electronics

radio, communication, industrial applications of electron tubes . . . engineering and manufacture

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AUGUST
1940

Price
50 Cents

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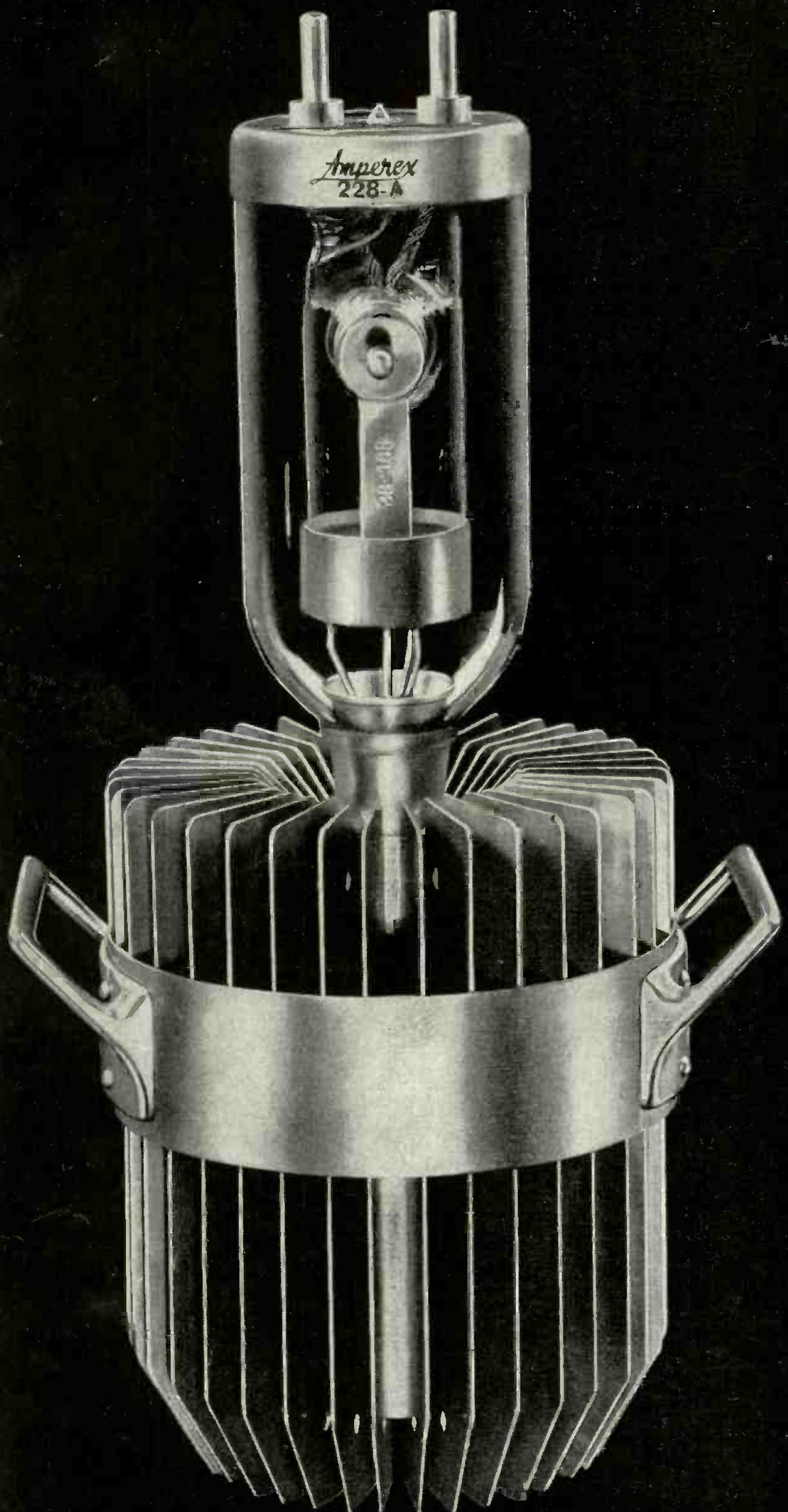

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AMPEREX ELECTRONIC PRODUCTS, Inc.

79 WASHINGTON STREET BROOKLYN, NEW YORK

electronics

A McGRAW-HILL PUBLICATION

CONTENTS—AUGUST, 1940

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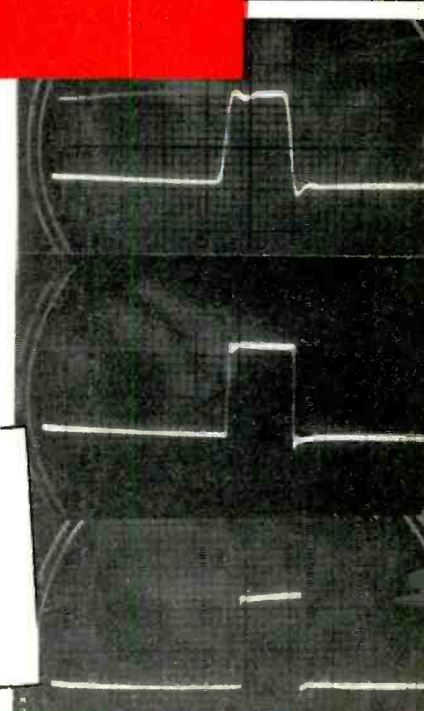
TOP PERFORMANCE BY EVERY TEST

AND EVERY G-E FM TRANSMITTER PASSES 100%

QUICKLY, accurately, G-E engineers determine by thorough square-wave measurements the over-all performance characteristics of *every* General Electric FM transmitter. Carefully they check frequency stability in the G-E "torture chamber" at temperatures from freezing to 122 F.

Noise level, cross modulation, linearity—from every angle General Electric proves the capabilities of each unit before it goes onto the job. That is your assurance of dependable, high performance at low cost.



These typical square-wave measurements show an a-f characteristic that is flat within ±0.5 db from 15 to 16,000 cycles.

Features Like These in G-E FM Transmitters* Speak for Themselves

EXCEPTIONAL FREQUENCY STABILITY	*Over a room temperature range of 32 to 122 F, stability is*	**±0.0025%**
FULL DYNAMIC RANGE	*At 100% modulation, FM noise is down from signal level*	**70 db**
SMALL TUBE COMPLEMENT	*All G-E tubes. Entire 1-kw transmitter requires*	**only 31**
SMALL SIZE	*Completely self-contained. Floor space required by 1-kw transmitter is only*	**9.3 sq ft**
AMAZING FREQUENCY RESPONSE	*A-f characteristic from 15 to 16,000 cycles is flat within*	**±1 db**
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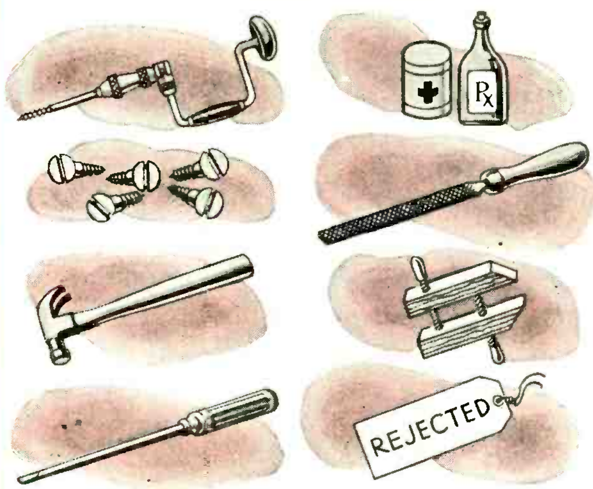
**Designed by General Electric under Armstrong license*

GENERAL ELECTRIC

160-4

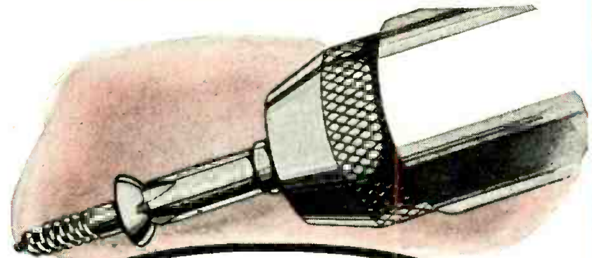
HERE'S YOUR EVIDENCE

WHY DRIVING OLD-FASHIONED SCREWS WASTES TIME.



Twice as many hands are needed with old-fashioned screw driving as with **PHILLIPS RECESSED HEAD SCREW** *shown at right.*

WHY PHILLIPS SCREWS SAVE AN AVERAGE OF 50% IN ASSEMBLY TIME.



Every item pictured left represents unnecessarily wasted time — hours which *can* be saved using Phillips Screws.

Phillips Screws shorten hours spent in screw driving, and speed delivery of your products by eliminating:

- need for drilling pilot holes
- need for a helper to steady the work
- slow driving with hand drivers
- crooked screws or split heads
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- delays caused by broken drivers
- refinishing screw driver scars

The Phillips Screw clings to the driver, permitting one-hand driving while the other hand holds the work. The recess prevents the driver from slipping, so it's safe to use a faster driving method. Fewer screws (or smaller, lower-cost sizes) can be used because the Phillips Screw provides greater holding power.

The reason you see Phillips Screws on most makes of cars, aircraft, electrical appliances, furniture, etc. — is that those manufacturers have proved it costs less — in time and money — to use Phillips Screws. Don't let slow-poke fastening cause an unnecessary jam of unfilled orders. Get in touch with one of the firms listed below.

PHILLIPS RECESSED HEAD SCREWS...

MACHINE SCREWS SHEET METAL SCREWS WOOD SCREWS STOVE BOLTS

Speed Product Deliveries by Cutting Assembly Time

U. S. Patents on Product and Methods Nos. 2,046,343; 2,046,837; 2,046,839; 2,046,840; 2,082,085; 2,084,078; 2,084,079; 2,090,338. Other Domestic and Foreign Patents Allowed and Pending.

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Transformers of Proved Dependability

Of paramount importance to ships at sea

THOROUGHLY dependable radio transmitting equipment provides the only means of communication with the outside world. In times of distress a radio signal may permit saving both human life and valuable property. At other times it provides continuous contact with land for transmission and reception of important messages.

● Radio room on Socony Vacuum Oil Company's new S. S. "Mobilfuel". Radio equipment, furnished by Mackay Radio, incorporates AmerTran transformers in its construction.

● Two standard marine radio transmitters in which AmerTran transformers are used throughout. Both were manufactured for Mackay Radio by the Federal Telegraph Company. Left (in photo above): Model 155, a 300-watt transmitter for operation in the range of 350 to 500 Kc. Left (below): Model 156, a 200-watt transmitter for 5.5 to 17 Mc. marine bands.

Evidence of the faith which the marine industry has in AmerTran products is shown by the fact that for many years the two largest manufacturers of marine radio equipment have made extensive use of our transformers, reactors and voltage regulators in their transmitters. Equipment supplied by us for marine service is of the same quality and construction as similar apparatus furnished for other commercial radio applications, such as broadcasting, air-craft and beacon stations. All units are designed to meet the most rigid specifications covering performance, efficiency and construction.

Let us submit data on transformers for your needs. Equipment is available to meet all standard and special electronic applications in both small and large quantities.

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Against Field Returns

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If you can't boast a similarly low return . . . you owe yourself an immediate investigation into the opportunities offered by genuine Mallory F. P. (Fabricated Plate) Capacitor performance.

Remember . . . there's a real performance difference between a genuine Mallory F. P. Capacitor and an imitation. Be sure you specify the genuine!

**Not etched construction*

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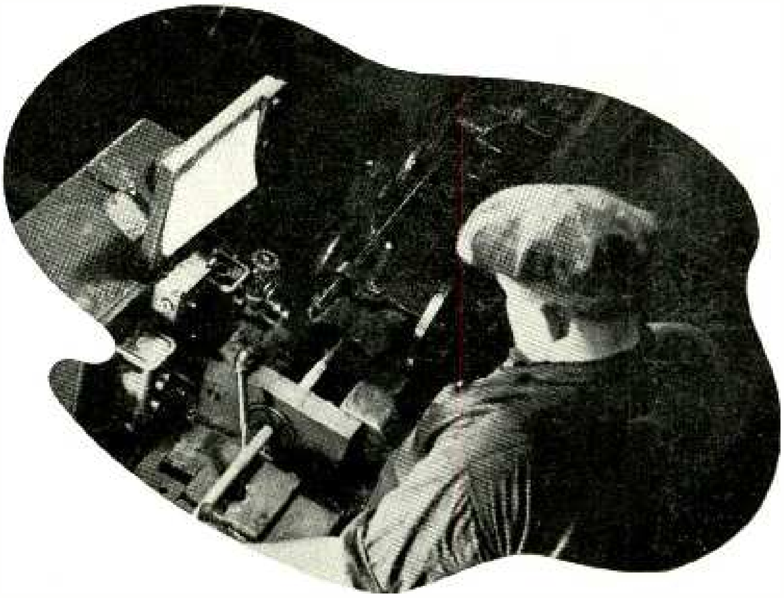

THE LONG and THE SHORT of IT

Cold drawing small tubing is a tedious process—*if you're not a small tubing man.* At Superior, we start with raw stock of about 1″ O.D. (seamless and welded)—and draw it practically out of sight, if that is what you need. We know just where to stop to meet your specifications. Every step down is small—a reduction of O.D. through the carefully machined die is made at the same time the wall is reduced by the mandrel. Time after time this operation is performed with intermediate anneals to keep the metal workable. Finally the tubing with Superior high finish is ready for laboratory check.

By concentrating in the small tubing field, Superior has made readily available to all industry a product which has erroneously been called "Specialty Tubing". *It is no specialty when you make it your only business.*

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[THE BIG NAME IN SMALL TUBING]

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DESIGNERS *are becoming increasingly aware that the solution to many of their small tube problems can be found at SUPERIOR TUBE . . . our doors are always open . . .*

Tubing from ⅝″ OD down . . . SUPERIOR Seamless in various analyses. WELDRAWN Welded Stainless. BRAWN Welded "Monel" and "Inconel". SEAMLESS and Patented LOCKSEAM Cathode Sleeves.

"FOR FINE SMALL TUBING"

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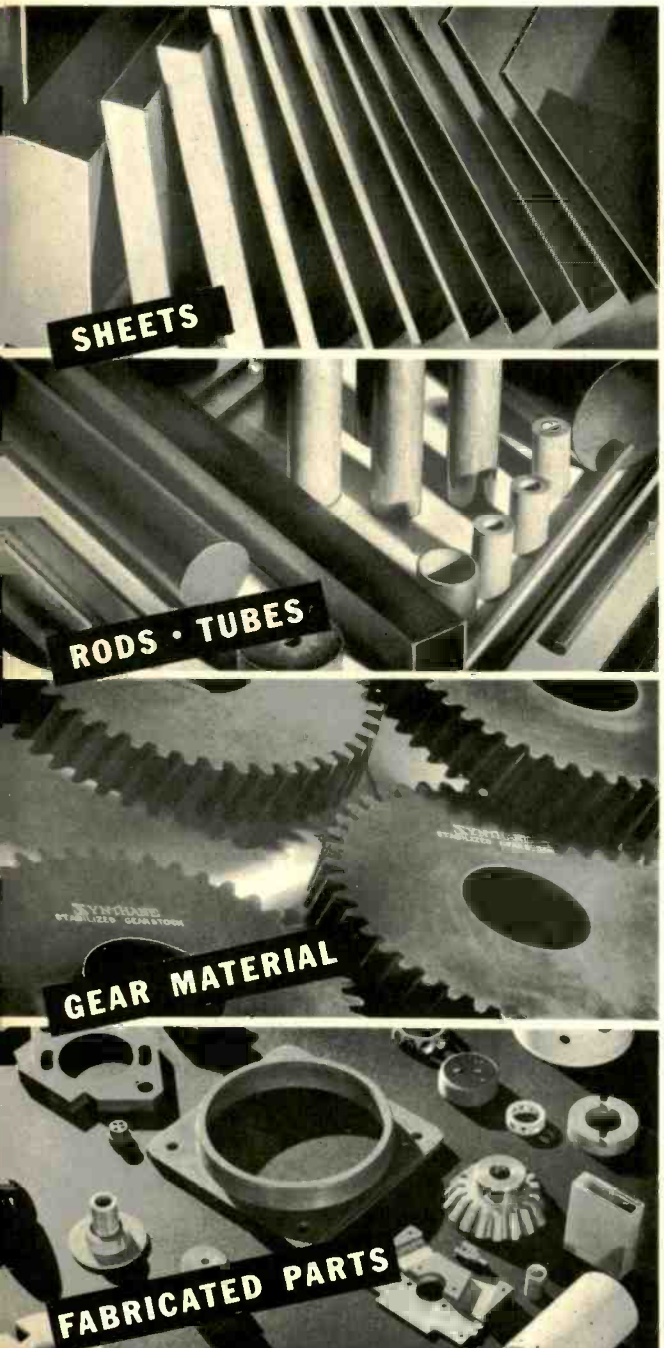
"BECAUSE SYNTHANE USUALLY OFFERS MORE USEFUL PROPERTIES IN COMBINATION THAN OTHER MATERIALS WHICH ARE CONSIDERED"

SYNTHANE Bakelite-laminated is a uniformly dense, solid material produced by the application of heat and pressure to layers of paper or fabric impregnated with a Bakelite resinoid. See forms available below:



SYNTHANE CORPORATION, OAKS, PA.

Gentlemen:

Please send me a sample of Synthane Bakelite-laminated for inspection.

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CITY ______________ STATE ______________

THERE, briefly, you have the reason Synthane is so widely applied, the reason new uses for it crop up almost daily. Here are a few of its combined properties:

LIGHT BUT STRONG—Synthane has about half the weight of aluminum yet it is hard, dense, and strong structurally. Tensile strength, for example, 7000 to 12,500 lbs./sq. in. depending upon grade.

EXCELLENT DIELECTRIC—Synthane is probably better known for its electrical properties than for any other. Its combination of high dielectric strength, low dielectric constant, low power factor and low moisture absorption is indispensable to the radio and electrical industries.

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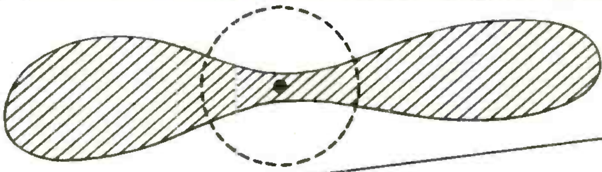
SYNTHANE

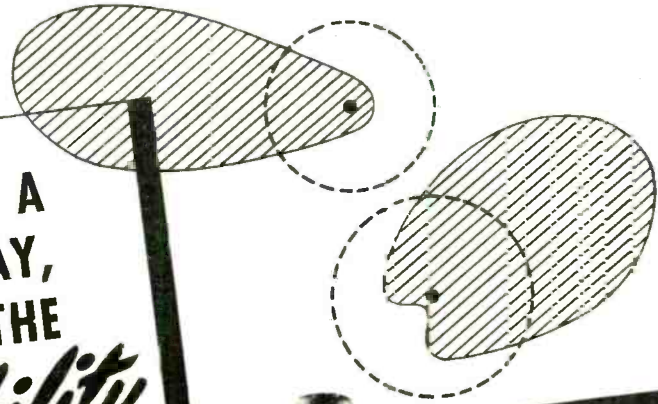
Bakelite — laminated

TECHNICAL PLASTICS

SYNTHANE CORPORATION, OAKS, PA.

Representatives in principal cities





IF YOU'RE TRYING TO TUNE A DIRECTIONAL ANTENNA ARRAY, YOU'LL BE GRATEFUL FOR THE LAPP CONDENSER'S *Stability*

For solving an interference problem with increased power, or for increasing signal strength over a desired area with no change in power, the modern directional antenna array offers a highly satisfactory solution.

The performance of the array depends, however, on a critically accurate and continuously maintained phase-relationship between various elements of the array.

You're likely to find yourself in water over your head if you try the delicate job of tuning an array with condensers that vary in capacitance as they heat up in operation.

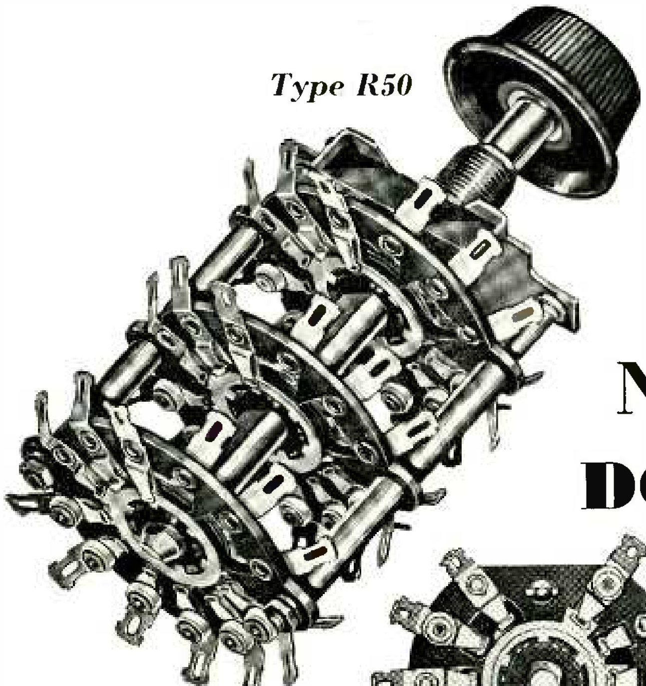
The safe way to proceed is to install Lapp gas-filled condensers in your antenna circuit. For these units offer capacitance at a constant value under any temperature change. Tuning adjustments are made with full power on. Besides, more power gets to the antenna (it's practically zero loss; the only solid dielectric is a porcelain bowl that carries the rotor); with no solid dielectric to puncture. you can operate at full rating for an indefinite time without failure; space requirement is an absolute minimum.

And aren't those the properties that make this condenser the best choice for just about any application?

Write for descriptive literature and list of sizes.

LAPP INSULATOR CO., INC., LEROY, N. Y.

Type R50



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MALLORY

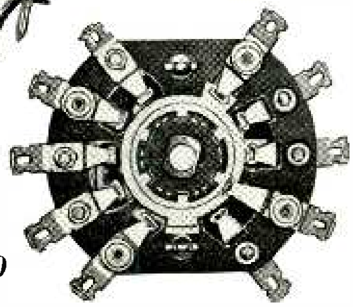
YAXLEY

Announces a

New and Improved

DOUBLE CONTACT ROTARY SWITCH

Types R50 and R60



Type R60

Here is the ideal double contact rotary switch for wave-change, tone and tap applications. The R50 series accommodates 12 terminals spaced at 30°. The R60 series is a fractional wafer design and features the same terminal construction and rotor details. It is specifically designed for those requirements demanding a narrow switch where the number of indexing positions does not exceed 5. It is also available with an A.C. switch.

In terminal design, both the R50 and R60 series afford unusually low torque, low contact resistance and freedom from the possibility of becoming damaged by soldering or strain on the soldering lug. This is accomplished by a new design contact that holds tight even though the eyelet may have been loosened by expansion in soldering. In addition, the terminal is held rigidly in position by the particular design of the combination stator and terminal.

The special material used in the terminal for the R50 and R60 switches provides increased flexibility and "follow through." The new design of contacting surfaces gives low torque without sacrificing contact pressure. An improved hard silver surface on the new design terminal results in lower contact resistance and longer life.

The R50 and R60 series switches are likewise identical in rotor construction. The new design "hill and valley action" indexing of these new switches provides smoother action, more definite positioning and exceptionally good life qualities. Life tests on the index mechanism have run beyond 50,000 cycles without affecting the quality of the indexing. The contour of the cam gives positive indexing action.

These switches are available in multiple sections and all terminal and circuit combinations.

Write today for complete details and specification sheets.

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CROSS TALK

✦ **WASHINGTON** . . . Manufacturers who wish to help the Government in the National Defense plans and who wish to keep down their overhead, will do well not to jump on the train and go to Washington. The Capitol city is overcrowded and the government offices are overcrowded with well wishing people who have done just this. If you want to know what your factory or your trade association can do to help, go to the nearest procurement office of the Army or Navy. Men there know what is wanted, they understand the Army and Navy points of view, they are familiar with the problems of industry, they are non-political.

Current or normal purchases are being made in about 500 Army posts and offices. For the emergency program purchases, major field offices have been established in 23 cities by the Navy and in 22 by the seven branches of the War Department.

Army Air Corps procurement offices are at Dayton, New York City, and Santa Monica. The Chemical Warfare Service has offices at Boston, Chicago, New York City, Pittsburgh, and San Francisco. The Corps of Engineers has offices at Chicago, New York City, Mobile, Philadelphia, Pittsburgh and San Francisco. The Medical Department has offices in Brooklyn, Chicago, St. Louis and San Francisco. The Ordinance Department has offices in Birmingham, Boston, Chicago, Cleveland, Cincinnati, Detroit, Los Angeles, New York City, Philadelphia, Pittsburgh, Rochester, St. Louis, San Francisco, Springfield, Mass., and Wilmington. The Quartermaster Corps has offices in Atlanta, Boston, Brooklyn, Chicago, Detroit, Jeffersonville, Ind., Philadelphia, St. Louis, Fort Sam Houston, Texas, and San Francisco.

The Signal Corps, which purchases general equipment for communications, photographic purposes, meterological studies, etc., has offices in Brooklyn, Chicago, and San Francisco. The Coast Artillery Corps gets most of its supplies through the Quartermaster Corps but its field office at Fort Monroe, Virginia, makes some purchases.

Navy materials are purchased through offices in Alameda, Calif., Anacostia, D. C., Annapolis, Boston, Charleston, S. C., Dahlgren, Va., Great Lakes, Ill., Indian Head, Md., Key West, Fla., Lakehurst, N. J., New London, Conn., New York City, Newport, R. I., Norfolk, Va., Pensacola, Philadelphia, Portsmouth, N. H., Portsmouth, Va., Puget Sound, Wash., San Francisco, San Diego, Washington, D. C., and Yorktown, Va.

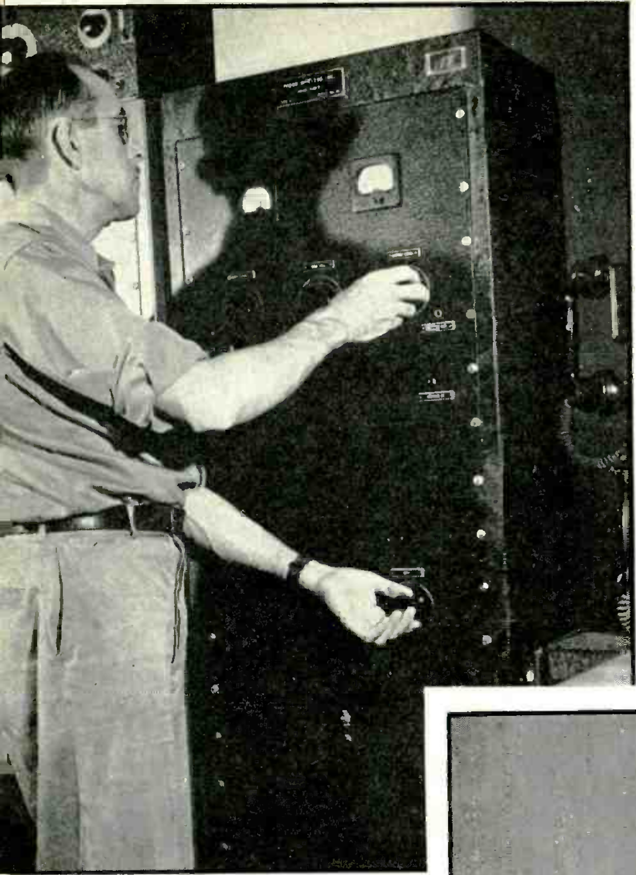
✦ **ORDER** . . . Under the auspices of the RMA and with official cooperation of the FCC a National Television Systems Committee has been formed and will meet for the first time before this issue of *Electronics* gets to its readers. A report on this meeting will be found on page 34 of this issue. The committee consists of not only members of RMA but of outside interested organizations as well, including the professional societies.

Said President Knowlson of RMA "both the Commission and RMA feel that in this way we are setting the vexing problem of television standards on a path which will lead to a satisfactory solution." Thus the industry now has a representative single group which, it is hoped, can reconcile the divergent viewpoints existant and really get this television service started on a scale it deserves.

There is a perfectly natural and understandable desire on the part of some to get television on the air now and to realize on it in commercial, social, or in other ways. There is another viewpoint, equally understandable, which wishes television to stay in the laboratory until it is "perfected." There are some who believe it is good enough now, others know there is great room for improvement within the present bandwidths, and still others who think that different standards could produce a system much better than that existing now.

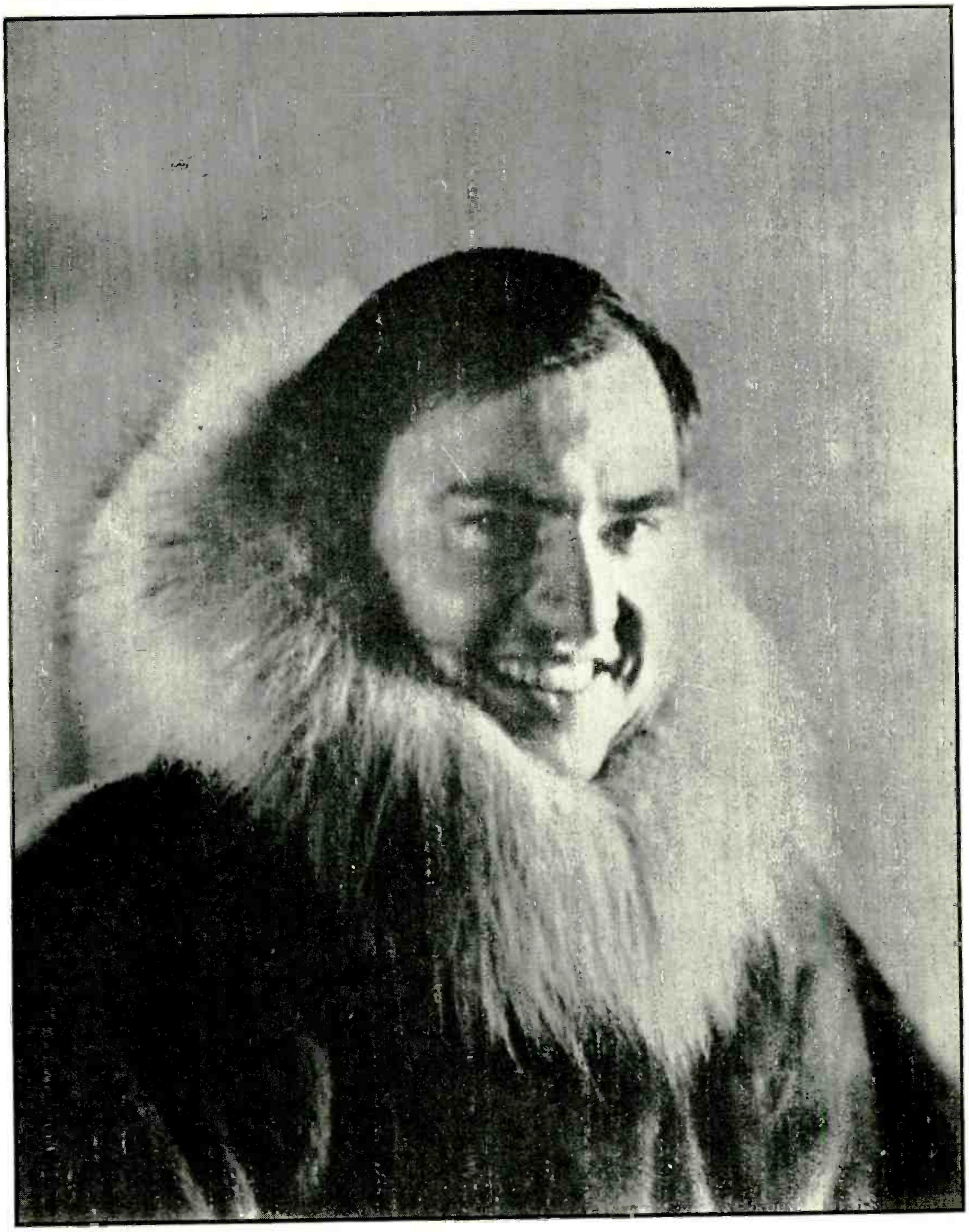
One must remember, it seems to us, that television can be too perfect to be practical. The more perfect the system, the more the transmission system will cost, the more the programs will cost and the more the receivers will cost. It might easily become so perfect that no one could afford to engineer the intercommunicating system, or if engineered, that no one could afford to hire its use. This is one limiting condition. The other condition is a set-up which could be put on the air cheaply, but of such poor quality that no one would want it.

Only a committee whose members represent the diverse knowledge of manufacturing, of broadcasting and of transmission can adequately settle the perplexing problem of standards.



12000-Mile Radiophoto

This picture of Dr. Paul A. Siple, in command of the New Little America base of the U. S. Antarctic Expedition, was radioed directly from the 500-watt transmitter at the base to the receiving station of Press Wireless, Inc., at Baldwin, Long Island. The extraordinary clarity of the reproduced picture is in part due to the use of an "anti-fade" unit at the receiver, shown at left

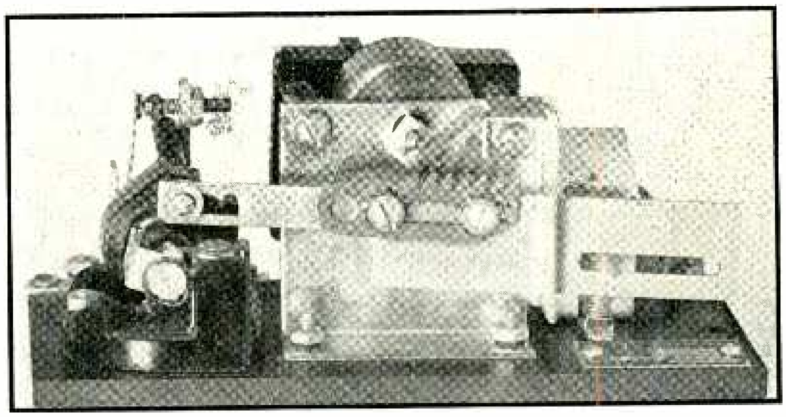


Relays for Electronic Circuits

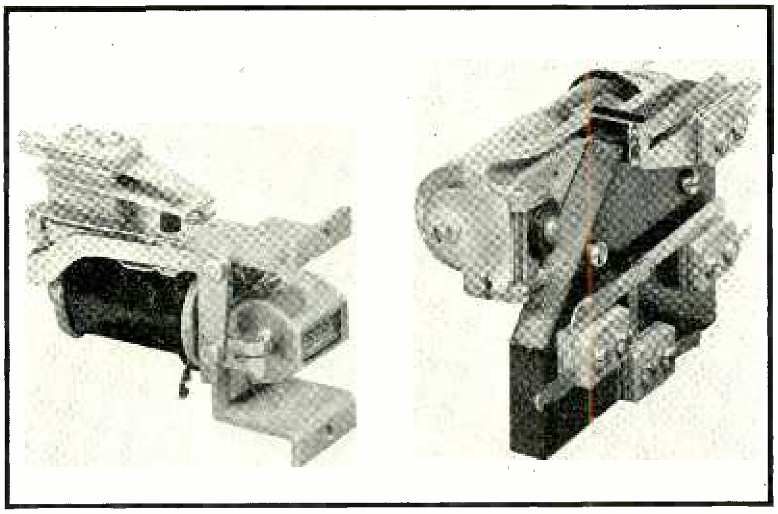
Wherever tubes are used for purposes other than communication, an electromechanical relay is very often an essential, and too often misunderstood, part of the circuit. The types of relays now available commercially are here reviewed and classified in their special fields

WHEN an engineer familiar with electronics is confronted with the necessity of designing a circuit for control purposes, the chances are that he can deal adequately with the purely electrical parts of the circuit. The chances are equally good that he is not so sure of his ground in the electro-mechanical part of the circuit, that is, the relay which transfers the current in the tube circuit to the controlled device. Too often the relay chosen for the purpose is the one closest at hand. If the relay is not ideally suited to the purpose, the tendency is to alter the circuit. But such compromises nearly always result in a loss of performance.

Obviously, more information on the characteristics of available relays is needed, but unfortunately the information is to be found only in manufacturers catalogs and in similar scattered sources which the designer has little time or inclination to consult. In the hope that a survey of the field may prove helpful to its readers, *Electronics* has compiled information on a variety of electro-mechanical relays useful in connection with tube circuits. The relays are classified in five groups, roughly in order of decreasing sensitivity: (1) the D'Arsonval moving coil ("meter type") relays which operate on currents as small as a few microamperes; (2) the telephone or "sensitive" type of relay which operates on currents from a few hundred microamperes to several hundred milliamperes; (3) the power relay intended for use in gas-tube circuits where plenty of current is available; (4) intermediate power relays for use as links between a sensitive relay and a heavy load; and (5) specialized relays for introducing time delay in cathode-heating circuits, and for use as auxiliaries in various timing circuits.



A typical clock-type delay relay, used for cathode protection in large gas-filled tube circuits. The relay introduces a fixed delay of six minutes, then automatically recycles itself ready for the next operation

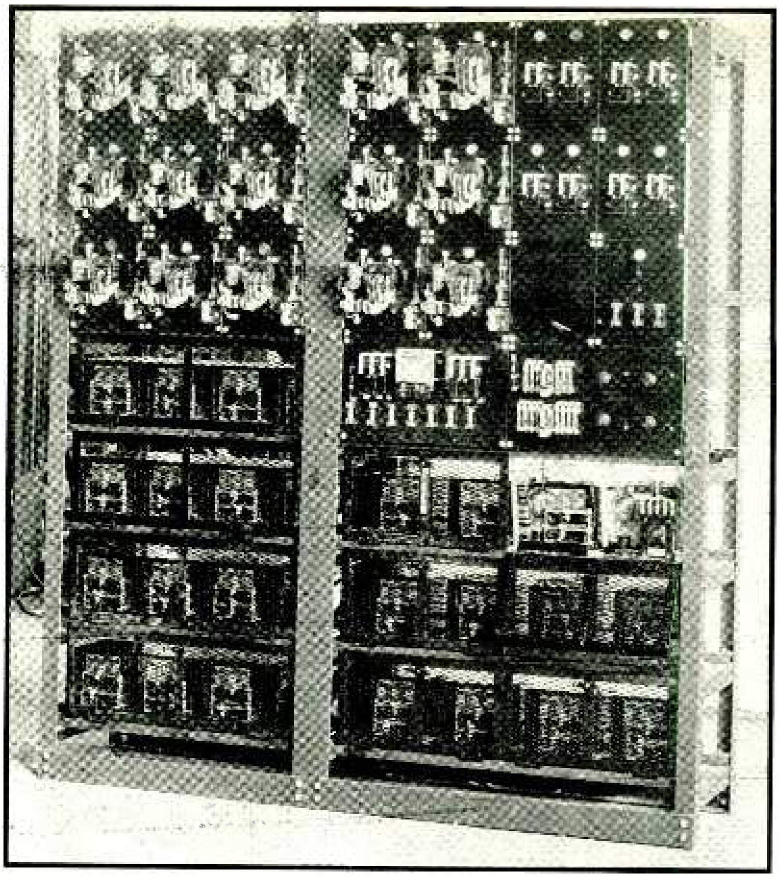


Two unusual constructions in the sensitive relay class: a high speed counting relay, and a relay, designed to have minimum capacitance, for switching the video circuits in a television studio

The most sensitive type of electromagnetic relay, the moving coil type, has been in use for as long as thirty years, but it has found its way into electronic practice only recently. The reason is that the moving coil relay is an expensive device, compared with other types, and it is not a rugged instrument nor can it handle heavy current through its contacts. But it is of great interest to electronic control specialists, if only for the reason that it can operate as a substitute for a tube circuit.

The moving-coil relay looks very much like a meter, with one contact on the pointer and the other fixed at one end of the scale. In the ordinary type of moving coil relay, the minimum current rating, necessary to close the contacts, is about 15 microamperes, and the contact rating is about 200 microamperes at 6 volts in non-inductive circuits. A recent improvement in this type of relay is the magnetic contact type, which will close on as little as 2 microamperes or 1 millivolt, and will handle through its contacts 50 milliamperes at voltages up to 110. In this latter type of relay, one contact is made of magnetic material and the other of iron. Hence when the "pointer" contact moves close enough to the fixed contact, the magnetic field between them takes hold and the contacts close suddenly and positively. Once closed the contacts must be separated by mechanical force before the relay is again ready for operation. For most purposes, especially in alarm circuits, manual resetting is feasible (and desirable since it demands the attention of the supervising operator). When an electric means of resetting the relay is necessary, a magnetic solenoid resetting device is available.

It is obvious that these relays, capable of being closed by currents of the order of microamperes, are in themselves highly sensitive electro-mechanical amplifiers, and hence may be used to perform the duties of a vacuum tube amplifier, wherever a simple on-off control suffices. Moreover these relays have several important advantages compared with tube circuits. First and foremost, they require no auxiliary power supply; second, they will operate from low-impedance sources, such as thermocouples and self-generating photocells; and third, they require virtually no maintenance or supervision. The restrictions are: cost, list prices ranging roughly from 25 to 50 dollars; the fact that the more sensitive meter relays cannot stand too much vibration or abuse and hence are not suitable for portable equipment; and finally the fact that their time of response is long, comparing poorly with a fast-acting relay in the plate circuit of a tube. For fixed installations, especially for use in conjunction with self-generating photocells, the meter relay is enjoying an increased popularity.



An application of relays for controlling heavy lamp loads, an electronic "Hysterset" dimmer panel. The heavy-duty contactors at the left are fitted with de-ionization chambers for dissipating the arc

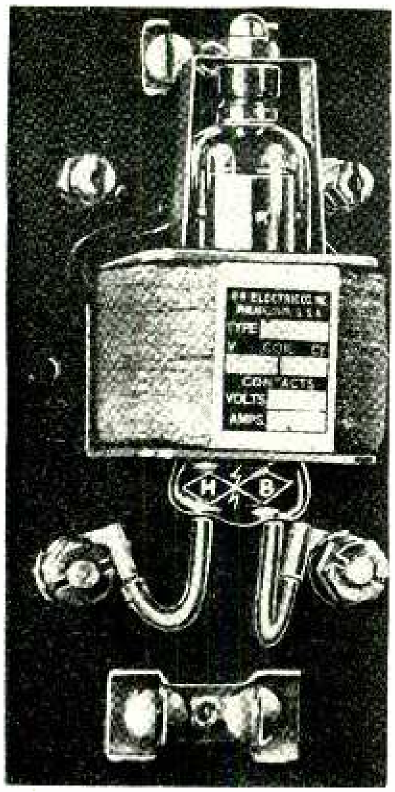
The Telephone Type Relay—Most Widely Used

The type of relay most widely used in electronic circuits is the "sensitive" or "telephone type" relay which employs a fixed coil, usually connected in the plate circuit of the relay tube, and a movable armature which closes or opens the contacts, through an intermediate mechanical linkage. The coil currents at which these relays operate range from about 0.5 milliampere upward to an ampere or more. Since this range includes the values of anode currents commonly found in receiving tubes, such relays are commonly employed in vacuum tube relay circuits.

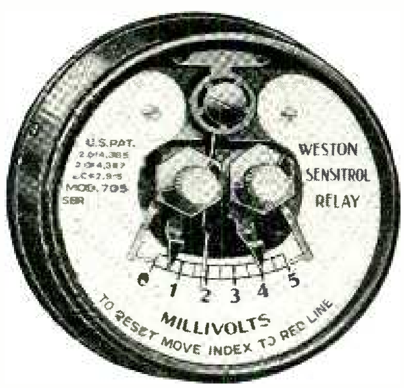
The current-carrying capacity of contacts depends on the circuit voltage, on the type of circuit (whether inductive or non-inductive), on the metal employed in the contacts, as well as on the contact pressure, the degree of vibration and other conditions of use. The two most widely used contact materials in the sensitive relay class are silver and palladium. Silver will break from 25 to 50 watts, but not more than 1 ampere in non-inductive circuits. It will carry, but not break, 50 to 100 watts. In inductive circuits the maximum break current is about one half as great. Palladium contacts will carry about 100 to 150 watts, and will break or make not more than 3 amperes. Somewhat higher wattage capacity, but no higher make or break current, may be obtained with platinum-iridium contacts. These ratings are representative only since the actual limiting values depend on contact pressure, the degree of wiping action in the contact motion, and the area of contact between the contact surfaces. When heavier currents or wattages are encountered in the controlled circuit, it is usually necessary to employ an intermediate relay between the sensitive relay and the load circuit. Usually no more than one intermediate relay is required, since the contact rating of the sensitive relay is sufficient to handle the coil current of a large power relay.

An interesting general rule given by one manufacturer for spark suppression at the contacts of a sensitive relay is to use a 0.5 μf condenser and 10 ohms in series across the contacts for 24 volts dc or less, and a 1.0 μf condenser with 200 ohms in series for 24 volts to 110 volts, dc.

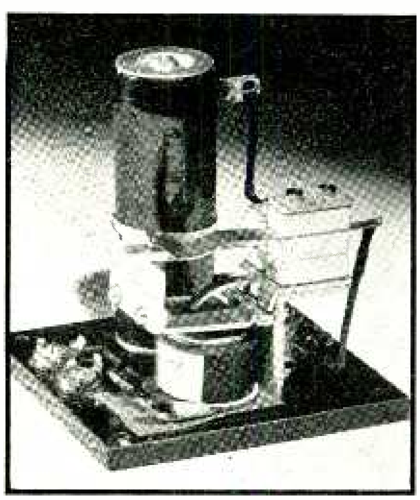
The designer has little freedom of choice so far as the contact ratings and operating conditions in the sensitive relay class are concerned. But in the choice of the coil a very wide range exists. In fact, the customer's requirements regarding coils are so diverse that some relay manufacturers find it expedient to make up coils exclusively to customer



The plunger type of mercury-contact relay may be operated at angles as great as 45° from the vertical



The magnetic-contact moving coil relay, which closes on currents as small as two microamperes or 1 millivolt



Specially designed to discharge filter condensers in transmitting equipment power supplies, this relay uses ceramic insulation

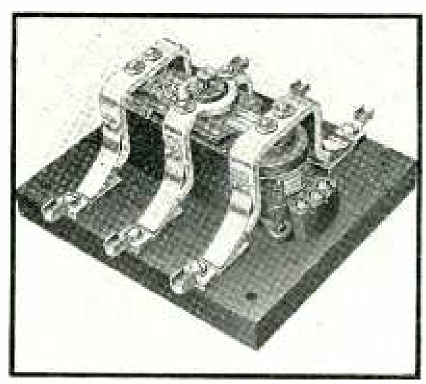
specification rather than to take them from stock. The resistance of the coil and the number of turns wound on it are the basic specifications for d-c service, since these factors determine the voltage and current ratings, as well as the number of ampere-turns available from a given current. When alternating current is used, however, the impedance of the coil depends on the inductance of the coil as well as the magnetic circuit of the relay itself. The value of current usually stated is that at which the armature moves so as to come in contact with the poleface of the magnet. This is the "operate" value of current. Then as the current is reduced, the effects of residual magnetism, etc., are such that the armature does not fall away from the poleface until a current somewhat less than the "operate" current is reached. This current value is often called the "drop-out" current. In on-off applications, the drop-out current value is of little importance, but in marginal relaying, in which the relay must close and open within definite current limits, both values must be known. Many sensitive type relays are fitted with adjustment screws which fix the limits of travel of the armature. and which fix the corresponding operate and drop-out current values. The contact springs may be bent to obtain the same effect, if necessary.

The specifications of sensitive relay coils are so varied that little can be stated about them in general. Reference to the manufacturer's catalog is the only sure answer. One general statement, however, is that for a given construction of magnetic circuit and a given mechanical arrangement, the coil requirement is a fixed quantity in watts for d-c service and in volt-amperes for a-c service. That is, the product of the coil voltage and the coil current is constant for a given type relay. The ratio of these quantities (the coil resistance or impedance) is not constant, however, but varies roughly as the inverse square of the coil current. In comparing relay constructions, therefore, it is convenient to calculate the coil wattage or volt-amperes. The lower the value, the more sensitive the relay. For example, one type of sensitive relay operates with 0.008 watts, dc, or 0.1 volt-ampere at 60 cps. In d-c service this relay will close with 0.56 milliamperes at 14.3 volts (25,500 ohm coil), at 8.15 milliamperes at 0.98 volts (121 ohm coil) or 144.5 milliamperes at 0.056 volts (0.385 ohm coil), these values representing the minimum, middle-range and maximum values of current. Another type of sensitive relay, somewhat resembling the first in general construction, operates with 0.014 watts dc, or 0.33 volt-amperes at 60 cps.

Another factor to be kept in mind in connection with relay coil specifications is the heat dissipation, which is usually limited to one or two watts per square inch of coil surface (coil ends omitted in calculation) when covered, or 2 to 4 watts when freely ventilated in air.

A third factor to be considered in coil selection is the contact combination used. Usually in electronic control circuits, the contact arrangement is simple, i.e. a single pole which may close one contact while breaking another. For special applications, however, the relay may be called upon to operate several groups of contacts at once. To maintain the proper contact pressure in such relays, obviously a higher ampere-turn rating is required in the coil. In a typical telephone type relay, for example, with comparable contact pressures and spring tensions, the number of ampere turns required for a single-make contact is 110; for a combined make and break, 120; for two-pole make and break; 165; triple-pole make and break, 220; four-pole make and break, 280.

Finally, the telephone type relay coil may be fitted with various magnetic auxiliaries for introducing time delay. Since the relay will not

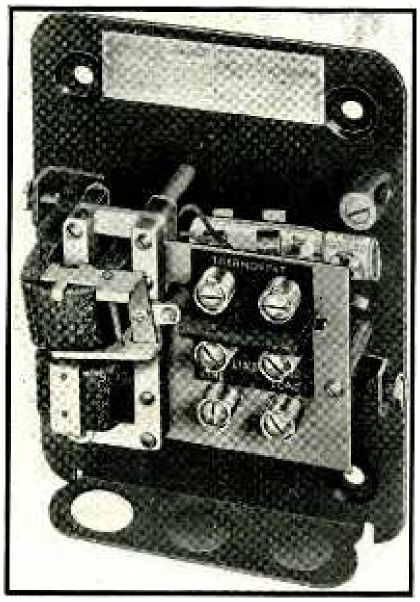


A relay-operated switch with separate coils for opening and closing the contacts. Power is applied to the coils momentarily during closing and opening close until the magnetic flux between pole and armature has built up to the specified value, time delay in closing may be obtained by delaying the build-up in flux. This delay may be introduced by employing a copper ring around the coil at the armature end of the coil. The ring acts as short-circuited secondary turn, linking the flux of the coil proper and delaying the rise to full flux a tenth of a second or more. Delay in the release time of a relay may also be obtained by using a similar copper ring on the end of the coil away from the armature. For delay on both closing and release, the entire coil may be enclosed in a copper sleeve.

As might be imagined, the mechanical construction of sensitive relays varies widely among different manufacturers and for different purposes. One relay of particular interest employs a mechanically-operated snap-action switch (such as the Micro-Switch or the Mu-Switch) actuated directly by the relay armature. The contacts of this auxiliary switch can handle 10 amperes at 125 volts, ac. This combination relay and switch often serves in applications which would otherwise require a separate intermediate power relay. Sensitive relays may also be fitted with mechanical counters, for counting purposes. Finally, sensitive relays fitted with auxiliary mercury contacts may be used to break as much as 20 amperes, although the extra weight of the mercury contacts decreases the sensitivity of the relay.

Intermediate Power Relays

The group of relays next higher in power handling capacity, and next lower in operating sensitivity, may be termed intermediate power relays. The mechanical constructions and contact arrangements of this group are legion. In general, however, they are characterised by coils which required an excitation of from about one to ten watts or more, and contact ratings from 5 to 30 amperes at voltages as high as 600 volts. Such relays are suited to the anode circuits of thyratron relay tubes, and as intermediate links between sensitive relays and a motor load, lamp load or other controlled device requiring several kilowatts of power. Since sensitivity is not the prime consideration, the coil specifications have to do primarily with the operating voltage, frequency and wattage only. The contacts, on the other hand, are widely diversified. The two general classifications are the mercury contact type, and the metallic contact type.



The transformer relay, which avoids the armature and pole-face construction by employing the repulsion between two transformer coils to actuate the mercury contact tube

In the mercury contact class, the usual maximum rating is 30 amperes, 125 volts ac or dc, with proportionately lower current ratings at higher voltage. The coil rating is usually 2 to 8 watts, the wattage rating being about twice as high for ac as for dc, other factors equal. Such relays are particularly suitable for controlling motor loads and hence are often rated in terms of the horsepower of the motor load they can handle. One disadvantage of the conventional mercury switch is the fact that it must operate in a fixed position, otherwise the mercury will flow away from the contacts. In some applications, especially on shipboard where the rolling of the ship might uncover the contacts, the conventional mercury switch cannot be used. An interesting variation of the mercury switch which overcomes this difficulty is the plunger type of switch. It consists of a vertical glass tube containing the mercury and a cylindrical ferromagnetic plunger floating on it. Surrounding the glass tube is the control coil. When the coil is energised (about four watts at 110 volts ac required), the magnetic plunger is pulled down into the field of the coil, causing the mercury to rise and cover the contacts, which will carry 30 amps at 110 volts ac. This type of construction permits reliable operation at angles as great as 45° either side of vertical, which suits it to use on shipboard and in semi-portable applications.

Another interesting type of construction applied to the mercury contact type of relay is the transformer-relay. This relay employs two coils, one fixed, the other movable, both mounted on a common laminated yoke. The fixed coil is permanently connected across the 110-volt or 220-volt a-c line, and induces about 24 volts in the movable secondary coil. Connected to the secondary coil is the pilot circuit. When the pilot circuit is closed, the movable coil is forced upward away from the fixed coil, thus moving the mercury tube and closing the contact circuit. When the pilot circuit is opened, the movable coil drops back by gravity. The advantages are the absence of springs, the ability to operate the relay from a low voltage (24 volts) circuit rather than from the 110 volt primary circuit, and quiet operation since there is no armature-to-poleface impact.

The metallic contact power relays are so diverse that little information on them of a general nature can be compiled. Since higher power is available in the coil, heavier contact pressures, greater contact areas, and more positive contact wiping action are obtained, and the contact ratings are correspondingly higher than in the sensitive type of relay. In a-c service, the typical intermediate duty relay will carry 10 to 20 amperes in its contacts, at voltages up to 250, although the rating for d-c service is considerably lower. While equally high ratings can be achieved in low voltage (below 20 volts) d-c circuits, the current rating goes down as the voltage goes up. Above 110 volts, dc, the contact ratings rarely exceed one or two amperes. Increased current ratings may be obtained, however, by using the so-called double-break or triple-break contact arrangement which employs two or three sets of contacts in parallel.

Among the specialized mechanical constructions employed in the power

(*Continued on page* 87)

Volume Expansion with a Triode

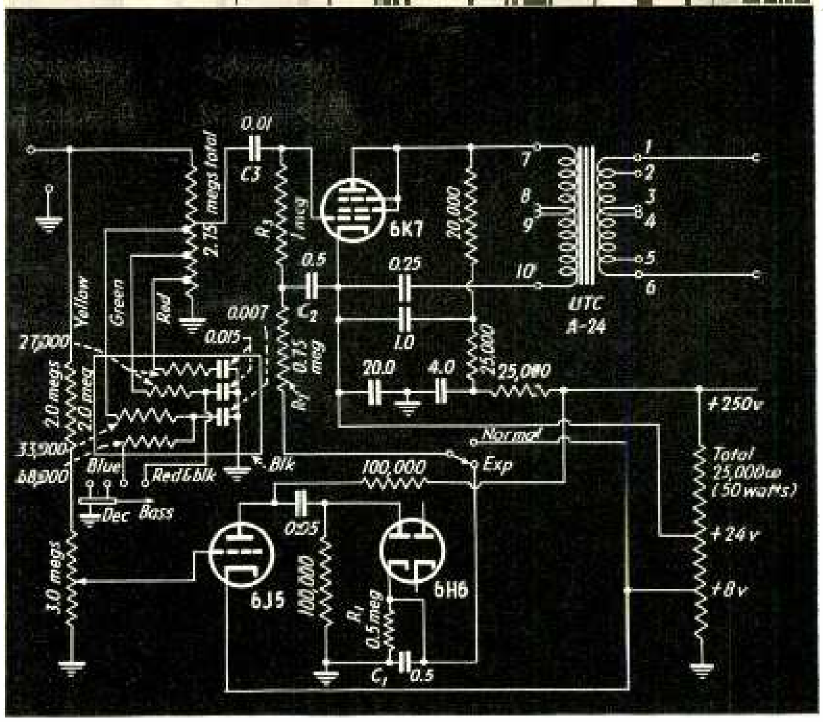


Fig. 1—Circuit diagram of the expander using a type 6K7 tube connected as a triode. The operate time is 0.385 second and the release time is 0.635 second

Advantage has been taken of the characteristics of a type 6K7 tube connected as a triode in the design of a new volume expander, resulting in excellent dynamic action and low distortion

By C. G. McPROUD

In the March 1938 issue of *Electronics* an article by M. L. Levy entitled "Distortion Limiter for Radio Receivers" advanced the premise that a 6K7 or equivalent tube operated as a triode offered the possibilities of control that were not available in other types. In addition, in the particular application for which the writer desired to use it, it was necessary to feed the expanded tube output directly into a tube-to-line transformer. The 6K7 was therefore tried as an expander in otherwise conventional expander circuits. The resulting circuit has served satisfactorily for almost two years on both radio and phonograph.

No one will dispute the value of an expander for reproduction of phonograph records. In addition, many listeners feel that radio programs are definitely improved by the use of about 6 db of expansion continuously. For symphony programs, the expansion should be increased to about 10 db. The maximum usable will be determined by the noise level and by the power output capabilities of the amplifier.

Figure 1 shows the expander circuit using the 6K7 as a triode, providing low impedance output from the transformer, and equipped with controls for varying the amount of expansion and for cutting the expander out if desired. The graph in Fig. 2 shows the range of control to be expected with the 6K7 operated as a triode.

The input to the expander is controlled by a compensated volume control, using standard parts. The volume control is coupled to the tube through a condenser to isolate the controlling voltage. The side amplifier is fed from the same source, before the volume control so that a change in volume setting will have no effect on the expansion control setting. The input is dropped somewhat to decrease the loading on the previous circuit and to keep the control signal down to a level which will not overload the 6K7. The 6J5 side amplifier is coupled to one section of a 6H6 diode, the other section being used in this case for avc in the receiver. The time constants of the circuit are controlled by R_1 and C_1, R_2 and C_2. A slight increase in the time constant is caused by R_3 and C_3. The operate time, therefore, is the product of R_2 and C_2 plus the product of R_3 and C_3, or 0.385 seconds. The release time is the product of R_1 and C_1 plus the operate time, or 0.635 seconds. These values are not absolutely correct inasmuch as the tube operates with a varying plate current, and consequently there is some time delay due to the plate load resistor and the blocking condenser. The resistor being small, however, this value becomes negligible and has been ignored in the calculations of the time constant. These values, while not nearly fast enough for use in volume limiter circuits, are such that they give a pleasing effect with symphony music. The distortion of this portion of the system unexpanded is 0.37 per cent at 400 cps. With full expansion, the distortion increases to 0.64 per cent, predominantly in the second harmonic.

The 6K7 is the first tube follow-

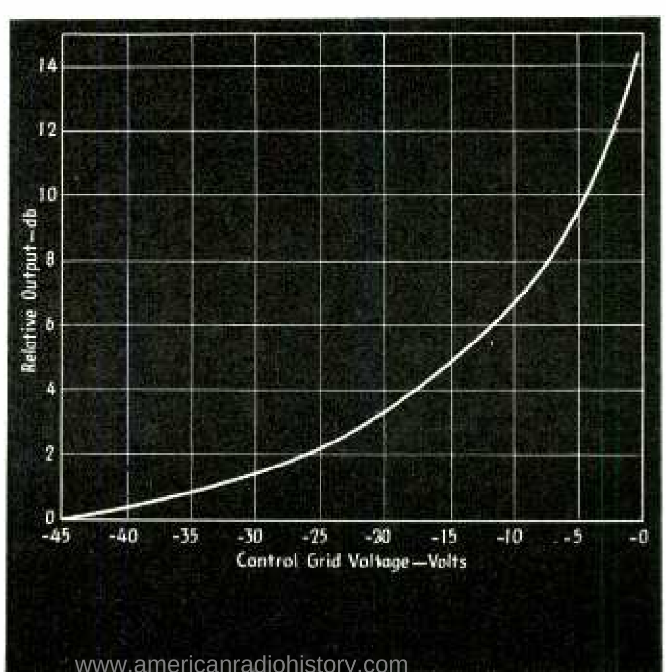


Fig. 2 — Relative output of triode-connected 6K7 (G_2 and G_3 connected to plate) amplifier with E_f = 6.3 v and E_p = 250 v

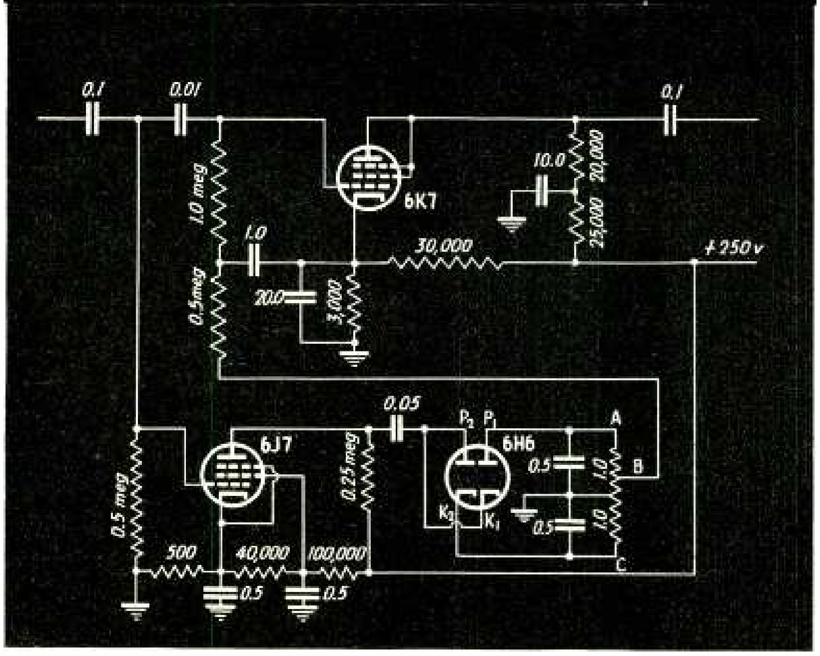


Fig. 3—Diagram of circuit used for both expansion and compression. Potentiometer is connected to both diodes of a 6H6 tube, which rectifies both positive and negative portions of the control signal

ing an infinite impedance detector of a wide-range type of receiver and the expander stage operates at an output level of about −25 db maximum. When used for phonograph reproduction, the 6K7 is the second tube, being fed by a single stage battery-operated pre-amplifier equalized for the recording characteristic. In either case, the input level is about the same and does not exceed two volts.

Figure 2 shows the relative output of the stage referred to the grid voltage. This curve was measured on a tube with a plate supply voltage of 250 volts, supplied through two 25,000-ohm filter resistors and a load resistor of 20,000 ohms, as shown in Fig. 1. There may not be sufficient expansion for some applications, but if more is required, control voltage can be applied to two consecutive stages of 6K7 tubes, which should give all that is necessary. The input to the second stage should be kept low enough not to overload it.

In considering the problem of the time constant of an expander, several factors should be considered. Primarily, the time constant must be great enough that individual cycles of the low audio frequencies will not operate it, but it should follow, in general, the envelope of the audio level. In the case of orchestral reproduction, let us suppose that a loud passage suddenly comes to a complete stop. There is a natural decay of sound level, which should be reproduced with the same amplification as applied to the passage itself. Hence the amplification should remain fairly constant for a short period. Likewise, the operate time should not be too short, or else a curious singing effect similar to that produced by a steel guitar, may occur. As previously stated, the best effect in the writer's experience is obtained with an operate time of around 0.25 to 0.5 seconds and a release time of from 0.5 to 0.75 seconds. These figures cannot be proven mathematically but are best determined by making tests with musically trained listeners.

Figure 3 is the circuit of an amplifier designed as a portion of a system built to demonstrate high-quality speaker systems. In this case, the 6K7 is also used as a compressor, simply by reversing the voltage applied to its grid. The method of obtaining this voltage and of controlling it is somewhat unique. The operation is as follows: During the positive half-cycle from the 6J7 plate, rectified current flows from P_2 to K_2 through half of the control *ABC* to ground, raising point *C* positive with respect to ground. During the negative half-cycle, current flows from ground through the other half of the control to P_1 and K_1, making point *A* negative with respect to ground. The entire d-c path is closed from P_1, K_1, P_2, K_2, and the potentiometer *C*, *B*, and *A*. The two 0.5 μf condensers serve as a filter, and control the release time. With the arm of the potentiometer between *A* and *B*, a negative voltage will be applied to the grid of the 6K7, resulting in a compressing action. With the potentiometer in the center position at *B*, the amplifier is normal. When the arm is rotated towards point *C*, a positive voltage is applied to the grid increasing the amplification and resulting in an expanding action. The potentiometer is of the type generally referred to as a fader although a smoother action would be obtained with a linear taper. It will be seen that the full range from full compression to full expansion is had by rotation of the control from one end to the other. Maximum compression on phonograph records is very amusing. On low level passages, music appears at a certain level with a very high background noise. High level passages come out at the same level, or a little lower, with no background. It offers no apparent practical value, but is an interesting demonstration.

A few words of caution are necessary. If too much expansion is attempted with the circuits shown, the tube will block, apparently when the grid goes positive, with attendant distortion and a dropping off of level. It is suggested that when the tube is used in resistance-coupled circuits that a plate load resistor of not over 50,000 ohms be used. When it is fed into a transformer it should be shunt fed with a resistor of 20,000 ohms. With so great a variation in the grid bias applied to the tube, it is obvious that the plate resistance also goes through a wide variation. With this in mind, it can be readily understood that the load offered by a transformer would not be constant enough to maintain a flat frequency characteristic without a low shunt-feed resistor. In any case, the tube has made the most satisfactory expander that the writer has tried except for the fact that it does not have as great a range as some types.

When used exclusively as a compressor, the side amplifier should be coupled to the output of the stage in order that the output will be asymptotic to a certain maximum, rather than actually having less output for a certain level than for another level lower than the first. For compressors, the action is similar to the avc of a radio receiver in which the level increases in a linear manner up to a certain point, and then increases at a slower rate. For use as both a compressor and expander, the side amplifier must be coupled to the input.

REMOTE CONTROL OF A MODEL BOAT

By WILLIAM P. WEST
The Franklin Institute, Philadelphia

AN application of electronic tubes somewhat out of the ordinary is the remote control system of a five-foot model of a 240-foot pleasure yacht which is in daily public operation at the Franklin Institute in Philadelphia. By means of the radio remote control, the model ship *North Star* may be made to maneuver in a manner very much like its prototype, both as to the operations performed and the relative speed of response. The *North Star* is shown in the accompanying photograph. Its measurements are given in the accompanying table.

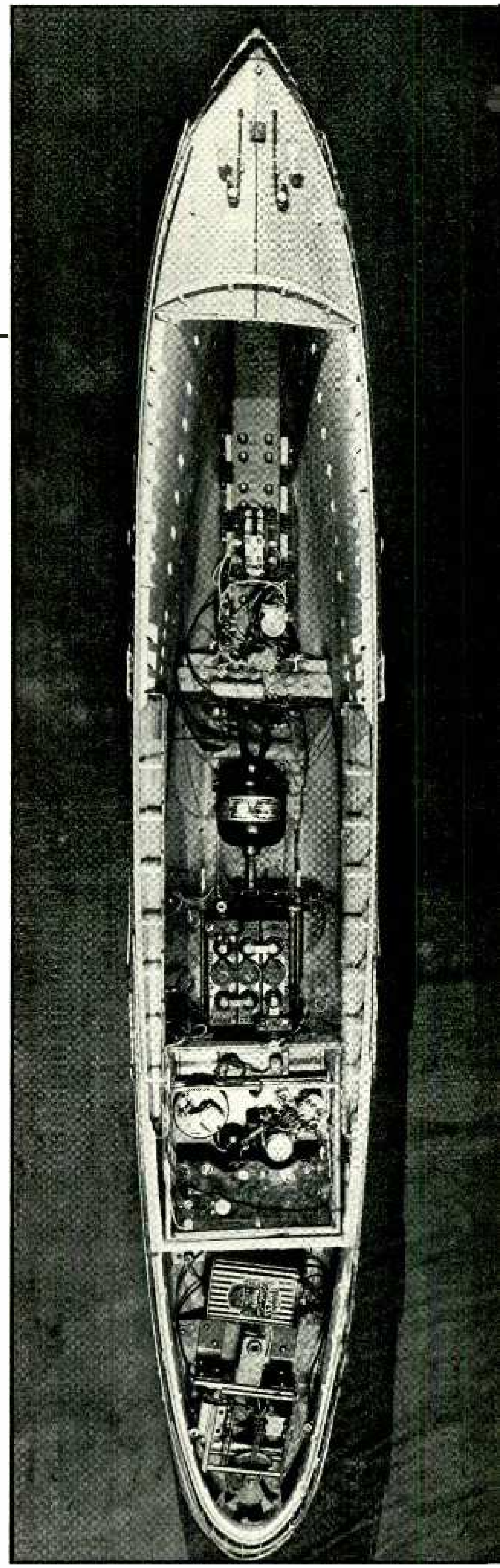
MEASUREMENTS OF THE "NORTH STAR"

Weight	47 lbs	loaded
Draft	5¼ inches	
Beam	10 "	
Main Deck	4¼ "	
Top of Antenna	23 "	above water
Length at Water Line	60 "	
Life Boat	5¼ "	
Motor Launch	7 "	
Motor Dory	6 "	
Sail Boat	6 "	
Hydroplane	6¾ "	w ing span

The boat is driven by a battery powered six-volt motor and is steered by means of a motor-driven rudder. The operations of both motors are controlled remotely by a radio system making use of a telephone dial to transmit a number of impulses for any desired operation and a stepping switch in the receiver which causes the correct relay to set in motion the maneuver called for by the operator on shore. The stepping switch is a device widely used in telephone work which is operated by a series of impulses such as those provided by a telephone dial. One impulse will cause circuit 1 to close, two impulses, circuit 2, etc. The transmitter is of the push-pull type making use of a single type 19 tube. The circuit diagram is shown in Fig. 1. A vertical radiator is used. The frequency of transmission is in the five-meter amateur band and the carrier is on the air continuously except during the actual transmission of the impulses.

The circuit diagram of the receiver is shown in Fig. 2. The circuit is the suggested arrangement given in the data enclosed with type RK-62 tubes. In experiments, it was found that the receiver would be more stable if seven turns were used instead of ten turns as indicated in the manufacturer's diagram. It was found that the length of the receiving antenna was not critical. This receiver responded so well in early tests and proved to be so free from interference that no further experimentation was made along these lines other than to introduce a second relay to relieve the Sigma relay from carrying excessive currents which caused freezing of its contacts. In order to protect the receiver from local interference, it was found desirable to use an independent filament supply, i. e., not to use a portion of the storage battery.

In the original arrangement, there was only one motor (the propelling motor) as the rudder was operated by solenoids with a spring arrange-



Interior view of the hull of the *North Star* showing the arrangement of the propeller motor, rudder motor, relays and batteries

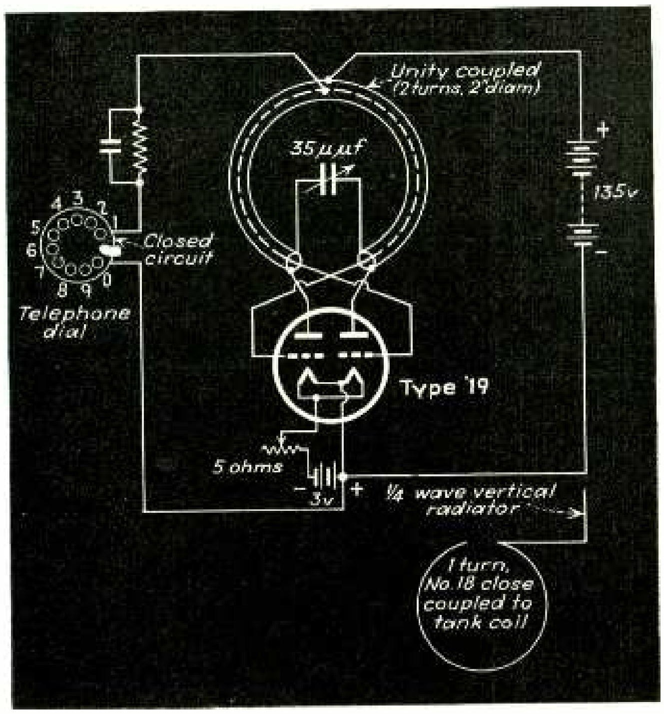


Fig. 1 — Circuit diagram of the transmitter, which operates in the 5-meter band. The telephone dial generates the series of control impulses

ment to return to the normal. This was found to be unsatisfactory because of the large current drain and necessarily weak restoring springs. Recently, a six-volt reversible motor became available and with a reduction gear to turn the rudder at the rate of two revolutions per minute, the rudder problem was solved. (The rudder motor is a standard motor designed for remote volume control of six-volt battery-operated radio receiving sets).

Operation of Selective System

As a single channel system is used, a selective system was designed to perform seven operations. Figure 3 shows the circuit diagram of this system which, through impulses sent in sequence and having equal time intervals, selects the proper relays to complete the electrical circuit to perform the following operations as indicated by markings on the dial

1. Blank
2. STOP (This stops the propeller motor)
3. STOP RUD (This stops the rudder motor and if moving in reverse changes to forward at the same speed)
4. PORT (This moves the rudder to turn the boat to port)
5. STBD (This moves the rudder to turn the boat to starboard)
6. SLOW (This runs the propeller motor slow forward unless REVERSE was dialed before)
7. REVERSE (This reverses the propeller motor at either fast or slow speed)
8. FAST (This runs the propeller motor fast forward unless REVERSE was dialed before)

An investigation of the operations described will bring out several points found desirable in the operation of such a boat. It will be noted that the rudder may be rotated to any angle to the port or starboard up to the maximum effective angle. In the case of the *North Star* this is 35 degrees. The rudder gear is arranged to operate limit switches controlling the maximum angle. Another desirable feature is that the propelling motor may be immediately reversed in case of an emergency or to aid in maneuvering the boat. It may be moving under power and the position of the rudder changed at the same time.

The principle upon which the selective system operates is based on a stepping switch. This switch has two relays, one of which rotates a contact arm one point for each impulse and the other is used to release the rachet mechanism and permits the contact arm to return to a starting position.

Reference to the diagram might lead one to believe that each relay is operated as the contact arm steps from one position to the next, but to overcome this difficulty, there have been introduced two relays (*M* and *N*) which operate quickly and require approximately one-quarter second to release. As long as a series of impulses are received less than one-quarter of a second apart, the two relays (*M* and *N*) are energized and open the circuit to the contact arm and to the "home," or release electromagnet of the stepping switch.

Typical Operation

Let us follow a typical operation, such as *SLOW*. The dial is rotated to the position which will count six impulses. The relay *R* is operated by the closing and opening of the Sigma relay (shown in Fig. 2) and therefore follows this series of impulses, making and breaking its contact six times. The first closing of the relay *R* causes relay *M* to close, which opens the circuit to the contact arm and closes the circuit to relay *N*. It in turn opens the circuit to the "home" electromagnet. The first motion of the contact arm closes an auxiliary contact to the "home" electromagnet, which is in series with the contact on relay *N*. This permits the remaining impulses to step the contact arm around to the sixth position, at which time the impulses have ceased. Relay *M* is then released, energizing the circuit through the contact arm to the *SLOW* relay. The release of relay *M* also releases relay *N*, completing

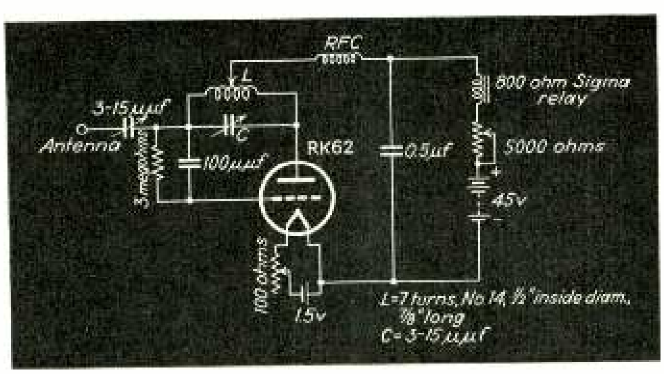
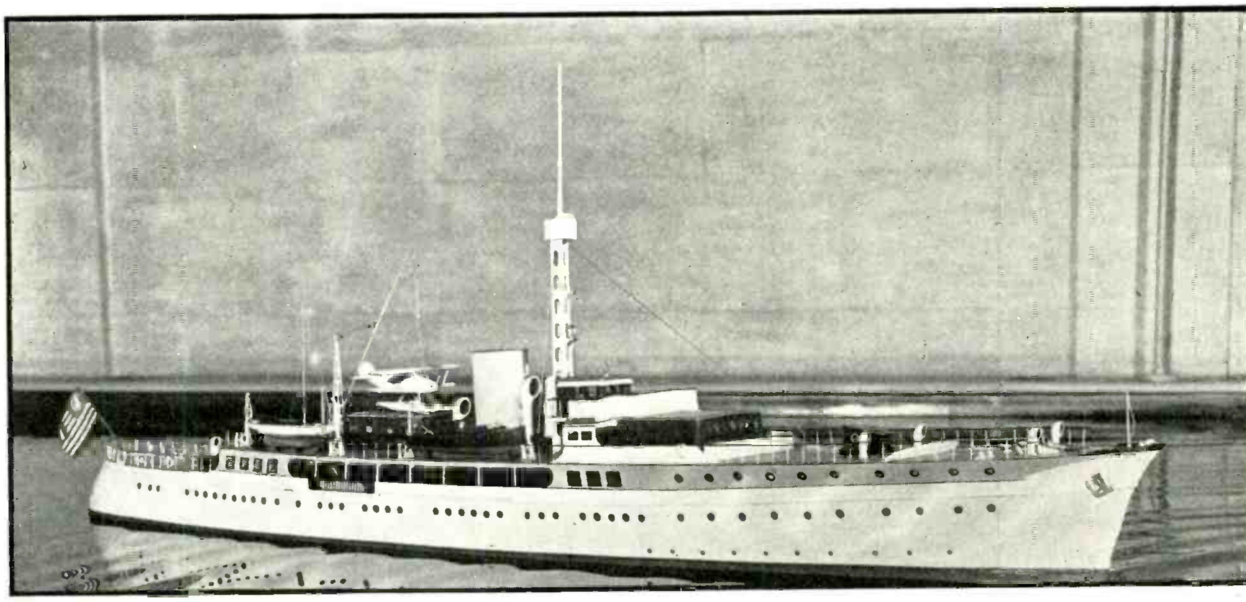


Fig. 2 — Circuit diagram of the receiver on board the boat. The series of pulses received from the transmitter controls the driving and steering motors



The *North Star* is a five-foot model of a 240-foot pleasure yacht. It is remotely controlled by means of a radio system and interlocking relays which operate propelling and steering motors

the circuit to the "home" electromagnet which in turn, releases the ratchet mechanism and permits the contact arm to return to the starting position.

To return to the operation of the *SLOW* relay, as soon as this relay operates, a holding circuit is made (left-hand pair of contacts) which keeps this relay in a closed position until either the *FAST* or *STOP* relays have been energized. In addition, this relay has completed the circuit to the propelling motor through a series resistance and opened the locking circuit to the *FAST* relay. The selection of any other operation is the same as *SLOW* with the exception that the circuit being completed is chosen by a different number of impulses.

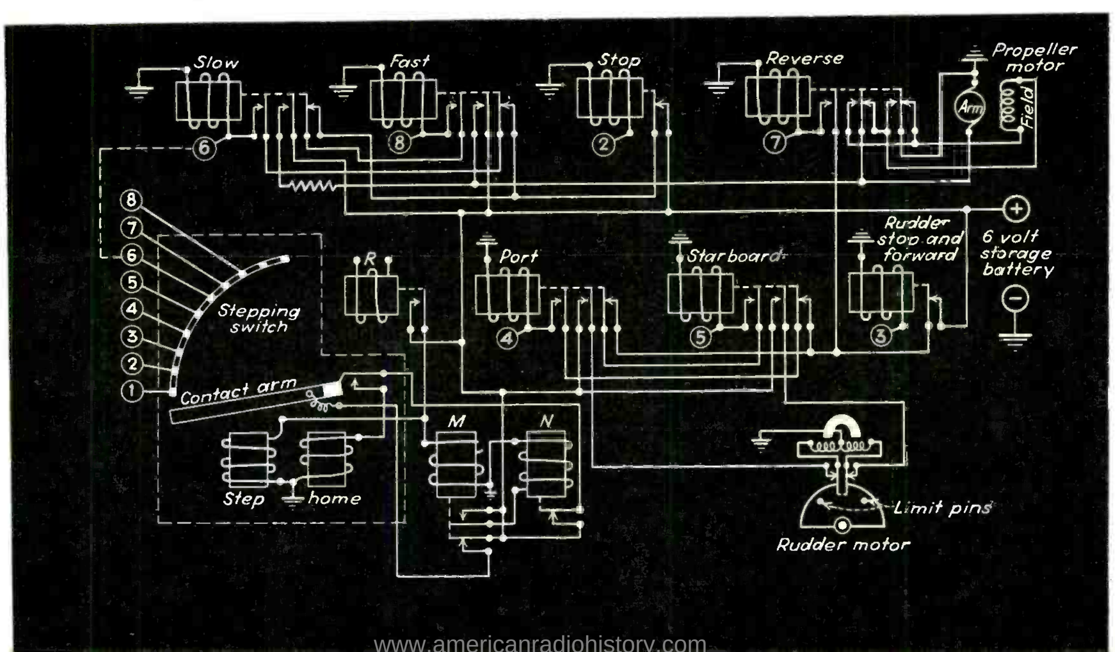
Examination of Fig. 3 shows that the two relays *SLOW* and *FAST* are interlocked so that the operation of one drops out the other and that the operation of the *STOP* relay will drop out either. This is also true of the *PORT*, *STARBOARD* and *RUDDER STOP*. It will be noticed that the *REVERSE* relay is not released by the *STOP* relay, but by the *RUDDER STOP*. The reason for this is to permit the propeller motor to be thrown into the *FORWARD* position when the boat is in *REVERSE* without having to stop the motor.

Steering

The steering operation is performed in the same manner as the speed selection. In addition, the rudder quadrant has two pins which operate contacts and in turn limit the maximum angle of rotation of the rudder. It will be noticed that the first position on the stepper switch is not connected to any circuit. This is done purposely to take care of random impulses or to prevent an operation when turning off the receiver. If space and weight permitted, it might be desirable to perform an additional pair of operations such as turning the lights of the boat on or off. These two operations would be connected to the last two contact points on the stepper switch.

The power supply consists of both dry and storage batteries. Power for the transmitter, which is designed for complete portability, is also furnished by batteries. In the operation of the boat, as used in the Museum of The Franklin Institute, the voltage for the transmitter is supplied from a power pack to save the expense of replacing batteries.

Fig. 3—Circuit diagram of the selective system which controls the various operations of the boat. The stepping switch causes the proper relay to trip according to the number of pulses transmitted



F-M RECEIVERS— DESIGN and PERFORMANCE

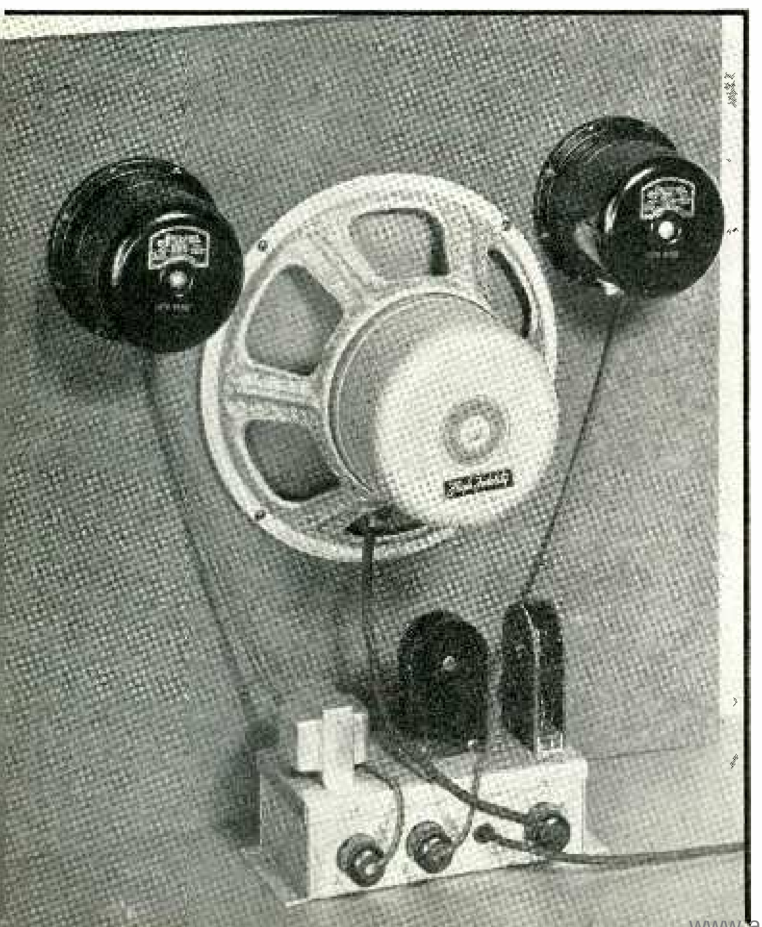
By MARVIN HOBBS

E. H. Scott Radio Laboratories, Inc.

ALTHOUGH it is to be expected that receivers for frequency-modulation reception will be somewhat similar in basic circuit design for some time to come due to the comparative infancy of the f-m art, they will differ somewhat in performance characteristics and in certain features which may affect their ability to do justice to the type of service which the wide band f-m system is capable of rendering. It is the purpose of this article to discuss the performance characteristics and the circuit features of the several models designed in the laboratories of E. H. Scott which provide reception of f-m signals in the tuning range of 41 to 50 megacycles.

The U-h-f Superheterodyne

As seen in Fig. 2 the first circuit of the superheterodyne is unconventional in that the input conductance of the r-f tube is neutralized. This is accomplished by connecting the grid return condenser to the cathode terminal on the socket of the 1853 tube, so that the voltage across the inductance in the leads of the cathode by-pass condenser can neutralize the degenerative effect introduced by the voltage across the cathode lead within the tube.[1] By choosing the proper ground point on the chassis it has been possible to make this neutralization effective over the 41 to 50 megacycle range and to improve the antenna gain and image rejection ratio by about 2 to 1. The 1853 tube is used in the r-f stage because of the desirability of a variable μ r-f gain control. When a u-h-f receiver is operated in the presence of strong signals it is very prone to produce a number of spurious responses because of the relatively poor selectivity of the u-h-f circuits with respect to signals whose frequency differs from the desired signal by only one-half of the intermediate frequency. It has been found desirable to reduce the r-f stage gain when signals of more than 50,000 microvolts are present at the antenna terminals in order to avoid receiving the signal at more than one point on the dial. In Fig. 3 the image rejection ratio of the Scott tuner using one r-f stage and the a-m f-m combination using two r-f stages are compared. The rejection ratio for the spurious response, which is due to the fact that the second harmonic of incoming signal as produced in the r-f or mixer stage beats with the second harmonic of the oscillator in the mixer circuit and there produces a signal at the intermediate frequency, is also shown as measured for the tuner. As mentioned above, if this figure is too low, strong signals can be tuned in at two points on the dial, although the second point is relatively weak and would appear to be so in an a-m receiver. However, because of the



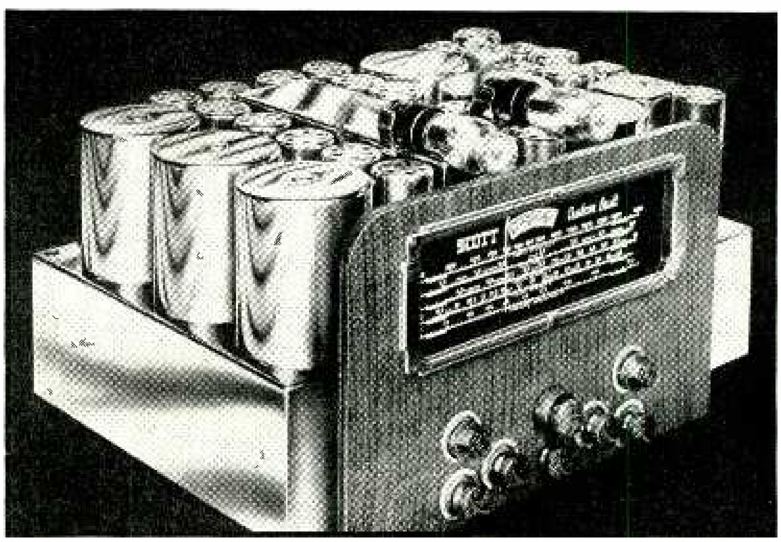


Fig. 1—The chassis assembly and the loudspeaker system of the Scott receiver. The loudspeaker system employs a 15-inch low frequency speaker for components below 2000 cps, two 5-inch tweeters for those up to 12,000 cps

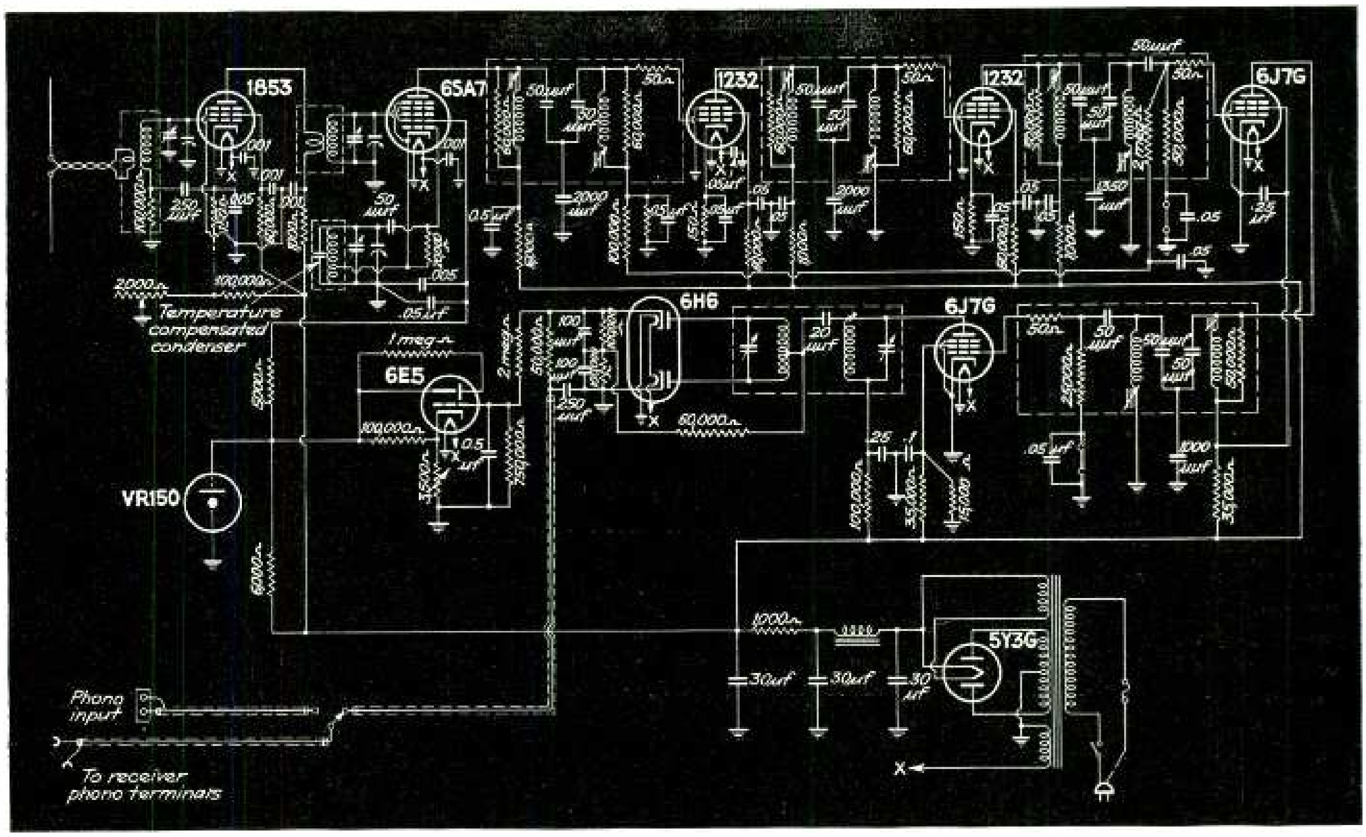


Fig. 2—Complete circuit diagram of the f-m tuner unit employing cascaded limiters

excellent limiter action of the f-m receiver both the correct and spurious signal may appear to be of equal audio level. The same consideration applies to the image signal.

Since the signal-to-noise ratio of converter tubes is relatively poor in the ultra-high-frequency band as well as elsewhere, it is desirable to obtain as much gain as possible before that point. In the f-m tuner the antenna gain is 6 and the r-f stage gain is 10 as measured under actual operating conditions (not as they can be measured by idealized vacuum tube voltmeter readings which omit the effect of the input conductance of the tubes). In the a-m f-m receiver employing two r-f stages an additional factor of 10 is added ahead of the mixer. These gains insure that the converter will have little control over the signal-to-noise ratio.

The 6SA7 tube is used as a mixer because of its oscillator stability. With no a-v-c voltage applied to this tube it is possible to vary the signal at the antenna from 1 to 100,000 microvolts with no shift in oscillator frequency. The other drift factor of importance is that experienced during the first few minutes of operation of the receiver. However, it will be noted from Fig. 4 that this has been reduced to a minimum in these receivers by means of a temperature compensated condenser. The maximum drift is seen not to exceed 3,800 cps which is comparable to the drift or frequency variation limitation at the transmitter.[2] In actual operation the receiver may be tuned after one-half minute of operation and it will remain tuned to the correct frequency except for the slight drift between the first and fifth minute.

Before describing the f-m performance characteristics it is well to consider the reasons for choosing an intermediate frequency of 5.25 Mc. The first consideration is that this higher frequency moves all image response signals from f-m transmitters in the 41 to 50 megacycle band outside that tuning range. Since these signals are likely to be the strongest ones capable of producing an image signal, the most serious possibility of image signal interference is automatically eliminated. Since the oscillator is tuned below the incoming signal frequency, transmissions in the band of 30.5 to 39.5 Mc are capable of producing image signals. However, with the image ratios shown in Fig. 3 there is little danger of any audible beat note interference with either the single stage or dual stage r-f systems. The second reason for choosing the high intermediate frequency is the obvious fact that it moves any spurious signal-producing voltages or image signals further along the r-f selectivity curve and makes the rejection ratios somewhat better than those obtainable with intermediate frequencies of 2,000 to 3,000 kc.

F-m Performance Characteristics

Once an intermediate frequency of 5.25 Mc. is chosen the problems of obtaining satisfactory f-m performance consist largely in obtaining the proper pass-band for a total deviation of 150 kc, sufficient adjacent channel selectivity, proper limiter action, and a linear discriminator circuit. The i-f amplifying section consists of two linear amplifying stages employing 1232 type loctal base tubes and two limiting stages containing 6J7G tubes. The last limiter feeds a 6H6 balanced detector across whose load the audio output voltage is developed. To insure freedom from regeneration and its ill-effects on the symmetry of the selectivity curve the sockets and wiring of each i-f stage are individually shielded. Plate and screen filters are also used to prevent audio voltage from the limiting stages from feeding back into the plate supply line, which is of particular importance in the combination a-m f-m receivers since such undesired voltages may feed into the audio system unless properly filtered and produce an audible output when the volume is adjusted to a low level.

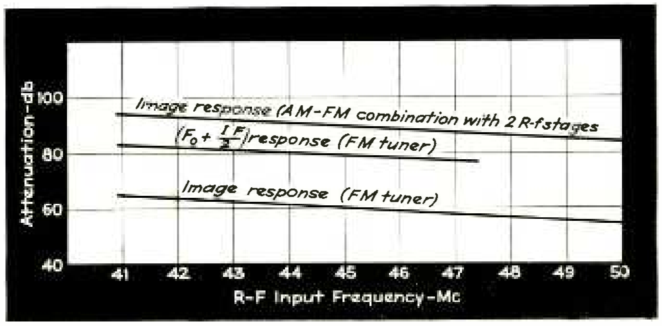


Fig. 3—Image and spurious-signal response of the two types of receivers

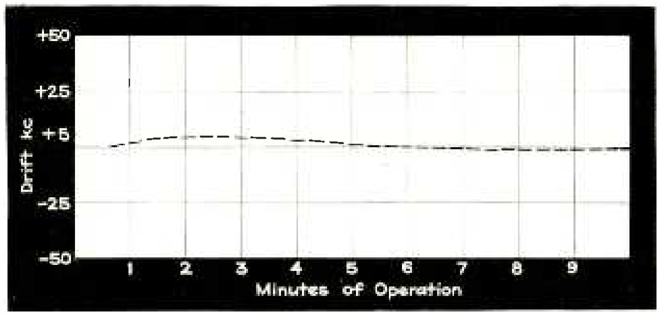


Fig. 4—Drift characteristic of the oscillator used in the receivers. Temperature compensation keeps the drift within 3800 cps

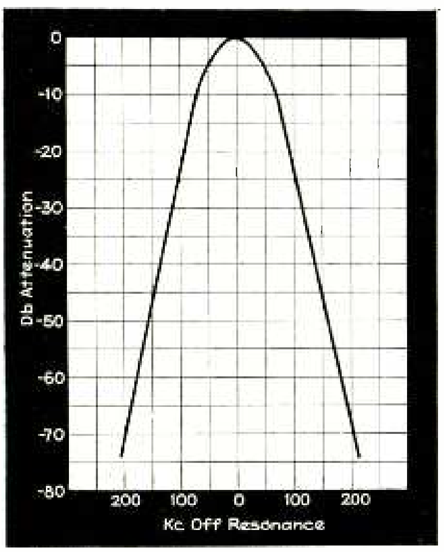


Fig. 5—Overall selectivity characteristic measured below input required for limiter action

The overall selectivity characteristic of the tuner is shown in Fig. 5. Three points along this curve are of particular interest. They are at 75, 125, and 200 kc from resonance. The 75 kc point is of importance because it shows the attenuation of the i-f amplifier at the maximum frequency deviation point. If there were no limiter present in the receiver it would be necessary to provide flat response over a range of 75 kc in order to prevent distortion. However, the cascaded limiters in these receivers operate at a signal input of only a few microvolts and can be depended upon to eliminate any amplitude modulation, which may result due to the selectivity characteristic, for all except very weak signals which would not be noise-free in any event. Listening tests and measurements indicate that the 12 db over-all attenuation at the 75 kc point produces no phase distortion of importance, provided the circuits are adjusted for optimum coupling. Without a certain amount of attenuation at this point it is difficult to obtain the desired degree of adjacent channel selectivity. At the 125 kc point, which is the edge of the frequency swing in the adjacent channel, an attenuation of 34.5 db, which is a measure of the immunity against cross talk from an adjacent channel signal, is shown. With this degree of adjacent channel selectivity we have found it possible to separate the signals of W9XEN, Chicago, on 42.8 Mc and W9XAO, Milwaukee, on 42.6 Mc. The listening test was made in Highland Park, Illinois, where the effective signal from W9XAO was about 20 microvolts and the signal of W9XEN was about 350 microvolts. A non-directional vertical dipole antenna was used.

In Fig. 6 the limiter characteristic for 25, 50, and 75 kc deviations is shown. It is desirable that these curves should be as flat as possible once they have passed the knee of limiter operation, in order to prevent any amplitude modulation due to the noise from reaching the detector, and in order to prevent the tuned circuit attenuation from causing distortion. About 3 db of variation of the amplitude due to selectivity can be tolerated and, therefore, the limiters may be assumed to be in full operation so far as distortion is concerned from a signal level 3 db below the input required to pass the knee of the curve. For signals below this level there is sufficient thermal noise from the first circuit to prevent noise-free reception. The dotted curve shows the noise attenuation characteristic insofar as the receiver itself is concerned. There is some question about the desirability of a sharp limiter characteristic for weak signals when a high level of impulse noise is present, and it is thought that the rounded initial characteristic shown in Fig. 6 is more desirable than a square shaped knee.

To reduce the effects of impulse noise it is necessary that the limiters be capable of acting very quickly. Hence, the limiter circuit time constants have been made as short as possible consistent with gain and selectivity of the limiter input circuits. From cathode ray oscilloscope studies it is apparent that a time constant of 2.5 microseconds or less is desirable. In these receivers the time constant of the first limiter grid leak and condenser is approximately 2.5 microseconds and that of the second limiter is 1.25 microseconds, thus assuring that the first limiter will be effective in reducing the peak interfering voltages of ignition impulses before they reach the second limiter. A minimum amount of a-v-c voltage from the first limiter grid leak has been applied to the control grids of the i-f amplifiers in some of the Scott receivers in order to prevent overloading in stages ahead of the limiter. However, the voltage used for this purpose has been kept low in order that the signal will be as far up on the limiter characteristic as possible and also to eliminate any delay in limiter operation which might result from the time constant of the a-v-c system.

In Fig. 7 the output characteristic of the discriminator detector is shown. This type of curve allows for a moderate amount of over-modulation at the transmitter without introducing distortion, yet it does not extend too far outside the channel to which the receiver is tuned[3]. The detector efficiency is such that no high degree of audio amplification is necessary after the detector in order to obtain adequate output, yet the signal level on neither de-

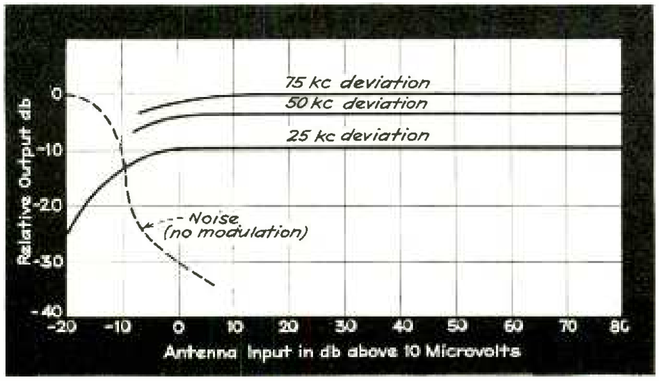


Fig. 6—Limiter action curves for various deviations. The curves continue to be flat above plus 100 db

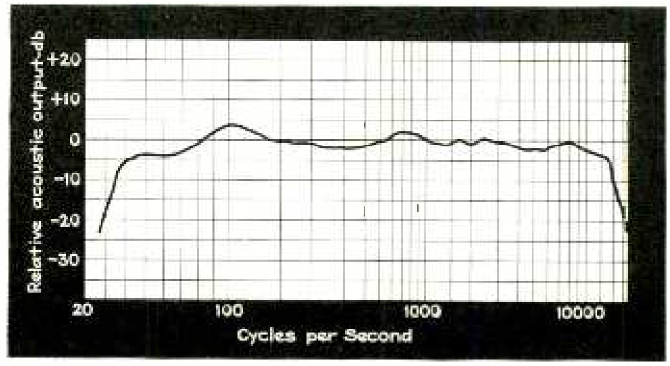


Fig. 8—Sound pressure curve, measured in the Jensen Laboratories, of the loudspeaker assembly shown in Fig. 1

tector drops sufficiently low to cause any appreciable rise of noise as the carrier is modulated[4]. Immediately following the detector load resistors a resistance-capacity filter is inserted to remove the pre-emphasis of the high frequencies which is introduced at the transmitter.

Tuning Indication

The problem of indicating the correct tuning point for a frequency modulation receiver is somewhat different from that encountered with an a-m set. There seems to be little doubt that tuning accuracy can be observed best by noting the voltage across the full discriminator detector load resistance. In a laboratory or communication type of receiver this voltage can be readily indicated by simply connecting a zero-center voltmeter of the proper sensitivity at this point. The receiver is tuned correctly when the volt meter is exactly between the symmetrical positive and negative voltage swings, or when it reads zero in this region.

Since it is no longer popular to employ any tuning indicator which smacks of the laboratory in a receiver for home use, it becomes necessary to consider tuning by means of a cathode ray "magic eye" tube which has been popular in home receivers for several years. However, exact resonance cannot be indicated by simply tuning for a peak response, as with the a-m receiver. The only practical solution seems to be one which uses the "magic eye" indicator to perform exactly the same function as the zero center volt meter, described above. In all of the Scott receivers this is accomplished by using a 6E5 indicator tube biased to cut off, so that the shadow just closes when no indicating voltage is applied to its control grid. The voltage for the 6E5 control grid is taken from the discriminator load circuit through an audio filter and, therefore, when the receiver is detuned in one direction the shadow opens and in the other direction it overlaps, the correct tuning position being for zero voltage from the discriminator with the shadow angle just closed. Practical tests with this system show that it is fully as accurate as the average zero center volt meter and that a good degree of stability is maintained when the supply voltages for the indicator tube are taken from a voltage regulated source.

The audio system of the combination a-m—f-m receivers requires a certain amount of consideration when switching from standard broadcast band a-m programs to the f-m programs. In order to obtain the maximum fidelity from the standard broadcast programs Scott a-m receivers have incorporated a high frequency boost choke in the plate circuit of the first audio stage to compensate for attenuation at the edges of the pass-band of the i-f amplifier. A peak of about 7 db is introduced at 6,500 cps for this purpose. For the reception of frequency modulation programs having a range of 15,000 cps such a peak is undesirable provided there are no corresponding deficiencies in other parts of the audio or loud speaker system. The presence of any peaks in an audio system of a wide-band f-m receiver is definitely undesirable for several reasons, one of which is the fact that they tend to exaggerate any noise which is modulated onto the carrier at the transmitter. In the Scott combination receivers a switch section is ganged with the wave band switch for the purpose of removing the high boost audio choke in the f-m position.

A low frequency boost choke capable of introducing a 7 db rise at its resonance point near 90 cps is present in the a-m receivers and has been retained in the combination receivers with the bass response control arranged so that it can remove or introduce this peak as the user may desire.

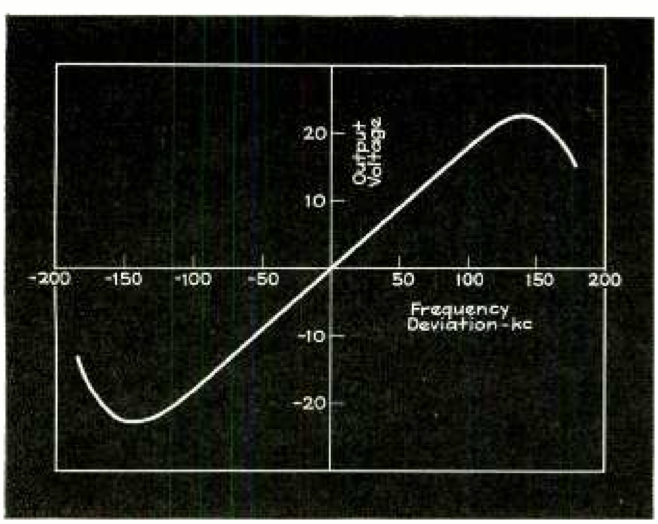


Fig. 7 — Frequency detector (discriminator) characteristic designed for 75 kc deviation each side of the central frequency

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[1] Input Conductance Neutralization, R. L. Freeman, *Electronics*, October, 1939.
[2] Notes on FM Transmitters, F. A. Gunther, *Communications*, April, 1940.
[3] A Receiver for Frequency Modulation, J. R. Day, *Electronics*, June, 1939.
[4] A Method of Reducing Disturbances in Radio Signalling by a System of Frequency Modulation, E. H. Armstrong, *Proc. I.R.E.*, May, 1936.

A New HIGH-SENSITIVITY PHOTOSURFACE

By A. M. GLOVER and R. B. JANES
RCA Manufacturing Co.

A NEW phototube utilizing a new caesium photosurface which possesses a remarkable sensitivity to the major portion of the visible spectrum is now available. The sensitivity of the surface used to incandescent light obtained from a tungsten lamp operating at a color temperature of 2870 degrees Kelvin averages 45 microamperes per lumen. This is about twice the sensitivity obtained with previous phototubes when used with an incandescent light source. However, a sensitivity of at least 120 microamperes per lumen is obtained from daylight illumination as a result of the spectral sensitivity of the surface. The surface is also very well suited for use with mercury arc or fluorescent light sources whose energy output is concentrated in the spectral region in which the sensitivity of the photosurface occurs.

In Fig. 1 are shown the spectral distribution curves for the new surface S-4 and for two types of photosurfaces previously available, the highly red-sensitive caesium-caesium oxide surface S-2, and the relatively blue-sensitive rubidium-rubidium oxide surface S-3. It will be observed that the new surface is very sensitive to green and blue light and to the near ultra-violet. The drop in sensitivity in the neighborhood of 3000 angstroms is due to the lime glass envelope used for this phototube. The sensitivity to red light is seen to be negligible, a fact which may be used to advantage in the design of apparatus for flame control in which the radiation from the background is high in red and infrared radiation. It should be noted that the response to an incandescent light source will vary with the temperature of the light source. The value quoted, 45 microamperes per lumen, is given for a color temperature of the lamp of 2870 degrees Kelvin. This temperature is approximately that of the exciter lamp used in motion picture equipment.

The relative areas under the curves in Fig. 1 may be taken to represent approximately the relative sensitivity to daylight of the different surfaces, inasmuch as the light energy in daylight is quite uniformly distributed throughout the visible spectrum. An exact analysis gives the average value for the daylight sensitivity as 120 microamperes per lumen. Measurements show that the new surface S-4 is at least ten times as sensitive to daylight as the caesium-caesium oxide surface S-2. If the radiation from a high-pressure mercury arc is employed, the response is about fifty times greater for the S-4 type surface than for the S-2. Because of the rapid increase in the use of gas discharge tubes as light sources, the importance of high sensitivity to such sources is much increased.

In addition to the increased sensitivity obtained, the process used in the manufacture of this surface yields a very high dark resistance. An increase in the dark resistance is equivalent to an increase in sensitivity in that it permits the use of a higher load impedance with consequent increased voltage sensitivity. The dark resistance of a phototube is determined by several factors

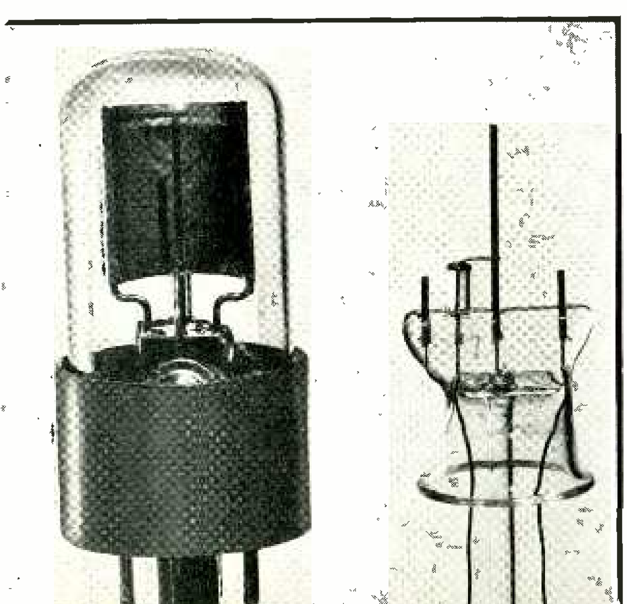


Fig. 2—The new type 929 phototube and its internal structure. The glass tube enclosing the anode lead increases the leakage path between electrodes

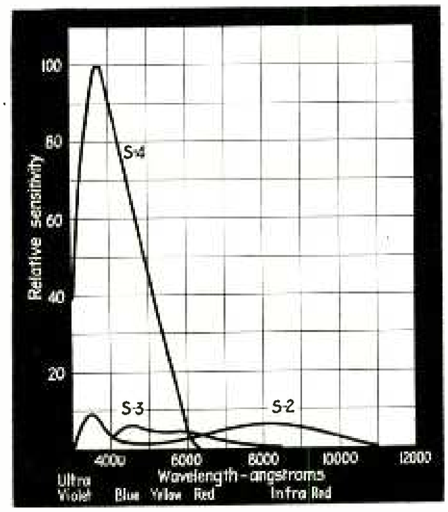


Fig. 1—The new photosurface S-4 compared with previously available surfaces S-2 and S-3

which can contribute to the passage of current in the absence of the light. The first and most important factor under ordinary conditions is leadage across the glass press and the base of the tube. This internal leakage of the new tube is lower than in other types of alkali-type phototubes because the glass press is entirely free from a deposit of alkali metal. A second factor tending to lower the dark resistance is thermionic emission, which is the flow of electrons from the photocathode as a result of its operating temperature. The thermionic emission from this surface is also lower than that of the caesium-caesium oxide surface. Preliminary measurements indicate that the thermionic emission is between 10^{-13} and 10^{-14} amperes per square centimeter at room temperature. The third factor is photosensitivity to unwanted radiation either visible or invisible. Ordinarily the most difficult stray radiation to eliminate is infrared radiation which may arise from the walls of the phototube shield. The absence of sensitivity to such radiation is, therefore, an asset when particularly sensitive measurements are being made on visible light.

The material used in the cathode surface of a new phototube is highly sensitive in the ultra-violet region and has negligible response in the red and infrared regions. The new cathode is ten times as sensitive to daylight as the best previously available surfaces

This new phototube, designated as RCA-929, is of the high vacuum type. The use of a high vacuum phototube of such a high sensitivity as to give an output equivalent to that of a gas-filled phototube with a lower intrinsic photosensitivity should result in an improved signal-to-noise ratio. Measurements under actual operating conditions in sound motion picture equipment verify this conclusion. A further improvement resulting from the use of this type of phototube is reduced distortion. This applies to both amplitude distortion and frequency distortion. The latter improvement results from the absence of the time delay caused by the transit time of the ions and metastable atoms of the gas which drift relatively slowly to the cathode and, thus, cause a decrease in sensitivity as the frequency of an audio signal is increased. The absence of the gas also results in a more linear output characteristic as a function of the light intensity with resultant decrease in amplitude distortion.

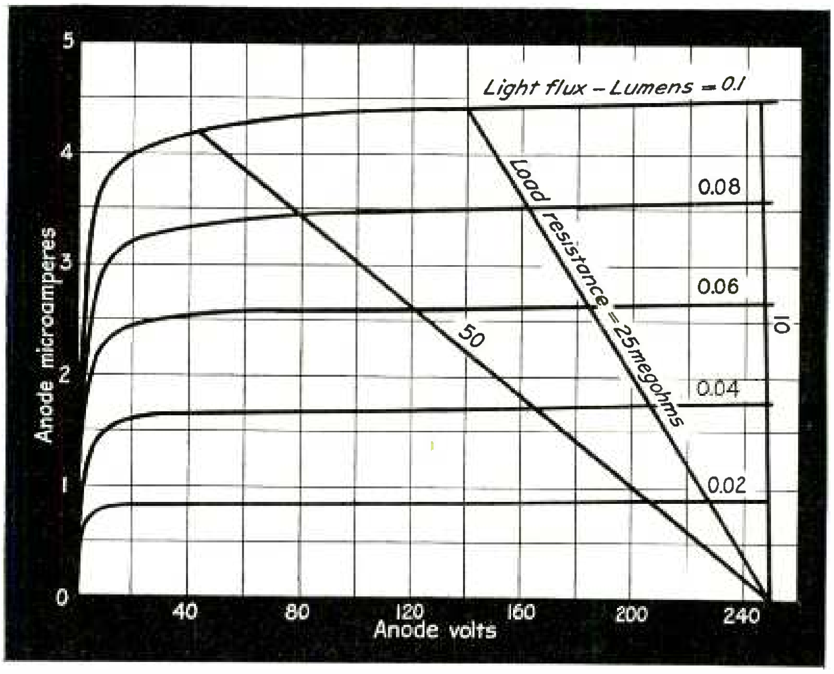


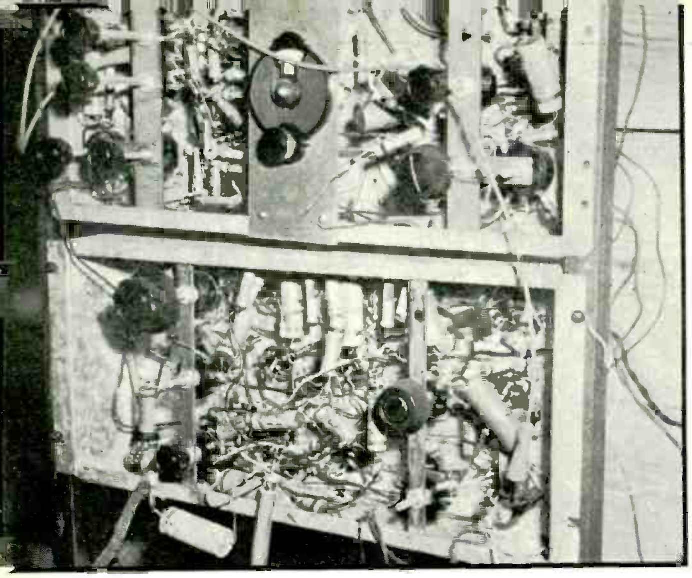
Fig. 3—Anode current characteristic for various values of light flux. Note that the anode current is independent of anode voltage over a wide range

In Fig. 3 is shown the anode current versus anode voltage curves of the RCA-929 phototube for several different values of light flux. It is apparent that the output of the tube is essentially independent of anode voltage over a very wide range, and is therefore independent of line voltage fluctuations. This fact, together with the high internal resistance of the tube, permits the use of high load resistance. It should also be noted that a high vacuum phototube is specially suitable for use directly from an alternating-current supply, since the tube may be operated at the high peak voltage of the supply and also may serve as its own rectifier.

The adaptability of the new photosurface to various applications is immediately apparent. The high sensitivity to daylight makes possible the design of a sensitive photographic exposure meter which may be used for the determination of very low light levels. This is possible since the high impedance associated with a vacuum phototube of the photo-emissive type permits the ready amplification of the phototube output to a value sufficiently large to operate a rugged and inexpensive output meter. A further extension to the field of photography is seen in the use of the RCA-929 in photographic densitometer equipment.

There are also many applications in colorimetry, organic analysis, and biochemical analysis where this new tube will prove useful. In three-color printing processes, the particular sensitivity of the tube may be used to advantage either by itself or in conjunction with a phototube containing the red sensitive caesium-caesium oxide surface. An increase in the sensitivity of the phototube used for astronomical telescope observations is equivalent to an increase in the light gathering power of the telescope or, specifically, to an expensive increase in the diameter of the light collecting system. In order to obtain the full benefit from this increase in sensitivity, the limiting factors of low dark current and thermionic emission are particularly important.

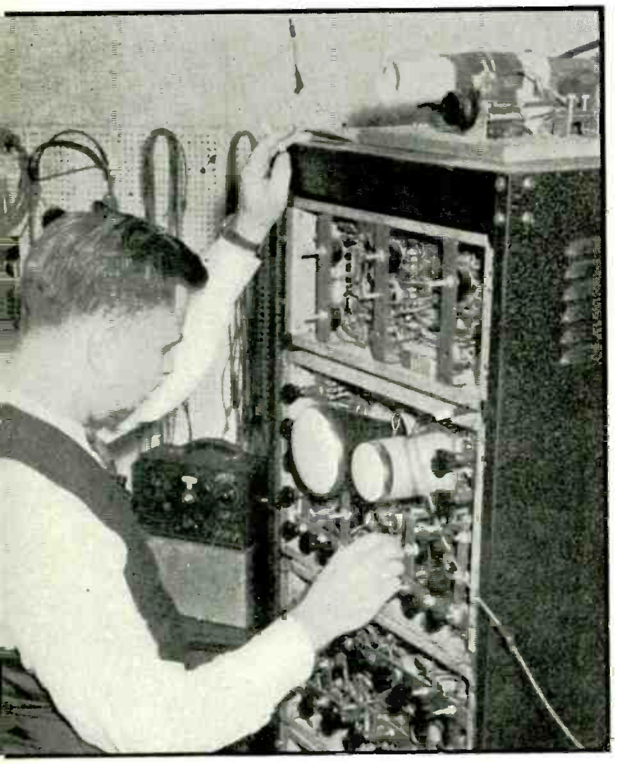
It is desirable that an automatic burglar alarm be concealed so that its presence can not be detected by an intruder. A burglar alarm may be designed to utilize the high ultra-violet sensitivity of the RCA-929. By the use of suitable filtering all visible light may be removed, but because of the high sensitivity of the new photosurface to the near ultra-violet, a large useful output can be obtained. The new phototube is remarkably free from variations in sensitivity with exposure to illumination. This inherent stability is a property which is highly desirable for industrial applications as well as for scientific uses.



Above, the monoscope used as a source of standardized fixed-image signal for testing and alignment. A 100-watt peak video transmitter is used for testing, but not put on the air

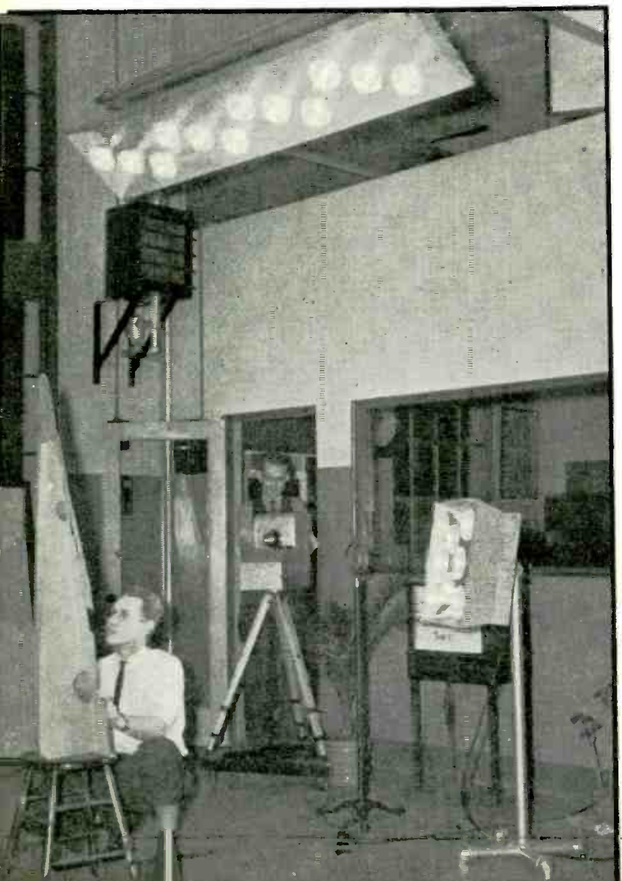
Upper left, the first model of the R.M.A. standard video signal generator, known locally as "the headache", worked surprisingly well, but has since been replaced by a more flexible unit

Left, monitor and camera control unit, showing image monitor and waveform oscilloscope with covers removed



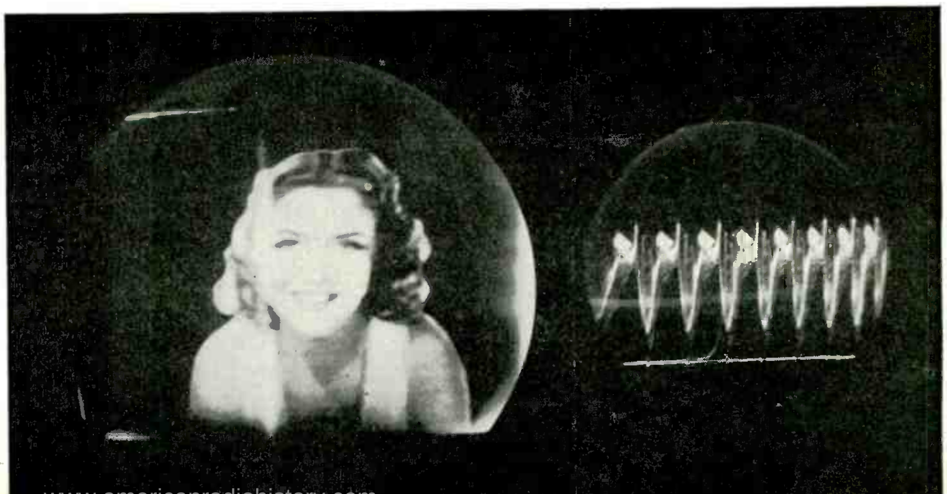
TELEVISION at TULSA

The management of KVOO, Tulsa, Oklahoma, has encouraged its operating staff to carry on an experimental program in television, simply to keep up with current developments, with creditable results



Left, the "studio", showing iconoscope camera, lights, and card-board image used for testing. Standard R.M.A. 441-line images are produced

Below, unretouched photos of image and video waveform as they appeared on the monitor equipment



Institute of Radio Engineers
Fourth Pacific Coast Convention

August 28, 29 and 30, 1940, Ambassador Hotel, Los Angeles, California

Program

WEDNESDAY, AUGUST 28

MORNING SESSION

"Causes of Frequency Variations in Klystron Oscillators", by E. L. Ginzton, W. W. Hansen, R. H. Varian, and J. R. Woodyard, Stanford University, California.

"Ultra-High-Frequency Tubes", by A. V. Haeff, RCA Manufacturing Co., Harrison, N. J.

"Rectilinear Electron Flow in Beams", by J. R. Pierce, Bell Telephone Laboratories, New York.

"Propagation of Electromagnetic Waves Inside a Cylindrical Metal Tube and Along Other Types of Guides", by C. P. Hsu, California Institute of Technology, Pasadena, California.

AFTERNOON SESSION

"Measurements of Noise and Vibration", by H. H. Scott, General Radio Co., Cambridge, Massachusetts.

"Distortion Measurements by Fundamental-Suppression Methods", by W. K. Hewlett and David Packard, Hewlett-Packard Company, Palo Alto, California.

"A Resistance-Capacitance Audio-Frequency Oscillator", by G. A. Brettell, California Institute of Technology, Pasadena, California.

"Generation of Square-Wave Voltages at High Frequencies", by W. H. Fenn, University of California, Berkeley, California.

"Design and Test of Sound Equipment by the Intermodulation Method", by J. K. Hilliard, MGM Pictures, Culver City, California.

"Building the World's Farthest-North Commercial Broadcasting Station", by J. W. Wallace, Puget Sound Broadcasting Co., Seattle, Washington.

THURSDAY, AUGUST 29

MORNING SESSION

"Frequency Modulation", by E. H. Armstrong, Columbia University, New York. (Address before joint meeting with A.I.E.E.)

"Frequency-Modulated-Wave Broadcast Transmitters", by W. R. David, Radio and Television Department, General Electric Company, Schenectady, N. Y.

"Performance Characteristics of Frequency Modulation in Ultra-High-Frequency Sound Broadcasting", by R. F. Guy, National Broadcasting Co., New York

AFTERNOON SESSION

"Frequency Modulation Tests and Experience", by M. V. Kiebert, Jr., Jansky and Bailey, Washington, D. C.

"Frequency Modulation Versus Phase Modulation", by C. J. Breitwieser, Lee de Forest Laboratories, Los Angeles, California.

"Loktal-Tube Design and Manufacture", by R. M. Wise, Hygrade Sylvania Corporation, Emporium, Pennsylvania.

"Vacuum Tubes in Chemical Research", by C. J. Penther and D. J. Pompeo, Shell Development Co., Emeryville, California.

"A Proposal for Reduction of Polarization Errors in Loop Direction Finders", by F. E. Terman, Stanford University, Stanford University, and J. M. Pettit, University of California, Berkeley, California.

"Radio Direction Finding for Meteorological Balloons at 1.67 Meters", by L. C. Yuan and S. S. Mackeown, California Institute of Technology, Pasadena, California.

FRIDAY, AUGUST 30

MORNING SESSION

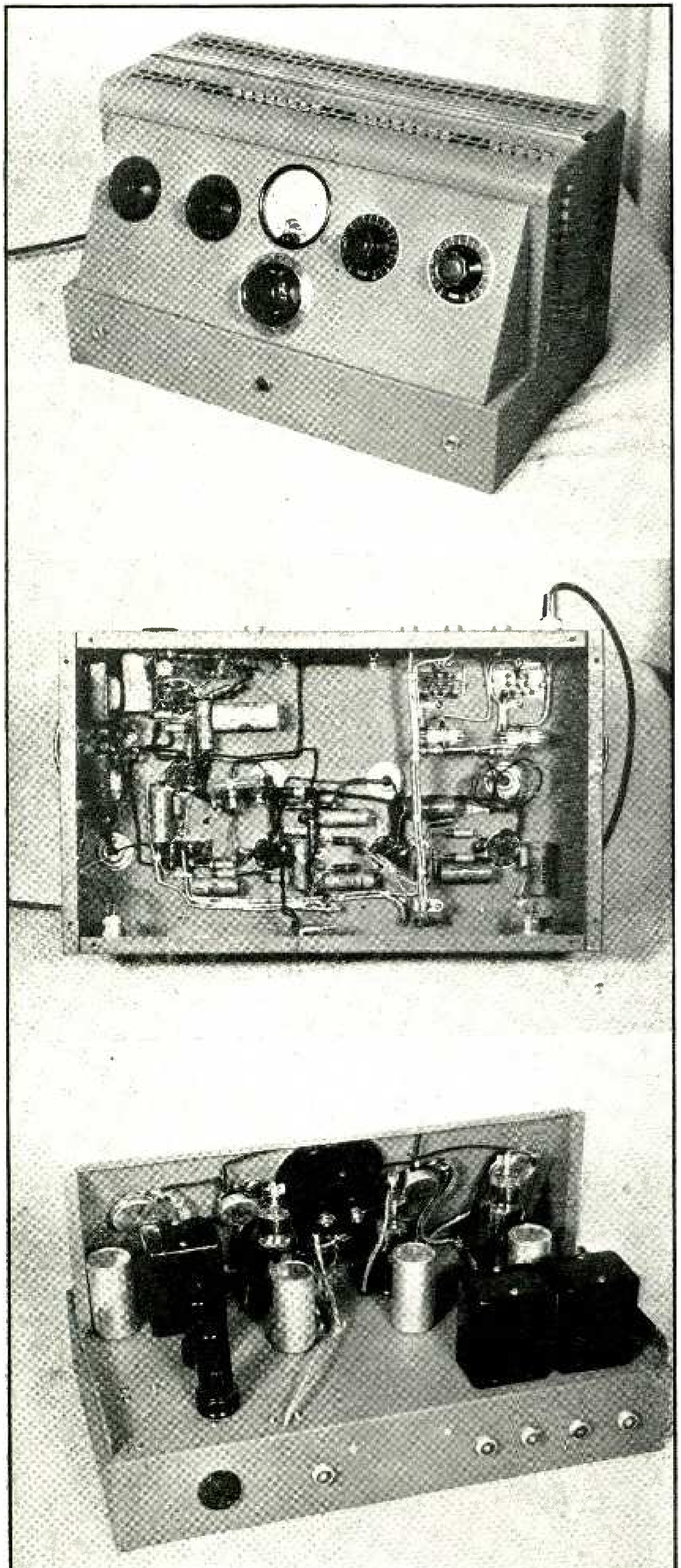
"Some Notes on Linear and Grid-Modulated Radio-Frequency Amplifiers", by F. E. Terman, Stanford University, Stanford University, Calif., and R. R. Buss, Heintz & Kaufman, Ltd., South San Francisco, California.

"A 500 Kilowatt High Efficiency Broadcast Transmitter", by J. O. Weldon, Weldon Engineering Company, Del Rio, Texas.

"RCA Portable Television Pick-Up Equipment", by G. L. Beers, RCA Manufacturing Co., Camden, New Jersey.

"Television Receiver Characteristics", by C. F. Wolcott, Gilfillan Brothers, Inc., Los Angeles, California.

"Mutual Acoustic Impedance in Multiple Speaker Systems", by H. S. Knowles, Jensen Radio Manufacturing Company, Chicago, Illinois.



A PICTURE

By
M. P. WILDER
and
J. A. BRUSTMAN
American Television Corp.

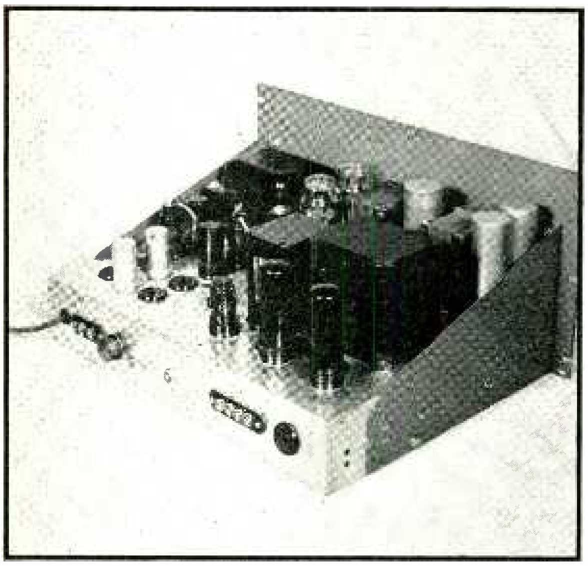
A MOST necessary part of all television pick up equipment is the sound equipment. In the signal generator here described the output amplifier and power supply are included in the bottom chassis in the right hand cabinet. The output amplifier employs four 6L6 tubes in push-pull parallel fed by a phase inverter tube on the same chassis.

An output transformer provides proper termination for one to six permanent magnet loud speakers. The audio control unit shown in Fig. 1 contains the microphone preamplifier, the gain indicator, and the mixing and fading controls for several mikes. We found it convenient to have a separate unit for audio monitoring which can be placed on the operators table, along side the left hand cabinet. Both shading and audio monitoring can be accomplished by one operator on all occasions for which this equipment was designed. A second man at the camera is required to center and focus on the subject to be televised. A telephone circuit is provided through a separate amplifier in the preamplifier unit so that the control operator can give instructions to the camera man. This telephone signal is carried along the main cable to the camera on one of the spare conductors and is available at an output jack on the camera. Either a microphone stand or boom is used to place the microphone for optimum pick-up.

Fig. 1—Front and rear views of the audio control console, showing mixing controls and volume indicator. Talk-back circuits from monitor to camera are included

SIGNAL GENERATOR-V

In the concluding installment, simple modulators are described for developing the picture and sound signals as r-f carriers, useful in testing the overall performance of television receivers. A four-channel r-f and i-f amplifier unit, to allow outside signals to be picked up, is also described



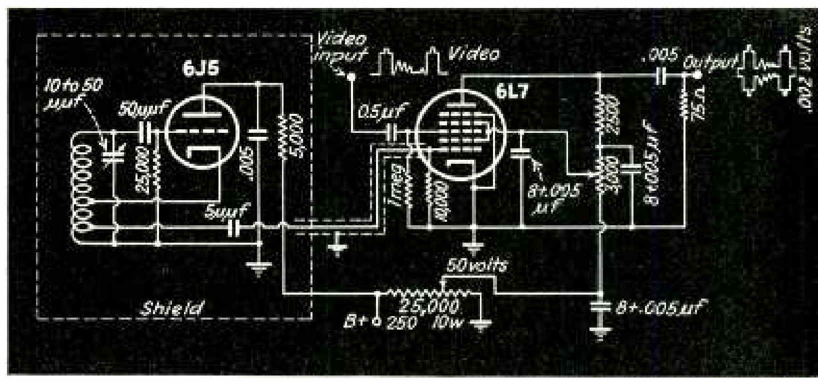


Fig. 3—Circuit diagram of the oscillator and modulator used in the picture channel. The percentage modulation is varied by adjusting the screen voltage

Fig. 2—The modulator chassis. Two 6L7 tubes are used as modulators to develop sight and sound carrier voltages in the range from 45 to 50 Mc

In order to make both the picture and sound available for overall receiver testing it was found desirable to include two r-f oscillators and two modulators, plus such other equipment as would allow the presentation of a modulated carrier signal to the antenna posts of the receivers. These oscillators, of conventional design, are variable over the range from 45-50 Mc. A high-C tank circuit of rigid mechanical construction was employed, but no other unusual precautions were found necessary to insure frequency stability. The oscillators are well shielded and supply approximately two volts of carrier signal by shielded cable to the control grids of the 6L7 modulator tubes. Grid leak bias is used. Video signals from the cathode of a 6AG7 cathode-coupled stage, of positive polarity, are applied to the number three grid through a coupling condenser. A peak-to-peak signal of about 4 to 6 volts is sufficient. A potential of about 50 volts is employed on the plate and screen and the percentage modulation is controlled by varying the screen voltage. The modulator anode voltage is fed through a 2500 ohm load resistor, while the signal is picked off a 72 ohm resistor coupled by a 0.006 μf condenser to the plate. About ten millivolts across 72 ohms is then available for receiver testing. Other circuits employing pentagrid converters such as the 6A7-6K8-6A8 can also be used in a similar manner. The circuit described, which proved the most satisfactory for this unit, is one suggested by Mr. Earl Anderson of the R. C. A. License Laboratory. A duplicate set up is provided for the sound channel. Both have proven quite satisfactory in operation.

The Television Receiver

In order to complete the flexibility of the signal generator it was felt desirable to include a multi-channel television receiver so that outside programs could be picked up for test and for comparison purposes. It was also felt that if the unit were to be used in hotels or department stores more use for the instrument could be obtained if it were possible to pick up regularly broadcast pictures under conditions allowing maximum control. These pictures could then be distributed throughout the building and thus avoid many of the problems resulting from multiple antennas and the resulting reflections which are difficult to eradicate when several receivers are fed from the same or closely adjacent antennas.

Since power, sweeps, monitor tube and video amplifiers are already provided in the unit, a simple r-f chassis is all that is required. The design of the circuits prior to the first detector follows conventional lines and allows switching for four channels. Both sides of the antenna coil are switched. One side of the grid coil is switched, and an additional coil is placed in parallel with the oscillator for each of the four bands. A single-turn inductance is used to

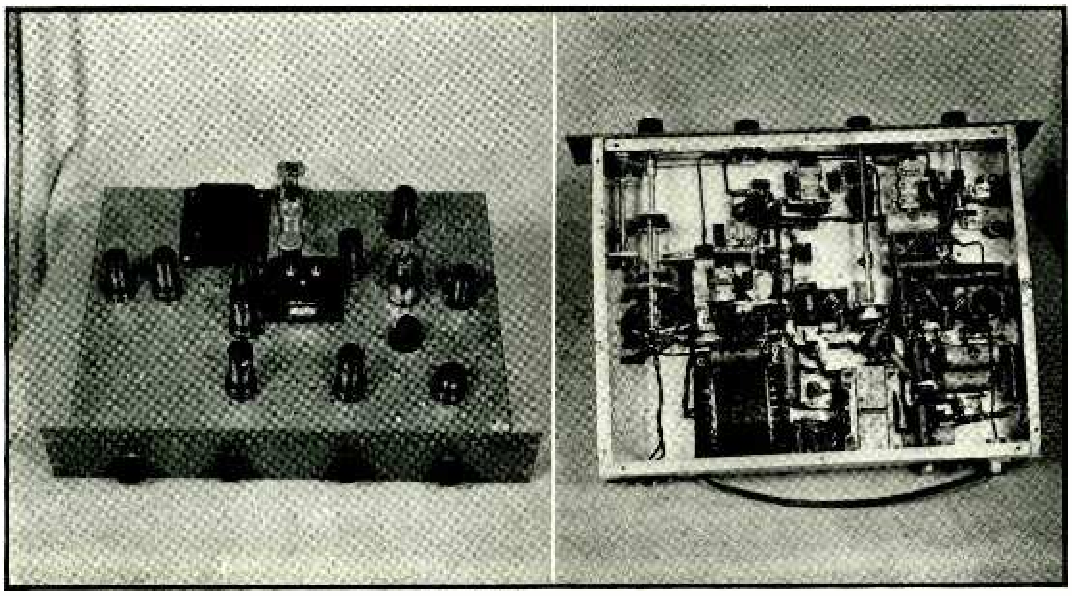


Fig. 4—Top and bottom views of the four-channel television receiver tuning unit, which permits outside broadcasts to be seen on the monitor tube

couple the antenna to the grid coil. This coil should have a value of about 30 millimicrohenries and should be tuned with a mica condenser to the mid-band frequency. The grid coil is damped with 1500 ohms. The pass band is better than 4.5 Mc. This method of coupling is not the most efficient but with a little adjusting of the coupling between primary and secondary will be found quite satisfactory.

The i-f stages have sufficient gain to allow the receiver to reach into the region of 100 μvolts with ease. It is to be remembered that considerable reserve gain is available after the second detector as the full gain of the line amplifier can be employed should this prove necessary. The design of i-f amplifiers for wide bands has been considerably simplified and can now be accomplished by simple double tuned circuits of the correct self and mutual inductances. In fact for the special case of R.M.A. recommended television i-f frequencies very simple but reliable formulas can be used. This is true providing certain definite parameters are chosen. These parameters are fortunately those which experience indicates are the most likely to be required. They are stated as follows: the midfrequency of the pass band is chosen to be 11.25 Mc and the pass band to be 4.2 Mc. The total capacitance plate-to-ground in the case of the primary and grid-to-ground in the case of the secondary must be known. It is then necessary only to divide the number 38,200 by the capacitance to ground in microfarads in the primary and the secondary circuits to obtain the proper value in ohms of the damping resistor to use across each coil respectively. The value of inductance for each coil is obtained by multiplying the number .00558 times the value of the respective load resistor in ohms. The result will be in microhenries. The proper value for the mutual between the coils is obtained by solving the equation $M = 0.352 \sqrt{L_p L_s}$, where L_p is the inductance of the primary and L_s equals the inductance of the secondary in microhenries. As an example, by measuring with a Q meter, it is found that $C_p = 16$ μμf and 4 μμf for tuning and $C_s = 26$ μμf and 4 μμf for tuning making $C_p = 20$ total and $C_s = 30$ total. The proper values of load resistance would then be $R_p = 1920$ and $R_s = 1270$, the inductances $L_p = 10.720$ μh, $L_s = 7.082$ μh, and the mutual 3.060 μh. The values decided upon are wound on a ⅜″ form with No. 36 enameled wire and measured by cut and try against a suitable bridge or a Q meter.

If the inductances measure to the correct values and if the coils are spaced approximately a sixteenth of an inch they can be adjusted to the desired mutual by slight movement of one winding with respect to the other on the form. The mutual can be measured by reading the inductance with the coils first in series aiding and then series bucking subtracting the difference and dividing by four. The gain of the stage depends on the minimum total capacitance so great pains should be taken to keep C_p as low as possible. The C total of 50 μμf taken in the example represents poor practice. Much lower values of C total are possible with neat wiring and short leads. The gain of the stage in the example, employing a 6AC7 tube, will be about 8.

First Detector and Trap Circuits

The mixer employs grid leak bias and must have at least two and not more than 4 volts of r-f from the oscillator inductively coupled to the grid. This is accomplished by winding the antenna and grid coil and shunt oscillator coil on the same form. A quarter inch spacing in each case will be satisfactory. Operation is best checked with a good vacuum tube voltmeter. The pass band shape of each stage is altered by means of traps, stage by stage, first at 14.25 Mc then at 8.25 Mc to shape the pass band to reject first the sound channel and then the adjacent channel interference. Sound is taken off the 8.25 Mc trap in the plate of the first i-f stage and amplified by a single 1852 stage. Conventional audio output circuits are used.

The second detector, a 6H6, is used also to strip off or separate the sync pulses from the video signal. The pulses are then amplified in a double triode, the first triode acting

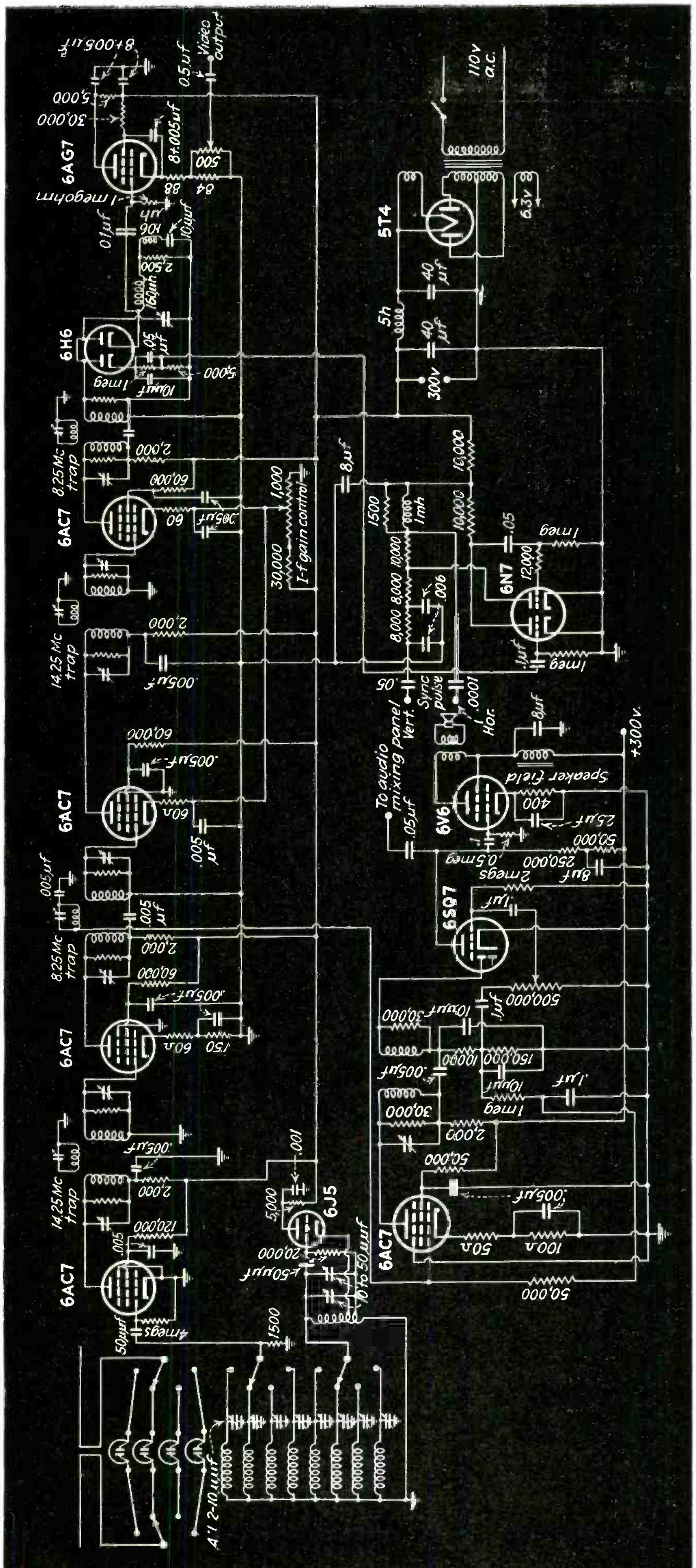


Fig. 5—Complete circuit diagram of the television receiver tuning unit, including r-f, i-f, second detector and sync separator circuits

partially as an additional stripper and partly as an amplifier. The second triode limits noise in its grid. The *L*, *R* and *C* networks in its plate circuit separate the vertical from the horizontal sync pulses.

The video output of the second detector diode is passed through a low pass filter to remove any higher frequencies other than video and impressed on the grid of an impe-

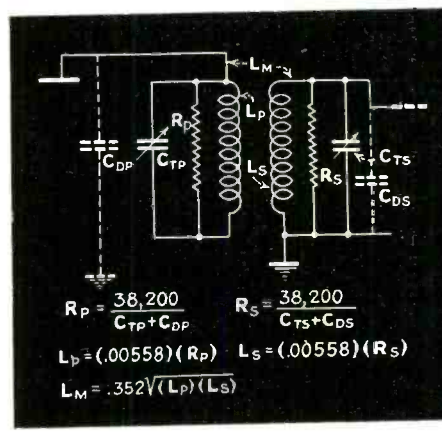


Fig. 6—Design relationships for a wide-band i-f transformer, based on a mid-band frequency of 11.25 Mc, and a bandwidth of 4.2 Mc

dance transformer (cathode-coupled) tube. The cathode of this stage has a variable resistor across its cathode load which allows simple control of contrast without high-frequency attenuation. The d-c component of the video signal is restored in the output stage of the line amplifier by a diode. The i-f gain of the picture channel is controlled by means of the cathode potential applied to the second and third i-f stages.

In concluding this series, the authors wish to express their appreciation to the management of the American Television Corporation for permission to publish the information and the circuit diagrams contained in the articles.

Editor's Note: The following errors should be noted in Fig. 3 of Part IV of this series: The switch arm is omitted in the plate circuits of the 6N7 sync pulse shaper amplifier. The slider is omitted on the vertical centering control of the upper 906 cathode-ray tube. The 1-meg resistor in the horizontal centering circuit of the lower 906 tube should connect to the slider of the centering control, not to the end of the control as shown. In Fig. 4, the vertical output transformer is R.C.A. type 32,900. The horizontal sweep input resistor should terminate at ground, not at the condenser as shown.

Television Committee Organizes

To formulate television standards agreeable to the majority of the industry's organizations, in close cooperation with the government, the National Television Systems Committee was organized July 31 under R.M.A. sponsorship and with the F.C.C.'s blessing

ON July 31, in the Hotel Roosevelt in New York, the National Television Systems Committee was organized for the purpose of determining basic standards for television transmission. The idea of the Committee arose in a conference between President Knowlson of the Radio Manufacturers Association and Chairman Fly of the Federal Communications Commission. Its purpose is to bring together representatives of all the larger television interests, whether they were members of R.M.A. or not, and to include those sponsoring competing standards proposals so that the differences might be composed and a single set of standards prepared and offered to the F.C.C. for official adoption. Fifteen commercial and professional organizations were asked to name one representative each to form the National Television Systems Committee (N.T.S.C.) proper.

The membership of the Committee is as follows: Radio Manufacturers Association, W. R. G. Baker, Chairman; Bell Telephone Laboratories, Ralph Bown; Columbia Broadcasting System, Adrian Murphy; Don Lee Broadcasting System, Harry Lubcke; DuMont Laboratories, Allen B. DuMont; Farnsworth Television and Radio Company, Ray Cummings; General Electric Company, E. F. W. Alexanderson; Hazeltine Corporation, Dan Harnett; J. V. L. Hogan; Hughes Tool Company, Albert Lodwick; Institute of Radio Engineers, A. N. Goldsmith; Philco Corporation, David B. Smith; Radio Corporation of America, E. W. Engstrom; Stromberg-Carlson Telephone Mfg. Co., Frederick Young; Zenith Radio Corporation, John R. Howland; Virgil Graham, Secretary.

In addition to the main committee, several sub-committees or "panels" will be organized by the N.T.S.C. The field is broken down initially into nine divisions, each of which will be examined by a separate panel, as follows:

1. System Analysis — The analysis of foreign and proposed American television systems.
2. Subjective Aspects—The influence of physiological and psychological factors in the determination of television system characteristics.

"Of course we got it *dreadfully* cheap, so we don't expect too much of it."

3. Television Spectra—Consideration of sound and picture channel widths and locations.
4. Transmitter Power — The consideration of transmitter output ratings, modulation capabilities and the relation between power requirements of picture and sound channels.
5. Transmitter Characteristics — Consideration of essential systems. Characteristics of the transmitter (signal polarity, black level, etc.).
6. Transmitter-Receiver Coordination—Consideration of the essential factors requiring coordination in the design of receivers and transmitters (sideband distribution, audio pre-emphasis, etc.).
7. Picture Resolution—Consideration of the factors influencing picture detail (aspect ratio, frame frequency, interlace, line density, etc.).
8. Synchronization — Consideration of methods and means of accomplishing synchronization.
9. Radiation Polarization — Consideration of the factors influencing a choice of the polarization of the radiated wave.

As the work proceeds, additional panels will be appointed as necessity arises.

Minutes of all the meetings of the N.T.S.C. and its sub-committees will be circulated to all the members, to the Engineering Department of the F.C.C. and to others authorized by the executive committee of the R.M.A. Each panel will prepare a report at the conclusion of its work, stating both majority and minority opinions. Standards formed on the basis of these reports may be approved by the N.T.S.C. and will then be submitted to the F.C.C. by the Board of Directors of the R.M.A. Thus a definite procedure from investigation through discussion and formulation of the standards through to their official adoption by the government has been set up in advance. Moreover the presentation of minority as well as majority opinions, as well as the recording of individual votes, will insure a clear understanding of the positions taken by the different members of each committee.

While the personnel of the N.T.S.C. contains the names of only four men (Ralph Bown, A. N. Goldsmith, J. V. L. Hogan and E. W. Engstrom) who served as members or guests on the earlier R.M.A. Television Committee, the organizations represented are the same in most cases (with the exception of the Sparks Withington and Crosley companies which are not represented). The Don Lee System, the DuMont Laboratories, The Hughes Tool Company and Institute of Radio Engineers are new additions.

Filter Design Charts—I

By JOHN BORST

THE values of the elements of various types of constant-k filter sections are easily and quickly determined by the use of the chart on the following page. The chart is applicable to low-pass, high-pass, symmetrical band-pass and band-suppression filters.

Figure 1 shows the configuration of T and π filter sections which can be built up from the full series impedance Z_1 and the full shunt impedance Z_2. The equations and diagrams (Figs. 1 to 5) refer to the full series and the full shunt impedances in all cases. Elements in the series arm are indicated by the subscript 1, while those in the shunt arm are denoted by the subscript 2. The equations used here are found in the work of T. E. Shea "Transmission Networks and Wave Filters" as well as in other textbooks on the subject.

In the chart there are two sets of four logarithmic scales, one set marked A, the other B. These two sets serve to solve the same equation and differ only in the ranges covered. For the sake of accuracy, the A scales cover only a very narrow range so that the significant figures of the element values may be obtained. The placing of the decimal point is then most easily accomplished by using the scales marked B. A single straight line will connect corresponding values of all variables on the four scales.

Use of the Chart

To obtain the values for low-pass filters, the illustrative diagram and equations of which are given in Fig. 2, the scales L_1, C_2 f_c and R are used. When a straight line connects any two to these variables on the scales mentioned, the intersection of that line and the other two scales will determine the other two values. Note that L_1 is read at the left of the L_1/L_2 scale and C_2 at the right of the C_1/C_2 scale. High-pass filter values (see Fig. 3) are obtained in the same manner using scales C_1, L_2, f_c and R.

Band-pass filters (see Fig. 4). Knowing the mid-frequency, f_m which is the geometric mean between the two cut-off frequencies, and knowing the desired characteristic impedance R, draw a line through the two desired values on the f_m scale and the R scale and read at the other intersections all four values: L_1, L_2, C_1 and C_2. These figures are for a filter with a bandwidth, $(f_2-f_1)/f_m$, equal to unity. When this factor has any other value, the proper size of the desired elements: L_{1k}, L_{2k}, C_{1k} and C_{2k} can be found on the chart using L_1, L_2, C_1 and C_2. For this purpose use the three scales with the designations at the bottom. Employing the values found for unity bandwidth, a straight line is drawn to connect corresponding values on the scales: L_1, L_{1k} and $(f_2-f_1)/f_m$; also. L_2, L_{2k} and $(f_2-f_1)/f_m$, etc.

For band suppression, (Fig. 5), using four times the desired value of R, find values of L_{2k} and C_{2k} as for a band-pass filter; also using $R/4$, find L_{1k} and C_{1k}. Then interchange subscripts 1k and 2k to obtain the corresponding elements of the band-suppression filter.

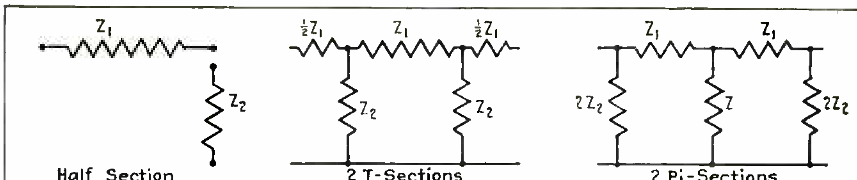
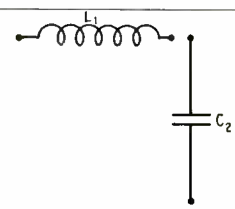


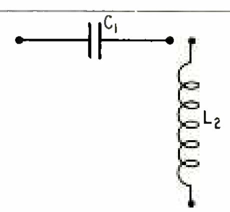
FIG. 1



$$R = \sqrt{\frac{L_1}{C_2}} \qquad f_c = \frac{1}{\pi\sqrt{L_1 C_2}}$$

$$L_1 = \frac{R}{\pi f_c} \qquad C_2 = \frac{1}{\pi f_c R}$$

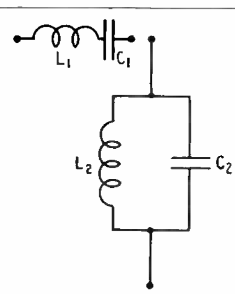
FIG. 2



$$R = \sqrt{\frac{L_2}{C_1}} \qquad f_c = \frac{1}{4\pi\sqrt{L_2 C_1}}$$

$$C_1 = \frac{1}{4\pi f_c R} \qquad L_2 = \frac{R}{4\pi f_c}$$

FIG. 3



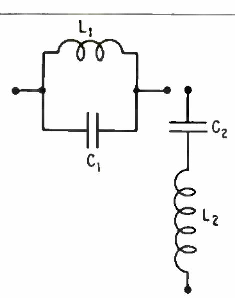
$$\sqrt{f_1 f_2} = f_m \qquad f_m = \frac{1}{2\pi\sqrt{L_1 C_1}} = \frac{1}{2\pi\sqrt{L_2 C_2}}$$

$$R = \sqrt{\frac{L_1}{C_2}} = \sqrt{\frac{L_2}{C_1}}$$

$$L_1 = \frac{R}{\pi(f_2-f_1)} \qquad C_1 = \frac{f_2-f_1}{4\pi f_1 f_2 R}$$

$$L_2 = \frac{(f_2-f_1)R}{4\pi f_1 f_2} \qquad C_2 = \frac{1}{\pi(f_2-f_1)R}$$

FIG. 4



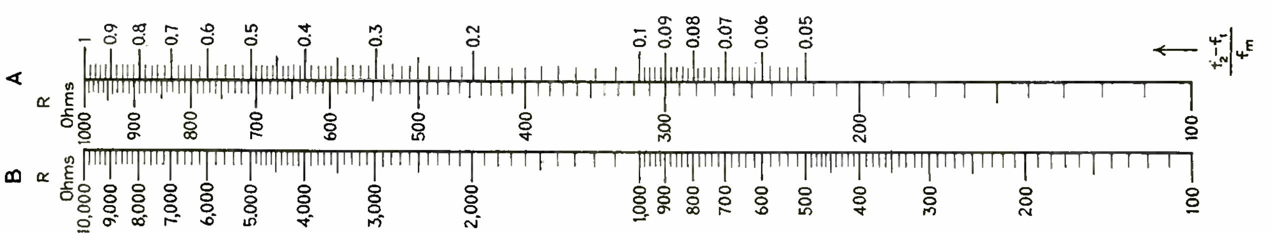
$$\sqrt{f_1 f_2} = f_m \qquad f_m = \frac{1}{2\pi\sqrt{L_1 C_1}} = \frac{1}{2\pi\sqrt{L_2 C_2}}$$

$$R = \sqrt{\frac{L_1}{C_2}} = \sqrt{\frac{L_2}{C_1}}$$

$$L_1 = \frac{(f_2-f_1)R}{\pi f_1 f_2} \qquad C_1 = \frac{1}{4\pi(f_2-f_1)R}$$

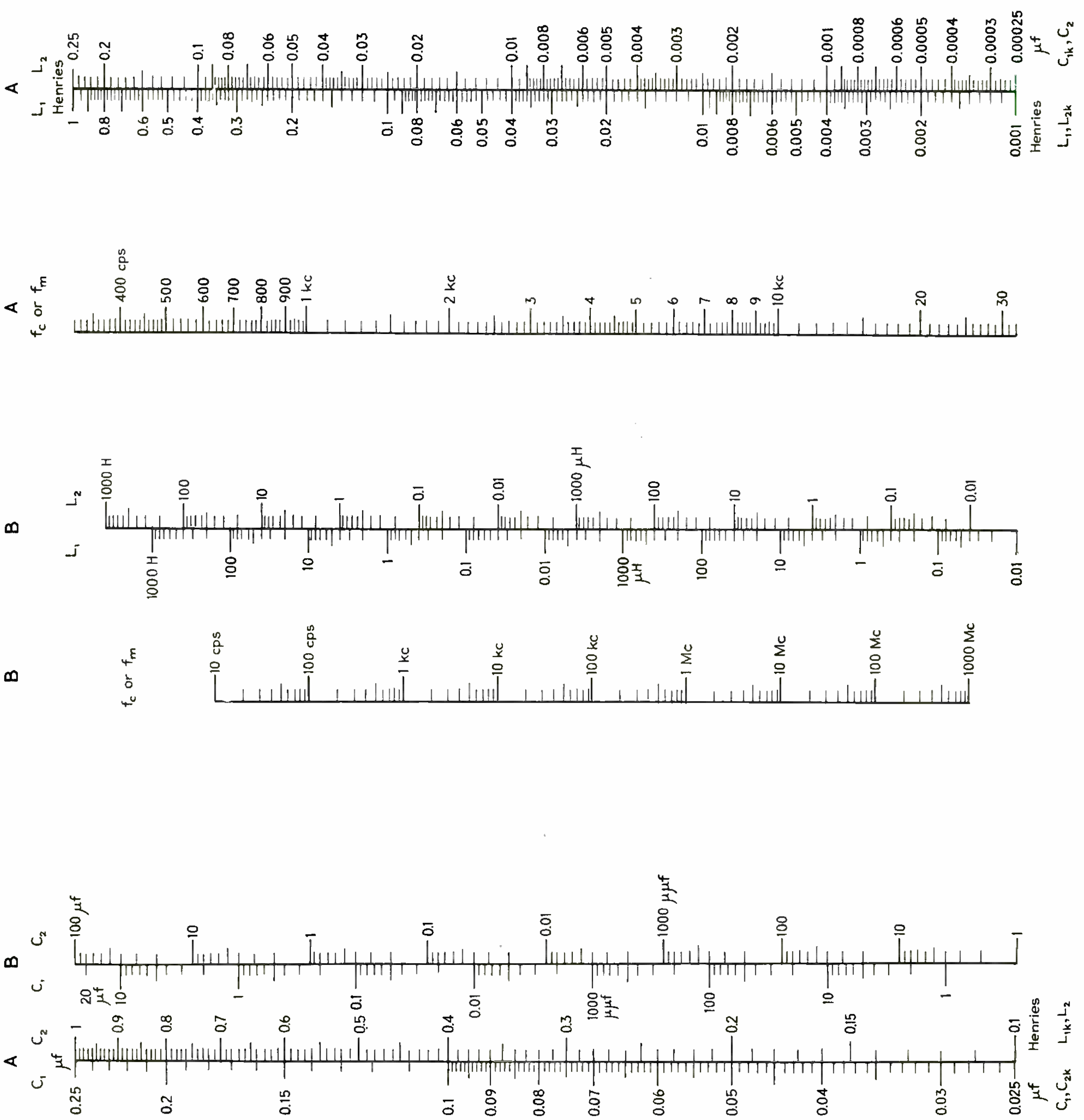
$$L_2 = \frac{R}{4\pi(f_2-f_1)} \qquad C_2 = \frac{f_2-f_1}{\pi f_1 f_2 R}$$

FIG. 5



Filter Design Charts—I

By JOHN BORST



ELECTRONICS REFERENCE SHEET

New Books

Moderne Kurzwellen-Empfangstechnik

(Modern Short-Wave Receiving Technique)

By M. J. O. Strutt. *Published by Julius Springer (Berlin) 1939, 245 pages.*

In this volume M. J. O. Strutt has assembled a detailed summary of short-wave receiving technique applicable to wavelengths below 50 meters and as short as 20 cms. The book is strictly confined to the subject of reception and treats most aspects of this field. Much of the information included is of recent origin and the book as a whole is, therefore, sufficiently up-to-date as to make it valuable to the expert. For example, some results which were not published until the first half of 1939 are included in the text along with older and better-known material. The book will appeal also to the new-comer in the field and the less expert, particularly, since the explanations are physical in nature and no mathematics is used in the text proper. (Most sections, however, include appendices which cover the most important mathematical derivations.) The text is made attractive to the practical-minded by many numerical examples as well as by photographs of finished apparatus. In short, this reviewer finds little to criticize although the fact that the book is written in German will reduce its attractiveness to many workers in this country.

Under antennas, an excellent elementary discussion is given of directivity, radiation resistance and selectivity of short-wave receiving antennas. The latter characteristic, which is of considerable importance in television, for example, is frequently neglected in antenna treatments and this reviewer is glad to see that Dr. Strutt has not forgotten to include it. In the second section of the book the elementary aspects of transmission lines as conducting media and as circuit elements are covered. This section also treats antenna systems, such as the wave antenna, which consist of sections of transmission lines. A short discussion of dielectric wave-guides is included. The section on measurements is based on the use of diodes for reading voltage and of thermocouples for current measurements and includes practical information on the determination of impedances and the inter-electrode admittances of vacuum tubes. One of the most important sections of the book is that on amplification. The treatment is based on measurements of input admittance, output admittance, and transadmittance of standard tubes and includes a summary of electrode-lead effects and their compensation. Considerable space is devoted to the overall selectivity of cascaded single-tuned circuits, staggered and otherwise. This reviewer finds it strange that no treatment of the commonly-used and more advantageous coupled circuits is given.

The section on frequency conversion comprises a summary of operating principles of conventional tubes including diodes, both singly and in push-pull. As in the case of amplification, there appears to be considerable merit in push-pull operation for these high frequencies; the advantages and disadvantages of the various possible arrangements are summarized. In the final section (except for the appendix) of the book very interesting considerations are presented covering high-frequency receiver design. Among the problems discussed are whether or not a receiver should have an r-f stage preceding the converter. The answer to this problem depends on the bandwidth which must be covered and on the fluctuation noise which can be tolerated as well as on various practical matters. Some details are given and accompanied by pictures of the parts of a one-meter receiver using push-pull tubes and sections of concentric line for circuit elements. It is indicated that a similar but modified arrangement is suitable for 20 cm reception. A considerable improvement in signal-to-noise ratio is claimed for these receivers over receivers using diode converters. The section concludes with a brief mention of the possibilities of frequency modulation for the reduction of noise.—E. W. Herold—*RCA Manufacturing Co., Inc.*

We Present Television

Edited by John Porterfield and Kay Reynolds. *W. W. Norton and Company, Inc., New York, 1940. 298 pages, illustrated. Price $3.00.*

This book is pre-eminently for the viewer of television programs, rather than for the technical fraternity which has produced and which operates the television system. Nevertheless, a very large part of the television audience at present consists of engineers, and these engineers will find much of interest between the covers of Miss Reynold's and Mr. Porterfield's compendium. The book was written by a staff of 12 specialists who describe their fields in terms understandable to the lay public.

Waldemar Kaempffert, Science Editor of the *New York Times*, contributes an excellent introduction to the volume which does thorough justice to television, its potentialities and problems, from the standpoint of a sympathetic but not uncritical observer. The general problem of initiating the television service is discussed by Vice President A. H. Morton, the engineering staff behind the service by Chief Engineer O. B. Hanson, the programming of the service by Program Manager T. H. Hutchinson, and the Director's duties by Director T. L. Riley, all of N.B.C. Your reviewer was charged with preparing the chapter on the technique of television and the history of the art. The lot of the actor in adapting himself to the new medium is described with enthusiasm by Earl Larimore, who has had experience to prove his points. H. R. Lubcke of Don Lee gives the picture on the West Coast. Jack Poppele of WOR throws in a look at frequency modulation and facsimile for good measure. C. E. Butterfield describes television in its most important program aspect, the gathering and depicting of spot news. Benn Hall makes some shrewd guesses anent the question of "who pays for it all", while Robert Edmond Jones gives an inspiring look into the future from the viewpoint of man who knows his theater thoroughly. In all, the volume is a well rounded account of television broadcasting as it now stands, written by men who have high hopes for its future.—D.G.F.

Aircraft Radio and Electrical Equipment

By H. K. Morgan, *Superintendent of Communications, Transcontinental and Western Air, Inc. Pitman Publishing Corp., New York, 1939. 374 pages, 214 illustrations. Price $4.50.*

This book is intended, according to the author's preface, for "people connected with aviation who would like to know more about electricity and radio". The book is elementary in approach, introducing the reader to the first elements of electricity by the use of hydraulic analogies and the like. The first 50 pages of the volume are accordingly not essential for readers of *Electronics*. Thereafter, the author gives a practical description of the electrical circuits and radio equipment commonly used in air transports of the present day. As such, the book gives a practical and direct insight into a specialized field of radio which is of increasing interest in radio engineering circles. The illustrative circuit diagrams are taken from commercial equipment, made by most of the larger manufacturers. While in the main descriptive, the material serves also as a practical guide for the installation, operation and maintenance of aircraft radio equipment. The book is recommended to radio engineers who wish to familiarize themselves with the specialized requirements in this field, as well as to the larger group of technicians for whom it was particularly written.—D.G.F.

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TUBES AT WORK

A neat multi-channel transmitter design, a tuned antenna system, a simple method of measuring the impedance of twisted pairs, and an electronic telescope control are described this month

A Flexible Beam Power Transmitter

By E. F. KIERNAN

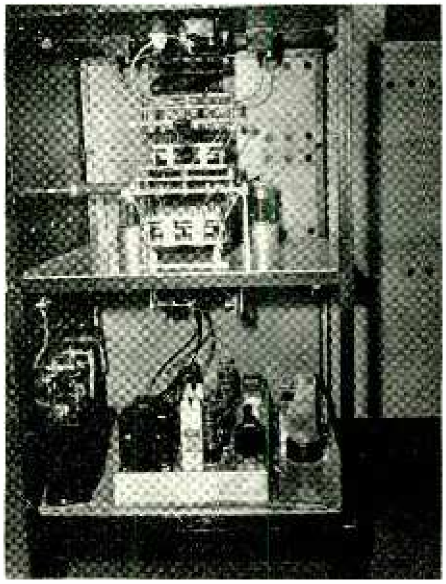
Western Air Express Corp.

THE DEVELOPMENT OF BEAM POWER transmitting tubes has simplified the design of medium power quick-shift transmitters. The one herein described features single control shift on three widely separated frequencies, and 500 watts output that keys cleanly at 50 words per minute.

To avoid a "Rube Goldberg" switching arrangement, each frequency has its own oscillator-amplifier exciter unit. The exciter units together with their power supply and a bias pack are mounted on a 12-inch x 22-inch chassis. Past experience with back-lash and lost motion in switching arrangements was responsible for the separate exciter design.

The exciter units are more or less conventional in arrangement. With the exception of the oscillator grid leaks, the various resistors are mounted on terminal strips. The by-pass condensers are grouped together and mounted on aluminum "L"s which are bolted to the chassis; performing at once the function of ground connection and support. The oscillator inductances are wound on sections of ⅜-inch bakelite rod which are fastened to the chassis by means of an 8-32 machine screw in one end. The various leads are brought out to terminal strips in the rear of the chassis. The buffer tank is connected to the final grid circuit by link couplings. The link enters the chassis through feed-through insulators. The buffer plate inductances are wound on five prong 1½-inch forms. Two of the channels use fundamental frequency crystals, and the buffers are neutralized for straight through operation. The third channel uses a half frequency crystal and the buffer acts as a doubler. For clean fast keying, both oscillator and doubler are keyed. The plate voltages on the oscillator and doubler are 140 and 350 volts respectively.

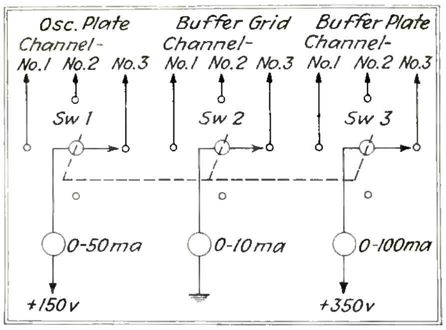
The switching mechanism has been concentrated around the final amplifier "turret". The lack of suitable commercially available switches necessitated the design and construction of this turret. Standard coils, mounts, and variable condensers were assembled on an aluminum base with suitable insulators and mounting plates.



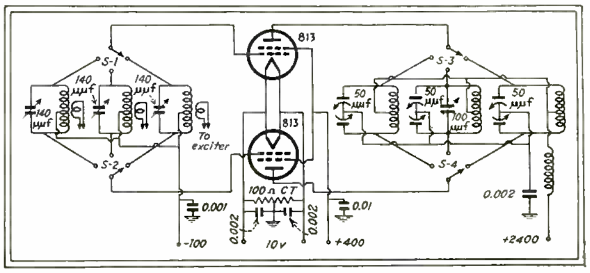
Rear view of the transmitter and power supply

Two condensers in parallel are used on the low frequency channel. The micalex plates of the switches S_3, S_4 act as supports for one condenser and coil mount. Final grid circuit switches S_1, S_2 and the meter switches SW_1, SW_2, SW_3, are mounted on angle plates below the turret and are operated by belt and pulley combinations from the shafts of S_3, S_4. The belts are of phosphor-bronze broken by two micalex insulating sections. The shaft of S_3, S_4 extends out to the operating wheel through a micalex insulating coupling. The final grid inductances are wound on sections of ⅜-inch bakelite rod and are mounted, together with the associated condensers, on the plate supporting switches S_1, S_2. Switches SW_1, SW_2, SW_3, S_1, and S_2 are small rotary types with ceramic insulation.

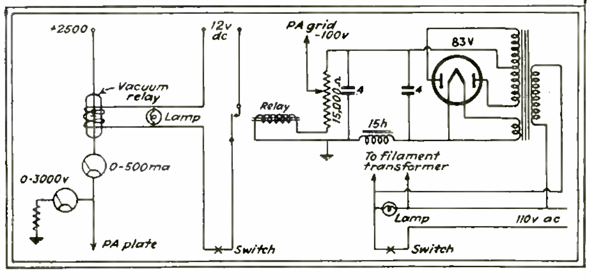
The final amplifier plate supply is taken from the power unit of another transmitter. Protection is provided by



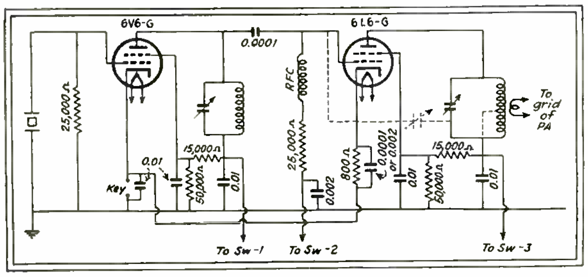
Above, meter switching for the exciter stages. All the switches are ganged



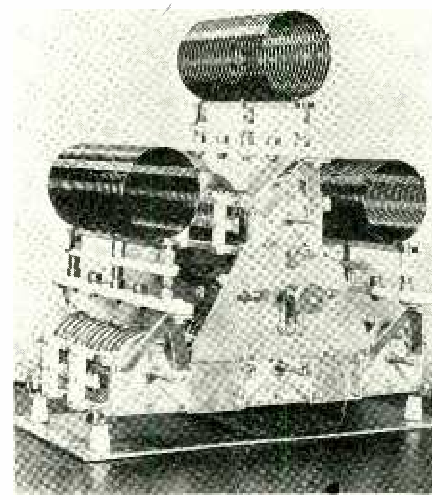
Right, final amplifier stage of the "quick-change" transmitter, employing switched tuned circuits



Lower right, bias supply, switching and relay circuits. The high voltage cannot be turned on unless the bias voltage is applied to the tubes



Below, exciter and buffer stages of the transmitter. A separate unit is required for each frequency



Structure of final amplifier tuned circuits

a vacuum relay in the plate lead. This relay is controlled by a switch from the front of the panel and another relay in series with the bleeder of the bias supply. This equipment has been in continuous twenty-four hour per day operation for several months without interruptions of any kind.

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A Multifrequency Tuned Antenna System

By HOWARD K. MORGAN
Transcontinental & Western Air, Inc.

THERE HAS BEEN NEED FOR A MULTIFREQUENCY antenna system which would eliminate the complicated tuning unit at the antenna and would allow for erection of a single balanced doublet antenna. Such an antenna has been

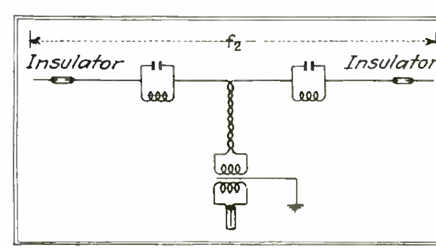
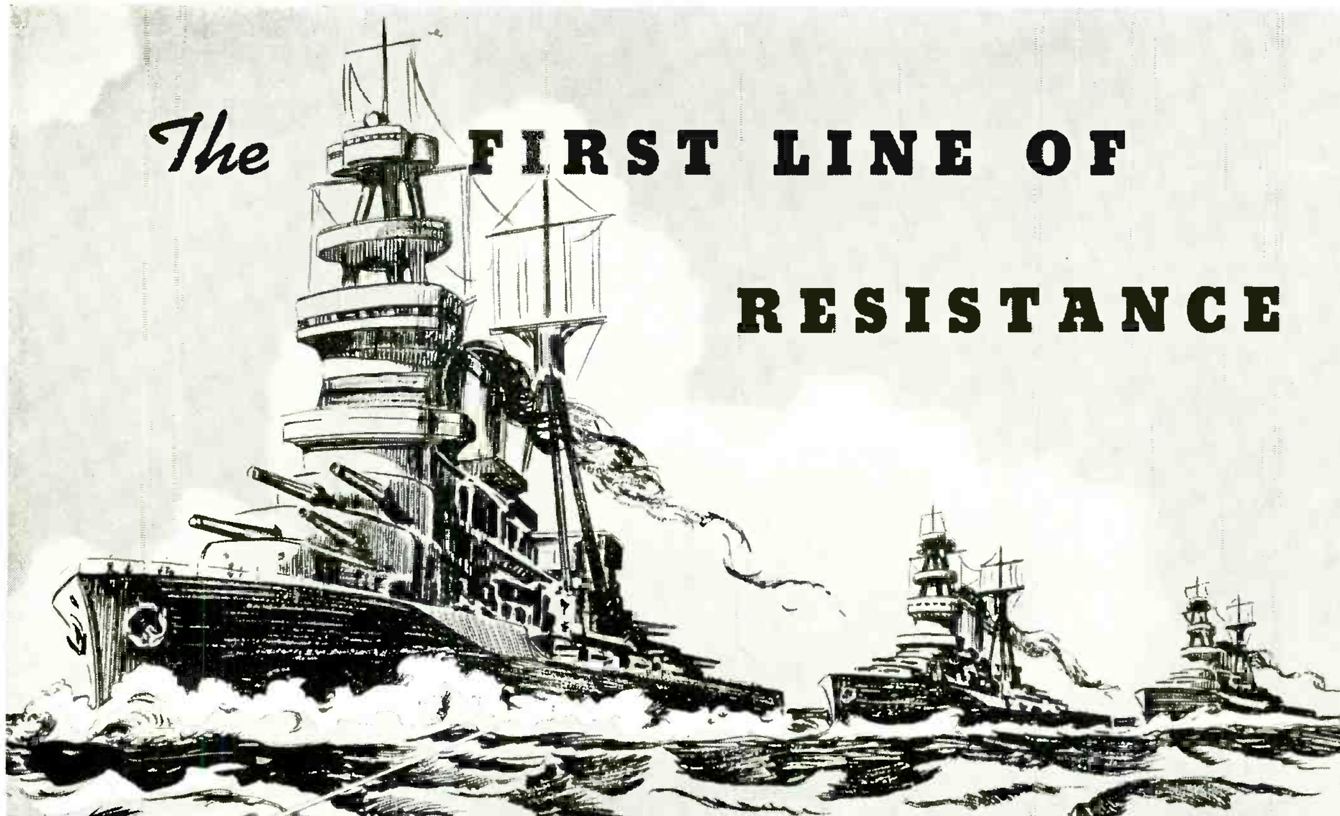


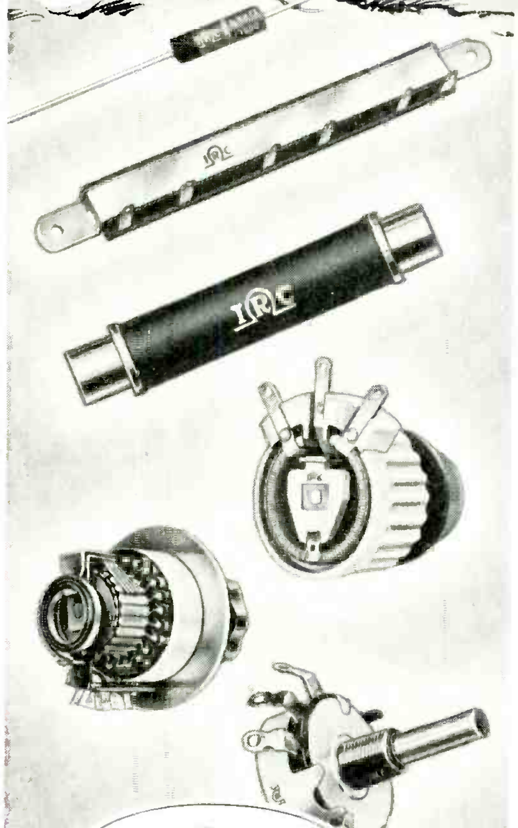
Fig. 1—Basic tuned antenna system devised by Mr. Morgan

developed and tested in the field. The first element of the antenna is a doublet cut to the proper length for resonance and attached through a transmission line of the outdoor twisted type to a coupling box on or somewhat above the ground. The use of a buried concentric line from this point to the receiver or transmitter is usually desirable.

In coupling the twisted line from the antenna to the concentric line there was employed a transformer wound on an iron dust core and with an electrostatic shield. This is important for receiving purposes to reduce pickup on



The FIRST LINE OF RESISTANCE



When the going gets tough outside, we come to appreciate the value of protection.

In the unpredictable times ahead, it is reassuring to be able to turn to an organization which has devoted its life to that job — which takes nothing for granted.

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The Defense forces, as well as their contractors and hundreds of other industrial concerns, count us in their "first line". We know our job for we have made nothing but resistors for fifteen years.

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any part of the antenna and lead-in system except the doublet itself. The dust core allows close coupling of the two windings and the transformer itself will show high efficiency over a wide frequency range providing that the impedances at the end of the two lines remain about the same.

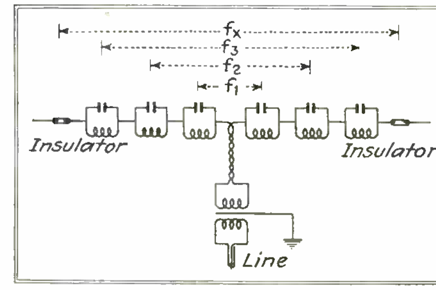
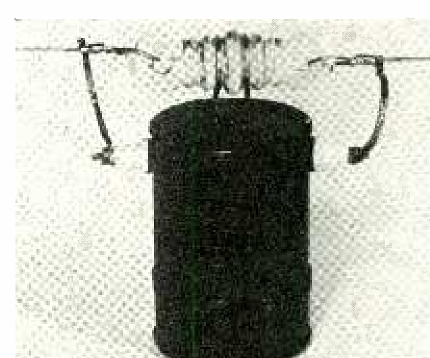


Fig. 2 — Tuned antenna system applied to several frequencies

The second frequency is added by adding a tuned circuit in place of the insulator at the end of the first antenna. Wire is then added beyond this point so that the system is resonant to a lower frequency. Figure 1 shows the method. As many pairs of tuned circuits may be added to the antenna as there are additional frequencies to be added. An experimental antenna was erected and tuned to four frequencies. It showed an overall efficiency of 85 per cent or better on all the frequencies used. Figure 2 shows such a system.

The impedance of the tuned circuit at resonance is generally many times the impedance at the end of the antenna so that changes in value of the resonant impedance, due to ice or water, will have very little effect. If it is found that the impedance at the center of the antenna is somewhat lower than that of the transmission line, it is possible to select another inductance-to-capacity ratio that will lower the impedance at the end and this in turn will cause the impedance at the center of the doublet to rise. This gives a convenient method of exact adjustment which is usually not necessary. Often the same effect may be obtained by changing the length of



External appearance of tuned circuit suspended from antenna

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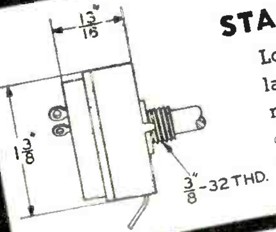
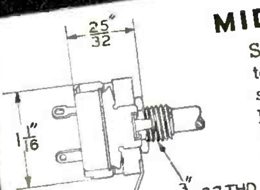


Long famous for the reliability of Centralab's non-rubbing contact and long wall type resistor. Available plain, or with one, two, or three taps, and with SPST, DPST, or SPDT Underwriters Approved switches.

MIDGET



Small in size, but large control efficiency due to the long straight path of the wall type resistor. Fits well in crowded chassis as solder lugs do not project far beyond the control radius of 17/32". Available single, dual, or triple, plain, or tapped, with SPST, SPDT, DPST, and a special dial lite push switch for battery sets.

In every branch of the electronic industry Centralab Controls play a major part in producing certain, smooth, flawless attenuation. Set manufacturers, servicemen and experimentors turn to Centralab for positive performance. Whatever your Volume Control needs may be . . . specify Centralab.

All controls furnished with any desired maximum resistance and with appropriate tapers. Control and resistor problems melt away when you put Old Man Centralab on the job.

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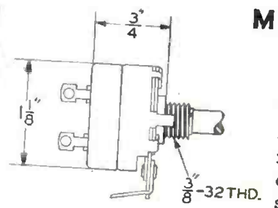
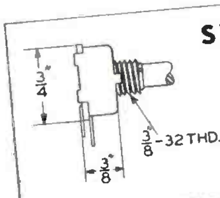
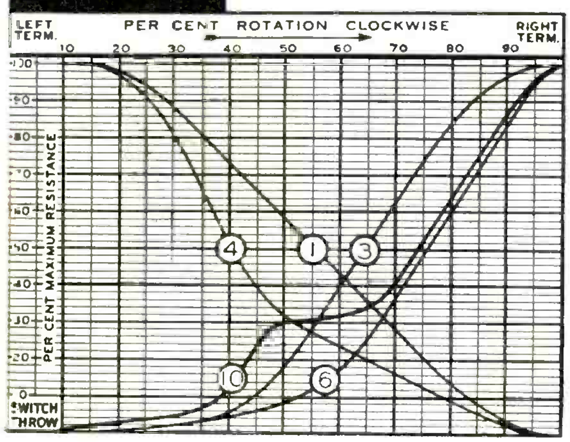


A simple, inexpensive control of sturdy reliability for the not too critical circuits. Shallow depth economizes space behind the panel. Has flat circular resistor, and Centralab's rocking disc contact. Available without taps only in single plain, or with SPST, or DPST switch.

SUB-MIDGET

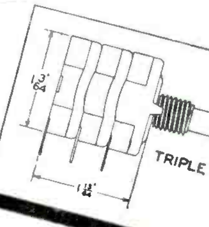


The smallest diameter reliable control. Long wall type resistor gives low noise level. Rapid Transfer of heat from resistor to metal shell gives maximum load rating of 1½ watts. No switch or taps. Available as grounded or insulated rheostat or potentiometer with solid or tubular shaft.



The resistor curve of a volume control is more important than its overall resistance . . . that is why Centralab controls are furnished with the variety of curves shown here. Curve six is most widely used for high resistance radio grid and diode controls. Curve 1, or 4, are best for C bias, and Curve 3 for antenna C bias. Curve 10 is used on tapped controls.

TWIN AND TRIPLE CONTROLS



Two or three sections assembled in tandem for special purposes. Each section fully shielded and has independent connections. All variable contacts attached to a single shaft. Twin controls also available with concentric shafts; one inside the other. Supplied with or without Underwriters Approval snap switches.

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the antenna by a small amount, effectively producing the same result.

Experimental work was carried on to determine the best method of tuning up such an antenna. It was soon realized that the individual tuned circuits could be resonated within a per cent or two by means of a Q meter or by absorption and that no further adjustment was required. The wire length between the various units in


Internal arrangement of suspended circuit

the antenna is adjusted for maximum power or current in the antenna by the usual means of cutting the antenna.

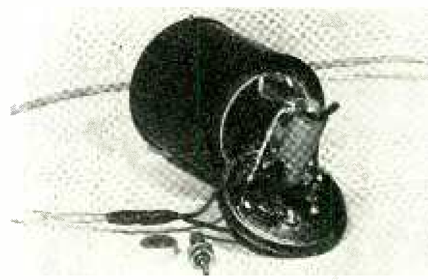
It has been found advisable to use a transmitter to adjust the antenna. The one used in the experimental work had an output of about 15 watts. First the transmitter is carefully adjusted to a load resistor of about seventy ohms. Then the resistor is moved to the end of the concentric line and the line is then checked for loss. The transmitter should not require further adjustment in this condition and this will be found to be the case if the resistor is of proper value to match the transmission line.

The load resistor is then placed on the far side of the coupling transformer and readings are obtained which include the loss in the transformer at the frequencies that are to be used. Finally the resistor is placed at the end of the flexible lead-in and readings are again obtained at each frequency. This gives complete data on the entire system except for the antenna. The tuning or coupling at the transmitter should not require any change up to this point. The antenna is then added and cut to the proper length. Transmitter tuning should be the same and the input power into the line and the line currents the same. As each pair of tuned circuits is added to the antenna, adjustment should be made of each new antenna section so that the system is operating satisfactorily.

By running through the simple tuning scheme outlined it will be found that the antenna efficiency will be high on all frequencies and the losses will be known. Once the process has been used it will be found that it is relatively simple to tune an antenna system for four frequencies within a period of a few hours.

The tuned circuits in the antenna

system must be thoroughly waterproofed and well insulated. The design should be such that ice will not cause serious detuning of the antenna elements. Voltages at the tuning unit will be high when such an antenna is used for transmitting purposes and condensers of sufficient spacing must be employed. It must be realized that the presence of the tuned circuits will affect the length of doublets in which there are included one or more tuned circuits which will be resonant at some higher frequency. This results in a reduction in antenna length which is desirable for economy of space, although it does reduce the radiating length of the antenna slightly. The loss is slight



Shielded transformer for coupling to transmission line

in radiation as the reduction in length does not amount to more than about twenty per cent at the very most.

It has been suggested that the tuned circuits might be done away with and that folded half wave loop sections might be employed. This is not possible, for the quarter wave loop stub only provides a high impedance at one frequency and on all other frequencies it supplies high coupling which results in an impossibility of tuning the system. Thus when the second tuned section is added to the first doublet, the first doublet would be thrown badly out of resonance unless the second section added just happened to be equal in length to the first doublet section.

The other alternatives to tuning an antenna for several frequencies usually involve standing waves on the transmission lines or a complicated tuning system at the antenna lead-in which must be switched to each frequency. It is believed that the system described accomplishes the results in a more efficient and simple manner than any other alternative.

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Measuring Characteristic Impedance of Twisted Pairs

By ANDREW ALFORD
Mackay Radio and Telegraph Company

THERE ARE SEVERAL DIFFERENT METHODS which may be used to measure the surge impedance of a twisted pair. The following procedure, however, is probably one of the simplest since it requires very little equipment. This procedure is based on a simple rela-

The Most Powerful Aircraft Ground Station in the U.S.A. NATURALLY Eimac Tubes Fill the Most Important Sockets

Mr. P. C. Sandretto, Supt. of Communications for United Air Lines with Mr. Devereaux Martin of the Federal Telegraph Co. inspect one of the Eimac 450T tubes which is being installed

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Above is the first of 11 new ground stations which are being built for the United Air Lines by the Federal Telegraph Company

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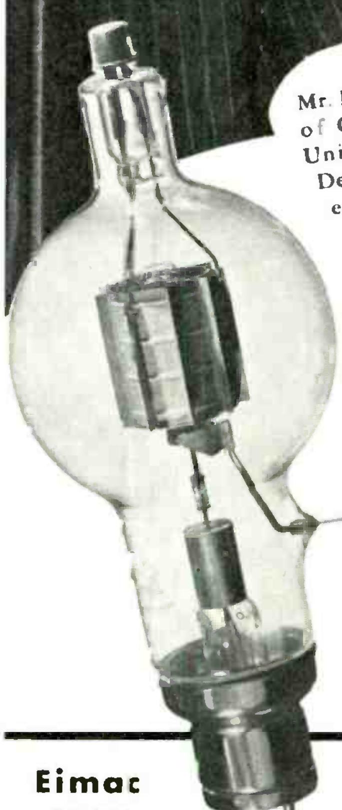

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EITEL-McCULLOUGH, INC. • SAN BRUNO, CALIFORNIA tion which exists between the relative velocity of propagation and the characteristic impedance and also on the fact that the relative velocity of propagation is comparatively easy to measure with reasonable accuracy.

The whole procedure involves three steps:

Step 1. Measurement of the relative velocity of propagation v/c in the twisted pair.

Step 2. Calculation of the characteristic impedance Z_a of the pair, assuming for a moment that the wires are in air, using the formula,

$$Z_a = 120 \cosh^{-1} D/d = 276 \log_{10} \frac{2D}{d}$$

in which

D = spacing between the centers of the two wires

d = diameter of each wire

Step 3. Calculation of the desired characteristic impedance Z_o of the twisted pair by simply multiplying Z_a found in Step 2 by v/c found in Step 1.

$$Z_o = Z_a\ (v/c)$$

The theory of this procedure is as follows: The velocity c of propagation along a pair of wires in air is given by the following equation:

$$c = \frac{1}{\sqrt{LC}}$$

where L = inductance per unit length

C = capacity per unit length

The velocity of propagation v in the

• • •

PHOTOCELL REPLACES NEEDLE

Replacing the old-time phonograph needle in this radio-phonograph combination is a photocell which is used to obtain greater fidelity of reproduction. A rounded jewel, which replaces the phonograph needle, has a tiny mirror mounted on it and this mirror reflects light from a lamp into the photocell. The vibrations of the mirror and jewel are converted into a pulsating light beam and thence into a varying current

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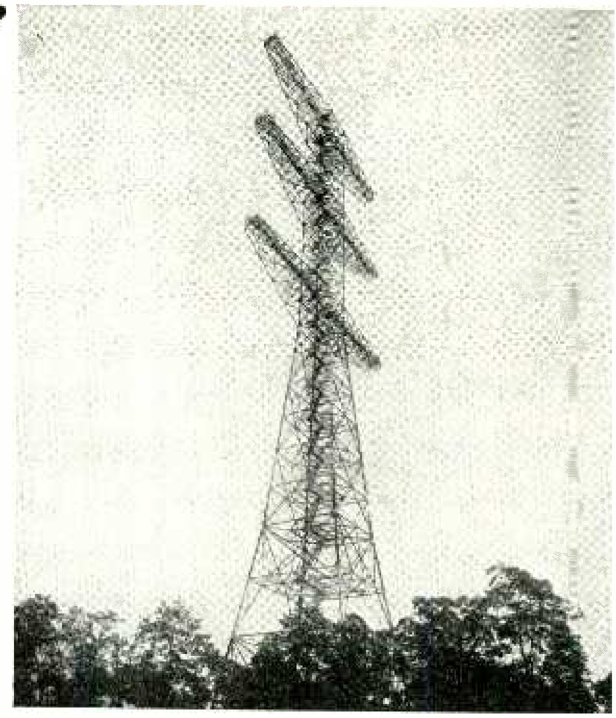
IN ACTUAL FM OPERATION

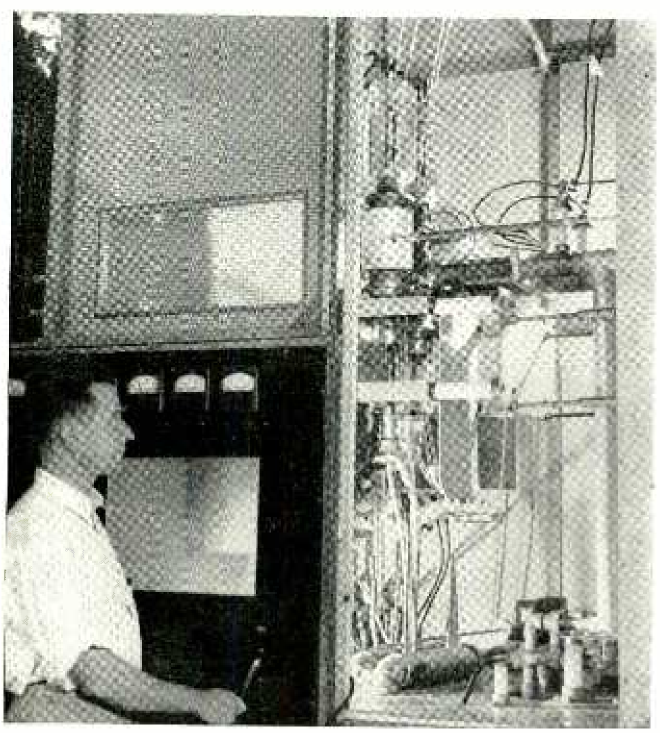
Westinghouse WL-899

HIGH FREQUENCY TUBE

In use since September, 1938, in Major E. H. Armstrong's 40 KW experimental station at Alpine, New Jersey, W2XMN



• The tower of W2XMN is 400 feet high and has "turnstile" antennae systems supported from the cross arms.



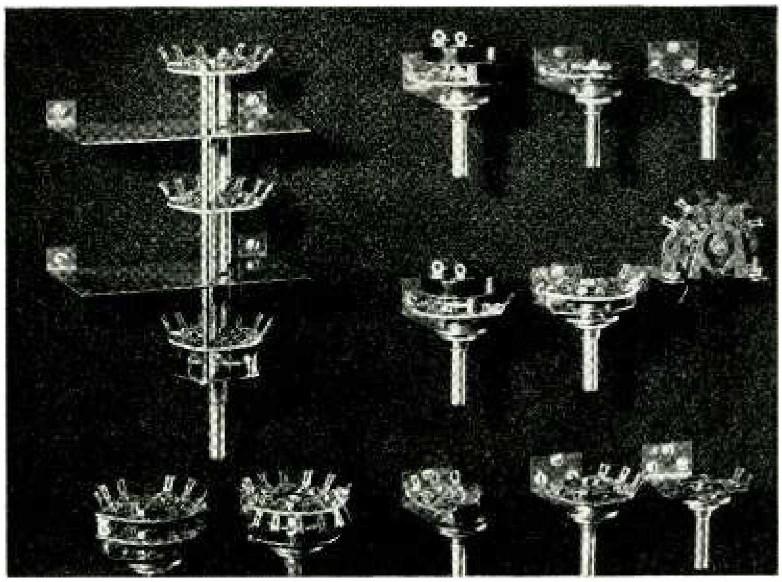
• Mr. P. H. Osborn, in charge of station W2XMN, shown before Westinghouse 899's.

● Naturally, Westinghouse is proud that one of its tube types, selected from its regular line, made possible the first high power FM transmission. These WL-899 tubes, pictured here as set up in Station W2XMN, are still operating successfully after nearly two years' service.

Through cooperation with such outstanding pioneers and leaders as Major E. H. Armstrong, and through operation of its own commercial stations, Westinghouse is able to anticipate the tube requirements of the radio industry and to offer a line of tubes of proved performance.

Westinghouse

The first name in radio broadcasting



twisted pair in which each each wire is surrounded by dielectrics other than air is given by

$$v = \frac{1}{\sqrt{LCK}}$$

where L = inductance per unit length (same as in air)
CK = capacity per unit length
K = constant by which capacity C per unit length in air must be multiplied to get the capacity per unit length when wires are surrounded by dielectric other than air.

The surge impedance of wires in air

$$Z_a = \sqrt{\frac{L}{C}}$$

The surge impedance of the twisted pair with wires surrounded by dielectric other than air is

$$Z_o = \sqrt{\frac{L}{CK}}$$

It follows that

$$v/c = 1/\sqrt{K}$$

so that

$$Z_a\,(v/c) = \sqrt{\frac{L}{C}}\,\frac{1}{\sqrt{K}} = \sqrt{\frac{L}{CK}} = Z_o$$

It does not make any difference so far as this derivation is concerned whether the dielectric fills the entire space between the two wires or not. Also it is immaterial if more than one dielectric material is used.

As stated above, the only measurement which is involved is the one in Step 1, and this measurement may be made for example as follows: Tune a receiver with a balanced input circuit to a known frequency. Cut off a piece three quarters of the wavelength long of the twisted pair in question. (The wavelength to be used here is in air). Shunt the sample across the input terminals of the receiver and proceed to cut small pieces (each a few inches long) off the free end of the twisted pair and observe the signal at the output of the receiver each time a piece is cut off from the end. As the cutting operation progresses the signal will start decreasing and will reach a minimum and then will start rising again. Measure the length S_1 which results in minimum signal. Continue to cut off pieces from the free end of the twisted pair until another point of minimum signal is reached. Measure this length S_2. The difference $S_1 - S_2$ is equal to a half wavelength in the twisted pair at reduced velocity of progagation. When $S_1 - S_2$ is divided by the half wavelength $\lambda/2$ in air the ratio

$$\frac{S_1 - S_2}{\lambda/2} = v/c = \text{the relative velocity}$$

of propagation (very nearly). This is the value of (v/c) which is referred to in Step 1.

Example: Suppose that the twisted pair in question consists of two wires No. 16 with $d = 0.0508$ inches and with center spacing between wires $D = 0.125$ inches. Each wire is insulated

with a layer of rubber and the two insulated wires are then twisted together. Suppose further that the measurement in Step 1 was made at 30 Mc with the result that $S_1 - S_2$ was found to be equal to 11.5 feet. Since the half wavelength in air is 16.4 feet, it follows that

$$v/c = \frac{11.5}{16.4} = 0.715$$

The calculation in Step 2 yields the following result:

$$Z_a = 276 \log_{10} \frac{2 \times 0.125}{0.0508} = 191$$

ohms (approx)

Then in accordance with Step 3 it is found that the surge impedance of the twisted pair in question is

$Z_0 = Z_a\, v/c = 191 \times 0.715 = 136$ ohms.

This same procedure may be used to measure the characteristic impedance of shielded cables in which the inner conductor is concentric with the outer conductor. In such a case, however, the formula to be used for calculating the surge impedance Z_a in Step 2 must be the well known formula for the surge impedance of concentric conductors, namely

$$Z_a = 138.5 \log_{10} \frac{r_o}{r_i}$$

in which r_i is the diameter of the inner conductor and r_o the diameter of the outer conductor.

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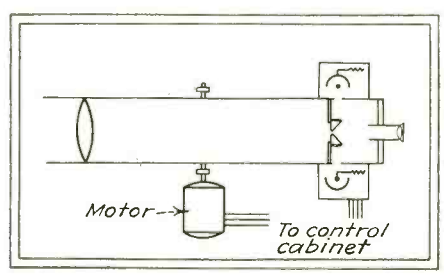
An Electronic Telescope Control

By A. L. Rubenstein

The design of an optical device for tracking aircraft in flight was briefly covered in an article by the writer in *Electronics* in July 1933. Recently, an instrument incorporating these principles has been successfully demonstrated. In this instrument, a refracting telescope is employed to form a real image which is separated into quadrants by four lens prisms. The



Basic phototube and prism arrangement

image at each prism is reflected and focused into the cathode of a phototube mounted on the telescope. Tubes in opposing quadrants are connected to form a balanced circuit operating a d-c amplifier mounted on the telescope. The output of each of the two d-c amplifiers operates high-low current micro-sensitive relays which, in turn, actuate power relays controlling small reversible geared-down motors. The

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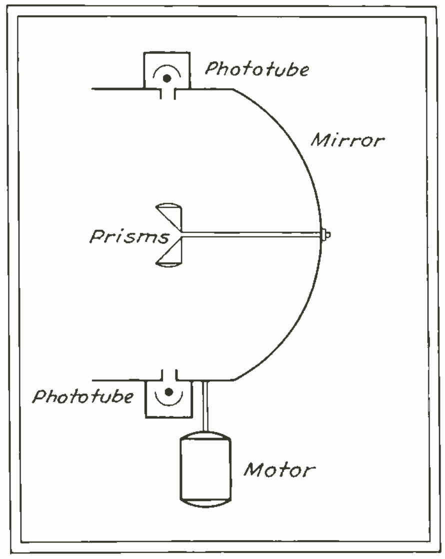
PLASTICS HEADQUARTERS

motors direct the horizontal and vertical motions of the telescope.

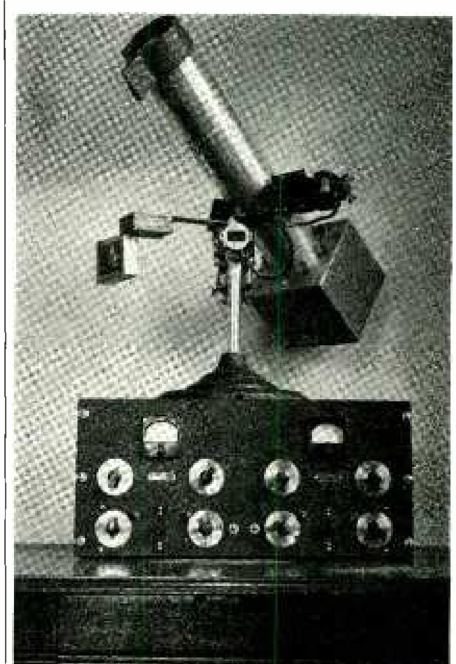
The tracking tube shown in the photograph has a diameter of 4 inches with an uncorrected objective lens of approximately 20 inches focal length. It may, therefore, be seen that the



Alternative system for use with reflector telescope

mechanical and optical assembly, together with the phototube and amplifier housing, form a compact and portable unit.

The control cabinet, which houses relays and signal lights, permits manipulation of the tracking tube by variation of the shield grid voltage of the d-c amplifier output tubes. This arrangement also permits automatic



The telescope control applied to a small refracting instrument

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FREQUENCY STABILITY: Western Electric now makes another great contribution to the radio art—*synchronized* frequency modulation. This new system of carrier wave frequency stabilization is unique—gives the 503A-1 (1KW) Transmitter a stability of better than .0025%.

FREQUENCY RESPONSE: Flat within ± 1 db from 30 to 15,000 cycles per second.

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DISTORTION: Typical measurements of r. m. s. audio frequency harmonic distortion with a distortionless F M audio monitor in the frequency range of 30 to 15,000 c. p. s. show less than 2% at a modulation corresponding to ± 100 K C swing. Distortion measurements include all audio frequency harmonics up to 30,000 c. p. s.

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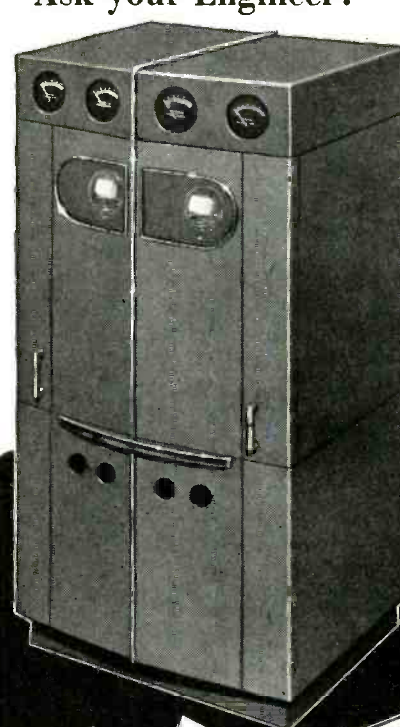
FM

Synchronized



BY

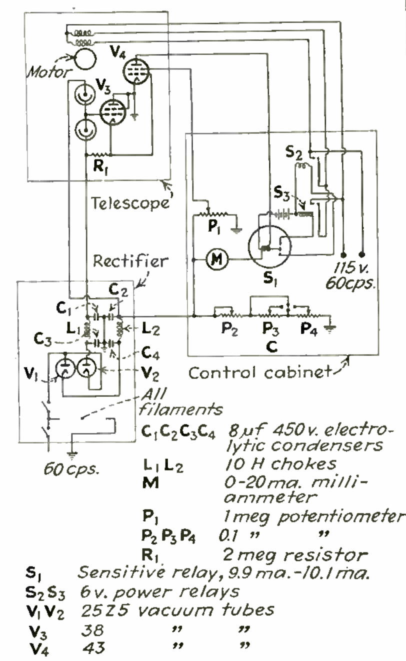
Western Electric

Distributed by Graybar

scanning of a selected sky area until the appearance of the object assumes control.

The rectifier consists of two voltage doubler circuits, one for each d-c amplifier and associated pair of photo tubes. The circuit is shown in the accompanying diagram.

It should be borne in mind that the efficiency of the device depends on the contrast in light values between the object and its surrounding field, and



Complete circuit diagram of the telescope control

experience with the model indicates that, to cope with minute light variations resulting from small sized objects or low visibility, a maximum light-gathering optical system is desirable. The refracting objective, as a means of image formation, has serious limitations both from the expensiveness of large diameter objectives and inability to secure a proportionate light increase for increased area of objective due to increasing lens thickness, especially where correction is introduced. As is well known, these considerations were responsible for the development of the reflecting telescope and this form of the optical unit is admirably suited for the tracking device.

At the focus of a mirror of relatively large diameter and small focal length, the same assembly of four lens prisms reflects the image to four points on the periphery of the mirror mounting. At these four points are mounted the phototubes equipped with suitable shields for the elimination of light from sources other than the corresponding lens prisms. The amplifiers are adjacent to the phototubes on the mirror mounting and the entire assembly is oriented by two reversible motors

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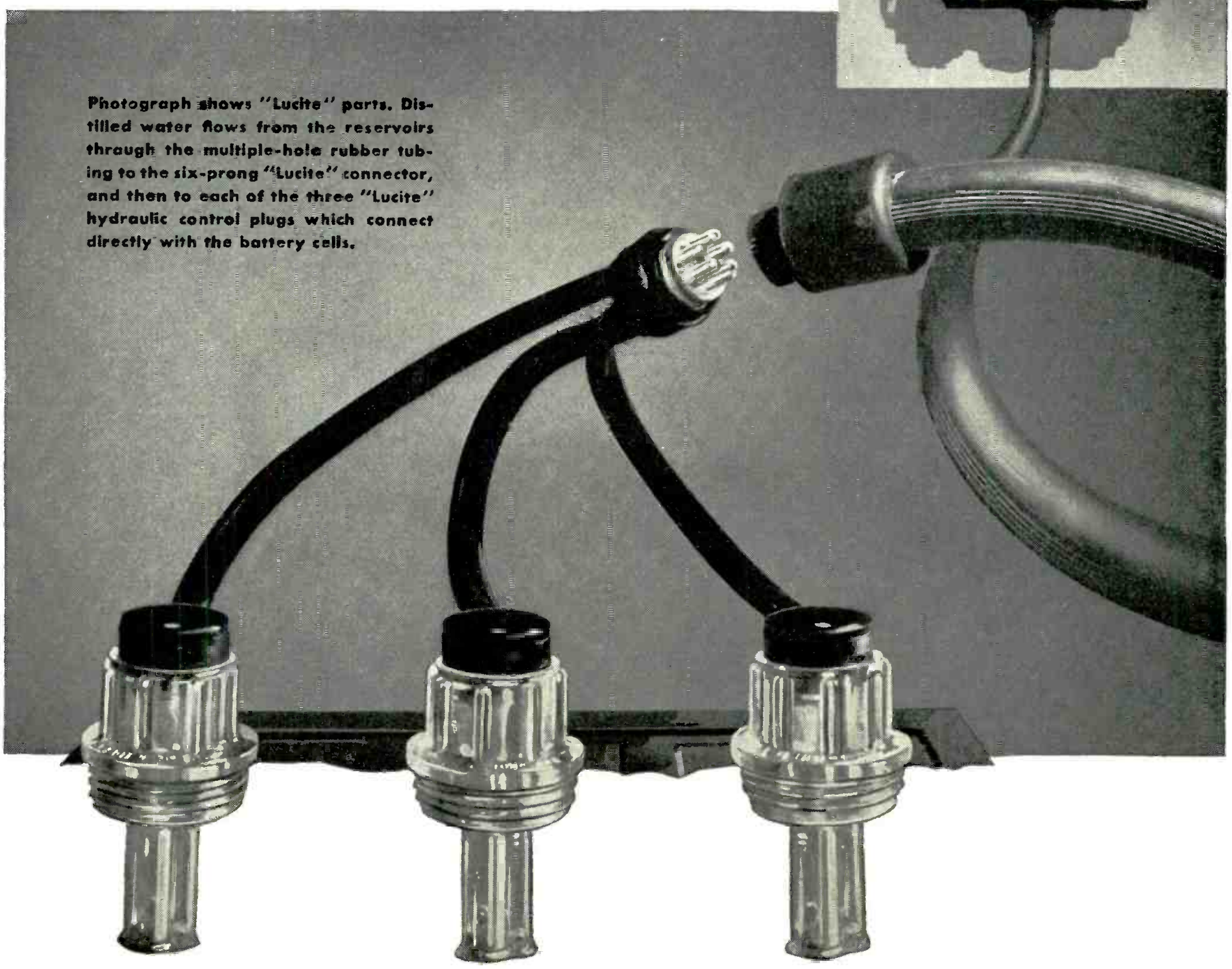

Photograph shows "Lucite" parts. Distilled water flows from the reservoirs through the multiple-hole rubber tubing to the six-prong "Lucite" connector, and then to each of the three "Lucite" hydraulic control plugs which connect directly with the battery cells.

. . . with the able assistance of molded "Lucite"

JUST AS a bottle feeds a baby, so the Mosher Automatic Battery Filler feeds thirsty car batteries. Simple, isn't it? But consider the problem of *wear*. That's where molded "Lucite" comes in.

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Let Mr. Mosher, President of the Evelo Manufacturing Company, tell you how this remarkable methyl methacrylate resin plastic met this test:

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in the same manner as the lens type tube.

Naturally, the optical method does not lend itself to tracking the target under conditions of poor or zero visibility. Tracking of aircraft at night by the optical method requires association of the tracking device with the searchlight to obtain interlock of the searchlight directing mechanism with the directing mechanism of the tracking device. This, of course, is accomplished by electrical interlock.

The Figure shows the circuit in a simplified form for either the horizontal or vertical planes of motion. The complete circuit consists of two identical circuits of this form. The driving motors are of the small shaded pole induction type which is reversible by switching an auxiliary winding. The motors operate at about 3000 rpm and include a gear reduction unit giving a drive shaft speed of about 4 rpm. The drive shaft speed of the motor actuating the vertical motion of the telescope is somewhat lower. The motor driving the telescope vertically is attached to a stirrup in which the tube swings vertically. This stirrup itself rotates horizontally on a thrust type ballbearing and the driving shaft of the second motor is coupled to a shaft which is an extension of this stirrup. In effect, the motor driving the telescope horizontally remains stationary while the motor driving the telescope vertically swings in a horizontal plane with the telescope.

The micro-sensitive relays in the plate circuit of the d-c amplifiers are high-low current meter type relays which operate to either side on increase or decrease respectively of 0.1 milliamperes from the 10 milliamperes median position. The group of controls marked *C* in the circuit drawing permit manipulation of the telescope by introducing an artificial increase or decrease in the normal 10 ma plate current value.

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A Fluorescent Lamp Voltage Stabilizer

THE EDITORS ARE INDEBTED to Monroe H. Sweet for the following description of a voltage stabilizer circuit developed by him for use with a phototube amplifier where very good regulation is required.

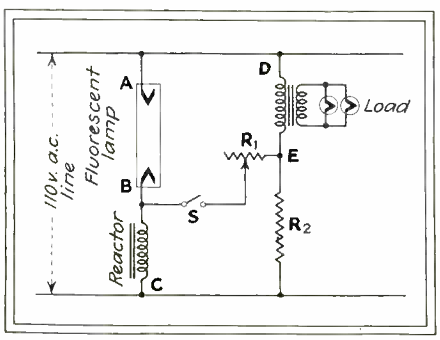
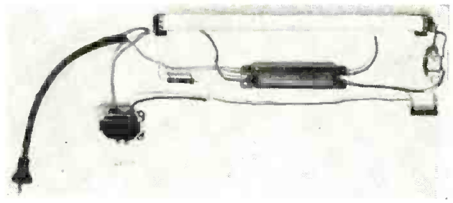


Fig. 1—Simple voltage stabilizer using a fluorescent lamp

In the circuit diagram, Fig. 1, the fluorescent lamp is a 15 watt unit,



The stabilizer may be assembled from readily-available parts

and the reactor is a standard choke designed as a current-limiter for use with 15-watt lamps. Initially the voltage is applied to the lamp and reactor with switch *S* open. Thereafter the switch is closed. If the line voltage rises the voltage across *AB* decreases, due to the negative voltage characteristic of the lamp, whereas the voltage across the load at *DE* rises in proportion to the rise in line voltage. The two shifts in voltage are combined by closing the switch *S*. By adjusting the resistor R_1 a balance position may be found at which the voltage across *DE* and hence across the load circuit remains constant within ¼ to ½ of one per cent for line voltage variations from 105 to 120 volts.

The action of the regulation is practically instantaneous, although sudden surges are transmitted to the load, as indicated by a meter connected across the load circuit. The values of the resistors R_1 and R_2 depend on the nature of the load, hence must be calculated or found by cut-and-try in each case.

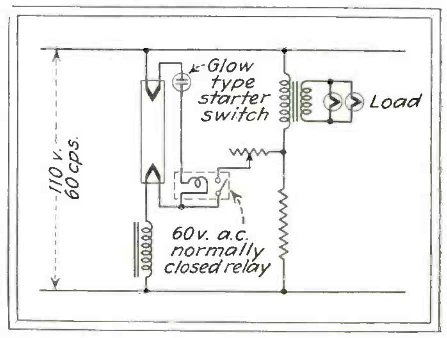


Fig. 2—Circuit using a relay for automatic starting

The maximum load applied in Mr. Sweet's application is the heater drain of four 6.3-volt, 0.3-amp tubes in parallel. Figure 2 shows a variation of the circuit which eliminates the necessity of using a manually operated switch. A glow-type fluorescent lamp starter and relay are used to connect the load circuit automatically when the lamp starts.

While the amount of power which may be supplied by this circuit is limited, the simplicity of the arrangement and the wide availability of the parts make the stabilizer a useful device for applications requiring not more than 10 to 15 watts of power.

TUBES

A discussion of factors governing the life of transmitting tubes and the listing of tubes, new and old, registered by the R. M. A. Data Bureau

Obtaining Long Tube Life

LONGER TUBE LIFE means lower tube costs. Find a way to increase the useful life of tubes in your equipment and the unit cost per hour of operation drops accordingly. This information concerning means of obtaining the longest life from transmitting tubes is presented here through the courtesy of *Tubes*, published by Federal Telegraph Co., Newark, N. J.

Many factors enter into the life of tubes. Of these the following are most apparent:

1. Filament voltage.
2. Plate voltage.
3. Operating temperature.
4. Amount and nature of residual gas in tube.
5. Number of times current is turned on and off.
6. Fatigue of metal parts.

Filament Voltage vs Filament Life

Fortunately the first mentioned factor, that of filament voltage, can be controlled. As illustrated by the accompanying curves an extremely small change in filament voltage results in a considerable change in filament life. The possibility of increasing tube life by reducing filament voltage and consequently filament temperature is the result of the fact that bright tungsten filaments may be operated at complete saturation. In other words, peak currents amounting in value to the total emission available may be drawn continuously without damage to the filaments.

Obviously, the curves show theoretical filament life based on normal evaporation of filaments and apply to bright tungsten filaments such as are generally used in water cooled tubes. While they may not hold for every installation, the ratios or relationships may be considered an average for a large number of tubes.

Note that the increase in life obtainable is considerable even at slightly reduced filament voltages. For the same reason a correspondingly large reduction in life results from even slightly increased filament voltages.

Actual Savings Made Possible

This may be shown in still another way and will serve to point out the savings made possible by reducing filament voltages.

	Filament Voltage	Total Hours of Useful Life	Unit Cost Per Hour
	90%	400%	25%
	95%	194%	52%
Normal	100%	100%	100%
	105%	50%	200%
	110%	26%	415%

In other words, let us take a typical example. Let us suppose a tube has a rated filament voltage of 20 volts and theoretical average life expectancy of 4000 hours. Let us assume further that the tube costs the station $400.00. If the tube were operated with 20 volts on the filament the life expectancy would be 4000 hours and the cost of operation would be ten cents per hour. Now let us assume that this same tube could be operated at 90 per cent of the rated filament voltage. The theoretical average life expectancy would be increased to 16,000 hours and the unit cost of operation would be reduced to two and one half cents per hour.

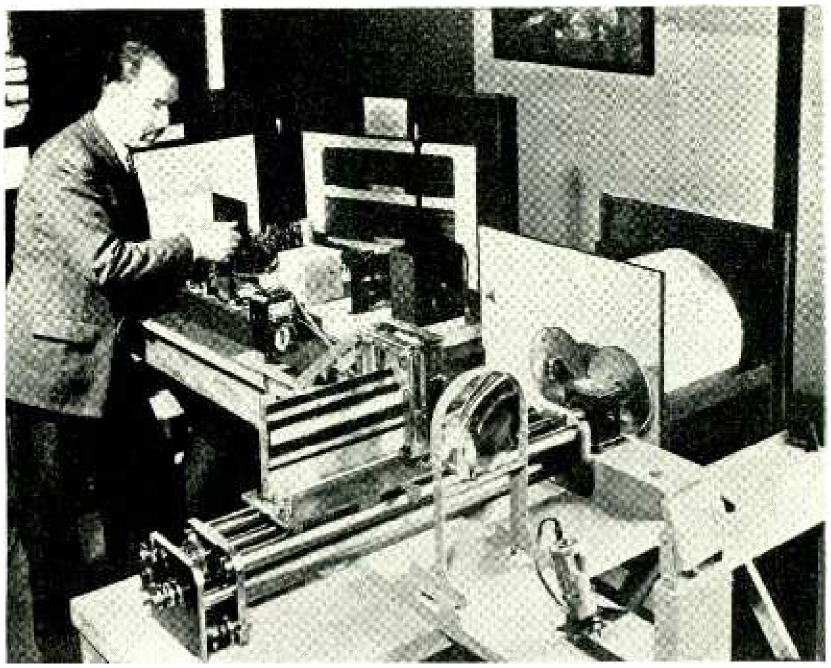
Tubes are designed to provide a certain amount of emission at certain input voltages. Obviously, if the whole amount of emission designed into the tube is not required it becomes possible for the user to obtain more than the life expectancy provided for in the design of the filament.

For the same reason as shown by the curves, an increase in tube life resulting from a decrease in filament voltage must be accompanied by a decrease in the available emission. The relationship of emission and theoretical filament life appears in the curves. Reduction in filament voltages, therefore, are recommended only in conjunction with reliable distortion measurements because of the possible flattening of positive peaks.

Thoriated Tungsten Filaments

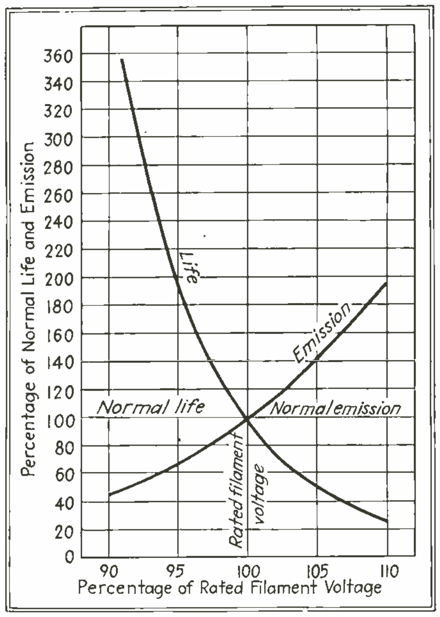
In the case of thoriated tungsten filaments such as are commonly used in transmitting tubes of intermediate sizes, these are operated at tempera-

REPRODUCES EARTHQUAKES



Arthur C. Ruge, professor of engineering seismology at the Massachusetts Institute of Technology, operating a machine which he developed to reproduce, in miniature, the tremors produced by earthquakes. The machine is used to enable engineers to make careful and complete studies of the effects of earth shocks on buildings and to classify and compare quakes quantitatively. The wave record of the quake, recorded as a wavy line is read by a phototube which converts the variations into pulsating current, which in turn is converted into tremors simulating those of the actual quake, but on a miniature scale tures of such degree that evaporation is negligble. This means that the life of the tube is not controlled by the reduction of the tungsten wire and cannot be extended by operation at reduced voltage as in the case of the water cooled tubes.

In thoriated tungsten filaments the source of emission is a layer of thorium on the filament surface. During oper-



Curves showing effect of filament voltage on life and emission of tubes

ation the thorium in this layer is constantly being removed by evaporation and bombardment and is constantly being replenished from within the wire. In order to maintain the balance between the loss and replacement of an active layer of thorium, therefore, requires operation within a comparatively narrow range of temperature.

Unusually short life may result, from the operation of thoriated filaments much below or much above rated values. In consequence, it is essential that the filament voltage be maintained at all times within the specified tolerances provided in the ratings of the various types of tubes.

This is highly important in the prolongation of the life of these tubes. Within the narrow range of temperature just mentioned the emission available is quite critical with respect to filament voltage. This is seen in the fact that a reduction of only 1 per cent in voltage causes a loss of approximately 5 per cent in emission.

Unlike bright tungsten filaments, thoriated tungsten filaments should never be operated at or near saturation. In other words, the peak currents drawn should not exceed more than one-half of the maximum of which the filament is capable of emitting. These filaments are, therefore, designed to provide at least double the emission that would be needed in any normal class of operation.

Mercury vapor rectifier tubes with oxide coated filaments are designed to operate at specific temperatures. Here again very short life may result from operating these tubes either hotter or colder than the temperature specified. In order to get the most out of these tubes, therefore, it is essential that the filament voltage be maintained within the range specified for any given type.

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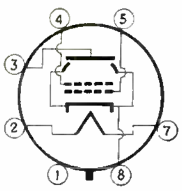
Tube Registry

Tube Types Registered by R.M.A. Data Bureau During June 1940

Type 6U6GT

BEAM deflection power amplifier; heater type; (T-9) glass envelope; seated height, 2¾ inches (max); 7-pin, intermediate shell octal base.

E_h = 6.3 v
I_h = 0.75 amp
E_b = 200 v (max)
E_{c2} = 135 v (max)
E_{c1} = − 14 v
I_{bo} = 56 ma
I_{c2o} = 3 ma
g_m = 6200 micromhos
r_p* = 20,000 ohms (approx)
R_l = 3000 ohms
$P.O.$ = 5.5 watts (10%)
* Peak input signal equal to bias
Basing 7AC-0-0



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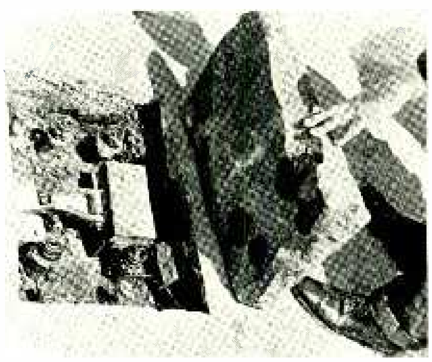
TALKING STONES AT THE WORLD'S FAIR OF 1940



Among the unusual applications of radio principles to be found at the World's Fair in New York are houses that speak in synchronization with the opening of their doors and flagstones which protest painedly when stepped on. Heart of the talking flagstone, one of which is shown opened, is a complicated system of phonograph recordings and controls which produce the desired conversation. Under the talking-flagstone is this electrical contact apparatus which starts the conversation, which comes from a loudspeaker located underneath a nearby grill

G and GT Designations

A NUMBER of tubes now have double designations of both the G and GT series. Any of these tubes will replace both the G and GT versions of these general tube types. Both the electrical and dimensional characteristics are defined by the data given in the announcement of the GT versions.

The location in *Electronics* of each announcement is given below.

1A5GT-1A5G	Feb 1940 page 52
1C5GT-1C5G	Feb 1940 page 52
1G4GT-1G4G	Nov 1939 page 69
1G6GT-1G6G	Nov 1939 page 69
1Q5GT-1Q5G	Feb 1940 page 53
5W4GT-5W4G	Nov 1939 page 73
6K6GT-6K6G	June 1940 page 80
6V6GT-6V6G	Nov 1939 page 69
6X5GT-6X5G	June 1940 page 76

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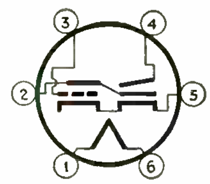
Tube Types Registered by R.M.A. Data Bureau During 1937

Types 6U5 & 6G5

TUNING indicator, heater type, (T-9) glass envelope, seated height (max) 3 9/16 inches, 6-pin base.

E_h = 6.3 v
I_h = 0.3 amp
E_b = 250 v
E_{target} = 250 v
I_b = 0.24 ma
I_{target} = 4.5 ma
Basing 6-R



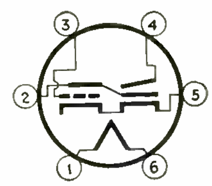
Type 6S5

CATHODE-RAY tuning indicator, heater type, (ST-12) glass envelope, 4¼ inches long, 6-pin base.

E_h = 6.3 v
I_h = 0.3 amp
E_{target} = 250 v
$E_{vane\ grid}$ = 135

E_c = 0 v
I_{target} = 2 ma
Illuminated angle = 300°

E_c = − 8 v
I_{target} = 0 ma
Illuminated angle = 0°
Basing 6-R



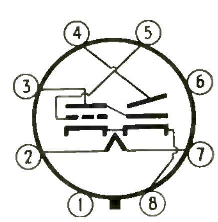
Type 6X6 (G)

CATHODE-RAY indicator tube, heater type, (ST-12) glass envelope, 4 inches long, 8-pin octal base.

E_h = 6.3 v
I_h = 0.3 amp
E_{target} = 250 v
$E_{vane\ grid}$ = 135 v

E_c = 0 v
I_{target} = 2 ma
Illuminated angle = 300°

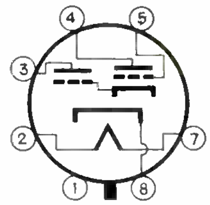
E_c = − 8 v
I_{target} = 0 ma
Illuminated angle = 0°
Basing 7AL



Type 6AC6 (G)

DIRECT coupled power amplifier, heater type, glass envelope, 7-pin octal base.

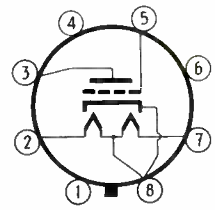
$E_h = 6.3$ v
$I_h = 1.1$ amp
E_b (input) = 180 v (max)
E_b (output) = 180 v (max)
$E_c = 0$ v
I_b (input) = 7 ma
I_b (output) = 45 ma
$r_p = 18000$ ohms
$R_l = 4000$ ohms
$P_o = 3.8$ watts (10%)
Basing 7-W



Type 6A5 (G)

POWER amplifier triode, heater type, (ST-16) glass envelope, seated height $4\frac{3}{4}$ inches, 8-pin octal base.

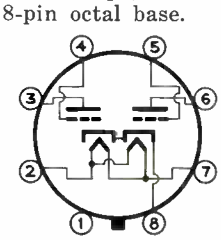
$E_h = 6.3$ v
$I_h = 1.0$ amp
$E_b = 250$ v
$E_c = -45$ v
$I_b = 60$ ma
$r_p = 800$ ohms
$g_m = 5250$ μmhos
$\mu = 4.2$
Basing 6-T



Type 6Y7 (G)

DOUBLE triode power amplifier, heater type (ST-12), glass envelope, seated height $3\frac{9}{16}$ inches, 8-pin octal base.

$E_h = 6.3$ v
$I_h = 0.6$ amp
$E_b = 250$ v
$E_c = 0$ v
I_b (zero signal) = 10.5 ma
R_l (plate to plate) = 14000 ohms
$P_o = 8.0$ watts
Basing 8-B



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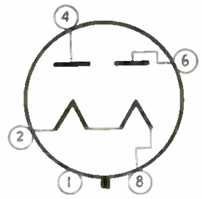
SOUND CHANGED TO ORDER

Gilbert Wright, inventor of the Sonovox, demonstrating his device for changing sound, such as that of a buzz saw, a high wind, or music into spoken English. It will be especially useful in movie cartoon work and in making foreign versions of American films. The type of sound to be modified into the spoken word comes from the record in the background and is applied by means of the cylinders, to the operators throat. The operator then speaks and modifies the sound from the record into spoken words

Type 5W4 (G)

HIGH vacuum full wave rectifier, filament type, (ST-12) glass envelope, seated height 3$\frac{19}{32}$ inches, 5-pin octal base.

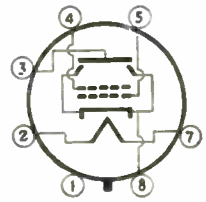
E_f = 5.0 v
I_f = 1.5 amps
CONDENSER INPUT TO FILTER
E_{ac} (per plate) = 350 v (max)
I_{dc} = 100 ma (max)
CHOKE INPUT TO FILTER
E_{ac} (per plate) = 500 v. (max)
I_{dc} = 100 ma (max)
E_{drop} (I_{dc} = 100 ma) = 45 v
Basing 5-T



Type 6V6 (G)

BEAM power amplifier, heater type, (ST-14) glass envelope, seated height 4$\frac{1}{16}$ inches, 7-pin octal base.

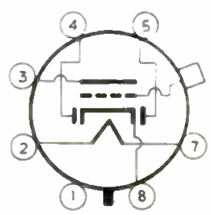
E_h = 6.3 v
I_h = 0.45 amp
E_b = 250 v
E_{c2} = 250 v
E_c = − 12.5 v
I_b(zero signal) = 45 ma
I_{c2}(zero signal) = 4.5 ma
R_l = 5000 ohms
P_o = 4.5 watts (8%)
Basing 7-AC



Type 6T7 (G)

DOUBLE diode, high mu triode, heater type, (ST-12) glass envelope, seated height 3$\frac{13}{16}$ inches, 7-pin octal base.

E_h = 6.3 v
I_h = 0.15 amp
E_b = 250 v
E_c = − 3.0 v
I_b = 1.2 ma
μ = 65
g_m = 1050
Basing 7-V



Type 6W5 (G)

HIGH vacuum full wave rectifier, heater type, (ST-12) glass envelope, seated height 3$\frac{9}{16}$ inches, 6-pin octal base.

E_h = 6.3 v
I_h = 0.9 amp
CONDENSER INPUT TO FILTER
E_{ac} (per plate) = 325 v (max)
I_{dc} = 90 ma (max)
CHOKE INPUT TO FILTER
E_{ac} (per plate) = 450 v (max)
I_{dc} = 90 ma (max)
E_{drop} (I_{dc} = 90 ma) = 24 v
Basing 6-S

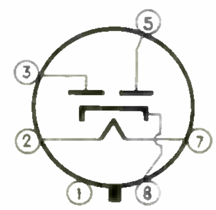


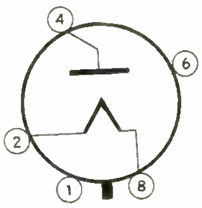
IMAGE OF ELECTRONS IN ACTION

Dr. L. J. Berberich, Westinghouse research engineer, projects an image of electrons entering a salt crystal. The heart-shaped cloud effect is formed by electrons entering the crystal which has been heated to a temperature of 1200° F. The electrons reveal their presence as a reddish mass, as their vibrations absorb all but the red and violet colors of white light passed through the crystal

Type 2X3 (G)

HIGH vacuum half wave rectifier, filament type (ST-12), glass envelope, 5-pin octal base. Two tubes with filaments in series are equivalent to one type 80 tube.

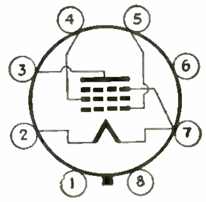
E_f = 2.5 v
I_f = 2.0 amps
TWO TUBES WITH FILAMENTS IN SERIES
CONDENSER INPUT TO FILTER
E_{ac} = 350 v (max)
I_{dc} = 125 ma (max)
CHOKE INPUT TO FILTER
E_{ac} = 500 v (max)
I_{dc} = 125 ma (max)
E_{drop} (I_{dc} = 125 ma) = 60 v
Basing 4-X



Type 1J5 (G)

POWER amplifier pentode, filament type, (ST-14) glass envelope, seated height $4\frac{1}{16}$ inches, 7-pin octal base.

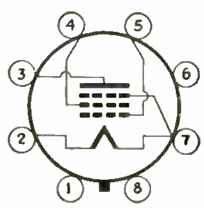
E_f = 2.0 v
I_f = 0.12 amp
E_b = 135 v
E_{c2} = 135 v
E_c = − 16.5 v
I_b = 7.0 ma
I_{c2} = 2.0 ma
R_l = 13,500 ohms
P_o = 0.45 watts
Basing 6-X



Type 1G5 (G)

POWER amplifier pentode, filament type (ST-14), glass envelope, seated height $4\frac{1}{16}$ inches, 7-pin octal base.

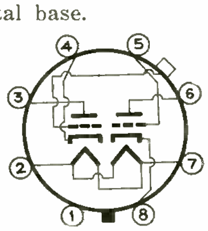
E_f = 2.0 v
I_f = 0.12 amp
E_b = 135 v (max)
E_{c2} = 135 v (max)
E_c = − 13.5 v
I_b (zero signal) = 8.7 ma
I_{c2} (zero signal) = 2.5 ma
R_l = 9000 ohms
P_o = 550 milliwatts (11%)
Basing 6-X



Type 6C8 (G)

DOUBLE triode amplifier, heater type, (ST-12) glass envelope, seated height $3\frac{9}{16}$ inches, 8-pin octal base.

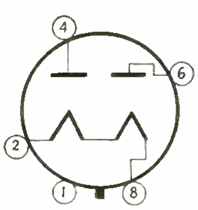
E_h = 6.3 v
I_h = 0.3 amp
EACH TRIODE
E_b = 250 v
E_c = — 4.5 v
I_b = 3.2 ma
r_p = 22500 ohms
μ = 36
g_m = 1600 μmhos
Basing 8-G



Type 5T4

HIGH vacuum full wave rectifier, filament type, metal envelope, seated height, $3\frac{3}{4}$ inches, 5-pin octal base.

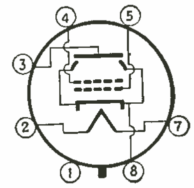
E_f = 5.0 v
I_f = 2.0 amps
CONDENSER INPUT TO FILTER
E_{ac} (per plate) = 450 v (max)
I_{dc} = 225 ma (max)
CHOKE INPUT TO FILTER
E_{ac} (per plate) = 550 v (max)
I_{dc} = 225 ma (max)
E_{drop} (I_{dc} = 225 ma) = 45 v
Basing 5-T



Type 25L6

BEAM power amplifier, heater type, metal envelope, seated height $2\frac{11}{16}$ inches, 7-pin octal base.

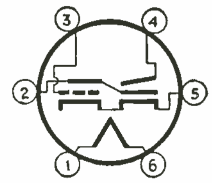
E_h = 25.0 v
I_h = 0.3 amp
E_b = 110 v (max)
E_{c2} = 110 v (max)
E_c = —7.5 v
I_b(zero signal) = 49 ma
I_{c2}(zero signal) = 4 ma
R_l = 2000 ohms
P_o = 2.2 watts (10%)
Basing 7-AC



Type 6H5

CATHODE-RAY indicator tube, heater type (ST-12), glass bulb, seated height $3\frac{9}{16}$ inches, 6-pin octal base.

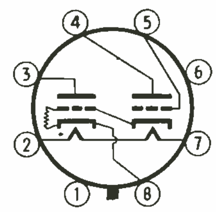
E_h = 6.3 v
I_h = 0.3 amp
E_b = 250 v
E_{target} = 250 v
I_{target} = 4.5 ma
E_c(zero shadow angle) = — 22 v
E_c(90° shadow angle) = 0 v
Basing 6-R



Type 6AB6 (G)

DIRECT coupled power amplifier, heater type (ST-12), glass envelope, 7-pin octal base.

E_h = 6.3 v
I_h = 0.5 amp
E_b(output) = 250 v (max)
E_b(input) = 250 v (max)
E_c = 0 v
I_b(output) = 34 ma
I_b(input) = 4 ma
R_l = 8000 ohms
P_o = 3.5 watts (10%)
Basing 7-AU-0-0



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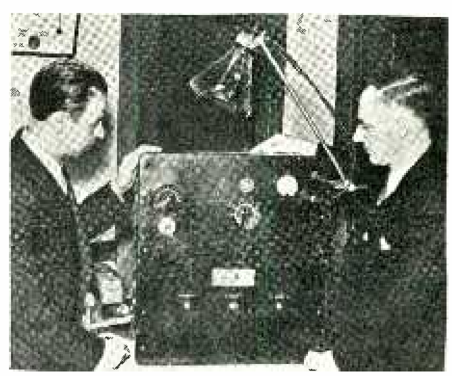
CLAIM RADIO RAY KILLS CANCER GERM



Royal Raymond Rife, left, inventor, and Philip Hoytland, co-worker, claim that the instrument which they are examining generates a high-frequency radio "ray" which "kills germs that cause cancer." The device was recently demonstrated at the California State Homeopathic Medical Association convention

THE ELECTRON ART

Among the subjects reviewed in the technical literature are the optimum number of scanning lines in a television system, factors influencing hearing aid design, amplidyne generators and inductance measurement at high frequencies

Optimum Number of Lines for Television

AN ARTICLE ENTITLED "A Determination of Optimum Number of Lines in a Television System" by R. D. Kell, A. V. Bedford and G. L. Fredendall, appears in the July 1940 issue of the *RCA Review*. The most satisfactory operation of a television system is obtained when the horizontal resolution and vertical resolution of the resulting picture are approximately equal. A test subject of a single abrupt transition in brightness is used to determine curves of horizontal and vertical resolution. The line of transition is placed perpendicular to the scanning lines for the analysis of horizontal resolution and nearly parallel to the lines for the analysis of vertical resolution. The picture repetition rate is also considered in this discussion. The advantages and disadvantages of the three frame rates of 15, 24 and 30 per second are discussed. The authors use the highest frame rate, 30 per second interlaced, in this discussion. It is concluded that for a maximum radio frequency signal of 4.5 Mc the optimum number of scanning lines is between 441 and 507 lines at 30 frames per second.

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Hearing Aid Design Factors

THE FACTORS INFLUENCING the design of hearing aids are discussed in the July 1940 issue of the *Journal of the Society of Motion Picture Engineers* by Willis C. Beasley in an article entitled "Partial Deafness and Hearing-Aid Design." Despite the gradual, but continuous improvement in the performance characteristics of hearing aids during the past fifteen years, the available units are far from satisfactory to a partially deaf person. The author describes briefly a coordinated research program which will overcome the first obstacles in relieving this situation. The greater portion of this article is devoted to a description of and the presentation of data concerning the several degrees of practical handicaps in hearing speech under everyday conditions.

The hearing abilities of persons are divided into six groups as follows: (1) normal hearing for speech—the person who has never experienced difficulty of any kind with his hearing; (2) partial deafness, stage 1—the person who has experienced difficulty in hearing at the theater, in church or at a conference of five or six persons, but who could understand direct conversation satisfactorily; (3) partial deafness, stage 2—the person who has experienced difficulty in hearing ordinary direct conversation, but could hear loud speech, telephonic conversations or speech amplified by other means; (4) partial deafness, stage 3—the person who has experienced difficulty in hearing ordinary telephonic conversation, but could hear speech by means of amplifiers such as telephone amplifiers, electrical hearing aids, etc.; (5) total deafness for speech—the person who could not understand speech under any circumstances, even by means of amplifiers, but the impairment was acquired after the person had learned to speak language by ordinary methods of training; (6) deaf mutes—the person who was born deaf or acquired severe deafness at such an early age that he did not learn to speak language by ordinary means. The characteristics of these various stages of deafness are discussed and the requirements of a satisfactory hearing aid are described. A thoroughly extensive bibliography of the literature on this subject is given.

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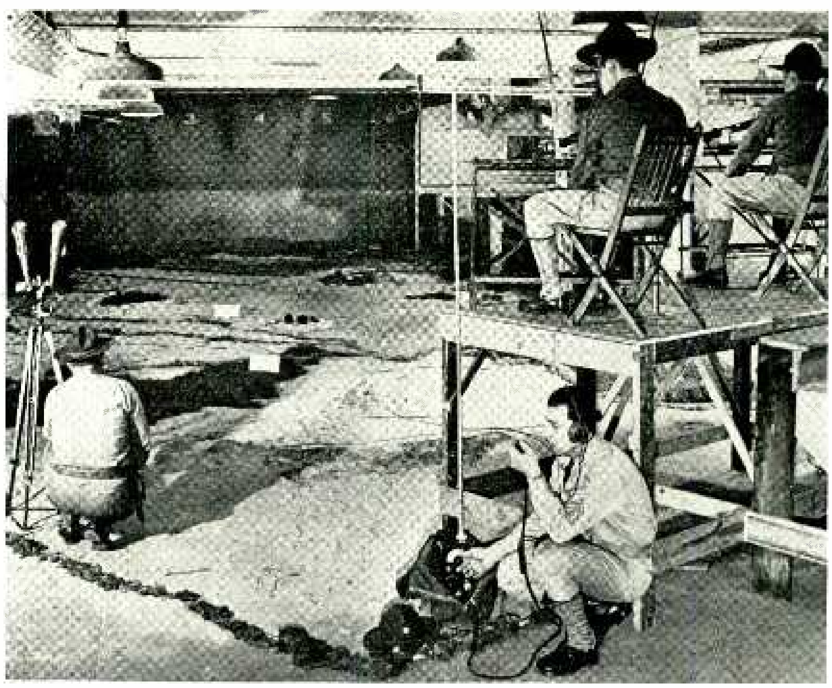
Amplidyne Generators

THE PRINCIPLES OF ELECTRONIC engineering and the principles of the engineering of rotating electrical equipment have been merged in the design of a new dynamo electric amplifier

MODEL BATTLEFIELD



To provide practice in aerial maneuvers, a model battle field has been built for the U. S. Army. An observer with telescope may be seen at the left, a radio operator in the foreground who relays observations to the center of firing directions on another floor, two gunners on the platform awaiting orders and, in the background an airplane observer. The model is built to scale to simulate actual conditions and is used to train soldiers for the defense of this country

known as the Amplidyne Generator. This new control instrument was developed to meet new control functions in industry where a high rate of amplification must be combined with quick and accurate response. A group of three articles appearing in the March 1940 issue of the *General Electric Review*, discuss its design and applications. They are "The Amplidyne generator—A Dynamoelectric Amplifier for Power Control" by E. F. W. Alexanderson, M. A. Edwards and K. K. Bowman, "Design Characteristics of Amplidyne Generators" by Alec Fisher, and "Industrial Applications of Amplidyne Generators" by D. R. Shoults, M. A. Edwards and F. E. Crever.

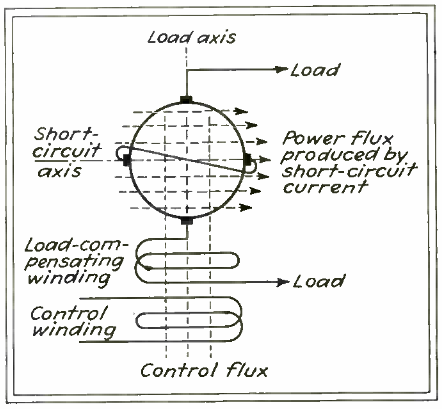


Diagram showing principle of operation of the Amplidyne Generator

This new control device is a two-stage amplifier incorporated into one dynamoelectric machine. In its physical structure it resembles the Winter-Eichberg motor, the Rosenberg generator and the Pestarini metadyne, characterized by a pair of short-circuited brushes at right angles to the power brushes. Its functions, however, are quite different. The first stage of amplification is from the control field to the short-circuited brushes, and the second stage from the short-circuited brushes to the power brushes. A high ratio of amplification of the order of 10,000 to 1 can be obtained by this system. The first mentioned article discusses the electronic analog and some of the characteristics of the Amplidyne Generator. Mr. Fisher's article explains the operation of the instrument and its operating characteristics under various conditions. The third article discusses the various methods of application to industrial operation. Actual installations of the Amplidyne Generator in a wide variety of applications are also described.

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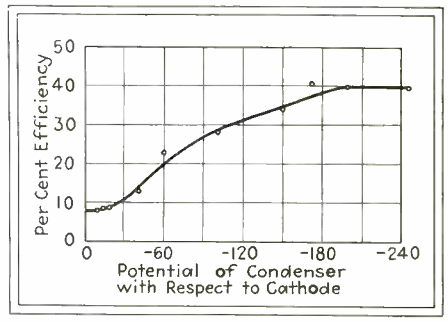
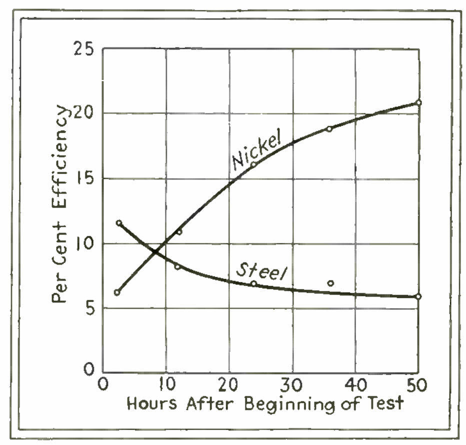
Mercury Condensation in Rectifiers

An article of interest to those concerned with the design of mercury-arc rectifiers is to be found in the July 1940 issue of *Electrical Engineering*. It is "Condensation of Mercury in Mercury-Arc Tubes," by Joseph Slepian and W. M. Brubaker. The successful operation of mercury-arc tubes depends to a great extent upon the vapor density being kept low, at least in the vicinity of the anodes. In mercury-arc tubes vapor is continuously evaporated from the surface of the mercury-pool cathode. It is re-condensed upon condensing surfaces which are kept cool either by water or air circulation. The vapor density in the tubes thus depends upon the dynamic balance between the evolution at the cathode and the removal of vapor by condensation at the condensing surfaces.



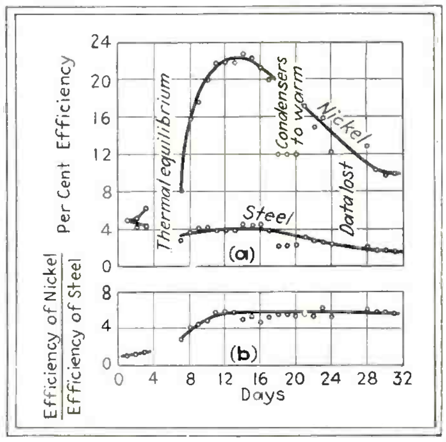
Curve showing effect of maintaining mercury condenser at a negative potential

It has been assumed that all mercury atoms reaching the condensing surfaces would be condensed. It was somewhat of a shock when attention was called to the fact that only extremely clean condensing surfaces have high condensing efficiency. Even the slightest contamination, quite unavoidable in practical tubes, reduces the condensing efficiency to very low values. The authors describe an experiment which they performed to determine the condensing efficiency on various surfaces under different conditions.



Comparison of nickel and steel condenser surfaces over a short period

The following conclusions were reached as a result of this experiment. Water cooled steel surfaces operating under conditions similar to those in a practical steel tank rectifier have very low condensing efficiency for mercury, usually less than 10 per cent. Operation at a negative potential with its resultant positive ion bombardment causes great increase in the condensing efficiency. The efficiency of nickel surfaces is usually several times as large as that for steel surfaces. Positive ion bombardment of the condensing surfaces of an 8,000-volt d-c, 25 ampere single phase ignitron rectifier greatly improved its operation. Similar treatment of a 3,000 volt, 200-ampere single phase rectifier however, produced no improvement in performance.



Comparison of nickel and steel condensers over a testing period of 32 days

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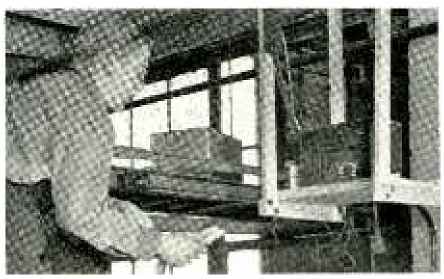
1940 VERSION OF THE POCKET RADIO

Gilbert Brown, of Hollywood, demonstrating how the four-tube radio which he built, can be carried in the pocket of a business suit. The miniature receiver is 6¼ inches long, 3¾ inches wide, 1¾ inches deep and weighs 1½ lbs. It is equipped with antenna and batteries sufficient for 100 hours of operation

Loudspeakers Speed Production

HOW A LOUDSPEAKER COMMUNICATION SYSTEM ties together the departments of the S. C. Johnson & Son plant in synchronizing production flow, straightening out tangles before they can cause tie-ups, and helping to get orders shipped faster, is described in an article by James Collier, in the July 1940 issue of *Factory Management and Maintenance.* It is entitled, "Loudspeakers Keep Us All in Step." With the installation of a modern conveyor system in this plant, the telephone system no longer provided adequate communication between the various departments.

Loudspeaker unit located in freight car to provide instant communication with shipping or production departments



This man controls shipping and loading operations by means of the loudspeaker unit

A loudspeaker system with nine master stations, each equipped to call any one of the other stations, was installed. By strategically locating these loudspeaker units, it was possible to have everything synchronized to keep a smooth and steady flow of goods going in the proper directions. The entire installation is quite inexpensive in comparison to the service it renders. The cost was about $35 per station.

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Locating Radio Interference

A NOVEL USE FOR BATTERY POWERED portable radio receivers is described in an article entitled "Portable Receiver Aids in Locating Radio Interference," by John F. Atkinson and Harold W. Kelley, which appears in the April 1940 issue of *Electric Light and Power.* Manmade interference is divided into two groups, interference originating on or near consumer premises and that originating on power lines. The first type is usually caused by electrical apparatus containing small motors, vibrators and thermostats. Therapy machines are also the cause of interference. Worn extension cords and broken plugs that do not make solid connections produce noise and, of course, faulty radio sets are the cause of a large number of complaints.

Power line interference caused a variety of defects in the line such as defective pin-type insulators, loose tie wires and pole hardware, defective transformers, transformer bushings, lightning arrestors and cutouts, and corona on wires and insulators.

Because of the loop antenna included in the portable receiver its reception is highly directional in character. By rotating the receiver until the signal from the interference is loudest, the direction to its source is indicated. With a little experience an operator can determine by listening to the interference the nature of its source and quickly locate it.

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Measurement of True Inductance at Radio Frequency

IT IS NOT ALWAYS SAFE to assume that at high frequencies circuit elements such as coil condensers or resistors are comprised of pure inductance, capacitance or resistance. It is therefore necessary to determine the true inductance capacitance or resistance of a circuit element in such a manner that the masking effect of other characteristics of that circuit element may be avoided. A method of measuring the

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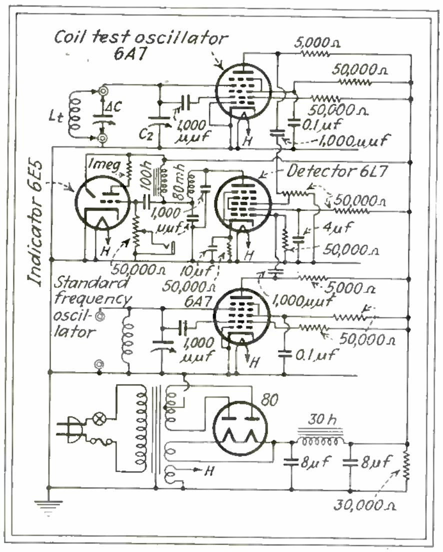
TRAINING THE EYES OF THE BRITISH NAVY

Instructional films are being prepared at the Royal Naval School of Photography to train British sailors. Here two men are seen recording sound for one of these instructional films true inductance of coils at high frequencies is given in an article by Henry R. Heese entitled "R-F Inductance Measurements Using Beat Frequency Test Equipment" in the May, 1940 issue of the *R.M.A. Engineer*. The true inductance of a coil may be determined by resonance methods by using two different and precisely known frequencies and noting the difference in the capacitances required to tune the coil to these two frequencies. The true inductance L_t together with its distributed capacitance C_o is first tuned to high frequency f_2 by shunt capacitance C_2; then by adding capacitance



Circuit diagram of instrument for measuring inductance at radio frequencies

C, the circuit is tuned to low frequency f_1. The resonance equations for the two frequencies are:

$$f_1 = \frac{1}{2\pi L_t (C_0 + C_2 + C)}$$
$$f_2 = \frac{1}{2\pi L_t (C_0 + C_2)} \qquad (1)$$

These equations may be combined and reduced to

$$L_t \Delta C = \frac{1}{(2\pi f_1)^2} - \frac{1}{(2\pi f_2)^2} \qquad (2)$$

from which the distributed capacitance C_o has been eliminated.

Calculations can be greatly facilitated by a suitable tabulation of frequency versus the reciprocal of $(2\pi f)^2$ and since

$$\frac{1}{(2\pi f)^2} = LC \qquad (3)$$

a table of LC values has been provided in the appendix. The LC product is substituted in Equation (2) to give

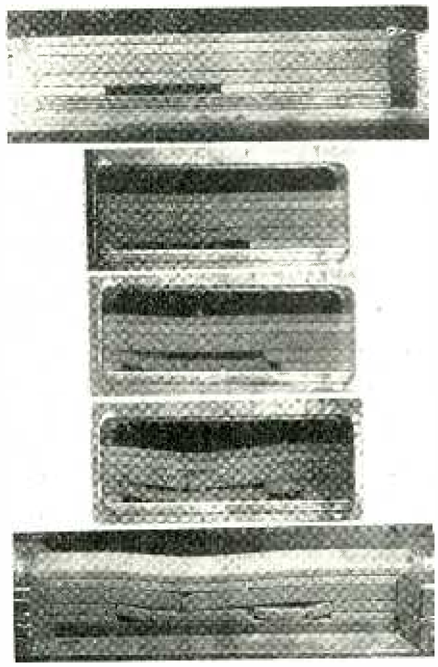
$$L_t = \frac{(LC)_1 - (LC)_2}{C} \qquad (4)$$

This is the equation for true inductance.

An instrument for performing this measurement is described by the author and the circuit diagram is given in the accompanying figure.

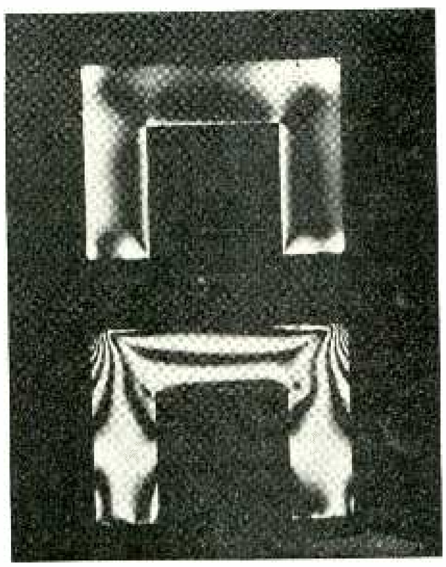
Stroboscope in Structural Research

"The Stroboscope in Structural Research," by F. Ireland, appearing in the July 1940 issue of the *General Radio Experimenter*, describes how the



Progressive stages of failure in a model mine wall structure in a centrifuge. Photographed with a stroboscopic camera

stroboscope is used by Professor Philip Bucky of the Columbia University School of Mines in studying various types of structures. Because of the unwieldly proportion of the original structure, a scalar model of more convenient size is made. The principle of similitude is supplied to the model by spinning it in a centrifuge and substituting the centrifugal field for the gravitational field. When spun at a speed such that the centrifugal force is increased at the same ratio as the linear dimensions of the prototype have been decreased, the model behaves exactly like its prototype. A camera is mounted over the centrifuge in a position to take a picture of the model as it passes directly beneath it and a stroboscope is arranged to give a single light pulse each time the model comes into position in front of the camera. The duration of the light is short enough so that the picture is not blurred.



Photographs of a model bakelite structure by polarized light. Upper photo shows unstressed model and lower photo shows model stressed with static loading

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Electronic Fire Detector

A new highly sensitive fire detector, making use of electronic principles, is briefly described in the July 1940 issue of *Electronics and Television & Short-Wave World*. It was noted by McClelland in 1899 and subsequently by Langevin, that the physical properties of air change in the vicinity of a combustion. It appears that the so-called Langevin-ions are evolved in large quantities from the combustion of material, but not with radiant heat.

The electronic fire detector contains an electrostatic relay which operates whenever the conductivity of the surrounding air space varies. The air space is permanently ionized by a radioactive substance in the detector, and its conductivity is continuously compared with that of a rare gas sealed within a glass vessel of the detector, which is also subjected to the rays from a radioactive substance.

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CHECKING F-M RECEPTION

This test car is used to check the reception in various parts of Wisconsin of the frequency-modulation station, W9OXA of the Milwaukee Journal. This is the only f-m station now operating west of the Mississippi

New Books

(Continued from page 38)

The Nature of Crystals

BY A. G. WARD

The Nature of the Atom

BY G. K. T. CONN

The Wave Nature of the Electron

BY G. K. T. CONN

The Cyclotron

BY W. B. MANN

Published by Blackie and Sons, Limited, London. Distributed by the Chemical Publishing Co., New York. 114 pages, 52 illustrations; 115 pages 15 illustrations; 78 pages, 17 illustrations; 92 pages, 31 illustrations, respectively. Price $1.50 each.

THESE FOUR LITTLE BOOKS make excellent sources of background material for electronic engineers who profess to know something of the physical background of their chosen field of work. The first three constitute a brief review of the nature of matter from the modern viewpoint, the last of one of the most important electronic tools in the hands of the physicist. While in no sense a required part of the professional equipment of electronic specialist, they nevertheless make worthwhile additions to a technical library.

Mr. Wards monograph reviews in simple but not popularized language the history and present status of crystalline structure theory, he suggests a very interesting hobby in the study of crystal forms. The two books by Mr. Conn are excellent reviews of the atomic and electronic entities. The "Wave Nature of the Electron" is especially interesting in that it gives a clear picture of wave mechanics in simple terms. Mr. Mann's description of the cyclotron gives considerable information of construction, high frequency oscillator circuits, and operation procedure hitherto available only in periodicals.—D.G.F.

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Radio At Ultra-High Frequencies

448 pages. Not for sale; available with subscriptions to the RCA Review. Published by RCA Institutes Technical Press, New York

THIS, A VOLUME OF COLLECTED PAPERS of R.C.A. engineers issued in connection with the promotion of the journal, *RCA Review*, is the fourth of a series which includes two volumes of papers on Television and one on Facsimile. The present collection of articles on Ultra-High Frequencies is divided into: Transmitting Methods and Equipment; Propagation and Relaying; Measurement; Reception; Above 300 Mc. Papers falling within this classification are presented in full; other work on uhf by R.C.A. engineers which does not logically fall within it is given in abstract form.

All of the papers, except those by Seeley and Barden, "A New Method of Measurement of Ultra-High Frequency Impedance," and Holmes and Turner, "Simple Antennas and Receiver Input Circuits for Ultra-High Frequencies," have been previously published. Many of the reprinted papers are widely known, among them Thompson and Rose on acorn tubes, Haeff on inductive output tubes, Crosby on frequency modulation and Nergaard on u-h-f measurements. It is of interest to point out that, of the 23 papers, 5 deal with frequency modulation.

While most of the papers have appeared before, many are not readily obtainable everywhere, and, in addition, it is convenient, particularly for the specialist, to have them available under one cover. The convenience of the volume is reduced somewhat by the lack of subject and author indexes, and by the lack of complete references —page and volume numbers—to the original sources of reprinted papers.—DALE POLLACK.

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CONTROL EQUIPMENT FOR TINY TOWN

Here is shown the reproducing and control equipment used in Tiny Town and the talking flagstones which are an innovation this year at the World's Fair of 1940. Houses open up before your eyes and a voice extols their advantages, or pavement stones object when they are stepped upon in this unusual exhibit

THE INDUSTRY IN REVIEW

News

✦ Preliminary tests to study the field strength of televised signals in the New York area are being launched by engineers erecting the new Allen B. DuMont television station, W2XWV, at 515 Madison Ave., New York City. A temporary antenna has been set up on the station building in preparation for the tests. When W2XWV officially goes on the air in the Autumn, it will be operated on 1 kw with an effective receptive range of more than 30 miles, it is estimated. The station had been assigned channel No. 4 in the 78-84 Mc band by the F.C.C. . . . The appointment of Col. Hugh Knerr, formerly of the U. S. Army Air Corps, as a Special Consultant to the Sperry Gyroscope Co., was announced. Col. Knerr will act as a consultant to the heads of the Marine, Aeronautical and other departments of the Sperry organization . . . Elastic Stop Nut Corp., announced the moving of its general offices from Elizabeth, N. J., to its new plant at 2332 Vauxhall Rd., Union, N. J. . . . Bakelite Corp., and Halowax Corp., have been moved from 247 Park Avenue to Carbide & Carbon Bldg., 30 East 42nd St., New York City . . . The Beaux-Arts Institute of Design, New York City, brought to a conclusion its first competition for the design of an ideal building in which to house a radio transmitter and its auxiliary equipment. First prize of $250 was awarded to Louis Shulman, second prize of $100 went to Roger W. Flood, and $50 as third prize was awarded Percy C. Ilfill. All of the prize designs, as well as 24 renderings receiving honorable mention, will be made available to the broadcasting industry. The contest was sponsored by the Western Electric Co. . . . Rowe Radio Research Lab. Co., is now located at 4201 Irving Park Blvd., Chicago. . . . E. F. Johnson Co., Waseca, Minn., has completed arrangements for the purchase of all assets connected with the antenna and concentric cable business of the Bassett Radio Mfg. Co., of Niles, Mich. . . . The appointment of Walter R. Jones, Emporium, Pa., to the post of Director of Commercial Engineering, Radio Tube Div., is announced by Hygrade Sylvania. Mr. Jones will administer and guide the activities of the company's engineering consultants and radio service schools . . . Callite Tungsten Corp., Union City, N. J., announces the acquisition of Harris Alloys, Inc., which will be conducted as a division of and under the corporate name of Callite Tungsten Corp., Frederick T. Harris, former Harris executive head, will have full charge of operations of this new division . . . Finch Telecommunications Inc., of Passaic, N. J., manufacturers of facsimile apparatus and other equipment announced the appointment of James W. Baldwin as assistant to the president and in charge of its new offices in the Bowen Bldg., Washington, D. C. Mr. Baldwin was formerly Secretary of the Federal Radio Commission . . . A substantial interest in National Union Radio Corp., Newark, N. J., has been purchased by Philco Corp., as the first step in a program to expand the scope and activities of National Union. It will continue as a separate company to manufacture its products and distribute them nationally under its own trademark, as in the past.

Literature

Voltage Regulator Transformer. A 4-page bulletin describes "Voltstat" variable voltage regulator transformer for light dimmers, heat, speed and line voltage control. Industrial Transformer Corp., 2540 Belmont Ave., New York City. Also available is a 1-page bulletin devoted to two models of insulation breakdown testers.

Resistors, Attenuators and Measuring Equipment. The Daven Co., 160 Summit St., Newark, N. J. has just issued an indexed bound catalog which contains technical information on the various standard resistors, attenuators and measuring equipment which it manufacturers for use in the communications field.

Coaxial Transmission Line. Bulletin No. 101-E (which supersedes No.101-A) gives specifications, illustrations and a description of ⅜-inch diameter coaxial transmission line. Isolantite Inc., 23 Broadway, New York City.

Power Supplies and Electronic Converters. Electronic Labs., Inc., Indianapolis, Ind., have available two bulletins. The first, entitled "Custom Built Power Supplies" is a pictorial review compiled from typical examples of unique custom built power supplies for the electrical, aircraft and general industries. The second bulletin "Electronic Converters" illustrates and describes several such instruments. Also contained in this bulletin is an electronic converter valugraph in which the converters are grouped by input voltage.

Insulation Testers. James G. Biddle Co., 1211 Arch St., Philadelphia, Pa., have published Bulletins 1655 and 1660 to explain methods of measuring insulation of nearly all types of electrical equipment. Bulletin 1655 tells how to get results with hand-driven "Megger" insulation testers intended for industrial plants. Bulletin 1660 discusses dielectric absorption measurements in large equipment using motor-driven "Megger" testing sets.

Transformer Catalog. Bulletin PS-404 incorporates a complete listing of the entire 1940–41 line of transformer components for broadcast, aircraft, industrial amateur and replacement service. United Transformer Corp., 150 Varick St., New York City.

Automatic Tuning. Discussed in Supplement No. 8 to the 3rd edition of the Mallory-Yaxley Radio Service Encyclopedia, available from P. R. Mallory & Co., Inc., Indianapolis.

Instruments and Instrument Transformers. Folder F 8563 is a new 3-page illustrated folder describing a simplified line of instruments and instrument transformers. Suggested application and accuracy are given for the various portable indicating, switchboard, socket and recording instruments. An illustrated page listing the ratings and accuracies of portable and standardized current and voltage transformers completes the leaflet. Dept. 7-N-20, Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

Zirconium. "Zirconium as a Getter" is an article contained in Vol. 13, No. 1 of Foote-Prints available from Foote Mineral Co., 16th and Summer Sts., Phila., Pa. Dr. J. D. Fast discusses the physical properties of zirconium and its ability to absorb gases and its possible use as a getter in radio tubes.

Broadcast Catalog. Catalog No. 500-E entitled "Tru-Fidelity" is devoted to descriptions and illustrations of broadcast transformers available from Thordarson Elec. Mfg. Co., 500 W. Huron St., Chicago.

Resistance Standards. The new No. 810-M bulletin describes accurately calibrated resistance standards from 1 ohm to 10 megohms in single units and in various combinations. Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.

House Organ. *Electrical Measurements* is the name of a house organ published by Sensitive Research Instrument Corp., 4545 Bronx Blvd., New York City. This is a bulletin devoted to a description of new and unusual instruments.

Rosin-Core Solder. Form 61 tells about Rosin-Core a self-fluxing solder available from Gardiner Metal Co., 4820 S. Campbell Ave., Chicago. One side of the bulletin gives information concerning dimensions and melting points.

Alcoa Aluminum. Aluminum Co. of America, Gulf Bldg., Pittsburgh, Pa., have issued a very beautifully illustrated catalog of products made from "Alcoa" aluminum. This catalog known as "Impact Extrusions and Pressings" contains among other items illustrations and descriptions of such products as electrolytic condenser cans, electrical and condenser parts, coupling and gears, coupling parts, sound-movie apparatus, etc.

Data Book. This book tells the how, where and why "Formica" is used. Formica is a laminated plastic product made with synthetic resins of the phenolic or urea types, which is cured into a hard compact material by heat and pressure. All classes of Formica are infusible and insoluble. Formica Insulation Co., Cincinnati, Ohio.

Sockets, Connectors and Accessories. Catalog No. 62, 1941, describes the products available for aircraft, radio and electrical industries from American Phenolic Corp., 1250 Van Buren St., Chicago. Two pages are devoted to a numerical index and list prices, while the back cover illustrates colored sockets, plugs and receptacles which can be had to identify circuits, etc.

Recording Blanks. The Gould-Moody Co., 395 Broadway, New York City, have produced a pamphlet which explains the characteristics, physical and chemical properties of the Gould-Moody "Perfected" disc, together with a brief discussion of some of the more prevalent disc-cutting and instantaneous recording problems.

Panel Instruments. Panel type 3-inch and 4-inch instruments are described in Catalog 4120 available from Roller-Smith Co., Bethlehem, Pa.

Welded Stainless Tubing. This data book tells what welded stainless tubing is, where it is used, and gives design and working instructions. Available from Carpenter Steel Co., Welded Alloy Tube Div., Kenilworth, N. J.

Extruding Tube. "Irv-O-Lite, a new low-cost extruding tubing", is the title of a bulletin available from Irvington Varnish & Insulator Co., 24 Argyle Place, Irvington, N. J. This bulletin covers the outstanding features of a new extruded tubing called Type XTE-30 and contains samples, gives sizes, etc.

Stop-Nuts. Many different types of elastic stop-nuts are included in this 57-page catalog available from Elastic Stop Nut Corp., 2332 Vauxhall Rd., Union, N. J.

G-R Experimenter. Three interesting articles make up the July issue of General Radio's (Cambridge, Mass.) house organ *Experimenter.* They are: A Portable Megohmmeter, The Stroboscope in Structural Research, and Using the Variac with Auxiliary Transformers.

Mu-Switch Catalog. A 10-page catalog presents the complete story of these switches. Basic design data, showing the simplicity of Mu-Switch construction, are supplemented by stroboscopic photographs. Mu-Switch Corp., Canton, Mass.

PA catalog. Sun Radio Co., (212 Fulton St., New York City) have recently published their first catalog, illustrated, on PA systems, accessories, microphones etc.

Coil Winders. Several bulletins which describe different models of coil winders such as for radio receivers, heavy duty winding, etc. are available from Universal Winding Co., P. O. Box 1605, Providence, R. I.

Coaxial Cable. "Use of Coaxial Cable in Television", "F-M and other u-h-f Services", "Coaxial Cable for Test Instrument Leads" and a description of a new Amphenol "Twinax" cable are all contained in the latest *Amphenol News* available from American Phenolic Corp., 1250 Van Buren St., Chicago.

New Products

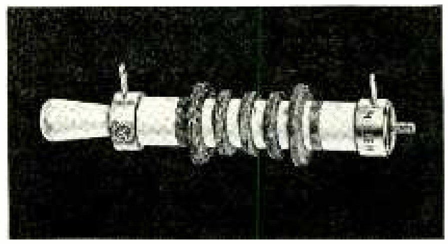
Solder Pots

Two electrically heated solder pots for tinning small electric wires and leads have been developed by Lectrohm, Inc., 5133 W. 25th Place, Cicero, Ill. They were designed for individual operator's use in services where only a pound or less of solder need be melted as requirements demand.

One of the chief advantages claimed for these solder pots is the greater convenience they promote in tinning wires. These pots are single heat units designed for continuous operation. They may be plugged into any 110-volt a-c or d-c outlet. Each unit has a cast iron pot of 1¾ or 2 lb solder capacity mounted on a cadmium plated steel stand. The heating element is an inexpensive quickly replaced Nichrome element. A 6-ft approved cord and attachment plug is regularly supplied.

Choke and Bushing

Two new products are available from James Millen Mfg. Co., Malden, Mass. The first is a Thru-Bushing of an unusual design. Instead of conventional lock washer and nut for holding in place, a metallic sleeve has been die cast around the Isolantite tube. Thus when the bushing is dropped in a ¼ inch hole in the chassis or panel and the metallic sleeve touched with a drop of solder, the bushing is held firmly in place and cannot vibrate or work



loose. While originally designed for aircraft and mobile equipment, the compactness and low price of this bushing makes it suited for many other applications. The other new development is a new 500 ma iron core r-f choke having extremely high impedance over wide range of frequencies. While originally designed for use on amateur bands between 30 Mc and 1.6 Mc, it is ideally suited for other commercial applications. A feature of this choke is the unique type of mounting comprising die cast end terminals with threaded stud inserts which makes it easier to use. The catalog number is 34150.

Photoelectric Cell

A new type Selenium Barrier Layer Photoelectric Cell, developed and manufactured by the Bradley Laboratories, Inc., of New Haven, Connecticut, is offered for light measurement and control. A special sensitizing process gives these cells high current sensitivity as well as high internal impedance. They are electrically stable and ruggedly constructed. The Bradley Cell is available in standard sizes or constructed to individual specifications.

Cutting Needles

Stiff tool metal is used to obtain hardness in the steel cutting needles available from Recoton Corp., 178 Prince St., New York City. Other features are: Special Swedish steel alloy retains the cutting edge for a longer time; Diamond-dust polishing affords a smoother cutting edge resulting in a quiet, shiny groove; and each needle has a flat on the shank making it impossible to insert it at a wrong angle.

Microphone Switches

A new series of microphone switches for crystal, dynamic and velocity microphones is announced by the American Phenolic Corporation, of Chicago, Illinois. The MCIS switch is of the "press-to-talk" type, a slight downward movement of the thumb locking it in the "on" position. Has a coupling ring at one end, with coupling threads at the other end, machined to fit standard MC1 microphone connectors. Switch spring is silver-plated for low resistance contact and continued noise-free operation.

ELECTRONICS—1940 . . .

Every Month Ahead of Last Year

Why?

BY RESULTS, advertisers have proved that ELECTRONICS is the product catalog for all important development men and engineers in radio, broadcasting, industrial control and other industries wherein the electronic principle finds use.

Critical need for rapid expansion of this field industrially, plus new and revolutionary procedures in broadcasting, plus a call for an unprecedented number of radios for a news-alert nation—add up to a new intensity of business which is reflected in ELECTRONICS advertising.

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Jan.	Feb.	Mar.	Apr.	May	June	July	this issue
49%	9%	14%	83%	16%	57%	19%	57%

GRAND AVERAGE INCREASE FOR 8 MONTHS, 37%

ADD ELECTRONICS TO YOUR SALES STAFF

Portable Television Pickup Equipment

Allen B. DuMont's (Passaic, N. J.) new pickup equipment, exclusive of the u-h-f relay transmitter and transmitter power supplies, comprises the camera and seven units which are as compact as a movie sound camera and just as easy to operate, and can be readily carried in any sedan automobile. The camera is of the iconoscope type. The image is focused by means of an f/2.5 9¾-inch lens on the mosaic screen of the iconoscope tube. The camera (weight 45 lbs) contains the preamplifier for building up the video signals which are passed through a heavy shielded coaxial cable to the

separate intermediate amplifier unit. Detailed information is available from DuMont Labs.

The latest DuMont 20 inch television receiver, Model 195, is designed for flexible reception which includes both RMA and DuMont types of synchronizing signals, which is achieved by a simple selector switch. The range of the sweep controls of this receiver is sufficient to cover line and frame combination from 625 lines at 15 frames to 507 lines at 30 frames. The receiver handles all-wave broadcast reception as well.

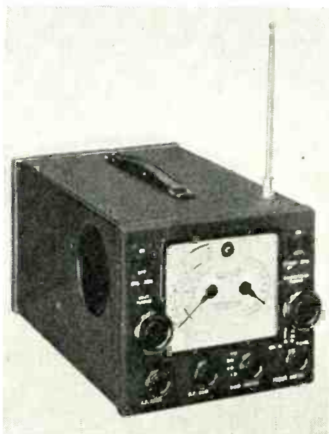
Crystal Unit

A new crystal unit for broadcast service, the G30 Thermocell, with a guaranteed temperature coefficient of less than one part per million per degree C has been announced by General Electric Co., Schenectady, N. Y. Approved by the FCC, the G30 is guaranteed to maintain transmitter frequency within ± 10 cycles at any specified point in the broadcast band. The low temperature-coefficient of the quartz plate is possible through the use of special x-ray equipment during manufacture which determines the angle of crystal cut. From a cold start, the new Thermocell is ready to go on the air in less than fifteen minutes. Only 2 watts of heating power are required, because of the small size and careful thermal design of the unit. The control ratio is more than 50:1. Detailed description is available from GE.

Also announced is a new square wave generator which simplifies and speeds up the study and recording of the response of electrical circuits. Instead of producing a voltage wave shape corresponding to the usual wave-like line with rounded tops and bottoms, as produced in power circuits, this generator, a vacuum-tube device, causes a sequence of virtually square figures on the screen of an oscilloscope. These voltages are applied to the circuit under test, and its response is observed on an oscilloscope. The range of frequencies covered is much wider than possible with previous equipment.

Portable Communications Receiver

The complete adaptability of Hallicrafter Model S-29 3-in-1 portable communications receiver for all types of service is indicated by the number of controls, the inclusion of both built-in speaker and headphone jack, a collapsible rod antenna socket mounted on the case plus external antenna connections for both doublet and "L" antennas. S-29 "Sky Traveler" has 9



tubes which provide one r-f and two i-f stages, mixer, detector and avc, two audio stages, beat oscillator, automatic noise limiter, and line rectifier. The tuning range is continuous from 542 kc, to 30.5 Mc in four steps and electrical band-spreading is provided for all parts of this range. Sensitivity averages better than 2 microvolts in all ranges. Operation is from any 110 volt a-c or d-c line or from batteries. It is available from Hallicrafter's Inc., 2611 S. Indiana Ave., Chicago.

Insulating Beads

A new glazed ceramic insulating bead is announced by the American Lava Corporation, Chattanooga, Tenn. It is made of AlSiMag and has the same high mechanical strength, density and electrical resistance, even at elevated temperatures. An outstanding feature is the smooth, glazed inside area which lowers friction, facilitates stringing, safeguards the wire against tearing during assembly and use. Smooth edges throughout are a feature of the new design. Developed as an improvement over imported glass beads, they are available in a wide range of sizes and come in dark colors.

Western Electric Products

"Synchronized frequency-modulation" is the term selected by Western Electric Co. (195 Broadway, New York City) to describe its new line of 503A-1 transmitters. It is a system, developed in Bell Laboratories, in which the average or carrier frequency of the f-m carrier wave is locked in step with the vibrations of a precision quartz oscillator. The carrier drift is thus confined to extremely close limits, to within .0025%, or approximately four times better than the present F.C.C. requirement of .01%. The unit is completely self-contained, functions either as a transmitter for powers up to 1 kw, or as a driver for high-power r-f amplifiers where more than 1 kw output is desired. All of the apparatus needed to take a program signal input and primary power to deliver a frequency modulated radio signal to a transmission line is mounted on a central structure.

A marine radio telephone of 25 watts output, especially designed for the deep sea yachtsman and for commercial ships plying coastal waters has been announced. Model 226C features crystal control on both receiver and transmitter, high intelligibility, and semi-automatic operation. It operates from 110 volts, 60 cps, ac, which may be supplied by a small, inexpensive, rotary converter. A universal phonograph reproducer which plays both the vertical cut and lateral cut records has also been announced. The response of Model 9A is essentially flat up to nearly 10,000 cps for both types of recording. The vibrating system employs two adjacent voltage-generating coils instead of one. An adjustable equalizer capable of introducing a series of complementary characteristics has been designed for use with the 9A reproducer. This unit is known as the 171A repeat coil and the K.S. 10066 switch which also serves as a means of matching the impedance of the unit to the input of the amplifier. These input values may be 30, 250, 500 or 600 ohms.

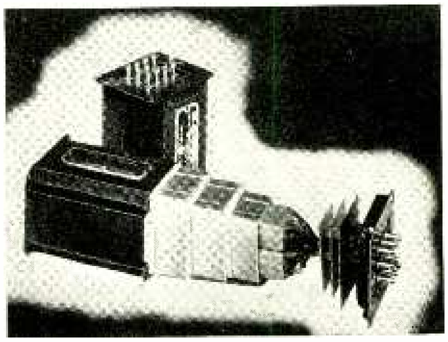
RCA Tubes

RCA Mfg. Co., Harrison, N. J., announces new tubes as follows: RCA-880 transmitting triode water-cooled type; RCA 889-R transmitting triode air-cooled radiator type. Both of these tubes have been designed for use with full input at frequencies as high as 25 Mc.

Also available is 117N7-GT, a multi-unit tube containing a half-wave rectifier and a beam power amplifier in the same envelope (T-9). It is intended primarily for use in portable battery a-c and d-c receivers. 827-R is a new air-cooled radiator type of u-h-f transmitting beam power amplifier. Design features of 827-R include multiple-ribbon filament leads, two multiple-ribbon grid leads to minimize the effect of lead inductance, and an entrant metal header.

Humbucking Transformers

Two new types of telescopic shielded humbucking transformers have been added to the line of Kenyon Transformer Co., Inc., 840 Barry St., New York City. Type P204, has a primary of 500, 333, 250, 200, 125, 50 ohms and secondary of 50,000 ohms (single class A grid). Frequency response plus or



minus 1 db 30 to 20,000 cps. Shielding, 90 db. Type P205 has a primary the same as P204 and a secondary of 100,000 ohms to P.P. grids. Frequency response is ± 1 db 30 to 20,000 cps. Shielding, 90 db. Transformers in this group are annealed after complete construction to remove all bending and shearing strains brought about during manufacture.

Microphones

Universal Microphone Co., Inglewood, Cal., has a new aircraft model microphone especially designed for private craft, marine installation and mobile transmitters. The unit is a single button carbon; impedance of 200 ohms; output approximately 30 volts rms across microphone transformer secondary. DPST press-to-talk switch connects the microphone and relay circuit simultaneously. A heavy duty "push-in" mounting bracket is included in the assembly. The case is of black bakelite and reinforced moisture proof cord is attached. Motor noises are damped out by specially designed anti-noise construction.

There has been announced by Electro-Voice Manufacturing Co., Inc., 1239 South Bend Ave., South Bend, Ind., the new "605" dynamic microphone. Among its features are an aluminum voice coil, polystyrene insulation, Durev diaphragm, Zamak castings, Armco iron magnetic circuit, a large Alnico magnet and a 5/8-inch 27 coupling for the mike stand. The frequency response is 45 to 8,000 cps and the output level is −57 db. Impedances available are 50, 200 and 500 ohms and Hi-Z for direct grid connection. It weighs 15 oz.

Microphone Stand

A heavy weight broadcast microphone floor stand offered by Shure Bros., 225 W. Huron St., Chicago, employs heavy, non-vibrating, large diameter tubing for rigidity and freedom from noise.

Power Tube Tester

A new power tube tester has just been developed by Harvey-Wells Communications Inc. of Southbridge, Mass., to facilitate taking accurate measurements of power and rectifier tube characteristics under variable load conditions. The Type R-83 tube tester was designed specifically for airlines and other organizations maintaining a relatively large group of transmitter installations, which must be kept at peak operating performance at all times. With the R-83 tester new tubes may be accepted or rejected after delivery and tubes in service can be checked at frequent intervals for correct performance.

Portable Recorder

A portable recording system adaptable as a PA system has been announced by The Webster Co., 5622 Bloomingdale Ave., Chicago. The system includes a recording amplifier with volume and tone controls and VI meter, a crystal pickup with a 2 oz needle pressure,

slanting control panel, and a monitor speaker. It will cut records up to a 10 inch size, and it has a crystal head self-groove cutter. There are 98 lines per inch. The speed of the turntable is 78 rpm. The system includes a carrying case as well as a microphone. A 33⅓ rpm model is also available.

Glass Enclosed Fuses

Littlefuse, Inc., 4757 Ravenswood Ave., Chicago, offers Underwriters approved Type 3AG glass enclosed fuses in ratings up to 8 amp for 250 volt ac or dc service or less. The size is 1¼x¼ inch. The glass sleeve condenses the metallic vapors released under short-circuit and reduces pressure due to this cause and also prevents the sudden wave front of air pressure from striking the outer glass casing due to sudden air expansion under the heat of short circuit.

PM Speaker

The new speaker, Model 12DM2 is an addition to numerous other Permag models. It is rated at 20 watts and is capable of greater peaks. A new type of voice coil construction and spider assembly improves the performance of the speaker. It is available from Oxford Tartak Radio Corp., 915 W. Van Buren St., Chicago. Another model available is Permag cabinet speaker 3ZM-CA which measures 4½x4x1¾ in. while a second unit, Model 3ZM-CM designed for use as a microphone is equipped with a special shielded transformer.

Microphone Cable Transformers

Three new microphone cable transformers, just released by United Transformer Corporation, 150 Varick St., New York City, are designed to be inserted in the cable circuit. The units are ruggedly constructed to withstand mechanical abuse. Cable connections are made through the spring strain relief to terminal boards inside the end caps. Standard fidelity and high fidelity line to grid models are available, as well as a crystal-to-line matching unit.

Small Power and Midget Relays

Potter & Brumfield Mfg. Co., Inc., Princeton, Ind., announce, as additions to their line of small power and midget relays, a series of multiple spring types and a series of compact low cost plate circuit relays. Either of the new types is offered for ac or dc and can be wound up to 10,000 ohms for maximum sensitivity in plate circuit applications. Radio antenna changeover and keying relays with polystyrene non-hygroscopic low-loss insulation are also new in the line.

Midget Phonograph Inverters

American Television & Radio Co., 300 East Fourth Street, St. Paul, Minnesota, announces a new line of Midget Phonograph Inverters. ATR Midget Phonograph Inverters are for operation on 110 volts dc inverting same to 110 volts ac 60 cycles at an output of 15 watts and are available in two models: Model PCP-F has a built-in r-f interference suppression system and is designed primarily for small record players in conjunction with radio sets, and Model PCP-R, which is intended primarily for the operation of the a-c phonograph portion in a-c d-c radio-phonograph combinations.

Other New Products

Because of the lack of space it is impossible for the editors to describe in detail the following items of interest. More information can be obtained from the manufacturers.

Portable Model T16 record player of Speak-O-Phone Recording & Equip. Co. (23 West 60th St., New York City), is released particularly for transcription playback. Model DR-125

SEARCHLIGHT SECTION

(Classified Advertising)

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COMPONENTS ENGINEER—Must be experienced radio parts engineer and graduate electrical engineer. Practical experience in analyzing electrical and mechanical quality and design of samples submitted, as well as actual designing experience preferred. All replies confidential but give particulars of age, experience and salary. P-241, Electronics, 330 W. 42nd St., New York, N. Y.

Brush Development Co. requires acoustical engineer experienced in theory and design practice of microphones, speakers, phones, etc. Mail full details, qualifications, experience, salary required to Brush Development Co., 3311 Perkins Ave., Cleveland, Ohio.

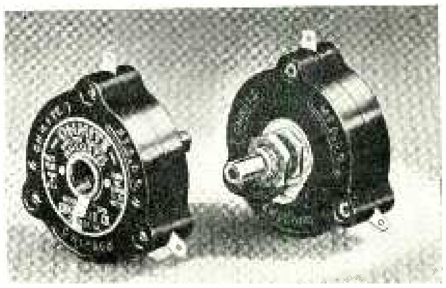
POSITIONS WANTED

CHIEF ENGINEER—Eastern NBC outlet necessary to live in milder climate desires position in the south or southwest. Present position 11 years satisfactory record as executive and engineer. Age 33. Available for interview at own expense latter part of August. PW-242, Electronics, 330 W. 42nd St., New York, N. Y.

PHYSICIST—Nine years experience in design, development, production and application of high vacuum and gaseous discharge tubes. PW-243, Electronics, 330 W. 42nd St., New York, N. Y.

PATENT ATTORNEY

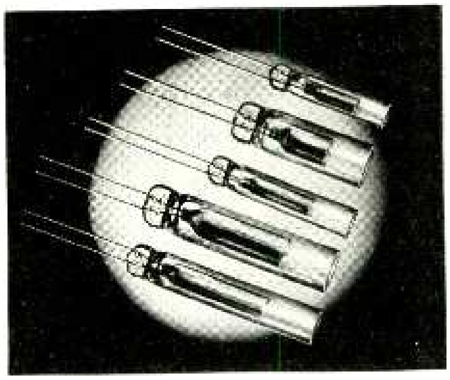
Preliminary Searches: Applications; Patent Sales; Charges Reasonable. Formerly Manager RCA Victor Patent Department. Thad Goldsborough, 2714 Quarry Road, Washington, D. C.



Ohmite's rheostat

direction indicator rheostat of Ohmite Mfg. Co. (4835 Flournoy St., Chicago), is a compact, convenient device for use in order to send an indication of the position to a remote point. Two items announced by Alden Products Co. are 440JL jewel pilot light assembly and 440FZS fuse holder. A power resistor decade box capable of handling real power so that it can be inserted in actual circuits to simulate working conditions, is announced by Clarostat Mfg. Co. (285 6th St., Brooklyn, N. Y). Catalog 160T, available from Cornell-Dubilier, S. Plainfield, N. J., describes in detail improved silver mica capacitors for applications in electronic circuits where the utmost in frequency stability is essential. Also announced by Cornell-Dubilier are (Type IF-18 "Quietone") radio noise filters which can be used either in the supply line to the radio set or in the line to a noise-creating electrical appliance.

Development of an improved non-insulated rigid sign electrode for neon and fluorescent tubing was announced by Callite Tungsten Corp., Union City,



Callite Tungsten's sign electrode

N. J. It is known as "Cal-lux." RCA Mfg. Co. (Camden, N. J.), introduced Model AR-77 "extended range" speaker for amateurs and short wave fans. Model 1632 is a complete wide-range signal generator available from Triplett Electrical Instrument Co., Bluffton, Ohio. Heavy number wheels are replaced by bakelite in a new streamlined mechanical counter developed by Production Instrument Co., 710 W. Jackson Blvd., Chicago. The Hart Mfg. Co., Hartford, Conn., announced a new single pole toggle switch with "snap-in" mounting. Catalog 600-E describes in detail a new microphone cable transformer available from Thordarson Elec. Mfg. Co., 500 W. Huron St., Chicago.

Relays

(Continued from page 16)

relay class are those for underload and overload protection (usually a self-latching relay with manual or solenoid reset), double relays for motor reversing service, and ratchet relays for step-by-step control of several circuits.

Time delay relays are of particular interest in protecting the cathodes of gas-filled tubes, as well as in control applications where time is a factor in the control. Two types of delay relay have prominence: the clock-operated relay and the thermal type. The clock relay usually employs a self-starting synchronous clock motor to which the initiating voltage is applied and an auxiliary mechanism for closing the coil circuit of an auxiliary relay when the desired time has elapsed. The motor is disconnected at the same time by an auxiliary contact, and the relay is "recycled" ready for the next initiating impulse. Almost any range of timing interval is available in the clock-type relay.

The thermal relays depend on the differential expansion of two pieces of metal, through one of which the control current passes. When sufficient time has elapsed, after the application of the current, the metal pieces snap over in the manner of a thermostat and close a contact in the coil circuit of an auxiliary relay. Such relays must be compensated for changes in the ambient temperature. This may be done by employing metallic pieces of different thickness, and thus having different thermal inertia. Slow changes of ambient temperature affect both pieces alike, whereas the quick change incident to the current flow affects the thinner piece first. Time delays from a few seconds to several minutes may be introduced in this manner.

In this brief review it has been impossible to discuss all the variations of mechanical construction which may be employed for special purposes. The illustrations, which show some of the unusual examples, may suggest to the reader the wide variety of functions which may be handled by relays of modern construction.

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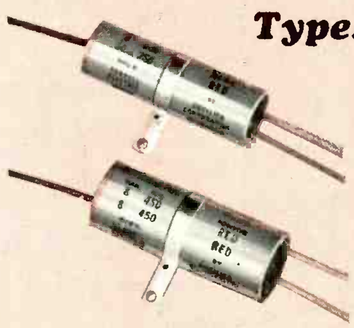

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A developmental r-f amplifier stage using the RCA-825 at 500 Mc. The photograph shows the resonator, the tube, the electromagnet and general arrangement of parts. In use at RCA Communications, Rocky Point, Long Island, N. Y.

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D-C GRID No. 1 VOLTAGE	−100 max. Volts
D-C COLLECTOR CURRENT	50 max. Milliamperes
D-C GRID No. 1 CURRENT	2.5 max. Milliamperes
COLLECTOR INPUT	100 max. Watts
GRID No. 4 INPUT	7 max. Watts
GRID No. 3 INPUT	5 max. Watts
GRID No. 2 INPUT	7 max. Watts
COLLECTOR DISSIPATION	50 max. Watts
GRID No. 1 DISSIPATION	0.15 max. Watts

**Modulation essentially negative may be used if the positive peak of the audio-frequency envelope does not exceed 115% of the carrier conditions.*

NOTE: In an inductive-output tube, the power input is equal to the product of the collector voltage and the d-c collector current, exactly as is the case in conventional tubes. The power dissipated at the collector is the difference between the power input to the collector and the power which is taken from the electron stream by the loaded tank circuit.

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