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ESTABLISHED 1917

Radio, Sound and Electronics

★

June, 1942

NUMBER 269
35c IN U.S.A.

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EDITORIAL

POST-WAR

There is a strong temptation in all walks of life to dwell upon the Utopian aspects of science as it will influence the post-war world. The automotive people, for instance, are bright-eyed over the prospects of magnesium-alloy cars with plastic bodies, and motors running on 90-octane gas. The housing people see prefabricated dwellings made of plastics and metals, mass-produced for the masses. What the aircraft manufacturers have in mind is even more startling.

These are mighty satisfying dreams, and it may be that they will come true, but war or no war, we are undergoing a social revolution, and the social problems to be solved are even more stupendous than the brilliant mind-pictures of the future. And so it is that we wonder about radio.

That there will be a huge market for new and improved radio and electronic equipment goes without saying. Television will open a new field, and another field will develop around electronic control equipment for homes as well as commercial establishments. The electron can, and may, govern our lives.

But it is our fear that the radio field may drift back to its old ways after the war is over. If it does, the bright picture most of us in the engineering field hold for the future may never materialize.

Part of the radio field has been cheap-John from its very beginning. And this can be attributed in a large measure to management. Management, on the whole, has been short-sighted, and has not shown the responsibility to society that one would expect from leaders of a field our size.

It is our hope that the war effort will serve as a proper education for the men who have, these many years, thought more in terms of the great I rather than the great US. If it does not, then it is our hope that these men will be displaced when the war has ended.

The men who make the technical advancements possible in our field have a right to hope for something better from radio in the post-war world. And so has the public.

REPLACEMENT POOL

The Defense Communications Board has recommended to the War Production Board approval of the plan initiating a co-operative "pool" of replacement equipment for the broadcast industry. The DCB further recommended that the FCC be delegated authority to administer those portions of the plan calling for centralized administration by the Government.

Such a plan could operate only with the full co-operation of the broadcasters and this co-operation is assured by the fact that it originated with the broadcasters themselves.

In general the plan provides for establishing throughout the nation 17 regional conservation districts, each to be administered by an administrator and two assistants. They are to be selected by the broadcasters in their respective districts, and they are to check the inventories, supervise distribution of replacement parts and see that efficient operation of each station is maintained.

Inventories will be kept in each district and at the FCC in Washington, the former for use within the regional areas, and the latter to be used as the basis of redistribution between districts on direction from the FCC. Regional administrators will operate under general supervision of the FCC, which in turn will be guided by rules, regulations, orders and policies of the WPB. Regional administrators will receive no compensation from the Federal Government, but for out-of-pocket expenses for travel and other incidentals connected with the "pools" they will be reimbursed by the stations within the districts concerned.

For those wishing to read the recommendations in their entirety, they will be found elsewhere in this issue. At the same time we would recommend the reading of Charles Singer's article on increasing tube life, on page 18, as being of equal importance.

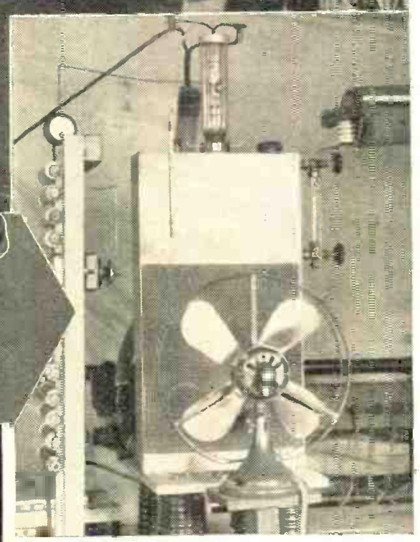
With full co-operation given to this pooling plan, all broadcasters will have reasonable assurance of continued operation for the duration.

M.L.M.

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

Remember the Days of the Lampshade Mike?

THAT'S WHEN GENERAL ELECTRIC COOLED TUBES WITH A "MODEL T" RADIATOR*



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

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

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- ★ ***high-power, water-cooled tubes***
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- ★ ***metal tubes for receivers and industrial uses***

WGY today serves about one million radio families 24 hours a day. It was the *first* station in the Great Northeast; today it is the *foremost*.

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

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If your firm has already installed the Pay-Roll Savings Plan, now is the time to increase your efforts: (1) To secure wider participation and reach the 90-percent goal; (2) to encourage employees to increase their allotments until 10 percent or more of your gross pay roll is subscribed for Bonds. "Token" allotments will not win this war any more than "token" resistance will keep our enemies from our shores, our homes. If your firm has yet to install the Plan, remember, TIME IS SHORT.

Write or wire for full facts and literature on installing your Pay-Roll Savings Plan now. Address Treasury Department, Section D, 709 12th St., NW., Washington, D. C.

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Published by EDITORS and ENGINEERS

Home offices: 77 Bedford Street, Stamford, Connecticut

Telephone: Stamford 4-7319

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SUBSCRIPTION RATES (in U.S. funds): Two years, $5.00, or $3.00 yearly in U.S.A. (plus tax in Illinois). To Canada (inclusive of current taxes), Pan-American countries, and Spain, $0.50 per year additional. Elsewhere, $1.00 per year additional. Twelve issues yearly; back issues are not included in subscriptions.

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21	Koopman-Robinson-Neumer
44	Stromberg-Carlson

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COVER

Speech input equipment (left) and testing equipment (right) at W71NY, WOR's New York f-m outlet at 444 Madison Avenue.

ARTICLES

MISCELLANEOUS

W45D

The Detroit News

C. H. WESSER

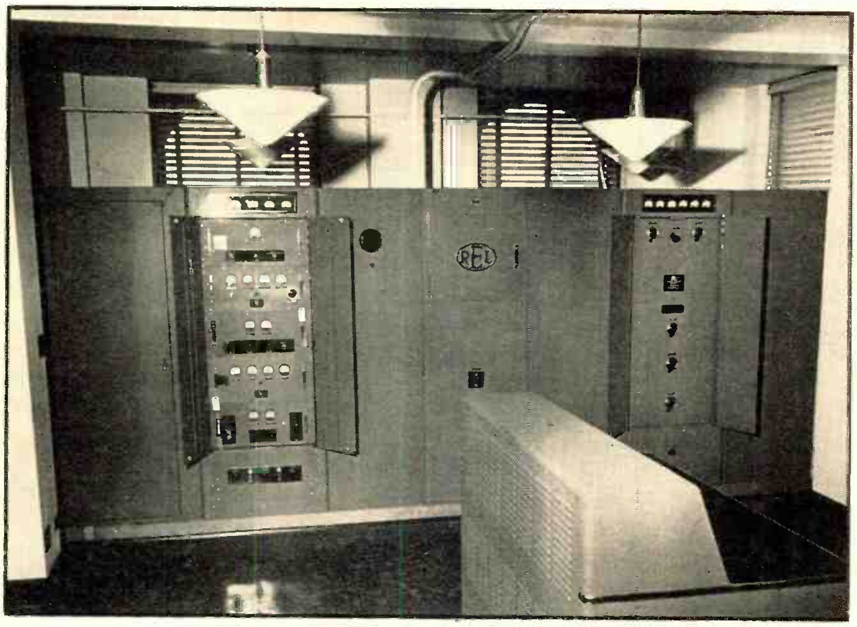
Chief Engineer

◀ A little over a year ago W45D made its debut in Detroit as Michigan's first F.M. Broadcast Station. It was the culmination of The *Detroit News'* experimentation and operation of broadcast equipment on the ultra-high frequencies. This work started late in 1935, and continued until a year ago, under call letters W8XWJ, first with a 100-watter, later with 500-watt equipment.

All operation prior to the institution of W45D had been with amplitude modulation, although for several years back it had been evident that f.m. was far superior to a.m., and plans for the change-over were made late in 1940. The location for W8XWJ, now W45D, was chosen in 1935 as the best spot in Michigan for a u.h.f. station. With a radiator almost 700 feet above street level, on top of Detroit's tallest building, in the very heart of the city, and an assigned service area almost as flat as a pancake, it was a simple job to satisfy the FCC requirements of serving Detroit's basic trade area of 6820 square miles at 50 μv/M along its outer contour.

Preliminary Problems

To prepare for the present as well as the future requirements of W45D, it was decided to install a



A front view of the 3-kw. driver unit at W45D. The panels house, from left to right: the modulator unit, the power supply, and the ipa-driver unit. A portion of the power control desk shows in the foreground.

50-kw. transmitter, the highest power equipment that can at present be bought for the purpose. It might have been possible to use much lower power—3 kw. for instance—fed into a radiator array with a gain great enough to deliver the minimum requirement of 50 μv/M along the outer contour of the service area, but such a radiator, on top of a 600-foot office building would have been an unwieldy affair, and proof of performance and re-adjustments would have been difficult. Moreover, W45D was expected to be unlimited commercial once it hit the air, and it was felt that no cutting and trying afterwards could be tolerated. Therefore, a radiator with a circular pattern, horizontally polarized, and with a gain of approximately 1 was decided upon. To serve the prescribed area, 13.3 kw. fed into this type of radiator, and at the available location, delivers the field intensity at the distance prescribed.

Since no power-supply circuits were available on the 45th floor of the building where the equipment was to be installed, it was necessary to install a power supply capable of handling the full 50-kw. output, plus certain additional load requirements of speech input and monitoring equipment, and a few emergency light circuits, so that the station could operate entirely independently of any and all building supply circuits.

The planning and installation of this 225-k.v.a. power-supply circuit was a job in itself, since the nearest primary service in the building was in the second basement. A run of approximately 800 feet was necessary, and much thought was given to the potential at which the power was to be brought up.

The final arrangement provided for a primary vault in the second basement, where three 75-k.v.a. single phase, 4600/440-volt transformers were in-

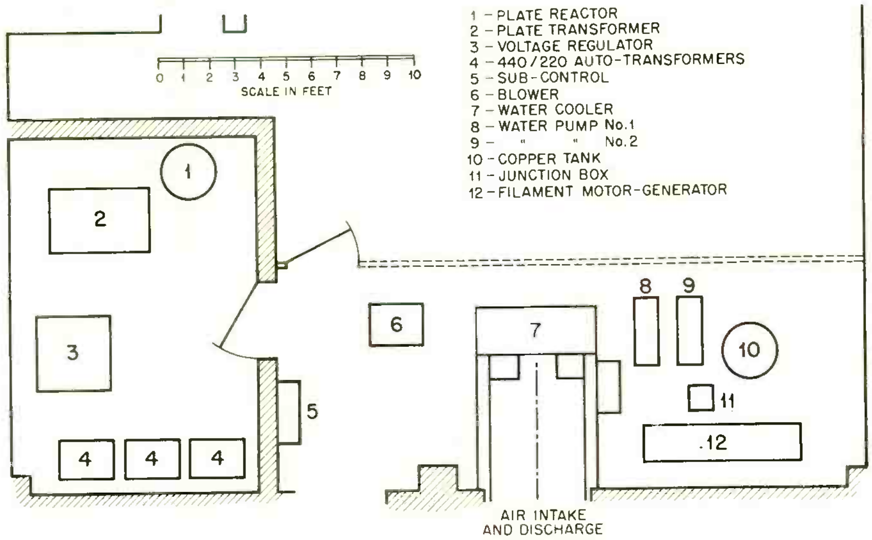
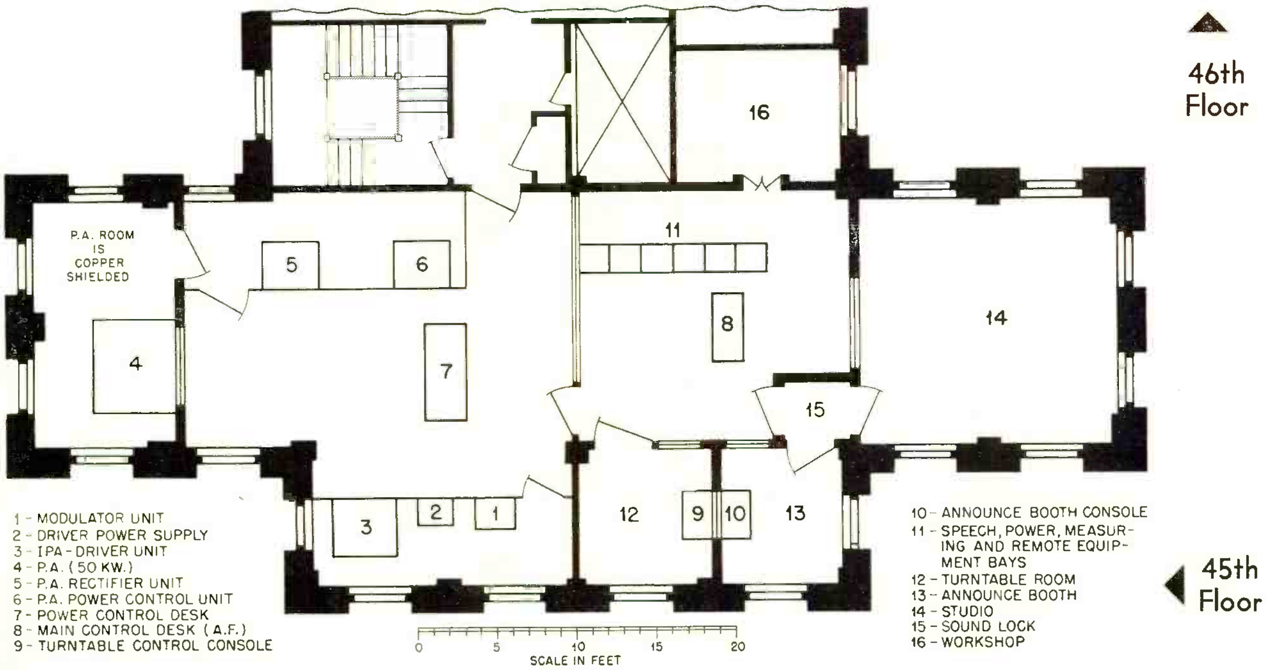


FIG. 1.
Floor plans of the 45th and 46th floors, showing the location of the various units. The power-generating equipment is in the basement of the building; the power supplies on the 46th floor. The 45th floor houses the speech and transmitter equipment.



stalled, complete with all necessary metering equipment, primary oil circuit breaker and secondary air breakers. From here, three 500,000 cm cables are run up in a 4" conduit to a secondary transformer vault on the 46th floor of the building. Since most of this run is, of course, vertical, it was necessary to have pull boxes on every floor, and cable anchors every 30 or 40 feet to support the weight of the conductors. On the 46th floor the circuit feeds three 75-k.v.a. single-phase, air-cooled auto-transformers which reduce the 440 to the required 220 volts, needed to supply the entire transmitter.

Layout of Equipment

Referring to *Fig. 1,* the REL 521 transmitter includes everything from the modulator unit through the power amplifier, which is capable of delivering 50 kw. or better into a transmission line system of proper design. It requires an a.f. input of zero level across 500 ohms to provide the required 75-kc. swing above and below the unmodulated carrier frequency. A swing of 75 kc. plus and minus is considered 100% modulation.

The transmitting equipment is divided into several major units, as indicated in *Fig. 1,* which also shows the location of speech input and other associated equipment. The major units of the transmitter are:

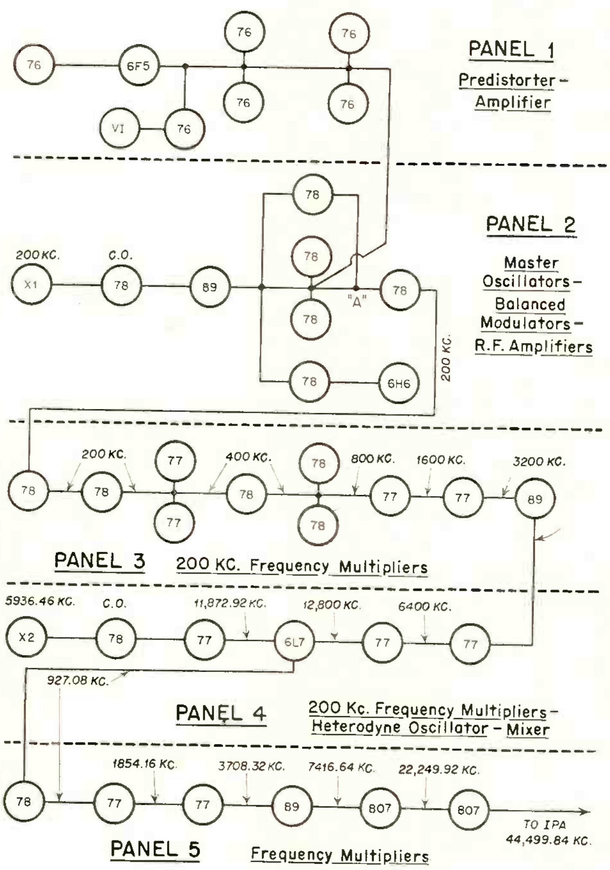


Fig. 2-A. Block diagram of the complete modulator unit.

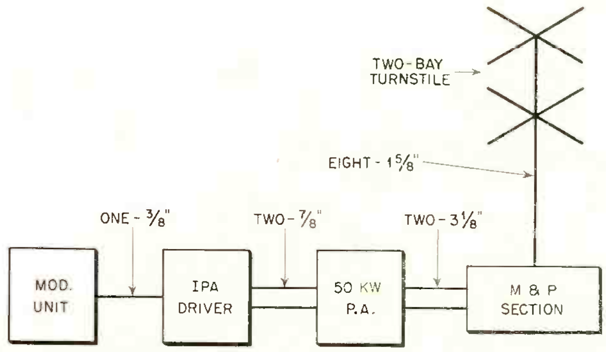


Fig. 2-B. Block diagram of transmitter and transmission line system and radiator, showing number and sizes of transmission lines linking various units.

Modulator Unit, IPA-Driver Unit, Driver Power-Supply Unit, P.A. Stage, P.A. Power Control Unit, P.A. Rectifier Unit, 50-kw. Plate Supply Transformer Vault, Cooling and Auxiliary Equipment, and Power Control Desk, from which all power circuits are remotely controlled.

The Modulator Unit

Fig. 2-A shows, in block diagram, the tube and stage line-up of the Modulator Unit, and the function of each stage. *Panel 1* is the a-f. input amplifier, which is fed at zero level from program source. It contains the predistorter circuit, which lifts the upper end of the 50—15,000 cycle response curve by 16 db. or more at the high end, in accordance with FCC requirements. The 76 tube in conjunction with *V.I.* is a simple v-t voltmeter which allows accurate measurement of the input voltage without presenting any load on the amplifier channel itself. The overall frequency response of *Panel 1* is flat within ¼ db. from 30-17,000 cycles.

Panel 2 is actually the heart of the entire modulator unit. It contains the master oscillator, controlled by an extremely stable 200-kc. crystal, followed by a 78 and an 89 buffer stage. The upper threee 78's in the following, or balanced-modulator stage, make up the phase-shift modulator. The center pair of tubes of the four shown, are screen-modulated and connected and arranged in a manner to deliver in their output circuit only sidebands, while the upper 78 in the block diagram is an unmodulated carrier amplifier. At point *A* the two outputs are combined, where the phase shift of the carrier appears, in accordance with modulation. The lower 78, feeding a 6H6G rectifier, which in turn drives a monitoring device, is used mainly to balance out the effects of the upper 78 in this stage. The phase-shifted 200-kc. signal appearing at point *A* is fed through the 78 output stage of this panel.

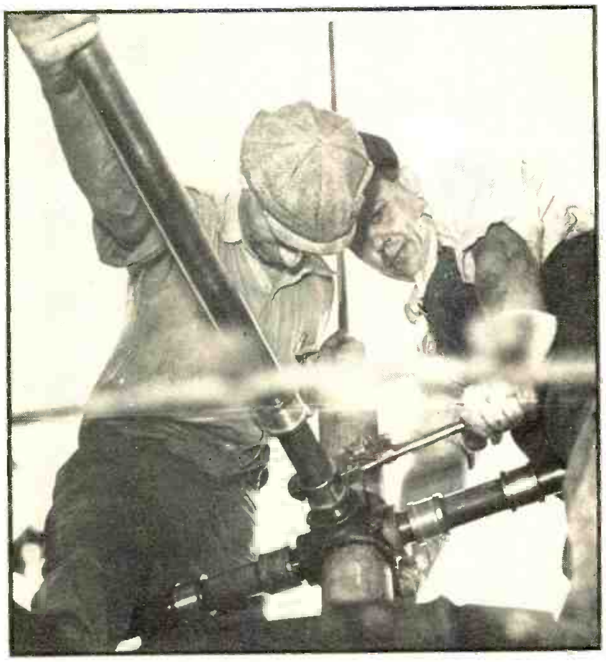
Panel 3 is a straight frequency-multiplying unit, using single tube and push-push doublers and multipliers, and is driven by the output of *Panel 2*. The output of this panel's final stage operates at 3200 kc. and drives the first stage of the next panel.

Panel 4. The first two 77's are straight doublers. The output of the second stage is mixed with the multiplied output of the carrier control crystal oscillator, which operates on 5936.46 kc., approximately, for our carrier frequency of 44,500 kc. Mixing of the two frequencies is accomplished in the 6L7G stage, shown on the diagram. The resulting beat frequency of close to 927 kc. is delivered to the input stage of the next and final panel of the Modulator Unit.

Panel 5 is a straightforward frequency multiplier with doublers and triplers. The final stage comes out at carrier frequency, completely swung with modulation to 75 kc. above and below the unmodulated carrier frequency, and at a power output on the order of 5 watts.

Correction to exact assigned frequency is accomplished by adjusting the air gap of the crystal holders, or plate tuning of the oscillators, or both, and it is an easy matter to adjust the frequency to within a hundred cycles or so against a standard.

The lower portion of the modulator frame contains the various plate and bias supplies, while the upper portion houses a meter panel and selenium rectifier supply for filament power. Rectified and filtered d.c. is highly desirable on all stages of the modulator unit to hold the overall noise level of the unit to a safe value below that required by FCC. Eighteen meters, through selector switches, allow the metering of all important currents and voltages in this unit.



The last of the upper bay radiator elements is fitted into place. Lightning rod rises 5 feet above top of 4-inch supporting pipe. Micarta insulators show at inner ends of radiator elements.

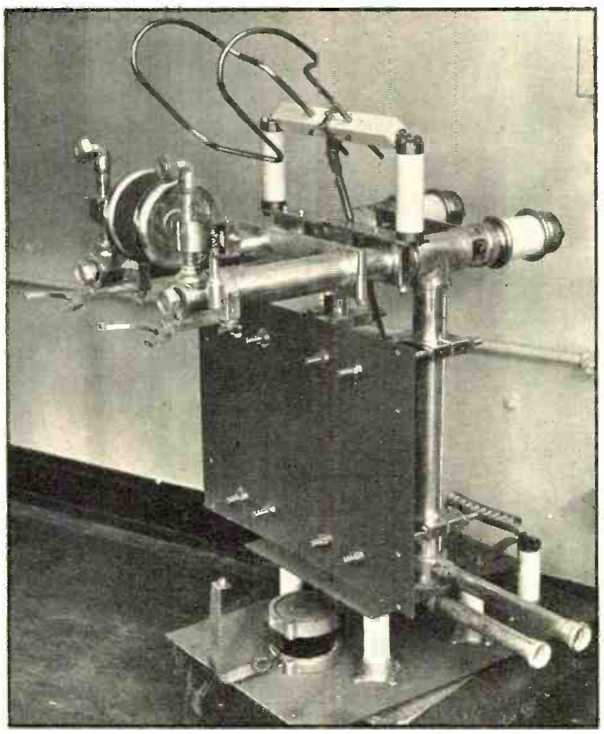


Fig. 3. The 50-kw. plate tank circuit assembly, before installation in p.a. unit; showing plate inductance, shorting bar, plate tuning condenser, two pairs of unions to which tubes are connected, concentric cooling water pipes, plate by-pass condenser (at bottom), and pick-up hairpin (at top).

IPA—Driver Unit

The IPA *(Fig. 2-B)* employs a pair of H.K. 257 tubes in push-pull, operating on carrier frequency, and driven by the output of the final panel of the Modulator Unit. Its grid and plate circuits are tuned to resonance, but since simple design precautions were taken, it is not necessary to neutralize this stage. The 257 output is fed to the grid circuit of the 3-kw. driver stage through a balanced pair of 3/8" concentric lines. The 3-kw. driver stage uses a pair of Eimac 1500-T tubes, with grid and plate circuits tuned, and conventionally neutralized.

The 1500-T's in this stage seem particularly well suited for high power operation at frequencies between 40 and 50 mc., and with input of 4 kw. and better, the life has been from 3000 hours and up.

The grid circuit of this stage is conventional, spaced-wound inductance, shunted and tuned by a split-stator 40 μμfd. variable condenser. The plate circuit consists of two parallel copper pipes, rough-tuned to frequency by adjusting a shorting bar, and fine-tuned with a 4" x 6" sheet copper "flipper". This flipper is copper plate with rounded edges and corners, hinged at one end in such a manner that the other end can be moved closer to, or farther away, from the shorted-end inductance. It was resorted to after several split-stator tuning condensers burned up under certain load conditions of the plate circuit. (Remember the old Federal Telegraph Company tuner that used this method of tuning by revolving a round, brass disc inside an inductance?)

The output of the 3-kw. driver is coupled into a pair of ⅞″ concentric lines with hairpin pick-up loops at each end, and fed into the grid circuit of the 50-kw. stage.

50-KW P.A. Stage

To allow the maximum power input of better than 100 kw., a pair of WL899-A Westinghouse tubes are used in the 50-kw. stage. For maximum power output and plate efficiency, this stage is operated at 15,000 volts plate potential.

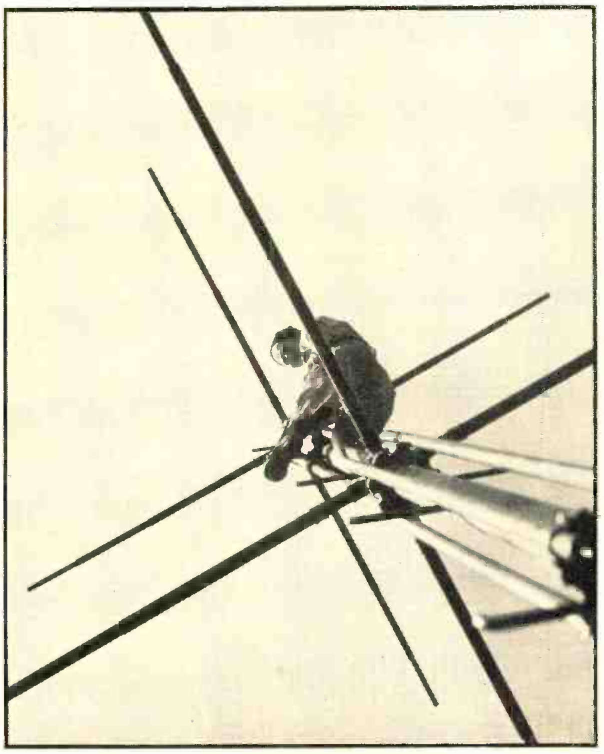


Fig. 4. Two-bay turnstile radiator almost completed. Concentric matching transformers and upper sections of 1⅝″ lines have been installed at upper bay. Lower bay elements have been installed, but matching transformers have not been put in place.

The physical size of the tubes and grid and plate circuits and associated equipment made extremely careful design and planning imperative in this stage. The plates of the tubes are, of course, water-cooled, but in addition, air-blast cooling of all tube-lead seals is necessary. All blocking and bypass condensers and parallel grid pipes, which make up the grid circuit, also require cooling.

A 3-h.p. centrifugal blower on the 46th floor supplies the necessary airblast for all these components. Cooling water in the closed-circuit cooling system, is fed to the plate jackets of the tubes through pipes that form the plate tank circuit. The return of the cooling water is through pipes that are concentrically mounted inside the plate tank pipes. All cooling water is cooled in a Trane evaporated type cooler on the 46th floor. The resulting arrangement actually cools the plate inductance as well as the plates of the tubes themselves, and aids in the reduction of the total plate capacity to ground, thereby allowing a larger plate circuit to couple into than would otherwise be possible.

As it stands, the plate inductance consists of only about 10″ of two parallel pipes of 2″ diameter, spaced approximately 10″, and rough-tuned by adjustment of a heavy shorting bar. Fine-tuning is accomplished by varying the spacing between two 4″ cast discs with smooth, rounded edges. These two discs form the tuning condenser of this circuit. The entire plate circuit, including the plate jackets and neutralizing condensers, is silver plated to reduce surface resistance. *Fig. 3* shows the plate tank circuit before it was mounted in the final stage frame.

The filaments of the 899-A tubes draw 185 amperes each at 14.5 volts, and filament power is taken from two d-c. generators, driven by a 10-h.p. motor. This motor-generator set is located on the 46th floor. A filament cabinet, located in a corner of the P.A. Room, contains two filament transformers and necessary transfer switches, which allow a.c. to be used on the filaments instead of d.c. Alternating current is used only in case the m-g. set is inoperative, since much better carrier signal-to-noise ratio can be maintained with d.c., although even with a.c. on the 899-A filaments, the overall carrier noise and hum level is better than 60 db. below 100% modulation.

The entire P.A. Room is shielded with fine-mesh bronze screen, and its entrance door, as well as all other doors leading into sections with exposed high circuits, are interlocked in accordance with FCC rules. All tuning, neutralizing and coupling controls are brought out through a recessed front panel where actual adjustments are made by turning small cranks which control the various adjustable elements of this stage through small gear-reduction boxes. Revolution counters on the front panel are used for logging all adjustments.

P.A. Rectifier Unit

The 15,000-volt, 7.5-ampere plate-supply unit is comparatively simple, and consists of an oil-cooled plate transformer and plate choke, and the plate transformer primary voltage regulator. These units are in the 46th floor transformer vault. The rectifier proper is part of the Rectifier Unit on the 45th floor, and uses six Westinghouse 869-B tubes in a 3-phase, full-wave rectifier circuit. This unit also houses the 2-μfd. filter condenser which, together with the .5-henry choke, gives sufficient filtering for the final stage plate voltage. Interlocks and an automatic filter condenser short circuiting device make it impossible to enter the enclosure and reach the filter condenser with high voltage on.

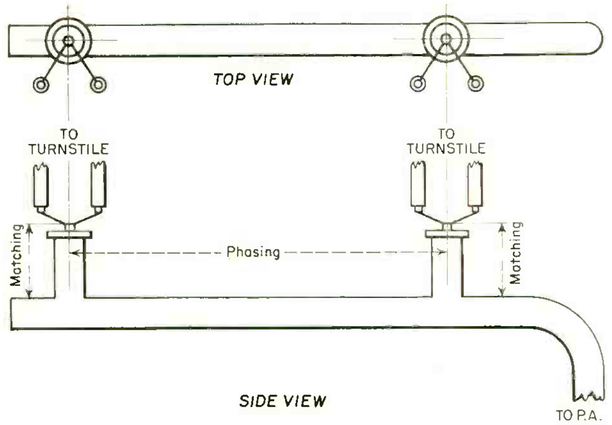


Fig. 5. The matching and phasing section for the two-bay turnstile. One element, as shown, used at upper end of each 3⅛″ line from p.a.

and coolers, sixteen minutes after the master "stop" button on the Power Control Desk has been pressed.

Power Control Desk

All control circuits of both Driver and P.A. Units come into the master control panel, with switches controlling all major power-control circuits. Above each switch is a pilot light which indicates the condition of the particular section of the circuit controlled by the associated switch. When all these switches are properly preset it is possible to start, and shut down, the entire transmitter, and with all necessary time delays. If trouble should develop at any point in the starting sequence, the first pilot in the row that fails to come on indicates the section of the circuit that failed. This arrangement saves much time in trouble shooting, although so far very little difficulty has been experienced in keeping the station on an 18-hour program schedule.

Power-Control Unit

This unit houses all major control relays and breakers, including a stepping relay recycling device that allows the entire transmitter to kick off in case of a short or overload in the plate circuit of the P.A. After the initial short or overload, it will restore all voltages in a few seconds, but until the plate voltage has been automatically reduced to the minimum of 5,000. If, by this time, the short or overload is still present, it will again kick off and restore once again, repeating this sequence eight times before it finally stays off. At the end of the eighth recycling sequence it can be reset manually by flipping a switch in the Power Control Desk. Also located in the Power Control Unit are all starting time-delay relays, as well as shut-down time delays. Shut-down time delays are necessary to allow gradual cooling of the tubes and components of the 50-kw. stage. The last of the shut-down sequence turns off the circulating pumps and coolers, sixteen minutes after the master "stop" button on the Power Control Desk has been pressed.

Transmission Lines and Radiating System

Two 3⅛″ concentric lines link the P.A. and the Matching-Phasing Section on the roof of the building, in the tower base. The Matching-Phasing Section, housed in a steel doghouse, 4′ x 4′ x 12′ long, consists of two sections of concentric line mounted horizontally, and each fed by one of the lines from the P.A. At the end of each of these sections, and at a point approximately ¼ λ from the ends, are mounted two short, upright sections of line, a total of four such stubs in all. The quarter-wave spacing between the vertical stubs provides the proper phasing between radiator elements, while the stubs are matching transformers whose function is matching impedances between each one of the lines from the P.A. and the four pairs of 1⅝″ concentric lines that connect the matching-phasing section to the eight quarter-wave elements of the two-bay turnstile radiator atop the tower.

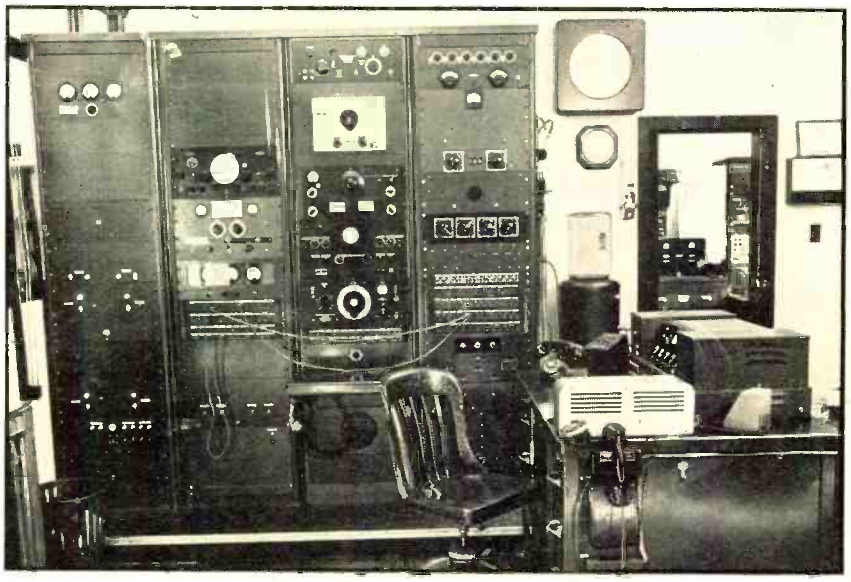


FIG. 6.
Speech bays, power supplies, measuring equipment, etc. Since this photo was taken two bays have been added, one for emergency, battery operated relay and speech equipment, and another for additional measuring equipment.

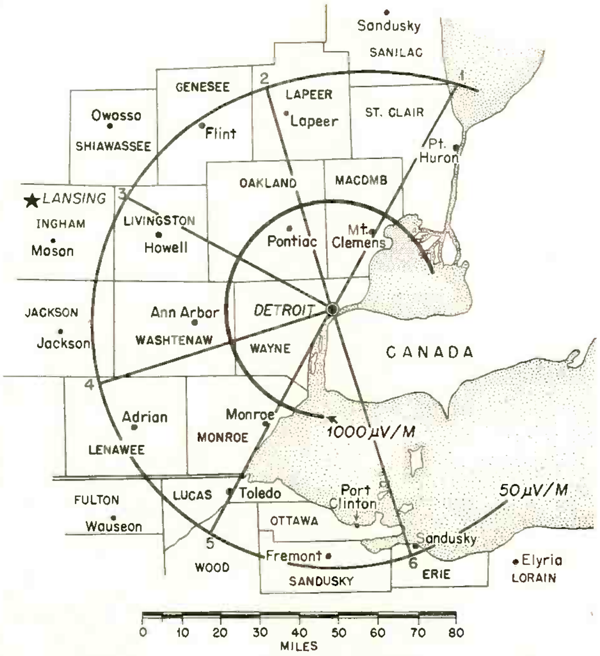


Fig. 7. Service area map, showing 1,000 μV/M and 50 μV/M contours, as calculated in accordance with FCC formula.

The radiator is similar in design to the 10-bay radiator of W43B, a picture of which appeared in the May issue of RADIO. Each one of the eight elements are insulated from the supporting structure and ground, and in order to match impedances properly between the upper ends of the 1⅝″ lines and the inner ends of the quarter-wave radiator elements, another concentric impedance-matching transformer is used.

The entire system behaves beautifully, although scarcity of certain insulating materials caused considerable difficulty when the system was first excited. As a poor substitute for isolantite or lava insulating beads in the 3⅛″ lines, natural bakelite was originally used, only because better material for the purpose was not available at the time. At close to 10-kw. input, both lines went dead short to ground. Immediately an open-wire line was constructed as a substitute link between the P.A. and the Matching-Phasing Section. This line is of approximately 500 ohms impedance and uses a shorted stub at the upper end to permit matching between it and Matching-Phasing Section. This section and all 1⅝″ lines were equipped with isolantite beads and micalex end-seals, so no difficulty was experienced there. The insulation in the matching stub, just ahead of the M & P section, offered some problems since extremely high voltages occur at certain points along that stub. Eventually, 16″ spacing between copper tubing at these points proved the closest safe spacing that would not flash over under any conditions. However, one of a pair of 7″ pyrex lead-in bowls that bring the open-wire line into the doghouse completely melted away when apparently a flash-over occurred at that point. This is not to be wondered at when arcs of 8″ and more, when once drawn, will sustain themselves in the air along certain sections of the line and stub!

The open-wire line is about to be replaced once again with concentric lines since finally isolantite beads were obtained to replace the bakelite spacers. *Fig. 4* shows the two-bay radiator, while *Fig. 5* is a sketch of the Matching and Phasing Section.

Speech-Input Equipment

W45D has always operated with its own independent staff, with programs not duplicated by any other f.m. or a.m. station within its service area. Naturally, a good portion of the programs are transcribed. For this purpose, the Turntable Room is equipped with two of RCA's latest turntables, with combination vertical-lateral high fidelity heads, which feed into a specially designed mixer-amplifier, built by the station's staff.

To get noise and hum down safely below the prescribed maximum allowed, plate power supplies for this, and several other amplifiers, are remotely located in a bay in the Main Control Room. In this room a modified Western Electric 23-B Console forms the heart of the station's a-f. equipment. The output of the turntable console feeds into the 23-B, as do mikes from Announce Booth and Studio.

A bay of line and remote amplifiers and specially designed and built equalizers handle incoming remote programs as well as programs from the Studios of WWJ, The *Detroit News'* a.m. station and network. The loops between W45D and WWJ are equalized at the W45D end, and are flat within 1.5 db. from 50-19,000 cycles. This is possible only because the physical length of these loops is under three miles. *Fig. 6* shows the bays that house power supplies, line amplifiers, monitoring equipment, and measuring equipment.

Overall performance if the station is well within the prescribed tolerances as to frequency response, distortion, noise level, both a.m. and f.m., and the assigned service area is nicely covered with sufficient signal for noise-free reception, providing a reasonably good receiver and receiving antenna installation is used. *Fig. 7* presents a picture of this service area, where the number of f.m. receivers has increased from less than 1500 in March of 1941, to nearly 15,000 at the present time. Many reports are being received from listeners outside this area, and in some directions, mainly because of intervening terrain, good and consistent reception can be had over distances up to 100 miles and better.

A 20-watt, 158-mc. f-m. relay transmitter with a 12-volt d-c. power supply and a 110-volt a-c. power supply, complete with associated crystal-controlled pick-up receiver, were delivered to us recently by REL, but since practically all remotes are banned for the duration, no use will be made of this equipment until after the war.

A Silent, Automatic

AIR-RAID ALARM

FRANK A. BRAMLEY

Radio Technician, Connecticut State Police

◀ In conformance with orders from the FCC radio stations are required to have either a direct wire to the Interceptor Command or to monitor continuously one of a group of designated key stations. The key stations are to interrupt their programs, upon orders from the Interceptor Command, and put a 1000-cycle tone on their carriers, at 100% modulation, for 30 seconds. This is followed by an announcement and the removal of the carriers from the air. All stations monitoring the key stations are supposed to do likewise, although there is a possibility that in the near future some classes of stations may be exempt from this ruling. In any case, all stations will want to know of the likelihood of an air raid.

It is obviously impractical for an operator to listen continuously to a station program without suffering fatigue. Hence, there is the ever-present possibility of the warning signal being missed. The use of an automatic warning device is therefore an essential item.

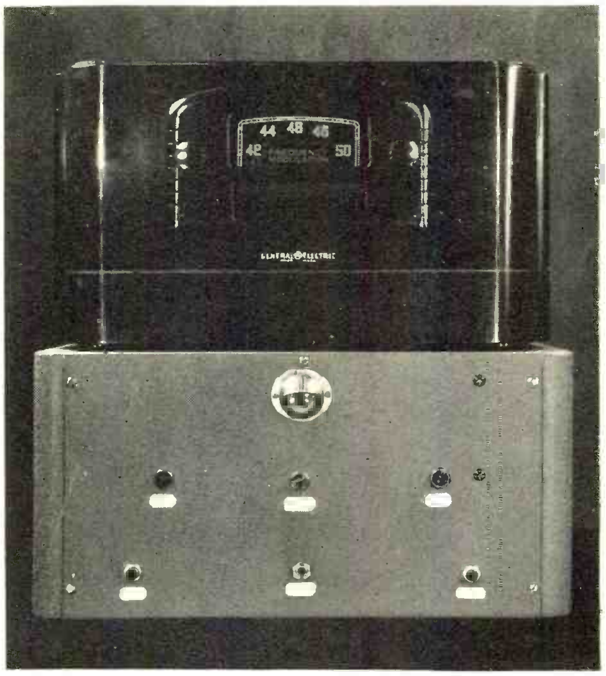
What It Does

The device here described is admittedly not a simple one, but it is reliable and foolproof. It gives a minimum of false alarms; in fact, no false alarms have been received to date. It remains totally silent unless actuated by a continuous tone of 1000 cycles which lasts for at least 10 or 15 seconds, and if the receiver fails a relay is arranged to ring a bell or light a light. An electron eye is included to facilitate tuning and indicate other conditions such as carrier failure, fading, and relative signal strength.

The required accessories are a radio tuner of some sort, a loudspeaker, and a good aerial producing noise-free signals on the station to be monitored. The receiver used here is an f.m. converter because more consistant reception is obtained from the local f.m. station than from the designated key broadcast station. The monitor unit proper contains an audio amplifier and power supply and is connected to a loudspeaker, alarm bell and signal lights at a remote point.

Tone Alarm

The monitor also contains three other units. Most important is the tone-operated alarm. This consists of a tuned circuit bridged across the audio system, and fed through a volume control to a 6SQ7 amplifier, thence to the diode section of the same tube where the audio signal is converted to d.c. The d.c. voltage is fed through a time-delay circuit consisting of *C1* and *R1*, to the grid of the 2051 thyratron tube. This tube normally draws current and holds down the armature of the relay in its plate circuit. The presence of a few volts negative bias on its control grid is sufficient to cause it to stop functioning *if* it has an a.c. plate voltage. Once a thyratron has "fired" the grid normally loses all control and it is necessary to open the plate or cathode lead to cause the plate current to cease. However, if a.c. plate voltage is employed the grid is able to regain control as the plate voltage passes through zero in its alternations. Such plate voltage is usually taken direct from the line; in this unit the



The automatic air-raid alarm unit and attendant receiver; in this case a G.E. f.m converter. A standard receiver may be used.

voltage is taken from the high-voltage winding of the plate transformer through a resistor that limits the current to about 10 milliamperes.

The plate-circuit relay may be as simple or as complex as are your requirements, but in this unit it has been arranged to open its own plate circuit when up. Thus, once the thyratron plate current has ceased it cannot be started again until the relay is manually reset. This feature allows monitoring after an alarm has been received and until an "all clear" is sounded. The manual reset consists of a momentary contact push-button which shorts the relay contacts so that the plate voltage is applied.

The other relay contacts are arranged to do two things: the first is to open the cathode of the audio amplifier output stage and simultaneously to connect the tuned circuit across the audio line from the receiver. Thus relay *1* is normally held own, the audio amplifier is dead and the tuned circuit is in a position to accept a 1000-cycle tone. If a tone is received the thyratron is "killed" and the loudspeaker reproduces the remainder of the 1000-cycle warning signal as well as the announcement and sign off.

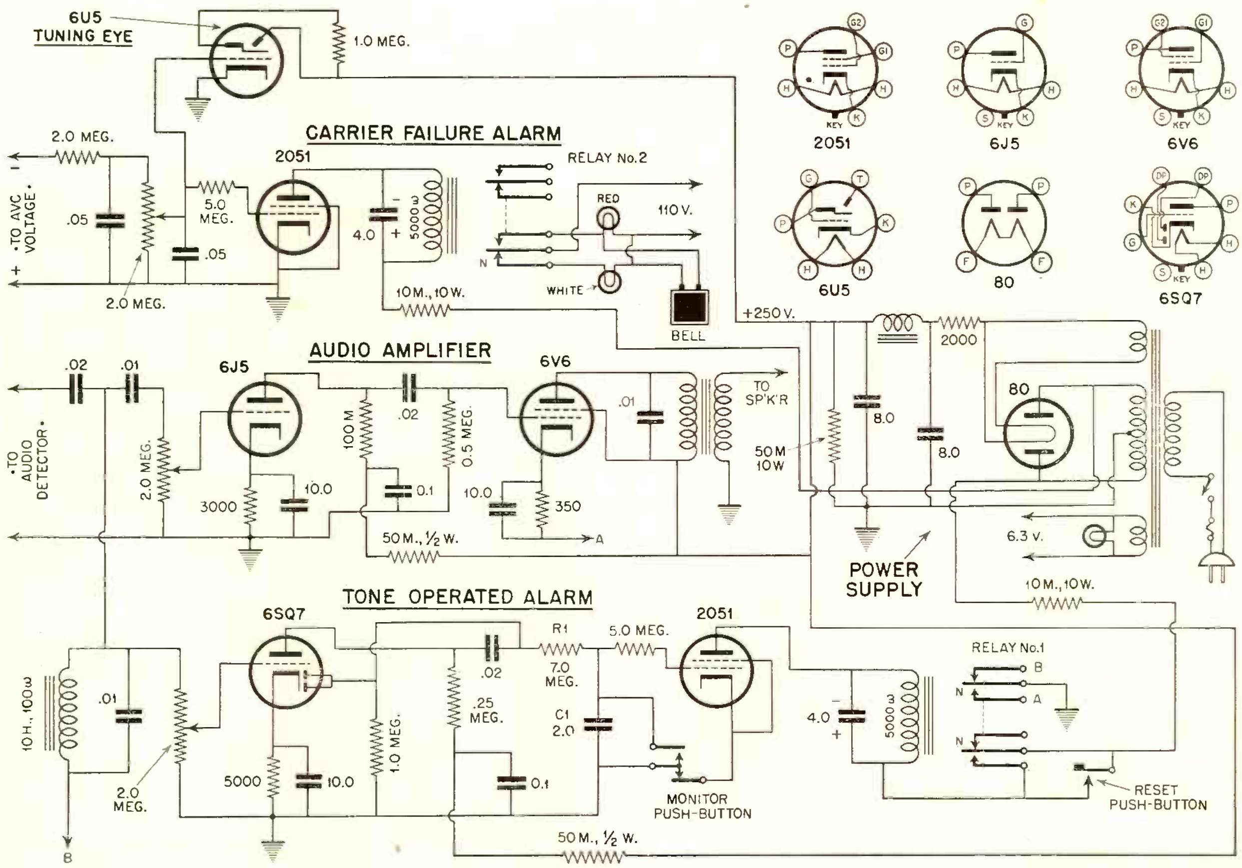
If it is desired to monitor the program audibly, the thyratron can be stopped manually by pushing a second button. This push-button momentarily opens the cathode circuit of the 2051 tube, stopping the plate current again until reset. This allows the amplifier to operate and also disconnects the tuned circuit from the audio input so that the reproduction will be normal. When silent monitoring is again desired it is usually necessary to push first this cathode push-button followed by the plate closure push-button, because the time-delay circuit charges up and does not allow the 2051 to return to normal. The cathode switch is arranged so that it has a back contact that will discharge the time-delay circuit and allow the 2051 to return to normal. When operating, the 2051 draws a small grid current which keeps this circuit discharged.

The Tuned Circuit

The tuned circuit plus the time-delay feature tend to prevent ordinary modulation from operating the device. High selectivity is obtained by placing the resonant network in the grid circuit. A low-resistance choke of high inductance is essential so that as little capacity as possible need be used to reach resonance at 1000 cycles. Much time will be saved if the specified choke is used, and if the .01-μfd. condenser is one selected from a batch for close tolerance.

If an audio oscillator and an oscilloscope are used to indicate resonance, be sure to connect the oscillator to the choke through a series resistance of 100,000 ohms or more; otherwise the output transformer of

[*Continued on page* 34]



Complete schematic diagram, with parts values, of the air-raid alarm unit. Points "A" and "B" connect to terminals "A" and "B" of Relay No. 1.

U. H. F. . . .

PERRY FERRELL, Jr.

◀ The publication of "Notes on U.H.F. Propagation" in the March issue has stirred up no small amount of comment—favorable and otherwise. While it had been supposed by one of the leading groups in this field that the hypotheses developed were generally acceptable to the gang, the onslaught of further information on Sporadic E DX peculiarities has left the subject in mid-air.

W6QLZ and W6OVK both claim their experiments with 56-mc. DX have been indicative of certain trends, contrary to the March paper, but which may be peculiar to their locality. Our readers will recall that for nearly two years 6QLZ and 6OVK were making twice daily contacts over a mountainous, 107-mile path. The QLZ 4-element beam was one of the results of this work.

Clyde writes, "As I recall, we began to note that preceding every 56-mc. Sporadic E opening our ground wave sigs began to drop out and in numerous cases we resorted to c.w. to maintain contact. It got so that if our 5 p.m. sked signals were weak we would know one or two hours later the band was going to open. In contrast, if our sigs were strong as the theory of T.A.B.B. implies, rain would come within 15 hours. Therefore, it seems likely that no bending ever took place at the end, although we made a considerable number of over-size skip contacts into the eastern seaboard.

We did note on several occasions while working 8CIR and into Ohio, which is definitely two-hop to Arizona, that the first hop was up in Minnesota or over in Nebraska, as we were hearing stations at that time from that vicinity. That's pretty far off the direct route. It seems likely to us that 1700-mile DX is caused by two hops of unequal length."

Meanwhile, from Washington, Mel Wilson, 1DEI, says, "I have case after case with weather data, estimates on E_s mass size and location, which, by their number, prove the Conklin Theory correct.. Although extreme cases probably exist where reflection may enter into the extension of skip . . . . . in general we are dealing with 'ideal' cases."

An unsigned letter points out, "I expect you are aware the layer height in the E region is always over 126 km., using the accuracy of the new ionospheric sounding apparatus, and if the E mass were located near or over the Great Lakes, the E layer would probably be about 132 km. You will recall the layer height increases proportionally with latitude (geomagnetic)."

While the March paper had been planned to serve one purpose, it has brought to light some very interesting information which gives all of us a clearer picture on Sporadic E DX. In about two months it should be possible to present some vitally important data on Sporadic E and Aurora.

F.M. and Fading

We have heard one broadcaster refer to the non-fading characteristics of his f-m. station. While this claim does have some basis, we know that f-m. signals, being of u.h.f. origin, do fade severely; however, this fading may be within limits exceeding the receiver's necessary limiter voltage (cut-off) and the audio output will remain constant. While f-m. signals do retain all the characteristics of u.h.f. propagation, fading as we hear it on a-m. signals, goes unnoticed, because of the limiting action.

Particularly interesting in connection with this subject have been the field-strength records of W71NY at 17 miles, where some really husky signal changes occur, even though the receiver is well inside the primary service area.

[*Continued on page* 50]

This ST relay equipment installed by W47A, Schenectady, was first under construction permit issued by FCC for ST equipment in the 330- to 342-mc. band. Shown are Lloyd Krause (left) of G.E., and D. S. Hoag, W47A's chief engineer.

INCREASING TUBE LIFE*

WAR SHORTAGES CALL FOR GREATER EFFICIENCY IN OPERATION

CHARLES H. SINGER

Technical Supervisor, WOR-W71NY Transmitters

Vacuum tubes should always be treated with proper care and consideration. Today, this is essential, because war has produced a scarcity of raw materials and productive capacity for the manufacture of new tubes for commercial stations. Anything the broadcast engineer can do *now* to prolong tube life and still keep them operating at, or very near, peak efficiency will be a boon to his own station, the station's audience, and to the industry as a whole.

Most engineers are aware of the many factors that enter into tube life. The more important ones are:

1. Filament voltage.
2. Plate voltage, residual gases.
3. Fatigue of metal parts.
4. Heating and cooling cycles.
5. Efficiency of cooling system.
6. Efficiency of transmitter, maintenance, and associated protective relays.
7. Care of spares and tubes in storage.

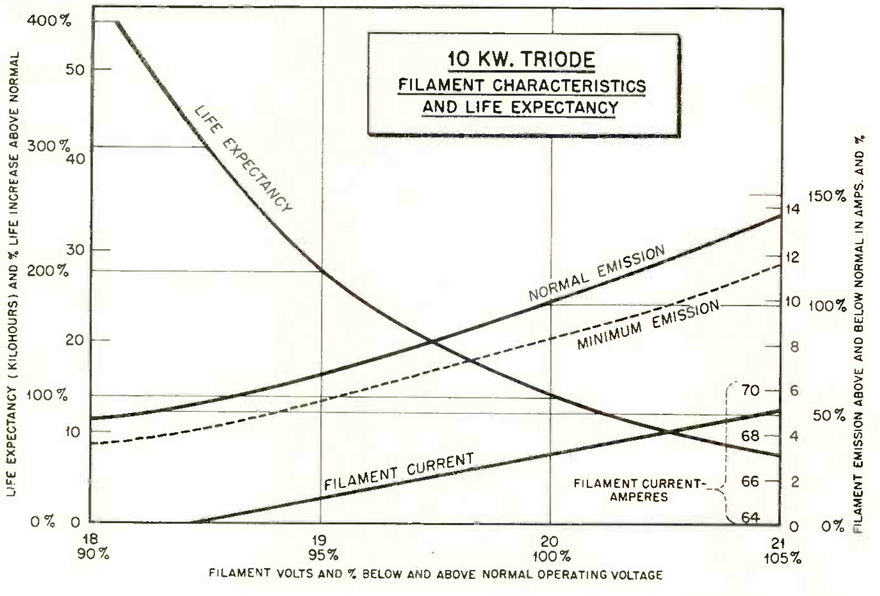
Proper precaution must be taken with *each* of these factors. Plotting a standard system of procedure for each will eliminate many of the abuses which may cause tubes to burn out or become inoperative long before their useful life is run.

Filament Voltage

Tungsten Filament Tubes: When direct current is used for heating the filament, returns of the plate and grid circuits are usually connected to the positive filament terminal. Electron current return flow is through one side of the filament. If the polarity is left the same for any length of time, there will be a greater thinning of one side of the filament, which can result in premature failure. Because of this, the polarity of these tubes should be reversed each week.

Correct filament voltage is of the greatest importance. The accompanying characteristic curves of a typical 10-kw triode used in a Class B linear transmitter show the important relationship between filament voltage and tube life. The rated filament voltage for this tube is 20 volts and its normal life expectancy is 13,500 hours. If filament voltage is reduced 5 per cent, filament life is doubled. Conversely, operating with a filament voltage 5 per cent above normal cuts

*Courtesy of "Pick-Ups"



Characteristic curves of a typical 10-kw. triode used in a Class B linear transmitter, showing the important relationship between filament voltage and tube life. If filament voltage is reduced 5 per cent, filament life is doubled.

its life nearly in half. At WOR by reducing filament voltage to 19½ volts, a reduction of 2½ per cent, the *increase in life expectancy of the tube is 4,100 hours.*

It follows that this reduced filament voltage will have some effect on electron emission. Modern transmitters provide a 22½ per cent increase in antenna current with full modulation, single frequency, when operated normally. Decreasing filament voltage will decrease this antenna current rise if the available filament emission is too low. The important point is—in time of war should we sacrifice idealistic operation in order to gain longer tube life, provided it does not seriously impair listeners' reception?

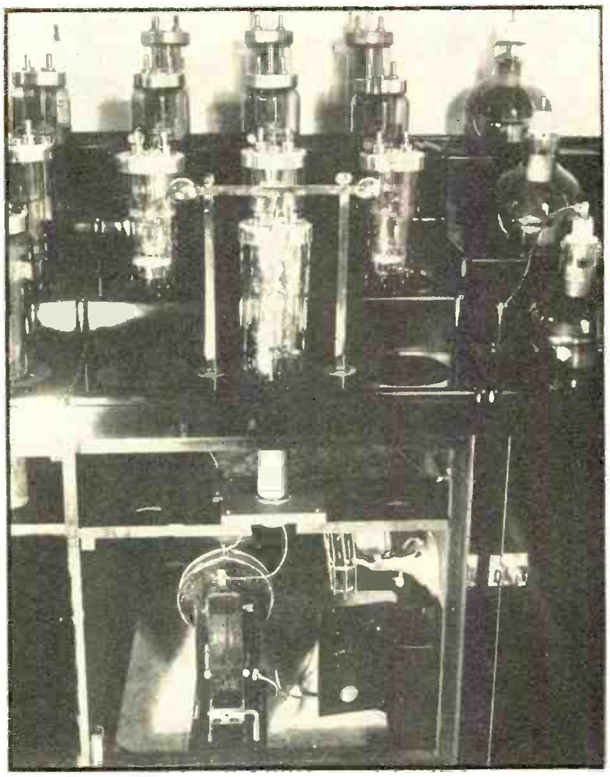
A reduction in filament voltage of 5 per cent can be applied to transmitters with slight effect on peak power. In fact, peak currents equal to the total emission available may be drawn continuously without damage to the filament, if it is of the pure tungsten type. Reference to the tube manufacturer's charts will reveal data on available filament emission. On certain types, such as the Western Electric 298A, marked voltages for a fixed emission are supplied by the manufacturer.

When there is an excess amount of emission available from tungsten filament tubes, it is possible to insert dropping resistors in series with the filament leads and thus gain many hundreds of hours of additional life. In transmitters of the Western Electric 306A type, filament voltages of the second power amplifier should be dropped from 20 to 19 volts. All the emission of the tubes is definitely not needed, and tube life can be extended to approximately 30,000 hours with little or no effect on the peaks of modulation.

Increased transmitter distortion may result from decreased filament voltage. This should be given individual consideration, depending on the spare tubes on hand or available in times of emergency.

WOR finds it important to check the accuracy of filament and bias voltmeters *each week,* using a standard calibrated meter which reads voltage at the tube terminals. Zero adjustment of the filament voltmeter should be checked *daily* and a standard method should be used. This can be done by standing directly in front of the meter at a distance of three feet and adjusting the meter to zero. Thereafter, the meter should be read from exactly the same position.

Thoriated Tungsten Filament Tubes: Tubes having this type of filament are being used in larger quantities than pure tungsten during these times and a severe shortage of productive capacity may result. Careful consideration should be given to filament temperature, to effect a proper balance between the loss and replacement of the thin layer of thorium on the filament surface. As a general rule, filament voltage should be kept to manufacturer's ratings, but in some cases it may be held slightly below this figure, depending on the peak currents drawn in the equipment. Manufacturers usually recommend that peak currents should be considerably less than the maximum which the filament is capable of emitting to insure long life.



Interior of WOR's tube reconditioner. See circuit on page 20. The Thordarson high-voltage transformer, bringing forth remembrances of things past, is in foreground, to the left of cooling fan.

A voltage check at the tube socket using a precision voltmeter is recommended each week. Gas in the tube will cause the thorium film to be carried off the filament at greater than normal rate. Proper bias and plate voltages must be maintained to prevent excess electrode dissipation. Plate voltage should be applied with care, taking the output capabilities of the tube into consideration.

In cases where a severe and prolonged overload has temporarily impaired the electronic emission of the filament, it can usually be restored to its normal condition by operating the filament at 30 per cent above normal voltage for a period of 10 minutes, followed by one or two hours of operation at normal voltage. During this rejuvenation, *plate and grid voltages must be off.*

Thermionic Mercury Vapor Tubes: This tube usually operates at high current with a low anode to cathode voltage drop. The oxide coated filament is designed to operate at a specific temperature. Sufficient time *must* be allowed for the filament to reach this temperature and also for mercury vapor pressure to become normal before the plate voltage is applied.

With good filament voltage regulation, a five minute preheat period will suffice. Filament voltage should be kept at the rated figure—never below. We believe it is good practice to operate one per cent above the rated voltage. We use a precision voltmeter to check voltages *each* week to get the longest service from these tubes.

Plate Voltage, Gases

High plate voltage can seriously impair the emission of thoriated tungsten filaments, due to their sensitivity to positive ion bombardment. Residual molecules of gas, present in all tubes after evacuation, are ionized by collision with the electrons flowing to the plate. The resulting positive ions are attracted toward any element which is negative with respect to the anode. Those which strike the filament tend to destroy the thin film of thorium from which the high emission is derived. As the velocity of the ions increases at the higher plate voltages, injury to the thorium film is greater.

When adjusting emergency circuits, it is good practice to reduce plate voltage, either with a voltage control switch regulator or a series resistance in the plate circuit.

Gas in a tube is not necessarily the result of air leakage, but is sometimes caused by the liberation of gas from the pores of the elements after the envelope is sealed and the tube conditioned for operation at high plate voltages.

Because of the care taken by manufacturers to remove gas before the tube is shipped, flash arcs seldom occur if the tube is put in service immediately. But with the long life of modern tubes, spares must remain on the shelf for extended periods. Those kept too long without being tested, are frequently found to be gassy when put in service.

Tubes operating at low voltages, such as required for receivers or low power amplifiers, are not generally affected by gas. It is the larger, high voltage, high power tubes which tend to flash arc if allowed to remain inactive. At WOR we consider that three months of inactivity is too long a period.

Gassy conditions may also develop in a tube which has been operating in the transmitter for many thousands of hours. The exact cause of this is not clear, but the result can be seen in the continuous flash arcs which occur with the tube operating at its rated plate potential and power. However, if the tube is placed in a circuit of lower plate potential, it is definitely possible to get many more hours of service from it. This point should be considered carefully before any tube is discarded because of flash arcs.

A simple and successful method of treating gaseous tubes and instructions for building the necessary equipment will be covered later in this article.

After long use, metal parts of tubes tend to evaporate, crystallize and become brittle. Severe shocks can cause damage which would never occur in a new tube. All tubes should be mounted and stored vertically and protected against mechanical shock or vibration. Failure to observe these precautions may cause filaments to break or cause misalignment of the elements. Water-cooled rectifier and power amplifier tubes should remain in their sockets until they burn out, for the shock of removing has been known to cause serious damage.

Heating and Cooling Cycles

Alternate heating and cooling of tube elements when transmitters are started and stopped causes

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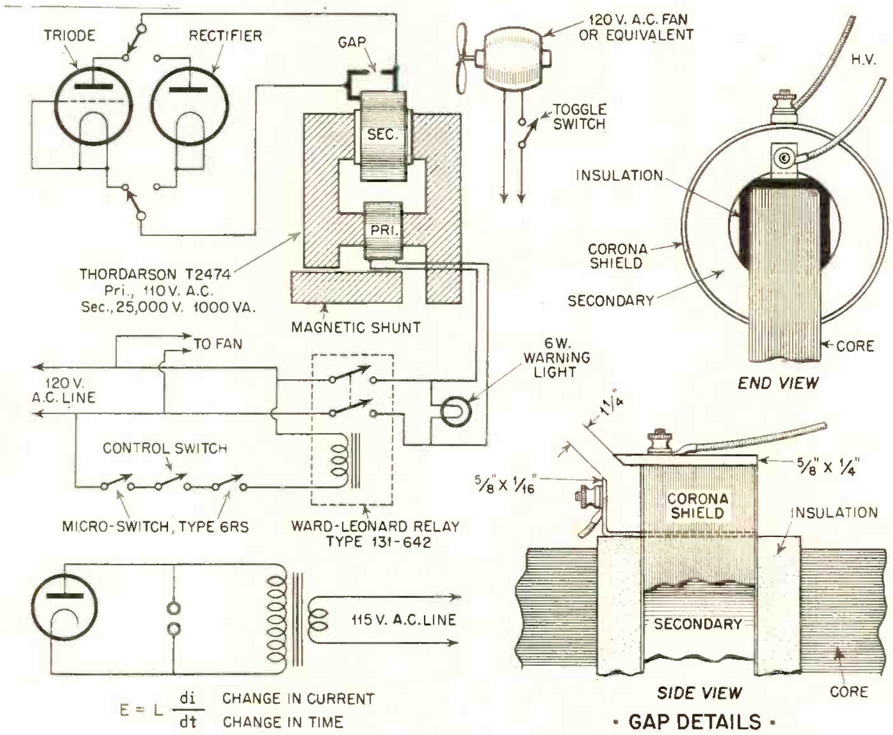
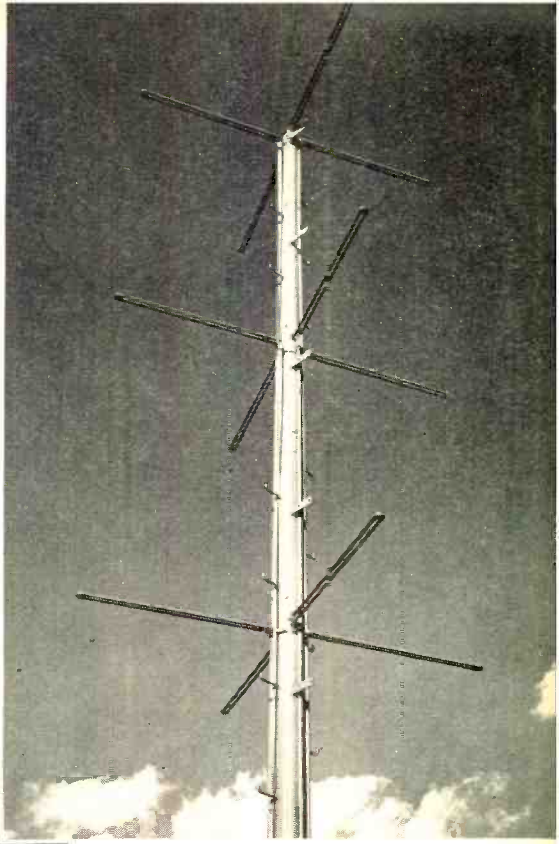


Operating diagram and transformer gap details of the WOR tube reconditoner pictured on page 19. Its operation is described in the text. Cost of construction, $70 to $100; and well worth it.

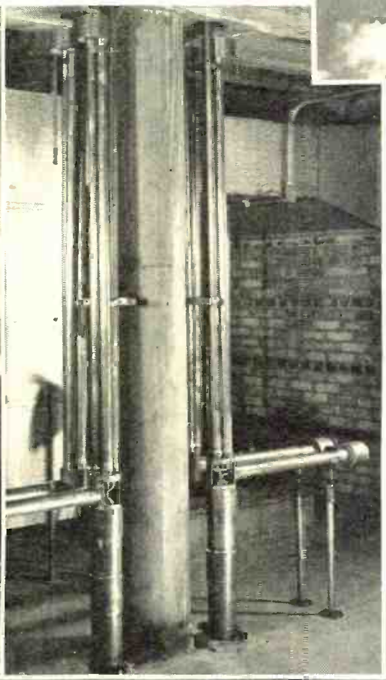
ZENITH'S W51C

◀ Photo-story of the Zenith Radio Corporation's frequency-modulation station W51C, in the Field Building, Chicago. In picture (1) is shown the bank of Westinghouse rectifiers that supply an output of 9,000 volts at 12 amperes for the 50-kilowatt final stage. The final amplifier is shown in picture (2). The tubes are G.E. 880's. That neutralizing condenser has 7-inch square plates. Picture (3) is a closeup of the antenna pole and feedlines, with matching sections and harmonic suppressors. Note the absence of complicated phasing sections necessary with most turnstiles—a development of Zenith engineers.



▲ The 2.9 gain turnstile on a 14-inch diameter steel pole 60 feet high, rising out of the penthouse where the matching sections are located.

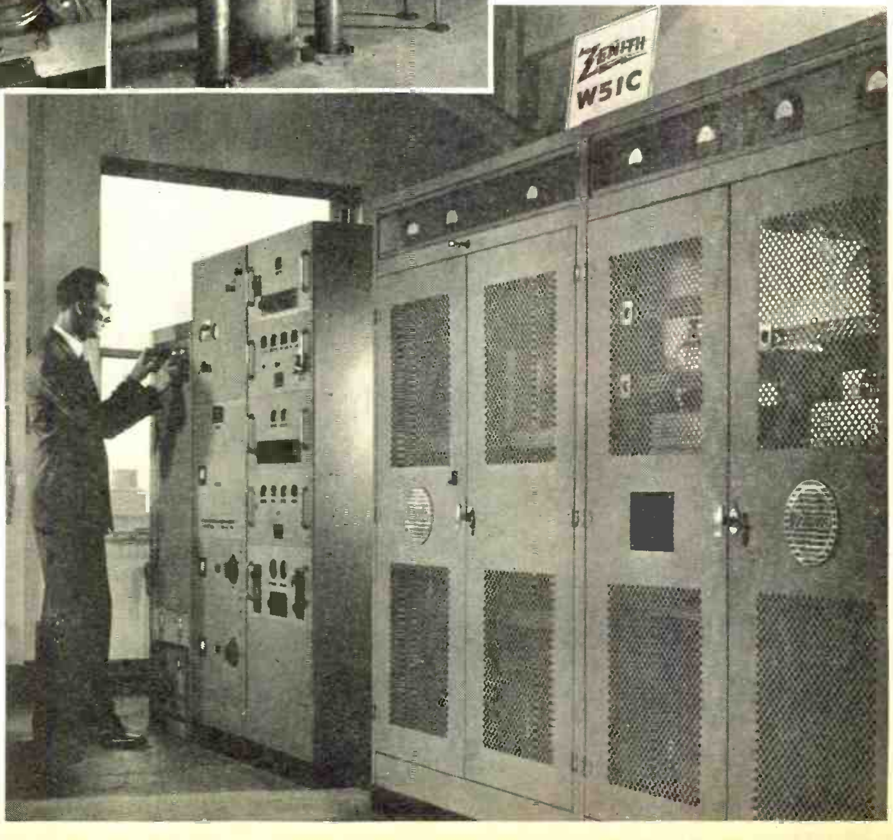
[1] [2] [3]



Reading up the line: The R.E.L. modulator; phase-shift unit; initial amplifier with 5-kw. output, with arrangement to shift over the antenna should the 50-kw. final fail.

▼

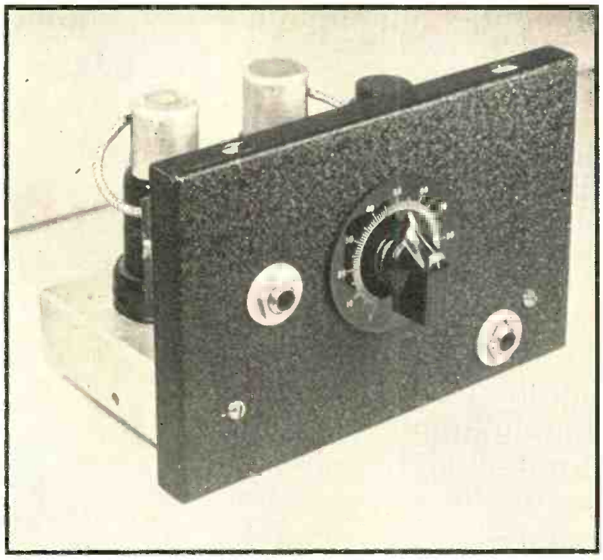
Riding the gain at the mixer, on the 45th floor.



An Improved

AIRCRAFT DETECTOR

CARL O. BOLTZ, Jr. and WILLIAM G. COLLINS

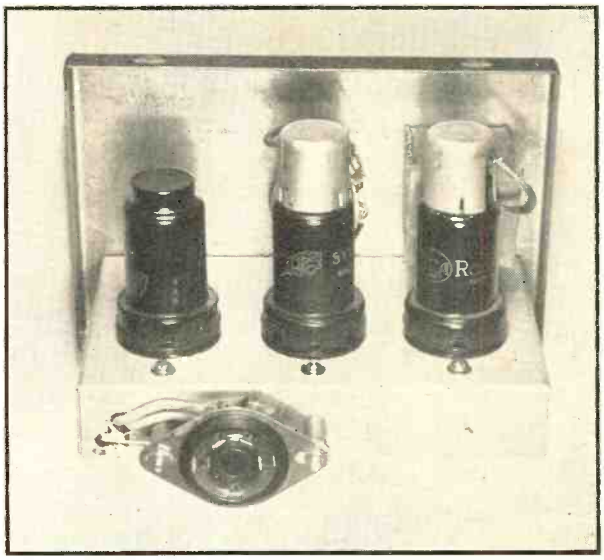


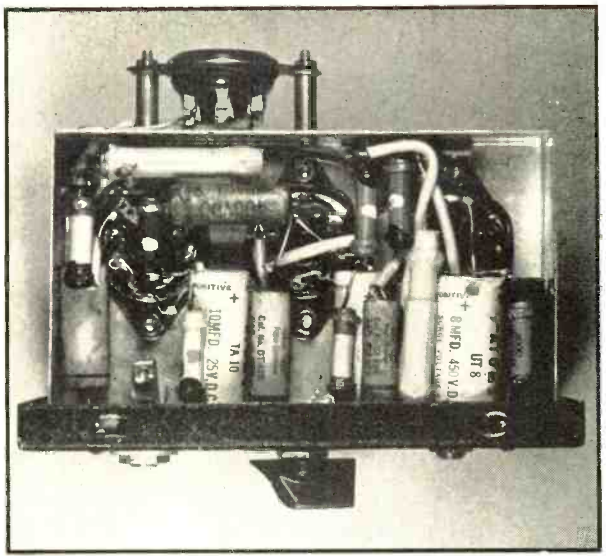
It is now certain that the status of Amateur Radio activity as we knew and enjoyed it "Before Pearl Harbor" has been suspended definitely for the duration. For awhile we had no doubt that there would be a place for at least our u.h.f. gear in the war effort, especially the 2½-meter equipment many of us had in our cars. By forming well-knit mobile communications nets working in conjunction with our local Civilian Defense Corps and Police Department, we were sure that the DCB would see fit to grant us operating privileges on 2½ meters, in order that we could do our bit to assist the municipal organizations in their efforts. However, with a few exceptions, the greater majority of us are totally and completely "off the air" . . . but definitely!

As a result of this, many of you probably already have heard, or have read articles about putting the audio pre-amp back into service for use as an aircraft detector or spotter. Fundamentally this is a swell idea. It offers opportunity for activity of some sort at least. Practically, however, it is very much apt to be a different story. At any rate, the authors found that their two-stage affairs would not deliver the goods when adapted to this purpose, which led to investigating the possibilities of building up an amplifier which would meet somewhat the following arbitrary requirements: (1) A minimum amount of thermionic noise with the hum level on the threshold of audibility *at maximum gain.* (2) Physical size at a minimum; and last but by no means least, (3) provisions for portable operation, preferably from a car.

General Discussion

It is probably safe to assume that the average crystal microphone pre-amp is a two-stage affair consisting of the popular combination of a pentode, resistance-coupled to a triode. A look at any tube manual will show that the voltage gain of a high-gain pentode is about 350, while that of the average triode is between 10 and 14. Resistance coupled, the maximum theoretical voltage gain is 4900. This, of course, is sufficient voltage swing to drive a pentode output or driver stage to full power output, but in this consideration however, we are not particularly concerned with the ability of the pre-amp as a driver, but rather as a straight voltage amplifier. By adding another resistance-coupled triode to our "average amplifier" it is possible to increase the voltage gain to 68,600.





Gain of 1,470,000

In comparison, however, let us look at the voltage gain capability of the three-stage amplifier shown herein. Reference to the diagram shows two resistance-coupled 6J7 pentodes, and a 6C5 output stage. Based on a voltage gain of 350 per stage, the possible voltage gain of two 6J7's alone is 122,500—almost twice as much as the full gain of our "average amplifier" with a third stage added to boot. But, now, by multiplying the gain of the two 6J7's by the gain of the 6C5, we obtain a final voltage gain of 1,470,000.

This figure, while attainable under ideal conditions, is difficult to approach in actual construction. In this particular amplifier, it was decided that it would be unwise as well as unnecessary to attempt to obtain maximum gain from the second stage, which was limited to 140, with a resulting overall gain of 588,000. This was done to minimize any possibility of magnetic feedback due to the close proximity of parts and leads.

Microphone and Power Supply

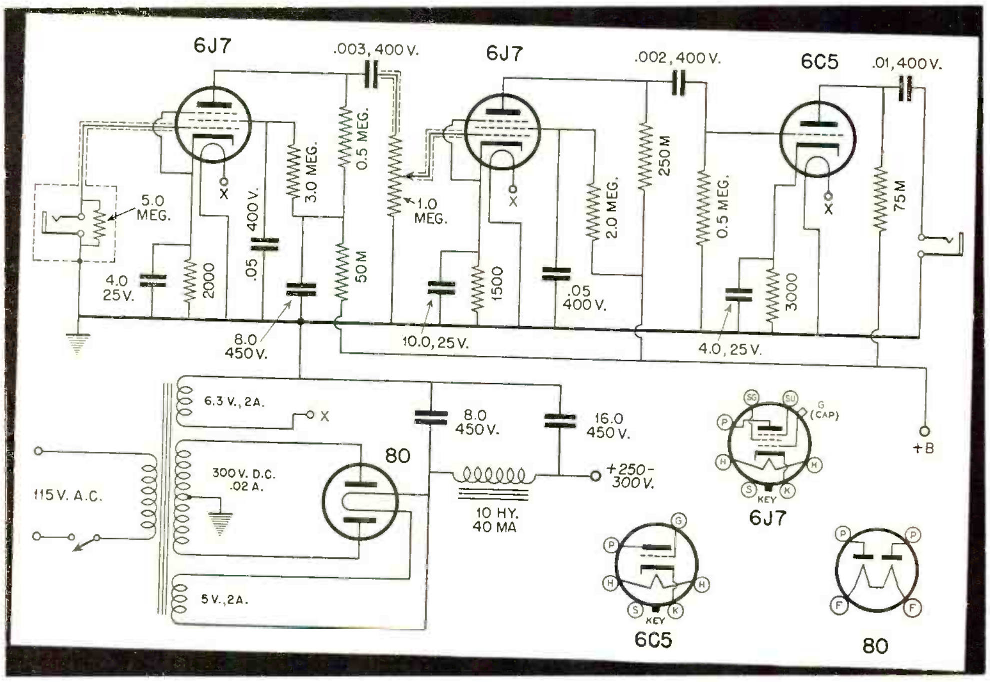
A crystal microphone was used at first, but a permanent-magnet type dynamic speaker, as used in the standard inter-office communication systems, was tried and the results were surprising. The p.m. speaker's output was higher, resulting in more usable signal, with less background noise. Mounting the speaker in a small box open at one end proved a slight advantage as it tended to reduce street noises, etc. Other types of microphones were tried but the p.m. speaker seemed the best for all-around use. A small one was finally chosen as the larger ones didn't justify their size.

And now a word about the power source. Gain calculations are on the basis of approximately 300 volts d.c. from the supply. The current drain is very low so almost any small, well-filtered supply can be used. If power is taken from an ordinary auto radio with about 200 volts d.c. available, the gain will be down slightly, but the results are still satisfactory. Possible difficulty from ignition noise was not given any particular consideration, although luckily enough none was encountered. However, actual mobile operation of the amplifier was found to be far from satisfactory, as pickup of engine sounds alone were enough to completely drown out practically everything else.

Construction

Inasmuch as it is a definite advantage to have an aircraft spotter portable, it was decided in consistency with the prerequisites to keep size at a minimum.

[*Continued on page* 26]



Schematic diagram, with parts values, of the aircraft detector. Its effectiveness is increased by the use of a directional mike, or a mike mounted in a parabolic pickup.

MULTIVIBRATORS

—Theory and Practice

DAWKINS ESPY
Research Engineer, Columbia University
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The variety of practical uses to which the multivibrator has been put makes it important to consider some of the aspects of its theory and operation. Beside its more common use as a frequency divider in frequency-measuring devices, the multivibrator also finds significant use in timing devices and in producing accurate audio frequencies.

As a self-oscillator, the multivibrator is quite unstable, but it has the ability of being easily locked into stabilization when driven by a small amount of voltage from a more stable oscillator. In this latter case the stability of the multivibrator would approach that of the controlling oscillator, and it becomes somewhat independent of varying circuit constants and conditions. The multivibrator may either produce harmonics or the more frequently used sub-harmonics.

Circuit Operation

The multivibrator consists of a two-stage resistance-coupled amplifier with feedback between the plate of the second stage and the grid of the first stage. Since there is a 180° phase shift in each tube, the voltage fed back into the grid of the first stage is in phase with the initial impulse of voltage. Thus, once there is an exciting voltage placed on the grid of the first stage it will be instantly reinforced by the feedback, causing a sudden change in the plate current of the first tube, and causing the grid voltage to fall to a value below cut-off on the second tube. Gradually the negative charge will leak off the grid and coupling condenser of the second stage through the grid leak, and the tube will begin to draw a small plate current. This condition is amplified by the feedback so that an instant later the amount of plate current is large and the first stage is biased to cut-off. The cycle then repeats itself.

Since the magnitude of the condensers' charges and the time of leakage of the grid resistances are obviously the two important factors in determining the frequency of the multivibrator, it necessarily follows that the coupling condensers and grid resistors *C1, C2, R1,* and *R3* in *Fig. 1* will be the constants which are most important. The time that the second stage remains inoperative in the first

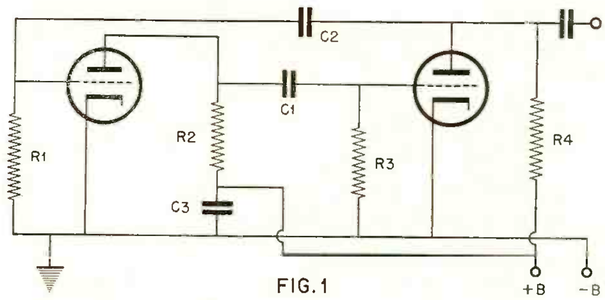


FIG. 1

Fundamental diagram of multivibrator. Capacitor C2 is the feedback element. Frequency is determined by the values of C1, C2, R1 and R3.

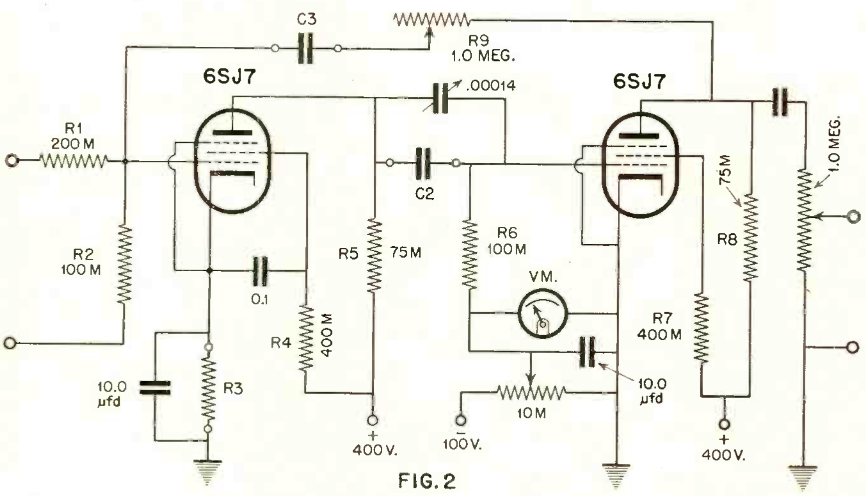
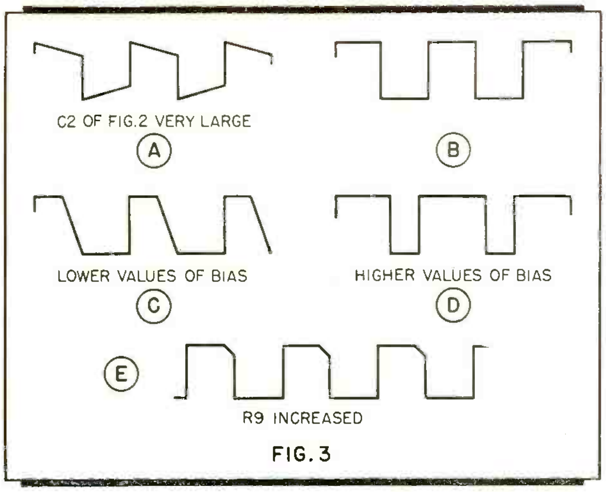


FIG. 2

Experimental multivibrator set-up. Circles denote that the element was "plug-in" in order that its value could be changed. For value of R3, see text.



Some of the waveforms obtained from the multivibrator. These provide outputs rich in harmonics.

part of the cycle described in the preceding part of the paragraph, depends upon the amount of fixed bias on the tube, a low value permitting the tube to resume operation more quickly than a high value of bias.

The upper limit of frequency at which a multivibrator can be operated is limited by the frequency at which satisfactory resistance-coupled amplification is possible. The lower limit is determined by the leakage of the grid condensers in relation to the condenser capacities.

An Experimental Circuit

The diagram of an experimental model of the multivibrator, built for the purpose of determining data concerning practical operation, is shown in *Fig. 2*. It will be seen that provision was made to vary the value of the interstage coupling condenser by use of the variable condenser *C1* in parallel with the normal coupling condenser *C2*, and to vary the effect of the feedback condenser *C3* by the use of the variable series resistor *R9*. The range of these variables was sufficient to vary a normal frequency division of 10-to-1 to 9-to-1 or 11-to-1. The set-up just described enabled determination of the synchronization properties of the multivibrator circuit.

It is apparent that when the grid voltage on the first stage is just slightly greater than cut-off, a slight positive impulse will cause the grid to go above cut-off and the plate current to flow, setting the trigger-like regenerative action to work. Conversely, a negative impulse can prevent the grid from going more positive than cut-off at the critical moment, thus preventing the plate current from increasing when it otherwise might. If such impulses are applied periodically at the approximate frequency of the multivibrator, the impulses will assume control of the frequency of the multivibrator oscillator. If the multivibrator frequency is an approximate harmonic or sub-harmonic of the impressed frequency, the kick will occur every *n*th cycle, where *n* is the order of the harmonic or sub-harmonic on which the multivibrator is operating. If *n* is not too large the multivibrator will keep in step with the harmonic or sub-harmonic frequency. By driving the grid of the first stage with an alternating voltage of proper frequency relationship to the multivibrator, synchronization may be obtained.

It was found experimentally that the multivibrator would operate on a sub-harmonic of the driving voltage even though it would not oscillate by itself when the driving voltage was removed. The magnitude of the exciting voltage was set at different points by adjusting variable resistor *R1*. If the exciting voltage is too small in magnitude, variation in one of the frequency-controlling components will result in a continuous variation of the multivibrator frequency rather than jumping from one sub-harmonic to the next as would be the case if the driving voltage were of sufficient intensity. Self-oscillation of the multivibrator is further characterized by the rough-sounding signal it emits. When the driving voltage is of the proper magnitude it should be possible to change one of the frequency-controlling components a small degree without jumping the frequency of the multivibrator to an adjoining sub-harmonic.

The waveform was not affected appreciably by changes of *C1*, *C2*, or *C3* as shown in the experimental circuit in *Fig. 2*. Slight effects were noticed, however, when *C2* was very large and the frequency of oscillation was low. The waveform, instead of being rectangular as shown in *Fig. 3-A* was like the one shown in *Fig. 3-B*. Varying the bias had a marked effect on the wave shape. With lower values of bias the wave took the form as shown in *Fig. 3-C*, while with higher values of bias the waveform was

CHART I

C	Grid Resistance (in Ohms)			
(μfd.)	100 kc.	10 kc.	1 kc.	0.1 kc.
.001	5000	50,000	500,000	
.002	2500	25,000	250,000	
.003	1666	16,666	166,666	
.004	1250	12,500	125,000	
.005	1000	10,000	100,000	
.006	833	8,333	83,333	
.007	714	7,142	71,428	
.008	625	6,250	62,500	
.009	555	5,555	55,555	
.01	500	5,000	50,000	500,000
.02	250	2,500	25,000	250,000
.03		1,666	16,666	166,666
.04		1,250	12,500	125,000
.05		1,000	10,000	100,000
.06		833	8,333	83,333
.07		714	7,144	71,444
.08		625	6,250	62,500
.09		555	5,555	55,555
.1		500	5,000	50,000
.2		250	2,500	25,000
.3			1,666	16,666
.4			1,250	12,500
.5			1,000	10,000
.6			833	8,333
.7			714	7,144
.8			625	6,250
.9			555	5,555
1.0			500	5,000
2.0			250	2,500

Various combinations of resistance and capacity that may be used to give multivibrator operation on specified frequencies.

as shown in *Fig. 3-D*. This occurred because varying the bias on one tube altered the time that the tube was inoperative. Increasing *R9* rounded the corners of the wave as shown in *Fig. 3-E*. With such peculiar wave shapes the output is obviously very rich in harmonics, and this fact is used to great advantage in frequency-measuring uses of the multivibrator.

Practical Considerations

Although the experimental circuit previously described employs two separate tubes, considerable space may be saved by utilizing a double or twin triode, the most popular of these tubes being the 6N7 and the 6SC7. If separate tubes are used, the most important point is that they have approximately the same inter-electrode capacities when $C1 = C2$, and $R1 = R3$ as referred to *Fig. 1*.

In this case (where $C1 = C2$, and $R1 = R3$) the operating frequency of the multivibrator may be determined from the formula

$$F = \frac{500}{RC}$$

where F is the frequency in kilocycles, R is either $R1$ or $R3$ in ohms, and C is either $C1$ or $C2$ in μfds. Thus, if it were desired to operate the multivibrator at a frequency of 10 kc. using .01 μfd condensers, the proper resistance for $R1$ and $R3$ would be approximately 5,000 ohms. Although this formula gives a good approximation as to the values of R and C to be used, it is usually desirable to make a portion of one of the resistors variable so that a close adjustment may be obtained. Chart 1[1] contains various combinations of resistances and capacitances that may be used to give multivibrator operation on the specified frequencies. This chart was calculated on the basis of the above formula.

A buffer amplifier placed between the control oscillator and the multivibrator will help prevent circuit changes in the multivibrator from affecting the frequency of the oscillator. A tuned harmonic amplifier following the multivibrator is often useful in assisting the multivibrator to produce strong signals at a high order of harmonics. A switch connecting the grid of one of the multivibrator stages to ground will serve to keep the plate current drain approximately constant, while placing the unit in an inoperative condition. This, together with the usual voltage regulator, should be a further help in obtaining good oscillator stabilization.

Perhaps the simplest way of checking the subharmonic frequency of the multivibrator is, for example, to use a receiver to locate first, two 100-kc. markers of a 100-kc. crystal, and then the 10-kc. markers of a 10-kc. multivibrator. If there are 10 spaces between the two 100-kc. markers, then the multivibrator has been adjusted to the proper 10-to-1 ratio. If, on the other hand, the 10-kc. markers had subdivided the space between the two 100-kc. markers into 9 or 11 spaces, it would be an indication that the multivibrator was not operating at the proper frequency, and that further adjustment was necessary.

[1] "Theory and Operation of Multivibrators", Aerovox Research Worker, November, 1940

AIRCRAFT DETECTOR

[*Continued from page 23*]

Not only from the standpoint of physical compactness, but from the electrical angle, the short leads which result prove advantageous in keeping undesirable feedback out of the picture.

The amplifier itself is built on a small chassis pan measuring 3½" x 5½" x 1". The front panel, as shown, is one of the covers from a small black crackle metal box, the actual use of which is not necessary, however, provided a larger chassis pan is used. Complete shielding of the microphone input jack and load resistor is strongly recommended, so in order to provide mounting space for them and also for the gain control potentiometer, it will be a case of either a larger chassis pan without a panel, or a small chassis pan as shown, with a panel. Adequate shielding is of course essential in almost any moderate gain audio amplifier, and in spite of the fact that this one has much more gain than the average, no serious difficulties should be encountered.

A word about the "SJ" equivalent type tube might be in order, if a larger chassis is used in lieu of a smaller one with panel, as their use will probably come to mind as a possible substitute for reason of better connection accessibility. The 6SJ7 not only has the disadvantage in having a lower signal-to-noise ratio, but has considerable less gain than the 6J7.

The accompanying photos show a rear view of the amplifier, with the first 6J7 on the right, the second 6J7 in the middle and the 6C5 output stage on the left. (The shield for the microphone jack and load resistor can be seen in back of the first stage). Mounting the sockets so that the pin slot is to the front makes for easy wiring in general, and also places the various base connections in such a relative position as to keep length of leads at a minimum. Furthermore, the sockets should be in a line and close to the rear edge of the chassis, to allow space in front for mounting the bulk of the parts. Then by punching the socket holes on the aforementioned line, and with equal space between socket centers and pan sides, adequate under-chassis space will result. It was found best to mount the paralleled cathode resistors and condensers first, and also the screen by-passes, as they are the bulkiest of the parts used.

A feeling of uncanniness was the first sensation experienced by the authors upon listening to the surprising amplification of the slightest room sounds.

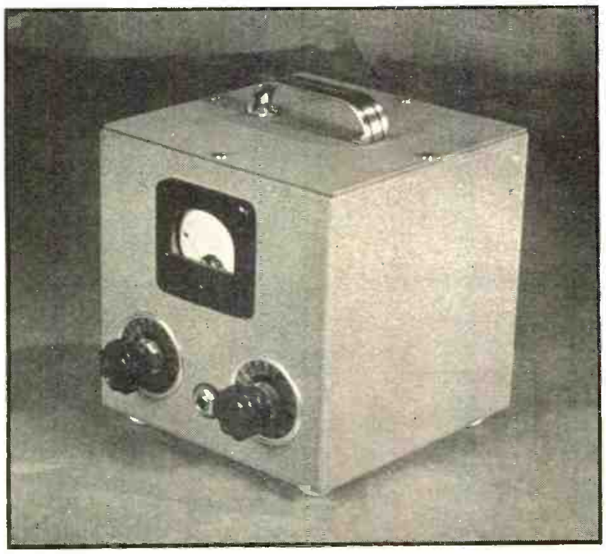
U.H.F. FIELD-STRENGTH METER

LLOYD V. BRODERSON

◀ With the probability now that the F.C.C. will permit limited amateur activity in the u-h-f bands, in conjunction with the requirements of local defense units, a field-strength meter designed specifically for 112 or 224 mc. will assume particular value for field tests.

Heretofore, most field-strength meters have been constructed primarily for operation on lower frequencies. In most instances, the practice has been to cover two channels with but a single tuned circuit. While this arrangement is adequate at the lower frequencies, it leaves much to be desired when the instrument is pressed into service on either 112 or 224 mc. Most standard components and insulating materials which suffice for the lower frequencies will show up rather poorly on the ultra-highs, resulting in decreased sensitivity and stability.

Shorn of all "frills," the meter herein described represents the simplest indicator one can construct, consistent with reasonable stability and sensitivity. It is lightweight, compact, easily constructed—and with a little judicious planning its cost can be kept surprisingly low.



The Circuit

The fundamental operating principle of any field-strength meter, be it complicated or the acme of simplicity, provides for some method of detecting the r.f. signal and indicating the relative signal strength.

An analysis of *Fig. 1* discloses the following: A Hytron 1G4-GT triode with its plate and grid tied together forms a simple diode power detector. The indicating device is a Triplett 0-1 (.001) d.c. milliammeter. *L1* and *C1* constitute the single tuned circuit resonant only in the 112-116-m.c. area. The closed-circuit jack provides a means for checking voice and tone transmissions. The only power requirement—a single 1.5-volt battery—is extremely economical inasmuch as the filament current of a 1G4-GT is but 50 ma. (.050).

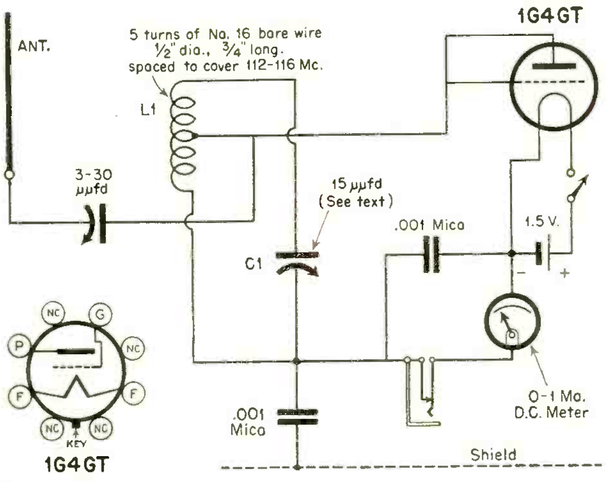


Fig. 1. Diagram, with values, of field-strength meter.

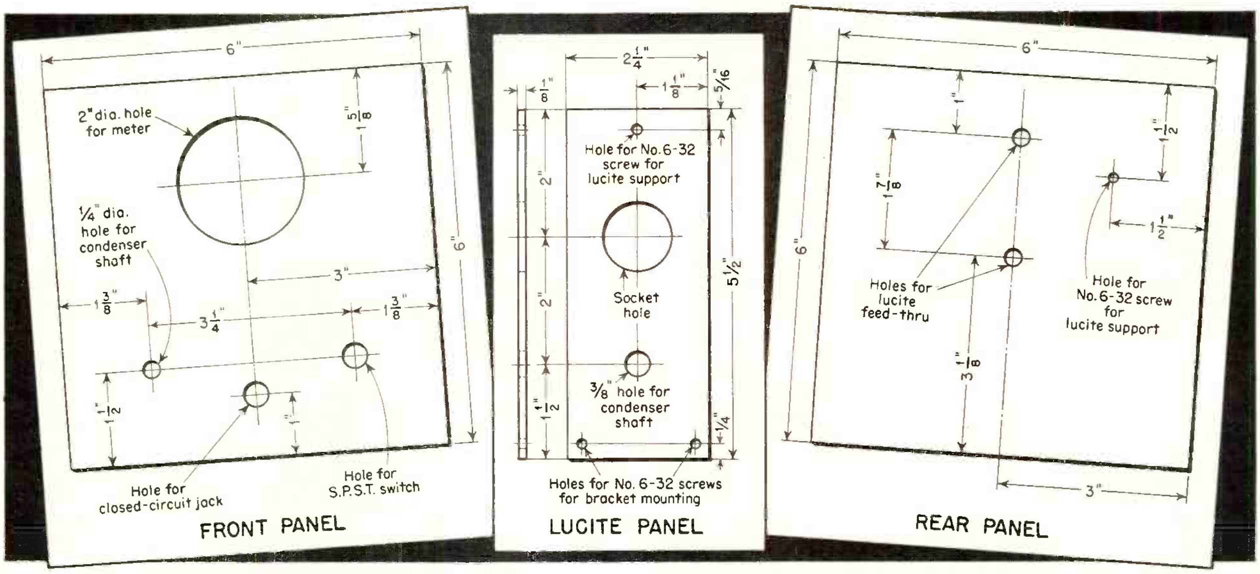
Construction

The entire unit is housed in a grey, crackle-finished Bud metal cabinet measuring six inches square, top and bottom plates being removable. The photographs and diagrams clearly illustrate the parts placement and panel layout.

As insulation assumes an important role on these frequencies, the socket, coil, tuning condenser and the upright support on which they are mounted should receive more than ordinary care.

The condenser shown is a Hammarlund five-plate u.h.f. midget variable, rebuilt to have but three plates (one rotor and two stator). The polystyrene socket is also "revamped" by removing all but four prongs (filaments, grid and plate). The elimination of excess metal in the form of unused socket prongs reduces the capacity effects within the socket itself. Little is gained by merely clipping short the unused prongs—an appreciable length remains imbedded in the socket and continues to constitute a loss.

The upright panel holding the socket and variable condenser is fashioned from a strip of lucite. Running the width of this strip at its base is a small right-angle bracket which is bolted to the bottom plate and serves to anchor the assembly. A ¼"-diameter lucite



rod serves as an additional support for the panel from the top. A flexible Isolantite coupling isolates the condenser rotor shaft which is extended to the front panel by a short length of quarter-inch diameter lucite shafting. The 1.5-volt filament battery is held in position by a U-shaped bracket fastened to the bottom plate.

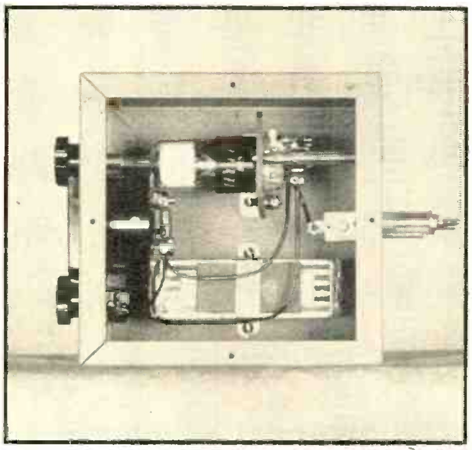
One side of the Isolantite coupling condenser is connected to the center of the coil, the other plate of this condenser terminating at the lower lucite feed-thru insulator mounted at the rear of the cabinet. The upper lucite feed-thru merely serves as a support for a vertical half-wave antenna rod.

On the front panel are mounted the 0-1 d.c. milliammeter, variable condenser control knob, on-off rotary toggle switch, and the closed-circuit jack.

Four rubber feet glued to the bottom plate and a standard three-inch chrome-plated drawer-pull handle fastened to the top plate completes the assembly.

Operation

After making certain that *L1* and *C1* resonate over the 112-116-mc. area, the 3-30 $\mu\mu$fd. coupling condenser should be set at approximately one-half



its total capacity. An antenna may then be connected to the lucite terminals at the rear of the cabinet.

An excellent antenna for this unit when working in close proximity to a low-power transceiver or transmitter is a half-wave vertical rod. With such a resonant antenna it is possible to obtain useful readings several wavelengths from the transmitter. Small, portable "flea-power" transceivers have been checked with very satisfactory results.

Bearing in mind that although the field-strength meter will show a greater deflection when close to the transmitting antenna, it also sets up a standing wave condition between the meter and antenna, and workable readings become unreliable. For this reason, the user should determine the greatest distance from the transmitting antenna at which he can obtain a usable deflection.

It is interesting to note that some adjustments on low-power 2½-meter transceivers are not apparent when checked by audible means. In one experiment, tighter antenna coupling showed no increase in audible signal strength when monitored by a receiver some distance away. However, a greater deflection was observed on the field-strength meter.

Headphones plugged into the circuit enable the user to monitor voice and i.c.w. transmissions. This method of checking modulation is especially useful when the equipment under test is a transceiver. Due to circuit phenomena and the fact that transceiver components serve dual purposes, transmissions heard in the "Receive" section are rarely a true index to the quality of signal emitted when the same transceiver is in the "Transmit" position.

Conclusion

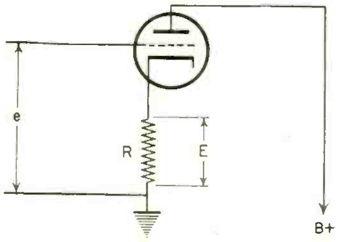
Although designed for the 2½-meter band, the unit described should prove satisfactory for the 224-mc. channel. The only changes necessary would be a reduction in the size of *L1* and a smaller capacity at *C1*. Removing one of the stator plates should accomplish the latter.

RADIO DESIGN WORKSHEET

NO. 2—AUDIO CIRCUITS

CATHODE FOLLOWER

Problem 1:—*Derive the expression for the voltage transfer through a "cathode follower" circuit in terms of amplification factor μ, plate resistance R_p, and cathode load resistor R.*



Solution:—Let e be the audio-frequency input voltage applied to the grid of the triode, and E be the output voltage across the cathode load resistor R.

The output voltage E will be equal to the product of plate current I_p and cathode load resistor R.

$$I_p = \frac{\mu(e - I_pR)}{R_p + R}$$

$$I_pR_p + I_pR = \mu e - \mu I_pR$$

Then: $I_p(R_p + R + \mu R) = \mu e$

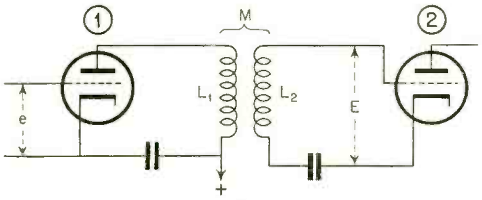
Therefore: $I_p = \dfrac{\mu e}{R_p + R + \mu R}$

Whence: $E = I_pR = \dfrac{\mu eR}{R_p + R + \mu R}$

From which it follows that: $\dfrac{E}{e} = \dfrac{\mu R}{R_p + R(1-\mu)}$

TRANSFORMER COUPLING

Problem 2:—*Derive the expression for voltage gain (i.e., grid-to-grid gain) of the accompanying transformer-coupled circuit, and find the relation between R_p and $2\pi fL_1$ for which gain is maximum.*



Solution:—Let μ = amplification constant of tube (1), R_p its plate impedance, and I_p its a.c. plate current. And let K = the coefficient of coupling of

$$L_1 \& L_2 = \frac{M}{\sqrt{L_1L_2}}$$

Assume the impedance looking into the grid of tube (2) to be infinite so that E is voltage induced in L_2.

$$E = 2\pi fMI_p = 2\pi fI_pK\sqrt{L_1L_2}$$

$$I_p = \frac{\mu e}{\sqrt{(4\pi^2f^2L_1^2 + R_p^2)}}$$

$$E = \frac{2\pi f\mu eK\sqrt{L_1L_2}}{\sqrt{(4\pi^2f^2L_1^2 + R_p^2)}}$$

$$\frac{E}{e} = \frac{2\pi f\mu K\sqrt{L_1L_2}}{\sqrt{(4\pi^2f^2L_1^2 + R_p^2)}} \qquad (1)$$

which is the voltage gain required.

To find the relation between R_p and $2\pi fL_1$ for maximum gain, it is necessary to resort to the calculus.

Thus: $\dfrac{d}{dL_1}\left(\dfrac{E}{e}\right) = 0$

$$\sqrt{4\pi^2f^2L_1^2 + R_p^2}\;\frac{2\mu\pi fK\sqrt{L_2}}{2\sqrt{L_1}}\,dL_1 =$$

$$\frac{2\mu\pi fK\sqrt{L_1L_2}}{2\sqrt{4\pi^2f^2L_1^2 + R_p^2}}\,(4\pi^2f^2L_1^2 \times 2L_1dL_1)$$

Simplifying $\quad 4\pi^2f^2L_1^2 + R_p^2 = 2L_1^2(4\pi^2f^2)$

$$R_p^2 = 4\pi^2f^2L_1^2$$

or $\quad R_p = 2\pi fL_1 \qquad (2)$

which is condition for maximum gain.

From an inspection of equation *1*, it is obvious that $\dfrac{E}{e}$ varies directly with K and the $\sqrt{L_2}$. It is obvious that the voltage gain is maximum at $K = 1$, which condition represents an audio amplifier coupled with an iron-core transformer.

RESISTANCE COUPLING

Problem 3:—*Derive the expression for voltage gain (i.e., grid-to-grid gain) of the accompanying resistance-coupled circuit.*

Solution:—Let R_p = plate resistance of tube (1), let μ = its amplification factor, and let $R_1 << R_2$

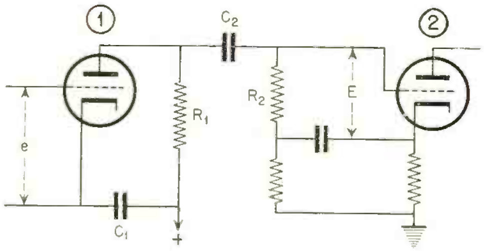
$$I_p = \frac{\mu e}{R_p + R_1}$$

$$E = I_pR_1 = \frac{\mu eR_1}{R_p + R_1}$$

$$\frac{E}{e} = \frac{\mu R_1}{R_p + R_1}$$

This equation indicates that the gain increases with an increase in R_1. The gain will obviously be maximum when R_1 is so large that R_p may be neglected. Whence

Maximum gain = μ.



The Cathode-Ray OSCILLOSCOPE

JAY BOYD

PART III—PRACTICAL OSCILLOSCOPE DESIGN

◀ In regard to the design of the saw-tooth oscillator, (*Figs. 5, 6,* and *7* in the May issue) it was pointed out that if fixed bias is used, the output will be essentially flat up to about 10,000 cycles, at which point the output diminishes rapidly.

A semi-fixed bias arrangement is shown in the complete diagram, *Fig. 8*. As previously mentioned, the bleeder current of about five milliamperes will be drained through *R5*. The 884 or 885[1] will operate with a charging current up to two milliamperes. However, the charging current in this particular design, which has worked so well in practice, never exceeds 0.550 milliampere.

At this low charging rate there will be less energy to discharge, for any given frequency, permitting its quicker disposal through the tube, resulting in a quicker sweep return time. Also, by making the bleeder current many times greater than the variation of charging rate, the variation of output is kept low. The whole results in simple design and excellent performance.

[1]The 884 and 885 are identical, except for heater voltage. The former tube operates at 6.3 volts, while the latter was designed for 2.5 volts. Choice depends on filament winding available.

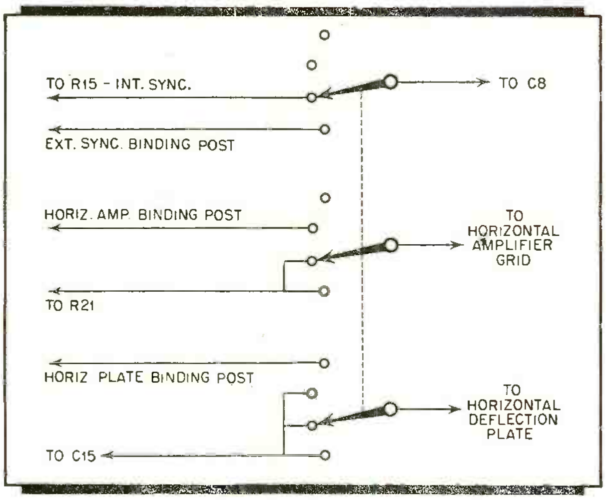


Fig. 9. Optional switching arrangement, combining synchronism selection with horizontal selector switch.

If You Have to Substitute

Unfortunately, though, the five-megohm potentiometer specified for *R19* in *Fig. 8* may be hard to obtain. A two- or three-megohm control may be used along with 300,000 or 450,000 ohms for *R20*. This will increase the charging rate, so the discharge resistor, *R18,* should be increased to 400 or 500 ohms to protect the tube. The increased charging rate also increases the oscillation frequency, so the values of all tank condensers, *C10* to *C14,* should be doubled to maintain the same approximate oscillation frequencies.

At the higher charging rate, operation may be erratic, or the tube may fail to oscillate. If this occurs, increase *R5* to 1000 ohms, or until satisfactory performance is obtained.

Calculating the Sweep Frequency

The values of *R19* and *R20,* and condensers *C10* to *C14* will give any frequency from 12 or 14 cycles up to the maximum oscillation frequency of the gas-triode, when operated at the bias voltage given.

For the benefit of those who like to juggle their own figures, we will say that the frequency in cycles per second will equal I/VC, the current being given in amperes, potential in volts, and capacity in farads. The voltage (V) will be the potential at which the tube flashes, minus its de-ionization voltage.

But since the writer has no definite figure on this latter voltage, the above formula doesn't mean too much. This de-ionization voltage, however, seems to be somewhere around 10 volts.

Note that *C11* is one-fourth the capacity of *C10*. Therefore its frequencies will be five times those of the former condenser. Also note that the ratio of *R20* to *R19* + *R20* is 7.66. A ratio of 5 to 1 is all that is required but the excess takes care of frequency variation from synchronization and prevents any lack of overlap between frequency ranges.

Making the Sweep Wave Linear

We have mentioned that the saw-tooth oscillator would give a linear output if adjusted for a low flashing voltage. The manufacturer's tube data tells us the output will be linear if the tank condensers are flashed at five percent of the charging voltage, but their later circuits specify a grid bias of 6.5 volts, which would cause flashing at over twice the former figure.

Experience has shown a bias voltage as low as 3.75 volts to be reliable and practical if the tank condenser charging rate does not exceed one milliampere. The flashing voltage is 28 or 30 volts and the useful peak-to-peak output around 18 or 20 volts. Under such conditions linearity is excellent and the sweep return time very fast.

Keeping It Linear

But generating a linear saw-tooth wave is but half the battle; it must be amplified and applied to the free horizontal plate without loss of this highly desirable linearity. If the horizontal amplifier is not linear, or if its grid circuit impedance loads the oscillator, a bend will occur in the saw-tooth waveform. If the total resistance of *R21* and *R22* equals four megohms the loading will be negligible. A higher resistance causes a phase shift in the grid circuit, while a lower impedance than two megohms will cause some departure from linearity.

The same statement holds true for the horizontal deflector plate return resistor, *R12*. Here five or ten megohms would be desirable for linearity. But since these plates pick up a few stray electrons, which must find their way to ground through this resistor, too many megohms will produce a bias on the plate. The beam will drift to one side, and change position with a variation in beam intensity. The most practical value, then, will be from one to four megohms, depending on the particular tube. But try the higher value first.

Amplifiers for Oscilloscopes

It is essential that the oscilloscope's amplifiers be capable of high voltage gain without distortion. While

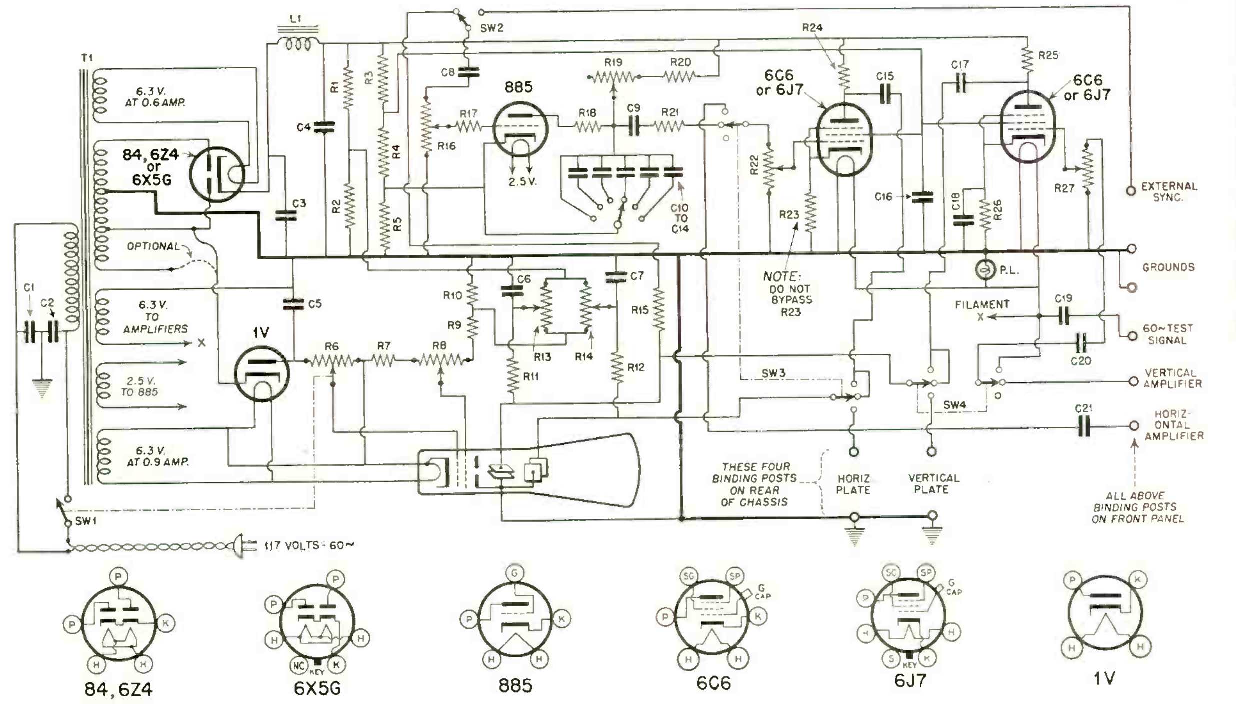


Fig. 8. Complete diagram for one- or two-inch 'scope. Also suitable for larger model, with appropriate power-supply changes.

R1—250,000 ohms, 1 watt
R2—50,000 ohms, ½ watt
R3—50,000 ohms, 20 watt
R4—20,000 ohms, 1 watt
R5—750 ohms, ½ watt
R6—50,000-ohm pot.
R6A—50,000 to 100,000 (see text)
R7—50,000 ohms, ½ watt
R8—50,000-ohm pot.
R9—150,000 ohms, 1 watt
R10—50,000 ohms, ½ watt
R11—0.5 to 2 megs.
R12—1 to 4 megs.
R13, R14—250,000-ohm pot.
R15—2 megs., ½ watt
R16—50,000-ohm pot.
R17—25,000 ohms, ½ watt
R18—200 ohms, ½ watt
R19—5-meg. pot.
R20—750,000 ohms, ½ watt
R21—1 meg., ½ watt
R23—1000 ohms, ½ watt
R24, R25 — 100,000 ohms, 1 watt
R26—1000 ohms, ½ watt
R27—1-meg. pot.
C1, C2—0.1 mfd., 400 v. tubular
C3, C4—8-8 mfd paper, actual capacity 1.75 mfd. per section
C5—Single 8, as above; actual capacity about 2.75 mfd.
C6, C7, C8, C9—0.1 mfd., 400 v. tubular
C10—0.5 mfd., 400 v. tubular
C11—0.1 mfd., 400 v. tubular
C12—0.02 mfd., 400 v. tubular
C13—0.005 mfd. mica
C14—0.001 mfd. mica
C15—0.1 mfd. 600 v. tubular
C16—3 mfd or more, paper
C17—0.1 mfd. 600 v. tubular
C18—10 mfd., 25 v. elect.
C19, C20, C21 — 0.1 mfd., 400 v. tubular
SW1—Line switch on brilliance control
SW2—S.P.D.T. toggle switch
SW3, SW4—Two-pole, 3-position rotary switch

not ideal in every respect, simple pentode amplifiers of the 6C6 or 6J7 type are quite practical, being found in most commercial oscilloscopes.

These are operated at higher plate voltages than usual, but being resistance coupled, only about half that voltage is actually applied to their plates. Plate load resistors are somewhat lower than usual. Cathode resistors must be those specified and screen voltage not less than 100 nor more than 125 volts.

The vertical amplifier cathode resistor may be by-passed by a high value of capacity to prevent degeneration. But don't by-pass the horizontal amplifier cathode resistor, as this will cause objectionable tails on the sweep wave.

The plate coupling condensers, *C15* and *C17,* should be of fresh stock. Old ones frequently pass a slight leakage current, placing some d.c. potential on the deflector plates, and preventing centering of the beam. The screen by-pass condenser, *C16,* must be not less than three microfarads, and preferably of the paper type.

Flexible Switching Arrangement

Two rotary switches are provided for deflector plate switching. The vertical plate may be switched either to the output of its amplifier or to a separate binding post for signals requiring no amplification. As r.f. is frequently applied to this plate, this binding post should be located on the rear of the chassis. No attenuation is provided in this case, potentiometers being rather allergic to r.f.

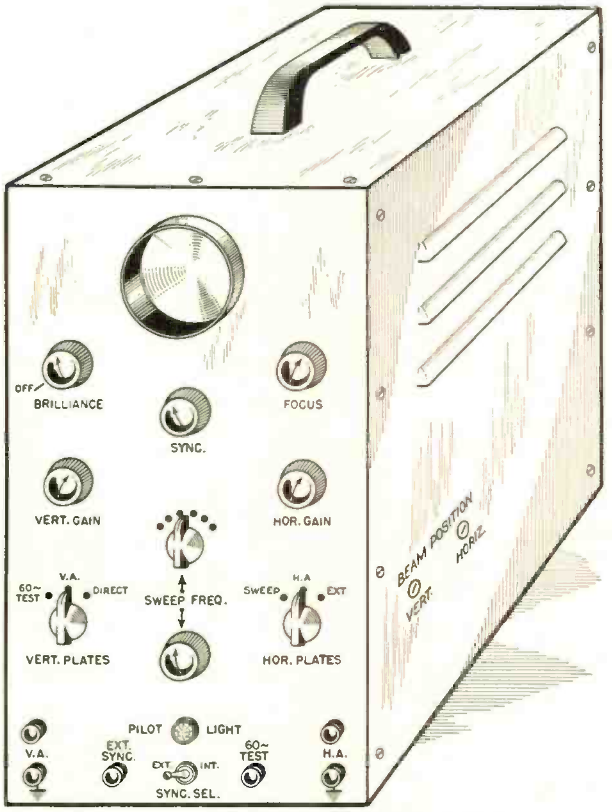


Fig. 10. Panel layout for one- or two-inch 'scope.

Smaller signals are applied to the vertical amplifier, which has its gain control and binding post on the front panel. A third position is provided so a 60-cycle test signal may be picked up from a filament winding. This is useful for focusing and comparison, and is too handy a feature to omit.

In most applications a linear sweep signal is used so the horizontal plate is connected to its amplifier, which, in turn, is switched to the saw-tooth oscillator. Sometimes the horizontal sweep voltage is taken from the apparatus under test, as in the case of transmitter testing, for instance, so a direct connection is also provided at the rear for the horizontal plate.

For certain types of work it may be desirable to feed the signal being tested into the horizontal amplifier, so switching should be provided in its grid circuit, too.

Synchronization

Synchronization of the saw-tooth oscillator is usually obtained by feeding back a small signal voltage from the vertical deflector plate. Receiver alignment work requires synchronizing the saw-tooth oscillator with the wobbulated oscillator, so an "external sync." binding post is provided, as well as a toggle selector switch.

This latter switch may be eliminated from the panel, though, by providing another gang and point on the horizontal switch. An optional circuit for this arrangement is shown in *Fig. 9.*

One of the front panel binding posts is marked "60-cycle test," but serves several purposes. Sixty-cycle synchronization may be had by running a jumper over to the "external sync." binding post.

Sometimes a 60-cycle sinusoidal sweep is desirable. A jumper from that binding post to the "H.A." post provides it when needed.

This useful post can also be used as a 60-cycle signal for running into amplifiers, either for testing or frequency comparison. It's worth its weight in rubber!

Constructional Pointers

With the various design problems disposed of, let's consider some constructional details. Anyone who has built a receiver, transmitter or amplifier should have no difficulty building a first-class oscilloscope if a few important points are adhered to.

To begin, we know the 'scope should be inclosed in a metal cabinet for shielding and protection of the c.r. tube and other parts. A typical cabinet and panel layout is sketched in *Fig. 10,* being quite similar to some commercial products. Unfortunately, there are no suitable blank cabinets available, but building one yourself or having it made by a good sheet metal shop offers no particular problem.

But don't try to stuff your 'scope into a regular receiver cabinet! If you do it will be necessary to place the power transformer under the c.r. tube or to one side of it—and such an arrangement just won't work. Magnetic fields from the transformer will spoil the job.

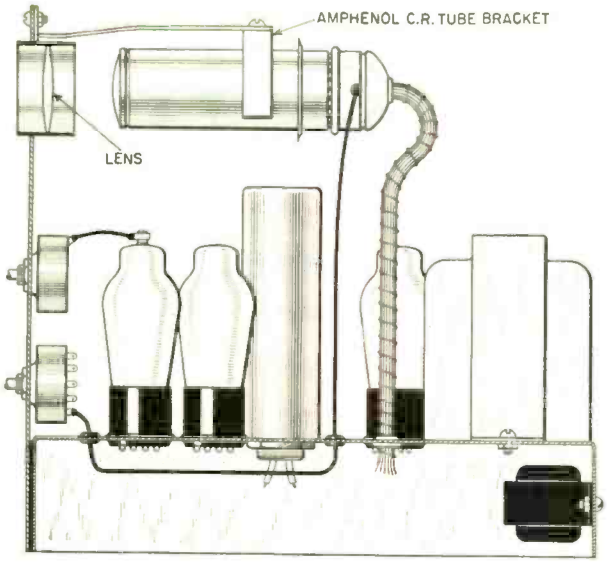


Fig. 11. Sectional view of one-inch oscilloscope. A satisfactory lens can be purchased at a Woolworth store.

The cabinet size will depend on the tube used, the following being recommended: For a one-inch 'scope, panel, 7x10 inches, with parts mounted on a 7x10x2-inch chassis. A bottom plate should also be provided. Such a stock chassis starts you off right. Add a panel and make up a cover and there you have it.

A two-inch oscilloscope requires a little more care. If laid out like *Fig. 12,* the chassis must be made to order. It should be 7x12½x4½ inches and the panel must be 11½ inches tall. If one wishes to use a stock chassis, placing the transformer on top, as shown in *Fig. 11,* the chassis must be at least 13 inches in length and 1½ or 2 inches high, with a panel one foot tall; no less. Spacing between the c.r. tube and transformer is a point that must be respected.

All the above specifications are based on using one of the special c.r. power transformers mentioned. If two receiver transformers are used, the chassis must be an inch longer in every case. A single transformer should be located in the center of the chassis so as to be in line with the tube. If two transformers are used place them side by side and make the lead wire holes large enough to allow reversing their position 180°. Turning one of them around may cause a bucking or balancing of fields so as to affect the beam as little as possible.

Panel Layout

It may not be apparent at first glance but the location of all panel controls follows a logical order. The two c.r. tube controls, brilliance and focus, are located nearest the screen. Running down the left we find the vertical gain control, vertical plate switch and vertical amplifier binding posts. The right side is similar except everything has a horizontal function. Using round knobs on potentiometers and bar type for switches makes the panel look simpler.

In the center row we find all controls for the sawtooth oscillator. The "sync. selector" switch may be omitted if the optional circuit, *Fig. 9,* is used. But keep the pilot light. A c.r.o. is noiseless in operation and it's too easy to leave it running all night long!

Construction will be made easier if an Amphenol cathode-ray mounting assembly is used, or you can make your own if you like. Cable all wires going to the tube, except those two going to the deflector plates, which must be kept in the clear.

Fig. 13 shows a chassis layout for two-inch 'scopes but is equally suitable for one- or three-inch jobs by altering the spacing to suit. Note that the oscillator tank condensers are mounted on top of the chassis, in front of the oscillator tube and behind their selector switch.

Hoods and Lenses

Although any tube affords sufficient brilliance for daylight observation, a hood should be used to prevent overworking the fluorescent screen. This is simply a metal tube of proper size, and can be made by rolling a piece of sheet metal.

If a 913 is used a magnifying lens will make observation a lot easier, when using the little 'scope for long periods of time. The dime stores can supply a suitable glass for a few cents. But don't try to get too much magnification as it will cause more eye strain than it saves. The actual screen size of the one-inch tube is about 15/16 inch. Enlarging this to an apparent size of 1¼ inches seems most satisfactory. Keep the lens well within the hood to minimize glare from external reflection.

Wiring

Wire the oscilloscope with the same care you would

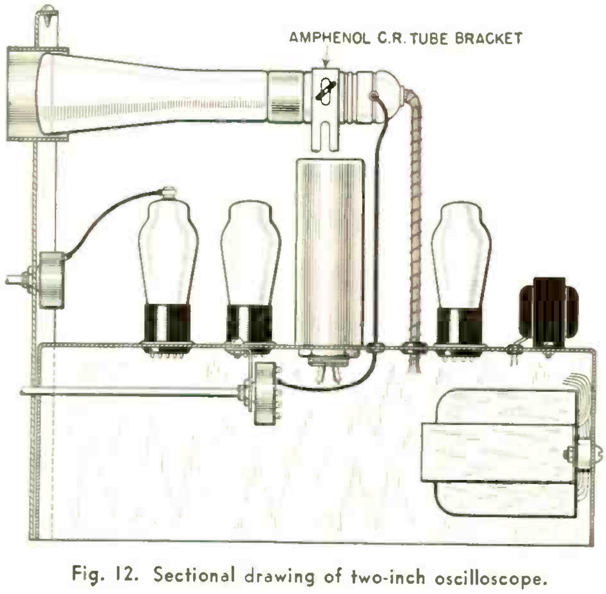


Fig. 12. Sectional drawing of two-inch oscilloscope.

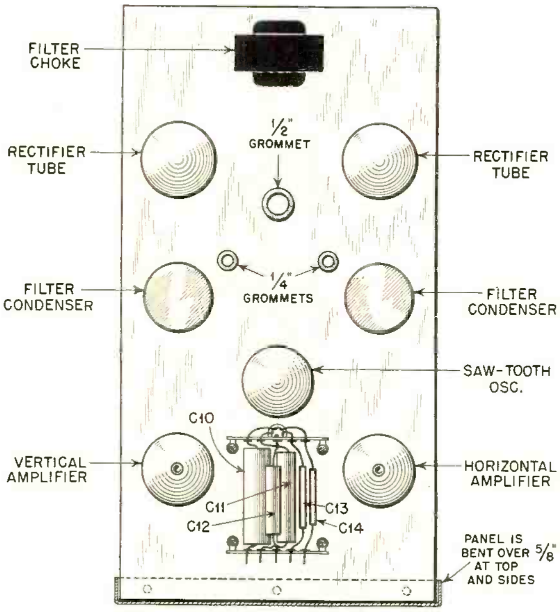


Fig. 13. Chassis layout for two-inch 'scope. Also adaptable for larger or smaller job by appropriate dimension changes.

a good amplifier. All filament and d.c. leads may be cabled *but don't cable anything else.* You will get bad interlocking of controls if you do.

You will see from the parts caption that an oscilloscope uses a goodly number of condensers and resistors. Don't let them hang around loose but anchor them down with plenty of tie points.

Beam-centering controls may be omitted for one-inch 'scopes. Place them on the right side of chassis, up near the front, on a two-inch job, with holes in the cabinet for screwdriver adjustment.

Suggestions for a Three-Inch 'Scope

A three-inch job should follow all those rules given for the two-inch 'scope. The writer has not had a chance to learn how much magnetic fields affect three-inch tubes so would suggest using the same cabinet dimensions found in commercial jobs; that is, about 14 inches high, 7½ or 8 inches wide and about 14 inches in depth. Inspecting the "innards" of commercial 'scopes you will find quite a bit of unoccupied chassis space—and you can be sure it was not left there without reason. With the larger panel, the beam-centering controls might well be placed below the "brilliance" and "focusing" controls.

When the power supply and c.r. tube circuit wiring is completed, insert the tube and see if the beam will focus and center properly. Place some voltage on the deflector plates and see if the beam deflects. Then finish the wiring. If the parts and circuit have been followed correctly the 'scope should work "right off the bat." If not, recheck wiring and parts. If either amplifier distorts, measure the cathode and screen voltages, which must be correct. You may have a defective resistor somewhere.

If the beam centers with amplifiers off and then changes position when they are switched on, replace the leaky plate coupling condenser. When checking voltages on the c.r. tube, remember to put the red probe on ground and the negative probe on the power supply.

Well, we wish you luck. Next month we'll tell you how to use it for just about everything imaginable!

AIR-RAID ALARM

[*Continued from page* 16]

the oscillator becomes a part of the resonant circuit and throws the measurements all off. Connect the oscilloscope to the plate of the 6SQ7.

Time delay is at a maximum of about 15 seconds and determined by the size of *C1* and *R1,* but this delay may be changed by adjusting the volume control in the grid circuit of the 6SQ7. If the volume control is well advanced, *R1-C1* will charge up sufficiently to control the 2051 in much less than 15 seconds.

The electrolytic condensers across the plate relays prevent relay chatter due to the a.c. plate voltage. Their polarity must be observed.

The cathode push-button must be arranged to lift the shield grid of the 2051 off of ground along with the cathode, as shown, or the plate current will continue to flow from shield to plate.

The Failure Alarm

The carrier-or receiver-failure alarm is similar to the tone alarm in that it uses a 2051, but it is normally non-operative. The relay arm is up because the control grid of the tube is negatively biased by a.v.c. or limiter voltage. Failure of the r.f. portion of the receiver, or the absence of a station carrier will cause this section to operate. The relay is arranged to ring a bell or light a red light, while normal operation is indicated by a white light.

Care must be observed in adjusting the amount of control voltage. Too little may cause false alarms when the station fades, and too much may cause tube noise and/or static to take hold and prevent an alarm when the station is actually off the air. The volume control on the input will take care of this.

The audio amplifier and tuning eye are straightforward and may, of course, be omitted or altered to suit other applications. The unit as a whole may be adapted to many other uses, the chief limit being one's imagination.

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paring and producing exchange broadcasts for use in short-wave shows to Central and South America. Several have already been produced, and the IBS plans an even bigger schedule for the future.

In cooperation with the USO, the IBS has designed transmitters similar to those used in the college stations, for use in Army and Navy camps.

Working with the National Government, IBS has established the college stations as distribution centers for U.S. Government transcriptions and publicity material. Cooperating with the OEM, the War Department, the Navy Department, the Treasury Department, and the U.S. Office of Education, the IBS Program Department distributes approximately eight 15-minute transcribed programs every week to each of the 35 college stations. The programs, all connected with some phase of the war effort, include such shows as "The Treasury Star Parade," and "You Can't Do Business With Hitler." In addition, the IBS handles script and announcement material from these agencies.

This increased activity has been undertaken by college students despite accelerated schedules of study.

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TECHNICAL MANUAL ON G-E RECEIVING TUBES

A 24-page technical manual on G-E radio receiving tubes, prepared to assist those who work or experiment with radio tubes and circuits, has been released by the Renewal Tube Sales Section of the General Electric Radio Television and Electronics Dept., Bridgeport, Conn. The manual can be obtained by radio service men, radio technicians, experimenters, radio amateurs, and others technically interested in radio tubes by writing the G-E department.

★

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"Modern Precision" has 16 pages, 10½ inches by 15⅜ inches. It contains valuable information for a wide variety of industrial, educational and scientific fields. A copy can be had upon request to Leeds & Northrup Company, 4934 Stenton Avenue, Philadelphia, Pennsylvania.

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SYLVANIA ENGINEER COMMISSIONED

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Lieut. Merkle is best known to the radio trade as Technical Editor of Sylvania News. Also, for a number of years he has been in charge of preparation of technical literature issued by the Radio Tube Division of Hygrade Sylvania Corporation.

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PERMO S. M. JOINS ARMED FORCES

Sherman Pate, for more than five years Sales Manager of Permo Products Corporation, has recently joined the United States Army. Mr. Pate will be away from his duties only for the duration.

Vice-President of Permo, E. C. "Gene" Steffens, will assume the duties of General Sales Manager during Mr. Pate's absence. W. F. "Bill" Hemminger will act as Sales Manager of the Fidelitone Needle Division. These appointments, announced by the President of the corporation, Arthur J. Olsen, are to be effective immediately.

★

SCHAIRER BECOMES DOCTOR OF ENGINEERING

Otto Sorg Schairer, Vice President of the Radio Corporation of America, in charge of RCA Laboratories, has been awarded the honorary degree of Doctor of Engineering by the University of Michigan. The degree, conferred at the Commencement Day exercises at Ann Arbor, Mich., was in recognition of "the unusual achievements of one of the University's alumni in the conduct and administration of scientific research for industrial purposes."

Dr. Schairer was graduated from the University of Michigan with an A.B. degree in 1901, and received his B.S. degree in electrical engineering in 1902.

Recognized as one of the country's outstanding authorities on research, invention and patents, Dr. Schairer is presently engaged in directing the construction of the new RCA Laboratories now nearing completion in New Jersey as the foremost center of radio and electronic research in the world.

★

AIR RAID CONTROL FEATURES TWO-WAY COMMUNICATION SYSTEM

New application has been developed of a standard two-way communication system and is now in use in a large metropolitan building, by a force of air raid wardens divided into 40 air raid sectors, to control all tenants and employees. Each sector has a warden, and serving him is one remote station of this communication system. The remote stations connect to a master unit in the Chief Warden's Headquarters in the third sub-basement of the building. An auxiliary amplifier at the master location permits high power broadcasting of simultaneous messages to all of the remote stations. The master station is arranged with an annunciator type of push-button selector to call or receive calls from individual remote stations. Thus the of labor. I feel the constant contact of the industry with WPB, and they, in turn, in coordination with the army and navy, was greatly responsible for this orderly and effective conversion.

"We have not been unmindful of our responsibility to the government and the public in providing replacement parts to keep the millions of sets now in the hands of the public in service. Provisions to accomplish replacement parts have been worked out by RMA committees and the civilian divisions of WPB. We are even investigating the prospects of training Boy Scouts in the servicing of sets for the public use to supplant radio service men entering the service.

"I have only high-spotted in brief the war effort of the radio industry. But time does not permit relating to you many interesting details and accomplishments technically and production-wise. Radio is going to play a big part in our winning this war. The industry is fully mindful of its responsibility to deliver a big order and promptly. WPB, the army, the navy and the air force all know what they want in radio apparatus. They have got their feet on the ground. The quality of our radio apparatus excels that of our enemies in every type—I know you'll be very glad to hear that. I have great confidence in the management, production and technical ability of the radio industry. The radio industry will deliver its part of the vast war program complete and successfully. I thank you."

★

PUBLIC RADIO-TELEGRAPH TRAFFIC WITHIN UNITED STATES CLOSED BY DCB

Chairman James Lawrence Fly of the Defense Communications Board announced on May 28th that the Board had directed the closure of all public domestic point-to-point radio circuits within the continental limits of the United States, effective midnight, June 30, 1942. Provision is made, however, that upon proper showing to the Federal Communications Commission and a finding by that Commission that a particular circuit is necessary to meet a vital public need, the DCB will seek ways and means to meet that need.

Transmission of private messages over domestic radio circuits can be heard and easily monitored outside the United States. In many instances the nature of these private messages can give information of value to the enemy. The burden of possible censorship has been deemed insoluble within reasonable limits of available man power and funds. In any event, the censorship which would be necessary if these circuits remained, would involve a delay in transmission not necessarily found in the case of domestic wire circuits.

Eighty stations operated by eleven companies will be affected by today's order. The chief carriers concerned are: R.C.A. Communications, Inc., Mackay Radio and Telegraph Co., Tropical Radio Telegraph Co., Globe Wireless Ltd., Press Wireless Inc. (press only), Radiomarine Corp. of America, Central Radio Telegraph Co., Michigan Wireless Telegraph Co., Wabash Radio Corp., Pere Marquette Radio Corp., and the Western Radio Telegraph Co. Their total traffic is considered quite small in comparison with all domestic message volume. Chairman Fly stated that adequate wire line communications facilities remain available to all users of these domestic radio circuits.

If upon recommendation of the Federal Communications Commission the DCB should permit any particular circuit or circuits to remain in business, it will follow as a matter of course that they will be effectively censored. Routine precautionary measures, including monitoring by the FCC Radio Intelligence Division, will continue in any case.

Not affected by the DCB order of today are the coastal and ship-to-shore radio stations, which are under the control of the Navy Department.

The order of the Defense Communications Board closing domestic radiotelegraph service throughout the United States on June 30 will not affect the public availability of the world-wide international radiotelegraph service of R.C.A. Communications, Inc., according to William A. Winterbottom, vice president and general manager.

Through an agreement of long standing between RCAC and Western Union, Mr. Winterbottom said, raidograms destined for foreign cities may be marked "Via RCA" and filed at any Western Union office in the country. Messages marked in this manner are relayed by Western Union wire to either San Francisco or New York, from where RCAC transmits them internationally by radio. The company operates direct radiotelegraph circuits between these two cities and more than forty nations.

The principal cities in which the domestic services of RCAC will be affected by the DCB closing order are Chicago, Detroit, Los Angeles, New Orleans and Seattle.

★

INTERCOLLEGIATE BROADCASTING SYSTEM

The Intercollegiate Broadcasting System is devoting much effort to Inter-American and War programs. Through the medium of some 35 college stations, IBS is cooperating with the national government, as well as local, city, and state authorities in the War effort.

Civilian Defense preparations and instructions occupy a portion of air-time on hook-ups in the nation's colleges. In campus defense, the college station is by far the most important unit. Students have been instructed to keep tuned to their college station as much as possible. The station serves as the official distribution agency for instructions during an emergency. During actual air-raids, the college station will be the only radio station allowed to remain on the air. In this way, the unification of all defense organizations has been greatly simplified.

In the field of Inter-American Affairs, the IBS has worked closely with the Nelson Rockefeller Commission in pre-

"It became evident to us of the radio industry in the summer of 1940 that this nation was obliged to change its pace and attitude in regard to National Defense. The President pointed the way in May 1940 with the original National Defense Program, which was modest in magnitude as we now look back in retrospect and in comparison with our present-day program. Some industries were more sensitive to their responsibilities in the National Defense Program than others.

"Under the leadership of the Radio Manufacturers Association, the radio industry took early action in the original National Defense Program of 1940. Our President of the Association, at that time Mr. James S. Knowlson, was an early and vigorous advocate that the radio industry lose no time in finding its spot in the Defense Program. Mr. Knowlson was later drafted by Mr. Donald M. Nelson, in September of 1941, to become his Deputy Director of Priorities in the old OPM organization—and is now Director of Industry Operations in the War Production Board.

"The Radio Manufacturers Association was one of the first to appoint a special committee on National Defense procedure. The Radio Manufacturers Association developed a complete survey of the facilities of the radio industry in the fall of 1940 with the object of acquainting the interested services, departments and bureaus in Washington as to who we were and what we could do. We readily recognized the prospective development of a tremendous military radio program with the equipping of airplanes, tanks, artillery and infantry with two-way radio communication apparatus and locating devices for the army, and added to this the requirements of the navy.

"Before the 1940 Defense Program, the army, the navy and the air force obtained their radio apparatus largely from five firms, namely, General Electric, Western Electric, RCA, Westinghouse and Bendix. Naturally, when the early release of orders for radio apparatus was made by the contracting divisions of the army and the navy, the orders went to these five firms who had established themselves through long years of contact, relations and experience. They knew the intricacies of the highly technical problems because of constant association with them—and they could produce.

"The Radio Manufacturers Association never attempted to get production contracts for any of its members, realizing how impractical this was. Instead, the Association sought to guide the industry into a groove in the Defense and War Production Program by influence: first, to influence the members of the industry that there was a big job to be done; that they should expose themselves to the problems technically to learn who and how to serve; also expose themselves to the procurement and contract divisions of the army and navy, so they would become known. We had to become acquainted with the problems and the people in the army and navy. The RMA was active in acquainting the proper people in the army and navy procurement and radio technical groups with the facilities of the radio industry. We fostered the idea that it was not a matter of how many square feet of floor space or how many tools we all had in the aggregate, but instead it was our technical talent, our experience, our background, our management and our years of mass production of radio sets, and a far-flung, finely-knit organization of myriads of specialty radio parts suppliers, coupled with their technical, production and management experience, which as a whole made a vast, well-fitted machine—that this machine could be readily utilized and was sufficiently capable to produce the ever-expanding radio war program.

"We realized it was necessary to convince the military and OPM that the Association supplied capable and reliable leadership to the industry. Opportunity to prove this leadership came in the spring of 1941 when it became evident that aluminum and nickel were to be very scarce. The RMA Priorities Committee met with the metals and minerals officials in OPM, where they were acquainted with the problems. Then we called an industry conference, in April 1941, and obtained agreement from the entire industry to reduce and/or discontinue use of aluminum and nickel in various components in receivers. Then we worked out the details with the metals and minerals group of OPM for its accomplishment.

"Throughout this entire past year the RMA has taken the industry leadership in all the relations with various governmental bureaus as applied to the radio industry. Influence was given to substitutions by the Material Bureau of our Engineering Department.

"The tube group of our industry was very influential to a tremendous degree in bringing about substitutions of materials of scarce nature, as well as accomplishing almost overnight developments of tubes for special purposes.

"It was very evident in the summer of 1941 that there was a billion-dollar-plus military radio program in the making. Set manufacturers and parts manufacturers began to find their place in the picture. Sub-contracting to other set manufacturers by the "big five" began and has expanded into what is known now as family groups—fostered by the War Production Board and the army and navy—wherein set sub-contractors are assigned to a specific one of the "big five" and thus spreading the work. Many other set manufacturers themselves became prime contractors. The parts manufacturers as a whole, excepting possibly the speaker manufacturers, have found their spot in the scheme and are making tremendous quantities of parts in the war program.

"The OPM, SPAB and WPB policy was for a gradual conversion of the industry, so as to maintain technical facilities and personnel intact. They provided for civilian production until war contracts were available. We were preparing for a tremendous curtailment of civilian production even before Pearl Harbor, but, of course, after the declaration of war the orders accelerated so rapidly that it was deemed wise that civilian production cease and this was so ordered by the WPB to be effective April 22nd, which was approximately coincidental to the war production program of the majority of the important producers.

"The present situation is that virtually all set manufacturers, excepting a very few employing only a few hundred people, have war contracts and are accelerating in their production.

"Conversion of the industry was accomplished with very little dislocation

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SUIT DISMISSED

Western Electric Company, Incorporated has dismissed without prejudice its suit filed on January 29, 1942 in the Federal Court for the Southern District of New York against Radio Wire Television, Inc., of New York, claiming infringement of several of its patents in the manufacture and sale of amplifiers. The Transformer Corporation of America, who manufacures these amplifiers, has taken a patent license from Western Electric.

Most of the concerns operating in the public address and related fields are licensed to manufacture and sell amplifiers under Western Electric patents. Such licenses, which were previously granted by Electrical Research Products, Inc., are now being handled by the Electrical Research Products Division of the Western Electric Company, Incorporated, since ERPI has been merged into the Western Electric Company, Incorporated.

★

CORRECTION

In the next to the last paragraph of the article "Determining the Characteristics of Audio Amplifiers," page 15, May issue, it is stated that, "A much simpler method than working out this formula is to determine the number of db of output and the number of db of input from Fig. 2, *then divide the first by the second*."

The italicized portion should read, "then subtract the second from the first."

NOTICE TO SUBSCRIBERS

★ With the work involved in instituting the New RADIO and the time required in moving the organization across continent, it was necessary to skip the April issue. We wish to assure the subscribers who have brought up this point, that their subscriptions have been automatically advanced one month.

RMA CONVENTION NEWS

An outstanding feature and attraction of the eighteenth annual and wartime convention of RMA, Tuesday, June 9, at Chicago, was one of the most prominent personalities in the government's war program, Honorable William L. Batt of the War Production Board. Mr. Batt, a key official of WPB, made a special trip from Washington to address the industry at the RMA membership luncheon at the Stevens Hotel on June 9. A special message on the industry's war production program was brought by Mr. Batt, insuring a large attendance at the RMA "all out" war convention.

Mr. Batt is Director of the Materials Division and a chief aide to Chairman Donald M. Nelson of WPB. Also he is Chairman of the special WPB Committee on War Requirements. He has been prominent, first, in the national defense program as deputy commissioner of the former National Defense Advisory Commission under Mr. E. R. Stettinius. Later he was deputy director of the OPM Production Division, and a few months ago was appointed by President Roosevelt on the special mission to Russia. Mr. Batt is an engineer and is a graduate of Purdue University. His acceptance of the invitation of President Galvin and the Directors of RMA, to be the guest speaker at the Association's annual convention on June 9, was regarded as a recognition of the industry's importance in the war program and of its cooperation toward 100 per cent war production.

President Galvin of RMA presided at the convention luncheon session. His annual report on the industry's present and future war problems was of special interest; and Treasurer Leslie F. Muter submitted a financial report.

RMA members voted on a proposal, recommended by the Executive Committee and Board of Directors, to expand RMA war services and activities by organizing a new Transmitter Division, and also another proposed amendment to change the name of the Amplifier and Sound Equipment Division to the "Speaker" Division.

The "strictly business," all-out war program of the RMA convention for the one-day session on June 9 also included annual meetings, for election of directors, of the Set Division under Chairman Ray H. Manson; the Tube Division under Chairman Roy Burlew; the Parts and Accessory Division under Chairman H. E. Osmun, and the new Speaker Division under Chairman James P. Quam, together with an organization meeting of the proposed new Transmitter Division in charge of Director W. R. G. Baker of the RMA Engineering Department. Also, there were meetings of several RMA committees.

The important part of the radio industry in the war program, including activities of RMA, was detailed by President Paul V. Galvin of the Association at the recent annual convention of the Chamber of Commerce of the United States at Chicago. His speech follows:

"Radio Industry War Activities"

Address of Mr. Paul V. Galvin, President, Radio Manufacturers Association, to the U. S. Chamber of Commerce, Stevens Hotel, Chicago, April 27, 1942

[*Continued on Page 62*]

URGENT NEED FOR METERS

A plan is suggested by Mr. D. E. Gaskill, of the Lockheed Purchasing Department, which will give all amateurs, experimenters, dealers and jobbers an opportunity to help the Aircraft Industry to "Get 'em Flying."

All aircraft engineering departments need electrical meters for design and test work but with meter manufacturers overloaded with orders, even the Aircraft Industry's A-1-A rating cannot get deliveries quick enough to permit this vital part of our war effort to speed ahead.

Mr. Gaskill suggests that all owners of electrical meters of all kinds submit lists of such equipment, giving all details such as make, model, range, case style and condition. The aircraft producers are willing to pay fair market prices on any such meters they requisition. After the war, when private activity can be resumed, plenty of new instruments of probably improved design will be available. So turn in your meters, invest the extra cash in War Bonds and deal a double blow to the Axis.

Send your lists to R. V. Weatherford, 1956 So. Figueroa Street, Los Angeles, California, who will make them available to all western aircraft manufacturers. This will be handled on a non-profit basis as a contribution to Victory. "Get 'em Flying."

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WAR POLICY FOR PHYSICS

At the American Physical Society Meeting, which convened in Baltimore May 1, American physicists recognized the important strategic position of their science in modern warfare and recommended the adoption of national man-power policies which will most effectively utilize physics and physicists in the war effort. The War Policy Committee of the American Institute of Physics, of which the American Physical Society is one of the five Founder groups, presented a report saying that "New tools of war have been devised which can swing the tide of victory. They utilize results of research in electronics, electric waves, acoustics, mechanics and optics. Physicists have devised these new tools, engineers have shaped them for manufacture, and manufacturers are producing them."

The Policy Committee report pointed out that, not only in the design of these tools but also in their military operation, a very large number of men with training in physics at all levels from high school graduates to doctors of philosophy are needed. High schools, colleges and universities were urged to emphasize such training. The Committee also endorsed the plans of U. S. Government agencies to augment the regular schools through establishment of emergency intensive courses of instruction in physics.

★

IRON AND GLASS SEAL

Tight seals between iron and glass, eliminating the need for nickel and cobalt, critical war metals, for wires leading into certain types of vacuum tubes, are now being made with a new development of General Electric scientists. Dr. Albert W. Hull and Dr. Louis Navias, of the G-E Research Laboratory, have just been granted a patent for their invention.

They have devised a series of glass compositions which can be used with iron and certain iron alloys. One consists of 45 percent silicon dioxide, 14 percent potassium oxide, six percent sodium oxide, 30 percent lead oxide and five percent calcium fluoride. The rate of expansion of these glasses is very close to that of iron.

In seals using these glasses a further and separately patented invention of Dr. Navias also proves useful. When a glass containing lead is sealed in contact with iron, some of the lead atoms migrate from the glass into the metal. This weakens the joint, and may let air leak into the tube. Dr. Navias proposed placing a thin layer of lead-free glass directly over the metal, then sealing the lead-containing glass to that. The thin glass layer prevents the lead from reaching the iron, yet it is not thick enough to crack and let air in.

★

SEEING IS DECEIVING

It's an old theory that "seeing is believing" and the camera tells the truth. As applied to color photography, however, there are certain phenomena of human vision which quite baffle the camera and cannot be duplicated. According to the Color Research Laboratory of the Eagle Printing Ink Company, Division of General Printing Ink Corporation, 100 Sixth Avenue, New York, the most notable difference between eye and camera is the ability of the first to make instanteous adjustments to light intensity and to be bothered not in the least by the problems of correct and accurate "exposure."

For instance, when the eye sees two yellow objects in a room, one near the brilliant light of a window and the other in deep shadow at the far end of the room, both objects will be seen as yellow. If a camera were to photograph the same setup, this human experience could not be duplicated. For if the exposure were adjusted for the bright light, the yellow object in dim light would be underexposed and would fade out into some dismal blackish or olive tone. If it were adjusted for the dim light, the object in bright illumination would be overexposed and might show as a fuzzy white.

According to Eagle there are two major principles to follow in achieving good results in color photography. (a) Keep uniform light intensity the same throughout a composition. (b) Or keep severe contrast between foreground and background. For if light intensities vary even slightly from one

News

MARINE CORPS NEEDS SPECIALISTS

The United States Marine Corps needs a large number of officers with electrical background for duty in the supervision and maintenance of radio aircraft warning devices, allied radio equipment and installations.

A call to civilians between 20 and 40 years of age to apply for commissions in the Corps has been issued by the Commandant Lieutenant General Thomas Holcomb.

Candidates for commissions should be able to fill one of the following:

Hold a degree of Bachelor of Science of Electrical, Radio or Communication Engineering or Electronic Physics awarded by an accredited college, or:

Hold a degree of Bachelor of Science in any engineering subject and have had reasonable practical experience in radio or electrical work, or:

Have successfully completed at least two years of electrical, radio or communication engineering subjects at a college, university or commercial school of recognized standing and have considerable experience in one of those fields, or:

Have the equivalent of any of the above by reason of extensive practical experience in the field of radio where the applicant has been connected with the design, erection or maintenance of ultra-high frequency radio transmitting or reception equipment.

Men who are commissioned will be sent to an officers' school for three months for an indoctrination course in military training.

Anyone interested in applying for a commission in this specialized field who lives in the Western Division comprising the states of Arizona, California, Colorado, Idaho, Nevada, New Mexico, Montana, Oregon, Utah, Washington and Wyoming is advised to write a letter to Lieutenant Colonel Raymond W. Conroy, Naval Reserve Aviation Base, Oakland Airport, Oakland, California, or The Commandant. U.S. Marine Corps. Headquarters. Washington, D.C.

In this letter a statement of qualifications should be made, and information giving age, full name and complete address should be included.

While applicants must meet other standard qualifications of the Marine Corps, certain waivers in physical condition may be requested for men who are particularly qualified for this work.

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REQUIREMENTS FOR BROADCAST STATION OPERATORS FURTHER RELAXED

The Federal Communications Commission, through its Order No. 91-A, upon recommendation of the Defense Communications Board, modified its rules to provide a further relaxation of its operator requirements for broadcast stations. The original action of February 17, 1942 permitted the operation of broadcast stations of any class by holders of radiotelegraph first or second class operator licenses or radiotelephone second class operator licenses. Holders of restricted radiotelegraph or radiotelephone operator permits are now added to the classes available for operation of broadcast stations.

The restricted radiotelephone permittee, however, first must be examined for proficiency in radiotelephone theory and secure endorsement of that fact on his permit. This may be done through special examination at a field office of the Commission, such examination being similar to the questions in radiotelephone theory required of a Class A amateur licensee. Necessary endorsement of the permit may be secured also by presenting both the restricted radiotelephone permit and a Class A amateur license to a field office of the Commission. A person having one of these classes of license may qualify by satisfactorily completing examination for the other class. In any case the restricted radiotelephone operator permit must be endorsed by the Commission before the permittee is qualified for broadcast station operation.

This relaxation is designed to relieve a growing shortage of operators as a result of war conditions and the requirements of the military forces for radio operators. It is not contemplated that technical operation will be impaired or labor standards in the industry lowered through reliance upon this action of the Commission. A first class radiotelephone operator, responsible for technical operation and other than minor transmitter adjustments, must be retained, and the station licensee will be held fully responsible for proper operation of the station.

The ions are bombarded against the plate, grid and filament. They hit so hard that they may be absorbed in the elements themselves and can only be released again by excessive heating. Sometimes this gas is never released, and thus can do no harm.

In practice, this is the routine followed at WOR in operating the equipment.

1. After checking to insure that the control switch is in the "Off" position, carefully insert the tube in the socket. Be certain that the shorting bar across filament and grid terminals makes a good connection. In the case of high-voltage rectifier tubes, be sure that filament leads are shorted.

2. Switch "On" the fan in the transformer compartment.

3. Set the transformer in the low-voltage position by putting the magnetic shunt all the way in, thus shortening the magnetic path of the lower leg of the transformer and by-passing a considerable portion of the flux.

4. Close the transformer compartment door, leave the tube room and turn the control switch to the "On" position. If an arc sustains across the transformer gap, break it by snapping the control switch to the "Off" position. Switch "On" again and leave on low voltage for *one minute*.

5. Throw the switch to the "Off" position. Go into the tube room and put the transformer in the high voltage position by placing the magnetic shunt all the way out which concentrates the magnetic path through the secondary of the transformer.

6. Leave the tube room and turn the control switch to the "On" position. If an arc is formed across the gap, break it by throwing to the "Off" position. Condition the tube on high voltage for *10 minutes after the last flash*.

Best results will come from the reconditioning process if tubes are treated immediately before being inserted in the transmitter tube socket. If this is done no flash arcs or arc backs will occur during operation. At times the treatment of a stubborn case may take one or two hours. If the 10-minute treatment after the last flash does not clean up the condition, the tube has probably developed a leak which will cause trouble when put in service.

If the tube under test has a small amount of air in it, a pinkish color can be seen when the voltage is applied. This color is evident in mercury vapor tubes as well as in amplifier tubes, but is mixed with the blue color due to mercury vapor. If a tungsten filament type tube has a crack which lets it down to air, a yellowish smoke will appear in the tube when the filament is lighted. This is a tungsten oxide formed from the filament burning in air.

We keep an accurate record of tube reconditioning on a special form. Space is provided for entering the serial number and type of tube, number of flash arcs observed on both low and high voltage, and time required for reconditioning. A condensed entry of this information is made in the log.

Filament Aging

A second part of the reconditioning treatment which has been tried with some success consists of filament aging of thoriated tungsten filament tubes for *10 minutes* with the filament voltage 30 per cent above normal, followed by *one or two hours* with normal filament voltage only—no plate voltage.

In order to age tungsten filaments of water-cooled tubes, the tube must be placed in the transmitter socket with the standard water-cooling conditions. The filament is lighted at the correct operating voltage as measured at the tube terminals. Lighting the filament at normal operating temperature tends to clear up residual gas and clean off the filament and grid surfaces. After one or two hours aging, the tube is ready to be tested in the transmitter under normal starting and operating conditions.

Even if your station has no reconditioner unit, we believe filament aging is still of some value. In a few instances the above treatment has been effective in reducing initial flashing during operation, even though the tube is again returned to the shelf for several weeks prior to being installed in regular service. It is recommended that spare tubes be conditioned by filament aging *every three months* to insure continuity of service. High vacuum rectifiers can be given the same treatment as amplifier tubes.

Unless a spare socket is available, this conditioning can be done during off hours when two tubes can be treated at the same time in the second power amplifier. In this way more than one spare is always conditioned and ready for use.

Due to long life, spare thermionic mercury vapor tubes usually remain on the shelf from 12 to 15 months. All mercury vapor tubes *must* be given a filament preheat test *every three months* for at least two or three hours at the rated filament voltage. We have discontinued the old practice of preheating at one-half filament voltage. We feel it is better to be one or two per cent above the rated voltage than to fall below it.

In our transmitter we remove all rectifier tubes, install the spares and preheat for three hours. Then we test the circuit for operation under full load. Accurate records are kept of these preheat periods.

Test at Maximum Plate Voltage

If a mercury vapor tube fails to rectify without arc backs after the recommended preheating time, the following treatment may be beneficial.

A resistance bank of approximately 1 megohm (such as twenty 50,000-ohm, 20-watt resistance units) is inserted in series with the anode. The voltage is left on for at least one hour or until all visible mercury is removed from the anode. Air at room temperature should be blown on the lower end of the envelope during this treatment. The tube then is operated under standard conditions without the resistance for one or two hours.

Clean and test all spare tubes periodically—this is the most important precaution. This precaution includes looking at glass presses and seals for cracks.

Tube Treatment

The foregoing has described the methods to be used in operating, handling and storing tubes in order to get the longest possible service from them. But what can be done with tubes that develop faults even when all these precautions have been taken?

At WOR we have several special methods of treating tubes. They can be outlined as follows:

1. Tube Reconditioning:
   a. Clean up gas in tubes with rated plate potentials above 8,000 volts.
   b. Trace faults in both low and high voltage tubes.
2. Filament Aging:
   a. Clean filament and grid surfaces and remove residual gas from tungsten filament air or water cooled tubes.
   b. Condition thoriated tungsten amplifier and high vacuum rectifier tubes.
3. Filament Preheat Test
4. Test at Maximum Plate Voltage

Tube Reconditioner

A common problem confronting engineers is the tube which becomes gassy, either from shelf wear or during use in the transmitter. There are only three alternatives—discard the tube, return it to the manufacturer for adjustment, or treat it yourself. The first of these is expensive and unnecessary. In returning tubes to the manufacturer, packing and shipping is a problem, and there is a chance of damage to elements and glass parts. It is much better to invest one or two hundred dollars in a reconditioner which cleans up gaseous tubes in a few minutes, adds considerably to their life and thus saves many times its moderate cost in a few years.

The reconditioner treats effectively all types of tubes operating at plate potentials above 8.000 volts. It can be used also in tracing faults in lower voltage types. Spares can be tested to eliminate any chance of a faulty tube being placed in service, and tubes which become gassy while in the transmitter can be cleaned up or "degassed" and returned to normal operation. Here is an example from our experience:

One of the Western Electric 342A water-cooled tubes in the power amplifier of WOR's 50-kw transmitter developed a series of flash arcs after 5,000 hours of filament life. The auxiliary transmitter was switched into service, the tube in question was removed from the circuit and treated in the reconditioner. At the close of the broadcasting day the tube was returned to its original position in the transmitter.

It operated normally for 1,000 additional hours before it again developed the tendency to flash arc. It was removed, reconditioned and put back into service a second time. It continued to operate properly until it finally burned out at the ripe old age of *18,386 hours*. This is but one of many cases of greatly increased tube life resulting from the use of our reconditioner.

When mercury vapor rectifiers haze up and cause occasional arc backs they can be treated in the same method. After treatment, if the haze disappears, the tube is ready to go back into service.

Construction of our unit is simple—a complete list of parts being shown on the schematic diagram, on page 20. The transformer was purchased for about $70.00 and the entire reconditioner was built for about $100.00. The photograph may serve as a guide to the placement of the parts.

Operation of the reconditioner is as follows:

Alternating current, 115 to 120 volts, is applied to the primary winding of the transformer, which induces a high voltage in the secondary. This induced voltage is applied to the tube between filament and grid tied together and the anode. When gas ionization is present in the tube, the current in the secondary increases suddenly. The applied voltage drops momentarily, due to transformer reactance, which breaks the internal arc. The sudden change of current develops an e.m.f. of sufficient magnitude to break across the protective gap, thus indicating that the tube has flashed. The internal flashing of the ionized gas in the tube either cleans it up or reorients it on the electrode surface.[1]

As previously pointed out tubes may become gaseous through shelf wear or the residue gases, such as mercury vapor in the case of rectifier tubes, may redistribute themselves on the electrode surfaces. Should the potential difference between electrodes become large enough to cause a flash arc, the residual gas molecules are broken up into positively and negatively charged ions. The former are attracted to the cathode—the latter to the plate. The positive ions are momentarily absorbed in the negatively charged electrodes and the negative ions are absorbed in the positive electrodes. A chemical action may even take place.

In the reconditioner, the filament or grid may form either the negative or positive element, depending upon which half of the cycle the flash arc occurs, while the plate assumes the opposite charge. Since the filament is not lighted, no electrons, except from so-called field current or cold emission, can help form a breakdown path which results in a flash arc. Thus when a flash arc occurs with the filament off, it must be the result of conduction gases or metallic vapors which are the positively and negatively charged ions in the tube itself.

[1]"The Thermionic Tube and Its Application" by Van der Bijl.

factory pressure. For example, the manufacturer recommends the following for 266-B tubes:

> For ambient temperature of 10° C. preheat 5 minutes
> For ambient temperature of 5° C. preheat 10 minutes
> For ambient temperature of 0° C. preheat 15 minutes

At WOR we have discontinued the practice of preheating mercury vapor tubes at half voltage as we believe that this poisons the tube.

Mercury vapor tubes on the shelf should be heated for one or two hours *every three months* to insure satisfactory operation when put into service. If allowed to remain inactive for a long period of time without treatment, they have been rendered useless by the mercury vapor diffusing slowly into the pores of the anode or cathode.

Tubes of this type should be kept in an upright position to prevent mercury splashing onto the anode and cathode. If this should occur, the tube must be preheated long enough to vaporize the mercury from the elements and condense it at the bottom of the tube. The lower end of the tube should be cooled by natural air circulation or by a thermostatically controlled blower to obtain proper condensation of the free mercury.

Cooling System Efficiency

Accumulation of scale on water-cooled tubes and in the water system should be avoided. Scale is a poor conductor of heat. When it forms on the anode, less heat is dissipated and the comparatively rough surface breaks up the smooth sheet of water flowing over the plate, causing localized boiling. Overheating of the anode may result.

A piece of scale is often the cause of water whistles. Reflushing the water system through the storage tank during off-the-air periods will usually dislodge the scale from the tube and eliminate the whistle. Water whistles, as a sign of an overheated anode, have caused tube plate distortion, which makes it difficult to remove the tube from its socket. Therefore, the whistle should be used as a guide to proper maintenance.

In many stations it is the practice to remove tubes from their sockets after 1,000 to 5,000 hours of operation in order to remove scale and test the spares. There has been much discussion on the advisability of this procedure. We have found that some tubes can be removed easily after as long as 18,000 hours, while others with but 5,000 to 10,000 hours are difficult to remove because of scale. Experience has shown that after several thousand hours of operation, tubes are usually jarred when removed from their sockets, with occasional breaking of grid laterals. When these tubes are reinserted in their sockets, flash arcs invariably result. These flash arcs pit the filaments, removing some tungsten, which results in shorter life.

At WOR a tube is never taken out of its socket simply to test another tube. We have weighed the matter of scale accumulation versus jarring and flash arcs, and have chosen to put up with the scale as the lesser of two evils. By leaving tubes in their sockets, we find that the filaments open clean and do not short out the grid circuit. This keeps the transmitter on the air and allows replacement after shutdown.

Since it is recommended that final amplifier tubes remain in their sockets until they burn out, methods must be devised for removing scale from tube plates and sludge from rubber hoses and other parts of the water system.

Sludge and residue in the system can be removed with tri-sodium phosphate, available in any paint store, or a commercial product known as "Oakite." After the water in the system has reached a temperature of 160° F., we remove two tubes, preferably from the second power amplifier stage, pour *two pounds* of the chemical into the sockets and dissolve with boiling water. Then we insert the tubes in their sockets and flush the chemical solution through the system for *one hour* with filaments on and the water at approximately 140° F. This will remove an amazing amount of sludge and residue.

We make sure to again flush the system thoroughly with distilled water before final refilling. The amount of leakage current flowing before final filling will indicate how successful the flushing has been. The complete routine procedure used at WOR in cleaning the transmitter water system will be sent to any engineer upon request.

We find the following procedure is helpful in removing accumulated scale from a tube:

Mix a 20 per cent solution of muriatic acid by first pouring eight glasses of water into a stone crock, then *slowly* adding two glasses of acid. *Never pour water into the acid* as this will cause boiling and spattering and possible acid burns. Stir with a wooden stick and avoid inhaling the fumes. Fold a small rag into a three inch square and wet this in the solution. (In its diluted state the acid will not injure the hands.) Rub the rag gently over the scale on the tube. Repeat operation until tube is clean. *Caution:* Do not clean *above* the clamping ring on the tube plate and do not drip acid on the glass seal. The bottom of the tube may be rested on the bottom of the crock, but hold the tube so the glass seal does not lie against the rim. When finished, be sure to wash the hands with warm water and soap.

Tube life can be increased by operating the various radio-frequency stages at highest efficiency. Water flow relays and overload d-c relays should be checked and adjusted at least twice a year. Contact points and relay bearings should be carefully maintained.

Care of Spares

Store all tubes where they will be free from mechanical shock and excessive vibration. Keep in a vertical position, with cushion rings for the larger tubes. Protect glass parts from scratches.

This new Burgess Acousti-Booth is designed for use in mills, factories, power houses, and other noisy industrial locations. Like other Acousti-Booths, it has no doors because it

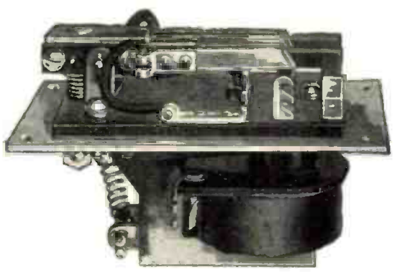
needs none. Factory racket is absorbed so completely by the lining of the booth that telephone calls can be made without interference, even under severe noise conditions.

Outside dimensions are 30 inches wide by 79½ inches high by 38 inches deep. The front opening is 24 inches wide. Approximate shipping weight is 225 lbs.

★

NEW DUNCO RELAY

Designed to handle circuits carrying milliamperes at microvolts in radio applications, the new Dunco laminated frame Relay CX3318 has sliding contacts and is likewise ideally adapted for switching thermo-couple circuits. It is constructed to withstand extreme vibration incident to aviation service and, like other Dunco units in this field, is carefully tested for operation at high altitudes.



The new relay is 3⅜" high x 2" wide and 2¼" deep and weighs 9½ ounces. Contacts are double-pole, double throw. Coils are for operation on a.c. only, and are shielded from the contacts.

★

ANNOUNCEMENT

★ Beginning with the July issue, we shall resume the **Q. & A. Study Guide.** We learned—as many editors learn by dropping a feature—that its interest to a large percentage of our readers was far greater than we had supposed.—**Editor.**

Increasing Tube Life

[*Continued from Page* 20]

mechanical strains on filaments and electrode supports. Provision should be made to limit the initial filament current at starting. This can be done by inserting additional resistance in the filament circuit when voltage is first applied, or by using a transformer having sufficiently high reactance.

It is good practice to reduce filament voltage as low as possible when the filaments are lighted. Operate at minimum voltage for five minutes—then increase to normal operating filament voltage.

When closing down the transmitter, lower the filament voltage after the plate voltage has been removed. Five minutes operation at lowered voltage will reduce thermal shock caused by sudden cooling. During operation, welding temperatures sometimes occur to wrench the filament out of shape.

Follow the above procedure for air-cooled tubes also, but leave the blower on for a minute after the filament has been turned off.

If mercury vapor tubes are operated at ambient temperatures of 20° C. or lower, extra time is required on starting for the mercury vapor to reach a satiscalibrates in two-tenths of a main division from *3* to *4*.

(6) Place four sections of decade in X arm, set bridge dial at center, adjust rheostat in D arm to balance and leave at this point.

Place rheostat in series with four sections of decade in X arm, set bridge dial at *5*, balance by means of rheostat in X arm. Cut out two sections of decade, balance main bridge dial, mark point.

(7) Proceed as before in (6) but set main dial at *6*.

(8) Use same procedure as in (6) above but set main dial at *7*. This calibrates in .5 of main division.

(9) Points *8*, *9* and *10* are units and are left as is.

This all sounds complicated and confusing, but is really very simple and takes much more time to tell than it really takes to do.

By using known standards in the arms of the bridge it is possible to find the value of any point on the scale by multiplying the value of the standard by the value marked on the scale.

Checking and Measurement

An audio oscillator is best for measuring values, but even a buzzer, or 60-cycle supply may be used. As most measurements of impedance are made at the standard frequency of 400 cycles, this is a good frequency to use. A coupling transformer must be used to match the impedance of the oscillator to the bridge. A speaker output transformer with the low-impedance side connected to the bridge will answer here.

The accuracy of calibration of the bridge may be checked by placing resistors of exactly the same value in each arm of the bridge. The reading of the scale should then be *1*. Then, by placing known values of resistance in the D arm, the other points can be checked. This can be done with the decade divider, or other standard resistors may be used.

Resistance can be measured with a.c. power supply providing the unit is not a coil or other component which has inductance or capacity in addition to resistance. Components having critical characteristics other than resistance must be measured with a battery supply in place of the oscillator. Inductance and resistance standards are placed in the D arm of the bridge and condenser standards are placed in the X arm.

In measuring the capacity of an electrolytic condenser, the condenser should be formed first.

Standards

Some of the standards may be constructed by using copper wire tables and figuring out the resistance for various lengths. These will enable measurements to be made accurately up to about 100 ohms, and higher values may be adjusted in the manner described for making the decade divider.

Condenser standards must be mica or paper. Good mica condensers may be relied upon to be accurate to within about 5 per cent. Most commercial tolerances run from 10 to 20 per cent of components used in manufacturing, so the accuracy of 5 per cent will be good enough in most cases.

In the same way commercial r.f. chokes may be used as standards, or coils may be constructed from inductance charts for coils and a.f. chokes. However, in view of the fact that the adjustments for inductance measurements are critical, it is recommended that standards be purchased for greatest accuracy.

Of course the bridge will be only as accurate as the standards used, so it is advisable to be sure the standards are somewhere near their stated values.

Wagner Ground

R2 is the Wagner ground. The arm is connected to ground for use when it is desired to measure components connected in receiver circuits or other apparatus. The main potentiometer arm on *R1* must be disconnected from ground at point *A*, in this case. A single-pole double-throw switch might be used here. The phones are switched to ground and *R2* is used to balance out stray capacity to ground.

New Products

[*Continued from Page* 48]

the relay from dust and against damage from rough handling. The relay is small and light in weight, weighing only 3¼ ounces, and is designed to meet all Air Corps requirements set up for devices of this type.

It has a maximum continuous current rating of 2 amperes at 32 volts, and a maximum make or break rating of 10 amperes. The coil is rated at 32 milliwatts minimum and 1 watt maximum. Maximum coil resistance is 3000 ohms. The contacts provide single-pole, double-throw operation.

★

BURGESS ACOUSTI-BOOTH

A new wooden Acousti-Booth, Model 210, finished in attractive walnut color, is announced by the Burgess Battery Company, Acoustic Division, 2825 W. Roscoe St., Chicago, Ill. This new booth is part of the line of wooden booths being developed to enable the company to supply industrial users without priorities or other restrictions.

Although NBC, CBS and Don Lee had planned no immediate curtailment, latest advices indicate a new NBC maximum of six hours per week, compared to their old fifteen, slacking off to the minimum of four hours about one week after you read this. These telecasts will be confined only to necessary issues, principally the current air raid warden training courses. CBS will maintain their schedule for a few more weeks before making any definite alterations.

The Commission, in allowing part-time operation, stated, "Our decision was made to prevent recession of this new art to a purely experimental or laboratory stage and to keep it alive till after the war emergency. Also, another objective is to conserve equipment and tube life and allow operation with a greatly reduced personnel."

Around the Field

W41MM made its debut on April 30th from Clingman's Peak with 3,000 watts, while installation will probably have begun on the 50-kw. final by the time this is in print. W41MM is now the loftiest f-m. transmitter in the country, having an antenna 6,885 feet above sea-level and reaching over 5,000,000 people within a 70,000 square-mile service area.

Of the more interesting new stations on the u.h.f. have been several operated by the Werner Timber Company, in Oregon. Using only 3 to 10 watts in portable transmitters on 31020 and 33460 kc., they are being used to relay emergency messages in connection with the vast logging operations needed to expedite production of wood materials for war use.

Latest f-m. stations on the air are W49PH of WIP, in Philadelphia, from 3 p.m. to midnight; W67B, in the Boston area, from 3 p.m. to 9 p.m.; and W75P, of Pittsburgh, scheduling 9 a.m. to 11 p.m. The national commercial f-m. station total now hovers around 30.

S.T.L.'s (studio transmitter links) have been popping up around the country quite frequently these days. Latest additions are the 12-mile gap from Schenectady, N.Y. to the W47A transmitter operating in the 330-mc. band (see photo); and the 102-mile link from Winston-Salem to W41MM.

Universal A.C. Bridge

[*Continued from Page* 41]

adjust rheostat in D arm for minimum signal. Then connect two sections of decade in X arm, as shown by dotted line in *Fig. 2,* and use the main bridge control this time to adjust for minimum signal. Mark this point on the scale. (The phasing controls should be set at short out position for these adjustments.)

Then connect three sections of decade in X arm, balance bridge as before and mark each point on dial. Continue to add one section at a time until all sections of decade are used. This calibrates the scale in units to the right of center.

(2) Leave all sections of decade connected in X arm, set bridge dial at center or *1,* and use rheostat in D arm to balance. Remove one section of decade from X arm, rebalance by means of main dial and mark point on scale. Remove another section of decade, rebalance bridge, mark point, and continue until all sections of decade are cut out. This calibrates the scale in tenths to left of center.

(3) Connect all sections of decade in X arm, set bridge dial at center, adjust rheostat in D arm to balance and leave at this point. Then connect a rheostat in series with all sections of decade in X arm, set bridge dial at *2* on scale and adjust rheostat in X arm to balance. Cut out one section of decade and rebalance main bridge dial, mark point and continue to cut out one section of decade at a time, rebalance bridge each time till all are used. This calibrates in one-tenth of a main division between *1* and *2* on scale.

(4) Repeat the procedure above but set bridge dial at *3* and cut out two sections of decade at a time until four points are marked. This calibrates in two-tenths of a main division from *2* to *3*.

(5) Repeat the procedure as in (4) but set bridge dial at *4* this time. This

Air-Raid Alarm

[*Continued from Page* 43]

of the rectifier, *RX*, is of the order of only 1 to 3 volts. This is not sufficient to trip relay *RL1*.

At 1000 cycles, however, the output voltage rises to approximately 5 volts which is sufficient to trip the armature of *RL1*.

To prevent frequencies in the neighborhood of 1000 cycles other than a warning tone from setting off the device, a time-delay circuit is used in conjunction with the solenoid of relay *RL2*. This consists of a high-capacity condenser *C2* and a resistor *R2* in shunt with the solenoid. If relay *RL1* flips open on a 1000-cycle note other than the tone signal, the charge in condenser *C2* leaking off through resistor *R2* will keep the solenoid of *RL2* energized, and therefore closed, for a period of 10 seconds.

When a warning signal is received, however, contact *A* of relay *RL1* remains open for the full 30 seconds. Hence, after the charge in condenser *C2* has leaked off after a space of 10 seconds, relay *RL2* is de-energized, and its armature flips over to contact *A*. This energizes relay *RL3*, causing its armature to cut out the filter and connect in the loudspeaker. The tone signal is therefore reproduced for the remaining 20 seconds—a sufficient warning for anyone nearby, and providing sufficient time to reach the device and switch *S1* to the "non-alarm" position for oral instructions.

Broadcast Equipment Pool

[*Continued from Page* 44]

station had on hand on January 1, 1942, tubes in excess of the requirements set out in the Commission's Standards, the minimum for such stations shall be considered the inventory as of January 1, 1942, provided, however, in no case will minimum requirements be considered more than 100 per cent spares.

In case a station has some part that is known to be subject to failure in excess of the general expectation and yet the transmitter is operating satisfactorily otherwise, this will be taken into consideration in establishing the minimum stock requirements for that station. Records shall be kept of the hours of tube use and the condition of the other equipment.

14. The original holder of equipment will be paid the then current market price of such equipment plus delivery charges when material is transferred from one station to another or from one district to another. The transactions will be on a C.O.D. or credit basis as determined by the seller.

15. Data on vacuum tube life and operating performance will be obtained from station records and tube manufacturers. When possible vacuum tubes will be reactivated. All dead vacuum tubes of over 100 watts output rating will be turned in for the material they contain. There are several other plans of operation that will be studied in connection with these plans. The administrator will own or have available an a.c. or d.c. voltmeter with range suitable for checking all filament voltages (0-20 and 0-50 v. range) with an accuracy of 1 per cent and scale of 5 inches. Possibly other equipment will be needed. In any event, no new test equipment will be required as sufficient equipment is on hand in the industry.

16. The district administrator and his assistants will receive no pay or subsistence from the Federal Government. They will be repaid for necessary out-of-pocket traveling expenses and subsistence when away from the city in which the station at which they are employed is located. These expenses shall be prorated between the stations in the district on the basis of the highest published daytime ¼ hour rate of each station. The headquarters of the administrator and assistants will be their present office. It is desired that no new civilian personnel or office space be required for these duties.

17. The administrator will be selected on the basis of known administrative ability and willingness to do this work. One assistant administrator will be selected for his technical ability and knowledge of the design and functioning of the technical equipment of stations. The other assistant administrator may be selected for his business or legal knowledge and familiarity with the licensees of his district. All administrators and assistants should be available under present expectancy for the duration of the war. Also careful attention must be given to their availability of time to devote to this work and willingness to do a difficult job in a proficient manner. No occupational deferments from Selective Service will be recommended for the administrator or assistants for this activity.

18. This conservation plan should be put into operation as soon as approved by the DCB and WPB for the industry and the administrative machinery, as outlined, can be set up.

U.H.F.

[*Continued from Page* 17]

Television

Another part-time casualty of the war effort will be television. Under the new FCC regulations a commercial station need only operate four hours per week, and even this time may be used up in a single day.

Ahead Today

The multiunit triode is today in fact what many thought could only exist in theory.

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

You've found Eimac ahead in the past . . . they're ahead today . . . and you'll find them still ahead in the future

Ahead in the Future

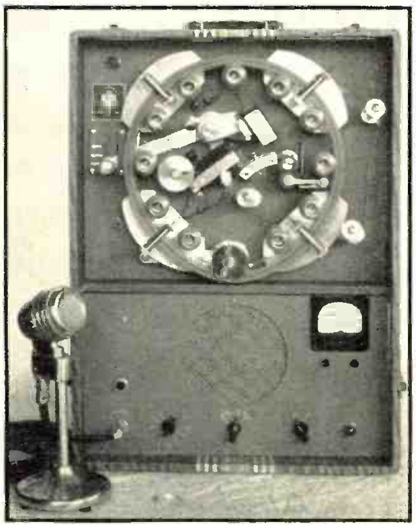
Certain new achievements cannot be revealed. Others are in the making. Rest assured that Eimac is keeping ahead.

Follow the leaders to **Eimac TUBES**

EITEL-McCULLOUGH, INC., SAN BRUNO, CALIFORNIA, U.S.A.

Export Agents: Frazar & Co., Ltd., 301 Clay Street, San Francisco, California, U.S.A.

(Continued from page 46)



able for use in recording business conferences, conventions, sales presentations, radio programs, telephone conversations, and in many other cases where a continuous recorder operating for periods of up to four hours without supervision is desired.

Consisting of a recording and playback mechanism, an amplifier, and a microphone, contained in a sturdily constructed light weight carrying case, the recorder may be put into operation by merely plugging in the power line to a convenient electric outlet and connecting the recorder to a radio or telephone line, or else to a microphone.

Once put into operation it will record through a normal 8-hour day without supervision, save for the changing of the tape at the end of 4 hours. Since the titles of all reference material can be marked directly on the tape and its filing carton, an easy access may be had to any recording through the use of a file index.

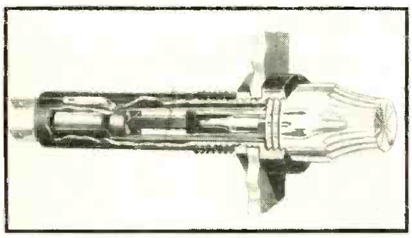
Both shavings and the necessity of changing needles are eliminated.

★

LITTELFUSE INDICATOR LIGHT

This light goes on *only* when the circuit is broken. This is the service rendered to remote control by an indicator manufactured by Littelfuse Incorporated, 4757 Ravenswood Ave., Chicago, Ill. It is listed as Littelfuse Panel Mounting, No. 1414.

When installed at any convenient



or desirable point in connection with remote motor control it works instantly, with a plainly visible signal to show "on" or "off." When the circuit breaker opens the light goes on.

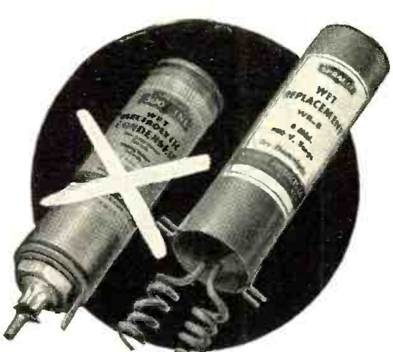
It can be had for 24 or 48 volt filament bulb, with which no resistor is used. Otherwise it uses a built-in 200,000-ohm protective resistor, in series with a neon lamp. The resistor prevents the lamp from blowing out, as ordinary lamps do, on unexpected high voltages. In the Littelfuse installation the lamp glows on currents as low as 100 microamperes.

The Littelfuse Indicator, or Panel Mounting No. 1414, has a black bakelite body, and transparent molded cap. It is made for panels up to 5/16" thick and ½" diameter mounting hole. Overall length 2" below panel, ⅞" above panel. The rating is 90 to 250 volts. Regularly furnished without lamp.

★

SPRAGUE WET REPLACEMENT CAPACITORS

The new Sprague Type WR Wet Replacement Capacitors are especially constructed for use in place of wet electrolytics which, due to their alu-



minum thread-neck cans are unobtainable because of war restrictions. They also replace various aluminum can type dry electrolytics, now no longer available.

Although standard dry electrolytic condensers can sometimes be used as wet replacements, the safety margin is likely to be insufficient in many applications. Hence Sprague Type WR's have a much higher voltage formation than standard drys to insure them standing up under the high peak voltages which are impressed on wet electrolytics. Also, they're built to handle the a.c. ripples that might cause standard 450 volt dry electrolytics to overheat to a point where they break down. The diameter of WR's is the same as that of standard wets so they will fit the screw-type can mounting holes. Their metal feet can then be soldered to the classis for firm mounting.

Sprague Type WR's are now available in three sizes, WR-8 which replaces wet or dry electrolytics in capacities from 4 to 8 mfd.; WR-16 which replaces capacities from 12 to 18 mfd.; and WR-25 which replaces capacities from 20 to 40 mfd.

★

MECK ELECTRONIC RAID SIREN

A new electronic type air raid siren, designed to give both great volume for alarms as well as a simple method of crowd control, is announced by Audiograph Division of John Meck Industries, 1313 West Randolph

Street, Chicago. Called the "Electro-Siren," this unit makes use of a vacuum-tube tone generator which can either duplicate the rising and falling tone of a mechanical siren, or can be set at any pitch for best audibility over traffic or manufacturing noises. It can also be used to send code messages to air raid officials by dots and dashes. Special circuit design allows 50 per cent more power than is possible from an ordinary sound system.

A microphone can be used for voice announcements over the same unit, which takes the place of a public address system.

The Audiograph "Electro-Siren" normally operates from any 110 volt source, but in the case of current failure can be instantly switched to 6-volt storage battery operation. It can also be used in police cars or other vehicles, operating from the car battery. The largest system can be operated continuously for four hours from a fully charged battery.

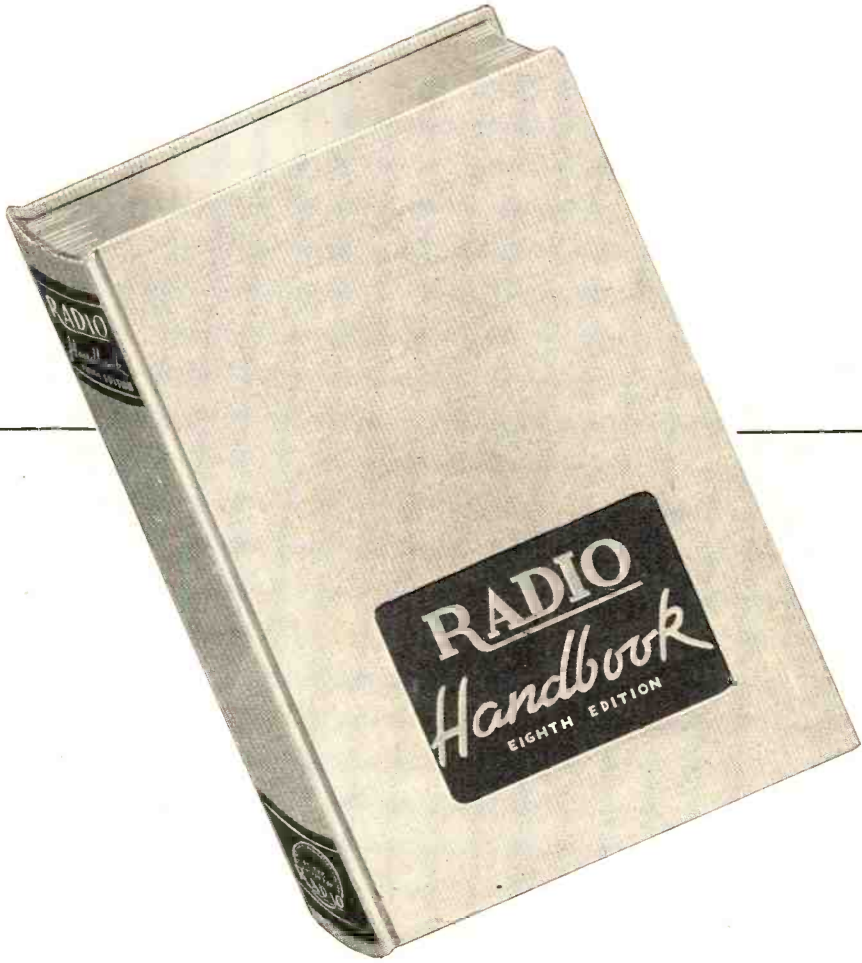
★

G. E. AIRCRAFT RELAY

A new sensitive direct-current relay for aircraft service has been announced by the industrial control division of the General Electric Company. The relay, designated CR2791-C100C, is specially designed for use in vacuum tube output circuits where the power available is so small as to require operation on extremely low currents.

A sealed aluminum cover protects

[*Continued on page* 52]

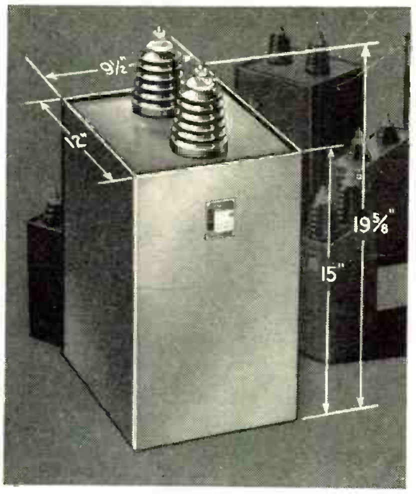

RADIO
Handbook
EIGHTH EDITION

New Products

NEW AEROVOX OIL CAPACITORS

To meet the exacting requirements of radio transmitters and other applications calling for high-voltage heavy-duty oil capacitors, Aerovox Corporation, New Bedford, Mass., announces its Type '20 units. These oil capacitors cover voltage ratings from 6000 to 50,000 d.c.w., including dual-section units for voltage-doubling circuits of 12500-12,500 volts or 25,000 volts output, in 0.25-0.25 and 0.5-0.5 mfd.

Multi-laminated kraft tissue and hi-purity aluminum foil sections for these capacitors are uniformly and accurately wound under critically controlled tension to avoid mechanical strains. Giant winding machines permit of handling several dozen "papers" for sections which are used singly or

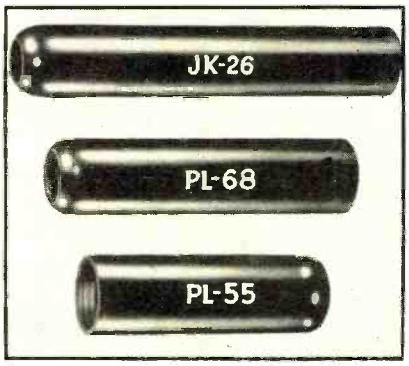


paralleled—in attaining given voltage ratings. The sections are thoroughly dried, vacuum-treated, oil-impregnated and oil-filled under continuous vacuum in specially designed and built tanks. A battery of these giant tanks permits a full pumping cycle for the thorough vacuum treatment of sections.

Because of the Hyvol dielectric oil used, these capacitors maintain their full rated capacity even at freezing temperatures, making them satisfactory for outdoor installations. Hermetically sealed in sturdy welded steel containers finished in rustproof and corrosion-proof dark gray lacquer, together with cork-gasketed pressure-sealed glazed porcelain high-tension pillar terminals, these capacitors are immune to humidity, temperature, and climatic conditions generally.

JACKS, PLUGS, AND "THROW-AWAYS"

American Molded Products Company of 1751 North Honore St., Chicago, Ill., is in production of molded



plastic plugs and jacks from stock molds for immediate delivery. Stock molds are now available for Jk-26, Jk-48, Pl-54, Pl-55, and Pl-68. Delivery may be had in any quantity.

These are for standard units and meet the most exacting requirements. Numbers are perfectly stamped and filled.

The new tough plastic "Throw-Away" is the familiar screw-plug, dummy-plug, cap-plug or other device for the protection of equipment or articles from dirt, dust and moisture while being handled or in transit.

The "Throw-Away" has no functual value after the shipment reaches its

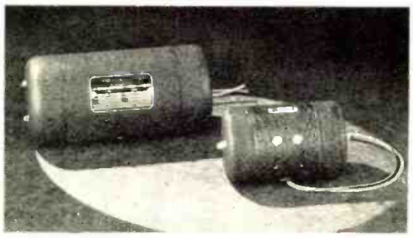
destination. It is literally thrown away. Hence the saving with efficient "throw-aways" in plastic as against critical metals is considerable.

G. E. COMMUNICATION DYNAMOTORS

The new line of General Electric dynamotors comprises five types, ranging from 25 to 600 watts in output, and from 3 to 31 pounds in weight. Formex wire insulation, light weight, and reliability under rigorous conditions are features. Each unit is designed for high output from a small frame size.

Objectionable alternating-current ripple is kept at a value which requires a minimum of filter to provide satisfactory operation of the communication equipment. The dynamotor commutators are carefully cut and undercut so that commutation will meet rigid standards.

The end caps are formed aluminum or steel covers which fasten to the end shields to keep dust and dirt out. End shields are of high-pressure cast aluminum or steel. Cartridge-type brush mechanisms are used, and brush holders are anchored in the castings.



Capacitors are supplied across the brushes when needed for suppression of radio interference, and brush springs are shunted with copper pigtails.

Other features are: spiraled armature punchings to reduce noise and eliminate locking effect; carefully selected ball bearings with provision for lubrication and cleaning; and a stator formed from stainless-steel tubing.

★

FONDA AV TAPE RECORDER

It has been announced that the Jefferson-Travis Radio Mfg. Corp., 380 Second Ave., New York, has taken over the manufacture and is conducting the sales activities of the Fonda AV Tape Recorder, a new type of portable equipment which makes use of non-inflammable acetate film as a means of permanent high-fidelity reference recording and automatic play-back.

This equipment is particularly suit-

[*Continued on page* 48]

F.M. KEEPS TRANSIT SYSTEM WORKING AT HIGHEST EFFICIENCY

A new two-way frequency modulation radio system is keeping the Cleveland Railway Company's transit system working at highest efficiency. The equipment consists of a 250-watt dispatcher transmitter and ten 25-watt mobile units. The headquarters transmitting antenna is mounted 270 feet above street level. All

The G-E 25-watt 2-way f-m communication equipment on desk of dispatcher of the Cleveland Railway Co.

equipment was supplied by the General Electric Company.

Since the installation of this new f.m. emergency communication system, delays in car service have been shortened and in some cases entirely eliminated by the ability of zone supervisors to reach a congested area quickly and to restore the flow of vehicles or direct the replacement or repairs of damaged equipment.

The headquarters station, with call letters WDCZ, is located at East Ninth Street and Carnegie Avenue in Cleveland. The ten zone cars are operated throughout the city, patrolling the lines of the company. The two-way feature of the communication equipment permits the supervisors to report to headquarters on traffic conditions, to learn immediately of traffic complications resulting from fires or other causes, and to reroute the company's vehicles as conditions require.

Zone supervisor using the G-E 2-way mobile f-m communication units.

Broadcast Equipment Pool

Careful does it—Ken Gardner, chief engineer of WHAM-W51R, holds a new 1500-T while checking up on power input. Conservation now is of prime importance.

Proposed Plan For Maintenance of Domestic Broadcasting During War Period

In order to obtain maximum life of domestic broadcast equipment, including vacuum tubes, to use fully replacements now in stock, and to require minimum new material which will be allocated by the War Production Board, the following plan is proposed governing the technical maintenance of standard broadcast stations for the duration of the war:

1. Make a detailed inventory of all the equipment now on hand at all domestic broadcast stations in the continental United States.
2. Establish the requirements for replacement of equipment from stock and from new material by one year periods.
3. Obtain an allocation of the new material and necessary priorities from the War Production Board to satisfy current and future requirements.
4. Make a detailed check of the technical performance of all domestic broadcast stations to establish that they are operating in a manner to give maximum life of equipment, including the vacuum tubes, consistent with good service and in keeping with the Commission's Rules and Regulations and the Standards of Good Engineering Practice. (The regulations and standards should be modified if it can be shown that a worthwhile improvement in the life of equipment will be accomplished.)
5. Divide the United States into "Conservation Districts." These districts will be as large as feasible and to contain as many stations as possible consistent with the requirements of communication and transportation between the stations and the administrator of the district. The districts should contain enough stations that a representative stock supply is available in each district.
6. The DCB will establish a central office in Washington, D.C., and will have control over all districts and the adherence to the plan by stations in the districts, subject, of course, to any final action that may be required by the War Production Board which is the agency set up by law to handle all priority matters.
7. Each district will be controlled by a civilian administrator and two assistants selected from the stations operating personnel in the respective districts.
8. The administrator of each district with the aid of his assistants, as needed, will check the inventory, administer the distribution and redistribution of equipment, requisition new equipment, and determine that proper and efficient operation of each station in his district is maintained. The administrators will operate under a very strict and specific directive issued by the DCB, with the approval of the War Production Board.
9. The administrator and assistants in each district will be selected at a conference of all stations in each district. An inspector or other Commission representative would preside until the administrator is elected. At this time the duties of the administrator and his assistants will be clearly set out, as well as the responsibility of the station licensee, in order to operate under the program for conservation of equipment.
10. The inventory in each district and between districts will be used as a basis of a redistribution of equipment as required between stations needing such equipment. The redistribution in a district will be handled by the administrator of that district. The redistribution between districts will be handled through directions from the Federal Communications Commission which will be based on War Production Board rules.
11. Material within a district will remain in its present hands, until such time as it is needed at other stations in the district or in other districts.
12. An inventory will be kept from day to day in each district and at the end of each week it will be cleared with the central office at Washington. All requisitions for additional materials will be sent through the central office.
13. A station will be considered as having the minimum required equipment (except vacuum tubes) when such equipment meets the manufacturers specifications for spare parts. No spare equipment will be taken from a station whose equipment just fulfills the minimum requirements. A station not having the minimum required spare parts will not be supplied spare parts to increase the inventory above that it had on hand January 1, 1942. Any equipment more than the established minimum requirement will be considered in excess of the requirements and subject to redistribution to other stations within the district or to other districts.

Minimum vacuum tube stock will be considered on the basis of the requirements for spare tubes set out in the Commission's Standards of Good Engineering Practice or up to 100 per cent spares, depending upon the previous practice at the station. In case a

[*Continued on page* 50]

AIR-RAID ALARM DEVICE*

Lieut. A. H. VICKERSON and Sergt. R. L. GRAY
Boston Police Department

Under the rules laid down by the United States Army in Signal Circular 8-2, it is necessary that stations on certain frequencies monitor a designated key or key relay broadcast station, in order to be at continual stand-by for the 30-second, 1000-cycle warning tones and subsequent oral instructions. It was found necessary at this station to assign three men to monitoring duty in order to comply with the regulations covering a 24-hour watch.

To release these men for other vital work, a device was developed to provide a loud warning signal automatically. It is used in conjunction with a standard receiver having high audio output, and is so arranged that the loudspeaker in the receiver is silent for a period of 10 seconds after the 1000-cycle tone goes on the air. At the end of the first 10 seconds of the 30-second signal, the loudspeaker circuit is automatically closed and the tone signal reproduced over a wide area at high volume level.

This automatic arrangement eliminates the possibility of human failure.

The Circuit

As shown in the accompanying diagram, a filter, *C1-X1*, is inserted between the grid of the receiver output tube and ground, through contact *A* of relay *RL3*. This filter offers a high impedance to frequencies from 900 to 1100 cycles, with its peak at 1000 cycles. All other audio frequencies are bypassed to ground. Contact *B* of the same relay grounds the speaker, thus completing its circuit to the receiver output transformer *T1*.

Transformer *T2* is connected with its low impedance toward the output transformer *T1*. Its output feeds the solenoid of relay *RL1* through the full-wave Rectox rectifier *RX*.

About 25 volts for the operation of relays *RL2* and *RL3* is taken from the receiver power supply through a suitable dropping resistor *R*.

With the switch *S1* in the open or "non-alarm" position, the receiver operates normally. In this case the solenoid of relay *RL3* is energized through contact *A* of relay *RL2*. Hence, contact *B* of *RL3* is grounded, which completes the loudspeaker circuit; and contact *A* of the same relay is open, which opens the circuit of filter *C1-X1*.

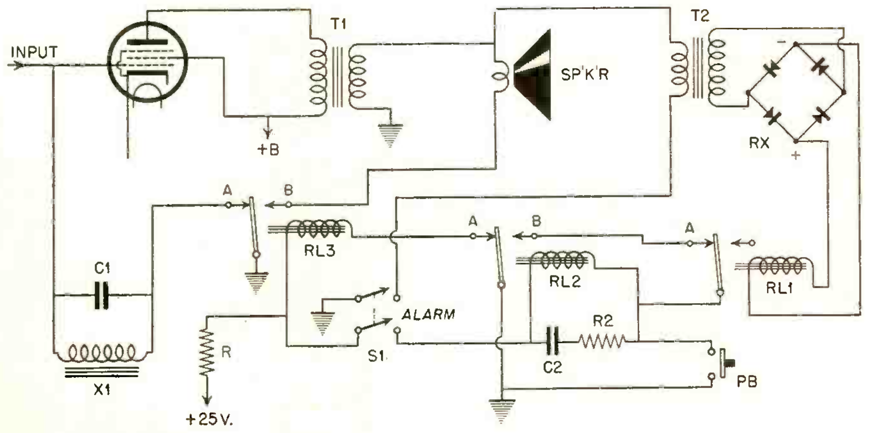
With the switch *S1* in the closed or "alarm" position, the "primary" circuit of *T2* is completed, and voltage applied to the solenoid of relay *RL2*. To "start" this circuit, however, it is necessary to momentarily close the push-button switch *PB*. This causes the armature of *RL2* to be drawn over to contact *B*. The circuit will then "hold" so long as the armature of relay *RL1* is on contact *A*.

This energizing of relay *RL2* opens its contact *A*. This opens the circuit of the solenoid of relay *RL3*, causing its armature to spring against contact *A*. The filter is now in circuit and the loudspeaker out of circuit.

Since the filter *C1-X1* is peaked at 1000 cycles—the tone frequency—it offers a low impedance to all other audio frequencies. As a result of this, the output of the receiver at off-frequencies is considerably attenuated, and the output

[*Continued on Page* 50]

*Patent rights reserved.



Circuit of air-raid alarm device for use in conjunction with standard broadcast receiver. Legend: T2—U.T.C. type S-14; X1—U.T.C. 39019; C1—.025 μfd.; C2—240 μfd. electrolytic (six 40's in parallel); R2—5000 ohms; RL1—Sigma 2000-ohm relay; RL2—Sigma 5000-ohm relay; RL3—Struthers-Dunn CXB-51 relay.

Notes on Station Operation

VERTICAL PICKUPS IN LIMITED SPACE*

BERNARD T. WILKENS

Chief Engineer, WKBN

Reconstructed vertical pickups in mobile sound truck at WKBN.

◀ When we installed two W.E. 9A reproducer assemblies recently, we were confronted with the problem of what to do with the two vertical pickups which the 9A's replaced. The only turntables with which they could be used were in a mobile sound truck, already equipped with two crystal low pressure pickups. However, the space available on this truck for mounting the vertical units was too small.

To fit the pickups into the limited space, several changes would have to be made. The overall length of each arm would have to be shortened and the arm axis moved up to keep the stylus pressure low. A special type of mounting would be necessary to obtain as long a radius of swing as possible and to maintain the head tangent with the groove at all diameters.

We went to work by stripping the arms down and shortening them two inches. The axis was then moved forward toward the head three inches and the new mounting checked for diameter tangency. It was found that an angle of 17 degrees would allow the head to track tangent at all diameters. A "V" cut was made on the inside of the arm just behind the connecting terminals and the arm was bent and soldered, making it as strong as it was originally. A substitute weight was placed on the completed arm to determine the amount needed for proper stylus pressure. We trimmed the original weight to approximately the correct amount and then assembled the arm. To obtain perfect balance, the weight was shaved down with a fine file.

Because the pickup output was quite small and required considerable amplification, any vibration originating in the machine would be picked up by the vertical head unless some suitable method could be found to absorb the vibration before it reached the arm. We solved this difficulty by mounting the arms on one inch felt pads.

We encountered an electrical problem caused by using both lateral and vertical pickups on the same truck, with only two faders available and no space for mounting others. In addition, we wanted to keep the equipment as flexible as possible and simple enough for an announcer to operate, if necessary. By adapting the equipment originally supplied with the vertical pickups and making a few minor changes, the trouble was eliminated. The faders were replaced by Daven 500/250 ladder pads having 30 steps and variable through 345 degrees.

The truck is mounted on large casters and can be moved around the studios at will. A line to the control room and an a.c. circuit are the only connections necessary. Contained in the truck are the necessary amplifiers, power supply, loudspeaker, equalizers, fading and mixing systems, etc. It is used for sound effects, auditioning, preparing programs for sponsors and for presenting air shows. Operation since the installation of the vertical pickups has been very satisfactory. Not only did we increase the value and usefulness of the sound truck, but we found a good place for two discarded vertical pickups.

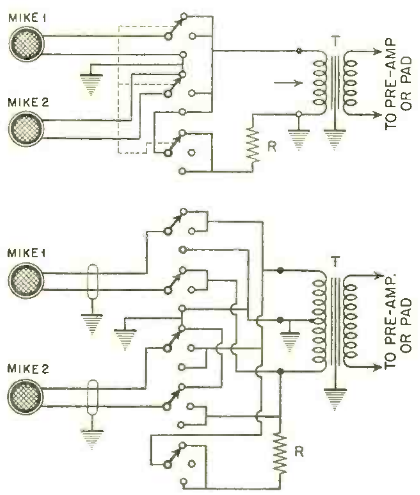
*Courtesy of "Pick-Ups"

PORTABLE MICROPHONE SWITCHING PANEL*

ROBERT H. DYE

Chief Engineer, KGFX

◀ The accompanying diagram shows the panel we use here at KGFX to convert a four-channel mixer into one capable of handling eight microphones, either individually or in pairs.



Circuit of switching panel at KGFX, capable of handling 8 mikes.

The switches were designed as shown, with the mike out of the circuit grounded. We thought switch clicks might occur when the gain was up but we have not encountered this difficulty, probably because static is kept drained off the mikes when out of circuit. The panel was put into use as soon as it was wired so we have had no opportunity to open the circuit and find out if this is actually the case.

The device is used in our studio and on remote jobs and it takes only a few minutes to connect the amplifier. Input and output terminals may be made to suit individual station needs.

3-pole triple-throw switch for single wire shielded mike cable

Inp. Z of T = ½ mike Z

R = mike Z

5-pole triple-throw switch for 2-wire shielded mike cable

Inp. Z of T = ½ mike Z

R = mike Z

One switch per mixer control

Switch position 1 = mike 1 on

Switch position 2 = both mikes on

Switch position 3 = mike 2 on

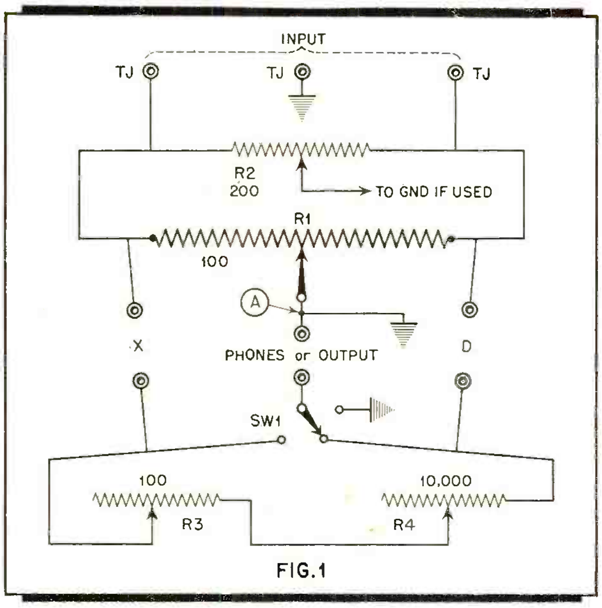


FIG. 1

Circuit of a.c. bridge. See Fig. 2 for calibration.

Constructing Decade Divider

If a decade voltage divider is not available, one can be made at small cost which will be accurate to within about 1 per cent.

An ohmmeter or other sensitive indicator with a freely moving element is necessary. Also be sure to use a fresh battery. Use a wire-wound rheostat to adjust the meter and test to see that the meter pointer always comes to rest at the same point when voltage is applied.

Ten 1000- or 1500-ohm carbon stick resistors are required; that is, plain carbon resistors with only paint over the elements. Determine by test the resistor which has the highest value. Then by using a file, cut small notches out of the other nine resistors to bring them all to the same value. This must be done very carefully so as not to go past the selected value. If this should occur accidentally, choose a slightly higher point and start over, but by using a little care in filing this should not happen.

If the test meter does not have a mirror back, arrange some way to avoid parallax. This may be done by using a small tube of metal or glass about one-sixteenth inch inside diameter and about 3 inches long, directly above the point to be observed on the meter scale, so that the pointer will always be seen from the same angle. The tube should be fixed securely so that it cannot move and when deciding on the point on the meter scale to be used, it is best to use one of the finer lines or divisions.

No attention is paid to the value to which the resistors are to be adjusted. This is so because the resistors are to be used as a divider, and the values make no difference. This is one reason the bridge can be made to indicate accurate values because the resistor divider or decade is used to calibrate the bridge. The bridge really indicates ratios and is independent of other factors outside of the potentiometer used to balance the bridge. In fact, after the bridge is once calibrated, every part may be removed and replaced and the bridge may be made as accurate as ever, because it is calibrated from the center of the scale both ways and it is only necessary to find the center of the potentiometer and then set the pointer at *1* on the scale and it will be as accurate as before.

After the resistor divider has been completed and the bridge wired, the bridge scale should be fixed temporarily to the panel so that it can be removed after the calibration points have been marked, in order to ink in the division lines and values. The scale and panel should be marked at some point so that the scale can be replaced exactly as it was when the points were marked during calibration.

An audio oscillator of some kind must be used to furnish an input signal to the bridge. A service oscillator may be used, or a small audio oscillator may be hooked up that will do just as well. Of course the bridge may be calibrated by using direct current, but this will not be as accurate, and a sensitive meter must be used.

By following the steps outlined below and making careful adjustments, the calibration will be accurate.

The scale is first calibrated from center to right, then from center to left, and finally the in-between points are found.

(1) Place one section of decade in *each* arm of the bridge, (X and D) balance to find center of scale

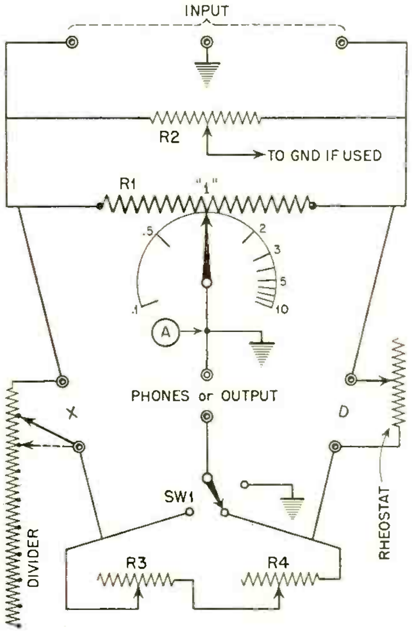


FIG. 2

and mark this point *1*, as shown in *Fig. 2*. Leave the pointer at this position.

Then place a 20,000- or 25,000-ohm rheostat in D arm, connect one section of decade in X arm, and

[*Continued on page* 51]

Building and Calibrating a

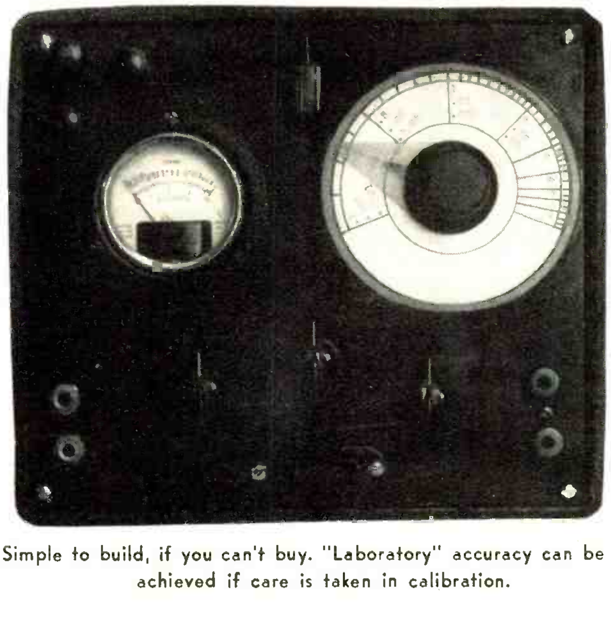
UNIVERSAL A. C. BRIDGE

A. K. McLAREN

◀ The measurement of the principal electrical characteristics of components in receivers, amplifiers, etc., is a problem that can only be solved by having the proper instruments to make the tests required. The a.c. bridge meets most of the requirements, for with the bridge, inductance, capacity, resistance, impedance and other factors may be measured accurately and over a wide range of values. As the bridge measures ratios, the matching of components is simple.

The bridge to be described may be built for a few dollars, and may be made accurate within 4 or 5 per cent, depending upon the care used in calibrating the instrument.

The photograph and the diagram, *Fig. 1,* show the location of parts and the method of calibrating and marking the dial scale. In the photograph the two power input jacks and ground connection are shown in the upper left corner. The upper center knob is the Wagner ground, *(R2* in *Fig. 1)* and to the right is the bridge scale *(R1* in *Fig. 1)*. In the lower left corner are the X-arm tip jacks, and in the lower right corner the D-arm tip jacks. The phone tip jacks, or output of bridge, are located at lower center of panel. The lower center knob is *SW1* in *Fig. 1,* and the knobs to the left and right of it are the phasing controls *(R3* and *R4* in *Fig. 1)*. The d-c. volt-ohm meter is not necessary, but is handy in measuring coil resistance.



Simple to build, if you can't buy. "Laboratory" accuracy can be achieved if care is taken in calibration.

The scale in the photo is shown with capacitance calibrations marked on it. If a larger dial is used, scales calibrated for resistance and inductance may be marked for direct reading simply by extending the calibrating points.

The controls used should be wire-wound and should have a linear taper. The bridge should be wired with heavy bus bar and the leads made short and direct. It is preferable to use a metal case, with all parts but the ground connection insulated from it.

Use of Bridge

When the pointer is to the left of center of the scale the readings will be in tenths of the standard, and when it is to the right of center the readings will be in units, corresponding exactly to the scale which reads *1, 2, 3,* etc. It is only necessary to multiply the reading of the scale on either side of center by the value of the standard. If standards are used that are even multiples of 10, the scale can be read much easier and the values may be placed directly on the scale. Thus, a 1-μfd. standard will read from .1 to 10 μfd. Similarly, a. 1-μfd. standard will read from .01 to 1 μfd.

The phasing controls *R3* and *R4* must be used when making measurements of inductance or capacity. The bridge is first set as near to balance as possible and then the phasing controls are adjusted until the input test signal is at a minimum. The phones are switched from one side of the bridge to the other while adjusting these controls and if either side shows a lower indication the switch *SW1* is left here and the phasing controls adjusted at the same time as the main control *R1* until minimum signal is obtained. The phasing controls are used to balance the resistance of the coil or condenser being tested with that of the standard.

Some amplification at the output will be helpful in finding a definite null point. Two stages of a.f. will do the trick, though one stage may be sufficient if a high-ratio transformer is used.

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equipment serves for normal use as well as for emergency.

In the event of an alert signal, the chief warden can call the sector wardens to attention without disturbing the employees in any of the sectors. He then can broadcast instructions, start and direct orderly movement with the aid of the sector wardens, toward the pre-arranged safety area for each sector. His sustained broadcast to all of the employees over the communication system is intended to back up the activities of the sector warden on each scene and prevent panic during the movement. At the same time the two-way arrangement permits any sector warden to report impending difficulty so corrective measures can be taken at once. Remote stations in the smaller areas are desk-type units in the standard "Executone" line. Trumpet models serve the larger areas. Each is designed to permit the sector wardens to talk back to the chief warden at some distance from the station itself. As recommended by the Office of Civilian Defense, the equipment is separate from the regular telephone service. It eliminates the need for disturbing sirens, bells, or whistles. The system, manufactured by Executone, Inc., 415 Lexington Avenue, New York, New York, can be converted to normal peace-time use after the emergency.

★

ELECTRONIC GADGETEERING ATTRACTING RADIO MEN

From now on we shall see a rapid development of electronic gadgeteering, which means the non-radio application of radio technique, so states Charley Golenpaul who heads the jobber sales for Aerovox condensers.

"I believe the era of electronic gadgeteering is now opening up in a big way," states this well-known sales manager. "In the first place the ban on amateur radio communications is not going to leave the enterprising Ham twirling his thumbs. Of course many Hams are already or will soon be in our armed and technical services. Many will find wartime jobs with other United Nations. But those remaining on the home front are going to put their experience, equipment and ambition to work on new and startling applications in the home, shop, factory and elsewhere, far removed from customary radio practice.

"I suppose most radio men have heretofore been too busy with radio proper to find extra time and energy for non-radio or electronic gadgeteering possibilities. However, many of them now are going to use their rigs and parts for new functions. I can visualize some pretty interesting developments—light-beam telephones for conversing over considerable distances; automatic photo-electric garage-door openers; photo-electric switches turning lights on and off with darkness or daylight; checking the stoking of furnaces or boilers by the chimney smoke; various comparators or instruments for comparing and matching colors and shades; checking solution concentrations and chemical studies by conductivity means; and so on.

"As a starter, electronic gadgeteering can be based on well-known elementary principles and basic circuits long known to radio and electrical workers. The *Aerovox Research Worker* already has released considerable data on the subject, and our engineers are working up further and more specific data to be released through our monthly bulletin and also through the radio and electronic press generally.

"Many industrial plants are already electronic-gadget conscious. I know of radio men who've gotten themselves good jobs in plants because of their ability to do things better, quicker and less expensively by electronic means.

"Radio parts jobbers are going to nurse this electronic gadgeteering trend along. The more enterprising jobbers will doubtless be on the lookout for installations in their territory, and will try to get the details wherever possible so as to pass such practical information on to others. I appreciate the reticence of industrialists to part with such information, more so in these wartime production days, but wherever possible such information should be made generally available in a helpful exchange of ideas.

"Make no mistake about it, the temporary suspension of Ham communications may well turn out to be a boost. It will generate a lively interest in electronic gadgeteering. And when Ham communications are resumed again with the return of peace, I venture to predict that electronic gadgeteering will comprise a greater field for radio parts, particularly the quality of extra-heavy-duty components, than all amateur radio activities put together. Furthermore, many a Ham will find an interesting way of making real money out of his hobby, and that's something."

★

SYLVANIA PROMOTES SALES EXECUTIVES

Appointment of R. P. (Bob) Almy to Manager of Renewal Radio Tube Sales was announced today by C. W. Shaw, General Sales Manager of the Radio Tube Division of the Hygrade Sylvania Corporation. Announcement was made at the same time of the appointment of A. R. Oliver to Field Sales Manager of the Renewal Tube Sales Division.

Mr. Almy will headquarter his radio tube renewal sales work at Emporium, Pa., while Mr. Oliver will operate out of Chicago. Both men are well known to parts jobbers and radio service dealers all over the county.

"Bob" Almy has been associated with Sylvania since the time when Renewal Radio Tube merchandising was established on a jobber, serviceman basis as it is known today. He has risen in the sales department to positions of Western Division Manager, Eastern Division Manager, Sales Supervisor, and Assistant Renewal Tube Sales Manager.

Mr. Oliver has been in the Chicago area for Sylvania for several years as Renewal Tube Western Division Manager. Recently he was made field sales supervisor and thus comes to his new post with broad field sales experience. Mr. Oliver will continue his field supervisory work which in recent months has taken him from coast to coast visiting Sylvania salesmen, jobbers and dealers.

★

REPEAT REQUEST

Radio hams are being asked to sell their transmitters and receivers for use by the armed forces of the United Nations, according to an announcement by the American Radio Relay League, which is centralizing information on available apparatus on behalf of the government agencies.

Only commercially-manufactured communications-type receivers and transmitters for which standard instruction manuals are available are required at present. Such equipment is more readily used and understood by military operators than homemade units, even though the latter may be of comparable quality, it was explained.

Urgent shortages of communications equipment required for defense needs led to the call, manufacturers finding themselves unable to make deliveries sufficient to fill the intensified demand as the theatre of war expands in widening circles.

Amateurs willing to turn over their apparatus to their country are requested to advise the ARRL at West Hartford, Conn., giving model number, condition, and the price for which it can be delivered crated to a local transportation agency. Only standard manufactured equipment should be offered, homemade or "composite" equipment not being required.

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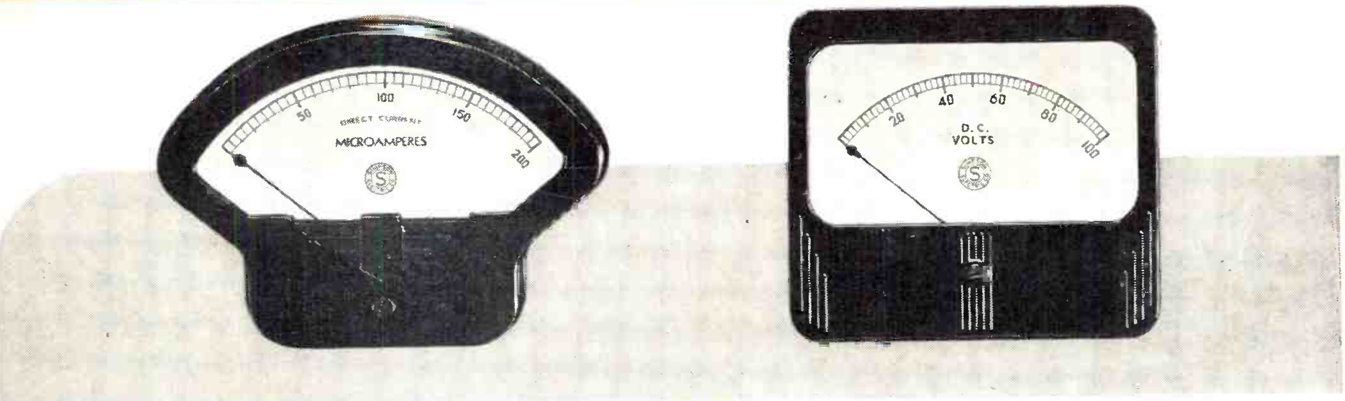

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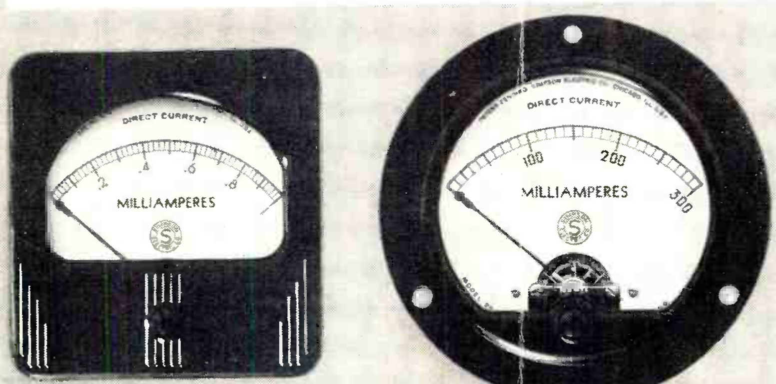

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