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MODERN RADIO HOOK-UPS

The Best Radio Circuits

A Complete Compendium of the Most Important Experimental and Custom-built Receivers

by R. D. Washburne

A GERNSBACK PUBLICATION

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Second Edition

Printed in U. S. A.

INTRODUCTION

IN consideration of the increasing complexity of modern radio receiver and other instrument design, an effort has been made not only to acquaint the average experimenter with these connections, but also to simplify the understanding of them.

To this end there has been compiled a chart of the symbols most commonly used in schematic circuits of these devices. Further, many diagrams have been examined to obtain only a limited number which would be representative of the many applications we now find for equipment embodying the principles underlying radio communication. Finally, these selected circuits have been so graduated as to be of interest alike to student and advanced technician.

To portray the versatility of instrument design, these diagrams have been selected and classified in the following manner: Broadcast receivers, all-wave circuits, short-wave sets, short-wave converters and adapters, television receivers, mobile radio sets, home recording apparatus, audio amplifiers, power units, miscellaneous equipment.

These modern devices incorporate not only circuit elements, the electrical values of which are obvious by reference to the hookup, but also numerous units, the characteristics of which cannot be determined from a diagram of connections. Also, in some instances, mechanical requirements necessitate the use of certain specified types of components. For these reasons there is included by make and model number, a list of the parts that go to make up each instrument.

Thanks are here extended to the Editorial Staffs of Short Wave Craft and Television News; their cooperation in the preparation of this book is deeply appreciated.

R. D. Washburne

New York, N. Y.
June, 1932.

CHAPTER I

Radio Symbols

SCHEMATIC circuits are the "shorthand" of the technician. By their use he is enabled to tell at a glance the manner in which various electrical units may be connected; and, approximately, the effect which one unit will have upon another.

The "symbols" in a diagram are the simplest possible representation of the various components of the circuit.

Symbols vary as the leaves of the trees; the appearance of a particular symbol being governed, it seems, by nothing more concrete than whether the technician or draughtsman hopped from the right or left side of bed the morning he started to draw an illustration!

However, a measure of uniformity has been maintained in the diagrams which follow; and to assist still further in making these figures more readily understood, the illustrations which immediately follow have been prepared.

Some of the simpler ones are shown below, and on the succeeding page all the symbols, for which there is room, to conclude a listing representative of those used in the schematic circuits within this book.

To show all the variations, of just these alone, conceived by ambitious individuals and through the medium of other publications foisted upon an unresisting public, would be too horrible to contemplate—and quite without end. Suffice it to say that no effort has been made to depict such figures as may be found in any diagrams other than the 101 which follow.

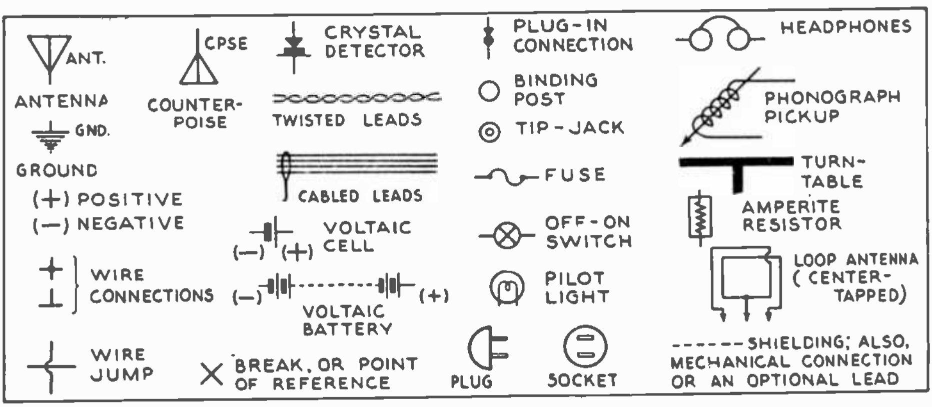
Vacuum tubes are of many types. Due to the fact that the present system of nomenclature ordinarily does not take into consideration, in the arrangement of the symbol, the electrical characteristics of these types, it becomes essential to identify them by means of their catalog number.

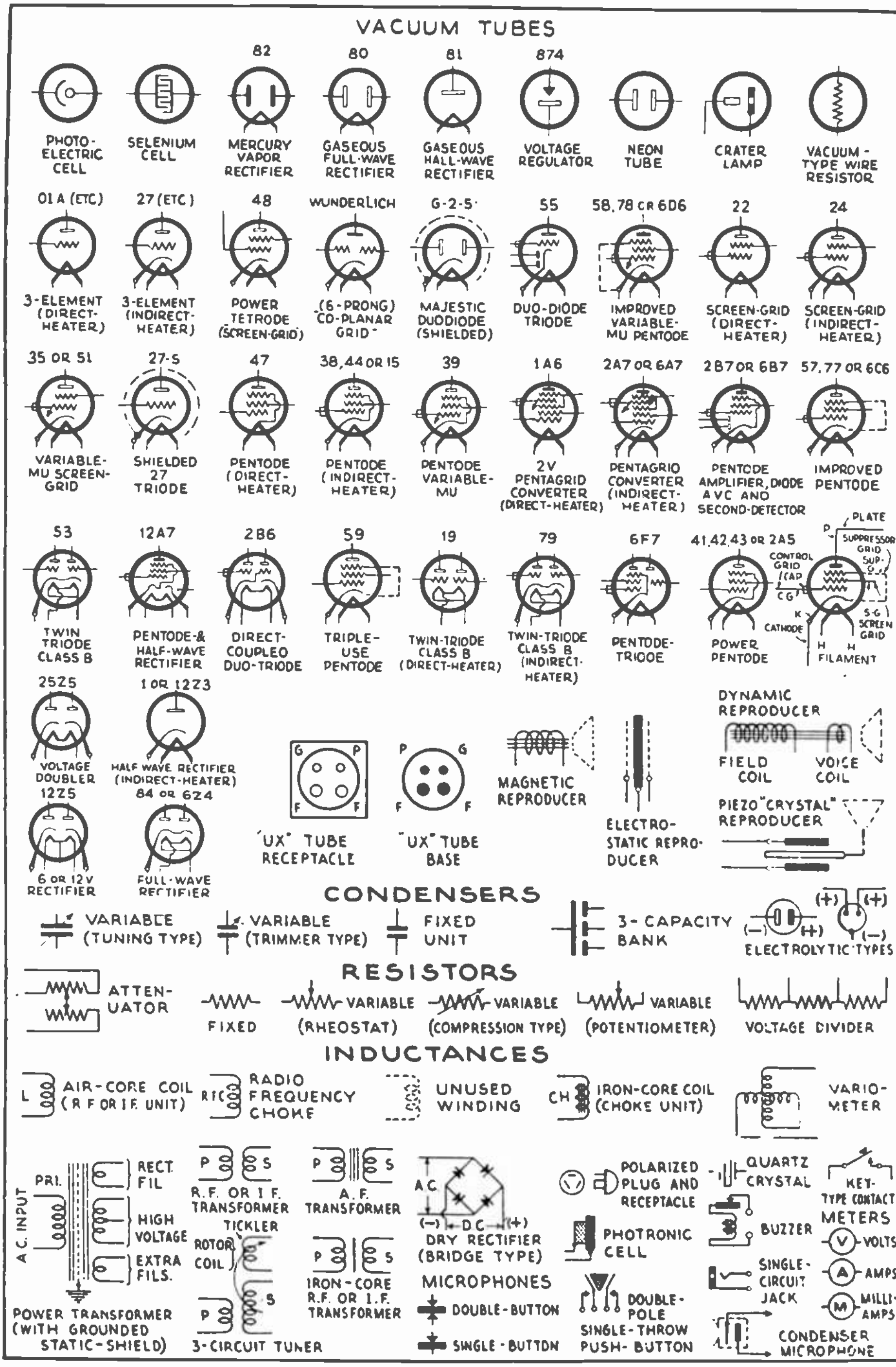
For instance, a three-element or triode tube may be an '01A, 00A, '00, '01, '12, '12A, '71, '71A, '45, WD-11, WD-12. '99, '30, '41, '64, '20, '31, '10, '56 or a '50. Since all have the same symbol, how are you going to decide which is which?

If the symbol does not carry a catalog designation, it then becomes necessary to closely examine the circuit, noting the components and their method of connection, to determine to which family the indicated tube may belong. Operating potentials often furnish a clue; the service to which the instrument is to be put may be another.

The apostrophe indicates a prefix which is the hall-mark of the manufacturer. For instance: UX-201A (RCA Victor); CX-301A (Cunningham); ER-201A (Eveready Raytheon); etc. However, the very newest tubes have only two numerals, and this may cause a little confusion. For instance, the '80 is a gaseous full-wave rectifier; the 82 also is a full-wave rectifier, but of mercury-vapor type. Again, the '41 is a voltage amplifier used to a certain extent in power amplifiers; the 41, on the other hand, is a power amplifier of pentode type and is designed for use in automotive radio sets. A confusing situation, but one which clarifies itself by the application of a little "horse sense."

Where the tube has a cap connection, it is indicated in the symbol. A variable-mu characteristic is represented by a diagonal arrow on the control-grid—inside the circle (bulb). Tube socket connections may be determined by reference to the charts entitled, "Radio-Craft Tube Table," in the July, 1932 issue of Radio-Craft.




VACUUM TUBES
PHOTO-ELECTRIC CELL
SELENIUM CELL
82
MERCURY VAPOR RECTIFIER
80
GASEOUS FULL-WAVE RECTIFIER
81
GASEOUS HALF-WAVE RECTIFIER
874
VOLTAGE REGULATOR
NEON TUBE
CRATER LAMP
VACUUM-TYPE WIRE RESISTOR
01A (ETC)
3-ELEMENT (DIRECT-HEATER)
27 (ETC)
3-ELEMENT (INDIRECT-HEATER)
48
POWER TETRODE (SCREEN-GRID)
WUNDERLICH
(6-PRONG) CO-PLANAR GRID
G-2-5
MAJESTIC DUODIODE (SHIELDED)
55
DUO-DIODE TRIODE
58, 78 OR 6D6
IMPROVED VARIABLE-MU PENTODE
22
SCREEN-GRID (DIRECT-HEATER)
24
SCREEN-GRID (INDIRECT-HEATER)
35 OR 51
VARIABLE-MU SCREEN-GRID
27-S
SHIELDED 27 TRIODE
47
PENTODE (DIRECT-HEATER)
38, 44 OR 15
PENTODE (INDIRECT-HEATER)
39
PENTODE VARIABLE-MU
1A6
2V PENTAGRID CONVERTER (DIRECT-HEATER)
2A7 OR 6A7
PENTAGRID CONVERTER (INDIRECT-HEATER)
2B7 OR 6B7
PENTODE AMPLIFIER, DIODE AVC AND SECOND-DETECTOR
57, 77 OR 6C6
IMPROVED PENTODE
53
TWIN TRIODE CLASS B
12A7
PENTODE-& HALF-WAVE RECTIFIER
2B6
DIRECT-COUPLED DUO-TRIODE
59
TRIPLE-USE PENTODE
19
TWIN-TRIODE CLASS B (DIRECT-HEATER)
79
TWIN-TRIODE CLASS B (INDIRECT-HEATER)
6F7
PENTODE-TRIODE
41, 42, 43 OR 2A5
POWER PENTODE
CONTROL GRID /CAP
CG
K
CATHODE
P
PLATE
SUPPRESSOR GRID
SUP-G
S-G SCREEN GRID
H H FILAMENT
25Z5
VOLTAGE DOUBLER
1 OR 1Z23
HALF WAVE RECTIFIER (INDIRECT-HEATER)
12Z5
6 OR 12 V RECTIFIER
84 OR 6Z4
FULL-WAVE RECTIFIER
G P F F
"UX" TUBE RECEPTACLE
P G F F
"UX" TUBE BASE
MAGNETIC REPRODUCER
ELECTRO-STATIC REPRO-DUCER
DYNAMIC REPRODUCER
FIELD COIL
VOICE COIL
PIEZO "CRYSTAL" REPRODUCER
CONDENSERS
VARIABLE (TUNING TYPE)
VARIABLE (TRIMMER TYPE)
FIXED UNIT
3-CAPACITY BANK
(–) (+) (+) (+) (–)
ELECTROLYTIC TYPES
RESISTORS
ATTEN-UATOR
FIXED
VARIABLE (RHEOSTAT)
VARIABLE (COMPRESSION TYPE)
VARIABLE (POTENTIOMETER)
VOLTAGE DIVIDER
INDUCTANCES
L AIR-CORE COIL (R F OR I F UNIT)
RFC RADIO FREQUENCY CHOKE
UNUSED WINDING
CH IRON-CORE COIL (CHOKE UNIT)
VARIO-METER
A.C. INPUT
PRI.
RECT. FIL
HIGH VOLTAGE
EXTRA FILS.
POWER TRANSFORMER (WITH GROUNDED STATIC-SHIELD)
P S
R.F. OR I.F. TRANSFORMER
P S
A.F. TRANSFORMER
TICKLER
ROTOR COIL
S
P
3-CIRCUIT TUNER
P S
IRON-CORE R.F. OR I.F. TRANSFORMER
AC
(–) DC (+)
DRY RECTIFIER (BRIDGE TYPE)
MICROPHONES
DOUBLE-BUTTON
SINGLE-BUTTON
POLARIZED PLUG AND RECEPTACLE
PHOTRONIC CELL
DOUBLE-POLE SINGLE-THROW PUSH-BUTTON
QUARTZ CRYSTAL
BUZZER
SINGLE-CIRCUIT JACK
CONDENSER MICROPHONE
KEY-TYPE CONTACT
METERS
V VOLTS
A AMPS.
M MILLI-AMPS

CHAPTER II

Broadcast Receivers

RADIO receiver metamorphosis from the simple crystal-and-tube set of which the Gernsback "Interflex", Fig. 26, is an example, to that engineering masterpiece of receiver fabrication, the 12-tube "Bi-Acoustic" or "Convention" model superheterodyne, Fig. 4, includes nearly every conceivable variation in the design of tubes, associated components and circuits.

However, a careful analysis of the 101 following diagrams will reveal only three basic functions, namely: (1), Boosting the intensity of the high-frequency electrical energy received by the antenna (radio frequency amplification); (2), changing the energy from high to low frequency (detection), and; (3), increasing the strength of the low-frequency electrical energy (audio frequency amplification).

Components arranged to achieve this sequence of effects constitute a tuned-radio-frequency or "T.R.F." receiver.

In addition to these circuit functions a radio set may incorporate an oscillator, an intermediate-frequency or "I.F." amplifier, and a second-detector. Units so connected are arranged for supersonic heterodyne reception; the completed device is a "superheterodyne" receiver.

Both the T.R.F. and superheterodyne instrument types may incorporate still another tube circuit, viz., automatic volume control or "A.V.C.;" and therefore, in some instances, an "A.V.C. amplifier."

Coupled with these fundamental electrical actions may be a number of less important ones; these often are touted to the layman as panaceas for nearly every manner of ailment.

In the R.F. circuit, for example, we may find one or more of the following features: band selection; light-line antenna; image frequency suppression; long- and short-antenna compensation; sensitivity control; R.F. pentode amplification; local- and long-distance switch; screen-grid amplification; manual volume control; automatic volume control; constant-coupling transformers; loop pickup; broadcast- and long-wave tuning; meter tuning.

Some of these characteristics also may be incorporated in the I.F. amplifier.

Detector circuits may be regenerative, and of grid-leak or grid bias type, and may include a diode, duodiode, triode, screen-grid, or pentode tube.

In the A.F. circuit may exist some of the previously mentioned functions, together with one or more of the following: tone control; push-pull amplification; hum balancers; push-push or Class B amplification; resistance-capacity coupling; phonograph pickup; direct or conductive coupling; sound recording; mute-tuning switch.

Oscillator circuits vary mostly in the manner of their coupling to the first-detector.

Power circuits are classified as A.C. or D.C. (referring to light-lines), or battery; and may incorporate a few variations in the circuit or equipment used—for instance a static-shielded power transformer; reversible, A.C.-D.C. light-line operation; voltage compensation; tuned filters.

Two extremely important elements in radio circuit design, and ones which are not readily apparent by inspection of the schematic circuit, are the constants of the components and their mechanical arrangement. For instance, a resistor of insufficient power capacity in a direct-coupled amplifier might so change in value, under load, as to render the instrument inoperative; again, the use of inductively-wound condensers in a high-gain R.F. circuit might well be the cause of undesired circuit oscillation; in a third instance, placing the detector tube near the rectifier may result in producing a strong hum at the output.

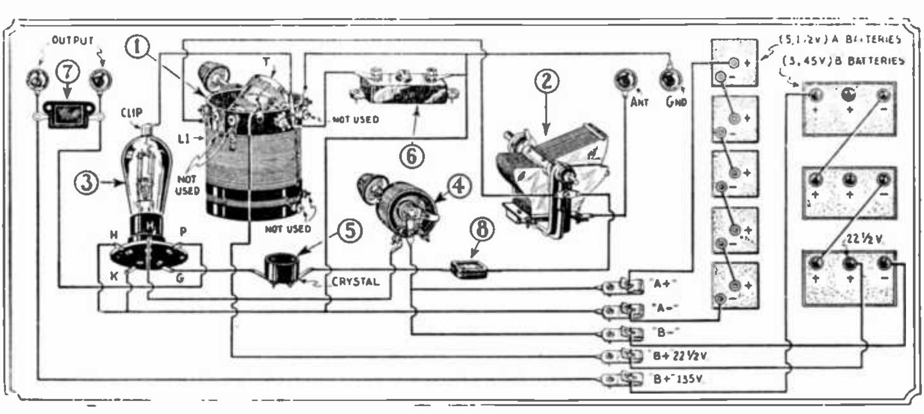


Fig. 1B. Gernsback "Megadyne" 1 tube Loudspeaker Radio Receiver. Picture diagram.

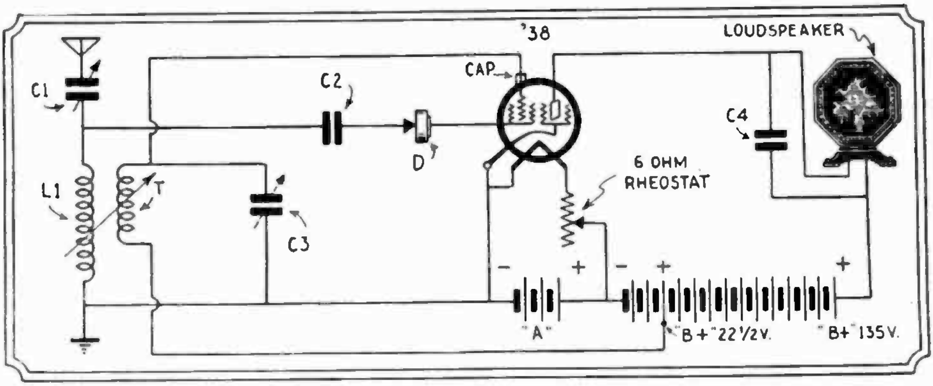


Fig. 1A. Gernsback Megadyne 1 tube Loudspeaker Set. Schematic circuit. A crystal and pentode set. The following parts are used: Condenser C1, Hammarlund type ML-23, 23-plate .0005-mf. variable condenser, with shield-plate; C2, Dubilier, .0005-mf.; C3, XL-Variodenser type G10, .0003- to .001-mf.; C4, Dubilier mica-insulated, .00025- or .0005-mf.; D, BMS fixed crystal detector; L1 Gen-Win 3-circuit tuner, with tickler T (primary, unused); pentode tube, type '38, 6.3-volt filament; Na-Ald No. 425 5-prong type socket; Carter 6-ohm rheostat; panel, 7x10x3/16-in.; Kurz-Kasch knobs and vernier dial. (Coil L1, 68 T. No. 30 D.C.C., 3 ins. in dia.; T, 32 T. No. 30 D.C.C., 1½ ins. in dia.) Note the '38's wiring.

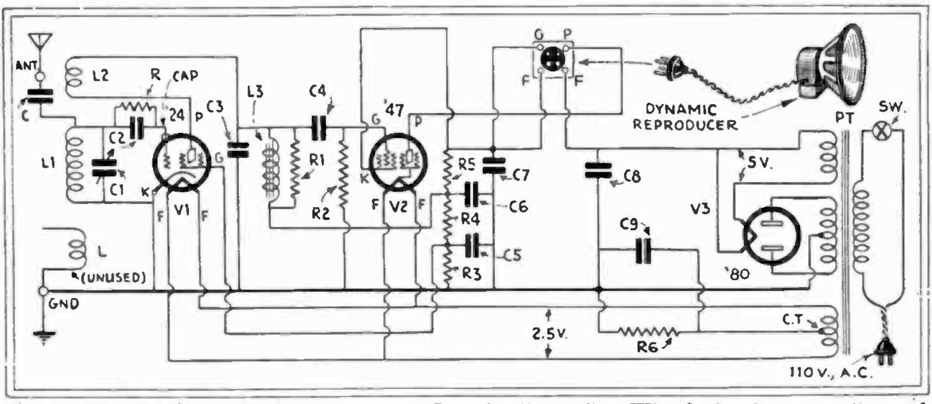


Fig. 2. The Radio-Craft A.C. "Pentode Portable." A Gen-Win 3-circuit tuner is used. The dynamic's field coil is the total filter inductance. Unit L3, 200 hy. or more. Fine experimental, regenerative circuit.

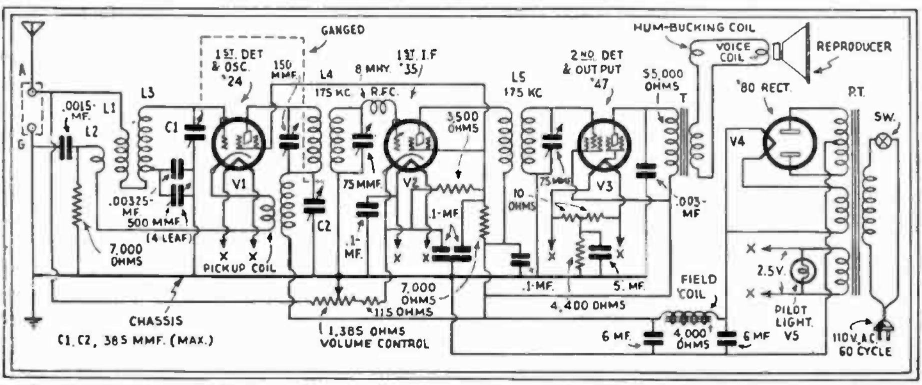
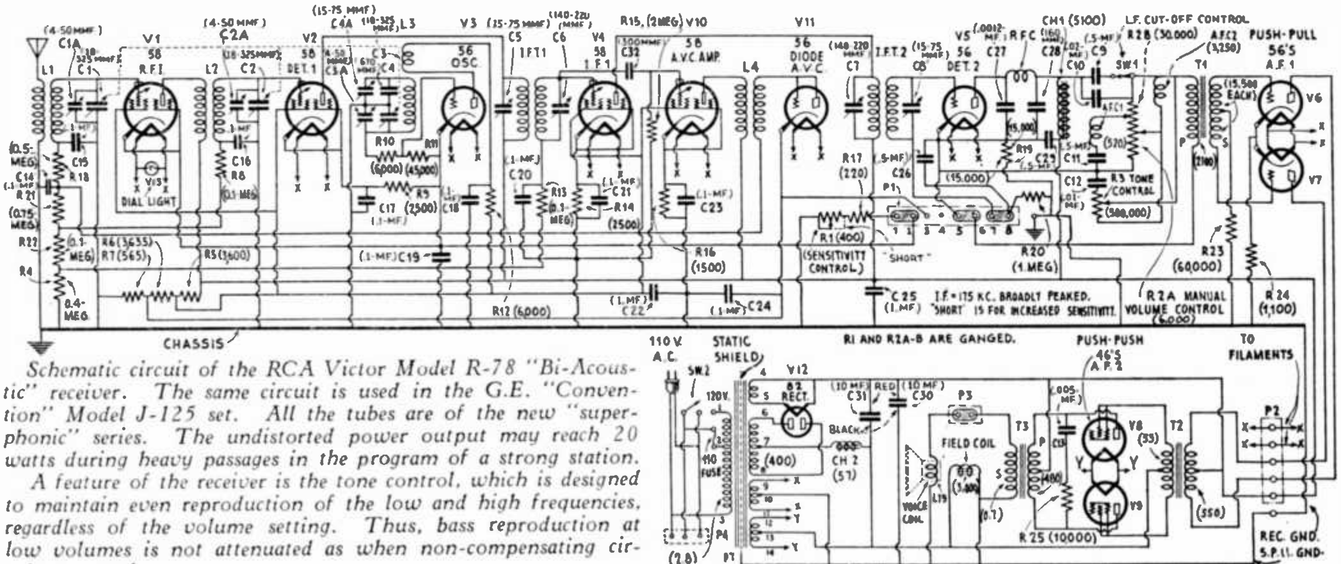


Fig. 3. Crosley "3-Tube" Superheterodyne. Type 131 "Tynamite" and "Bonniboy."



Schematic circuit of the RCA Victor Model R-78 "Bi-Acoustic" receiver. The same circuit is used in the G.E. "Convention" Model J-125 set. All the tubes are of the new "superphonic" series. The undistorted power output may reach 20 watts during heavy passages in the program of a strong station.

A feature of the receiver is the tone control, which is designed to maintain even reproduction of the low and high frequencies, regardless of the volume setting. Thus, bass reproduction at low volumes is not attenuated as when non-compensating circuits are used.

Fig. 4. A 1932-'33 12-Tube Superheterodyne Broadcast Receiver. The resistance and capacity values of the respective units are indicated by figures within parentheses.

The following operating voltage and current readings are for a 120-volt line, the volume control set at "minimum," and no signal being received.

Filament potential, all tubes, 2.5 volts. Plate potential (to cathode or filament), V1, V2, V4, V6, V7, V10, 210 volts; V3, 70 volts; V5, 200 volts; V8, V9, 400 volts; V11, zero. Plate current, V1, V10, 3 ma.; V2, 1.5 ma.; V3, V6, V7, 5 ma.; V4, 2.5 ma.; V5, 1. ma.; V8, V9, 6 ma.; V11, zero. Control-grid potential (to cathode or filament), V1, V2, V3, V4, V8, V9, V10, V11, zero; V5, 12 volts; V6, V7, 8 volts. Screen-grid (to cathode or filament), V1, 100 volts; V2, 4, 10, 95 volts. Cathode (to heater) potential, V1, V3, V10, 7 volts; V2, 10 volts; V4, 8 volts; V5, 12 volts; V6, V7, 11 volts; V11, 16 volts.

The input signal potential for the I.F. amplifier is applied also to the A.C. amplifier tube due to the grids of both being coupled together by means of C32. The output of the I.F. amplifier V4 is applied to second-detector V5 through a sharply-tuned transformer I.F.T. 2; however, the output of A.V.C. amplifier V10 is coupled to A.V.C. tube V11 through a broadly tuned unit.

The voltages developed across resistors R4, R21, R22, furnish control-grid bias for V1; the drop across R4, R22, is the control-grid bias for V2; and the drop across R4, control-grid bias for V4.

As the drop in these resistors is due to the signal potential applied to the A.V.C. tube and this voltage is in turn dependent upon the bias of the R.F., first-detector, and I.F. amplifier, an automatic action is obtained; greater voltage is applied to the R.F. and first-detector than to the I.F. to prevent overloading of these tubes due to a strong, undesired adjacent carrier.

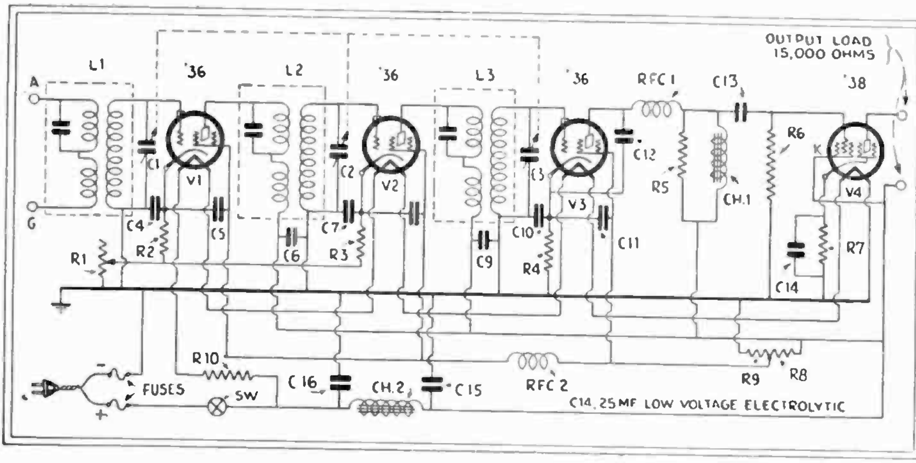


Fig. 5. A 110-volt D.C. Screen-Grid and Pentode 4-Tube Receiver. Note the use of a screen-grid tube as detector V3. Ballast resistor R10 must pass 0.3-amp. and drop to the 25 volts required for the four tubes in series; fortunately, the value is not critical. It is 283 ohms, for a 110-volt line, and 317 at 120 volts. Considerable amplification is obtained.

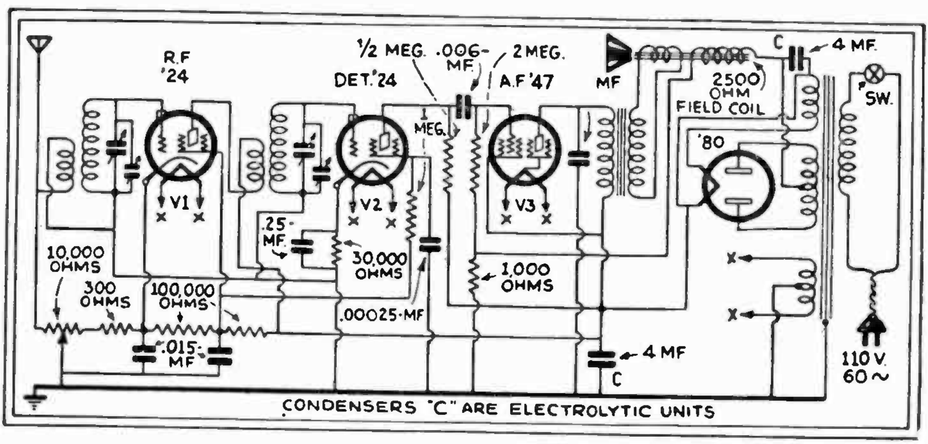


Fig. 6. The "Peter Pan" Model 84 Midget Set. Note the space-saving features: speaker field coil used as filter choke; resistance coupling between detector and power tube. Line switch and volume control are ganged. The output transformer must match V3.

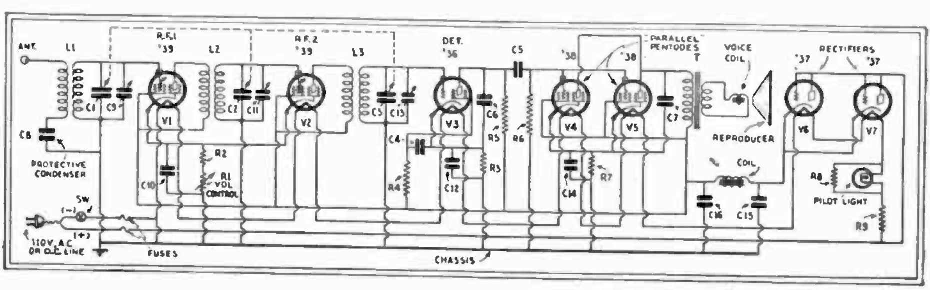


Fig. 7. A Modern A.C.-D.C. Pentode Portable Receiver. Two type '37 tubes, with the elements in parallel, furnish adequate rectification on A.C. circuits; on D.C. they act merely as a series resistance. Tubes V1 and V2 are variable-mu R.F. pentodes. Use no ground.

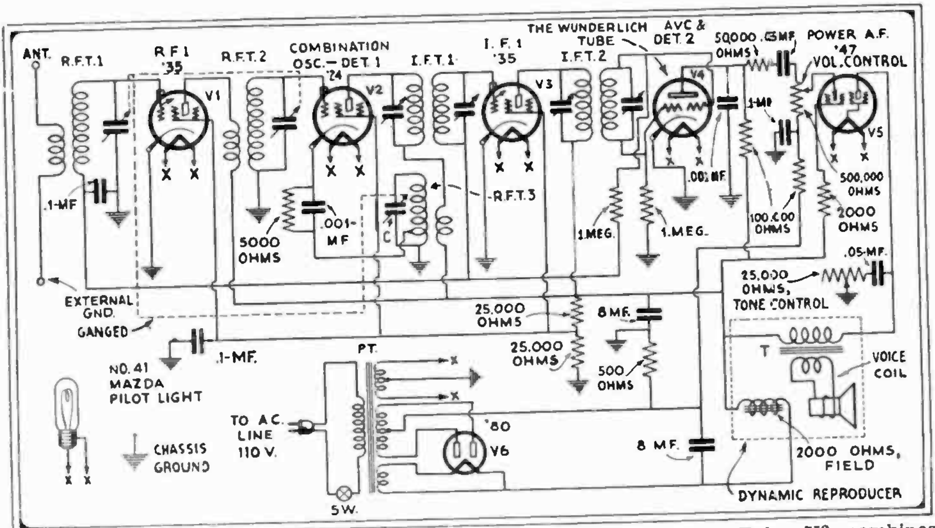


Fig. 8. An Ultra-Modern, Wunderlich-Tube, A.C. Superheterodyne. Tube V2 combines oscillator and first-detector; V4, A.V.C. and second-detector. This set is the Revere Model K2 chassis; the I.F. is 175 kc. Tube V4 is a "coplanar-grid" type Wunderlich "A" or "B."

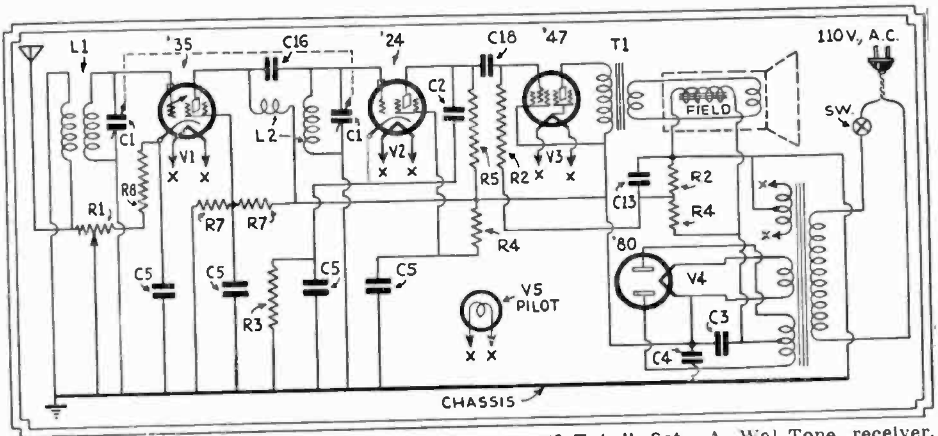


Fig. 9. A Variable-Mu, Screen-Grid and Pentode "3-Tube" Set. A Wal-Tone receiver.

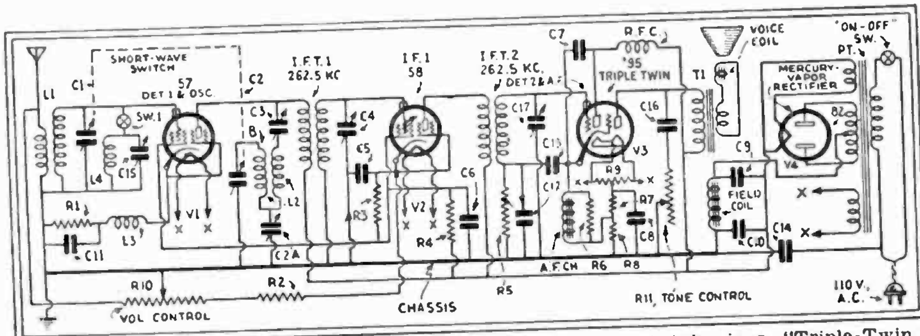


Fig. 10. The Mathews "3-Tube" Superheterodyne. The output tube is a "Triple-Twin." Coils L2 and L3 are inductively coupled. This is an extremely novel circuit arrangement.

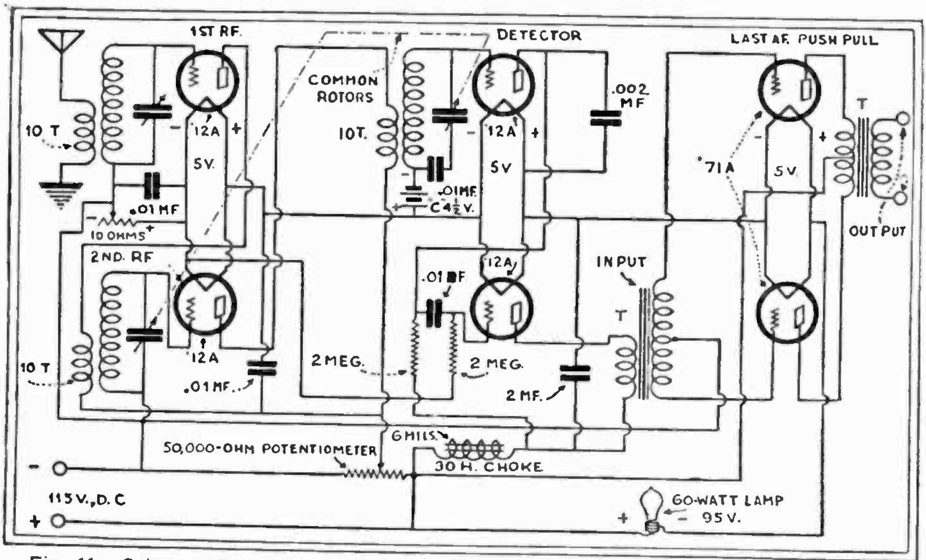


Fig. 11. Grimes "New Yorker" 110-Volt D.C. Receiver. Series-parallel filaments.

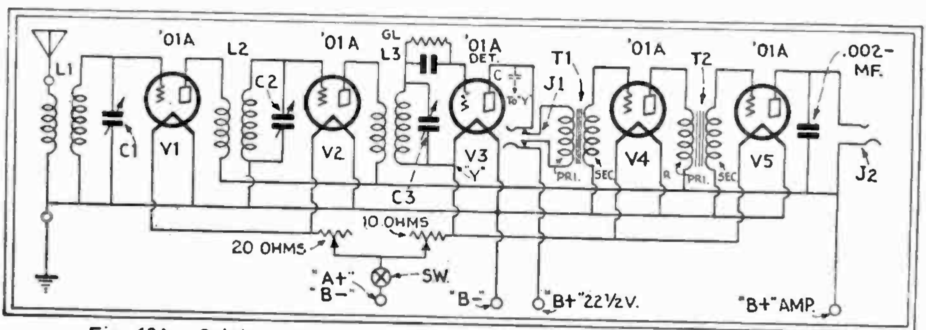


Fig. 12A. Original Freshman "Masterpiece" Battery-Type Radio Set.

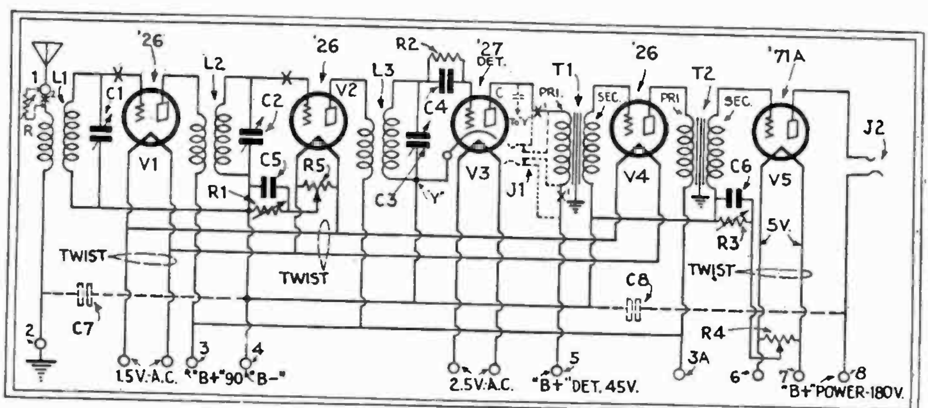


Fig. 12B. Circuit followed in electrifying the Freshman "Masterpiece," Fig. 12A, and other sets of similar design. "Electric" tubes are used as V1 to V5. A type '27 as V3 reduces hum; grid suppressors at X prevent "whistles." Resistor R may improve the operation.

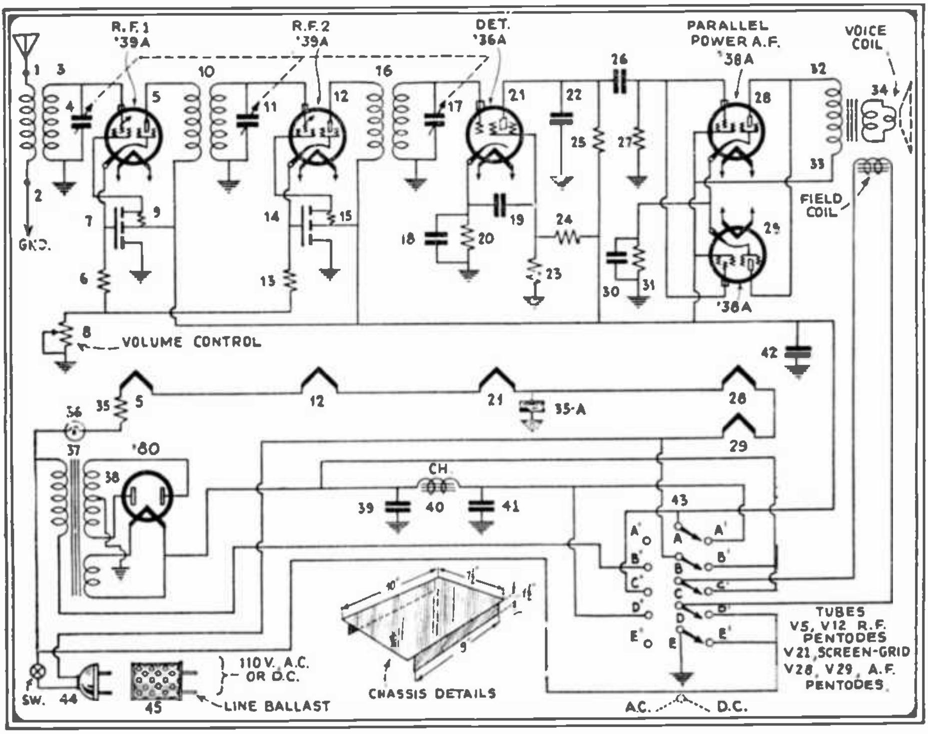


Fig. 13. An A.C.-D.C. Pentode Midget Set. Switch 43 controls circuit change-over. The tuning inductances are Conoid shielded units; their tuning condensers, a triple-ganged unit, Cardwell Type 317-C (shielded) .00035-mf. The dynamic reproducer is equipped with a 7,000 ohm (approx.) impedance output transformer, and a 2,500 ohm field. A Clarostat 50-watt-type automatic line voltage regulator, 45, is used. The power transformer is in use only when the set is connected to an A.C. power line; the unit is of Trutest make, with a 5-volt secondary for the filament of the '80. A Trutest choke is used as unit 40; it is rated at 30 hy. and 200 ohms. The multi-polar switch may be a Best, Type 5N.S. 2 sectional rotary unit, 5-pole, double-throw. Shield the '39A and '36A tubes, 5, 12 and 21.

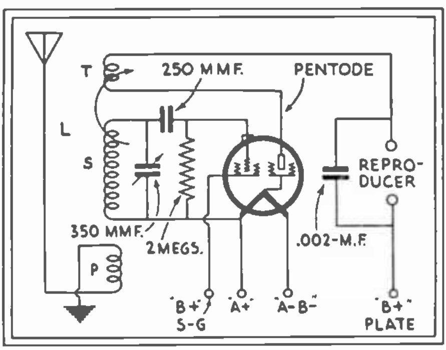


Fig. 14. A 1-Tube Pentode Receiver. For broadcast wavelengths, the grid-leak and grid-condenser may have the usual value, respectively, of about 2 megs. and .00025-mf.; for short-wave reception, over 3 megs. and below .00015 mf. A standard 3-circuit tuner and tuning condenser are used in this set-up. Although a battery-type tube is shown, considerably greater output would be obtained from an A.C. tube. The plate voltage will depend on the individual tube.

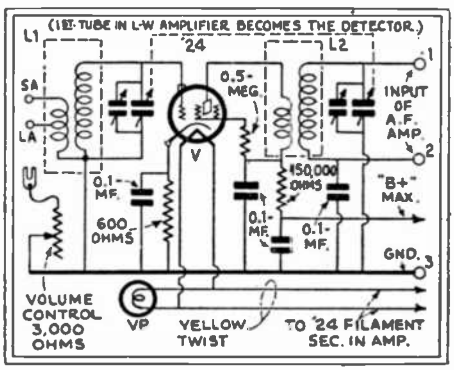


Fig. 15. A Selective Screen-Grid Pre-Amplifier. This is the circuit of connections in the Electrad Loftin-White Type A-224 Tuner, which is designed to be connected to an Electrad Loftin-White Type A-245 direct-coupled A.F. amplifier. The first tube in the amplifier functions as a detector. The advantage of this type of unit is that the amplifier voltages are not disturbed.

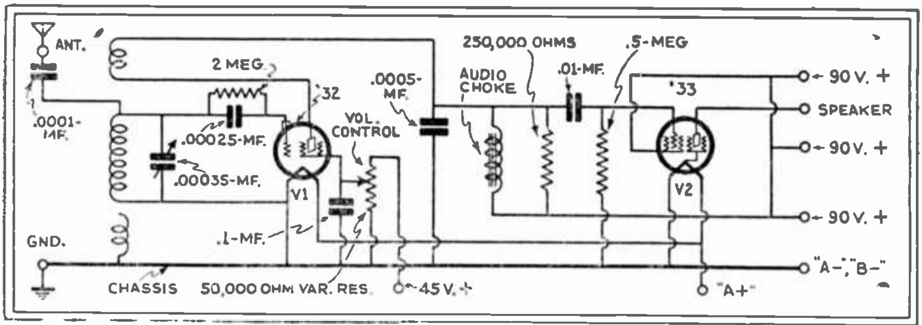


Fig. 16. The Radio-Craft "Pentode Portable"—Battery Model. An improved version of a sensitive, small-space receiver. Regeneration is smoothly controlled by the variable resistor.

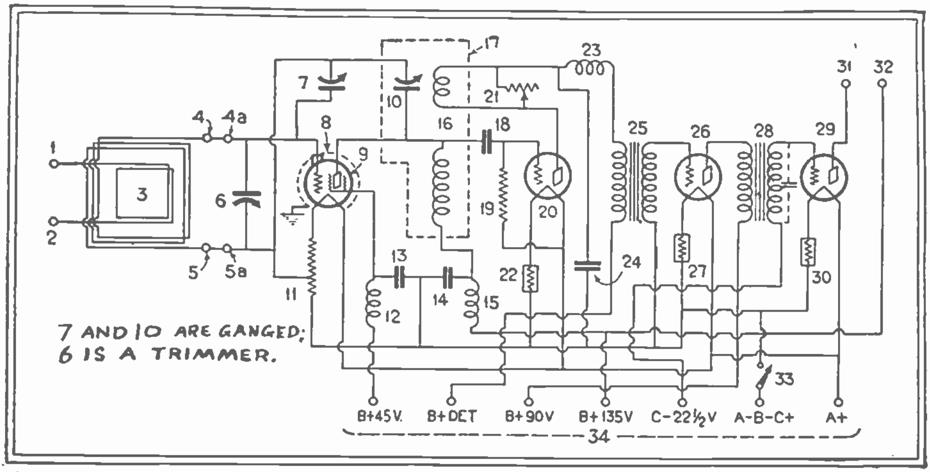


Fig. 17. A Portable Screen-Grid "4" Radio Receiver. A loop antenna is the pickup. If available, an outside antenna may be connected to loop terminals 1 and 2, for increased pickup.

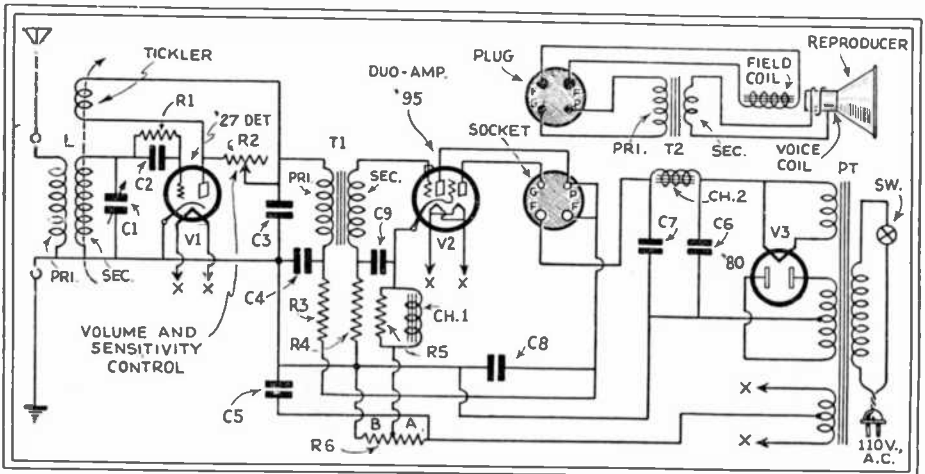


Fig. 18. Radio-Craft's "Triple-Twin" Receiver. Loudspeaker reception is obtained. Experimenters may wish to try circuit arrangements incorporating a "general purpose" pentode as V1.

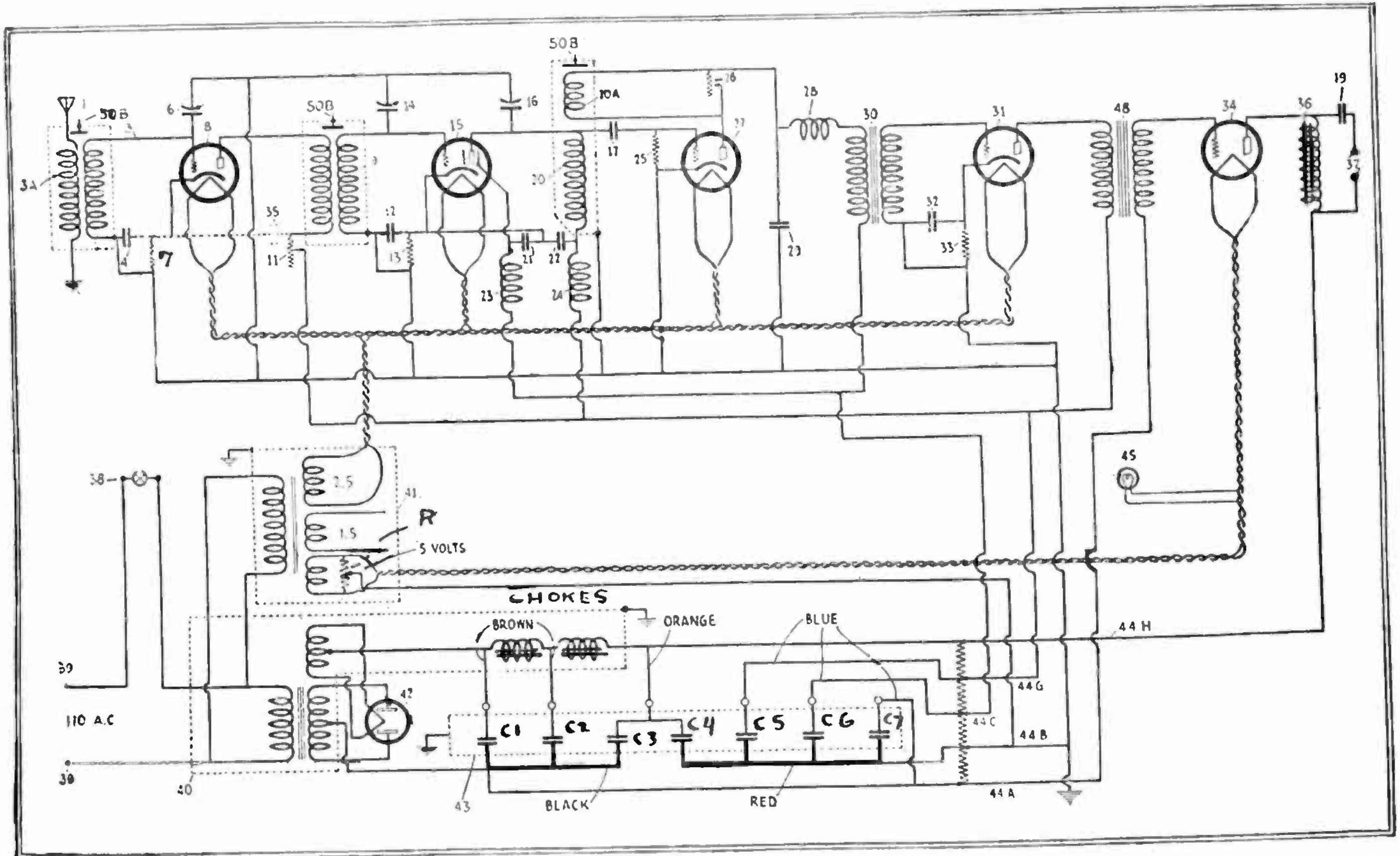


Fig. 19. The A.C. Screen-Grid Peridyne. The inductance of each R.F. transformer is balanced by means of "Peridyne plates."

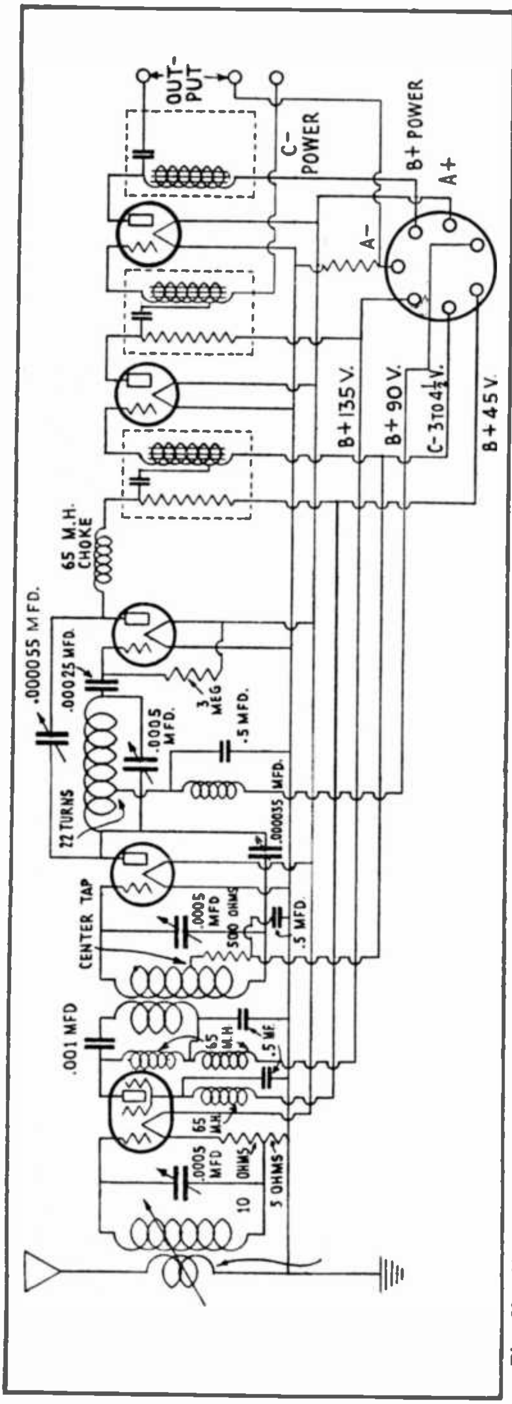


Fig. 20. Moore-Daniels "DX" Receiver. Exceptional care in the design of a supersensitive receiver resulted in this chassis.

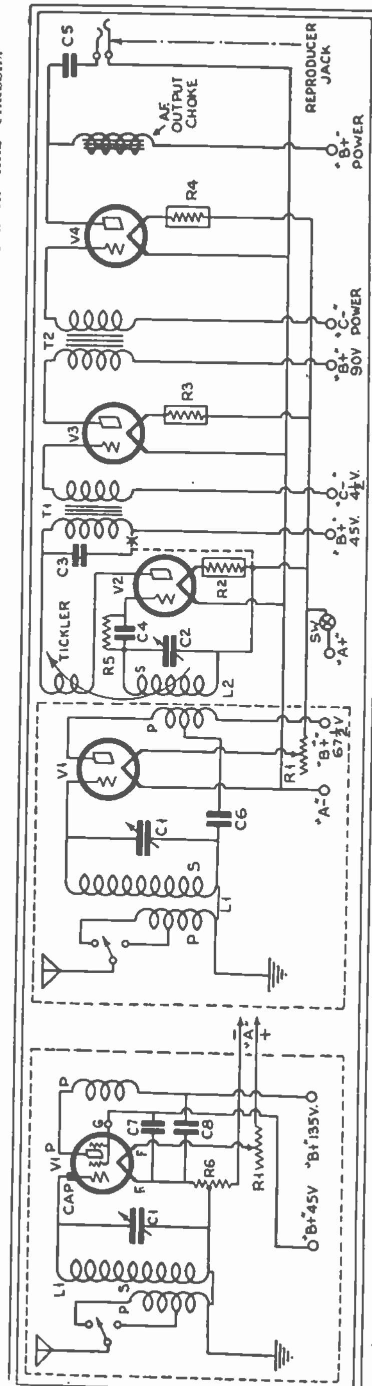


Fig. 21. The "Ambassador 4" Screen-Grid Set. A popular receiver is modernized to use a high-gain screen-grid R.F. tube.

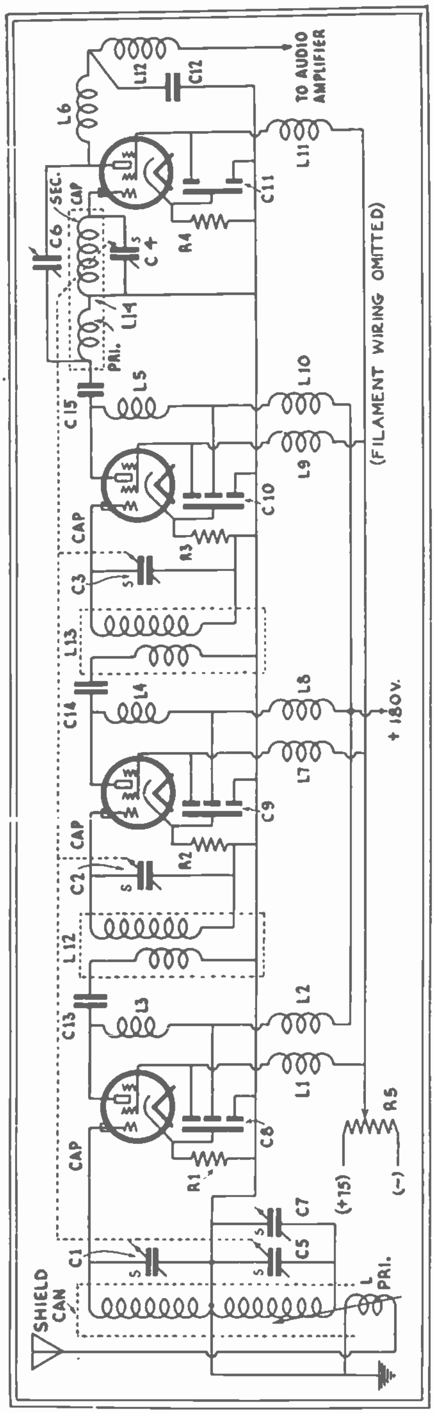


Fig. 22. The "Da-Lite-R" DX R.F. Tuner-Chassis. A unit of high sensitivity to be followed by any desired type of A.F. amplifier.

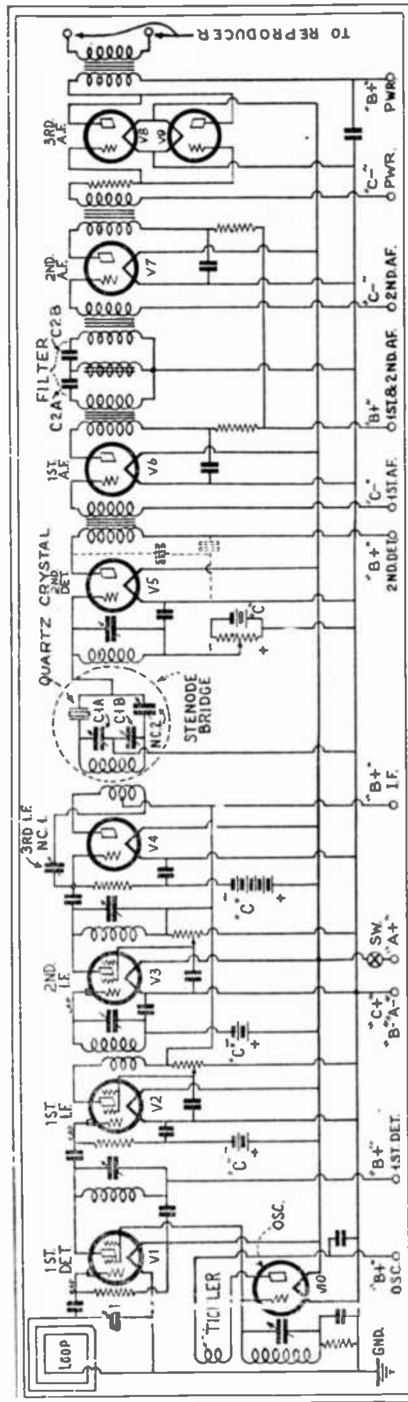


Fig. 23. A Stenode Receiver. Super-selectivity is obtained by means of the "Stenode bridge"; A.F. correction is then applied.

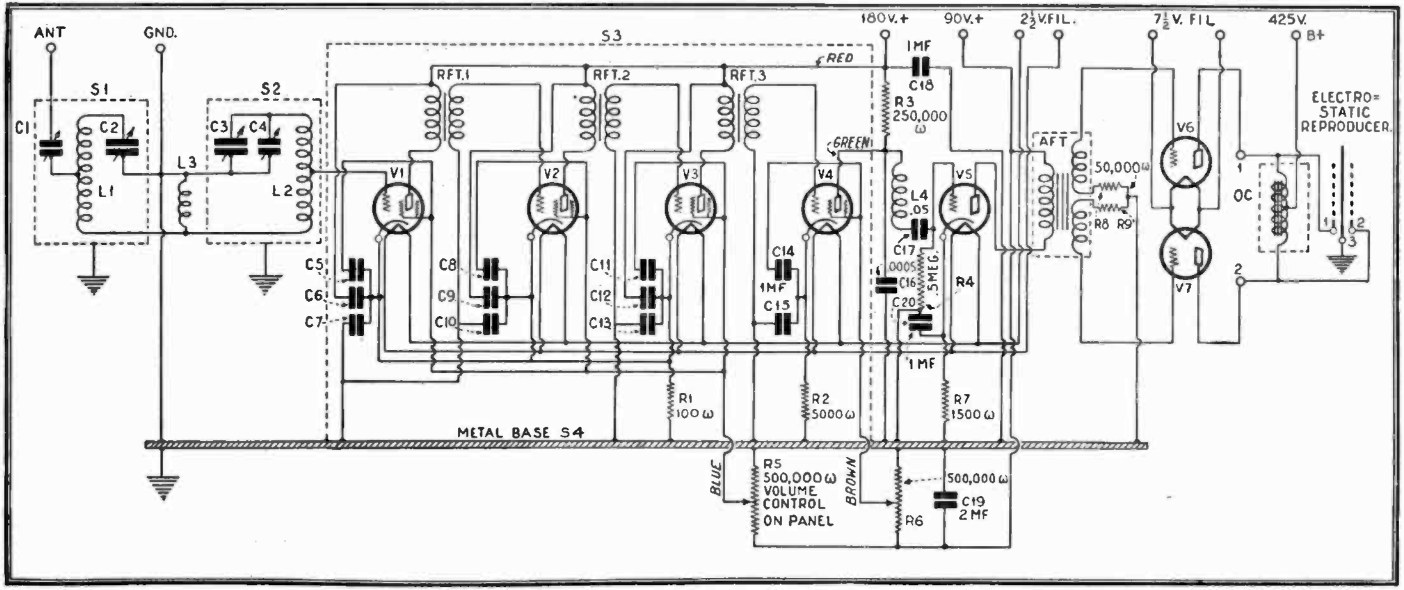


Fig. 24A. A Band-Selector Screen-Grid Receiver. By the simple process of varying the number of turns on coil L3, any desired degree of band-selection is obtained; the selected signal is then amplified without further tuning by means of the flat, or un-tuned (aperiodic) R.F. amplifier, which incorporates aperiodic R.F. transformers TRF-1, 2 and 3. These may be the standard Duratran type of R.F. transformer or, preferably, "Screen-Grid" Duratrans. The greatest difficulty in the home construction of these units is in obtaining the "radio frequency iron" out of which to make the 200 core laminations required for each transformer. These measure, approximately, ¼ in. wide by 1⅞ in. on the long length of the L and 11/16 in. the short length; 100 pieces are turned in one direction, and the remainder in the other; they are butted, not alternated. Each pile of 100 laminations should not be much over ¼ in. thick. A paraffin-paper tube ½ in. in diameter and 1⅛ in. long is made to slip over each core leg. Over one, centrally, is wound the primary of about 115 turns for the standard type (ordinarily used with '27's), or about 135 turns for the "screen-grid." The secondary for either type may have about 170 turns. Number 38 enameled wire is suitable for primary and secondary. Band-selector coils L1 and L2 consist each of 85 turns of No. 28 D.C.C. wire wound on forms 2 in. in diameter; center-tap these inductances. (The original receiver used Hammarlund space-wound coils.) These, together with their tuning condensers, are mounted inside the shield cans indicated by the dotted lines. Coupling coil L3 is made by winding about 4½ turns, of any convenient wire, on a vacuum-tube base, plugging this into a socket; this makes it convenient to change the band-selection width by adding or removing turns, plugging the base into the receptacle after making the desired changes. Antenna coupling condenser C1, mounted on bakelite, is a Hammarlund midget unit of 23-plate size: trimmer C4 is a Hammarlund 9-plate midget. Tuning condensers C2, C3 are Hammarlund "Midline" units of .00035-mf. capacity, with an extension shaft. The shield cans S1, S2 measure 6x8x5⅜ in.

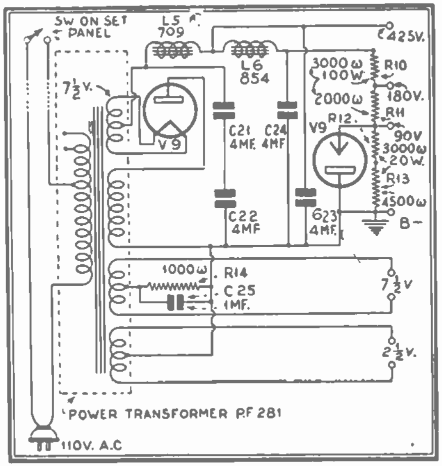


Fig. 24B. Band-Selector's Power Pack.

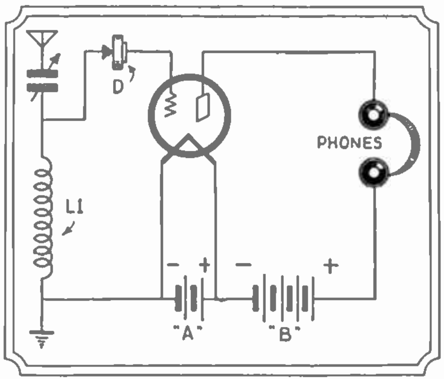


Fig. 26. The Gernsback "Interflex" Receiver.

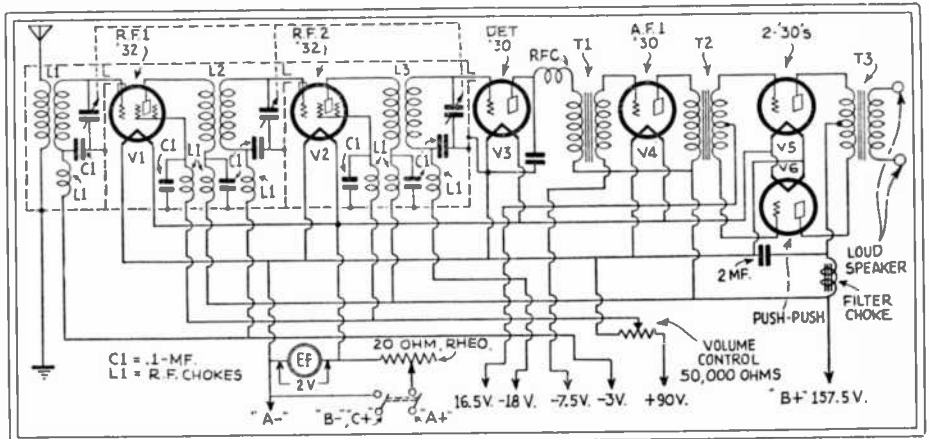


Fig. 25A. A "Push-Push" Battery-Model Receiver. Two '30's are the output tubes. The circuit of Fig. 25A develops 1. watt; the circuit of Fig. 25B develops 1.2 watts.

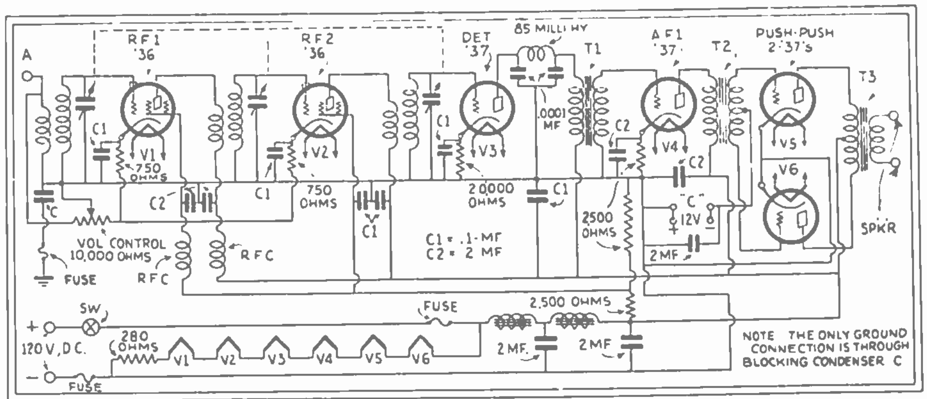


Fig. 25B. A "Push-Push" 110-Volt D.C. Receiver. Two '37's are the output tubes. Class B amplification is particularly desirable for the circuit requirements of Fig. 25A and 25B.

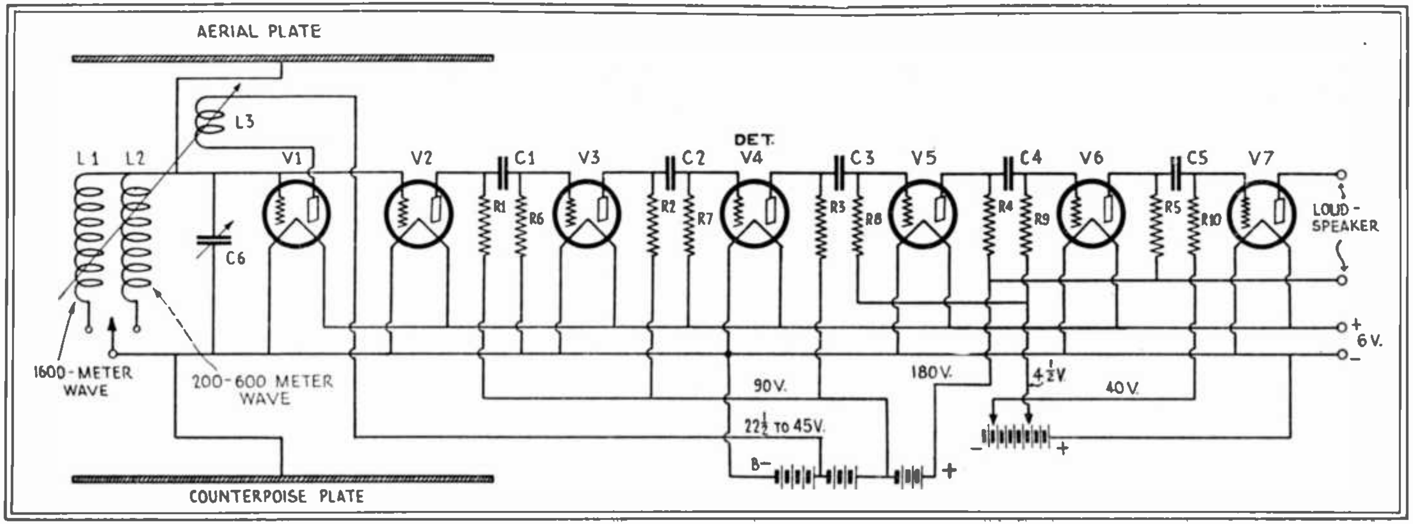


Fig. 27. An All-Resistance-Coupled, Broadcast- and Long-Wave Receiver. Although the original design of this set was arranged for the particular requirements of the King of England, the outstanding characteristics are of general interest; and readily adaptable to the technical demands on this side of the "pond." To obviate the necessity of running lengthy leads inside Windsor Castle for connection to the antenna and ground, capacity-plates were arranged inside the cabinet; one acted as the pickup or antenna, and the other as ground or counterpoise. These plates may be of copper, each measuring about 18-40 in. The electrical values for American tubes would be approximately as follows: Tube V1, V4, '01A; V2, V3, V5, V6, '40's; V7, '71A. Resistors R1, R2, R4, R5, ¼ meg.; R3, ½ meg.; R6, 1. meg.; R7, 2 megs.; R8, 9, ½ to 1 meg; 10,, 1/10-meg. Condenser C1, .001-mf.; C2, .00025-mf.; C3, C4, C5, .01-mf.; C6, .0005-mf. Coil L1, a 250-turn honeycomb; L2, 50-turn honeycomb; L3, 25-turn honeycomb. Note the grid and plate connections of tubes V1 and V2; by thus incorporating the regenerative action in a separate tube, greatly improved operation is obtained. It is a relatively simple matter to apply this circuit to the use of higher-gain tubes, such as those of screen-grid or pentode types. In this case it is necessary to increase the supply voltages to values sufficient to overcome the loss occasioned through the use of resistors as the plate loads; for preliminary tests it will not be necessary to change the values of the fixed coupling condensers. The honeycomb coils, if used, must be placed in variable inductive relation, as indicated by the arrow; for ordinary broadcast reception, the 1,600-meter inductance may be left out of the design, and an ordinary "3-circuit" tuner used as the tuning unit. It is a simple matter to replace output '71A tube V7 with a unit of great power/sensivity ratio, such as an output pentode. The original design of this set did not necessitate a circuit of extreme selectivity; therefore, in some districts special measures may be necessary to obtain a receiver arrangement free from cross-talk and ordinary interference. Resistance coupling between R.F. amplifiers V2, V3 and detector V4 insures aperiodic amplification which is an attribute where it is desired to receive over a wide band of wavelengths. Resistance coupling between the succeeding audio amplifier tubes insures high audio quality; condensers C1 and C5, must be of very high grade. A particular objection which may be raised is that the honeycomb coils take up too much room. However, this is easily settled by winding these units with fine wire—for instance, about No. 36 silk-enam.

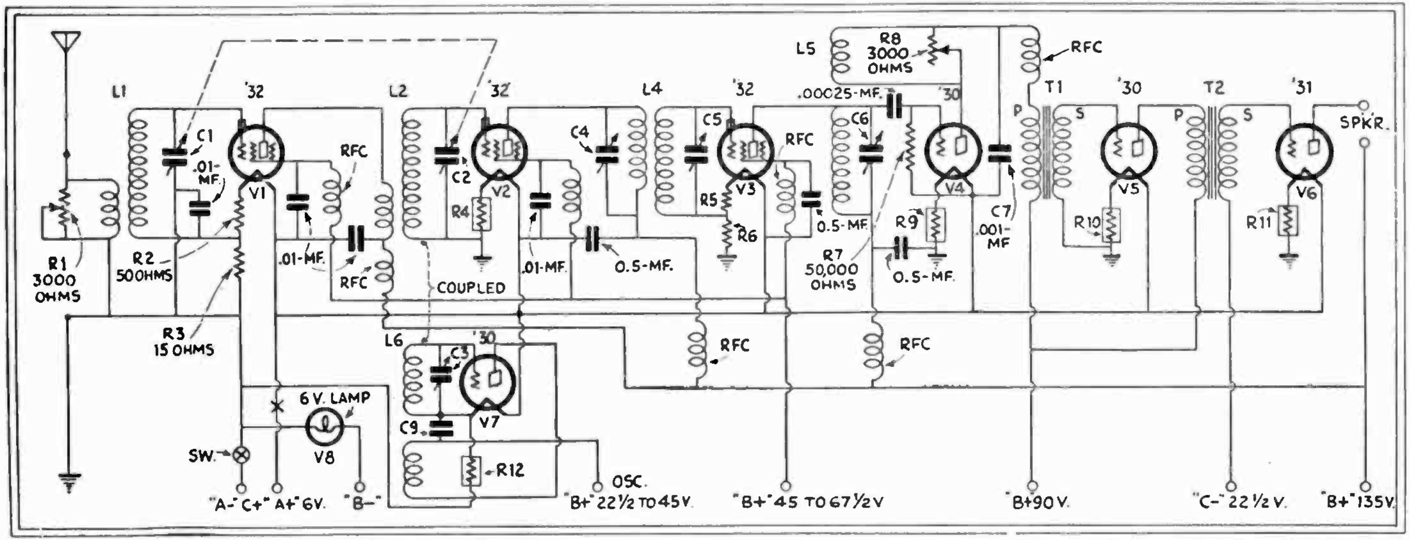


Fig. 28. A Superheterodyne Using 2-Volt Tubes. High sensitivity and "CW" reception are obtained by regenerating V4.

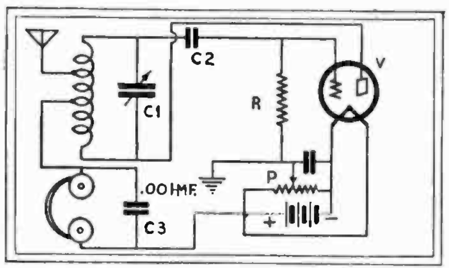


Fig. 29. The "B"-Less "Solodyne" Set. Plate potential for this receiver is obtained from the "A" battery. The coil is standard; grid condenser, .00025-mf.; grid leak, 2 megs.; P, 3,000 ohms; the tube, any type of triode.

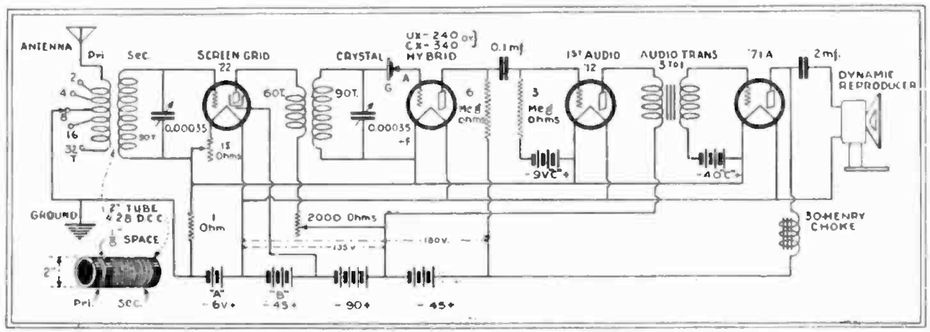
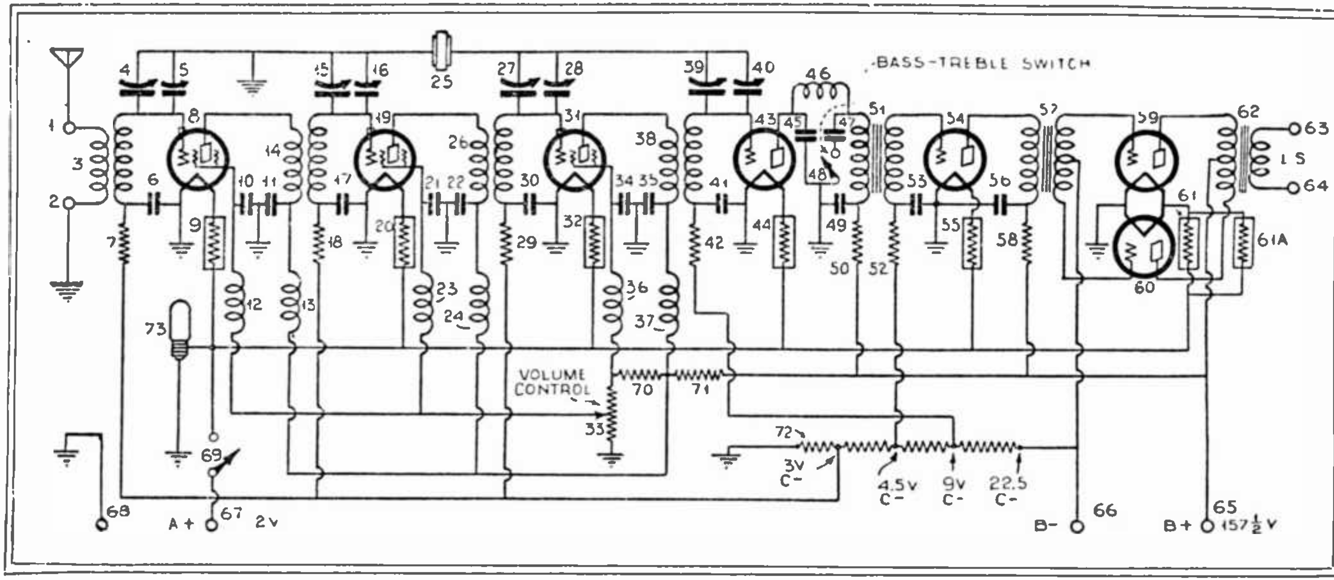


Fig. 30. The Grimes Hybrid-Crystal Receiver. Shield the '22 and second R.F. transformer.



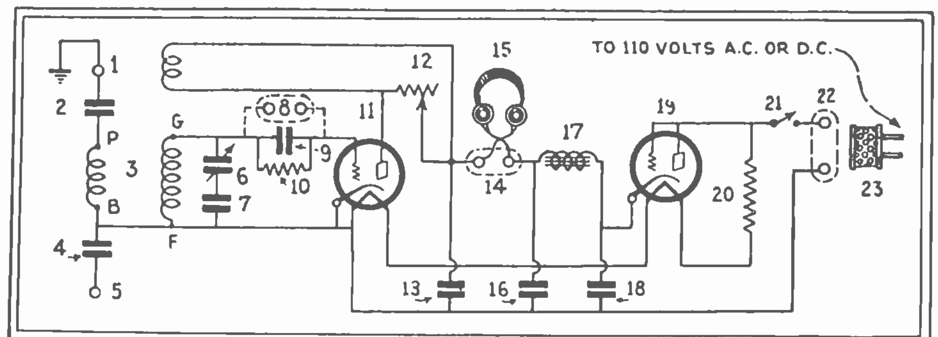


Fig. 31, above. The "DeLuxe 2-Volter" Battery-Powered T.R.F. Radio Receiver

Fig. 32, right. Cisin "Cash-Box" A.C.-D.C. Receiver. In the original set, the following parts were used: Electrad regeneration control, type RI-232P, 12, with power switch 21; a shielded Conoid antenna coupler with special tickler consisting of 70 turns of No. 29 enameled wire wound on a cardboard tube 1 in. in diameter and ¾-in. long. Headphones 15 are Trutest "Lightweight" type. Electrolytic condensers 16, 18 are Aerovox dry units of 4 mf. size, type E-54, small. These parts, and those in the supplementary list, fit nicely into a metal "cash-box" measuring, inside, 11¾x5¼x2⅝ ins.; the cover measures 11¾x5¼x11 ins. Resistor 20, Electrad 75-watt, type D-4.

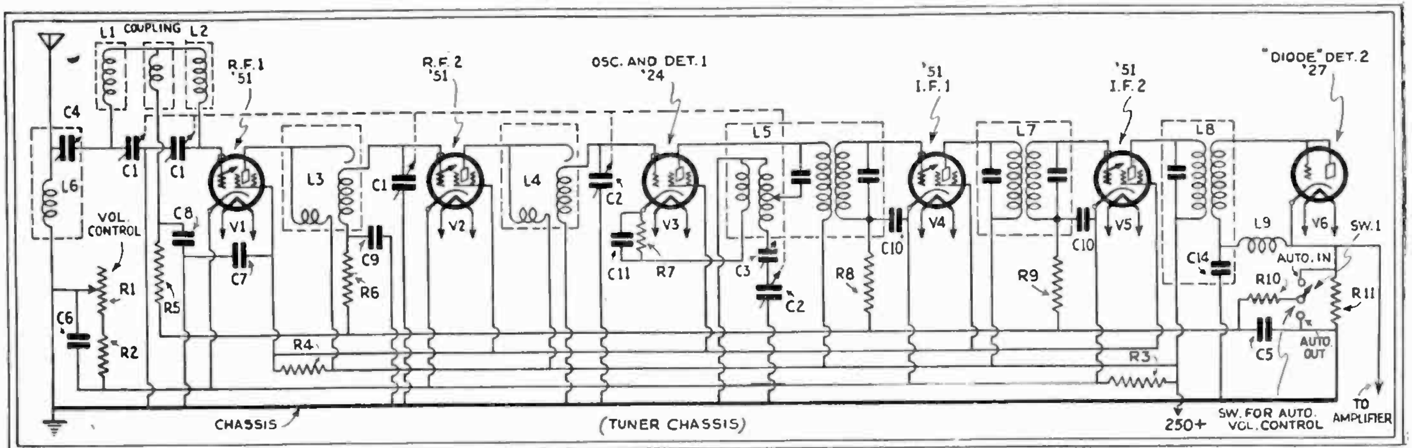


Fig. 33A. A Modern Superheterodyne Tuner-Chassis—The Super-Da-lite-R. Readily adaptable to any power unit; includes A.V.C. and band-selection. To reduce cross-talk to minimum, type '51 variable-mu tubes are used in R.F. and I.F. Second-detector V6 is a diode.

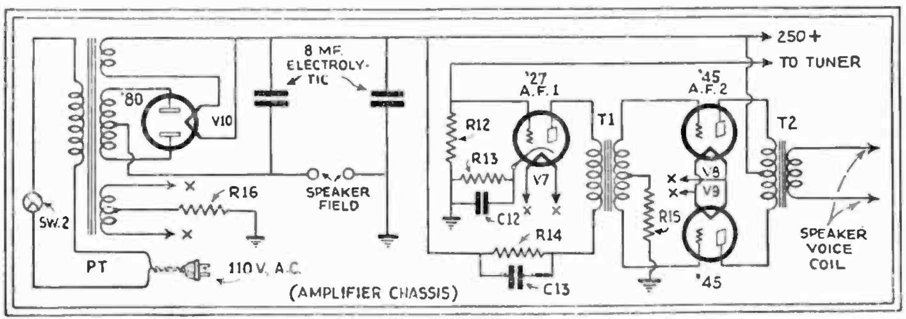


Fig. 33B. A Modern Superheterodyne Tuner-Chassis—Power Pack Circuit. Suitable A.F. power amplifier and current supply unit. Note that the negative connection of the electrolytic condenser across the output of the '80 is not directly grounded. The designer of this circuit has specialized in the development of radio receiver chasses having exceptional sensitivity and selectivity characteristics; the power supply and audio amplifier are given a purely incidental place in the specifications of the Super-Da-Lite-R.

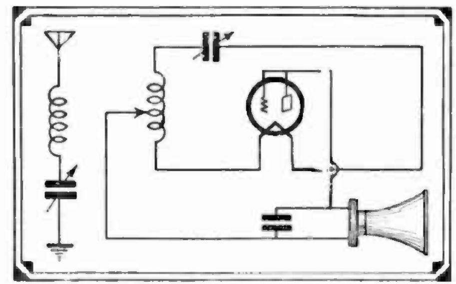


Fig. 34. A Batteryless Tube-Type Receiver. The '71A filament receives its power fron the broadcast station, which must be a high power local. The secondary coil is 3¾ in. in diameter and 2¾ in. long; No. 22 D.C.C. wire; primary, (wound with bell wire), and condenser, experimental. Tuning condenser, .0005-mf.; the speaker bypass, 0.25-mf.

CHAPTER III

All-Wave Circuits

UTILITY is the parent of the "all-wave" receiver which may cover a frequency band twenty times more broad than can be encompassed by the lowly "broadcast" set.

This seeming miracle is accomplished by the simple process of changing in a tuned circuit the value of the inductance, capacity, or both.

Early receiver designs accomplished this change by replacing one or more coils of a selected value, by a set of inductances having a second, selected response characteristic; later design called for a change in tuning capacity; while a third step incorporated continuous and simultaneous variation of both the coil and condenser. Many modern sets now include an "inductance bank"—a unit incorporating a complete set of coils required for a particular series of tuning bands.

All-wave receivers are available both in T.R.F. and superheterodyne types.

Being built as a complete, integral chassis, they ordinarily are far more efficient than such "combinations" as result when either converters or adapters are used in conjunction with a standard broadcast receiver.

Due to the extremely high frequencies of the lower-wavelength stations (20,000 kc. at 15 meters) as compared to the higher wavelength stations (600 kc. at 500 meters), the unwary experimenter in the former sphere of activity may be astonished at phenomena quite non-existent in the latter.

Only by giving the most minute attention to detail will the short-wave enthusiast be rewarded with the remarkable results that may be obtained with good all-wave receivers.

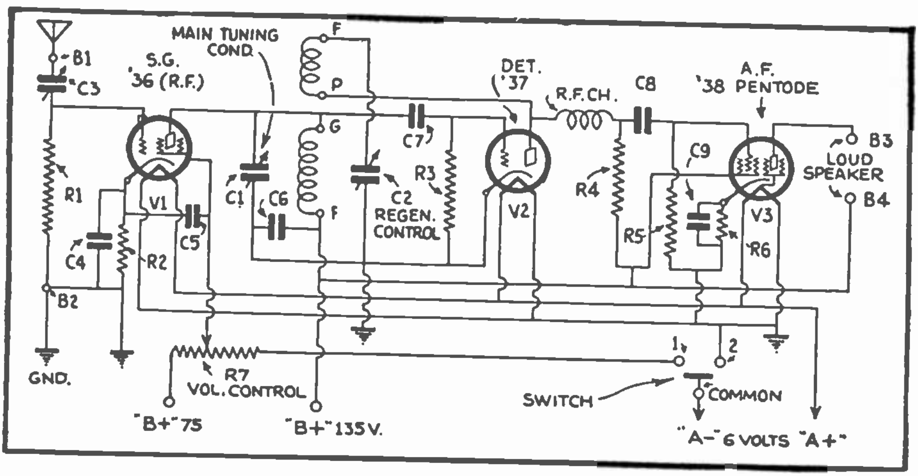


Fig. 35A. A Modern, Simple All-Wave Receiver. Battery or A.C. supply may be used.

By applying rectified A.C. to the filaments of automotive-type tubes hum-free operation is obtained. To cover a band of 12 to 560 meters five plug-in coils of tube-base type are required. For 73-170 meters, 50 turns of No. 28 and 16 of No. 36; 32-77, 15 of No. 28 and 8 of No. 36; 12-45, 8 (spaced) of No. 18 enam. and 4 of No. 28; 125-295, 136 No. 36 enam. and 10 of No. 36; 250-560, 250 No. 36 enam., 20 No. 36. Except as otherwise indicated, the covering is D.S.C.; first figure, G-F, second, F-P.

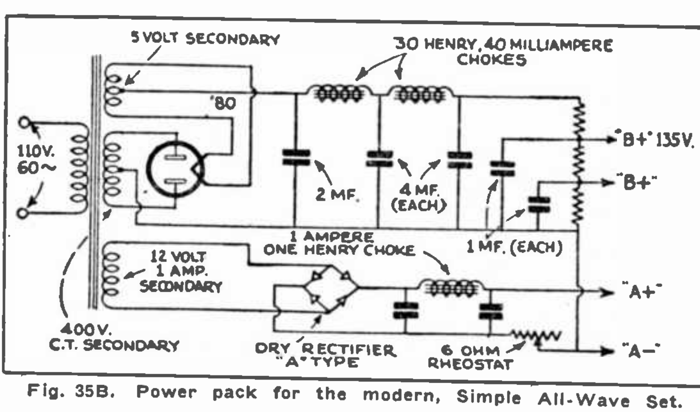


Fig. 35B. Power pack for the modern, Simple All-Wave Set.

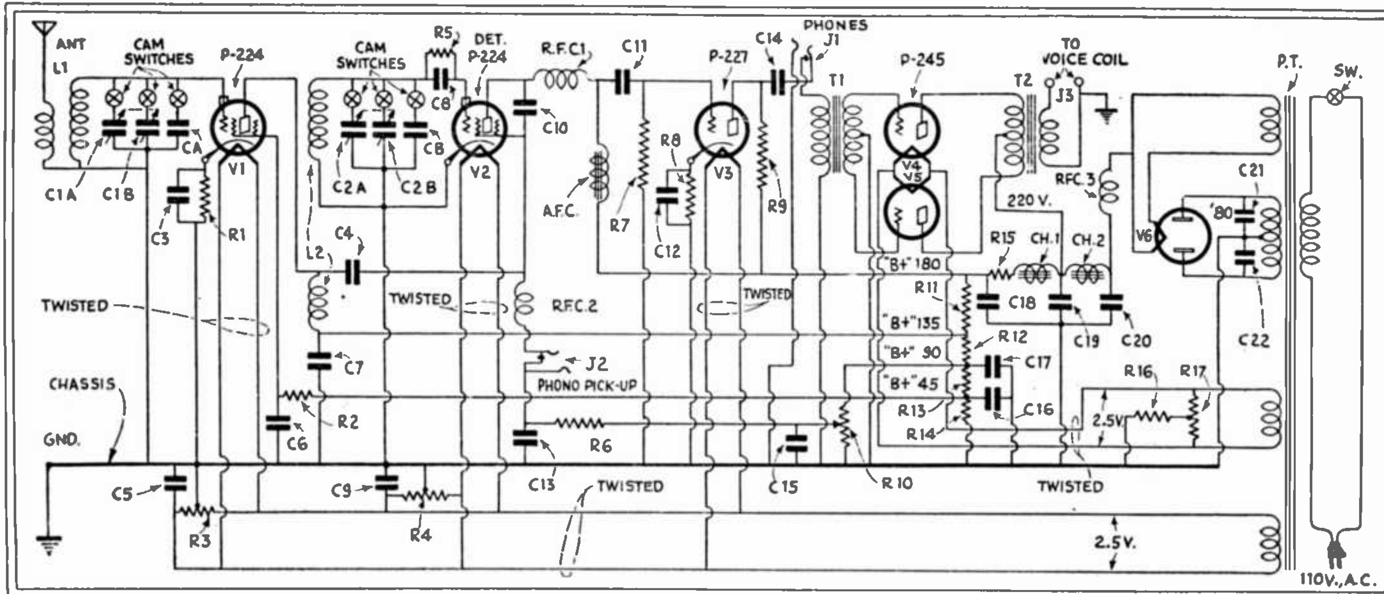


Fig. 26. The Pilot "Universal Super-Wasp" All-Wave Receiver. A master switch operates cams to simultaneously control the circuits for tuning over the band of 15 to 650 meters; although only one set of coils is shown, there are actually seven required for this tuning range, each being put into circuit, and the tuning capacities balanced accordingly, as required—automatically. The following parts values are used in this chassis: C3, C5, C6, C7, C9, 0.2-mf.; .0005-mf.; C8, .00025-mf.; C10, .00004-mf.; C11, .01-mf.; C12, C13, 0.6-mf.; C14, .06-mf.; C15, C16, C17, 1. mf.; C18, C19, 3 mf.; C20, 2 mf.; C21, C22, 0.1-mf., buffer condensers. The resistors measure: R1, R2, 450 ohms; R3, R4, R17, 20 ohms; R5, 2 megs.; R6, R8, 2,000 ohms; R7, 0.5-meg.; R9, R10, 50,000 ohms; R11, R12, R13, R14 comprise the regular 25,000 ohm voltage divider; R15, output losser; R16, 1,000 ohms. Resistor R10 is the regeneration control. Fixed .0004-mf. condensers C3 and CB are used only in tuning above 470 meters. For simplicity, the four antenna couplers permanently mounted inside the set are represented as a single coil L1, and the four detector coils also as one unit L2. Each of these coils has two windings; L1 has a primary and a secondary, and L2 has a combination primary and tickler, and a secondary. One end of each winding is permanently grounded; either directly to the chassis or through a non-inductive condenser, as in the case of the primary-tickler. The other ends of the respective coils are brought to contacts on the cam switches, and are connected in the correct sequence as the switches are turned. (Winding values must be determined experimentally.) The antenna and detector tuning condensers, C1 and C2 in the diagram, are actually double units; one section of each has a maximum capacity of 130 mmf., and the other, 415 mmf. They have a common rotor connection but separate stators; the latter connections are also brought out to contacts on the cam switches, so that there are 15 contacts altogether on the switches; the small sections are designated by A (C1A, etc.) and the large, B (C1B, etc.). The method of regeneration control is novel; it also varies phono-volume. Special short-wave tubes are indicated. Ranges: 15-23; 22-41; 40-75; 70-147; 140-270; 240-500; 470-650 meters.

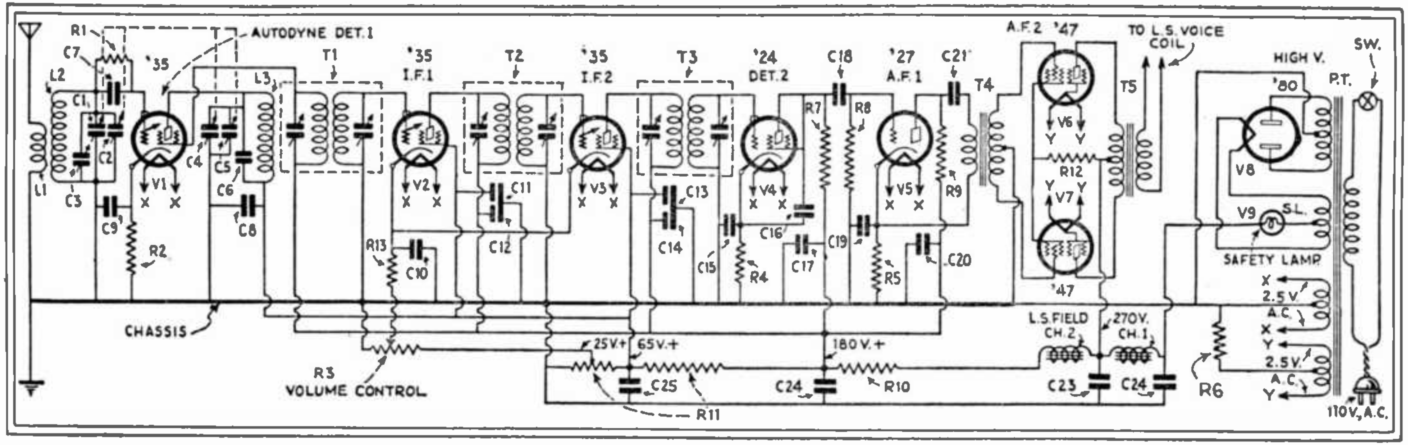


Fig. 37. The "Tetradyne" All-Wave Receiver. The tuning condensers are of the two-stator type. They are National type E.C.4 units (original capacity, .0004-mf.); several plates are removed from each section so that now the smaller section is composed of three plates and has a capacity of .0001-mf. The larger section has seven plates and a capacity of .0003-mf. in each section, which is used to tune the broadcast band. The smaller sections are used only for the short-wave bands, and are automatically connected into the circuit by means of the plug-in coils. Condenser C3 is manipulated by means of a separate knob on the front panel. Condenser C6 is an equalizing unit of about 50 mmf. and is permanently connected to the broadcast-band coil; once adjusted it need not again be varied. The complete receiver, including the power supply, will mount on a sheet of 14-gauge aluminum, 11¼x21x2½ ins. high. The modulator-oscillator tube, the coils, tuning condensers, and dial are mounted in an 18-gauge aluminum shield-box, 10¼x6x8¼ ins. wide. The shield box for the I.F. and second-detector is 8¼x5x6 ins. high. It is divided into three equal compartments; No. 18 gauge aluminum is used. The coil forms may have a diameter of 1½ ins.; they are wound to the following specifications: The 200- to 550 meter band, L1, 20 turns; L2, 98; L3, 66. Coils L1 and L2 are wound on the same form (on all the different wave-band coils), are separated by 1/16-in., and are wound with No. 28 D.S.C. The 80- to 205-meter band; L1, 14 turns; L2, 57 turns; L3, 58 turns. Coils L1 and L2 are separated by ⅛-in., and are wound with No. 24 D.S.C. The 40- to 80-meter band: L1, 10 turns; L2, 22 turns; L3, 21 turns. Coils L1 and L2 are separate ¼-in., and are wound with No. 24 D.S.C. wire. The 20- to 45-meter band; L1, 8 turns; L2, 10 turns; L3, 10 turns. They are separated by ¼-in., and are wound with No. 24 D.S.C. wire. For wavelengths up to 25 meters; L1, 4 turns; L2, 6 turns; L3, 6 turns. Coils L1 and L2 are separated ¼-in., and are wound with No. 24 D.S.C. wire. Any good I.F. transformers may be used. However, they may be home-constructed by jumble winding a primary of 162 turns of No. 28 enameled wire on a tube 2 in. in diameter (and 3 in. long) in a space ½-in. wide. Spaced ⅜-in. away, is the start of the secondary, of 213 turns of No. 28 enameled wire. The .0001- and .0002-mf. condensers are connected together in the broadcast coil only, thus leaving only the .0001-mf. section of the tuning condensers for the short-wave band; the same method is used for the oscillator coil. In addition to the units included in the supplementary list, the following components are used: two National Type E.C. special 2-stator condensers, C1 and C2, C4 and C5; one 50 mmf. trimmer, C3; one Hammarlund 10 to 70 mmf. equalizing condenser, C6; one Aerovox, .00015-mf. mica condenser, C7; three Aerovox 0.1-mf. bypass condensers, C8, C9, C10; two Dubilier 0.1-mf. condensers C11, C12, C13, C14; two Concourse 5 mf. dry electrolytic condensers, C15, C19 (of 35-volt type); Aerovox .0005-mf. mica-dielectric condenser, C16; two Concourse 4 mf., 400-volt type dry electrolytic condensers, C17, C20; Aerovox 0.1-mf. 400-volt type condenser, C18; Aerovox 0.25-mf. condenser, C21; Aerovox filter type 1. mf., 600 volt condenser, C22; Aerovox 8-8-8 mf., 475-volt type dry electrolytic condensers, C23, C24, C25.

CHAPTER IV

Short-Wave Sets

THERE is no thrill like that of hearing an overseas announcer as he identifies his station speaking in his native tongue This sensation is non-existent for those who do not have the ambition to "fiddle" with short-wave equipment.

As intimated, there is more to short-wave reception than just hooking together the parts specified, and then intently listening.

After due test we may grant that the components have the correct electrical characteristics, but unless they have been mounted in correct relation to each other, results may not be very satisfactory.

The final requisite is experience in operating the finished instrument.

Too often are experimenters prone to cry that "short-waves are the bunk," only to find out later that certain units were of incorrect value, coils were placed too close to the chassis, or it was not known that the "zip-zips" actually were stations that needed only a little more careful tuning to be identified as transmitters located at distant points.

Climatic conditions over which there is no control exert tremendous influence on radio signals of short wavelengths. Consequently, if the "air" seems at times to be as dead as a graveyard, do not condemn the set—wait 'till another time to try for station programs; however, this condition is seldom found on all the shorter wavelengths at the same time.

The enthusiast who takes his short-waves seriously will make it a point to study weather maps and program time-tables, and adjust his reception schedule so that enjoyment is obtained from the short-wave set, no matter whether it has one tube or a dozen.

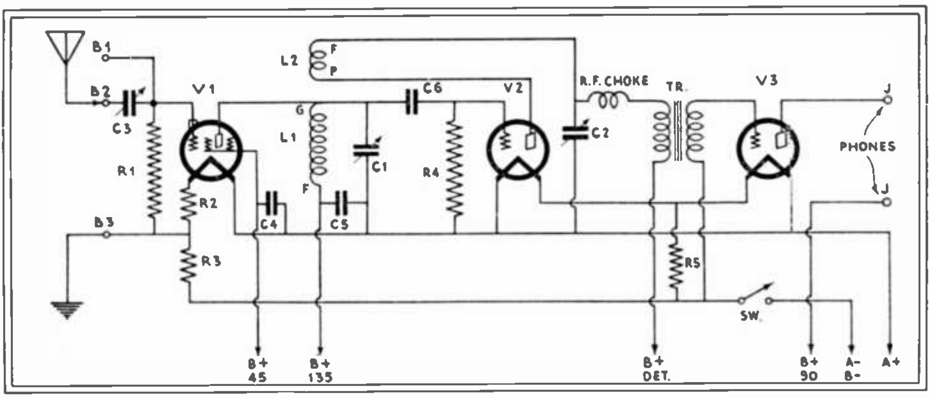


Fig. 38. Short-Wave Screen-Grid "Craft-Box" Set. One R.F., one A.F. stage.

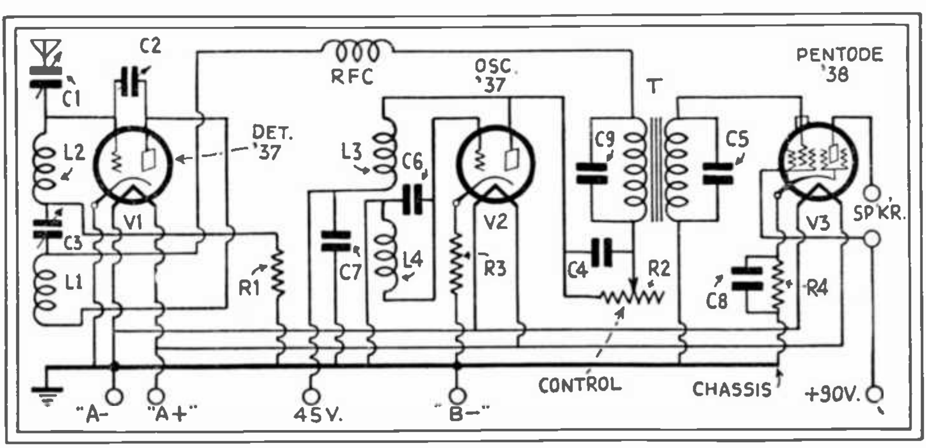


Fig. 39. A 5-Meter Superregenerative Receiver. A "quasi-optical" frequency set.

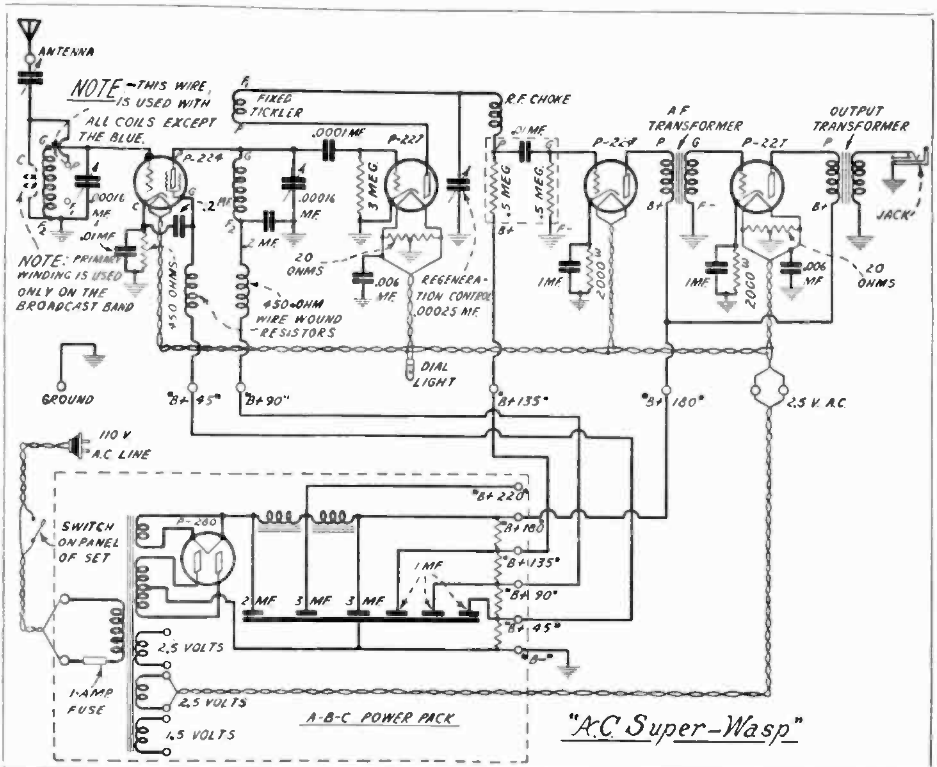


Fig. 40. The Pilot "A.C. Super-Wasp" Short-Wave Set. Four receiver tubes and a rectifier.

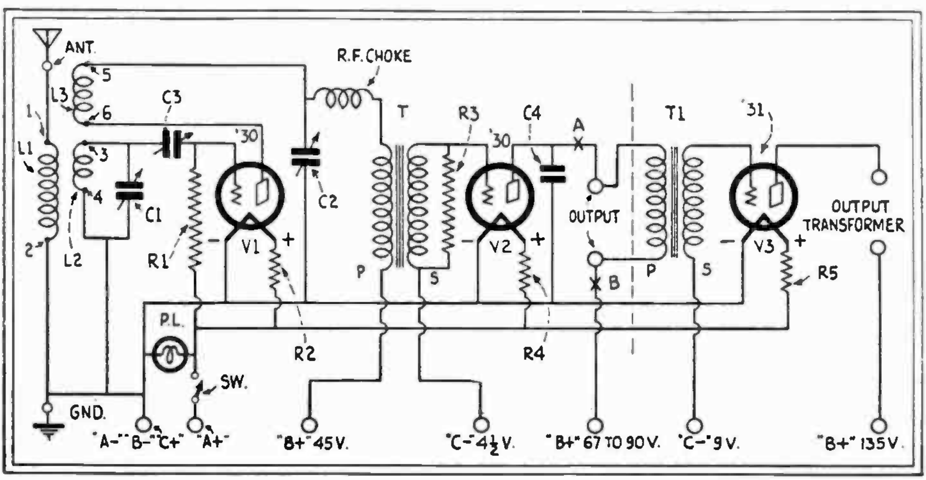


Fig. 41. The Hammarlund "Hawk" Short-Wave Receiver. The turns on the 14-24 meter coil are: grid 3, plate 3; 22-40 meters, grid 7, plate 5; 36-65 meters, grids 15, plate 6; 60-110 meters, grid 24, plate 12. The aerial winding L1 has 6 turns, 1-13/16 ins. in dia., No. 18 S.C.C. for all ranges. Number 16 D.S.C. wire, 10 turns to the inch, 2 ins. in diameter, is used for the secondaries and ticklers; except for the 80-meter coil, which uses No. 18 D.S.C. wire, 16 turns to the inch. Between L3 and L2 the space is equal to one turn of wire. The R.F. choke is helical wound and has a distributed capacity of only about 3 mmf.

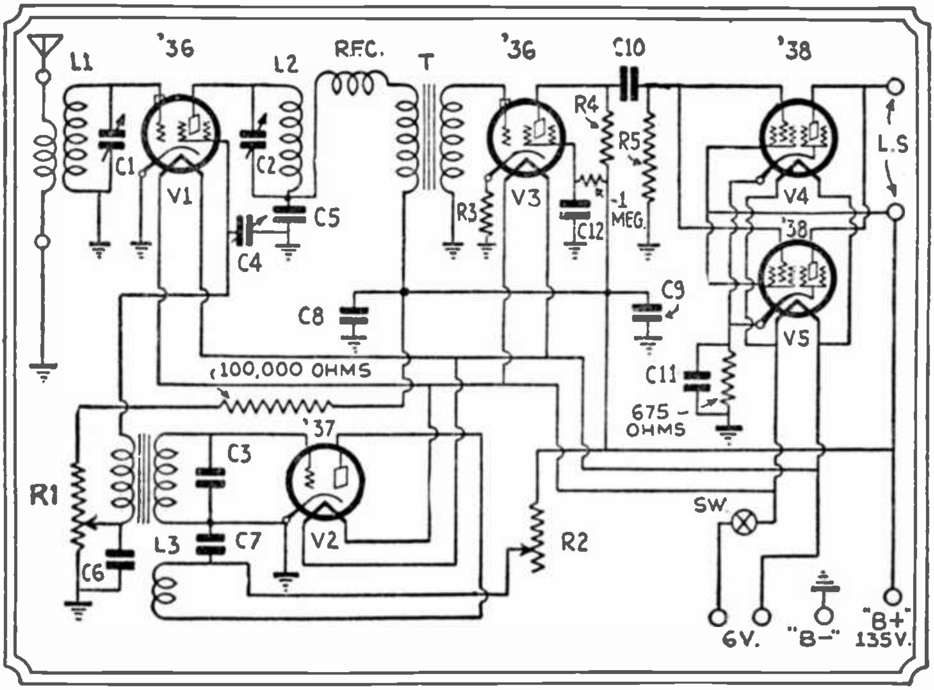


Fig. 42. The "Superregenode"—With 6.3-Volt Tubes. Two pentodes in parallel insure a good sensitivity/power output ratio. It is difficult to obtain an output transformer with an output impedance of 15,000 ohms at about 90 cycles; therefore by using two tubes in parallel, the output impedance is reduced to 7,500 ohms, which is more satisfactory. The screen-grid '36's must be selected by actual test in the receiver, until a really good tube is obtained. The success of the receiver as a whole can always be traced to the "detector" tube. Experiments indicate that the best value for the locally-generated suppressor-frequency is in the order of 1/1000 of the received signal frequency; that is, the former is expressed in cycles corresponding to the kc. of the latter (as indicated in Table I). The sensitivity of the receiver increases steadily as the signal frequency rises. At the highest frequencies the locally-generated frequency is quite inaudible; it falls to 7,500 cycles only above 40 meters. At 5 meters the suppressor operates at R.F., 60 kc., which does not cause interference, and requires no A.F. filtering for receiving very short wavelengths. An extremely important element in the construction of sets for operation at these very high frequencies is the placement of the apparatus. A high-frequency hiss, due to the super-regenerative action, may be reduced or eliminated by judicious selection of A.F. components non-responsive to it.

TABLE I

R.F. Input Signal		Suppressor Frequency		C3 Cap.
Meters	Kc.	Cycles	(Meters)	Mf.*
10	30,000	30,000	10,000	None
15	20,000	20,000	15,000	.001
20	15,000	15,000	20,000	.0025
24	12,500	12,500	24,000	.004
30	10,000	10,000	30,000	.006
37½	8,000	8,000	37,500	.01
50	6,000	6,000	50,000	.02
60	5,000	5,000	60,000	.03
75	4,000	4,000	75,000	.05
100	3,000	3,000	100,000	.08
120	2,500	2,500	120,000	.10
150	2,000	2,000	150,000	.2
200	1,500	1,500	200,000	.3

* Approximating computed value.

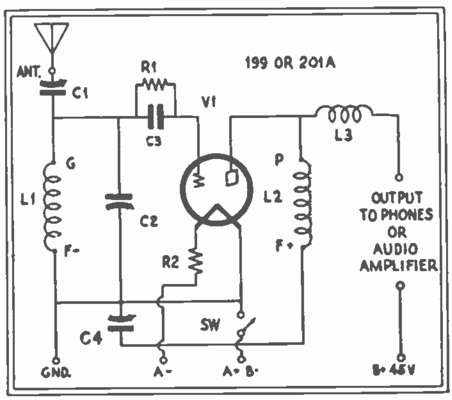


Fig. 43. Grand "Sun" Short-Wave Tuner. A simple circuit arrangement for the beginner. A good design for "breadboard" construction.

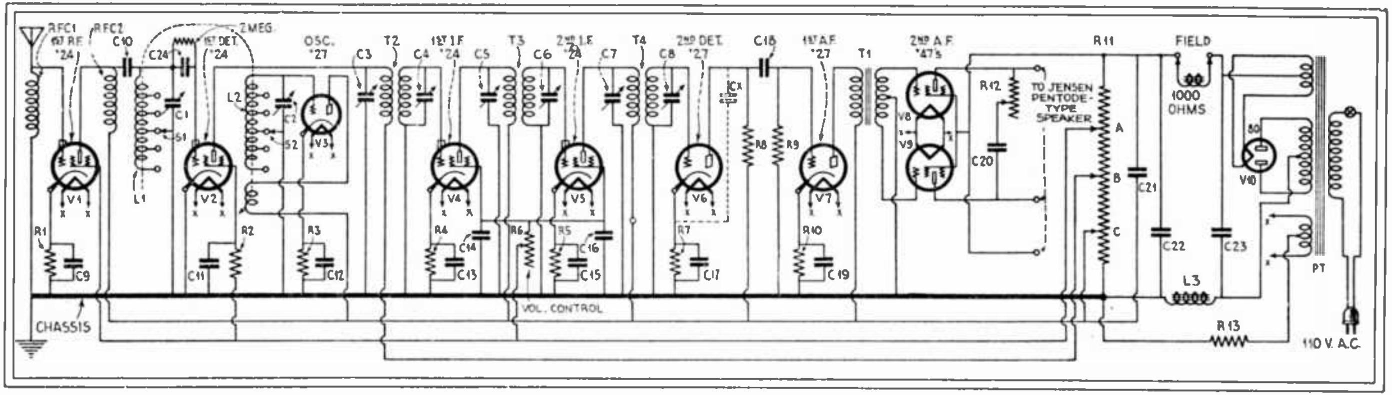


Fig. 44. The "Tropic 10" Short-Wave Superheterodyne. Designed primarily for use in torrid climates, it yet has general interest. The monel-metal chassis measures 20¾x11x3 ins. high. Coils L1 and L2 are wound in the same direction, on forms 1⅝ ins. in diameter, and 2⅝ ins. high; these are spaced 5 ins. between centers, both grid terminals being at the tops of the respective coils. Coil L1 has a total of 103 turns; L2 is similarly wound and tapped. Spaced two turns from the latter is wound the feedback coil of 30 turns; lack of oscillation may be due to reversed connections. It is essential that, for use in tropical climates, the specified parts be used. For instance, the three 8-mf. Mershon electrolytic condensers, C21, C22, C23, must be of the copper-case-type. To cover the range from 25 to 100 meters, the detector tuning coil L1 and oscillator coil L2 are wound to the specified number of turns of No. 26 D.S.C. enam. wire, on a bakelite tube. The feed-back coil of the oscillator is wound with wire of the same size and covering. The original set used a Lafayette 60 H. filter choke as L3, and Lafayette 25- cycle power transformer, P.T. A transformer of this design results in extremely low hum output and fine regulation.

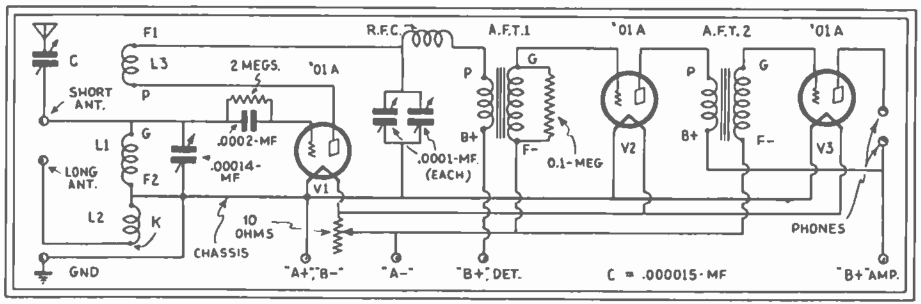


Fig. 45. The Pilot "Wasp" Short-Wave Receiver. The original circuit of one of the most popular short-wave sets ever offered to the experimenters. Its subsequent ramifications, of which this is the progenitor, bear little resemblance to this plain little diagram. The A.F. transformer may be any desired make; the ratio, for instance, may be about 3.5 to 1. Regeneration is controlled by the two .0001-mf. variable condensers connected in parallel. Note the extremely small capacity of antenna condenser C. The plug-in coils and their tuning condenser may be of any desired make, just so they are a match for the desired ranges; or, coils may be made in accordance with the standard directions for the construction of short-wave coils of different types. Experimenters may wish to adapt the new tubes to this circuit; the results will be interesting.

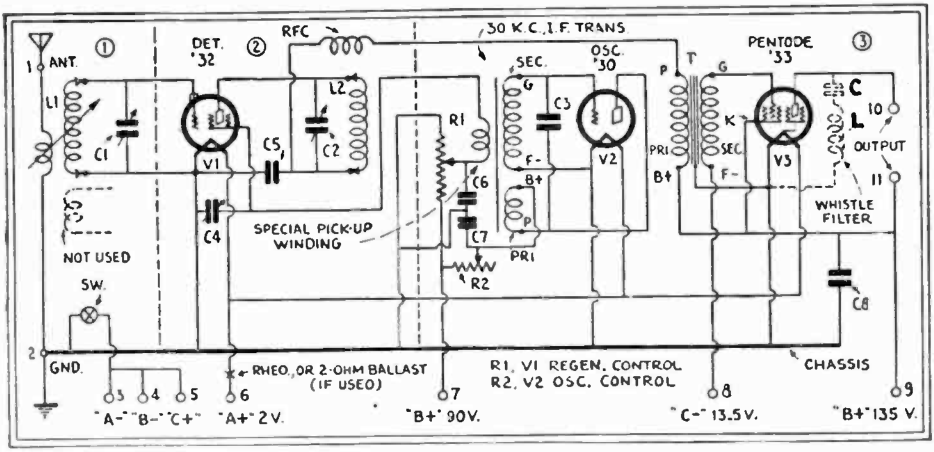


Fig. 46. The Short-Wave "Superregenode"—With 2-Volt or "Dry Cell" Tubes. An ordinary 30-kc. I.F. transformer is used to obtain the super-audible suppressor frequency.

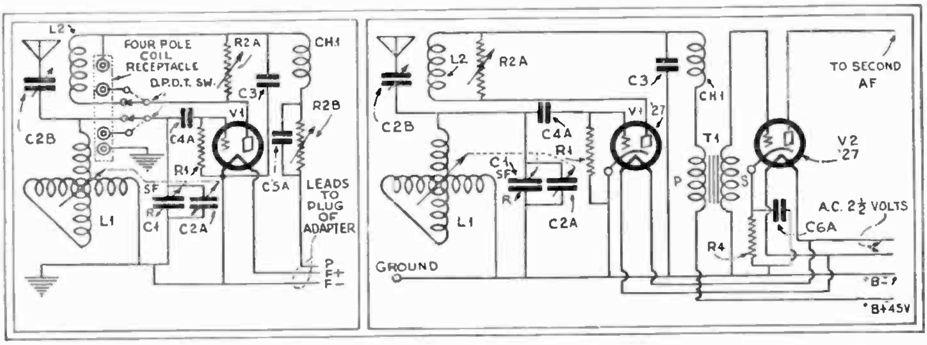


Fig. 47. An "Automatic Tuner" Short-Wave Receiver. By ganging a special variometer L1, and two variable condensers C1, C2A, unique and wide-range tuning is obtained.

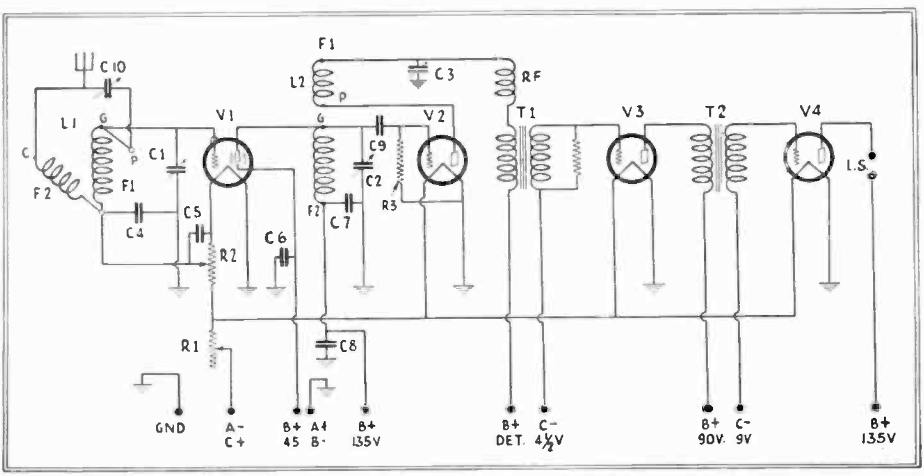


Fig. 48. The Pilot "Super-Wasp" Receiver. A complete receiver capable of reception from distant stations and at "loud speaker volume," so called. A very effective short-wave set.

CHAPTER V

Short-Wave Converters and Adapters

SHORT-WAVE converters and adapters are of particular interest to the broadcast listeners; and to those amateur experimenters to whom the cost of more expensive equipment is a deterrent.

Converters may be defined as units which change the short-wave signals from their incoming wavelength to the longer wavelength for which the associated broadcast receiver is adjusted. These converters may be self-powered, or they may derive operating potentials from the broadcast set.

Adapters connect into the broadcast receiver at the detector—making connection either to the grid or plate circuit. These devices, too, may be self-powered, or they may connect into the power system of the associated receiver.

Upon reflection it will be clear that the converter should be more satisfactory than the adapter; since the former utilizes all of the amplification possibilities of the associated broadcast receiver. The adapter, on the other hand, uses only the audio portion of the receiver.

For this reason we find that in converter designs it is usually considered sufficient just to affect the program transfer from the short- to the broadcast wavelengths. In the adapter, however, we often find circuit arrangements for obtaining considerable amplification at the short-wave lengths—since there is no R.F. amplification in the associated set.

In fact, it is not possible to say that one or the other is "best," since losses in the converter may offset low sensitivity in the adapter.

At this point it may be interesting to call attention to the sequence of circuits when a good superheterodyne short-wave converter is connected to a good superheterodyne broadcast receiver. Each step will be given its correct designation.

The initial stage is the radio frequency amplifier, followed by: first-detector; first-oscillator; first-intermediate frequency amplifier; second-detector; second-oscillator; second-intermediate frequency amplifier; third-detector; audio frequency amplifier. Quite a formidable array.

Of course, if there is a fault in any portion of this system, only mediocre results will be obtained. Not only must each section be correctly aligned, but each one must be correctly matched to the other, component sections.

For this reason, among others, it is a good plan to always have available an auxiliary short-wave receiver which may be used to monitor or double-check reception conditions. By arranging it to oscillate, it also may be used as a service oscillator.

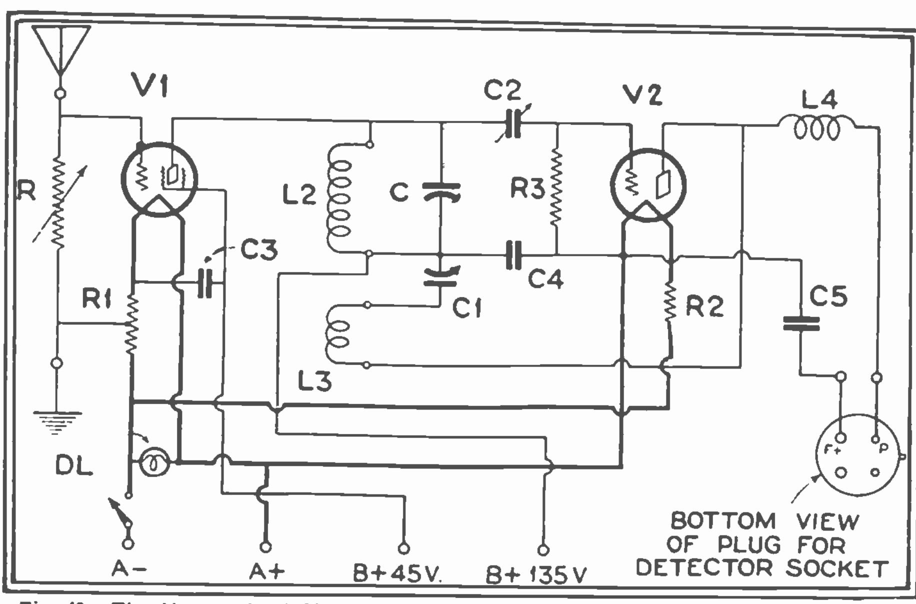


Fig. 49. The Hammarlund Short-Wave Adapter-Receiver. An easily constructed unit.

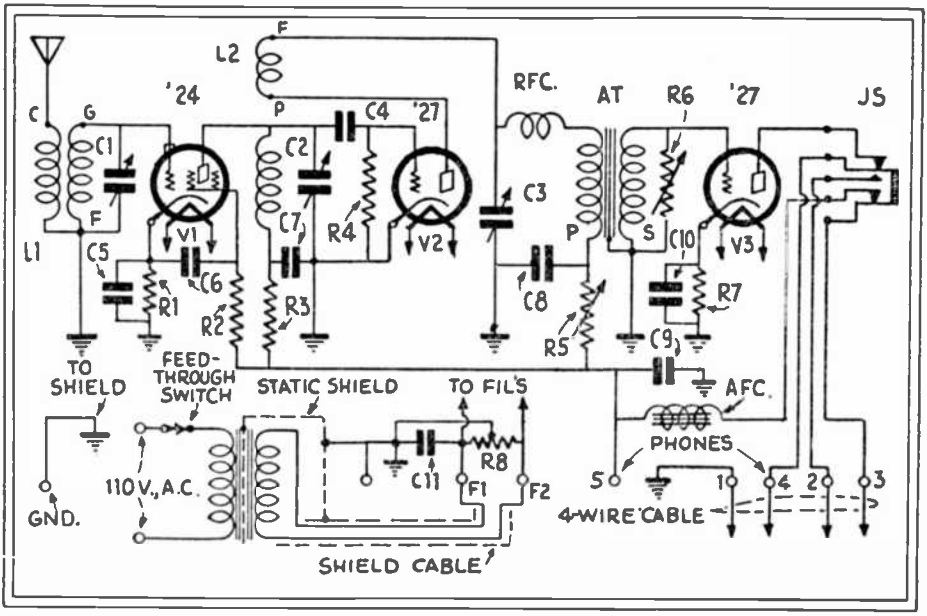


Fig. 50. A Short-Wave Adapter-Receiver. An R.F., detector, and A.F. combination.

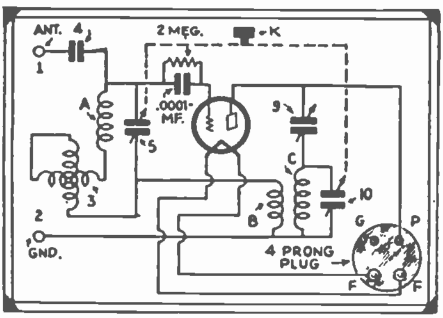


Fig. 51A. Police-Call Converter—'01A, Etc.

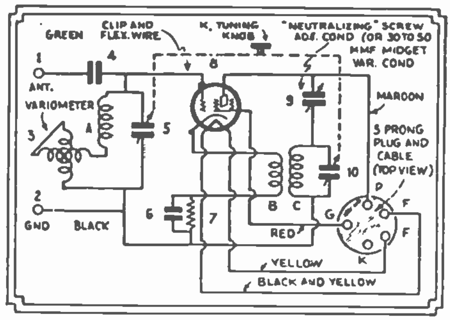


Fig. 51B. Police Converter—Cathode-Type.

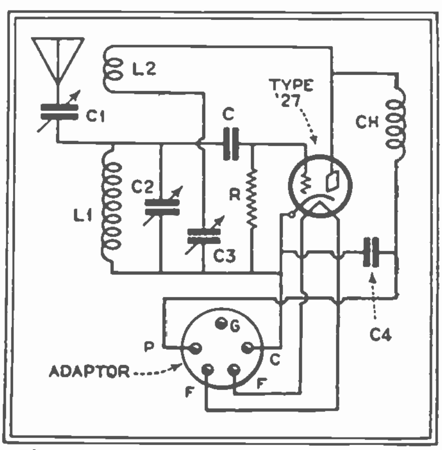


Fig. 52. An A.C. Short-Wave Adapter.

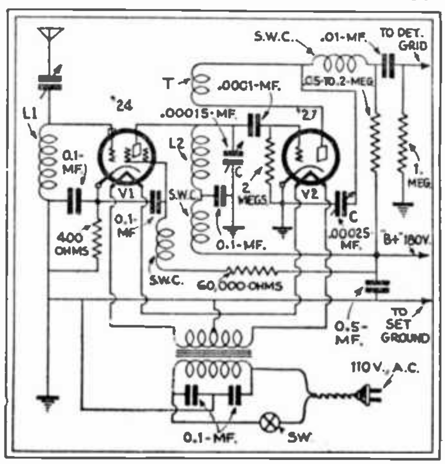


Fig. 53. A Screen-Grid S.W. Adapter.

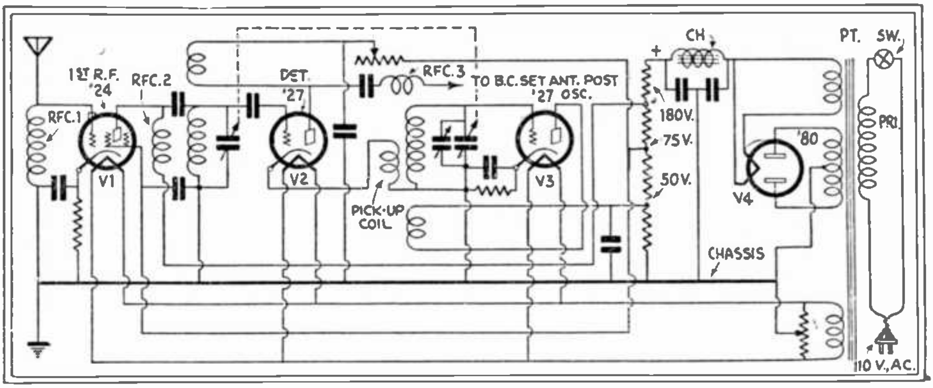


Fig. 54. The Walker "Model 4" Short-Wave Converter. A self-powered instrument.

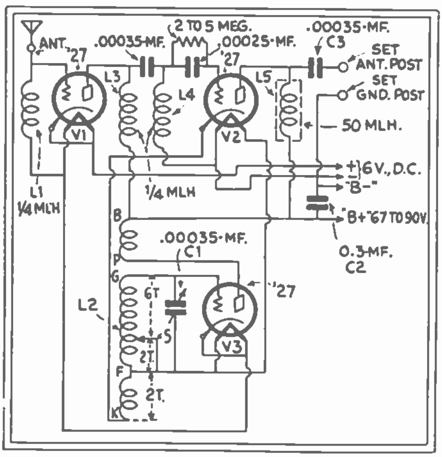


Fig. 55A. The Air King S.-W. Converter. A "Hi-Low" switch shorts 2 turns of L2.

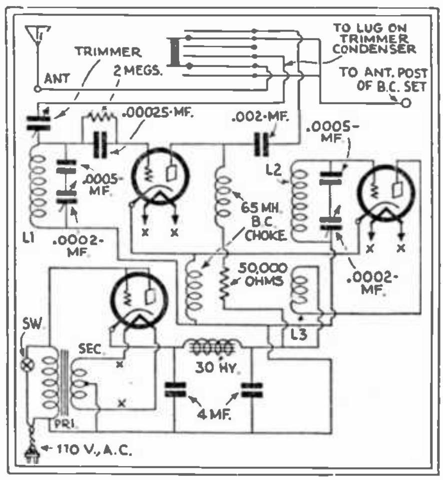


Fig. 56. The "Antipodes" Super-Converter.

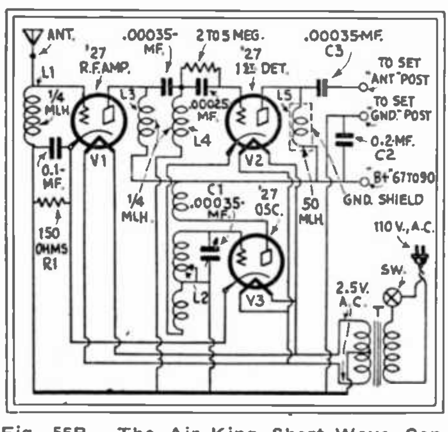


Fig. 55B. The Air-King Short-Wave Converter. Self-powered. A 2.5-volt transformer T supplies the "A" potential for the type '27 tubes used as R.F., det. and oscillator.

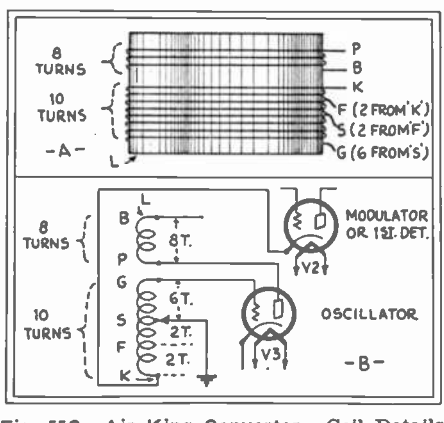


Fig. 55C. Air King Converter. Coil Details. The tickler and secondary windings of L, spaced ⅛-in., are No. 24 S.S.C. wire, on a tube 1¾ ins. in diameter.

CHAPTER VI

Television Receivers

FROM one viewpoint, television receiver efficiency must be ten times as great as a broadcast receiver, since it must cover a frequency band ten to twenty times as wide. In other words, extreme care must be taken in the design and construction of a receiver specifically intended to receive television signals.

It would be "fine business" if every experimenter had available a calibrated oscillator with which he could check his completed instrument. However, in lieu of this he will need to depend upon his judgment of the pictures he receives.

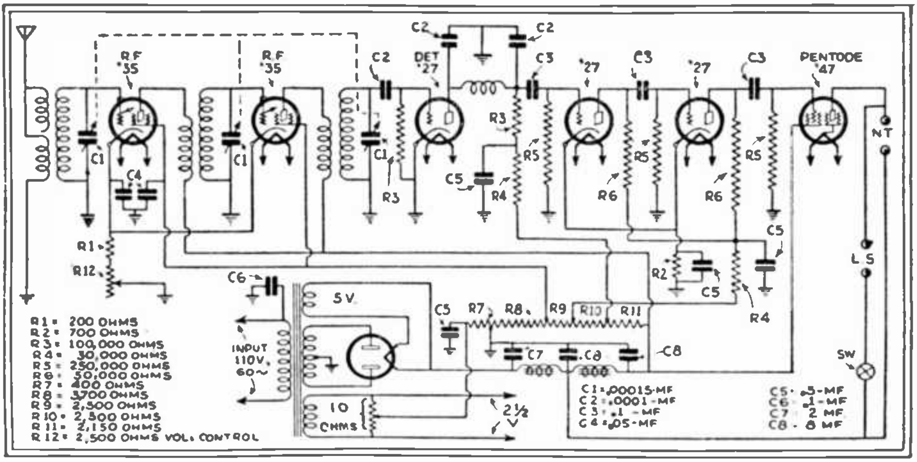


Fig. 57. A Direct-Coupled Television Receiver. Use only accurate, high-watt resistors.

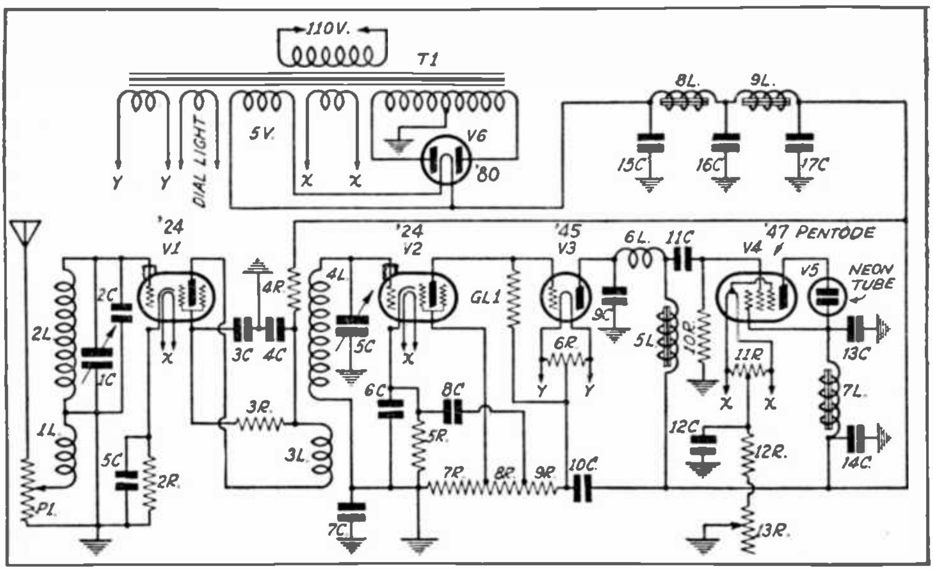


Fig. 58. A Simple Television Receiver. High quality is obtained by resistance coupling.

CHAPTER VII

Mobile Radio Sets

AUTOMOTIVE radio is a lucrative field that is rapidly being built up through established sales channels which formerly handled only cars; or cars and non-radio accessories.

For that matter, mobile radio activities now include police radio installations, trans-continental-bus sets, express train radio service, boat radio receivers, and aircraft set installations; while still other applications are being unearthed.

For all of these services there obtain essentially the same demands, i.e.: extreme sensitivity, remote control, clear reproduction and in most instances, automatic volume control. The physical arrangement of the components is varied to suit individual specifications.

To the average Service Man, therefore these circuits present nothing new, since they contain the general elements of an ordinary, sensitive broadcast receiver.

However, there are a few elements which in mobile installations must be given expert attention; particularly, in automotive radio receivers.

For instance, the aerial screen must be 3 ins. away from the edge of the car body, dome light, dome-light wires, and all grounded objects. Shield the dome-light wires from the switch and ground the shield; also, ground the metal case of the dome light to the wiring shield. Be sure the front and rëar edges of the aerial screen and the lead-in wire are soldered; also make sure that the mesh of the screen is well bonded together.

Interference and sensitivity go hand-in-hand. Thus, exceptional contra-interference measures are required to complete the installation of a modern, sensitive car radio unit.

A resistor is required in each spark-plug lead and another at the distributor. Bypass condensers of 0.2-mf. are required; for instance, one must be connected to the generator and another to the battery lead at the ignition coil. Still others may be required to bypass the ammeter, fuse blocks, cigar lighter, etc.

Shielding, too, holds a place of importance. The antenna lead must be shielded from the receiver to the cornerpost. When the ignition coil is located on the instrument panel it may be necessary to shield the high-tension lead as far as the engine compartment. Securely ground all shields.

Grounding of certain units is imperative. For example, choke and spark rods, speedometer cable, oil lines and other metal tubing. Motors that are mounted on rubber and thus insulated must be grounded at each corner to the dash.

Additional measures to reduce interference may be required. Separate the high- and low-tension wires; dress other wiring as required. Try removing from the metal conduit which carries other ignition wires, the leads which connect to the horn. Reverse the two primary leads to the ignition coil to determine the connection for least interference. Note that a defective spark-plug, or a coil or distributor condenser, may cause noisy operation.

Finally, make absolutely certain that all the circuits are correctly aligned; and that all the tubes are perfect.

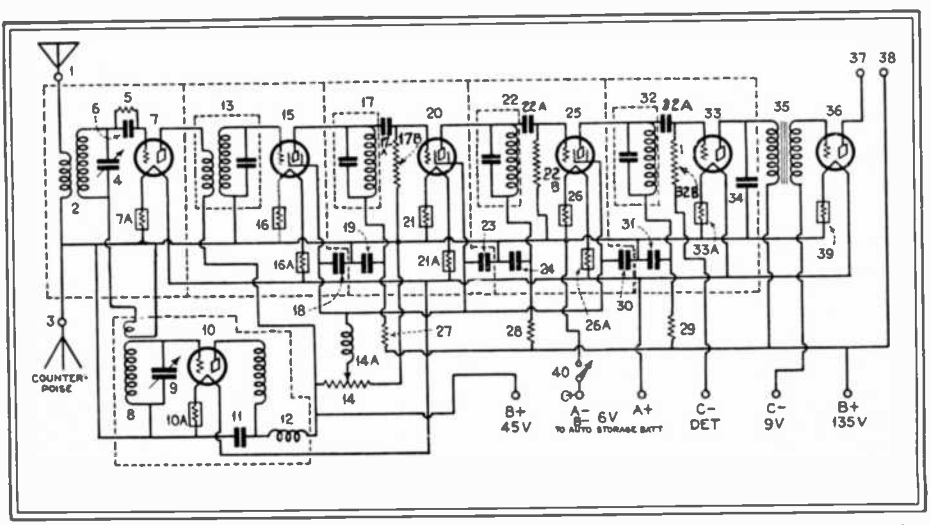


Fig. 59. Cisin "Screen-Grid" Automotive Superheterodyne. Complete details are appended.

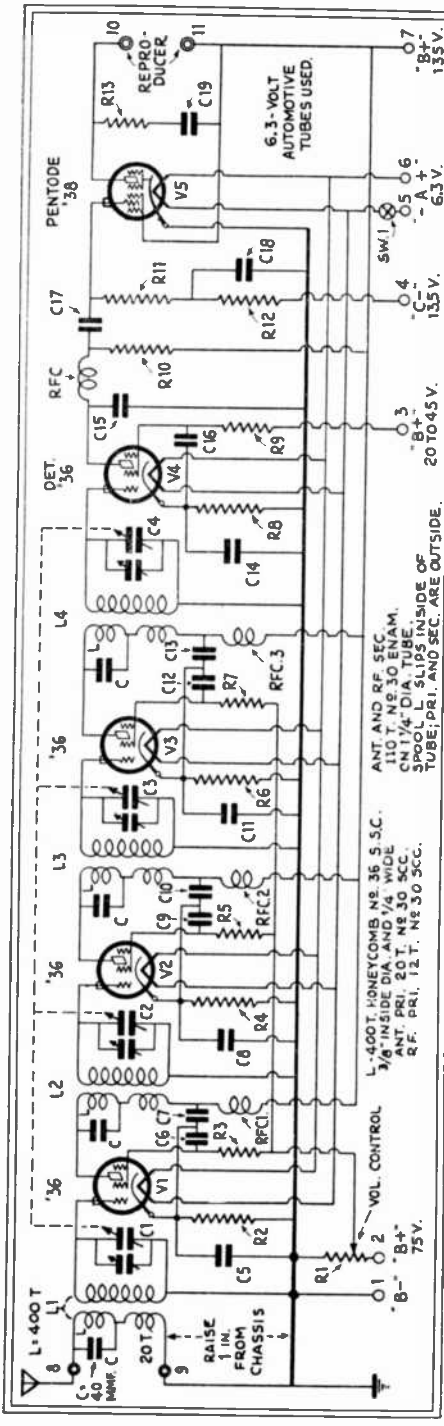


Fig. 60. Motor-Car Receiver Using "Automotive" Tubes. Four "compensated" R.F. transformers insure uniform sensitivity and selectivity.

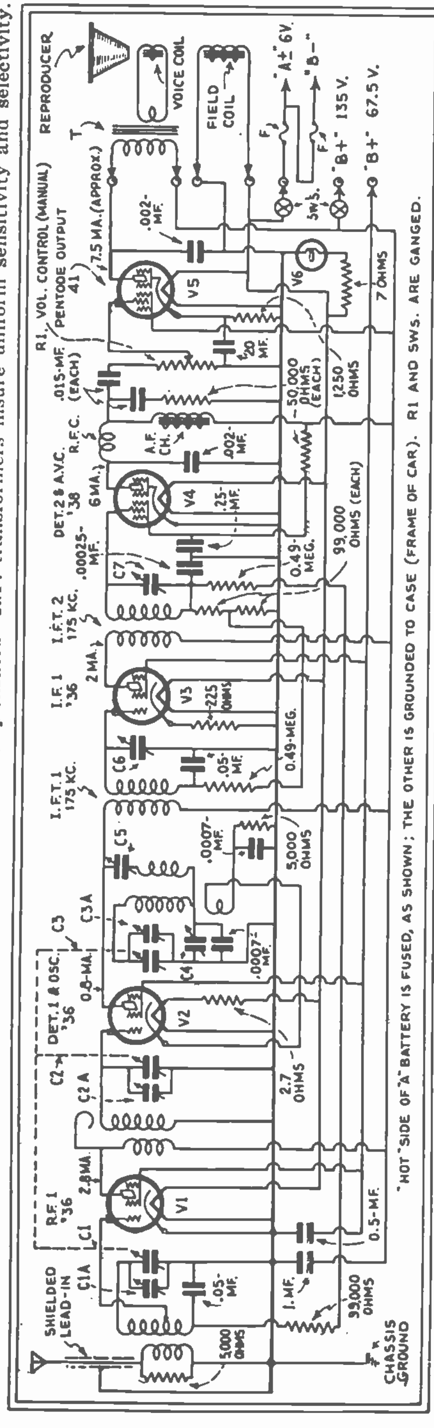


Fig. 61. The Philco "Transitone 7" A.V.C. Superheterodyne. Units C1, C2, C3, 325 mmf.; C4, 250 mmf.; C5 to C7, C1A to C3A, 50 mmf.

CHAPTER VIII

Home Recording Apparatus

DUE to the fact that every day there is brought forth a new application of recorded sound, this field is proving increasingly attractive to technicians.

Stripped of its complexities, it resolves into a few components. A simple microphone picks up the original sound, an amplifier increases the intensity, and a recording head actuated by this current inscribes a record blank. The second and final step is the play-back. In place of the recording head a phonograph pickup is used. This is followed by an amplifier which is used to increase the minute currents developed by the pickup. The output of the amplifier connects to a loudspeaker.

Aside from its application in commercial fields, as in the production of studio records for "spot" broadcast service, recording has many other uses.

For instance, photographers are now making sound records at the same time they take a picture of Cousin Nell, or Grandfather Hicks; duplicate records bring a tidy sum. Musical students are eager for recorded proof of their ability. John Law has recognized the legality of recorded contracts. Recordings are valuable in certain kinds of school work; also, they have industrial applications. Proprietors of stores readily place orders for individualized records concerning timely sales, etc., which they can publicize through a simple public-address system. A "home recording" booth at amusement resorts is a good money-getter. Finally, we have records made in the home—"instantaneous" recording under domestic conditions.

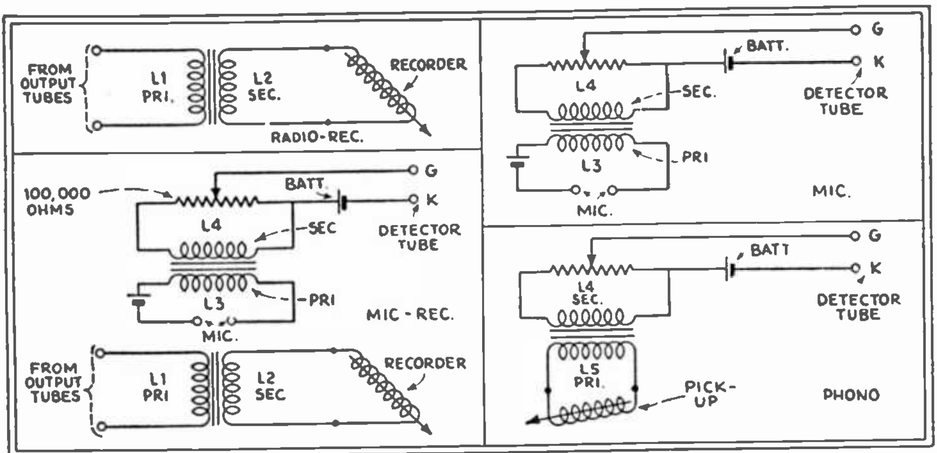
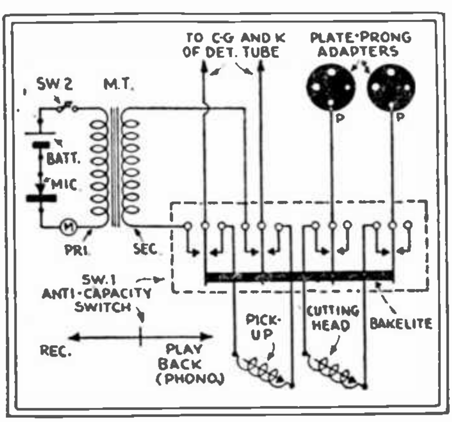


Fig. 62A, upper left; B, lower left; C, upper right; D, lower right. Recording.



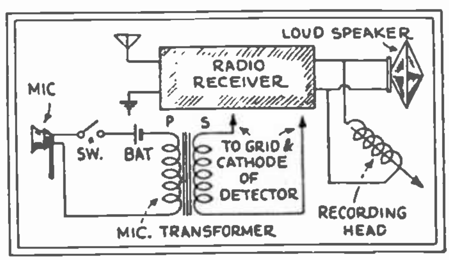


Fig. 62E, left; F, above, Recording. In Fig. 62 we find: A, connections for recording radio programs; B, circuit for recording voice, etc.; C, hookup for "home broadcasting"; D, reproducing recorded voice, etc. These changes may be switch-controlled, as indicated at E. Fundamentally, the circuit is very simple, as shown by the picture arrangement of the parts at F.

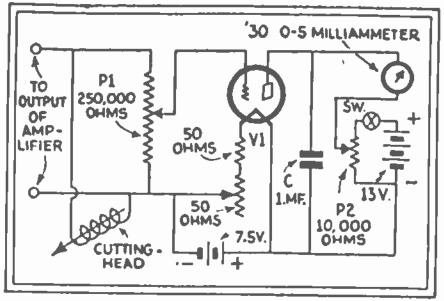
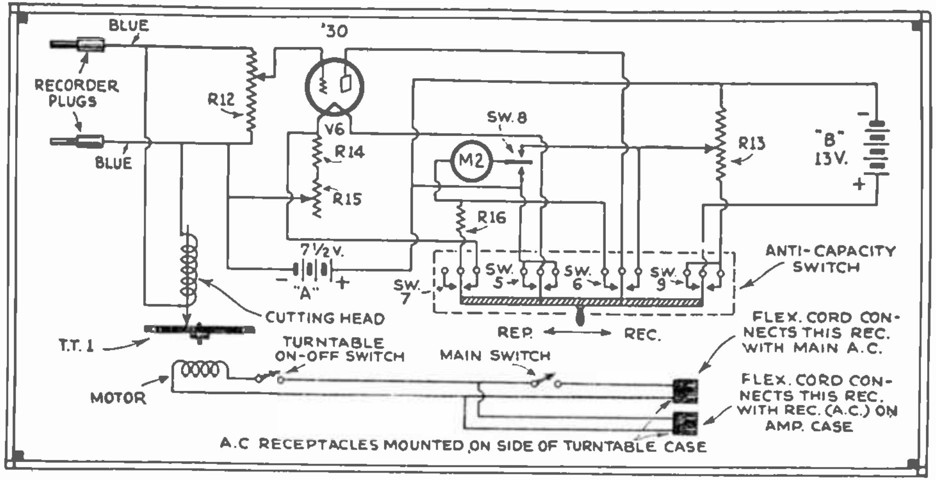


Fig. 63. Volume-Level Indicator for Home Recording. Condenser C damps the action of the D.C. milliammeter. Potentiometer P2 furnishes the accurate control required over the potential applied to V1. Swing of meter to maximum (three-quarter) position is controlled by P1. Predetermine best reading for record types.

Fig. 64B, right. Turntable-case circuit.



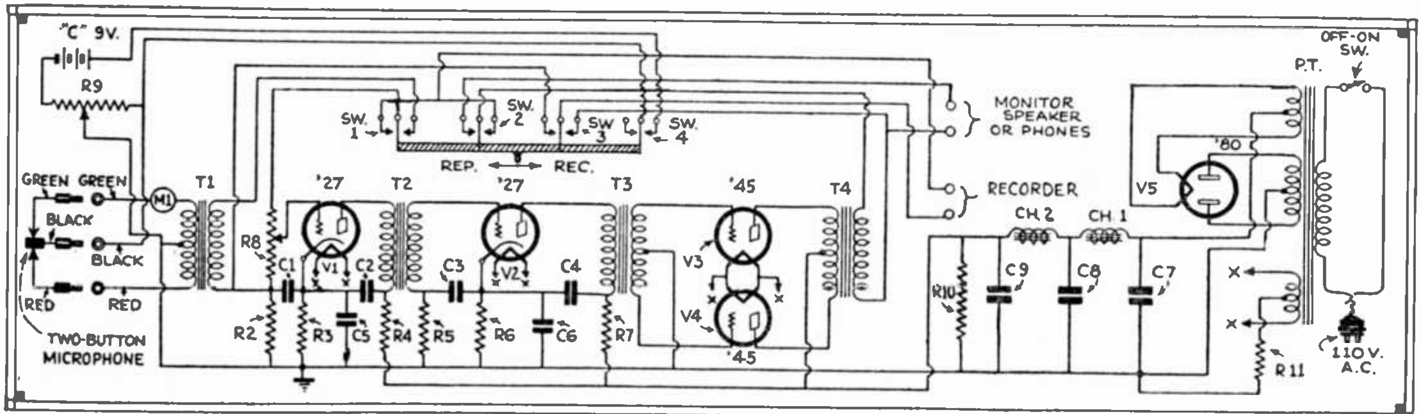


Fig. 64A. A Portable Recording Amplifier. Diagram of connections within the amplifier case; its turntable hookup, Fig. 64B.

CHAPTER IX

Audio Amplifiers

TO audio amplifiers attaches an interest that is not shared by any other instrument. In addition to its use as the audio power section of a radio set, it finds useful application in experimental work, public address equipment, "talkies," remote control devices, demonstration work, record recording, radio servicing, and laboratory investigation.

In other words, the audio amplifier as an individual unit is a proposition for commercial exploitation. In concrete evidence we offer the following rather extensive, yet incomplete list of uses wherein the power amplifier has proved to be the foundation of thousands of dollars profit:

Factories, airplanes, apartment houses, amusement parks, auditoriums, athletic fields, radio demonstration of photo-electric effects, bathing beaches, banquet halls, baseball parks, brokerage offices.

Radio demonstration of microphonic sounds, burial-vaults, bell-less church chimes, cabarets, charitable institutions, churches, clubs, conventions, exhibitions of legerdermain, vaudeville shows, political gatherings, dance halls, encampments, fairs, dancing schools, filling stations, flyng fields, clinical work.

Physics laboratories, shipyards, depots, football games, hockey matches, home entertainments, hospitals, hotels, educational institutions, ice skating rinks, merry-go-rounds, buses, motor trucks, demonstrator cars, trains, open-air assemblies, orphan asylums.

Paging systems, polo games, landing fields, race tracks, regattas, receptions, restaurants, roller skating rinks, sanitariums, stores, summer resorts, swimming pools, veterans' homes, carnivals, automatic protective devices and automatons.

The foregoing catalog of audio amplifier services should be sufficient indication that no single design of equipment will be suitable for any but a limited number of uses.

Nevertheless, there is little variation in the fundamental connections involved. In general, it may be stated that amplifier units designed to increase the strength of electrical energy at audio frequency vary mainly in the use of tubes and circuit; the components are selected on the basis of their characteristics as determined by the tubes and circuit used.

Tubes are the first consideration. They must have a sufficiently high amplification factor to achieve the desired sensitivity/power output ratio for the particular service for which the amplifier is being designed. To realize the amplification figure at which the tubes are rated it is absolutely essential that the associated components have exactly the correct constants; and that the voltage and current ratings of the tubes are adequately met by the power supply system.

The type of tubes used and their quantity are dependent upon the sum of a number of individual limitations and preferences, such as fidelity, volume, input load characteristics, output load characteristics, mechanical limitations (marine or land, mobile or stationary use, etc.), and that ever-present "nigger in the woodpile," *cost*.

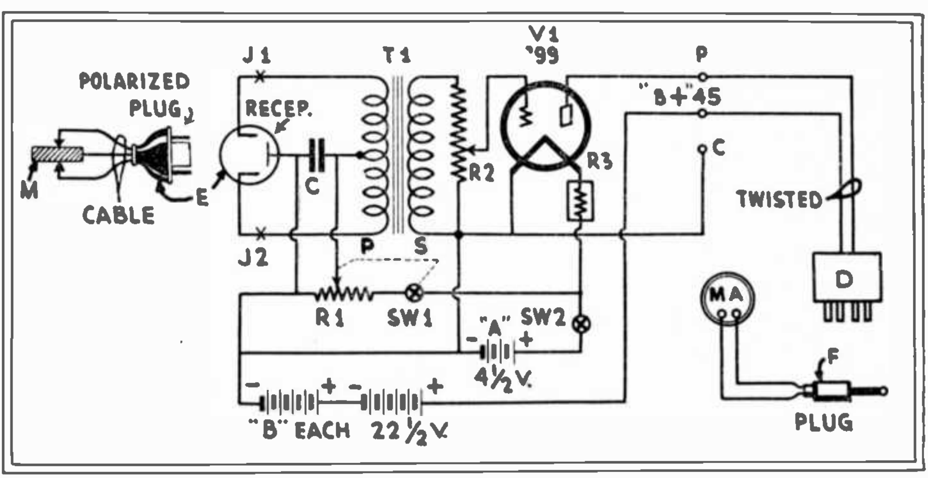


Fig. 65. RCL Public Address Adapter-Unit. Designed to work into an audio amplifier.

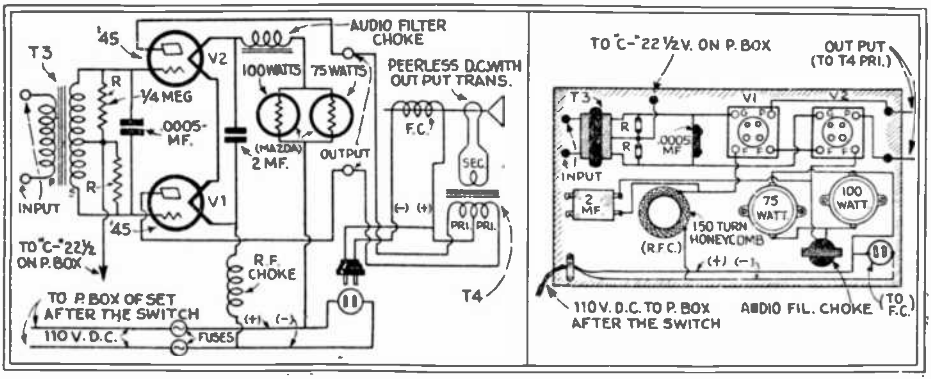


Fig. 66A, left; B, right. A 110-V., D.C. Audio Power Unit. At B, the parts layout.

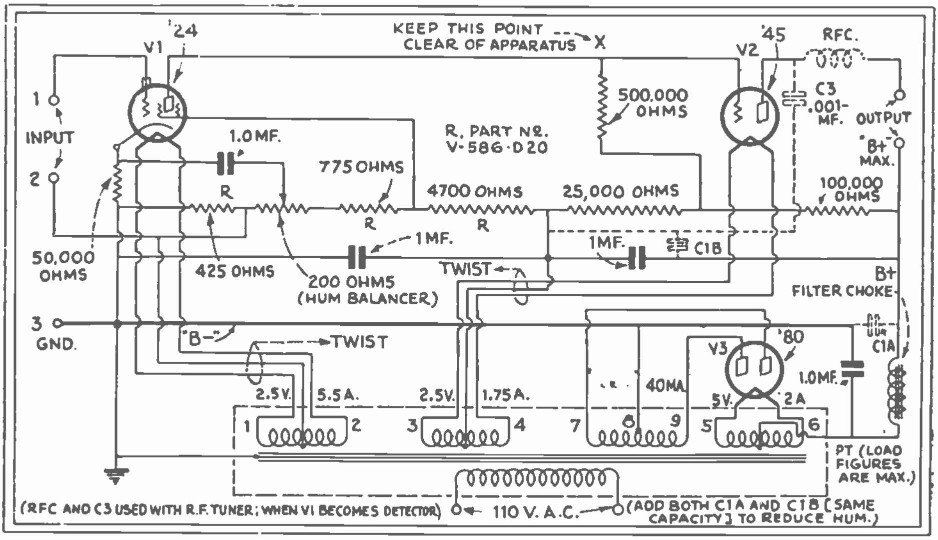


Fig. 67A. Type '45 Direct-Coupled Audio Amplifier. Fidelity is exceptionally good.

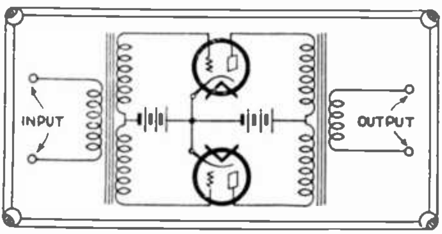
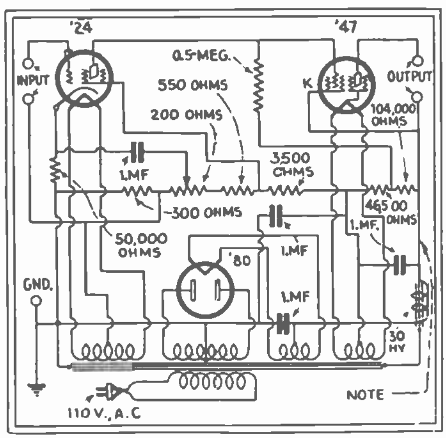


Fig. 68. A 1-Stage Push-Pull or Push-Push Amplifier. Whether the circuit is push-pull or push-push, depends upon the tubes and potentials. For push-pull action, use for "C" bias the potential shown in tables as correct for the tubes used. For push-push (class B, divide Vp by the tube's mu to obtain the tube's grid bias for plate current cut-off; use Class B transformers.

Fig. 67B, right. Type '47 Direct-Coupled Audio Power Amplifier.



CHAPTER X

Power Units

CURRENT supply devices are controlled in their design by the current requirements of the devices with which they are to be used; and by the type of available power line supply.

Modern vacuum tubes and their circuits have reached such a high stage of development that the current taken from the power pack, for a given sensitivity/power output ratio of a radio set or other device, is becoming less and less; at the same time, an increasingly large proportion of this current is being taken by the audio section of the instrument. Thus, for a particular type of device, more current is made available for the operation of auxiliary equipment.

Where the power unit is to be used to furnish current for a radio receiver, the selection of the components and their circuit connections must enable the set to satisfy the following conditions: sensitivity, selectivity, tone quality, undistorted power output, and last but not least—economy (including in this figure the cost of maintenance and service).

The selection of power pack components of incorrect type is sure to be the most expensive action a set builder could possibly take. It is only by using instruments of good quality and correct characteristics that the builder will be enabled to meet the conditions stipulated in the paragraph above.

Power supply units may be required to operate on A.C. or D.C., at 110 to 120 volts. On A.C. lines the frequency may be 25, 40 or 60 cycles; a power transformer designed for 25 cycles may be used on 60-cycle supply, but not vice versa; the 25-cycle supply will necessitate increased filtration to reduce the hum level.

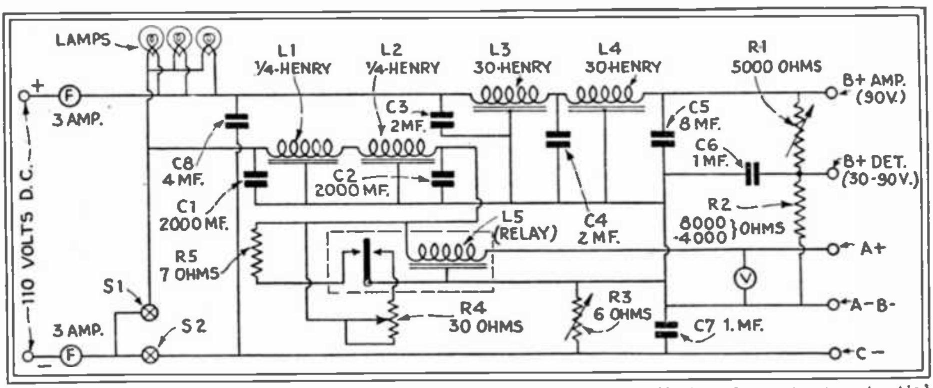
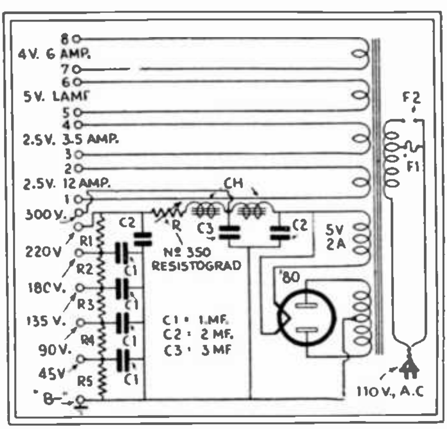


Fig. 69. An "A-B-C" Power Pack for D.C. Lines. Line voltage limits the output potential.



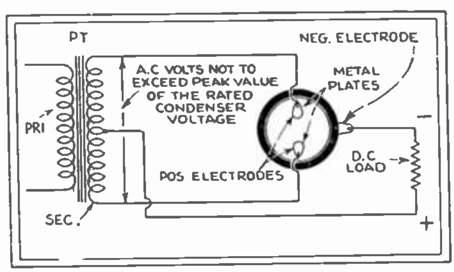


Fig. 70, above. An Electrolytic-Condenser Rectifier. A novel circuit of new design. The output of a unit of this type is limited by the characteristics of the electrolytic condenser. The voltage divider is indicated as "D.C. load." This arrangement is still in the experimental development stage.

Fig. 71, left. A Standard '45 Power Pack.

CHAPTER XI

Miscellaneous Equipment

EXPERIMENTERS will find in this chapter many diagrams of particular interest to them—everything from a simple code-practice arrangement to a complete, modern amateur short-wave transmitter.

Although all possible electrical values are given the technician, he will, in some instances, be put very much "on his own" to correctly assemble and wire units built in accordance with the 29 figures which follow. For there always is some difference between the performances of two devices built by experts in accordance with the same set of instructions—even when complete layouts, photographs, and drilling templates are available. Consequently, inexperienced constructors may not be able to obtain perfect operation of the finished instrument, at the first attempt, unless the circuit is followed exactly—and a horseshoe is hung in a prominent location.

For this reason we will analyze some of the stumbling blocks which may be encountered in attempting to build up a circuit "blind"—that is, without accompanying data concerning the location of the various components, etc.

"Don't take anything for granted; check all the components for correct electrical and mechanical ratings."

These stipulations include all vacuum tubes, regardless of the type. If there is any question concerning their performance, it often is a great convenience to compare measured figures with the factory ratings as shown in special tube charts. Since these tabulations necessarily consume a large amount of space, the technician is referred to a listing of these values and terminal connections for fifty-four representative types of tubes, in the July, 1932 issue of Radio-Craft, pages 26 and 27.

It must be remembered that if one unit develops a fault, it may cause another to break down; consequently, replacing the first item may not necessarily restore the ensemble to normal operation. (See "Servicing the Broadcast Receiver," by Julius G. Aceves, in the September, 1929 issue of Radio-Craft.)

Correct inductive relationship and adequate shielding must be maintained, whether between wiring, components, or both. If undesired coupling takes place between certain circuits, it may be sometime before the cause of the trouble is located. This is particularly true in the case of excessive hum, which may be due to a filter choke or power transformer placed too close to certain elements of the remainder of the equipment. Circuit oscillation is another bugbear which in many instances may be traced to undesired coupling between unshielded leads—especially, in R.F. circuits; look also for open bypass condensers.

Noisy operation usually is traceable to imperfect contacts in the wiring or equipment.

Total lack of performance often leads to the discovery of a complete short-circuit in the system; wires or instruments may, for instance, be accidentally grounded.

In conclusion, the author advises the technician to follow three steps in servicing new devices: (1), take voltage and current readings; (2), make tests of continuity between various portions of the circuit; (3), take resistance measurements—particularly, from tube sockets to the chassis (with the current turned off).

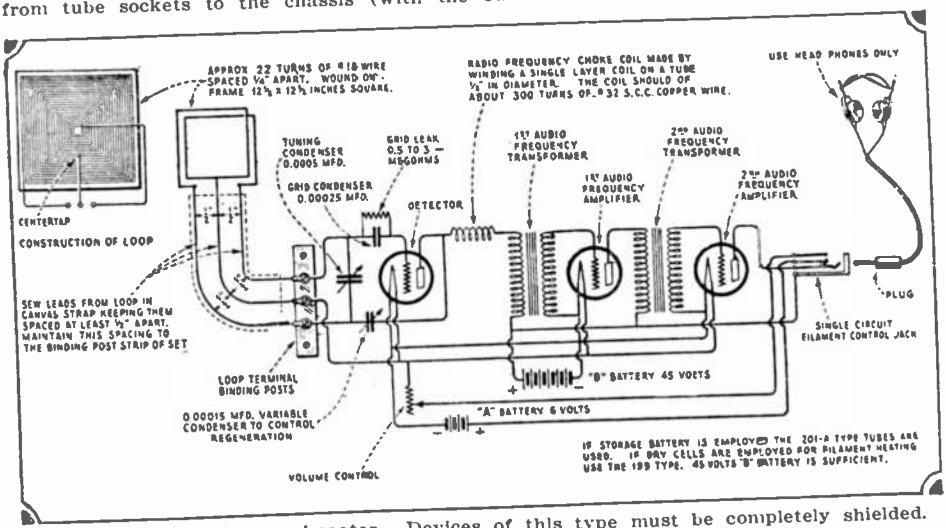


Fig. 72. An Interference Locator. Devices of this type must be completely shielded.

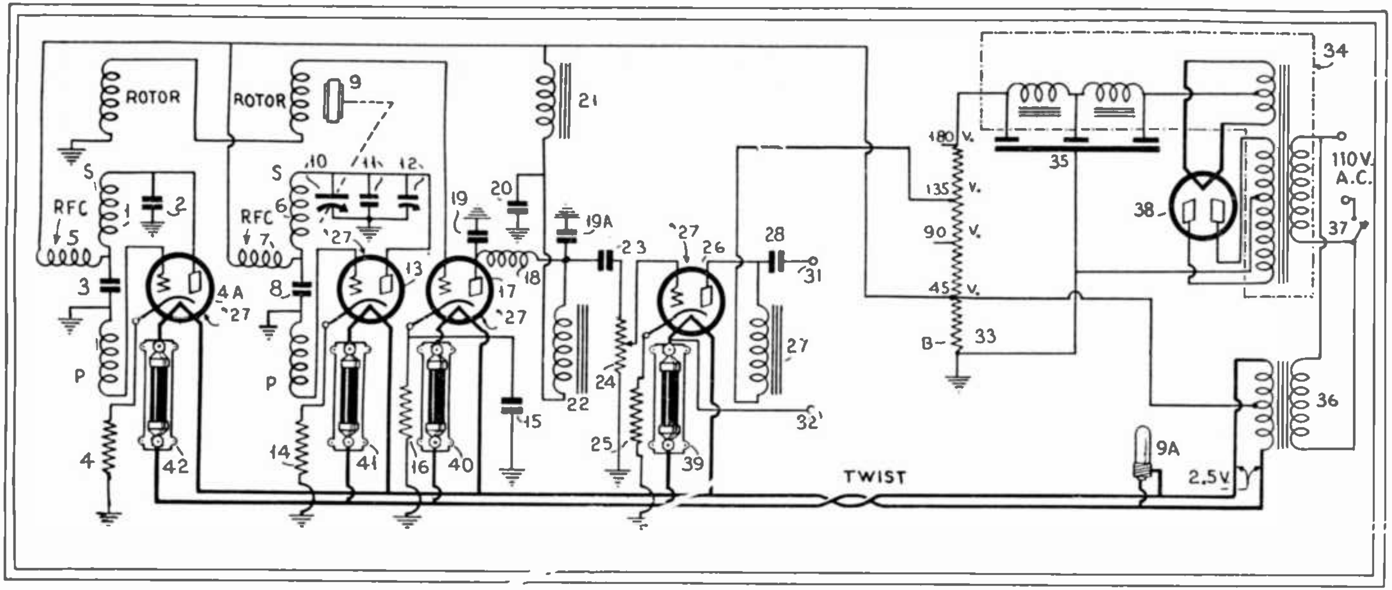


Fig. 73. An A.C. Beat-Frequency Oscillator. The complete circuit of the beat-frequency oscillator; as its name indicates, the pure audio note is produced by heterodying the variable frequency of the oscillator 13 against the fixed frequency of the oscillator 4A. The fixed-tune capacities 2 and 11 should closely match. The range of this oscillator is from approximately 30 cycles to above 10,000 cycles; volume is controlled by resistor 24. Useful for testing the response of reproducers, and the frequency characteristics of audio amplifiers, transformers, choke coils, pickups, determining room acoustics, taking "overall gain" and "fidelity" figures of radio sets and amplifiers and for general service work. The instrument comprises two oscillators 4A and 13; a detector 17; and an A.F. amplifier 26; all of these tubes are of '27 type. Rectifier 38 is an '80. The frequency of oscillator 4A is fixed at 100 kc.; 13 can be varied to 20 kc. from the fixed frequency; both are coupled to the grid circuit of the detector tube. Thus, by supplying the detector with a low voltage from each oscillator, the tendency of the two oscillators to pull into synchronism, as zero beat is approached, is eliminated. Midget condenser 12 corrects slight inaccuracies in fixed condensers 11 and 2, or the coils in the plate circuits of tubes 4A and 13. Condenser 10 tunes the desired A.F. over the entire range. Minimum harmonic generation, with highly satisfactory wave-form, may be obtained by keeping the coupling of the rotors of coils 1 and 6 at a minimum. Note that if the coupling is too tight, the percentage of harmonics will be large. Use tuning forks or a piano to calibrate the completed instrument. The 60-turn rotors of the oscillator coils are connected in series, as shown: the 396-turn winding of each coil is connected in the plate circuit of its respective oscillator tube, with the 99 2/3-turn slot winding in the grid circuit. Both coils are Silver-Marshall plug-in long-wave units, Type 111-E. The chassis measures 8x15x3 ins. high. Condenser 10 is a Hammarlund "midline" type ML-23, .0005-mf.; units 5, 7, 18 Hammarlund R.F. chokes type RFC-250. Voltages are supplied by a simple power compact; transformer 36, external to the pack, furnishes filament potential for the '27's; a standard voltage divider is used.

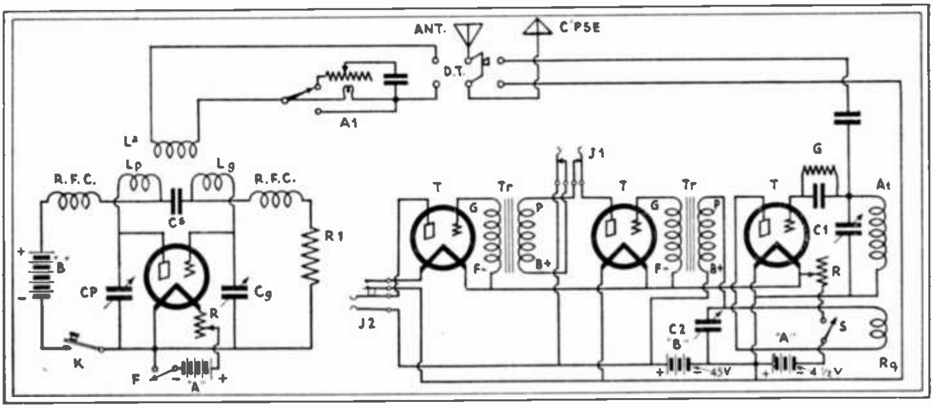


Fig. 74. A Complete Portable Transmitter-Receiver. Transmitter is a "Split-Colpitts."

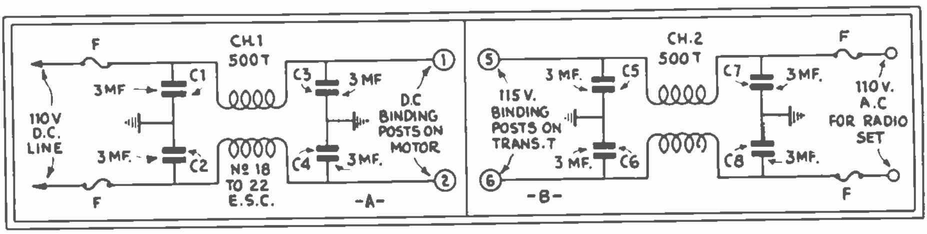


Fig. 75A, left: B, right. D.C. to A.C. Converter. Filters; A, input; B, output.

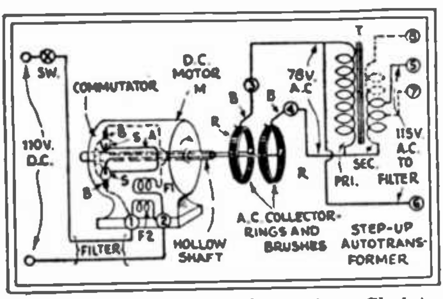


Fig. 75C. D.C. to A.C. Converter. Skeleton view of connections. Transformer T steps up the "R.M.S." output of the motor, M.

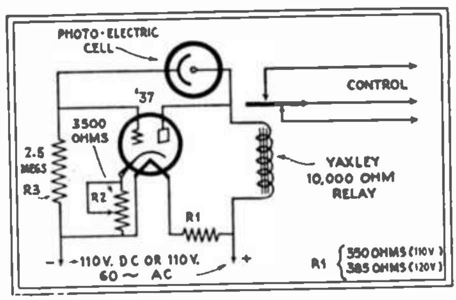


Fig. 76. A P.E.-Tube Relay for A.C. or D.C. Heavy plate current to work relay is due to plate-to-grid-leakage through cell.

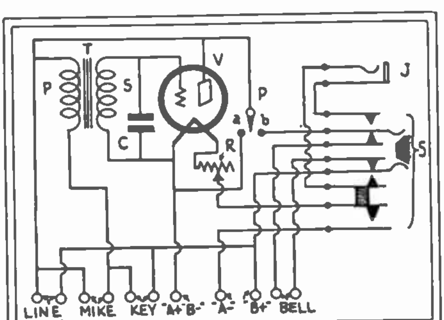


Fig. 77. A Condenser-Mike Pre-Amplifier. The condenser microphone and the pre-amplifier usually are contained in one case.

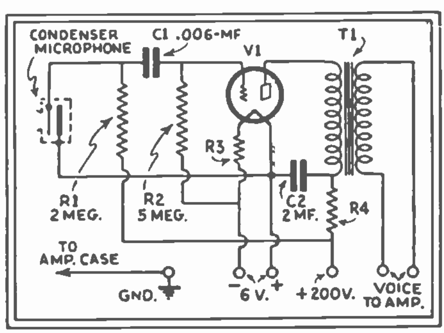


Fig. 78. A Home-Telegraph and Phone Set. With one at either end of the line, 2-way code and voice conversation are possible.

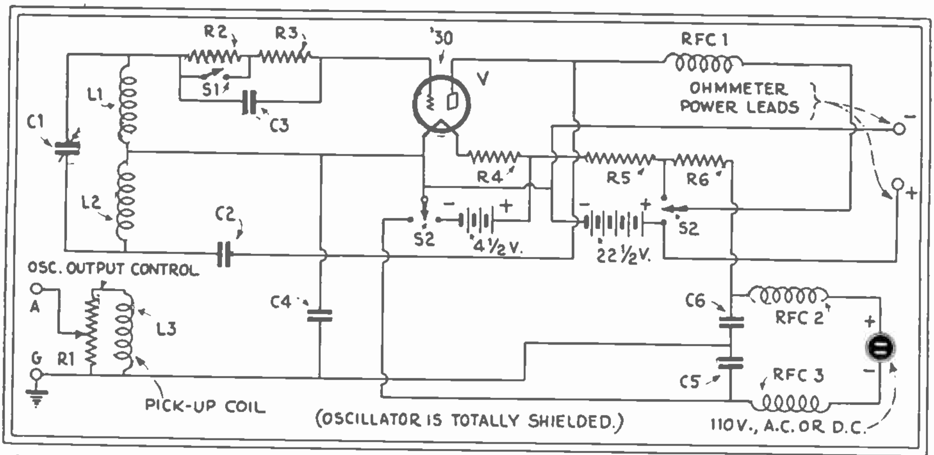


Fig. 79A. A 90-to-1,500 Kc. "Harmonic" Service Oscillator. This instrument is adaptable to 110V. power lines, A.C. or D.C. and also battery operation. Fuse the power leads.

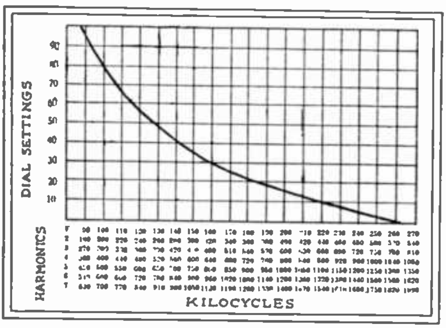


Fig. 79B. Harmonic Oscillator. Graph. Dial "difference" indicates the harmonic in use.

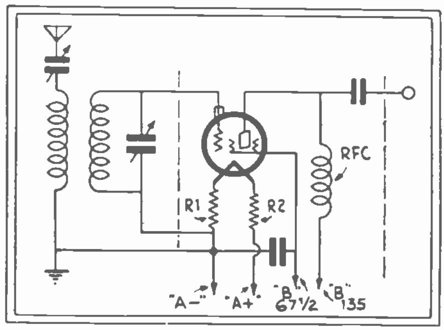


Fig. 80. A Screen-Grid Booster Unit. The tube may be any type suited to the set.

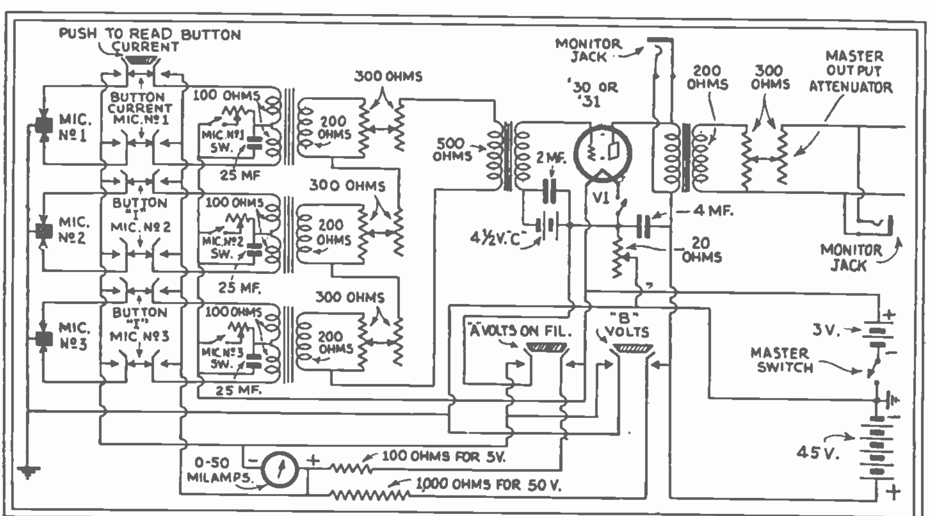


Fig. 81A. A Carbon-Mike Mixing Panel. Accurate matching is obtained by "pads."

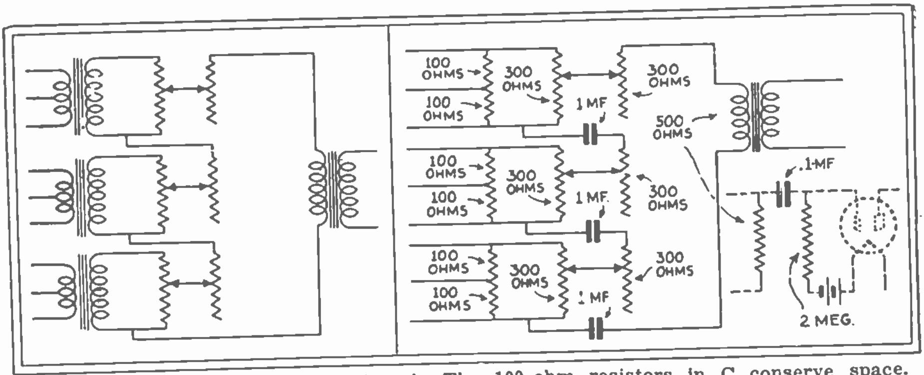
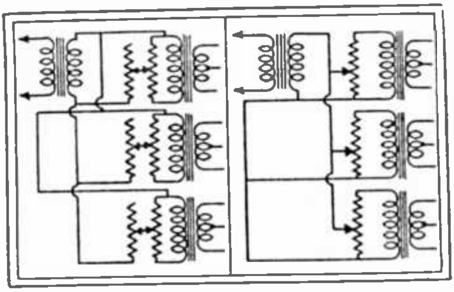


Fig. 81B, left; C, right. Mixing Panel. The 100-ohm resistors in C conserve space.



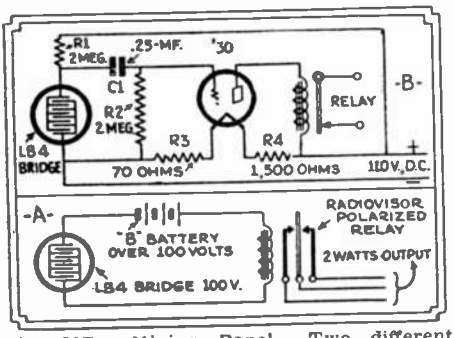


Fig. 81E. Mixing Panel. Two different types of parallel connections for three pads.
Fig. 82B. P.E. Relay Control—Selenium. At A, D.C. and at B, A.C. circuit connections.

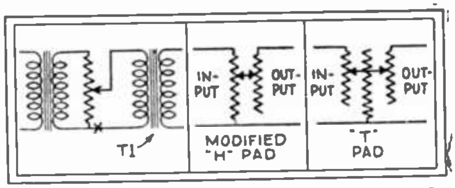


Fig. 81D. Mixing Panel. Types of pads.

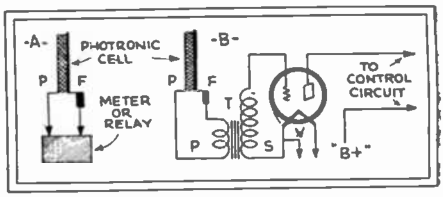


Fig. 82A. P.E. Relay Control—Photronic.

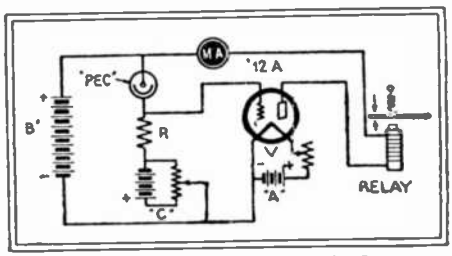


Fig. 82C. P.E. Relay Control—Gaseous.

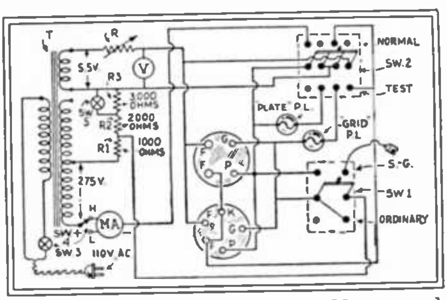


Fig. 83. A Simple Tube Tester. Meter readings are to be checked against a tabulation.

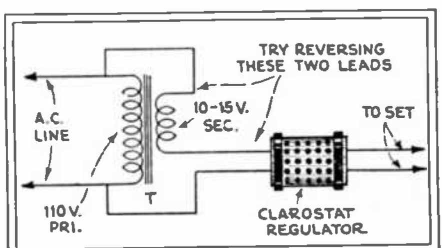


Fig. 84. Boosting Low Line Voltages. Reversing "sec." leads lowers line potential.

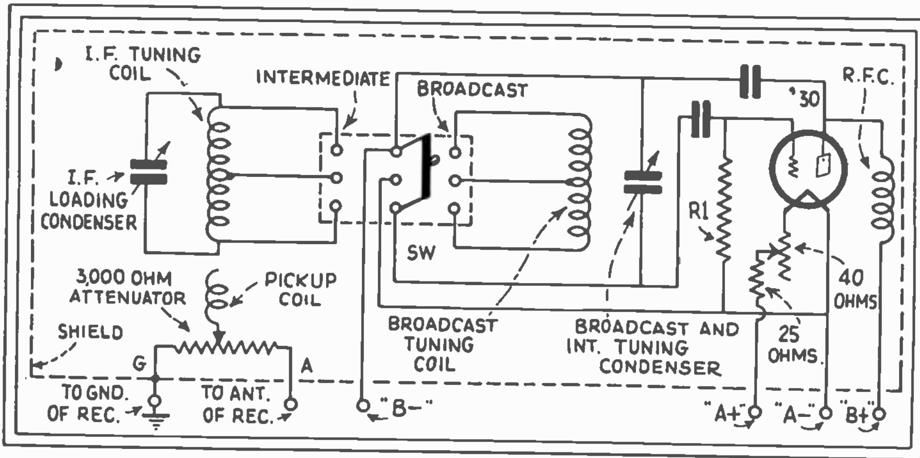


Fig. 85A. A 550-1,500 and 175 Kc. Service Oscillator. Resistor R1 is tone control.

HARMONIC CHART

Harmonic	Frequencies						
(1)	130	140	150	160	170	175	180
2	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-
4	-	560	600	640	680	700	720
5	650	700	750	800	850	875	900
6	780	840	900	960	1020	1050	1080
7	910	980	1050	1120	1190	1225	1260
8	1040	1120	1200	1280	1360	1400	1440
9	1170	1260	1350	1440	-	-	-
10	1300	1400	1500	-	-	-	-
11	1430	-	-	-	-	-	-

Fundamental (1) and harmonic frequencies, in kc. Additional harmonics may be similarly calculated.

Fig. 85B. Service Oscillator—Chart. Intermediate frequencies have useful harmonics.

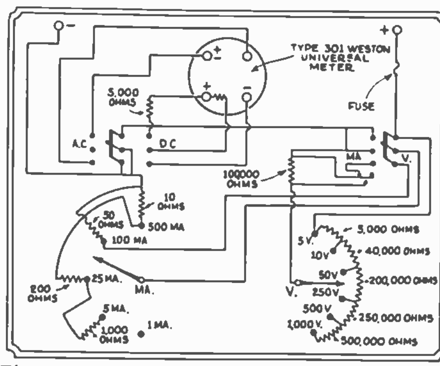


Fig. 86. A Wide-Range A.C.-D.C. Volt-Milliammeter. A general purpose test instrument.

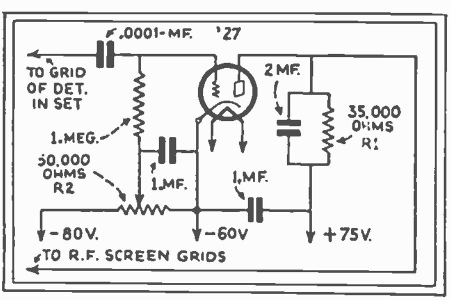


Fig. 87. An Automatic Volume Control Connection. A popular circuit arrangement.

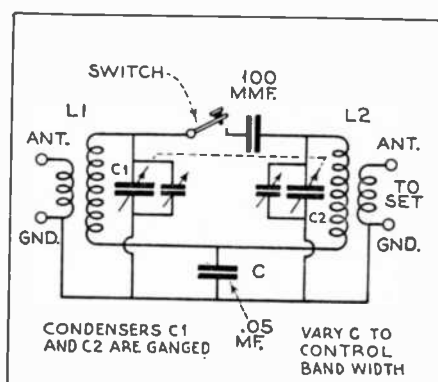


Fig. 88, above. A Band-Selector Unit. By varying the inductive relation of L1 and L2 control of the degree of band selection is obtained. Condenser C and the 100-mmf. unit further control the band selection.

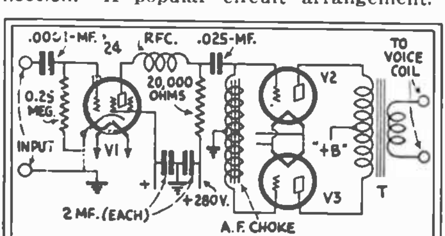


Fig. 89, left. High-Quality Detector-Amplifier Circuit. The output circuit is push-pull.

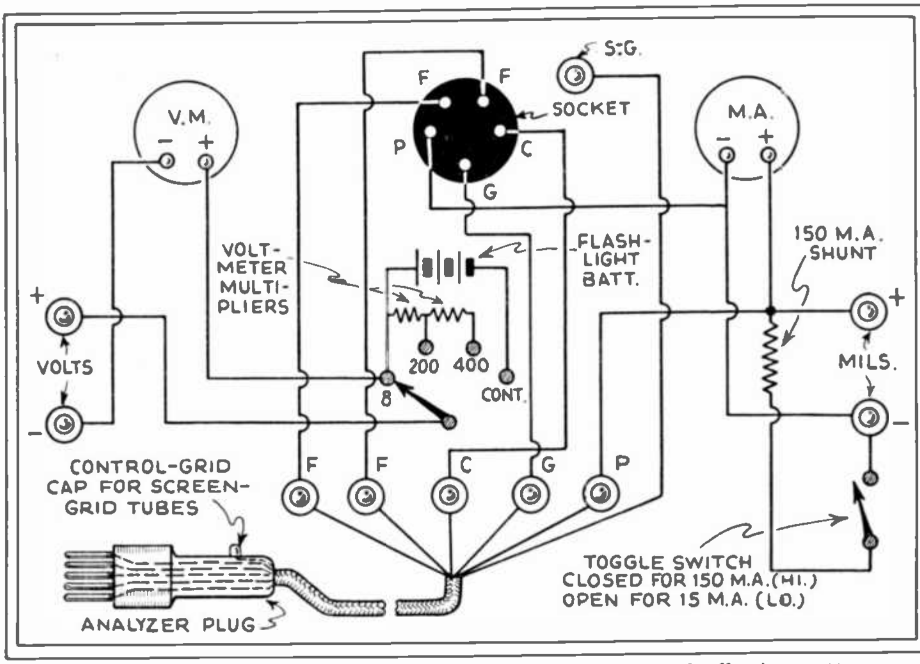


Fig. 90A. A Simple Set Tester. A two-meter instrument of effective pattern.

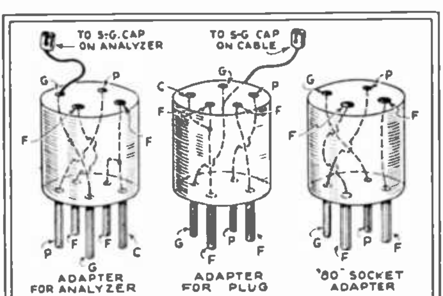


Fig. 90B. A Simple Set Tester. The adapters. New 6- and 7-prong tubes require two additional adapters, each.

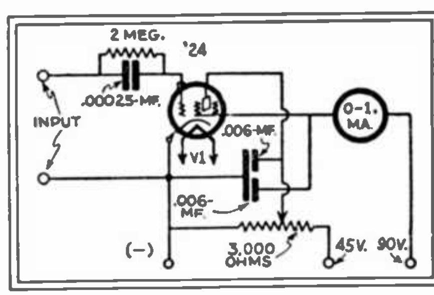


Fig. 91. A Dynatron Vacuum-Tube Voltmeter. Ultra-sensitive, this instrument will indicate 0.2-ma. with an input of only .05-volt, A.C. or D.C. A useful test device.

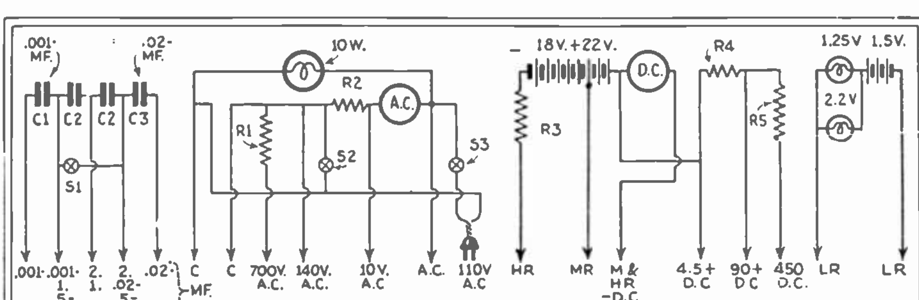


Fig. 92. An Inexpensive Test Panel. The wiring is simple, and the beginner should experience no difficulty with this design. May be used as an ohmmeter, continuity tester, capacity meter, and to read A.C. and D.C. voltages within the ranges indicated—and higher, if so designed. Arrowheads indicate tip-jacks. Condensers C2, 1 mf., each.

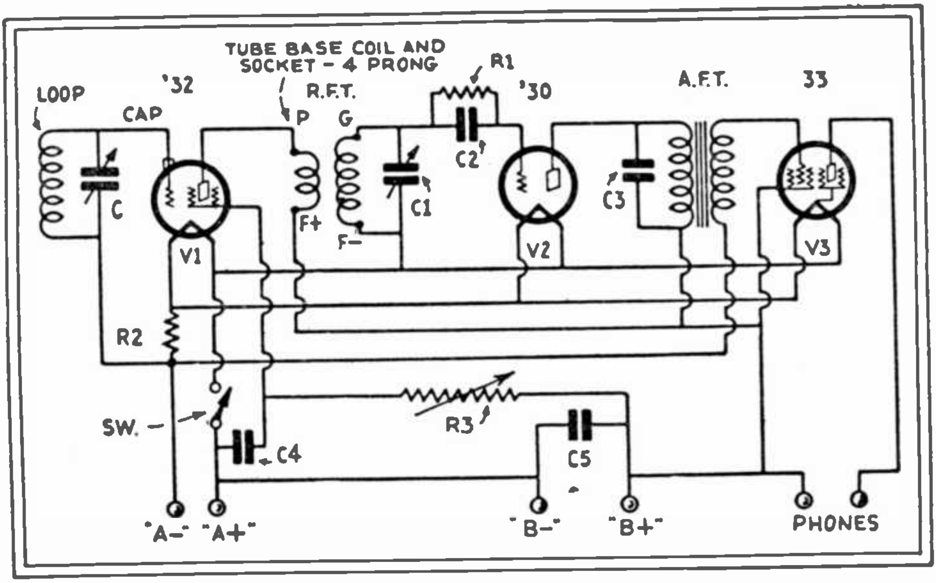


Fig. 93A. A "Treasure" Finder. The receiver; a simple short-wave set for 'phones.

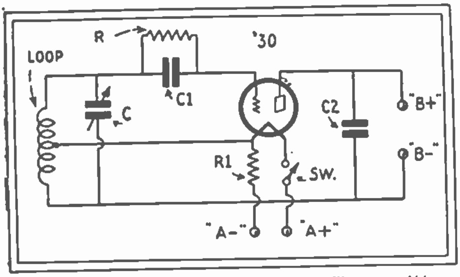


Fig. 93B. A "Treasure" Finder. Transmitter.

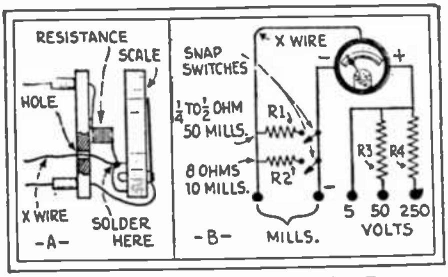


Fig. 94. Increasing A Meter's Range.

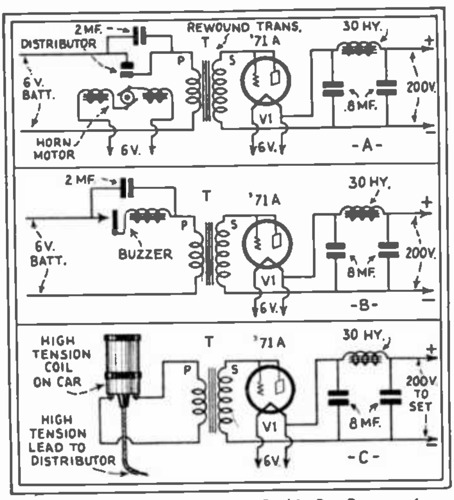


Fig. 95. Experimental D.C./A.C. Converters.

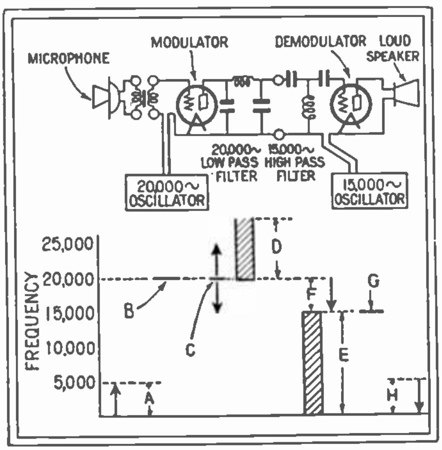


Fig. 96. The Speech Inverter. Above; a skeleton circuit of the method of connections which makes possible "garbled" speech. Below; graphic illustration of the system.

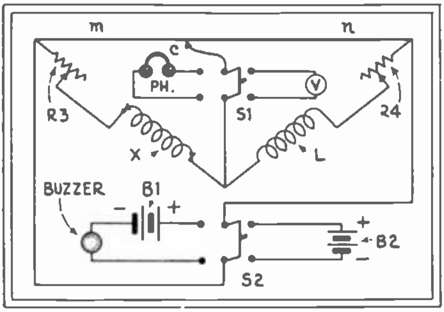


Fig. 97A. Wheatstone Bridge. True-read.

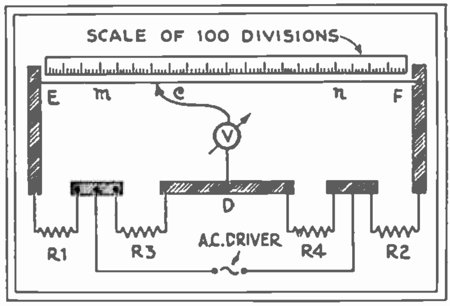


Fig. 97B. Wheatstone Bridge. Meter-rule.

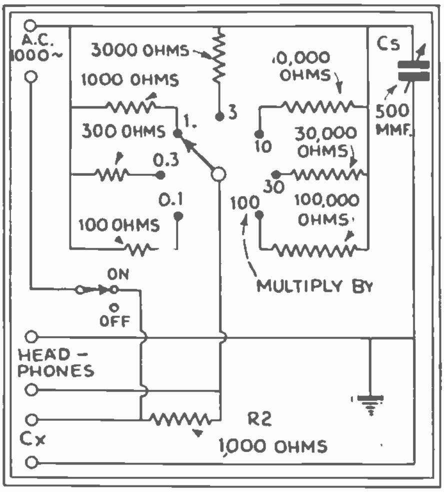


Fig. 97C. Wheatstone Bridge. Capacity.

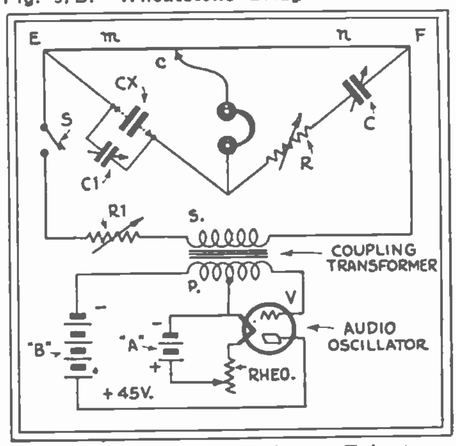


Fig. 97D. Wheatstone Bridge. Tube-type.

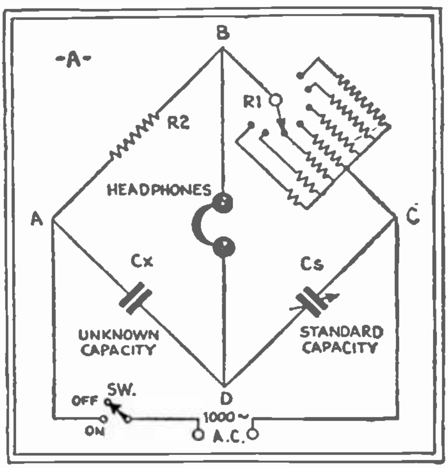


Fig. 97E. Wheatstone Bridge. Capacity.

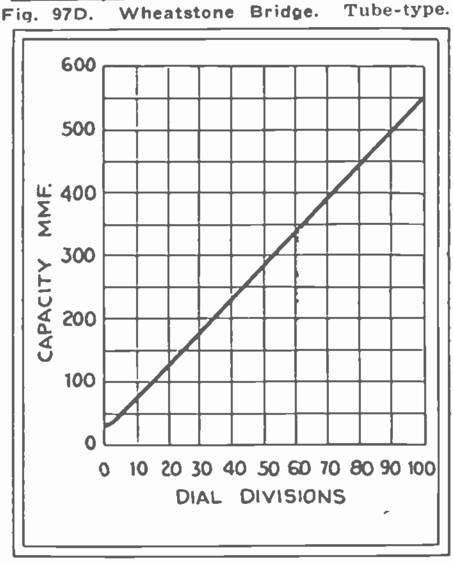


Fig. 97F. Wheatstone Bridge. Graph.

Since it is quite impossible to adequately cover in the space here available the extensive subject of the Wheatstone Bridge and its myriad applications, an effort has been made only to present in conveniently available form the foremost arrangements of this test system, in connection with the analysis of units incorporating inductance, resistance or capacity, or a combination of these qualities. For a more extensive treatment of the Wheatstone Bridge, the reader is referred to the issues of Radio-Craft mentioned in the following chapter on reference data; or, most electrical handbooks.

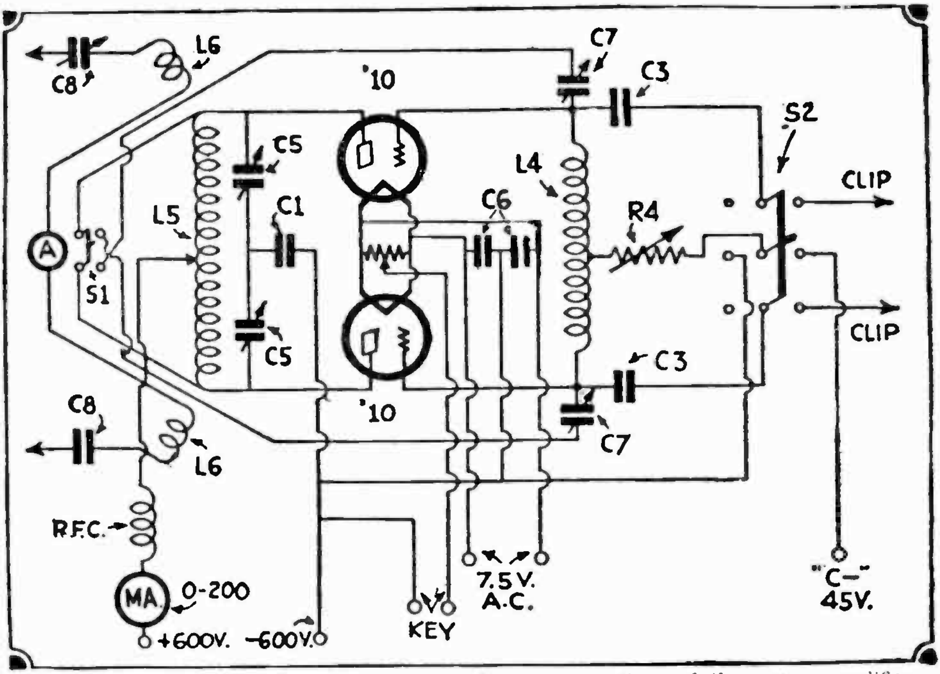


Fig. 98A. An Amateur Short-Wave Transmitter. Connections of the power amplifier.

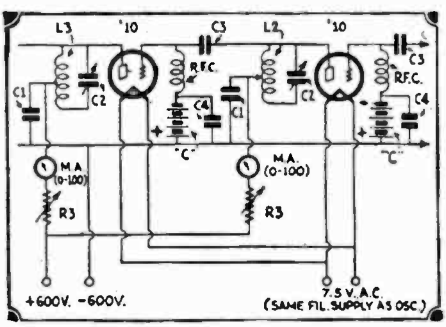


Fig. 98B. Transmitter. Frequency doubler.

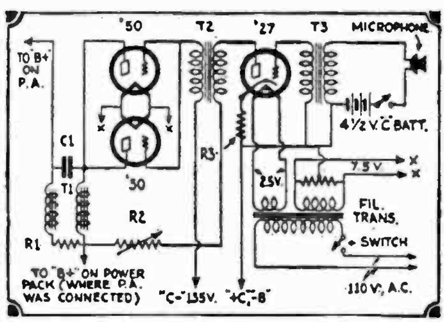


Fig. 98C. Transmitter. Modulator unit.

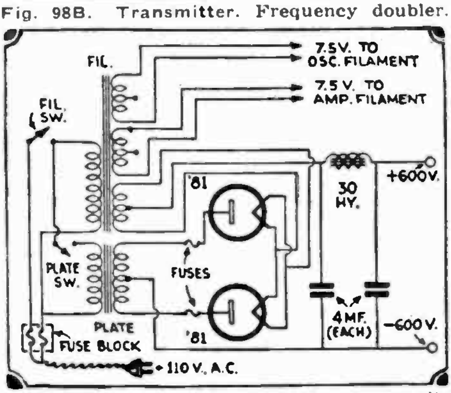


Fig. 98D. Transmitter. Power supply unit.

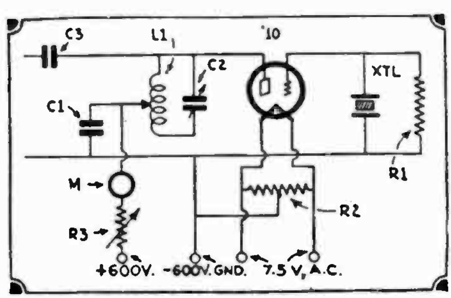


Fig. 98E. Transmitter. Oscillator hookup. When the five component units, A, B, C, D and E are connected together the ensemble is an up-to-date amateur phone and code transmitter—radio station W9DFR.

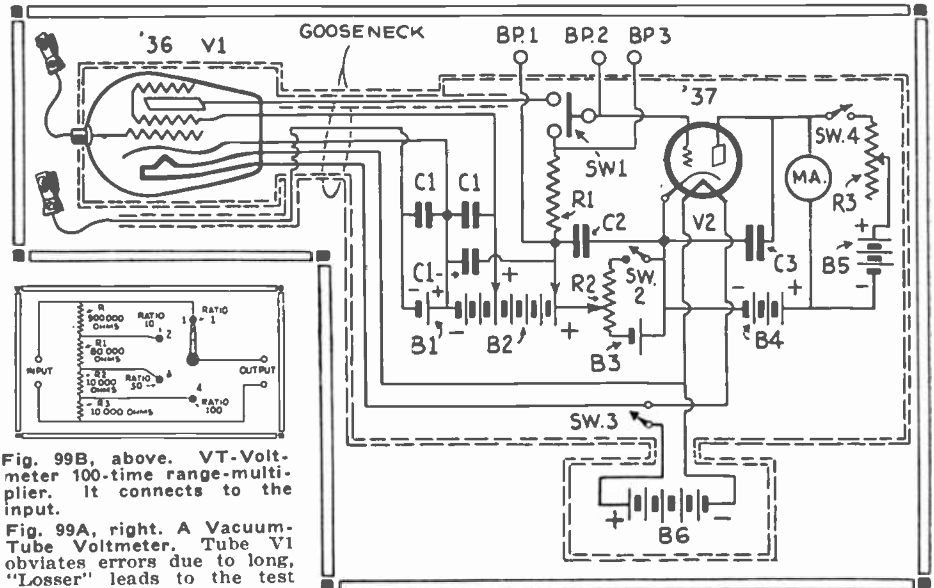


Fig. 99B, above. VT-Voltmeter 100-time range-multiplier. It connects to the input.

Fig. 99A, right. A Vacuum-Tube Voltmeter. Tube V1 obviates errors due to long, "Losser" leads to the test points.

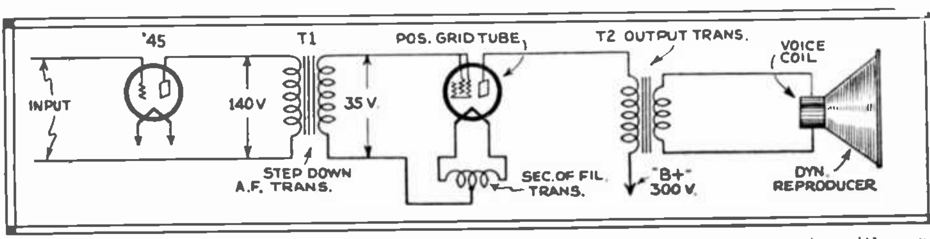


Fig. 100. "Class B Tube" Amplifier. The tube is a "46," designed to operate with zero plate current, under the "no signal" conditions. Note that transformer T1 steps down the voltage.

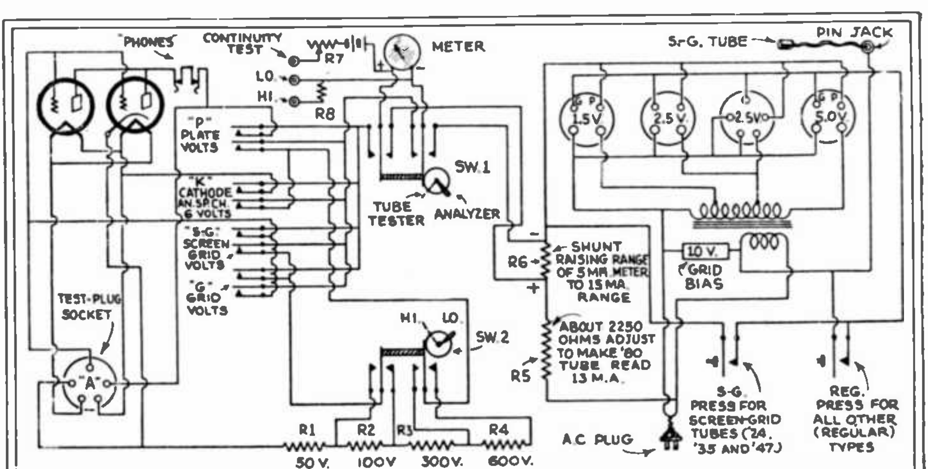


Fig. 101. A Set Analyzer and Tube-Tester. Contains a tube tester, phone-test, continuity tester, pre-heater, ohmmeter, and set analyzer. As designed, it tests all the older tubes without recourse to adapters. Only one meter, 0-5 ma., is needed in this test instrument.

CHAPTER XII

Reference Data

IN these concluding columns will be found the available data concerning the components essential to the construction of the preceding 101 circuits.

Although in most cases factory designations are given, it should be realized that in the majority of the instances judicious substitutions may be made. These changes, in turn, may modify the arrangement of other components and thus, the dimensions of the chassis. In general, substitutions are inadvisable.

Unknown values often may be determined by comparing the circuit arrangement with another of similar type, and observing the values of the components incorporated in the latter.

FIG. 1. (Radio-Craft, July 1932, p. 12.)

FIG. 2. (Radio-Craft, September 1931, p. 156.)

One Utah "Midget" dynamic speaker, with 2,500-ohm field winding; output transformer and UX-base plug;
One Gen-Win three-circuit tuner, for .00035-mf. condenser (L, L1, L2);
One Hammarlund "Midget" .00035-mf. variable condenser (C1);
One Hammarlund A.F.T. (secondary) L3;
Three Aerovox fixed condensers: one .00025-mf. (C2); one .0005-mf. (C3); one .01-mf. (C4);
Two Flechtheim filter condensers: one 2-mf. (C5); one 1-mf. (C9);
Three Concourse 4-mf. electrolytic condensers (C6, C7, C8);
Two International grid-leak resistors: one 2-meg. (R); one ½-meg. (R2);
One International 250,000-ohm plate resistor, (R1);
Three Electrad wire-wound voltage-divider resistors: two 120,000-ohm (R3, R4); one 5000-ohm (R5);
One Electrad wire-wound 400-ohm resistor (R6);
One Earl power transformer, with 2.5-, 5- and 400-volt center-tapped secondaries (PT).

(Coil L1, 63T. No. 26 D.C.C., 2 ins. in dia.; L2, 32T., No. 26 D.C.C., 1¼ in. dia. and inside L1.)

FIG. 3. (Radio-Craft, July 1932, p. 19)

FIG. 4. (Radio-Craft, August 1932, p. 101.)

FIG. 5. (Radio-Craft, August 1931, p. 97.)

One shielded antenna coil, L1;
Two shielded R.F. coils, L2, L3;
Two R.F. chokes, RFC1, RFC2;
One A.F. choke (A.F. trans. sec.), CH1;
One 30-henry filter choke, CH2;
Two 800-ohm resistors, R2, R3;
One 50,000-ohm volume control, R1;
One 10,000-ohm biasing resistor, R4;
Two 0.5-meg. resistors, R5, R6;
One 1,200-ohm biasing resistor, R7;
One 7,000-ohm resistor, R8;
One 5,000-ohm resistor, R9;
One 3-gang, .00035-mf. variable condenser, C1, C2, C3;
Seven .01-mf. bypass condensers, C4 to C9, C13;
Two 1-mf. bypass condensers, C10, C11;
One .001-mf. bypass condenser, C12;
One low-voltage dry-electrolytic condenser, 25-mf., C14;
Two 200-volt filter condensers (one 2-mf.; one 4-mf.), C15, C16.

FIG. 6. (Radio-Craft, January 1932, p. 398.)

FIG. 7. (Radio-Craft, August 1932, p. 74.)

One set of Automatic Coil Winding inductances, L1 to L6, inclusive;
Three Aerovox dry-electrolytic condensers: one 50 mf., 100 volt, C16; one 8 mf., 500 volt, C15; one 10 mf., 20 volt, C14;
Five Aerovox 0.1-mf., 200 volt tubular condensers, C4, C5, C8, C10, C12;
One Dubilier .0035-mf., mica condenser, C7;
One Dubilier .00025-mf., mica condenser, C6;
One Mountford, 250 ohm, 50 watt vitreous-enamel resistor, R9;
Five Trutest 1-watt carbon resistors: one ½-meg., R6; two ¼-meg., R4, R5; one 50,000 ohms, R3; one 650 ohms, R7;
Two Truvolt flexible resistors; one ohm, R2, R8;
One Carter combination switch and 10,000 ohm (volume control) resistor, R1;
One Jensen type P.M.1 magneto-dynamic reproducer; transformer T for parallel '38's;
One Kenyon low-resistance choke (coil);
One DeJur No. 3503, 375 mmf. 3-gang condenser, C1, C2, C3, with trimmers.

FIG. 8. (Radio-Craft, June 1932, p. 742.)

FIG. 9. (Radio-Craft, February 1932, p. 464.)

The values of the various parts listed in the diagram are as follows: Resistor R1, 8,020 ohms; R2, 1. megohm; R3, 25,000 ohms; R4, 6 megohms; R5, 0.5-meg.; R7, 60,000 ohms; R8, 200 ohms. Condensers C1, two-gang variable unit; C2, 100 mmf.; C3, 8 mf.; C4, 4 mf.; C5, .1-mf.; C6, .02-mf.; C7, 16 mmf.; C8, .006-mf. Transformer T1, an antenna coil; T2, an R.F. coil.

FIG. 10. (Radio-Craft, August 1932, p. 86.)

One DeJur 2-gang type 3502 condenser, C1, C2;
One dynamic reproducer with 2,500 ohm field and T1 primary of 4,000 ohms;
One Carter type 3562 power transformer, PT;
One Carter choke, type 4073 (10 hy. at 10 ma., resistance less than 200 ohms), A.F.Ch.;
One Meissner, 262½ kc. output I.F. transformer with trimmers, I.F.T.2;
One Meissner, 262½ kc. composite oscillator coil and input I.F. transformer, I.F.T.1, L2, L3;
One 8 millhy. R.F. choke, R.F.C.;
One Meissner antenna coil, type N, L1;
One combination switch and 10,000 ohm volume control resistor R10;
Two 70 mmf. padding condensers, C15, C17;
One DeJur .001-mf. padding condenser, C2A;
One DeJur dual trimmer, 140 mmf., C3, C4;
One 6 mf. and one 8 mf., 450-volt electrolytic condenser with leads, C9 and C10, respectively;
Two .001-mf. Dubilier condensers, C7, C11;
One .005-mf. Dubilier condenser, C12;
One .25-mf. Cub type 200-volt condenser, C13;
Two .1-mf. 200-volt Cub condenser, C5, C6;
One 20 mf. electrolytic condenser, 50 volt, C8;
One short-wave coil and bracket, L4;
One 50,000-ohm variable resistor, R11;
One .05-mf. Cub condenser, C16;
One .01-mf., 400-volt Cub condenser, C14;
One 7,500-ohm, 1/5-watt resistor, R1;
One 200-volt, 1/5-watt resistor, R2;
One 25,000-ohm, 1 watt resistor, R3;
One 25,000-ohm, 1/5-watt resistor, R4;
One 1-megohm, 1/5-watt resistor, R5;
One 100,000 ohm, 1/5-watt resistor, R6;
One 400-ohm, 1/5-watt resistor, R7;
One 1,000-volt, 1/5-watt resistor, R8;
One 20-ohm center-tap resistor, R9;

FIG. 11. (Radio-Craft, February 1930, p. 391.)

The inductances may be a standard R.F. coil kit. Current consumption of entire set, only 60 watts. Fuse the D.C. line.

FIG. 12. (Radio-Craft, October 1930, p. 205.)

Two Pilot Resistograds, R1, R3;
One 2 meg. grid leak, R2;
Two Aerovox center-tapped 20 ohm resistors, R4, R5;
Three Dubilier bypass condensers, 1 mf., C5, C6, C7;
Two "replacement" transformers, low ratio, T1, T2;
One suitable filament transformer (not shown);
One 500 mmf. Dubilier mica condenser, C;

One anti-motorboating condenser, 8 mf., C8.

FIG. 13. (Radio-Craft, June 1932, p. 730.)
Two Aerovox type 461-31 triple section metal case condenser, .1-mf., (7, 14);
One Aerovox type 260 bypass condensers, .5-mf., (18);
One Aerovox type E25-25 electrolytic condenser, 25 mf., (30);
One Aerovox type E5-248 triple-section electrolytic condenser, in can 2½ in. high by 3-in. dia. (8 mf.—39) (4 mf.—41) (2 mf.—42);
One Aerovox type 1460 mica condenser, .001-mf., (22);
One Aerovox type 1460 mica condenser, .01-mf., (26);
One Aerovox type 461-21 double section condenser, (19—35A);
One Conoid (shielded) Antenna Coupler, (3);
Two Conoid (shielded) R.F. coils, (10, 16);
Two I.R.C. Durham type F-1, metallized resistors, 50,000 ohm, (20, 24);
Two I.R.C. Durham type F-1, metallized resistors, 75,000 ohms, (9, 15);
One I.R.C. Durham type F-1, metallized resistor, 10,000 ohm, (23);
Two I.R.C. Durham type F-1, metallized resistors, 50,000 ohm, (25, 27);
One Standard Mazda dial light, 3.2 volt, .35-amp. (36);
One Electrad type 2G-500 flexible resistor, (31);
One Electrad type R1-202 volume-control potentiometer, (8), with switch, (44);
Two Electrad type 2G-500 flexible resistors, (6, 13);
One Electrad type C-3 Truvolt fixed resistor, (35);
One Crowe moving light full-vision dial, (36A);
Five Arcturus tubes, (5, 12, 21, 28, 29).

FIG. 14. (Radio-Craft, March 1931, p. 569.)

FIG. 15. (Radio-Craft, July 1931, p. 40.)

FIG. 16. (Radio-Craft, April 1932, p. 608.)
The audio choke is an A.F.T. primary and secondary, in series. A standard 3-circuit tuner is used.

FIG. 17. (Radio-Craft, July 1929, p. 16.)
One Gen-Win 3-Circuit Tuner, with rotable primary used as tickler (16);
Two Hammarlund 500 mmf., "midline" variable condensers (7, 10);
One Electrad "Royalty" resistance, type "F", 0—2000 ohms (21);
One Durham 2 meg. metallized resistor, (19);
One Micamold, 250 mmf. mica grid condenser (18);
Two Thordarson transformers, 3½ to 1 ratio, type R-150 (25, 28); or a 6 to 1 ratio, type R-151 may be used at (28) for greater distance;
Two Amperites, No. 4V-199, with mounting (22, 27);
One Amperite, No. 120 with mountings (30);
Three Silver-Marshall R.F. chokes, type 276 (12, 15, 23);
One Silver-Marshall midget condenser, type 340 (6);
Two Micamold, .01-mf. mica condensers (13, 14);
One Micamold, 500 mmf. mica condenser (24);
One Carter JU-5-15 tapped resistor (11);
Two Carter open-circuit short jacks for loop sockets;
One spool No. 22 D.C.C. Corwico wire for loop (3);
One 7-conductor cable with mounting plate (34);
Four Gold Seal tubes, types GSX222 (9); GSX199 (20, 26); GSX120 (29);
One loudspeaker unit;
One sheet of Burtex or Alhambra paper, 12x12 inches for loudspeaker cone;
Three 1½ volt dry cells ("A" battery);
Seven small 22½ volt "B" batteries;
One carrying case, 12 x 14 x 10 ins.; the loop has 60 turns, 12 x 14 ins., No. 18 bell-wire—outside antenna coil, (1, 2), 4 turns.

FIG. 18. (Radio-Craft, April 1932, p. 592.)
One Hammarlund, Type ML17, 350-mmf. variable condenser, C1;
Two Aerovox, Type 200-S, 1-mf., bypass condensers, C4, C9;
One Aerovox, 250-mmf. molded mica condenser, C2;
One Aerovox, 500-mmf. molded mica condenser, C3;
One Aerovox, Type 200-S, 4-mf. bypass condenser, C5;
Two Aerovox, Type Hi-Farad electrolytic filter condensers, 4 mf., C6, C7;
One Aerovox, Type Hi-Farad electrolytic filter condenser, 8 mf., C8;
Two National, 60-ma., 30-henry chokes, unmounted, CH.1, CH.2;
One Thordarson, replacement type A.F.T., T1;
One Franklin midget power transformer, 85 watts, PT;
One Electrad Super-tonatrol, 0-10,000 ohms, tapered, R2;
One Electrad Truvolt resistor, Type B, 500 ohms, with tap, R6;
One Durham resistor, metallized, 1 watt, 2 meg., R1;
One Durham resistor, metallized, 2 watt, ¼-meg., R3;
One Durham resistor, metallized, 2 watt, 12,500 ohms, R5;
One Durham resistor, metallized, 1 watt, 0.1-meg., R4;
One Utah midget dynamic speaker, 2,500-ohm field, 4,000-ohm transformer primary, 4-prong plug, LS;
Three Speed tubes, V1, V2, V3.
Coil L has a 12T. primary wound over the 110T. secondary; No. 30 cotton-covered enameled wire is wound on a 1¼-in. tube. The tickler has 25T. No. 28 enameled wire on a 1 in. tube which fits into the larger tube, at the grid end.

FIG. 19. (Radio-Craft, September 1928, p. 102.)
Three Silver-Marshall coils, Type 132A, 1½-in. dia. (3, 9, 20);
Seven Aerovox fixed condensers, 1-mf., 200-volt D.C. (working voltage) (4, 12, 19, 21, 22, 32, 35);
Three Hammarlund "midline" variable condensers, .00035-mf. (6, 14, 16);
Two Electrad grid suppressors, 1,900 ohms, (7, 33);
One Electrad variable resistor, 0-200,000-ohm, (11);
One Electrad grid suppressor, 1,000-ohms, (13);
One Pilot fixed condenser, .00025-mf. (17);
Three Silver-Marshall R.F. chokes, Type 276 (23, 24, 28);
One Carborundum grid leak, 1½-meg. (25);
One Electrad "Royalty" variable resistor, Type F., 0-2,000-ohms (26);
One Dubilier fixed condenser, .0005-mf. (29);
One Amertran DeLuxe first-stage A.F.T., (30);
One Amertran DeLuxe second-stage A.F.T., (48);
One Pilot output choke, 20 henry (38);
One Thordarson power compact, Type R280 (40);
One Pilot filament transformer, Type 386 (41);
One Aerovox filter condenser, Type BC280 (43);
One Electrad Truvolt voltage divider, 14,000-ohms, (total), with five taps (44);
Six tubes: '27, (8, 27, 31); '24, (15); '71A, (34); '80, (42);
Six brass pillars (coil socket supports) ⅝x1½ inches;
One Radio Trading copper strip (for Peridyne plates), 7½ x 2½ x 1/32 inches (50B);
Winding forms of 5-prong type are used—dia., 1½ ins. Each secondary has 98½ T. No. 30 enam. wire, spaced slightly; No. 3A primary, 15T. No. 26 enam. of 1¼ in. tube at filament end of secondary. Second R.F. primary, 40T. No. 36 D.S.C. in slot 1/16-in. by ⅛-in. deep at filament end. Coil 20A, 25T. No. 32 D.S.C. on a 1¼ in. tube to fit into secondary. The Peridyne plates are 2¼ ins. in dia. and 1/16-in. thick, at grid end of coils.

FIG. 20. (Radio-Craft, August 1929, p. 56.)
Coil data: Antenna coil primary, 18T. No. 22 D.C.C., 2 ins. dia.; Secondary, 77T.; same—tube spacing, ⅛-in. Second inductance, same size tube; primary 18T.; secondary, 77 T., center-tapped; primary is wound over one end of secondary. Third coil, same size tube; 77 T., tapped at 22 T.

FIG. 21. (Radio-Craft, June 1930, p. 648.)
The electrical values of the parts used in this set are as follows: C1, C2, .0005-mf.; C3, .001-mf.; C4, .00025-mf.; C5, 2 mf.; C6, .01-mf.; C7, 0.25-mf.; C8, 0.25-mf.. R1, 30 ohms; R2, R3, R4, filament ballasts of the "one-tube" type; R5, 2 megs.; R6, 15 ohms tapped at 10 ohms. T1, T2, the A.F. choke, and C5 are the usual audio components.
The constants for L1 and L2 are as follows: L1, 6 turns of No. 26 D.S.C. wire on a tube 2⅝ in. in diameter, for the primary, and 56 turns of the same size wire for the secondary. L2 has a 6-turn primary, center-tapped, wound on a 2⅝ in. form; a 56-turn secondary; and a 14-turn tickler, the latter wound on a rotor 1½ ins. in diameter. The distance between primary and secondary should be about 5/16-in. It is recommended that, if convenient, the primary of L2, when used with a screen-grid tube, be increased to 20 or 30 turns; the best value depending upon the selectivity required by local reception conditions.

FIG. 22. (Radio-Craft, February 1931, p. 478.)
The R.F. inductances are wound on forms 1¼ inches in diameter; the primaries being alongside the secondaries, but spaced therefrom 1⅝ inch. The primary or antenna winding of L consists of 30 turns of wire, which may be of any convenient size; for instance, No. 24 D.C.C.
The two secondary windings of L consists of 120 turns; as do the secondaries of L12, L13, and L14. The primary windings of L12, L13 and L14 consists each of 40 turns of wire. The shield cans have a diameter of 2⅝ inches. Note that the can shielding the antenna coil is open at the end where the antenna coupling coil is placed.
Condensers C8, C9, C10, C11 are banks of 0.1-mf. capacities. The tuning condensers C1, C2, C3, C4, C5, used were "USL" .00042-mf. units. Condenser C6 has a capacity of .000025-mf.; C7, .000015; C12, C13, C14, .002-mf.; C15, .00025-mf. Dubilier condensers were used.
The radio-frequency chokes L1, L2, L7, L8, L9, L10, L11 are the standard 85-mh., chokes which usually are

scramble-wound with about 750 turns of wire on a small core. Chokes L3, L4, L5, L6 are specially designed, with 1,000 turns of small-sized wire (about No 36 D.C.C.), and are rated at 150 mh.
Resistors R1, R2, R3 are 400 ohms; R4, 7,500 to 25,000 ohms; R5, 50,000-ohm Centralab potentiometer. Except for the last unit, Aerovox resistors were used.
All tubes are type '24.

FIG. 23. (Radio-Craft, October 1930, p. 210.)

FIG. 24. (Radio-Craft, November 1929, p. 204.)
RECEIVER CHASSIS
One Hammarlund dial, illuminated, 0-100, type SDB-1;
Two Electrad 0.5-meg., Type E potentiometers (R5, R6);
Four Type '24 tubes; one Type '27 tube; two Type '10 tubes;
One Amertran input transformer, Type 151 (AFT);
Two Electrad 50,000-ohm resistors, (R8, R9);
One Electrad 0.25-meg. resistor (R3);
One Flechtheim .05-mf. condenser (C17);
One Daven 0.5-meg. resistor (R4);
One Electrad 100-ohm "Truvolt" wire grid resistor, R1;
One Electrad 5000-ohm "Truvolt" wire grid resistor, R2;
One Electrad 1500-ohm "Truvolt" wire grid resistor, R7;
One Silver-Marshall 85 mh. R.F. choke (L4);
One Flechtheim .0005-mf. bypass condenser (C16);
Thirteen Flechtheim 1-mf., 250-volt condensers (C5 to C15, C18, C20);
One Flechtheim 2-mf., 250-volt condenser (C19);
Three Duratran "screen-grid" R.F. transformers (RFT1, RFT2, RFT3);
One Amertran output choke, No. 641;
POWER PACK
One Amertran power transformer, Type PF 281 (PT);
One Amertran choke, Type 709 (L5);
One Amertran choke, Type 854 (L6);
Two Flechtheim 1000-volt condensers, two sections 4-mf. each (C21-22, C23-24);
One Flechtheim 250-volt, 1-mf. condenser (C25);
One Aerovox 3000-ohm 100-watt resistor (R10);
One Aerovox 2000-ohm 100-watt resistor (R11);
One Aerovox 3000-ohm 20-watt resistor (R12);
One Aerovox 4500-ohm 20-watt resistor (R13);
One Aerovox 1000-ohm 10-watt resistor (R14);
One '81 rectifier; one '74 voltage regulator glow tube.

FIG. 25. (Radio-Craft, February 1932, p. 470.)

FIG. 26. (Radio-Craft, July 1932, p. 12.)
Strong signals with exceptionally good tone quality are possible with this circuit. A tuning condenser of 500 mmf. is connected in series with a coil L1 having 68 T. No. 30 D.C.C. wire on a tube 3 ins. in dia. Reverse the crystal leads to find best position.

FIG. 27. (Radio-Craft, January 1930, p. 332.)

FIG. 28. (Radio-Craft, May 1931, p. 672.)
Two Pilot .00035-mf. variable condensers, C1, C2;
One Pilot .0005-mf. variable condenser, C3;
Three Pilot R.F. transformers No. 176, altered as per text (L1, L2, L6);
Two I.F. transformers (L4, L5—see below);
Ten Pilot sub-panel UX sockets, for coils and tubes;
Three X-L Variodensers, G-5 (C4, C5, C6);
Five Pilot 80-millihenry R.F. chokes, No. 130;
Two 3,000-ohm variable resistors (R1, R8);
Four wire-wound filament resistors: two 50-ohm, (R2, R5); two 15-ohm (R3, R6);
Five Amperites; four 630 (R4, R9, R10, R12); one 631 (R11);
Eleven fixed condensers; four 0.5-mf.; four 0.1-mf.; two .001-mf. (C7, C9); one .00025-mf. (C8);
The oscillator coil, L6 has 50 turns of No. 28 enam. wire for the grid winding and 30 turns for the plate winding; L1, pri. 12 T. No. 30 enam. at low-potential end of secondary of 100 T.; L2, 50 T. No. 35 enam. (in a slot at the low-potential end of sec.), and a secondary of 105 T. No. 30 enam.; all wound on Pilot plug-in forms 1⅜ ins. in dia. The I.F. coils have 200 turns of No. 36 S.S.C. wire on a 1-inch core for each winding except the tickler of L5 (which has but 100 turns); these windings are to be tuned by the Variodensers until they match.

FIG. 29. (Radio-Craft, October 1930, p. 251.)

FIG. 30. (Radio-Craft, August 1929, p. 82.)

FIG. 31. (Radio-Craft, April 1931, p. 594.)
Two Cardwell dual variable condensers, type 217-CL (4, 15), and type 217-CR (27, 39); capacity, each section, .00035-mf.;
One Silver-Marshall R.F. shielded coil, type 124 (3);
Three Silver-Marshall R.F. shielded coils, Type 121 (14, 26, 38);
Seven Silver-Marshall R.F. chokes, Type 275 (12, 13, 23, 24, 36, 37, 46);
One Silver-Marshall illuminated drum dial, Type 810-B (25), with pilot light (73);
One Electrad No. 3 "Super-Tonatrol," 50,000-ohm potentiometer (33);
One Electrad "Truvolt" resistor, Type B-250 (70);
One Electrad "Truvolt" resistor, Type B-30 (71);
One Electrad "Truvolt" resistor, Type C-8, (72);
Two Electrad filament switches (48, 69);
One Flechtheim midget condenser, .001-mf., Type M-E (45);
One Flechtheim midget condenser, .006-mf., type M-J (47);
Nine Flechtheim midget condensers, .01-mf., type M-K (6, 10, 11, 17, 21, 22, 30, 34, 35);
Three Flechtheim bypass condensers, 1.0-mf., type B100 (41, 53, 56);
One Flechtheim bypass condenser, 2-mf., Type B200 (49);
Five Durham "Powerohm" metallized resistors, 50,000 ohms, type M.F.4 with pigtail terminals (7, 18, 29, 42, 52);
One Durham "Powerohm" metallized resistor, 40,000 ohms, type M.F.4 (50);
Five Amperites, No. 631, (9, 20, 32, 44, 55);
Two Amperites, No. 630, (61, 61A);
Four Meter or X-L midget variable condensers, 3 mmf. to 50 mmf. (5, 16, 28, 40);
One Thordarson A.F. transformer, Type R-260 (51);
One Thordarson A.F. transformer, push-pull input, Type T-2922 (57);
One Thordarson A.F. transformer, push-pull output, Type T-2903 for dynamic reproducer; or Type T-2880 for magnetic reproducer (62);
One Eveready "Air-Cell" "A" battery;
Four Eveready Type 486 "B" batteries;
Two DeForest Type 430 tubes (43, 54); two Type 431 (59, 60); three Type 432 (8, 19).

FIG. 32. (Radio-Craft, May 1932, p. 663.)
One Cardwell .000365-mf. "Midway" Featherweight variable condenser, Type 407-B, 6;
One Aerovox .00025-mf. mica condenser, (9);
Two Aerovox .0005-mf. mica condensers, (2, 13);
One Aerovox .006-mf. condenser, (4);
One Aerovox .01-mf. tubular condenser, Type 280, (7);
One I.R.C. 2-meg. metallized resistor (Durham), Type MF-4 (10);
One Trutest 30-henry choke (small) Type 1892-A, (17);
Two 137-A Arcturus Universal A.C.-D.C. tubes (11, 19);
One Hubbell 115-volt depressed outlet (prongs are on outlet instead of on plug) (22);
One special plug for Hubbell outlet, 6 ft. lamp cord;
One Clarostat automatic line-voltage regulator, Type "50-Watt," (23);
One Universal single-button "Handi-Mike," Model No. 50.

FIG. 33. (Radio-Craft, April 1932, p. 598.)
One set Moore "Super-Da-Lite-R" coils, L1, L2;
One set Moore "Super-Da-Lite-R" tuning coils, L3, L4;
One set Moore "Super-Da-Lite-R" oscillator coils;
One set Moore "Super-Da-Lite-R" I.F. transformers L5, L7, L8, L9;
One Moore tuned antenna impedance, L6, C4;
One three-gang .000365-mf. clockwise tuning condenser, C1;
One two-gang .000365-mf. counterclockwise tuning condenser, C2;
One Hammarlund padding condenser, C3;
Two 1.-mf. condensers, C5, C13;
Two .5-mf. condensers, C6, C7;
Three .02-mf. condensers, C8, C9, C10;
One .002-mf. condenser, C11;
One bypass condenser, 4 mf., C12;
One 3,000-ohm volume control R1 and switch SW.2;
One 225-ohm resistor, R2;
One 12,500-ohm resistor, R3 (25 watts);
One 25,000-ohm resistor, R4 (25 watts);
Two 100,000-ohm carbon resistors, R5, R6;
One 7,500-ohm carbon resistor, R7;
Two 250,000-ohm carbon resistors, R8, R9;
Two 50,000-ohm carbon resistors, R10, R15;
Two 25,000-ohm carbon resistors, R11, R14;
One 500,000-ohm carbon resistor, R12;
One 2,000-ohm resistor, R13;
One 750-ohm resistor, R16.

FIG. 34. (Radio-Craft, April 1932, p. 609.)

FIG. 35. (Short Wave Craft, Dec. '31 — Jan. '32, p. 252.)
One Hammarlund Type ML 5 condenser (C1);
One Hammarlund Type ML 11 condenser (C2);
One Hammarlund Equalizer condenser, 32 mmf., (C3);

Two Sprague or Aerovox tubular bypass condensers, 0.1-mf., (C4, C5);
Two Sprague or Aerovox tubular bypass condensers, 0.5-mf., (C6, C9);
One Aerovox moulded mica condenser midget type, .00015-mf., (C7);
One Aerovox moulded mica condenser, .02-mf., (C8);
Two Lynch metallized resistors with pigtails, 1 watt, 100,000 ohms, (R1, R4);
One Lynch metallized resistor with pigtails, 1 megohm, 1 watt, (R5);
One Lynch metallized resistor with pigtails, 6 megohm, 1 watt, (R3);
One Lynch metallized resistor with pigtails, 1500 ohms, 2 watt, (R6);
One Electrad 500-ohm pigtail grid-suppressor resistor, (R2);
One Electrad 0-50,000 ohm bakelite shell Supertonatrol, (R7);
One Blan "Bryant Electric" switch, power type, single pole single throw two position;
One Pilot 80-millihenry R.F. choke;
Two National type C vernier dials, (C1, C2);
One 236; one 237; one 238, automobile tubes; (Arcturus used in tests);
One Hiteohm voltage divider (25,000 ohms), for power pack.

FIG. 36. (Radio-Craft, April 1931, p. 604.)

FIG. 37. (Radio-Craft, May 1932, p. 650.)
One Lynch 250,00-ohm pigtail resistor, R1;
One Electrad 1,000-ohm grid resistor, R2;
One Carter 5,000-ohm potentiometer, C. P. 5 M., R3;
One Lynch 25,000-ohm pigtail resistor, R4;
One Lynch 6,000-ohm pigtail resistor, R5;
One Electrad 200-ohm resistor, R6;
Two Lynch 0.5-megohm pigtail resistors, R7, R8;
One Lynch 100,000-ohm pigtail resistor, R9;
One Electrad 15,000-ohm Type D, 75-watt voltage divider, R10-R11;
One 2,000-ohm resistor, R12;
One Electrad 200-ohm grid resistor, R13;
Three 175-kc. transformers, T1, T2, T3;
One Thordarson input push-pull transformer Type 2408, T4;
One Thordarson output push-pull transformer Type 4831, T5;
One Polo power transformer, '45 type, PT.;
One Polo 30-henry choke, CH. 1; CH. 2 is field coil.

FIG. 38. (Radio-Craft, October 1929, p. 160.)
Two seven-plate midget condensers, 32-mf., C1, C2;
One unmounted A.F. transformer, (TR);
One 85-millihenry R.F. choke;
Two mica fixed condensers, .006-mf. (C4, C5);
One mica fixed condenser, .001-mf., (C6);
One grid leak, 2-megohm (R1);
One grid leak, 5- or 6-megohm (R4);
One filament resistor, 15-ohm wire, tapped at 5 ohms to provide grid bias for the '22 R.F. tube (R2, R3);
One resistor, 10-ohm wire, for the '99 filaments (R5);
No. 28 D.C.C. magnet wire, ¼ pound, for coils;
One '22 tube (V1); two '99 tubes (V2, V3);
Five small "B" batteries, 22½-volt portable;
Two "C" batteries, 4½-volt for filament supply.

Coil A, 18-25 meters: L1, 7T.; L2, 7T. Coil B, 25-35 meters: L1, 10T.; L2, 10T. Coil C, 35-45 meters: L1, 15T.; L2, 14T. Coil D, 45-65 meters: L1, 20T.; L2, 18T. Coil E, 63-100 meters: L1, 50T.; L2, 50T., on a tube fitting into L1. Tube bases of "long" UX-type are used; use No. 28 D.C.C. wire. Except for coil E, the primary is wound over the secondary.

FIG. 39. (Radio-Craft, May 1932, p. 675.)
Following are the electrical values of all the parts used in this receiver: Condensers C1, C2, 30 mmf. (each), "compensator" type; C3, Cardwell Type 404-B, 105 mmf.; C4, 0.5-mf.; C5, .00025-mf.; C6, .0025-mf.; C7, 0.1-mf.; C8, 1. mf.; C9, .005-mf. Resistor R1, 2 megs.; R2, variable, 50,000 ohms; R3, R4, 2,000 ohms (carbon). Radio frequency choke R.F.C. is space-wound with 40 turns of No. 36 S.S.C. wire on a form ¼-in. in diameter. Coils L1, L2, each consist of 6 turns of No. 18 bare copper wire air-wound to a diameter of ⅝-in.; L3, 800 turns of No. 40 S.S.C. wire; L4, 1,500 turns, No. 40 S.S.C. (core diameter, ½-in.). Transformer T has a ratio of 3½ to 1.

(An Acme 30 kc. I.F.T. may be used as L3-L4.) The wavelength range is 3 to 8 meters (approx.); by reducing the size of L1-L2 a minimum of 1 meter may be reached.

FIG. 40. (Radio-Craft, January 1930, p. 310.)
A standard Electrad 25,000 ohm wire-wound voltage divider resistor may be used in the power pack. Special "short-wave" tubes are indicated in the circuit. The same coil-kit may be used as in the "Super-Wasp" (Fig. 48).

FIG. 41. (Radio-Craft, March 1931, p. 541.)
One Hammarlund 125-mmf., Type "MLW-125" (C1);
One Hammarlund 100-mmf. condenser, Type "MC-23" (C2);
One Hammarlund 20-100-mmf. condenser, Type "EC-80" (C3);
One Hammarlund LWT-4 short-wave coil set (L1, L2, L3): consisting of an "LWT-B" base, with adjustable primary; and one each "LWT-20," "LWT-30," "LWT-40," and "LWT-80" coils, to cover the 14- to 110-meter range.
One Hammarlund LWT-120 coil, (grid, 44T.; plate, 18T.; No. 22 S.S.C., 30T. per in.; 105-205 meters);
One Hammarlund R.F. choke, Type "RFC-85";
One Hammarlund A.F. transformer, Type "HL-15" (T);
One 3-megohm grid leak (R1);
Two 15-ohm filament resistors (R2, R4);
One 100,000-ohm resistor (R3);
One .001-mf. fixed condenser (C4);
One Hammarlund drum dial and knob, type "SDW-1";

FIG. 42. (Short Wave Craft, May 1932, p. 41.)
This general circuit arrangement is discussed in connection with Figs. 39 and 46; see also the August and October 1931 issues of Radio-Craft, p. 222.

FIG. 43. (Radio-Craft, September 1929, p. 116.)
One set of four Octocoils (L1-L2)
Green coil 16 to 20 meters
Brown coil, 29 to 58 meters
Blue coil, 54 to 110 meters
Red coil, 103 to 225 meters;
One Pilot 80 mhy. R.F. choke coil, (L3);
One Pilot, No. J-13, .00005-mf. midget variable condenser, (C1);
One Pilot, No. 1608, S.L.F. .00015-mf. variable condenser, (C2);
One Aerovox .00015-mf. grid condenser, (C3);
One Pilot, No. J-23, .0001-mf. midget variable condenser, (C1);
One Carborundum 8-megohm grid leak, (R1);
One Yaxley fixed resistor (R2)., (50 ohms for type '99 tube or 4 ohms for '01A tube);

The coils are of plug-in type, 1¼ ins. in dia., wound as follows: Green L1, L2, 6T.; brown L1, L2, 13T.; blue L1, 21T., L2, 15T.; red L1 54T., L2 27T.

FIG. 44. (Radio-Craft, November 1931, p. 290.)
Three Amsco "450 kc." I.F. transformers, T2, T3, T4;
Two Amsco .00015-mf. S.L.F. variable condensers, C1, C2;
One Electrad 15,000 ohm 50 watt voltage divider, R11;
One double-pole rotary switch, S1, S2;
Two Carter 0.5-meg. variable resistors, R6, R12;
Eleven Dubilier .01-mf. fixed condenser, C9 to C19;
Six Hammarlund 100 mmf condensers, C3 to C8;
Two 60-mhy. R.F. chokes;
One Lynch 0.5-meg. resistor, R9;
One "metallized" 80,000 ohm resister, R8;
One 20,000 ohm carbon resistor, R10;
Six Ward-Leonard 250 ohm resistors, R1, R2, R3, R4, R5, R7;
One 2-meg. grid leak;
One .00025-mf. grid condenser, C24;
One push-pull input audio transformer, T1;
One Dubilier .002-mf. condenser, C20;
One Ward-Leonard 200-ohm resistor, R13.

Coils L1 and L2 are tapped at 3, 8, 18 and 60 turns, they are wound with No. 26 D. S. C. wire.

FIG. 45. (Radio-Craft, July 1932, p. 41.)

FIG. 46. (Radio-Craft, August 1931, p. 91.)
Two Hammarlund "MLW-125" 125 mmf. short-wave condensers, C1, C2, and two Kurz-Kasch vernier dials;
Two Hammarlund 14-to-110 meter Model LWT-4 short-wave kits, L1, L2;
One Hammarlund Type RFC 250, 250-mh. R.F. choke, RFC1;
One Hammarlund Type EC 80, 80 mmf. equalizing condenser, C4;
One Flechtheim filter block (five 1-mf. units), C6, C7 (2 mf.), C8 (1 mf.);
One Ferranti "Type AF-5," 3.75-to-1 ratio audio transformer, T;
Two Sangamo .001-mf. fixed condensers, C3, C5;
Two Electrad 50,000-ohm "Supertonatrols," R1, R2;
One Acme 30-kc. I.F. transformer, L3;
One Yaxley 7-wire cable, 3 to 9;
One Blan aluminum cabinet 7x9x18x3/32-in. thick;
Two Blan aluminum sheets (partitions), 7⅝x9⅝x3/32-in. thick.

Remove the shield-case over the Acme 30 kc. transformer and wind over the secondary a pick-up coil of 150 T. No. 28 enam., random wound. An experimental equivalent to the 30 kc. Acme unit is a combination of three honeycomb coils of 200, 1,000 and 1,500 turns. The whistle filter consists of a 30 hy. choke and 250 mmf. condenser, if the suppressor frequency is about 6,000 cycles; a variable resistor of

10,000 ohms in series will broaden the range of this selector circuit.

FIG. 47. (Radio-Craft, May 1930, p. 572.)
C1, 150 mmf.; C2A, C2B, 135 mmf., variable; C3, .0005-mf.; C4A, C4B, .00015-mf.; C5A, C5B, 1.0 mf.; C6A, C6B, C6C, C6D, C6E, C6F, C6G, .002-mf.; R1, 10 megs.; R2A, R2B, 10,000 ohms ("Bradleyohms"); R3, 20 ohms; R4, 600 ohms; R5, 15 ohms; R6, 2-tube ballast; R7, 100,000 ohms; R8, 400 ohms; R9, 2,000 ohms. Ch1, Ch2, Aero No. C-60 low-impedance R.F. chokes; Ch3, Aero No. 65 high-impedance R.F. choke. L1-L2, special short-wave variometer. T1, T2, Aero AE-300 (peaked for code reception), or Thordarson R300 (for phone reception) A.F. transformers.

The stator tube of the variometer has 4¾ T. of wire, 1⅞ ins. in dia.; the rotor has 4½ T., 1-11/16 ins. in dia.; both are wound with No. 24 D.S.C. wire. The tickler consists of 5 T. No. 28 D.S.C., placed over the stator coil.

FIG. 48. (Radio-Craft, July 1929, p. 22.)
Two No. 1608 .00016-mf. variable condensers;
One No. 1613 .00025-mf. variable condenser;
One No. 906 rheostat, 6 ohms;
One No. 961 tapped resistor, 15 ohms;
Two special Super-Wasp shield cans, with all necessary mounting screws;
One No. J5 midget condenser, 5 plates, with special bakelite mounting strip;
Two No. 931 A.F. transformers;
Two No. 212 five-prong sockets (for plug-in coils);
One No. 758 3-megohm grid leak;
One No. 750 100,000-ohm grid leak;
One No. 50B fixed condenser, .0001-mf.;
Five No. 59 fixed condensers, .01-mf.;
One No. 130 R.F. choke coil;
Two sets of plug-in coils, made especially for the Super-Wasp.
(The parts listed are Pilot.)

Inductance L1 have the following values, for the secondary coils: Red, 4½ T.; orange, 9½ T.; yellow, 20½ T.; green, 46¼ T.; blue 128 T. The last coil has, in addition, a primary of 29 T., spaced about ⅛-in. from the secondary.

Inductances L2 have the following characteristics; (the first figure is the primary and the second is the secondary); Red, 4—3½ T.; orange, 6—7½ T.; yellow, 7—17¾ T.; green, 15—45¾ T.; blue 25—106 T.

Wind these on ribbed forms 1¾ ins. in dia. All the coils except the blue are wound with No. 24 D.S.C. wire; the blue coils are wound with No. 28 S.S.C. wire. The primary and secondary of L2 are spaced about ⅛-in.

FIG. 49. (Radio-Craft, February 1930, p. 387.)
One Hammarlund .00014-mf. variable condenser, Type ML-7, C;
One Hammarlund .0001-mf. midget variable condenser, Type MC-23, C1;
One Hammarlund equalizing condenser, Type EC-80, C2;
Three Sprague 0.1-mf. fixed condensers, Type F, C3, C4, C5;
One set of Hammarlund short-wave coils, Type SWC-3, and one special short-wave coil, Type SWT-120, L2, L3;
One Hammarlund radio-frequency choke coil, Type RFC 250, L4;
One Electrad Tonatrol, Type P, R;
One Yaxley 20-ohm mid-tapped fixed resistor, Type No. 820C, R1;
One Yaxley 4-ohm fixed resistor, Type No. 804, R2;
One Durham metallized grid leak, 2 to 9 megs., R3;
One Hammarlund knob-control drum dial, with light, Type SDW;
One Hammarlund adapter plug and cable, Type SWAP;

The coils are wound as follows: For the 20-meter band, L2, 4 T., L3 3 T.; 40 meters, L2 10 T., L3 5 T.; 80 meters, L2 21 T., L3 9 T.; 120 meters, L2 32 T., L3 15 T. The first three coils are wound with No. 16 S. S. C. wire; the fourth, size 18.

The first three coils are wound on a 2 in. tube; the fourth, 3 ins. in dia. The primary, used only in conjunction with the fourth coil, has 6 T. No. 18 S.S.C., wound on a form 1-13/16 ins. in dia.

FIG. 50. (Radio-Craft, August 1931, p. 91.)
Two National S.W. condensers, "Type S.E." 125 mmf., C1, C2;
One National equicycle condenser, 250 mmf., C3;
One Micamold molded fixed condenser, 150 mmf., C4;
Five Micamold molded fixed condenser, .01-mf., C5, C6, C7, C10, C11;
One 1-mf. bypass condenser, C8;
One 2-mf. bypass condenser, C12;
One X-L Variodenser, "Type N," C12;
One 2000-ohm fixed resistor, R1;
One 2-meg. grid leak, R2;
One 500-ohm fixed resistor, R3;
One 3-meg. grid leak, R4;
One Clarostat volume control, R5;
One Centralab Radiohm, 500,000 ohms, R6;
One 1800-ohm resistor, preferably variable, R7;
One Clarostat "Hum-Dinger" hum balancer, 20 ohms, R8;
One Silver-Marshall audio transformer "Type 225" or "255", AT;
One A.F. filter choke, 80 hy., AFC;
One filament transformer, 2½ volts, 6 amperes, FT;
One Hammarlund shielded, polarized S.W. choke, RFC;

The coils are wound on standard UY coil forms, 1½ ins. in dia.; No. 24 D.S.C. wire is used. The grid winding is at the top in each instance, with the tickler ⅛-in., or the primary ⅛-in. below.

Winding data: For 18.5 to 32 meters, coil L1, primary 5 T., secondary 6½ T.; coil L2, secondary 4¾ T., tickler 5⅓ T. For 31.5 to 52 meters, coil L1, primary 6 T., secondary 9½ T.; coil L2, secondary 8¾ T., tickler 6⅓ T. For 50 to 85 meters, coil L1, primary 7 T., secondary 18⅛ T.; coil L2, secondary 17½, tickler 8½ T.

FIG. 51. (Short Wave Craft, May 1932, p. 14.)
One Amrad vernier variometer No. 2610, 3;
One Aerovox 50 mmf. mica condenser, 4;
One Hammarlund 140 mmf. midget dual condenser, Type MCD-140M, 5, 10;
One Dubilier .01-mf. mica, shielded condenser, 6;
One 2,000 ohm, 1. watt resistor, 7;
One 30 mmf. neutralizing condenser, 9;
One 5-prong plug, with cable.

This police-wavelength converter is designed to plug into the first R.F. stage of any radio set, whether T.R.F. or superheterodyne. This converter operates on the superheterodyne principle; this, the broadcast set must be adjusted to a suitable intermediate frequency—try any setting between 250 and 500 meters.

At A are indicated the connections for 3-element tubes, such as '01A, '12A, '99, or '30; at B, the circuit design for tube types '24, '35, '51, or '36.

The tuning coil is in three sections, all are wound on one tube, 1 in. in dia. Coil A has 41 T., spaced ⅜-in. from B; latter coil, 20 T., 1/32-in. from C; this last coil has 35 T.; all are wound in the same direction, with No. 31 S.S.C. wire.

Variometer 3 consists of two fixed and two rotable spools, each one of which is wound with 11 T. No. 28 S. S. E. wire. The spools are 9/16-in. in dia. and ⅛-in. wide; the two rotors' clearance is 1/32-in. All four coils connect in series.

(Designed, constructed and tested by H. Gernsback and Clifford E. Denton, it works! And how!)

FIG. 52. (Radio-Craft, October 1929, p. 178.)
Inductances L1 and L2 are the standard windings, which constitute one of the coils of a short-wave kit. The 5-prong plug is a standard tube base. Resistor R is a grid leak wih a value of about 3 megohms or more. Condenser C4 is of .00025-mf. capacity. Condensers C2 and C3 are the usual tuning and regeneration units, the capacities of which are determined by the particular set of short-wave coils decided upon. The antenna coupling condenser, C1, is very necessary and has a value of about .0001-mf. The grid condenser, C, is .00015-mf.

FIG. 53. (Radio-Craft, October 1931, p. 228.)
One Hammarlund midget condenser (the antenna series unit), 100 mmf.;
Two Pilot condensers—one 8- and one 13-plate—C, C;
Two Twin-Coupler R.F. chokes, SWC;
One National No. 10 impedance, L1.

The bypass condensers are rated at 300 volts D.C. In lieu of the National units as L1, the designer of the circuit recommends winding 222 T. No. 30 D.S.C. wire on a bakelite form ½-in. in dia.

Unit L2, for 17 to 110 meters, consists of three coils; tube bases are used. Winding data: Coil 1, secondary 7 T., tickler 4 T.; coil 2, secondary 14 T., tickler 7; secondary wire, No. 22 D.C.C., tickler, No. 30 D.C.C., both wire-spaced. Coil 3, secondary 26 T. No. 26 D.C.C., tickler, 13 T. No. 30 D.C.C.; windings close-wound.

FIG. 54. (Radio-Craft, July 1931, p. 23.)
A self-powered converter for a band from 14 to 200 meters, which connects to the broadcast receiver only at the antenna post. The power pack follows standard design. Tube V1 is biased by a 350 ohm resistor, bypassed by 0.1-mf.; V3, 300 ohms and 0.1-mf.

Additional values: Tuning condenser, 135 mmf.; oscillator condenser, 150 mmf.; RFC 2, RFC 3 and detector grid coupling condensers, 100 mmf. (each); 50-volt bypass, .002-mf.; 75-volt bypass, 0.1-mf.; plug-in coils are used.

FIG. 55. (Radio-Craft, June 1931, p. 734.)
Two versions of short-wave converter design; at A, a battery design, and; at B, a self-powered A.C. circuit.

Plug-in coils have been obviated, for the tuning range of 20 to 110 meters; the recommended I.F. is 190 to 200 meters.
Coils L1, L3, L4, 275 T. No. 40 enam., on a bakelite tube ⅝-in. in dia. L5, standard broadcast R.F. choke.

FIG. 56. (Radio-Craft, October 1931, p. 224.)
Two Hammarlund 200-mmf. midget condensers;
One National "Type G" dial, clockwise movement;
One 2½-volt filament transformer, and one 30-henry filter choke, not over 2⅞ inches high;
Two R.F. chokes, 65-millihenry;
One Lynch 50,000-ohm, 2-watt resistor, and one Lynch 2-meg. grid leak;
Two Aerovox 4-mf. electrolytic condensers, with mounting rings;
Five Aerovox fixed condensers: two .0002-mf. midgets; two .0005-mf., one .002-mf.;
One Yaxley 6-point change-over switch;
The recommended I.F. is 480 meters; converter range, 14 to 197 meters.
Coil data: Range, 14 to 26 meters, L1, L2, L3, 3 T. each; 25 to 52 meters, L1 7 T., L2 6¾ T., L3 6 T.; 50 to 106 meters, L1 18 T., L2 16 T., L3 9 T.; 100 to 197 meters, L1 46 T., L2 40 T., L3 18 T. Use Pilot plug-in forms; L1 on one set, L2-L3 on another; use No. 24 D.S.C. Space L2-L3 3/16-in.

FIG. 57. (Television News, March-April '32, p. 24.)
Four coils; Two antenna, 1L, 2L; two detector, 3L, 4L;
Five 30 hy. chokes, 5L to 9L;
Two .00035-mf. variable condensers, 1C, 5C;
One trimmer condenser, 2C;
Four 0.1-mf. condensers, 3C, 4C, 7C, 8C;
Two 1. mf. condensers, 6C, 10C, 11C;
One 2 mf. condenser, 12C;
Four 4 mf. condensers, 13C, 14C, 15C, 17C;
One 8 mf. condenser, 16C;
One 0.1-meg. potentiometer, P1;
Two 1. meg. resistors, GL1, 10R;
One 1,000 ohm resistor, 2R;
One 0.5-meg. resistor, 3R;
One 50,000 ohm resistor, 4R;
One 0.2-meg. resistor, 5R;
Two 20 ohm center-tapped resistors, 6R, 11R;
One 500 ohm resistor, 12R;
One 2,000 ohm variable resistor 13R;
Six tubes: Two type '24, V1, V2; one '45, V3; one '47, V4; one neon lamp, V5; one '80, V6;
One power transformer, (with two 2.5 volt windings, one winding suitable for supplying the dial light, one 5 volt winding, and a high-voltage secondary, 350 volts each side of the center-tap), T1.
Coil data—television band: Winding 1L, 14 T.; 2L, 28 T., on a tube 1½ ins. in dia.; spacing, ¼-in. Winding 3L, 40 T., on a tube snugly fitting inside secondary; 4L, 28 T. on a tube 1½ ins. in dia.; Use 28 S.S.C. wire.
Coil data—broadcast band: Winding 1L, 20 T.; 2L, 105 T. Winding 3L, 40 T.; 4L, 105 T.; same specs. as above for wire and forms.
In both instances, sliding 3L to a different position will re-determine the degree of selectivity; to a lesser degree, it may be necessary to change the spacing of 1L-2L for the same reason.
This circuit won a contest prize.

FIG. 58. (Television News, March-April '32, p. 32.-

FIG. 59. (Radio-Craft, July 1930, p. 32.-
Two .00035-mf. Hammarlund "midline" variable condensers (4, 9);
One Remler antenna coupler, interchangeable inductance No. 550 (2);
One Remler interchangeable inductance, No. 612 (13);
Three Remler interchangeable inductances No. 614 (17, 22, 32);
One Remler oscillator inductance, No. 570 (8);
Three 1000-ohm Electrad "Truvolt" flexible wire resistors (27, 28, 29);
One Electrad "Royalty" Type "B" potentiometer (14) with filament switch attached (40);
Two Silver-Marshall R.F. chokes, Type 276 (12, 14A);
One .001-mf. Dubilier mica condenser, (34);
Ten .006-mf. Dubilier mica condensers, (11, 17A, 18, 19, 22A, 23, 24, 30, 31, 32A);
One Thordarson A.F. transformer, Type R-300 (35);
One .00025-mf. Micamold grid condenser (6);
One 2 meg. Durham metallized resistor (5);
Three 2 meg. Durham metallized resistors Type MF4-2 with tinned-wire pigtail leads (17B, 22B, 32B);
Three Amperites, No. 1-A (7A, 10A, 33A);
Six Amperites, No. 120 (16, 16A, 21, 21A, 26, 26A);
One Amperite, No. 112, with mounting (39);
Coil data: Inductance 2, primary 17 T. No. 38 enam. wire; secondary, 110 T. No. 30 enam., spaced 1/16-in. from primary and on a tube 1¼ ins. in dia. Inductance 8, grid winding 80 T., separated 1/16-in. from plate winding of 54 T.; both wound with No. 30 D.S.C. wire on a tube 1¼ ins. in dia. Over the grid coil is wound a 10 T. pickup coil.
The I.F. coil 13 has a primary of 85 T., wound over the filament end of a secondary of 350 T. No. 40 D.S.C. on a tube 2 ins. in dia., the same as 17, 22 and 32; all four "secondaries" are shunted by Type G-5 (500 mmf., max.) Variodensers, for 115 k.c.

FIG. 60. (Radio-Craft, July 1931, p. 33.)
One Hammarlund "battleship" Type 4-gang, .00035-mf. variable condenser, C1, C2, C3, C4;
Nine Aerovox 0.1-mf. rectangular-type bypass condensers, C5, C6, C7, C8, C9, C10, C11, C12, C13;
Three Concourse 1-mf. 200-volt rectangular-type condensers, C14, C16, C18;
One Dubilier .001-mf. mica fixed condenser, C15;
Two Dubilier .01-mf. mica fixed condensers, C17, C19;
One Electrad "Tonatrol" 50,000-ohm potentiometer, R1;
Three Electrad 400-ohm flexible, wire grid resistors, R2, R4, R6;
Four Durham 50,000-ohm "metallized" 1-watt resistors, R3, R5, R7, R12;
Two Durham 10,000-ohm "metallized" 1-watt resistors, R8, R13;
One Durham 0.1-meg. "metallized" 1-watt resistor, R9;
Two Durham 0.25-meg "metallized" 1-watt resistors, R10, R11;
One 7-wire cable, 1, 2, 3, 4, 5, 6, 7;
Four shielded R.F. transformers for .00035-mf. tuning condensers, L1 antenna, L2, L3, L4 radio-frequency;
Four Dubilier .00004-mf. mica fixed condensers, C;
Four 85-mh. R.F. chokes, RFC1, RFC2, RFC3;
Four Cunningham Type C-336 6.3-volt screen-grid tubes, V1, V2, V3, V4;
One Cunningham Type C-338 6.3-volt pentode tube, V5;
One Blan aluminum chassis, 7 x 16 x 3 ins. high;
One Carter or Federal automotive remote control unit.

FIG. 61. (Radio-Craft, September 1932, p. 167.)

FIG. 62. (Radio-Craft, September 1931, 6. 142.)
(See also the June 1931 issue, p. 724, for picture representation, F.)

FIG. 63. (Radio-Craft, November 1931, p. 288.)

FIG. 64. (Radio-Craft, January 1932, p. 414.)
(AMPLIFIER)
One Jewell, 0-50 ma. milliammeter, M1;
One Thordarson microphone transformer, T1;
One Sangamo 1st stage A.F. transformer, T2;
One Sangamo push-pull input transformer, T3;
One Sangamo push-pull output transformer, T4;
Two Electrad 20,000-ohm resistors, R2, R5;
Two Electrad 1,000-ohm resistors, R3, R6;
One Electrad 30,000-ohm resistor, R4;
One Electrad 50,000-ohm resistor, R7;
One Electrad ¼-meg. potentiometer; R8;
One Electrad 10,000-ohm potentiometer, R9;
One voltage divider, R10;
One Aerovox 2-section condenser unit, 2 mf. and 200 V. (per section), C1, C3;
One Aerovox 2-section condenser unit, 2 mf. and 400 V. (per section), C2, C4;
One Aerovox filter condenser block, 2, 4, 8 mf., respectively, C7, C8, C9;
Two Thordarson filter chokes, (300 ohms, or less) CH1, CH2;
One Thordarson power transformer, PT1;
One carrying case, 9 x 12 x 18 ins.
(TURNTABLE AND LEVEL-INDICATOR CASE)
One Electrad ¼-meg. potentiometer, R12;
Two Electrad 50-ohm resistors, R14, R15;
One Akra-Ohm 10,000-ohm resistor, R16;
One Electrad 10,000-ohm potentiometer, R13;
One turntable and feed-screw, TT1;
One Jewell, 0-5 ma. milliammeter, M2;
One carrying case, 9 x 13 x 18 ins.
Designed by George J. Saliba for Ampec Engineering Laboratories.

FIG. 65. (Radio-Craft, October 1930, p. 218.)
Two Yaxley "No. 702 Junior" closed-circuit jacks (J1, J2);
One Stromberg-Carlson "No. 15" phone plug, (F);
One Universal "Model KK" double-button microphone, with stand and 12-ft. cable (M);
One Amertran "No. 923" microphone trans.; (pri., 100 ohms each side of center-tap; sec., 6,000 ohms) (T1);
One Electrad poten., 400 ohms, with switch (R1);
One Electrad Type E resistor, 500,000 ohms (R2);
One Amperite "No. 4V-99" (R3);
One Weston "Model 506" milliammeter, 0-15 ma. (MA);
One Flechtheim 2-mf. bypass condenser (C);
One tube base, 4- or 5-prong; 4-ft. twisted wire (D);
One Hubbell plug and receptacle, polarized (E);
Two Burgess "No. 4156," 22½-volt "B" blocks ("B");
Three Burgess "No. 6" dry cells ("A");

FIG. 66. (Radio-Craft, November 1930, p. 273.)
One 150-turn honeycomb coil (for filtering);
One audio filter choke (made by winding about ½ lb. No. 18 D.C.C. wire on an old transformer core);
Two ¼-meg. leaks;
One Dubilier .0005-mf. fixed condenser;
One 2-mf. Dubilier bypass condenser;
Two porcelain screw-base lamp sockets;
One Amertran push-pull A.F. input transformer, T3;
Two fused receptacles and 10 amp. fuses; one outlet.

FIG. 67. (A, Radio-Craft, July '31, p. 25; B, Aug., p. 97.)
The circuit at A is the Loftin-White Type A-245, PT is rated at 40 ma. at 475 V., A.C. (each side of center-tap). Circuit B calls for a filter output of 41 ma. at 435 V. Resistors must be of accurate, high-watt type.

FIG. 68. (Radio-Craft, January 1932, p. 415.)

FIG. 69. (Radio-Craft, October 1930, p. 222.)
Two Aerovox 2,000 mf. dry electrolytic "A" condensers, C1-C2;
Two Todd Type C2 chokes, 2-amp., ¼-henry, L1-L2;
One 7-ohm Todd special heavy-duty resistor, R5;
One Todd special relay, L5;
One Flechtheim "B" condenser bank, 450-volt rating: 2-2-8-1-1-mf., C-3, 4, 5, 6, 7, respectively;
One Flechtheim 4-mf. fixed condenser, 450-volt, C8;
Two Todd type C30 chokes, 30-henry, 85-milliamp., L3-L4;
One Electrad "Truvolt" 5,000-ohm variable resistor, R1;
One Electrad "Truvolt" 8,000-ohm adjustable resistor, R2;
One Carter "Midget" type-MW heavy-duty (2-amp.) 6-ohm rheostat, R3;
One Frost 30-ohm rheostat, R4;
One Readrite 0-8-scale voltmeter, V;
Two Cutler-Hammer power toggle switches, S1-S2;
Two 3-amp. fuses, F, with porcelain sockets.
Uses lamps, as shown, or Ward-Leonard Type 507 screw-base resistors to control filament current. The relay is a protective measure.

FIG. 70. (Radio-Craft, December 1931, p. 344.)
(Refer also to the later comments by Mr. Jarowey, in the May 1932 issue, p. 674, and July, p. 38.)

FIG. 71. (Radio-Craft, August 1931, p. 75.)
Resistors R1 to R5 may be set to correct value for the particular receiver with which the pack is to be used; thus, a single 25,000 ohm voltage divider, with four sliding contacts, may be used. This is the Pilot "A-B-C" power supply unit; secondary, rectified output rating, 125 ma. at 300 V.

FIG. 72. (Radio-Craft, February 1930, p. 364.)

FIG. 73. (Radio-Craft, May 1931, p. 655.)
Two Silver-Marshall plug-in long-wave coils, Type 111-E (1, 6);
Two Silver-Marshall coil sockets, Type 515;
One Silver-Marshall illuminated drum dial, Type 810-L (9), with 2½-volt dial light (9A);
One Silver-Marshall midget condenser, Type 342 B (12);
Two Thordarson choke units, Type R-196 (21, 27);
One Thordarson autoformer, Type R-190 (22);
One Thordarson power-supply transformer, Type R-280 (34);
One Thordarson filament transformer, Type T-3660 (36);
One Electrad "Royalty" variable grid leak, potentiometer Type O (24);
One Electrad "Truvolt" resistor, Type C 130 S (33);
Two Flechtheim midget fixed condensers, .00025-mf., Type M-C, and two .0001-mf., Type M-A, to give two .00035-mf. capacities (2, 11);
Two Flechtheim midget condensers, .0001-mf., Type M-A (19, 19A);
Four Amperites, No. 227, (39, 40, 41, 42);
Four Durham "Powerohm" metallized resistors; three 2,000-ohm (4, 14, 25) and one 50,000-ohm (16);
Four Flechtheim bypass condensers: Two 0.5-mf., Type B-50 (3, 3); and two 1-mf., Type B-100 (15, 20);
One Flechtheim midget coupling condenser, .01-mf., Type M-K (23);
One Flechtheim filter condenser, 4-mf., Type F401 (28);
One Flechtheim condenser block, Type F14 (35—used as 2-2-4-mf.).

FIG. 74. (Radio-Craft, August 1929, p. 68.)
RECEIVER
Antenna series coupling condenser, ½-sq. in. plates; G, grid leak 2 megs. and condenser .00025-mf.; At, antenna coil, 7 T. bell wire, "over one, skip one," on 11 nails in a 3 in. circle; Rg, regeneration coil, 9 T.; S, fil. switch; A, 4½ V. "C" battery; B, 45-V. "B" battery; C1, 5-plate variable condenser; C2, 11-plate variable condenser; T, three type '99 tubes; Tr, two 3½ to 1 transformers; J1, double-circuit jack; J2, filament-control jack; R, filament rheostat, 125 ohms.
TRANSMITTER
At A, a 4½ V. "C" battery; B, 67½ V. "B" battery; Cg and Cp, two .00025-mf. variable condensers, 9-plate; Cs, .001-mf. mica condenser; Lg and Lp, 7T., each, No. 12 bare copper wire, 3 ins. in dia.—turns spaced ¼-in., and coils 2 ins., La, antenna coupling coil, 5 T.; the tube is a type '99; R1, 5,000 ohm grid leak; R, fil. rheo., 125 ohms; two R.F. chokes, RFC, 40 T. No 22 D.C.C., "over one, skip two," on 8 nails in a 1¾ ins. circle; RFC, two 40 T. R. F. chokes; K, key; Al, antenna indicator; DT, D.P.D.T. switch; F, fil. switch.

FIG. 75. (Radio-Craft, April 1931, p. 613.)
One General Electric 115-volt Type SD, compound wound motor, 1,725 r.p.m., (28 segments) 1/6-h.p., 2 amps.;
Twenty-four Radio Trading Company, No. 1703 replacement condensers, 1 mf. each;
Two General Electric porcelain fuse blocks, F1, F2; and two 2-amp. fuses;
Two General Electric porcelain screw-type plug receptacles, R1, R2;
Four pounds No. 21 cotton-enameled copper wire (for filter chokes and auto-transformer primary);
One pound No. 18 cotton-enameled copper wire (secondary of auto-transformer T);
The chokes at A and B are wound on a tube 1 in. in dia., one coil over the other; those at A may not be needed.
The auto-transformer T, at C, has a primary of 400 T. No. 21 cotton-enam. on a form 1⅛ ins. sq. and 2 ins. long; about 72 silicon-steel laminations 1/65-in. thick fit into this space. Over the primary 3 layers of Empire cloth are wound, and in the same direction, 225 T. No. 18 cotton-enam., tapped at 150, 175 and 200 T.
A 15 W. lamp in series with the shunt field speeds the specified motor from 1725 to 3600 r.p.m.

FIG. 76. (Radio-Craft, April 1932, p. 614.)

FIG. 77. (Radio-Craft, April 1932, p. 610.)
Adjust the value of rheostat R3, filter resistor R4, and the filament potential to suit the tube V1.

FIG. 78. (Radio-Craft, April 1931, p. 612.)
Parts used: One All-American Type R-21 A.F. transformer, T; one type '99 tube, V; one 60-ohm rheostat, R; one fixed condenser, .001-mf., C.

FIG. 79. (Radio-Craft, July 1931, p. 10.)
Values of components: Resistor R1, 500 ohms, tapered R2, R3, 60,000 ohms; R4, 42 ohms; R5, 300 ohms; R6, 1,591 ohms. Condenser C1, 500 mmf.; C2 to C6, .01-mf.
With S1 open A.F. modulation is obtained.
All forms are ½-in. in dia. and wound with No. 30 ins. wire. All chokes, 700 T., 11/32-in. wide. Coils L1-L2, 660 T., center-tapped and 7/16-in. wide (inductance, total, 6.2 mhy.); L3, 6 T.

FIG. 80. (Radio-Craft, March 1931, p. 545.)
Resistor R1, 25 ohms; R2, 30 ohms; the tube is a '32. A standard "antenna" R.F. transformer may be used, thus dispensing with the antenna series condenser. Screen-grid bypass condenser, .25-mf.; plate R.F. choke, 85 mhy.; plate coupling condenser, mica, .006-mf. The completed unit connects to the antenna post on a radio set.

FIG. 81. (Radio-Craft, February 1932, p. 467.)
Four Clarostat duo-type 300-ohm constant-impedance pads (Clarostat);
One Weston 0-50-ma. meter;
Three 200-ohm variable resistors;
Three Aerovox 25-mf. electrolytic condensers;
One Aerovox 2-mf. condenser Type 207;
One 4-mf. Aerovox condenser (electrolytic);
Three microphone mixing transformers 200-ohm input and 200-ohm output;
One matching transformer 500-ohm input to grid of type 230 tube.
One impedance-matching transformer input from plate of type UX 230 to 200-ohm output;
One 20-ohm resistor (variable);
Five "on-off" switches; six 2-way;
One 45-V. Burgess "B" battery; one 4½ V. "C", and; two No. 6 dry cells.

FIG. 82. (Radio-Craft; A. Dec. 1931, p. 336; B, Feb. 1932, p. 409; C, Nov. 1931, p. 274.)
For potassium cells, R is 10 megs. and the "B," 135 V., approx.; for caesium, 2 megs. for R and 90 V. for "B."

FIG. 83. (Radio-Craft, June 1932, p. 731.)

One Pilot Universal "B" eliminator transformer, or similar unit delivering 5.5 V. at 2 A.; also, 275 V.;
Four switches; One D.P.D.T., Sw.1; one S.P.S.T., Sw. 3; one S.P.D.T., Sw. 4; one push-button, Sw. 5;
Two 6 volt pilot lamps and sockets, P.L.;
One Giant Power variable resistor, 60 ohms, R;
One 1,000 ohm resistor, R1;
One 2,000 ohm resistor, R2;
One 3,000 ohm resistor, R3;
Two sockets; one UX and one UY;
One Readrite double-scale milliammeter, 0-20 and 0-100, ma.;
One Readrite A.C. voltmeter, 0-10 V., V.

All types of tubes may be tested for mutual conductance, emission and shorts.

FIG. 84. (Radio-Craft, May 1931, p. 679.)

A bell-ringing transformer T of sufficient rating is required.

FIG. 85. (Radio-Craft, May 1932, p. 670; August 1932, p. 106.)

The capacity of the broadcast and int. tuning condenser is .0005-mf.; I.F. loading condenser, .0005-mf.; grid condenser, .001-mf.; feedback condenser, .001- or .002-mf. The value of R1 is 0.1- to 1. meg., depending upon the tone desired. The broadcast coil form is 1¼ in. in dia. and contains 100 turns of No. 24 wire, center-tapped; the I.F. tuning coil is 1¼ in. in diameter and contains 485 turns of No. 34 wire, center-tapped; the value of the R.F. choke is 85 mhy.; the pickup coil contains 15 turns of No. 34 wire wound ¼-in. from the grid end of the I.F. tuning coil.

This is the Readrite No. 550 service oscillator.

FIG. 86. (Radio-Craft, January 1932, p. 406.)

This circuit was developed by the engineers of Shallcross Mfg. Co.

FIG. 87. (Radio-Craft, May 1932, p. 667.)

FIG. 88. (Radio-Craft, December 1931, p. 377.)

Winding data: Coil L1, primary 15 T.; secondary 70 T.; coil L2, vice versa. Form, 1¾ ins. in dia.; wind with No. 28 enam.; variable condensers, 500 mmf., shunted by trimmers.

FIG. 89. (Radio-Craft, September 1931, p. 164.)

The A.F. choke is a center-tapped unit, an Amertran No. 641 A. F. choke, 200 hy. each side of the center-tap.

FIG. 90. (Radio-Craft, May 1932, p. 659.)

The meters are Weston Model 506. The voltmeter reads 0-8 and 0-200 V., D.C.; the milliammeter has a range of 0-15 ma. The values of the shunts and multipliers must be adjusted to suit individual meter requirements. The circuit arrangement shown is convenient for making simple tube and circuit tests, taking voltage and current readings in a circuit, measuring resistors, and for making continuity measurements.

FIG. 91. (Radio-Craft, April 1932, p. 614.)

FIG. 92. (Radio-Craft, March 1932, p. 533.)

One inexpensive A.C. double-range voltmeter, 0-10-140 volts;
One resistor to increase the 10-volt range to 140 volts A.C., R2;
One resistor to increase the 140-volt range to 700 volts A.C., R1;
One inexpensive 4.5-volt, 10,000-ohm resistance meter;
One resistor to increase the ohmmeter range to 50,000 ohms, R3;
One resistor to increase the 4.5-volt range to 90 volts D.C., R4;
One resistor to increase the 90-volt range to 450 volts D.C., R5;
Two miniature flashlight-bulb porcelain receptacles;
One 1.25 V. and one 2.2 V. flashlight bulb;
One .001-mf. condenser, C1;
Two 1-mf. condensers, C2;
One .02-mf. condenser, C3;
One strip white cardboard 1 x 12 ins.; 19 tip-jacks;
One rubber panel 7 x 14 ins.;
One 110-volt porcelain receptacle; plug for same;
One roll hook-up wire; 5 ft. lamp cord.

FIG. 93. (Radio-Craft, June 1932, p. 716; October 1932, p. 229.)

At A is illustrated the receiver, which incorporates the following units: Two Hammarlund 250 mmf. midget variable condensers, C, C1; one Dubilier 250 mmf. fixed condenser, C2; one Dubilier 500 mmf. fixed condenser, C3; two Dubilier .5-mf. fixed condensers, C4, C5; one 2-megohm resistor, R1; one 2½-ohm resistor, R2; one 0-100,000-ohm variable resistor, R3; one Air King or Gen-Win plug-in type, 100-200 meters, R.F.T.; one 3½ to 1 audio-frequency transformer, A.F.T.; 1 switch, SW.

At B is shown the circuit arrangement of the transmitter, the components of which have the following values; Condensers C, (variable) and C1, (fixed), 250 mmf.; C2, .5-mf.; R, 1 megohm; R1, 15 ohms.

The two box-type loops are made by winding 10 T. bell-wire on a frame each 15 x 15 x 3 ins. wide; the transmitter-loop is center-tapped. The receiver-loop is mounted (directional into the earth) on one end of a 5- or 6-foot carrying stick; the transmitter-loop (directional toward the receiver-loop—therefore, parallel with the ground) is mounted on the other end; the latter loop is so mounted that it will swing freely as the stick is tilted with respect to the ground. Balance for minimum sound: metals then are indicated by a change in the tone (which has been pre-determined partly by the particular value selected for transmitter grid-leak R).

The constants of the R.F transformer, R.F.T., may be approximated by winding 30 T. No. 30 cotton-enam. on a tube base, for the secondary; and for the primary, spaced two turns, 15 T. of the same size wire; this will cover the 100 to 200 meter band assigned for this type of "work."

This "treasure" finder was approved only after it was demonstrated that the presence of a metal object about 1 ft square and 6 feet distant could be indicated by a change of tone in the headphones.

The "A" potential is 2 V.; the "B", 90 V., both for transmitter and receiver.

FIG. 94. (Radio-Craft, May 1932, p. 654.)

Shunts R1, R2 connected into circuit via added wire X, multiply a meter's range.

FIG. 95. (Radio-Craft, May 1932, p. 674.)

Transformer T is an auto spark-coil, rewound to have 100 T. No. 22 D.C.C., for the primary and 4,000 T. No. 32 enam. for the secondary.

FIG. 96. (Radio-Craft, October 1931, p. 226.)

FIG. 97. (Radio-Craft, A, B, D, June '31, p. 741; C, E, F, Sept. '31, p. 172.)

The slide-wire is a 40 in. length of No. 24 to 28 B. & S. gauge constantan resistance wire.

FIG. 98. (Short Wave Craft, Feb.-Mar. 1932, p. 314.)

A—POWER AMPLIFIER

Condenser C1, .001-mf., 1,000 V.; C3, 250 mmf., 1,000 V.; C5, double-section G.R. condenser, 500 mmf. per section; C6, 1. mf., each; C7, 23-plate midget, double-spaced, for neutralizing; C8, 250 mmf., each, antenna tuning units. Resistor R4, 0 to 0.1-meg., Bradleyohm.

Plate coil L5 must carry the plate D.C. and also the R.F. current. Obtain a one-foot section of gas pipe 2½ ins. in dia. and drill at one end a hole which is a slip fit for a 5/32-in. bolt. Flatten and drill, for a 5/32-in. bolt, a length of 3/16-in. or ¼-in. copper tubing. Bolt the tubing to the pipe and close-wind the copper tubing on the pipe form, by turning the pipe in a vise; to space, run a screw-driver between the turns. Mount on stand-off insulators spaced 4½ ins. (for all coils). For 3½ megacycles, 20 T. of 3/16-in. tubing will be about right; 7 megacycles, 12 T., ¼-in. tubing; 14, 6 T.

When the circuit of A is used as an amplifier the grid coil L4 functions as a grid choke and its constants are not critical. For 3.5 megacycles, wind 48 T. No. 20 D.C.C. on a tube base, connecting the two outside leads to the filament prongs, and a tap from the exact center to the plate prong; 7 megacycles, 24 T.; 14, 12 T. Polish the tubing and paint with Duco to reduce skin effect.

If any changes are made in the number of turns, or the diameter or size of wire, the coil must be brought into resonance in the following manner: Open S1 and reverse S2 so that the last stage is operating as an oscillator. Turn C5 until milliammeter shows the lowest reading and, if this occurs with the condenser at maximum, remove a turn or two from L4 and try again. If the dip occurs with the condenser at minimum, add a turn or two; repeat this test until the drop in plate current occurs at a frequency just at the top of the band in which the coil is to be used.

The switch S1 is closed and S2 thrown so that the center-tap of L4 goes to the "C" bias battery, when using this stage as an amplifier. If it is desired to use this as a self-controlled oscillator, merely open S1 and reverse S2. In this way it is possible to obtain operation anywhere in the band without buying a flock of crystals.

Condensers C6, of 1. mf., should eliminate key clicks. Use C1 only to prevent arcing across C5.

For 3.5 megacycle work the two excitation clips leading to the grid of the last stage are connected to opposite ends of the oscillator inductance, and both doubler tubes are removed from their sockets. Insert correct coils as L4, L5. See that the amplifier is correctly neutralized before the plate voltage is applied, when operating on the fundamental of the crystal.

For 14 megacycle operation, both doublers are used, with number two feeding the amplifier. The antenna for this 20-meter work may be a zeppelin voltage-feed system consisting of a single wire 32 ft. long, fed by two 15-ft. feeders spaced 6 ins.

B—FREQUENCY DOUBLERS

Condenser V1, .001-mf., 1,000 V.; C2, 250 mmf., variable; C3, 250 mmf., mica, 1,000 V.; C4, .001-mf., mica.

The two frequency doublers are somewhat similar to the oscillator, except for the grid circuit. Batteries "C" are 135 V.; they may be common with both doublers and the power amplifier.

The first doubler which serves also as a buffer has a tank coil L2 identical to L1 in the oscillator, Fig. 98E, when working in the 3.5 megacycle band. In this case the tube in the second doubler is removed from the socket and the two clips feeding into the grids of the power amplifier are clipped at opposite ends of L2. For 7 megacycle work, L2 has 20 T. No. 20 D.C.C., 1⅜ ins. in dia.

Coil L3 is the tank in the second doubler stage. Since this stage is only used for 7 and 14 megacycle work, no 80-meter or 3.5 megacycle coil is needed. For 7 megacycles, use 20 T. No. 20 D.C.C., 1⅜ ins. in dia.; for 14, 12 T.

C—MODULATOR UNIT

Condenser C1, 1. mf., 1,000 V. Resistor R1, 1,500 ohms, variable (must pass 200 ma.); R2, Clarostat (to reduce "B" to 180 V. for the type '27 tube); R3, 2,000 ohms. Unit T1, double-section 30 hy. choke, each 150 ma.; T2, A.F.T., about 5 to 1 ratio; T3, microphone-to-tube transformer.

D—POWER SUPPLY UNIT

The filter condensers should have a working rating of 1,000 V. The filter choke should be rated at 250 ma.; its insulation should be high. The fuses are ¼-A. rating (a flashlight bulb will serve).

E—OSCILLATOR

Condenser C1, .001-mf.; C2, 250 mmf., variable; C3, 250 mmf., mica, 1,000 V. Resistor R1, 48,000 ohms (field resistor); R2, 40 ohms, center-tapped; R3, Clarostat, 40-watt rating.

Oscillator tank coil L1, 34 T. No. 22 D.S.C., (2½ ins. long), 1⅜ ins. in dia. This tank circuit will resonate at any frequency in the 3½ megacycle band. Should the oscillator "spill," move the clip towards the center.

Quartz crystal XTL has a fundamental between 3,500 and 3,600 kc.

GENERAL

All the R.F. chokes, R.F.C., consist of 150 T. No. 30 enam., random-wound in three slots ⅛-in. wide and deep, in a dowel ¾-in. in dia.; the slots are separated 1 in. (There are 50 T. per slot.) Dip the completed choke in Duco; dry, and dip again.

Assuming the transmitter to be correctly wired, the final step is to tune the several stages.

The oscillator milliammeter will drop sharply when the tank condenser of that stage is tuned to resonance with the crystal. Care should be taken to see that no more than 250 volts is applied to this stage, or injury to the crystal may result. Voltage regulation is secured by means of R3. A flashlight bulb, in circuit with one turn of wire, if brought close to the inductance will indicate circuit oscillation; also, the milliammeter of the first frequency double until excited by the oscillator will indicate 5 ma. or less.

After the oscillator is operating, clip the two excitation leads of the power amplifier onto the first frequency doubler, remove the tube from the second one, and tune the tank of the first doubler until the milliammeter shows a dip. The flashlight bulb should light when held close to L2, if the tank is tuned to a harmonic. With the correct coils in L4 and L5 for the 7,000 kc. band, tune C5 with the key open until the flashlight bulb lights when held close to the tank coil, L5. Then to neutralize, condensers C7 are rotated together until the light disappears.

The bulb may now be removed and the key closed. Condenser C5 should then be readjusted carefully for minimum plate current; if everything is operating correctly the plate current will be from 40 to 80 ma.

The antenna is coupled to the amplifier and brought into resonance by means of C8 and the clips on L6. The same number of turns should be used in each antenna coil, thus providing an ideal coupling system for a zeppelin-type antenna.

The final, and very necessary adjustment (especially when using the last stage as a straight oscillator, since the antenna current is increased by as much as ¼-A.) is to vary R4 for maximum antenna current.

FIG. 99. (Radio-Craft, February 1932, p. 466.)

One Weston Model 301, 0 to 200 microamperes, or Jewell microammeter, M1;
Three power switches, Sw2, Sw3, Sw4;
One three point, single-throw power-switch, SW1;
One Electrad Supertonatrol, 0 to 500,000 ohms, R3;
One Yaxley midget 100-ohm potentiometer, R2;
One Lynch or Shallcross wire-wound precision resistor, 200,000 ohms, R1;
Two Sprague or Aerovox, 1-mf. fixed condensers, C2, C3;
Three Sprague or Aerovox, 0.1-mf. fixed condensers, C1;
One 12-in. length hollow BX tubing, gooseneck;
One empty "Mennens" talcum powder can, to shield V1;
One Blan aluminum panel 4¼ x 12 x ⅛-in. thick.
One Blan aluminum sheet 2 x 6½ x 1/16-in. thick; for wafer socket support;
Two tubes; one '36, V1 and one '37, V2;
Six portable 22½-volt "B" batteries, Burgess type 4156, B2;
Two 4½-volt "C" batteries, B4, B5;
Two 1½-volt flashlight cells, B1 and B3;
Four No. 6 dry-cell batteries in metallic container for filament supply, B6.

FIG. 100. (Radio-Craft, March 1932, p. 523.)

Transformers T1 and T2 must be types designed for class B operation. A type '45 tube drives the 46 to an undistorted power output of 8 watts.

FIG. 101. (Radio-Craft, January 1932, p. 410.)

One A.C. outlet socket;
Three 5-hole and four 4-hole tube sockets;
One meter (used 0-5 ma.; recommend 0-1 ma.);
One phone jack; seven pin jacks; two push buttons;
Four D.P.S.T. push button switches;
Two D.P.D.T. jack switches (Sw. No. 1 and No. 2);
One power transformer made out of old Freshman transformer;
One rheostat 200—250 ohms R1;
One 400-ohm resistor R8;
Two 10,000-ohm resistors R1 and R2;
One 40,000-ohm resistor R3;
One 60,000-ohm resistor R4;
One 2250-ohm resistor R5.

Four sets of leads are required as follows: An A.C. 2-wire cable terminating in plugs at either end; a set of test leads, comprising two wires terminating in plugs; a screen-grid test lead terminating in a screen-grid clip at one end and a panel plug at the other; and a standard 5-wire analyzer cable.

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