening contacts Y-2 connects the timer circuit.

(31) Returning to operation No. 28: Closing contacts X-1 energizes relay P, thus returning the unit to the condition that existed at the beginning of operation No. 1, when relay P was energized by closing the foot switch.

This sequence of operations will be repeated as long as the foot and repeat switches remain closed. The speed of the operations depends upon the setting of the potentiometer which controls the timer charge and discharge rates.

Time studies have revealed that with manual controls a single Erco 2002 riveter can handle only about 10 normal airplane panels in an eight-hour day. With the Mandel sequence control unit, the same machine will turn out approximately 12½ normal airplane panels in an eight-hour day.

DOUBLE-STUB LENGTHS

(*Continued from page* 96)

has a radius of $1/(R+1)$. The centers of the X or B circles lie on a vertical line through the intersection of the horizontal center line and the $Q = \infty$ circle at a distance of $\pm 1/X$ from this center line and the radius of each equals $1/X$. The mathematical derivation of these equations has been shown elsewhere by the author.[2]

[1] "Transmission Line Impedance Matching Chart" (single stubs), Robert C. Paine, Radio, p. 34, Feb., '45.
[2] "Transmission Line Calculator," Robert C. Paine, Electronics, p. 140, March, '45.

MEASUREMENT TECHNIC

(*Continued from page* 93)

continuously. No recordings are planned on the harmonics of any FM broadcasting station.

Chart Analysis

The charts are to be analyzed currently at the recording site. The method of analyses for sporadic E and other long distance signals, which will occur at distances beyond 400 miles (Laurel is also to analyze sporadic E signals from WGTR in this manner) is to determine the minutes of occurrence of fields of certain selected intensities and to block them in on the proper Occurrence Sheet, a sample of which is reproduced. The selected field intensities are to be standard at all recording points and are to be taken in steps of 0.5, 1.5, 5, 15, 50, 150, 500, etc., μv/m throughout the range of the recorded signals.

(*Continued on page* 198)

PURE
Apple-polishing

We appreciate that anything we say about ourselves is liable to be a little bit prejudiced. However, in this case it's the gospel truth. The war switched us temporarily from the steel office furniture business into the manufacture of electronic equipment. But even the war couldn't change the old Corry-Jamestown custom of doing a quality job.

The electronic equipment we have built has been mighty fine equipment. Our customers, all leaders in the industry, have told us so. With peace, we're going back into the steel office furniture business—and STAY in the electronic equipment field.

Two separate divisions with one distinct aim — QUALITY at a FAIR PRICE. Sound interesting to you? We can make it even *more* interesting. How? Send us your specifications.

BUY WAR BONDS

CORRY-JAMESTOWN
MANUFACTURING CORPORATION
CORRY, PENNA.

Steel Age

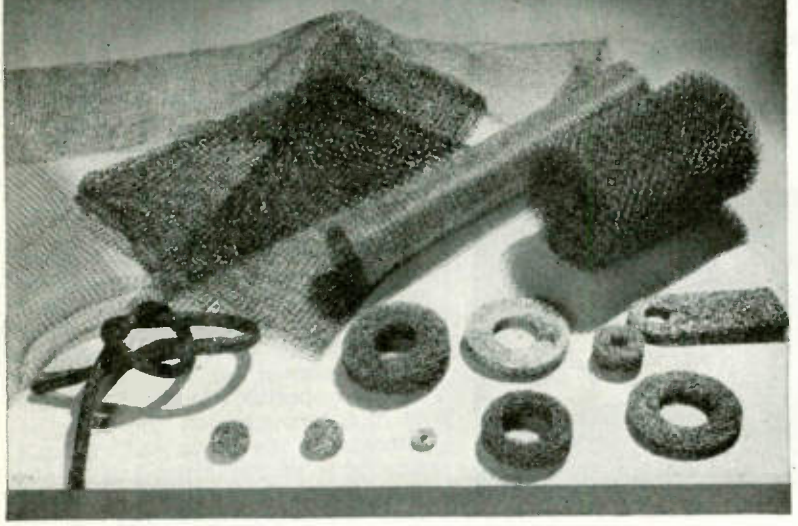
"I want A FLEXIBLE GASKET TO WITHSTAND 2000° F." said the airplane part maker

"I want A RESILIENT SHIELDING CUSHION" said the set manufacturer

"I want A FINE TUBE GRID THAT WON'T SAG" said the electronic tube maker

"I want A LASTING WICK FOR AIRPLANE HEATERS" said the cabin heater maker

They found what they wanted in *KNIT MESH* made of INCO Nickel Alloys



Today, metal mesh knit from INCO Nickel Alloys does *all* these varied jobs.

Tomorrow? Perhaps it's the answer to an electronic problem now on your drafting board.

For Knit Metal Mesh, product of the Metal Textile Corp., Orange, N. J., has many properties that point to its wide future use in electronics.

Knit from Monel, Nickel or Inconel, it is rustless corrosion-resistant, tough, strong, able to withstand high temperatures. In addition, its special *linked-loop* design is flexible, highly resistant to breakage, unusually strong on the bias. It offers, for instance, a firm fabric for grids because the linked loops allow normal expansion when the grid is heated, and return the fabric to its original shape as the grid cools.

The knit fabric holds together even when made of very fine wire (.0045 diameter), and with as few as 4 or 5 openings to the inch.

For further information about mesh knit from the INCO Nickel Alloys . . . and for other technical service on metal problems . . . address: The International Nickel Company, Inc., 67 Wall Street, New York 5, N. Y.

"I want A BETTER AIR FILTER MEDIUM" said the filter manufacturer

"I want A FLEXIBLE STRAP THAT WON'T JIGGLE LOOSE" said the magneto maker

NICKEL INCO ALLOYS

MONEL • "K" MONEL • "S" MONEL • "R" MONEL • "KR" MONEL • INCONEL • "Z" NICKEL • NICKEL • *Sheet . . . Strip . . . Rod . . . Tubing . . . Wire . . . Castings . . . Welding Rods (Gas & Electric)*

MEASUREMENT TECHNIC

(*Continued from page* 194)

Take for example a section of chart for station WGTR recorded at Atlanta during June, 1945. From the recorded input calibration and the field/input ratio, it may be determined that the field strengths varied between the noise level and 600 μv/m. With this range of fields the lower part of the meter scale will be so condensed that the 5 μv/m level will be the lowest practical level of analysis. The chart will thus be analyzed at the 5, 15, 50, 150 and 500 μv/m levels, which should be next determined and marked on the chart next to the input calibration.

This will require five Occurrence Sheets, one for each level. Each sheet is to be filled in at the top with the station call letters (WGTR), the frequency in mc (44.3), the recording site (Atlanta), the month and year (June, 1945), the type of propagation if identifiable (Trop., E, etc.) and the level at which the fields were analyzed (e.g., 5 μv/m) for entry on that sheet.

If the chart speed is ¾ in./hr. a 40 in. engineer's scale can be used very readily for analysis to the nearest minute, each division constituting two minutes. For a 3 in./hr. chart speed the 20 in. engineer's scale will read one minute per division. The occurrences are to be blocked in with a medium pencil (H) to the nearest minute at the proper time of day and proper day of the month.

For each section of the chart which is analyzed at one time there will be entered in the right hand margin of the Occurrence Sheet the highest level the maximum field recorded on that section of chart, opposite the day and time of day during which the value occurred. If the value was off scale, the value will be entered as greater than the maximum scale reading, this 750 μv/m. Similarly, on the lowest level Occurrence Sheet opposite the proper day and time of day the lowest field for the period will be entered. If below the noise level, the value will be entered as less than the noise level, this 1 μv/m. This type of analysis will permit a fairly rapid determination of signal levels exceeded for given percentages of time, of the diurnal variations in signal level, and of the periods of coincidence in signals for different frequencies, different transmitter locations and different recorded sites.

For tropospheric signals, such as will be recorded at Schenectady, Milwaukee, Princeton, Philadelphia and Laurel, the chart is to be analyzed to determine the field strength exceeded for 30 minutes of each hour.

"CQ..." we'll hear it again-SOON

THE HAM IS COMING BACK... STRONGER THAN EVER

Who Said The "Ham" Is Finished?

THERE have been rumors to the effect that the radio Amateurs were going to be denied their old frequency bands, and given new bands of such high frequency as to be useless for medium and long distance communication.

Some rumors say "Remember the last War? We are going to get the same treatment this time!"

Now, we don't believe the "Hams" should be denied their rightful place on the air in bands suitable for communication beyond the horizon——and further, we do not believe that our Government would want to see those privileges denied.

Are not the "Hams" fighting on many battlefronts, working in war factories and laboratories for a New World wherein the individual will be able to live and enjoy his hobbies, his church and other personal freedoms which go to make up a healthy, happy world?

It is well-known among Government officials whose task it was to build our great war-time communications system that from the rank and file of amateurs came executives, instructors and thousands of engineers and operators. Without this nucleus of experienced men, it would no doubt have taken a much longer time to reach the present high degree of perfection in the communications branch of our fighting forces.

In every emergency Amateurs have proved their ability and willingness to come to the aid of their Country——who would be so unjust as to want to deny them their small place in the radio spectrum? We do not believe these rumors that the "Ham" will be denied his privileges, we believe rather that those who speak so much of justice coming out of this war will see to it that the Amateur receives his just reward.

The entire radio industry knows well, and appreciates the many contributions "Hams" have made for the advancement of high frequency radio communications, and surely they too can be counted on to assist the "Ham" in regaining his privileges *when the right time comes.*

HAMMARLUND MANUFACTURING CO., Inc.
460 West 34th Street, New York 1, N. Y.

THIS AD APPEARED IN MARCH, 1944

WE never lost faith in the friends of amateur radio. We believe progress up to this very moment indicates that Hams have many friends in high places. Of course, there is a lot of romance to Ham radio, but the place won by the Ham in the hearts and minds of important people is the result of a very practical demonstration of real worth—real American ability.

We wish to openly express our sincere appreciation for the wisdom of those whose job it was to guide amateur radio through these troubled times. And those who have given Hams a just portion of the spectrum are to be commended for their farsightedness.

American amateurs can be thankful they live in a country where ability receives its just reward.

LLOYD A. HAMMARLUND, President

HAMMARLUND MFG. CO., INC., 460 W. 34th ST., NEW YORK 1, N. Y.

Is this Memo for you?

INTER-OFFICE MEMORANDUM

FROM: A.J.R.
TO: Engineering Department
SUBJECT: Rectifiers

Let's stop trying to solve our rectifier problems ourselves. After all, we're not specialists, and it seems to me that it's false economy.

I've just read that Green Electric Co. has over a million amperes of rectifiers now in use in leading companies. That sounds like some sort of record to me, and it also sounds as if Green is the outfit we ought to put on our particular job. Your comments will be appreciated.

A.J.R.

Rectifier Experts...

Yes, Green has a darned good record in the rectifier field. And tough problems are our specialty. We survey your requirements and submit recommendations as to the type of equipment best suited to your needs, from every standpoint. Then, when you give us an okay, we build units to order—or make an adaptation of a standard model. We've got an A-1 rating on both metal-plate (low voltage) and tube (high voltage) jobs—on anything that calls for rectifier equipment.

MUNNING & MUNNING, INC.
202 Emmet Street
Newark 5, N. J.

BRUJAC ELECTRONIC CORP.
11 Park Place
New York 7, N. Y.

CROWN RHEOSTAT & SUPPLY CO.
1910 Maypole Avenue
Chicago 12, Ill.

A. J. LYNCH & CO.
2424 Enterprise St.
Los Angeles 21, Cal.

"Rectifier Engineering is our Business"

SELENIUM • ARGON • MERCURY VAPOR • GRID CONTROL • HIGH VACUUM • XENON

W. GREEN ELECTRIC COMPANY, INC.

SELECTRO-PLATERS AND ALL TYPES OF RECTIFIER EQUIPMENT

GREEN EXCHANGE BUILDING 130 CEDAR STREET NEW YORK 6, N.Y.

RECTIFIER G ENGINEERS

ENGINEERS

FOR DESIGN WORK ON RADIO RECEIVERS, AUDIO AMPLIFIERS, TELEVISION

Men with substantial experience wanted, preferably those having Degrees in Electrical or Communications Engineering. Write, giving details of experience and salary expected, to:

FREED RADIO CORPORATION

Makers of the Famous Freed-Eisemann Radio-Phonograph

200 HUDSON STREET
NEW YORK 13, N. Y.

ENGINEERS

Mechanical & Electrical

•

Experienced in Electronics, Chassis Design and Development, Variable Condensers and Transformer Design

•

TOP FLIGHT SALARY

•

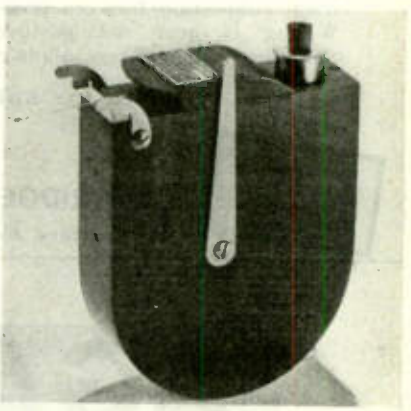
For Interview
Apply or Write

HUDSON AMERICAN CORPORATION
25 WEST 43RD STREET
NEW YORK 18, N. Y.

Resistance Capacitance Calculator

Allied Radio Corp., 833 West Jackson Blvd., Chicago 7, Ill., is manufacturing a new parallel-resistance and series-capacitance calculator designed to provide a rapid and accurate means of determining the reciprocal of the sum of two reciprocals as expressed by the formula $\frac{1}{x} = \frac{1}{a} + \frac{1}{b}$.

A single setting of the slide automatically aligns all pairs of a and b values which will satisfy the equation for any given value of x. This calculator indicates in one setting the numerous pairs of resistances which may be connected in parallel, or capacitances in series, to provide any required resistance or capacitance value. Range is 1 ohm to 10 megohms; 10 mmfd to 10 mfd. Capacitance and resistance figures on the face of the rule can also represent inductance, impedance, reactance, or other units.

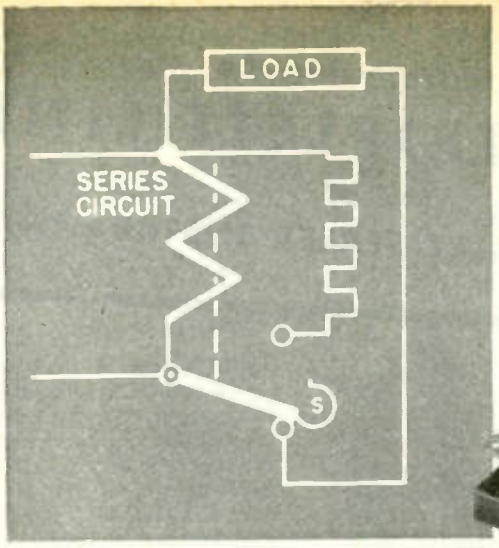


Recording Galvanometer

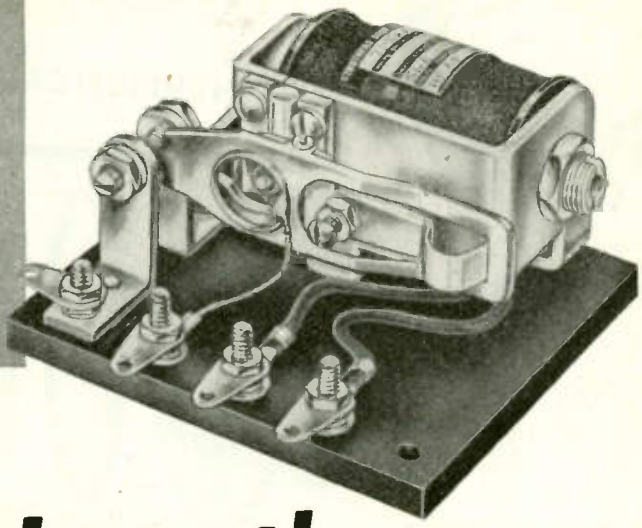
The Brush recording galvanometer makes direct ink on paper chart recordings of wider frequency range and greater sensitivity than heretofore attainable. It embodies a low mass, 3 in. long tapered tube recording pen, actuated by a permanent magnet penmotor utilizing newly developed material and techniques. The pyrex tipped pen faithfully records directly in ink on a moving paper chart, pressures, vibrations, strains, currents and voltages of frequencies from dc to 120 cps. It has no overshoot up to 70 cps at a maximum swing amplitude of 20 mm. each side of center line. Frequency response flat to 70 cps, accurate to 120 cps. Impedance of penmotor is 1500 ohms. Minimum sensitivity is 1.1 mm. per volt, 1.6 mm. per ma., 21 volts full scale. Available as shown or with 3-speed paper drive (2 in. wide chart), one or two channels and single speed paper drive (12 in. wide chart), four to six channels. Made by the Brush Development Co., 3405 Perkins avenue, Cleveland 14, Ohio.

Metallic Coatings

The O. Hommel Co., Pittsburgh, Pa., has developed special metallic coatings which are being used by the electrical industry as a conductive surface. This surface can be used not only for conductive purposes but also as a base for soldering. It is adaptable to a glass surface as well as to glazed or unglazed ceramics. A special product for use on mica in condenser work has also been developed. The material can be prepared for spraying, hand painting, printing through a silk screen and dipping.



An extremely close differential application using a shunted coil circuit on the armature of a standard Struthers-Dunn Type 79XAX Snap-Action Relay.



Anything Less than EXACTLY THE RIGHT RELAY . . . . . is Poor Economy

5,312 Relay Types

Don't waste time and money engineering "around" a relay or timer that is not EXACTLY suited to your application. Nine times out of ten Struthers-Dunn can fit you out with *standard* units ideally suited to your uses in every respect. Actually there are 5,312 *standard* Struthers-Dunn types from which recommendations can be made. Each one is subject to almost infinite design adaptations. Going beyond this, Struthers-Dunn engineering experience is such that no concern is better fitted to design custom built relays to meet your specific conditions.

STRUTHERS-DUNN, INC., 1321 Arch St., Philadelphia 7, Pa.

STRUTHERS-DUNN

Relay and Timer Specialists Since 1923

DISTRICT ENGINEERING OFFICES: ATLANTA • BALTIMORE • BOSTON • BUFFALO • CHICAGO • CINCINNATI • CLEVELAND DALLAS • DENVER • DETROIT • HARTFORD • INDIANAPOLIS • LOS ANGELES • MINNEAPOLIS • MONTREAL NEW YORK • PITTSBURGH • ST. LOUIS • SAN FRANCISCO • SEATTLE • SYRACUSE • TORONTO

"precision control"

in electronic equipment is a certainty with the

CETRON CE-309 TUBE

Wherever precision control is of prime importance in electronic devices, this CE-309 Thyratron will serve capably and efficiently. It is a mercury vapor filled rectifier designed especially for exceptional service in such operations as handling primary currents of small resistance welders, motor control, etc. It is quick starting, averaging 5 seconds heating time . . . conservatively rated for 2000 hours . . . in every way a tube that reflects Cetron quality engineering and our thorough understanding of the needs and problems of tubes for industrial use.

Write for catalog of our COMPLETE LINE of Rectifiers . . . Phototubes . . . Electronic Tubes.

CONTINENTAL ELECTRIC CO. *Geneva, Ill.*

CHICAGO OFFICE: 903 MERCHANDISE MART • NEW YORK OFFICE: 265 W. 14TH STREET

PERSONNEL

New Chairman of IRAC

Capt. E. M. Webster, chief of communications of the U. S. Coast Guard, is now chairman of the Interdepartmental Radio Advisory Committee of the United States Government, the Federal body which advises the President in his assignment of radio frequencies for the use of Government departments including the Army and Navy. Such assignments take first precedence at all times, and it is only the frequencies not thus allocated by IRAC which are then assigned by the FCC for civilian use. Chairmanship of IRAC is rotated each year. Captain Webster succeeded Comdr. Paul D. Miles of the Navy, as chairman. The new vice-chairman of IRAC is Col. A. G. Simpson, Army Signal Corp., who is scheduled to become IRAC chairman next year.

Charles H. Singer has returned to his post as assistant chief engineer of radio station WOR, New York. He has been on loan as a consulting engineer to the Army.

W. A. Paterson has been added to the engineering staff of Webster-Chicago Corp., Chicago. His previous connections include a spell with Victor research laboratories and as an engineer with the Minneapolis-Honeywell and National Mineral companies.

Lt. Colonel George T. Brownell has been appointed chief engineer of Majestic Radio and Television Corp., St. Charles, Ill. Prior to entering the service in 1940 he owned Electro-Safety Co., manufacturer of electronic products.

Frank M. Folsom, who has been vice president in charge of RCA Victor Division since January, 1944, has been elected executive vice-president in charge of RCA Victor Division, Radio Corporation of America. At the same time, **John G. Wilson** was elected operating vice-president of RCA Victor Division.

Colonel Clinton B. Allsopp has been elected a vice-president of the International Telephone and Telegraph Corp. He has served since December 8, 1941, with the Army Signal Corps and will assume important duties involving I. T. & T.'s rehabilitation program in various parts of the world.

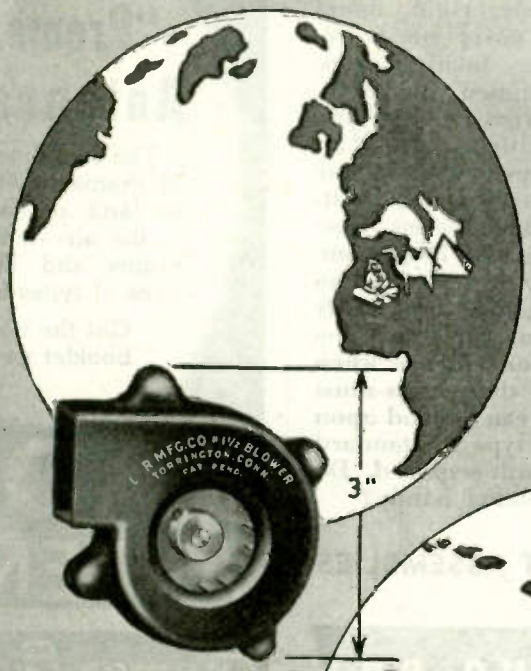
Harold F. Cook, who for the past eight years has acted as assistant advertising manager under Walter B. Masland at Tung-Sol, Inc., Newark, N. J., has now been appointed advertising and sales promotional manager.

Under all temperature and climatic conditions

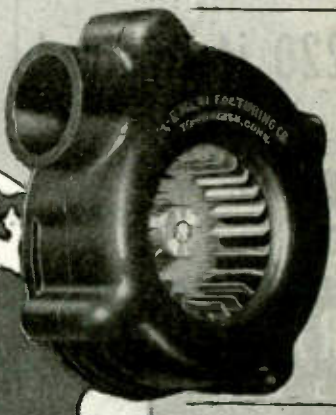
L-R BLOWERS

give maximum heat dispersion

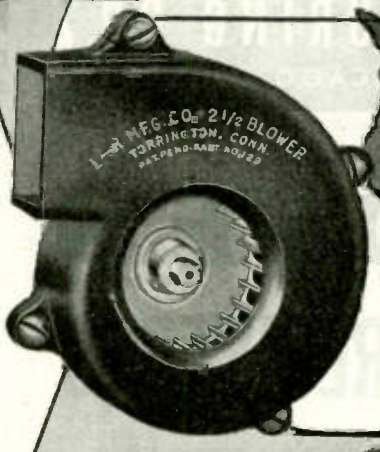
LIGHT - COMPACT - EFFICIENT



MODEL 1½
Weight (less motor): 2 oz.
Output: 15 C.F.M. at 8000 R.P.M.



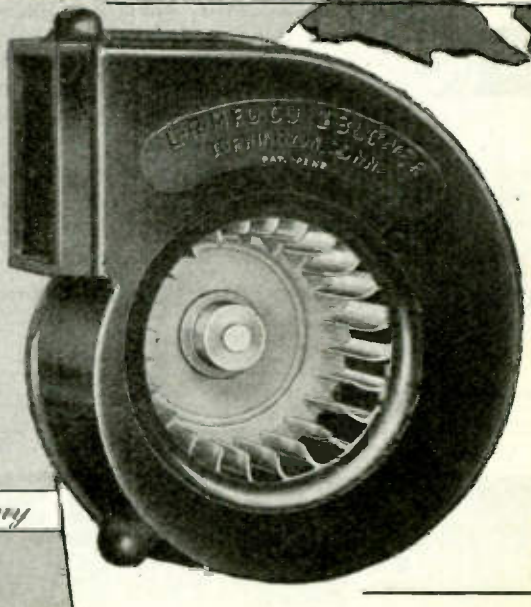
MODEL 2
Weight (less motor): 4½ oz.
Output: 25 C.F.M. at 8000 R.P.M.



It's New!

MODEL 2½
Weight (less motor): 4 oz.
Output: 50 C.F.M. at 8000 R.P.M.
Height: 4½"

MODEL 3
Weight (less motor): 12 oz.
Output: 260 C.F.M. at 8000 R.P.M.
Height: 6½"



L-R Blowers produce maximum C.F.M. with minimum space and weight. Light-weight, high-impact plastic housings. Turbo-type wheels. Clockwise or counter-clockwise rotation.

L-R MANUFACTURING CO. Division of

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For 110 volt Circuits or 220 if Desired

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Types GW-3, GW-4, GW-5 immediately available. Standard tolerance: ±1%. Closer tolerances supplied at slightly higher prices. Other types for delivery in near future. Your inquiry invited.

Catalog upon request

Nominal Composition	Max. Res. .0015 inch Diameter Wire GW-3	GW-4	GW-5	Max. Resistance GW-3	GW-4	GW-5
80% Nickel—20% Chrome Wire	85,000	270,000	750,000	145,000	450,000	1.25 Meg.
55% Copper—45% Nickel Wire	37,500	120,000	320,000	50,000	150,000	425,000

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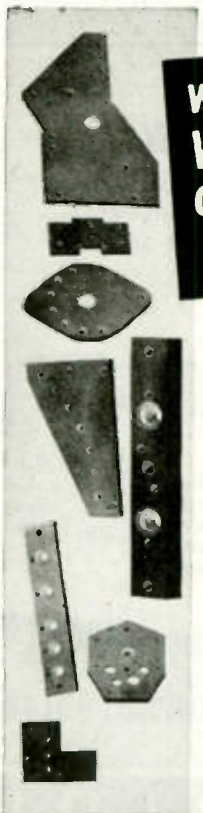

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NEW BULLETINS

Temperature Cabinets

A new catalog No. 325, on temperature control cabinets has been issued by Precision Scientific Co., 1750 No. Springfield Ave., Chicago 47, Ill. It contains 48 illustrated pages, covering an extensive variety of standard and special models. Included are electrically heated ovens for drying, preheating, conditioning, rubber aging; sterilizers, incubators, paraffin embedding ovens, low temperature cabinets, humidity control cabinets; steam-heated explosion-proof cabinets carrying underwriter's approval; vacuum ovens and combustion-tube furnaces for laboratory use. Included also is general information pertaining to heat transfer by forced draft and by natural circulation.

Machining Zinc Castings

A 67-page book, "Practice in Machining Zinc Alloy Die Castings" has been issued by the New Jersey Zinc Co., 160 Front St., New York 7. In these pages current machining procedures on such castings are summarized. As in the machining of other metals, there are often variations in practice. Frequently there are two or more ways to do the same job well. Every method reviewed in this book is, or has been in actual commercial use and conforms to the practice of some die caster, some large user of die castings, or some tool manufacturer. Nearly all possible machining operations, including unusual ones such as planing and shaping, are mentioned and discussed.

Lighthouse Tubes

A new eight-page publication (ETR-7) on the GE disk-seal, widely known among radio engineers in the military services as the "lighthouse tube," has been published by the tube division of the General Electric Co., Schenectady, N. Y. The pamphlet describes the basic principles of design and operation of the tube and its advantages in the fields for which it is designed. The tube, now being used in war applications, will be applied to television, FM and other fields in the ultra-high frequency spectrum.

Insulation Tester

A new bulletin on Midget "Megger" insulation testers as now made in the U. S. has just been issued by the James G. Biddle Co., 1211 Arch St., Philadelphia 7, Pa. An illustrated description of the method of use and of the operating principles as well as complete specifications are included. Three models are listed giving readings to 10, 20 and 50 megohms respectively.

You are cordially invited to help write the "specs" for this new Gammatron Tube

Heintz and Kaufman Ltd.—first to design and produce such popular tube types as the 24, 24G, 54, and 257B—cordially invite you as a designer or manufacturer of electronic equipment to have a hand in the development of a new series of H & K "firsts." ☆ Our engineering staff welcomes your suggestions for additions to the Gammatron line. If you have a requirement not adequately met by existing tubes, please let us know so that our development program may be directed accordingly. ☆ It will be to our mutual benefit if you will take a few minutes now to set forth your suggestions, and thus participate in the designing of outstanding new Gammatrons.

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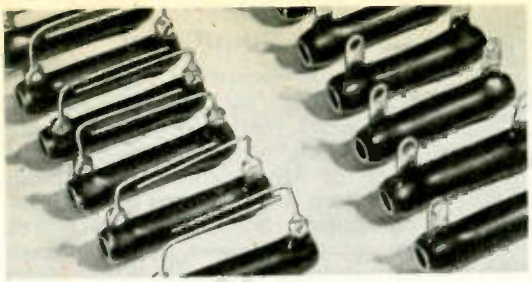

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differ—

(1) in being the only specialty of Lectrohm.

(2) in being a product of specialized experience.

(3) in being produced under personalized supervision.

—all of which totals up to the highest standard of dependable operation obtainable in a production item. Then too, the Lectrohm Line offers you a wide selection of fixed, adjustable, ferrule terminal and "Rib-on-edge" resistors, Power line and R F plate chokes. Send your specifications for recommendations.

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INCORPORATED

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Division of The National Lock Washer Co., Newark, N. J.

EISLER EQUIPMENT

...the plus factor in tube manufacture

CHAS. EISLER specialized facilities are supplying high-efficiency manual, automatic and semi-automatic machinery for vacuum tube and electronic component production. Hundreds of devices are included — glass tube slicers, stem and sealing machines, flaring units, laboratory apparatus, etc.

(A) No. 161-WH Glass Tube Constriction Forming Machine drows, rapidly, outomotically.

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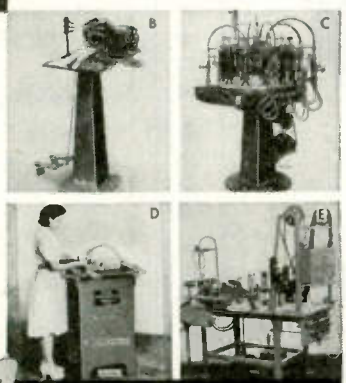
(C) No. 23-12LD, new type 12 head giont Tipless Stem Mochine.

(D) No. 11-TU Gloss Tube Slicer, mokes clean, shorp cuts—does not require skill.

(E) No. 57-X Loborotory Unit for gloss cutting, flaring, stem making, sealing-in, exhousting, basing.



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Eisler ENGINEERING COMPANY

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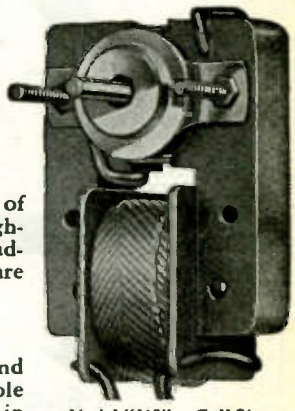
1,001 USES

Condensed Power for Years of Service

VERSATILITY and dependability were paramount when *Alliance* designed these efficient motors— *Multum in Parvo!* . . . They are ideal for operating fans, movie projectors, light home appliances, toys, switches, motion displays, control systems and many other applications . . . providing economical condensed power for years of service.

Alliance Precision

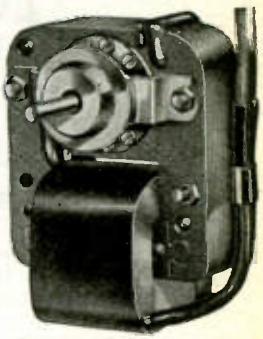
Our long established standards of precision manufacturing from highest grade materials are strictly adhered to in these models to insure long life without breakdowns.



Model "MS"— Full Size Motor Measures 1¾" x 2 x 3⅛"

EFFICIENT

Both the new Model "K" Motor and the Model "MS" are the shaded pole induction type — the last word in efficient small motor design. They can be produced in all standard voltages and frequencies with actual measured power outputs ranging upwards to 1/100 H. P. . . Alliance motors also can be furnished, in quantity, with variations to adapt them to specific applications.



New Model "K"— Full Size Motor Measures 2⅛" x 2⅜" x 3 1/16"

DEPENDABLE

Both these models uphold the *Alliance* reputation for all 'round dependability. In the busy post-war period, there will be many "spots" where these Miniature Power Plants will fit requirements . . Write now for further information.

Remember Alliance!
—YOUR ALLY IN WAR AS IN PEACE

ALLIANCE MANUFACTURING CO.

ALLIANCE . OHIO

Maguire Adds Powder Metallurgy

Maguire Industries, Inc., Greenwich, Conn., has entered the field of powder metallurgy through the acquisition of stock of Ferrocart Corp. of America and Micro Products Corp., both located in Hastings-on-Hudson, N. Y. Ferrocart is well known as producer of parts made of powdered magnetic iron. Harry A. Ford pioneered this product in this country commencing in 1933 and will continue as president of Ferrocart and Micro, both of which corporations continue to operate as separate entities with the same management and personnel. Earl S. Patch, formerly associated with the Moraine Division of General Motors Corp., has joined Ferrocart and will set up a new division of Ferrocart for the purpose of producing powdered metal parts for mechanical uses.

Stupakoff Appoints Esco

Stupakoff Ceramic and Mfg. Co., Latrobe, Pa., has appointed Electrical Specialty Co. as its sales representative on the West Coast. Electrical Specialty Co.'s main offices are in San Francisco, with branch offices in Seattle, Portland and Los Angeles.

Hearing Aid Tests

The standards committee of the American Hearing Aid Association, Chicago, has issued new specifications for methods of measurement of the performance of electrically operated hearing aids. The specifications are designed to cover a scientifically accurate method of making tests.

Patent Licenses

The U. S. Patent Office has lengthened its service to industry starting June 1 by publishing lists of patented inventions under which the owners are willing to grant licenses at reasonable terms. Such lists are to be published in the Patent Office Gazette.

Ken-Rad Resumes Identity

After an absence of some time, Ken-Rad of Owensboro, Ky., manufacturer of metal self-shielding radio receiver tubes, is resuming its national trade advertising on a large scale. Officials announce that Ken-Rad intends to maintain its rank as a leader in the manufacture of home radio tubes. As previously reported, the radio-tube division of the old Ken-Rad company was purchased by the General Electric Co., and the Ken-Rad incandescent-lamp division was recently bought by the Westinghouse interests.

New Buchanan Organization

Buchanan Research Laboratories, Inc., has been organized with offices at 2 West Jersey St., Elizabeth, N. J., by Stephen N. Buchanan, who originally founded Buchanan Research Laboratory in Newark, N. J. The new organization will take over the business of the older one and will be headed by Mr. Buchanan as president. The organization will undertake research and development projects in the fields of radio, telephone, television, aircraft and general commercial wiring. Other officers of the company are Clarence R. Sanford, chairman of the board, and Frank C. Sterck, executive vice-president. Buchanan Electrical Products Co. Inc., a wholly-owned subsidiary, will manufacture and sell products already developed by the Laboratories.

Grenby-Cardwell Join

The Grenby Mfg. Co., Plainville, Conn., and the Allen D. Cardwell Mfg. Corp., Brooklyn, N. Y., have consolidated. Both companies will maintain their present corporate identity and will continue their present management. The Grenby company is well known for its manufacture of precision machine tools and radar equipment. Cardwell has had a long and successful career in the electronic field and has been producing critical electronic equipment for the war effort.

Record Changer

A new low-priced record changer for use on home radio and phonograph sets soon will be manufactured in Milwaukee by Milwaukee Stamping Co. It will be known as the Milwaukee - Erwood record changer.

Raytheon Adds Five

Following the merger of Belmont Radio Corp., Chicago, with the Raytheon Mfg. Co., five new directors have been added to the Raytheon board. They are P. S. Billings, Belmont's president; Harold C. Mattes, vice-president of Belmont in charge of engineering production; Joseph Pierson, founder and former president of Press Wireless; Emmons Bryant, Jr., manager of N. A. Woodworth Co., Detroit, and manufacturer of aircraft parts, and George L. Langreth, who for some time has been acting as a special consultant to Raytheon.

Adelman to Export

Harry Adelman, advertising and sales promotion manager for the past five years of the Sun Radio & Electronics Co., New York, resigned April 1, to open his own export offices at 53 Park Place, New York, under the style The Radelma Co.

ELECTRONIC INDUSTRIES

Advertisers—July, 1945

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We seek the services of an experienced receiver designer to take charge of our work in the broadcast field. The man must be ingenious, capable of engineering competitive designs and well versed in radio engineering. We will consider a man for work in either our New York or New London laboratories. *Write:*

Templetone Radio Mfg. Corp.
New London, Connecticut

ACOUSTIC ENGINEER TO DEVELOP LOUD SPEAKERS

Familiar with laboratory and measurement devices for checking loud speaker characteristics.

Right hand man to chief engineer.

Permanent, post-war position with rapidly-growing loud speaker manufacturer located in New York City.

Salary commensurate with qualifications.

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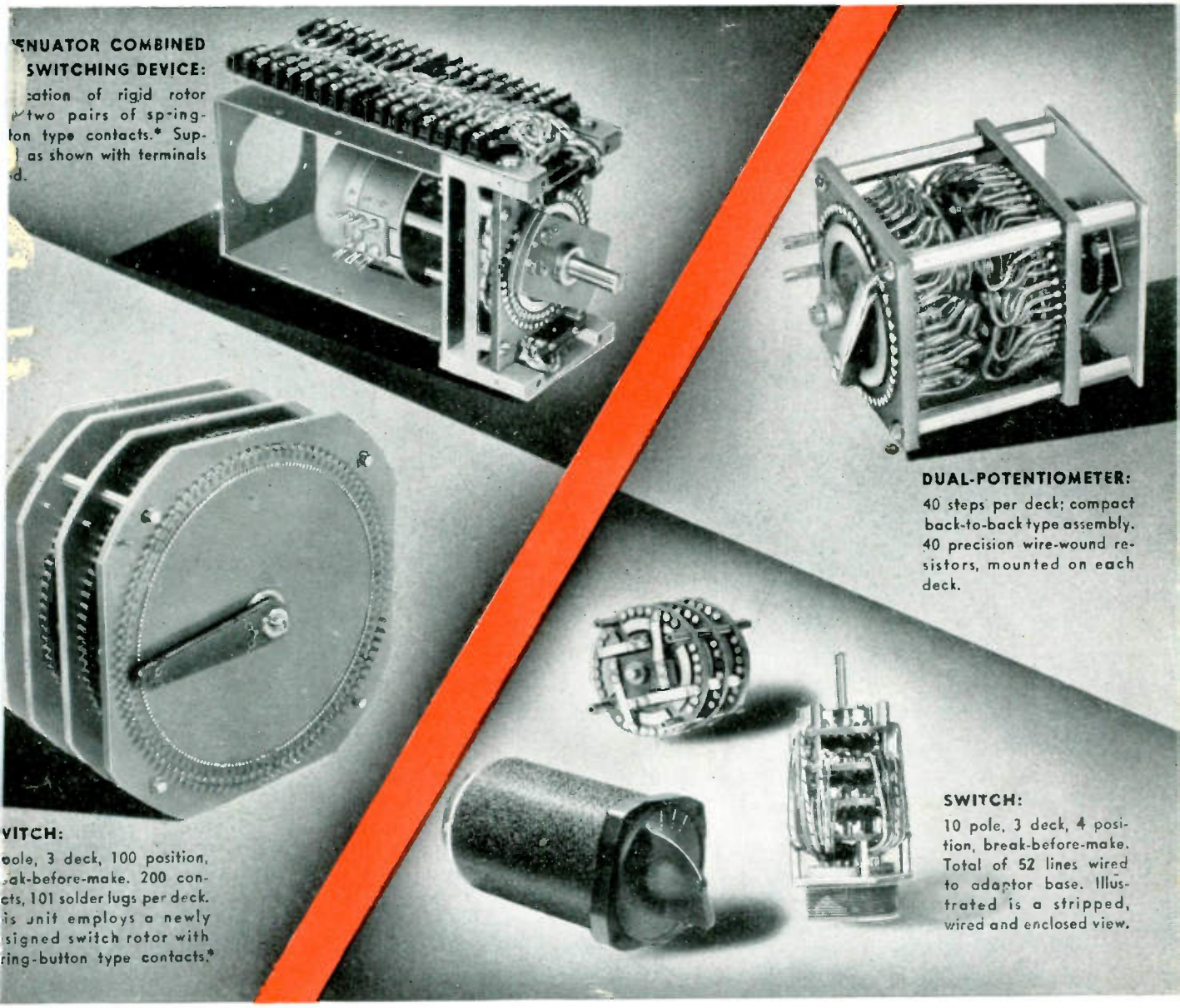

ENUATOR COMBINED SWITCHING DEVICE:
cation of rigid rotor two pairs of spring-ton type contacts.* Sup- as shown with terminals d.

DUAL-POTENTIOMETER:
40 steps per deck; compact back-to-back type assembly. 40 precision wire-wound resistors, mounted on each deck.

VITCH:
ole, 3 deck, 100 position, ak-before-make. 200 con-cts, 101 solder lugs per deck. is unit employs a newly signed switch rotor with ring-button type contacts.*

SWITCH:
10 pole, 3 deck, 4 position, break-before-make. Total of 52 lines wired to adaptor base. Illustrated is a stripped, wired and enclosed view.

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Engineered by DAVEN

FEATURING LOW AND UNIFORM CONTACT RESISTANCE

The four precision controls illustrated are but a few of the DAVEN-engineered switches now filling important war assignments. Each unit represents the skilled adaptation of basic DAVEN techniques to the problems of the specific application. The distinct advantage of this method of engineering switches is the assurance of a result ideally suited for the job, plus important savings in time and cost of development. DAVEN-engineered switches are built in a wide range of sizes, of many types of materials, with varied numbers and arrangements of poles, positions, decks and terminals, in shorting and non-shorting types. A DAVEN engineer will gladly work with you on your switch problems.

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Beam-power tubes provide simple, compact equipment — a wide range of power-output — high power-sensitivity — over-all efficiency and economy.

IN AM TRANSMITTERS: Beam-power transmitting tubes provide high output with low driving-power. They enable you to design more compact, simpler, more economical broadcast transmitters than other types of tubes.

Transmitters designed around beam-power tubes are *more compact* because fewer stages are required and because neutralizing circuits are eliminated; they are *more simple* because the transmitter does not have to be re-neutralized each time tubes are replaced; they are *more economical* because fewer tubes and fewer stages can be used for a given power-output.

IN FM TRANSMITTERS: The self-neutralizing property of beam-power tubes provides a simple, efficient means of obtaining stable operation in wide-band FM circuits without complex auxiliary circuits.

IN TELEVISION TRANSMITTERS: The high-gain and self-neutralizing properties of beam-power tubes make possible stable, efficient wide-band video and r-f amplifiers, with a minimum of tubes and without neutralizing circuits.

LOOK TO RCA FOR YOUR TUBES: In beam-power transmitting tubes, RCA has developed a whole family of high-performance champions such as the RCA-807, 813, 814, 815, 828, 829B, and 832A—*the most complete line offered by any manufacturer!*

For complete technical information on RCA beam-power tubes, see the RCA HB-3 Handbook. If you do not have a copy of this handbook, or if you have questions on the application of beam-power tubes, write to RCA, Commercial Engineering Department, Section 62-33J, Harrison, N. J.

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