If your problem is weight (our smallest units weigh only one-third ounce) or size (our sheet metal division can run off a case to accurately fit your particular requirements) or precise adjustments or tougher than ordinary electrical characteristics or mechanical requirements or submersion type components, etc. . . .

UTC IS THE LOGICAL SOURCE

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  - (d) < 4.0 MMF to > 20.0 MMF
  - (e) < 6.5 MMF to > 35.0 MMF
  - (f) < 35.0 MMF to > 55.0 MMF
  - (g) < 55.0 MMF to > 75.0 MMF
  - (h) < 70.0 MMF to > 90.0 MMF
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  - (c) < 2.0 MMF to > 6.0 MMF
  - (d) < 4.0 MMF to > 20.0 MMF
  - (e) < 6.5 MMF to > 35.0 MMF
  - (f) < 35.0 MMF to > 55.0 MMF
  - (g) < 55.0 MMF to > 75.0 MMF
  - (h) < 70.0 MMF to > 90.0 MMF
  - (i) < 90.0 MMF to > 110.0 MMF

VOLTAGE RATING:
- 500 Volts D.C.
- Flash test 1500 V.A.C. peak

CENTRALAB: DIVISION OF GLOBE-UNION, INC., MILWAUKEE, WIS.

May 1942 — ELECTRONICS
MINERAL OIL. Most tracing papers are treated with some kind of oil. Mineral oil is physically unstable, tends to "drift", never dries completely. Papers treated with mineral oil pick up dust, lose transparency with age.

VEGETABLE OIL, chemically unstable, oxidizes easily. Papers treated with vegetable oil become rancid and brittle, turn yellow and opaque with age.

ALBANITE is a crystal-clear synthetic solid, free from oil and wax, physically and chemically inert. Because of this new stabilized transparentizing agent ALBANENE is unaffected by harsh climates—will not oxidize with age, become brittle or lose transparency.

ALBANITE produces a Better Tracing Paper

No wonder this remarkable new tracing paper has found its way into the best drafting rooms in America. It gives you every possible drawing advantage, and a permanence that protects your tracings against the ravages of time!

For ALBANENE is made of 100% long fiber pure white rags—treated with ALBANITE—a new crystal clear synthetic solid developed in the K&E laboratories. It is free from oil and wax, physically and chemically inert. ALBANENE will not oxidize, become brittle or lose transparency with age.

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K&E Albianene
THE STABILIZED TRACING PAPER

EST. 1857
KEUFFEL & ESSER CO.
NEW YORK—HOBOKEN, N. J.
CHICAGO—ST. LOUIS
SAN FRANCISCO—LOS ANGELES—DETROIT—MONTREAL

USERS TELL US...

K&E Albianene
THE STABILIZED TRACING PAPER

EST. 1857
KEUFFEL & ESSER CO.
NEW YORK—HOBOKEN, N. J.
CHICAGO—ST. LOUIS
SAN FRANCISCO—LOS ANGELES—DETROIT—MONTREAL
The ageless spring

Westinghouse
no "spring-set" after 100,000 full-scale readings

Instrument accuracy has a new life expectancy today because Westinghouse has developed a spring that does not change its characteristics with age. Useful life of instruments is extended—and need for replacements is reduced.

Springs keep their shape for life. Convolutions do not touch under any degree of tension or in any position, regardless of temperature conditions or type of service.

Every manufacturing operation in making these springs is closely controlled for absolute uniformity and correct elasticity. Special alloys and forming methods are the result of a major research program. All springs are tested individually and assembled in precision jigs. No human variables are permitted to affect the uniform quality of this spring construction and assembly.

These methods—as well as those applied in producing permanently white dials—non-blunting pivots, high-strength tubular pointers, and nonaging permanent magnets are typical of the exacting care which we take in building every part of every instrument. This is one of the big reasons why our instruments are in such widespread demand today when maximum efficiency in so many production machines and war weapons is dependent on sustained accuracy in electrical instruments.

Your selection of electrical instruments can be made much easier by using this new Westinghouse Instrument Selector book. If you don’t have a copy, write for B-3013, to Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., Dept. 7-N.
This complex combination of Dunco Relays controls Turnpike repeater station receivers and transmitters. Transmitters are operated by 37.5 Mc. signals from distant cars, or by 116-119 Mc. signals from other repeaters. Only one signal must be capable of operating a repeater at a given time. Receivers tuned to these frequencies turn on the transmitters, then serve as speech amplifiers for them. Transmitters automatically turn themselves off after two minutes.

Communication engineering progress as exemplified in the radio equipment of the famous Pennsylvania Turnpike not only calls for skill of a high order; equally important, it calls for selection of components of unquestioned dependability. Thus, it is with pride, that we point to the use of Dunco Relays throughout—and particularly in the automatic repeater station transmitters illustrated here where Dunco sensitive relays, Dunco time-delay relays, and sequences of Dunco power relays play major parts in assuring unique short wave communication performance throughout the Turnpike's 161 mile length.

Dunco walks hand in hand with engineering leadership—because Dunco means dependability—and because Dunco is equipped to supply standards, adaptations, or special units for practically any need.

DUNCO RELAYS TIMERS

STRUTHERS DUNN, INC., 1326 CHERRY ST., PHILADELPHIA, PA.
ONLY **WINCO** GIVES YOU

**ALTI-TEMP**

**DYNAMOTORS**

Alti-Temp Dynamotors are specially designed to insure maximum efficiency under all operating altitudes and temperatures. By specifying Winco Dynamotors you insure a power supply that has:

* **PERFECT BALANCE**
* **MINIMUM AC RIPPLE**
* **LOW VOLTAGE REGULATION**
* **COMPLETE DEPENDABILITY**
* **COMPACTNESS AND LIGHT WEIGHT**

...And, whatever your power problem—whether you need a simple single input and single output Dynamotor or a complex multi-commutator unit—Winco will meet your exact need. Our complete free Advisory Engineering Service is yours without obligation. Why not consult us?

**WINCO DYNAMOTORS**

WINCHARGER CORPORATION – SIOUX CITY, IOWA
FEW peacetime necessities have so many wartime applications as radio. Today it is the “sixth sense” of our military forces.

So it is essential that our nation be second to none in efficient use of this vital weapon.

One of Sylvania's contributions to unfailing radio reception is the Lock-In Tube—stout and durable enough to meet all the trials of modern battle.

Its connections are all welded. It has fewer joints, stronger support rods.

Add an all-glass header, an improved mount support—and you have a tube that's everyway primed for combat service—a tube that will help America rule the air waves!

HYGRADE SYLVANIA CORPORATION

New York City EMPORIUM, PA. Salem, Mass.

Also makers of HYGRADE Incandescent Lamps, Fluorescent Lamps and Fixtures

May 1942 — ELECTRONICS
The lampshade microphone was designed to prevent "mike fright." This is an early scene at WGY, this year celebrating its 20th anniversary.

More watthours per dollar; smaller, more compact tubes; longer life—what General Electric's 29 years in the tube business means to you today. Here are a few of the major advancements in tube design G-E engineers have contributed.

- thoriated tungsten filaments
- high-power, water-cooled tubes
- hot-cathode, mercury-vapor rectifiers
- the first accurate rectifier emission test
- the screen-grid tube
- metal tubes for receivers and industrial uses

Today we are speeding the conquest of the ultrahighs with such tubes as the GL-880, GL-889, and GL-8002R. Bulletin GEA-3315C brings you the story on our complete line of tubes for all classes of service. General Electric, Schenectady, N.Y.

20 YEARS AT WGY, one of G.E.'s proving grounds

Discussing electronics in WGY's laboratory (left to right) G.E.'s Dr. Irving Langmuir, inventor of the high-vacuum tube; Professor J.J. Thomson, the English physicist; discoverer of the electron; and Dr. William D. Coolidge, famous for his work in X-ray tube design, now director of the G-E Research Laboratory.

One of the immortals of science, Dr. Charles P. Steinmetz in one of his rare appearances before the microphone (at WGY March, 1922). Among Dr. Steinmetz's contributions while with General Electric were the solution of perplexing high-voltage problems in electrical transmission, and the analysis of the behavior of transient electric currents.

First use of crystal control on a broadcast transmitter for regular program service (WGY, September 19, 1925). Contrast this with G.E.'s new hermetically sealed G-3B Thermocell for precision temperature control. (Insert—cutaway view.)

The first use of "superpower"—100,000 watts in the antenna—August 4, 1927 (the tubes were ancestors of the GL-802). Other WGY "firsts" include the first broadcast of two-way communication with England, February 21, 1928, in co-operation with BBC; first remote television pick-up on August 22, 1938; first round-the-world broadcast of voice transmission on June 30, 1930.

One of the earliest attempts to systematize sound effects. This self-contained unit, used about 1929 at WGY, included bells, buzzers, horns, sirens, and gadgets for simulating thunder, rain, a dog's bark, and a lion's roar.

*Photo shows the first application of a water-cooled modulator—in WGY's 1922 transmitter.

Remember the Days of the Lampshade Mike?

THAT'S WHEN GENERAL ELECTRIC COOLED TUBES WITH A "MODEL 1" RADIATOR

WHAT A DIFFERENCE! TODAY, HARDLY A HANDFUL GIVES 1800 WATTS OUTPUT

WGY today serves about one million radio families, 24 hours a day. It was the 2nd station in the Great Northwest; today it is the foremost.

GENERAL ELECTRIC
THE ever-widening scope of Lumarith applications is due to the fact that not only is Lumarith unsurpassable in its own numerous fields—but as shortages of other materials crop up, Lumarith is found to be the ideal replacement. In dielectric strength, toughness, and ease of processing, Lumarith has advantages that suggest immediate investigation by electrical designers and manufacturers.

Our technical staff will gladly supply the data you want—plus active cooperation in development work, if needed. Celanese Celluloid Corporation, 180 Madison Ave., New York City, a Division of Celanese Corporation of America. Sole Producer of Lumarith* (cellulose acetate plastics in sheets, rods, tubes, molding powder, transparent film and dope)...*Trademark Reg. U. S. Pat. Off.
Pledge

TRIPLETT MEN AND WOMEN HAVE SIGNED THIS PLEDGE TO AMERICA'S VICTORY

The Nation needs us strong — I WILL KEEP FIT!

Lost hours help our enemies.
My working time is America's time — I WILL TAKE NO "TIME-OFF"!

Carelessness causes accidents.
Accidents annually cost enough man-hours to build
15,000 bombers — I WILL BE CAREFUL!

Some American soldier may die if indifference to the
importance of small jobs results in poor work —
I WILL KEEP MY INTEREST!

The future welfare of America will rest upon the
increased knowledge which will emerge from present
necessity — I WILL ADVANCE!

These things I PLEDGE that our future
may be secure for Life, Work and Service

*       *       *

ACCURACY—AS EVER

Despite the rush of present production there is no relaxation from rigid requirements of accuracy in calibration and inspection of fine Triplett instruments. No compromise is permitted to affect in the slightest those exacting standards which have become the international Hallmark for precision and quality.

TRIPLETT ELECTRICAL INSTRUMENT COMPANY
BLUFFTON, OHIO

ELECTRONICS — May 1942
BEAT THE SCHEDULE

WIDEST RANGE OF STOCK UNITS. Ohmite produces the widest range of types and sizes in Power Rheostats, Resistors and Tap Switches. This facilitates selection of the right units for most applications. It often avoids the necessity of designing special units. Close Control Rheostats in ten sizes from 25 to 1000 watts. Wire Wound Resistors from 1 to 1500 watts. High Current Tap Switches in five models from 10 to 100 amperes A.C. There are over one thousand stock items alone available for quick needs.

ENGINEERING SPECIAL UNITS. Because of long, specialized experience in supplying units for electronic, scientific and industrial applications—and because of familiarity with Government specifications—Ohmite Engineers can take a “load” off your mind and your time. Let them work with you to expedite the engineering of special units for you.

DELIVERIES. Increased plant size and productive capacity are speeding up the production and delivery of Ohmite Products for essential needs. Everything possible is being done to help win the race against time.

Send for Catalog and Engineering Manual No. 40
Especially helpful today. Complete 96-page guide in the selection and application of Rheostats, Resistors, Tap Switches, Chokes, Attenuators. Write on company letterhead for your copy today.

How OHMITE can save you man hours of Engineering and Production Time

BE RIGHT WITH OHMITE
Rheostats-Resistors Tap Switches

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4817 Flournoy St., Chicago, U.S.A.
Formerly Manufacturer of Power Rheostats, Resistors, Tap Switches
A special message to industries converting to war production

If You Have Any Magnet Wire and Coil Problems, or need Increased Production on These Items...

Anaconda Can Help!

Anaconda's Central West plants still have unfilled capacity on magnet wire and coil production...for war work. In addition to these facilities, they have experienced personnel to help solve problems you might have with this phase of manufacture.

Here is an opportunity to release your time so that it can be devoted to other important problems. Our sales offices, located in all principal cities, are near you. Call today. A representative will be glad to discuss your problem.

General Offices: 25 Broadway, New York City
Chicago Office: 20 North Wacker Drive
Subsidiary of Anaconda Copper Mining Company
Sales Offices in Principal Cities

These Improved Insulations Are Now Available
Nylon—Vitrotex—and Formvar
The commercial development of Nylon and Vitrotex insulations is in part the result of Anaconda research...research that continues with redoubled effort producing new products for war work. Of course, when peace comes, the benefits of this research will be ready for industry everywhere.

Magnet Wire and Coils
Anaconda Wire & Cable Company

Electronics — May 1942
ERY ACCURATE calibrations are furnished with many General Radio instruments. No matter how good the internal stability of any instrument, its usable accuracy depends upon the reliability with which the variable-control element may be reset after calibration. An incorrectly engraved dial or a dial with irregularities in its scale will immediately nullify the stability of the best electrical circuit.

Many General Radio instruments are equipped with dials, such as the logarithmic type, on which the scale divisions are not uniformly spaced. Most instruments of this type are individually calibrated in the laboratory, the setting for each calibration point being indicated on the dial by a fine pencil mark. The dials are then transferred to a hand-operated engraving machine (illustrated) where the divisions are carefully engraved over the pencil lines; they are then sent to the laboratory for replacement on the instruments, and for final checking.

Other instruments require linear scales engraved with great accuracy. Dials with photo-etched scales do not have the necessary accuracy, hence these scales are engraved on an automatic self-indexing engine divider on which a geared motor accurately rotates the dial through the required arc, the dial pausing in its rotation long enough for a steel tool to engrave the divisions.

Only through engraving of this type is it possible for General Radio to insure usable calibrations of the highest accuracy on precision variable-element instruments such as beat-frequency oscillators, standard-signal generators, precision variable condensers and wave analyzers.
"Change Please!"

Now! Sales Tax Tokens of National Vulcanized Fibre

Change from hard-to-get metals and certain plastics — release of vital materials for all-out war effort... that's the imperative need today.

In this vital changeover, available National Vulcanized Fibre is now being used for Sales Tax tokens by several states. Other uses, which release needed materials, are: identification tags and markers of all types. The characteristics which make National Vulcanized Fibre perfect for these uses are: Lightness — about one-half the weight of aluminum. Strong — one of the strongest materials per unit weight known. Tough — can absorb sudden repeated impacts without damage. Wear — stubbornly resists wear and abrasion. Fabrication — can be machined, fabricated, stamped with ease. Printing and Embossing — lends itself readily to these processes. Perhaps it is the material you are looking for. No matter how unusual your problem may be, we are interested in working with you. Our engineering and research facilities are at your disposal. Wire, phone or write us.

Available National Vulcanized Fibre now being used extensively for identification tags and markers.

NATIONAL VULCANIZED FIBRE COMPANY

WILMINGTON
Delaware
Offices in all Principal Cities

Broadening American Enterprise through Dependable Plastics

You can use this National Vulcanized Fibre Handbook profitably. Write for free copy today.
HARDWICK, HINDE PRODUCTS ARE SERVING WITH DISTINCTION

In planes, tanks, ships, mechanized equipment, and in innumerable other vital defense needs.

HARDWICK, HINDE, Inc.
Newark, N. J., U.S.A.
Manufacturers of
RHEOSTATS and RESISTORS
Wake Island... Reykjavik—it takes equipment plenty dependable to maintain radio communications with the United States Marines. But it's being done in this war. In helping our Armed Forces to telescope time and space, the makers of modern radio communication equipment are performing a most important service to their fighting Uncle Sam.

Radio communication is just one of many strategic "Battle fronts" on which Cornell-Dubilier capacitors serve today.

To the gigantic task of supplying the Arsenal of Democracy, Cornell-Dubilier is contributing more than thirty-two years experience.

The extra dependability this background enables C-D engineers to build into capacitors of every type for the nation's needs now, will be industry's to profit by more than ever as soon as peace is won.


Mica Transmitting Capacitors
Copied, imitated...but never duplicated.
Types 50 to 59 Mica Capacitors are of improved design, adaptable and dependable for use as grid, plate blocking, coupling, tank and by-pass applications. They are sealed in low-loss white glazed ceramic tubes with cast aluminum end terminals. Patented series mica stack utilized in the construction of these capacitors eliminates corona and affords uniform voltage gradient.

Cornell Dubilier Capacitors
MJCA • PAPER • DYNANOL • WET & DRY ELECTROLYTIC CAPACITORS

More in Use Today Than Any Other Make
Electronics—May 1942
"DREAM ROAD" TO MOTORISTS, Pennsylvania's $70,000,000 all-weather Turnpike stretches 161 miles through the rugged Alleghenies, historic obstacle to travellers since Indian Times. Tunnels straight as arrows pierce the hearts of seven mountains, where motorists once crawled and corkscrewed tortuously over the ridges. It is guarded throughout its length by an intricate emergency radio network developed, constructed and installed through the coordinated efforts of Raymond Rosen & Co., RCA Victor distributor, and RCA engineers.

Not all new installations are so complex, or present such new problems. But the background and experience that permit solving the tough problems help RCA to produce more efficient, more reliable radio equipment for the armed forces.
AS REVOLUTIONARY AS THE TURNPIKE ITSELF! To cover the Pennsylvania Turnpike with reliable radio communication and still meet the functional requirements of such a system appeared to be a hopeless task. But RCA and Raymond Rosen engineers accomplished this through the design of automatic “Booster” stations using the newly assigned 116-119 mc. frequency band. These unattended stations form the “heart” of this extensive network as they relay messages from mountain top to mountain top.

IMMEDIATE ACTION! Control stations like this are manned night and day, to dispatch police, repair crews and other units instantly to the scene of any emergency requiring fast and coordinated handling.

FIRST AID, radio summoned, arrives without delay to help motorists requiring immediate assistance. The same communication network expedites the movement of mobile military units in time of war, and commercial and pleasure traffic in time of peace.

RCA Emergency Communication Equipment
RCA Manufacturing Company, Inc., Camden, N. J.
The Navy says:

"WELL DONE!"

...and Radio Research Contributed

The Navy "E" pennant, symbol of achievement in war production, is the highest praise the United States Navy can bestow on an industry.

Recently awarded to RCA Manufacturing Company, this emblem of excellence is a tribute to the loyalty and cooperation of the men and women who are working night and day to "Beat the Promise" to the Government on delivery dates of vital war equipment.

It is a tribute, also, to RCA radio research which has helped in large measure to make America's naval and military radio equipment the finest in the world.

When the war is won, many of these wartime applications will serve industry and the public, by helping to create new services and products. Today, at Princeton, N. J., the new RCA Laboratories building is taking shape—destined to be the world's foremost center of radio research. Surrounded by every modern tool of research, workers in the new Laboratories will continue to seek new knowledge of radio and electronics... new discoveries for America at war and America at peace.

RCA LABORATORIES
A Service of the Radio Corporation of America

Other RCA Services:
RCA Manufacturing Company, Inc. • R.C.A. Communications, Inc. • Blue Network Company, Inc.
National Broadcasting Company, Inc. • Radiomarine Corporation of America • RCA Institutes, Inc.

May 1942 — ELECTRONICS
ALSiMag
HIGH FREQUENCY CERAMIC MATERIALS FALL INTO 5 CLASSES

CLASS 1. AlSiMag 35 and 196, the low loss steatite ceramics for high and ultra-high frequency applications.

CLASS 2. AlSiMag 190, the material of exceptionally high dielectric constant.

CLASS 3. Special AlSiMag compositions with definite temperature coefficients of capacity. (Not offered for general use.)

CLASS 4. AlSiMag 72 and 202, materials with low temperature coefficient of expansion.

CLASS 5. AlSiMag 211, 222, 393 and Lava, for vacuum and cathode ray tube applications.

Complete physical characteristics of the more generally used AlSiMag and Lava bodies are detailed in Property Chart No. 416 which is sent free on request. The full range of physical characteristics of these bodies is not available from any other single source.
* Provide dependable compensation for frequency drift in high frequency communications

The inherently stable retrace characteristics of Erie Ceramicons with respect to temperature insures dependable compensation for frequency drift. When properly used, one of these small, silver-ceramic condensers will accurately compensate for drift caused by temperature changes in any number of components in the circuit.

Erie Ceramicons are made in nine different temperature coefficients from +.00012/°C. to —.00075/°C., according to tentative RMA standards. Insulated Ceramicons are made in capacities up to 375 mmf.; non-insulated units up to 1100 mmf., as shown in the table at the left. Write for a data sheet that gives complete characteristics of Erie Ceramicons.

ERIE RESISTOR CORP., ERIE, PA. LONDON, ENGLAND - TORONTO, CANADA.
PERFORMANCE CHARACTERISTICS OF LAPP RADIO INSULATORS ARE DEPENDABLE FACTORS

Lapp's contributions to radio broadcast engineering are recognized as highly significant in the advance of the science. Practically every development of antenna structure design, for example, has been worked out with the co-operation of Lapp engineers. Since Lapp developments have been wholly pioneering in nature, it has been necessary to maintain complete testing facilities. In the Lapp laboratory is the usual equipment for 60-cycle electrical, mechanical and ceramic testing. In addition is complete equipment for determining characteristics of units at radio frequency—heat run, radio frequency flashover, corona determination and capacitance. For mechanical testing (lower picture), a 1,500,000 lb. hydraulic testing machine is used—for test of new designs, and for proof-test of every insulator before shipment.

In the construction of new broadcast equipment—or the modernizing of old—the safe bet is to specify "insulators by Lapp." Descriptive literature on Lapp antenna structure insulators, porcelain water coils and gas-filled condensers is available on request. Lapp Insulator Co., Inc., LeRoy, N. Y.

Specify LAPP FOR SECURITY IN ANTENNA STRUCTURE INSULATORS
Extra Stamina

So great is the pounding of these speedy, torpedo firing mosquito boats that their men must be heavily padded and lashed to their stations. Every part, screw and fiber must have extra stamina if these craft are to carry through their mission successfully.

This kind of extra stamina is built into every GAMMA-TRON tube. Sturdy mechanical construction and ability to handle enormous electrical overload makes it possible for them always to complete their mission...even in the face of terrifying abuse.

Complete tantalum construction, special exhaust process, and modern design assure this extra stamina. Write for data on all GAMMATRON tubes 50 to 5000 watt capacity.

HK 854
450 watt plate dissipation
1800 watt output

GAMMATRONS OF COURSE!

May 1942 — ELECTRONICS
In a coil wound with Formex magnet wire the insulation is where it belongs: on the wire itself. The self-sufficiency of Formex wire permits the elimination of cotton or other protective coverings; and in most cases reduces the function of the treating varnish applied after assembly to the single purpose of cementing or bonding. The combined effect is a reduction in the amount of varnish used, and a simplification of varnish treatment.

But more. Formex wire has high solvent resistance, and this allows the use of more efficient varnishes, previously avoided because of their active solvents.

More about varnish treatments, as well as about the other outstanding properties of Formex magnet wire, will gladly be supplied by the nearest G-E office. General Electric, Schenectady, N.Y.

**TEST RESULTS ON THE ACTION OF SOLVENTS**

<table>
<thead>
<tr>
<th>Solvent</th>
<th>Heavy Enamel</th>
<th>Heavy Formex</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kerosene</td>
<td>slight softening</td>
<td>no effect</td>
</tr>
<tr>
<td>Petroleum naphtha</td>
<td>slight softening</td>
<td>no effect</td>
</tr>
<tr>
<td>Toluol coal tar</td>
<td>fails</td>
<td>no effect</td>
</tr>
<tr>
<td>Alcohols—methyl, ethyl, acetyl, butyl, etc.</td>
<td>fails</td>
<td>no effect</td>
</tr>
<tr>
<td>Xyloc coal tar</td>
<td>fails</td>
<td>slight softening at 4000 hr</td>
</tr>
<tr>
<td>Acetone</td>
<td>fails</td>
<td>no effect</td>
</tr>
<tr>
<td>Freon F-12 gas</td>
<td>fails</td>
<td>no effect</td>
</tr>
<tr>
<td>SO$_3$ gas</td>
<td>fails</td>
<td>slight softening at 4000 hr</td>
</tr>
<tr>
<td>Gasoline</td>
<td>fails</td>
<td>no effect</td>
</tr>
<tr>
<td>Asphaltic or petroleum-asphalt compound</td>
<td>fails</td>
<td>no effect</td>
</tr>
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**FORMEX WIRE IS A PRODUCT OF GENERAL ELECTRIC RESEARCH**

**GENERAL ELECTRIC**

*ELECTRONICS — May 1942*
If ounces and inches count...Clare type K

Engineers who are faced with design problems in which space and weight savings are imperative will welcome these details of the Clare Type K d.c. Relay.

As illustrated, it is extremely small, measuring only 1 1/4" x 1 1/2" x 1 1/4", and weighs approximately 1 1/2 ounces...It can be furnished in the contact forms shown above with any number of springs, up to and including 12...coil voltage range is from 1.5 volts to 60 volts d.c....Contacts of either 18 gauge silver, rated one ampere. 50 watts, or 18 gauge palladium, rated two amperes, 100 watts can be furnished.

In addition to the typical Clare "custom-built" features illustrated at the right, this relay has additional features worthy of your consideration...It is unusual in the fact that the design is such that the relay itself is capable of withstanding severe vibration. Therefore, no anti-vibration springs are employed...The screws by which the contact spring pile-ups are fastened to the heelpiece are tightened under pressure and secured into the heelpiece by a coating of Glyptol as an added precaution...All metal parts of this relay are specially plated to withstand a 200 hour salt spray test.

The size and weight of this relay is a very definite contribution to design problems and, like all Clare Relays, can be "custom-built" to meet your specific requirements. Write us regarding them. We will make suggestions. In the meantime, send for the Clare catalog and data book, C. P. Clare & Company, 4719 West Sunnyside Ave., Chicago, Ill. Sales engineers in all principal cities. Telephone address: CLARELAY.

The small coil is equipped with a front speed head having a flat side. This locks the entire coil in place against the heelpiece, preventing it from turning or becoming loose. The screw holding the coil in the heelpiece is equipped with a split type lockwasher. The coil is carefully wound to exact turns on precision machines. Coils can be supplied impregnated with a special varnish. They are covered with a transparent acetate tape. Each coil shows data regarding resistance and type number.

Spring bushings of Bakelite are designed, constructed and attached to the springs so that the small springs used in this relay are not weakened. Uniformity of relay operation and long service life are thereby assured.

**CLARE RELAYS**

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INSULATION AND CABLE COVERING RESISTANCE TESTER
... for use with WESTON Models 785 and 772
An extremely compact unit, operating from any 100-130 volt AC 50-60 cycle supply line... connects into the ohmmeter circuit of Models 785 or 772 by a pair of leads, and provides for resistance measurements up to a value of 900 megohms on the ohmmeter scale. Supplied with Models 785 or 772 on order.* Unit also sold separately for use with instruments now in service.

Already recognized throughout industry as the most complete tool for maintenance test needs, the utility of the Model 785 is now further increased to include insulation and cable covering resistance testing.

Thus this one instrument now serves for checking motor and control circuits... lighting circuits... sensitive relay circuits... communications and electronic circuits... and insulation resistance as well. The broad range coverage of Model 785 is as follows:

DC VOLTAGE...0-1/10/5/200/500/1000 volts - 20,000 ohms per volt. (*5000 volt range with external multiplier.)
AC VOLTAGE... 0-5/15/30/150/300/750 volts - 1000 ohms per volt.
DC CURRENT... 0-50 microamperes, 1/10/100 milliamperes, 1 ampere and 10 amperes (*ranges above 10 amperes with external shunts).
AC CURRENT... self-contained ranges 0-5/1/5/10 amperes (*higher ranges with an external current transformer).
RESISTANCE... 0-3000, 0-30,000, 0-300,000 ohms, 0-3 megohms, 0 to 30 megohms (self-contained batteries), 0-900 megohms (*with compact Model 792 Resistance Tester described at the left)
...

In addition to wide adaptability which enables today's busy plants to cut corners and costs in maintenance and other test work, Model 785 also provides the years of measurement dependability so typically WESTON. The complete story on Model 785 and other WESTON instruments can be secured from the WESTON representative near you, or, by writing Weston Electrical Instrument Corp., 618 Frelinghuysen Avenue, Newark, New Jersey.

*Extra equipment on special order.

ELECTRONICS — May 1942

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SPECIALIZED TEST EQUIPMENT LIGHT MEASUREMENT AND CONTROL DEVICES... EXPOSURE METER... AIRCRAFT INSTRUMENTS... ELECTRIC TACHOMETERS... DIAL THERMOMETERS.

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There's a type of P-K Self-tapping Screw for every type of metal and plastic assembly. No matter what materials you're working with, you'll get stronger, speedier fastenings. You'll save time by eliminating tapping, and you'll save the cost of maintaining taps and tapping equipment.

The change-over to Self-tapping Screws calls for no special skill or special tools—Involves no costly tool-ups. You can start them on your assemblies immediately.

But be sure to specify Parker-Kalon Self-tapping Screws so that your assembly line won't be slowed up by "doubtful screws"—Screws that look all right, but some of which fail to work right. The Parker-Kalon Laboratory, without counterpart in the screw-making industry, guards the quality of every P-K Screw produced. This extra dependability has saved countless hours for war-busy plants. Parker-Kalon Corporation, 192-194 Varick Street, New York, N. Y.
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- **FLEXIBLE VARNISHED OIL TUBING** — SATURATED SLEEVING — meeting the all-purpose requirements of a sleeve insulation to stand guard against breakdown, moisture absorption — all commonly encountered acid and oil influences.

- **VARNISHED GLASS TUBING** — for those applications where extremely high heat resistance becomes the above-all consideration.

- **EXTRUDED TUBING** — where extreme sub-zero temperature resistance to any of the effects of embrittlement becomes a prerequisite.

For proof ask for samples of each; also for new specimen board and list of standard sizes. There is no obligation.

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**Formica**

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For ships, airplanes, tanks, military cars, or for factories, they make accurate control of apparatus easy when no visible light can be used.

They can also be made up into signs to direct the public in hotels, theaters, and buildings during blackouts, if identical signs are needed in sufficient quantity to make manufacture practical.

These plates may be printed in phosphorescent pigments, which are activated by ordinary white light but will glow for two hours or more after the light is turned out. Another type is fluorescent and will glow as long as it is illuminated by "Black" or ultra-violet, invisible light.

Lettering is available in many colors in either type of direction plate. Let us send complete details.

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Many special products have been developed by the Formica research department for special, electrical, mechanical and chemical purposes. If you have a problem that laminated plastics might solve let us hear from you.

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Everlastingly seeking improvements in the performance capabilities of the vacuum tube. That's the creed of the personnel in the Eimac shops. That's why you find Eimac tubes in the key sockets of practically every new development in the field of electronics, why communications men throughout the world have come to measure results in terms of the performance capabilities of Eimac tubes. This high standard of excellence was deliberately planned at Eimac... and is being deliberately maintained despite the rigors of wartime production.

You've found Eimac ahead in the past... they're ahead today... and you'll find them still ahead in the future.
Designing stressed structures of aluminum or aluminum alloys? Building them? You'll want us to rush you one or more free copies of the new Mallory technical booklet, "Spot Welding Aluminum Alloys".

This terse, carefully diagrammed 12-page treatise offers you drawings, graphs, tables and factual descriptions. Here are some highlights:

- **Spot welding characteristics of aluminum and its alloys**... with comparative values for other metals. Tabular data and discussion.
- **Spot welding equipment for aluminum alloys**. Diagrams and descriptive data on:
  a. Welding machines
     1. Magnetic Storage Welders
     2. Condenser Storage Welders
     3. Rectified Three Phase Welder
     4. Standard A.C. Welders
  b. Electrodes
     1. Materials
     2. Design
     3. Electrode Holders and Cooling
- **Design of spot welded joints**. Diagrams, tabular data, graphs and discussion.
- **Aluminum welding technique**. Graphs, tables and discussion relative to the four types of welding machines listed above.

Why not take a moment now to write for your free copy or copies of "Spot Welding Aluminum Alloys"? It's the supplement you need for the 79-page Mallory Resistance Welding Data Book... which also belongs in your technical library.

MALLORY in the Aircraft Industry

Mallory's contributions to resistance welding progress in the aviation industry include: better electrode materials for spot, seam and flash or butt welding; advanced electrode designs; improved holders for spot welding tips; progressive research on electrode cooling; and Malloryton Capacitors for Condenser Discharge Spot Welders.

But that's not the half of it. Mallory Electrical Contacts and Complete Contact Assemblies actuate a host of electrically-driven aircraft accessories... from variable pitch propellers to bomb releases. Mallory Approved Precision Products... vibrators, Vibrapacks, rectostarters, rectifiers, resistors, noise filters, condensers, switches and other electronic parts... all help "Keep 'Em Flying!"

If you want to keep "ahead of the game", you'll appreciate the factual information offered by Mallory metallurgical and electronic engineers. Consult with us freely about your specific problems.

MALLORY in the Aircraft Industry

MALLORY in the Aircraft Industry

MALLORY in the Aircraft Industry

MALLORY in the Aircraft Industry

MALLORY in the Aircraft Industry
BLACKOUT . . . New York City is having a hard time deciding how to turn off its street lights (31,000 of them) during air raids. Several schemes have been advanced to David Sarnoff, head of a committee on defense communication for the city. One plan considered the use of remote control via some sort of “alert” receiver installed at each of the light posts. Another scheme is known as the “odd cycle” method and involves a relay placed in each lamp post sensitive to a small change in power line frequency. In Allentown, Pennsylvania, street lights are turned on and off by a carrier frequency signal sent over the power wires. This was described, briefly, in Electrical World December 13, 1941. The frequency utilized is 4950 cycles and this is amplified enough at the transmitter end to give the required two volts at each remote substation.

PATENTS . . . Last month a department was added to ELECTRONICS for which there has been considerable demand—devoted to recent U. S. patents in our field. For many years a similar department was a regular feature of ELECTRONICS and then, for some reason or other, it was dropped. Now it is here again. The editors wish to point out several things about it: it is written from the weekly publication of the U. S. Patent Office, the Gazette, which anybody can get by subscription; in this publication an illustration and (usually) a single claim of the patent appears; very often the published claim gives no clue as to what the inventor had in mind, and in this case our guess is as good as anybody’s as to what the patent means; not every patent described in the Gazette is described in our department and, therefore, this department is no gage as to the number of patents issued nor do we claim that the most important are reviewed; our estimation as to what the patent means may be totally wrong since many patents are written up to confuse the reader (apparently) and anyhow, we have only a single claim and the diagram to go by.

UHFI . . . In March 1942 we gave Dr. DeForest’s version of what to do about terminology when speaking of the higher and higher frequencies now coming into use. Two more suggestions are at hand. Here they are:

First, from Greenleaf W. Pickard, “Thanks to our valedictorian (DeForest), we may now consider the GUHFI incident closed, and get down to a practical terminology for our ever-widening radio spectrum. It seems to have escaped general notice that frequency units run in steps of a thousand-fold, so we need only two units beyond the megacycle to carry us clear through the visible spectrum and into the ultraviolet. For many years we have had, beyond the now humble million, the billion and trillion, which almost automatically extend our units, so:

Kilocycles 10⁶
Megacycles 10⁶
Billicycles 10⁶
Trillicycles 10⁶

Thus, yellow sodium light, although not quite monochromatic, has a mean frequency of 599.1 trillicycles; and a wavelength of one centimeter is a frequency of 30 billicycles.”

Second, from Burton McKim, “Why not call from 0 to 1 Mc the first octave, then from 1 to 2 Mc the second octave, 2 to 4 Mc the third octave? In this fashion you would have bands roughly comparable to the musical scale and something which could be easily remembered. It is true that some octaves overlap bands which we have now segregated by such names as Standard Broadcast Band, etc. This might be obviated by selecting other limits for the first octave.

“The chief advantages of such a scheme, as I see it, will be that we won’t ever run out of adjectives, or super-adjectives, nor will we be confronted by such things as Dr. DeForest’s ‘Goofy’.”

WAR . . . So far this is a phony war. Four months now and we have not seen a single parade, have not heard a single band, seen no flag go marching by. We’ve seen only one gun and that was strung across the shoulder of a prep school boy and it didn’t look as if it would shoot. We have not had a single lump in our throat, none of that feeling of pride and courage and desire to do something that comes with seeing the flag.

Something new should be added to our war effort; that something should be a parade and a band. Out in Los Angeles the Cannon Electric Development Company has contributed a $15,000 check to the U. S. Navy, the result of a three-shift Sunday’s work, the employees contributing their day’s wages, the company an equivalent amount in cash. They got out a navy band and an Admiral with lots of gold braid and had a whale of a big time. This war is no phony to them. It’s our guess that if management (or labor) asked for a military band and a thousand soldiers to parade the next time labor (or management) got uppish, there would be no need to holler for help from any labor relations board. P. S. There was a swell parade on April 4 in New York City and a lot of throat lumps. Hurrah!
$300,000 AM-FM radio installation provides two-way communication between toll booths at ten interchanges, six maintenance buildings, portals of seven mountain tunnels, turnpike patrol headquarters, mobile units traversing the 161-mile super highway and distant offices of the State police. Automatic repeater stations, and horizontally and vertically polarized antennas, play an important part in performance.

Setting a Super Highway Pattern for the future, the Pennsylvania Turnpike traverses the Allegheny Mountains from Middlesex (16 miles west of Harrisburg) to Irwin (21 miles east of Pittsburgh), occupying for much of its 161 mile length the 200 ft. wide right-of-way of the abandoned South Pennsylvania Railroad.

The turnpike speeds automobile traffic from its 400 ft. eastern and 1,000 ft. above-sea-level western approaches across successive valleys, ranging up to 2,500 ft. in altitude. It avoids stiff switchback climbs by tunnelling boldly through the 3,532 to 6,782 ft. bases of seven mountain ridges crossing its path. These rise from 300 to 1,000 ft. above easy valley grades.

There are 11 entrances and exits or “interchanges” along this super highway. At ten of these (all except Middlesex) there are utility buildings, built off at either side of the right-of-way with ticket booths straddling the highway itself or feeder roads. There are, in addition, six maintenance buildings, set back on their own service roads a short distance from the highway at other points, and ventilation buildings at both portals of each of the seven tunnels (except at Ray's Hill, which has no ventilation building at its eastern portal). Turnpike police occupy a headquarters building at “The Midway.”

High driving speeds permitted by the concrete surfacing of this barrier-divided six-lane highway having banked turns, long straightaways and no grade crossings require close traffic supervision. Twenty-six police cars are assigned exclusively to the turn-
pikes to provide such supervision, a patrol passing any given point at least once every 20 minutes. The rugged country through which the highway passes also requires close coordination of maintenance facilities.

**Communications Contract Specifications**

While the highway was in the blueprint stage it became obvious to the Pennsylvania Turnpike Commission that traffic control, accident handling and road maintenance could be facilitated by equipping patrol cars with two-way radio equipment so that patrols could communicate with each other and also with all the fixed points listed above. It was simultaneously decided that, inasmuch as most of the fixed points were remote from telephone lines, radio rather than land lines would also be used for inter-communication between all fixed points. (A number of independent telephone companies operate in the area traversed by the turnpike, many of them using dissimilar equipment.) Thus highway communications involve radio alone. There are no telephones on the turnpike’s entire right-of-way.

Specifications, prepared for the Commission by resident engineer William F. Gould, required two-way simplex communication between the following points:

- Thirty cars (26 patrol cars and four used by the superintendents of fares, maintenance, police and communications); seventeen ticket booths at interchanges and the ten utility buildings associated therewith; six maintenance buildings; and patrol headquarters at The Midway. Specifications also required a tie-in between all fixed points and mobile units on the highway and the Commission’s Harrisburg offices as well as with station WPSP, maintained by the Pennsylvania Motor Police elsewhere in that city.

The communications system contract required that

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**PHYSICAL PANORAMA**—The lower drawing shows pictorially the location of all fixed turnpike stations, the distances between them and approximate altitudes of stations above sea level. Dotted lines from antenna poles to buildings indicate coaxial r-f feeders. Dotted lines between buildings indicate audio and power cabling. Road direction is not, actually, a straight line.

**ELECTRONIC PANORAMA**—The upper block diagrams show frequencies upon which fixed stations transmit and receive, methods of modulation, antenna polarization and directivity, types of antennas and their grouping on supporting poles. Mobile stations, not diagrammed, transmit 37.5 Mc a.m signals and receive 33.94 Mc f.m signals.

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**ELECTRONICS — May 1942**
tuned determines whether than half the interchange the turnpike's pike, frequency modulated Allegheny, the receivers reception all equipped an carrier requirement. There the function very upon which portal ventilation buildings in the bases of the hills upon which these transmitters stand.

Why Both AM and FM

Repeater stations operating on 116-119 Mc channels function very much like u-h-f television relays. But any one of them must be able to initiate operation of the entire chain when excited by a 37-5 Mc amplitude modulated signal. There is also another special requirement.

Repeater transmitters convey speech as well as carrier control currents. Any fixed point, such as an interchange or maintenance building, may be equipped with a 116-119 Mc receiver tuned to the nearest repeater. Since the repeater stations do not all use the same transmitter frequency 116-119 Mc reception is impractical for cars moving along the turnpike. Patrolmen would have to re-tune their receivers when leaving an area covered by a repeater operating on one frequency and entering the field of the next repeater, operating on another frequency. Therefore frequency modulated transmitters uniformly tuned to 33.94 Mc were also installed in the buildings housing repeater transmitters atop Laurel, Allegheny, Sideling and Blue Mountain. These frequency modulated transmitters are always placed in operation simultaneously with the 116-119 Mc amplitude modulated repeater transmitters located in the same buildings. (Frequency modulated transmitters were not needed on Ray's Hill or Tuscarora as the four mentioned above provide adequate field strength for cars over the entire length of the turnpike, even penetrating 85 percent of the way through the turnpike's longest tunnel.)

All car receivers are frequency modulated units tuned to 33.94 Mc. As a matter of fact, so are more than half the interchange and maintenance building receivers, although at fixed points local field strength determines whether an amplitude modulated receiver tuned to a 116-119 Mc repeater or a 33.94 Mc frequency modulated receiver is used.

Because repeater stations use different frequencies, auxiliary hilltop transmitters were obviously necessary to serve the patrol cars. Why frequency modulation rather than amplitude modulation for this purpose? Because the use of frequency modulation prevents heterodyning between 33.94 Mc transmitters located on high hills when patrol cars are midway between, which would certainly have been prohibitive if these transmitters were amplitude modulated on the same frequency. It is well known that the strongest frequency modulated carrier, operating on a given frequency, blankets out a weaker signal similarly modulated. Frequency modulated transmitter field strength between hills is so smoothly "blended" that patrolmen cannot tell from reception when they are passing from an area covered by one station to that of another.

Typical Message Routes

Before proceeding with details of the system, it seems desirable in view of the several frequencies, modulation and control methods involved to give one or two examples illustrating the manner in which typical messages get from point to point. Discussion on a point-to-point basis may aid the reader in his study of the system even though, as previously stated, "everybody listens when anybody talks."

Assume that a patrol car moving along the turnpike between Blue Mountain and Carlisle interchange, near the eastern end of the highway, wishes to summon an ambulance parked beside the ventilation building at the western portal of Tuscarora tunnel. The patrolman listens to make sure the 161 mile long "party line" system is not in use. Then he depresses his push-to-talk button, waits 15 seconds to be certain all repeater station relays are energized and calls. His 37.5 Mc amplitude modulated signal excites and modulates a receiver on top of Blue Mountain and electrical relays in the output circuit of this receiver turn on the 116.15 Mc repeater at that point. (All other repeater stations are turned on by 116-119 Mc radio remote control.) A 116.15 Mc receiver on Tuscarora Mountain, 10.4 miles to the west, picks up the amplitude modulated Blue Mountain signal and feeds audio down the hillside over a cable to Tuscarora's west portal building (as well as to the Tuscarora transmitter). The attendant at that point speeds the nearby ambulance on its way.

To acknowledge the call from the patrol car, the Tuscarora tunnel portal attendant turns on the 118.55 Mc amplitude modulated repeater transmitter on the hill high over his head by electrical remote control, waits 15 seconds and calls the car. The signal from the Tuscarora repeater transmitter energizes relays in the output circuit of a 118.55 Mc receiver on top of Blue Mountain and these relays turn on the 33.94 Mc frequency modulated transmitter (as well as the 116.15 repeater transmitter) at that point. The patrol car's fixed-tuned frequency modulated receiver picks up the signals from Blue Mountain and the patrolman knows the ambulance is on its way.

All point-to-point messages, it will be seen, must

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ANTENNAS

HORIZONTAL HALF WAVE ANTENNA

HORIZONTAL BI-DIRECTIONAL ARRAY

VERTICAL BI-DIRECTIONAL ARRAY

HORIZONTAL UNIDIRECTIONAL ARRAY

TRANSMISSION LINE

DETAILS—The five antenna types used by fixed stations are here illustrated, with electrical as well as mechanical data shown. All of them employ 70 ohm coaxial transmission lines.

VERTICAL HALF WAVE ANTENNA

LAUREL

ALLEGHENY

SIDEWELLING

TUSCARORA

BLUE

REPEATERS—The six hilltop stations have two 40 ft. poles apiece, with 116-119 Mc relay receiving and transmitting antennas on the separated poles to minimize interaction. Antennas feeding 37.5 Mc amplitude modulated repeater control receivers and antennas transmitting 33.94 Mc frequency modulated signals to cars and some fixed points are mounted on these same poles, similarly separated. Poles shown at the left in the drawings are near the northern boundary of the turnpike’s right-of-way.

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pass through at least one mountain top repeater station (the rare exceptions being contacts between wire-connected Donegal interchange and maintenance buildings, Burnt Cabins maintenance building and Tuscarora tunnel's portals, Kittatinny and Blue Mountain tunnel portals). No conversation of any kind, between any two points, can be held without placing all of the repeaters in operation.

**Pennsylvania Turnpike**

**ANTENNA and FEEDER DETAILS**

As mentioned in the preceding general analysis, 116-119 Mc amplitude modulated hilltop repeater transmitters are prevented from blocking 116-119 Mc repeater control receivers located in the same buildings by operating successive repeaters on different frequencies within the licensed band. Interaction is further minimized by mounting 116-119 Mc receiving and transmitting antennas on separate 40-ft. poles, spacing the two poles as far apart (up to 160 ft.) as right-of-way width permits.

A final precaution to avoid interaction between individual pairs of 116-119 Mc repeater transmitters and receivers is the use of vertically and horizontally polarized antennas. Starting at the eastern end of the turnpike and tracing repeater signals west, the Blue Mountain repeater transmits a vertically polarized 116.15 Mc wave westward. Tuscarora receives this signal on a vertically polarized antenna located on one pole near the northern right-of-way boundary and repeats it on 118.55 Mc over a horizontally polarized transmitting antenna located 139 ft. south. Sideling picks up the horizontally polarized 118.55 Mc signal from Tuscarora and repeats it, vertically polarized, on 117.75 Mc. Ray's Hill picks up the vertically polarized 117.75 Mc signal and repeats it, horizontally polarized, on 118.15 Mc. Allegheny picks up the horizontally polarized 118.15 Mc signal and repeats it, horizontally polarized, on 117.35 Mc. Laurel Hill picks up the horizontally polarized 117.35 Mc signal and repeats it, vertically polarized, on 116.15 Mc. Tracing repeater signals from west to east instead of from east to west, the same transmitters successively excite each other in a similar manner, using a different set of 116-119 Mc control receivers and receiving antennas.

It will be noted that the ideal scheme of avoiding the use of similarly polarized 116-119 Mc receiving and transmitting antennas at any one repeater location is violated at Ray's Hill when working west and on Allegheny when working east. Frequency separation and orientation of antennas was relied upon at these two points to avoid interaction. Horizontally polarized signals pass in both directions between Ray's and Allegheny because this 40-mile stretch is the longest 116-119 Mc path signals are called upon to traverse and the horizontally polarized beam antennas used in this communication system give somewhat greater directional gain than do the vertically polarized types.

Repeater stations employ directional antenna arrays for transmission and directional arrays (as well as...
REPEATER BUILDING INTERIOR—This typical hilltop structure contains a 50-watt 116-119 Mc amplitude modulated repeater transmitter, a 250-watt 33.94 Mc frequency modulated transmitter and a steel-enclosed rack and panel unit housing control receivers and automatic relays.

HILLTOP REPEATER BUILDING—One of six identical cinder-block structures. Coaxial transmission lines are bunched in a weatherproof canvas cover, divide just above the building and are carried horizontally to two antenna poles (one of which is visible here) suspended from a steel messenger cable.

REMOTE CONTROL RECEIVERS—Two of the units at the left are fixed tuned in the 116-119 Mc band while the third is tuned to 37.5 Mc. All three are amplitude modulated receivers and excitation of any one of them turns on associated transmitters. The three cases at the right contain receiver power supplies.

AUTOMATIC RELAY PANELS—Six of these special units, photographed before shipment to the turnpike, are installed in hilltop repeater buildings while the seventh performs "shuttle" relay duties at the Midway police patrol headquarters. Repeater station control receivers are inside these same cabinets.
REPEATERS

simple dipoles) for reception in the 116–119 Mc automatic relaying band. The only other point in the entire system using a directional array (a special "star" with parasitically excited reflector) is The Midway patrol headquarters. There are no directional arrays of any kind used in the 30–40 Mc band.

**Dipoles and Directional Arrays**

Three directional array types are used by the 116–119 Mc repeaters. These, identified as types B, C and D in accompanying drawings, are as follows: B consists of two horizontal dipoles stacked one above the other ½ wavelength apart and cross-connected to operate in phase, providing bi-directional broadside directivity. C consists of a horizontal dipole with a so-called "close-spaced" parasitically excited director and a similarly excited reflector element, giving uni-directional gain. D consists of two "star" type antennas having vertical ½ wavelength radiators and four ground-plane elements, the two stars mounted ½ wavelength apart and fed in phase accomplishing bi-directional broadside directivity.

Antenna types A and E are simple dipoles, the first having horizontal and the second vertical polarization. Vertical dipole E consists of a ¼ wavelength rod, mounted on an insulator atop a steel tube extending above the supporting pole and a ¼ wavelength pipe "skirt" dropped down over the tube. The skirt is electrically connected to the supporting steel tube at the top but insulated from it at the bottom. A 70-ohm co-axial transmission line with its inner conductor connected to the base of the ¼ wavelength rod and its outer conductor connected to the top of the ¼ wavelength skirt is properly terminated and a suitable impedance match obtained between transmission line and antenna without recourse to a matching stub.

**Impedance Matching Stubs**

Horizontal dipole A and directional arrays B and C use 70-ohm coaxial transmission lines but matching stubs are required because the mechanical design of these antennas is such that an impedance of 35 ohms

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appears at their centers. Stubs illustrated in accompanying drawings are a full wavelength long, the coaxial transmission line tap position \( \frac{1}{2} \) wavelength away from one end of the stubs accomplishing two things, i.e., preservation of proper phase relationship between dipole halves and termination of the transmission line in 70 ohms. (The \( \frac{1}{2} \)-wavelength and \( \frac{3}{2} \)-wavelength sections of the stub actually present two 140-ohm impedances in parallel at the point where the co-axial transmission line taps in.)

The "double star" type D directional array is fed by a 70-ohm co-axial transmission line, a \( \frac{1}{2} \) wavelength stub system tapped at the center preserving required phase relationship and presenting a 70-ohm termination at the end of the line.

Several 116-119 Mc repeater station control receivers use type E vertical dipoles where directional gain is not required. Separate antennas of the same type are also used on the hilltops for reception of 37.5 Mc exciter signals from interchanges, maintenance buildings and cars. Still other type E vertical dipoles are used on the hilltops for transmission of 33.94 Mc frequency modulated signals.

**Exciter Station Antennas**

Type E vertical dipoles are invariably used for transmission of 37.5 Mc exciter signals from interchanges.
and maintenance buildings and where these fixed points are equipped with 33.94 Mc frequency modulated receivers these dipoles serve for both transmission and reception. Where interchanges and maintenance buildings receive signals from horizontally polarized 116-119 Mc repeaters, separate type A horizontal dipoles are erected on the same pole.

It may be noted when studying the drawings that the Newville maintenance building transmits on a type E vertical dipole resonant at 37.5 Mc and receives 116.15 Mc vertically polarized signals from the Blue Mountain repeater on the same antenna. In this instance there is sufficient signal strength from the nearby repeater to give satisfactory reception despite the obvious mismatch on 116.15 Mc. The common Harrisburg 37.5 Mc transmitting and 33.94 Mc receiving antenna, on the other hand, is cut to resonate at 35.5 Mc, this compromise being necessary to insure satisfactory two-way contact with the more distant Blue Mountain repeater.

Coaxial R-F Transmission Lines

All fixed station antenna types described have their own individual coaxial r-f transmission lines. All of these consist of solid copper inner conductors, copper tubing outer conductors and ceramic spacers. All r-f transmission lines are filled with dry nitrogen.

Lines come down the steel poles supporting antennas lashed to the outside of these poles between climbing spikes. From the base of interexchange and maintenance building poles (40 or 75 ft. high, depending upon location) the lines run underground in 18-inch deep trenches to transmitters and receivers. Up at the hilltop repeater stations, where there is no aesthetic need for concealing feeders, coaxial lines are grouped together in 3-inch diameter weatherproof canvas covers (to avoid formation of ice between lines) suspended from messenger cables stretched tautly between the two poles. The bunched feeders drop down from a junction point near the center of this horizontal span to repeater station houses.

Mechanical Design and Construction

Antenna supporting poles are galvanized inside and out and all antenna elements, fittings and supports are either galvanized or are made of copper, brass or bronze to withstand the rigors of weather. Antennas and their supports were designed to withstand transverse wind pressures of 50 lbs. per sq. ft. when coated with ½ inch of ice.

Antenna type D lends itself reasonably well to placing of insulation where it is subjected to minimum mechanical strain. The driven elements of antenna types A, B and C are unique in this respect because, as will be seen from detailed antenna drawings, each tubular element is placed coaxially over a smaller galvanized steel rod driven through-and-through the supporting pole. A metal shorting plug between the outer ends of the tubing and rods and an insulated spacer between their inner ends holds the outer, or radiating, tube in place over the strongly supported inner rod in such a manner that there is almost no weight and little mechanical strain on the ceramic spacer at the inner end. (This insulated spacer is necessary to "split" the ± wavelength radiator and provide a low impedance feed point.)

Considered from a direct-current standpoint, the outer ends of the driven elements are grounded through the metal shorting plugs to the supporting pole. But at the radio frequency resonant period of the antenna there is little or no r-f voltage near the center of the dipole. The inner steel rod thus serves as a "metallic insulator," voltage appearing on its outer end tapering off to zero as the supporting pole is approached. (Note that the parasitically excited director and reflector elements of antenna type C are supported by similar "metallic insulators" fastened at their voltage nodes and at the grounded supporting pole.) These antennas therefore function very much the same as dipoles of more conventional design having their elements supported entirely by center insulators.

Pennsylvania Turnpike

REPEATERS and TUNNEL REMOTES

REPEATER station equipment is housed in unheated, 5 by 5 ft. square buildings of cinder block construction. These are seven feet high, have raised concrete floors, copper roofs and a steel door. They are built as near the turnpike right-of-way center line as hilltop terrain permitted.

Housed in the buildings on Blue Mountain, Sideling, Allegheny and Laurel are three steel encased units: A 50-watt, 116-119 Mc amplitude modulated repeater transmitter; a 250-watt, 33.94 Mc frequency modu-
REPEATER—50-watt, 116-119 Mc amplitude modulated transmitter of special design. There is one of these at each of the six hilltop relay stations and one at the Midway patrol headquarters.

AUXILIARY—250-watt, 33.94 Mc frequency modulated transmitter. Four of these are used, one each at Blue Mountain, Sideling, Allegheny and Laurel.

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TRANSMITTEDS (continued)

FIXED EXCITER—50-watt, 37.5 Mc amplitude modulated transmitter. One of these is installed at each of the interchanges. Its signals turning on the nearest hilltop repeater station. Speech equipment, not diagrammed, is in another unit.

MOBILE EXCITER—22-watt, 37.5 Mc amplitude modulated transmitter. One of these is installed in every patrol car. Maintenance buildings (and WPSP at Harrisburg) are equipped with this same transmitter, operated from the highlines.
lated transmitter; a rack and panel unit containing control receivers and automatic relaying equipment. Equipment at Tuscarora and Ray's is the same, except for the fact that at these two repeater houses there are no frequency modulated transmitters.

Transmitters and Receivers

Special 50-watt, 116-119 Mc amplitude modulated repeater transmitters, shown schematically within these pages, employ 12 tubes. Two are rectifiers in the power supply, two are audio drivers, four are push-pull modulators and the remaining four are in r-f service. The r-f section starts with an 807 crystal oscillator operating somewhere between 12.9 and 13.2 Mc (the exact frequency depending upon the repeater station at which the transmitter is installed) followed by a capacity-coupled 807 tripling to 38.7-39.6 Mc. The 807 is link-coupled to a push-pull 829 tripler delivering 116.1-118.8 Mc driving power to the final push-pull 829 via capacity coupling. Resonant lines roughly tuned by shorting bars and finely tuned by variable condensers placed near their high r-f potential ends are used in the output circuit of the 829 tripler-driver and in both the input and output circuits of the final 829.

The 250-watt 33.94 Mc frequency modulated transmitters employ 14 tubes in all, four of these being in the power supply. Modulation is obtained by the phase-shift method. R-f design is conventional for police service equipment operating at this frequency.

One 116-119 Mc amplitude modulated repeater control receiver is used at Blue Mountain and at Laurel, two at Tuscarora, Sideling and Allegheny and three (the third unit tuned to The Midway patrol headquarter's 116.95 Mc 'shuttle' relay transmitter) at Ray's Hill. All of these receivers are fixed tuned, crystal controlled double superheterodynes with three detectors, using harmonic oscillators and intermediate frequency amplifiers adjustable between 1.94 and 2.06 Mc and between 10.7 and 11.06 Mc. They have radio frequency amplifiers, a.v.c., noise-balancing and squelch circuits. Twelve tubes are used, including rectifier. Amplitude modulated 37.5 Mc repeater control receivers, of which there is one at each of the hilltop stations, are similar double superheterodynes using a somewhat different tube lineup. Intermediate frequency amplifiers are adjustable between 415 and 495 kc and between 5.5 and 7.5 Mc.

Sensitive, Delay and Power Relays

When repeater station transmitters are to be placed in operation and modulated by 37.5 Mc signals radiated from distant cars, interchanges or maintenance buildings, or by 116-119 Mc signals from other repeaters, it is obvious that local receivers tuned to these frequencies must turn on these transmitters and then serve as speech amplifiers for them. And only one signal must be capable of placing a repeater in operation and modulating it at a given time. This calls for a complex combination of relays between repeater station receivers and transmitters.

TOLL BOOTH CONTROL—Each booth, at every interchange, can listen and talk. The meter is an r-f indicator, included to make doubly sure that two or more ticket collectors do not modulate the repeater-exciting 37.5 Mc transmitter at their interchange at the same time.

Each individual repeater station receiver is equipped with a sensitive relay. When this relay is actuated all other receivers in the repeater building are at once effectively muted. Operation of the sensitive relay actuates a 2.5-second time-delay relay (delay is required by the FCC to guard against accidental operation of unattended repeaters by stray signals and static). The time-delay relay then energizes a sequence of power relays which turn on the transmitters and simultaneously feed audio output from the receiver to transmitter modulators through a 100-4,000 cycle bandpass filter discriminating against unwanted frequencies.

Once placed in operation in this manner, the transmitters continue to operate for two minutes, at the end of which time the signal originally exciting them loses control and they automatically turn themselves off. This is a design precaution included to prevent the system from being tied up by unnecessarily long conversations. They can be re-energized by the offending operator only if he momentarily turns off his exciter transmitter and then turns it on again. At the completion of a normal transmission the relays operate in reverse sequence. Transmitters leave the air, time delay relays re-set and all sensitive receiver relays are
cleared for incoming signals in this order.

Repeater station relay racks must also provide electrical remote control of transmitters from one or more tunnel portal ventilation buildings. Two such remote controls are required at Tuscarora, Sideling, Allegheny and Laurel. One is needed at Ray's, where only the western tunnel portal is equipped. Four are needed at Blue Mountain, which has remote at both tunnel portals and also handles the two portals of nearby Kittatinny, the one tunnel hill upon which there is no repeater station.

East and west portal buildings of individual tunnels are tied together by two-wire lines running through the tunnels. One of the portal buildings at each tunnel is linked to the repeater station on the top of the hill through which the tunnel runs by a two-wire “parkway” cable buried in an 18-inch deep trench carried from the base of the hill to the top. Low voltage transmitted over this cable permits the hilltop repeater stations to be turned on and off from the tunnel portal buildings.

Tunnel portal ventilation buildings from which cables rise to hilltop repeaters are equipped with 5-tube remote control units. In these units, shown schematically among accompanying diagrams, two tubes operate as microphone output amplifiers and are provided with an audio level meter. Audio voltage delivered to hilltop relay racks over the parkway cable carrying control voltage modulates the hilltop transmitters. Two separate tubes amplify audio which is fed down over the same two wires from the repeater control receivers and drive a built-in speaker. The fifth tube serves as a common power supply rectifier.

Similar, but somewhat simpler remote control units are used at portal buildings linked to these main portal remote controls by wire lines running through the tunnels.

Audio and Power Cables

Another parkway cable, originating in the tunnel portal ventilation building from which the control and audio line rises to hilltop repeater stations is laid in the same trench and carries 220 volt 60-cycle power up to the repeater buildings. Control and power cables running from ventilation buildings to hilltop repeater stations range up to 3,000 ft. in length, exclusive of the runs through tunnels between east and west portals.

A 5-kw gasoline driven generator installed at the bottom or ventilation building end of the 220-volt supply cable automatically cuts in and delivers emergency power to remote control amplifiers as well as repeater equipment high overhead in the event that highline service fails. All repeater stations are protected against power failure in this manner.

INTERCHANGE and MAINTENANCE BUILDINGS

All ten interchange utility buildings are equipped with 50-watt, 37.5 Mc amplitude modulated transmitters. These, exciting distant repeater stations in the manner described in earlier paragraphs, are of conventional u-f police service design.

In the Blue Mountain, Willow Hill, Fort Littleton and Breezewood interchange utility buildings, there are 116–119 Mc amplitude modulated receivers identical to those used in repeater stations. Carlisle, Bedford, Somerset, Donegal, New Stanton and Irwin interchange utility buildings are equipped with 33.94 Mc frequency modulated receivers employing 11 tubes including rectifier. These receivers are fixed-tuned, crystal controlled, double superheterodynes. They use harmonic oscillators and three detectors. The first i-f amplifier is adjustable between 4.2 and 6.4 Mc and the second is adjusted to 455 kc. Noise is suppressed in the carrier-off condition, or when signal strength falls below 1 mv absolute, by a rejection circuit. Bandwidth at 1 mv input is approximately 40 kc.

Interchange ticket booths, of which there are five at Irwin, four at Carlisle and one each at other interchanges, are cabled to adjacent interchange utility buildings. Each ticket booth is equipped with a handset and speaker, permitting utility building transmitters and receivers to be remotely controlled and thus making two-way radio communication possible between any ticket collector and any other point on the entire turnpike system including mobile patrol units. All
REPEATERS—116-119 Mc amplitude modulated receiver. One or more of these are used at each of the six hilltop stations. Several interchanges and a majority of radio-equipped maintenance buildings use one apiece. (37.5 Mc amplitude modulated receivers employed at repeater stations, not diagrammed in these pages, are identical from a circuit standpoint, differing only with respect to tubes and intermediate frequencies.)

MOBILE—33.94 Mc frequency modulated receiver. One of these is used in every patrol car. Most interchanges and maintenance building use one apiece. WPSP at Harrisburg has one...
ticket booths and interchange utility buildings are equipped with r-f indicating devices consisting of LC circuits fixed tuned to 37.5 Mc, halfwave diode rectifiers and one-milliampere direct-current meters. These, picking up r-f signals from the local transmitting antenna, indicate to busy ticket collectors when their local transmitter is in use, visually supplementing aural checks sometimes difficult when traffic noise momentarily obscures sound emanating from speakers. These devices prevent two or more operators at one interchange from modulating the communication system simultaneously.

All interchange utility buildings are equipped with 1-kw gasoline driven emergency generators which automatically cut in if highline service fails.

**Toll Booth Burglar Alarms**

All ticket booths and interchange offices are equipped with burglar alarms designed to foil holdups. It is impolitic to say more concerning these than that operation of a concealed manual switch by a ticket taker transmits a 30-second film-recorded warning over the entire communication system and simultaneously mutes the speakers at the attacked interchange so that communication between other points for the purpose of effecting a rescue may thereafter be carried on without the intruder being aware of it.

Maintenance buildings at Newville, Everett, Kegg and Somerset are equipped with 22-watt, 37.5 Mc amplitude modulated transmitters of conventional design. Everett uses a 33.94 Mc frequency modulated receiver while the other three maintenance buildings mentioned have 116–119 Mc amplitude modulated receivers such as those used in repeater stations and at certain of the interchanges. All four of these maintenance buildings are equipped with r-f indicating meters such as those used in interchange ticket booths and offices. All four are provided with 200-ampere hour, 6-volt storage batteries, battery chargers and dynamotors for emergency power supply in the event that highline service fails.

The Donegal maintenance building is connected by parkway cable to the transmitter and receiver installed at the nearby Donegal interchange, obtains highline and emergency power from that point, and is equipped with an r-f carrier indicator. The Burnt Cabins maintenance building is wire linked to the remote control at the west Tuscarora tunnel portal ventilation building. Equipment at both these points is similar to the remote control units used at tunnel portals.

**Pennsylvania Turnpike
MOBILE and SPECIAL EQUIPMENT**

PATROL and other two-way radio equipped cars used on the turnpike have 22-watt, 37.5 Mc amplitude modulated transmitters (identical with those used at maintenance buildings) and 33.94 Mc fixed-tuned frequency modulated receivers identical to those used at certain interchanges and maintenance buildings.

Transmitter, receiver and high voltage supply dynamos are installed in the rear trunk compartment, with handset, speaker and controls on the instrument panel. All cars are equipped with heavy duty charging generators and 200-ampere hour storage batteries.

A single vertical ¼ wavelength steel whip-type antenna serves for both transmission and reception, and is connected to transmitter and receiver tank circuits through the send-receive relay.

**Shuttle Repeater Station**

Equipment maintained at The Midway police patrol headquarters consists of a special automatic relay rack, a 116.95 Mc amplitude modulated 50-watt transmitter similar to those used at repeater stations, a 33.94 Mc frequency modulated receiver and a 37.5 Mc amplitude modulated receiver. Two poles 75 ft. high spaced 95 ft. apart support a "star" transmitting antenna with a parasitically excited reflector and a type E vertical dipole serving commonly for reception of 37.5 and 33.94 Mc signals.

Although its individual units will be familiar, this unique combination of equipment, quite unlike any combination found elsewhere in the turnpike system, serves as a "shuttle" repeater. When the turnpike system was originally planned it was believed that the transmission path of 40 miles between Ray's Hill and Allegheny was too long for a reliable 116–119 Mc repeater signal hop. The Midway station was to have served as a full-fledged 116–119 Mc repeater between these two hills. It was later determined that this was unnecessary but it was decided to guard against the possibility that 37.5 Mc signals from patrol cars mid-
way between Ray’s and Allegheny might not be able to satisfactorily excite either repeater by picking up such signals at The Midway and feeding them through the fixed transmitter at that point to Ray’s.

Shuttle repeating by The Midway equipment takes place as follows: A nearby patrol car transmits, its signal is picked up on the E antenna and The Midway’s 37.5 Mc receiver relay is energized. The station’s 116.95 Mc transmitter is automatically turned on and the car’s signal is fed to a 116.95 Mc receiver at Ray’s, exciting this hilltop station’s repeater transmitter. When equipment at patrol headquarters is not engaged in such shuttle service the 116.95 Mc transmitter may be used as an exciter transmitter (there is no 37.5 Mc exciter transmitter at The Midway police patrol headquarters) for messages originating at that point, while the station’s type E antenna and 33.94 Mc frequency modulated receiver provide reception from Sideling.

**Forestry Service Tie-In**

At longwave police station WPSP, operated by the Pennsylvania Motor Police in Harrisburg, there is a 22-watt, 37.5 Mc amplitude modulated transmitter identical with those found in turnpike maintenance buildings. There is also a standard 33.94 Mc frequency modulated receiver. Both units utilize a common type E vertical dipole mounted on top of a tower 148 ft. high. Thus State police officials may monitor all conversations taking place over the turnpike communication system, being tuned in on the frequency modulated transmitter at Blue Mountain. More important, they can talk over the turnpike system by energizing the repeater at Blue Mountain in precisely the same manner in which other fixed points with 37.5 Mc exciter transmitters energize it. Weather reports, coming in hourly from Department of Forests & Waters radio stations scattered around Pennsylvania are frequently repeated for the benefit of turnpike maintenance men, permitting them to anticipate and prepare for conditions which might otherwise disrupt traffic. Cinder trucks, for example, are frequently dispatched from maintenance buildings to threatened areas along the turnpike when icing of the road is expected.

**REAR TRUNK COMPARTMENT**—One unit in this typical patrol car is a 37.5 Mc amplitude modulated repeater-exciters transmitter and the other is a 33.94 Mc frequency modulated receiver. The dynamotor visible at the upper left delivers high voltage to the transmitter. The receiver dynamotor is encased

The Pennsylvania Turnpike Commission’s own offices, located elsewhere in Harrisburg, are linked to WPSP over a leased telephone line. Thus the Commission’s officials may monitor turnpike conversations and also talk over its communication system. Line amplifiers used at both ends of the leased telephone line are conventional in design and control equipment closely resembles that used at remote control points along the turnpike itself. Emergency power supply equipment at both Harrisburg points consists of 200-ampere hour, 6-volt storage batteries and battery chargers.

**Pennsylvania Turnpike**

**INSTALLATION and SERVICE EXPERIENCE**

The turnpike communication system required 65 men, directed by D. N. Lapp and field assistants E. T. Rowland, M. Rodgers, Leon Schwartz, Charles Grosser, Bernard Bierman, R. A. Woodward, D. Crabtree, Harry Lapp and William Felsher, a little over six months to install. (Automatic repeater relay rack circuits were developed over a period of four years in connection with other Raymond Rosen & Company communication contracts. Construction of some equipment for the turnpike job was started several months before field installation work began.)

Engineers Rowland and Rodgers continue in residence near the turnpike until September 1942, supervising service until that time under the terms of the contract. A frequency meter, u-h-f signal generator, tube tester, audio oscillator and circuit analyzer used in maintenance work remain the property of the turnpike when its own engineers take over.

Some Minor Changes

Since the communication system was completed there has been some substitution of frequency modulated receivers for amplitude modulated receivers at fixed points. Minor changes have been made in a few control circuits. Mercury-vapor rectifier ovens originally installed in repeater station transmitters proved adequate protection against winter temperatures as low as -35° F but it was subsequently necessary to do something about crystal drift in the summer time, when outside temperatures went to 95° F and inside temperatures soared to 140° F. Thermostatically controlled exhaust fans in each repeater building cured this “summer complaint.”

Considering the fact that the turnpike installation involves 56 transmitters, 64 receivers, 79 antennas erected in particularly exposed country, hundreds of automatic repeater station relays actuated by an average of 100 transmissions each 24 hours and remote control equipment operated by comparative laymen, it is considered particularly trouble-free and a credit to the electronic art.—W. MacD.
The FLUXGRAPH

An automatic machine for plotting the magnetic fields of coils. May also be used for studying deviations from a standard pattern caused by irregularities in windings or inaccuracies in the dimensions or positioning of core materials.

By PAUL G. WEILLER
Research Department
Kollmorgen Instrument Division
Square D Company

IN THE COURSE of our research work, it became necessary to determine the field configuration of odd shaped air core coils and magnetic circuit parts. The volume of work was too great to permit the usual method of point by point flux determination with a manually operated search coil. It became advisable to design and build a machine which would automatically plot magnetic fields on paper. The method of plotting desired upon was as follows:

The coil to be investigated is firmly fastened to the center of a turntable which may be indexed at various angles by means of a pawl and ratchet arrangement. The test coil is energized. A search coil, rotated at 1800 rpm, is attached to a carriage and travels from the periphery of the turntable toward the center. As the search coil approaches the test coil the voltage induced in the search coil increases. At a predetermined output voltage an electronic trip circuit causes the position of the search coil to be recorded on a paper disc attached to another turntable rigidly coupled to the turntable carrying the test coil. At the same time the carriage motion is reversed and both turntables are indexed to the next position. The search coil and recording stylus travel back toward the periphery of the turntables, where motion is again reversed by a limit switch and the process is repeated.

The plot obtained in this fashion is a line of equal flux density. A number of such plots can be taken with the search coil at various heights and for any number of positions of the coil to be investigated. In this way a complete tri-dimensional pattern is obtained which accurately represents the field conditions. The machine can also be used to discover and study comparatively small deviations from the general pattern caused by irregularities in windings, or inaccuracies in position or dimensions of core materials.

Construcational Details

The search coil has 200 turns of fine wire wound on a Bakelite form ⅛ inch in diameter. It is attached to a hollow shaft, the leads being carried through the shaft to two slip rings, the output of the coil being picked off by two multiple brushes. The test coil may be energized by a 110 v, 60 cps source, a plug being provided for this purpose on the switch panel. It may be excited by current of other frequencies. An external oscillator to supply 400–800 cps is frequently used. The test coil may also be excited by direct current.

The chief problem encountered in working out a smoothly operating machine was amplification of the low output voltage of the search coil. In order to obtain required sensitivity an amplifier with a total voltage gain of 130,000 was used. Referring to the circuit diagram, note that sensitive relay A, stabilized by a condenser across its coil, must operate the entire traversing, reversing and indexing mechanism as well as the recording device. This entails a sequencing arrangement.

Sensitive relay A controls solenoid relay B which has two normally open contacts. One of these contacts control latch-in relay C. The other contact controls the recording circuit. The latch-in relay C controls solenoid relay D which has two normally closed and one normally open contact. One of the normally closed contacts is in the anode circuit of the 6AC7 amplifier output rectifier. The object of this set of contacts is to break the anode circuit after each sequence to assure the dropping out of the anode circuit relay once for each sequence. The second normally closed contact operates the forward motion solenoid. The normally open contact operates the reversing solenoid.

In this manner, reliable operation of the reversing mechanism is assured from a momentary closing of the anode circuit relay. So long as latch-in relay C is in one position, regardless of whether or not its coils are energized, one of the reversing solenoids is energized and the carriage carrying the machine's search coil and recording stylus runs in one direction. If the latch-in relay C is in the other position the motion of
the carriage is reversed and remains reversed until the latch-in relay operates again. This is a convenient way to operate reversible motions from a series of momentary impulses.

Methods of Recording

Three methods of recording are provided:

The first method consists merely of a pencil lead inserted in a quill and a weight pressing it lightly against the paper. This type of recording will yield a plot similar to that of Fig. 1. Using this method it is impossible to plot several lines on one single record.

The other two methods of recording utilize a condenser discharge circuit, shown in the diagram of the completed machine. A 60 µf condenser is discharged through the record to ground by means of a wire stylus replacing the pencil lead. If yellow glazed paper is used a high voltage discharge will pierce it and also make a bluish-black dot around the hole as shown in Fig. 2. This type of record is fairly legible and, because of the holes, can be duplicated by ordinary blueprint methods. If a more distinct record is desired, resistance is inserted in the condenser discharge circuit and the plotting is done on “Teledeltos” paper, manufactured for the Western Union Telegraph Company. The record will then look like Fig. 3.

Circuit diagram showing the electronic and electrical details of the machine. Complete control is provided at the switch panel.
Since the first device for automatically recording systolic and diastolic blood pressures was constructed, a considerably improved version has been built. The improved recorder is described here.

Before describing the mechanics and the electronic circuits involved, it seems desirable to review the principles of indirect blood pressure determination. A typical arterial pressure curve is shown in Fig. 1. The systolic pressure, represented by $a$, is the highest pressure reached and occurs during systole, or contraction of the heart. The diastolic pressure, represented by $b$, is the lowest pressure reached and occurs during diastole, or relaxation of the heart. A typical blood pressure is 120/80, where the systolic pressure over the diastolic pressure is given in mm Hg.

The physical situation is very similar to that of a water system in which a single cylinder pump provides an intermittent flow which is smoothed out by the elasticity of an air column. In the physical case the smoothing is accomplished by elasticity of the arterial walls. Without this elastic factor the blood pressure would drop to zero between contractions of the heart.

Principle of Operation

When blood pressure is determined by a physician, an inflatable cuff is placed around the upper arm and a stethoscope applied over the brachial artery a few inches below the cuff. The pressure in the cuff is raised well above the systolic pressure and allowed to fall gradually. When the cuff pressure is above the systolic pressure, the artery will remain collapsed and no sound will be heard. When the cuff pressure falls to a point slightly below systolic pressure, the arterial pressure oscillates above and below the cuff pressure. There results an excursion of the walls of the artery, and a sharp booming sound is produced each time the walls slap together. As the cuff pressure falls the oscillation of the arterial pressure above and below the cuff pressure continues until the cuff pressure falls below diastolic arterial pressure. The artery then remains patent throughout the cardiac cycle and the blood pressure sounds decrease sharply or disappear entirely.

Blood pressure is determined clinically by noting the pressure in the cuff when the blood pressure sounds first appear and when they decrease sharply, the former being the systolic and the latter the diastolic pressure. The blood pressure recorder operates on the same principle, a record being made of the cuff pressure and the sounds on a moving chart. The cuff is automatically in-

The instrument in use, cuff on patient's upper arm and stethoscope strapped to forearm. Amplifier, power supply, control thyatron and relays are contained in the lower unit, while the modified dynamic speaker structure driving the sound actuated pen may be seen projecting to the left of the upper unit housing the pressure recorder.

Inside view of the unit housing the amplifier, power supply, thyatron and relays.
PRESSURE RECORDER

Electronically controlled device records systolic and diastolic blood pressure at 20 second to 5 minute intervals over extended periods without discomfort to the patient. May also be used to count pulse and respiratory rate, record heart sounds, or as a lie detector inflated and deflated, and the time intervals controlled electronically.

Because the pressure recording pen of the instrument moves in an arc, it is necessary to use a celluloid arc to read the pressures. The method of reading the record is shown in Fig. 2. The sounds are recorded by means of a Shure stethophone and a high gain amplifier connected to a penwriter which makes a record of the intensity of the sounds on the edge of the pressure record. The penwriter was made from a dynamic speaker structure with the voice coil rewound on a thin brass cylinder. The brass cylinder is in a strong magnetic field and thus exerts a considerable damping effect. The voice coil is coupled by a thin rod vibrating in its long axis to a pen mechanism which came with the pressure recorder and was originally designed to act as a simple indicating marker on the edge of the record.

A compressed air line, Fig. 3, inflates the cuff. The pressure is reduced to the desired maximum cuff pressure by a standard adjustable flow control device such as is used in oxygen therapy. An Esterline-Angus pressure recorder with a special calibration (0 to 325 mm Hg.) records the cuff pressure, with a paper speed of 6 inches per minute. The paper moves only while a record is being made.

Electronic Timing Control

The simplified valve control circuit, Fig. 4, used in the present recorder is based on an electronic timing control previously described. Its operation is as follows:

The relays are in the position shown when not energized. When switch S1 is closed, voltage is applied and the thyratron 2A4G breaks down, its anode current closing R5. The contact between points 12 and 13 is broken, stopping the chart motor. Contact is made between points 14 and 15, opening V2, the outflow valve. The device is now ready for operation.

The interval at which the blood pressure is to be recorded is determined by selecting by means of S5 one of four contacts which are grounded by touching projections on a brass cylinder driven by a 1 rpm synchronous motor, the duration of contact being about 4 seconds. The contact for the 20 second interval is placed over the portion of the rotating brass cylinder which has 3 projections, the 30 second over 2 projections, the 1 minute over 1 projection, and the 5 minute over a single projection on a gear turning once in 5 minutes.

When the contact is grounded R1 is closed. (The 50,000 ohm resistor shunting the contact to ground allows sufficient current to pass to reduce sparking, but insufficient to hold the relay closed.) Points 1 and 2 are separated, removing the negative voltage from the cathode of the 2A4G, stopping its plate current and opening R5. Points 14 and 15 are separated, closing V5. Points 12 and 13 are in contact, but the chart motor does not start because points 4 and 5 are no longer in contact. Points 5 and 6 make contact, opening inflow valve V6, and inflating the cuff. Points 2 and 3 are brought together, causing the 3 μf condenser to charge to about 150 volts through the 100,000 ohm bleeder.

When at the end of 4 seconds the ground is removed, R5 opens. Point 5 moves from point 6 to point 4, closing V5, and starting the chart drive motor. Air starts to leak from the cuff through the needle valve. Point 2 moves from point 3 to point 1, again applying negative voltage to the cathode of the 2A4G. The 2A4G does not break down immediately because of the negative 150 volts applied to the grid by the 3 μf condenser. This charge gradually leaks through the variable 3 megohm resistor across the condenser, and when

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Fig. 1—Typical arterial pressure curve. Systolic pressure is represented at a, diastolic at b.

Fig. 2—A celluloid arc is required for reading the pressure record by the method illustrated here.
the negative potential has decreased to about 6 volts the tube breaks down and closes $R_n$, turning off the chart motor by separating points 12 and 13 and opening the outflow valve $V_o$, by bringing points 14 and 15 together.

The time of inflation of the cuff in relation to the rest period, when the cuff is completely deflated, is thus controlled by the variable 3 megohm resistor. When the blood pressure is to be recorded every 30 seconds, for example, the resistor is adjusted so that the cuff will be deflated about 20 seconds after inflation, to allow for a 10 second rest period. With this adjustment the pressure may be recorded every 30 seconds for several hours without discomfort to the patient. The pressure is adjusted so that the peak cuff pressure is well above the systolic, and the leak is so adjusted that the cuff pressure falls well below the diastolic before the cuff is deflated.

Sudden cuff deflation is much more comfortable than allowing the pressure to leak out slowly, as must be done when taking the pressure manually. Previous methods of recording blood pressure accurately have lease of pressure, and the chart motor stops. This cycle is repeated at any desired interval.

**Advantages and Other Uses**

Switch $S$, permits continuous movement of the chart. Thus the stethophone $M$ may be placed over the heart and a record made of heart sounds. The pulse rate may be determined by counting the beats in 0.6 inch and multiplying by 10. Another pen, driven by a tambour, may be used for recording respiration. If the chart moves intermittently, as when taking blood pressures, intermittent records are obtained of blood pressure, pulse and respiratory rate.

The movement of the recording pen with each excursion of the arterial wall is sufficient to produce an easily audible sound. Thus the pressure may be determined by ear.

Although the recorder was built for use in clinical and physiological research, it has a very definite value in practical clinical work. In a long operation, such as a craniotomy, it is especially useful. If no record is required, the chart drive may be turned off and the pressures taken by ear. This leaves the anesthetist free to take care of the patient, except for a glance at the pressure indicator as the cuff pressure is falling. It may be used in many other similar situations in a hospital, as for following the postoperative blood pressures of critical cases, recording blood pressure, pulse, and respiration of head injury cases.

Blood pressures as determined in a doctor's office are frequently elevated because of excitement. The use of this machine for a period of 30 minutes eliminates the psychic pressor effect to a considerable extent, as well as providing an indisputable record of the blood pressure.

Another possible use of the device is in lie detection, where the intermittent determination of actual blood pressures is preferred by many authorities to the modified Erlanger type apparatus usually used.

The Burdick Co., Milton, Wis. will manufacture the device under the license of the Wisconsin Alumni Research Foundation when the materials are available.

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Fig. 3.—Diagram of the air pressure system. Valves 1 and 2 are electronically controlled.

Fig. 4.—Diagram of the stethophone amplifier, power supply, chart and timer motor control circuit.

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FREQUENCY MODULATION possesses several characteristics which suggest its use in connection with carrier current telephony.

Favorable signal to noise ratios may be obtained. Class C amplifiers can be adjusted to maximum output. Mismatch between transmitter and high tension lines due to changes in line characteristics caused by switching operations does not result in loss of speech quality.

It is, however, difficult to obtain wide modulation deviations when working at the low frequencies required for efficient carrier current transmission. Even if it were feasible to develop wide modulation deviations by the process of frequency multiplying in early stages, common practice in high frequency transmitters, the complication of the transmitter and the large number of tubes involved would be undesirable in carrier current service. Transmitters used by power companies must sometimes operate for months without direct supervision and are frequently installed at widely scattered points. Narrow band f-m seems indicated.

Narrow band f-m carrier current telephony is used by the Puerto Rico Water Resources Authority power system with considerable success. The equipment to be described maintains communications between various power generating stations, load centers and the load dispatcher and appears to be satisfactorily trouble-free for such service.

The Transmitters

The frequency modulated carrier current telephony transmitter diagrammed in Fig. 1 employs a carrier frequency of 70 kc. Total maximum frequency deviation for the reactance tube adjustment found to give best results is 12 kc, obtained without frequency multiplication. (A test with an oscillator operated at one fourth this carrier frequency and followed by multipliers permitted somewhat greater frequency deviation but introduced two undesirable features, i.e., marked reduction in stability and a substantial reduction in power output from equipment using the same number of tubes.)

It will be observed that a wavemeter circuit was incorporated in the transmitter. This was dictated by the fact that the frequency of the electron coupled oscillator, satisfactorily stable for carrier current service, is affected by variations in the voltage of the battery in the reactance tube.

Fig. 1—Circuit diagram of transmitter working "straight through" without frequency multiplication. The reactance tube modulator provides a maximum frequency deviation of 12 kc.

Fig. 2—Circuit diagram of receiver. The first tube serves as an r-f amplifier, limiter and f-m conversion unit.

(Continued on page 119)
A Wide-Band High-Frequency SWEEP

By E. J. H. BUSSARD and T. J. MICHEL

The Crosley Corporation, Cincinnati

THE advent of bandpass r-f circuits in f-m receivers demanded special equipment for rapid, accurate alignment. Signal generator-voltmeter tuning of over-coupled, double-tuned circuits proved very slow and tedious. Such alignment is not in harmony with modern production methods and had to be discarded. The problem was the development of something more practical. No available equipment was capable of handling the problems presented.

Visual reference is desirable in alignment involving double peaking, especially where speed of operation is an important factor. Previous experience with such alignments at lower frequencies predicated the use of a sweep generator-oscilloscope in this instance. Five- and nine-inch cathode-ray oscilloscopes were available which give pictures of sufficient detail but the sweep generator had to be developed. Of course, the development was primarily to facilitate production but the generator described has proved valuable as laboratory apparatus.

The problem encountered in designing a satisfactory generator may be clarified somewhat by a consideration of the r-f amplifier requirements. The f-m band is from 42 to 50 Mc and the gain must be essentially constant within this range or cross modulation may result. Also, attenuation must be great just beyond these end frequencies so that interference at i-f or image frequencies is avoided. Our ideal bandpass amplifier would have the same peak gain at all frequencies from 42 to 50 Mc and zero gain at all other frequencies but it would be impractical and uneconomical. However, a single stage having constant gain within 2 percent over the f-m range and attenuating to 50 percent within 3 Mc above and below this range has proven feasible in production receivers using a high frequency i-f amplifier. A sweep generator, to facilitate correct alignment of such a system must cover a range of 39 to 53 Mc with constant output.

An electronic sweep circuit is not especially practical for such an extended high frequency range although it received some consideration in an effort to eliminate mechanical movements that might produce modulation. Careful dynamic balancing of the rotating parts of the motor-driven sweep was necessary to prevent distortion of the oscilloscope picture.

Circuit of the sweep generator developed is shown at the top of Fig. 1. It incorporates a modified Colpitts oscillator with balanced output. This oscillator is tuned through the range of 39 to 53 Mc by varying a portion of the capacity in the tank circuit. Wiping contacts are eliminated by employing a two-gang condenser of 100 µf sections in series. The relatively high capacity of the rotor is centered to ground, permitting a more accurate balance.

The oscillator tuning condenser is driven through a flexible insulating coupling 14 inches long, with ½ inch of insulation. Capacity to ground is reduced by mounting the condenser on long insulating strips. The variable condenser is rotated at a constant speed of 1800 rpm by a 1.75 hp synchronous motor. Such operation varies the frequency of the tank circuit from minimum to maximum with each revolution of the variable condenser, or thirty times a second. This frequency permits 60 cps synchronization of the oscilloscope and the resulting double picture aids the operator in determining the proper slope of the gain characteristic.

The motor is shielded from the high frequency circuits and is exposed to the air for ventilation.
A power supply may be included but in this instance it was more convenient to use the excess power available from another unit. The generator unit is 10½ inches wide, 9½ inches high and 6 inches deep overall. The motor and all parts included in the high frequency circuits are mounted upon a heavy steel plate and the system is dynamically balanced. These parts are floated above the base on double inverted conical compression springs. This mounting is necessary to reduce to a satisfactory level the modulation generated by the vibration of the moving parts. Vibration of the tubes produces amplitude modulation and vibration of the leads produces frequency modulation.

The generator with its high frequency shield removed is shown in Fig. 2. The electrically balanced amplifier is shown in front of the variable condenser and the oscillator components to the rear. This arrangement permits very short leads in all critical circuits. The tank inductance is soldered onto the terminals of the variable condenser and the grid and plate condensers just span from these terminals to the respective terminals of the oscillator socket. On the opposite side of the gang the grid condensers likewise span the interval to the amplifier sockets. In this manner, stray coupling is reduced to a level found to be practical.

A 6SA7 type tube was selected for the oscillator because of its ruggedness and high mutual conductance. With the circuit temperature compensated by the two 80 µuf negative temperature coefficient ceramic condensers in the tank circuit there is essentially no frequency drift. The output voltage balance may be controlled within reasonable limits by selecting the grid leak and plate series resistance of the oscillator. Values noted in Fig. 1 were found satisfactory for the required output although they are not critical.

Voltage from the oscillator is fed in opposite phase relationship and equally to the grids of 1852 type amplifier tubes. Two 10 µuf zero temperature coefficient ceramic condensers are employed in this coupling. Automatic compensation for minor variations in oscillator output is obtained by individually grid leak biasing the amplifier tubes and by selecting a linear portion of the tube characteristic to work over. This feature made voltage regulation to the power supply unnecessary. Output load resistors of the low values shown are employed to stabilize the output voltage and produce a very low generator impedance.

Amplifier gain is screen-grid controlled and the output may be varied from about 3 to 15 volts. One volt at the output terminals is sufficient for all conditions so far encountered and permits the use of oscilloscopes with relatively low gain amplifiers. While the output system is designed for use with receivers employing a balanced antenna system, it may be used with receivers using single input circuits by connecting between one high side and center. The amplifier output impedance employed simulates that of a good dipole antenna and may be connected directly to the receiver input terminals without false alignment resulting. A dummy antenna must be used when making sensitivity measurements.

A typical bandpass r-f amplifier is shown at the bottom of Fig. 1 with the input connections indicated. The voltage developed across the input transformer must be rectified for the oscilloscope and it is convenient to use the normal amplifier tube of the circuit for this purpose whenever possible. The instance shown utilizes the rectified voltage developed across the grid leak. A resistor of about 200,000 ohms in series with the oscilloscope is necessary to eliminate excessive loading of the tuned circuit.

The output voltage of the sweep generator is constant within 1 percent through the range when properly adjusted. However, a variation of about five percent might be tolerated without seriously affecting the alignment operation.

In practice, marker signals are superimposed at 42, 46, and 50 Mc. These signals are generated by separate electron coupled oscillators. The marker signals, together with a reference screen in front of the cathode-ray tube, reduce the alignment operation to the mechanical adjustment of the padding condensers. The sweep generator-cathode-ray oscilloscope method of alignment largely eliminates the personal equation of the operator in this nominally tedious alignment problem.
Fig. 1—The completed instrument which will measure phase angles from zero to 180 degrees.

Electronic Phase-Angle Meter

By EDWARD L. GINZTON
Sperry Gyroscope Co., Garden City, N. Y.

THE phase angle between two sine waves is frequently of considerable interest and can be conveniently measured by the instrument described in this article. The frequency range of this instrument can be made to cover a wide frequency spectrum and it is not necessary that the two signals be of the same amplitude. The indicating meter can be calibrated directly in degrees difference in phase angle. The device is simple in both principle and operation.

Principle of Operation

The two signals whose phase angle difference is to be measured are fed into two separate channels, each consisting of several amplifiers and limiter circuits as shown in Fig. 3. Each wave is amplified and limited a sufficient number of times so that at points 1 and 2, indicated in Fig. 3, the sine waves become square waves. The limiters are so adjusted that the square waves are of equal amplitude. These square waves are then applied to the grids of the sum tubes, which are merely Class A amplifiers with a common load resistance \( R_o \). These sum tubes can be made to produce currents in the resistance \( R_o \) independently of each other, and, therefore, a voltage appears across resistance \( R_o \) which is the algebraic sum of the square waves.

Examples

If the two input sine-wave voltages are in phase, the currents in the resistance \( R_o \) are also in phase and the voltage drop across \( R_o \) will be as shown in Fig. 2A. Figures 2B and 2C are drawn for phase relationships of 90 degrees and 180 degrees respectively. Inspection of Fig. 2A shows that the duration of current flow in the resistance \( R_o \) is directly proportional to the phase angle between the sine waves. An average of

Fig. 2—Algebraic addition of two square waves produces a wave whose average amplitude is a direct indication of the phase angle between the original waves.
current taken over one cycle is, therefore, a direct measure of the phase angle. The pulses of Fig. 2 can be rectified by means of a diode and a d-c meter used to read the average current. The d-c meter can then be calibrated directly in degrees, from 0 degrees to 180 degrees.

**Design Considerations**

The accuracy of the instrument depends primarily upon the squareness of the square waves. The two factors which influence this primarily are:

(a) The amplitude of the input voltages must be neither too small nor too large. If too small, the limiters will not operate, and square waves will not be obtained; if too large, the first amplifier may distort the wave and the resultant square waves will not be symmetrical, and this would introduce a serious error. The instrument shown in Fig. 3, for instance, requires an input voltage of 0.5 to 5 volts rms for proper operation. The upper limit of 5 volts can be increased by means of a potentiometer volume control at the input of the first amplifier. The lower limit can be extended by using additional amplifying and limiting stages, each one similar to those shown in Fig. 3. In this manner, the device can be used to indicate phase angles not only between small or large voltages, but also between voltages which are greatly different from one another.

(b) The frequency response of amplifiers and limiters must be designed to pass frequencies at least ten times as great as the highest frequency and one-tenth of the lowest frequency which are to be measured by the device. A schematic diagram is shown in Fig. 3 of a phase-angle meter built for experimental purposes. The circuit constants have been so chosen that the instrument would be accurate from 250 to 10,000 cps. Adjustments of circuit constants would allow lower and higher frequency limits of operation. A vacuum tube voltmeter is shown in Fig. 3 which measures the d-c voltages across the resistance $R_a$; the d-c milliammeter in the plate circuit of the voltmeter was calibrated directly in degrees.

**Calibration**

The most convenient and precise way of calibrating the phase-angle meter is by means of some standard phase-shifting device. If one is not available, several other means can be used, such as resistance-capacity networks which can be computed and checked by means of a cathode-ray oscilloscope. Also, a fairly accurate calibration can be obtained with a three-point method. First, a voltage of some convenient frequency is applied to one of the channels, with the other channel short-circuited at its input terminals. The volume control is then adjusted so that the output meter reads half-scale (90 degrees). Then the voltage is introduced into the second channel and the first short-circuited, and the volume control in this channel adjusted to produce half-scale deflection. If now the same voltage is applied to both channels at once, full scale deflection should be produced, corresponding to a phase angle of zero degrees. If now one voltage can be reversed in phase by means of a transformer which is known to have zero phase shift, the meter should read zero, corresponding to a phase angle of 180 degrees.

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New Books

Electronics

Fundamentals of Vacuum Tubes

Principles of Electron Tubes
By Herbert J. Reich (688 pages. Price $8.50. McGraw-Hill Book Co.)

Here are two new texts, and a revised edition, all dealing with electronics and the fundamentals of electron tubes. Because of the close parallelism of the subject material treated in these three volumes, they are reviewed together. As might be expected, there is a considerable overlap of treatment of certain of the subjects, and yet each one has its own characteristic emphasis, purpose and point of view. All three may be regarded as intermediate texts suitable for college students in the engineering or physics courses and having a background of differential and integral calculus as well as differential equations, and at least an introductory acquaintance with electricity. All three volumes are of the same page size and have uniform binding.

It is perhaps unwise and unfair to compare too closely, these three books, unless it be for a particular purpose and with a particular objective in mind. Nevertheless, this reviewer believes it may be instructive to indicate, approximately, the relative amount of space devoted in each of the three books to those topics where there is (or may be expected to be) similarity or overlapping of treatment. Accordingly, the table shows the relative percentages of text material devoted to the subjects enumerated for each of the three books as estimated by this reviewer.

APPROXIMATE PERCENTAGE OF SPACE DEVOTED TO VARIOUS TOPICS

<table>
<thead>
<tr>
<th>Subject</th>
<th>Millman</th>
<th>Eastman</th>
<th>Seely</th>
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<td>21.2</td>
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<tr>
<td>Electron Tubes</td>
<td>25.0</td>
<td>21.2</td>
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<td>12.1</td>
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<td>Oscillation</td>
<td>19.8</td>
<td>19.8</td>
<td>19.8</td>
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<tr>
<td>Modulation and Detection</td>
<td>3.4</td>
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<td>Contact Conductors and</td>
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From this table it is at once apparent that the divisions of subject matter in the text by Reich and by Eastman are roughly parallel, whereas considerably more space is devoted to the fundamentals of electronics, and virtually no mention of oscillation and modulation and detection in the text by Millman and Seely. This general state of affairs may be easily surmised from the titles of the three books. The text by Millman and Seely is suitable for courses in which the emphasis is to be placed on fundamental theories and the physics of electronic devices as well as on those courses in which the principal objective is to study the technical and engineering applications of the devices. In the other two texts the emphasis is placed on the application and use of the electron tube and both show the imprint of electrical communication. All are reviewed alphabetically by title.

It appears to this reviewer that the principal characterizations and outstanding features of the Millman and Seely book are: (1) the rather comprehensive treatment of motion of charged particles in electric and magnetic fields and the application of these motions, (2) a discussion of the basic physical principles of electronics as applied to electron tubes, (3) the inclusion of appreciable material on the kinetic theory of gases and electrical discharges in gases in a book also treating tubes, (4) three excellent chapters on ordinary rectifiers, controlled rectifiers, and filters for rectifying systems and (5) a chapter on triodes as circuit elements which is applicable to the communication as well as to the industrial application of tubes. The authors have been careful to insert unretouched oscilloscopes to give assurance of the physical reality of the graphical methods usually employed. Rather extensive use has been made of graphical methods of analysis although the more general analytical method employing college mathematics are employed wherever necessary. By and large the mathematics employed is not (or at least should not be) beyond the ability of engineering students, but the authors have very wisely used mathematics to teach fundamentals rather than to demonstrate their own cleverness.

To this reviewer it appears that "Electronics" is the first attempt in book form to correlate electronics as the physicist learns it, with electronics as the engineer learns it, and to show the importance of the fundamentals as well as of application. As compared with most books on electronics and electron tubes, this one has less of the communications approach but this can hardly be regarded as a disadvantage. Indeed, with the increasing use of electron tubes in industrial application, and with the greater recognition of electronics as an integral part of electrical engineering, it would seem that Millman and Seely should provide an excellent text for engineers whether the user enters the industrial or the communications field.

"Fundamentals of Vacuum Tubes" by Eastman is not a new book in the sense that it originally appeared in 1937. However, the second edition may almost be considered as a new volume since the classification has been changed and the subjects have been completely rearranged. Part I deals with basic concepts applicable to tubes in themselves, whereas Part II deals with the application and circuits, or more generally, the uses of each. These changes in organization are such as to increase the utility of the books for the industrial user of tubes without detracting from its value to the communication engineer. Moreover, since the basic concepts, once established, are subject to little change, the first portion of this book probably require minor modification in subsequent editions. On the other hand, as the engineering application will change with times, the second part of the book can be readily updated without an advantage. The author takes cognizance of the industrial and power uses of electron tubes in various places throughout the book with specific examples. A particularly useful chapter for the industrial electrical engineer is Chapter 8 dealing with the vacuum tube as a control device. The larger portion of the chapter on modulation and demodulation is given to a discussion of amplitude modulation. At the same time, approximately 25 pages are devoted to frequency and phase modulation which are becoming of increasing importance with greater utilization of ultrahigh frequency.

Professor Reich’s book is completely new although those who are familiar with larger treatises in the field "Theory and Application of Electron Tubes" will note some similarity between the two volumes by the same author. Indeed, in the preface, Professor Reich states that the present volume is an abridgement of his previous book, and is offered primarily for students who do not intend to specialize in communications. In spite of the statement that this volume intended for those not following communication, there are evidences (as in the chapter on modulation and detection) that a background and familiarity in electrical communication has influenced the writing of this material for this volume. A number of these communications field are given, but there are few, if any, specific examples of the application of problems of industrial and power applications of the tubes are not as obvious as the problems and solutions which a communications engineer would seek. The final chapters on rectifiers and filters and on

(Continued on page 92)

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SOLENOID INDUCTANCE CALCULATIONS

A short and accurate method, based on Nagaoka's formula, for determining the dimensions of any single layer solenoid, together with a brief summary of its derivation

To calculate the inductance of single layer solenoids, an equation was derived in 1909 by H. Nagaoka, which involved the use of a factor, K, which is a function of the ratio of the diameter to length. Nagaoka's equation is

\[ L = 0.03948 \cdot a^2 \cdot n^2 \cdot K/b \]  

where \( L \) is the inductance in microhenries, \( a \) is the radius of the coil in centimeters, \( b \) is the length of the coil in centimeters, \( n \) is the number of turns, and \( K \) is a form factor determined by the ratio \( 2a/b \).

This formula takes no account of the shape or size of the cross section of the wire, merely giving the inductance of an equivalent cylindrical current sheet, which is a winding in which the wire is replaced by an extremely thin tape, the center of each turn of tape being situated at the center of a turn of wire, the edges of adjacent tapes being separated by an infinitely thin insulation.

However, Nagaoka's formula is quite accurate and is the basis of practically all the formulas for single layer solenoids in use today. As a matter of fact, the reason why it has not been usable itself is because of the factor \( K \) which must be employed. Values of the coefficient \( K \) for all ratios of diameter to length from 0 to 100 have been computed and are published in the Bureau of Standards Circular C-74.

For calculating the inductance where the number of turns and the ratio \( 2a/b \) are known, this equation is quite usable. Most often however, we are designing coils of desired inductance on a given coil form, with a given wire size and pitch and we wish to know the number of turns to be used. At this point Nagaoka's formula has been found useless because any calculations involve use of the factor \( K \), and in the case of determining the number of turns the factor \( K \) which is used in the computation is itself a function of \( n \). (This is readily seen, because the length is not given and can not be used to determine the ratio of \( 2a/b \) and hence \( K \)).

For this reason, various empirical formulas have been developed, based on Nagaoka's formula and usable over a certain limited range of the ratio \( 2a/b \), with an error which varies from plus to minus two per cent.

To appreciate the accuracy of Nagaoka's formula we might note some of the calculations made by the Bureau of Standards Circular C-74 in which a small correction is applied to take into account the fact that round wire is used in place of tape.

Example. For a coil 22.3 cm in diameter \( (a = 11.15 \text{ cm}) \), and 9.12 cm long \( (b = 9.12) \) the factor is \( K = 0.4772 \). If the number of turns is \( n = 79 \), the inductance, determined by Nagaoka's equation is,

\[ L = (0.03928 \times 11.15^2 \times 79^2 \times 0.4772)/9.12 = 1,002.5 \text{ microhenries}. \]

The correction factor, taking account of the shape of the wire conductor, necessitates subtracting 5.8 microhenries from this value, leaving the corrected inductance as 1,959 microhenries. The measured value is 1,505 microhenries.

It is seen that calculations correct to three figures and accurate enough for all design work may be made.

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**ELECTRONICS REFERENCE SHEET**
by means of Nagaoka’s formula. Now to overcome the formula’s only disadvantage, its inadaptability to the calculation for determining the number of turns required. To transpose the equation in order to remove this objection we will use symbols as follows:

Let \( L \) = inductance in microhenries
\( a \) = radius of coil in centimeters
\( b \) = length of coil in centimeters
\( d \) = diameter of coil in inches
\( l \) = length of coil in inches
\( n \) = number of turns
\( b = \) turns per centimeter
\( T = \) turns per inch
\( A = \frac{b}{2a} = \) length diameter, and
\( K = \) a factor determined by the ratio \( 2a/b \)

By multiplying through by \( b \), we may write Nagaoka’s equation as

\[
Lb = 0.03945 a^2 n^2 K
\]  

(3)

We can now multiply both sides by the same quantity, \( 2a/b \), to give

\[
(2a) Lb = 0.07896 a^2 n^2 K
\]

(4)

from which, by dividing by the factors in parentheses,

\[
\frac{Kb}{2a} = \frac{Lb}{0.07896 a^2 n^2}
\]

(5)

where all dimensions are in cm. If dimensions are in inches, this becomes

\[
Kb/2a = 39.89 L/\delta T^2 = C
\]

(6)

For convenience we will use the following notation:

\[
C = \left( \frac{Kb}{2a} \right) A = \text{diam/length}
\]

The relationship between these two factors is shown on the alignment chart.

Knowing the corresponding values of \( C \) and \( A \), we may now calculate the inductance of a single layer solenoid without explicitly being bothered by the form factor. The problem may now be presented in two forms.

1. To determine the number of turns for a coil of specified inductance when the winding pitch and coil diameter are known, we determine the value of \( C \) from Eq. (6). From the alignment chart the corresponding value of \( A \) is determined. Now, since \( n = b/2a = 1/A \), the required number of turns is

\[
n = \frac{dT}{A}
\]

(7)

Example: Determine the number of turns of No. 22 enameled wire (\( T = 37 \)) close wound on a 2 inch form to give an inductance of 250 microhenries.

The value of \( C \) is found to be

\[
C = \left(\frac{39.89 \times 250}{(2a \times 37)}\right) = 0.91
\]

from which \( A \) is found from the alignment chart to be 0.806. The required number of turns is then found to be

\[
n = \frac{2 \times 37}{0.806} = 91.8 \text{ turns}
\]

2. To determine the inductance of a coil when the number of turns, the length, and the diameter are known, find the value of \( A \) from the equation \( A = d/l \). From the graph determine the corresponding value of \( C \). The inductance may then be determined by the equation,

\[
L = 0.02507 C d^2 T^2
\]

(8)

which is derived from Eq. (6).

Example: Determine the inductance of a coil having 58 turns per inch, and whose length is 5 inches and whose diameter is 1.5 inches.

The value of \( A \) is \( d/l = 1.5/5 = 0.3 \). The corresponding value of \( C \) is 2.95. The inductance is then

\[
L = 0.02507 \times 2.95 \times 1.5^2 \times 58^2 = 1,450 \text{ microhenries}
\]

The problem can be further simplified by using the log-log plot based on the equation,

\[
L/T^2 = 0.02507Cd^2
\]

derived from Eq. (6). For any value of \( L/T^2 \) there corresponds a value of 0.02507Cd with definite values of \( l \) and \( d \). These are plotted on the chart, the linear family giving values of \( L/T^2 \) for any inductance and winding pitch, while the curved family gives corresponding values of diameter and length.

Example: A coil is wound, 10 turns per inch on a 2.5-inch form. How many turns are required for an inductance of 100 microhenries?

The 100 microhenry value intersects 10 turns per inch on the curve \( L/T^2 = 1.0 \). On the curved family, corresponding to 0.025Cd = 1.0, the required length is 7.4 inches, and inductance is 74 microhenries.

Example: A coil 4.5 inches in diameter and 3 inches long is wound with 24 turns. Find the inductance.

The correct length and diameter factors intercept the 0.025Cd curves at 0.9. For \( L/T^2 = 0.9 \), and winding pitch of 24/3 or 8, the inductance is found to be 58 microhenries.

Alignment chart correlating \( A \) and \( C \) of Eqs. (6) and (8)

<table>
<thead>
<tr>
<th>A</th>
<th>C</th>
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<tr>
<td>0.010</td>
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<td>0.011</td>
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TUBES AT WORK

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Kinescope Power Supply.......................... 68
Concentric Line as Harmonic Filter............... 68

Standby Filament Saver for Police Transmitters
By John E. Wagenseiler
Heubach & Badcock Company
Philadelphia, Penn.

Tube filaments are normally operated continuously in police and other similar transmitters that must be capable of functioning on an instant's notice. If they were turned off between transmissions it would then be necessary to wait at least 30 seconds after restoring filament voltage before applying plate potentials. Such delay is not ordinarily permissible.

At WQOC, police radio station in Sharon Hill, Pennsylvania, continuous operation of filaments resulted in an average tube life of four months. This necessitated the replacement of 20 tubes three times a year. Experiments indicated that if the filaments were operated at one half their rated voltage during standby tube life could be nearly doubled. It was also found that proper operating temperatures could be reached from this standby condition within four seconds after the application of full filament voltage. A four second delay was considered permissible and it was decided to arrange the transmitter for this type of operation.

The automatic electronic device described here accomplishes the purpose outlined and still permits the operator to control the transmitter by means of a single switch. In the standby position of switch S (the condition shown in the diagram) relay RS, is open and the primaries of all filament transformers receive 55 volts from autotransformer TA. When switch S is thrown to the transmit position contact a closes relay RS, and 110 volts is immediately applied to all filament transformer primaries. Contact b is closed but plate power is not immediately applied to the transmitter as the upper contact of relay RS, is still open. Switch contact c is closed, permitting condenser C, to charge through resistor R. At the end of four seconds when the condenser has received a full charge, the grid of the OJS is biased sufficiently negative to cut off this control tube's anode current and relay RS, opens. Opening of relay RS, closes relay RS, and plate power is applied to the transmitter. Timing may be adjusted by varying the setting of the arm of voltage divider R.

When, after a transmission, control switch S is returned to the standby position, switch contact b immediately removes plate power from the transmitter. Note, however, that even though switch contact a is simultaneously opened relay RS, remains closed because switch contact a is shunted by the lower contact of relay RS, Filaments continue to receive full voltage for three minutes after the transmitter's plate power is removed because it takes that time for the charge to leak off condenser C, through resistor R, after opening of switch contact c. Until the charge does leak off, RS, remains open and RS, and RS, remain closed. This feature permits rapid repeats and acknowledgments after the initial contact without waiting four seconds for tube filaments to heat up. If the transmitter remains off the air for three minutes or more filaments drop to half normal potential.

Public Utility Emergency Radio System
By W. H. Blankmeyer
Communication Engineer
The Montana Power Company
Butte, Montana

Since the Federal Communications Commission set aside frequencies for Special Emergency communication utilities have shown considerable interest in radio and it has rapidly developed into an essential form of communication. Radio is a natural means of communication where so much depends on line switching and clearing to restore and maintain service to the public. Often, whatever interrupts power service interrupts telephone and carrier channels as well.

Portable 2726 kc 'phone transmitter-receiver used by Montana Power line patrolmen. It runs 2½ watts output, weighs 22 lbs with batteries and antenna. The box on which the unit stands contains the batteries and antenna reel.

The Montana Power Company gas transmission department promoted the installation of the first seven sets and the electric department installed two. Both departments are now planning several more installations. Company lines run through considerable mountainous territory. During the winter season many sections of the lines are inaccessible except by horse or hiking and sometimes can be reached only with the aid of snowshoes. This established the first requirement for radio sets used by patrolmen. The sets had to be extremely portable. We selected U. S. Department of Agriculture Forest Service type SPF combination transmitter and receiver, which with batteries and antenna fits into a knapsack and weighs 22 pounds. These sets are easily operated by non-technical
WANTED:

The versatility of G-E mycalex is shown in these typical parts—compression molded, injection molded, and fabricated.

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1. You can produce moderately intricate shapes.
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4. Metal parts can be inserted or combined with it during molding process.
5. Alloys can be cast around mycalex without affecting its structure—machining and sealing-molded operations are eliminated.

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- High mechanical strength
- High dielectric strength and insulation resistance
- Low losses at high frequencies
- Good arc resistance
- Resistance to sudden temperature changes—can be immersed in liquid air
- Chemical stability; no deterioration with age
- Dimensional stability; freedom from warpage and shrinkage
- Imperviousness to water, oil, and gas
- Low coefficient of thermal expansion
- Heat resistance—operation as high as 325°C
FOR ELECTRONICS—A structural and insulating application in a cut-back switch of a G-E 10 kw FM transmitter. Stability of power factor, high dielectric strength make mycalex the ideal insulation for any electronic device.

FOR INDUSTRIAL HEATING—Mycalex sealed terminal connectors (injection-molded) are used on many G-E Calrod heaters. The ability of G-E mycalex to withstand mechanical abuse, oil, water, and many chemical fumes make it the strongest seal available.

FOR MOTORS—The highly arc-resistant quality of G-E mycalex, the fact that it won't oxidize or carbonize and its resistance to deterioration make it the ideal material for compression-molded brush-holder studs.

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www.americanradiohistory.com
Kinescope Power Supply

By Esten Moen

The diagrammed power supply circuit provides nearly 900 volts d.c. for the operation of a three-inch type 906 kinescope, developing approximately 450 volts above and below ground by means of a voltage doubling arrangement utilizing two type 1-V tubes. When the circuit is used in this manner, the cathode-ray tube must be isolated from the rest of the power circuit. The cathode-ray tube control grid must be fed through a capacitor of sufficient voltage rating to withstand the negative 450 volts on the cathode.

![Circuit diagram of power supply designed to operate kinescope type 906 and associated amplifiers](image)

Universal Electronic Relay

By Lester F. Boss

The relay circuit shown here schematically operates from 110 volt a-c or d-c lines, consumes less than 30 watts of power, is readily arranged for either forward or reverse control operation and will handle 1000-watt inductive or 1,800-watt non-inductive loads. Because of its extreme flexibility and simplicity the circuit should find many industrial and other applications.

The circuit possesses the following desirable features: (a) Low potential in the control circuit, which functions at 6.5 volts maximum. This minimizes erratic operation due to dampness of input insulation and capacity between leads. (b) One side of the control device and one side of the load (with the load relay open) is at ground potential. To accomplish this the 115 volt plug is inserted in the power line receptacle in such a manner that the 6 volt pilot does not light. (c) Sensitivity may be adjusted within rather wide limits by substituting other values for the 30,000 ohm resistor in the input circuit.

![Schematic of electronic relay suitable for operation on a.c. or d.c.](image)

Gas line cathodic protection generator driven by Ford V8 engine. This typical 40 volt d-c 3 kw device also supplies emergency power for emergency operation of radio equipment, charging a 32 volt battery driving a 32 volt d-c to 110 volt a-c rotary converter.

Concentric Transmission Line as Harmonic Filter

By Raymond E. Snoddy

Some time ago I had occasion to help install a 4-inch concentric transmission line as a second harmonic filter for a transmitter using a fundamental frequency of 450 kc. A quarter wave transmission line short-circuited at its far end offers a high impedance to the fundamental and at the same time a low impedance to the second harmonic. Therefore such a line, when connected to a point of high harmonic voltage,
EVEN MORE WAR ORDERS FOR G-E MYCALEX

THE INSULATOR WITH A THOUSAND APPLICATIONS

FOR ELECTRONICS—A structural and insulating application in a cut-back switch of a G-E 10-kw FM transmitter. Stability of power factor, high dielectric strength make mycalex the ideal insulation for any electronic device.

FOR INDUSTRIAL HEATING—Mycalex sealed terminal connectors (injection-molded) are used on many G-E Calrod heaters. The ability of G-E mycalex to withstand mechanical abuse, oil, water, and many chemical fumes make it the strongest seal available.

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A 30 watt fixed station in operation in a natural gas pipeline dispatch office. Normally operated from the 110 volt a-c lines, all of these stations have emergency power supplies.

The only requirement for satisfactory service is that the receiving locations be reasonably free of man-made interference. This requirement was easily met since we do not operate the receivers near distribution systems. Our highest fixed station operating power at present is 30 watts. The next lower power is 20 and then 12. We make daily routine tests morning and evening over a maximum distance of 200 miles and establish test contacts over this distance about 98 percent of the time. For normal emergency work it is not necessary to operate farther than 50 miles so there is a large safety factor as to distance. The battery-operated portables have an output of 21 watts. The reasons for using low power even on the sets normally operated off the lighting circuits was to permit use of gas line cathodic protection 40 volt d-c generators and batteries as emergency radio equipment power supplies.

All sets were designed to use L-wave Hertz off-center fed antennas. The same antenna is used for transmitting and receiving in all of our installations to date. Several future installations will require remote controlled receivers and a separate antenna for transmitting and receiving. Several cars are equipped with receivers only, for one-way operation. The receivers used are standard Philco Model AR-9, having a broadcast band and two shortwave bands. One of the shortwave bands is revamped to operate on 2726 kc. We plan on using two-way car installations with "controlled current" antennas.

Universal Electronic Relay
By Lester F. Boss

The relay circuit shown here schematically operates from 110 volt a-c or d-c lines, consumes less than 30 watts of power, is readily arranged for either forward or reverse control operation and will handle 1000-watt inductive or 1,800-watt non-inductive loads. Because of its extreme flexibility and simplicity the circuit should find many industrial and other applications.

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Gas line cathodic protection generator driven by Ford V8 engine. This typical 40 volt d-c 3 kw device also supplies emergency power for emergency operation of radio equipment, charging a 32 volt battery driving a 32 volt d-c to 110 volt a-c rotary converter.

Schematic of electronic relay suitable for operation on a-c. or d-c.

Concentric Transmission Line as Harmonic Filter
By Raymond E. Snoddy

Some time ago I had occasion to help install a 2-inch concentric transmission line as a second harmonic filter for a transmitter using a fundamental frequency of 470 kc. A quarter wave transmission line short-circuited at its far end offers a high impedance to the fundamental and at the same time a low impedance to the second harmonic. Therefore such a line, when connected to a point of high harmonic voltage,
Skillfully designed to fit the requirement, durably made to give lasting satisfaction, the “Cinch” Retainer Ring Type Molded Socket requires no rivets or eyelets for assembling to chassis—a saving in space, assembly costs and rivets. Illustrated Nos. 9861 and 9865... are locked firmly in place by retainer ring—No. 8493—socket is prevented from turning by keyway in side. Other “Cinch” Molded Sockets are available with saddles for customary riveting to chassis; See Nos. 9864 and 9868 illustrated above (left) supplied with $1\frac{3}{8}$ and $1\frac{5}{8}$ mounting centers respectively. In these trim, space saving sockets are embodied the “Cinch” distinctive features: “Cinch” solder coating, silver plating, or tinning—all of which meet government specifications—and the best material and workmanship.
makes an excellent harmonic trap because of its low loss and permanence of tuning. In the case of a quarter wave vertical antenna, the highest harmonic voltage will be at the base of the tower, that is, where the impedance is \( R_{\text{at}} + j0 \) at the fundamental.

The length of the required line as calculated from the constants given by the line manufacturer was 297 feet. It was found experimentally that the greatest harmonic attenuation was obtained with a line 311 feet long. To a line somewhat shorter than the approximate length, a short section was added. Holes were drilled an inch apart in this section. A sharp instrument was then inserted in the different holes so that it made good contact with both the inner and outer conductors. When the point of minimum impedance was found, this “flute” section was replaced by a permanent section of the right length. (Caution: Such a line should always be short-circuited at the far end when making adjustments with the transmitter on, since a quarter-wave open-circuited line is resonant to the fundamental and would cause a short-circuit at that frequency.) Experimentally determined optimum length was later checked with an impedance bridge for minimum impedance at the second harmonic and found to be correct.

For a time the discrepancy between mathematical calculations and experimental results was passed off as another one of those “unsolved mysteries” that the practical radio engineer so often encounters. Recently I determined to investigate the cause.

The constants for a 60 foot section of concentric line as given by the manufacturer were as follows: Capacity 1054 \( \mu \)uf, Inductance 4.44 \( \mu \)h, Resistance 0.4 ohms, Conductance 4.7 \( \mu \)mhos, Characteristic Impedance 65 ohms, db

**Bullets X-Rayed in Action**

Millionth of a second x-ray pictures through one inch of steel armor plate are made possible by this twin tube unit operating at 300,000 volts and 2,000 amperes in the Frankford Arsenal. Dr. C. M. Slack of Westinghouse explains its operation to Dr. Herschel Smith, civilian aide at the Arsenal, and an assistant.
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for Military Applications of Signal Tracing UP TO 80 MEGACYCLES

By combining this new Chanalyst UHF Converter with your RCA Rider-Chanalyst, the horizon of your radio servicing is extended into the high frequencies to include such important services as F-M, Facsimile, Television, Aviation, Marine and Police Radio, as well as a host of others. Your present signal tracing methods can now be applied to the most modern devices used in these UHF services, placing you in a position to take advantage of the ever-increasing demand for competent technicians in this fast-growing field.

The RCA Chanalyst Converter reduces the higher frequencies (up to 80 megacycles) to values within the range of your RCA Rider-Chanalyst. From this point on, the procedure is exactly the same as that used at standard frequencies. You use exactly the same controls on your Chanalyst to make the same tests, the same measurements, and in exactly the same manner as before. There is no new technique to learn!

The new probe used with the Chanalyst Converter almost completely isolates instrument effects from the circuit under test. You can probe high frequency circuits without detuning them beyond the extent of ONE-HALF OF ONE MICRO-MICROFARAD. This allows unprecedented freedom of operation while the receiver is functioning.

Panel height and decorative features of the Converter match those of the Chanalyst. In every respect, it is an ideal companion piece—a necessity for the modern service dealer—a real opportunity for greater profits.

OVER 4,000 SATISFIED USERS
are saving time, money and effort through Signal Tracing servicing with the RCA Rider-Chanalyst.
Where Dependability is Paramount

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Are Used

Cannon Plugs or Cable Connectors are designed to handle electrical circuits wherever it is necessary to make or break contact frequently for the installation, inspection or servicing of electrical equipment. Where such equipment must render trouble-free service under exacting conditions, you will find that Cannon Connectors are used extensively.

More than 11,000 catalog numbers are required to list the Cannon fittings which meet all normal requirements in the fields of Radio, Television, Sound, Aeronautics, Geophysical Research and Commercial Power. Each of these fittings must conform to the standards of design and workmanship which have created universal acceptance of the Cannon Trade-mark.

Typical fittings of the Cannon AN9534 specification, available in all approved sizes and contact arrangements.

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Sан FRANCISCO AREA:
W. V. Brainard, 1064 Ordway St., Berkeley

SEATTLE:
James J. Backer Company, 169 Bell St.

May 1942 — Electronics

loss 0.0264. The impedance of the line was evidently arrived at after making capacity and inductance measurements, by the following equation: Z = \sqrt{L/C} (1), which gives a value of 0.65 ohms.

The diameters of the inside and outside conductors were carefully measured and found to be as follows: Inside diameter of the outside conductor 25.32 in., outside diameter of the inside conductor 1 in. The characteristic impedance was then calculated by the use of the following equation: Zc = 10 \log_10 \left( \frac{b}{a} \right), where \( b \) is the radius of the outer conductor in centimeters, \( a \) is the radius of the inner conductor in centimeters and \( Zc \) is the characteristic impedance:

\[ Zc = 10 \log_{10} \left( \frac{0.4945}{0.317317} \right) = 138 \log_{10} 3.125 = 138 \times 0.4945 = 68.2 \text{ ohms} \]

Then, rearranging Eq. (1), \( C = \frac{L}{Zc^2} = \frac{68.2^2}{954 \mu \text{f per 60 foot section}} \) was calculated. The radio frequency resistance of the line was also calculated by use of the following equation: \( R = 1.268 \sqrt{1/(\pi + 1/6)} \times 10^8 \), and found to be 0.4552 ohms per 60 foot section for 1480 kilocycles. This indicated discrepancy, however, had little effect on the final answer.

The exact length of a line of any number of electrical degrees or fractions of a wavelength can be found if we have the constants per unit length as given above, resistance, conductance, inductance and capacity. It is sometimes more accurate to calculate the capacity by means of physical dimensions and the proper equations, than it is to rely on capacity measurements. In order to find the length of such a...
We could show pictures of planes and tanks, guns and ships, instruments and wiring systems — and every illustration would be a picture of Superior Tubing at work. Small tubing — max. OD. $\frac{5}{8}''$ — the stuff you come to depend on and see only as a line on a blue print. And that's all right with us.

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Tubing from $\frac{5}{8}'' \text{ OD down} ... \text{SUPERIOR} \begin{array}{c} \text{Seamless in various analyses.} \end{array} \text{WELDRAWN} \begin{array}{c} \text{Welded and drawn Stainless.} \end{array} \text{BROWN} \begin{array}{c} \text{Welded and drawn "Monel" and "Inconel". SEAMLESS and Patented LOCKSEAM Cathode Sleeves.} \end{array}

ELECTRONICS — May 1942
O

other catalogs available are No. 500, illustrating and describing many types of transformers for broadcast, aircraft, military and other communications uses; Catalog No. 600 covers the complete line of Thordarson amplifiers.

The Industrial Department will be glad to discuss with you special types of any characteristics, size or quantity.

THORDARSON

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TRANSFORMER SPECIALISTS SINCE 1895

line it is first necessary to find the wavelength constant per "unit length" or "section". The propagation constant per unit length is given by the expression \( \gamma = \alpha + j3 \), where \( \gamma \) is the propagation constant per unit length, \( \alpha \) is the attenuation constant expressed in nepers per unit length, and \( 3 \) is the wavelength constant expressed in radians per unit length in this case being a section of 60 feet. This can also be expressed in the polar form \( \gamma = \sqrt{Z Y} \), where \( Z \) is the impedance per unit length along the line and \( Y \) is the admittance per unit length along the line.

The impedance per section is (for 1480 kc)

\[
Z = R + j2\pi fL
\]

\[
= 0.4552 + j(6.28 \times 1480 \times 10^4 \times 4.44 \times 10^{-6})
\]

\[
= 0.4552 + j 41.23 = 41.23 /89.368^\circ
\]

The admittance per section is

\[
Y = \alpha + j2\pi fC
\]

\[
= 4.7 \times 10^{-6} + j(6.28 \times 1480 \times 10^4 \times 954 \times 10^{-9})
\]

\[
= 4.7 \times 10^{-6} + j(8870 \times 10^{-6})
\]

\[
= 0.00887 /89.967^\circ
\]

The propagation constant is then equal to

\[
\gamma = \alpha \times 3 \gamma = \sqrt{Z Y}
\]

\[
= 41.23 /89.368^\circ \times 0.0087 /89.967^\circ
\]

\[
= 0.605 \times 179.335^\circ
\]

\[
= 0.605 /89.667^\circ
\]

\[
= 0.00352 + j 0.605
\]

0.605 is the wavelength constant expressed in radians per section and since there are \( \pi \) radians in one-half wavelength, the number of sections required is \( 3.14 /0.605 = 5.19 \) sections, and the length in feet is \( 5.19 \times 60 = 311.4 \). The terminal connections probably accounted for the extra 0.4 of a foot.

THERAPY TREATMENT
FOR Colds

As an experimental measure to prevent loss of time, due to colds, the British Ministry of Aircraft Production has set up a short-wave therapy clinic where members of the staff may receive treatment. The treatment lasts for ten minutes and since October 1941, when the machine was installed, 3,800 persons have been treated.
ONE MORE DETOUR...

Six times in a century-and-a-half, the swift and peaceful progress of America has swerved temporarily from its peaceful course... six times we have been detoured into war by enemies who misunderstood our love of peace, and interpreted it as weakness.

After each of these historic detours, we have gotten back on the road again: the road that has led us to higher attainments than any other nation has yet attained.

Once again we are on such a detour: in a war we did not seek, and which our enemies will one day regret seeking. Once again we have deferred our peaceful progress and have dedicated every effort to getting through that detour. And once again—when we are through—we shall turn our eyes towards greater horizons... towards new achievements through science and industry—new things for a new and greater America.

Here at RCA, this is our creed... and we fear neither today nor tomorrow. We know that when this war is won, radio has many contributions to make to our way of life. New techniques of broadcasting. Television. New applications of radio science to industrial production. Facsimile... the list is endless.

And we know, too, that the war will be won. That's as sure as History... as certain as the course of American Destiny has always been!
Three-Dimension Color Television

STEREOSCOPIC OR THREE-DIMENSIONAL television images were first demonstrated by J. L. Baird, pioneer television experimenter as early as August 1928. At that time it was shown that it was possible to produce television images with the quality of depth. However, no further development was undertaken at the time because of the pressure of other work. Recently, experiments were resumed and the latest results are outlined in the February 1942 issue of Electronic Engineering in an article called “Stereoscopic Television” by Mr. Baird.

The effect of depth in a scene may be produced by observing simultaneously two plane views taken from points corresponding to the separation between the eyes (approximately 2½ inches). It is also possible to achieve the effect of depth by combining the views seen by both eyes into one picture in such a manner that the respective images may be later separated and viewed by the correct eye. This is sometimes done by producing two images of complementary colors. For example, one picture may be green and the other red. Then the two are combined and the result is viewed through glasses fitted with red and green filters. In this manner each eye can see only the view corresponding to its particular viewpoint and thus the scene is given the appearance of depth as before. Polarized light may also be used and discrimination obtained by viewing through glasses fitted with polaroid screens.

The stereoscopic scheme was used in early experiments dealing with three-dimensional television pictures. In general the subject was scanned alternately from two positions by means of the scanning disc which had two sets of spirally arranged holes to give a 30-line screen. The light was reflected to a bank of phototubes and the variations in the tube currents were amplified and transmitted in the usual way. At the receiving end a similar scanning disc was employed with a light behind the scanning areas, and the images formed on the disc were viewed through a prismatic stereoscope.

In the most recent development of Mr. Baird a mirror device splits the emerging light beam into two paths separated by the interocular distance. A revolving shutter causes each beam to scan the scene alternately so that the images corresponding to the right and left eye are transmitted in rapid sequence. Another disc with red, green, and blue filters breaks up the image into its color components. Thus superimposed red, blue, and green pictures are transmitted for left and right eye alternately to produce an image of natural colors. At the receiver the colored pairs of pictures are reproduced in sequence and are projected on the field lens. Alternate halves of the lens projecting are exposed by a rotating shutter so that the observer’s left and right eyes are presented alternately with left and right images. The combined effect is a stereoscopic image in full color. At the transmitter it is desirable to maintain the total illumination of the subjects constant to avoid flicker. Thus the shutter is fitted with a spiral mask shaped so that the area obscured in one light beam at any moment is equal to the area uncovered on the other. At the receiver this is unnecessary so a plain alternate mask is used.

The image must be viewed in one position to get the proper effect. If the head is moved so that the right eye sees the left-eye image the effect of depth is lost. Consequently one or at the most two people may view the scene properly. Further experiments are now under way for making it possible for a large audience to be able to view stereoscopic pictures without the aid of glasses.

In the apparatus demonstrated in London, the frame frequency was 150 per sec, the scanning altered to a field of 100 lines interlaced five times to give a 500 line picture, successive 100 line frames being colored green, red and blue.

Two Aids for Transient Study

In recent years the subject of transient effects has received wide attention among electrical engineers. The study of these effects usually involves tedious
The more exacting your capacitor problem, the better we like it. Since the beginning of Radio, the Sprague reputation has been based on the ability to supply finer units to particular users.

The particular Sprague condenser types illustrated are widely used in exacting Army and Navy applications.

SPRAGUE
CONDENSERS—KOOLOHM RESISTORS
Quality Components • Expertly Engineered • Competently Produced
SPRAGUE SPECIALTIES COMPANY, NORTH ADAMS, MASS.

ELECTRONICS — May 1942
COLUMBIA BROADCASTING'S
50KW. WABC TRANSMITTER
IS EQUIPPED WITH
HEINEMANN
Fully Electro-Magnetic
CIRCUIT BREAKERS
IN THE RELAY SYSTEM

On such installations as this powerful new WABC Transmitter, only the most accurate circuit protective devices can be used—and the logical choice was HEINEMANN CIRCUIT BREAKERS, timed to the split second. These breakers are accurately calibrated, set and adjusted at the factory with the magnetic trip unit hermetically sealed to prevent any possible tampering. The breakers open instantaneously on short circuits while a time delay feature permits momentary, harmless overloads such as the passage of inrush current. They are available in all ratings from 50 milliamperes to 50 amperes. The breakers may also be used as switches to provide simple and effective control circuits.

Send for Catalog No. 40 Showing Complete Line

Fig. 1—Diagram of the surge generator, sweep circuit, and cathode-ray oscillograph.
ELECTRICAL instruments have been called upon to do a big job—and that is the kind of job that Simpson Instruments are built to handle.

This fact stands out in the Simpson record. Try to find a Simpson model that has not been a complete success. Try to find a Simpson Instrument that has failed to do its job properly. Can you think of any product for which a better record could be cited?

If your requirements are vital enough to give you the right to buy instruments, they are vital enough to deserve the best.

On their record — past and present — that means Simpson!

SIMPSON ELECTRIC CO., 5212 Kinzie St., Chicago, Ill.

MODEL 260
High Sensitivity Tester

Here is a typical example of Simpson leadership. At 20,000 ohms per volt this tester is far more sensitive than any other instrument in its price range—covers a wide range of unusual conditions which cannot be checked by ordinary servicing instruments. Six voltage ranges—0-2.5, 10, 50, 250, 1000 and 5000 V.—both AC and DC. Current readings from 1/2 ohm to 10 megohms. Five decibel ranges, —10 to +52 DB.

The SIMPSON Full Bridge Type Movement, with Soft Iron Pole Pieces

This is the fighting heart of every Simpson Instrument. Soft iron pole pieces distribute magnetic flux evenly, assuring perfect accuracy. Bridge type construction holds the moving assembly always in perfect alignment.
Blind Landings!

GAMMATION TUBE, an achievement to which CALLITE contributed.

Lives depend on an unfailing signal when a plane glides in for a blind landing. Gammatron tubes — heart of modern blind landing systems — guard against even a split-second gap in this unseen safety path.

- Designed to operate at high voltages and high frequencies, Gammatron tubes call for something new in stamina. During the exhaust process, for instance, the Type 454 is operated at eight times its rated plate dissipation — must withstand abnormal temperatures, fantastic filament overloads and otherwise measure up to the toughest conditions that may be encountered later — when lives depend on uninterrupted service.

In selecting the most reliable materials, Heintz & Kaufman naturally turned to Callite. Callite tungsten grid and filament supports, mounting springs and filaments play their vital role in this brilliant new achievement — with the dependability that characterizes all Callite materials in scores of electronic applications.

Specialists in the manufacture of electrical contacts of refractory and precious metals, bi-metals, lead-in wires, filaments and grids — formed parts and raw materials for all electronic applications.

CALLITE TUNGSTEN CORPORATION

644-50th STREET UNION CITY, N. J.

Cable: "CALLITE" Branches: Chicago, Ill. - Cleveland, O.

May 1912 — ELECTRONICS
Jensen

SPEECH
REPRODUCERS
ARE ON ACTIVE DUTY
WITH THE NAVY
AND
THE SIGNAL CORPS

Jensen
RADIO MANUFACTURING CO.
6661 S. LARAMIE AVE., CHICAGO

ELECTRONICS — May 1942
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GUN SWITCH HANDLES
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America depends on RELAYS by Guardian

This "G" in the shield ... high in the air—sweeping the sea—sweeping the land ... in jeeps—guns—tanks—planes—ships—is doing a 100% "all out" job for America!

Strictly defense, production time open for government approved items, with samples immediately available for any job for the U. S. Army, Army Air Corps, Navy, Naval Air Corps, Marine Corps, Signal Corps, Ordnance.

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P.S. Want to take advantage of some of our recent developments for that "after it's over" product you have in mind? Samples only available now!

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GUARDIAN ELECTRIC
1425 WEST WALNUT STREET, CHICAGO, ILLINOIS
LARGEST LINE OF RELAYS SERVING AMERICAN INDUSTRY

May 1942 — ELECTRONICS

may be easily understood by referring to Fig. 3 which shows a block diagram of the complete system.

The carrier frequency which is modulated by the signal fed into terminals a and b is amplified and passed through a filter to eliminate spurious signals and then through a switch to the recording head. The carrier frequency is generated by oscillator 6 which also supplies through amplifier 7 an obliterating current for the obliterating head 8. The endless tape moves over two rollers 10 and 11 so that it passes first through the obliterating head 8 and then through the recording head 5. A signal recorded by head 5 remains on the tape until it passes through head 8. The transient signal is fed into trigger circuit 12 which operates with a time delay. As soon as the transient occurs the trigger circuit becomes energized, and after a short time interval, slightly shorter than one complete tape cycle, it blocks the obliterating amplifier. Simultaneously, the trigger circuit disconnects the recording circuit from the

Fig. 3—Block diagram of the complete magnetic recording and reproducing system
WHEN DIMENSIONAL ACCURACY IS A MAJOR FACTOR, ISOLANTITE* INSULATORS OFFER OUTSTANDING ADVANTAGES

WHEN a high degree of accuracy is essential in the dimensions of ceramic insulators, manufacturers find special advantages in the use of Isolantite parts. Isolantite's manufacturing processes permit extremely close dimensional tolerances as compared with general ceramic requirements. Certain critical dimensions on coil forms like those illustrated, as well as many other types of Isolantite parts, can be fabricated after firing on special equipment, thus facilitating assembly.

This is but one of Isolantite's advantages — for Isolantite is characterized by the unique combination of advantages which it offers in a single ceramic body. Uniformity of product, nonabsorption of moisture, electrical efficiency, high mechanical strength — all these features combine to make Isolantite the choice of leading manufacturers of radio and communications equipment.

These advantages have naturally led to a widespread demand for Isolantite parts in a variety of essential applications — and Isolantite is now pushing to completion an expansion program planned to render more efficient service to the many users of its products.

*Registered trade-name for the products of Isolantite Inc.
recording head by means of switch 4. The reproducing head which is the
same as the recording head supplies the
induced voltage produced by the mag-
netized tape to amplifier 13. The out-
put is passed through a band pass
filter to a demodulator and then to the
oscilloscope.

The unmodulated carrier is so ad-
justed that the extreme values of the
envelope produced by the modulating
signal lie within the linear portions of
the magnetization curve of the mag-
netic recording medium. Since not more
than 70 percent modulation is used the
non-linear portion near the beginning
of the curve has very little effect. Thus
the peak values of magnetic induction
recorded on the tape will be linearly
proportional to the peak values of the
carrier frequency, and will produce a
magnetic facsimile of the envelope. The
instrument has proved valuable in in-
vestigating welding processes and can
be adapted readily to other applications.
Some of these are studying transient
occurrences in power lines, transient
phenomena in loudspeakers, illumi-
nation patterns of photo flash bulbs, and
shock-excited vibrations of mechanical
parts.

Feedback for Stabilizing
Light-Valves
A DESCRIPTION OF HOW the well-known
principle of negative feedback is used
to stabilize the response of light-valves
used in sound-film recording appears in
the March 1942 issue of the Journal of
the Society of Motion Picture Engi-
neers. The article is called "Stabilized
Feedback Light-Valve" and is written by
All electromechanical devices may be
regarded as feedback circuits if their
motional impedance is interpreted as a
feedback counter-emf. In the device of
arbitrary nature shown in Fig. 1, the
input voltage $E_i$ produces a motion of
velocity $V$ in the armature. If the de-
vice is of an electromagnetic or electro-
dynamic nature the motion of the arma-
ture will produce in the electrical input
circuit a counter-emf proportional to
the armature velocity. Since the unit is
built for the sake of the mechanical
motion produced, one can regard its
velocity as the "output", and as corre-
sponding to the output current of an
amplifier. Thus we can regard this

---

*Fig. 1—An electromechanical device where the input voltage produces a motion of velocity $V$ in the armature*
AmerTran is improving its product to meet the exacting needs of today...tomorrow you will reap the benefit.

Today...our entire plant output is being devoted to one purpose...to help win the war. Transformers of every type and description are being required in larger quantities than ever before, not only by Government departments but also by defense plants and electric utilities.

AmerTran is doing its share to meet this demand...we are developing improved designs and improved manufacturing methods...we are increasing our personnel and facilities...in short, we are shipping more and better transformers.

Tomorrow...when our bombers pull victoriously out of their last dive the resumption of peace time demands will find AmerTran equipment far better than ever before.

During these days when customers without priorities are deprived of transformers, we are supplying the exact same type of product as previously and are developing improvements at a more rapid rate than usual. Customers of the future will benefit from these developments.

As for the past 41 years, AmerTran will continue to hold the place of leadership in the communication field it has gained by the high excellence of transformers supplied for all electronic and radio applications. Manufacturers with sufficient priority rating are invited to discuss their transformer requirements with us now...all others must wait for victory.

AMERICAN TRANSFORMER COMPANY, 178 Emmet St., Newark, N. J.

Manufactured Since 1901 at Newark, N. J.
TIME IS SHORT! Meet your delivery schedules, release fabricators for other jobs in your plant by sub-contracting your LAMICOID (laminated Bakelite) fabricating to Mica Insulator Company.

We have specialized in laminated plastics for more than 10 years. With expanded facilities both for manufacturing and fabricating LAMICOID, we can give you prompt service and the uniform, high quality that Army and Navy specifications demand.

Parts like those shown are being shipped every day to war work contractors as well as government agencies. Send us your blueprints for prompt quotations. Our engineers and service agents are available to help in speeding delivery of LAMICOID parts for both electrical and mechanical applications. The coupon below is for your convenience.

\[\text{USE THE COUPON TODAY!}\]

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We are sending blueprints (or samples) of our \[\text{[blank]}\] giving dimensions, details of machining operations and other essential data. Quote price and delivery on quantities of \[\text{[blank]}\] This is NOT an order.

Name \[\text{[blank]}\] Title \[\text{[blank]}\]

Company \[\text{[blank]}\] Address \[\text{[blank]}\]

\[\text{May 1942 — ELECTRONICS}\]
You engineers in broadcasting have always been a forward-looking lot—working constantly for the growth and improvement of your chosen industry.

Now we're at war, no one can see just what's ahead. Many of your hopes and plans—like ours—must be laid aside until the war is won.

Meantime, let's glance back a moment to strengthen our confidence in the future of radio. Look into case after case of once-outstanding developments that are preserved in the Bell Labs Museum. Many of them are just "museum pieces" now because research brought forth far better communication equipment!

Here's proof of the amazing progress made in years past—and a promise of still better things to come. For today Bell Laboratories engineers are pushing ahead in radio research under the increased pressure of war.

Look ahead with confidence! Count on Bell Labs and Western Electric to adapt war-time discoveries and developments to your peace-time needs—for Better Broadcasting—when the threat to America has been crushed!
Extreme easy to operate, hp-Distortion Analyzers provide a rapid and accurate check for normal operation in Audio Frequency apparatus. When used in development work, their advantages will be readily appreciated because the amount of distortion can be measured at the same time its character is observed.

With the desired voltage adjusted to the proper frequency, the fundamental is entirely eliminated. Elimination filter is then switched out and the attenuator introduced. With proper adjustment, the setting of the attenuator gives the amplitude of the harmonic voltage in direct readings.

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The most modern facilities in the industry, coupled with twenty-five years of experience, produce REA Magnet Wire for the Army, Navy and Air Forces. It is furnished exactly as wanted...delivered with the greatest possible speed..."tailor-made" when necessary to fit special applications.

REA quality characteristics—longer continuous lengths, maximum efficiency and superior spooling—are helping to speed up America's Victory Program. Submit your procurement, engineering and production problems to us for fast action!

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Remember...American Industry can outproduce the world—let's get the job done FAST!
Extra dependability to assure broad, consistent coverage. That's just one of the many things war demands of America's great broadcasting industry. Blaw-Knox is proud that it is helping to answer this challenge—proud that more than 70% of all the radio towers in the nation were built by Blaw-Knox.


The stabilizer circuit appears in Fig. 2. A change in the load voltage, say a decrease, will change the voltage between B and C causing the drop across $r_1$ to make the grid of $T_1$ more positive and therefore the plate of $T_1$ more negative. This will reduce the bias on $T_2$, cause a drop in $r_2$ that will make the grid of $T_2$ more positive permitting an increase in circuit $T_3$ thus compensating for the change in the load voltage. This is the usual degenerative action that occurs in most electronically regulated power supplies.

With zero current in $T_2$, the effects of resistor $r_2$ are relatively negligible with the circuit constants shown in Fig. 2. The decrement of bleeder current caused by a change in $V_a$ causes a decrement in potential across $r_2$ that has two effects: a small potential decrement which contributes to the degenerative action is applied directly to the grid of $T_3$ and, other things being equal, the drop across $r_2$ reduces $V_2$, thus the potential decrement across $r_2$ is slightly less than it would be with $r_2$ equal to zero. This effect opposes the degeneration.

When there is appreciable grid current in $T_2$, practically all of it is also in $r_2$, and a change in this current is in phase with a change in the grid potential. Thus if $T_2$ changes so that by degenerative action the grid voltage of $T_2$ increases, the grid current will also increase and produce an additional potential increment across $r_2$. There are two effects of opposite phase produced by grid current in $r_2$. The first is an opposition to the degeneration caused by direct decrease of the $T_2$ grid potential. The second is a decrease in the bleeder current in $r_2$ which reduces the
drop across this resistor, and after two stages of amplification increases the grid potential of $T_1$. This effect contributes to the degeneration, and because of the two stages of amplification, is much more important than the first effect. The effect of the grid current is to exaggerate the degenerative action and to remove the restriction on the degree of compensation. The authors have christened this type of circuit a "super-degenerative" stabilizer. With the proper choice of resistors, and a relatively large change in grid current, the net degenerative action may actually cause over-compensation for the initially assumed change. By a simple adjustment, perfect compensation or an infinite stabilization may be achieved. The expression for the stabilization ratio is:

$$S = 1 + \frac{R_1}{R_0 + R_2} \left[ \frac{r_{pl}}{R_0} + \frac{a n_1 n_2}{r_{pl}} \right]$$

where

$$a = r_1 - (r_1 + r_2 + r_3)$$

and the condition for perfect stabilization is

$$a n_1 n_2 r_3 = 1$$

The cathode-plate and cathode-grid variational resistances of a tube are $r_2$ and $r_3$, and $n$ is the gain of a stage of amplification.

**SALVAGE OF THE DESERT**

Here are all kind of radio, including transmitting and receiving sets, which were captured at Bardia. The South African Signal Corps collected them.

---

**Custom Designed**

**TRANSFORMERS OF ALL TYPES UP TO 10KVA...**

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**ELECTRONICS — May 1942**
**Lingo Antennas**

"Stand Guard" over the vital Pennsylvania Turnpike

Now in Operation...

22 Specially Designed

LINGO UHF ANTENNAS

30 Tubular Steel SUPPORTING TOWERS

The huge job of constructing and erecting the specially designed antennas and supporting towers on the Pennsylvania Turnpike is another example of Lingo flexibility to meet any situation. The erection work, particularly on mountain tops was quite difficult... in some cases material was hauled by sled, mule back and manpower.

It is characteristic of Lingo to meet and conquer unusual problems and to fulfill all requirements promptly and satisfactorily.

Four types of Lingo receiving and transmitting antenna systems are now in use:

- **Horizontal Half Wave**
- **Horizontal Bi-Directional Array**
- **Vertical Unidirectional Array**
- **Vertical Bi-Directional Array**

Wherever installed Lingo AM and FM Radiators have exceeded all efficiency expectations... the same is true on this 161-mile super highway. Lingo continues to strive for better radiation standards for a greater radio industry in the future.

---

**Book Reviews**

(Continued from page 62)

Electron tube instruments will certainly appeal to the industrial user of tubes as well as to communication students.

It is encouraging to see that the trend of engineering application of electronics, as evidenced by the three volumes, is receiving attention so far as its power and industrial applications are concerned. The unification of physics and engineering, as exemplified by Millman and Seely is likewise a much needed forward step. All three of the volumes can be recommended for use of college level and the choice of which of these is the most suitable will depend upon the interest and educational needs of the reader.—B.D.

... Elements of Electrical Engineering


The New Edition of this book has been extensively revised, several sections having been completely rewritten. For the benefit of those who are not acquainted with this work it can be said that it deals with the fundamentals of electrical engineering and their applications in practice. The text is divided into four general divisions; electric and magnetic circuits, direct-current machinery, alternating currents, and alternating-current machinery. Included in the latter section is a chapter on electronic devices. The appendix includes seven tables of useful information on area and size of conductors, current carrying capacities of conductors, protection of motor branch circuits, and current and size of branch circuits for a-c and d-c motors. These tables have been rewritten to comply with the recent revision of the National Electrical Code.

The treatment of the subject matter is along elementary lines, with the view of having the book serve as the basis of a short course for electrical students and also non-electrical students in colleges. Fundamental principles are stressed, and formulas are kept to a minimum. Numerous applications are cited, and, in general, the student gets a good bird's-eye view of the entire field of electrical engineering. However, a disappointing feature is the small space devoted to electronic devices. In view of the increasing importance of electron tubes in industry, the author might have devoted more attention to this phase of electrical engineering.—E.R.G.

**Sigmund Cohn**

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*Micro-Dimensional Wire & Ribbon* for Vacuum Tubes

In a complete range of sizes and alloys for Transmitting, Receiving, Battery and Hearing-Aid Tubes.

Melted and worked under close supervision to assure maximum uniformity and tensile strength.

*Wires* drawn to .005" diam.

*Ribbon* rolled to .001" thick

**Special Alloys** made to meet individual specifications...

Write for list of stock alloys

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**No Engineer** whose work takes him into the field of sensitive electrical devices can say—today—that he is thoroughly grounded unless he "knows his electronics."

Because electronic circuits more and more are getting into industrial work as an automatic hand, an automatic eye, a new means of generating heat, etc., etc., they have become the background for a new cycle of industrial progress.

Are you trying to get along without ELECTRONICS? Better subscribe today!

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May 1942 — ELECTRONICS
TUBES

WPB Eliminates 349 Tube Types From Civilian Use

The long-standing headache of the radio industry, that of far too many tube types with many duplicates or near duplicates, has been removed to a large degree by a WPB order signed by J. S. Knowlson, Director of Industry Operations of the War Production Board and formerly president of the Radio Manufacturers Association. Radio Tube manufacturers were ordered to discontinue manufacture, as of April 24, for civilian use of 349 out of 710 tube types now on the market. The 349 discontinued types represent duplicate, obsolete, and small-demand tubes and it was explained by the Radio Tube Unit of the WPB that present inventories of the discontinued types will be sufficient for civilian needs for at least two years. This stock will be added to by rejects from military production of the same types. In the elimination of duplicate types, one of each group of duplicate types will be kept in production. Obsolete types and those for which there is almost no demand will not be replaced.

The obsolete and small-sales categories represent 289 types of tubes, or approximately 41 percent of the total number of types produced. However, sales in 1941 of these types amounted to only 6/10ths of one percent of the total number of radio tubes sold last year.

List of Tubes Barred from Manufacture for Civilian Use

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<td>1E7</td>
</tr>
<tr>
<td>1G7GT</td>
<td>2X3G</td>
<td>6AF6G</td>
<td>6M8GT</td>
<td>6Z5</td>
<td>1F7</td>
</tr>
<tr>
<td>1H5G</td>
<td>2Y2</td>
<td>6AF7G</td>
<td>6N6</td>
<td>512/155</td>
<td>1N7</td>
</tr>
<tr>
<td>1J1</td>
<td>2Y3</td>
<td>6AG5G</td>
<td>6NSG</td>
<td>6NSG</td>
<td>1Y4</td>
</tr>
<tr>
<td>1J5G</td>
<td>2Y4</td>
<td>6AG6G</td>
<td>6N6</td>
<td>627G</td>
<td>1Y4</td>
</tr>
<tr>
<td>1K1</td>
<td>2Z2</td>
<td>6AL5G</td>
<td>6N6</td>
<td>627G</td>
<td>17</td>
</tr>
<tr>
<td>1K4</td>
<td>2Z2</td>
<td>6AL5G</td>
<td>6N6</td>
<td>627</td>
<td>17</td>
</tr>
<tr>
<td>1K5</td>
<td>3</td>
<td>6B6</td>
<td>67G</td>
<td>7BSL</td>
<td>20</td>
</tr>
<tr>
<td>1K5</td>
<td>3B8G</td>
<td>6B7S</td>
<td>67GT</td>
<td>7BSL</td>
<td></td>
</tr>
</tbody>
</table>

My, what big ears you have...Herr Hitler

Yes, big ears to hear things not meant for them. And big eyes looking for things they should see—just yet.

You, Adolph, would be interested in the things we've developed for you. American resourcefulness, and determination to win are now at work. And the great plastics industry is performing miracles in the battle against time and production obstacles.

Richardson Plasticians, for example, are doing things that "can't be done"—saving other critical materials for other essential jobs—helping numerous producers increase their output.

A few of the ways in which INSUROK and the Richardson Plasticians' experience are now serving:

1. Increasing output per machine-hour
2. Shortening time from blueprint to production
3. Facilitating sub-contracting
4. Saving other critical materials for other important jobs
5. Providing greater latitude for designers
6. Doing things that "can't be done"
7. Aiding in improved machine and product performance

War Products Producers Please Note:
If you have a problem which laminated or molded plastics might solve, write us about it.

The Richardson Company, Melrose Park, Ill.; Lockland, Ohio; New Brunswick, N. J.; Indianapolis, Ind. Sales Offices: 75 West St., New York City; 584 M. Building, Detroit.

INSUROK

ELECTRONICS — May 1942

93
year, 780,000 tubes out of a total of 135,600,000 tubes sold in 1941. Nevertheless, as long as these types were produced they had to be carried in stock, tying up critical material in inventory, and their production resulted in loss of man hours, machine hours and materials.

Robert C. Berner, Chief of the Radio Section, estimated that 156,000 man hours and 80,000 machine hours will be released annually by the elimination of these tube types. In addition, critical materials will be used more efficiently by long production runs of the tube types not eliminated by the Order.

The order does not apply to tubes manufactured for the Army, Navy, Maritime Commission, Panama Canal, Coast and Geodetic Survey, Coast Guard, Civil Aeronautics Authority, the National Advisory Commission for Aeronautics, the Office of Scientific Research and Development, and Lend-Lease.

Tube Registry

New tube types registered by the RMA Data Bureau during March 1942

Type 7T7 (GL)

Pentode voltage amplifier, sharp cutoff; heater type. T-9 integral glass envelope-base; seated height 21 inches; 8-pin lock-in base.

RATINGS

Eg = 2.0 v
If = 0.25 amp
Es = 300 v (max)
Ea = 150 v (max)
Maximum Plate Dissipation = 1 watt
Maximum Screen Dissipation = 0.5 watts

TYPICAL OPERATIONS

Eg = 0.5 v
If = 0.3 amp
Es = 250 v
Ea = 150 v
Ia = 1.1 ma
Ig = 0.9 ma
Is = 4000 ma
r = 0.5 
Es for cutoff = = 0.5 v
G, = 7.5 ma
C, = 4.5 ma
G, = 0.005 ma
Raising 84:1.5

Cathode-Ray Tubes

Type 2530D9

DuMont

Cathode-ray tube, medium-persistence, white fluorescent screen; electrostatic focusing and deflection; usual application, oscillographic and high frequency: diameter 9 inches; 11-pin magnal base.

Eg = 6.3 v
If = 0.6 amp
K (anode 1) = 2900 v
K (anode 2) = 3000 v
K (grid) for cutoff = = 650 v
G (inenclosure) = 10,000 v
Deflection Factor
D, = Es = 36 v (d.c.)/kilo-volt-inch
D, = Es = 34 v (d.c.)/kilo-volt-inch
Type 2533A5
DuMont
Cathode-ray tube; medium-persistence, green fluorescent screen; electrostatic focus and deflection; intended for use where space is at a premium and a high intensity, small spot is required; diameter 5 inches; 12-contact peripheral base.

\[ E_1 = 2.5 \text{ v} \]
\[ I_1 = 2.1 \text{ amps} \]
\[ E (\text{anode} 1) = 1800 \text{ v} \]
\[ E (\text{anode} 2) = 5000 \text{ v} \]
\[ E (\text{grid}) \text{ for cutoff} = -125 \text{ v} \]
\[ E (\text{intensifier}) = 8000 \text{ v} \]

Deflection Factor

\[ D_1 - D_0 = 94 \text{ v (d.c.)/kilo-volt-inch} \]

\[ D_3 - D_2 = 72 \text{ v (d.c.)/kilo-volt-inch} \]

Type 2533B5
DuMont
Cathode-ray tube; long-persistence, green fluorescent screen; electrostatic focus and deflection; intended for use where space is at a premium and a high intensity, small spot is required; diameter 5 inches; 12-contact peripheral base.

\[ E_1 = 2.5 \text{ v} \]
\[ I_1 = 2.1 \text{ amps} \]
\[ E (\text{anode} 1) = 1800 \text{ v} \]
\[ E (\text{anode} 2) = 5000 \text{ v} \]
\[ E (\text{grid}) \text{ for cutoff} = -125 \text{ v} \]
\[ E (\text{intensifier}) = 8000 \text{ v} \]

Deflection Factor

\[ D_1 - D_0 = 94 \text{ v (d.c.)/kilo-volt-inch} \]

\[ D_3 - D_2 = 72 \text{ v (d.c.)/kilo-volt-inch} \]

Type 2533C5
DuMont
Cathode-ray tube; short-persistence, blue fluorescent screen; electrostatic focus and deflection; intended for use where space is at a premium and a high intensity, small spot is required; diameter 5 inches; 12-contact peripheral base.

\[ E_1 = 2.5 \text{ v} \]
\[ I_1 = 2.1 \text{ amps} \]
\[ E (\text{anode} 1) = 1800 \text{ v} \]
\[ E (\text{anode} 2) = 5000 \text{ v} \]
\[ E (\text{grid}) \text{ for cutoff} = -125 \text{ v} \]
\[ E (\text{intensifier}) = 8000 \text{ v} \]

Deflection Factor

\[ D_1 - D_0 = 94 \text{ v (d.c.)/kilo-volt-inch} \]

\[ D_3 - D_2 = 72 \text{ v (d.c.)/kilo-volt-inch} \]

Type 2533D5
DuMont
Cathode-ray tube; medium-persistence, white fluorescent screen; electrostatic focus and deflection; intended for use where space is at a premium and a high intensity, small spot is required; diameter 5 inches; 12-contact peripheral base.

\[ E_1 = 2.5 \text{ v} \]
\[ I_1 = 2.1 \text{ amps} \]
\[ E (\text{anode} 1) = 1800 \text{ v} \]
\[ E (\text{anode} 2) = 5000 \text{ v} \]
\[ E (\text{grid}) \text{ for cutoff} = -125 \text{ v} \]
\[ E (\text{intensifier}) = 8000 \text{ v} \]

Deflection Factor

\[ D_1 - D_0 = 94 \text{ v (d.c.)/kilo-volt-inch} \]

\[ D_3 - D_2 = 72 \text{ v (d.c.)/kilo-volt-inch} \]
NEWS OF THE INDUSTRY

Radio receiver production amounted to 13,600,000 units, $233,800,000 in 1941. War production shows a steady increase. F-M audience grows

Production

"GENERAL ELECTRIC has produced already more war goods for the present conflict than the Company turned out during the entire first World War," Charles E. Wilson, G-E president, stated on April 16.

"Nearly everything that we now make is for war, and every practicable means is being employed to increase production still further. We now have the largest number of employees in the history of General Electric. The majority work more than 40 hours a week; some of them work 60 hours. The average for our largest plant is 47.7 hours a week per worker."

"This war must be won in plants like ours and anything that can be done to induce men to concentrate their minds and hands on the tasks shall be done."

Hygrade Sylvania Corporation has recently purchased a new plant at Mill Hall, Pennsylvania, and are now in the process of putting it into shape for their use in the manufacture of radio tubes. They hope to have this plant in operation within a few months and it is understood that they will employ a large percentage of women operators.

C. A. Haines, who has been superintendent of the Salem Tube plant, will be in charge of operations of this new plant.

Radio City Products Co., Inc., manufacturer of test instrument, has moved its plant and offices to new and larger quarters at 127-133 West 26th Street, New York City. This move doubles the floor space occupied by the company and, with additional equipment now being installed, will greatly extend production facilities.

Metallizing Company of America, manufacturers of metallizing wire accessory apparatus, has moved its general offices and midwestern warehouse to new and larger quarters at 1330 West Congress St., Chicago.

Barker & Williamson, manufacturers of air inductors, announce the opening of a new and larger factory at 235 Fairfield Ave., Upper Darby, Pa.

1941 RADIO RECEIVER PRODUCTION
From RCA Licensee Reports 1941

<table>
<thead>
<tr>
<th>Broadcast Receiving Sets</th>
<th>Units</th>
<th>Sales</th>
<th>1941</th>
<th>1940</th>
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</thead>
<tbody>
<tr>
<td>Table Set</td>
<td>5,988</td>
<td>85,998,400</td>
<td>5,341,322</td>
<td>51,967,400</td>
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<tr>
<td>Console Set</td>
<td>705</td>
<td>25,211,600</td>
<td>23,552</td>
<td>27,529,200</td>
</tr>
<tr>
<td>Portable Set (Battery and/or AC-DC)</td>
<td>1,568</td>
<td>19,640,300</td>
<td>1,218,955</td>
<td>13,388,200</td>
</tr>
<tr>
<td>Television (Without Sound)</td>
<td>26</td>
<td>2,000</td>
<td>46</td>
<td>500</td>
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<tr>
<td>Auto Set</td>
<td>2,597</td>
<td>42,646,500</td>
<td>2,131,477</td>
<td>34,145,400</td>
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<tr>
<td>Farm Battery Set (Table or Console)</td>
<td>767</td>
<td>9,756,700</td>
<td>549,807</td>
<td>6,766,700</td>
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<tr>
<td>Frequency Modulation Adapter</td>
<td>9,984</td>
<td>211,300</td>
<td>1,805</td>
<td>55,000</td>
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<tr>
<td>Electric Phonograph Including Wireless Record Players</td>
<td>231,416</td>
<td>2,780,800</td>
<td>296,579</td>
<td>2,377,400</td>
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<td>Combination Apparatus</td>
<td>624,756</td>
<td>12,831,500</td>
<td>320,939</td>
<td>5,469,900</td>
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<tr>
<td>Console Combination Set</td>
<td>695,523</td>
<td>45,576,000</td>
<td>422,569</td>
<td>28,654,100</td>
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<tr>
<td>Radio, Phonograph and Recorder</td>
<td>76,129</td>
<td>5,577,400</td>
<td>20,647</td>
<td>1,007,300</td>
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<tr>
<td>Television (Built-in or Phonograph)</td>
<td>330</td>
<td>74,400</td>
<td>1,296</td>
<td>213,200</td>
</tr>
</tbody>
</table>

13,262,917 $227,228,900 11,390,774 $170,614,400
375,690 6,573,300 494,265 6,336,000

13,638,607 $233,802,200 11,855,099 $176,970,400
3,727 38,900 4,331 47,500

Total 13,642,334 $233,841,100 11,859,370 $177,017,900

May 1942 — ELECTRONICS
same date, approached the 30,000 mark.

Other cities reporting sizable gains were Philadelphia, Los Angeles, Pittsburgh, Milwaukee, Boston and Detroit. At present there are 25 commercial FM stations operating throughout the country, as well as ten FM transmitters still on an experimental basis.

Six new studios, designed with special regard for the acoustical perfection demanded by FM broadcasting, were dedicated by The Yankee Network of New England, which operates W4311 in Boston and W39B in Mount Washington, on March 20. One of the studios is three stories high and houses a 15-ton organ with 2,630 pipes ranging from 16 feet long to smaller than an ordinary lead pencil.

The South, where FM will be a great boon to listeners because of the high static density there will have its first taste of noise-free high-fidelity broadcasting when the FM station W41MM on top of Clingman's Peak goes into operation in May. Located some 6,800 feet high, signals will penetrate to a great part of the population of North Carolina, South Carolina, and parts of Tennessee, Virginia, Kentucky, Georgia and West Virginia.

On March 3 Walter J. Damm, manager of radio for WTMJ-W55M, Milwaukee, was elected president of FM Broadcasters, Inc., the national trade association of FM stations. The new vice-president is Theodore C. Steibert, W71NY-WOR, New York City, while Robert T. Bartley of The Yankee Network, Boston, was re-elected secretary-treasurer.

Two new construction permits for additional FM stations have been granted by the FCC, approving installation of transmitters in Grand Rapids, Mich., and Amarillo, Texas. The Michigan permit went to the King-Trendle Broadcasting Corp., which operates WXYY in Detroit, and authorizes construction of a station on 46.9 Mc to serve 5,300 square miles. The Amarillo Broadcasting Corporation received permission to build a station on 45.1 Mc, covering an area of 5,600 square miles.

11A111O

PAPER CAPACITORS-at their best!

Solar experience plays a vital part in the production of completely dependable paper capacitors for the Armed Service Branches of our Government.

Consult Solar for prompt solution of your paper capacitor problems

SOLAR MFG. CORP. . . . BAYONNE, N. J.

www.americanradiohistory.com
NEW PRODUCTS

Month after month, manufacturers develop new materials, new components, new measuring equipment; issue new technical bulletins, new catalogs. Each month descriptions of these new items will be found here.

Coil Testing Equipment

A new line of coil testing machines is announced, for quickly checking all of the electrical properties of a coil in one handling. Tests are provided for checking the limits of insulation resistance, coil resistance, effective a-c resistance, inductance, and shorted turns. Additional tests are for checking effective turns, direction of windings, and other properties. There are two types of machine, the automatic and semi-automatic. Each machine has a holder adapted to the special shapes of coils to be tested.

Light-Current Low-Voltage Relay

Designed to handle circuits carrying milliamperes at microvolts in radio applications, a new laminated frame relay (Type CX3318) has sliding contacts and is also suitable for switching thermocouple circuits. It is constructed to withstand extreme vibration incident to aviation service and is tested for operation at high altitudes. The relay measures $3\frac{3}{4}$ in. high, 2 in. wide, and 2$\frac{1}{8}$ in. deep, and weighs 9$\frac{3}{4}$ ounces. Contacts are double-pole, double throw. Coils are for operation on alternating direction of each winding; and finally checks the high and low limits of inductance. All of these tests are performed in a few seconds without strain or fatigue.

An automatic machine for the same purpose uses relays to supervise itself and to pass from one test to the next without attention from the operator. Up to 300 complicated coils per hour may be tested automatically for twenty-one possible defects. The operator merely inserts and removes coils, and notes presence of any defect from a bank of lamps.

Photobell Corp., 116 Nassau St., New York, N. Y.

High-Speed Limit Bridge

Model LB-1 high-speed limit bridge is designed to speed up production testing of capacitors or resistors, either by the manufacturer or the user. Its main features are: negligible setup time, great flexibility, wide range, accuracy within 1 percent plus or minus of standard, and ruggedness. When used in conjunction with a DK-2A Decade Capacitor in checking capacitors, the bridge covers the ranges of 0.001 to 1.1 $\mu f$, in 0.001 $\mu f$ steps. The bridge can also be used with decades of other ranges, or with independent capacitance standards. In checking resistors the unit is supplied with a resistance standard having a range of 1000 ohms to 1.11 megohms. Other resistance standards may be used if desired. Different models are required for capacitance and resistance measurements. For production testing, the instrument's high-low dials are set for the desired plus-minus limits and when the limits are exceeded the closing of a corresponding cathode-ray null indicator gives immediate warning.

The limit bridge is entirely self-contained and furnished with tubes. It operates on 105-130 volt, 50-60 a-c line. It uses a Wheatstone bridge circuit and readings are independent of line voltage fluctuations and tube characteristics.

Industrial Instruments Inc., 156 Culver Ave., Jersey City, N. Y.

Vacuum Tube Multi-Range Tester

The Series EV-10 multi-range tester is a new electronic measuring instrument which is compact, complete and ultra-sensitive. It provides the full functions of eight individual instruments for measuring requirements of present and future communications, electronics and electrical fields. It combines both VTVM as well as standard 1000 ohm per volt a-c d-c test circuits and permits rapid, accurate measurements without materially disturbing

May 1942 — ELECTRONICS
A WAR MESSAGE TO
ALL EMPLOYERS

From the United States Treasury Department

Dear Sirs:

While the war is being waged, Congress has authorized the Secretary of the Treasury to issue Pay-Roll Savings Bonds and Stamps to qualified employers.

A Pay-Roll Savings Plan is the simplest, the swiftest way of raising funds for defense. As a result, it is already being used by 32,145 employers, with a total of over 17,700,000 employees.

Have YOU Started the Pay-Roll Savings Plan in YOUR Company?

Like a strong, healthy wind, the Pay-Roll Savings Plan is sweeping America! Already more than 32,000 firms, large and small, have adopted the Plan, with a total of over seventeen million employees—and the number is swelling hourly.

But time is short! More and more billions are needed, and needed fast, to help buy the guns, tanks, planes, and ships America's fighting forces must have. The best and quickest way to raise this money is by giving every American wage earner a chance to participate in the regular, systematic purchase of Defense Bonds. The Plan provides the one perfect means of sluicing a part of ALL America's income into the Defense Bond channel regularly every pay-day in an ever-rising flood.

Do your part by installing the Pay-Roll Savings Plan now. For truly, in this war, this people's war, VICTORY BEGINS AT THE PAY WINDOW.

Plan Easy to Install

Like all efficient systems, the Pay-Roll Savings Plan is amazingly easy to install, whether your employees number three or ten thousand.

For full facts and samples of free literature, send the coupon below—today! Or write, Treasury Department, Section C, 709 Twelfth Street NW., Washington, D. C.

MAIL THIS COUPON NOW

Treasury Department, Section C
719-12th St., NW.
Washington, D. C.

We want to do our part. Please rush full information regarding the Pay-Roll Savings Plan.

NAME

Position

Company Name

Address

Number of Employees

This space is a contribution to NATIONAL DEFENSE by Electronics

ELECTRONICS — May 1942
How to Get Experienced Help and Production Machinery Without Investment

*Too good to be true? Here's the facts.* If you use transformers of standard or special specification, all your problems concerning their design and production can be eliminated from your mind. Just turn the job over to Acme. Acme has three modern transformer manufacturing plants, (at Cuba, N. Y., and Clyde, N. Y.) fully equipped with the finest types of money and time-saving equipment. A complete staff of transformer engineers are ready to work with you and a specially trained production organisation to produce your transformer to Acme acknowledged quality standards. If your transformer design can be adapted to the hundreds of designs for which complete tools, dies and fixtures are on hand, you can immediately save tooling costs and months of time.

You need this Breakdown Tester

The Identification Transformer Bulletin 515 may help you adapt your transformer design to make use of tools and dies available for immediate production.

31 Water St.
Cuba, N. Y.

Volt-Ammeter

Type AK-1 Hook-on a-c volt-ammeter has four current and two volt ranges. It is an instrument for general plant testing, particularly where an accurate measurement of circuit conditions is needed in a hurry. Alternating current can be read on both insulated and non-insulated conductors by simply hooking the instrument around the line. A-c voltages may be read without the use of auxiliary equipment. Current ranges are 0-15, 60, 150 and 600 amps, and the voltage ranges are 0-150 and 600 volts which may be obtained by setting a six-position switch. Accuracy is within 3 per cent. The indicating instrument used in this device is the G-E Type DO-40 rectifier-type instrument. The volt-ammeter measures 133/4 x 21/2 x 31/4 inches, and weighs 3 lbs.

General Electric Co., Schenectady, N. Y.

Plastic replaces aluminum in a new tungsten wire spool developed by Callite-Tungsten Corp., and at a saving of 20 percent. The spools are molded by Universal Plastics Corp. The Bakelite material is made in two sections which are fitted together and cemented to insure a permanent bond.

Performance of the circuit under analysis.

The tester uses a voltage regulated bridge type circuit. It provides the following ranges on an 8½ inch meter: Eight zero-center VTM ranges from ±3 to ±6000 volts direct current; six circuit probing, zero-center, VTM ranges from ±3 to ±600 volts direct current; six ohmmeter-megohmmeter ranges up to 2000 megohms; eight a-c and eight d-c voltage ranges at 1000 ohms per volt from 0.5 to 0.6000 volts; seven d-c current ranges, 0-600 an to 0-12 amps; eight a-c output ranges to 6000 volts; and eight db ranges from —20 to +70 db.

Available as an accessory item to this Series EV-10 is an RP-10 vacuum tube probe which provides direct means for measurement of supersonic, r-f and u-h-f voltages.

Precision Apparatus Company, 617 Kent Ave., Brooklyn, N. Y.

Write for NEW 1942 CATALOG
Address—Dept. ES

Great Time Savers

Unbrako

Knurled Socket Head Cap Screws

Literally—the Knurled head is a great time saver. Greasy, oily fingers welcome the Knurled non-slip grip... no slip, no lost motion.

And—the Knurling also enables quick, easy locking after countersinking.

Deliveries are better than average... and no premium price. So—send for details and make your next order "Unbrako".

The Knurling of Socket Screws originated with "Unbrako" years ago.

Standard Pressed Steel Co.
Box 326
Jenkintown, Penna.

May 1942—ELECTRONICS
Air Raid Warning Device

KNOWN AS “ROBOT RAID WARDEN,” this set is designed to control lighting circuits or give audible alarm during an air raid warning. The device is tuned to the carrier signal of key radio stations which are on the air 24 hours each day. In the event of a signal from the Interceptor Command for the station to cease broadcasting, the Robot Raid Warden is automatically set in action. Incorporated in the set is a pilot light which is located on the front panel of the unit. This light goes

on as soon as the unit is plugged into the power source and indicates that the Robot itself is operating efficiently. In the event of unusual mechanical or electrical disturbance within the Robot, the pilot light is automatically extinguished.

The instrument is tuned to the key station continuously. When the broadcasting station’s carrier goes off the air, the Robot synchronous motor driven time delay unit starts operating. When the carrier has been off the air for 2 minutes a relay is actuated operating a set of single pole double throw contacts capable of controlling loads up to 10 amps, which control the previously determined alarm or lighting circuits.

Standard units are rated at 115 volts, 50 or 60 cps alternating current. Price is approximately $65 f.o.b., from Industrial Timer Corp., 115 Edison Place, Newark, N. J.

Hand Tachometer

THE JONES HEAVY-DUTY hand tachometer is an indicating instrument for measuring speed directly in revolution per minute or feet per minute. It is simply designed and of rugged construction and may be used by both skilled and unskilled workers. The tachometer comes in both single and triple-range models for speeds from as low as 200 to as high as 2000 rpm. It is supplied complete with carrying case, and includes tips and other accessories.

Bulletin 1710 describes this instrument more thoroughly and is available from James G. Biddle Co., 1211 Arch St., Philadelphia, Pa.

We’re 1A in the Draft

* In the thick of the fight—in America’s airplanes, tanks, guns and ships—Wilo’s thermostatic bi-metals and special electrical contacts are proving themselves unbeatable. On the war production front too, The H. A. Wilson Company offers a wide variety of specialized thermostatic bi-metals of high and low temperature types. Also a series of resistance bi-metals, from 24-140 ohms per sq. mil. ft. Wilco electrical contact alloys meet war requirements...are available in Silver, Platinum, Gold, Tungsten, Special Alloys, Metal Powder Groups. Wilco Aerofluy is the outstanding aircraft magneto contact alloy.

STABILIZED A. C. VOLTAGE

UP TO 25 KVA

INSTANTANEOUS ACTION
NO MOVING PARTS

When a precision electrical device or a critical process is powered from an AC line, a Raytheon Voltage Stabilizer will permanently eliminate all of the detrimental effects caused by AC line voltage fluctuations. Made for all commercial voltages and frequencies, single or three phase.

Raytheon’s twelve years of experience in successfully applying the Stabilizer to hundreds of perplexing voltage fluctuation problems is at your service. It will pay you to take advantage of our engineering skill.

Write for Bulletin DL48-71 E describing Raytheon Stabilizers.

RAYTHEON MANUFACTURING CO.
100 Willow Street, WALTHAM, Massachusetts
ABBOTT ULTRA HIGH FREQUENCY COMMUNICATIONS EQUIPMENT

Measuring up to the most rigid and exacting requirements, our standard models have been incorporated in civilian emergency and military communications networks. However, the extreme flexibility of our design and production facilities make ABBOTT an ideal source of supply for "RUSH SPECIALS".

KENYON IS UP TOP "DOWN UNDER" TOO

Kenyon Transformers...recognized everywhere as being of superior design...are "up front" because of the way they are made. When a transformer bears the name of Kenyon you know that it contains the finest of materials and workmanship.

Whether it's a small "A" line unit or a large oil cooled type for modulation, plate and filament supplies, Kenyon can provide the answer to your problem.

Miniature Panel Instruments

For radio transmitters, control panels, industrial test units and general test work in electrical laboratories, a new line of miniature panel instruments has been announced. D-c and a-c, thermocouple, and rectifier types of the three and one-half inch class for indicating volts and amps are made with a chassis construction where only a change in cover is needed to make up square, circular, flush or projection type instruments.

Capacities as low as 20 ma are available for d-c measurement. Self-contained amplifiers to 100 a c-v. direct current and alternating current, and voltmeters up to 500 volts alternating and direct current are also available. Higher ratings may be obtained by using resistors, shunts, or transformers. On rectifier instruments the dial is calibrated in rms values with a sensitivity of from 1000 to 5000 ohms per volt. These are used for measuring a-c values when low energy consumption is important. Thermocouple styles are available with either self-contained or external thermocouples developed for maximum overload and stability and are used for measuring a-f currents. Frequency errors have been reduced to a minimum, and the overall design is balanced to give the minimum capacity or inductive errors. All instruments in this classification have permanent white dials, high torque to weight ratio, and Moldavita cases.


Remote Controllers

Series 250 remote controllers utilize a new principle designed to provide simpler solutions for liquid level controls where previous methods were cumbersome or unduly expensive. The level-sensitive condenser or cage glass pick-up unit forms part of a h-f resonator which is connected, by means of a coaxial cable, with the control cabinet. The electronic tube of the instrument performs three functions: the generation of h-f oscillations which are transmitted to the pick-up; the de-
RESOURCEFULNESS
—is only one of the many characteristics of the Eicor organization. This has been demonstrated again and again in the solution of difficult design problems and in the development of rotary electrical apparatus to meet the most unusual conditions.

Does the Materiel you are producing require a compact DC motor—a Multi-Output Dynamotor—or a special Generator? The ability of Eicor Engineers to produce special units or variations of standard units can be of real assistance to you.

ILLUMINATION BLACKOUT CONTROL UNITS

BLACKOUT CONTROLS, Types A28C and A16E permit illuminated billboards, store window displays, and other time-switch controlled illumination to remain in operation in districts where blackout regulations are in effect. The blackout control unit may be installed on the billboard, or in the store window, which is to be operated. It is aligned with the nearest street lamp. When this centrally located street lamp is turned out, the blackout control observes this and turns off the illumination which it is controlling.

Type A28C is conservatively rated for operation up to 100 ft from any average street lamp. It is equipped with a tamper-proof sensitivity adjustment so that it may be set to control illumination under varying conditions of ambient light and at various distances from a street lamp. The specially designed optical system on this unit makes it relatively insensitive to light from any source other than the street lamp which it is observing. A time delay is designed into the circuit of the control to make it independent of momentary fluctuation and flickering of the street lamp. It is operated from a 115 volt, 60 cps, a-c line. It is listed at $81.50.

Type A16E is available with large and small optical systems for operating...
Finding the right resistor for a specific application is likely to be no easy problem. Because the solution so often is found in Globar Brand Ceramic Resistors we urge you to acquaint yourself with the distinctive qualities of these versatile resistors. The handy chart below shows types available, together with their characteristics.

### Characteristics of Globar Ceramic Resistors

<table>
<thead>
<tr>
<th>Type</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>Z</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diam.</td>
<td>1.75</td>
<td>1.75</td>
<td>1.75</td>
<td>1.75</td>
</tr>
<tr>
<td>Max.</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Leng.</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Max.</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Watt</td>
<td>1-4</td>
<td>1-4</td>
<td>1-4</td>
<td>1-4</td>
</tr>
<tr>
<td>Rating</td>
<td>0.04</td>
<td>0.04</td>
<td>0.04</td>
<td>0.04</td>
</tr>
<tr>
<td>Voltage</td>
<td>0.04</td>
<td>0.04</td>
<td>0.04</td>
<td>0.04</td>
</tr>
<tr>
<td>Temperature</td>
<td>0.04</td>
<td>0.04</td>
<td>0.04</td>
<td>0.04</td>
</tr>
</tbody>
</table>

In addition to these standard items, special resistors can be made to meet definite specifications both as to shape and characteristics. Ask for Bulletin R and give us details of your requirements.

**Globar Division**

**THE CARBORUNDUM CO.**

**NAIAGA FALLS, N.Y.**

*Carborundum and Globar are registered trade marks of and licensed manufacturers by The Carborundum Company.*

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ranges of 20 ft and 10 ft, respectively, from a street lamp. It is operated from 115 volts alternating or direct current. Prices are $49.50 and $45.00.

In both of these models the output terminals are those of a single-point switch and are rated to handle a load of 2,000 watts alternating current, or 600 watts, direct current. They measure 91 x 6 x 74 ins.

Available from Photoswitch Inc., 21 Chestnut St., Cambridge, Mass.

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**Time Totalizer**

This instrument is for use in radio transmitters, welding machines, vacuum tube devices, etc., and acts as an elapsed time meter to show an exact record of machine hours. Production costs of any a-c operated machine can be readily computed from the visible hours and minutes shown on the totalizer dial. The instrument is operated by a long-life synchronous heavy-duty self-lubricating motor, connected through gears to a five digit hour counter. The visible totalizer gives a record up to 10,000 hours.

The instrument is available in various frequencies and voltages from Industrial Timer Corp., 117 Edison Place, Newark, N. J.

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**High-voltage Oil Capacitors**

**Type '20 Units** are for use in radio transmitters and other applications which call for high-voltage heavy-duty oil capacitors. These oil (Hyvlar dielectric oil is used) capacitors cover working ratings from 6,000 to 50,000 direct current, and include dual-section units for voltage-doubling circuits of 12,500–12,500 volts or 25,000 volts output, in 0.25–0.25 and 0.5–0.5 µF. They are hermetically sealed in welded steel containers, finished in corrosion-proof and rust-proof dark gray lacquer, together with cork-gasketed pressure-sealed glazed porcelain high-tension pillar terminals. The capacitors are immune to humidity, temperature and climatic conditions generally, and will maintain their full rated capacity even at freezing temperatures.


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**New Carter Aircraft Type Genmotors**

- **SENSATIONAL!** That's the word for the new Carter Multi-Output Dynamotor. Since its introduction a year ago, Police Departments, Government Agencies, and manufacturers of Tank Radio Equipment have found it has no equal for small size, high efficiency, and extra light weight. It's the coming thing for all Transmitter and Receiver installations.

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**Carter Motor Co.**

1606 Milwaukee Ave. 
Cable: Genmotor
Carter, a well known name in radio since 1922

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**May 1942 — ELECTRONICS**

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www.americanradiohistory.com
Locking Vernier Control Head

A new, positive locking vernier control head is available for remote control problems where the point of control is disadvantageously situated with reference to the point of application. The control is designed for installations where the vernier adjustment and the lock are primary considerations and push-pull movement is of secondary importance. When coarse adjustment is required, a slight pressure of the hand releases the thread engagement which provides the positive lock as well as the worm thread for fine adjustment. A small pin set at the top of the face plate rides in the groove of the worm thread when the pressure exerted by a spring in the bottom of the face forces the plunger, or movable threaded rod, into engagement. The engagement is released when the pressure of the hand on top of a knob depresses the spring and allows the plunger to move freely. Upon release of hand pressure, the spring forces re-engagement and the positive locked condition. The control head can be mounted on any type control.

Arens Controls, Inc., 2253 S. Halstead St., Chicago, Ill.

Metal Booster Pump

A new high capacity metal vacuum pump, known as the Metal Booster Pump, Type MB-200, is available for use with forepumps having low volumetric efficiency at pressures below 1 mm of Hg. This two-stage oil diffusion unit will boost the pumping speed to 200 liters per sec and will carry the vacuum from 0.5 mm to 5x10\(^{-7}\) mm of Hg. The unit is small and compact, having a vertical casing 6 x 20 inches and is readily connected to large mechanical pumps by 1\(\frac{1}{2}\) inch stand pipe fittings, or in the optional model (which is illustrated) by a 2 inch i.d., 4 inch o.d. flange. The vacuum attainable is sufficient for metal sputtering and evaporation, ultracentrifuge, vacuum insulated flasks, and drying chambers.

Distillation Products, Inc., Rochester, N.Y.

ELECTRONICS — May 1942
STANDARD PRACTICE for SAFE PERMANENT Electrical Circuits

- Performance is safeguarded, maintenance difficulties cut to the minimum when electrical circuits are permanently sealed against corrosion with Kester Rosin-Core Solder.
- The patented, plastic rosin flux, especially compounded for electrical soldering, is self-contained in the core of the alloy in proper amount for perfect results. It will not contaminate insulating material. Guesswork is eliminated; production is speeded up, safely!
- Kester Acid-Core Solder is the ideal material for all general-purpose soldering. Contains scientifically prepared acid flux: makes a neat, tight, permanent union.
- All Kester alloys are pure, virgin metals. Failure due to impurities found in reclaimed metals can't happen with Kester Cored Solder! They stand up under bending, shock, vibration, contraction and expansion.
- Kester engineers, backed by 43 years of highly specialized experience, stand ready to assist you on any production or maintenance problem that solder may solve. Consult them freely . . . without obligation.

KESTER SOLDER COMPANY
4204 Wrightwood Avenue, Chicago, Illinois
Kester Plant: Newark, N. J. Canadian Plant: Brantford, Ont.

Kester Cored Solder STANDARD FOR INDUSTRY

BUD Condensers for every application
BUD precision built condensers are made in a wide variety of sizes and capacities for many electronic applications. Special capacities, air-gaps and mechanical details can be supplied. Prompt quotations submitted on receipt of your prints or specifications.

Power Supply Systems

The variation possible from the SC types power supply units makes them useful for practically any supply requirement, particularly in design laboratories working on electronic equipment, or in shops which service electronic equipment, especially where low-voltage high-current sources are not available except by the use of rectifiers which are usually of the fixed voltage type. The SC line comprises standard units supplying voltages as high as 24 volts at 20 amps, alternating or direct current, and also up to 1000 volts at 500 ma direct current. The unit illustrated is the SC-4 which produces 7.5 volts at 5 amps alternating current, and 500 volts at 200 ma, direct current.

Low voltage-high current and high voltage-low current outputs can be combined in one instrument, or units are available with either output. In any case, each output may be varied from zero to full voltage by a separate control on the front of the unit. Full rated current is available down to fractional voltage adjustments. Hum and noise are reduced by filtering to 60 db below the output level being used. High voltage outputs have low resistance and good regulation, making them especially suitable for supplying current to the plates of Class B stages.

Gates Radio & Supply Co., Quincy, Ill.

Plastics Capacitors

Specially designed, inverted type, tubular capacitors with lock-nuts are available in modern plastics for chassis top installation. These may be had in single or multiple units, over a wide range of capacities and working voltages, in both electrolytic and paper bypass types. The capacitors are jar and vibration-proof with effective insulation from chassis to container, and have an ample safety factor for voltage surges. The insulated leads cannot ground.

Additional information may be obtained from the manufacturer, American Condenser Corporation, 2508 S. Michigan Ave., Chicago, Ill.

May 1942 — ELECTRONICS
Panel Mounting

Panel Mounting No. 1414 is an indicator for circuit breakers, line switches, aircraft applications, etc. When used with remote motor control equipment it works instantly with a visible signal to show "on" and "off." The light glows on only when the circuit is broken. This mounting is available for 24 or 48-volt filament lamps (without a resistor), or a built-in 200,000 ohm protective resistor in series with a neon lamp. The resistor prevents the lamp from blowing out on unexpected high voltages. The lamp glows on currents as low as 100 μA. The mounting has a black Bakelite body, and transparent molded cap, and is available for panels up to ½ ins thick and 1 inch diameter mounting hole. The overall length is 2 ins below the panel and 4 ins above the panel. It is rated at 90 to 250 volts.

Littelfuse Inc., 4757 Ravenswood Ave., Chicago, Ill.

Blackout Signs

Laminated plastic plates printed in phosphorescent and fluorescent inks, both of which glow brightly in the absence of visible light are available as blackout aids where mechanical and electrical devices are employed. The phosphorescent type is activated by ordinary white visible light and will remain legible for two hours after the light is turned off. The fluorescent type is activated by ultraviolet or "black" light and remains legible as long as ultraviolet light is thrown upon it.

These plates are printed in various colors. The lettering is protected by plastic films which prevent the lettering from being injured by grease or cleaning solutions. The signs may be had only where identical signs are required in considerable quantity and are not available where only one or two of a kind are needed.

Formula Insulation Co., Cincinnati, Ohio.
**Detonation Instrument**

A new electro detonation filter and pickup provides means for selecting detonation or other explosion or vibration frequencies in automotive or aircraft engines. It immediately detects detonation or knock in an engine. The unit is tuned so closely that only the knock or other desired frequencies to which it is tuned can be heard.

This instrument is for use with a CFR testing engine or can be applied to studies with other engines for vibration and explosion phenomena. Model 2300 filter covers the range from 2000 to 8000 cps, and when used with Model 3000 pickup and cathode-ray oscillograph, it immediately indicates presence of detonation.

Electro Products Laboratories, 549 W. Randolph St., Chicago.

**Vacuum Tank Condenser**

**This condenser was developed on the principle that a “perfect vacuum” is a “perfect insulator.”** The infinite resistance of vacuum, regardless of its dimension or volume, forms a dielectric capable of withstanding the highest voltages. The plate spacing in this condenser is determined by mechanical rather than voltage limitations. The new device has an overall length of 62 ins and a maximum diameter of slightly over 2 ins. It carries a peak r-f voltage rating of 32,000 volts. A single section vacuum condenser may be used in a push-pull 100 percent modulated transmitter operating at 4,000 volts on the plate. Correspondingly higher voltages may be used in single ended amplifiers and where no modulation is required. Single units are available in 6, 12, 25 and 50 µf capacities. Proper combination will provide any desired capacity for optimum circuit efficiencies on any frequency at any voltage. Radio frequency current rating is 20 to 50 amps per unit, depending upon the frequency. Those condensers are also for use in padding capacities of open plate condensers. It is unnecessary to use a split capacity to maintain circuit symmetry in a push-pull amplifier.

Eitel-McCullough, Inc, San Bruno, Cal.

**WIRE-WOUND Controls**

Fry the dust-proof protective metal cap off a Clarostat wire-wound rheostat or potentiometer, and here's what you see:

Precise winding on bakelite strip; positive, smooth, wear-proof contacts; perfect lubricant; steel shaft accurately fitted in brass bushing. Obviously many years of fool-proof service. And even without prying off that dust-proof cap, just try turning that Clarostat wire-wound unit. That test usually identifies a Clarostat beyond a doubt—that velvety, smooth, easy rotation. Don't take our word for it. Try it yourself.

Available as L-pads, T-pads, mixers, faders, etc. in multiple assemblies even up to 18 units in tandem for one-knob operation.

**Send Your Problem...**

If it has to do with control or resistance, send it along for our engineering collaboration, specifications, recommendations. Quotations, latest engineering data sheets sent on request.

---

**A Precision Crystal**

**Secondary FREQUENCY STANDARD THAT HAS BEEN "Designed for Application"**

A precision frequency standard variable or tuned to WWV or some other primary standard and having unit-to-unit accuracy within 0.01% is obtainable. The unit provides a frequency of 100,000 cycles/sec, plus or minus 100 cycles, to whatever accuracy desired. The crystal is mounted in a resonant circuit and is replaced in a metal tube for protection. The self-contained AC power supply has 120-220 volts and 60 cps, and when used with a 6-volt battery it is designed for mobile use. The crystal is contained in a standard metal tube with a B-400 glass envelope. The unit is designed for use with an electronic oscillator, multimeters, and frequency synthesizers. It is a must for anyone interested in accurate frequency measurements, including radio engineers. The unit is available for immediate shipment, and is priced at $500.00. For further information, write to the manufacturer at 205 North Sixth St., Chicago, Ill.
Small Circuit Breaker

A new, small circuit breaker for the protection of airplane lighting, motor, radio and control circuits is available. The unit measures 213/4 x 33/4 x 0.865 inches, and weighs 43/4 ounces. The maximum capacity of the breaker is 50 amps. It operates on circuits up to 28 volts direct current while its interrupting capacity is 3,500 amps. The device is fully electro-magnetic and has a definite instantaneous trip point entirely independent of its time delay characteristics. The magnetic trip with time delay gives delayed trip on harmless overloads such as the passage of inrush current, but provides a high speed trip on short circuits and dangerous overloads. After the breaker opens it may be reclosed at once providing the current has returned to normal. The breaker cannot be held closed against any existing overload or short circuit. Due to the absence of any heating elements, its current carrying capacity and the minimum and instantaneous trip points are not affected by sudden and extreme changes in temperature. The breaker is vibration proof and resistant to shock.

Heinemann Circuit Breaker Co., 97 Plum St., Trenton, N. J.

Literature—

Protective Concealment. This booklet discusses camouflage methods for new factory buildings and those of older construction and their location from the standpoint of topography and proximity to urban or rural localities. Railroad yards, storage yards, tank farms and air fields are among the specific types of installation for which protective concealment are considered most effective. Ask for "Protective Concealment" from the Office of Civilian Defense, Social Security Bldg., Washington, D. C.

Vibrator Guide. This up-to-date replacement guide contains a vibrator chart for auto radio and battery-operated household receivers, basing diagrams of various vibrators, specifications for replacement vibrators, instructions for installing radios in 1942 cars, a buffer condenser chart and types of auto radio condensers. P. R. Mallory & Co., Inc., Indianapolis, Ind.

Tubing and Sleevmg Chart. A handy chart for engineering departments and purchasing agents containing samples of tubing and sleevmg and chart of sizes. B & C Insulation Products, Inc., 22 W. 21st St., New York City.

ELECTRONICS — May 1942
Resistor Chart. A chart giving essential data on 122 sizes in 18 standard types of IRC fixed and variable resistors. It is of compact size, suitable for wall hanging, desk use or filing. It contains information on wattage and voltage ratings, dimensions, maximum and minimum resistance values available, terminals, mountings, temperature rise, etc. All in all it contains much that should be known about a resistor. Ask for IRC Resistor Guide, from the International Resistance Co., 403 N. Broad St., Philadelphia, Pa.

Cable Tests. An abstract of an article in Railroad Signaling is presented in the Neoprene notebook 32. This article explains the various cable tests to determine resistance to oxidation, sunlight and moisture. Rubber Chemicals Division of E. I. DuPont de Nemours & Co., Inc., Wilmington, Delaware.

Precision Machines. A catalog on the Di-Acro system of metal duplicating without dies describes the development of the system, various parts made, application of the machines, typical users of the machines, questions and answers about Di-Acro units and engineering services. Catalog No. 42-1, O'Neill Irwin Mfg. Co., Minneapolis, Minnesota.


Interference Elimination Manual. The 1942 edition tells the reader how to locate noise-making devices and how to determine exactly what filters are required before any units are purchased or any permanent installation is made. Correct filter circuits and parts required to reduce noise from electrical devices are described and illustrated. The manual tells radio servicemen how to establish a profitable interference elimination business. Twenty-five cents from Sprague jobbers or directly from Sprague Products Co., North Adams, Mass.

Electrical Instruments. A new 34-page booklet (B-3013) describing portable switchboard and miniature panel instruments for industrial, central station, laboratory and general use. Design features and physical characteristics of meter pivots, springs, pointers and cases are also described. Dept. 7-N-20, Westinghouse Elect. & Mfg. Co., East Pittsburgh, Pa.
Magnet Wire Data Chart. A wall chart giving all pertinent information on enameled magnet wire. The chart is printed in green and black on heavy paper, top and bottom is metal bound and it measures 22 x 36 inches. Rea Magnet Wire Co., Inc., Fort Wayne, Ind.

Sound Systems. A booklet on sound equipment and accessories. It describes the application and features of sound systems of various wattages, de luxe phono-top p.a. equipment, mobile systems for battery and 115 v. a-c operation, intercommunicating equipment, musical instrument amplifying systems, musical contact microphones, speaker cabinets, microphone stands and mike booms. Mark Simpson Mfg. Co., Inc., 186-194 W. Fourth St., New York City.

Switches. A booklet describing precision control switches. It contains specifications and engineering data, load conditions and how they affect switch operating and a description of the various types of switches. Acro Electric Co., 3159 Fulton Road, Cleveland, Ohio. Ask for stock list No. 10.

Tablet Compressing Machines. A 48-page illustrated booklet describes methods used in the production of motor brushes, porous bearings, iron gears, contact points, Alnico magnets, iron radio cores, "getter" tablets and other electrical parts made from powdered metals and combination of metals, carbon mixtures, etc. Various tabletted parts are shown as well as the machines on which they are made. It compares the advantages of eccentric, cam, toggle-type and rotary pressures. Catalog 41-T, F. J. Stokes Machine Co., Tabor Road, Olney P. O., Philadelphia, Pa.

Ceramic Data. An engineering bulletin describing a custom built ceramic, Crotile. Pieces are made to meet exact specifications and to meet delivery schedules. It describes the three basic procedures in the fabrication of various pieces: extrusion, pressing and machining. It also gives the three basic bodies or formulae in regular production, general characteristics, and the description of the tests made on Crotile 29 and results of the test. Henry L. Crowley & Co., West Orange, N. J.

Data Chart. A data chart which will be an aid to the users of sheet metals in war work. It gives a series of metals which frequently may be substituted for critical materials in a wide variety of applications. Apollo Metal Works, 66th Place and South Oak Park Ave., Chicago, Ill.

Electro-Voice Microphones

Unfortunately, it now becomes apparent that Electro-Voice microphones for civilian applications will be drastically curtailed. However, better-than-ever microphones, in ever increasing numbers, are being made available to our fighting forces. We will continue to supply manufacturers whose facilities are devoted to the production of war equipment.

ELECTRO-VOICE MFG. CO., Inc.
1239 SOUTH BEND AVENUE, SOUTH BEND, INDIANA
Export Division: 100 Varick St., New York, N. Y.—Cables: "Arlab"

Electric Systems

Constant Voltage

... undistorted!

SOLA Constant Voltage Transformers are famous for low distortion... Now available in units that deliver an almost Perfect Sine Wave... A regulated source of Constant Voltage, free from harmonic distortion... A final solution to your voltage regulation problems.

SOLA ELECTRIC CO., 2525 CLYBOURN AVE., CHICAGO
ask for bulletin DCF-74
RECENT U. S. PATENTS

Each week the United States Patent Office issues grants to many hundreds of inventions that pass the acid test of that office. A few of those relating to electronics are reviewed here.

Television Circuits

Signal Combining Network. Method of preventing the transmission of frequency components outside a given range comprising three serially connected short circuited transmission line sections, two of the sections having an effective electrical length equal to an odd number of quarter wavelengths at the same frequency and the third having an effective electrical length equal to an odd number of quarter wavelengths at a different frequency. T. M. Gluyas, Philco Radio & Television Corp. Mar. 15, 1939. No. 2,275,587.


Transformer. For use in a television receiver having a chassis which may be ungrounded, a high voltage unit having its low voltage side connected to the chassis and a high voltage transformer with the secondary turns starting adjacent to the primary and ending at a point comparatively remote from the primary whereby the first turns only are adjacent to the primary. A condenser between primary and secondary whereby most of the voltage difference between the windings is at the secondary turns remote from the primary. K. A. Chittick and R. C. Ballard, RCA. March 30, 1940. No. 2,275,028.

Shading Control Circuit. Generating a cyclically varying voltage of substantially saw-tooth wave form and of a frequency corresponding to one of the scanning rates, and utilizing the wave form to cause the voltage variations to be confined to the final portion of each cycle or confined to the initial portion and separate means for independently determining the polarity and for controlling the intensity of each distorted wave form. S. W. Seeley, RCA. June 27, 1939. No. 2,271,876.

Tone Control. Television system comprising means of producing a variable image current corresponding to a field of view scanned for transmission and having a peak value equal to zero illumination with means for utilizing the current variations of the peak value to control the average tone value of an image of the field. Frank Gray, BTL Inc. Sept. 16, 1931. No. 2,274,686. See also Nos. 2,274,709 and 2,274,710 to W. A. Knoop, on patents involving the direct current component as representative of average tone value.

Transmitting Tube. A tube utilizing secondary emission comprising two electron gun structures as a means of neutralizing spurious signals generated by one of the electron beams. H. A. Iams, RCA. Dec. 21, 1940. No. 2,269,588.

Translation System. An un unstabilized television modulation signal having trace and retrace intervals and varying during trace intervals in accordance with video-frequency components having a wide range of frequencies, and during the retrace intervals varying in accordance with synchronizing signal components. A. V. Loughren, Hazeltine Corp. May 31, 1939. No. 2,269,540. See also No. 2,269,534 to G. W. Edwards, Hazeltine Corp. Nov. 17, 1939; on synchronizing signal separating apparatus. Also Reissue 22,065 to C. M. De Toulon, Hazeltine, on removing spurious pulses.

May 1942 — ELECTRONICS
Recording Apparatus

Background Control. Image producing system for transmission of black and white pictures comprising means for suppressing certain low frequency components and transmitting the higher frequency components of the current corresponding to a field of view, and light control which emits the same amount of light when energized by current of different amplitudes for controlling the production of an image of the field of view, and establishing a uniform background under control of the transmitted current. H. E. Ives, BTL, Inc. Feb. 10, 1932. No. 2,274,887.

Photometer. Apparatus for measuring the rapid fluctuations of light caused by the movement of an object of varying density through a light beam. C. G. Suits and J. L. Michaelson; G.E. Co. Sept. 27, 1939. No. 2,277,421. See also No. 2,279,242 to F. L. O'Brien, Western Union Co. on a facsimile signal inverter.


Noise Reducing System. System for recording sound involving four parallel ribbons, two inner ribbons recording the speech, in accordance with the instantaneous values of the speech, and means to supply current derived from these signal currents to the outer ribbons, to move the ribbons in accordance with the envelope of the signal currents. E. C. Manderfeld, W.E. Co. Nov. 21, 1939. No. 2,275,947.

Sound Effects. Patents Nos. 2,273,077 and 2,273,078 to G. M. Wright, Los Angeles, Calif. on means and method for reproducing sound effects by mechanically applying vibrations of audible frequencies to the skin of a human in the region of the throat, to cause the air within the vocal cavities to vibrate. Oct. 10, 1938 and March 27, 1939.

Phasing Apparatus. In a picture transmission system of the type having rotatable members at different points designed to be run in time and phase synchronism, means associated with one member to transmit a low frequency pulse phasing signal to the other member and a means to render the phasing device automatically effective, including a trip magnet, a selective low frequency pulse amplifier, etc. A. G. Cooley. Times Telephone Equipment, Inc. Nov. 28, 1939. No. 2,275,249.

AMP solderless wiring devices eliminate the faults of soldered connections and give assured service under conditions of the lowest operating currents and over the range from DC to the highest radio frequencies, as well as under normal current rating.

The design of these thoroughly engineered electrical devices assure economy, efficiency and convenience in production. A few outstanding characteristics are listed below:

1. greater flexibility of installation
2. greater resistance to bending failure under repeated reversals of mechanical loading.
3. greater resistance to corrosion.
4. many types available with unique AMP "Diamond Grip" insulation support which protects wire, eliminates tape and insulation tubing illustrated at right. (Write for Bulletin #13)
5. facilitates insertion of wire.
6. more intimate electrical contact.
7. greater mechanical strength of the connection.
8. high safety factor for overload conditions.
9. greater tensile strength than required by government specifications.
10. quality of electrical joint can be determined by visual inspection.
Recording System. Means for forming a light beam into a predetermined shaped beam and varying the dimensions of the beam with a spherical-cylindrical lens combination for destroying the image as impressed on the film only in a direction transverse to the film for producing a line of light of varying intensity. C. N. Batsel, RCA. July 29, 1938. No. 2,289,074.

Direction and Location Indicators

Direction Finding System. Rotatable loop antenna having upper and lower horizontal members above ground and a second horizontal antenna rotatable therewith and mounted at a height of the order of the sum of the heights of the horizontal members and substantially in the plane of the loop antenna, together with means for inter-connecting the loop and second antenna in phase opposition. F. E. Terman, International Standard Electric Corp. Feb. 23, 1940. No. 2,276,119.

Course Indicator. Indicating the position of a radio wave front with respect to a reference line by deriving currents non-directionally from equipotential points spaced along the wave front, frequency modulating the currents and indicating the phase after demodulation by comparison with a reference phase. W. L. Carlson, RCA. Sept. 23, 1938. No. 2,272,056.

Distance Determination. Measuring the distance between two points in space by generating oscillations, the frequency of which varies according to a predetermined non-linear periodic function with respect to time, and means for transmitting a portion of the energy generated to the second point and back therefrom to the first point, the difference between which is to be measured. G. Guanella, Radio Patents Corp. March 6, 1940. No. 2,269,074.

Landing System. Method for guiding aircraft to a landing comprising a transmitter for producing a radiation signal pattern having a given curve of constant field intensity in a vertical plane extending over the landing surface, and a second transmitter for transmitting a radiation pattern intersecting the first pattern, the two transmitters being located substantially in line with the direction of approach of the aircraft. In space the effective sum of the radiation patterns of the two antennas produces a signal forming a substantially straight constant intensity line landing path. Andrew Alford, Int. Tel. Co. Inc. Oct. 11, 1939. No. 2,272,997.


May 1942 — ELECTRONICS
Industrial Applications


Furnace Control. Sparking electrodes for igniting combustibles, an inductance connected across the sparking electrodes and across a source of alternating potential to cause arcing across the electrodes with a discharge tube which fires when arcing is present. C. G. Suits, G. E. Co. April 1, 1941. No. 2,278,863.


Multiplex System. Several photoelectric transmitters each comprising a cylindrical scanning device having a helically arranged series of slots, one corresponding to each element of a code, whereby each scanning device acts in succession as a transmitting distributor for the signals controlled by the transmitter of which it forms a part. L. M. Potts, Teletype Corp. Dec. 22, 1938. No. 2,278,486.


Wattmeter. Two patents to G. H. Brown, RCA. Nos. 2,278,686 and 2,278,687 on radio frequency wattmeters.

Gas Detection. A device for monitoring gas to detect a reactive deleterious material carried by the gas, consisting of a pair of electrodes, an electrolytic contacting medium forming part of the circuit, the medium being reactive with the deleterious material and a vacuum tube amplifier responsive to the presence of the undesirable material. W. A. Darrah, Chicago, Ill. Dec. 6, 1939. No. 2,278,248.

FOR WAR WORK

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Backtalk

This department is operated as an open forum where our readers may discuss problems of the electronic industry or comment on articles which ELECTRONICS has published.

After April 22—what?

Editor’s Note—Late in March, ELECTRONICS wrote to many suppliers of components, materials and assemblies of communication and industrial electronic equipment to determine the impact of the stoppage of production of home radio receivers on April 22. The following letters are typical of the answers received:

“If we do not have to be ‘sold’ on the idea of converting our plant facilities to war production. We have been laying the groundwork to switch over to war production for some time, but, as we are a comparatively small concern—any large enough to get a prime contract—too small to be considered among the first for sub-contracts, we are finding it very difficult to line up something we can get started on.

“We are working on samples of several different items which we hope to have approved. These samples are really engineering developments for specific purposes and we have been hampered by seemingly unnecessary red tape in securing small quantities of material for development work, such as the necessity for securing an order from a prime contractor, having priorities extended, all papers and records completely filled out just as though it were for an order of 100,000 quantity, in order to secure 1/2 lb. of laminating stock. In another case we wasted three to four days untangling the red tape to get material for a dozen samples which had an A-1-a rating.

“It seems to me, there could be something done to help facilitate procurement of small quantities of material for development work which would help speed up this transition period a great deal. Engineering time is one of the most important factors in making these changes, and to see an engineering department stop work on defense items while waiting for small quantities of material which are within reach, and yet cannot be had because of red tape, seems a bit ridiculous.

“We are ready and anxious to devote our energies 100 percent for the war effort, but so far, we do not have anything concrete to work on. We have men contacting the Army, Navy Air Corps procurement offices, daily. We are also keeping in close contact.

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with our customers who for the most part are radio set manufacturers. We believe that they will be in a position to help us with some sort of sub-contract work since they are large enough to be prime-contractors.”

“I wonder if you couldn’t sell Washington on the need for utilizing all the productive capacity of the country, even the smaller plants, in the armament program.”

“I think our situation must be typical of a number of the small radio manufacturing companies. We are willing and anxious to turn our entire plant and our personal efforts 100 percent to war work. Our normal production is being stopped by government order on April 22 so our whole existence depends on making this conversion. So far, in spite of constant effort for almost a year, we have no production orders to which the factory can turn. Development work and model making—yes, more than we can handle, but we could not carry the factory overhead on engineering work.

“Just tell Washington to give us more work to do and we’ll work day and night to get it done.”

Resonance

The resonance formula given in March “Talk Talk,” by Mr. Frank L. Pulcinski is of unlimited convenience and value where a large number of such problems is to be solved. However, the student who is studying to qualify for the examination to Element IV of the FCC license examination may now have more than one such problem to solve, if at all, and so may find the memorization of such a short-cut to be more of a mental burden than the problem is worth. His time will be better spent in memorizing the more funda-

F-M TRANSMITTER

The rectifier of the 10-ku F-M transmitter built for the Columbia Broadcasting System’s Station W67C, Chicago, Ill., by General Electric is being discussed by W. C. White, left, and D. E. Chambers.

LET’S LOOK at the RECORD

— in fact three records made by
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mental formulas in their most convenient form. For instance, it is easy to remember that at resonance the net reactance is zero because the capacitive reactance and the inductive reactance are equal; that is:

$$\omega L = \frac{1}{\omega C}, \text{ or } 2\pi fL = \frac{1}{2\pi fC}$$

When $L$ is in henries, $C$ is in farads, and $f$ is in cps.

From this relation it is easy to cross multiply, as Mr. Puciloski has done and arrive at the conventional expression:

$$f^2 = \frac{1}{(4\pi fL C)}.$$  
This is fundamental and every student should commit it to memory. However, it is even more convenient to memorize the derivative thus far —but here we go: on memorizing his derivation thus far. 

---

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**Question 25 in Element IV:** Find the capacitance necessary to resonate 66 µh at 5000 kc.

By rearrangement of the basic formula, \(C = \frac{25300}{FL}\). Substituting 66 for \(L\) and 5 Me for \(f\) in the equation, then, \(C = \frac{25300}{(25 \times 56)} = 18 \mu f\).

What could be simpler? Applying these principles now to an occasional problem like the one given by Mr. Puciloski, in which \(2\pi fL = 12000\) ohms, and \(10^8/2\pi fC = 8000\) ohms, (in terms of \(\mu h\), \(\mu f\), and \(Mc\)): By rearrangement; \(L = 12000/2\pi f\). Since \(f = 3\) Mc, then \(L = 666\) h. Likewise; \(C = \frac{10^8}{(25 \times 5600)} = 6.36 \mu f\). Hence \(L \times C = 4215\).

To find the resonant frequency we have only to substitute in the formula: \(F = \frac{25300}{LC} = 25300/4215 = 6.01\); the square root of which is 2.461 Mc, or 2451 kc.

By this method, the student has gained practice in the use of his fundamental knowledge, and has not been required to memorize a formula for which he would have little practical use. However, the value of Mr. Puciloski's method as an academic exercise in the derivation of equations is not to be overlooked. We wish to simply present a simplified practical method of approach which is much used, and well known amongst practical radio mathematicians, and which we feel ought to be taught universally to all students who ever hope to make any practical use of their radio training.
F-M Telephony
by Carrier Current

(Continued from page 57)

ance tube modulator circuit. The
wavemeter also provides a useful
overall check on transmitter perfor-
mance.

The calling circuit, not shown in
the diagram, consists of a mechan-
ic oscillator whose tone is inter-
rupted by a dialing device on the
handset.

The Receivers

The 70 kc f-m receiver dia-
grammed in Fig. 2 is much simpler
than those used for radio reception.
It performs satisfactorily despite
this simplicity because the attenua-
tion of signals transmitted over
power lines is much less than when a
radio path is employed. The trans-
mitter diagrammed, for example,
produced an r-f current of 10 ma in a
line tuning unit at Guyama, when op-
erated over the high lines from
Ponce, 60 miles away.

The receiver uses a single r-f stage
which amplifies and is also made to
serve as a limiter by the inclusion
of a potentiometer which varies the
plate and screen voltages from 30 to
2 volts. The r-f transformer has a
pass band of 6 kc. The self-biased
plate circuit detector employed has
been found suitable for carrier cur-
rent detection due to its ability to
handle signals of varying intensities
without overloading. F-m conversion
is accomplished by detuning the plate
circuit of the 58. For a high degree
of conversion the Q should be high
and the coil used in this instance has
a Q of 316.

It has been observed, incidentally,
that the f-m transmitter shown can be
received on a G-E KCA3CB1 a-m
carrier current receiver by detuning
this receiver's detector stage. Simi-
larly, the f-m receiver will receive
a-m signals if the limiter voltage is
raised to the maximum and the slope
filter is tuned.
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