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RADIO REFERENCE ANNUAL

THIS VOLUME CONTAINS MANY ARTICLES, IMPORTANT DATA AND IDEAS FOR THE EXPERIMENTER, SERVICE MAN AND RADIO "FAN"—A USEFUL BOOK FOR ALL RADIO MEN.

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CHAPTER 1

Receivers, Converters, Pocket Sets

——"The Book-End 3"——

THE circuit schematic shows 3 tubes—a 6K7 R.F. amplifier, a 25A6 power detector, and a 25Z6 rectifier—in what, at the first glance, will appear to be a rather complex and unusual line-up, but which on careful inspection will prove itself to be an extremely simplified arrangement.

Let's begin with the rectifier which is connected conventionally in an A.C.-D.C. power supply hook-up. Switch Sw.1, ganged to tone control R5, connects the A.C. or D.C. 110 V. line to the "B" minus lead. The "B" minus is NOT connected directly to chassis ground but through condenser C17. The chassis, therefore, is not "hot." (It is recommended, although not specified by the author, that both sides of the line be fused as shown in the schematic and pictorial diagrams of the power unit. If desired a "fused plug," available from practically any electrical supply house, may be used.—Editor)

Resistor R6 is the 180-ohm filament dropping resistor in the 3-lead line cord and connects to the 25Z6 filament and out to one prong of the power-supply cable for connection to the tuner unit. The rectifier plates are tied together and to the 110 V. line as shown. One output element feeds the 3,000-ohm speaker field which is filtered by parallel-connected electrolytic condenser C13, and one provides the D.C. voltage for the receiver.

The input circuit of the 25A6 is tuned to the desired signal by the C2-C7-L2 combination. Coil L2 is an ordinary shielded midget R.F. transformer, matched to the antenna transformer, L1. Capacity Cx, in L1 and L2, is built-in. Condenser C2 is one section of the 2 gang variable condenser C1-C2. Condenser C7 is required to complete the LC circuit; the secondary of L2 is brought to "B—" which is not directly grounded to chassis), while, the variable condenser is mounted on that chassis with rotors grounded via the condenser frame. Condenser C10 is a small bypass across the output to smooth out the tone, and its use may or may not make R5, the tone control, an unnecessary refinement. Unit C11 bypasses "B plus" to "B minus," and C8 bypasses "B plus" to chassis.

The power detector in this receiver is a sensitive affair. Nevertheless, in order to provide its control-grid with signals strong enough for speaker volume audio output, it becomes advisable to get as much R.F. amplification as possible out of our single R.F. stage. And this is achieved through the use of our old standby, regeneration or feedback.

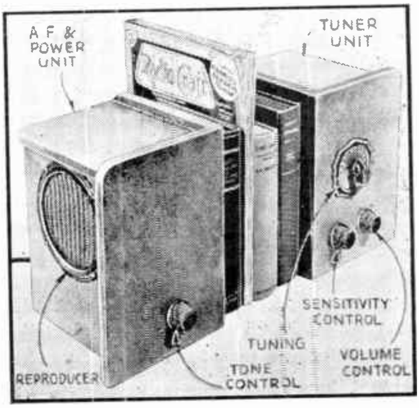


Fig. A, The Complete Receiver.

Feedback in the 6K7 circuit increases the strength of the amplified signal directly and effectively, as follows: directly, by reason of the regenerative action itself, and effectively, by reason of the increased selectivity which regeneration gives to an R.F. stage.

Note the connections here carefully. The suppressor-grid, ordinarily directly wired to the cathode, is tied to "B—" through the bypassed bias resistor, R3. The suppressor-grid side of R3 is then brought to cathode through a small feedback coil. This arrangement permits the proper biasing of both cathode and suppressor-grid but keeps the R.F. out of the suppressor-grid circuit.

The cathode-coil method of regeneration involves what is known as electron coupling and the builder should remember this admonition: NEVER TIE SUPPRESSOR-GRIDS AND CATHODES DIRECTLY TOGETHER WHEN ELECTRON COUPLING IS EMPLOYED WITH TUBES OF THE TYPES 6K7, 6D6, AND 58; the suppressor-grid should be always wired as shown, connected directly to ground or "B—", or tied to the screen-grid. In "EC" circuits for regeneration, direct connection between cathode and suppressor-grid will nullify

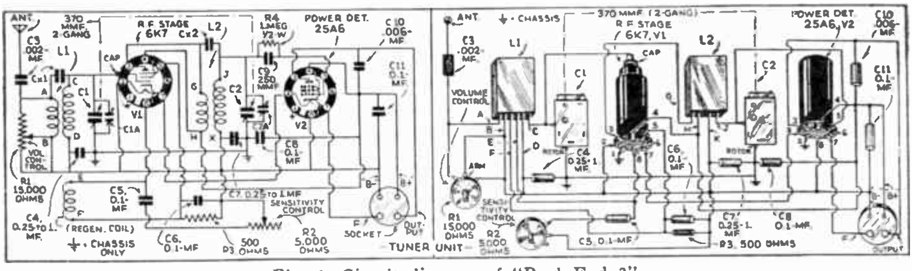


Fig. 1, Circuit diagram of "Book-End 3"

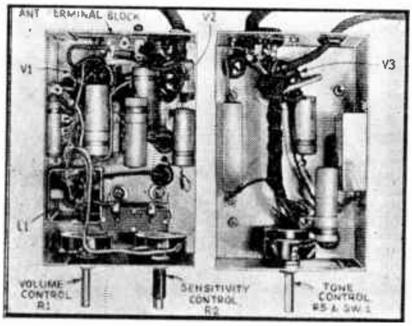


Fig. C, Chassis Views

the effect of internal shielding and cause instability.

Condenser C1 is the first section of the 2-gang variable condenser, with C4 the means of completing the circuit between condenser rotor (chassis connected via the frame) and the "B—" return for the L1 secondary.

Units C5 and R2 provide means for controlling feedback and may be eliminated where a fixed adjustment for maximum regeneration and selectivity (without circuit oscillation anywhere in the tuning range) is desired and can be effectively attained. Potentiometer R2 might be simply called our sensitivity control.

Potentiometer R1, wired across the L1 primary, shorts the winding; and thus, by varying voltage applied to the control-grid of V1, functions as a volume control.

With R1 at the maximum-right position, tune for a signal. If signals are heard, back up R1 and align C1 and C2 at both high- and low-frequencies ends of the tuning range by means of the variable condenser trimmers. If signals are not intercepted, recheck the wiring, and if you have a voltmeter test for "B plus" voltage at the tube plates and the screen-grids. The voltage will be somewhere in the neighborhood of 100, with the screen-grid readings approximately that of the plates.

If following proper alignment the circuit breaks into oscillations or shows signs of instability, try increasing the size of R3 by 100 ohms or so. Do not make this resistor too large, however, as sensitivity will suffer—and if squeals and whistles still persist, check over C4 and C7. These two condensers have much to do with stability. Increase their size if necessary, and above all, see that they are tied to the coils right at the secondary-return lugs.

If hum is in evidence, increase the capacity of C14 or C15, or both to 8mf. If the hum can be traced to the reproducer, similarly increase the size of C13. In the laboratory model, 4-mf. units at all three points proved entirely adequate, with no hum trouble whatsoever experienced.

If the speaker hums just enough to prove that it is receiving proper excitation, or if about 100 V. can be measured across its field, and yet no "B" is measurable or the "B plus" output is abnormally low, interchange the 4-to-8 terminal connections on the 25Z6. If the "B plus" to the receiver jumps to normal and the field excitation disappears or drops off appreciably, the rectifier tube is faulty, one set of its output elements alone giving proper service. The author has found many of the 25Z6s troublesome in this respect.

To install the regeneration feature, first unsolder the temporary connection between the 6K7 cathode and suppressor. Bring a lead from the cathode up to one lug of a 4-point tie strip. Mount C5 conveniently near and follow C5 out to the left-hand-tapper potentiometer, R2. The R2 center arm goes to "B—".

Now for some trial and error experiments.

The L1 coil core is not very large in diameter. As a matter of fact it is only about½ in. across. Consequently, our feedback coil must have a smaller diameter in order to fit inside. In the laboratory model, here illustrated, such a coil was wound on a small celluloid core not much larger than a lead pencil).

No hard and fast "turns" rules will, nor can, be given for the feedback coil. Begin by winding the maximum possible number of turns along the length of your "tickler" (regeneration-coil) core, dropping the wound form into L1, and bringing the leads out to 2 tie points—one connecting to cathode, one to suppressor-grid. Adjust R2 for maximum selectivity (knob turned completely to the right), and turn on line switch Sw. 1. If enough turns have been wound on the feedback form, the circuit will undoubtedly oscillate—a con-

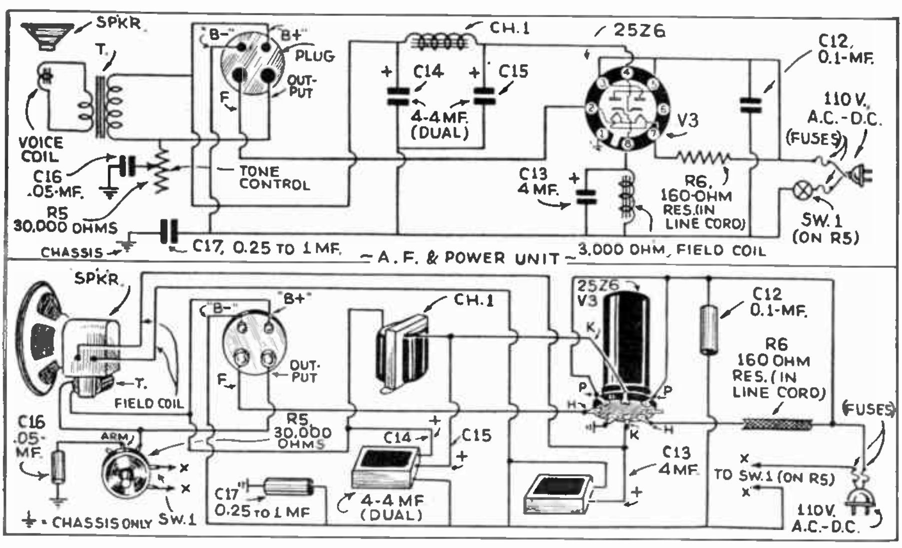


Fig. 2. Power Supply Circuit

dition which we won't exactly want but which will serve at least to show us now that regeneration is being had. If no shrill carriers on signals are obtained just increase the number of turns. Or reverse either the position of the feedback coil or the lead connections.

With oscillation obtained, back off R2 slightly. The oscillating condition should disappear; if not, remove turns from the feedback coil until the circuit will break into oscillation only when the R2 knob is at extreme right-hand position.

Tune to a signal with R2 adjusted for minimum selectivity or regeneration. Move the variable arm to the right. The signal should grow definitely stronger and sharper. With the R2 knob turned as far to the right as possible and the circuit just under the point of oscillation—as indicated by increased noise level between stations—tune across the band. Signals will come in sharply and clearly.

List of Parts

1—shielded, midget antenna coil, type 2436, L1;

1—shielded, midget R.F. coil, type 2437, L2;

1—Wholesale Radio Service or Allied Radio Corp. 2-gang variable condenser, 370 mmf. (max.) per section, C1, C2;

1—Aerovox condenser, type 284, .002-mf. C3;

3—Aerovox condenser, type 284, 0.25 to 1.-mf. (not critical), C4, C7, C17;

4—Aerovox condensers, type 284, 0.1-mf., C5, C6, C8, C11;

1—Aerovox mica condenser, 250 mmf., C9;

1—Aerovox condenser, type 284, 0.006-mf. C10;

1—Aerovox condenser, type 484, 0.1-mf., C12;

1—Aerovox single electrolytic condenser, type PBS2, 4-mf., C13

1—Aerovox dual electrolytic condenser, type PBS-2, 4-4 mf., C14 ,C15;

1—Aerovox condenser, type 284, 0.05-mf., C16;

1—Electrad potentiometer, type 20!, 15,000-ohms, R1;

1—Electrad potentiometer, type 278, 5,000 ohms, R2;

1—Continental resistor, 500 ohms, ½-w., R3;

1—Continental resistor, 1. meg., ½-w., R4;

1—Electrad potentiometer, type 241, 30,000 ohms, R5;

1—resistor-line cord, 160 ohms, R6;

1—switch (on Electrad 241 potentiometer; or rotary S.P.S.T.) Sw. 1;

1—length 4-wire heavy-duty shielded cable (desired size);

1—5-in. dynamic speaker, equipped with output transformer for 25A6, 3,000-ohm field;

1—choke, type 466-420, Ch. 1;

1—Allied Radio Corp. Aluminum chassis, size 6x8x2¼ in.

1—National Union type 6K7 tube, V1;

1—National Union type 25A6 tube, V2

1—National Union type 25Z6 tube, V3;

3—sockets, type S8, for V1, V2, V3;

1—socket, type S4, (used as "output socket");

1—chassis plug, type CP4;

Miscellaneous (direct-drive dial, pointed knob, 2 round knobs, hardware, etc.).

Simplified Converter For Short-Wave Radio Beginners

The Simplified Converter is A.C.-D.C. operated and has a 6K7 stage of I.F., tuned to the low-frequency end of the broadcast band. It employs separate high-frequency mixer and oscillator tubes, for highest possible conductance and a minimum of off-alignment oscillator swing with detector tuning. It obtains best possible signal-to-noise and signal-to-image ratios by using detector regeneration—the only effective substitute for a costly, hard-to-build tuned-R.F. stage; and makes use of a 3-gang, 6 pole switch for band switching.

The photographs show only one (general coverage) set of coils, all others having been removed for a clear view of the various components. This coil set, by the way, has the widest possible coverage (from approximately 19 to approximately 60 meters—depending upon the adjustment of the oscillator trimmer) and suggests the construction of a converter for a single high-frequency band, requiring no costly band switch. Shielding between coils has also been removed to reveal points of physical construction—not to imply that such shielding may be eliminated.

The detector is a 6L7, conventionally connected, but with its cathode-return through the usual resistor-filter condenser combination to a tap on the detector coil, rather than to ground. The screen-grid, carefully filtered, is tied to the center arm of a 40,000-ohm, potentiometer across the power supply which serves as regeneration or input sensitivity control. The cathode tap on the coil is so placed that, with the control adjusted for maximum sensitivity (maximum screen-voltage slightly less than the measured "B plus") full regeneration is had without detector-circuit oscillation.

The oscillator voltage is fed through a small capacity to the injector, or No. 3 grid of the 6L7 detector; with a 50,000-ohm resistor, R5, connected as shown.

The variable condenser is a 2-gang affair with low minimum capacity, and trimmers removed; although they may be retained for high-frequency alignment where the converter uses but one set of coils. The maximum capacity may be anything from 360 to 420 mmf. Endeavor to obtain a condenser whose minimum capacity is not greater than 12mmf.

By employing a single stage of moderate gain, not only is the instrument described made adaptable to receivers of wide efficiency range, but its proper line-up with these various receivers is facilitated. The converter is built to work at an I. F. of approximately 550 k.c.

The converter is coupled to the receiver by matching the secondary of its output I.F. transformer to the high-impedance primary of the receiver's antenna transformer.

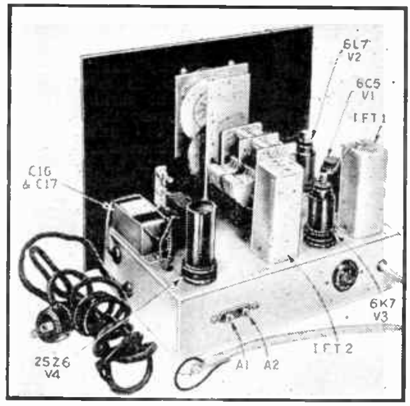


Fig. B, The Complete Converter

A D.P.-D.T. switching arrangement permits changeover from broadcast to converter operation. The leads from switch to receiver and from output transformer to switch are shielded in low-capacity tubing. (The importance of the former lead should be noted; the lead must not pick up broadcast signals, and shielding must necessarily be very effective . Further, the cable should be of true low-capacity type to minimize signal loss.)

The chassis pan should be high enough for installation of the coil switch; drill and cut it.

Wire the filaments in series; follow the schematic carefully, and use fairly heavy, well-insulated cable. Wire up the power circuit; test for filament continuity and for shorts to ground. If an A.C. meter is available, put in all tubes, plug in the A.C. cord on the line, and get an over-all filament reading. This should be approximately 44v., and the 3-wire line cord should have a self-contained resistor of 250 ohms.

Wire in all other parts which have been installed. Add tie points, supports soldered to chassis, wherever they may seem necessary. Be sure to have one near the band switch, so that the return leads of coils may find secure anchorage. Bring a lead from the condenser rotors through the chassis to a short, direct, soldered ground, and then connect bypass condensers from the oscillator and detector coil ground-return tie points to this same ground point. Do not fail to bypass these coil terminals here. If one terminal is used for returns of both oscillator and detector coils, one bypass alone will be needed, but don't forget it, even if "B—" is bypassed elsewhere. The complete high-frequency circuits MUST be localized properly.

If you haven't done it before, you must now do some work on the I.F. coils before these are

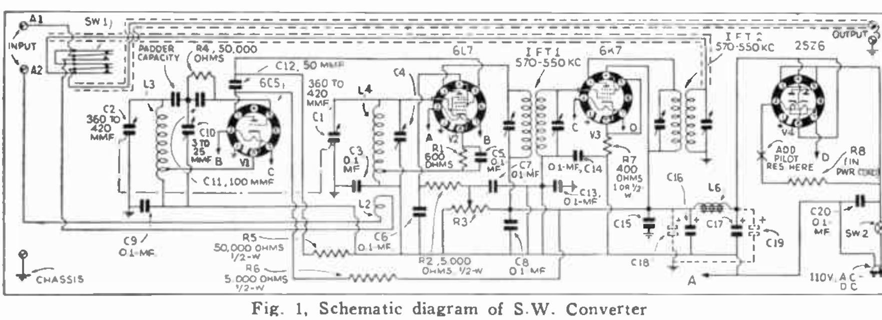


Fig. 1, Schematic diagram of S.W. Converter finally installed. Remove the shield cans, carefully unsolder the leads to the trimmer condensers, and then unwind from each coil (4 in all—2 primaries and 2 secondaries) approximately 60 turns. It will now be necessary to carefully clean the wire of its insulating enamel, and resolder to the trimmer terminals. Every care should be exercised in doing this. Test each coil for continuity; then get a resistance reading. The resistance for each coil should measure around 12 ohms.

Replace the cans, mount the coils, and wire the 2 I.F. components into the receiver. (Red wires to "B plus", blue wires to plates, green wires to grid and output ground, black wires to "B—", and output connection to the D.P. D.T. switch.)

However much the coils may track on paper, it will be found that alignment difficulties, even with variable trimmers and padders, will be experienced on actual construction and application. Build and install one set of coils at a time, removing turns from both oscillator and detector units (or adding turns) until both H.F. limit alignment and desired H.F. limit "spotting" are had. If the detector circuit oscillates, connect the cathode to a lower point on the coil. If the 6C5 circuit does not oscillate, run the cathode tap up higher on the oscillator coil-selecting a final adjustment which will assure a fairly strong and uniform R.F. for injection into the 6L7's No. 3 grid. Antenna connection loading may throw off H.F. limit tracking, but the variable detector-circuit trimmer should permit easy compensating adjustment. If detector tuning has a frequency "pulling" effect on the oscillator, provide better shielding between coils.

List of Parts

1—Meissner I.F. transformer, type 5712, 456 kc. (60 T. removed from each winding), I.F.T.1;
1—Meissner I.F. Transformer, type 5714, 455 kc. (60 T. removed from each winding), I.F.T.2;
1—A.C.-D.C. midget choke, app. 400 o. resistance, ch.
1—D.P.D.T. jackswitch, type 60, sw. 1
1—S.P.S.T. rotary line switch, sw. 2.
2—2-gang low-minimum variable condensers, closing right, trimmers removed, max. capacity 360 to 420 mmf. C1, C2.
1—Hammarlund Star midget variable condenser 50 mmf. C4.
8—Aerovox condensers, type 284, 0.1 mf. C3, C5, C7, C8, C9, C13, C14, C15;
1—Aerovox condenser, type 284, 0.1 mf. C6;
1—semi-variable trimmer, 3 to 25 mmf. or smaller, one for each oscillator coil, C10;
1—Aerovox condenser, type 1468, 50 mmf. C12;
1—Aerovox condenser, type 1468, 100 mmf. C11;
2—Aerovox dual electrolytic condensers, type PBS 2, 8-8, or 8-16 mf., C16, C17;
2—Aerovox dual optional condensers, type PBS 2, 4-4, or 8-8, mf. C18, C19;
1—Aerovox condenser, type 484, 0.1 mf. C20;
1—padder condenser, one for each wide-range or medium-frequency oscillator coil. (To consist of Aerovox type 1467 mica pad, 500 mmf. to .005 mf., paralleled with variable trimmer of widest possible capacity range, total capacity to be variable approximately 20% of estimated required value), Padder capacity;
1—Continental resistor, 600 ohms, ½-w or 1-w. R1;
2—Continental resistors, 5,000 ohms, ½-w. R2; R6;
2—Continental resistors, 50,000 ohms ½-w. R4, R5;
—Continental resistor, 400 ohms 1 or ½-w. R7;
1—Line cord 250 ohms, R8
1—Electrad potentiometer, type 997 or 202, R3;
1—Centralab 3-gang 6-circuit band switch, number points to suit;
1—Micromaster dial, type 318;
1—pointer knob, type 588;
4—small round knobs;
1—2-ft. length low-capacity shield tubing;
1—25-ft. coil special R.F. wire for grid circuits and coils;

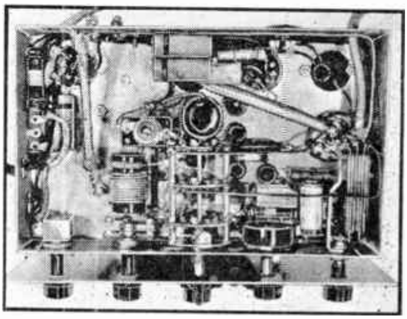


Fig. C, Underside of Chassis

1—Blan aluminum, steel or electralloy chassis, 6 x 10 x 2½in. high;
2—steatite low-loss octal sockets, type RSS, (for V1, V2;)
2—octal moulded sockets, type S8 (for V3, V4);
1—National Union or Raytheon type 6C5 metal V1;
1—National Union or Raytheon type 6L7 metal V2;
1—National Union or Raytheon type 6K7 metal V3;
1—National Union or Raytheon type 25Z6 metal V4;

Fig. A, A Compact Portable

3-Tube Portable Battery Set

THE case of this receiver measures only 5¾x6x 9¼ ins. long, including the cover which, when shut, fully protects all the controls and the speaker. It would be possible to make the outfit considerably smaller by using smaller batteries, but this is impractical and highly uneconomical. The batteries used will last about 30 hours, if used on the basis of 3 hrs. a day. Naturally, the less they are used the greater will be their useful life. The "B" drain is only about 12 ma., while the filaments work well on 310 ma., although, if run at the rated 2 v., the drain is 340 ma.

Of course, some compromises had to be made in design, the main one being the use of the new 1E7G tube. This consists of 2 pentodes in one shell, and is used for both 2nd.-detector and A. F. amplifier. Since both screen-grids are run to one base pin it was necessary to use an A.F. choke through which to supply plate voltage to the 2nd-detector, as a resistance would have dropped the voltage so much that a lower screen-grid voltage would be necessary, and this in turn would greatly reduce the efficiency of the output section. As finally arranged, both sections use full screen-grid voltage, and each section takes about 3.5 ma. plate current. The 2nd-detector section plate current might be cut down by application of more "C" bias but this would introduce complications. Naturally, with only 3.5 ma. plate current, the power output of the receiver is not very great. However, it is quite sufficient to work the 3 in. P.M. dynamic reproducer at surprising volume and with good quality.

Another compromise will be found in the "C" battery, which comprises 4 grid-bias cells delivering about 4v altogether. This 4v. is used on the control-grids of all tubes and while a little higher than needed, it serves to reduce the plate current somewhat from the value (about 17 ma.) obtained with 3V. bias.

The bias cells all fit in a single holder, but the latter must be cut down in size to fit on the chassis. This is a simple matter and consists only of putting the mounting brackets between the cell holders. Be sure to mount the cells as shown, with the cup shaped holder next to the tuning condenser. Another precaution! Never short the bias nor try to measure their voltage as this positively will ruin them. If properly treated they will never need replacement, but a current of even a few microamperes will completely spoil them.

A few slight changes are needed in the coils. The oscillator coil is removed from its shield, the shield cut down about ¾ in. and the antenna coil mounted therein.

A small trimmer, found on the antenna coil is removed as the panel trimmer condenser takes its place. The control-grid lead, which comes from the top of one of the I.F. transformers is run down through the bottom of the transformer instead. This coil feeds the detector. The I.F. transformer used between tubes V1 and V2 is unaltered.

Alignment of the circuits is the same as in any other superhet. A test oscillator is of great help. The I.F. transformers are aligned first and the tuning circuits last.

Results are fine, even with a very short antenna and no ground. A 10 ft. piece of wire with a clip on one end is always carried with the set and is quite sufficient for local stations. It may be fastened to any metal object, even a water pipe. The R.F. trimmer will be found quite sharp in tuning and of great help in bringing in weak stations. For DX work a pair of phones may be plugged into the panel jack; this will automatically cut out the speaker. With a fair antenna and ground connection, real DX results equal to those obtained with much larger receivers will be had. The iron-core coils used throughout undoubtedly contribute much to the fine performance of the receiver.

Again let us caution the constructor to gather together all parts and measure them for size before building the case. The writer speaks from sad experience on this important point.

List of Parts

1—Meissner tuning condenser, 2-gang type 15114;

1—Meissner padding condenser 500 mmf. type 2500;

1—Meissner dial, type 18245;

1—Meissner R.F. choke 60 mh. type 6844;

2—Solar Domino condensers, 0.05 mf., 200V.;

5—Solar Domino condensers, 0.25 mf., 200V.;

1—Solar Domino condensers 100 mmf.,

1—Solar Domino condensers, 250 mmf.;

1—Solar Domino condensers, .004 mf.;

1—Solar Domino Condenser, .002 mf.;

1—Hammarlund trimmer condenser, type APC 100;

1—Aladdin antenna coupler, 504;

1—Aladdin oscillator coil, type 2001;

1—Aladdin I.F. transformer C100 M., 465 kc.;

1—Aladdin I.F. transformer C101 M., 465 kc.;

4—grid-bias cells;

1—cell holder, No. GB4;

3—IRC resistors, ½-W., 50,000 ohms;

1—IRC resistors ½-w., 10,000 ohms;

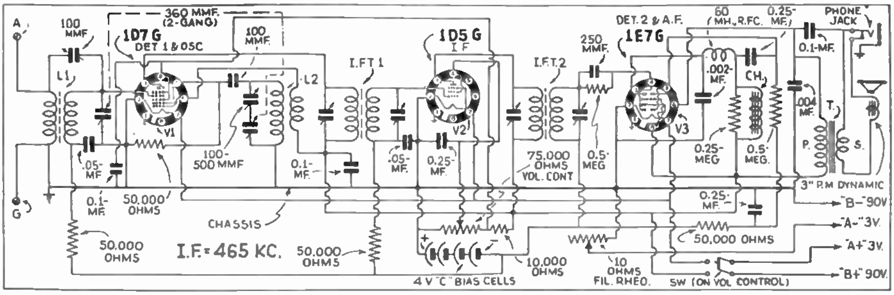


Fig. 1. Wiring diagram of Battery Portable

2—IRC resistors, ½-w., 0.5 Meg.
1—IRC resistors, ½-W., 0.25 Meg.
1—IRC DPDT switch No. 22;
1—IRC volume control 75,000 ohms.;
1—3 in. permanent-magnet dynamic speaker, type 3 AMP with transformer;
2—portable batteries 45V., No. Z30PX;
2—1½ V. cells. No. 44;
1—U.T.C. midget A.F. choke (output transformer for 1E7G will do);
1—10-ohm. midget potentiometer;
1—Raytheon 1D7G tube;
1—Raytheon 1D5G tube;
1—Raytheon 1E7G tube;
3—Octal sockets;
1—Case;
Aluminum for chassis and panel;
Hardware knobs, jacks, etc.

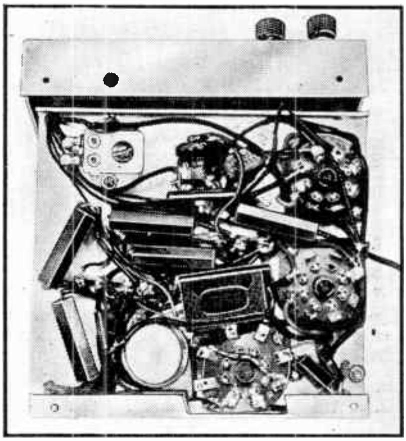


Fig. B, How the Parts are Placed

Pocket-Size Crystal Set For Beginners

Many people would like to try building a radio set but hesitate to do so because of the fear of spending money for equipment and then getting no results. Even a crystal set can run into some money, but of course such a set is the simplest and cheapest for the beginner. Keeping in mind the desire for an inexpensive set, the

Fig. A, Compact Crystal Set

one shown in use in Fig. A was made up. It is quite diminutive, although no particular effort was made to produce an "ultra-midget" set. All the parts being small, the result is a small set that can easily be slipped into a coat pocket.

The case is a piece of tubing, either cardboard or bakelite, 1¾ by 1½ ins. Two ends are made, of any convenient material (even cigar box wood!) and one end is glued in. See Fig. 1A for layout of parts.

The tuning condenser is a, so-called, padding type, and should have a capacity range of 120 to 330 mmf. This condenser is fastened to the end of the case which was glued in, 2 small screws being used for the purpose. Since the condenser is operated by means of a screw which is too short to fasten a knob to, the screw must be replaced with one about 1 in. long. A small knob is fastened to the outer end.

The coil may now be wound in place. It consists of 100 turns of No. 28 double silk-covered wire. The ends pass through holes in the tubing to connect to the circuit.

The other end of the case must be removable and may be made simply, a press fit. In it are drilled holes for 2 phone tip-jacks, 2 binding posts, and the crystal detector. The latter consists of a mounted galena crystal, soldered to a bolt that passes through the case end. Another bolt holds a short piece of fine, spring wire that touches the crystal surface lightly. This wire is termed the "catwhisker."

The wiring is very simple. The phone condenser is connected directly to the end of the pin-jacks and the other necessary connections made as shown in Fig. 1B and C; then the end is pushed into place.

Operation is simple and certain if the circuit has been carefully followed. A good ground and a fairly long antenna are essential if the receiver is to be used more than about 25 miles from a powerful station. If closer, a much shorter antenna will do. To work the receiver it is necessary for the "catwhisker" to make contact with a sensitive spot on the crystal, and this can be ascertained by operating a door bell, buzzer or any other spark-producing device near the antenna. If the buzz (or the electrical noise which it produces) can be heard in the headphones, then that particular spot on the crystal is suitable for receiving radio signals. Otherwise reset the "catwhisker" and make the buzzer test over again. If a buzzer is not available than it is a matter of trial and error. Move the wire over the crystal surface until a spot is reached that will detect the incoming signals.

This little crystal set was first tested in a modern steel building in New York City with a 20 ft. wire dangling from a window as an aerial. The results were remarkable, considering the circumstances. Five different stations were tuned-in with comfortable earphone volume. Several others were also tuned-in, but faintly. With a decent outdoor aerial they would have been much louder.

If upon completing the set you fail to receive any stations, try the following remedies:

1, Check the wiring against the diagrams for possible errors; 2, Clean the crystal detector by wiping the surface with a cloth dipped in ether or cleaning fluid; 3, File the very tip of the "catwhisker," or snip it with a cutter, to a very fine point to assure good contact; 4, Try resetting the "catwhisker" on various points of the crystal surface in order to find the most sensitive spot; 5, Check the aerial and ground connections and the aerial itself; 6, Try several other pieces of galena—usually there is wide variation in sensitivity; 7, Make sure the headphones are really sensitive—sometimes the pole-pieces are so far from the diaphragm, or the magnets are so weak, that the phones are no longer sensitive to weak signals, although they may be quite satisfactory for strong signals.

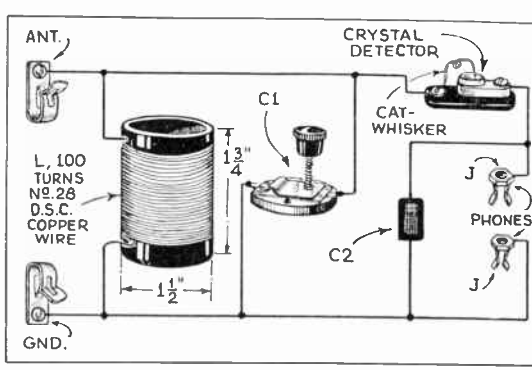
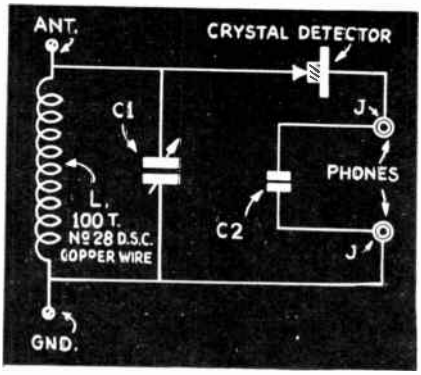


Fig. 1C, Pictorial Diagram



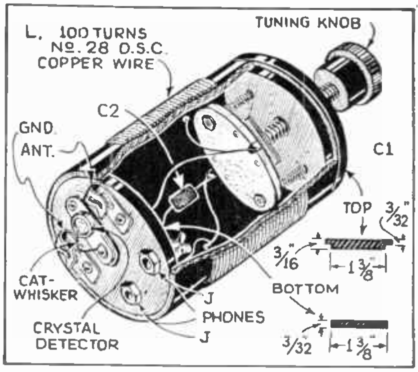


Fig. 1 A-B. Diagram and Construction Details

Crystal sets, of course, have certain inherent disadvantages. They are by no means as sensitive nor as selective as even the simplest of single-tube regenerators.

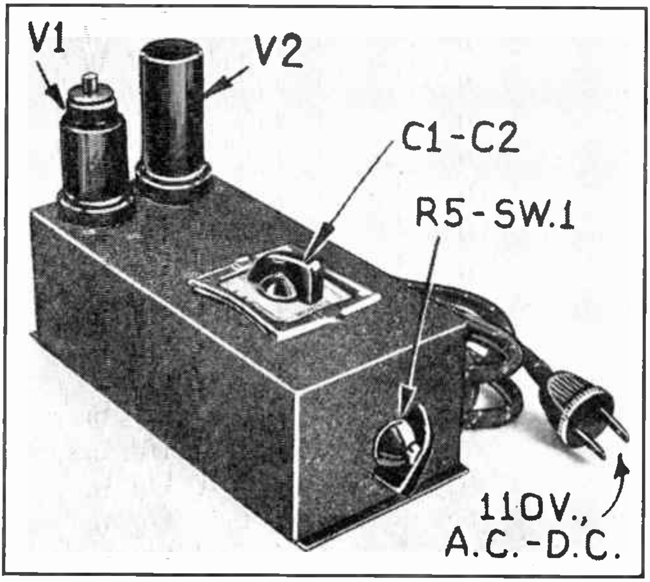
Although you may read of "long distance" crystal sets, take what you read with a grain of salt. Under extraordinarily favorable conditions, such sets will be able to tune-in high-power stations. But they will not afford reception of all stations within a given area day-in- and day-out, under all sorts of weather conditions and at all times of the day.

While these facts may be familiar to the reader, they are given here so that those who build the set described in this section will not be disappointed with results.

The set gives excellent results; excellent results, that is, for a simple crystal set. Do not expect it to afford tube performance.

List of Parts

1—Solar padding condenser, 120 to 330 mmf. C1;
1—Solar fixed mica condenser, .001 mf. C2;
2—phone tip-jacks, J;
1—mounted crystal, C;
2—small binding posts, ANT, Gnd;
Wire and tubing for unit L;
Hardware.



Designed To Control Receiving Sets From Your Armchair

"Long Arm" A Remote Set Control

There have been many complicated remote-control units described in the past. Most of them were costly to construct and never quite satisfactory in operation. Here is a simple form of remote-control—a veritable "Long Arm"—that is low in cost, easy to construct and will give years of service with any receiver.

The diagram of Fig. 1, shows the simplicity of the electrical circuit. Two tubes are used, one is the 6A8 pentagrid converter tube and the other is the 25Z6 rectifier tube used in a half-wave connection.

Due to the fact that all of the circuits involved in the operation of the unit are working at radio frequencies, adequate power supply filtration is obtained without the expense of iron-core chokes and large values of filter capacity. The power supply filter network thus consists of only resistor R3, and condensers C7 and C8.

The circuit of the 6A8 is conventional, with the triode section used as the oscillator and the pentode section used as the modulator or mixer tube. Note that the volume control is of the combination type, although a simple form of potentiometer, R5, is used. When the volume is reduced the bias on the control-grid of the pentode section is increased and the primary of the antenna transformer is shorted. An old, but effective means of volume control.

This remote control can be used with any type of receiver either T.R.F. or superhet., and due to the inclusion of the extra 2 tuned circuits, plus the conversion gain of the pentode section one can expect an improvement in the performance of the receiver. Generally this improvement will be noted in a slight increase in sensitivity and sharper tuning. There should be no loss in volume and sharpness in tuning, if the unit is properly adjusted and installed.

It is not necessary to make any internal connections to the radio set when the remote control unit is used, as, it is self-powered. This is a very important feature, as the average radio set is designed with a power supply adequate only for its own needs, and the addition of extra tubes with the resultant increase in the filament and plate current drain may cause the receiver to overheat or change the plate voltages on the tubes. In many of the present-day receivers a change in the applied plate voltages can cause the circuits to become detuned. Thus, necessitating a re-alignment job that would take time and if the set is of the multi-band type expensive test equipment may be necessary.

After all of the connections are made and checked according to Fig. 1, and the bottom cover-plate attached to the chassis (to prevent radiation from the wiring), and the tubes placed in their respective sockets, run 2 wires, in the form of a twisted pair, from the radio set to be controlled, to the remote control unit. Connect one end of one wire to the antenna post and the other wire at this end to the ground post of the receiver. The remote free ends of this 2-wire cable are connected as follows.

If the radio receiver has a low-impedance antenna primary, connect the wire from the antenna post of the receiver to the white lead of the adapter. Connect the ground wire from the receiver to the black lead. Leave the green lead of the remote control unit unconnected.

If the radio receiver has a high-impedance primary, connect the antenna wire from the set to the green lead and the ground wire to the white and black leads. If impedance is unknown try both connections for best results.

The external antenna formerly connected to the radio receiver is now connected to the antenna post of the remote control and the ground lead is connected to the ground post. Plug in the power cord to a convenient receptacle and turn the unit on by rotating the volume control knob to the right. Turn on the radio receiver and tune to the low-frequency end of the tuning range (broadcast band) where no local station is being received. Set the volume control of the receiver to the loudest comfortable volume.

With the volume control on the remote unit well up, tune in a station by means of the selector knob on top of the unit. Select a station near the high-frequency end of the scale (lowest wavelength). Adjust the 2 compensators, C1A, C2A, on the remote-control tuning condensers by means of a screwdriver inserted through the 2 holes in the side of the chassis. Adjust for maximum volume. Then tune in a station at the low-frequency end of the bend and adjust the padder condenser, C11 through the single hole which is in the rear of the tuning condenser compensators. This setting should be made for maximum volume. Recheck the tuning condenser compensators at the high-frequency end and the unit is ready for operation.

The remote control herein described is just what is desired by lazy louts (such as the author) who like to sit in their comfortable arm chairs with a good book in one hand and a pipe in the other, while a musical background fills the room. The annoyance of getting up to tune-out unwanted programs almost counteracts the relaxation afforded by the radio entertainment.

It is also highly desirable for the use of invalids, who find it a strain to go to the radio, and even more so for those who are bed-ridden.

In fact, the uses of a device of this type are well-nigh innumerable.

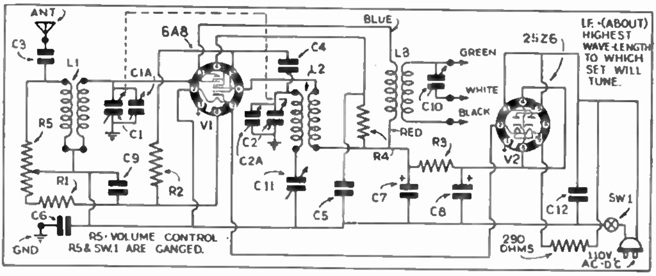


Fig. 1, diagram of remote set control unit.

List of Parts

Kit Components

One Meissner output I.F. transformer, L3;
One Meissner I.T.F. with C10, 7-80 mmf.;
One Meissner antenna-oscillator coil, L1-L2;
One 2-gang tuning condenser (with trimmers), 360 mmf., C1, C2;
One selector dial plate and escutcheon;
One volume control and power switch, 25,000 ohms, R5-Sw. 1;
Two small bar knobs;
One isolantite padding condenser, 300 to 500 mmf., C11;
One 3-terminal tie lug;
One 3-lug terminal strip;
One 2-lug terminal strip;
One ½-in. rubber grommet;
One ¼-in. rubber grommet;
Two octal 8-prong metal tube sockets, for V1, V2;

Miscellaneous Components

One resistor, 500 ohms, ½-W., R1;
One resistor, 50,000 ohms, ½-W., R2;
One resistor, 20,000 ohms, 1 W., R3;
One resistor, 30,000 ohms, ½-W., R4;
One mica condenser, 0.002-mf., C3;
One mica condenser, 100 mmf., C4;
One paper condenser, 0.1-mf., 200 V., C5;
Three paper condensers, 0.1-mf., 400 V., C6, C9, C12;
One electrolytic filter condenser, dual-section, 4-4 mf., C7, C8;
One power cord, with plug, 290 ohms;
One metal-tube grid shield;
One metal-tube grid clip;
Six lengths of colored hookup wire for all connections;
One lacquered steel base plate;

Will Convert Any Radio Set Into a P. A. System

"Home Broadcaster"

Every owner of a radio set has, at some time or another, wished that he might be able to hook a microphone to said set. The desire is usually prompted by an idea that it might be a lot of fun to imitate some particularly well liked radio program for purposes of amusing friends or guests at a party, or just to "play around" with a "mike" to see what it feels like to be an "announcer."

Sometimes the set owner feels that the set might be pressed into service as a small P. A. system for some neighborhood or school activity. Since the average radio set is capable of producing a fair amount of volume it stands to reason, argues the set owner, that there is or ought to be, some means of making it do other things than just bringing in a few programs during the week. And if a small P. A. system is needed for only a short length of time, and since the radio receiver originally cost quite a bit of money, well, why not, and how can it be done?

The answer isn't nearly as difficult or as expensive as a lot of people have been led to believe.

First, and simplest is by means of one of the very cheap microphones readily obtainable at most every radio store or supply house. These "mikes" are usually fitted with a small wafer-type adapter that fits under one of the tubes in the radio set. Such gadgets can be obtained for less than a dollar, and surprising as it may seem they usually work quite well.

The drawbacks to these "home microphones" as they are called is their inability to really make use of the gain and volume of which the radio set is actually capable. It is for this reason that they will always remain more or less of a toy, and not reach any great degree of popularity as a means to satisfying the public demand for a really efficient microphone attachment for the average radio set.

During the past 3 or 4 years the set manufacturers have had a tendency to keep increasing the output volume of their sets in order to get better tonal reproduction at low volume levels. Most of the present-day sets have the ability to turn out volume ranging from about 3W. in the smaller sets, up to 30 W. in some of the larger multi-tube sets.

Here is an adapter unit that will permit using a microphone of the double-button carbon type with any radio set. The more powerful the set, the better the results will be.

This unit is easy to build, simple to operate, and most important—the parts necessary for its construction cost very little. All plate and heater voltages are taken from the set with which it is

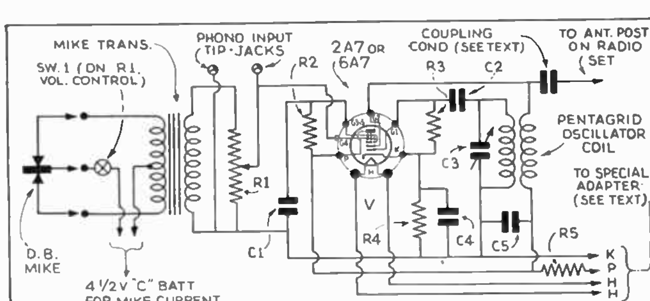


Fig. 1, Diagram of Home Broadcaster

used. To put it into operation insert power cable adapter (See Fig. 1 for hook-up) under the output tube in the receiver, connect the antenna lead from the unit to the receiver antenna terminal, and turn the set on. The signal from the unit is tuned in exactly as you would tune in a regular broadcast program.

Fundamentally the unit consists of a modulated oscillator of low power output, or in other words, a miniature broadcast station. A pentagrid oscillator tube, either a type 2A7 or a 6A7 is used, the pentode section being used for the modulator to plate-modulate the output of the oscillator, thus enabling you to hear whatever voice or music is put into the unit to be heard in the radio receiver. The whole radio, from the 1st. R.F. stage through to the audio output stage is used, resulting in extremely powerful results.

(Early designs of equipment of this type, in which such an R.F. unit feeds into the standard radio set, have been described in the April 1934, and subsequent issues of Radio-Craft—Editor).

The diagram, Fig. 1, is almost self-explanatory and indicates the extreme simplicity of the unit. The total cost, including mike, is under $10.00.

The only point in constructing the unit which might require special mention here is the output coupling between the unit and the receiver. This takes the form of a very small capacity, as shown in the circuit diagram. The capacity effect is brought about by taking a short piece of stiff insulated hook-up wire, attaching it to the oscillator plate terminal, and, winding 3 or 4 turns of similar wire tightly around it. The other end of this latter wire is connected to the antenna post on the set. Care must be taken to see that the two wires do not make electrical contact with one another. The capacity thus formed is sufficient to couple a strong signal into the set, without radiating to other sets nearby. If too much capacity is introduced, the oscillator will not oscillate.

The tuning range of the oscillator is approximately 900 to 1,700 kc. allowing it to be set to be received at some point on the receiver dial where no other regular broadcast program would normally be received.

List of Parts

One small aluminum or electralloy chassis base, 4 x 3 x 2 ins.;
One carbon resistor, 300 ohms, ½-W.;
One carbon resistor, 20,000 ohms, ½-W.;
One carbon resistor, 30,000 ohms, ½-W.;
One carbon resistor, 50,000 ohms, ½-W.;
One volume control and switch, 1 meg.;
Two tubular condensers, 0.1-mf., 400 V.;
One tubular condenser, 0.05-mf., 400 V.;
One mica condenser, 250 mmf.;
One double-button microphone transformer;
One bar knob
One grid clip;
One triple tip jack;
One 7s tube socket;
One trimmer condenser, 220 mmf.;
One pentagrid oscillator coil;
One tube shield;
One hardware kit: consisting of
- Eight 5/16 x 6/32-in. machine screws
- Six 6/32-in. hexagon nuts
- Four ½-in. rubber grommets
- One 12-in. length spaghetti tubing
- Three solder lugs
- Five ft. solid push-back hook-up wire;

Two ft. 4-conductor cable;
One ft. 2-conductor cable;
One Knight 2A7 or 6A7 tube;
One power tube adapter (4, 5, 6, 7M, or 8 prong);
One pair tip jacks.

Accessories

One double button carbon microphone;
One microphone desk stand;
One "C" bat., 4½ V.;
Twenty-five ft. 3-conductor microphone cable.

This article has been prepared from data supplied by courtesy of Allied Radio Corporation.

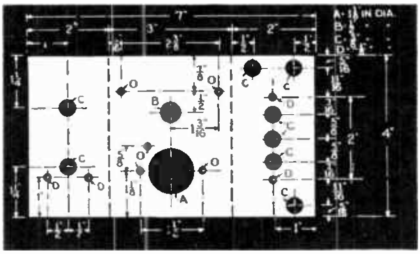
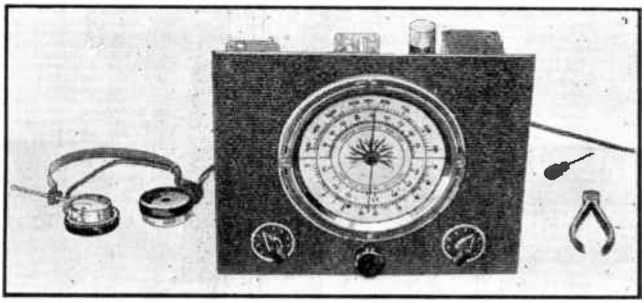


Fig. 2, Chassis layout



This Tuner Can Be Used With Any Good P.A. Unit

HI-FI P. A. and "Universal" Radio Tuner

As can be seen from the photographs, the tuner is compact without being crowded. The parts were laid out so that all "hot" R.F. leads would be very short. For instance, the lead from 6A8 plate to "P" lug on the I.F.T. is barely ¼ in. long. The 3 coils are mounted underneath the chassis for several good reasons. The most important being that they are, in effect, doubly shielded when mounted this way.

The blank chassis specified should be drilled according to layouts given in Figs. 2A-2B. An ideal tool for the home constructor is the socket punch and circle cutter recommended in the List of Parts. The writer used the ¼ in. punch for several of the holes required. The larger size (1 3/16 in.) was used to punch out all the socket holes and also the openings for the filter choke and A.C. receptacle. The circle cutter is needed to cut out the 5¼ in. hole for the dial on the front panel. These tools are practically indispensable to the home constructor for this type of work. Check the accuracy of the holes you drill by trying each part for correct fit and position. A little care at this stage will insure a finished product of precision appearance.

The front panel should not be touched until all parts have been assembled on the chassis. The height of the 3 protruding shafts (volume, tone, and dial) should be measured from their centers to the bottom edge. If all is correct, then the front panel markings may be measured-off on the smooth back. Cut the large circle first, then drill the 3 shaft holes. Inasmuch as the front panel is 1 in. higher than we need, it is best to have a tinsmith cut off the excess on a power shears machine. At the same time, have him bend the two edges at 90 deg. angles as shown in the photograph. The finished panel will then be approximately 9 ins. high and 11 ins. wide. The tone and volume indicating plates are mounted by means of small escutcheon pins.

The wiring comes next. A good method to follow is to wire one element of each tube at a time. For instance, wire all the shell prongs of the metal tubes to ground. Next, connect all cathodes, and so-on. This method eliminates a lot of checking and jumping back and forth.

The author never takes it for granted that a part is O.K. merely because it is new. So, if an ohmmeter is available, check the following items before mounting them on the chassis.

D. C. RESISTANCE

L1, Primary 20 ohms; Secondary 6.5 ohms.
L2, Primary 65 ohms; Secondary 6.5 ohms.
L3, Primary 2 ohms; Secondary 3.2 ohms.
L4, Primary 8 ohms; Secondary 8.0 ohms.
L5, 170 ohms.
Ch., 800 ohms.
P.T., Primary 32 ohms. High-voltage secondary, 1,100 ohms to plate.
Fil. winding (0.9-A), 0.5 ohm.
Fil. winding 0.6-A 1. ohm.

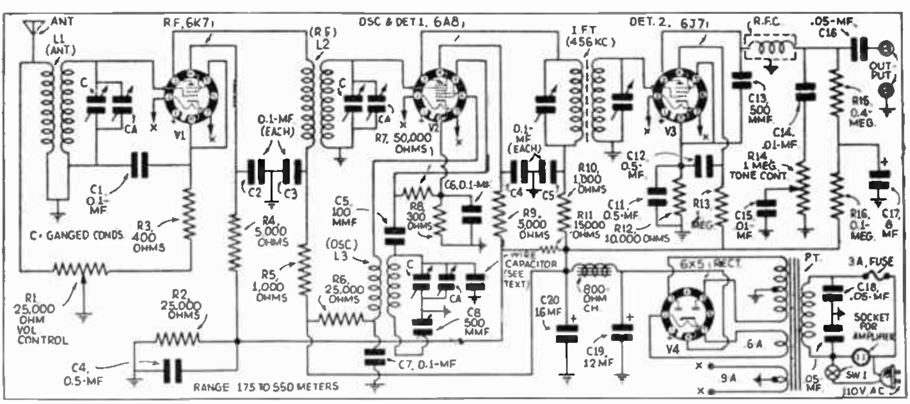


Fig. 1, Schematic diagram of tuner.

Check all resistors and discard any that are 20% off their rated value. Also check the by-pass condensers for shorts or leaks. Check the tubes.

When all wiring is complete, follow out the circuit for wrong connections and continuity. Turn the set on, do not use an antenna, turn dial to 1,700 kc. and volume on full, then check the voltage at each point as indicated below. Use 1,000 ohms/volt meter on 500-V scale. All readings to chassis are given in Table II.

TABLE II

Tube	Pl.	S.-G.	Cath.
6X5	——	——	250 V.
6J7	22 V.	60 V.	5 V.
*6A8	230 V.	80 V.	—
**6A8	160 V.	——	2.7 V.
6K7	220 V.	80 V.	2 V.

*Pentode section. **Oscillator.

If these voltages are more than 10% off, check everything all over again.

Now we come to the subject of alignment. The I.F.T. should be accurately peaked at 456 kc. Upon this adjustment depends a great part of the sensitivity of the set as a whole. If you haven't the equipment to do this job right, then by all means have it done by a competent technician.

If you have the equipment, the procedure is as follows: turn the set on, take the grid clip off the 6A8 and connect your oscillator to the top cap. The ground lead of the test oscillator should be connected to the tuner chassis. Connect an output meter or oscilloscope to the output tipjacks at the rear of the chassis. The test oscillator should be accurately set on 456 kc. and the attenuator set for 1/3-deflection on the output meter. Peak the 2 air trimmers for maximum response, attenuating the test signal if the meter goes off scale.

Next, set the test oscillator to 1,600 kc., replace the 6A8 grid cap. Feed the test signal through a small mica condenser 100) mf. to the antenna post. The tuner dial should be set at 1,600 kc. and the 3 trimmers on the variable condenser should be screwed in tight all the way.

The antenna and R.F. trimmers should be unscrewed a little bit for maximum signal. It may be necessary to use additional capacity across the oscillator trimmer to bring the pointer to the exact line on the dial. The writer added about 3 mmf. by soldering a 4-in. piece of wire to oscillator stator and wrapping 3 turns around the spacer Bar. This wire may be seen, in Fig. B, upon close inspection of the variable condenser section nearest the panel. This is the item, marked "wire capacitor", shown in Fig. 1, which is connected to condensers C and Ca. Note that although the other side of this "wire capacitor" is shown grounded, this is only a fictitious or effective ground and DIRECT CONNECTION TO GROUND MUST NOT BE MADE.

Fig. B, Rear view.

The low-frequency padder should first be screwed up tight and adjusted for maximum response at 600 kc. Rock the dial pointer slowly up and down while adjusting for the best peak. You will find that the high-frequency end may have shifted 10 or 20 kc., so go over the 3 trimmers again and then check 600 kc. again.

All this may sound hard but it really isn't. Our unit was all peaked in 15 minutes and rarin' to go.

Disconnect the test equipment and use either headphones or an amplifier for the air tryout. Connect an antenna not longer than 75 feet to the set. As a rule, no ground wire is needed.

List of Parts

One Meissner antenna coil, No. 6862, L1;
One Meissner R.F. coil, No. 6864, L2;
One Meissner oscillator coil, No. 4243, L3;
One Meissner ferrocart I.F. transformer, No. 6643, 456 ks., L4;
One Meissner shielded R.F. choke, No. 5592, 30 myh., L5;
One Meissner 3-gang variable condenser, No. 15122, 365 mmf.;
One Meissner 6-in. dial, No. 18246;
One Meissner padder trimmer, No. D2500, 500 mmf., C8;
One Kenyon power transformer, No. T249, T1;
One Kenyon filter choke, No T156, 30 hy., Ch.;

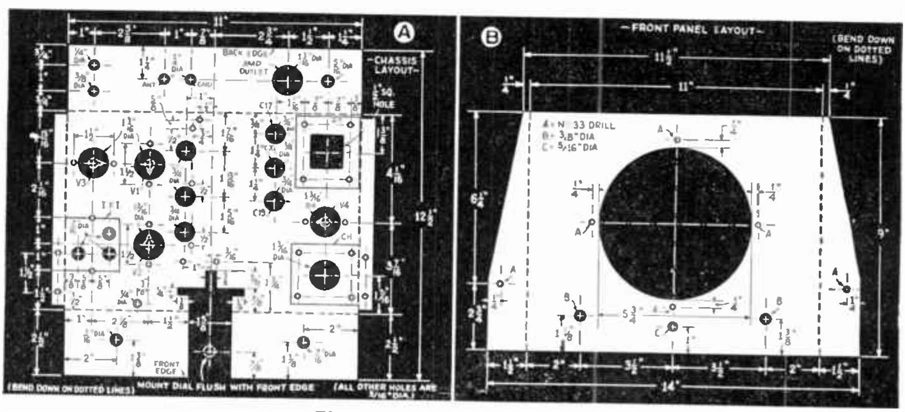


Fig. 2A, Drilling for chassis

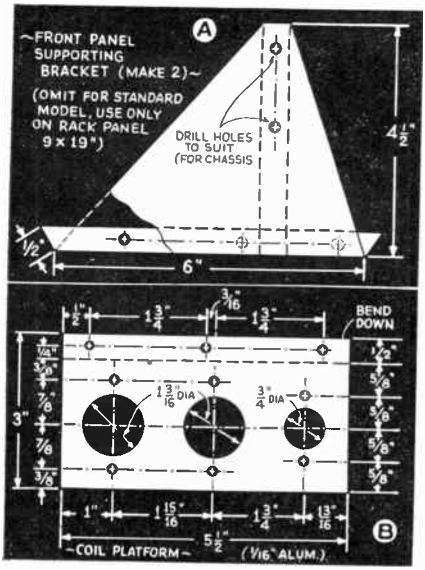


Fig. 2B, Panel details.

Seven Aerovox tubular bypass condensers, type 484, 0.1-mf., 400 V., C1, C2, C3, C6, C7, C8, C10;
Three Aerovox tubular bypass condensers, type 484, 0.5-mf., 400 V., C4, C11, C12;
Two Aerovox tubular bypass condensers, type 484, 0.01-mf., 400 V., C14, C15;
One Aerovox tubular bypass condenser, type 484, 0.05-mf., 400 V., C16;
One Aerovox dual tubular bypass condenser, 0.05-0.05-mf., 400 V., C18;
One Aerovox electrolytic condenser, GLS 5, 8 mf., 450 V., C17;
One Aerovox electrolytic condenser, GLS 5, 12 mf., 450 V., C19;
One Aerovox electrolytic condenser, GLS 5, 16 mf., 450 V., C20;
One Aerovox mica condenser, type 1467, 500 mmf., C13;
One Aerovox mica condenser, type 1467, 100 mmf., C5;
One General Electric type 6K7 metal tube, V1;
One General Electric type 6A8 metal tube, V2;
One General Electric type 6J7 metal tube, V3;
One General Electric type 6X5 metal tube, V4;
One General Electric molded rubber A.C. line cord;
Four terminal connectors
One pair tipjacks, 1—red, 1—black;
One Centralab volume control potentiometer, No. 72-102, 25,000 ohms, R1;
One Centralab tone control potentiometer, No. 62-116, with switch, 1 meg., R14;
One Centralab carbon resistor, 2 W., 15,000 ohms, R11;
One Centralab carbon resistor 1 W., 25,000 ohms, R2;
One Centralab carbon resistor, ½-W., 25,000 ohms, R6;
Two Centralab carbon resistors, ½-W., 5,000 ohms, R4, R9;
Two Centralab carbon resistors, ½-W., 1,000 ohms, R5, R10;
One Centralab carbon resistor, 1/3-W., 1 meg., R13;
One Centralab carbon resistor, 1/3-W., 0.4-meg., R15;
One Centralab carbon resistor, 1/3-W., 0.1-meg., R16;
One Centralab carbon resistor, 1/3-W., 50,000 ohms, R7;
One Centralab carbon resistor, 1/3-W., 10,000 ohms, R12;
One Centralab carbon resistor, 1/3-W., 400 ohms, R3;
One Centralab carbon resistor, 1/3-W., 300 ohms, R8;
*One antenna ground terminal strip,
*One indicating plate (volume),
*One indicating plate (tone),
*Two pointer knobs, 1¼ in.,
*One black round knob,
*Sour octal wafer sockets,
One black wrinkle front panel, 10 x 14 x 1/16 ins.,
*One blank cadmium chassis, 11 x 7½ x 2½ ins.,
*Two socket punches,
*One circle-cutter,
*One piece alumnium for coil platform, 3 x 6 x 1/16 ins.;
*One fuse mounting.
Hookup wire, hardware, etc.

*Names of manufacturers will be supplied upon receipt of a stamped and self-addressed envelope.

CHAPTER 2

—Servicing—

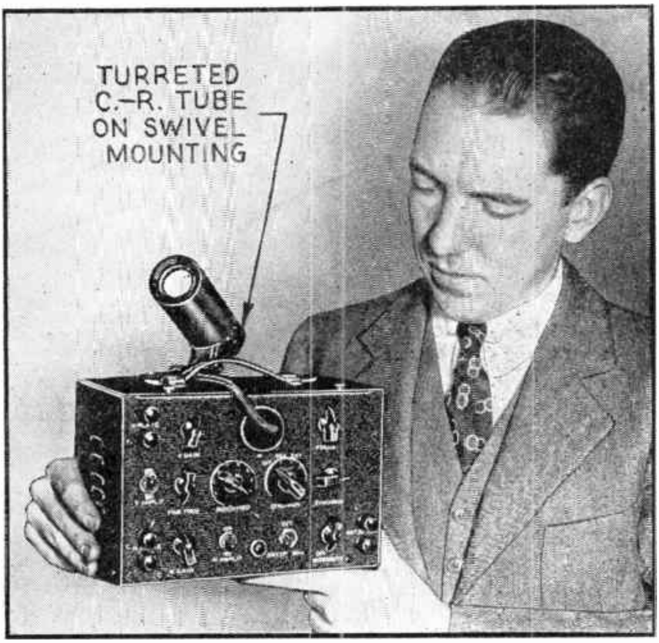


Fig. A, Complete Oscilloscope for Servicemen

Midget Oscilloscope

THIS instrument has every feature of the full-size instruments as well as several which are not found on most. It can be used for virtually every possible test the Service Man or experimenter wishes to make.

A very novel feature is the fact that the 913 tube may be mounted in either of 2 positions, inside the instrument, or in the "trench mortar" on top. The socket in the latter is connected by a cable to the inside 913 tube socket so that the changeover is quickly accomplished. For portable use, the inside mounting is to be preferred since the addition of the "mortar" or turret makes the apparatus a little more unwieldly and unhandy to carry.

The frequency of the sawtooth sweep oscillator is controlled in 8 rough steps, and in addition a fine control is provided.

Provision is made by proper switching, to use the horizontal amplifier for either 60-cycle or sawtooth sweep, or it may be used to amplify any external input to the horizontal plates. Either amplifier may be cut in or out separately and the amplitude controls for vertical or horizontal plates are available for voltage control whether the amplifiers are in use or not.

An additional control is provided through the use of a single-pole double throw switch on the potentiometer which controls vertical amplitude. This switch cuts out the potentiometer entirely when the instrument is to be used for transmitter R.F. measurements. The R.F. is no respecter of potentiometers, as many hams have found to their sorrow! Even if the control is "on" fully, a great deal of heating occurs and the control is usually ruined; so the best we can do is to cut it out. When the potentiometer is turned fully counterclockwise the switch operates to cut it out. A slight operation must be performed on the resistance element as it is essential that the contact arm be entirely open-circuited when the switch is operated. It is a simple matter to scrape sufficient carbon from the element so that this is accomplished. The "off" position is noted on the diagram.

Through the medium of a switch and a potentiometer full synchronization of patterns is easily attained. The switch allows for (1) internal, (2) 60-cycles, or (3) external synchronization. In the latter position a "wobbler" may be connected for use when tuning-up sets or for observing R.F. transformer or amplifier response curves.

It should be noted that this synchronization input circuit is of high impedance, rather than low impedance, as found on most commercial oscilloscopes. If it is imperative to have low-impedance synchronization connections, this may easily be accomplished by use of a transformer with the high-impedance winding connected to the binding posts. A microphone transformer will give a very low-impedance input if this is needed.

Wiring should start with all A.C. leads, that is, the power transformer primary and all heater leads. A good deal of shielded wire was used in the original model, all leads in the input circuits and "hot" amplifier plate leads being so covered.

All resistors except the two in the voltage dividers are of the insulated, ½-W. size.

All fixed condensers of over 0.005-mf. except electrolytics are of the newly-developed "molded

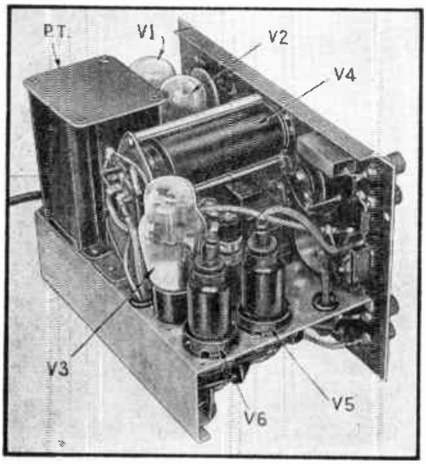


Fig. B, Rear view.

paper" type. These are about the size and shape of dominoes and many can be packed into the small space available.

It is suggested that the complete high-voltage circuit for the 913 be hooked up first and the tube tried. If it is possible to obtain a small round spot by manipulation of the focus and brilliancy controls, then the rest of the apparatus may be wired.

If all wiring is correct, the oscilloscope should work perfectly at the first try. It is suggested that the builder connect an A.C. source of about 2.5 to 5V. to the "V" input terminals and experiment with the various controls to become acquainted with their action. Do not worry if the controls appear to "interlock" or affect one another. This is quite correct and will be found to be usual in other oscilloscopes as well.

The "trench mortar" or "cannon" mentioned previously is not a necessity, but is a great convenience. The large tube may be of any metal, but steel is to be preferred for its magnetic shielding qualities. If a magnifying glass is to be used, the tube may be obtained of a size to fit it. The mounting should be of "universal" joint type; flexible both in a circle and vertically—and may be made in any convenient manner, the one shown being built up of aluminum strip. A ball and socket joint (as used on some mike stands) is another good bet.

ADDING 2-IN. TUBE FOR LARGER IMAGES

In order to accommodate the large tube it is necessary to build a new top-of-case "cannon," similar to that described originally but of larger size. It should be emphasized here that this new equipment is not intended to entirely supersede the 1-in. or type 913 tube. The latter still retains the great advantage of small size, and its use means that the technician will have available a tiny portable instrument devoid of any clumsy projections, for the cannon type of mounting is just that. With the 913 inside, the apparatus is ideal for portable work. In the laboratory where convenience is of no great consequence, however, the use of the 2-in. tube in a flexible mounting is a distinct advantage.

The new 24XH tube is rated at 400 to 600 V. so that with the voltage supplied by the original instrument we can obtain satisfactory patterns. In fact, there are no circuit changes needed whatsoever since the ratings of the 24XH at 400 V. are very close to those of the 913. Thus the ranges of all controls are adequate and no circuit changes need be made.

Since the new tube is about twice as sensitive ast the 913, a pattern which will cover the screen of the latter will cover that of the 24XH so that again no changes are required, and a simple substitution will suffice.

All parts of the original "gun" except the actual tubing itself may be reemployed. A new piece of steel tube 8¾-in. long by 2¼-in. dia. will be needed. Steel or iron tubing is required since the 24XH is not shielded as is the 913 and is very sensitive to external fields, a characteristic common to all cathode-ray tubes of the glass bulb type.

The tubing is cut to size, the ends smoothed and the necessary holes drilled. The same type of socket as used originally is needed. This consists of an aluminum cup about 1½-in. in dia. and ⅝-in. high in which the socket is mounted. The socket is removable and the small tongue in the socket hole must be filed-off so that the socket may be turned. This allows the tube to be revolved so that the pattern may be aligned correctly. The socket should be placed so that the groove in the center hole is uppermost. Any slight variations in the tubes may then be corrected by rotating the latter slightly after it has been connected and is in operation.

The aluminum socket cup may be held with 3 screws, placing washers between the cup and the

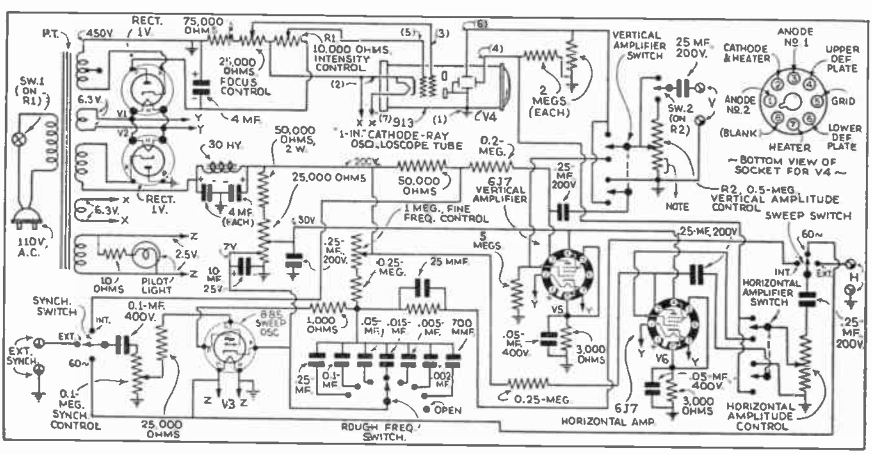


Fig. 1, Complete diagram and other details.

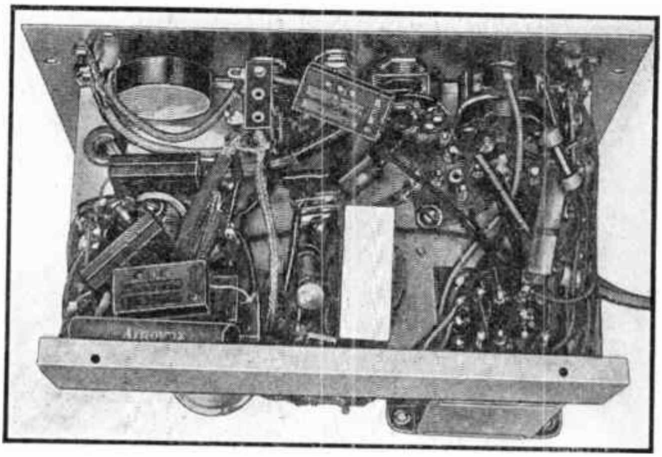


Fig. C, Bottom View of Oscilloscope

tubing so that a firm fit will result. A piece of 3/16-in. bakelite may be turned to a close fit for the rear of the tubing. This about finishes the job except for coating and tubing inside and out with flat-black enamel. When this dries, pads of felt may be put in the front end so that the 24XH will be held away from the walls.

This mount and the new tube will be found to greatly increase the usefulness of the original instrument and if properly interchanged with the 913, a truly versatile apparatus will result.

List of Parts

One Kenyon transformer, type T-207;
One Kenyon midget A.C.-D.C. choke;
Two Electrad potentiometers, one with S.P.D.T. switch, 0.5-meg.;
One Electrad potentiometer, 1 meg.;
One Electrad potentiometer, 25,000 ohms;
One Electrad potentiometer with S.P.S.T. switch, 10,000 ohms;
One Electrad potentiometer, 0.1-meg.;
One Electrad resistor, 25,000 ohms, 25 W.;
Two IRC resistors, 2 megs., ½-W.;
One IRC resistor, 5 megs., ½-W.;
One IRC resistor, 25,000 ohms, ½-W.;
One IRC resistor, 1,000 ohms, ½-W.;
Two IRC resistors, 3,000 ohms, ½-W.;
One IRC resistor, 0.5-meg., ½-W.;
Two IRC resistors, 0.25-meg., ½-W.;
One IRC resistor, 0.2-meg., ½-W.;
One IRC resistor, 50,000 ohms, ½-W.;
One IRC resistor, 50,000 ohms, 2 W.;
One IRC resistor, 75,000 ohms, 2 W.;
One IRC wire-wound resistor, 10 ohms;
One Solar electrolytic condenser, 4-4 mf., 450 V.;
One Solar electrolytic condenser, 4 mf., 450 V.;
One Solar electrolytic condenser, 10 mf., 25 V.;
Six Solar "domino" condensers, 0.25-mf., 200 V.;
Three Solar "domino" condensers, 0.05-mf., 400 V.;
Two Solar "domino" condensers, 0.1-mf., 400 V.;
Three Solar "domino" condensers, 0.05-mf., 400 V.;
Two Solar "domino" condensers, 0.005-mf., 400 V.;
One Solar mica condenser, 0.002-mf.;
One Solar mica condenser, 700 mmf.;
One Solar mica condenser, 25 mmf.;
One case, 5 x 6 x 9 ins.;
Eight bar knobs;
Two octal sockets;
Two 4-prong sockets;
One 5 prong socket;
Two insulated grid caps;
One RCA Radiotron type 913 tube;
One RCA Radiotron type 885 tube;
Two RCA Radiotron type 1V tubes;
Two RCA Radiotron type 6J7 tubes;
Two sockets;
Six binding posts;
One 8-pt. switch;
One 3-pt. switch;
One 3-position toggle switch;
One power cord;
One pilot lamp and socket;;
Hardware, wire, etc.

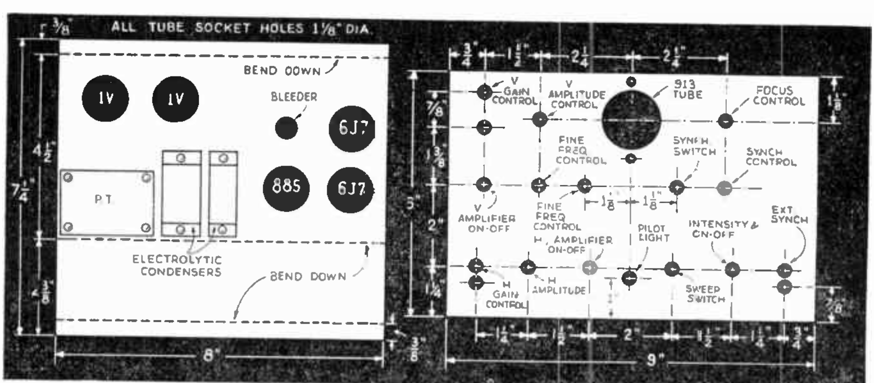
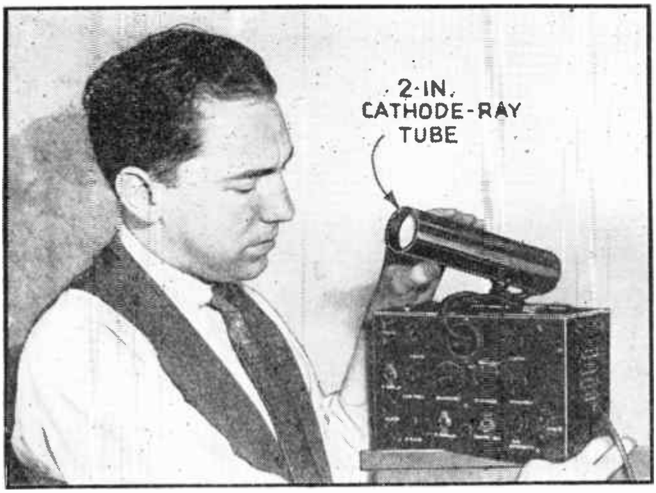


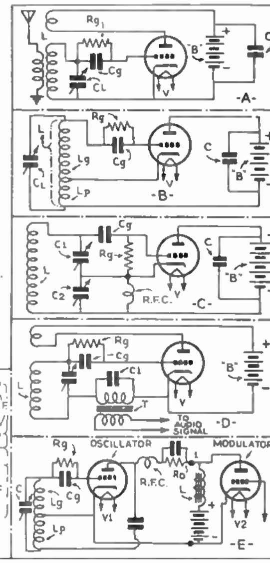
Fig. 2, Complete drilling and mechanical details.



The 2-inch Tube In Place, Better Detail Is The Result

Mixer Circuits You Should Know

This article will greatly help the service man



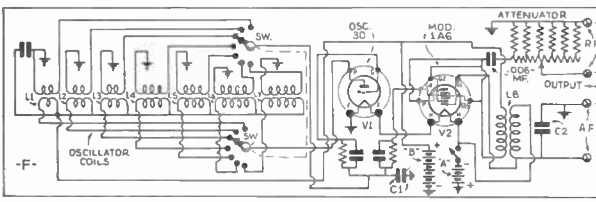


Fig. 1, Circuits of various mixers.

For testing MIXER CIRCUITS, we desire not only to have a source of R.F. oscillations, or "waves," but to modulate it, as a transmitting station's carrier wave is modulated. This enables us to test the R.F. amplification better, and also the audio stages and the reproducer of our set.

We may, for instance, take a regenerative set and introduce into the control-grid circuit an A.F. transformer (Fig. 1D) through the secondary of which we increase and decrease the voltage existing between control-grid and plate; superimposing thus A.F. variations on the R.F. oscillations already set up. This is done when we cut a microphone or a phonograph pickup into a control-grid circuit; except that, normally, we do not permit the tube to oscillate when we do this. But a system was worked out, some years ago, rather successfully when receiving sets were of less power, to apply the pickup to an oscillating R.F. tube, and pass a modulated wave through the whole set, like a station signal.

We do not, however, need a phonograph or a microphone. We may, instead, introduce into the circuit a resistor Rg with a condenser across it Fig. 1D; so proportioning the values that the condenser will continually charge up, and discharge through the resistor. A given pair of values corresponds to a given frequency; as with a condenser-coil combination, the time lengthens with the increased capacity and increased resistance. (There is an effect of this kind in every grid-leak detector circuit; but the value of the usual grid condenser is too low to allow the note thus created to disturb the ear of the listener, or to check oscillation, in a tube provided for that purpose.)

However, in a circuit of the voltage-modulated type, just discussed, the audio modulation of the control-grid voltage changes the bias on the control-grid too much, for good modulation. So, like the transmitting amateurs before him, the Service Man looks for a combination which will maintain the signal at the proper oscillation frequency, yet give a good, pure audio note.

We find, for instance, the Heising circuit (Fig. 1E) in which there is a split tuning coil, as in Fig. 1B; but, attached to the plate of oscillator tube V1 is a source of A.F. variations, in the form of modulator tube V2. The high-impedance choke, L, keeps a fairly constant D.C. plate voltage on both tubes. The resistor, Ro, lowering the voltage on the plate of the oscillator, makes the ratio of V2's output to V1's, and thereby the percentage of modulation higher; an important matter in broadcasting, as well as in testing. This circuit, therefore, is much in favor in test apparatus.

However, these methods require changes in the D.C. voltages applied directly to the grids and the plates of the oscillator tube, and these tend to change the frequency and create instability of operation. But, with the introduction of the modern multi-element tubes, it became possible to apply the modulating voltage to other elements, located between cathode and plate, and thereby alter the flow of electrons inside the tube, with the minimum of disturbance to the regularity of R.F. oscillation.

The basic method of Electron Modulation is shown in Fig. 1F; the audio modulation may be obtained from a tube circuit oscillating at audio frequency (by the use of a circuit of suitable resistance-capacity values) or from any other desired source. The plate and signal-grid circuits of the tube are oscillating at the radio frequency determined by the grid capacity-inductance of the tuned circuit; but the amount of the current flow is varied, without altering the regularity of the oscillations, by the A.F. voltage introduced between the cathode and the second grid to which the input is connected. This form of electron modulation is preferred for work of great accuracy.

It is to be explained that, just as a high percentage of modulation is desired in a broadcast station (since it gives more signal in proportion to the power of the station), so it is desirable in a service oscillator used to adjust a receiver for reception of this type. By 100% modulation (since the modulation is the proportion of A.F. current variation to R.F. current variation in the wave) the audio system and reproducer of a receiver may be fully tested without over-loading in the R.F. and I.F. sections. In addition an instrument operated from an A. C. line may be used to modulate the output of the oscillator tube at 60 cycles, with a single tube and great simplicity of equipment. (This is a very low frequency for audio aligning work, however). Since the plate is connected, not to a D.C. source, but to one side of the line which varies in potential, half the time it is negative with respect to the cathode, and no current can flow; but, whenever positive, the tube is functioning, and can even oscillate up to its filament-emission limit at radio frequency. At 1,500 kc. for instance, it can be seen that there is time for 12,500 R.F. impulses in the tube during the positive half of each cycle.

For the sake, also, of economy, oscillators are made whose tuned circuits do not cover all bands; these depend on harmonics.

Just as a violin does not give off a pure tone, but with it others of higher pitches (which give the instrument timbre, color or quality) called harmonics, so an oscillating circuit, because it is not perfectly simple, has harmonics in its output. These are frequencies which are multiples (and designated by this factor) of the fundamental frequency to which the principal circuit is tuned; and, while they are feeble in comparison with the fundamental, they can be recognized by sensitive apparatus. The 13th harmonic of a long-wave (European) station has been heard on a short-wave set!

For instance, suppose the fundamental of the oscillator is 150 kc. or 2,000 meters: the harmonics could be recognized at: (2) or second harmonic, 300 kc.; (3) at 450 kc.; (4) at 600 kc.; (5) at 750 kc.; (6) at 900 kc.; (7) at 1050 kc.; (8) at 1200 kc.; (9) at 1350 kc.; (10) at 1500 kc.; (11) at 1650 kc.; (12) at 1800 kc.; (13) at 1950 kc.; and so on. The odd harmonics are stronger, proportionately, than the even ones; weakening in strength as the number designating them increases.

In addition to the features of frequency control and modulation, another important factor for the service test oscillator is that of its output control; since it is desirable to test receivers on weak signals, as well as on strong ones, to determine the alignment of circuits and the working of A.V.C. etc. Various forms of attenuator or voltage-divider controls regulate this, in addition to tightening or loosening the coupling between the oscillator and the set being serviced.

In the selection of test apparatus, cost and fineness of performance must be balanced, one against the other, as with all other measuring equipment, in view of the particular demands of the business.

While mixers are not used in home radio receivers, their application in commercial installations is widespread. They are used where it is desired to keep a recorded musical program running uninterruptedly from two turn-tables, to switch from one microphone to another, to cut a microphone into a phonograph circuit, to fade from one loud speaker to another, and for similar purposes.

Stripped of all but its essentials, a mixer is merely a means of attenuating one output (or input) while increasing another. The potentiometer is, perhaps, the simplest form of mixer. If, for example, its resistance is connected across the primary of a transformer, it may be used to mix the output of two pick-ups or similar devices. One side of one pick-up is connected to one side of the element, one side of the other pick-up to the other side of the element. The two free leads (one from each pick-up) may then be connected together, and to the arm of slider of the potentiometer. Thus, as more resistance is cut in across the first pick-up, there will be less across the second, until the former is at full volume and the latter shorted out.

Other means than resistance may be used in mixing. One such is variable capacity, applied to high frequency circuits.

Simple Condenser Analyzer

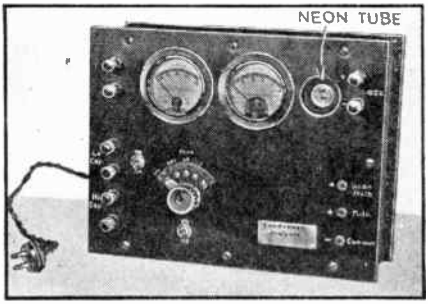


Fig. A. Front view.

Low cost and simplicity are the features of this Condenser Analyzer which checks any filter or bypass condenser, either paper or electrolytic type, for leakage and capacity.

The 2 meters required are of a type commonly found around many radio shops or readily available on the used-parts market. This particular instrument shown in the photo, Fig. A, was built in the case of an old W.E. type 7A amplifier, but of course any suitable cabinet may be used.

The meter used by the writer for checking capacity is described in the List of Parts. Closing switch 1 connects this meter to the A.C. line in series with the 2 binding posts, Fig. 1, marked Low Capacity. Switch 2 is left open. Paper condensers between the sizes of 0.01-mf. and 0.5-mf. will give readings on the meter which are referred to the calibration chart you make up from standards. Do not attempt to check electrolytic condensers on this range, as they would be damaged by the high A.C. voltage.

To prepare the meter for reading higher capacities, it is necessary to open the meter case and bring out 2 leads directly from the movement. These leads attach to the junction of the movement and the multiplier coils, of which there is one in either leg. These leads connect to the High Capacity binding posts.

To use the high-capacity range, close switches 1 and 2, then any condenser connected across the High-Capacity binding posts acts as a shunt across the meter movement and causes the hand to drop back to a value which may be referred to the shunt line on the chart to determine the capacity. This range may be used to check the capacity of electrolytics, since the A.C. voltage across the meter movement is so small that it does not damage them.

(A convenient paper on which to draw the capacity chart is Keuffel & Esser No. 258-71 Semi-Logarithmic paper. On this paper the capacity "curves" are straight lines.)

The other section of the analyzer consists of a milliammeter and a neon bulb (one or two watts) connected to an external power supply,

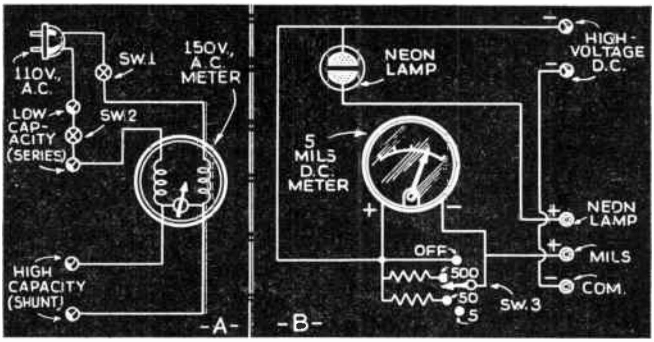
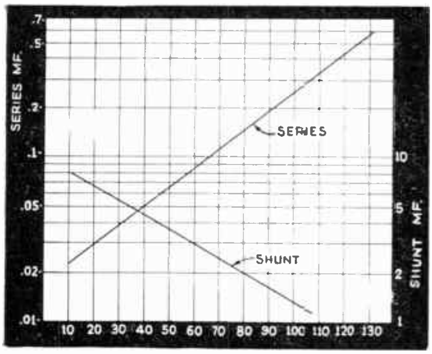


Fig. 1, Diagram of Condenser Analyzer.

preferably one with several voltage taps such as 25 V., 50 V., 100 V., 200 V., 300 V., and 450 V.

The neon bulb checks leakage in paper condensers. Insert test prods into tip jacks marked Common and Neon Bulb and touch prods to the terminals of the condenser. A good condenser caused the bulb to flash once and go out; a shorted condenser gives a steady glow; a leaky condenser makes the bulb flash intermittently.



Series and parallel curves.

For checking leakage of electrolytic condensers, the milliammeter used has a scale of 5 or 10 ma. and has shunts for multiplying the range by 10 and 100. Be sure the rotary switch Sw. 3 is the type that shorts between contacts. Note that the "Off" position shorts out the milliammeter to provide for the initial surge of current when an electrolytic is connected to the tip-jacks marked Common and Mils. After the condenser charges, the switch may be thrown to the other positions for reading leakage current. Electrolytic condensers which show a leakage of more than about 1 ma. per, mf. are defective.

List of Parts

One Weston Model 476 A.C. voltmeter, 0-150 scale;

One Weston D.C. milliammeter, 0-5 ma. scale; and multiplier shunts for 50 and 500 ma.;

One Blan the Radio Man neon lamp, 1 or 2 W.;

One Blan the Radio Man rotary switch, 4-point, for 500 ., Sw. 3;

Two Blan the Radio Man snap switches, for 110-V. line;

Three Insuline tip-jacks;

Two Insuline test prods and leads;

Six binding posts;

One Blan the Radio Man light plug and cable, wire, etc;

One cabinet or baseboard for mounting.

How To Use V.-T. Voltmeters In Radio And P.A. Servicing

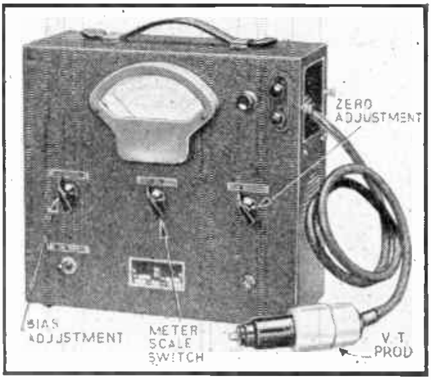


Fig. A. V.-T. voltmeter.

There are 3 general classifications of measurements to which a V.-T. voltmeter may be applied in the design and servicing of modern electronic circuits:

(A) Measurement of Root Mean Square or "Effective" voltage. This is the reading indicated by ordinary voltmeters less what error occurs in the circuit through added resistive drop due to the current drain added by the introduction of the voltmeter into the circuit being measured.

(B) Determination of the Value of Voltage Wave Peak. The so-called "slide-back" peak voltmeter has long been a favorite of leading engineers and laboratories for measurement of the peak value of voltage waves, and is now available for the first time in a commercial instrument with an internal source of buck-out potential.

(C) Measurement of Direct-Current Voltages. As in the first classification of measurements, the indications of the peak voltmeter are secured without drawing current from the circuit under measurement.

(1) MEASUREMENT OF R.M.S. VOLTAGE

General. The top scale of the instrument illustrated, is calibrated directly in r.m.s. or effective voltage, with full-scale deflection indicating 1.2 v. Potentials as low as 0.1-V. may easily be read with an instrument of this sensitivity.

The r.m.s. (root, mean, square) value of an alternating-current voltage wave is, by definition, exactly the same as the value of direct-current voltage which will produce an equal amount of heating in a circuit composed solely of resistance (no capacity or inductance). When considering a pure sine-wave alternating voltage, the r.m.s. value will be equivalent to 0.707 times the peak voltage of the waveform. However, if a wave has other than a pure sine form this relationship will not hold true.

The r.m.s. scale of the vacuum-tube voltmeter is very valuable for many measurements of non-sinusoidal voltages, such as the checking of stage or overall gain of radio—and audio-frequency and high resistance.

It is necessary that this instrument be connected in such a way that the voltmeter tube control-grid circuit is conductive to direct current, otherwise the grid may accumulate a charge be indicated.

If it is necessary to take measurements in circuits where there will not be a D.C. path from the voltmeter control-grid to ground, a leakage path for the control-grid charge may be established either by leaving the tube prod within the instrument case (which has a built-in resistor) for low-frequency measurements or by placing a 3-meg. resistor from the voltmeter tube control-grid to the ground, and capacity—coupling the voltmeter tube control-grid, to the circuit it is desired to measure, with a 0.01-mf. (mica) condenser.

With a connection made to the circuit from the free end of the condenser, the instrument will show either peak A.C. voltage values or r.m.s. voltages. To secure true r.m.s. values from peak-voltage indications, multiply 0.707, although this need not be done in measuring gain, as all readings are proportional.

(2) GAIN MEASUREMENTS IN GENERAL

A typical set-up is illustrated in Fig. 1A, wherein a signal generator is connected to a tube circuit. The same procedure would hold for a multi-stage circuit if desired to measure its gain as a unit.

(a) Connections. Fig. 1A is a typical circuit and is the basis for the specialized measurements described in later paragraphs. Units R1 and R2 are resistors, either fixed and of known value, or variable and of known calibrations. For low intermediate radio frequencies, these may be small commercial units of the variable or fixed type. For higher intermediate frequencies, broadcast and short-wave frequency measurements, it is necessary to use resistors of such construction that capacity and inductance effects have been reduced to a minimum.

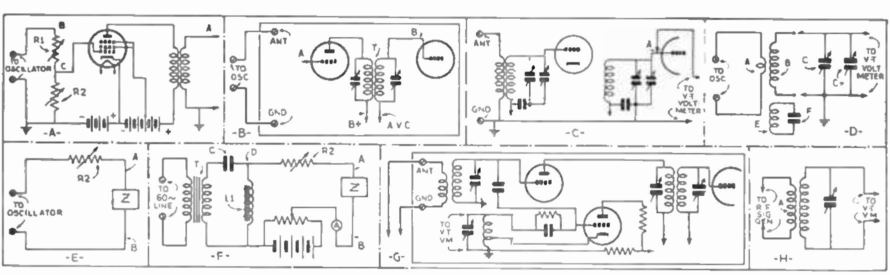


Fig. 1. Circuits that can be tested with V.-T. voltmeter.

The effect of the internal capacity and inductance of any resistor may be determined by applying to the circuit of Fig. 1A a voltage of the frequency at which it is desired to take the gain measurement, and comparing the value of voltage indicated on the vacuum-tube voltmeter at point B with the voltage at point C. This ratio of voltages should correspond accurately with the ratio of resistances R1 and R2 if the capacity and inductance effect is negligible at this frequency.

resonance with the oscillator, or if untunable, adjust the oscillator to resonance. The measuring procedure will then be identical to that described above for audio-frequency circuits.

(3)) CHECKING R.F. GAIN IN RECEIVERS

It is not always convenient to remove the interstage transformer or coupling unit in order to check its gain. For this reason the following procedure is frequently employed. In the case

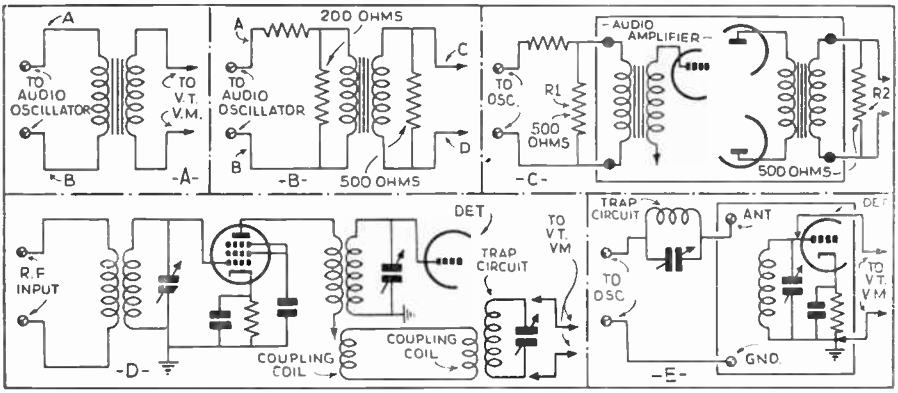


Fig. 2, More circuits that can be tested.

(b) Audio-Frequency Circuits. For testing such, it is necessary to have as voltage source, an audio signal generator of the continuously-variable-frequency type. Set this instrument to the desired frequency and the actual gain in the circuit can be evaluated in two ways. One is to read the voltage at point A, in which event, the gain of the circuit will be given by the formula.

$$\text{GAIN} = \frac{(\text{R1 plus R2})}{(\text{R2})} \cdot \frac{(\text{vA})}{(\text{Vb})}$$

The other method is usable only on circuits where it is permissible to vary the value of R1 and R2 without upsetting bias and load matching. In this case, the voltage at point A to the same value. When this has been done, the gain of the circuit will be given by the formula.

$$\text{GAIN} = \frac{(\text{R1 plus R2})}{\text{R2}}$$

As stated above, these procedures are general in nature and more specific procedures will be outlined in following paragraphs.

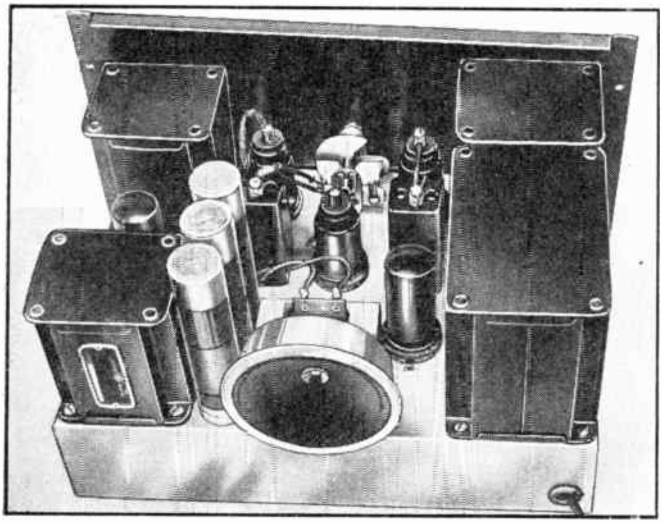
(c) Radio - Frequency Circuits. Here a radio frequency signal generator is used as voltage source. If the circuit is tunable, adjust it to

of an intermediate-frequency transformer "T," the operation of which is in doubt, Fig. 1B may be taken as representing the typical condition.

Connect an R.F. signal generator to the antenna and ground posts of the receiver as shown, and the vacuum-tube voltmeter to the control-grid of the type preceding the transformer in doubt (at point A, in Fig. 1B). Tune the receiver to the test oscillator output frequency and adjust the input to the receiver by means of the attenuator on the signal generator until a small reading, say 0.5-V., is obtained on the vacuum-tube voltmeter. If the receiver has automatic volume control, all operations should be made at a signal level that is below the A.V.C. actuating voltage.

Should point A be located in a tuned circuit of the receiver, and such will usually be the case, it may be necessary to slightly re-adjust its resonance after the vacuum-tube V.M. is connected to compensate for input capacity of the vacuum-tube V.M.

After taking the reading at point A, transfer the voltmeter to point B and adjust the trimmers in both circuits A and B until the greatest voltage is indicated on the meter. The ratio of the voltage read at point B to the voltage read at point A, is the gain of the amplifier stage under test.



Rear View Of Audio Oscillator

Service Man's Audio Oscillator

Two R.F. oscillators are utilized in this instrument, neither of which is modulated and each producing a continuous wave of R.F. current. When both waves are of exactly the same frequency they cancel, and this point is known as the zero-beat.

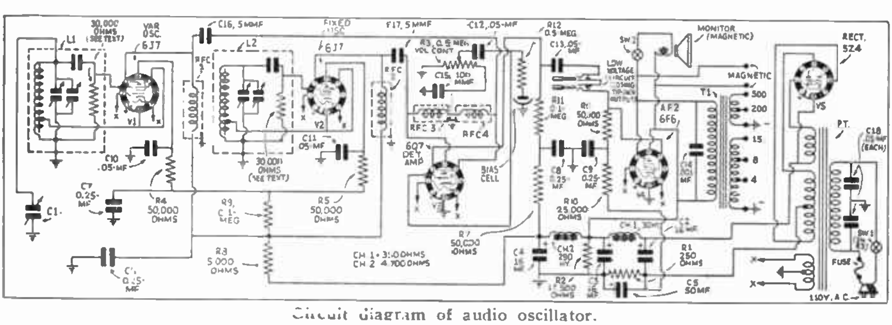
At every other point, where the variable oscillator differs in frequency from the fixed oscillator, the phenomenon of beat frequencies appears. Thus, if we mix two waves, one of 465 kc. and the other, 460 kc., we will obtain the sum and difference beat frequencies; that is, 465 minus 460 equals 5 kc. and 465 plus 460 equals 925 kc. We are not interested in the frequency of 925 kc. because it is inaudible when both waves are rectified by the 6Q7.

The difference of 5 kc., is the one we want. The essential part of the 2 rectified waves produces a 5 kc. beat which is audible and in our case is applied to the control-grid of the pentode amplifier.

The actual useful range of frequencies generated in this manner extends from below 50 cycles to above 20,000 cycles. The lowest frequency attainable is zero cycles, which is of no use because there is no audio component wave at this point. It is well known that 2 oscillators operating at slightly different frequencies have a tendency to fall in step, or interlock.

It can readily be seen that it takes extremely good design, shielding and other factors to maintain a difference of only 20 cycles or less between oscillators and still prevent interlocking to zero-beat. For this reason most commercial units are rated from 50 cycles, up. Under test our unit has "gone down" to 5 cycles per sec. and maintained it for several seconds before blooping out. The upper limit is determined by the maximum capacity of the vernier condenser with the plates fully in which in our unit is enough to reach up to about 30,000 cycles. The power output available is close to 5 W. with a total of 7% distortion. Ordinarily this amount of power is used only to determine at what frequencies a dynamic speaker cone starts to rattle or distort.

In the initial calibration it is necessary to obtain zero-beat as close as possible to the extreme left-hand point on the "tuning" scale with the



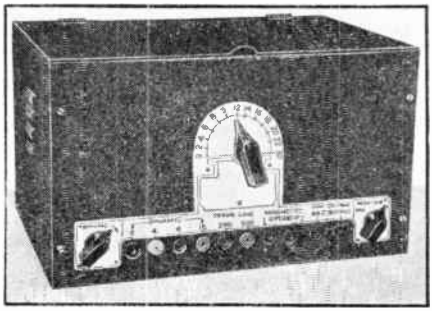
Circuit diagram of audio oscillator.

vernier fully unmeshed. If this cannot be done, the next step will be to readjust the beat-frequency oscillator trimmers. Each oscillator coil has a pair of trimmers located at the top of the can. Adjusting any one of these 4 trimmers will affect the zero position.

However, this does not mean you should adjust all 4. The BFO coils are accurately adjusted to 465 kc. at the factory. Inasmuch as we are placing a vernier condenser across one of these coils then that coil will be detuned from 465 kc. even though the vernier is fully out. Therefore, it is only necessary to unscrew (left or right) a very slight amount one or both of the trimmers on this coil only until zero-beat is obtained.

The rest of the dial may be calibrated against a standard piano keyboard, by striking the notes which are closest in frequency to the dial markings and listening to both the monitor note and piano tone until they match exactly. This operation should be carried out for about 10 different settings. The highest frequency which the instrument can produce, is entirely inaudible, but can be observed and studied on the oscilloscope screen.

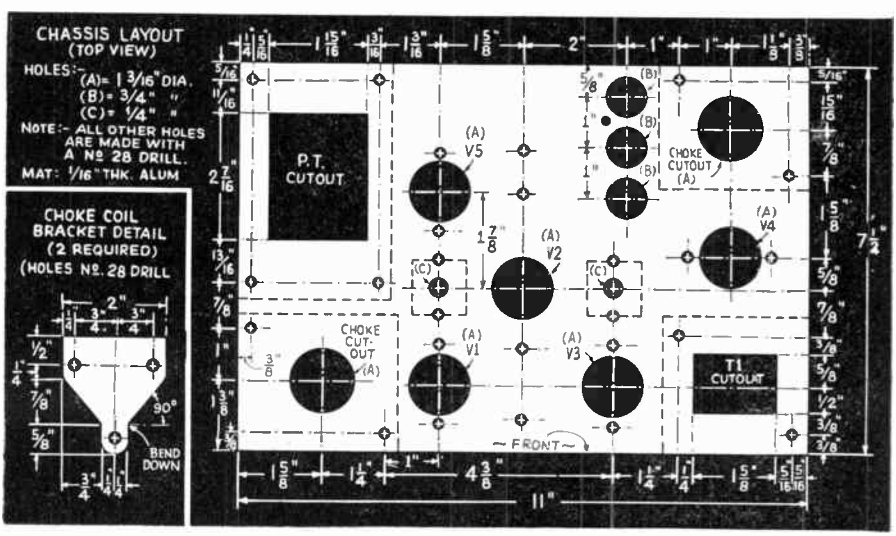
Before assembling the BFO coils on the chassis, open both, and replace each 0.1-meg. resistor with 30,000-ohm, 1/3-w. resistors. On the BFO which is to be used as the variable oscillator, it is necessary to solder a 4-in. piece of solid hookup wire to the control-grid side of the 2 small trimmers which are wired in parallel. Bring both leads out through the small hole at the top of the can. Enlarge this hole if necessary. The original control-grid lead goes to the top cap of the 6J7 and the new lead goes to vernier stator.



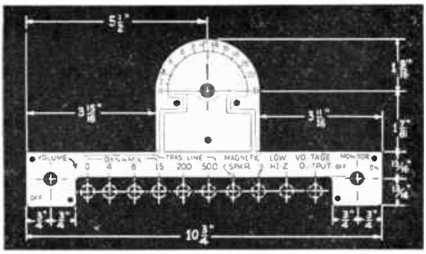
Panel view showing controls

List of Parts

One Kenyon power transformer, type T205, PT;
One Kenyon filter choke, type T153, Ch.1;
One Kenyon filter choke, type T155, Ch.2;
One Kenyon output transformer, type T104, T1;
One metal cabinet 12x8x7 ins.;
One chassis, 11x7½x2 ins.;
One magnet speaker, 3½ ins. dia.;
Two beat-frequency oscillators, L1, L2;
Four Meissner shielded chokes, No. 5592, R.F.C.1, R.F.C.2, R.F.C.3, R.F.C.4;
One Hammarlund midget condenser, type MC20S, C1;
Two General Electric type 6J7 tubes, V1, V2;
One General Electric type 6Q7 tube, V3;
One General Electric type 5Z4 tube, V4;
One General Electric type 6F6 tube, V5;
Three Aerovox electrolytic condensers, type GLS5, 16 mf., 450 V., C2, C3, C4;
One Aerovox electrolytic condenser, type PR50, 50 mf., 50 V., C5;
Four Aerovox bypass condensers, type 484, 0.25-mf., 400 V., C6, C7, C8, C9;
Four Aerovox bypass condensers, type 484, 0.05-mf., 400 V., C10, C11, C12, C13;
One Aerovox bypass condenser, type 484, 0.001-mf., 400 V., C14;
One Aerovox mica condenser, type 1467, 100 mmf., 400 V., C14;
One Aerovox mica condenser, type 1467, 100 mmf., C15;
Two Aerovox mica condenser, type 1467, 5 mmf., C16, C17;
Two Aerovox dual condenser, type 484, 0.05-0.05-mf., 400 V., C18;
One Aerovox resistor, type 930, 250 ohms, 5 W., R1;
One Aerovox resistor, type 931, 17,500 ohms, 10 W., R2;
One Centralab volume control and switch, No. 72-105, 0.5-meg., R3;
Four Centralab resistors, 50,000 ohms, ½-W., R4, R5, R6, R7;

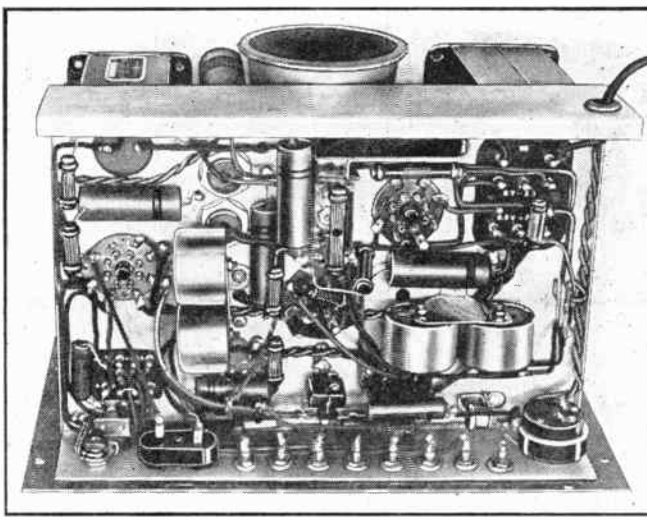


Details of chassis.



Scale calibration.

One Centralab resistor, 5,000 ohms, 2 W., R8;
One Centralab resistor, 0.1-meg., 1 W., R9;
One Centralab resistor, 25,000 ohms, ½-W., R10;
One Centralab resistor, 0.1-meg., ½-W., R11;
One Centralab resistor, 0.5-meg., 1/3-W., R12;
Five octal wafer sockets;
Two brown tip-jacks;
One black tip-jack;
One green tip-jack;
One light blue tip-jack;
One orange tip-jack;
One yellow tip-jack;
One dark blue tip-jack;
One black twin jack;
Two black bar knobs, 1¼ in.;
One black bar knob, 2¼ ins.;
Four terminal connectors;
One grid-bias cell;
One cell holder;
One S.P.S.T. jack switch, No. 10, Sw. 2;



◆

Bottom View Showing the Many Condensers and Resistors

◆

CHAPTER 3

Photo Tubes and Cells When To Use Them

A PHOTOEMISSIVE device is a light-sensitive unit which functions by virtue of the emission of electrons from a surface into free space. A photovoltaic device is a light-sensitive unit which functions by virtue of the displacement of electrons from a semi-conducting medium into a contiguous conducting medium.

Purely for the sake of brevity, we shall call a photoemissive device a "phototube" and a photovoltaic device a "photocell."

We choose also to define in this article) "light" to include radiant energy in that portion of the spectrum commonly associated with photoelectric phenomena. (Inasmuch as the "electric eye" is susceptible to or, otherwise, will "see" what ordinarily would be referred-to as a "radiation."—Editor.) Hence, we may consistently refer to not only visible light, but also infra-red "light," or ultraviolet "light."

(Both the latter may be referred-to as the so-called "black light"; but it is the latter that, in contrast with infra-red radiations, due to its property of causing fluorescence in certain materials is commonly called "black-light."—Editor)

Fundamentally, there is no difference in the functioning of phototubes and photocells. In both types the energy of a "light quantum" (a given amount of light) is imparted to an electron which rends itself from its orbit with an excess of kinetic energy to escape in the one case into free space or, in the other case, into a conductive medium.

To use a crude physiological simile, the surface of a phototube cathode might be likened to the raw dermis of animal skin, the electron corpulses bleeding out into the open; while the surface of a dry disk photocell may be likened to the skin complete with epidermis.

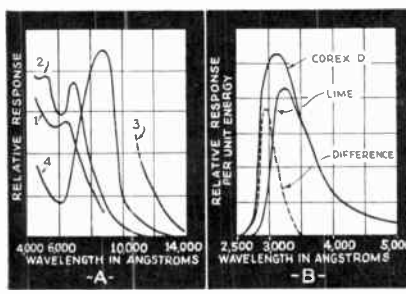
As a matter of fact, a phototube will develop an electromotive force on an open circuit when exposed to light, and will also deliver a short-circuit current, both without aid of an external battery. On the other hand, a photocell may be used with an external battery to exhibit the characteristics of a phototube shunted by a nonohmic resistance.

The phototube may be regarded as a light-actuated current valve which is opened by an amount directly proportional to the incident light flux. The current, small as it may be, can be driven full-strength through any resistance, the maximum value of which is limited only by the available e.m.f. in the external circuit.

The photocell may be regarded as a light-actuated generator, the output of which is a direct function of the intensity of the incident light. If a photocell is connected to a low-resistance device, and its own internal series resistance is low, the current delivered will be linearly proportional to the light intencity.

The useful characteristics of the photocell are its low-resistance current sensitivity expressed in microamperes per lumen, or better, microamperes per foot-candle per sq. in., and especially its maximum power output expressed in microwatts per foot-candle per sq. in. Current sensitivity ranges from about 100 to 500 microamperes per lumen or about 1 to 4 ma. per foot-candle per sq. in. Maximum power output ranges up to 1 microwatt per foot-candle per sq. in. The logical application of the photocell is first of all to light-metering, in which the cell is associated with a calibrated meter in a portable unit or in which the cell serves as a light-intensity indicator in an associated circuit, and, secondarily, to certain control devices in which it has been proved feasible to employ a delicate d'Arsonval relay as the fisrt of a sequence of relays.

It does not seem necessary here to reproduce all of the characteristic curves for typical phototubes and photocells, as our present interest is more restricted to their use in measuring light in various parts of the spectrum. Hence we shall limit ourselves to an examination of typical spectral response or "current-color" curves. In order that we may follow some logical principle of division in our procedure, let us begin with the long waves of the infra-red and then proceed toward the regions of shorter wavelength.



Phototube curves.

There is no photoelectric device which has any appreciable response for wavelengths longer than 2 microns. In practice, one need not expect any useful response beyond 1.2 micron in cesium-oxide phototubes.

In Fig. A are given spectral curves for some experiments cesium-oxide phototubes made by Teves. It appears that these curves illustrate the greatest infra-red response that has been reported to date for phototubes. In the region of 0.7 to 1.4 micron such can be very conveniently used to measure or to be actuated by infra-red light. A cesium-oxide tube, together with a visibly opaque, infra-red transmitting filter such as Corning Glass No. 254 or Jena Glass No. RC-9 or Wratten No. 87, comprises a unit sensitive only to the region just defined. As tungsten lamps radiate maximum energy in the same region, an efficient system for an invisible burglar alarm is readily suggested.

Both selenium and copper-oxide photocells can be made to have near infra-red response, although generally the selenium cell is more red-sensitive as seen in Fig. D, where curves for typical copper-oxide and selenium cells are shown together with a shaded curve illustrating the range of sensibilities for 125 human eyes.

In the visible spectrum it becomes convenient to evaluate light intensities in terms of visibility. Hence it is highly desirable to employ a light-sensitive device, the spectral response of which resembles as nearly as possible that of the eye. Photocells meet this specification much more nearly than phototubes, as a matter of fact copper-oxide cells can be made with natural response amazingly close to the average eye curve. In general, copper-oxide cells tend to be somewhat shy in red response, while selenium cells have excess sensitivity in both red and violet. However, by use of a suitable filter, at the expense of rated sensitivity, the selenium cell can always be made equivalent to the eye.

In devices such as color matchers or color analyzers in which it is necessary to obtain comparable responses in all parts of the visable spectrum, one should have a light-sensitive unit at least as responsive to violet as it is to other colors. In fact, since the tungsten lamps, which serve as sources, are notoriously weak in violet radiation compared to red, it is highly desirable to use a light-sensitive unit more sensitive to violet and blue than to red. In Fig. C it may be seen that the normal cesium-oxide tube is relatively weak for blue light. Fortunately it is possible to modify the manufacturing schedule so as to obtain a "blue-sensitive" tube which is almost ideal for the application. Superfluous infra-red response can be conveniently removed by means of an infra-red absorbing filter such as Corning Aklo Glass.

It is probably a general impression that cesium-oxide cathodes have a sharp maximum of response in the near ultra-violet. This peak, however, is only apparent as is shown in Fig. C. The sharp cut-off on the short wave-length side is caused by the absorption of the glass envelope. Putting the cathode in a Corex D envelope, which is more transparent to ultra-violet, the curve is seen to shift. Such a tube is doubtless the most sensitive device known for measuring ultra-violet light between 2,000 and 3,000 Angstroms.

Typical spectral curves for such tubes, as "photox" or special ultra-violet phototubes developed by Rentschler, Henry and Smith, are given in Fig. E. It is apparent that practically any desired region may be isolated by suitable choice of metal and envelope. It is feasible to amplify the current from these tubes, many suitable circuits having been published.

The captions for the graphs are hriefed as follows

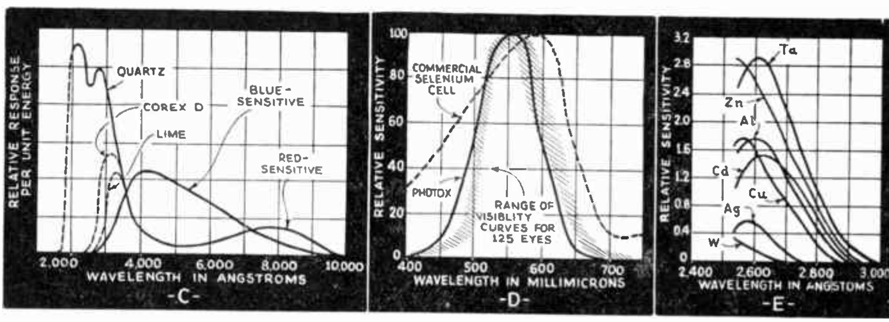
Fig. A—Spectral curves for several experimental cesium-oxide phototubes showing extent into the infra-red. (After Teves)

Fig. B—Spectral curves for cesium-oxide tube in lime glass and Corex D glass envelopes. The dotted curve illustrates the differential response as a method of measuring intensity in an isolated spectral region.

Fig .C—Spectral curves for 'red-sensitive" and "blue-sensitive" cesium-oxide phototubes on ultra-violet response of the "red-Sensitive" type.

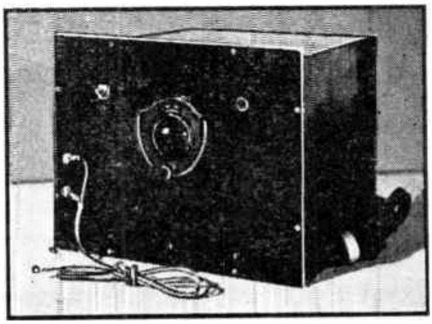
Fig. 1D—Spectral curves (typical) for selenium and copper-oxide cells as compared to the range of sensibility curves for the human eye.

Fig. E—Spectral curves showing change in threshold of frequency in the ultra-violet for various metallic cathodes. (After Rentschler, Henry, and Smith, By courtesy of R.S.I.)



Other interesting curves for photo tubes.

Tester For Intermittent Opens In Condensers



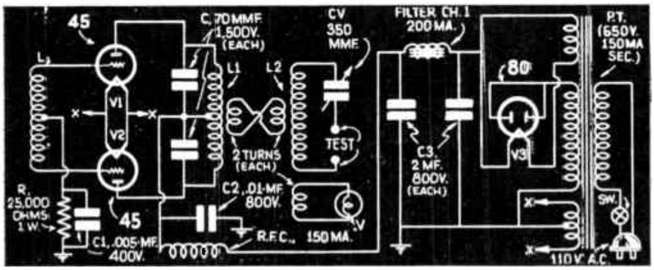


Photo and Diagram of Condenser Tester

One of the most difficult condenser troubles to detect is the problem of open, or "intermittent open" paper condensers. To detect these conditions quickly and efficiently a special type of tester has been designed and is in use in a well-known condenser factory. Service Men may wish to duplicate it.

The tester consists of a push-pull oscillator circuit that will deliver approximately 8 watts of R.F. power. This current is sufficient to tend to break down any intermittent contact between the condenser terminal, or wire, and the condenser foil. In some cases this break-down will occur immediately, and in others it may be necessary to allow the condenser to "cook" for 5 or 10 minutes. If such a weak contact is present it is certain that the heavy R.F. current, which passes through the condenser, will produce the desired permanent open and thereby the faulty condensers can be eliminated.

The circuit is so arranged that the condenser under test is placed in a series resonant circuit with the variable condenser of the tester. By varying the capacity of the variable condenser CV, with the test condenser in the circuit at terminals TEST, resonance is indicated by maximum glow of the pilot light, V. Also, it is possible to have a capacity indicator by calibrating the variable condenser with standard condensers of known capacitance. Intermittent-open condensers can be detected by the flicker of the pilot light; and no-glow indicated a completely-open condition.

In construction of the tester, it may be necessary to adjust the coupling coils in the resonant circuit to obtain maximum glow of the pilot light, however, after a few trials this condition can be obtained satisfactorily. Use well-insulated test prods and keep safely away from the R.F. output of this "breakdown-test-oscillator" in order to avoid high-frequency burns.

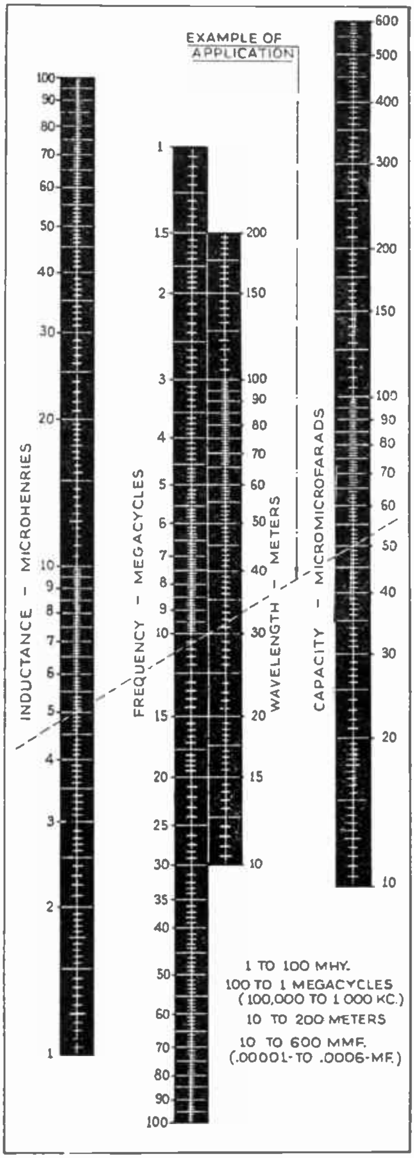
Coil L consists of 76 turns of No 24 enam. wire wound on a form (preferably, air-core) 1½-ins. in dia. Coils L1 and L2 each consist of 50 turns of No. 14 enam. wire wound on a form 1½-ins. in dia.

The following List of Parts is suggested to builders who may want to try out this idea in a lab. set-up. Substitutions may be made by the experienced radio man as necessary to suit individual convenience.

List of Parts

One Standard Transformer Corp. power transformer, 650 V., ma. sec and a 2.5 V. sec., T;
One Standard Transformer Corp. filter choke, 200 ma., Ch.1;
One Hammarlund R.F. choke. 150 ma., Ch.;
One Hammarlund variable condenser, 350 mmf., CV;
Two Tung-Sol type 45 tubes, V1, V2;
One Tung-Sol type 80 tube, V3;
Two Sprague condensers, No. TX-24-70, 70 mmf., 1,500 V., C;
One I.R.C. resistor, 25,000 ohms, 5 W. (no less), R;
One Sprague condenser, No. TC-25, 0.005-mf., 400 V., C1;
One Sprague condenser, No. TR-11, 0.01-mf., 800 V., C2;
Two Sprague condensers, No. OT-21, 2 mf., 800 V., C3;
One R.F. coil unit (see text for construction data) L, L1, L2;
One SP.S.T. toggle switch, X,
One bulb (and socket), 2.5 V. filament, V.;
Three 4-prong sockets.

Short-Wave Coils In A Jiffy



The useful chart shown in diagram at the left can be used for almost any desired short-wave coil calculations in receiver and converter construction. Its utility range is confined, therefore, to the frequencies covered in practical short-wave receiver service. Using the chart, the designer may directly and easily find an unknown with 2 known factors, of course, the 2 knowns may be found on the chart scales, and the unknown lies in the straight-line relation range.

With the 2 known spotted, a straight line is drawn between them and the unknown found where the line crosses the 3rd. scale, either in traveling between the points or in extention.

For example, suppose we have a coil of known 5 micro-henries inductance and we wish to know the frequency to which this coil will tune with a capacity of 50 mmf. or .00005-mf.). We check these 2 figures on the capacity and inductance scales, draw a straight line between them, and find that we cross the frequency scale at 10 mc. (10,000 kc. or 30 meters). Or, if we have a variable condenser which we wish to use in a tuned circuit and which at a value of 50 mmf. is to "hit" 30 meters; we draw a straight line between the known frequêncy and capacity scales, from known point to known point, and extend it to cross the 3rd scale for inductance at 5 micro-henries. The coil required should have this inductance; to be found by trial and error, and the application of a simple formula found in almost every ratio text book.

The inductance figures are in microhenries and not milli-henries. The frequency figures, for the sake of simplicity, are given in terms of megacycles; the capacity figures in terms of microfarads. These same terms are used in the inductance formula.

The chart may be used to give readings below or above the scale ranges by dividing or multiplying straight-edge figures by 10, or multiples of 10. If we wish to know the inductance required to tune to 500 meters or 600 kc., for instance, with a capacity of 400 mmf., we simply draw a straight line between the 50-meter and 40-mmf. points, and extend the line to cross the inductance scale. We find the inductance reading to be approximately 16. As we divided both capacity and wave-length figures by 10 (inorder to use our limited-range chart), we must now multiply 16 by 10 in order to get the true required inductance.

The chart is fairly accurate and for almost all practical purposes may be relied upon where two factors are known—one desired, one measured. Where one "known" factor (particularly capacity) must be estimated, the results must, of course, be considered a near or approximate reading only. Approximations, however, will be acceptable in designing coils for the converter, accuracy of alignment to cover desired frequencies being a matter of adjustment, and check-up against the carriers of stations known to be crystal-controlled, with coils built and wired into the circuit.

Courtesy—Crosley Radio Corp.

How To Get "Long Distance" On Your All-Wave Set

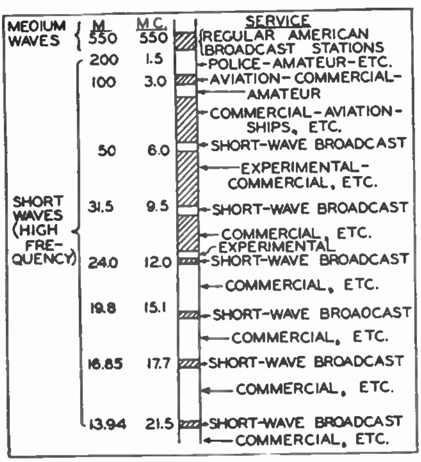
DXing Still Holds Thrills For Many

A great deal of confusion has been caused by the terms meters, kilocycles and megacycles which are used interchangeably to denote the channels on which various stations operate. Actually they are 3 different ways of saying the same thing. No useful purpose would be served here to go into an involved explanation of the significance of these terms. Simply let it be said that they are units of measurement, somewhat as a foot or yard is a unit of length.

For example, broadcast station WLW in Cincinnati operates on a wavelength of about 428 meters. Another way of saying this is that WLW operates on a frequency of 700 kilocycles. (To translate meters into kilocycles, divide either into 300,000—which is about the speed in kilometers with which a radio signal travels. The quotient is the desired figure.—Editor).

The kilocycle (or kc.) method of figuring is used more often today because it is more convenient than the meter system. The shorter the wavelength of a given station, the higher its frequency in kc. will be. A station operating in kc. will be. A station operating on 200 meters has a frequency of 1,500 kc. while one on 10 meters has a frequency of 30,000 kc.!

When dealing with these short-wave stations, the use of kilocycles becomes a nuisance. For example, a certain station operates on 25.53 meters. This is equivalent to 11,750 kc. The frequency is a large number. Therefore, it has become the practice when dealing with short-wave stations to give their frequency in megacycles instead of kilocycles. Mega means million, while kilo means thousand. Therefore, a kilocycle is really a thousand cycles and a megacycle is a million cycles. Consequently 1 megacycle equals 1.000 kilocycles or kc. Thus the station whose frequency is 11,750 kc. can be identified as operating on 11.75 mc. Note that the last figure of the frequency in kilocycles is generally dropped when using megacycles. Megacycles are not used with regular broadcast-band stations because there the kilocycle method is satisfactory since the figures involved are small. Station WLW on 700 kc. could be written as 0.7 mc. if desired. For aid in remembering the difference between these three, a list giving the meters, kc. and mc. of a number of reference points is given, as follows: 50 meters equals 6,000 kc. or 6 mc.; 30 meters equals 10,000 kc. or 10 mc.; 25 meters equals 12,000 kc. or 12 mc.



FREQUENCY	LOCATION OF STATIONS	TIME OF DAY IN E.S.T. FOR BEST RECEPTION.
30-20 M C.	EUROPE SOUTH AMERICA ASIA & AUSTRALIA	7 TO 11 A.M. 11 A.M. TO 2 P.M. 3 TO 6 P.M.
20-17 M C.	EUROPE ASIA & AUSTRALIA SOUTH AMERICA	7 A.M. TO 1 P.M. 2 TO 6 P.M. 10 A.M. TO 3 P.M.
17-13 M C.	EUROPE ASIA & AUSTRALIA SOUTH AMERICA	5 A.M. TO 9 P.M. 11 P.M. TO 9 A.M. 7 TO 9 A.M. 4 TO 7 P.M.
13-11 M C.	EUROPE ASIA & AUSTRALIA SOUTH AMERICA	4 P.M. TO 5 A.M. 10 P.M. TO 3 A.M. 6 A.M. TO 9 A.M. 5 TO 7 A.M. 6 TO 8 P.M.
11-8 M C.	EUROPE ASIA & AUSTRALIA SOUTH AMERICA	4 P.M TO 4 A.M. 4 TO 9 A.M. 5 P.M. TO 7 A.M.
8-5 M C.	EUROPE ASIA & AUSTRALIA SOUTH AMERICA	10 P.M. TO 2 A.M. 5 TO 7 A.M. 7 P.M. TO 5 A.M.

Do not expect to be able to turn on your radio set and tune-in a certain short-wave station at any time of the day. This is impossible. First of all the factors mentioned is the effect of the time of day on reception.

During broad daylight the shorter waves or higher frequencies are the only ones capable of providing long-distance reception. Thus the waves from 10 to 20 meters (30-15mc.) give best results when there is daylight either at the station; at the receiver; or, at both places. The shorter the wave, the better it is for daylight communication.

The stations operating near 20 meters are heard best in the Fall and Winter when there is daylight over most of the distance between the station and the listener. The stations below 15 meters, or above 20 mc. are heard best during these seasons when there is daylight over the whole path. Practically, this means that European stations operating near 15 mc. are heard best in the U.S.A. at this period from 4 to 7 a.m. and 11 a.m. to 4 p.m. The stations above 20 mc. are heard best from 7 to 11 a.m. Asiatic and Australian stations in these bands are heard best from 9 a.m. to 7 p.m.

The stations operating between 25 and 35 meters are heard best when there is darkness over most of the path between the listener and the station. Thus the Europeans in this band are heard best from 4 p.m. to 5 a.m. Asiatic and Australian stations are heard best from midnight until 9 a.m. Wavelengths from 35 to 60 meters give best long-distance reception when the whole area is in darkness. Europeans are heard in this band from 6 p.m. to 2 a.m. At present this band does not give very good reception of European stations at any time; the higher frequencies are superior for this purpose. However, many South American stations can be heard from 5 p.m. until 6 a.m. in this band and especially near 6 mc. The waves above 60 meters are not suitable for long-distance reception (over 2,000 miles), at present.

In summer the higher frequencies give better results, even at night, while in Winter the lower frequencies are most effective and provide the clearest signals. The various short-wave stations realize this and generally broadcast on 2 or more frequencies, simultaneously, using a high and a low frequency. These stations also change the operating frequencies several times during a day shifting to lower frequencies as darkness approaches. They also make seasonal changes in frequencies used to insure good reception at all times. A great many newspapers carry daily schedules of the best-heard short-wave foreign stations; these station lists give last-minute details as to the exact frequencies being used at any time. There are also a number of magazines which publish the operating schedules (frequency, and time on the air) of all stations.

There are also a number of other points which must be observed in order to get a great deal of distance reception on an all-wave set. Though these are quite obvious, sometimes their very simplicity causes one to overlook them. For this reason, it is essential that they be appended.

First: Do not expect to get as much distance with a cheap all-wave set as your friend gets with a more costly one. Nor should you expect an all-wave set to give results as satisfactory as a set designed for short wave use exclusively. While many of the better all-wave sets are efficient on all the bands they cover, few of them will equal in sensitivity those sets designed to work only on the higher frequencies.

Second: Do not expect to get as much distance with an old all-wave set as with a newer model, other things being equal. Radio sets are being improved continually, and later models afford better distance than do comparable earlier models.

Third: Make sure that your set is in good condition. If one R.F. or I.F. alignment has shifted, the set will not be as efficient as though the stages are correctly aligned.

Fourth: Have your tubes tested, and replace any which may have deteriorated through service. Even one tube that is slightly deactivated can impair distant reception seriously.

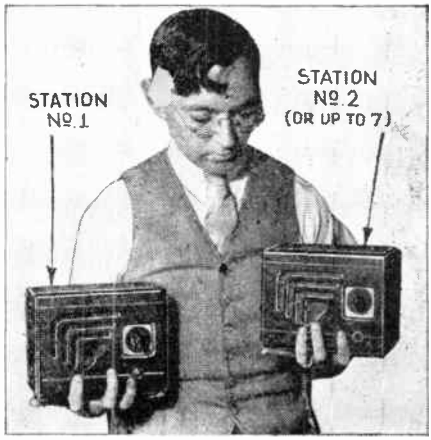
Fifth: Have an adequate antenna. The best you can get is the one recommended in the instructions which the manufacturer supplied with your set. He wants your set to work as well as possible; follow his suggestions. Should you have not such instruction sheet, your dealer's suggestions are the best substitute. Remember that no set can be better than its antenna, and do not skimp when making the antenna installation. Should your set require a ground, as most sets do, be sure to have a good ground on it.

Sixth: Be patient. Tuning is critical on distant stations, particularly on the short waves. If the controls are turned too rapidly, you will pass stations which you might otherwise hear. Take your time, and tune carefully.

CHAPTER 4

Interphones

1-Tube A.C.-D.C. Interphone



The complete set-up.

In order to understand the principle of operation of the 1-tube intercommunicating system, examine the 2-station type which is shown in simplified block diagram.

In Fig. A station No. 1 and No. 2 are shown in the "stand-by" position ready to receive messages from each other. In Fig. B, station No. 1 has thrown its switch to the send position and is talking to station No. 2. When station No. 1 releases the switch, both stations are again in stand-by position and station No. 2 talks to station No. 1 as shown in Fig. C. Notice that during transmission, the 2 amplifiers are in cascade in order to give the required amount of amplification. The total amount of gain is "divided" equally between the 2 stations.

The schematic circuit of a single unit of a 2-station system is shown in the diagram. In installing the system, a 2-wire cable (with plug and socket connections) is run from one unit to the other. Each unit uses a 12A7 type tube which consists of a half-wave rectifier and a high-gain power pentode.

Note that the rectifier system does not use a choke for filtering. The 2,000-ohm resistor, R2, provides adequate filtering without causing excessive voltage drop. This is due to the fact that the 12A7 draws only 15 ma.

Switch Sw. 1 is a double-pole double-throw unit of the press-to-talk type. This means that it should contain a spring to return it to the "listen" position. Of course an ordinary D.P.D.T. toggle switch may be used, but this is more difficult to manipulate than the spring-return type.

Input transformer T1 is designed to feed from a 4-ohm line into a control-grid. The output transformer, T2, is of the universal type with the full winding used as primary, and taps 2 and 5 for the 4-ohm secondary. By shifting the taps of this output transformer, variations in tone may be effected. In general, however, the 2 and 5 taps will be found best.

When more than 2 stations are necessary, circuit B in the diagram should be used. An examination of this circuit shows that a 7-point switch, Sw. 3, has been added. Also an octal-type socket has been substituted for the 5-prong socket. We can now install 7 of these units as a selective-type intercommunicator. The 7-point switch allows us to select any one of the other 6 stations with the last point used as an "off" or "stand-by" position.

The complete interconnecting wiring diagram of the 7-station intercommunicating system is shown. The materials required consists of an 8-wire color-coded cable (of sufficient length to pass through all the rooms in which the stations are to be installed), and 7 octal-type plugs.

The 7 octal plugs Pa, Pb, Pc, etc., are connected to adequate lengths of 8-wire cable as shown. The color code of all should be identical and are to correspond to that of the main cable to which the plugs connect. In connecting the plug cables to the main cable, simply skin back the wires, make the proper connection (solder all connections), and tape each individually. These connections are made at the points where slack was left in installing the cable. For the sake of appearance the cable junction should be covered with a small box. Note that plugs Pa and Pg may be connected directly to the ends of the main cable. The next step is to insert the 7 plugs into their respective units and plug the line cords of the units into the A.C. or D.C. line. The system is now ready for operation.

The indication of the outlying stations on each unit may be made by studying the various drawings. Thus on station "A", the pointer knob

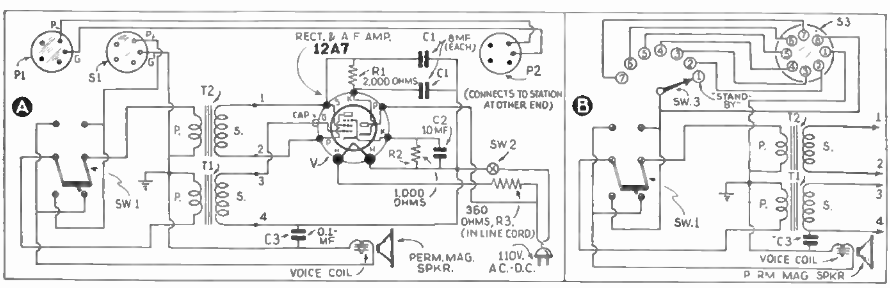
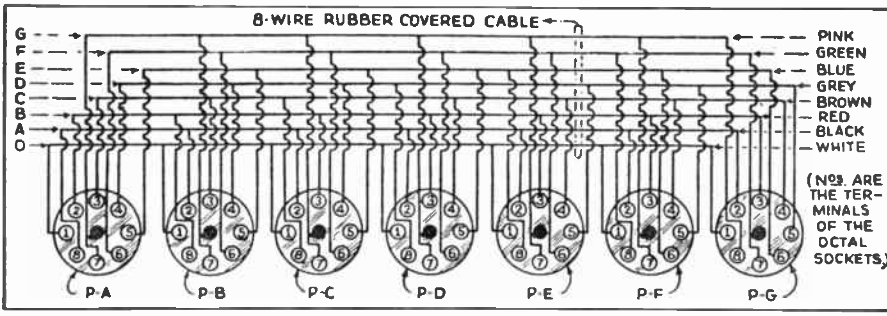


Diagram of two station system.



Selective or private circuits.

of switch Sw. 3 indicates as follows:

Point No. 1............"off" or "stand-by"
2............to station "B"
3............to station "C"
4............to station "D"
6............to station "E"
7............to station "F"

The dial markings of station "B" are similar, except that Point No. 2 indicates station "A" instead of "B," etc. The operation of the system is as follows: All stations are normally on point No. 1 or "stand-by." If station "A" wishes to call station "B," the knob of Sw. 1 is pressed for the "call" position. When station "A" is finished talking, station "B" need only press Sw. 1 in order to answer. This feature of the system saves much time because in the usual interphone system "B" would have to know from what station the call had originated in order to reply.

If station "A" wishes to have a conference with stations "B" and "C" simultaneously, he calls them each individually and asks them to get on his line. A 3-sided conversation is then possible. This may be also arranged for any number of stations. Even while talking to all 6 outlying stations there is no loss in either volume or quality. This is due to the design whereby the voice is transmitted to a load which absorbs a very small amount of power. In the usual type of intercommunicator, the power delivered is in inverse ratio to the number of speakers on the line.

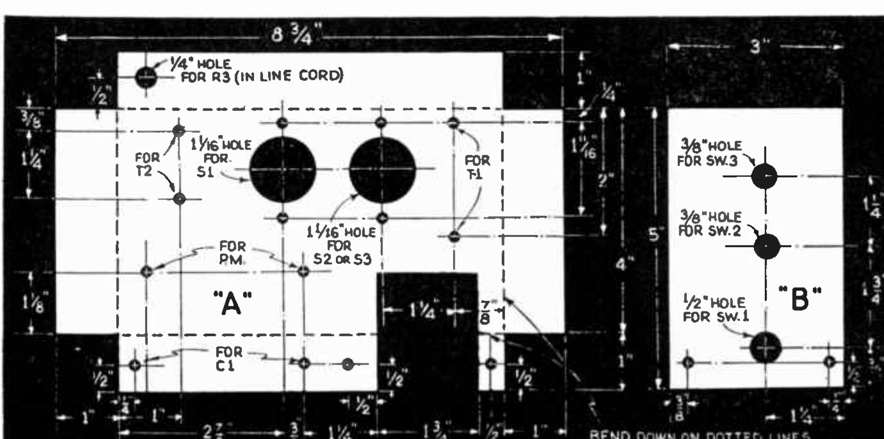
While the system described was for 7 stations, any number of stations may be arranged-for by means of slight changes. For instance, if a 3-station system is desired, only a 4-wire cable between stations is necessary. Only that portion which includes Pa, Pb, Pc, need be used. For more than 7 stations, the number of points on Sw. 3 must be increased proportionately, and the cable like-wire. Also binding post strips will be necessary instead of the octal sockets used. (The constructor may wish to try the recently-announced type 25A7G, 25-V. tube—not as yet available to the writer—if increased amplification is desired.)

In constructing the units, we first make the chassis. The main part of the chassis is formed from a piece of No. 16 gauge aluminum. All holes are made with a No. 28 drill unless otherwise indicated. Next to, or in between the pairs of holes is indicated the part which is mounted there. Before the parts are mounted, flaps are bent down in order to form the chassis. The small front panel on which the switches are mounted is fastened to the main chassis with two screws. The 3-in. P.M. dynamic speaker is mounted on the chassis by 2 small angle brackets.

In wiring the unit there are no special precautions except to note as already mentioned, and the "B" minus return does not ground directly to the chassis.

The dimensions shown are for the inside of the box. The front panel should be ¼-in. thick, and the sides may be any thickness desired.

The speaker hole may be either the simple circular type shown, or else the grill type.



Chassis layout of interphone.

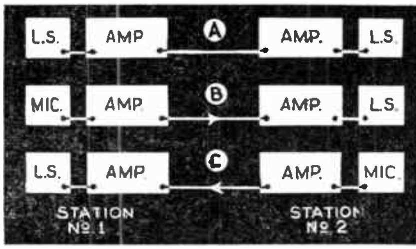
After the units are set up, try reversing the line plug while one station is transmitting to the other. The best position as to minimum hum should be noted and maintained. If the units have been wired up correctly there is almost no chance of trouble.

List of Parts

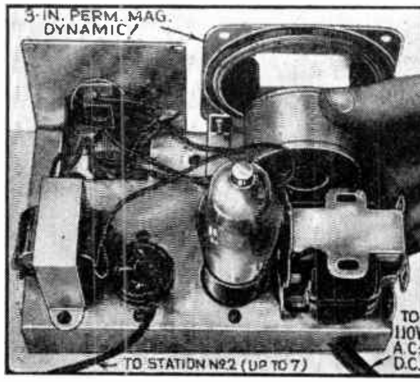
One Sylvania type 12A7 tube, V (see text re 25A7G);
One Sprague dual electrolytic condenser, 8 mf., 200 V., C1;
One Sprague electrolytic condenser, 10 mf., 25 V., C2;
One Cornell-Dubilier paper condenser, 0.1-mf., 200 V., C3;
One Stancor input transformer, 4 ohms to grid, T1;
One Stancor universal output transformer, type A-2855, T2;
One 3-in. permanent-magnet speaker, P.M.;
One "12A7" type socket;
One 5-prong socket, S1;
One Centralab D.P.D.T. switch, Sw. 1;
One Centralab S.P.S.T. switch, Sw.2;
One I.R.C. resistor, 2,000 ohms, 1 W., R1;
One I.R.C. resistor, 1,000 ohms, ½-W., R2;
One Resistor, 360 ohms, R3;
One 5-prong plug, P1, P2;
One chassis;
One cabinet.

Additional Parts for Multi-Station Type

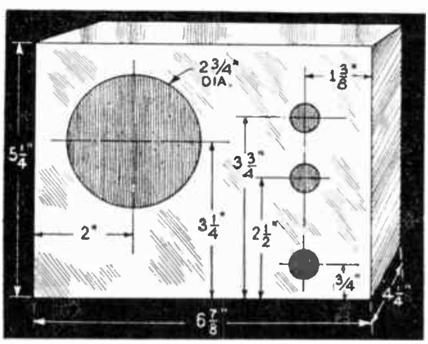
One Centralab 7-point switch, Sw.3;
One octal socket, S3;
One octal plug, P-A to P-G;
8-wire rubber-covered cable.

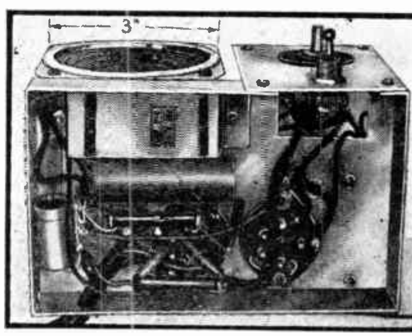


How circuits line up.

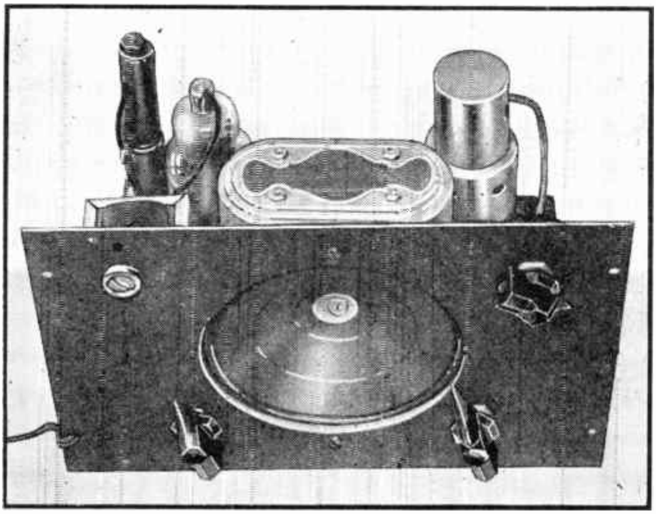


Rear view.





Front panel layout and bottom view.



2-Tube Inter-Phone

◆

A Perfect Interoffice Wireless

◆

The elements vital to a carrier intercommunication unit are given in the following paragraph.

(1) Radio-frequency oscillator tube—this may be used as the detector when receiving. (2) Power modulator tube—for modulating the R.F. This may be used as a power tube when receiving. (3) Voltage amplifier tube—to step-up the signal from the microphone (in this case the permanent-magnet dynamic type loudspeaker). When receiving, this is used to amplify the output from the detector. (4) Rectifier tube—to deliver requisite current. (5) Switching system—which will change the above elements to their proper relationships when sending and receiving.

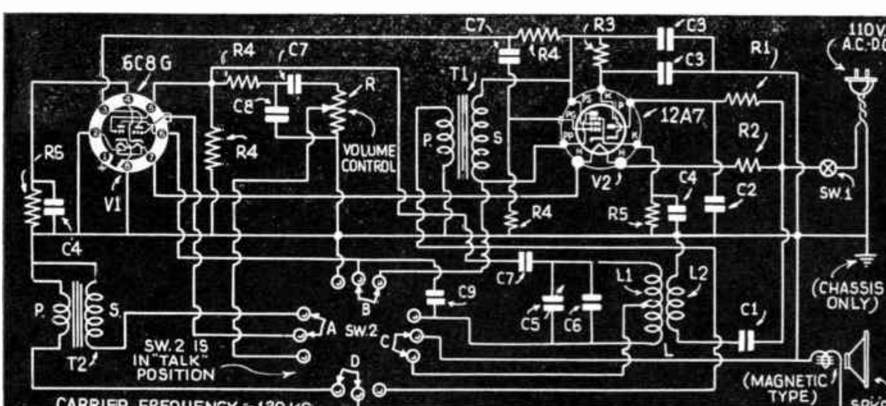
These points are explained in the block diagram. This shows graphically how the change-over system works.

The requirements for the tubes are that they shall be of the 0.3 type and that 2 tubes shall perform the functions listed above. The combination of the rectifier and power tube is accomplished by the use of the 12A7 tube.

The combination of the oscillator and voltage amplifier tube has been made easy by the recently-designed type 6C8G twin triode tube. An important—for our purpose—design feature of this tube is the fact that it has separate cathodes. This enables us to completely isolate the oscillator-detector section (as we will use the tube) from the amplifier section of the tube. The grid (cap) section is used for the voltage amplifier, and the lower section for the oscillator—detector.

Now let us trace the path of the signal when the unit is in the talk position. The "microphone" (Sp'k'r) picks up the sound and the output voltage is brought to the grid-cap-triode of the 6C8G by the step-up transformer, T2. The amplified signal is sent to the pentode section of the 12A7. This signal which now is of the order of about 50-V. peak, is used to modulate the oscillations of the second triode of the 6C8G. This modulated R.F. signal is passed to the low-impenence primary of the R.F. transformer, L, and then on to the line by means of condenser C1.

The other unit which is in the receive position picks up the signal from the line. Then it is sent through the R.F. transformer L, to the grid of the second section of the 6C8G. This tube is now being used as a diode, the real plate of the



Wiring diagram showing switch 2 in talk position.

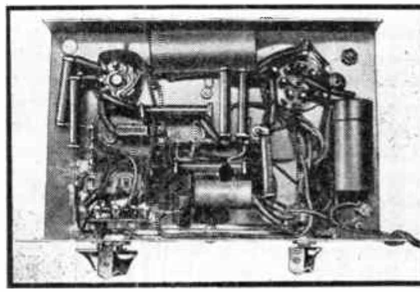
tube being grounded by the C section of Sw. 2 The detected signal then passes through a low-pass filter—R4, C8, which permits only the A.F. component of the signal to pass.

After passing the volume control, R, the signal goes through section B of Sw. 2 to the grid cap triode of the 6C8G. The signal is then amplified by the pentode section of the 12A7 and finally reproduced (after passing T1 and section B of the Sw. 2) by the speaker, Sp'k'r.

The details of the construction of the oscillator coil L are shown in the sketch. Coil L1 includes 300 turns of No. 30 D.S.C. copper wire-wound, honeycomb fashion, on a dowel stick 3/8-in. in diameter and ¾-in. long. When complete, the winding should be approximately 1 in. in diameter and 3/16-in. wide. A tap-off, T, is taken at 150 turns. Coil L2 is composed of 50 turns of No. 26 D.C.C. copper wire wound, straight layer fashion, between two cardboard washers (as shown). The outer end, 0, of L2 goes to ground and the inner end, I goes to condenser C1. The outer end G, of L1 goes to the grid and the inner end, P, goes to the switch, Sw.2.

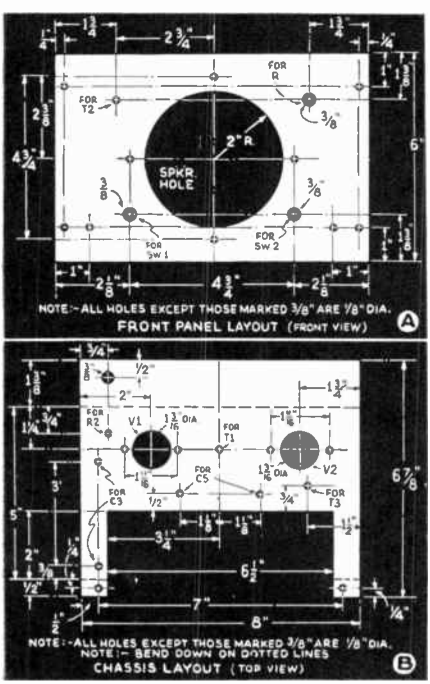
Tunning of the coil is effected by means of condenser C6 and trimmer C5. This trimmer may be omitted if desired as the tuning is quite broad. The frequency of the carrier is approximately 130 kc.

The chassis consists of 2 parts, a front panel and the chassis proper. The photographs indicate how the sections are bolted together. This type of arrangement allows for mounting in a metal box, or if desired in a suitable wooden cabinet. The proper places for mounting the parts are indicated by the letters next to the respective mounting holes. Note that all the parts on the chassis are mounted on top with the exception of a 5-terminal-lug strip which is mounted directly beneath the trimmer condenser. All other parts are fastened directly in place by soldering. The photographs should give many suggestions as to the proper method of wiring. The only shielded lead is the one leading from section B of switch Sw. 2 to the grid cap of the tube 6C8G.



Bottom view.

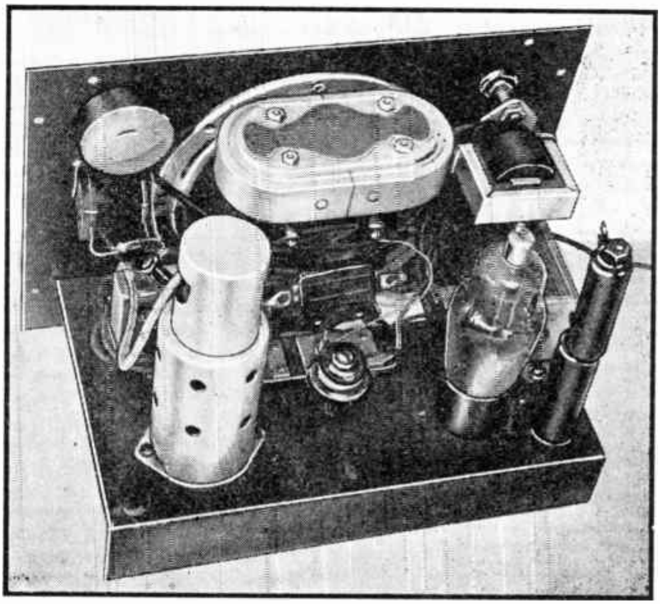
The installation and operation of the radio-type intercommunicators is the height of simplicity. The units are plugged into the A.C. or D.C. outlets near the places where they are to be installed . The volume control is turned full on and the talk-listen switch is left in the listen position. When either party wishes to talk, the switch is thrown to the talk position and upon completion of a portion of the conversation, the switch is thrown back to the listen position. The other unit may now be thrown to the talk position and the conversation continued.



Panel and chassis dimentions.

List of Parts

- One R.F. oscillator coil, L;
- One A.F. output transformer, 14,000 to 4 ohms, T1;
- One A.F. input transformer, 4 ohms to tube grid, T2;
- One Aerovox resistor, 400 ohms, 1 W., R1;
- One Aerovox resistor, 330 ohms, 30 W., R2;
- One Aerovox resistor, 2,000 ohms, 1 W., R3;
- One Aerovox resistor, 0.1-meg., ½-W., R4;
- One Aerovox resistor, 1,000 ohms, 1 W., R5;
- One Aerovox resistor, 3,000 ohms, ½-W., R6;
- One Electrad volume control, 0.4-meg., R1;
- One General Electric S.P.S.T. switch, Sw.1;
- One 4 P.D.T. switch, Sw. 2;
- One magnetic speaker, 4 ohms;
- One Sprague dual electrolytic condenser, 8 mf., 200 V., C3;
- One Cornell-Dubilier paper tubular condenser, 0.1-mf., 400 V., C1;
- One Solar paper tubular condenser, 0.5-mf., 200 V., C2;
- One Cornell-Dubilier dual electrolytic condenser, 5 mf., 25 V., C4;
- One Hammarlund trimmer condenser, single plate, C5;
- One Cornell Dubilier mica condenser, 500 mmf., C6;
- Three Cornell-Dubilier mica condensers, 0.001-mf., C7;
- One Cornell-Dubilier mica condenser, 520 mmf., C8;
- One Cornell-Dubilier mica condenser, 0.004-mf., C9;
- One ICA chassis;
- One cabinet to fit chassis;
- One large pointer knob;
- Two small pointer knobs;
- One Raytheon type 6C8G tube, V1;
- One Raytheon type 12A7 tube, V2;
- One ICA tube shield (for V1);
- One 5-lug terminal strip, assorted nuts, bolts, wire, sockets, etc.



Rear View Showing Parts Arrangement

While interphones have had their widest acceptance in commercial applications, there is a far wider field which has been touched but little if at all.

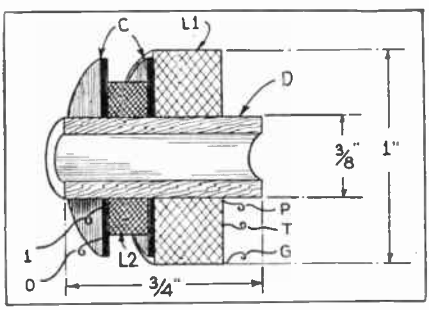
Almost every home, except for small apartments, might well install equipment of this sort. It can be used to communicate between the upper and lower floors of houses, from living room to kitchen in the large apartments, between house and garage in country estates, and in a number of other ways.

Even small business can use such equipment to advantage, for transmitting messages between the receptionist's desk and the inner offices, between sales counter and stock room, etc.

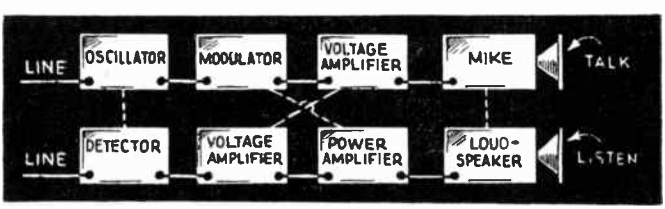
Schools, too, will find interphones invaluable, for communicating between the executive office and one or more of the class rooms, from a workshop to a laboratory, and for similar uses.

In fact, there are, literally, hundreds of purposes to which interphone is particularly well adapted.

With this in mind, the experimenter may derive profit as well as pleasure from his work with this type of apparatus. Inexpensive to construct, interphone equipment has always commanded reasonably high prices. If neatly and efficiently made, it should sell readily to numerous places which have not hitherto installed it merely because it has not been properly brought to their attention.



Coil details above. Right—how the system works.



The Much-Abused Ballasts For A.C.-D.C. Radio Receivers

"Why should there be over 100 types of A.C.-D.C. ballasts?" is a question many technically-inclined Service Men ask themselves.

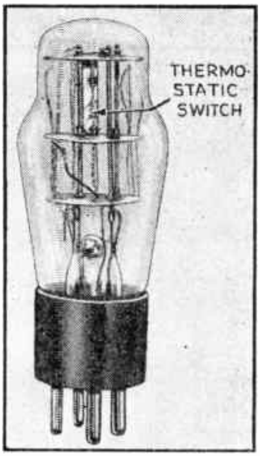
The answer is, "there is no good reason."

Every time a manufacturer designed a new A.C.-D.C. set the ballast supplier thought he would get all the replacement business by changing the number and specifications of the ballast so that it could not be easily replaced. As a result many ballasts of identical specifications have different numbers—or different prong connections! Some manufacturers have gone so far as to purposely change the prong connections of the ballast so that ballasts now on the market would short across the line or short the line across the pilot light resistors, and in that way burn out some part of the ballast! This is something that Service Men will have to look out for—and the only way out is for them to be guided by a good replacement chart.

If ordinary resistance wire is used in the ballast, the amount of wire must be changed, depending upon the number of tubes in the set. This, therefore, would require approximately 10 different "ballasts" using ordinary resistance wire to take care of the variation in total tube voltages.

It is really incorrect to call units using either Nichrome or ordinary resistance wire "ballasts". A real ballast resistance is one whose resistance changes very rapidly with small changes in current.

If a real ballast resistance is used and the sets wired uniformly, the number of ballasts required for A.C.-D.C. sets could be reduced to practically one each for total filament voltages of 15 to 40 V.; 40 to 75 V.; and 75 to 105 V. The resistance of the Amperite automatically varies to make up the variation in line voltages as well as the variation in the number of tubes used. For



Glass Type Ballast Tube.

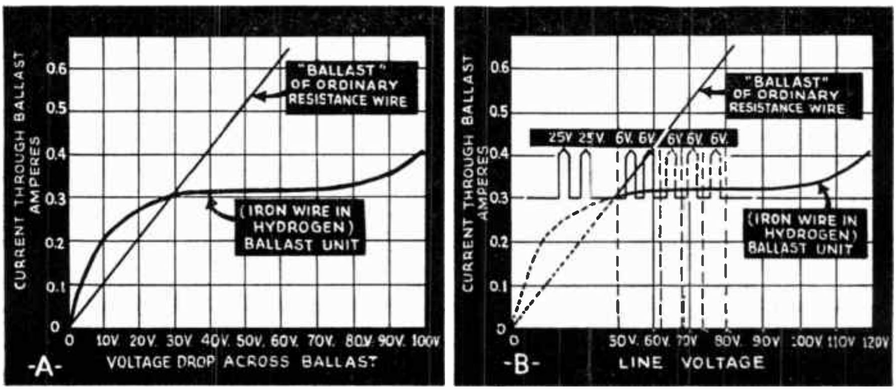
example one such ballast can be used for any set having a total tube filament voltage of 40-75 V. This practically takes care of most A.C.-D.C. sets. As shown in Fig. 1A the voltage drop across the Amperite itself varies from 30-80 V., taking care of a variation of 50 V.

Circuit details series A to D show the various arrangements in pilot light combinations used in most A.C.-D.C. sets.

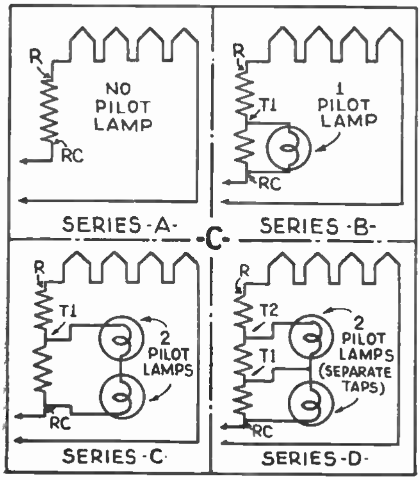
By putting two pilot light resistances in the ballast, as shown in series D, it could be used for either 1 or 2 pilot lights. The same ballast can of course be used without pilot lights. If not used, the small pilot light resistances will make no material difference in the circuit. The same Amperite could therefore be used for (a) none, (b) 1 or (c) 2 pilot lights and for a set having a total filament voltage of 40-75 V.

A series of octal-base ballasts are numbered K42A, K42B, L45A, etc. The A, B, C, or D refers to the wiring diagram of pilot lights as shown in the series of diagram. The K refers to 0.150-A. pilot light and L to 0.250-A. pilot light. Center number refers to the voltage drop across the ballast.

The Amperite KL45 for example is designed as shown at D and will take care of either the A, B, C, or D arrangement, and any set with a total filament voltage drop between 40 to 75 V. It will therefore replace any octal-base ballast starting with K or L, ending with A, V, C, or D and



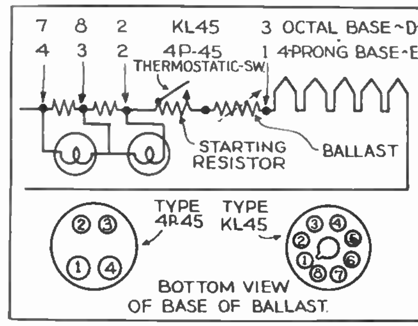
Curves for various ballast tubes.



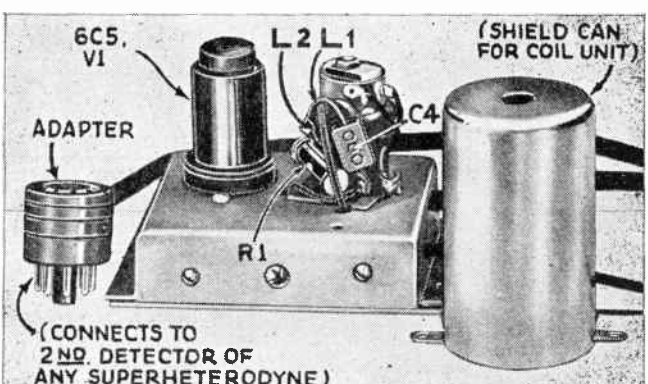
Pilot lamp circuits.

having a center number of anything between 40 and 75.

The unusually low resistance of the 6 V. tubes causes an unusual surge when the set is first turned on. In order to eliminate this surge the Amperite regulator (see photo) is equipped with a patented starting resistance which allows only approximately 70 V. on the set when it is first turned on, and is automatically shorted out when the tubes warm up. It is an ideal combination since it starts the tube at a low voltage, takes care of any voltage variation of the line from 90 to 135 V. and also takes care of variation in the number of tubes in the set.



Circuit details for KL45 tube.



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Beat Oscillator For DX Reception

◆

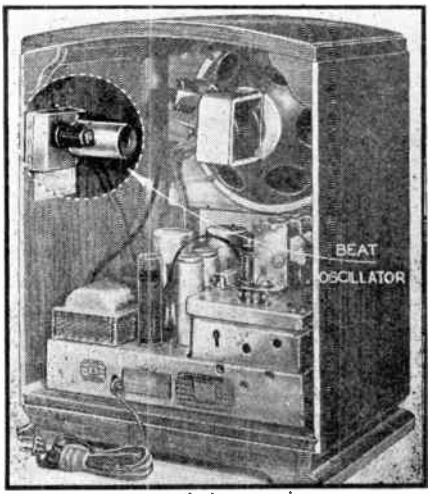
Designed to enable the shortwave enthusiast to receive, with his standard all-wave set, the interesting code signals which are so numerous, this beat-oscillator unit will assist also in locating weak DX broadcast and S.-W. stations; because it will bring out the carrier wave strongly as an audio whistle, and thus afford apparent sharper tuning.

Radio, as a means of point-to-point communication, depends on the production of a carrier wave which is interrupted at intervals to give a tone; but may be used to produce a steady note by "beating" it, with a locally-generated frequency, to produce an audihle heterodyne or whistle. With the old-fashioned regenerative sets, such reception was easy to obtain by tuning the detector, in a state of oscillation, a kilocycle (1,000 cycles) or less off the received C.W. (continuous-wave) signal.

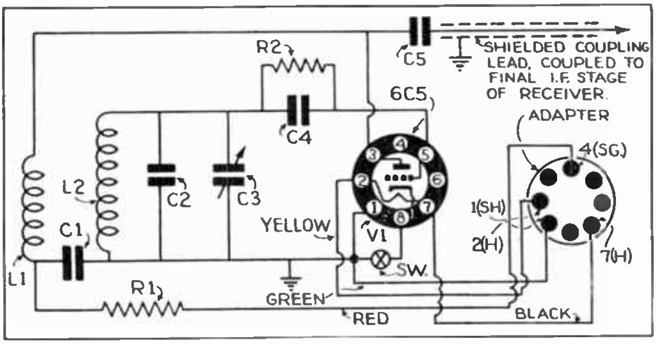
This new unit, designed for attachment to later sets, performs the same purpose when connected ahead of the 2nd-detector of any modern superheterodyne. The connections are as simple as those of the older converters or "signal boosters"; the adapter used is plugged into the socket of a 6F7 output pentode, to draw current for energizing a 6C5 tube used as a triode. The parts shown can be mounted in, and shielded by, a metal chassis only 4⅜ x 3 x 1 in. high; the gridleak and condenser, mounted on the coil, are covered by its shield. The shielded coupling lead is bared for about 1½ ins. at the end so that, when placed alongside the control-grid lead of the last I.F. stage in the set, it will couple-in the local oscillation which it generates. The stronger the signal, the closer should be the coupling, but vice versa on weak signals; too much coupling will cause the A.V.C. to take hold and reduce receiver sensitivity. The unit is not furnished complete—being an experimenter's instrument—but parts may be obtained, with the grid coil tuned to 465 kc., so that it will beat against the standard I.F. signal; 300 to 500 cycles detuning will give a good note. Trimmer condenser C3 is adjusted with a screwdriver when necessary; the grid coil L2, tuned by condenser unit C2-C3 has a larger impedance—and higher D.C. resistance than L1. (Since the instrument does not radiate it cannot cause outside interference.)

List of Parts

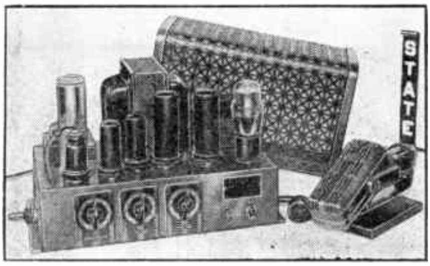
One General Electric oscillator coil. No. RL-207, L1, L2.
One General Electric carbon resistor. No. RR-187, 30,000 ohms, 1/2 W. R1.
One General Electric carbon resistor. No. RR-050, 0.01-meg. 1/4 W, R2.
One General Electric Paper-dialectric cond. No. RC-040, 0.01.-mf. 400 V., C1.
One General Electric padding cond., No. RC-235, 100-mmf. C2.
One General Electric trimmer cond., No. RC-607, 35-mmf. max., C3.
One General Electric mica dialectric cond. No. RC-258, 250-mmf., C4.
One General Electric mica dialectric cond. No. RC-202, 4-mmf., C5.
One S.P.S.T. toggle switch, Sw.;
One General Electric coil shieid, No. RS-103;
One General Electric wafer-type socket, No RS-200;
One RCA type 6C5 tube;
One adapter and cable assembly, No. 977MML.



The unit in operation.



Wiring Diagram of Handy Beat Oscillator



Complete amplifier.

Compensation Of Amplifier Response

It is almost impossible to satisfy everybody with one particular amplifying system. Some prefer low-pitched reproduction — others, high. Then again the speakers as well as the acoustics of various rooms are so different that some compensation device must be used to obtain best results.

In any P.A. installation, it is of paramount importance that the reproduction be free from peaks. It is the peaks that tire the listener. A slightly rising characteristic is not at all objectionable. The best method to obtain this result is to start off with a flat microphone and flat amplifier and introduce compensation in the amplifier as required.

In order to create the illusion of hearing the original, not only must the frequency response be wide enough but the sound must have its original loudness. In movie and large hall installations, a signal louder than the original is required; in small rooms a signal lower in volume than the original. With a lower signal it is usually more desirable to increase the low-frequency response in order to create the illusion of the original, while with the louder signal it is best to increase the higher frequencies.

A system which can introduce a slightly rising characteristic is therefore immediately adaptable to practically any sound installation and can please any taste.

Equalizing devices have been used for a number of years to compensate for the losses in telephone lines. However, that type of equalizing system is not practical, due to its large cost and decrease in overall efficiency. Besides those compensating devices tend to introduce distortion of their own, due to transients. The latter become very objectionable when the equalization amounts to more than 15 db. per octave.

An inexpensive compensating circuit permits gradual compensation of low and high frequencies without any decrease in efficiency, or the introduction of annoying transients. This circuit is used in conjunction with a degenerative amplifier—the latter permitting a larger amount of power with a low per centage of harmonic distortion.

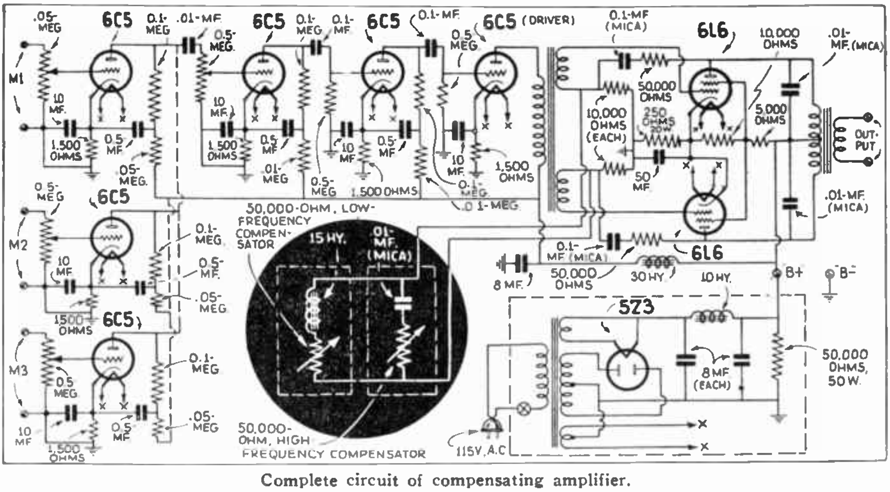
Standard parts are used throughout. All resistors without watts ratings are 1W. Condensers below 1 mf. should be paper, except those marked mica. The push-pull input transformer is of the split-secondary type and is obtainable in standard makes. Positions M2 and M3 can be added if an electronic mixer is needed—can be omitted if only one input is required. The diagram shows the various curves obtainable with the above compensating device. Any of the 9 curves shown can be obtained by adjusting the controls. For example, a rising low- and high-frequency response can be obtained as shown in curve AC. Of if you prefer you can obtain the curves AF, AD, EC, ED, BC, BF or BD.

A complete amplifier, with flat-response microphone, is shown in the diagram.

It is quite evident that even the most exacting person can be satisfied by a response following one of the above 9 curves.

In addition to its primary use for public address work, this amplifier may be use for recording, phono playback, or even as the audio section of a radio receiver.

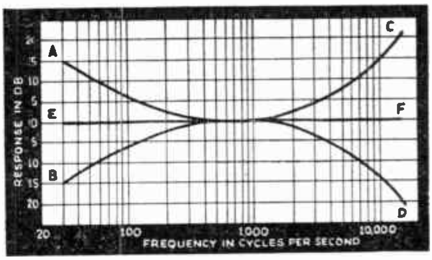
The various curves which it affords make it a true tone control. While a curve such as EF would give excellent response for a speaking



Complete circuit of compensating amplifier.

voice, at low output it would not give music as much "color" as might be desirable, in which case it might be adjusted to produce a curve such as AC, or if that proved too "boomy", EC, or even BC. When highs are objectionable, as they are under certain circumstances, they may be reduced, as the curve at D indicates. Such attenuation of the highs is sometimes desirable in playback work, particularly if the record has considerable surface noise or "needle scratch."

An amplifier as versatile as this one is provides the greatest possible degree of satisfaction, for it not only provides the most faithful reproduction, but also enables the user to compensate for defects in the original sound, poor transmission, acoustice peculiarities of the room where the installation is made, and even for the individual taste of the listeners.



Curves of amplifier.

The Radio-Craft Tube Tester

One ingenious idea that cut the cost of the tester is the use of a plain aluminum panel. This panel was carefully drilled as indicated in the drawing, with a series of beveled ¼ in. holes, located at each indicator marking position of the selector switches. Four pieces of white cardboard 2⅛ in. square with appropriate numbers and letters carefully drawn with india ink provided the scale markings for the various test positions. Transparent celluloid was used to cover the scales for protection from dust and damage.

Every part of the tester can be obtained from radio supply houses even to properly finished 2-color scales for the meter. If it is desired to make the scales for the meter in the lab. the details as shown can be followed.

The first step in constructing the tester is to lay out the panel very carefully for drilling. Cut the panel to the proper size and center-punch all holes as indicated, especially those holes used as windows for the various identifying switch numbers and letters. Countersink these holes from the top of the panel so that the minimum of shadow will be cast on the letters by the side walls of the holes.

Wire-in the interconnections between the various switch taps before mounting the switches on the panel. This applies to the several sections of Sw. 1, and Sw. 2, and Sw. 3.

After the switch wiring is finished and checked, start mounting all of the parts on the aluminum panel, including the indicator scales. The proper placement of the parts can be checked from the bottom view photograph and the mechanical drawing. The electrical circuit drawing is so laid out that all of the parts are in their proper mechanical place as well as showing the electrical connections. Test for panel shorts between alive terminals and the insulated jacks with an ohmmeter.

The 2 sections of the dual rheostat R1 are connected in parallel when the tester is used on 110 V. A.C. lines.

Wire-in the 5 tube sockets as indicated to the selector switches. Check each lead at least twice.

Wire-in the leads from the power transformer to the filament and plate supply circuits following the directions furnished with the particular transformer used.

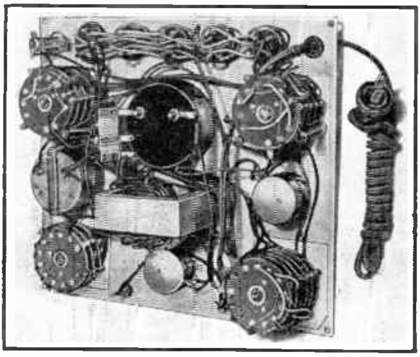
Check all wiring again so that no connections will be missed and if the final examination shows that the tester has been wired properly then proceed with the calibration which is very simple.

Take new tubes having different switch and shunt setting and adjust the position of the shunt knob on the 20-ohm rheostat, R5, so that the meter pointer reads 40 on the scale. This is in the GOOD area. Take a screwdriver and reset the bar knob on R5, so that when the meter pointer reads 40 on the scale the bar knob will be pointing to the proper number as given in the third or SHUNT SET, column on Table 1.

A new type 27 tube is a good starting tube. Set the 2 selector switches to A (left-hand Selector Switch) and X (right-hand Selector Switch). Vary the Shunt Control until the meter pointer reads about 40. Note the position of the Shunt Control bar knob. If it is at 91 no further changes are necessary. If it is some place else on the scale carefully reset the bar knob without changing the position of the moving contact arm to 91. Check with other tubes known to be good of the same type and then check tubes having different Shunt and Selector settings. If the tubes are good they will give meter readings of approximately 40 with the proper shunt setting. Thus it will be noted that the hardest part of calibrating is the proper setting of the shunt control bar knob.

Note: After the calibration is set, notice the relationship between the setting of the shunt rheostat contact arm and the actual position of the bar knob pointer. Rotate the knob (slowly) to the left. Ordinarily, it is impossible to bring the bar knob pointer to "O". Do not try to force the "O" position as you will upset the calibration for tube testing. The instructions for resistor and capacity testing call for a "O" setting of the shunt control. This means a "O" setting of the contact arm and not a "O" set position of the bar knob. When making "O" set adjustment simply turn the bar knob as far to the left as possible without forcing knob.

The R.C. Tube Tester.



Rear view of tester.

It is very important that the following instructions be memorized and that the same procedure be carried out every time a tube is tested.

First, turn all 4 selector switches to the blank indicator positions at the bottom of the scales. Connect the line cord to the A.C. circuit and the tester is ready to work.

When making short and leakage tests be sure that the tube selector switches are at the "Off" position. Turn the short test switch through the various test positions at 2-3, 3-4, C2, etc. The neon will glow brightly when a short occurs at any position of the switch. High-resistance leaks will be indicated by a dim glow of the neon.

Always make the short test first. If the short test is made after the tube has been heated there may be a glow from the neon for a short period of time even though there is no leakage in the tube. This false glow will rapidly disappear if the tube is not leaky.

Hot-cathode leakage tests can be made as follows. Set the Short Test switch to KL. There should be no indication on the test meter if there is no leakage. Any reading indicates leakage between heater and cathode.

After the short tests have been made and the tube tests O.K. proceed to test the tube in the following manner. Note allow ample time for the tube to heat and set Line Voltage Control so that the pointer on the A.C. meter is at the arrow.

(1) Turn the Short-Test Switch (Sw. 3) to the "T" position.

(2) Adjust the Filament Selector Switch (Sw. 4) as indicated on the chart.

(3) Reset the Line-Voltage Control so that the pointer is properly set at the arrow.

(4) Adjust the Shunt Control, R5, to the numerical setting indicated on the chart.

(5) Permit the tube to heat and note reading GOOD, or POOR.

Combination types of tubes with 2 sets of elements are tested individually as indicated in the Reference Chart. The 2 sets of elements are listed as A and B.

Rectifier Tubes are listed as (HW) half-wave (FW) full-wave. Diode sections are listed as (D). A reading beyond the line marked "Diodes" "OK" indicates a good diode section.

In some cases one setting of the tube selector switches is indicated. When this occurs the second selector switch can be in any position without affecting the test. However, it is best to set the unused selector switch at the "blank" position for such tests. This will help to avoid confusion.

When making Shunt settings be careful not to force the knob as this will upset the calibration of the instrument.

A type 84 tube is used for resistance and capacity measurements. This tube should be tested before it is used and the meter reading should be 40 when the shunt is set at 90. The Filament Selector Switch setting for this tube is 7. Do not use a tube that will not give a reading of 40. Do not touch the live ends of the test prods as the voltage across them is more than 100 V.

Set the Short Test Switch to the "R2" position and adjust the line voltage meter pointer to the arrow on the dial scale.

Connect the test leads to the top-jacks and short the opposite ends. Adjust the shunt until the meter reads full-scale (50). If the meter will not adjust to full-scale by varying the shunt, reset the Line Voltage Control until it does.

TABLE I

TUBE AND SWITCH REFERENCE CHART

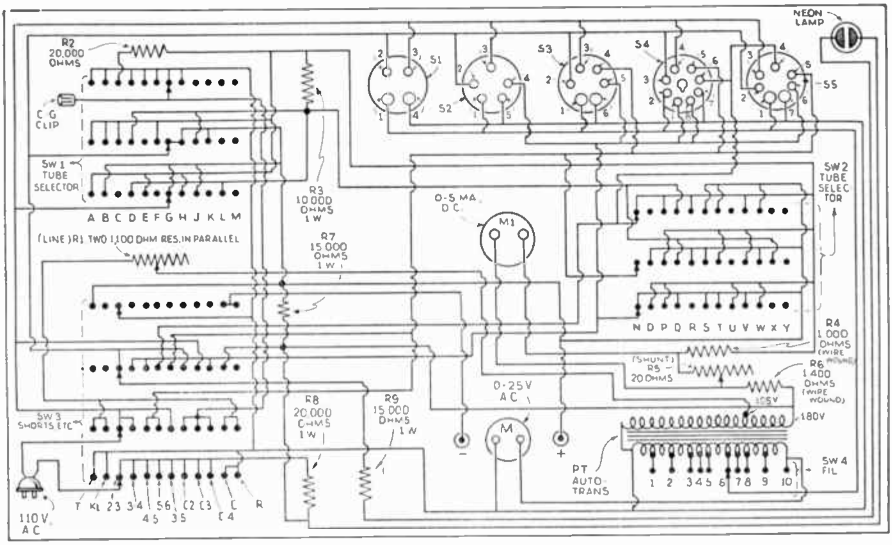
TUBE	FIL. SW.	TUBE SEL. SW.	SHUNT SET.
(Late Types)			
1A4	1	A	76
1A6 (A)	1	[illegible]	75
(B)	1	[illegible]	87
1B4	1	A	71
1B5 (A)	1	BL	84
(D)	1	[illegible]	70
1C6 (A)	1	[illegible]	80
(B)	1	[illegible]	50
1C7G (A)	3	[illegible]	43
(B)	3	[illegible]	90
1D5G	3	AN	72
1D7G (A)	1	[illegible]	82
(B)	3	[illegible]	82
1F4G	1	AN	75
1E7G (A)	3	AL	91
(B)	3	[illegible]	84
1F4	2	[illegible]	78
1F5G	3	CN	30
1F6 (A)	3	AN	87
(D)	3	[illegible]	74
1F7G (A)	3	CN	20
(D)	3	KX	60
1H4G	3	[illegible]	40
1H6G (A)	3	CN	87
(D)	3	KX	72
1J6G	3	AN	91
(B)	3	1T	91
2A3	4	B	89
2A5	4	AN	73
2A6 (A)	4	CN	40
(D)	4	[illegible]	80
2A7 (A)	4	[illegible]	70
(B)	4	[illegible]	90
2B6 (A)	4	[illegible]	65
(B)	4	[illegible]	60
4A7 (A)	4	AN	65
(D)	4	MQ	75
2B7 (A)	4	MT	84
(B)	4	AN	73
5V4G (A)	6	EN	92
(B)	6	[illegible]	92
5W4 (A)	6	[illegible]	90
(B)	6	[illegible]	90
5X4G (A)	6	[illegible]	91
(B)	6	IX	10
Connect 1 and 9 on [illegible] 5X4G 5Y4G			
5Y3 (A)	6	[illegible]	91
(B)	6	[illegible]	90
5Y4G (A)	6	[illegible]	91
(B)	6	IX	10
5Z3 (A)	6	[illegible]	91
(B)	6	F	91
5Z4 (A)	6	[illegible]	92
(B)	6	[illegible]	94
5Z4MG—See 5Z4			
6A3	7	B	90
6A4	7	BO	88
6A6 (A)	7	AN	92
(B)	7	IP	92
6A7 (A)	7	AN	88
(B)	7	1T	90
6A7MG—See 6A7			
6A8 (A)	7	AN	83
(B)	7	4T	91
6A8MG—See 6A8			
6B4G	7	FW	90
6B5	7	AN	45
6B6 (A)	7	CN	88

TUBE	FIL. SW.	TUBE SEL. SW.	SHUNT SET.
(D)	7	NQ	70
6B7 (A)	7	AN	80
(D)	7	NQ	80
6B7M—See 6B7			
6B8 (A)	7	[illegible]	65
(D)	7	NQ	79
[illegible]	7	[illegible]	40
6C5MG—See 6F8			
6C6	7	CN	65
6C8 (A)	7	CN	[illegible]
(D)	7	NQ	40
6D6	7	BN	85
6D8	7	AN	75
6D7	7	AN	45
6E6G (A)	7	AN	[illegible]
(B)	7	BT	[illegible]
6F5 (A)	7	AN	55
(B)	7	ET	55
[illegible]	7	AN	91
[illegible]	7	[illegible]	91
6F7	7	AN	75
6G5	7	[illegible]	30
6J5MG	7	[illegible]	30
[illegible]	7	[illegible]	[illegible]
[illegible]	7	[illegible]	[illegible]
6G7	7	[illegible]	[illegible]
[illegible]	7	AN	79
6T8M—See 6F7			
6G5 (A)	7	AN	80
(B)	7	[illegible]	90
6H6 (D)	7	JY	90
(D)	7	NQ	80
6H6MG—See 6H6			
6H7 (A)	7	1N	80
(D)	7	NQ	80
6H7M—See 6H7			
6J5G	7	CT	91
6J7	7	AN	45
6J7MG—See 6J7			
6K5G	7	CN	[illegible]
6K6G	7	AN	[illegible]
6K7	7	AN	70
6K7MG—See 6K7			
6K8G	7	IT	55
6L6	7	AN	[illegible]
6L7 (A)	7	CT	75
[illegible]			
6L7MG—See 6L7			
6N6 (A)	7	AN	[illegible]
(B)	7	IT	[illegible]
6N6G (A)	7	[illegible]	[illegible]
(B)	7	[illegible]	[illegible]
6N7 (A)	7	AN	[illegible]
(B)	7	MT	[illegible]
6P7 (A)	7	AN	[illegible]
(B)	7	BV	[illegible]
6Q6G (A)	7	CN	[illegible]
(D)	7	NQ	[illegible]
6Q7 (A)	7	CN	[illegible]
(D)	7	[illegible]	[illegible]
6R7 (A)	7	[illegible]	[illegible]
(D)	7	[illegible]	[illegible]
6S7G	7	[illegible]	[illegible]
6T7G	7	[illegible]	[illegible]
(D)	7	[illegible]	[illegible]
6Z5	7	[illegible]	[illegible]
6Z4 (A)	7	[illegible]	[illegible]
(B)	7	[illegible]	[illegible]
7A6 (A)	7	[illegible]	[illegible]
(B)	7	[illegible]	[illegible]
12A5	9	AN	[illegible]
12A7 (A)	9	AN	[illegible]

TUBE	FIL. SW.	TUBE SEL. SW.	SHUNT SET.
(B)	9	MT	91
12Z3	9	B	92
12Z5 (A)	9	BY	90
(B)	9	MO	90
14Z3	9	B	92
25A6	10	AN	[illegible]
25B6G	10	AN	91
25B8 (A)	10	BY	91
(B)	10	MO	91
25Z3	10	B	91
25Z5 (A)	10	BY	92
(B)	10	MO	92
25Z5MG—See 25Z5			
25Z6 (A)	10	BY	91
(B)	10	MT	91
(Early Types)			
01A	6	B	55
01A	6	B	60
1V (HW)	7	B	91
10	8	B	85
1-A	6	B	[illegible]
11	9	AN	55
15	3	AN	80
17	9	AN	90
18	9	AN	75
19 (A)	3	AN	90
(B)	3	MT	90
20	5	B	77
22	3	A	60
24A	4	AN	60
26B (A)	4	BU	94
(B)	1	DQ	70
26	2	B	71
27	4	AN	41
29	4	AN	[illegible]
30	3	B	60
31	3	B	[illegible]
32	3	A	60
33	3	AN	90
34	3	A	70
35	4	AN	70
36	7	AN	90
37	7	AN	90
38	7	AN	[illegible]
39MG	7	AN	[illegible]
39	7	AN	[illegible]
40	8	AN	[illegible]
41	7	AN	90
41M	7	AN	80
42	7	AN	70
43	0	AN	[illegible]
43MG	10	AN	[illegible]
44	7	AN	40
45	4	B	[illegible]
46	4	BO	[illegible]
47	4	AN	90
48	10	AN	90
49	3	BO	81
50	8	B	[illegible]
51	4	AN	70
52	2	AN	[illegible]
53 (A)	4	AN	[illegible]
(B)	4	MT	[illegible]
55 (A)	4	CN	[illegible]
(D)	4	DQ	80
58AS (A)	7	AN	83
(D)	7	DQ	80
56	4	AN	90
57	4	AN	90

TUBE	FIL. SW.	TUBE SEL. SW.	SHUNT SET.
57AS	7	AN	80
58	4	AN	73
58AS	7	BN	70
59	4	AN	80
64	7	AN	80
65	7	AN	84
67A	7	AN	80
68	7	AN	85
69	7	AN	89
70	7	AN	88
71A	6	B	87
75 (A)	7	CN	84
(D)	7	DQ	80
75MG—See 75			
76	7	AN	91
77	7	CN	45
78	7	AN	74
79 (A)	7	AR	90
(B)	7	CO	63
80 (FW) (A)	6	E	91
(B)	6	F	91
81 (HW)	6	F	91
82 (FW) (A)	4	E	91
(B)	4	F	91
83 (FW) (A)	6	E	91
(B)	6	F	91
83V (FW) (A)	6	E	91
(B)	6	F	91
84 (FW) (A)	7	EN	90
(B)	7	FN	90
85 (A)	7	CN	87
(D)	7	DQ	80
6A4	4	E	85
85AS (A)	7	CN	87
(D)	7	DQ	80
87	7	AN	83
88 (FW) (A)	7	E	91
(B)	7	F	91
89	7	AN	85
89RS (A)	7	AO	85
(B)	7	OU	82
90 (A)	4	CN	78
(D)	4	DQ	80
95	4	AN	84
98 (FW) (A)	7	EN	88
(B)	7	FN	85
99	8	B	30
183	8	V	88
401	3	B	60
482A	6	B	85
484A	5	B	90
485	8	BN	80
486	5	B	83
586	8	B	85
861	8	B	40
864 (A)	7	EN	91
(B)	7	FN	91
865	1	B	40
866	4	C	30
950	3	AN	55
951	3	A	88
965 (FW) (A)	6	EN	80
(B)	6	FN	80
LA	7	EO	88
PZ	4	AN	80
PZH	4	AN	82
Wund	6	AN	90
Wund (Auto)	7	AN	90

Reference chart for different tubes.



Wiring diagram of tube tester.

Connect the test leads to the resistor or circuit to be measured and note the meter reading. Refer to Fig. 3 and note the value of resistance. A reading of 34 on curve "A" indicates a resistance value of 13,000 ohms.

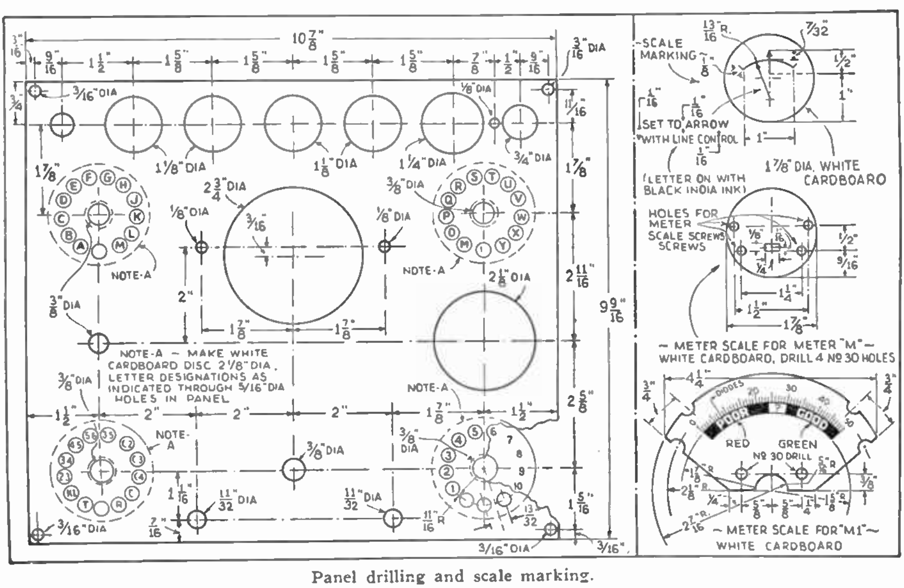
Resistors having a value greater than 50,000 ohms can be checked by setting the shunt to "O"; read meter and refer to curve "B" to determine the resistance. Remember, "O" setting of the Shunt control will not be the "O" setting of the knob but will be the "O" setting of the contact arm. Do not force the knob as it will upset calibration of the instrument for tube testing.

Circuits having a resistance greater than 1 meg. and up to 10 megs. can be checked for continuity by setting the Short Test Switch on "C" and watching the neon tube. A faint glow will be seen even though the resistance of the circuit under test is 3 megs. or more.

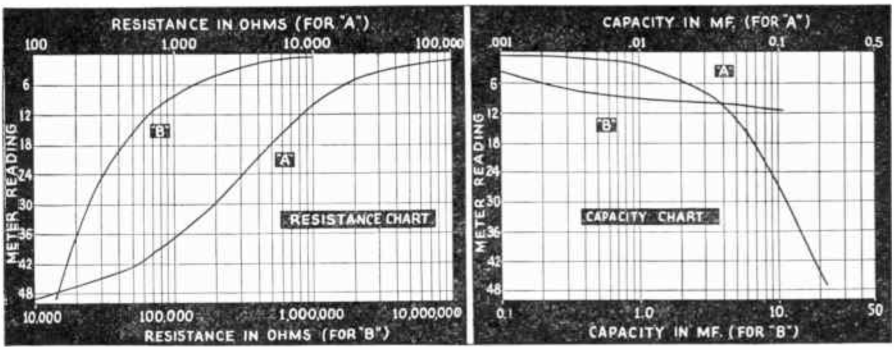
Leave the 84-type in the socket and set the Short Testing Switch to "C". The Filament Switch will be set at 7, and the Selector Switches at "EN."

Adjust the Line Voltage Control so that the pointer is set at the arrow on the scale. Set the Shunt Control to "O" and connect the test leads to the capacity under test. Electrolytic condensers can be measured but be sure that the red lead or tip-jack connects to the positive side of the condenser.

Read meter and note capacity by referring to



Panel drilling and scale marking.



Charts for using tube tester.

the Capacity Chart. Use scale "A" if the value is less than 0.25-mf. Capacities greater than 0.25-mf. will cause the meter pointer to go off scale. Reset the Shunt Control to 90 and check meter reading with the "B" scale on the chart.

Very small values of capacity can be noted by watching the neon lamp. A faint glow around one of the lamp sections indicates a good condenser. An open condenser will give no glow at all and a shorted condenser will cause a bright flash and the meter pointer will go off scale.

List of Parts

One aluminum panel, 9 9/16 x 10⅜ x 1/16-in.;
One Dependable 0-5 ma. Milliammeter, 5½ in. fan type, M1;
One Dependable 0-25 V. A.C. iron-vane type, M2;
One Dependable English-reading scale for M1;
One Dependable line-set scale for M2;
One Dependable 1-pole, 12-pos. selector, Sw. 4;
One Dependable 3-pole, 12-pos. selector, Sw. 1, Sw. 2;
One Dependable 4-pole, 12-pos. selector, Sw. 3;
One Dependable fil.-plate transformer, P.T.;
One Electrad 20-ohm wire-wound rheostat, R5;
One Electrad 1,100-ohm dual rheostat, R1;
One 1 W. carbon resistor, 10,000 ohms, R3;
Two 1 W. carbon resistors, 20,000 ohms, R2, R8;
Two 1 W. carbon resistors, 15,000 ohms, R7, R9;
One 2 W. wire-wound resistor, 1,000 ohms, R4;
One 2 W. wire-wound resistor, 1,400 ohms, R6;
Five sockets:—one 4-prong; one 5-prong; one 6-prong; one octal; one 7-prong universal;
One 2-in. etched scale, marked 0-100, 270 deg.;
Six Allied Radio Corp. small bar knobs;
One Allied Radio Corp. 8 ft. line cord and plug;
One neon lamp;
One universal insulated grid cup;
One candelabra base for neon lamp;
Two insulated tip-jacks—1 Red, 1 Black.

CHAPTER 5

Recent New Tubes

THIS crop of new tubes affords the experimenter an opportunity to try out many of his pet circuits.

In this chapter we present a rather complete list of tubes together with their operating characteristics.

6AB6G Dynamic-Coupled Power Tube.

Since the type 6B5 tube was developed early in 1935, many manufacturers of auto-radio sets have selected this unique tube for their higher priced sets. The unique qualities of the "dynamic coupling" which provide a high power sensitivity, yet with lower harmonic distortion than equivalent pentode types, added to the remote cut-off characteristic, made it a popular one.

The new 6AB6G is a strictly class A tube and as such, any of the high-resistance amplifiers may be used to supply the input signal; a grid resistor of 1 meg. is permissible under any operating conditions. When used in push-pull, the plate power can be reduced during periods of no-signal by connecting a self-bias resistor in the cathode lead (80 ohms) to introduce a 5 V. bias. This provides a semi-class AB operation in that plate current is reduced—but no driving power is required for this service.

6AB6G Characteristics

Heater voltage	6.3 A.C. or D.C.
Heater current	0.5-A.

Amplifier (Class A)

	Single	Push-Pull	
Output plate (P2)	250	250	max. V.
Input plate (P1)	250	250	max. V.
Grid	0	0	V.
Plate current (P2)	34	68	ma.
Plate current (P1)	5	10	ma.
Amplification factor	72		
Plate resistance	40,000		ohms
Mutual conductance	1,800		mmhos
Load resistance	8,000	10,000 p-p	ohms
Power output	3.5	8	W.
Harmonic distortion	10	6.5	per cent
Signal volts for rated power	18	42	g-g r.m.s.

Push-Pull Amplifier (Class AB)*

Output plate (P2)	245	max. V.
Input plate (P1)	245	max. V.
Self-bias resistor**	80	ohms
Zero-signal plate current (P2)	50	ma.
Full-signal plate current (P2)	68	ma.
Zero-signal plate current (P1)	8	ma.
Full-signal plate current (P1)	17	ma.
Load resistance	10,000 p-p	ohms
Power output	8	W.
Harmonic distortion	10	per cent
Signal volts for rated power	53	g-g r.m.s.

Push-pull values are for 2 tubes.

*Grid current does not flow during any part of the input cycle.

**Common cathode resistor which is not by-passed. If this resistor is adequately bypassed or if a fixed bias of -5-V. is used, the class AB distortion is reduced nearly to that of the class A push-pull.

The total resistance introduced into the grid circuit by the input coupling device should not exceed 1.0 meg.

The characteristics of the new 1-in. cathode-ray tube, to be known as the type 913, are listed below.

913 Characteristics

Heater voltage (A.C. or D.C.)	6.3 V.
Heater Current	.6 A.
Fluorescent Screen Material	Phosphor No. 1
Direct Interelectrode Capacity:	
Control Electrode to all other Electrodes	10.3 max. mmf.
Deflecting Plate D1 to Deflecting Plate D2	3.55 max. mmf.
Deflecting Plate D3 to Deflecting Plate D4	4.25 max. mmf.
High-Voltage Electrode (Anode No. 2) V.	500 max. V.
Focusing Electrode (Anode No. 1) V.	125 max. V.
Control Electrode (Grid) V.	Never positive
Grid Voltage for Current Cut-off-50 approx. V.	
Peak Voltage between Anode No. 2 and any Deflecting Plate	250 max. V.
Fluorescent Screen Input Power/sq. cm.	5 max. milli-W.

Typical Operation:

Heater Voltage	6.3	6.3	V.
No. 2 Anode Voltage	250	500	V.
No. 1 Anode Voltage	45	90	V.
Grid Voltage	Adjusted to give suitable luminous spot		
Deflection Sensitivity			
Plates D1 and D2	.15	.07	mm per volt D.C.
Plates D3 and D4	.21	.10	mm per volt D.C.

6AC6G Dynamic-Coupled Tube

Like the 6AB6G, the new 6AC6G, also developed by Triad, is a twin-triode tube, dynamically-coupled within the envelope of the tube itself. This tube is similar to the well-known 6B5, but is designed for those small A.C. sets which operate with a low plate voltage (less than 180 V.) in conjunction with a series speaker field.

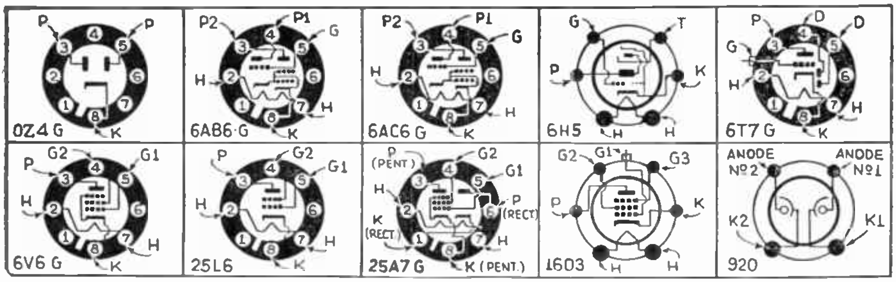


Fig. 1. Socket connections. Notice the complicated construction.

It is expected that a field of 700 to 800 ohms will be used as the filter choke, which will give both ample plate supply filtering and ample field power. A single tube used in this way will provide 4 W. of audio power at 10 per cent over-all harmonic distortion.

There will be no difficulty in providing sufficient input signal to the grid of the 6AC6G if the type 75 or 6Q7 voltage amplifier is operated with a plate voltage of 180. The resistance of the grid circuit may be as high as 1 meg. which is of importance in resistance-coupled A.F. systems. In some cases, the over-all sensitivity will be greater than in systems using a more sensitive output tube which requires a lower value grid resistance, and thus reduces the gain of the preceding stage.

When used in push-pull the 6AG6G will produce 9.5 W. of audio power at a total harmonic distortion of 10 per cent. When necessary to minimize plate current, a bias of 50 ohms which reduces the total plate current to 70 ma. at no-signal. may be used.

6H5 Tuning Indicator. The 6H5 differs from the 6G5 and 6E5 tuning indicator tubes in the addition of a current-limiting grid around that portion of the cathode which furnishes emission for the target current.

The A.V.C. voltage required to change the shadow from 90 deg. to 0 deg. is 22 V. Where the A.V.C. voltage in the receiver reaches higher values than 22 V., a voltage dividing system is necessary to limit the bias applied to the 6H5.

6T7G Duo-Diode High-Mu Triode. This is a new tube having a filament current of only 0.15-A. The tube has characteristics very similar to the 6Q7G. The triode section operated with a plate voltage of 250 and a plate load resistor of 0.1- to 0.25- meg. should have a negative bias of 2.5 V. on the grid.

6V6G Beam-Power Amplifier. The 6V6G is a beam-power amplifier similar in design features to the 6L6G, but having a high power sensitivity, high power output, and low percentage of third and higher order harmonics.

The 6V6G should prove very desirable where heater and plate current must be maintained at a minimum. The heater current of 0.45-A. is rather low for a power tube having the power capabilities of the type 6V6G.

6V6G Characteristics

**Class AB1 amplifier (push-pull)
Values are for 2 tubes**

Heater voltage	6.3	6.3 V.
Plate voltage	250	300° V.
Screen-grid voltage	250	300° V.
Total plate and screen-grid dissipation (per tube)	.....	12.5W.max.
Control-grid voltage*	-15	-20 V.
Peak input signal (grid to grid)	21.2	28.2V.apprx.
Plate current (zero signal)	70	78 ma.
Plate current (max. signal)	79	90 ma.
Screen-grid current (zero signal)	5	5 ma.
Screen-grid current (max. signal)	12.	13.5 ma.
Load Resistance (plate to plate)	10,000	8,000 ohms
Total harmonic distortion	4	4 per cent
3rd harmonic	3.5	3.5 per cent
Power output	8.5	13.5 W.

°Maximum. "1" used in conjunction with the terms class A and class AB indicates that no grid current flows during any part of the input cycle.

*Transformer and impedance coupling devices are recommended and the resistance introduced in the control-grid circuit should be kept as low as possible. For fixed bias this resistance should not exceed 50,000 ohms. The maximum control-grid resistance when self-bias is employed may be 0.5-meg.

The self-bias resistor should be shunted with a suitable filter network to reduce degeneration.

25A7G Pentode - Rectifier Tube. This tube combines the functions of power amplification and rectification within one envelope. A pentode power-output section similar to the type 43 and a half-wave rectifier—somewhat similar to the 12Z3—compose the internal elements.

Designed for small A.C.-D.C. receivers where space is at a premium, this combination tube will produce a power output of 0.77-W. with about 9 per cent distortion and will supply a voltage for the speaker field and the plate supply at a maximum current of 75 ma.

25A7G Characteristics

Heater voltage	25.0 V.
Heater current	0.3-A.
Operating Conditions	Pentode Section
Plate	100 V.
Screen-grid (grid No. 2)	100 V.
Control-grid (grid No. 1)	-15 V.
(Grid No. 3 tied to cathode within tube)	
Plate current	20.5 ma.
Screen-grid current	4 ma.
Amplification factor	90
Plate resistance	50,000 ohms
Mutual conductance	1,800 mmhos
Load resistance	4,500 ohms
Total harmonic distortion	9 per cent
Power output	770 milliwatts
	Rectifier Section
A.C. plate voltage (r.m.c.)	125 max. V.
D.C. output current	75 max. ma.

25L6 Metal Beam Power Amplifier. The design of the 25L6 is similar to that of the 6L6 with the difference that the 25L6 is intended for use in the output stage of transformerless receivers operating from a 115 V. power line, either A.C. or D.C. According to the data received from RCA, this tube has high sensitivity, high efficiency and high power output. With 110 V. on the plate and screen-grid, the 25L6 is capable of giving an output of 2.2 W. with a maximum signal input of only 5.3 V, r.m.s.

25L6 Characteristics

Heater voltage	25.0 V.
Plate voltage	110 max. V.
Screen-grid voltage	110 max. V.
Control-grid voltage	-8 .V
Zero-signal plate cur.	45 ma.
Max.-signal plate cur.	48 ma.
Zero-signal screen-grid cur.	3.5 ma.
Max.-Signal screen-grid cur.	10.5 ma.
Signal input voltage	5.65 V. r.m.s.
Plate resist. (Approx.)	10,000 ohms
Transconductance	8,000 mmhos
Load resistance	2,000 ohms
Distortion: Total harmonic	11.5 per cent
Power output	2.2 W.

25Z5 Improved Rectifier. One radio tube company* has just released an improved type of 25Z5 rectifier tube which reduces to a minimum the possibility of flash-overs, open cathode tabs, slow heating, shorts and filament burnouts. These improvements should remove some of the headaches which dealers and Service Men have encountered with this type of tube.

920 Twin Phototube. This new tube announced by the RCA Manufacturing Co. is a gaseous-type photoelectric cell containing 2 separate photo-cells in one glass envelope. It is designed primarily for use with double-soundtrack film in a system of sound reproduction having a high signal-to-noise ratio. In this system the light on one unit of the 920 varies from zero to maximum in accordance with the positive half-cycles of the signal recorded on one sound track. The light on the other unit varies from zero to maximum with the negative half-cycles recorded on the other sound track. The outputs of the 2 phototube elements are combined to give a full-wave signal current.

1603 Triple-Grid Detector-Amplifier. This tube is designed for preamplifier equipment which is critical as to noise and microphonics. As a pentode, the 1603 is capable of delivering a large A.F. output voltage with relatively low input voltage. As a triode (that is, with the grids tied together) the tube has a high mutual conductance together with a comparatively high amplification factor. The tube is constructed with an internal shield connected to the cathode.

1603 Characteristics

Heater voltage (A.C. or D.C.)		6.3 V.
Heater current		0.3-A.
As class A amplifier pentode		
Plate voltage	100	250 max. V.
Screen-grid voltage (grid No. 2)	100	100 max. V.
D.C. grid voltage (grid No. 1)**	-3	-3
Suppressor (grid No. 3)	tied to cathode at socket	
Amplification factor	1,185	greater than 1,500
Plate resistance	1.0	Greater than 1.5 megs.
Mutual conductance	1,185	1,225 mmhos
Plate current	2	2 ma.
Screen-grid current	0.5-	0.5- ma.
As class A amplifier triode*		
Plate voltage		
D.C. grid voltage	180	250 max. V.
Amplification factor	-5.3	-8 V.
(approx.)	20	20
Plate resistance	11,000	10,500 ohms
Mutual conductance	1,800	1,900 mmhos
Plate current	5.3	6.5 ma.

*D.C. grid voltage is -7 V. for cathode current cutoff.

ULTRA HIGH-FREQUENCY OSCILLATOR

The 316A 0.4-Meter Transmitting Tube. The radio amateur and experimenter in ultra-high frequency equipment will be interested in the new W.E. type 316A tube which provides approximately 7.5 W. output at frequencies up to 750 megacycles (about 0.4-meter).

The tube is a direct-filament triode made without a base, to eliminate the capacity and losses associated with the insulation and parallel prongs at the very high frequencies. For correct oscillation at the upper frequency limit of the tube it is necessary to provide tuning in the filament to ground circuit. The use of adjustable concentric lines of approx. ¼-wavelength is probably the most satisfactory arrangement. The grid and plate leads should also be connected at node points, if possible.

316A Characteristics

Amplification factor	6.5
Plate resistance	2,700 ohms
Grid-to-plate transconductance	2,400 micromhos

Average Direct Interlectrode Capacities

Plate-to-grid	1.6 mmf.
Grid-to-filament	1.2 mmf.
Plate-to-filament	0.8 mmf.

Maximum Ratings

Max. direct plate voltage	450 V.
Max. direct plate current	80 ma.
Max. direct grid current	12 ma.
Max. plate dissipation	30 W.

Maximum plate voltage may be used at any frequency if maximum plate dissipation is not exceeded.

R.F. Oscillator or Amplifier—Unmodulated

Max. direct plate voltage	450 V.
Max. direct plate current	80 ma.
Max. direct grid current	12 ma.
Nominal power output at 500 mc.	7.5 W.

Grid bias or leak should be adjusted to optimum value for the particular tube.

R. F. Oscillator or Amplifier—Plate Modulated

Max. direct plate voltage	400 V.
Max. direct plate current	80 ma.
Max. direct grid current	12 ma.
Nominal carrier power at 500 mc.	6.5 W.

Grid bias or leak should be adjusted to optimum value for the particular tube.

VARIABLE-MU ACORN PENTODE

The 956 Acorn. A tiny tube of particular interest to the short-wave radio man is the new acorn tube just released by RCA. This tube, known as the 956, is a companion tube to the 954 pentode, having similar heater characteristics and physical size, but having variable-mu characteristics. This variable mu characteristic makes the tube very effective in reducing cross-talk and modulation distortion. The tube may be used as an R.F. and I.F. amplifier, or as a mixer in receivers operating at wavelength as low as 0.7-meter!

956 Characteristics

Heater Voltage (A. C. or D. C.)	6.3	V.
Heater Current	0.15	A.
Plate Voltage	250 max.	V.
Screen-grid Voltage	100 max.	V.
Control-grid Voltage (Minimum)	-3	V.
Suppressor-grid	Connected to	Cathode at socket
Plate Current	5.5	ma.
Screen-grid Current	1.8	ma.
Plate Resistance	0.8	Meg.
Amplification Factor	1,440	
Mutual Conductance	1,800	Micromhos
Mutual Conductance (At -45 V. bias)	2	Micromhos
Grid-Plate Capacity (with shield-baffle)	0.007 max.	mmf.
Input Capacity	2.7	mmf.
Output Capacity	3.5	mmf.

NEW NON-DISTORTING OSCILLOSCOPE TUBE

The 34-XH Oscilloscope Tube. By means of several changes in the design and construction of their 3-in. type 34-XH tube the Allen B. Dumont Labs. has been able to effect two outstanding changes in the characteristics.

First, the addition of a corrector electrode, tied internally to the gun and changes in the shape of the gun itself combine to eliminate the "edge distortion" prevalent, up to this time, in all 3-in.

New tubes appear from time to time, and it is manifestly impossible for anything save a monthly or weekly periodical to keep abreast of current developments.

Readers who are interested in this phase of radio should by all means become regular readers of some technical or trade publication which feature this type of information. Incidentally, R. D. Washburn, managing editor of Radio-Craft Magazine, is an authority on the subject, and his articles, "The Month's New Tubes" appear regularly in that publication.

Trends in tube design have been marked, from time to time. Shortly after the 5-volt tubes made their appearance, there was a trend toward reducing filament current, followed by a trend toward multiple elements and, subsequently, to highly developed special purpose tubes. More recently came the metal tube trend, and a development of this is seen in the octal-base glass tubes, with standardized elements and envelopes, which at least one manufacturer is producing.

What the next trend will be can be learned only by keeping abreast of engineering work, through reading various technical radio publications.

tubes. The corrector electrode (a new term in oscilloscopy) is placed at the end of the deflector plates and serves to step up the speed of the cathode stream to the speed at the end of the gun, thus eliminating the retarding action of the deflectors.

Second, the correction of the image has also permitted increasing the sensitivity of the tube to just twice the sensitivity of previous types!

The combination of these two improvements has resulted in a vastly improved tube in the popular 3-in. size.

0Z4G Full-Wave Gas - Filled Rectifier (Ionic-Heated-Cathode Type). The 0Z4G was developed primarily for use in vibrator-type "B" supply units for automobile receivers, according to the Raytheon Production Corp. from which the characteristics were obtained. This tube has the typical characteristics of all gaseous rectifiers (old-timers will remember the BH and BA rectifiers of this type) as regards a constant internal voltage drop and ability to handle peak currents. In common with the older types of ionic-heated gas-filled tubes, the 0Z4G has a tendency to generate R.F. noise. This R.F. interference can be eliminated by proper filtering and by connecting the metal shell to the point giving the best shielding. The shielding and filtering commonly used to eliminate vibrator noise will usually be sufficient.

This tube is available both in glass and metal types, both having octal bases. In the metal type, the metal shell serves chiefly as a container and electrostatic shield for the glass bulb which is required to insulate the contained gas from the grounded shell.

0Z4G Characteristics

D.C. voltage output	300 max. V.
D.C. output current	30 min. ma.
	75 max. ma.
Peak plate current	200 max. ma.
Starting voltage	300 min. V.
Voltage drop (dynamic)	24 avg. V. (peak)

5U4G Rectifier Tube. This rectifier, according to a bulletin from Raytheon Production Corp., has similar characteristics to the glass rectifier—type 5Z3. It is equipped with an octal base though, instead of the older type.

6A8, 6L7 and 6K7 Isolantite Grid Caps. Also received from Raytheon is news that the 3 types of tubes mentioned here are now fitted with isolantite insulation between the metal shell and the grid cap. This reduces R.F. losses at high frequencies, where the insulation resistance of most insulating materials falls off badly. The gain in short-wave and the high-frequency bands of all-wave receivers is definitely improved, according to the engineering report.

AMPLIFIER

6C8G (Glass) Twin Triode Voltage Amplifier. The triode units of this tube are independent of each other as the elements of this triode are brought out to separate prongs. Designed for service as a voltage amplifier or phase inverter. The voltage between heater and cathode should be kept as low as possible for they are not directly connected. Both triodes have been designed to match each other closely making it possible to build an inexpensive high-quality push-pull audio output system. The mechanical design is illustrated in Fig. 2.

Ratings

Heater voltage	(A.C. or D.C.) 6.3 V.
Heater current	0.3 A.
Max. plate voltage	250 V.

Direct Interelectrode Capacities

	Triode L (triode R to cathode)	Triode R (triode L to cathode)
Grid-to-plate	2.5	2.4 mmf.
Input	3.4	2.5 mmf.
Output	3.5	3.9 mmf.
Grid-to-grid	0.1	
Plate-to-plate	1.5	

Amplifier—Class A—Each Triode

Plate voltage	250	V.
Grid bias	-4.5	V.
Amplification factor	38	
Plate resistance	26,000	ohms
Transconductance	1,450	micromhos
Plate current	3.1	ma.

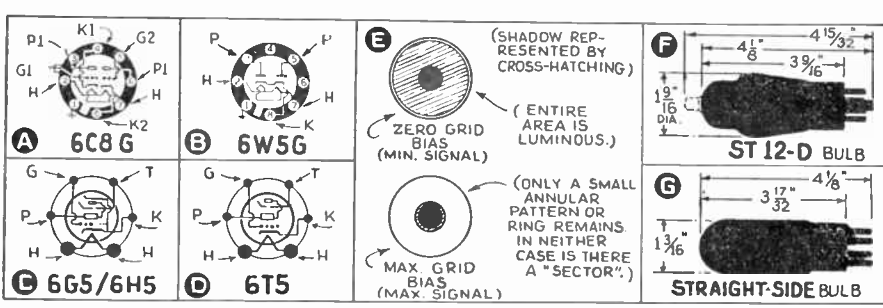


Fig. 2. Base connections and bulb styles.

Phase Inverter

Plate supply voltage	250	250	V.
Control-grid bias	-3	-3	V.
Plate current (per plate)	1.7	1	ma.
Plate resistor (per plate)	0.05-	0.1-megohm	
Grid resistor (following tubes)	0.1-	0.5-megohm	
Maximum output voltage r.m.s. (G to G)	60	80	V.
Cathode resistor (common to both triodes)	900	1,500	ohms

RECTIFIER

6W5G (Glass) Rectifier for Car-Radio Sets. This tube is interchangeable with the type 6X5 and 6X5G, where higher output is desired. The tube was designed primarily for service in car-radio receivers and may be used in either vibrator type or A.C. operated power supplies.

**Full-Wave Rectifier—
Condenser-or Choke-Input Filter**

Heater voltage (A.C. or D.C.)	6.3 V.
Heater current	0.9 A.
Max. A.C. voltage per plate (r.m.s.)	350 V.
Max. D.C. output current	100 ma.
Max. D.C. voltage between heater and cathode	500 V.

TUNING INDICATORS

6G5/6H5 Remote Cutoff Tuning Indicator. This is an improved type of tuning indicator interchangeable with the old 6G5. This tube affords "almost unbelievably better and more uniform illumination" with both high- and low-voltage supplies than its predecessor, states one manufacturer. The most noticeable improvement is that it maintains constant current throughout its normal life and has no tendency to "run away."

6T5 Annular-Pattern Tuning Indicator. Instead of "opening" like a fan, the "eye" of this new tube fills the area uniformly as shown in Fig. 2. This tube has operating conditions similar to those for the 250 V. rating of the type 6G5.

The lighted portion covers only a very narrow region at the periphery of the target when no voltage is applied to the control-grid of the tube. When negative voltage is applied to the control-grid the width of the fluorescent ring increases until it covers practically all of the target. Changes in annular width, or diameter of the shaded section, are more readily detected than are changes in the shaded angular sector when the type 6G5 is employed.

In actual circuit use the varying negative voltage for controlling the shadow may be obtained from some point in the A.V.C. circuit, thus giving an indication of resonance when the unlighted portion of the target is at a minimum.

Type 6T5 is mounted in a T-9 bulb on a standard small 6-pin base. The tube is not designed for 100-volt operation.

Characteristics

Heater voltage A.C. or D.C.	6.3 V.
Heater current	0.3-A.

Operating Conditions and Characteristics

Heater voltage	6.3 V.
Plate supply voltage	250 V.
Target supply voltage	250 V.
Plate current (triode unit)*	0.24-ma., max.
Target current	3.0 ma., approx.
Control-grid voltage (triode unit)‡	0.0 V.
Control-grid voltage (triode unit) ‡‡	-22.0 V.
Triode plate resistor	1.0 Megohm

*With triode grid voltage of zero volts.
‡For minimum illumination of target.
‡‡For maximum illumination of target.

SPECIAL SERVICE

2-RA-6 Mercury Rectifier Charger Bulb. This is the first in a new line of rectifier tubes being produced by a well-known manufacturer of electronic devices. The tube, illustrated in Fig. C, is interchangeable with other bulbs of the same rating, despite the fact that it incorporates many radical developments.

Chief among these is the new and different type of filament, of non-sagging construction, which has been designed along the lines of those used in industrial tubes where a life expectancy of 5,000 to 10,000 hours must be had; the life of the 2-RA-6 in practical service considerably exceeds its factory rating of 2,000 operating hours.

The universal type of cap connection permits the use of a fahnestock clip. Base connection is welded-on. Designed for use in battery chargers or any other device where rectified alternating current is desired.

Characteristics

Filament voltage	2 V.
Filament current	13 A.
Output	6 A.
Inverse peak voltage	300 V.

WL-461 Ultra-H.F. Therapy and Radio Oscillator-Amplifier. Some of the main fields of application in which this new tube will be used, due to its unique characteristics, are for therapy, radio, and such other purposes as may require an ultra-high frequency oscillator and amplifier.

In therapy work, in particular, it will permit higher power output to be obtained at the shorter wave lengths than has heretofore been conveniently possible. It can be used equally well in ultra-high frequency radio transmitters, wherever a 3-element radio frequency amplifying tube of its characteristics is required.

This tube has a plate dissipation of 160 W. and is capable of delivering 400 W. of useful power up to 50 megacycles.

The simplification of the internal supporting structure has also made it possible to reduce the size of the tube to the point where only a minimum amount of space need be reserved for it.

Ratings

Max. D.C. plate voltage	2,000 V.
Max. A.C. plate voltage	2,500 V.
Max. plate current	250 ma.
Filament voltage	5 V.
Filament current	11.5 A.

AMPLIFIERS

**6V6 Unipotential-Cathode Tetrode
Power Amplifier.**

The 6V6 and 6V6G (the latter is described elsewhere in this chapter) tubes were designed by one company primarily for use in the output stage of auto-radio receivers. Both have similar characteristics, the chief advantages being (1) use of the beam principle introduced first in the 6L6 and (2) a relatively low heater drain of only 450 milliamperes. Its features permit high output power to be realized in the automobile-type radio receiver without any appreciable increase in the drain from the storage battery. In fact, some manufacturers of deluxe auto sets are using two 6V6G tubes in push-pull in the output stage of their receivers.

The 6V6 is similar to the 6F6 in size (and the 6V6G compares with the 6F6G and 42 in size and general appearance).

6J5 Detector and Amplifier Triode. Except for its higher transconductance this tube is similar to the type 6C5 tube. More detailed data follow. See Fig. 3B.

The 6J5 is a new addition to the line of metal receiving tubes. This new tube, a detector-amplifier triode, has an exceptionally high value of transconductance — 2,600 micromhos. The other characteristics of the tube are similar to those of the 6C5. Because of the high transconductance of the 6J5, the tube makes an excellent oscillator for superheterodyne receivers. The high transconductance also gives the tube advantages for use as the frequency-control tube in A.F.C. circuits.

Characteristics

Heater voltage (A.C. or D.C.)	6.3 V.
Heater current	0.3-A.
Direct interelectrode capacities*	
(approx.)—grid-plate	3.4 mmf.
grid-cathode	3.4 mmf.
plate-cathode	3.6 mmf.

*With shell connected to cathode.

As Class A[1] Amplifier

Plate voltage (max.)	250 V.
Control-grid voltage	-8 V.
Plate current	9 ma.
Plate resistance	7,700 ohms
Amplification factor	20
Transconductance	2,600 mmhos.

Screen-grid voltage	135 V.
Control-grid bias	-13.5 V.
Transconductance	7,000 mmhos.
No-signal plate current	58 ma.
Max.-signal plate current	60 ma.
No-signal screen-grid current	3 ma.
Load resistance	2,000 ohms.
Power output	3.6 W.
2nd-harmonic	2.5%
3rd-harmonic	9%

6V6G (glass) Unipotential-cathode Tetrode Power Amplifier. Transformer or impedance input are recommended for use with this tube. If resistance-capacity coupling is used the D.C. resistance in the control-grid circuit must not exceed 0.5-meg. with self-bias, or 0.1-meg. with fixed-bias. Note that the voltage between heater and cathode should be kept as low as possible. A direct connection is recommended. See Fig. 3D.

Characteristics

Heater voltage	6.3 V.
Heater current	0.45-A.
Plate voltage (max.)	300 V.
Screen-grid voltage (max.)	300 V.
Plate and screen-grid dissipation (total)	12.5 W.

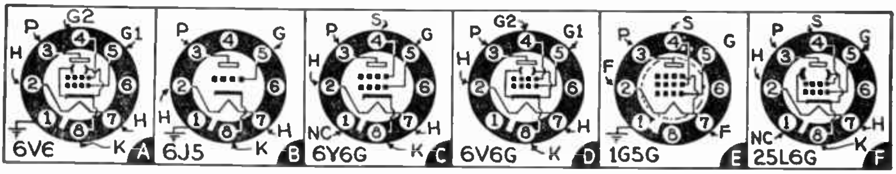


Fig. 3 Connections for 6 new tubes.

6Y6G Heater-Type Tetrode Power Amplifier. The usual A.C. radio receiver operates with fairly high plate voltages. The A.C.-D.C. receivers operate at considerably lower voltages. The recent introduction of 2 tubes, the 25B6G and 25L6, for A.C.-D.C. receivers has made possible receivers giving approximately 2 W. output at about the same cost as the previous A.C.-D.C. receivers which gave about 0.9-W. output.

The 2 W. A.C.-D.C. receivers are thus giving about the same performance as the small A.C. receivers using a 42-type output tube with about 220 V. available for plate and bias voltages. It would be necessary, using conventional tubes, to increase the cost of the small A.C. receivers considerably to make them give appreciably better performance than the 2 W. output A.C.-D.C. receivers.

The performance of the small A.C. receivers may be improved in economy as well as power output by using an output tube similar to the 25B6G or 25L6 at lower voltages and larger currents than would be the case with the 42-type output tube .

The 6Y6G tube is being introduced to fill the need for an output tube which will give even more output at 135 V. on the plate and screen-grid than the type 42 with 250 V. on plate and screen-grid. The high mutual conductance of the 6Y6G results in a fairly low input voltage requirement for full power output, and permits some degeneration to be used where desired. See Fig. 3 C.

Characteristics

Heater voltage (A.C. or D.C.)	6.3 V.
Heater current	1.25 A.
Plate voltage (max.)	135 V.
Screen-grid voltage (max.)	135 V.

As Class A[1] Amplifier

Plate voltage	135 V.
Control-grid voltage	-12.5 V.
Amplification factor	218
Plate resistance	52,000 ohms
Mutual conductance	4,100
Plate current	45 ma.
Screen-grid current	4.5 ma.

Operating Conditions, Class A Amplifier

Plate voltage	250 V.
Screen-grid voltage	250 V.
Control-grid voltage	-12.5 V.
Peak signal	12.5 V.
Plate current (no signal)	45 ma.
Plate current (max. signal)	47 ma.
Screen-grid current (no signal)	4.5 ma.
Screen-grid current (max. signal)	6.5 ma.
Load resistance	5,000 ohms
Power output	4.25 W.
2nd-harmonic	4.5%
3rd-harmonic	3.5%

Operating Conditions, Class AB (2 tubes)

Plate voltage	250	300 V.
Screen-grid voltage	250	300 V.
Control-grid (see item in text concerning input systems)	-15	-20 V.
Peak signal (grid-to-grid)	30	40 pk. V.
Plate current (no signal)	70	78 ma.
Plate current (max. signal)	79	90 ma.
Screen-grid current (no signal)	5	5 Ma.
Screen-grid current (max. signal)	12	13.5 ma.
Load resistance (plate-to-plate)	10,000	8,000 ohms

Power output	8.5	13 W.
3rd-harmonic	3.5	3.5%
Total harmonic	4	4%

1G5G Low-Plate Voltage Power Output Pentode. This tube is designed especially for operation from a 90 V. "B" supply and will be used mainly in battery receivers, particularly where current limitations are a factor.

Resistance coupling may be employed and the rated output obtained under class A operation. Larger power output is available by employing 2 tubes in push-pull service. (See Fig. 3E)

Characteristics

Filament voltage	2 V.
Filament current	0.12-A.
Over-all length (max.)	4 11/16 ins.
Diameter (max.)	1 13/16 ins.
Bulb	ST-14
Base	Medium G Type Octal No. 6-X

Operating Conditions and Characteristics

Filament voltage	2-V.
Filament current	0.12-A.
Screen-grid voltage	90-V. max.
Plate voltage	90 V. max.
Control-grid voltage	-6 V.
Plate current	8.5 ma.
Screen-grid current	2.7 ma.
Plate resistance	0.135-meg.
Mutual conductance	1,500 mmhos
Amplification factor	200
Load resistance	8,500 ohms
Power output	300 mw.
Total harmonic distortion	9%

25L6G (Glass) Beam Power Tube. This tube has electrical characteristics that are identical to those of its metal counterpart the 25L6 described in the April, 1937, issue of **Radio-Craft.** However unlike the 25L6 which uses beam deflector plates the newer tube incorporates suppressor grids. See Fig. 3F.)

5-METER "BEAM" TRANSMITTING TUBE

The 807 5-meter Transmitting Tube. The beam-type power tube which has raised such a furor in the audio amplifier and radio receiver circles has now invaded the short-wave transmitting field in the form of an R.F. power amplifier tube having ceramic base, top cap for low interelectrode capacity, and improved shielding to minimize the need for neutralization.

This tube, known as the 807 in the RCA line has a maximum plate dissipation of 21 W. and high power sensitivity. The latter characteristic makes it especially suited for use as a crystal oscillator, frequency doubler or buffer amplifier. Two 807s in class C for C.W. operation, will provide more than 50 W. output. The tube can be driven at the maximum ratings listed below on frequencies up to 60 mcs. (5 meters, approx.).

807 Characteristics

Heater voltage (A.C. or D.C.)	6.3	V.
Heater current	0.9	A.
Mutual Conductance, for plate cur. of 72 ma.	6,000	Micromhos
Direct Interelectrode Capacities:		
Grid-Plate (with external shielding.)	0.2 max.	mmf.
Input	11.6	mmf.
Output	5.6	mmf.

A.F. Power Amplifier and Modulator—Class AB

D.C. plate voltage	400 max. V.
D.C. screen-grid voltage	300 max. V.
Max.-signal D.C. plate current*	100 max. ma.
Max.-signal D.C. plate input*	40 max. W.
Plate dissipation*	21 max. W.
Screen-grid dissipation*	3.5 max. W.

*Averaged over any A.F. cycle

R.F. Power Amplifier—Class B Telephony

(Carrier conditions per tube for use with a max. modulation factor of 1.0)

D.C. plate voltage	400 max. V.
D.C. screen-grid voltage	300 max. V.
D.C. plate current	80 max. ma.
Plate input	32 max. W.
Plate dissipation	21 max. W.
Screen-grid dissipation	2 max. W.

Plate-Modulated R.F. Power Amplifier—Class C Telephony

(Carrier conditions per tube for use with a max. modulation factor of 1.0)

D.C. plate voltage	325 max. V.
D.C. screen-grid voltage	250 max. V.
D.C. control-grid voltage	-200 max. V.
D.C. plate current	83 max. ma.
D.C. control-grid current	5 max. ma.
Plate input	27 max. W.
Plate dissipation	14 max. W.
Screen-grid dissipation	2 max. W.

R.F. Power Amplifier and Oscillator—Class C Telegraphy

Key-down conditions per tube without modulation**

D.C. plate voltage	400 max. V.	
D.C. screen-grid voltage	300 max. V.	
D.C. control-grid voltage	-200 max V.	
D.C. plate current	100 max. ma.	
D.C. control-grid current	5 max. ma.	
Plate input	40 max. W.	
Plate dissipation	21 max. W.	
Screen-grid dissipation	2 max. W.	
Typical operation:		
Heater voltage	6.3	6.3 V.
D.C. plate voltage	300	400 V.
D.C. screen-grid voltage	250	250 V.
D.C. control-grid voltage	-50	-50 V.
Peak R.F. grid voltage	80	80 V.
D.C. plate current	95	95 ma.
D.C. screen-grid current	10	9 ma.
D.C. control-grid current approx.)	3	2.5 ma.
Driving power (approx.)	0.2	0.2 W.
Power Output (approx.)	17.5	25 W.

**Modulation essentially negative may be used if the positive peak of the A.F. envelope does not exceed 115 per cent of the carrier conditions.

***Ultra-Violet Phototubes; WL-773, WL-774 and WL-767.** These "electric eyes" do what no human eye can do, namely, "see" in the dark! The "trick" lies in peaking the response characteristics of this type of "light"-sensitive cell in the region just beyond the high-frequency limit of human visibility or the ultra-violet range.

Features of the several types: WL-774, tungsten cathode, range of 2,200 to 2,700 A.U., useful in bactericidal field (measuring ultra-violet light used in killing bacteria, preventing mold and in general food preservation); WL-767 titanium cathode, range of 2,700 to 3,200 A.U., useful in measuring erythema (sunburn) and vitamin D irradiation (of milk, for instance); WL-773, thorium cathode, range of 2,700 to 3,600 A.U., useful in measuring vitamin A and in making general ultra-violet measurements.

One of the distinctive features of these phototubes is that they may be used without recourse to shielding the tube from radiations in the visible portion of the spectrum, hence they may be used in direct sunlight, with the knowledge that all of the photoelectric current change is due solely to radiations in the particular ultra violet portion of the spectrum to which the phototube is sensitive.

The threshold response value is determined by the particular metal used for the cathode and the cut-off value is determined by the type of glass used for the bulb. These characteristics render it unnecessary to use frequency filters.

Optimum response from these tubes requires high input impedance in the amplifier; an electrometer-type tube is ideal.

Infra-Red, Gas-Type Prong-Base Photocell; Type 923. Because of the high sensitivity of this type cell, which can "see" radiations in the infra-red region quite invisible to the naked eye, it is particularly useful in applications where incandescent lamps are employed as light sources. Base connections are given in Fig. 4.

Cathode is semi-cylindrical, caesium-coated; anode-supply voltage (max.), 90; anode current 20 microamperes; sensitivity, 100 microamperes/lumen; cathode window area, 0.43-sq. in. Load resistance, not over 10 megs. This tube is similar electrically and mechanically to the type 918, but has a shorter overall length.

Infra-Red, Gas-Type Cartridge-Base Photocell; Type 921. Substantially identical characteristics to the type 923, but with cartridge-type base like the type 922 photocell. Also, the 921 has a window area of only 0.38-sq. in.; input capacity is 1.1 mmf. Load resistance, not over 10 megs. ase connections in Fig. 4.

Infra-Red, High-Vacuum Type Cartridge-Base Photocell; Type 922. The new double-ended construction (as in the 921) eliminates the conventional base and provides a long insulating path between electrodes. The terminals at either end are in the form of metallic buttons, so designed as to permit inserting each phototube easily and positively in a clip mounting. The features of this construction are lower cost, low interelectrode capacity (for the 922, 0.6-mmf.), and convenience in circuit arrangement.

Characteristics: cathode, caesium-coated and semi-cylindrical; window, 038-sq.-in. Anode-supply voltage, 250 (max.); anode current, 30 microamperes (max.); load resistance, 1 meg.; sensitivity, 20 microamperes/lumen. Light response may be made practically linear for light inputs up to 1 lumen with proper adjustment of supply voltage and load resistance. See Fig. 4 for base connections.

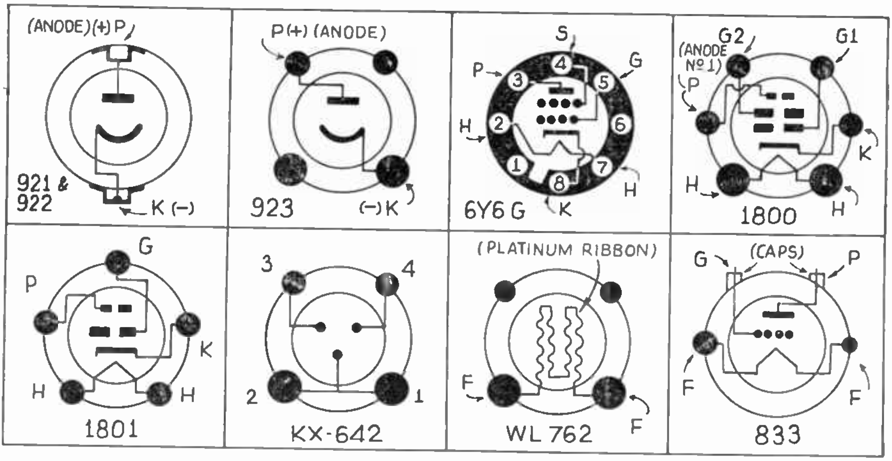


Fig. 4, Underside connections of new tubes.

AUDIO POWER TUBE

Beam Power Tube for A.C.-D.C. Radio Sets; Type 6Y6G. The new tube is intended for use in the output stage of A.C. receivers, particularly those in which the plate voltage for the output stage is relatively low. With 135 V. on the plate and screen-grid it is capable of giving an output of 3.6 W. with a maximum signal input of 13.5 V. Under these conditions the total distortion is about 9.5%. Additional characteristics follow.

Heater voltage, 6.3 V.; current, 1.25 A.

Plate voltage, 135, max.; current (zero-signal), 58 ma., and (max. signal), 60 ma.

Screen-grid voltage, 135 V. (max.); current (zero-signal), 3 ma.

Control-grid voltage, -13.5 V.

Transconductance, 7,000 mmhos.

Load resistance, 2,000 ohms.

Distortion, 2.5% 2nd harmonic and 9% 3rd.

Power output, 3.6 W.

Base connections appear in Fig. 4.

TELEVISION RECEIVING TUBE

Cathode-Ray Kinescope (Television Receiving Tube), 5-in. Size; Electromagnetic Deflection; Type 1801. For the first time, experimenters now have available a commercial-built (as compared to the school-built type now being described in Radio-Craft) cathode-ray tube specifically designed for television-reception experiments! The screen is of medium-persistence type; the fluorescence color is yellow (phosphor No. 3); max. screen diameter, 5 1/16 ins. Base connections are given in Fig. 4. Additional characteristics follow:

Heater voltage, 2.5; current, 2.1 A.
Direct interelectrode capacity (control-grid to all other electrodes), 12 (max.) mmf.
High-voltage electrode (anode No. 2) 3,000 V. (max.)
Focusing electrode (anode No. 1), 1,000 V. (max.)
Control electrode (grid), voltage never positive; grid voltage for current cut-off, -35 V. (approx.)
Fluorescent-screen input power/sq.cm., 10 milliwatts (max.).

Typical operation: heater, 2.5 V.; anode No. 2, 2,000 V.; anode No. 1, 325 V.; control-grid voltage adjusted to give suitable luminous spot; control-grid signal-swing voltage, taking peak-to-peak value for optimum contrast, 15 V.
(Data courtesy RCA Radiotron).

Cathode-Ray Kinescope (Television Receiving Tube), 9-in. Size; Electromagnetic Deflection; Type 1800. Like the type 1801 kinescope this model has a medium-persistence screen; and phosphor No. 3 (yellow). Base connections are given in Fig. 4; and characteristic data follow:

Heater, 2.5 V.; 2.1 A.
Direct interelectrode capacity (grid No. 1 to all other electrodes), 12 mmf. (max.).
High-voltage electrode (anode No. 2), 7,000 V. (max.).
Focusing electrode (anode No. 1), 2,000 V. (max.).
Accelerating electrode (grid No. 2), 250 V. (max.).
Control electrode (grid No. 1), never pos.
Grid No. 1 for current cut-off, -75 V. (approx.).
Fluorescent-screen input power/sq.cm., 10 milliwatts (max.).

Typical operating conditions are available for anode No. 2 voltages of 3,000 to 4,500 and 6,000, but since the average experimenter probably will get the 9-in. size tube only with the expectation of getting the maximum possible brilliance in the image, only figures for one voltage will be given here. Heater, 2.5 V.; anode No. 2, 6,000 V.; anode No. 1, 1,250 V.; grid No. 2, 250 V.; grid No. 1, adjusted to give suitable luminous spot; grid No. 1 signal voltage (peak-to-peak value for optimum contrast), 25.
(Data courtesy RCA Radiotron).

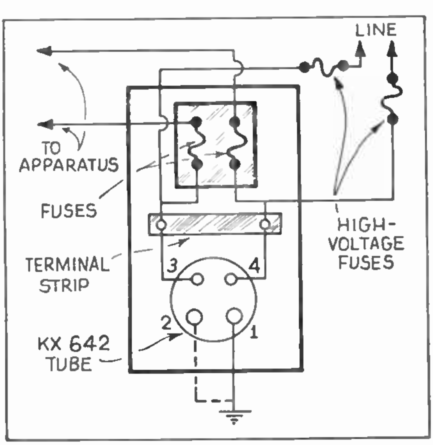


Fig. 5, Bridge circuit for vacuum-test tube.

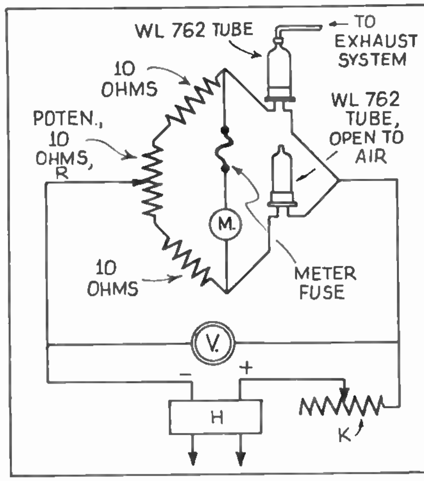


Fig. 6, Circuit for anti-surge tube.

SPECIAL-PURPOSE TUBES

***Supervisory Control Protector Tube; Type KX642.** Wherever protection against overload is desired, as for instance in radio transmitting stations for switching operations and wherever remote meter readings are taken, as well as in radio stations as a protection to condensers, transformers, and testing equipment, the "supervisory control tube" may be connected across the line and the 3rd connection grounded, as shown in Fig. 6 to serve as protection to equipment and operator in the event of surges exceeding 300 V.

The device consists of 3 graphite electrodes mounted in a gas filled bulb. The tube may be used in place of the more familiar overload relays which require re-setting. The protector tube will stand considerable overload, shunting the overload to ground, without being damaged.

The capacity of this protector, as the characteristic data indicate, is 50 A. for 2 seconds. Under these conditions the bulb has a life of many severe discharges without change in characteristics. It is recommended that a resistor of 60 ohms be placed in series with the tube to prevent possible short-circuit of the supply source through the tube when discharging any disturbance; also, fuse the line with 10 A. fuses as shown in the diagram. Characteristics follow:

Breakdown voltage, 300 to 500 V.
Max. discharge (2-sec. periods), 50 A.; (10-min. periods), 7 A.
Typical operating line voltage, A.C., r.m.s., 115 V.
Average arc drop, 20 to 30 V., D.C.
Max. short-circuit current at which tube will clear at first current zero, at 230 V., 10 A.; at 115 V., 15 A.

***Pressure-Indicating Tube; Type WL-762.** Experimenters who are already dabbling in vacuum-tube work, or who plan to take up the study either in a school lab. or at home, will be interested to know about the means of obtaining indications of changes in atmospheric pressure electronically.

The "pressure-indicating tube" consists essentially of a long platinum ribbon suitably mounted inside of a glass bulb. The tube is connected by means of the usual tubing to the vacuum system in which measurements are desired and changes in the heat conductivity between the filament wire and the bulb to the atmosphere can be used to obtain readings indicating the amount of gas remaining in the exhaust system.

One circuit in which this tube, together with a second, may be used to particular advantage is shown in Fig. 5. The supply voltage (or current) must be kept absolutely constant. Meter M is a 0-10 ma. unit. Item H is a double-stack dry-disc rectifier; meter V monitors the output to obtain about 12 V. Meter M may be calibrated to read atmospheric pressure directly (for instance, down to 1 micron).

The principle of operation of this tube is interesting. At atmospheric pressure there is a definite rate of cooling of the heated filament by the particles of air which carry the heat from filament to the bulb. As the amount of air in the tube is reduced the rate of conduction of heat from the filament to the bulb decreases, resulting in an increase in filament temperature. Hence the resistance of the filament increases, causing the current in the filament circuit to decrease. The increase in resistance continues as the vacuum conditions are improved or as the air pressure and consequently the number of molecules of air are decreased. The same phenomenon occurs if the tube is used in measuring pressure conditions of gases other than air.

Base connections are shown in Fig. 4; the operating current range is approx. 0 to 0.3-A.

ULTRA-SHORTWAVE TUBE

U.-H.F. High-Mu and High-Vacuum Transmitting triode; R.F. Amplifier, Oscillator and Class B Modulator; Type 833. A minimum amount of insulation within the tube, low internal lead inductances, and a post terminal construction which makes bases unnecessary, are features that enable the new type 833 tube to develop high power on 30 to 100 megacycles (10 meters to 3 meters).

As a result of its construction, the 833 provides high plate efficiency at moderate voltages. For example, it is capable of giving in broadcast service a carrier output of 635 W. at 2,500 V. on the plate, and with this carrier output, can be modulated 100%. In other services, such as police transmitters, diathermy apparatus, aviation transmitters, and experimental ultra-high quency transmitters (for experiments with radio-controlled equipment. etc.), the 833 also provides excellent efficiency.

Terminal connections are shown in Fig. 4.

RECTIFIER TUBE

***Mercury-Vapor Rectifier; Type 2-RA-15.** This heavy-duty rectifier is designed to deliver very high values of pulsating direct current; it is thus suitable on a bench "A" supply for testing radio sets without resorting to a storage battery for filament D.C. It also may be used to supply D.C. for energizing field coils in high-grade P.A. systems. Tube life is about 2,000 operating hours. Characteristics follow:

Filament voltage, 2.5; current, 16 A.; heating time, 2 to 3 mins.

D.C. average output, 15 A.; crest, 45 A.

Arc drop, 5 to 8 V.

Pick-up voltage, 8 to 11 V.

D.C. output voltage, 60 (max.); D.C. crest inverse voltage, 200 V. (max.).

*Names of manufacturers will be supplied upon receipt of a stamped and self-addressed envelope

CHAPTER 6

Useful Circuit Ideas

From Radio Craft's Readers

AN IMPROVED DIODE DETECTION circuit that also provides interstation noise suppression. I have tried out many of the circuits you have presented from time to time for modernizing old receivers. The diode detectors (55, 2A6, 2B7) have helped very much, and make it easy to add automatic volume control; but they have two main faults—attenuation of low frequencies, and poor quality at low volume.

The circuit I submit (Fig. 1) overcomes these faults, and provides additional suppression of noise between stations. I have found the 2B7, with screen-grid tied to plate, superior to the other two. None of them are good amplifiers when the bias becomes less than 1V. By increasing self-bias R1-C1 in diagram) another volt, this fault is overcome. As they will not detect or amplify signals below 1V., the ordinary noise is suppressed; though without loss of sensitivity, as lower signals would not be heard above the noise level.

Attenuation of low notes at low volume is caused by the low impedance in the control-grid circuit of the amplifier section of the tube. This is overcome, in the better modern receivers, by the use of an "L" pad as volume control; but it is done with less trouble and expense, almost as well, by putting the .01-meg. resistor (R2 in diagram) between the control-grid and the arm of the volume control. The lead to the control-grid cap should be shielded, and shield grounded; this will also by-pass high frequencies that may get through.

Thomas H. Jasper.

AN OSCILLATOR FOR TESTING LOUDSPEAKERS. The cost of an A.F. oscillator, for checking speaker rattles, is saved by this method, applied to a superheterodyne with a service R.F. oscillator, which is cut into the cathode-return of the 1st I.F. tube, as shown in Fig. 2. The oscillator is tuned to approximately the I.F., and then varied to give a beat note of any desired pitch. For instance, if the I.F. is 175 kc., the service oscillator at 174 kc. will give a 1,000-cycle audio note. The I.F. transformers should first be lined up.

Charles Forsch.

OUTPUT METER FROM TESTER. The meter in your tube tester may be used as the output indicator of a set, with the simple addition of a type 58 tube. Simply place the tube in the socket, and connect to its control-grid cap the set which is to be balanced, as shown in Fig. 3. Reduce the bias, and adjust the other element controls for maximum swing. The meter, which is protected from overload, will read downwards for maximum swing.

Walter L. Shearman.

FULL-WAVE RECTIFICATION WITHOUT A POWER TRANSFORMER. Here is a full-wave rectifier for supplying "B" current to A.C.-D.C. sets, energizing speaker fields, and fo rsupplying high voltage to test apparatus, etc. See Fig. 4.

Because of the full-wave action, less filtering is required than with half-wave circuits. Also, the voltage is slightly higher and the maximum current drain is much greater than with equivalent half-wave circuits.

If the 25Z6 metal tubes are used it can be made very compact.

Loren Svobida.

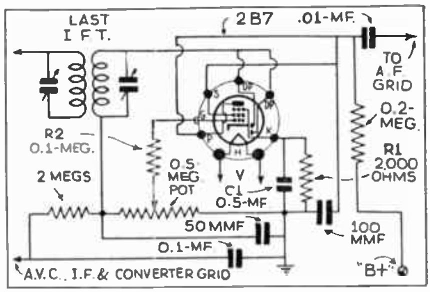


Fig. 1, Improved diode detector.

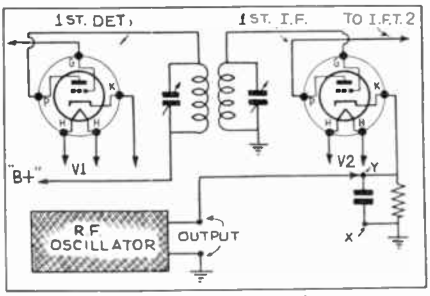


Fig. 2, For testing speakers.

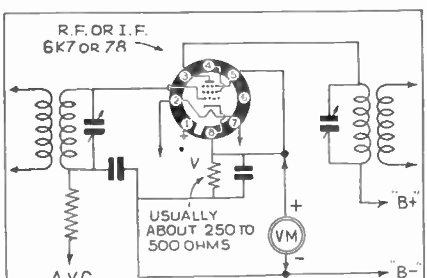


Fig. 3, Output meter.

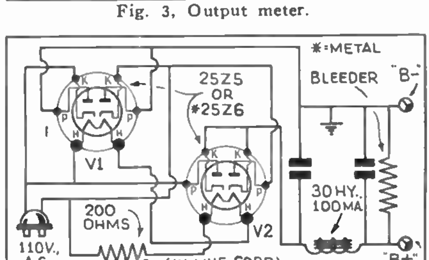


Fig. 4, Full wave power-supply.

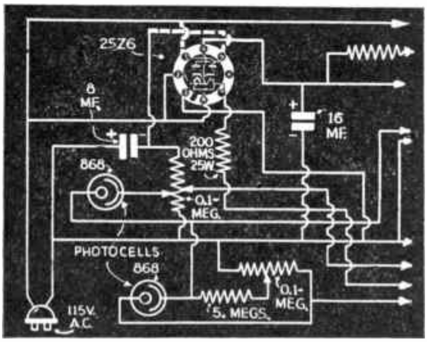


Fig. 5.

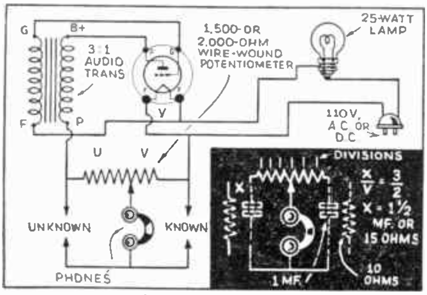


Fig. 6, Audio tester.

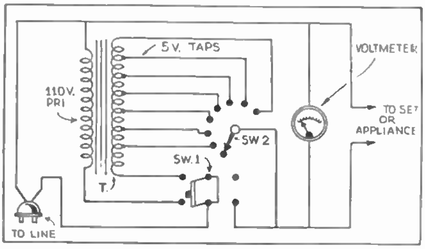


Fig. 7, Line voltage booster.

AN A.C.-D.C. "B" SUPPLY USING FILAMENT-TYPE TUBE AS RECTIFIER. "Necessity is the mother of invention." A small amount of .90 V. "B" was needed. An inventory of the available junk box showed no transformers, not even for filaments. The accompanying diagram shows the exact "B" eliminator that was rigged up. An 01A, 71A, or similar tube that draws ¼-A. filament current would give more output. The less said about the efficiency of this circuit the better, but it is simple and served the purpose. See Fig. 5.

I have never seen a similar hook-up using a filament-type tube.

Oliver H. Smith

TESTING AUDIO AMPLIFIER STAGES WITH A.C. LINE HUM. The A.C. line hum may be used as a quick and convenient method of determining whether the audio amplifier stages of a receiver are operating. Such hum is applied to the various points in the audio circuit through a condenser and test lead as shown in Fig. 6. The prong of the A.C. plug to which the lead is connected must be placed in the "hot" or ungrounded side of the service outlet.

With the receiver turned on, the terminal of the test lead is touched to the plate of tube No. 1, "B plus" of tube No. 1, the grids of tubes No. 2 and 3, or "C minus"; if all parts of circuits included are operating correctly a hum or buzzing sound will be heard in the speaker. This hum should be louder, due to amplification, at the plate of tube No. 1 than at points on other tubes.

Howard J. Surbey.

LINE-BOOSTER TRANSFORMER. Such a scheme is shown in Fig. 7. The transformer T should have a rating in watts equal to, or greater than, the appliance to which it is connected. The transformer should have a 110-V. primary and a secondary tapped in 5-V. steps. The secondary is connected in series withe the line and the transformer of the appliance. The secondary must be connected "series aiding" or in other words in phase with the other transformer.

Switch Sw.1 is the on-off control for the booster. When turned to the left it cuts in the booster and in the right-hand position it removes the booster from the line circuit. When the booster is being used the A.C. voltmeter M. should always be in the circuit to prevent application of excessive voltage. Switch Sw.2 controls the amount of booster voltage added to the primary circuit of the radio set transformer.

W. T. Moore

CHAPTER 7
HANDY INDEX
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